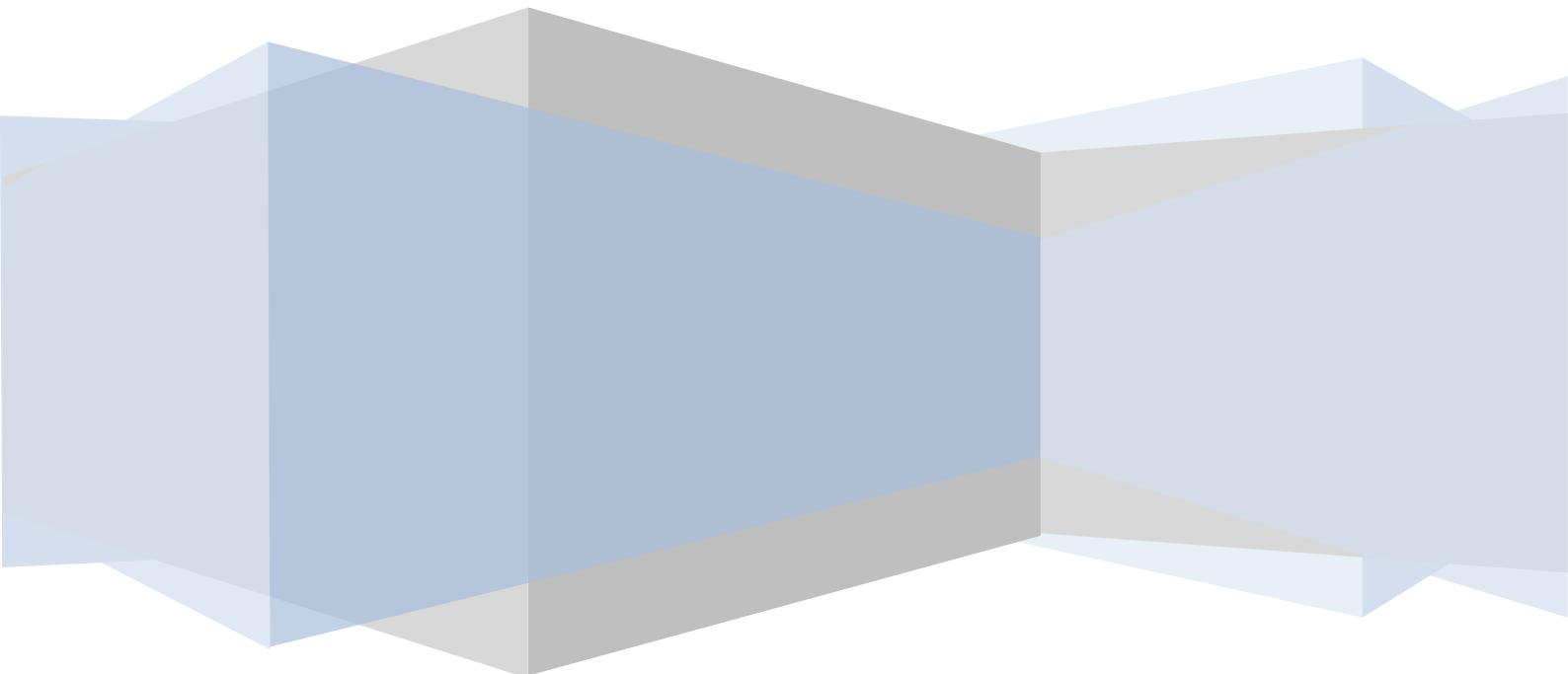


The University of Auckland

# Okahu Bay Restoration

Summer Studentship 2013

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## Abstract

Okahu bay is a central site to the local hapu – Ngāti Whātua O Orakei and the local residents who have lived in the area since the 1950's. There have been various noted changes to the environmental characteristics within the bay – attributed to the increased pollution and siltation, and also due to construction and discharge in the bay. These changes to the bay have had noted negative effects on the residents, and local eco systems. Using the Mauri Model decision making framework, various scenarios were considered and analysed, using the Mauriometer assessment – incorporating the four dimensions of mauri/wellbeing – whanau/ economic, community/social and Hapu/cultural. The Mauri Model equates sustainability with the Maori ethic of kaitiakitanga – enhancing the mauri of the ecosystem. The results of this research indicate that the recently constructed Marina has diminished the mauri of Okahu Bay. Without addressing the problems that have resulted from initial Marina development, the proposed Marina extensions are likely to result in a further negative impact upon the mauri of Okahu Bay.

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## 1.0 Introduction

Okahu Bay lies within the Orakei catchment in Auckland City. Okahu Bay is the ancestral home of Ngāti Whātua O Orakei - where the marae and papakāinga were positioned. The characteristics of the Bay changed significantly with the development of Auckland City and works done around the Waitemata harbour since the early 1900's. These developments and increased recreational and commercial shipping use of the harbour has resulted in siltation and other pollution accumulating in Okahu Bay. For many years boats have been stowed at the hardstand at the west headland.

Undesirable changes have resulted within the Okahu Bay ecosystem; and reductions in the local shellfish population have been noticed following Marina developments. These changes to the environment have an effect on all people who use Okahu Bay primarily Ngāti Whātua and the local Orakei residents. These changes should be investigated further to identify the causal factors, and investigate the measures that would be able to help restore the Mauri of Okahu Bay such that Ngāti Whātua and the other users will want to continue to revitalise their relationship with Okahu and participate in its future enhancement.

## 2.0 Objectives

- To investigate the effects that the introduced structures in Okahu Bay (Orakei Marina, hardstand, local storm-water system) have had on the mauri of Okahu Bay ecosystem – also considering the implications on the people especially Ngāti Whātua who are in cultural terms - an inseparable part of this ecosystem.
- Using the Mauri Model Decision Framework, compare various situations concerning construction in Okahu Bay. Investigate the relative effects of each option, and assess their sustainability - considering the implications on the local ecosystem.

## 3.0 Okahu Bay

### 3.1 Historical Setting

Okahu Bay lies within the Orakei catchment, surrounded by the Waitemata harbour. Historically, Okahu Bay is the location where the Papakāinga was located – including the marae and homes. This site is now marked by a church and a small cemetery – south of what is now Tamaki drive (Council, A. C. 1996).

Pre-European settlement, Okahu and Waitemata provided an essential protein source for Ngāti Whātua - being an abundant source of fish and shellfish during the warmer months.

Okahu Bay was also where expeditions were organised to transport resources to new settlements within the isthmus, used as a landing and departing area for waka (Kahui-McConnell, R. 2011).

Following the signing of the treaty, in 1841 Ngāti Whātua extended an invitation to Captain Hobson to establish a township on their lands – in exchange for education, medicine and trading opportunities. Within ten years of accepting the invitation, Ngāti Whātua would lose control of most of their lands in Tamaki Makaurau (Corporate, N. W. O. O. 2009).

In recent times the government has returned the title deed to the lands, and paid compensation for offences committed against the Treaty of Waitangi (Corporate, N. W. O. O. 2009).

### **3.2 Human impacts upon the Mauri of Okahu Bay**

The impacts of human activity have been most pronounced since the establishment of Auckland in 1840. The impacts of greatest consequence have resulted from the deforestation, urbanisation, infrastructure developed to facilitate increased urbanisation, and commercial and recreational boating. These have all compromised the mauri of Okahu Bay – namely altering the natural hydrological flows in the catchment and changing the

### **3.3 Early Construction in Okahu Bay**

Mid-19th century, construction and city developments around the Waitemata harbour were in full swing. This created many problems for Ngāti Whātua, with the increased siltation due to large scale removal of native vegetation and increased use of Waitemata harbour for commercial purposes.

By 1909 work had begun on the Auckland and Suburbs Drainage Scheme – which was made necessary by the health problems that arose due to the inadequate management of human waste produced by the newly settled Auckland region. The solution chosen was for Auckland's suburban and commercial waste water was to be discharged to Okahu Bay. In 1914, the sewerage system was operational and raw sewage was discharged to the shellfish beds of Ngāti Whātua in Okahu Bay (Tribunal, T. W. 1987). This was not only an insult to Ngāti Whātua, but also caused health problems for the people who continued to harvest shellfish from these beds. In addition, the two meter high pipe obstructed access and created drainage problems within the papakāinga.

A road was also constructed upon the trunk sewer. Storm-water run-off was discharged directly into Okahu Bay. This still continues today, with storm-water from sealed road in the catchment still being discharged directly into Okahu Bay.



Figure 1: Sewer pipe construction 1910

### 3.4 Okahu Bay Hardstand

A hardstand area was constructed by Marina developers to store and provide maintenance for commercial and recreational vessels. The hardstand also incorporated ramps for boat access to the water for the general public.

All the activities associated with this facility have introduced pollutants into Okahu bay – such as anti-fouling agents and cleaning chemicals used for boat maintenance, for many years. These pollutants and other pollutants associated with boating, namely the petrol hydro-carbons can deteriorate the water quality which can build up and have adverse effects on the marine organisms (McMahon, P. J. T. 1989).

### 3.5 Orakei Marina

In 2005, The Orakei Marina Management Trust completed construction on a 170m berth Marina – west of hardstand on the Waitemata. There are 180 boat berths, protected by a solid breakwater on three sides (Mair, A. 2006). Construction involved dredging of approximately 140,000 m<sup>3</sup> of marine sediment from the existing seabed, and construction of two sandstone breakwaters totalling 550m in length (Taylor, T. a. 2006). These changes to the coastal characteristics of Okahu Bay have had noticeable impacts to flow patterns within the bay.

The development included new yacht club facilities, refuelling facilities, floating pontoons, piles and other miscellaneous fittings for the Marina (Kahui-McConnell, R. 2011).

## 4.0 Low impact development

Low impact development is an alternative design to the traditionally used storm-water system Dietz, M. E. (2007). The traditional engineering solution for storm-water - the piped collection and concentrated discharge into nearby receiving waterways, negatively impacts the local hydrological cycle within the catchment. The establishment of towns and increasing in urbanization in the past two centuries has increased the amount of impervious surfaces – which in turn has increased the amount of run-off which has resulted in large quantities of run-off exhibiting poor water quality. Urban storm-water runoff has become a major problem for many waterways adjacent to the cities (Dietz, M. E. 2007).

Low impact development is a method for addressing the negative impacts of increasing urbanisation and the growing area of impervious surfaces. Low impact development helps to reduce run-off concentration and mitigated peak run-off - which is what traditional systems are designed to do (Booth, D. B., & Jackson, R. 1997).

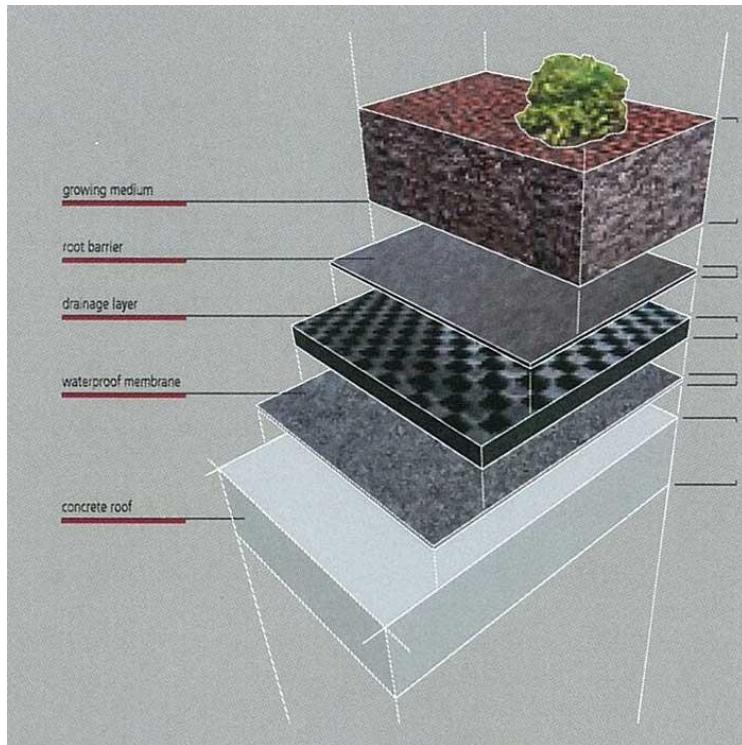
### 4.1 Bioretention

Bioretention is a plant based storm-water low impact development practice (Davis, A. P., M. Shokouhian, et al. 2003). This involves installing or utilising depressed areas in the landscape – rain gardens or bioretention areas, to collect storm-water run-off (Dietz, M. E. 2007). These areas usually comprise trees, shrubs or other perennials covered in mulch or soil – and can be installed both commercially and residentially (Kim, H., E. A. Seagren, et al. 2003). Implementation of bioretention areas can result in decreased surface run-off from impervious surfaces and improved water quality. The removal of heavy metals such as copper, lead and zinc is beneficial – both to waterways and water treatment facilities (Dietz, M. E. 2007).

### 4.2 Green roofs

The modern green roof consists of a vegetation layer, a substrate layer and a drainage layer. Modern designs, also called “extensive green roofs”, are thinner than traditional designs – intensive green roofs and place less structural stress on buildings (Mentens, J., D. Raes, et al. 2006). Green roofs are used to reduce the peak run-off rate in rain fall events. This reduction in run-off rate is through the storage capacity in the media used and the evapo-transpiration processes of the plants integrated in the green roof (Dietz, M. E. 2007). This system of low impact development may be less strenuous as it does not require additional land to implement – only requiring existing roof space on buildings. This is also an efficient use of what could be called “excess roof space” – with up to 50% of urban roof space going

unused buildings (Mentens, J., D. Raes, et al. 2006), and reducing up to 70% of water from a roof (Dietz, M. E. 2007).



**Figure 2: Green roof composition**

### 4.3 Pervious Concrete

The major problem with urban storm-water management is the ever increasing area of impervious surfaces – mainly concreted surfaces and asphalt surfaces (roads). The implementation of pervious concrete and pervious asphalt surfaces can be used to reduce the negative effects associated with urban storm-water management. Pervious concrete differs from traditional concretes in that it contains no sand and must be either tamped or rolled into place. Pervious concretes work by allowing water to seep through to the ground, to be discharged directly into the receiving soil (Tennis, P. D., M. L. Leming, et al. 2004). The use of this concrete can be a more efficient use of land – reducing the need to use bioretention areas (Tennis, P. D., M. L. Leming, et al. 2004) – although installation requires more experienced installers, being more difficult than conventional concrete installation (Dietz, M. E. 2007).

## 5.0 Decision Making Model:

### 5.1 Mauri Model

The Mauri Model is a decision making framework that integrates the social, economic, environmental, and cultural well-being dimensions of sustainability assessment. The Mauri Model Decision Making Framework adopts mauri ('integrity' or the binding force between the physical and the spiritual elements or capacity to support life) as the measure of environmental, economic, social, and cultural well-being in place of the monetary basis used conventionally for sustainability assessment.

Mauri is the bonding force between the spiritual and the physical. When this bond is extinguished the result is death in a living organism or alternatively the loss of capacity to support life in a material such as air, water or soil. The decision making framework incorporates this concept into a series of steps to determine whether the mauri of each dimension is being fully restored, enhanced, maintained, diminished, or totally destroyed. The Mauriometer assessment allows determination of the long term environmental, economic, social, and cultural sustainability of different courses of action. The use of mauri rather than money as the measure of sustainability avoids the disadvantage of making decisions based solely on economic or psuedo-economic considerations which is more in line with Maori thinking – therefore well suited for this application.

The model uses the four dimensions of wellbeing, adapted from Daly's triangle of sustainability. Project wellbeing and sustainability is expressed in terms of the mauri of the four dimensions of wellbeing:

- Mauri of the environment (ecosystem wellbeing)
- Mauri of the hapu (cultural wellbeing)
- Mauri of the community (social wellbeing)
- Mauri of the whanau (economic wellbeing)

## 5.2 Analytical Hierarchy Process

Different stakeholders perceive value differently. The stakeholder priorities that influence this perception of value are determined using a technique called AHP. The analytical hierarchy process is used to determine the priorities of the stakeholder groups. A table is used to conduct a peer-wise assessment of the wellbeing dimensions, for each stakeholder. Each wellbeing dimension is compared with every other dimension to find the relative importance of each wellbeing dimension to each stakeholder. Scores for ranking wellbeing dimensions are decided using data gathered from interviews and other research conducted. The scores for each dimension are normalised, and converted into a percentage which is a numerical representation for the importance of each dimension, to each stakeholder. The resulting priority weighting of each well-being/mauri dimension is used later to conduct a sensitivity analysis on the Mauriometer results.

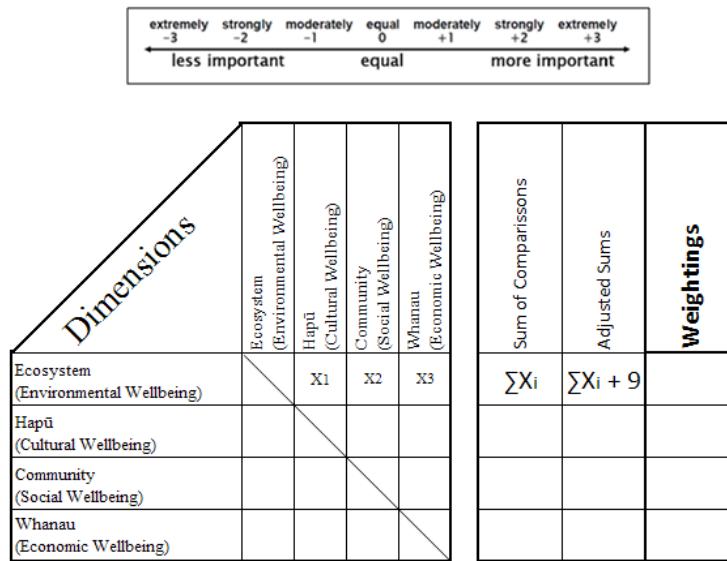


Figure 3: Example of AHP

### 5.3 Mauriometer Assessment

In this step the stakeholder viewpoints and priorities towards each of the wellbeing dimensions (which have been numerically represented as percentages), are combined with the performance indicator scores, for each option. This results in the final Mauriometer score being weighted, by applying the stakeholder bias, to achieve scores which reflect the stakeholder's priorities in terms of Okahu Bay. This application of stakeholder viewpoints to the Mauriometer assessment ensures that requirements of these stakeholders are being provided for.

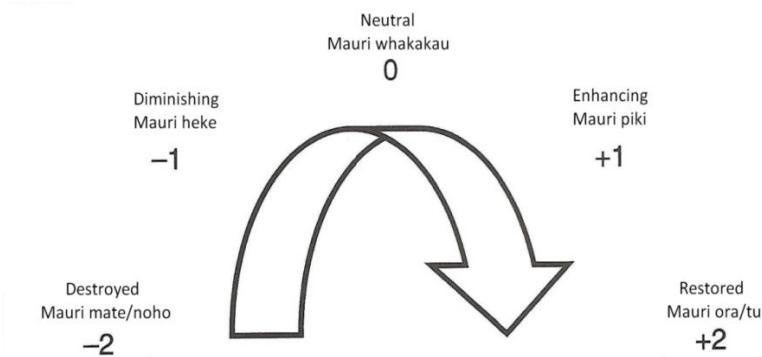


Figure 4: Mauriometer

### 6.0 Stakeholders

Stakeholders are all the groups that have vested interest in Okahu Bay including the construction of ocean structures such as the Marina. Stakeholder viewpoints and priorities will influence the decision making process – as the decisions made must be able to satisfy the requirements of the stakeholder groups.

From the restoration plan I have identified these stakeholders as the main stakeholders who have vested interest in the decision making process concerning Okahu Bay.

Stakeholders/viewpoints considered:

### **6.1 Ngāti Whātua**

Based on the treaty of Waitangi, the Tangata Whenua have some rights over the land. Therefore the government cannot proceed with a conceptual design without their consent. They care for the sustainable use and restoration of Okahu Bay and the preservation of Maori culture and heritage.

### **6.2 Orakei Residents**

These are the local residents who live in Orakei, who use Okahu Bay. Local residents have an affinity to Okahu Bay, as non-Ngāti Whātua O Orakei residents have also lived in close proximity to Okahu Bay for many years now, and would like to see the health of the Bay restored and protected.

### **6.3 City Council**

The city council issues resource consents for any construction, and controls the wastewater runoff into the Bay, through structures in place.

### **6.4 Marina Users**

These are the users of the Okahu Marina, who use the Bay recreationally and as a port to dock their boats.

## **7.0 Performance Indicators**

Performance indicators are factors that allow us to measure the effects of different course of action, in relation to others, for each wellbeing dimension. These factors were chosen based on how each wellbeing dimension would be affected by the different possible courses of actions and their importance to the stakeholders – with precedence given to Ngāti Whātua values. Important environmental, economic, cultural and social issues that arise within Okahu Bay were identified during research. These issues were compiled into performance indicators that were able to be measured and investigated. Initially 21 performance indicators were proposed, but reduced to 12 after further consideration (removing less relevant indicators, and indicators which duplicated each other).

## 7.1 Environmental Wellbeing/Ecosystem Mauri

The mauri of the ecosystem, specifically the environmental wellbeing in Okahu Bay is determined by the following indicators:

### 7.1.1 Water Quality

Due to the tidal cycles and harbour currents water quality is generally that of waters in the Waitemata. The movement of seawater can be restricted and/or changed by the erection of structures on the bed, and on the coastline.

The quality of the water determines whether or not the water is safe to use recreationally (swimming, kayaking) and for food gathering. Storm-water infrastructure and recreational boating impact negatively on the water quality due to the pollutants they introduce – cleaning chemicals, motor fluids.

### 7.1.2 Sediment Quality

Okahu Bay sediments accumulate material present in the seawater and seawater entering Okahu Bay as well as debris from boat hulls and fluids from motors on power boats.

The quality of the sediment can affect shellfish quantities and quality, and the aquatic plant life. Heavy metals can accumulate in the sediment and shellfish - which may result in the reduced shellfish population. The heavy are typically introduced in run-off from the catchment, and boating activities.

### 7.1.3 Aquatic Life

Historically, Okahu Bay was a prolific source of shellfish and fish for Ngāti Whātua . The presence of fish is influenced by the seasonal migrations of fish stocks, their reduction due to commercial fishing and predators, and the availability of food in the sediments in Okahu Bay.

The presence of shellfish species and other aquatic plant life is a major influence on the mauri of Okahu Bay. Since a lot of these aquatic species are major food sources for Ngāti Whātua O Orakei, and other locals - the presence and numbers of aquatic life is a very important indicator.

The levels of aquatic life can reflect the environmental stressors introduced by changes to the ecosystem.

## 7.2 Economic Wellbeing/Whanau Mauri

The Mauri of the whanau or economic wellbeing is determined by the following indicators:

### 7.2.1 Implementation Costs:

The cost to implement, financial return of a given option can be expressed in terms of the net change in household equity caused. The portion of this cost that is borne by residents is another factor which must be included during the consideration process. This includes all costs that accompany implementation – consents, installation, equipment, labour and materials.

### 7.2.2 Operational Costs

Associated with a particular course of action are all the costs required to keep maintain Okahu Bay in a stable condition and ensure potential adverse impacts resulting from the course of action do not eventuate. This can include testing, cleaning and restoration/preservation efforts. Depending on the course of action, varying levels of maintenance and prevention will be required if the source of these costs is a potential or actual household expense.

### 7.2.3 Provision of Resources

Okahu Bay is historically a major source of food for Ngāti Whātua O Orakei, often referred to as the 'kapata kai'. Shellfish and fish were once harvested on scale sufficient to feed the community. The kapata kai is now used by the wider community, as many people – other than those of the Ngāti Whātua use the Bay to gather seafood. Over harvesting may be a factor leading to the decline in shellfish levels and consequently fish.

The sea space itself has also been utilised as a resource – with the Marina being built to house the ships.

## 7.3 Cultural Wellbeing/Hapu Mauri

The mauri of the hapu measures the wellbeing of Ngāti Whātua in terms of concepts and factors drawn from Tikanga Maori, identified as important to Ngāti Whātua in terms of the Okahu Bay restoration.

### 7.3.1 Preservation of Wahi Tapu and Wahi Whakahirahira

Wahi Tapu are the places or sites that have deep historic, cultural and spiritual significance to the Tangata Whenua. For Ngāti Whātua O Orakei, there is a strong historic relevance of the papakāinga and its association with Okahu as principal source of sustenance and main arrival/departure point for people and resources – waka based economy and travel.

### 7.3.2 Mahinga Kai

Kai moana was a major source of food for Maori – especially for Ngāti Whātua O Orakei as they are a coastal oriented hapu. Okahu provided the source for sustenance of Ngat Whatua as well as the means to manaki guest with the best foods from the area. The practice of gathering kai moana has been passed down from generation to generation, and is still today an important part of Ngāti Whātua culture. The continued relevance of cultural practices in relation to Okahu goes hand in hand with manaakitanga, as food is provided to manuhiri for events such as hui, tangi and weddings.

### 7.3.3 Preservation of Cultural Identity

This is one of the most important factors to Ngāti Whātua O Orakei. One of the main goals of the hapu is the renewal of lost connections with whanau. Reconnection can be achieved through events that bring the hapu back to the area - passing on the traditions and knowledge on to the next generation. As the Tangata Whenua, Ngāti Whātua still have a cultural responsibility as the kaitiaki of Okahu Bay - and active participation in the preservation of the mauri can be a major part in restoring cultural identity.

## 7.4 Social Wellbeing/Community Mauri

The mauri of the community represents social wellbeing or the happiness and security of the community in their homes, jobs, health, leisure or education. The community includes the local residents who have developed an affinity to the area and Bay, as well as other visitors including recreational fishing and boating.

### 7.4.1 Health of Community/ Public Health

Since the Bay is used for swimming and harvested for kai moana, the health of the public is very important, and is indicated by the water and marine sediment quality. Pollution in the Bay could have significant effects on the public who use the Bay recreationally (swimming, fishing and kayaking).

### 7.4.2 Recreational Use of Bay

Due to the urban setting of Okahu Bay and the close proximity to the Auckland city centre, Okahu Bay is used frequently by local residents for many community and recreational activities. These include swimming, kayaking and boating. The continuing facilitation of these recreational and communal activites is therefore an important factor.

### 7.4.3 Aesthetic Appeal

The aesthetics of Okahu Bay are important, as the first and lasting impression of a place are its appearance and smell. Increased level of muddy and silty sediment, are perceived as undesirable and unhealthy. Many users of the Bay are inclined to prefer beaches with a Mauri reflecting aesthetic qualities such as – less muddy sand, presence of aquatic species, nice smell of the area and the colour of the water.

The beautiful scenery also attracts many people, who enjoy the ocean view.



Figure 5: Okahu Bay

## 8.0 Options Being Considered:

### 8.1 No Marina Built

In this scenario the Marina is not present. Testing this option allows us to see the effects on the Bay, had the Marina not been put into place. Using the results of tests done in the Bay previous to the construction of the Marina, all the factors can be considered to judge the overall well-being of the Bay using the factors identified above and stakeholder viewpoints.

### 8.2 Marina Present

This is the current scenario on Okahu Bay. Using the testing being done presently, the overall impact of this option can be seen and compared with the previous state of the Bay – giving an overall picture of the effects on the Bay's mauri.

## 8.3 Implementing Low Impact Development into Storm-water Run-off Management

This scenario would involve implementing low impact development into current storm-water management practices. This would decrease the amount of heavy metals being deposited into Okahu Bay during rain fall events, from impervious concrete or asphalt surfaces. This would be possible by utilising bioretention areas to detain storm-water from catchment, to facilitate the removal of harmful compounds (heavy metals, hydro-carbons), before storage and subsequent release into the water body.

## 8.4 Marina extension

This option is a very real possibility in the near future. This scenario would consist of an extension of the existing berth marina currently in place in Okahu Bay. This extension would provide more storage facilities for boat users, and larger capacity for boat maintenance and launching sites. This increased boating traffic in the Okahu Bay vicinity would most likely increase the amounts of heavy metals and anti-fouling agents being deposited in the water and sediment. These effects would be most likely to intensify negative impacts felt in Okahu Bay.

## 9.0 Gathering of Aspects

In this step the stakeholder viewpoints and priorities towards each of the wellbeing dimensions (which have been numerically represented as percentages), are combined with the performance indicator scores, for each option. This results in the final Mauriometer score being weighted, by applying the stakeholder bias, to achieve scores which reflect the stakeholder's priorities in terms of Okahu Bay. This application of stakeholder viewpoints to the Mauriometer assessment ensures that requirements of these stakeholders are being provided for.

## 10.0 Results:

### 10.1 Analytical Hierarchy Process

**Table 1: Analytical hierarchy process**

stakeholder/mauri dimensions	Environmental	Hapu	Community	Whanau
Ngāti Whātua O Orakei	32	35	18	15
Orakei residents	35	18	29	18
Marina users	26	6	43	26
Local council	27	15	24	33

From the analytical hierarchy process, percentages for each stakeholder were calculated representing stakeholder viewpoints and priorities toward each of the Mauri Model wellbeing dimensions. Ngāti Whātua hold the mauri of the hapu as being, most important, followed closely by the mauri of the environment. The Orakei residents rank the mauri of the environment as being most important. The Marina users value the mauri of the community most highly. The local council rank the mauri of the whanau (economic wellbeing) as being most important.

Considering the stakeholder viewpoints cumulatively, the most important wellbeing dimension is the mauri of the environment. For every stakeholder, the wellbeing of the environment is one of the two most important dimensions. This can be attributed to the mutual use and importance that Okahu Bay has to all the stakeholder groups. It is in all stakeholder groups best interest that the environmental wellbeing of the Bay is preserved. The dimension which had the least importance overall was the mauri of the hapu. This can be attributed mostly to the lack of public awareness of the factors that affect the Tangata Whenua in terms of the decision making process.

## 10.2 Mauriometer Assessment:

**Table 2: Mauriometer assessment**

stakeholder/option	Marina built	Marina not built	Low impact development	Marina extension
Ngati Whatua O Orakei	-0.89	0.67		0.47
Orakei residents	-0.71	0.57		0.46
Marina users	-0.50	0.46		0.38
Local council	-0.72	0.54		0.24
<b>Total</b>	<b>-2.82</b>	<b>2.24</b>		<b>1.55</b>
<b>Average</b>	<b>-0.71</b>	<b>0.56</b>		<b>0.39</b>

From the final Mauri Model analysis the option that would be most beneficial for the mauri of Okahu Bay would be not building the Marina (+ 0.56). Implementing low impact development to reduce the wastewater runoff into the Bay is also mauri positive (+ 0.39) indicating that is beneficial to the wellbeing of Okahu Bay.

Having the marina (- 0.71) and an extension of the current marina (-0.55) are detrimental on the Mauri of Okahu Bay. These scores reflect the poor environmental and cultural evaluations that these options were given when contemplating their implications on the indicators in the Mauriometer assessment.

## 11.0 Discussion

### 11.1 Implication of Results

Considering the results of the Mauriometer analysis the option that enhances the Mauri of Okahu Bay the most is having marina implemented. This is because we are able to compare the current status of the Bay with the previous status of the Bay (before construction of the Marina berth). It has been shown that there has recently been a lack of flushing in the Bay, which may accommodate the build-up of heavy metals from storm-water run-off from the roads and other impervious suburban surface and boating activities associated with the Marina. This may have had an effect on the aquatic life in the Bay, although further study will be needed to confirm this. The lack of flushing has also caused a build-up of silt in Okahu Bay, which has led to some more 'muddier' areas – which are aesthetically undesirable to users.

Implementing some low impact development to deal with wastewater and storm-water runoff was a sustainable option. This would include inputting measures to reduce the amount of this stormwater that makes it into Okahu Bay, or at least preventing heavy metals and other detrimental substances from entering Okahu Bay. These would also prevent a lot of the silt from entering the Bay. Actual implementation of low impact development would be very costly as increasing pervious surfaces for drainage, green roofs and constructed wetlands – to name a few, would require a lot of capital to purchase, install and maintain.

These results give a good baseline for restoration, as the comparative effects of having a Marina and not having a Marina are assessed.

The analysis also shows that extending the Marina will further negatively impact the Mauri of Okahu Bay. Although an extension would provide more recreational opportunities for Okahu Bay – by providing a larger capacity to store and provide maintenance for boats, there would be increased pollution of Okahu bay. The increased deposition of heavy metals in the water from increased boating activities, would contribute to the already present heavy metals in the sediment causing more problems to the aquatic life – especially to the shellfish populations.

### 11.2 Decision Making Framework:

When considering a situation as complicated and delicate as construction at and restoration of Okahu Bay, basing decisions on cost benefit analysis or similar processes alone does not provide an inclusive evaluation of the situation. Cost benefit analysis relies on being able to assign a monetary value to all relevant factors in the decision making process into costs and benefits and weighing the various options. However there are other influencing factors in

the decision making process that cannot be expressed in monetary terms such as – cultural values and emotion, but are the nonetheless important and must be included.

The Mauri Model provides an unbiased approach to assess relevant factors in the decision making process, including intangible factors. In the context of the Okahu Bay restoration, there are many intangible factors that must be included in the decision making process such as public anxiety after an earthquake, and cultural values which must be upheld and preserved – taking into account obligations to the Treaty of Waitangi.

### **11.3 Limitations of Project:**

Due to time availability there were a limited amount of surveys collected. To get a better analysis of stakeholders, more interviews should be collected with a wider participant range and variation.

The limited research and documentation on Okahu Bay, made it difficult to assess the different courses of action. Due to the difficulty to find records of suitable length and content to be used, some of the data used to assess the options was based on related studies and conceptual studies.

The limited time and resource availability made testing all factors an impossible feat. The factors that we could measure in the time period had to suffice for the time being.

### **11.4 Further Research Opportunities:**

The summer period for this research was not a long enough period to test all relevant factors fully. A longer period of time devoted to this project could further refine the indicators used to get the right balance between all stakeholders, as the indicators were constructed with major precedence given to Ngāti Whātua . More time spent on this project would also give a better understanding of the relevant factors, and allow more testing to be done – further strengthening the results of the model.

More options for restoration and remediation can also be investigated and tested – giving a complete picture of all possible courses of action. This includes testing further possible construction plans by the council or Marina developers. This would give Ngāti Whātua and the local community more information on the implications that these possible structures would have on Okahu Bay.

Ideally the next situation to test would be the proposed extension of the existing Marina in Okahu Bay. It would also be beneficial to test the scenarios over a long time period, for example a fifty year analyses to see the effects of an extended period on Okahu Bay.

## 12.0 Conclusions

- From the analyses on the scenarios, building the Marina is not a sustainable option – as was shown when comparing the current situation (marina built) to the previous situation (no Marina built).
- Implementing some low impact development into the wastewater management of the catchment is a sustainable option overall, increasing the mauri of Okahu Bay.
- Taking into account the results looking at the construction of the Marina – being detrimental to the Mauri of Okahu Bay, a marina extension would further deteriorate the Mauri of Okahu Bay.
- An extended study would strengthen the findings and allow a wider scope to be investigated – incorporating more options to be looked at.

### 13.0 References:

Booth, D. B., & Jackson, R. (1997). "Urbanization of aquatic systems: Degradation thresholds, stormwater detection and the limits of mitigation". Journal of the American Water Resources Association, **33**(5), 1077–1089.

Corporate, N. W. O. O. (2009). "A Brief History." Retrieved 12/12/2012, from <http://www.ngatiwhatuaorakei.com/silo-2-landing-page-link/103-brief-history-of-ngatiwhatuaorakei.html>.

Council, A. C. (1996). Tamaki Drive design guidelines. Auckland.

Davis, A. P., M. Shokouhian, et al. (2003). "Water quality improvement through bioretention: Lead, copper, and zinc removal." Water Environment Research: 73-82.

Dietz, M. E. (2007). "Low impact development practices: A review of current research and recommendations for future directions." Water, Air, & Soil Pollution **186**(1): 351-363.

Kahui-MCconnell, R. (2011). Okahu Bay Restoration Plan.

Kim, H., E. A. Seagren, et al. (2003). "Engineered bioretention for removal of nitrate from stormwater runoff." Water Environment Research: 355-367.

Mair, A. (2006). "Orakei Marina." From <http://www.totalmarineservices.co.nz/orakei.html>.

McMahon, P. J. T. (1989). "The impact of marinas on water quality." Water Science and Technology **21**(2): 39-43.

Mentens, J., D. Raes, et al. (2006). "Green roofs as a tool for solving the rainwater runoff problem in the urbanized 21st century?" Landscape and Urban Planning **77**(3): 217-226.

Taylor, T. a. (2006). Orakei Marina, Auckland, NZ.

Tennis, P. D., M. L. Leming, et al. (2004). Pervious concrete pavements, Portland Cement Association.

Tribunal, T. W. (1987). Report of the Waitangi Tribunal on the Orakei Claim. Wellington, Department of Justice.