Ngāti Kea Ngāti Tuara Electricity Utilization

Feasibility Plan for a Greenhouse to Benefit the Ngāti Kea Ngāti Tuara Hapū of Horohoro, New Zealand

Submitted by:

Allison Buckley

Martin Fitzgerald

M. Paige Myatt

Nathan Peterson

Project Advisors:

Professor Robert Kinicki and Professor Bethel Eddy

Project Sponsors:

Victoria University of Wellington and Te Rūnanga o Ngāti Kea Ngāti Tuara

Submitted on: December 17, 2015

Table of Contents

List of Figures

List of Tables

Chapter 1: Introduction

The pursuit of utilizing clean, renewable energy resources emerged as an important response to the irreversible environmental consequences of more traditional, non-renewable energy options. The Māori, New Zealand's native people, have values deeply rooted in conserving resources and respecting the environment. Hydroelectric power, just one form of clean alternative energy available in New Zealand, has seen particular success in the country. For the year of 2011, hydropower produced 57.6% of New Zealand's overall electricity. Eleven percent of that production came from "small hydropower", defined as systems that produce less than 10 MW of electricity (Esser, Liu & Masera 2013).

In December 2013 the Māori community of Ngāti Kea Ngāti Tuara (NKNT) in Horohoro installed a series of micro-hydroelectric turbines to power their *hapū* (village). The turbines utilize the potential energy of a waterfall in the nearby Pokaitu stream to produce clean, sustainable electricity while preserving the natural environment. The turbines operate without the use of a dam or reservoir and currently produce more than enough electricity to power the hapū's *marae* (traditional meeting-house). Currently the system suffers from intake congestion due to debris in the water column. The project's initial goal will be to recommend a solution to mitigate the congestion.

The hapū currently sells the surplus energy back to the grid for a marginal profit. As such, the hapū expressed interest in undertaking a project to use the energy in a more productive manner. Our project sponsor, Dr. Maria Bargh of Victoria University at Wellington, conveyed to us the community's desire to construct a greenhouse to utilize the available electricity. Green agriculture can employ the micro-hydro power in a manner that is amiable to the local cultural values. NKNT's location in Horohoro, 16 kilometers outside of popular tourist destination Rotorua, places the community in a unique position to sell greenhouse products in specialty markets.

Our team will create a full feasibility report to explore the design parameters and requirements necessary to construct a greenhouse capable of fulfilling the needs of the community. To accomplish these goals, the team will work closely Dr. Bargh and the members of the hapū to recommend a plan for the intake congestion problem and outline a greenhouse that will effectively utilize the available energy produced by the community's micro-hydro power system.

Chapter 2: Background

This chapter provides the cultural, political, economic, and technical context necessary to understand the hapū's micro-hydro system and explores the possibilities of using the available energy to build and maintain a greenhouse.

The chapter begins with a discussion of the current conditions of the hapū, including population statistics and information on the economy of Rotorua. This section includes a brief discussion of the economics of Māori communities in order to situate NKNT in a larger economic context. Next, there is a summary of the Māori values surrounding the project. An overview of both the technology of micro-hydro systems and the system currently in use in NKNT follows. The chapter then moves into an outline of the design factors the team will consider in the final feasibility report. These parameters include crop selection, distribution, building materials, and the markets of surrounding area.

2.1 Economic Profile of the NKNT Hapū and the Horohoro Region

Ngāti Kea Ngāti Tuara is located in the central North Island of New Zealand in a farming district called Horohoro, situated approximately 16 kilometers southwest of Rotorua, one of the Bay of Plenty's largest urban areas. The marae of the hapū lies next to the Pokaitu Stream. The hapū has approximately 1,500 members; 10% of hapū members live overseas and about 30% live in other parts of the country. The remaining 60% live in the Bay of Plenty area, although few live in Horohoro itself.

2.1.1 Economic Profile of Māori Communities

The Māori economy heavily contributes to multiple industries, including fishing, tourism, energy and agriculture. Twenty-nine percent of the collective asset base in New Zealand resides in the Bay of Plenty Region, with the majority of that being in agriculture and forestry (He Mauri Ohooho, 2014).

Nearly 90% of Māori people in New Zealand live on the North Island and over 25% live in the Bay of Plenty Region. Of this demographic, 44% of the Bay of Plenty Māori are under 15 years old (Stats.govt.nz, 2002). The average Māori adult makes NZ$14,800 per year and only one in twenty make more than NZ$50,000 per year. Due to their relative economic disparity and abundance of youth, it is of utmost importance that the Māori plan for long-term success by making the best use of their available resources and ensuring the youth’s education on economic and environmental sustainability. The Bay of Connections, a governance group of industry leaders and economic development agencies, focuses on and encourages Māori employment as a path toward sustainability. The plan emphasizes leadership and governance for the Māori as well as self-sovereignty for the Māori over their own economies and cultures. In order to achieve these ends, the plan highlights the need for sustainability, connectivity and education (He Mauri Ohooho, 2014). One group successful in implementing these goals is Indigenous New Zealand Cuisine (INZC), which has found success in growing crops with a greenhouse and selling to local tourist destination resorts and restaurants. INZC connects the Māori-grown food and delicacies to buyers to help them grow into export markets around the world.

The NKNT hapū is located near Rotorua, which “has been the biggest contributor to the Māori economy within the wider Bay of Plenty” (He Mauri Ohooho, 2014). In 2010, forestry, property and business services, health and community services, and cultural and recreation services comprised more than half of the total Maroi GDP in Rotorua. The total Māori GDP for these services in this year totaled NZ$387 million. (He Mauri Ohooho, 2014).

Tourism constitutes a significant proportion of the Bay of Plenty's revenue, accounting for 3% of the region's overall GDP at NZ$387 million per year (Slack & Schluze, 2013). Rotorua in particular considers tourism an integral part to their existing economy. Additionally, tourism has promising potentials for future growth. However, growth in the area has stagnated, dropping in yearly percent growth across many categories (RDC, 2011). While there are many factors contributing to the decline in the area’s growth, unsuccessful branding and lack of meaningful innovation have particularly damaged the tourism industry (RDC, 2011). Currently, “tourism in Rotorua is ... based on Māori culture, geothermal attractions, lakes and the natural environment” (RDC, 2011). Although some aspects of Rotorua's economy may be suffering from stagnation, the investment potential in the area leaves the hapū with an advantageous market to utilize through their greenhouse.

2.2 Guiding Māori Values

Our project emphasizes awareness of how Māori cultural values will shape our decision-making. The team chose a set of three critical cultural coordinates from the “list of traditional values” (NKNT, 2013) provided in Ngāti Kea Ngāti Tuara's Iwi Hauora Plan. These three coordinates are whakapapa, katiakitanga, and no te hapū. The team will evaluate greenhouse design factors and ideas to ensure they are consistent with these values. Dr. Maria Bargh details a similar approach in her 2012 article for the *Journal of Enterprising Communities* wherein she describes four pan-Māori cultural coordinates one could use to navigate Māori affairs. Brief explanations of each of these values and how they are relevant to the project follow.

Whakapapa, found in humans, non-human animals, as well as the natural environment, denotes genealogy (Bargh, 2012). As an individual develops, they develop their own whakapapa. As these individuals interact with one another and with the environment, the group itself develops a whakapapa. The whakapapa formed is unique to each individual and group is non-interchangeable. Thus, a river has its own whakapapa, and the Māori in the area have a whakapapa in relation to the river as well. This means that, in interacting with the environment, the team will be interacting with a distinct entity that has its own specific genealogy. Both waste from runoff and tire treads would damage a specific whakapapa rather than the environment as a whole.

Kaitiakitanga implies, in a rough sense, guardianship (Bargh, 2012). Kaitiakitanga applies especially to the relationship between tribes and the environment. Bargh notes that this value finds particular resonance with the balance of natural resource consumption (Bargh, 2012). However, as a value, katiakitanga goes beyond balance and stands for active protection of the environment. There is thus a normative quality to katiakitanga.

In this context, no te hapū indicates a strong desire for communal benefit over the benefit of any one individual (NKNT, 2013). This principle serves to direct how our team can consider the generated revenues to best help the community. Depending on the resources available, no te hapū may also suggest that the team considers hiring labor from the hapū community before hiring outsiders.

2.3 Micro-hydro Power Systems

There is currently a huge untapped potential for hydropower systems in New Zealand, particularly in the Bay of Plenty region (World Small Hydropower Development Report 2013: New Zealand, 2013). The Ngāti Kea Ngāti Taura hapū joined the pursuit of hydroelectric power in December of 2013 with the installation of their micro-hydro facility. Now they seek to utilize their system's full potential by applying the available electricity to better the community and environment.

Micro-hydro power systems produce less than 100 kilowatts of electricity and present a clean, alternative energy option for those with nearby running water in the form of rivers or streams. A kilowatt measures the rate of energy production. To put this in perspective, a 10kW system can produce about enough electricity to power a large home, small resort, or farm (Energy.gov, 2015). With some systems capable of operating in as little as 13 inches of rushing water, almost any stream or river can produce hydroelectric power. Micro-hydro systems require a 'head', or altitude drop, to generate power. Water enters an intake and travels down the penstock where turbines convert its kinetic energy to rotational energy. This mechanical energy is the source of the electricity produced. Figure 1 displays a simplified diagram of a micro-hydro system.

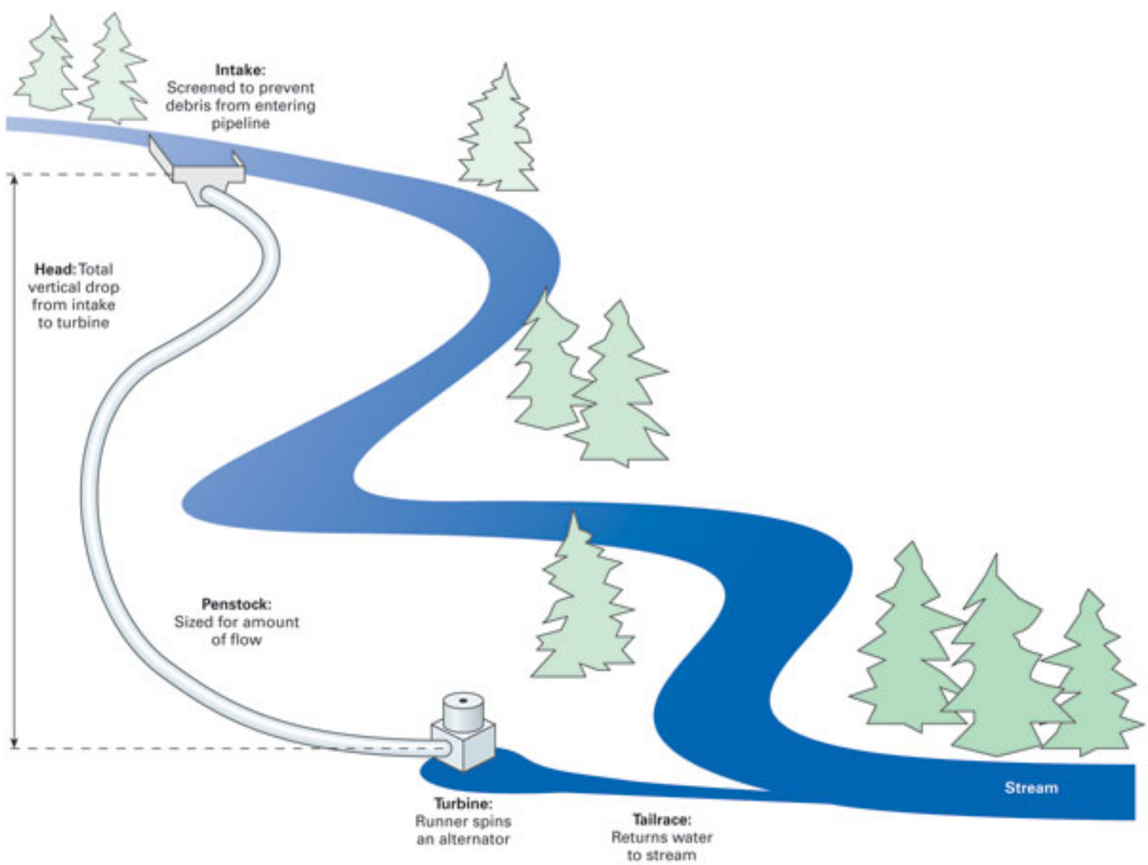

Figure 1: Simplified Micro-hydro System Illustration (Micro Hydro Power)

Micro-hydro power systems have many benefits. For one, they are very reliable and only require a surprisingly small amount of flow (AENews, 2006). Since micro-hydro power is a "run-of-the-river" system, it does not require a dam nor reservoir. The environmental impacts are relatively low in comparison to larger hydropower systems. Water returns to the river with little impact on the surrounding ecosystem. Inexpensive and ideal for small communities and villages, micro-hydro power presents a great opportunity to use existing natural resources in order to produce electricity for these communities or sell it back to the grid.

Although mostly efficient and reliable, there are some downsides to micro-hydro power. The size of the rushing water source is the limiting factor and does not allow for expansion. For this reason, finding sites that are suitable for micro-hydro power can be a challenge. Micro-hydro power may also be seasonal, with the flow rate fluctuating between summer and winter months. Although thought to generate very clean energy with little environmental impact, a micro-hydro can have adverse effects on an ecosystem. Fish may get caught in the screen of the intake, but this is uncommon. Depending on the location of the stream, debris may also be a factor. In the case of NKNT's system, the current screen in front of the intake allows for pine needles and other small debris to pass through. The following section further explains the situation at Horohoro.

2.4 Existing Micro-hydro Power System at Ngāti Kea Ngāti Tuara Hapū

Horohoro is home to the installation of a micro-hydro power system in the Pokaitu Stream. The system borders the Kearoa Marae, a meeting ground and cultural center for the hapū as shown in Figure 2. The micro-hydro facility powers a church, Māori language immersion play-center and Horohoro Primary School all in the area. The objective of the installation was to help the

Figure 2: Map of Hapu (PowerSpout, 2014)

community become more sustainable and self-sufficient and act as an example of how micro-hydro power can be an environmentally friendly resource in rural areas (PowerSpout, 2014, page 22). The system operates with an intake that runs perpendicular to the river to minimize the intake velocity and the resulting threat to fish and eels. In 2011, the Marae used around 19,000 kWh. The existing three-turbine, micro-hydro power system can produce up to 23,000 kWh/year, which leaves excess electricity to be sold back to the grid for no more than $1000 per year, and allows the community to produce for itself what would have costed $4000 otherwise (Watson, M., 2014).

2.4.1 Problems with Debris

Due to the small scale of micro-hydro power relative to larger forms of hydroelectric power, leaves and debris can be problematic for the intake of the system as shown in Figures 3 and 4. In the case of the micro-hydro facility at the NKNT Hapū, pine needles and other debris cause intake congestion. Once the turbine stalls, a worker must manually clear the intake must before the turbine can generate power again. For this reason, the facility at Horohoro is not producing energy to its potential and it requires regular maintenance. If we are able to analyze and recommend a solution that would eliminate the effect of debris on the micro-hydro, the hapū will benefit from the receipt of more energy and less required maintenance.

Figure 3: External View of Intake Grate (Maori Television)

Figure 4: Underwater View of Intake Grate Congestion (Maori Television)

Micro-hydro intake systems filter and transfer water from the source to the turbines. In *Serious Microhydro: Water Power Solutions From the Experts,* Jerry Ostermeier (2008) outlines self-cleaning intake designs to address this common hindrance of debris congestion. The most commonly seen intake is a simple pipe with a screen, which is cost-effective but requires frequent cleaning. Figures 3 and 4 show the existing intake style of Ngāti Kea Ngāti Taura's facility. Debris decreases the flow rate of the water reaching the turbines and a worker must clean out the congestion regularly to maintain power production.

In the case of the NKNT hapū, a worker may need to clear the debris from this simple type of intake twice a day. Pine needles, which unlike other forms of debris float and penetrate screens designed to keep debris out, are the primary culprit of intake congestion. As mentioned, the system has a low velocity intake designed to meet the hapū's environmental standards. Our recommendation aims to accommodate for these characteristics in a cost-effective manner so that the hapū can receive the full potential of their current system. We must know the amount of available power to outline a potential greenhouse project.

2.4.2 Power Production Potential

Ngāti Kea Ngāti Taura’s existing system has three turbines that generate electricity. However, the hapū does have resource consent and the potential to add three more turbines into the existing headstock. Figure 5 illustrates the existing turbines within the headstock.

Figure 5: Headstock with Three Turbines (PowerSpout)

If the hapū decides to double the number of turbines, the system would produce about twice as much power, which would in turn change the scale and potential of the greenhouse and offer the community the potential to undertake other projects in the future.

2.5 Overview of Greenhouse Initiative for NKNT

Although the members of Ngāti Kea Ngāti Tuara are interested in constructing a greenhouse, meeting the needs of the community will require our team to consider many design and construction parameters. Among these considerations are crop selection, building materials, size, growing technologies, construction time, construction cost, labor costs, and product distribution. In order for the greenhouse to be economically feasible and culturally consistent with the community's values, our team's final recommendations will speak to these considerations.

Crop selection is the most fundamental of the factors and will have a substantial effect on the remaining design parameters. The community has previously expressed interest in growing watercress, a leafy green aquatic plant, koura, a kind of freshwater crayfish, or eel, which is a culturally important livestock. The crop or livestock that the hapū will harvest directly influences technological options such as hydroponics, heating systems, and water pumps. This crop and the technology it requires are strong indicators of what size greenhouse is appropriate, how long the greenhouse will take to build, and how much initial capital it will require.

However, this greenhouse must also produce products that the hapū can sell in an economically feasible way. The market value of the crop alone is not a good indicator of its feasibility; our team must consider the cost of labor and distribution in their own right. The cost of labor is a function of the available labor pool in the surrounding area, the skill and quantity of labor the greenhouse will require. Distribution, too, calls for its own kind of solutions. An automobile must distribute the crops to the market, which incurs its own cost. But, also, the distribution strategies, e.g. wholesaling or direct sales, will modify the design as well.

2.6 Potential Crops and their Production Methods

According to the Food and Agriculture Organization of the United Nations, aquaculture is the one of the fastest growing rural industries in New Zealand (Jeffs, 2005). As displayed in Figure 6, the industry has exploded since the 1980s. Aquaculture contributes greatly to the employment and economic activity of rural areas and has the potential to do the same for Horohoro.

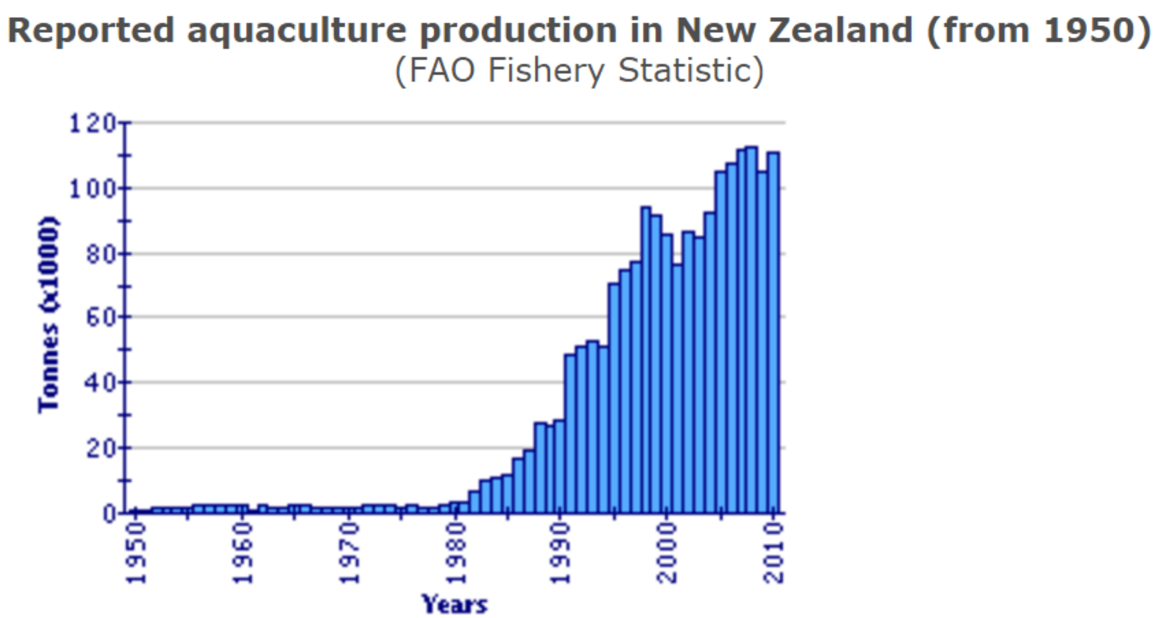

Figure 6: Aquaculture Production Growth in New Zealand (Jeffs, 2005)

Aquaculture is the process of farming fish, shellfish, or plants for consumption. Hydroponics harvests plants without soil in a nutrient-enriched recirculating water system. (George, 7). Aquaponics is a "symbiotic cultivation of plants and aquatic animals in a recirculating environment. It is similar to a hydroponics system except instead of adding nutrients, [fish are relied on] as nutrient-generators" (potfish.org, 2012). The following sections detail the applications of each method.

2.6.1 Eel

Eels native to New Zealand include the long fin and short fin eels, both of which are difficult to breed in captivity since they migrate out to sea to spawn but spend most of their lives in freshwater. Farmers often catch glass eels, also known as juvenile transparent eels, in estuaries and grow them for the rest of their lives. While this may be a popular practice in other parts of the world, New Zealand law requires a special permit to collect the eels for research only. The long fin eel, indigenous only to New Zealand, is ranked as 'At Risk - Declining' in the New Zealand Threat Classification System listings from 2009, while the short fin eel is indigenous to New Zealand, Australia and some Pacific islands (McEwan & Joy, 2013). The long fin eel is less able to adapt to human impacted environmental changes, such as pollution, dam building, and vegetation loss, than the short fin eel. Off the coast of Maine, in the northeast US, fisherman who catch glass eels have caused a rapid population decline (Sneed, 2014). The depleting of eels due to this practice goes against Māori values. The preliminary feasibility report deemed the difficulties farmers encounter when trying to commercially farm New Zealand eels too tough to overcome for it to be commercially viable option for the hapū (George, 2014, p. 5).

2.6.2 Koura

Koura, a type of freshwater crayfish, are a delicacy in New Zealand. The two species of Koura in the country, the Northern Koura and Southern Koura, sell for high prices at local markets. Many attribute their high value to their slow growing process; a farmer must grow Koura for 2-3 years before the fish reach market size. Additionally, they hibernate in the winter, slowing down their reproduction time. (George, 2014, p. 6).

Currently, the demand for Koura is higher than the production rate. Furthermore, there is not a successful Koura farm in the area. The initial feasibility report recommends "funding be sought to start building a koura farm to help restore local populations of koura and increase to commercial production" (George, 2014, p. 7). Koura's lengthy production time would act as a trial before entering the commercial market. The market consists of Koura for consumption and as an aquarium fish. Currently wholesale prices of live koura for eating range from NZ$65 - $98 per kg. Current approximate price for aquarium koura is NZ$25-$30 each. (George, 2014, p. 9).

Aquaponics would allow the hapū to grow koura within the greenhouse. The system would recycle the water used for the koura and could reuse it to facilitate the growth of watercress. Koura presents a promising option as a potential crop to produce. Further market analysis while in New Zealand will help our team determine the viability of this option within the context of the NKNT Hapū.

2.6.3 Watercress

Watercress, a hardy perennial plant, is another potential crop option as it grows rapidly and thrives in hydroponic cultivation. It is a known as a "super-food" with "antioxidant effects and presence of anti-cancer fighting compounds" (George, 2014, p.7). When harvested in the wild, it often grows in manure or near geothermal waters, such as those present in Horohoro. This poses a problem to the purity of the plant, as manure can contribute to parasites and geothermal waters may cause the plants to contain arsenic. Due to these concerns, there is a market for hydroponically grown watercress in Horohoro. The hapū could cultivate watercress in their greenhouse and grow it year-round. Watercress also grows relatively quickly. Workers first harvest watercress 6-10 weeks after they sowed the seeds when the sprouts are 6-8 inches long (George, 2014, p. 7).

The market for watercress may be unstable as some think it to be a passing fad in New Zealand. However, a Washington Post article from 2014 had watercress topping a list containing 41 super-foods (Bernstein, 2014). Experts have revered this plant for its health benefits since 400 BCE when Hippocrates, the father of medicine, located his hospital by a stream so he could grow watercress to help his patients (Watercress.co.uk, 2015).

There is potential to sell watercress to local restaurants, supermarkets, and local farmers' markets in the region. If the hapū grew watercress hydroponically and without contamination, it would meet New Zealand's demands and food safety standard. The corresponding price differentials follow (George, 2014, p. 10):

- Wild watercress goes for NZ$2 - $4 a bunch
- Hydroponic watercress NZ$4 – 5 a bunch
- Pesticide free watercress NZ$20.14 for 500g
- Baby watercress NZ$4-5 for 100g

Another added benefit of watercress is that it is a nitrogen-fixing plant. This gives it some innate ability to deal with the waste produced by a koura farm (George, 2014, p. 8). The option to grow both koura and watercress in a symbiotic system is a promising one and the team will evaluate its potential using the methods outlined in the following chapter.

2.6.4 Benefits of Hydroponics

Hydroponics would offer a clean and manageable environment in which to cultivate a plant. It requires a steady power supply for pumps and lighting, which the micro-hydro system would supply in Ngāti Kea Ngāti Taura's case. Because hydroponically grown watercress is safer to eat than wild watercress, and food safety is an increasing concern of consumers, watercress grown with this method is in high demand. This principle applies to many forms of produce. If the water in the Poikatu Stream proves to be uncontaminated, this method of growing would yield an untainted harvest and potentially large profit.

Although hydroponic farming does require labor, labor-intensive work needed for traditional farming is not required with the use of hydroponics. Thus, labor costs will be less if we choose to recommend this method.

Hydroponic systems are incredibly efficient. Plants grown using hydroponics use an estimated 1/10 of the water used by the same plants grown traditionally (Vandenberg, et al.). Furthermore, because plants do not need to compete for space in the absence of soil, hydroponics allows for more production per unit area. Plants grown hydroponically typically grow at a faster rate and to a larger size.

The efficiency of hydroponics, especially given how well it aligns with Māori cultural values, makes it a very appealing option. The use of hydroponics to utilize the hapū's excess electricity would further strengthen the marketability of the final product.

The main drawback of hydroponics is cost. Because hydroponic equipment is capital intensive, the hapū may not be willing to invest in this type of venture. However, the efficiency and marketability of a hydroponic system may ultimately outweigh the high initial cost.

2.7 Market in Horohoro and Surrounding Areas

Part of the tourist industry relies on gourmet and fine dining, which has seen success in serving koura, a type of crayfish, and watercress, an aquatic leaf vegetable (George, 2014). These items, and others, are candidate solutions to utilize Ngāti Kea Ngāti Tuara's excess hydroelectric energy (George, 2014). Where "large tourism and wood processing companies have recently completed, or are planning, new investment to leverage greater value," (RDC, 2011) the hapū is situated to collaborate with local tourist industries.

2.7.1 Treetops Lodge

Treetops Lodge is a high-end resort located just 4km from the NKNT Hapū. The Lodge currently has a vegetable garden where guests can accompany the chef to pick fruits and vegetables for the kitchen (Treetops.co.nz, 2015). Dr. Maria Bargh alluded to this resort as a possible business partner to which the hapū can sell the crops the greenhouse produces. With the lodge's current interest in involving their guests in the culinary process, it may be worth exploring a more in depth partnership in which the guests could take a trip to the hapū to explore the greenhouse and immerse themselves in Māori culture.

2.7.2 Hobbiton Movie Set

The Hobbiton movie set is an extremely popular tourist attraction with 240,000 visitors in 2013 and 800,000 since it opened in 2002. (Media.newzealand.com, 2015). The attraction is a 1 hour and 15 minute car ride away from Horohoro; buses run from hotels in Rotorua to the attraction daily. Hobbiton also boasts "Farm Stays", a type of visit that feature a three-course dinner with fresh New Zealand produce (Hobbiton Tours, 2015). Therefore, this attraction offers a promising market for the hapū to sell its produce.

2.7.3 Farmers' Markets and Grocery Stores

There are four farmers' markets in the Bay of Plenty and Wakaito Region: Tauranga Farmers' Market, Waikato Farmers' Market, Cambridge Farmers' Market, and Hamilton Farmers' Market (Farmersmarkets.org.nz, 2015). These markets sell food from local growers and food makers and appear well attended with dozens of stallholders. This venue would require a hapū member to rent and staff a spot at the markets to sell the crops. Farmers' markets are more appropriate for some crops, particularly produce, than others, such as raw fish. We will consider each market more closely after determining which crop to farm. In addition to the farmers' markets, a few local grocery stores may also be worth contacting.

2.8 Distribution Considerations

Distribution plays an essential role in creating a successful business plan; a method of transportation is necessary to get the product to buyers. Ngāti Kea Ngāti Tuara is outside of the primary economic areas; the hapū must consider a method of distribution for the greenhouse's products. The avenues and channels of distribution will depend greatly on the buyer and their location. A hapū-owned vehicle could potentially service a long-term buyer who purchases large quantities of the chosen crop or livestock from the greenhouse. However, if the product requires specialized transportation such as a refrigerator truck, then this may no longer prove to be a viable choice.

Even if the hapū is able to transport their product with fairly simple infrastructure, a localized solution to distribution will become less feasible as the number of buyers increase and their geographic location becomes further from the production site. If the number of orders increases past what is practical for the hapū to complete on their own, then the greenhouse would likely rely on an outside service to adequately solve distribution. For example, an outside firm could pick up the product and distributed it with its own fleet of trucks. Alternatively, the option to wholesale to a specialty food company may prove attractive. If suitable, a wholesale company could alleviate the need for multiple distribution routes, as the food could be brought directly to their facility, and could also find new buyers for the product.

2.9 Greenhouse Design Options

2.9.1 Materials for Construction

The team will consider three candidate materials for the construction of the proposed greenhouse. Glass is the most expensive option, depicted in Figure 7, estimated to be hundreds of thousands of dollars, but also the most durable option, lasting 40-50 years. Advantages include that glass is non-combustible, resistant to UV radiation and air pollutant degradation, and would be easy for the hapū to maintain. Negatively, harsh weather conditions can easily damage the glass.

Figure 7: Glass Greenhouse (Agricultural Structures, 2010)

Polyethylene film, shown in Figure 8, is the cheapest option, estimated at tens of thousands of dollars. It is the simplest form of covering and is very flexible. Photochemical degradation processes in all plastics from ultraviolet radiation, air pollutants, and chemicals from pest control, all resulting in plastic's life expectancy of only 3-5 years.

Figure 8: Thin Film Greenhouse (American Society of Agricultural and Biological Engineers, 2007)

Rigid panels fall under the category of Polyethylene film. This option, displayed in Figure 9, is more expensive than the film but has a life expectancy of 10-15 years and is easier to maintain. Greenhouse designers can space the panels wider apart, creating less shade on the crops than glass. The downside of this option is that it has low air infiltration. This improves energy savings but contributes to humidity, which affects crop production. Better estimates of the materials will be available once we contact local businesses in New Zealand (Giacomelli, 2001).

Figure 9: Rigid Panel Greenhouse (The Big Greenhouse Project, 2007)

2.9.2 Ground and Soil

In order for construction to take place at Ngāti Kea Ngāti Taura, the land must be well-drained, level, of good water quality, and have access to roads for materials and products. A water quality test determines its pH, hardness, salinity, and dissolved minerals.

With the future of a greenhouse in mind, it is also important to consider which method, ground-to-ground (Quonset) or gutter-connected structure, the team should propose for the greenhouse. Quonset is initially cheaper, but its space is limited. Unlike a Quonset design, a Gutter-connected structure would allow the hapū to expand the structure in the future. This design can share environmental control systems and other machines. The downside is that there is no isolation for disease or pest control. Heating and cooling systems are essential for the survival of crops within a greenhouse. Without them, plants grow at different rates, potential diseases arise, and the plant production system requires more maintenance (Giacomelli, 2001).

2.9.3 Trial Greenhouse Possibilities

A trial greenhouse is a possible solution if the team does not feel the economy is stable enough for a more permanent structure or if the initial expenses related to building and maintaining a greenhouse are too high. A trial greenhouse, such as a hoop house as seen in Figure 10, is a non-permanent solution and much cheaper alternative. Mobile hoops allow for the better use of cover crops and crop rotation, while increasing crop production. A full-time hoop house farmer could fit about ten hoop houses onto one acre and earn about $25,000 a year. The downside to a hoop house is that it has no ventilation fans or heater, so the hapū would need someone to open it every morning and close it every afternoon. A solution to this is removing the plastic skin and then covering half of the hoop house with shade cloth. Builders can install sprinklers on the ground or attach them to the top of the hoop house for cooling and irrigation (DeVault, 2003).

Figure 10: Hoop House (Agricultural Structures, 2010)

2.10 Summary of Main Considerations

The design factors in the construction of a greenhouse are not readily apparent, nor are their solutions always easy to come across. However, to produce a greenhouse capable of providing the community with a high level of benefit, our team must minimize the cost and maximize the production of the greenhouse. Crop selection, market variables, distribution, and construction all relate to each other and have their own influence on the project in and of themselves. Their resolution requires the careful outline of these variables and a corresponding translation into suitable and functional methodologies. A thorough detail of methodology will allow our team to convert the existing design problems into workable and concrete recommendations.

Chapter 3: Methodology

The goal of this project is to develop a feasibility plan for a greenhouse that will present the members of the Ngāti Kea Ngāti Tuara hapū with an effective strategy to utilize the available energy produced by the community's micro-hydro power system. The final report will also include a recommendation to solve the intake congestion problem. In order to accomplish the goals of the project, our team developed the following objectives:

- Identify relevant stakeholders and their roles.
- Suggest a strategy to alleviate turbine congestion.
- Research and recommend which crops to grow in the greenhouse.
- Propose a greenhouse structure.
- Investigate methods of distribution for the produced crops.

The team will develop recommendations through an iterative process detailed in Figure 11.

Figure 11: Guiding Research Questions

To answer the questions from Figure 12, the team will utilize literature reviews, interviews, surveys, participant observation and conduct a market analysis. Appendices A - D outline four categories of interview questions: interviews with members of the hapū, interviews with potential business partners, interviews with current greenhouse farmers and managers, as well as interviews with potential distributors. The survey in Appendix E targets tourists and locals to gauge their interest of Māori-produced food.

3.1 Suggest a Strategy to Alleviate Intake Congestion

To address the problem of intake congestion, our team must first concretely understand how the debris affect the system. To do so, the team will meet with local members of the hapū, such as Riki Oneroa and Eugene Berryman-Kamp, as they perform routine maintenance. Dr. Maria Bargh scheduled this meeting for the team's first visit to the hapū. Once the problem is well-defined, a review of technical literature and case studies will allow the team to propose a solution within the first few weeks of the project. Although the hapū may not immediately implement the recommended solution, we can predict its effect on the system and gain a more accurate measure of the available electricity.

3.2 Identify Relevant Stakeholders and their Roles

The primary stakeholders divide into five broad categories: District councils, hapū members, crop buyers, tourists, and distributors. Our team will keep track of stakeholder perspectives using a graph of interest versus influence. Figure 12 depicts the stakeholders plotted according to their interest and influence in the construction of a greenhouse at the hapū. The position of each stakeholder may shift as the project progresses.

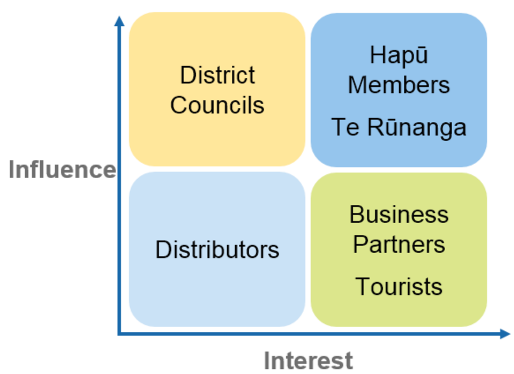

Figure 12: Stakeholder Interest vs. Influence Graph

The team will interview members of the hapū first as the project is fundamentally concerned with synthesizing the needs of the hapū community with the available greenhouse design options. The team hopes to set up interviews through current NKNT connections, such as Dr. Bargh and her contacts in the community, and conduct the interviews in a communal space. To ensure their involvement, the team will interview NKNT members during both visits to Rotorua. The first round of interviews will take place during the first week, and the second will occur during approximately week five (see Table 3). We will interview both NKNT members who live in Horohoro as well as those who have moved to Rotorua and its surrounding suburbs. Appendix A outlines the questions we intend to ask this stakeholder group. In the initial round of interviews, the questions tend to be broad and exploratory. The team is concerned with both gauging the response to our current recommendations as well as providing space for hapū members to voice any concerns that they deem relevant.

The second visit to Horohoro will include focus groups of six to twelve hapū members to present our findings and receive feedback in an environment conducive to conversation. The team plans to interact with more than one focus group to gain many varying perspectives. The questions we will ask depend on the progress of our project up until that point. Our team will synthesize the interview and focus group responses using a coding procedure, which will create sets of data for both NKNT members' individual responses as well as the community as a whole.

The governing district councils form another important stakeholder group. The team will conduct interviews with members of local district councils to ensure that the greenhouse will be compliant with all building regulations. We plan to ask them questions regarding building code and land use policy involved with the construction of a greenhouse. From these responses, the team can ensure that the hapū constructs the greenhouse legally and with the proper approval.

We must also consider the roles of potential business partners and distributors once the hapū members and district councils approve the project. These stakeholders have less direct influence in our project but play a large role in our market analysis. Section 3.3 discusses the interviewing process for these stakeholders.

3.3 Research and Recommend which Crops to Grow in the Greenhouse

This section focuses on the strategies the team will employ to gain understanding of the market in the region surrounding Horohoro. The team will use interviews, surveys, and market analysis to determine which crop(s) to recommend.

Once the needs of the hapū become apparent, the team will conduct interviews with current greenhouse workers along with potential buyers, including restaurants, local markets, and tourist sites. Many of the potential buyers operate near the hapū, as detailed in section 2.7, so the team will schedule these interviews in advance and they will take place during our first visit to Rotorua (see Table 3). Appendix B lists the interview questions for potential buyers. Our goal is to gauge the buyer's desire for a range of crop options and determine if the hapū's crops align with the needs of the business. We can only propose a feasibility plan for a greenhouse once we ensure there is interest in buying the product from the greenhouse, making this is a crucial step in ensuring the success of the project.

The team also intends to interview greenhouse managers and farmers. We will contact these businesses soon after arriving in New Zealand. We plan to gain more insight into possible greenhouse technologies, including aquaponics, by talking to experienced greenhouse workers and asking the interview questions found in Appendix C. We want to determine which crops will work best in New Zealand's weather conditions, as well as gain an understanding of the costs involved with growing and maintaining these crops. The semi-structured interviews aim to answer our own questions as well as allow the interviewee to share further knowledge on other crops with which they have seen success. Real world experience is invaluable, so the team plans to gather as much of that relevant experience as possible.

If time permits, the team will also conduct phone interviews with distributors. The questions in these interviews concern the requirements to distribute the chosen greenhouse products. Section 3.5 details the research process for distribution.

Lastly, to assess the response of the public on our proposed crops, the team will survey tourists and locals in Rotorua. Appendix E outlines questions the team will pose to the public. We will administer this survey to people we interact with on the streets of Rotorua, thus employing convenience sampling methods. The team will hand out clipboards with this brief survey to willing participants. The survey is short in length with the hopes of gathering a larger pool of responses. The scope of the questions encompasses the population's familiarity with Maori cuisine, their willingness to try one of our candidate crops, as well as demographic information.

Although the surveys feature some room for free response, the majority of the form will produce quantitative, statistical data. This data can build narratives that the team can present to business for branding. The team will use this data to determine how successful the crop will be in the market.

The team plans to accomplish this goal within the first couple of weeks since the rest of our goals are dependent on the crop grown inside the greenhouse.

3.4 Propose a Greenhouse Structure

To determine a recommendation for greenhouse structure, the team will use SWOT analysis, cost analysis, and literature reviews. The initial crops considered will affect the design of the greenhouse, as each crop requires different growing technologies.

The team will use SWOT to consolidate strengths, weaknesses, opportunities, and threats for each crop, greenhouse structure option, and technological consideration into one figure. Tables 1 and 2 include two SWOT analyses applicable to our project. The team will learn about New Zealand's weather conditions, the land on which the greenhouse will be built, as well as the materials and prices needed for the construction of the greenhouse through the interviews and surveys we complete.

Table 1: SWOT Analysis for Koura Farm (George, 2014)

Strengths	Weaknesses	Opportunities	Threats
Land available	Trial and error as learn to grow koura	Local market	Already well developed farms in competition
Build off koura restoration projects	Underdeveloped market for koura	Restaurant market	Cold winters
Water available	Slow growers	Potential export market	
Power available	Good quality water imperative	Current farms not meeting demand	

Table 2: SWOT Analysis for a Hydroponic Watercress Glass House (George, 2014)

Strengths	Weaknesses	Opportunities	Threats
Land available	Do not store well	Local market	Potential increase in market is 'just a fad'
Water available		Restaurant market	
Power available			
Easy, hardy plant to grow			

The team will conduct a cost analysis while in New Zealand which will outline specific dollar amounts, as well as what the distribution, maintenance and replacement costs would look like. This approach weighs the initial and maintenance costs of design factors, such as glass, thin film, or rigid panel construction, against the increase in productivity they cause. An initial cost analysis by Kataraina George shows that glass greenhouses fall into the hundreds of thousands of dollars, while rigid panel and thin film greenhouses fall into the tens of thousands of dollars (George, 2014). We will use the information gathered from literature reviews and interviews to conduct this cost analysis. If the analysis is inconclusive, the team may recommend the hapū build a trial greenhouse. The trial would provide empirical data at a low cost that may be hard to come by otherwise.

The team will also investigate projects done by other groups in similar situations. Literature reviews offer knowledge into the thought processes involved in greenhouse design. The team plans to use these reviews to learn about successes and failures, not only regarding the structure of the greenhouse but also the crops grown inside. We plan to find these literature reviews on the web as well as utilizing the resources at Victoria University in Wellington. SWOT analysis, cost analysis, and literature reviews offer valuable insights that we can apply directly to the greenhouse feasibility plan; we plan to further develop these upon our arrival in New Zealand.

3.5 Investigate Methods of Distribution for the Produced Crops

After the team has a good understanding of the needs of the hapū and the surrounding market, and if time permits, we will implement a strategy of market research and interviews to recommend a viable method of product distribution. The recommended crop and the number of buyers directly influence feasible distribution options. If the buyer-count is small, then the team will interview members of the hapū to gauge whether we can recommend distribution jobs to the community.

If, however, the buyer-count is large or the product's transportation requires special equipment, the team will conduct phone interviews with representatives of distribution companies around Horohoro. Appendix D describes the interviewing process. Combining the distributor interviews with market research allows the team to recommend a distribution strategy that will be feasible. Interviews with distributors around Rotorua or currently related to the hapū, if any, will be helpful in this regard.

Although the actual distribution may not occur for another two to three years when the greenhouse is up and running, it is still a large component of the feasibility plan we will propose. We plan to use the interviews discussed in previous sections, as well as literature reviews, and the results of our SWOT and cost analysis to determine the most logical distribution method. The team will not complete this goal until the later weeks of our project, if at all, since the distribution methods depend on the crop grown in side of the greenhouse.

3.6 Proposed Project Timeline

The team devised a timeline of tasks to complete in New Zealand as displayed in Table 3.

Table 3: Proposed Project Timeline

Week 1: Jan 14-20	Week 2: Jan 21-27	Week 3: Jan 28-Feb 3	Week 4: Feb 4-10	Week 5: Feb 11-17	Week 6: Feb 18-24	Week 7: Feb 25-March 3	March 4
Interview local businesses, tourist attractions, markets, etc. as potential buyers	Literature reviews on potential crops and greenhouse structures	Reach out to farmers about growing decided crop to get more information on special skills needed to grow crop	Outline details regarding crop production and green house (size, scale)	Present findings to hapū	Once plan approved from hapū and buyers, continue to work out financial details	Finalize financial details surrounding project and deem a worthwhile investment or not	Final Presentation
Interview tourists in region	Decide on a crop to grow	Reach out to manufacturers about installing structure and get price estimates	Consider distributors	Recommend device to clear debris to be installed			
Identify turbine congestion problem and determine importance and feasibility of solving the issue in our time frame	Decide on structure in which to grow the crop(s)			Confirm interests with buyers in area			
	If deemed important and able to be done in time frame, decide on solution to recommend for intake congestion problem						

Key:
To be completed in Rotorua/Horhoro
To be completed in Wellington

Bibliography

AENews,. (2006). *Micro Hydro Power – Pros and Cons*. Retrieved 8 November 2015, from http://www.alternative-energy-news.info/micro-hydro-power-pros-and-cons/

Agricultural Structures [Photo]. (2010). Retrieved from https://www-static.bouldercolorado.gov/docs/Ag-Plan_Agricultural_Structures-1-201506101323.pdf

American Society of Agricultural and Biological Engineers. (2007). *Air-Inflated Double-Layer Polyethylene Greenhouse* [Photo], Retrieved from http://www.asabe.org/awards-landmarks/asabe-historic-landmarks/air-inflated-double-layer-polyethylene-greenhouse-44.aspx.

Bernstein, L. (2014). Watercress tops list of 'powerhouse fruits and vegetables.' Who knew?. *The Washington Post*. Retrieved from https://www.washingtonpost.com/news/to-your-health/wp/2014/06/05/finally-a-list-of-powerhouse-fruits-and-vegetables-ranked-by-how-much-nutrition-they-contain/

The Big Greenhouse Project [Photo]. (2007). Retrieved from http://hullquist.com/Energy/greenhouse.htm.

Davis, S., & Ebrary Academic Complete. (2010). *Serious micro-hydro: Water power solutions from the experts*. Gabriola Island, B.C: New Society Publishers.

DeVault, G. (2003). *Low-Cost, Versatile Hoop Houses*. *Mother Earth News*. Retrieved 6 December 2015, from http://www.motherearthnews.com/organic-gardening/hoop-houses.aspx?PageId=4

EcoInnovation. (2014). *PowerSpout LH Case Study.* New Plymouth, New Zealand: Ford-Robertson, J., & Lawley, M.

Energy.gov,. (2015). *Micro-hydropower Systems*. Retrieved 8 November 2015, from http://energy.gov/energysaver/micro-hydropower-systems

Farmersmarkets.org.nz,. (2015). *Market Locations*. Retrieved 7 December 2015, from http://farmersmarkets.org.nz/

Franklin, M. (1989). Māori Politics and the Treaty of Waitangi. *The Australian Quarterly, 61(2)* 292-299.

George, Kataraina. (2014). *The Feasibility of Tuna/Koura/Watercress Cultivation*. Te Runanga o Ngāti Kea Ngāti Tuara

Giacomelli, G. (2001). *Greenhouse Structures*. Retrieved 6 December 2015, from http://ag.arizona.edu/ceac/sites/ag.arizona.edu.ceac/files/Greenhouse%20Structures.pdf

Hanson, A. (1989, December 1). *The Making of the Māori: Culture Invention and Its Logic*. Retrieved November 1, 2015.

He Mauri Ohooho,. (2014). *Māori Economic Development Strategy*. *Bay of Connections*. Retrieved 15 November 2015, from http://www.bayofconnections.com/downloads/final%20131024%20-%20BOC%20MĀORI%20ECONOMIC%20Strategy%202013%20small%20FA.pdf

Hobbiton Tours,. (2015). *Farm Stay*. Retrieved 7 December 2015, from http://www.hobbitontours.com/FarmStay/tabid/119/Default.aspx

Hochmuth, G. (2015). *Financial Considerations: Florida Greenhouse Vegetable Production Handbook, Vol 1*. *Edis.ifas.ufl.edu*. Retrieved 6 December 2015, from http://edis.ifas.ufl.edu/cv245

Jeffs, A. (2005). *FAO National Aquaculture Sector Overview (NASO)*. *Fao.org*. Retrieved 1 December 2015, from http://www.fao.org/fishery/countrysector/naso_newzealand/en

Liu, H., Masera, D. and Esser, L., eds. (2013). *World Small Hydropower Development Report 2013*. United Nations Industrial Development Organization; International Center on Small Hydro Power. Available from www.smallhydroworld.org.

Mader, W. (2015).Māori History. *Māorisource.com*. Retrieved 3 November 2015, from http://Māorisource.com/MāoriHistory.html

Māori Television,. (2014). *Project Whenua, Series 1 Episode 10*. Retrieved from http://www.Māoritelevision.com/tv/shows/project-whenua/S01E010/project-whenua-series-1-episode-10

McEwan, A., & Joy, M. (2013). *Freshwater eels in New Zealand: Eels*. *Doc.govt.nz*. Retrieved 6 December 2015, from http://www.doc.govt.nz/nature/native-animals/freshwater-fish/eels/freshwater-eels-in-new-zealand/

McRae, J. (1984). *The Function and Style of Ruunanga in Māori Politics, The Journal of the Polynesian Society, 93*(3), 283-293.

Media.newzealand.com,. (2015). *Fact file: The Hobbiton Movie Set - Tourism New Zealand Media*. Retrieved 6 December 2015, from http://media.newzealand.com/en/story-ideas/fact-file-the-hobbiton-movie-set/

Micro Hydro Power [Photo]. Retrieved from http://www.mapawatt.com/2010/09/30/micro-hydro-power.

Mutu, M. (2015). *Māori Issues*. *FullTextFinder@WPI*. Retrieved 4 November 2015, from http://au4sb9ax7m.search.serialssolutions.com/?ctx_ver=Z39.88-2004&ctx_enc=info%3Aofi%2Fenc%3AUTF-8&rfr_id=info:sid/summon.serialssolutions.com&rft_val_fmt=info:ofi/fmt:kev:mtx:journal&rft.genre=article&rft.atitle=MĀORI+ISSUES&rft.jtitle=Contemporary+Pacific&rft.au=Margaret+Mutu&rft.date=2015-01-01&rft.pub=University+of+Hawaii+Press&rft.issn=1043-898X&rft.eissn=1527-9464&rft.volume=27&rft.issue=1&rft.spage=273&rft.externalDocID=3680566531&paramdict=en-US

Newzealand.com,. (2015). *Early settlement - The arrival of Māori | New Zealand*. Retrieved 3 November 2015, from http://www.newzealand.com/us/feature/early-settlement/

Nzhistory.net.nz,. (2014). *The Treaty in brief - The Treaty in brief | NZHistory, New Zealand history online*. Retrieved 7 November 2015, from http://www.nzhistory.net.nz/politics/treaty/the-treaty-in-brief

Ostermeier, J. (2008). *Micro Hydro Intake Design* (1st ed.). Retrieved from http://www.pumpfundamentals.com/water%20intake.pdf

PowerSpout LH Case Study: Installation at Kearoa Marae In association with Te Runanga o Ngāti Kea Ngāti Tuara. (2014) (1st ed.). Retrieved from http://www.powerspout.com/assets/Published/public/LH/LH-Installs/LH-case-study-april-2014-published.pdf

Portfish.org,. (2012). *Aquaponics vs Hydroponics vs Aquaculture | PortFish, Ltd*. Retrieved 1 December 2015, from http://portfish.org/aquaponics-vs-hydroponics-vs-aquaculture/

Rāwiri, T. (2015). 2. – Tribal organisation – Te Ara Encyclopedia of New Zealand. Teara.govt.nz. Retrieved 1 November 2015, from http://www.teara.govt.nz/en/tribal-organisation/page-2

Schulze, Hillmarè, & Slack, Adrian. (2013). *Bay of Plenty Scenarios: Exploring Alternative Futures*. Berl Economics.

Sneed, A. (2014). *Glass Eel Gold Rush Casts Maine Fishermen against Scientists*. *Scientific*

American. Retrieved 6 December 2015, from http://www.scientificamerican.com/article/glass-eel-gold-rush-casts-maine-fishermen-against-scientists/

Stats.govt.nz,. (2002). *Census snapshot: Māori*. Retrieved 16 November 2015, from http://www.stats.govt.nz/browse_for_stats/people_and_communities/Māori/census-snapshot-Māori.aspx

Strategy Project Reference Group & Rotorua District Council (RDC). (2011). *Rotorua Sustainable Economic Growth Strategy*. RDC Economic and Regulatory Services Committee

Treetops.co.nz,. (2015). *Our Vegetable Garden | Organic Fine Dining, Rotorua*. Retrieved 6 December 2015, from http://www.treetops.co.nz/vegetable-garden

Vandenberg, Halsey Alexander Student author -- CM, Jorgensen, Eric Dean Student author – ME, Gomez Enriquez Riart, Nicolas Student author -- IE, Fitch, Karen Lois Student author -- ECE, Kinicki, Robert Faculty advisor -- CS, & Miller, Fabienne Faculty advisor -- MG. (2015). *Promoting the hydroponics project of the chaipattana foundation in prachinburi, thailand*. Worcester, MA: Worcester Polytechnic Institute.

Watercress.co.uk,. (2015). *Historical Facts | Watercress*. Retrieved 1 December 2015, from http://watercress.co.uk/about/historical-facts/

Watson, M. (2014). *Weekender: Hydro unit helps save on marae power bills - Rotorua Daily Post - Rotorua Daily Post News*. *The New Zealand Herald*. Retrieved 1 November 2015, from http://www.nzherald.co.nz/rotorua-daily-post/news/article.cfm?c_id=1503438&objectid=11228119

Appendix A: Interview with NKNT Hapū Members

Interview Introduction

To begin each interview, our team will ask the following questions:

- Can we record this interview?
- Can we quote your responses in a report?
- Can we use your name in a report?
- Can we attribute your quotes to you in a report?

Then, before proceeding, the interviewer will state the following: To protect your privacy, your name will not be stored next to your interview responses, either physically or digitally.

The interviewer will introduce the project to the interviewee before proceeding.

Preliminary information

- Name
- Age, sex, occupation
- Place of residence
- Relationship to the hapū

Questions

1. Would you like to see a greenhouse built in the hapū?
    a. If so, why do you think the community would benefit from a greenhouse?
    b. If not, why do you think a greenhouse is not a good fit for the community?
        i. Further, is there another project that you think *would* suit the community's needs?
    c. If you do not have a strong opinion, is there any information we could provide which would help inform your decision?
2. Do you think a greenhouse would provide jobs for the community?
    a. Can you, without naming names, think of any members of the community who would consider working in a hapū-owned greenhouse?
        i. If so, roughly how many people can you think of who would fit this description?
    b. If not, why don't you think so?

3. Our team is strongly considering recommending koura and/or watercress as the greenhouse's primary crop(s). Do you find either of these crops particularly likable or objectionable?
    a. If yes for either, why do you say so?
    b. Can you think of another crop that you consider to be a good fit for the community?
4. Do you have any other concerns or information that you'd like to share with us?

Appendix B: Interview with Potential Business Partners

Interview introduction

The introduction is the same as in Appendix A.

Preliminary Information

- Name
- Age, sex
- Occupation
- Place of employment and position

Questions

1. Are you familiar with the Ngāti Kea Ngāti Tuara hapū?
    a. If so, could you describe what you know about them?
2. Has or does your company currently have business relations with Māori-owned businesses?
    a. If so, could you briefly describe the nature of those relations?
3. Does your company have a broad branding strategy?
    a. If so, what is it?
        i. If so, does the Māori community play any role in it?
    b. If not, how does your company market itself?
4. In your experience, does a food labeled "Māori-grown" sell better than the same product without that label?
5. Has or does your company currently sell koura?
    a. If so, does your company consider it a successful product?
    b. If so, how much does your company currently pay for each unit of koura?
    c. If so, who currently sells you your koura?
        i. How often does your company place orders with this supplier?
    d. If you do not currently sell koura, in your judgment, would your company potentially find this product useful?
        i. What would this product's usefulness depend on?
        ii. How much would the company be willing to pay for this product?
6. Has or does your company currently sell watercress?
    a. If so, does your company consider it a successful product?

    b. If so, how much does your company currently pay for each unit of watercress?
    c. If so, who currently sells you your watercress?
        i. How often does your company place orders with this supplier?
    d. If you do not currently sell watercress, in your judgment, would your company potentially find this product useful?
        i. What would this product's usefulness depend on?
        ii. How much would the company be willing to pay for this product?

7. In your judgment, are there any other crops or agricultural products that your company would like to purchase?
    a. Are there any such crops that would strengthen your company's branding?
    b. Are there any such crops that, your company would prefer to purchase from a Māori grower?
8. Do you know of any other buyers who would be interested in buying the previously mentioned crops?
9. Do you know of any other buyers who would be interested in buying any sort of crop from Ngāti Kea Ngāti Tuara?

Appendix C: Interview with Current Greenhouse Farmers and Managers

Interview introduction

The introduction is the same as in Appendix A.

Preliminary Information

- Name
- Age, sex
- Place of employment and position

Questions

1. What is the size of the greenhouse you work in?
2. How much does your greenhouse cost to run per month/year?
3. How much electricity does it use per month/year?
4. Does the cost, energy usage, and growing procedures fluctuate with the seasons?
5. What crops do you grow in your greenhouse?
6. What technology do you use to grow these crops (hydroponics, aquaponics, etc.)
7. Has or does your greenhouse currently grow koura or watercress?
    a. How much does it cost per unit?
    b. How much does it sell per unit?
    c. To whom do you sell it?
    d. What kind of climate control do you use to grow it?
    e. Have you faced any challenges in growing these crops?
    f. Is there any special knowledge a worker must know before growing it?
8. What is the management structure like in your greenhouse?
9. How long does it take a worker to learn to work in a greenhouse?
10. How many employees work at your greenhouse?
    a. How many are working at any given time?
11. What is your distribution method for the crops?
12. Do you have any other information about operating a greenhouse that you could share with us?

Appendix D: Interview with Potential Distributors

Interview introduction

The introduction is the same as in Appendix A

Preliminary information

- Name
- Age, Sex
- Place of employment
- Title of occupation

Questions

1. Does your company have any experience transporting koura or watercress?
    a. If so, what kind of transportation requirements does this crop have?
2. Are there any constraints on what crops you can transport?

Appendix E: Survey for Tourists in Rotorua

Survey information

Our team will potentially distribute these surveys in Rotorua and surrounding tourist attractions during the team's initial visit to the Hapū.

Questions

1. How old are you?
2. What is your gender?
3. Are you a local of this area, or are you visiting?
    a. From where are you visiting?
    b. If you are visiting, what are your lodging arrangements while you are in the area?
    c. What made you want to visit this area?
4. Did the Māori culture have any influence on your visit?
5. How would you rank your knowledge of Māori cuisine?
    a. (I don't know anything about it / I know a little about it / I know a lot about it / I have excellent knowledge of it)
6. Have you ever eaten what you would consider "Māori food"?
    a. If so, what did you eat?
    b. If so, where did you eat it?
7. How much more likely would you be to try a dining option if a Māori village produced it?
    a. (I would not be more likely to try such a dish / I would be a little more likely to try such a dish / I would be a lot more likely to try such a dish / I would certainly try such a dish)
8. Have you ever eaten koura?
    a. (I have eaten koura and I would try it again / I have eaten koura and I would not try it again / I do not know what koura is / I know what koura is but I have not eaten it)
9. Have you ever eaten watercress?
    a. (I have eaten watercress and I would try it again / I have eaten watercress and I would not try it again / I do not know what watercress is / I know what watercress is)