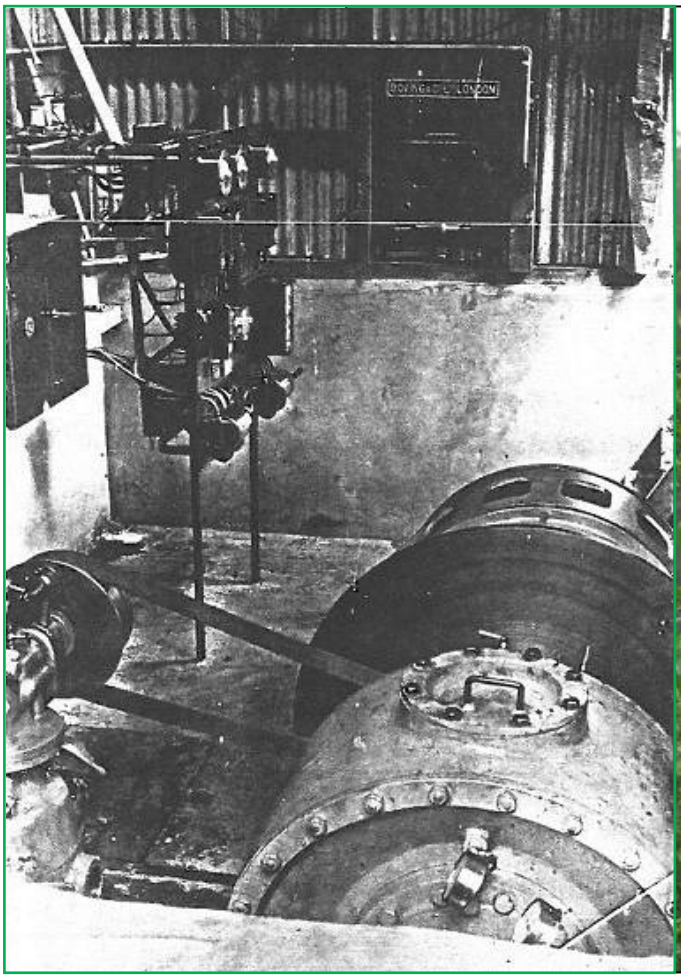
Kerikeri Hydro-Electric Station

Historic Heritage Assessment

Bay of Islands Area Office

Melina Goddard 2011 and Bay of Islands Electric Power Board



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Department of Conservation
Te Papa Atawhai

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Melina Goddard, DoC, Bay of Islands Area Office 2011

Cover image: Left: The powerhouse from 1930, showing the switchboard, and the machinery. The text of the backwall "Boving and Co LTD London" Right: Rainbow Falls M. Goddard 2011.

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Contents

Contents image: *the "lower falls" M. Goddard 2011*

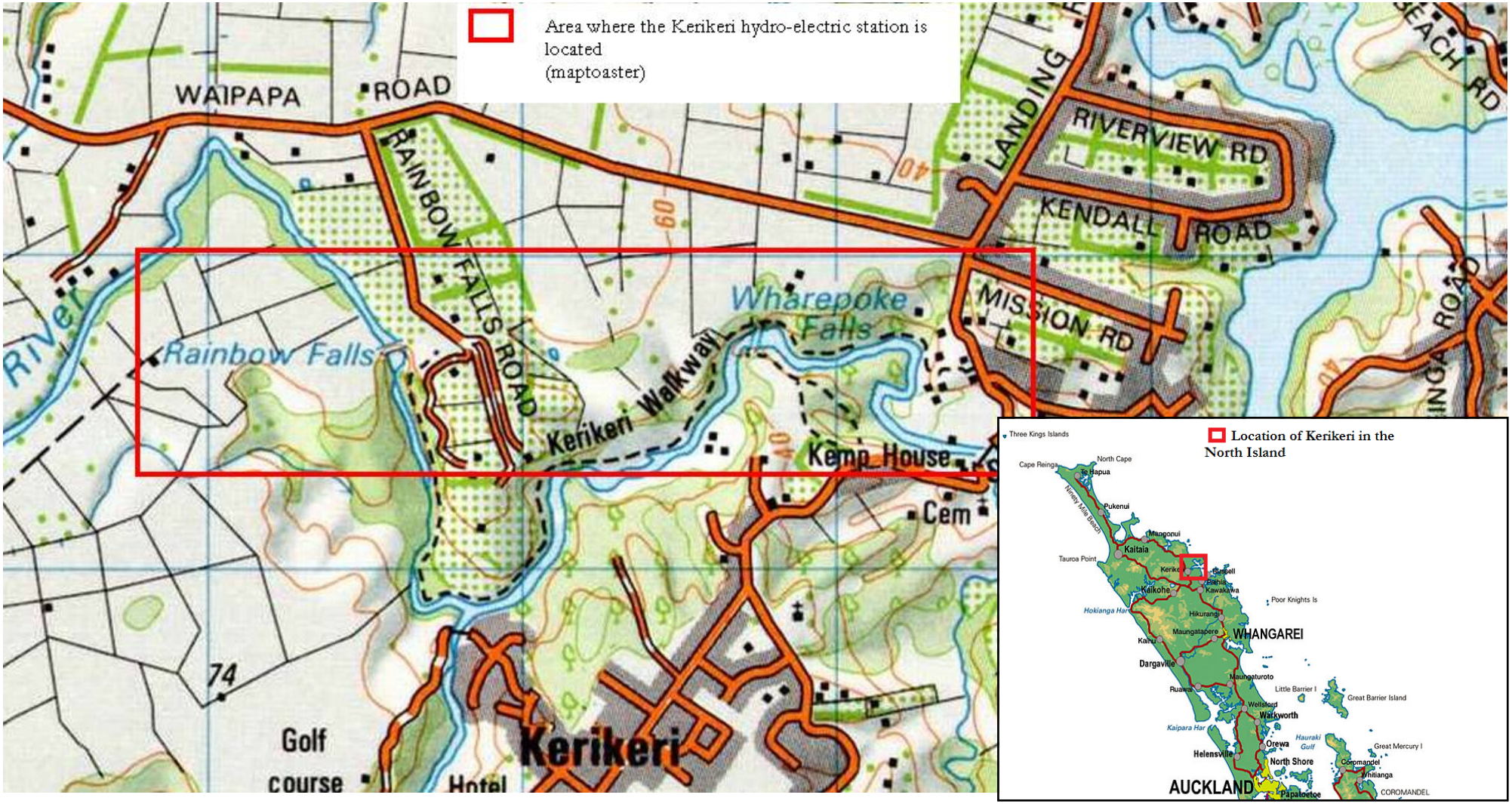

Figure 1: Location map of the Hydro station, Kerikeri

Site Overview

A hydro-electric station is situated along the Kerikeri River Scenic Reserve which is administered by the Department of Conservation (fig 1). It was Kerikeri's first electricity generating station built in the 1920's to attract people and industry to what was then a remote part of Northland. Set up by the Alderton Utility Company, the station began to produce power for Kerikeri on the 11th July 1930. It operated successfully during sometimes challenging times until 1966 when it was deemed to be at the end of its use life. Today the main components of the power station are still intact and represent a period of Kerikeri's early history which shaped the town as it is today.

Land status: *Scenic Reserve*

Administered by: The *Department of Conservation, Bay of Islands area office under the Reserves Act 1977*

Access by: *The Kerikeri River Track, The basin, Edkins Road and Rainbow Falls Road*

Visitor numbers: *Rainbow Falls: 20 months from 2009:36,168. From Basin past the powerhouse 16 months from 2009: 35,253*

Heritage status: P*rotected under the Conservation Act 1987 and comes under the ICOMOS charter as a place of cultural heritage value.*

Site area: *From Rainbow Falls to the end of the access road is approx 1,700m*

Functional location number: *DN-61-200-2063*

NZAA site record #: P05/516

History Description

Prior to 1927 Kerikeri was quite a substantial village, with six European houses, a store, a blacksmiths shop, barns, farm buildings, a church, and a thriving kainga (Kororipo). But by 1927 there were only two old houses, the stone store, a small post office, a church and school.[1] It was about this time when George Edwin Alderton, soon to become a pivotal figure in Kerikeri's history, introduced the "Group Settlement Scheme". The scheme involved establishing citrus fruit farms to be sold. The aim, to attract retiring British civil servants to a new home in a favourable climate, where they could manage an orchard under

expert supervision.[2] It was through this scheme the "Kerikeri Syndicate Limited" that electricity was brought to Kerikeri.

Previously attempts to bring electricity to the north had been unsuccessful. On the 4th of November 1926, delegates from the Bay of Islands and Mangonui counties and the Kawakawa, Russell and Kaitaia town boards had a conference to discuss power proposals. A.E Bisset chaired the meeting and Lloyd Mandeno, later to become the consulting engineer for the Bay of Islands Electric Power Board, submitted a report on the problem of no power in the North. Following the meeting they made an application to the government to consider reticulation of the North. The reply from the minister of works came 6 months later:

"It would appear that without the Whangarei Borough, which is at present supplied by the Domain Portland Cement Company, there is not sufficient load available to warrant extension of the line North from Henderson".[3]

And so the North was left in darkness. Power was essential for the North to combat the comparative isolation, the lack of communication and the relatively primitive conditions. However it was these factors that led to the government considering it not necessary to connect the area.[4]

However, for prospective settlers interested in Alderton's settlement plan "electricity was essential". Given the prospectus for the plan was circulated to China, Malaysia and India in 1928,[5] where Europeans were used to both servants, and electricity.

It was clear that the installation of electricity was necessary to persuade many of the families to emigrate. Richard Benner recalls that:

"As was normal in the East in those days, all households had at least three servants sometimes five or six and ours was no exception. My mother on hearing that servants were virtually unprocurable in New Zealand, said quite emphatically that, without servants electricity was essential, she would not consider coming unless there was electricity",[6]

Due to this overall response regarding settlement of Kerikeri, the North Auckland Land Development Corporation, whom Alderton transferred the Kerikeri Syndicate to, began considering possible ways of bringing electricity to the area. And as a result they formed the Alderton Utility Company. The directors and shareholders consisted mainly of prospective settlers from Asia,[7]

Edward S Little who heard of the scheme from China, and who was now director of the corporation employed Lloyd Mandeno, then a chartered electrical and registered civil engineer to report on the potential of the Kerikeri River as a source of energy for generating electricity and the costs of a hydro-electric scheme,[8]

Mandeno carried out the survey between the 9th and 12th of March 1929 along the river. He found that during dry season there would still be a sufficient amount of water flow to get power from the river, of 300 horsepower (this assumes' the use and storage of diversion of the Puketotara Stream). It was considered that 300 hp was more than ample for the needs of the settlement for years to come.[9] He then suggested the following developmental outline:

- A dam and intake weir to be constructed on the Kerikeri River, upstream from the upper falls (Rainbow Falls).
- This water should be channeled through an open water race for approximately 4,480 ft to a holding dam situated above the proposed power house.
- The power house was to be located just below the lower falls.
- Power was to be generated and then transmitted by high tension overhead lines to various step-down transformers.
- Low tension lines would then convey the current to individual consumer's premises.[10]

The estimated costs for building a 95kw generating plant was at £3,727 with a yearly running cost of £280.[11]Overall the estimates that Mandeno provided suggested that the Alderton Utility Company should just make a profit in its first year and that when all debentures were redeemed they should be in a good position to make a profit regularly.[12]

The Alderton Company based on the reports from Mandeno applied for a licence to generate and approval was swiftly received by the Public Works Department. By the end of 1929 10 months after the scheme had been initiated construction began along the Kerikeri River.

All of the construction was done manually mainly by men from Yugoslavia. These men had previously worked the gum fields of Northland and were now out of work and eager to take on anything. The work was a digging, hauling and building operation. For unskilled labour the Company was paying 1s 4.5d per hour and also providing camp and cooking utensils for the men. This is compared to A.E Thompson who was in charge of line erection and other related work, a skilled job and was being paid £6 per week.[13]

As outlined by Mandeno the concrete dam and diversion weir were constructed above the upper falls, or Rainbow Falls as it is known today (fig 2). Before construction could begin

Figure 2: Construction of the concrete dam and diversion weir at Rainbow falls (BOIEPB).

the river needed to be diverted to the south bank. This was done during a dry spell in December 1929. Earth filled bags were placed upstream from the weir site forming a coffer dam. They then grouted (mixed sand, cement and water) eight 3/4inch steel pins into the rock bed. The surface of the rock was cleaned of slime and roughened in order to make a secure bond with the concrete. They built boxing to make a tidy alignment and concrete was poured and built up to the required height.[14]

The diversion weir then fed the river into the water race that started at Rainbow Falls and covered a distance of 4,480ft all of which was hand dug apart from 550 ft that was a natural waterway (fig 3). It ran over paddocks and through Captain Edkins property then across a suspended sheet-iron flume.

The race then went across more paddocks and into an aqueduct that led to the fore-bay above the power-house. The water was held in this earth dam above the power house and then conveyed through concrete pipes into the powerhouse. The water race was fenced to prevent stock getting caught in the race which would block the flow of water to the power house and cause a black out for the settlement.[15]

Figure 3: Part of the water race being inspected by the Russell Power Board (BOIEPB)

The power-house was built on what was allotment No. 16 on Kemp's old land claim plan number 60 on the north bank of Kerikeri River just below the lower falls. The site was chosen by Lloyd Mandeno for its central position to the land development scheme and the natural gradient that the presence of two waterfalls indicated.[16] The power house was situated in a position to avoid floodwaters of the river and Mandeno also noted that he planned to build 3 feet concrete walls around it to protect it from floods. The powerhouse was safe up until 1981 when it was washed away in a flood.[17]

The Kerikeri hydro-electric scheme was undertaken with a view to being fully automatic, capable of running without continuous attendance. In August 1929, tenders were called for a 130 hp turbine and a generator, and including governor, exciter and voltage regulator. The suppliers of the machinery for the power house were electrical firms in Auckland and Wellington. The machinery was brought to Kerikeri by boat and a Mr. C.O Tubbs was responsible for receiving and delivering the machinery to the power house site.[18]

The house wiring was done by a group of Auckland electricians. There were light points and power points for radiators, irons and other portable appliances. Special installations were required for cooking stoves and water heaters.

On Friday the 11th June 1930 the power was officially turned on in Kerikeri. At this time there were 16 transformers and 17 consumers and reticulation measured a distance of about 5 miles.[19]

After the power was turned on Mr. Little released a promotional document which he called 'Electricity Company Notes':

"It is an unqualified success. It is remarkable the change that has come over domestic life by the arrival of this silent servant which is always willing and does not go on strike". [20]

Little talks of the powerhouse as a major step for Kerikeri, which has attracted interest from all over New Zealand:

"Our powerhouse is the last word in modernity and is absolutely automatic. Nobody goes near it except once a week to see the lubricating oil containers are full".[21]

"The plant is self contained- a perfect unit- and is so constructed that it can be doubled or trebled as further current is required".[22]

To establish Hydro-electric power during the depression, and to bring to Kerikeri the first sizable electric plant north of Whangarei, when Kerikeri was by no means a major town was no small feat.[23] As more settlers came to Kerikeri the reticulation was further extended and by July 1939 it had increased to 11 miles with 94 consumers.[24]

For the supply of electricity consumers were charged a flat rate which was based upon the number of rooms in a house, the number of people over 16 living in the house and the quantity and size of appliances. Overall the system meant that consumers paid for electrical consumption based upon how much electrical equipment they owned not on how much electricity they used in total.

This however led to instances of wastage. For example radiators were left on all night with containers of water on them, not only did this keep the house warm but gave hot water early in the morning. Others would leave the oven on with its door open all night and the Homestead often left its lights on all night[25]. One power customer was charged for 150 light bulbs. He placed these above his fruit trees in the hopes that his plants would grow faster and stronger as he thought they would grow not only in the day but at night as well.[26]

The Company's profit from the supply of power was minimal. They reportedly had many debts and received threats from the bank and creditors. These issues developed from not charging consumers enough and consumers not paying their debts.[27]

In 1932 Mandeno advised Alderton Co to install meters, however the company was in a position where they had no finance to do this and without the needed meters they had no

finance forthcoming.[28] As stated by Mandeno, Kerikeri consumers brought their electricity at a lesser rate that any other consumers in New Zealand[29]. It was not until H.S Benner took over the chairmanship of the Company in March 1935, that the Company began to recover from its financial problems. Bennett was one of the original purchasers in the land development scheme and had a strong business background. He was able to push through the installation of meters in individual households making individual consumers financially responsible for the power they used.[30]

Figure 4: The powerhouse under construction (BOIEPB)

Not wanting to shock consumers with the new meters and the costs that came with them after they were installed he gave them a month long trial period at the end of which the Company sent them the bill that they did not have to pay, but gave them an idea of future costs. As a result some power bills went down 25% as the previous wastage decreased. Additionally this remedied the load problems the Company had been having and they were now able to connect more households to the supply.[31]

The safety regulations of the station also had an overhaul in 1935 when Mr. Reid Anderson became the director of the Alderton Company. Anderson had been a Scottish electrical engineer who had been in charge of the Shanghai Power Company, a coal burning power station. Anderson got all the safety procedures of the power house up to standard. A few months later when caretaker Perrin Williams fell off a ladder from getting an electric shock, he received no sympathy and was told it would never have happened if he had used the newly purchased safety equipment.[32]

The station had one full time caretaker employed to run and maintain the station. Its first keeper was Mr. A.R Emanuel (his father being the director for the Alderton Company). He described his job as "secretary and general dogs-body". He worked for 2 years at £40 per annum. He conducted a weekly check of the power house and the lubrication of all the moving parts. His main concern was to keep the power generating which involved investigating faults at all hours of the night. It was also his job to collect bills from the consumers and to "drop everything" when Mandeno came (usually twice a year) for checks, such as earthing tests on the transformers. Emanuel resigned in 1932 which he says he was glad to be rid of.[33]

The replacement was a Mr. Perrin Williams. He was described by Mandeno:

"this young man is strongly recommended by his late employer as being of very dependable type and I am satisfied should fill the position well both in the matter of attention to the plant and also in dealing with the consumers requirements…".[34]

A letter dated 19th August 1932 from Mandeno to Williams outlined his job:

- Keep a weekly log which included a water level reading.
- Keep Mandeno informed of any proposed changes in the equipment or distribution systems.
- Keep the race and the screens free of obstructions.
- Ensure the brushes, rings and commutators were working freely.
- Keep an eye on the turbine bearing and repack the stuffing box, taking care not to run it too tight.

During times of floods there was a high possibility of damage occurring to the race, particularly at the spillways or overflows. Therefore he needed to clean the screens more frequently during this time. In times of drought it was important to ensure that sufficient water was brought down the race to the power house. If the water level fell to low at the

forebay (earth dam), the governor would open at full gate and the power house would continue to run at a reduced speed with gates wide open.[35]

Mr. Williams worked with the Alderton Company until it was taken over by the Bay of Islands Electric Power Board in 1940, and worked for them until his death in 1950.[36] Ted Gawthorne a retired engineer of Rawene Hospital took William's job and then his successor was J. Draper, followed by Mr. H.S Blackwell and Rangi Wynward.[37]

Despite their financial difficulties the Alderton Company continued to operate at low prices and was a great success. However the company came under pressure as the population of Kerkeri increased and with it the demand for electricity. In March/April 1933 the forebay above the power-house was deepened to increase storage capacity for times of drought coupled with higher consumption. The plans to divert the Puketotara stream had not yet come about due to the difficulty of obtaining the appropriate permissions firstly from NALDCO and later the Public Works Department.

In May 1935 the company wrote to Mandeno that they were contemplating either duplicating the present plant or purchasing a diesel engine which would carry the load during dry spells. However opposition to this came from the Public Works Department and during the depression "money was scarcely to be found anywhere".[38]

As early as 1935 the Company had shown the desire for the station to be run by different hands. They asked the Public Works Department if the government would be interested in taking over the station. However they replied that an isolated and purely local business such as this could be more economically run by the people of the district than by a government department.[39]

By 1936 the population of Kerikeri had grown to 217 inhabitants compared to the 68 in 1926. And the company's ability to supply power to everyone was inadequate.[40]

In 1936-37 the Bay of Islands Power District was formed, its aim to fully reticulate the North. The Alderton Company made contact early with the board requesting the supply of bulk power. In 1938 the board agreed to support the Company and that the linking of the board and company would be the best economic solution to the difficulties they faced. As far as charges were concerned, for most those of the Bay of Islands Power Board would be similar to those of the Alderton Company.[41]

Also during 1937 the suspended iron sheet flume which connected the race over a gully was replaced with a totara aqueduct which is still standing today (fig 9). An account of the iron aqueduct by R. Benner sums up its replacement:

"My Father took me, in 1935 to have a look at the old aqueduct to see what was going on because the water supply seemed pretty poor and we found to our astonishment that it looked as though it was made of corrugated iron and number 8 wire tied together to form a flue. I am probably wrong, it might well have been 44 gallon drums instead, welded together, but there was a series of little waterfalls coming out of it all the way across and we got the idea that perhaps they were getting about 50% of the original water supply by the time it had gone over this aqueduct".[42]

The Kerikeri Settlers Association had become active in persuading the board to take over the interests of the company and to extend its operation to Kerikeri. A census was taken by the association in 1939 which showed that 93 people had electricity and 123 did not. Additionally a petition to the board signed by 141 Kerikeri residents requested they supply power to them.[43]

Rather than supply power to the Company the board decided on 23rd June 1939 that they would be prepared to discuss taking over the power station from the Alderton Company. On 20th July 1939 the company indicated they were willing to sell. The Board requested a valuation of the plant to be done and it was estimated at £5868. The Board offered the company £5700 for the whole station and this was finalized on 3rd April 1940. The Alderton Company who had supplied electricity to Kerikeri by the skin of its teeth for 10 years was now in liquidation.

From 1940 up until its close in 1967 the station was run by the board a larger and more influential organization, and the problems of debt and upkeep began to disappear.[44]

Most of the work done by the board in connection with the station took place in the 1940's, when the board was reticulating all of the area north of Hukerenui and had to ensure that the supply they extended to Kerikeri was co-ordinate with the existing supply. One of the first things that the board did was move the lines onto the roadsides making them easier to maintain than having them cross country and through Eucalyptus windbreaks.[45] All of the power produced by the station was fed into the grid system. If the system failed for any reason a switch would activate and enable the station to continue to supply only Kerikeri. If this did not happen Kerikeri would be unable to carry the load and the gate would automatically drop, shutting the flow of water to the turbine. A visit to the station was then needed to start the turbine and synchronize the Kerikeri station to the grid.[46]

In 1959 repairs were carried out on the station, and it was estimated by the Acting Engineer that the station had another three years of life left in it. The station however continued to operate for another six years. On the 31st January 1966 the figures were considered, it was found that the cost of running the plant was more than the return and they were having

trouble with the hydraulic governor. Then in December it was reported that the station was at the end of its useful life and its disposal was recommended.

"This small hydro-electric plant, which began life supplying power to consumers in and around Kerikeri in 1929 developed some serious faults in the governor equipment and as the headworks, governor and other small parts have come to the end of their useful economic life with the water resources available, the board decided during the year to close the plant". [47]

When the Bay of Islands Electric Power Board closed down it was supplanted by North Power, and today electricity is supplied by Top Energy.

Fabric Description

The station was closed in 1966 and the headgate was filled in sometime after 1967. The wooden gates from the point where water was taken in from the concrete weir at Rainbow Falls were removed in the 1980's by ranger Bill Wright.

A flood in 1981 is said to have washed the powerhouse away and the tailrace still contained flood debris in 1992.[48] Many of the smaller features such as the race gates, power machinery, transformers and the means to transmit power are missing.

The Bay of Islands Power Board states that the machinery in the power house was not replaced during its 37 years of operation. According to various accounts (Rangi Wynward and others) the machinery was removed prior to 1980 and stored by the BOIEPB. In the mid 1980's the turbine was returned from the Kaitaia depot to the Ranger Station (presumably Bay of Islands Area Office). It is reported that the generator, fly wheel and exciter were at Waitiki Landing in 1981 and that Perrin Williams the caretaker of the station designed "robot" that cut water to the turbine during times of drought was in store at Kaikohe.[49]

The station was first recorded as an archaeological site (P05/516) by McKay in 1982. In 1986 Challis described the features in more detail and drew a rough sketch map. The site was visited by J. Robinson in 1992 who conducted a brief site survey. The power house foundations were excavated in 1993.

In 1995 the housing structure of the powerhouse was rebuilt and the turbine and generator were reinstalled. Interpretation of the machinery and a brief of the station's history is in the power house and also at the dam and concrete weir of Rainbow Falls.

Much of the main components of the station are still intact and in good condition. The race in parts runs over private property and some damage may have occurred. The main threat to the race however is one which was experienced when it was operational and that is

vegetation growth in the sides causing parts to collapse. Regular maintenance spraying can act as a preventative.

The following description is of the hydro-electric stations component parts as they are documented by the Bay of Islands Electric Power Board:

- *1 concrete diversion intake weir and gates above Rainbow Falls.*
- *4 sections of open water race totaling 4480 feet in length:* The race was fenced and bridges were built over it to allow stock movement. Included in its length was 550 feet of natural water way. In 1946 a new water race was installed in the area of Waipapa Road and reportedly an emergency weir although further information of this was not found. Prior to 1966 two further wooden water gates were situated in the race between the weir and the old wildlife station.
- *A 78 foot suspended sheet iron flume*: This was replaced in 1937 by a totara wood aqueduct flume supported on a substantial structure that is still standing today.
- *1 small earth dam at the forebay above the powerhouse*: In March/April 1933 the forebay above the power-house which feeds into the headgate was deepened to increase storage capacity up to 1000 gallons for times of drought coupled with higher consumption.
- *1 18 foot headgate at the top the cliff.*
- *A penstock and concrete pipes.*
- *1 power house building:* The substructure was of concrete while the superstructure was galvanized iron on a wooden frame. This contained the turbine, a 400 volt generator and ancillary machinery.
- *1 access road and gateway connecting the main road to the powerhouse.*
- *1 tailrace returning the water to the river*: This was reportedly deepened in the 1940's from 3 ft to 30 ft.
- *Transformer substations boosting voltage to 11,000 volts.*
- *Overhead lines strung on poles and carried over the river by a swing suspension bridge that took power to Kerikeri.*

Based upon the surveys by Challis and Robinson the major features of the hydro-electric station are all still in existence and were relocated in 2011 (fig 5).

- The concrete weir and dam at Rainbow Falls (figs 6 & 7)
- The 4480 foot water race (in part) (fig 8)
- The wooden aqueduct flume (fig 9)
- The earth dam above the power house (fig 10)
- The headgate (fig 11)
- The concrete pipes and penstock (figs 12 & 13)
- Access road to powerhouse
- The reconstructed power house with turbine and generator and two transformers.

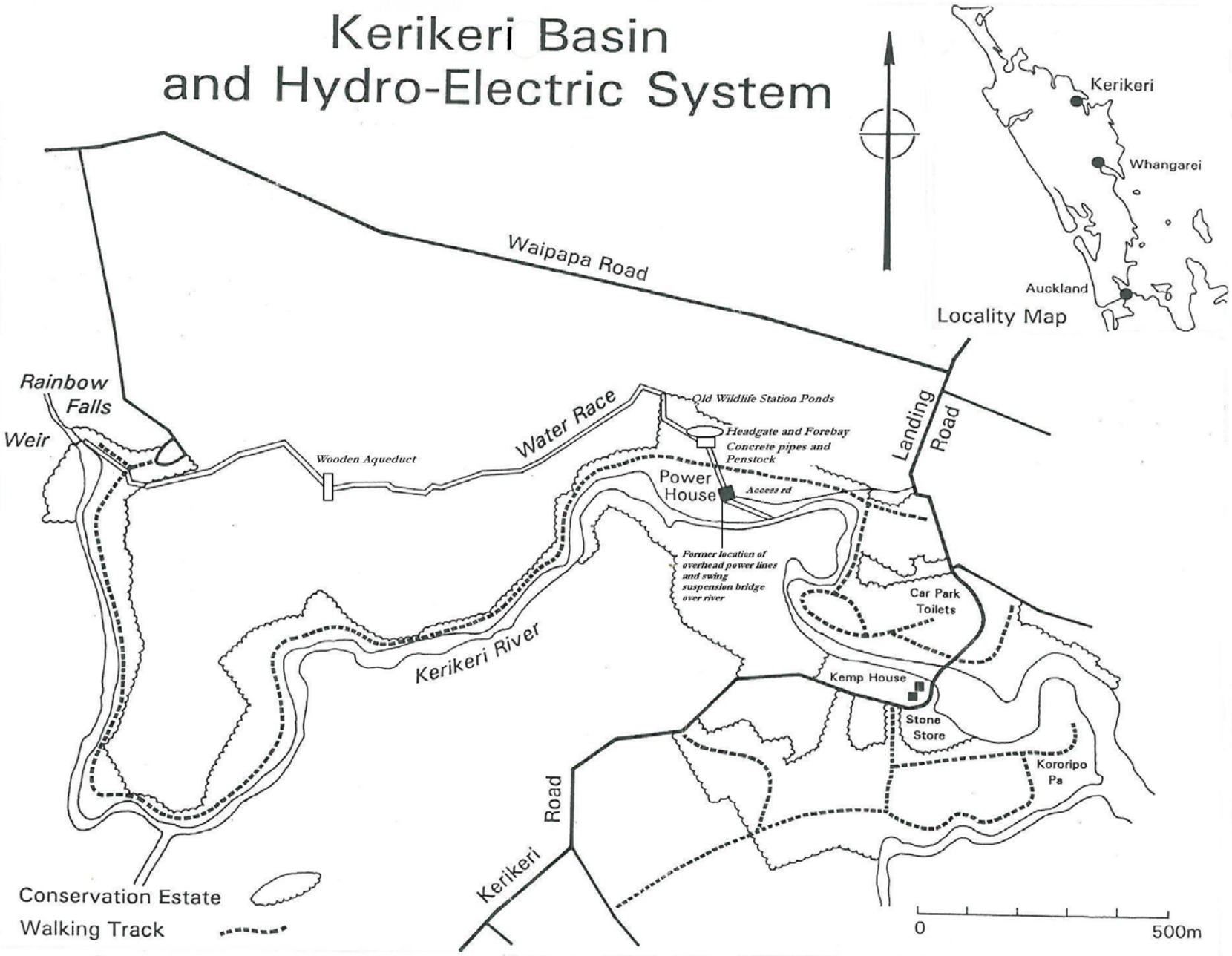

Figure 5: Location of hydro-electric station features by Robinson 1993 added to in 2011 by DoC

The concrete dam and diversion weir at Rainbow Falls

Figure 6: The concrete dam at Rainbow Falls (DoC 2011)

Figure 7: The entrance to the race at Rainbow Falls (DoC 2011)

The 4480 foot water race

This is up to 2m deep and winds through the scenic reserve from Rainbow Falls and eastward through private property over a gully behind Blue Marlin Drive, then by means of an open wooden aqueduct flume to the top of the cliffs at the old wildlife station.

Figure 8: A section of the water race at Rainbow Falls (DoC 2011)

The wooden aqueduct flume

This is built on cross posts that are bolted and concreted into the ground surface and is quite stable. However the open square flume is deteriorating.

Figure 9: The totara aqueduct that reconnects the race over the gully (DoC 2011)

The earth dam above the power house

The wildlife station is closed and reportedly in 1992-93 the ponds still contained water and have small gates which allow drainage into the race. On a visit in 2011 visit these ponds were dry and the small gates described were not relocated. It is suggested that one or more of these ponds is likely to have been the earth dam that fed water to the head-gate.

Figure 10: Earth dam. Taken from the headgate forebay that narrows down into the race (DoC 2011)

The head-gate

Water was fed from the race which widened into the forebay and then through the 2x3m rectangular concrete head-gate located at the top of the valley wall. This was then carried down the valley side in a concrete pipe. When the head-gate was in use it contained filters and a gate to control water flow. This gate (penstock) was winched open by a steel cable operated from the powerhouse.

Figure 11: The headgate now filled in (DoC 2011).

The concrete pipes and penstock

The concrete pipe that takes a steep descent from the headgate to the powerhouse is 450cm in diameter, sunk in a trench in sections 2.5 to 5.0m long with steel banded joints and concrete buttresses. The concrete pipe consisted of 240 feet of 18 inch and 160 feet of 15 inch diameter sections.

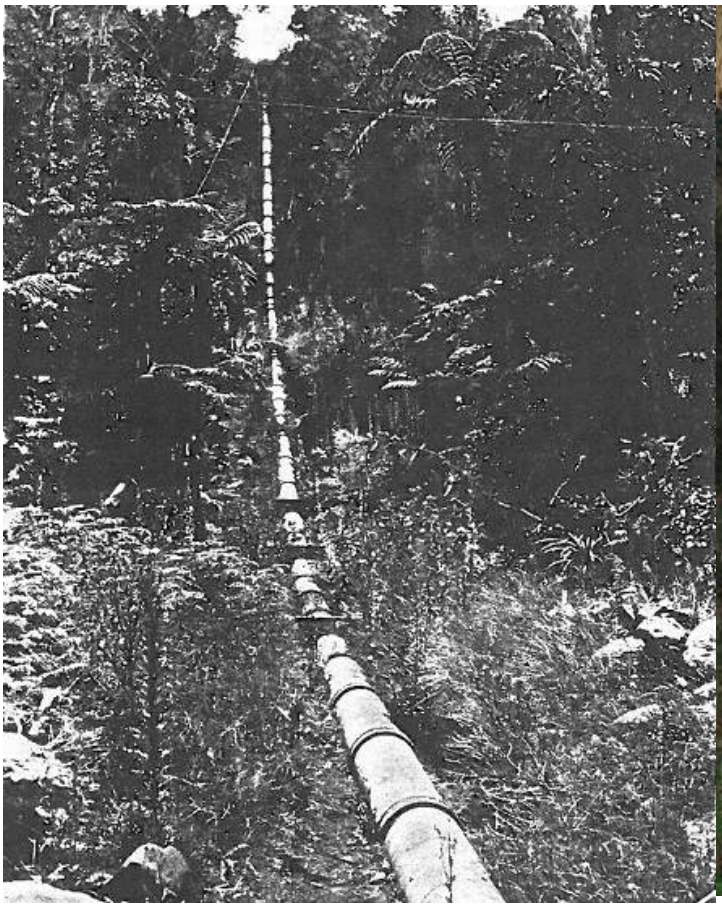

Figure 12: The concrete pipes that ran down from the headgate to the powerhouse (BOIEPB)

Figure 13: Part of the concrete pipes today still intact but not highly visible under vegetation (DoC 2011)

The access road to the powerhouse

An access road from the station to Landing Road is clearly visible to the east of the power house. This runs for 170m along the valley floor to a bridge over a stream, then upslope through a cutting before the junction of the present public tracks then up a steeper rise to reach the road. This road is now overgrown and the bridge is partly broken.[50] In fine weather this road was used to drive all the way up to the power so that maintenance could be carried out.[51]

The reconstructed power house with turbine and generator and two transformers

Before the powerhouse was excavated in 1993 and restored its only remains were its concrete foundations. In 1992 as described by Robinson it had a bifurcated tail race up to 2.8m deep with heaps of excavated material on the northern side of the foundations. Also described was iron wheels, galvanized materials and conduit wiring, a dilapidated split post wire fence. The race outlets by the river were blocked by flood debris. As reported by Mr. Rangi Wynward the excavated material, wiring, galvanized material and wheels are now in an area covered by vegetation and have not been located. Sometime prior to the flood the turbine must have been removed since it was returned to ranger Wright in the 1980's.

There is no surface evidence of the transformers or how the power was taken from the powerhouse to the consumers. However there are two parts of the transformers that have been placed in the power house. These have been identified as they have been marked 230 volts which was the voltage that was fed to consumers (fig 14). The 4 large step up transformers were located on the south side of the power house and the power was taken by power pole and a cable cross country to the Kerikeri township, crossing the river on a swing suspension bridge.[52] The bridge is no longer in existence.

Today the machinery that remains of the powerhouse is the turbine and generator (fig 15). The turbine purchased for the hydro station was a 130 HP Francis inward-radial-flow reaction single discharge type with a cast iron spiral casing imported from overseas through Boving and Company Limited London. The following is a comment from the memoirs of Lloyd Mandeno:

"*As is necessarily the case with most hydraulic turbines the one for Kerikeri was specifically designed for the particular conditions there*".[53]

Figure 14: Part of the transformers located in the powerhouse (DoC 2011)

Figure 15: The Francis turbine and generator in the reconstructed powerhouse (DoC 2011)

Benoit Fourneyron, built the first successful water turbine in 1827. It was an outward-radial-flow device with guide vanes inside the wheel. Its efficiency was 80% at full gate. Then in 1838 Samuel B. Howd of New York produced the first successful inward flow turbine. Inward flow resulted in smaller, less expensive wheels that ran at higher speeds than outward-flow

wheels. Around 1849, James B. Francis improved Howd's design, and advanced the technology by performing accurate tests, publishing the results, and formulating rules for turbine runner design. He helped the United States become a leader in the development of hydraulic turbines and his name became synonymous with inward-radial-flow turbines. The Francis turbine was the first modern water turbine and is still the most widely used water turbine in the world today. Several American manufacturers improved on the Francis design, evolving different forms of mixed flow turbines that combined radial and axial flow. The mixed-flow wheels ran at higher speeds and produced more power.[54]

The generator was an 118hp standard 1000rpm 'Witton' revolving field alternator. It was of open design and produced 230/400 volts at 50 cycles a second. Supply was four wire three phase. The generator and exciter were supplied by the British General Electric Company Limited.

The governor automatically controlled the oil pressure of the turbine. This was a VK 'B' type, with a working pressure of 160 1b/in2, also purchased from Boving and Company Limited London.

The voltage regulator was a 'Brown Boveri' supplied by the Allum Electrical Company Limited. It maintained a voltage up to 7.5% plus or minus normal operation.

The transformers were oil insulated, self cooling and weather proof with low core loss characteristics. They were insulated for 11,000 volt service but operating on 6350 volt, 50 cycle circuits with one sided earth.[55]

The documentary evidence collected by the Bay of Islands Power Board states that the machinery installed was not replaced during its 37 years of operation.[56] It was removed sometime prior to 1980 and was stored by the BOIEPB. Some notes in documentation mention that the generator, fly wheel and exciter were at Waitiki landing in 1981 and that Perrin Williams designed the 'robot' that cut off water to the turbine in times of drought was being stored in Kaikohe.[57]

Power was generated was through three main points or steps along the river:

Headworks: The concrete weir located at Rainbow Falls ensured a constant level of water at the entrance to the water race. Once the gate was opened the water ran along the race for 2km to the collection dam above the power house. Here the concrete headgate controlled the flow of water into enclosed concrete pipes which channeled the water down 118 ft to the valley floor and into the powerhouse.[58] This vertical enclosed drop and the narrowing of the concrete pipe from 18 to 15 inches provided water with kinetic energy and the momentum to turn the turbine.

Powerhouse: The piped water passed through the powerhouse spun the turbine round at high speeds turning an electro magnet inside a coil of wire. This movement generated an electric current. Power from the generator that was attached to the turbine was then transmitted at 400 volts to a step-up transformer which increased the voltage to 11,000. It was then transmitted to various step-down transformers converting the supply back to 230 volts and being fed into overhead high tension transmission lines that took the electricity via a swing suspension bridge over the Kerikeri River to the consumers in town.[59]

The overhead lines were constructed mainly of galvanized iron wire and carried on especially imported Australian iron bark poles. BOIEPB report that because of the voltage drop (this must be from 11,000 volts to 230 volts or how the line drops straight down), the lines between the step down transformers and the individual consumers premises had to be kept as short as possible. So the lines were taken not along the road but over private paddocks via the most direct route. This system however led to problems: It had been part of NALDCO's program to enclose each twenty acre section within a chain wide belt of Eucalyps with the intention of providing shelter belts and also afforestation. Today Kerikeri is surrounded and full of the ancestors of these Eucalyptus's. Thus before the power lines could be installed many areas had to be cleared. In some cases the power lines ran down the centre of these shelter belts which made the maintenance of growth and re-growth a time consuming job. When the Bay of Islands Electric Board took control of the company in 1940 they moved all the power lines to the roadsides to remedy this problem.[60]

Tail-works: Once the water powered the turbine and creating an electrical current the water was piped out of the power house into another open race which fed directly back into the river above the stone store in the Kerikeri Basin. Various changes were made to this system in its 37 years of operation especially when the national grid reached the area and power from this station was fed into the grid system rather than directly supplying the consumers.

National Context

Today hydro-electricity is the largest source of power in New Zealand. New Zealand's public supply of power began in 1887, when a company formed in Reefton, on the West Coast of the South Island. The company harnessed the power of the Inangahua River and operated the first hydro-electric plant. Wellington followed in 1888, Stratford in Dunedin in 1898, Dunedin itself in 1902 and Auckland in 1907. By 1928 62.5% of the country had been reticulated.[61]

In terms of supplying electricity the North was slow to develop compared to the rest of New Zealand.[62] There were four areas with electricity north of Whangarei. Kohukohu (1933) and

Rawene (1926) had their own oil driven plants Moerewa was supplied by the Auckland Farmers Freezing Company, and Kerikeri which was the only hydro-electric scheme.[63]

Cultural Connections

The hydro-electric station is part of Kerikeri's early history, a period which shaped Kerikeri as it is today.

Historic Significance

The Kerikeri hydro-electric station was the first electricity generating plant in Kerikeri and the first hydro-electric station in Northland.

Fabric Significance

The fabric of the station is largely intact and in good condition, therefore making it of a high significance. The whole station from Rainbow Falls to the tailrace is able to be interpreted even if some parts are not on conservation land. These are portions of the race, the wooden aqueduct and part of the former access road. The station is highly significant within the historically rich context of Kerikeri Basin. If the stations surviving components are monitored and continue to be preserved the values of the station will continue to rise and will become a valuable asset for Kerikeri.

Cultural Significance

Significant as part of Kerikeri's early pioneering history.

Management Recommendations

- Photo point monitoring of the wooden aqueduct on Blue Marlin Drive.
- Replacement of the interpretation images at Rainbow Falls which are now faded and discoloured.
- Rust treatment is required immediately on the turbine and generator. Additionally the transformers need to be treated.
- Graffiti removal from the concrete foundations of the power house.
- Monitoring and maintenance spraying of vegetation along the water race to prevent collapse of the sides. This is important to do while the vegetation is still small creating more efficient management over the long term.

- Checking the power house after the river has been in flood. A large amount of water still comes down the slope from the headgate either in the pipes or in the small trench that was dug to accommodate the pipe which is actively eroding out. Water then pours directly into the power house and since the turbine is no longer connected it goes onto the floor. There is a small drain where this water can slowly escape and wash out into the tailrace however it tends to get blocked with debris. Checking this is clear after or before floods would be beneficial for safety purposes and also for the conservation of the turbine and generator.

Management Chronology

- 1966: the hydro-electric station was closed.
- 1967: and onwards the headgate was filled in probably to try to prevent the flow of water though it to the pipes.
- Pre 1980's: the machinery was removed from the power house and stored by the Bay of Islands Electric Power Board.
- 1980's: wooden gates removed from concrete weir at Rainbow Falls by Ranger Bill Wright.
- 1982: the hydro-electric station was recorded as archaeological site P05/516 by McKay.
- Mid 1980's: the turbine was returned from Kaitaia Depot.
- 1986: Challis described the features of the station in more detail and drew a rough sketch map.
- 1992: A brief site survey of the station from Rainbow Falls to the basin was conducted by James Robinson.
- 1993: the powerhouse foundations were excavated.
- Mid 90's: the structure of the powerhouse was restored and the remaining original machinery was placed within it. Interpretation was created for the powerhouse and at Rainbow Falls of the weir.
- A large amount of miscellaneous items from the power house are held at the Bay of Islands area office. The photo database for these items is docdm: 789869.

Management Documentation

Heritage assessment: docdm: 1002735

Baseline inspection: Robinson, J. 1993. An outline history and archaeological report on Kerikeri's first hydro-electric generating station site P05/516. Report to Department of Conservation.

Heritage Assessment: *Docdm: 786200*

Northland - Bay of Islands Area Office - **Kerikeri Hydro Station** HHA-01-02-10 NLB-1 15/08/2006, Northland - Bay of Islands Area Office - **Kerikeri Hydro Station** HHA-01-02-10-01 NLB-1 14/12/1981 Northland - Bay of Islands Area Office - **Kerikeri Hydro Station** - Research and Assessments HHA-01-02-10-02 NLB-1 26/04/1995 Northland - Bay of Islands Area Office - **Kerikeri Hydro Station** - Historic Research and Background HHA-01-02-10-03 NLB-1 01/07/2010 Northland - Bay of Islands Area Office - **Kerikeri Hydro Station** - Maps

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Author unknown, 1999. A history of turbines: The Kinne collection of water turbines. A mechanical engineering heritage collection. The American Society of Mechanical Engineers. http://www.jeffersoncountyhistory.org/pages/collection-kinne.htm

Author unknown, date unknown. The Will to Power. Bay of Islands Electric Power Board. Held in Bay of Islands Area Office.

Benner, Richard. No date. Notes. Held in Bay of Islands Area Office.

Blackwell, H.S. No date. Held in Bay of Islands Area Office.

Mandeno, L. 1920. Memoirs, 1918. Auckland War Memorial Museum Library. MS 831. http://muse.aucklandmuseum.com/databases/LibraryCatalogue/21194.detail?Ordinal=1&c_subject_search=mandeno,+james+lloyd,+d.+1921&c_subject_logic=or. Part of this in relation to the hydro station held at Department of Conservation.

Ministry of Economic Development, 2005. Energy in New Zealand - A Short History, http://www.med.govt.nz/templates/MultipageDocumentPage____10135.aspx

Pickmere, N. 2008. *Heritage of Dreams*. Calders design and print co ltd.

Robinson, J., 1993. An outline history and archaeological report on Kerikeri's first hydro-electric generating station site P05/516. Department of Conservation, Northland Conservancy.

Further documents that exist from the Bay of Islands Electric Power Board held in Department of Conservation:

- Specifications for the construction of the water race, concrete weir and earth 1929.
- Tenders for the turbine, governor, alternator, exciter, and voltage regulator.
- Excavation work at the forebay.
- Specifications for carting poles and other materials 1929.
- Tenders for power pole installation and removal of certain power lines 1936.
- Information from a book headed "Alderton Utility Co. Ltd. Public Works Dept.
- Valuation of assets of the Alderton Utility Company, December 1939.
- Notes on possible location of machinery taken from the generating station.

Endnotes

[1] Pickmere, N. 2008:84

[2] BOIEPB, The Will to Power:4

[3] *Op cit:* BOIEPB:3

[4] *ibid*

[5] *Op cit:*BOIEPB:4

[6] *Op cit:* BOIEPB:3

[7] *Op cit:* BOIEPB:5

[8] *Op cit:* BOIEPB:6

[9] *ibid*

[10] *Op cit*: BOIEPB:8

[11] *Op cit:*BOIEPB:6

[12] *Op cit:* BOIEPB:8

[13] *Op cit:* Pickmere:101

[14] *Op cit:* BOIEPB:11

[15] ibid

[16] *Op cit:* BOIEPB: 12

[17] *Op cit:* BOIEPB 13

[18] *ibid*

[19] *Op cit:* BOIEPB: 16

[20] *ibid*

[21] *ibid*

[22] *ibid*

[23] *ibid*

[24] *ibid*

[25] *Op cit*:BOIEPB: 18

[26] Turner.M DoC. Personal communication

[27] *Op cit*:BOIEPB:23

[28] *Op cit*:BOIEPB:18

[29] *Op cit*:BOIEPB:25

[30] *Op cit*: BOIEPB:26

[31] ibid

[32] ibid

[33] *Op cit*:BOIEPB:19

[34] *Op cit*:BOIEPB:21

[35] *ibid*

[36] *ibid*

[37] *Op cit*: Pickmere:100

[38] *Op cit*:BOIEPB: 28

[39] *Op cit*:BOIEPB:30

[40] *Op cit*:BOIEPB:29

[41] *Op cit*:BOIEPB:31

[42] *Op cit*:BOIEPB:32

[43] *ibid*

[44] *Op cit*:BOIEPB:34

[45] *ibid*

[46] *ibid*

[47] Chairman's Annual Report: 31st march 1967

[48] Robinson,J. 1993:16.

[49] *ibid*

[50] *Op cit*: Robinson,J.

[51] Blackwell, H.S.

[52] *Op cit*: Robinson. J:7.

[53] Mandeno, L.1920: 61

[54] History of turbines 1999

[55] *Op cit*:BOIEPB:14

[56] *Op cit*: Robinson. J: 15

[57] *ibid*

[58] *Op cit*:Robinson. J:3

[59] *Op cit*:BOIEPB:15

[60] *ibid*

[61] *Op cit*: BOIEPB:2

[62] *ibid*

[63] *ibid*