Essential Services for Isolated Communities

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1 Introduction / Background

In the mid-1990s my parents left Mangere (Auckland) and went home to my great grandmother's turangawaewae in the Far North. Both parents had been freezing workers for decades however the closing down of the freezing works, Westfield and Hellaby's (AFFCO), left them unemployed and, in their mid 50s, almost unemployable. My father worked a few years as a bartender at the local tavern while my mother managed to gain employment cleaning at the local school and Auckland airport. Eventually these work options also ended and the opportunity to move home was a reality.

My mother and her three brothers are the sole shareholders of 18 acres of untouched, undeveloped, gorse covered coastal land [on the Karikari Peninsula] located on the East Coast of the Far North. There are less than 100 permanent residents in that area though it is not unusual for the population to swell 30 fold during the summer holiday period. With the approval of her brothers, my mother and my father began the long and expensive process of building a one bedroom whare at Karikari for their retirement. Over a two year period a track was cut through, gorse was cleared from the building site and a Skyline garage was installed and altered to resemble a one bedroom home. Covered decking around 3 sides of the whare gave the illusion of space. During the building phase, my parents and my two brothers travelled from Auckland to Karikari every weekend. They slept in their cars, erected a cookhouse, a long drop latrine and carried water from the nearby camping grounds.

This development was done, out of necessity, with minimal cash outlay. We were 'asset rich' and 'cash poor'. Our major assets were a share in the land at Karikari and the whānau home sitting on a quarter acre section in Mangere. The most painless way to fund the building of the new whare in Karikari was to sell the house in Mangere. However, my parents chose not to finance their retirement with the sale of the whānau home, as it continued to house some of their children and most importantly, some of their mokopuna. Thus, the Karikari home was basic in design and without essential infrastructure when my parents moved in. Over time, a large water tank (the largest on offer to meet the needs of visiting whānau) was installed and a small diesel generator was purchased. These met their most basic needs of intermittent power and access to water for drinking, cooking and washing. It would take almost ten years before an inside flush toilet was installed and working, though this was dependent on the diesel generator running. The luxury of a flush toilet required a septic tank for waste collection and treatment. The cost associated with this essential service was beyond their means so an innovative solution was required. Together, my father and my brother designed and installed their own on-site wastewater management system.

In time, my mother was diagnosed with a chronic illness. We worried terribly for her due to their isolation and distance. Phone communication was poor as no landline could be installed and cell phone signal was, and still is, intermittent. We felt local healthcare services were too far away and community health nurses, especially non-Māori nurses, could not be relied on to visit the whare regularly due to their perceptions of substandard infrastructure (poor roading). At that time, the Karikari whare did not have, and still does not have, continuous power supply or running water (without the generator on) and we felt that as my mother's health diminished, these were unacceptable conditions for living and healing.

It was at this point that this research project was conceptualised. We wanted our parents and all other Māori moving back to their papakainga to do so with access to services and innovative solutions for essential infrastructure technologies, despite our reality of a limited cash base. We believe that without these essential services the health and safety of whānau, in particular the most vulnerable (the sick, kaumatua and pepi), are at risk.

Thus, this pilot project sought to answer the following questions:

- What stand alone onsite infrastructure options for power, water and waste management are available in Aotearoa, New Zealand?
- What do whānau in isolated communities consider to be essential infrastructure and services for a comfortable quality of life?
- How do whānau in isolated communities prioritise essential infrastructure and services?
- What essential services are missing in your isolated community?
- If you have limited power and water resources, how do whānau prioritise power and water use?

- What innovations or practices have whānau in isolated communities implemented?
- What technological innovations do these whānau know of?
- Are any of these innovative technologies or practices transferable for use by other whānau in isolated communities? Can these innovations be shared?

2 Performance against objectives

A	Conduct literature review of infrastructure (water, energy and waste management) options for isolated communities
B	Conduct pilot survey of whānau living in isolated communities to document their infrastructure priorities and local infrastructure innovations
C	Report on analysis of whānau survey responses and evaluation of local infrastructure innovations

2A Conduct literature review of infrastructure (water, energy and waste management) options for isolated communities

For the purpose of this pilot study literature review, essential services refer to the capture and storage of potable water, energy generation and storage and finally, waste management systems. We placed extra limitations on this review in that the options for these essential services are relevant for isolated communities in Aotearoa, New Zealand.

2A.1 Capture and Storage of Potable Water

Access to safe drinking water is essential for health. Whānau in the isolated communities targeted in this pilot study generally did not have access to potable[1] water reticulation from their local Council and were responsible for harvesting, storing and treating their own drinking water supply.

In a normal household it is estimated that we only drink approximately 5 % of the total water that we use. The rest goes down the drain or is used outdoors[2].

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[1] *Potable water*: Water that is safe to drink because monitoring that meets the requirements of the Drinking Water Standards for New Zealand (DWSNZ) has shown it not to contain any contaminants that exceed their maximum acceptable values (MAV) more frequently than is allowed by the DWSNZ.

[2] Metro water website (**http://www.metrowater.co.nz/environment-and-conservation/conservation/Pages/Water_in_your_home.aspx**), 7 October 2009.

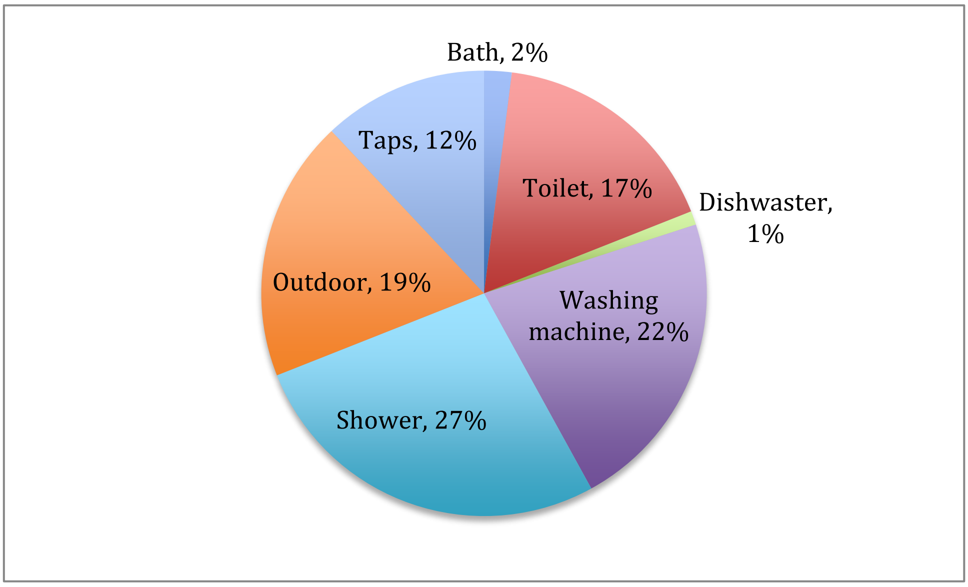

Figure 1. Water use for a typical Auckland household[3]

Water Harvesting

Water can be harvested from various sources (including rain, streams, lakes, bore or springs) then stored in a tank until needed. As water can easily become unsafe either at source or during collection and storage, some form of treatment is required before drinking.

Irrespective of the source of water, the connection between the tank and household plumbing requires a building consent. Some Councils also require a consent to install the tank. Rainwater is commonly sourced for drinking water however, as the rainwater has direct contact with numerous surfaces (roof, spouting, piping and tank), it is important that each component is made from material suitable for rain collection. Rainwater should not be collected if the roofing materials include lead, chromium or cadmium. Furthermore, rainwater can react with unpainted metal surfaces so collection roofs should be painted with paint deemed suitable for potable water supply and, plastic piping is preferred over metal.

Water Storage

Tanks are available in a variety of materials: plastic (polyethylene), concrete, fibreglass, timber and galvanised steel. Concrete tanks render the water slightly alkaline (rainwater is slightly acidic, pH ~ 5.6) from calcium carbonate leaching from

3 BRANZ Auckland Water Use Study, 2008.

the cement. Plastic is inert and will not alter the pH however, the slight acidity of the water can react with copper piping and cause blue staining in baths and showers. Placing marble chips or concrete bricks in the tank will raise the water pH thus stopping the reaction between H^+ (rainwater) and copper metal.

The size of the collection tank selected will depend on the household water needs, amount and pattern of rainfall, area of the collection surface (roof) and the water security required by the whānau.

Rainwater Contamination

Contaminated water will cause illness (diarrhoea and/or vomiting) with vulnerable people (infants and children, pregnant women, elderly and those with damaged immune systems) most at risk. Rainwater contamination is likely to occur during capture and storage. Dirt, dust, bird faeces, leaves, insects, air particulates etc on water catchment areas (roof) or in header tanks are potential health risks to consumers.

Keeping Roof Collected Rainwater Safe

The following devices and practices are recommended to keep rainwater safe.

1. First flush diverter: This is fitted to the tank inlet and prevents the first flow of 'contaminant laden' water from the roof from entering the collection tank.
2. Gutter guards: These prevent leaves and other large contaminants from settling in the gutters and travelling with the rainwater to the collection tank.
3. Screen/filter over the tank inlet: This keeps out insects, birds and other animals.
4. Covering the tank: This will reduce evaporation/water loss and prevent small animals and insects entering the water supply.
5. Using a two tank collection system allows any sediment to settle in the first tank while drawing water from the second tank.
6. Install the inlet pipe to the tank so that the roof water enters the tank from the bottom through a 'U' bend in the pipe. This avoids disturbing sediment in the bottom of the tank.

7. Avoid planting trees by the house as leaves can clog gutters and the trees are convenient roosting spots for birds.
8. Avoid placing TV aerials or other antennae on the roof for birds to perch on.
9. Avoid throwing scraps out on the lawn to attract birds and other animals.
10. Avoid long horizontal sections of piping that are capable of holding water during dry spells and any organic matter in the water will decompose and be forced into the tank following the next rain.
11. Clean and disinfect the entire capture and storage system every 6 to 12 months. Disinfect with 167 mL of household bleach per 1000 L of water. Leave in the tank for a few hours before flushing to waste. It is best practice to clean during high rainfall periods to ensure that the household does not run out of water.

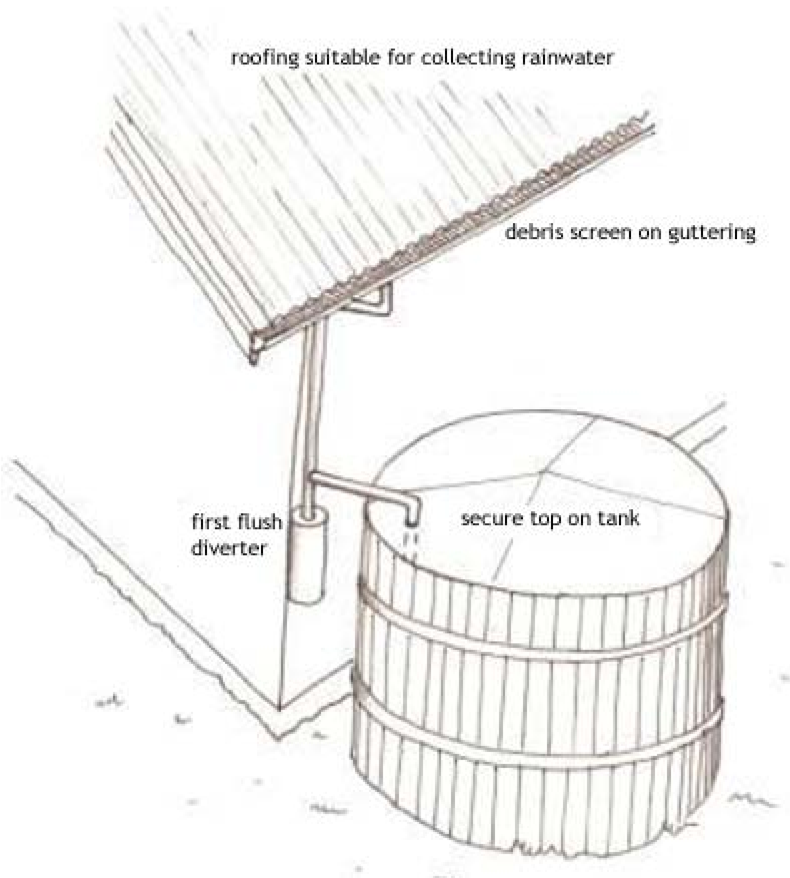

Figure 2. Typical rainwater system set-up to minimise contamination[4].

[4] Diagram taken from the smarter homes website (http://www.smarterhomes.org.nz/water/collecting-and-using-rainwater/) on October 6, 2009.

Despite these initial preventative methods, rainwater should undergo further treatment.

Rainwater Treatment

Rainwater can be treated using a number of household water treatment (HWT) technologies. These are devices or methods used to treat water in the home by removing or inactivating microbes. Coupled with safe storage, these treatment methods can significantly improve drinking water quality.

When selecting a HWT technology it is mindful to know that not all technologies will remove or inactivate all microbes. For example chlorine disinfection will not inactivate the oocysts of *Cryptosporidium sarvum* and likewise, ceramic and cloth filters will not remove enteric viruses. The following is a list of the HWT technologies available:

- Chemical disinfection: chlorine, ozone, other oxidants, strong acids and bases. Chlorine is the most widely used disinfectant as it is effective, widely available and relatively inexpensive.
- Membrane, porous ceramic or composite filters: These remove microbes/contaminants by physically filtering them out as the water passes through the membrane.
- Granular media filters: Microbes are retained by the filters using physical straining, sedimentation and chemical adsorption of the microbes onto antibacterial or bacteriostatic surfaces.
- Solar disinfection whereby microbes are inactivated by solar radiation.
- UV light treatment: UV radiation (wavelength set at 254 nm) is used to inactivate microbes.
- Thermal treatment: These include boiling the water for a short period of time.
- Coagulation, precipitation or sedimentation: Uses the process of coagulation or precipitation to remove suspended particles from the drinking water.

2A.2 Energy Generation and Storage

When your home cannot be connected to the electricity grid, stand-alone power systems can meet your energy needs. These systems are therefore common in isolated communities where connection is either far too expensive or not possible. Connecting to the nearest electricity grid point can cost up to $25,000 per kilometre[5] making the costs associated with stand-alone systems a viable option.

Electricity can be generated from a combination of sources – solar, wind or hydro – then stored in a battery bank. Diesel or petrol generators can also be used as either a primary or back-up supply of electricity.

Figure 3. Battery bank at a household using photovoltaic (solar) panels.

Though these systems provide autonomy from the electricity grid, households will need to carefully manage their electricity use. Adopting the following energy efficiency strategies can reduce the peak electricity load demand meaning that a smaller electricity generating system can be installed at a correspondingly lower cost.

- If possible, incorporate passive solar design into your home. Orient the house to capture and make the most of the sun's heat and include features that will help minimise heating and cooling requirements, such as double glazing.
- Minimise use of electricity for cooking, water and space heating – other options such as gas, wood stoves, solar water heating or a wetback can be more cost effective for these tasks.

[5] Energy Efficiency and Conservation Authority (EECA) Renewable Energy Fact sheet 2: Stand-alone Power Systems, 2008 (http://www.eeca.govt.nz)

- Avoid running a number of energy intensive appliances (such as electric heaters, ovens, clothes dryers and electric hot water cylinders) simultaneously.
- Invest in energy efficient appliances. Look for a high number of stars on the energy rating label on appliances and white-ware. Energy efficient compact fluorescent lights use around 20% of the electricity of an ordinary light bulb.

Total household electricity use and peak loads can be calculated. This is done in the following way:

- List all electrical appliances and lights.
- Note the power that each item will use. This is usually written on the appliance and measured in watts (W).
- Note for approximately how long each appliance and light will be used.
- Multiply the power rating in watts for each appliance and light, by the number of hours it will be used each day.
- Power rating (W) x hours per day = watt hours per day (Wh/day)
- Add the watt hours per day used by all appliances and lights for an estimate of your daily electricity usage. To convert Wh into kWh you simply divide the total Wh by 1,000. For example, a 2,000 watt heater running for one hour uses 2 kWh of electricity.
- Peak demand can be estimated as follows:
- List all electrical appliances and lights.
- Add up the power rating of all appliances and lights that may be used simultaneously. The combined power rating indicates the peak demand.

Solar / Photovoltaic system (PV)

Solar / Photovoltaic systems convert radiant energy from the sun directly to electricity. These systems have a projected lifetime of 30 years, are silent, consume no fuel, require minimal maintenance and generate no pollution[6]. PV systems have

[6] Energy Efficiency and Conservation Authority (EECA) Renewable Energy Fact Sheet 4: Photovoltaics, 2005 (http://www.eeca.govt.nz)

the further benefit of being able to be installed in stages allowing you to expand your system as your electricity requirements and your finances grow.

Stand-alone PV systems usually consist of an array of photovoltaic panels (oriented at approximately 40^{o} to horizontal, facing North), battery storage and an inverter. The PV panels convert sunlight to electricity and this is stored in the batteries. Lead acid batteries (12V to 48V) are commonly used as are sealed and deep cycle batteries. Charge controllers can be purchased and these will control battery charging and extend the life of the batteries. Typically, the batteries will need replacing after 4 to 10 years depending on the quality, sizing and how the batteries were used. As the PV panels produce direct current (DC) this must pass through an inverter to produce a high quality alternating current (AC) that is necessary to operate televisions and other domestic appliances. A rectifier modifies the AC sign-wave power characteristics to be more consistent and suitable for appliances requiring a higher quality power source.

Installation of these systems should be conducted by skilled personnel for safety reasons. New Zealand safety standards for electrical wiring and installation of batteries must be adhered to further reducing the risk of fire. If these systems are designed and installed by skilled personnel, they can be covered by most insurance providers however, homeowners should be mindful of the limits of coverage.

Figure 4. Photovoltaic panels positioned to capture sunlight.

Solar water heating is the most common alternative energy source and kit-set solutions for a variety of situations are readily available. These systems place the water in a panel oriented for maximum direct solar radiation and circulate the water as heated into a hot-water cylinder that may be located on the roof or inside the building. Retrofitting these systems to existing buildings requires care to ensure that the roof structure is capable of carrying the additional loading. These systems are also vulnerable to temperature extremes and problems can result if the system is not designed for freezing in mountainous regions, or boiling in enclosed areas without wind.

Wind Turbines

If there is sufficient wind, a small wind turbine can be considered to provide electricity. Wind turbines often compliment a stand-alone power system. These systems are based on a wind turbine which would replace the photovoltaic panels in the system above or alternatively compliment the solar power source. Electricity is generated as long as there is reasonable wind-speed. A drawback with this option is that no electricity is generated when there is no wind and, if the wind is too strong.

The moving parts on the turbine will also require more attention to maintenance than the photovoltaic panels. As with the PV panels, a battery storage system with inverter to convert the direct current to alternating current is needed.

Micro-hydro

Micro-hydroelectricity systems are an option if you have access to a continuously flowing water supply on your property. These schemes convert the energy available in falling water into electricity and since the water source is flowing constantly, allowing electricity to be generated constantly, no electricity storage facility is required. These systems are also referred to as ‘run of river’ (without significant storage) as part of a water course’s flow is passed through a turbine before being returned.

Geothermal energy

These systems are more complex and usually suited to larger developments as the engineering is not available in the kit-set forms of the previous examples, but rather the engineering solution is designed and constructed for the specific situation being addressed. The use of geothermal steam directly for cooking and heating is an option where these surface features are available, for example in some locations in and around Rotorua.

Fossil Fuel Generators

These are typically for back-up power generation when battery storage is low or in the situation where a renewable energy source is not available or affordable. In some cases battery systems would be cost prohibitive if required to power conventional electric ovens, microwave ovens, washing machines, electric kettles and other high wattage appliances. In these cases an alternative fuel source is usually used such as compressed natural gas (CNG) or liquid petroleum gas (LPG) to run refrigerators, and provide direct combustion heat for cooking and water heating.

2A.3 Waste Management

Waste is defined as any material, solid, liquid or gas that is unwanted or unvalued and discarded or discharged by its owner. Most solid wastes are disposed of in landfills or cleanfills though solid hazardous waste require specialised and controlled disposal often by high temperature incineration. Liquid waste is collected by some type of sewage system, treated then discharged into rivers or coastal waters. Thus for liquid waste, dilution appears to be the favoured solution. Gaseous wastes are emitted from open fires, incinerators, industrial processors and vehicle emissions. Once airbourne, these wastes are very hard to control or manage therefore capturing these wastes before they become airbourne is the best strategy.

For all communities, the way we handle waste is vital to our ability to live sustainably. Reducing waste is a high priority for the New Zealand Government's commitment to sustainability[7] and arguably an obvious priority for isolated communities. The NZ Waste Management Strategy (MFE, 2002) emphasises the reduction of waste by managing waste from the point of generation through to disposal. Thus, the long term challenge for any community is to reduce the amount of waste we generate and eventually discard by taking responsibility for our own waste, expecting to pay for waste (via waste disposal charges, utilisation of non-recoverable resources and, the pollution of our environment) and keeping ourselves informed as to current best practice for the different waste streams (green waste, plastics, paper, glass, cans, hazardous waste, sewerage including greywater).

Isolated communities have limited access to waste disposal facilities. As a consequence, members may have a natural tendency to reduce, reuse and recycle waste since the convenience of kerbside rubbish collections is not an option. Instead, isolated communities have access to transfer stations capable of accepting a range of waste including general waste, recyclables, green waste, hazardous waste, car bodies, scrap metal and whiteware. The location of transfer stations in the Far North District and the types of waste they accept are shown in Figure 5.

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[7] Ministry for the Environment, New Zealand Waste Strategy 2002, Wellington, NZ

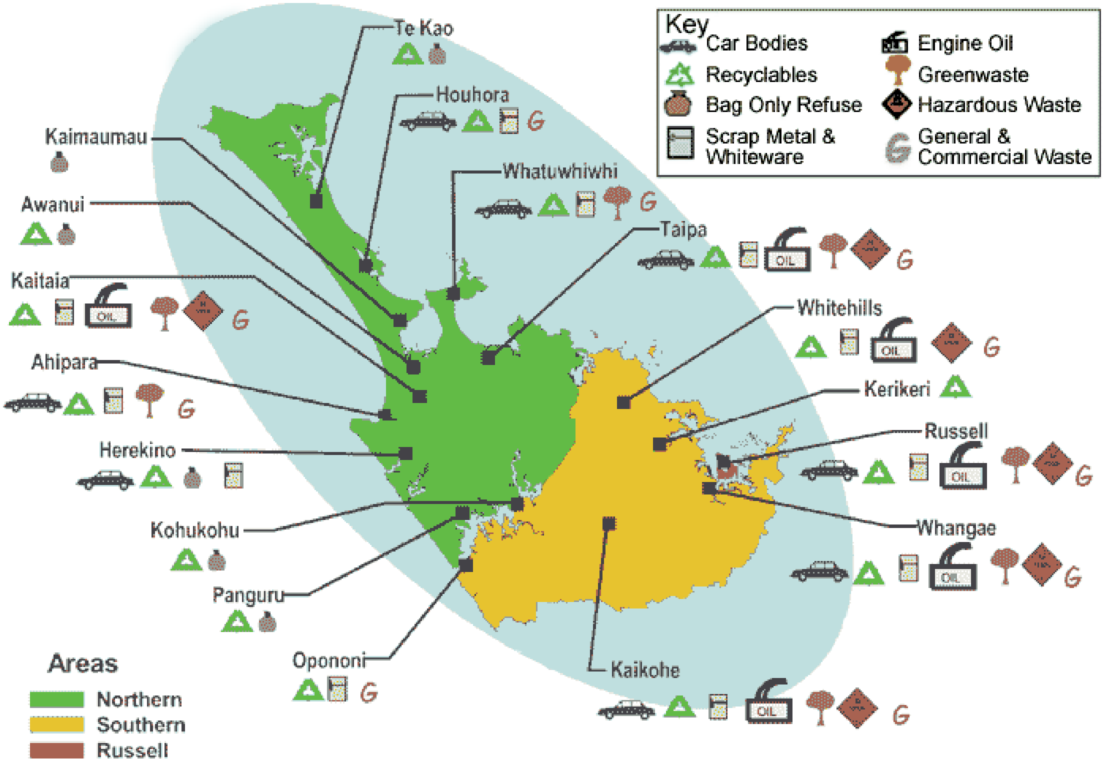

Figure 5. Transfer stations in the Far North, Aotearoa, New Zealand.

On-Site Wastewater Systems

When a mains sewerage system connection is not available, individual households must utilise on-site wastewater systems such as septic tanks with associated soakage treatment area (Figure 6). With these systems, wastewater (blackwater and greywater)[8] from the home is piped to one or more chambers for treatment before underground discharge to a soakage treatment area. The treatment chambers are made of concrete, fibreglass or plastic. Solid waste remains in the chamber and must be pumped out every few years[9]. Installing the on-site wastewater system requires a building consent and in some instances, a resource consent. Regional councils may even impose requirements with respect to the effluent discharge and may insist on additional treatment of the wastewater with ozone, ultraviolet light, filtration or chlorine treatment to render the effluent safe.

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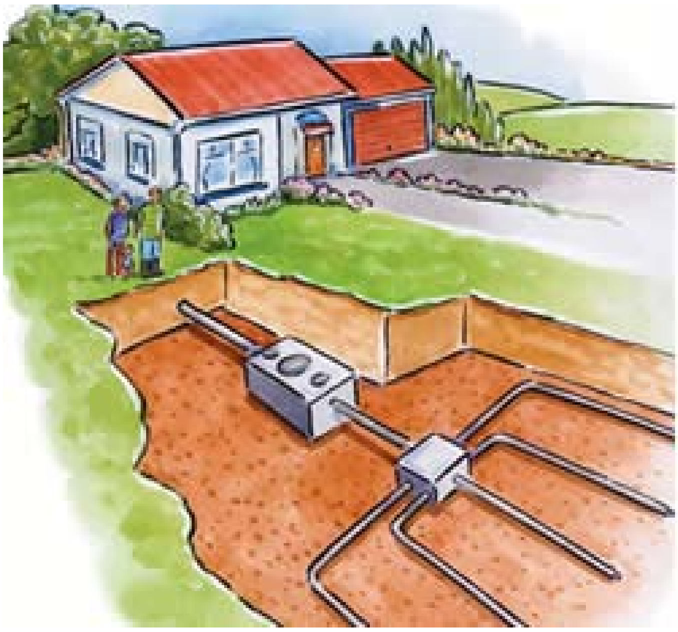
[8] Blackwater is wastewater from the toilet and bidet while greywater is wastewater from all other areas of the household.

[9] The Far North District Council has a bylaw (On-site wastewater disposal bylaw) requiring septic tanks to be pumped out every 3 years.

On-site sewerage systems can break down waste either aerobically or anaerobically. Anaerobic breakdown of wastewater is the established method and is usually associated with one collection chamber. Aerobic breakdown occurs with two or more collection chambers and is referred to as secondary treatment. As effluent does eventually end up in our ground water supplies, it is recommended that secondary treatment is available since the end product effluent is safer for us and the environment.

There are many systems available for those requiring on-site wastewater systems. Most Councils require systems with at least two treatment chambers to improve treatment efficacy. The size of your on-site wastewater system is dependent on the current and future size of the residing whānau keeping in mind that the average person uses 160 to 250L of water per day. Therefore, a family of 6 will require a system capable of treating approximately 2000L of wastewater per day. If the system is not big enough for the number of people in the house, it may lead to ground water



contamination releasing a number of pathogens into the environment. Furthermore, if the household is located close to sensitive environmental areas (e.g. lakes, rivers, estuaries and beaches), these can be polluted making these areas unsafe for recreation, food gathering or harvesting.

The soakage treatment area removes any remaining pathogens before the effluent reaches our precious ground water supplies. Pipes with small holes distribute treated effluent slowly on or just below the soil surface. The effluent reaches the treatment area either by gravity or with a pump. Gravity is ideal in areas where power supply is intermittent or unreliable though the effluent does not necessarily get distributed evenly over the treatment area. Moisture loving plants such as native grasses thrive in the soakage area and their presence will enhance the soakage effect. Soil type and depth[10] determines the required size of the soakage area though Councils often impose the area required based on the area footprint of the house and the number of bedrooms. Even though technology in the area of on-site wastewater systems has improved and requires less soakage treatment area, this is not currently taken into consideration by some Councils.

Greywater reuse

Greywater includes all household wastewater from the kitchen, laundry, showers, baths and basins. Greywater significantly reduces total household water requirements when used for toilet flushing and watering the garden. Installation of a greywater reuse system, particularly if it is destined for toilet flushing, requires a plumber and will need to comply with local building consent regulations.

As greywater can contain faecal matter and microbes, greywater must be separated from drinking water. The presence of microbes in greywater means that users should avoid direct contact with the water. Any untreated greywater should be used within 24 hours. If using greywater for the gardens, it should be discharged under the soil to reduce the risk of above ground pooling that could lead to bacterial exposure.

Greywater reuse hints:

- Divert residual faecal matter away to the on-site sewerage system
- Avoid washing powders that contain bleach or enzymes
- Avoid detergents or cleaners containing boron
- Don't use too much greywater on the garden
- Divert the first flush of water from the washing machine directly to the on-site sewerage system
- Note that greywater is often alkaline (pH > 7) and some plants will not thrive in these conditions. Ask for advice as to what plants will and will not cope with greywater

[10] An Engineer's report and soil analysis may be required to determine where to site the treatment chambers and the soakage field including the size of the soakage field.

- Keep greywater away from fruiting food plants

Dry composting toilets (DCT)

Dry composting toilets (waterless toilets) are an addition to on-site wastewater systems and can take the burden off these systems to cope with black water. The composting toilets are particularly useful in situations where water supply is limited and/or when there is insufficient land available for the soakage treatment area.

Composting toilets work by separating liquid and solid waste with the liquid evaporating off and the remaining solid undergoing aerobic decomposition. The resulting inert product resembles topsoil and is an excellent compost that must be removed and buried in an area away from general use, food plants or bodies of water. Enhanced systems include a negative pressure composting compartment that draws odours away from the toilet cubicle, urine separation, worms for vermicasting, and solar assisted heating for improved composting in colder climates.

A number of proprietary systems are available for a similar cost to a conventional septic tank. While these systems can reliably handle the composting of human excrement, and are better suited to intermittent use than septic tank systems, composting toilets using worms for vermicasting are recommended for constant occupancy situations. Composting toilets require regular unpleasant maintenance such as raking, emptying and pest management.

An on-site wastewater management system is still required to safely manage grey water wastes from the kitchen, laundry and bathroom.

Ventilated Improved Pit Latrine (VIP)

This is a longdrop which includes a negative pressure composting compartment similar to that referred to above for the composting toilets. The negative pressure compartment below the toilet pedestal is created by installing a ventilation pipe in the toilet floor that draws air out of the composting compartment in a number of ways. The simplest approach is to paint the ventilation pipe black so that solar radiation is absorbed by the pipe, heating the air inside the pipe and causing it to rise, thus creating the vacuum in the composting compartment. Other approaches may use the wind to generate an updraft or have a solar powered fan that sucks air up the pipe when the toilet seat lid is opened. For these systems to operate correctly it is essential that the floor of the composting compartment is well-sealed to the ground. A simple alternative for toilets that are used very rarely is to raise the floor of the long-drop and allow air to circulate freely between the composting cavity and the pedestal. However, this approach can be unhygienic as there is no control of flies or other insects that will be attracted to the composting material.

2B Conduct pilot survey of whānau living in isolated communities to document their infrastructure priorities and local infrastructure innovations

Prior to developing the survey interview sheets, a working definition of an isolated community was required. Rural communities are typically defined as having a population less than or equal to 10,000. We decided that our definition of an isolated community consisted of whānau who:

- Live on papakainga with,
- Less than 15 whare on the papakainga and are,
- Dependent on their own water capture and storage and are,
- Dependent on standalone wastewater (sanitation) units

This definition could also have included dependency on stand-alone power systems however many communities, such as in the Tuhoe and Tairawhiti areas, while currently serviced with electricity from the National Grid, do not have long-term supply agreements with their current electricity supplier. Thus, while some isolated communities included in this pilot have existing electricity connections to the National Grid, many may not in the near future.

Finding appropriate interviewers was integral to the success of this pilot project. Our wish was to have Maori interviewers who could whakapapa to and were themselves, part of the communities that they were to survey. These criteria then determined which rohe the surveys would be conducted in. The benefit of interviewers from and familiar with the survey rohe was their relatively easy access to whānau participants based on previously existing relationships of respect and trust.

Initially our target isolated communities were located at Karikari and Ruatāhuna with 3 whānau (separate households) surveyed in each rohe. As the pilot progressed we were fortunate to undertake more surveys, in additional rohe, than were anticipated. The extra surveys were conducted on papakainga at Pawarenga, Awahou and Opihikao (Puna, Hawai'I Nui, USA). A total of ten surveys were conducted.

The survey interview sheet underwent several iterations before interviews began. Interviewers provided valuable feedback on the appropriateness of the questionnaire in terms of content and how understandable it was. Their feedback and suggestions were incorporated into the final survey interview sheet (Appendix 3).

On completion of surveying, interviewers and participants provided valuable feedback with respect to the relevance of the research, the interview process including the interview questions. Did we ask the right questions? Did we leave anything out? Were any questions irrelevant or offensive?

2B.1 Local Infrastructure Innovations

One of our theories and observations prior to the start of this scope was that a limited cash base demanded innovative solutions for services considered essential. For the purposes of this pilot study, essential services in the domestic context are water, energy (for cooking, heating and electricity) and waste management.

Water (Capture, Storage and Use)

Most of our participants use roof catchment (capture water from their roofs) to store for later use in either concrete or plastic tanks. The challenge with this situation is that power is required to move the water from the tank to the whare. For those whānau who are dependent on intermittent power from a generator (half the participants), this poses a problem since water from the taps, and water to flush the toilet, are only available when the generator is on. Two of the participants overcame this 'hoha' by installing a 'water header tank'. Electricity is still required but not for every time water is needed in the whare. Instead, power is used to pump water from the collection tank (every few days depending on water consumption) to the header tank raised several metres high on a platform. Water is then continuously available by gravitational feed to the household irrespective of power supply.

Waste Management

There is no weekly rubbish collection and taking rubbish to the landfill incurs cost. Thus, sorting the rubbish limited the volume of rubbish that needed to be dumped. All food scraps are fed to animals (pigs, chickens, dogs and cats) or used for composting. Recyclable material are further sorted (paper, plastic, tin/aluminium) and only remnant rubbish is dumped at landfill. The local landfill serves as a free source of all manner of goods. Participants regularly source spare parts for cars and whiteware at the landfill before, and in preference to travelling large distances (to the nearest supply town) for the same part and paying too much for the effort. These landfills are well stocked especially if they concurrently serve wealthy, predominantly holiday home, populations.

One participant has converted a leaking water tank into a storage shed after several attempts to get the water tank suppliers to remove the damaged (new) water tank from the papakainga failed. The participant installed a recycled door and several air vents for its new use as a storage shed.

Greywater (from the kitchen, bathroom, shower and laundry) was collected by several households for reuse on their mara. This reuse is particularly important during the hot summer months in areas where rainfall is limited and the water supply is subject to higher use resulting from visiting whānau during the Christmas and New Year period. The mara was a significant contributor to the pataka of these whānau as vegetables (and fruit) in their area are not considered affordable.

Conventional flush toilets require the concurrent installation of a septic tank and soakage treatment area. Two separate households with a relatively large land area to work with, built and installed their own septic tanks for blackwater collection and treatment. Both of these households also concurrently had outdoor longdrop toilets for use during the day and over holiday periods when whānau would visit.

Power

For whānau dependent on intermittent power from generators (3 from 10), spent car batteries are used for lighting (external and internal) and portable radios. This provides several benefits including savings in diesel/petrol by not having to run the generator, savings in batteries for the portable radio and, household lighting without the noise level output from the generator. Solar garden lights and wind up torches are also used during the night when access to power is not available.

2C Report on analysis of whānau survey responses and evaluation of local infrastructure innovations

The survey was developed to answer the following questions:

- What do whānau in isolated communities consider to be essential infrastructure and services for a comfortable quality of life?
- How do whānau in isolated communities prioritise essential infrastructure and services?
- What essential services are missing in your isolated community?
- If you have limited power and water resources, how do whānau prioritise power and water use?
- What innovations or practices have whānau in isolated communities implemented?
- What technological innovations do these whānau know of?
- Are any of these innovative technologies or practices transferable for use by other whānau in isolated communities? Can these innovations be shared?

Whānau responses to these guiding questions are presented in the following sections.

2C.1 Essential infrastructure technologies and service priorities in isolated communities

The principal question that we had as researchers for this project was: What do whānau in isolated communities consider to be essential infrastructure and services needed for a comfortable quality of life (as defined by participants themselves)? Here are their responses:

- Reliable and continuous supply of power e.g. solar energy supply or connection to mains power supply (though this was not an option for half of the participants)
- Access to water for drinking and cooking
- Phone coverage/communication technologies for emergency situations (landline or mobile)

- Vehicle access to and from the papakainga
- Inside toilets especially for vulnerable people (pregnant women, mums, kaumātua and tamariki)

Power supply

Three of our ten participants' only source of power came from diesel or petrol generators. These participants had considered alternative power supply (solar and wind generated) but found the cost of these options far too high. Two other participants had solar power with a diesel generator providing back up supply. These participants recommended solar power over other forms (generator, wind turbines) due to continuous supply, low maintenance of the units, no moving parts and no noise pollution. The participants using diesel/petrol generators and those on solar supply reduced their electricity demand by using gas water heaters (Califonts), cookers and ovens.

Priorities for electricity use differed depending on whether whānau were connected to mains power supply or not. Those on mains supply included cooking, heating water and washing clothes as priority uses for electricity. These did not appear as priorities for respondents living off the mains supply as cooking and heating water utilised gas, while washing clothes was sometimes considered too heavy a burden on water use and electricity demand, and hence were laundered offsite. This raises a necessary adjustment for communities currently connected to mains supply when electricity is no long available to them from the National Grid.

Table 1. Priorities for electricity use for whānau with or without current connection to the National electricity grid.

Priority	ON mains supply	OFF mains supply
1	Cooking	Refrigeration
2	Lights	Lights
3	Refrigeration	Pumping water
4	Heating water	Communication

Priority	ON mains supply	OFF mains supply
5	Washing clothes	Entertainment

High quality drinking water

Water was mainly captured from participants' roofs for storage. One participant sourced his water from an onsite bore. All participants ranked water for drinking and cooking as high priority.

Some participants raised concerns with regards to water security. During the dry summer months where there are extended periods of limited rainfall combined with visiting relatives, water supplies were easily depleted. Practical solutions include encouraging visiting relatives to bathe/shower offsite (fresh water lake, camping grounds) and mandatory use of long drop latrines.

Phone coverage for emergency situations

Half of the participants do not have access to a landline. These participants are wholly dependent on mobile phone communication. The concern for these participants (and their urban based whānaunga) is the relatively poor mobile phone coverage offered by the major telecommunication companies, Telecom and Vodafone. This poses a considerable health risk in the event of an emergency as these participants may not be able to contact emergency services. Alternative, affordable communication devices are required.

Vehicle access to and from the papakainga

There is limited or no public transport passing near the surveyed papakainga (other than the school bus). Thus, participants needed road worthy vehicles to access their homes, the local store and gas supplier, the nearest town including health services. The state of the roads leading to or past their papakainga was of concern to participants especially for those where the road was unsealed gravel. For these participants the general level of public road maintenance was poor. The exception to this is during the summer holiday season when local councils put a greater effort in to the roads for the benefit of holiday makers. Some participants were at increased risk of respiratory illness from raised dust resulting from the large number of vehicles using the unsealed gravel roads adjacent to their papakainga during the summer holiday season.

Inside toilets for vulnerable people

Outside toilets are a reality for many whānau living on papakainga in isolated communities. For our participants, this is a cheap and practical solution to inside flush toilets as water consumption is considerably reduced and there is no pressing need for a septic tank. However, this is not the ideal solution for vulnerable people (pregnant women, middle aged, kaumātua and tamariki) needing to visit the toilet during the night. Indoor alternative solutions are required such as dry composting toilets.

2C.2 Essential services missing in surveyed isolated communities

The following services were missing completely or were poorly provided for:

- Reliable communication technology
- Rural mail delivery to the papakainga
- Same day / Equal service for LPG gas bottle refills from the local service centre
    - Holiday makers received same day or 'on the spot' service while locals were made to wait 1 to 2 days
- Small community supermarkets e.g. Four Square Superette with reasonably priced staple foods (milk and bread)

2C.3 Evaluation of Local Infrastructure Innovations

The following innovations were gathered from this survey:

1. Header tank for water supply when electricity supply is not continuous.
2. Greywater (from the kitchen, bathroom, shower and laundry) collected for reuse on the mara.
3. DIY septic tanks.
4. Spent car batteries used as power source for lighting (external and internal) and portable radios.
5. Solar garden lights and wind up torches are ideal for mobile light.

6. LPG califont for water heating in the absence of continuous power supply.
7. Ventilated Improved Latrine.

These innovations are then subjected to the following assessment criteria which are further defined and given a rating of low, medium or high. An assessment of ‘high’ for any of the criteria is a measure of the viability of the innovation for uptake by other whānau living in isolated communities. The more ‘high’ assessments an innovation has, the more viable it is for uptake. A moderate rating is also an indicator of viability thus a high ratio of high/moderate to low ratings is also desirable.

- Affordability
- Availability
- Maintenance
- Safety
- Serviceability
- Scaleability
- Transferability
- Independence

Table 2: Definitions of categories for assessment criteria.

Criteria	Low	Moderate	High
Affordability	> $500	< $500	< $50
Availability	imported	Auckland	local
Frequency of Maintenance	weekly	monthly	annual
Safety	Requires protective equipment or specialist skills to set-up, use or maintain	Requires physical confinement	No/low risk or danger imposed
Serviceability	Requires specialist technician	Requires training to use and maintain	No training required to use and maintain
Scaleability	Difficult to reproduce in any other context/area	Applicable only within certain areas	Can be used and mass produced in all areas
Transferability	Context specific and unable to be used elsewhere	Applicable only within certain areas	Universal solution
Independence	Dependent on other infrastructure	Applicable in specific contexts only	Universal solution

Table 3. Criteria ratings for each innovation solution used by participating whānau.

Innovation	Affordability	Availability	Frequency of Maintenance	Safety	Serviceability	Scaleability	Transferability	Independence
Header tank	Low	**High**	**High**	Low	Moderate	**High**	**High**	Moderate
Greywater reuse	**High**	**High**	Moderate	Moderate	**High**	**High**	**High**	**High**
DIY septic	Moderate	**High**	**High**	Moderate	Moderate	**High**	**High**	**High**
VIP (waterless toilet)	Low	Moderate	**High**	Moderate	Moderate	**High**	**High**	**High**
Used Car batteries	**High**	**High**	**High**	**High**	**High**	**High**	**High**	**High**
Friction and solar lights	**High**	Moderate	**High**	**High**	**High**	**High**	**High**	**High**
LPG califont	Low	**High**	Moderate	Moderate	Moderate	**High**	**High**	Moderate

The table indicates that all local innovations gathered in the survey are readily transferable for use on other papakainga in isolated communities. Any limitations to their uptake could be considered minimal given their usefulness to residents. In the case of the LPG califont, the ‘low’ ranking for affordability is a cost that most participants must endure in the absence of power connection to the National electricity grid. Without the califont, hot water would not be readily available. The other low scoring innovation, with respect to affordability and safety, is the water header tank. For those participants who do not have continuous power supply to run the water pump to inside (and outside) taps and flush toilet, this is an excellent alternative to turning on the diesel/petrol generator every time water is needed in the home. The benefits for vulnerable whānau members (pregnant women, kaumātua and children) to be able to use an inside (flush) toilet during the nights are also greatly appreciated. The low score for ‘safety’ is due to the very real risk that a 1 to 5 tonne water tank can have if it is sited on a poorly supported platform. The whānau who installed these tanks (1 for each household) were fortunate to have both a builder and a civil and environmental engineer within their immediate whānau.

3 Staff Appointments

Project Leaders	Dr Te Kipa Kepa B. Morgan (Ngāti Pikiao, Ngāti Kahungungu, Kai Tahu)
	Dr Robyn D. Manuel (Te Rarawa, Ngāti Kahu ki Whangaroa)
Subcontractors:	Mr David W. Manuel (Te Rarawa, Ngāti Kahu ki Whangaroa) and Ms Sarah Murray (Te Rarawa)
	Dr Tepora Emery (Ngāti Pikiao) and Mr Del Raerino (Tuhoe)

4 Publications and Conference Papers

5 Work Completed in Addition to Objectives

Initially our target isolated communities were located at Karikari and Ruatāhuna with 3 whānau (separate households) surveyed in each rohe. As the pilot progressed we were fortunate to undertake more surveys, in additional rohe, than were originally anticipated. The extra surveys were conducted on papakainga at Pawarenga, Awahou and Opihikao (Puna, Hawai'I Nui, USA). A total of ten surveys were undertaken.

Dr Robyn Manuel gave a presentation on this pilot project to participants at the Ngā Pae o te Māramatanga winter writing retreat, Rotorua, June 2009.

6 Future Research Directions and Proposals Arising from Project

Both the interviewers and those being interviewed expressed a desire for this project to be expanded and include the following objectives:

- Research and collate available sources of financial and technical support for whānau to acquire essential infrastructure services.
- Research opportunities for technology transfer design.
- Review the available technologies (with respect to water, power and sewage management options) and determine the most appropriate and cost effective solutions for whānau living in isolated communities
- Produce 2 information booklets:
  1) External support available to whānau in isolated communities,
  2) Water, power and sewage management options for whānau in isolated communities.
- Develop response strategies for disaster response to increase community resilience.

What the whānau surveyed want from future research:

- Interest free loans to purchase essential technologies (esp. solar systems)
- Training to manage technological solutions as technical support or assistance can be delayed days or weeks to suit service provider
- Discounts for bulk purchase of systems to provide an incentive to adopt community wide solutions.
- Information regarding available technologies (costs, suppliers, contractors, plans for self-installation)
- Subsidies and Grants guide.
- Solutions that use local resources.
- Solutions that can be implemented by the communities themselves.
- Solutions that draw on existing skills base.

Finally, future research could investigate the driving forces for Maori urban migration; what was gained?; what was lost?; what trends are likely and what can be expected in the future?

7 List of all those involved in this study

David W. Manuel

Sarah Murray

Tepora Emery

Del Raerino

Robyn D. Manuel

Te Kipa Kepa B. Morgan

Whānau participants from:

- Karikari (Whatuwhiwhi, Te Tai Tokerau)
- Kākānui (Ruatāhuna, Tuhoe)
- Pawarenga (Whangape, Te Tai Tokerau)
- Awahou (Rotorua, Te Arawa)
- Opihikao (Puna District, Hawai’I Nui)

8 Summary for a general audience

The pilot project “Essential services for isolated communities” arose out of a desire to make the transition for many whānau relocating from their city/urban lives back home, as comfortable as possible. We wanted our parents and all other Māori moving back to their papakainga to do so with access to services or innovative solutions for essential infrastructure technologies, despite our reality of a limited cash base. In our opinion access to or lack of access to these infrastructural technologies played an important role in the quality of life experienced by our whānau. To this end we have defined essential infrastructure services as those related to water capture and storage, energy generation and, waste management. The first part to this pilot project reviews water, energy and waste management options available in New Zealand for use in isolated communities. This was followed by a survey of 10 whānau living on their papakainga in isolated communities to establish from their perspective what essential service technologies are necessary for a comfortable quality of life?; how are essential services and their uses prioritised?; what essential services are absent?; in the absence of these services, what innovative practices or solutions do they use?; and finally, are those innovative practices or solutions transferable for use by other whānau in isolated communities?.

The results of the survey indicated that the essential service technology priorities for a comfortable quality of life are:

- Water for drinking and cooking
- Reliable and continuous power supply and,
- Waste management system.

And, other services valued are:

- Phone coverage for emergencies
- Year round vehicle access to and from their papakainga
- Inside toilets for vulnerable whānau,

as these are the services that many whānau do not have.

A suite of innovative practices and solutions have been gathered from the participants and these have been assessed for uptake and transference by other whānau in isolated communities.

Appendix 1: Participant Information Sheet

E ngā mana, e ngā reo, rau rangatira ma, tēnā koutou, tēnā koutou. Ngā mihi o ngā ahuatanga o tēnei wā ki a koutou katoa.

Ko Te Arawa te waka

Ko Matawhaura te maunga

Ko Ngāti Pikiao te iwi

Ko Te Rotoiti i Kitea a Ihenga te moana

Ko Ngāti Te Rangiunuora te hapū

Ko Te Puna Whakareia a Rakeiao te marae

Ko tēnei he panui hei whakamarama te kaupapa mo tēnei rangahau e pa ana ki ngā mahi hangatu whare me ngā whakapukahatanga mo ngā rongoa kai runga ngā papakainga o tātou. Na tēnei rangahau hei whakamarama ngā rongoa pai hei whakapiki te oranga o tātou katoa. No reira, me tautoko i tēnei kaupapa hei hapai i o tātou oranga me te oranga o te ao hoki mo ngā whakatipuranga katoa.

Aim of this Research Project

The aim of this research is to identify the essential service technologies needed in remote and rural papakainga developments, assess the associated risks of inadequate levels of access to essential services, and to record and disseminate effective solutions already in use.

Participant Information

Our names are Drs Kepa Morgan, Robyn Manuel, Tepora Emery and Mr David W. Manuel. The consultancy, Mahi Maioro Professionals, is conducting research to identify the essential service technologies that are required in remote and rural developments, and to record effective solutions already being used, and to distribute information about these solutions to participants and other potential end users once the research is complete.

Thank you for taking part in these interviews. The interview can be conducted in Te Reo Māori or English, or both. Your participation is entirely up to you and will involve no more than 3 hours of your time. A survey form will be completed during the interview which will be later reviewed to assist with the distillation of the main technologies identified. If your particular contribution is reported or published, this will be done in a way that does not identify you as its source if this is your preference. You have the right to withdraw your information up to 30 June 2009.

You are asked to note that by signing the participant register, you are agreeing to your participation in this research project. You can terminate your involvement in this project at any time. The research will be conducted during the period from 1 December 2008 to 30 June 2009. Once this project is completed, research findings will be distributed to interested participants. All data will be kept for a period of six years for research and peer reviewed publications.

Ko te kōrero mai rano tēnei.

Nā to rourou, nā taku rourou, kia ora ai te iwi. Mauri ora!

Naku iti noa

Dr Te Kipa Kepa Brian Morgan BE MBA PhD CPEng Int PE

Managing Director
Mahi Maioro Professionals
21 Tiri Road, Oneroa
Waiheke Island
Auckland 1081

Tel: (09) 372 4503 email: k.morgan@auckland.ac.nz

Appendix 2: Whānau / Participant Consent Form

THIS CONSENT FORM WILL BE HELD FOR A PERIOD OF SIX YEARS

Project title: Essential Services for Isolated Communities

Researcher names: Robyn Manuel, Tepora Emery, David W. Manuel and Kepa Morgan

I acknowledge that I have read and understood the Participant Information Sheet and that I agree to take part in a whānau / individual interview for this trial of the Whānau Survey for the proposed research project: *Essential services for isolated communities*. I understand that I will have the opportunity to ask questions and have them answered, and I am free to withdraw myself at any time, and to withdraw any data traceable to me up to 30 June 2009.

- I understand that my feedback will be used to refine the survey process and questions to ensure that research practice is culturally appropriate and that the survey discovers the data relevant to this research.

- I understand that I will be provided with a copy of the final report.

Signature: Date:

Contact: **Dr Te Kipa Kepa Brian Morgan BE MBA PhD CPEng Int PE**

Managing Director

Mahi Maioro Professionals

21 Tiri Road, Oneroa

Waiheke Island

Auckland 1081

Tel: (09) 3724503 email: k.morgan@auckland.ac.nz

Appendix 3: Survey Interview Sheet

Location:

Name of Land Block:

Name of Papakainga:

Number of dwellings:

Number of dwellings permanently occupied:

Number of permanent occupants living on papakainga (Adults / Children):

Number of people living in this whare (Adults / Children):

Size of whare (external dimensions / number of rooms):

Type of construction (timber frame and cladding/ brick / other / photo):

Age of whare:

Insulation (walls / ceiling / underfloor):

Duration that whānau have lived at location:

Income range of whānau (optional):

1. What technologies, for example ‘24 hour a day electricity supply’, are important to you in that they help to make your life here at the papakainga safe and comfortable?

2. Please draw a sketch to show the relationship that your whānau has with the papakainga environment.

3. How familiar/confident/competent are you with the technologies that are available to you?

   Please circle:

   Expert
   Can install, maintain & repair
   Can maintain
   Can contact expert
   No support

4. Please indicate your satisfaction/dissatisfaction with the following domestic arrangements in your home; if dissatisfied with any, please cross them out.

   Water

   Electricity

   Heating

   Cooking

   Communication methods (phone/mobile/mail/web/radio/television/other)

   Vehicle access / mobility

   Solid waste disposal

   Greywater disposal

   Wastewater disposal

5. By ranking 1st – 7th please show the priorities for water use in your whare:

   Drinking;

   Cooking;

   Washing dishes;

   Washing clothes;

   Washing personal hygiene;

   Toilet flushing;

   Irrigation;

   Water for other uses (identify e.g. spiritual or cultural purposes):

6. By ranking 1st – 12th please show the priorities for electricity use in your whare:

   Cooking;

   Heating water;

   Refrigeration;

   Space heating;

   Space cooling;

   Washing clothes;

   Pumping water;

   Communications devices;

   Entertainment devices;

   Treating wastewater;

Treating greywater;
Other:

7. By ranking 1st – 7th please show the priorities for fossil fuel usage (gas or diesel) in your whare:

    Generating electricity;
    Cooking;
    Heating water;
    Refrigeration;
    Space heating;
    Transport;
    Other:

8. By ranking 1st – 10th please show the importance of your location for:

    Access to water supply;
    Land for food;
    Sea for food;
    Lake for food;
    Land for cultural identity;
    Sea for cultural identity;
    Lake for cultural identity;
    Access for people;
    Access for vehicles;
    Access for boats:

9. What are your current solutions for:

    Water supply;

    Sanitation;

    Solid waste;

    Electricity supply;

    Mobility;

Communications:

10. Do you have any innovative technology solutions (for example solar power generation of electricity) that you currently use and consider essential in your situation?

11. What other examples of appropriate technologies that work for other whānau living in a similar situation, are you aware of?

12. Can you suggest ways that could/would improve your current living situation?

13. Please circle one of the following descriptions (in each of the categories) to show what you think is the impact of current technology solutions on the mauri of your whānau.

Water supply:	mauri tū/ mauri piki/ mauri heke / mauri noho (mate)
Electricity:	mauri tū/ mauri piki/ mauri heke / mauri noho (mate)
Fossil Fuels:	mauri tū/ mauri piki/ mauri heke / mauri noho (mate)
Sanitation:	mauri tū/ mauri piki/ mauri heke / mauri noho (mate)
Communicaitons:	mauri tū/ mauri piki/ mauri heke / mauri noho (mate)
Mobility:	mauri tū / mauri piki/ mauri heke / mauri noho (mate)
	fully intact / enhancing / diminishing / destroyed

14. What new technologies would be most useful to you? Please rank if more than two.

15. If accessing these technologies, what types of information would be most useful to you?

    Source of technology

    Information on cost

    Contractors in your area

    Plans and specifications for self-installation

    Other

16. What else do you think we should be asking about in relation to what you consider are the essential technologies and services required in your community?

17. Do you have any preferences how the results of this research are presented back to you?

Please indicate if you would you like to:

- check the interview record after interview
- agree to the use of any photographs taken before use in the report
- check the draft report
- receive a copy of the final report
- have the final report presented back to you at a hui with other participants

Ngā mihi ki a koe me to whānau hoki mo tēnei awhina. Ko te kōrero; Nā to rourou, Nā taku rourou, kia ora ai te iwi. No reira, Mauri ora!

Appendix 4: Far North District Council Drinking Water Suppliers

Kaitaia Water Carriers - M & T Kirtlan 09 4084885 or 027 2246072

Coolstar Water Carriers LTD - William J.King 09 4084098 or 027 2305092

Town & Coast Water Delivery - MJ & DA Wikitera 09 4083662 or 027 2545051

Top H20 Ltd (John Elliffe) 09 4094569 or 027 4843969

Russell Contracting - Roy Francis Hornell 09 4037107

Edward Court 4011276

Ken Rintoul Cartage & General contractors Ltd 4019535

Waterboys - FT & SJ Veldhuizen Partnership 401 9241

Keri Haul Ltd - Lyall Quaife 407 6001

Keri Water Supplies - James Kiff 407 4433 or 027 4521450

Appendix 5: Far North District Council Septic Tank Contractors

Septic Tank Contractor	Contact Person	Areas Serviced
Speedy Septic Tank	Wayne Henwood 09 405 0418	All of Far North District and Whangarei
E Court Septic Tank Cleaning Services	Edward Taki Court 09 401 1276	Kawakawa, Karetu, Taumarere, Moerewa, Otiria, Pokapu, Matawaia, Tautoro, Awarua, Picadilly Road, Te Iringa, Mataraua, Waimate Nui Area, Waimate North, Te Ahuahu, Ohaeawai, Ngawha, Ngawha Springs, Okaihau, Umawera, Horeke, Utakura Valley, Rahiri
BOI Septic Tank Cleaners	Simon Taylor 0274991123 or 09-4037730	Russell-Jacks Bay, Dick's Bay,Parekura Bay, Te Uenga Bay,Rawhiti,Taupiri,Bland Bay,Ngaiotonga,Waikare Valley, Karetu,Kawakawa,Taumere,Moerewa,Maromaku,Motatau, Towai,Waikino,Opua,Paihia,Puketona,Waitangi,Haruru Falls,Ohaeawai,Waimate North
Allens Septic Tank Cleaning Service	Graham Cumming 09 407 8137	Kerikeri, Matauri/Te Ngaere, Puketona, Paihia, Kawakawa, Moerewa, Okaihau, Kaikohe, Ohaeawai
Northland Septic Tank Services Ltd	S and R Guthrie 0800 763 559 or 09-405 3033	Kerikeri, Waipapa, Okaihau, Moerewa, Ohaeawai, Kawakawa, Kaikohe, Paihia, Kohukohu
Reihana Paniora	Reihana Paniora 09 405 4899	South Hokianga, Waipoua, Katuea
Ahipara Septic Tank Cleaners	G Butler 09 409 4739	Service from Hihi,Kohukohu, Rangipoint,Panguru,Pawarenga,Mitimiti and all North to the Cape
Steve's Take Aways - Septic Tank Cleaning	Steve Webster 0274 570399 or 0800 000306	All of Far North District
STY LTD	Michael Young 021 1268725 or 09-4067107	From the Cape to Kohukohu, Rawene, Panguru, Mitimiti, Herekino, Pawarenga, Taipa, East Coast, Hihi, Ahipara
Suckit Limited	Michelle Shepherd 09 408- 0154	All of Far North District and Whangarei
Rossmore Tanks Ltd	Steve & Karla Tyler-Whiteman 09-4337113	Towai/ Hikurangi Area