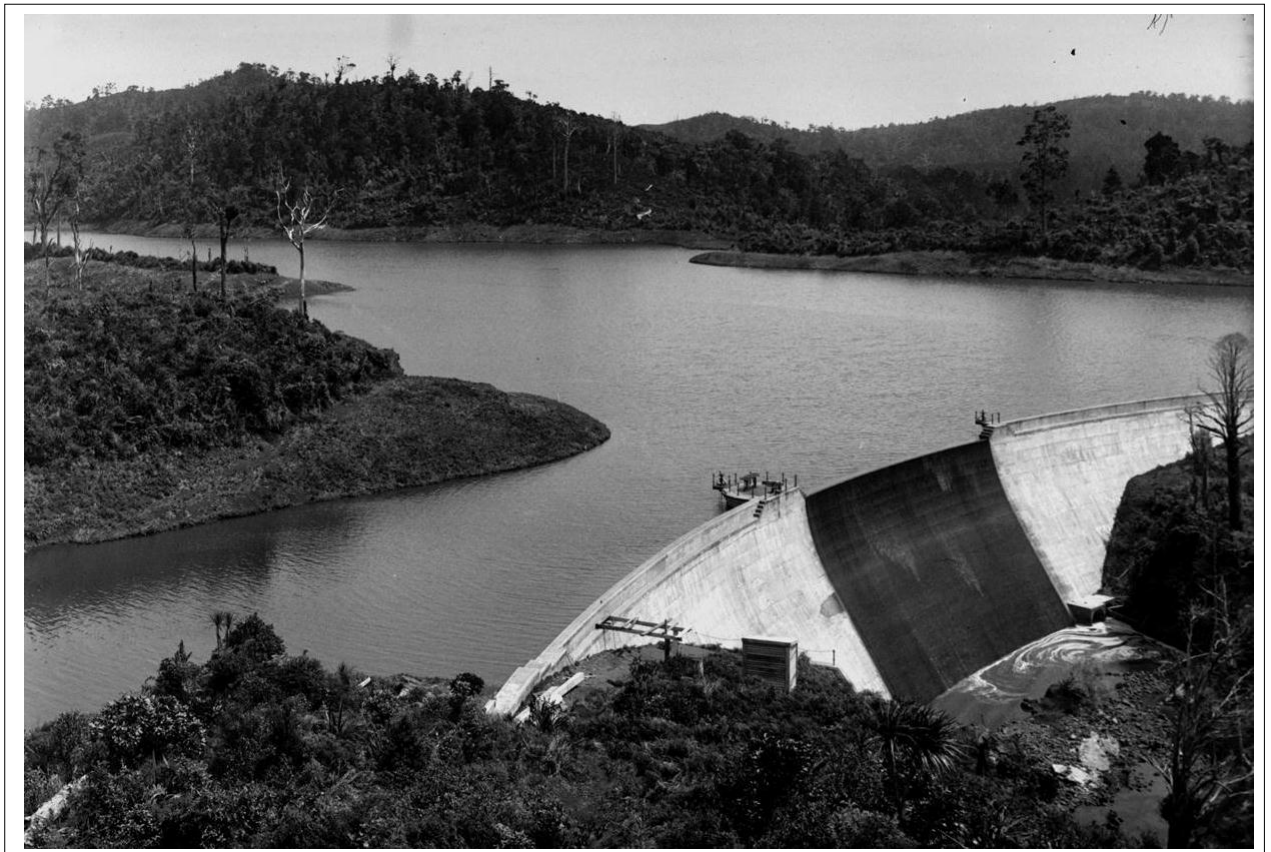


## IPENZ Engineering Heritage Register Report

# Waitakere Ranges Water Supply System

Written by: John La Roche FIPENZ and Karen Astwood  
Last amended 17 August 2011



Waitakere Dam and Reservoir, 4 November 1917. Sir George Grey Special Collections, Auckland Libraries, 1-W1612

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## A. General information

**Name:** Waitakere Ranges Water Supply System

**Alternative names:** Auckland Water Supply System; Auxiliary Nihotupu Dam; Lower Huia Dam and Reservoir; Lower Nihotupu Dam and Reservoir; Main Nihotupu Dam; Upper Huia Dam and Reservoir; Upper Nihotupu Dam and Reservoir; Waitakere Dam and Reservoir; Waitakere Ranges Water Supply Dams; Waitakere Ranges Regional Park Water Catchment

**Location:**

Waitakere Regional Park

Waitakere Ranges

Auckland

**Geo-reference:**

Lower Huia Dam and Reservoir - Latitude: -36.989, Longitude: 174.567

Lower Nihotupu Dam and Reservoir - Latitude: -36.962, Longitude: 174.614

Upper Huia Dam and Reservoir - Latitude: -36.964, Longitude: 174.538

Upper Nihotupu Auxiliary Dam (former) - Latitude: -36.933, Longitude: 174.556

Upper Nihotupu Dam and Reservoir - Latitude: -36.951, Longitude: 174.563

Waitakere Dam and Reservoir - Latitude: -36.899, Longitude: 174.529

**Legal description:**

Lower Huia Dam and Reservoir: Part of Pt Lot 9 PSH and Lot 14 PSH, Karangahape, North Auckland Land District

Lower Nihotupu Dam and Reservoir: Pt Lot 33 PSH, Waikomiti; Pt Lt 2 DP 19340 (CT NA10B/611), North Auckland Land District

Upper Huia Dam and Reservoir: Pt Lot 112 PSH, Karangahape (CT NA12D/361), North Auckland Land District

Upper Nihotupu Dam and Reservoir: Part of Lot 112 PSH, Karangahape (CT NA12D/361); Lot 95 PSH, Waikomiti (CT NA10D/397), North Auckland Land District

Waitakere Dam and Reservoir: Part of Pt Lot N82 PSH, Waitakere; Lot S50 PSH, Waitakere, North Auckland Land District

**Access information:**

All of the Waitakere Ranges water supply dams and reservoirs are within the Waitakere Regional Park. They can be viewed by following access roads or walking

tracks. This is a working system and as such there are access restrictions to the structures. Restricted areas are fenced and/or signposted.

**City/District Council:** Auckland Council

**IPENZ category:** Engineering work

**IPENZ subcategory:** Infrastructure

**IPENZ Engineering Heritage number:** 2385

**Associated IPENZ Engineering Heritage numbers:** Lower Nihotupu Dam (EH no.87); Upper Nihotupu Dam (EH no.288)

**Date registered:** 18 October 2011

**Other IPENZ recognition:** "Engineering to 1990" plaque, Lower Nihotupu Dam

**Other heritage recognition:**

- New Zealand Historic Places Trust: N/A
- Associated Local Authority District Plan heritage listings:
  - Huia Filter Station – Waitakere District Plan, Heritage Appendix, p.5, CHI no. 1257
  - Nihotupu Filter Station – Waitakere District Plan, Heritage Appendix, p.6, CHI no. 1283
  - Waitakere Filter Station – Waitakere District Plan, Heritage Appendix, p.6, CHI no. 1289
- Other: Waitakere Ranges Heritage Area Act 2008

## B. Description

### Summary

The Waitakere Ranges Water Supply System taps into the resources of these ranges in West Auckland and its Huia, Nihotupu and Waitakere streams. A series of five large dams were constructed throughout the 20th century. These created the reservoirs and associated tramways, piping, tunnels and filter stations; other structures were also built to facilitate access to the water catchment and create a gravitational water supply into Auckland.

A good water supply is essential to human existence. Early historical accounts show a marked improvement in health after a piped water supply was introduced to Auckland city from Western Springs in 1877. Financial stringency delayed the water from the Waitakere ranges being supplied to Auckland until 1902 when the first temporary supply was introduced. Severe water shortages and deterioration of the quality of Western Springs water forced Auckland City Council to act. From that time, progressive development of the water resources of the Waitakere Ranges continued to keep up with population growth, not only of Auckland, but also with demands from surrounding districts.

Auckland is very fortunate to have two upland catchment areas, the Waitakere Ranges and the Hunua Ranges. At these catchment locations rainfall is higher than at lower levels and much of the water can gravitate to the city without pumping. The Waitakere water supply, followed by supplies from the Hunua Ranges and more recently from the Waikato River, has undoubtedly contributed enormously to the Auckland region's wealth and prosperity.

The system's main structures are the dams which are still in use: Waitakere Dam (completed 1910), Upper Nihotupu Dam (completed 1923), Upper Huia Dam (completed 1929), Lower Nihotupu Dam (completed 1948) and Lower Huia Dam (completed 1971). Concrete gravity dams characterise the first three, while the latter are earth dams. The Waitakere Dam was among the first large scale concrete dams in New Zealand, and the Lower Nihotupu Dam was the country's first earth dam.

The Waitakere Water Supply System is of outstanding significance because the succession of structures demonstrates the evolving theory, techniques and materials of New Zealand dams in the 20th century. The system is also associated with many

of Auckland's notable engineers, including Hugh Munro Wilson (1865-1929), James Carlaw, Walter Ernest Bush (1875-1950), Arthur D Mead (d.1976), Cyril Firth (1903-2003), Don Wilson and others.

## Historical narrative

The Waitakere Ranges, west of Auckland city, have long been known for their water resources. Numerous streams not only provided early local Māori with drinking water, but also a plentiful supply of *koura* and eels. Later, these same waterways were dammed and utilised by early European settlers involved in milling and mining activities.<sup>1</sup>

In 1840 Governor William Hobson (1792-1842) founded Auckland, the new capital of the New Zealand colony. During the first few decades citizens depended on stored rain water, springs, and public and private wells for their water. Even in this early Colonial period demand was such that queues would form at the central public wells before daybreak. This situation remained largely unchanged until the 1870s.<sup>2</sup> At this time Edward Orpen Moriarty (1824-1896) investigated several water supply options, which included the Nihotupu Stream. However, Western Springs was chosen as the site from which to pump water. Mr Moriarty anticipated this supply would be sufficient for up to 25 years, and he was proven correct.<sup>3</sup>

At the turn of the 20<sup>th</sup> century Auckland was already the leading industrial province in New Zealand and attracted people due to its “delightful climate and other advantages.”<sup>4</sup> As such, it was apparent Auckland’s water supply issue needed to be addressed. Indeed, in a report on the situation in 1900, engineer Richard Liron Mestayer (1844-1921) stated that “the position of Auckland in respect to its water supply is critical in the extreme [...] in fact, on the verge of water famine.”<sup>5</sup> Later that year, Henry Atkinson proposed building a temporary solution in the form of a timber dam across the Upper Nihotupu Stream.<sup>6</sup> Mr Mestayer envisaged the first stage of a system, later involving the Nihotupu and Huia streams, would involve damming the Waitakere River, an approach which the Auckland City Council adopted. The idea of the timber dam was supported by consulting engineer, Hugh Munro Wilson (1865-1929), a New Zealand-born engineer who went on to design the Waitakere Dam.<sup>7</sup>

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<sup>1</sup> F. MacDonald & R. Kerr (ed.), *West: The history of Waitakere*, Auckland, 2009, p.309; J. Reidy, ‘Waitakere Water: A city’s need for water,’ in B. & T. Harvey (ed.), *Waitakere Ranges: Ranges of inspiration*, Auckland, 2006, p.312

<sup>2</sup> J. Barr, *Municipal and Official Handbook of the City of Auckland, New Zealand*, Auckland, 1922, p.121

<sup>3</sup> *Ibid.*, p.122; F. W. Furkert, *Early New Zealand Engineers*, Wellington, 1953, p.230

<sup>4</sup> The Cyclopedia Company Limited, *Cyclopedia of New Zealand [Auckland Provincial District]*, Christchurch, 1902, p.29

<sup>5</sup> Quoted in R. E. Offer, *Walls for Water: Pioneer dam building in New Zealand*, Dunmore Press, Palmerston North, 1997, p.38

<sup>6</sup> ‘Auxiliary Water Supply,’ *Auckland Star*, 30 October 1901, p.2

<sup>7</sup> *Progress*, 1 May 1909, p.251; Offer, p.38

A few years later Mr Wilson, and James Carlaw, Auckland's Waterworks Engineer, were asked to report on how best to develop a "permanent" water supply for Auckland, drawing on the Waitakere Ranges catchment. They recommended building a concrete gravity dam at the Waitakere Falls.<sup>8</sup> This 1902 report was one of a long history of reports submitted to the Auckland City Council. The acceptance of Messrs Wilson and Carlaw's recommendation finally saw the beginning of a new era of dam building in the Waitakere Ranges, spanning much of the 20<sup>th</sup> century.<sup>9</sup>

### *Waitakere Dam*

Tenders for constructing the Waitakere Dam were called in 1905 with work commencing in 1906. However, constructing this first substantial dam was not straight forward. The pipeline route and access tramline for example tracked around rocky bluffs and through tunnels. George's Tunnel, 693 metres (m) long, had to be constructed under the main Waitakere ridge. As well as this, there were 25 kilometres (km) of 533 millimetre (mm) and 686 mm locking bar bitumen coated steel pipe to be laid. This piping was manufactured by Mephan Ferguson, a Wanganui company which established a factory in New Lynn. The piping and other supplies were brought by rail to Swanson railway station and then delivered to the dam site by horse drawn trucks along the access tramline. Once these pipes were laid, water supply from two temporary timber dams, one on the Waitakere River and the other on Kelly's Creek, provided water to the city.

The main dam's construction continued to be slow causing friction between the contractor and the engineer, which resulted in the original contractor withdrawing. A new contractor, Schischka, took over but progress was hindered because of wet weather and supply problems. A major storm in May 1910, for example, brought down a large slip of earth and trees on to the temporary dam, causing its failure and sweeping away tools and boxing from the partially completed permanent dam downstream. At the aggregate quarry beside the entrance to George's Tunnel a slip blocked the tunnel and broke the water supply pipes.<sup>10</sup> However, continuing water shortages in the city reinforced urgency for completing Waitakere Dam, which was achieved in November 1910.

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<sup>8</sup> Barr, p.125; 'Permanent Water Supply,' *Auckland Star*, 9 April 1900, p.3. In his report outlining prospective development of a water supply system, Mestayer noted that 'permanent' was a term relative to the existing situation which involved temporary or auxiliary water supplies.

<sup>9</sup> G. W. A. Bush, *Decently and in Order: The centennial history of the Auckland City Council*, Auckland, 1971, p.135

<sup>10</sup> Offer, p.66



**Figure 1:** Creator unknown: Photograph of a spillway at Waitakere dam, Auckland region, 1910-1926. ID: 1/2-032996-G. Permission of the Alexander Turnbull Library, Wellington, New Zealand must be obtained before any re-use of this image.

Later, in 1925-26 the reservoir's storage capacity was doubled through raising the dam by 4.8 m. This was thought necessary as a stop-gap while the Upper Huia Dam was being constructed.<sup>11</sup> Despite its now higher wall, the dam was overtopped by flood waters in 1926, as was the Upper Nihotupu Dam, highlighting the issue of adequate spillway allowances in dam design.<sup>12</sup>

#### *Upper Nihotupu Dam*

Although the Waitakere Dam's pending completion promised relief, by 1909 it was obvious to Mr Carlaw that more water would soon be required. Therefore, a permanent dam at Nihotupu was soon being planned. Slips in the steep country along the temporary pipeline route and deterioration of the light-gauge steel pipes caused frequent disruption of the water supply from the temporary Nihotupu wooden dams. To alleviate this problem, between 1911 and 1913 tunnels were dug under intervening ridges on the pipeline route, shortening the pipe length by four kilometres and reducing its vulnerability to slip damage.

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<sup>11</sup> Bush, 1971, p.136; Offer, p.66

<sup>12</sup> Offer, p.76



**Figure 2:** Wooden Dam at Nihotupu in process of demolition, 1914. Sir George Grey Special Collections, Auckland Libraries', 4-2456

The City Engineer, Walter Ernest Bush (1875-1950, Figure 7), designer of the Upper Nihotupu Dam, favoured a site on the Nihotupu River north of Piha Road where he considered an earth dam could be built with good storage capacity. However, foundation difficulties were uncovered when consulting engineer Henry Metcalfe (1851-1918) was engaged to investigate the feasibility of Mr Bush's proposal. A site further down the valley, just above Nihotupu Falls, where a concrete dam could be built was recommended. William Hobbard Morton (d. 1924), Wellington City Engineer, was called upon in late 1914 for a second opinion to settle the site issue, and he favoured Mr Metcalfe's plan.<sup>13</sup> Tenders were then called in 1915 and the contract to construct the Upper Nihotupu Dam was awarded to Gisborne firm, Langlands and Company.<sup>14</sup>

Construction supplies were brought by boat across the Manukau Harbour to a special wharf and storage hoppers at Big Muddy Creek. A tramline was constructed up the Nihotupu Valley to "The Incline". Here a steep ascent required trucks to be hauled up to the pipeline track using a steam-powered hauler. A quarry site for aggregate was cleared at the head of the reservoir and a tramline constructed to the dam site. This work's inherent danger was demonstrated by an incident in March 1916. During blasting for this tramline a rock was sent flying 100 m and crashed through the roof of the site office, killing the contractor William Langlands (1860?-1916). Despite this

<sup>13</sup> Offer, pp.13, 70

<sup>14</sup> *Evening Post*, 19 April 1915, p.10; La Roche

setback for the company the contract continued under the control of Mr Langlands' partner.<sup>15</sup>

As with the construction of the Waitakere Dam, progress was hindered by heavy rain. Flooding of the site caused several washouts, tunnel collapses, and delays in the transportation of materials. These difficulties were compounded by the major shortages of labourers and materials caused by World War One. In the four years to 1919 construction had not progressed past completing the foundations and some concrete being poured.<sup>16</sup>

During this period the continuing installation of flush toilets in Auckland city, and increases in population, the supply rapidly increased local water consumption. The influx of people during the decade from 1910 to 1920 saw Auckland's population double to over 150,000.<sup>17</sup> As such, the slow progress at the Upper Nihotupu Dam's slow progress put considerable pressure on the Council.<sup>18</sup> To expedite additional water storage, James Tyler (1878?-1953), the Assistant City Engineer, designed a 5.48 m high concrete slab and buttress dam at Mr Bush's dam site option. Mr Tyler had first been employed by the Council as a resident engineer on the Grafton Bridge project. Under urgency, this buttress dam was completed by June 1921 (Figure 3). However, like its counterpart Wellington's Morton Dam, in 1986 the Nihotupu Auxiliary Dam was retired from service.<sup>19</sup>

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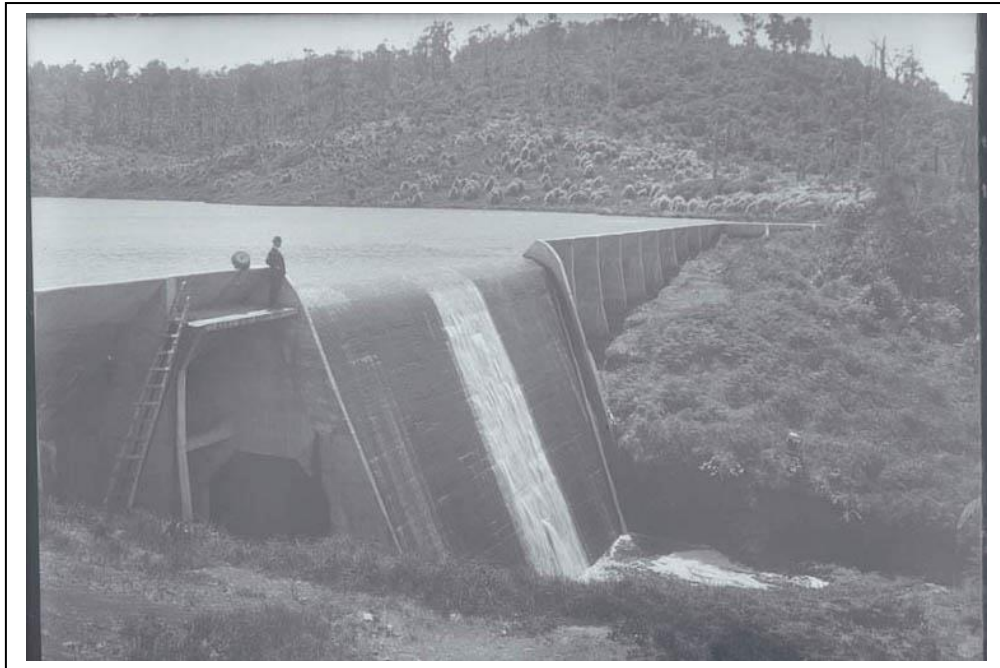
<sup>15</sup> J. La Roche, 'Auckland's Water Supply,' unpublished manuscript (paper to be published late 2011), 2011. IPENZ Auckland Heritage Chapter Book file; 'Contractor Killed,' *Evening Post*, 1 April 1912, p.12

<sup>16</sup> La Roche; *Evening Post*, 13 September 1917, p.6

<sup>17</sup> Barr, pp.1, 5

<sup>18</sup> Offer, p.70

<sup>19</sup> *New Zealand Engineering*, Vol. 8:3 (1953), p.120; Barr, p.101; Offer, p.70; Reidy, p.314. The decommissioning of this dam involved punching a hole in its surface and draining and grassing the former reservoir.



**Figure 3:** Auxiliary dam at Nihotupu. Sir George Grey Special Collections, Auckland Libraries', 1-W339

In 1922 the Council touted that “Auckland occupies a high position among the municipalities of the Dominion. Its civil engineering works are large and include at the present time the erection of two dams...The smaller is practically finished [at the time of writing], and the larger will be completed in 1923.”<sup>20</sup> However the completion date for the Upper Nihotupu Dam was not as assured as the Council would have liked. Langlands’ contract continued to get further behind. A request for an extension of time in January 1921 was refused and Council took over control of the work using its own engineering staff and day labour. Mr Tyler was directed to complete the dam by 1923. He reorganised the whole project with separate supply contracts for cement and sand. Under his leadership the tramway was re-graded and the wooden rails were replaced with steel from the Waitakere tramline. He also reorganised the quarry and purchased new locomotives, along with other improvements.<sup>21</sup>

Despite exceptionally heavy rainfall, and gales on the Manukau Harbour, causing further supply difficulties, by February 1923 the last concrete had been poured on the project.<sup>22</sup> Costing almost £200,000, the Upper Nihotupu Dam was officially opened by the Hon Joseph Gordon Coates (1878-1943), Minister of Works, on 14 April 1923 (Figure 4).<sup>23</sup> With the Waitakere, auxiliary and Upper Nihotupu Dams in place it was estimated that Auckland would be able to withstand a drought of up to 153 days.<sup>24</sup> As

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<sup>20</sup> Barr, p.13

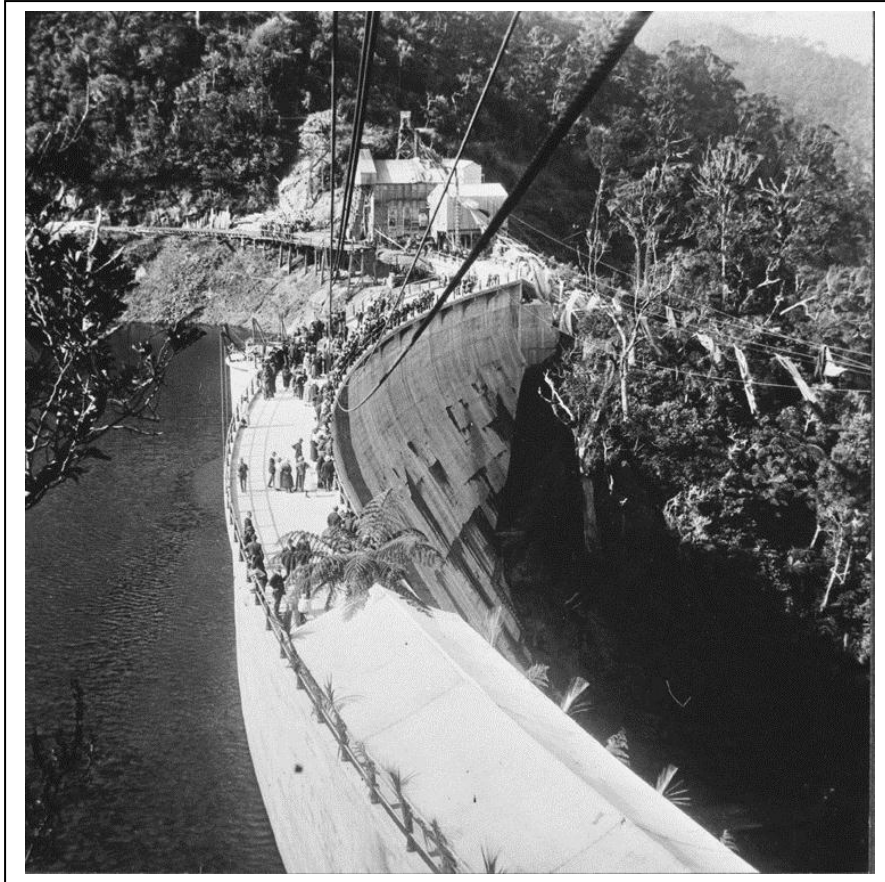
<sup>21</sup> Bush, 1971, p.136

<sup>22</sup> Offer, p.74

<sup>23</sup> *Evening Post*, 16 April 1923, p.6

<sup>24</sup> *Evening Post*, 6 December 1921, p.6

such the Council was comfortable that Auckland would have a liberal supply of water to sustain the current population.<sup>25</sup>



**Figure 4:** Official opening of the Nihotupu Dam, 1923. Sir George Grey Special Collections, Auckland Libraries, 4-5891

#### *Upper Huia Dam*

However, the Council recognised that the Waitakere, Upper Nihotupu, and the Nihotupu auxiliary dams and reservoirs would still be insufficient to meet Auckland's future water supply demands. This was compounded by the eminent closer of the unsanitary supply from Western Springs.<sup>26</sup> Arthur D Mead (d.1976) had investigated the suitability of permanently damming the Huia Stream as early as 1915 in his role as an assistant engineer.<sup>27</sup>

This idea only began to become a reality in October 1923 when the Council approved the proposal for the Upper Huia Dam.<sup>28</sup> Mr Bush designed the Upper Huia Dam for the site previously occupied by an old kauri log dam. When he retired in 1929, Tyler

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<sup>25</sup> Bush, 1971, p.247

<sup>26</sup> Ibid.

<sup>27</sup> Mead, 'The Huia Water Supply Extension for the City of Auckland,' *Proceedings of the New Zealand Society of Engineers*, Vol.17, Wellington, 1931, p.145; La Roche

<sup>28</sup> *Evening Post*, 8 October 1923, p.6

took over the management of the project. Around this time Mead was promoted to the role of Waterworks Engineer, a position he retained until 1953.<sup>29</sup> During the period when the dam was being constructed the Council received alarming reports regarding the purity of the current water supply. As a result Nihotupu and Waitakere filter stations were constructed, and one also for the Huia supply when that dam began feeding into the system.<sup>30</sup>

The Council decided to build the Upper Huia Dam themselves using day labour because of the past experience at the Waitakere and Upper Nihotupu Dams when the contractors had not being able to complete the works on both occasions. Work commenced in 1924 under the direction of resident engineer H. E. Goldsbro (d.1962) after further investigation confirmed the location for the Upper Huia Dam.<sup>31</sup> In 1927 it was recorded that 200 men were employed on the dam and associated water supply line.<sup>32</sup>

The scale of the Upper Huia project is indicated by the size of its work camp which included 45 buildings: huts, a cookhouse, engine shed, post office, and later a school. "Top Camp" had electricity and its own water supply from a small dam higher in the ranges.<sup>33</sup> The 54 acre (22 hectare) bush-clad area which was to be flooded when the reservoir was established, was cleared of millable timber beforehand and the remaining scrub burnt off. Much of the timber was then used to build the huts, and for plant construction.<sup>34</sup> It has been noted that these types of workers camps became increasingly common on dam construction projects in the 1920s and were the forerunners of the permanent towns which resulted from the substantial hydro-electric installations later in the 20<sup>th</sup> century.<sup>35</sup>

A key issue for all the concrete dams in the Waitakere Ranges was to identify a suitable nearby quarry site from which aggregate for concrete making could be obtained. Therefore, the first task in the Upper Huia Dam project was to build tramlines from the dam site to the quarry, as well as one from a new landing at Huia Bay up the valley to the dam site. Rising 140 m in 6.4 km, the tramline from Huia Bay

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<sup>29</sup> Mead, 1931, p.145; La Roche; Offer, p.74; Reidy, p.315

<sup>30</sup> G. W. A. Bush, 'Bush, Walter Ernest – Biography,' from the Dictionary of New Zealand Biography. Te Ara - the Encyclopedia of New Zealand, URL: <http://www.TeAra.govt.nz/en/biographies/3b61/1> (updated 1 September 2010); La Roche

<sup>31</sup> Mead,1931, pp.145-46

<sup>32</sup> 'Municipal Works,' *Evening Post*, 18 March 1927, p.5

<sup>33</sup> La Roche

<sup>34</sup> Mead, 1931, pp.154-55

<sup>35</sup> Offer, pp.74-75

was a significant project in itself, involving deep cuttings, two tunnels and three main bridges.<sup>36</sup> Because of the elaborate preparations needed for constructing this dam, the first concrete for the Upper Huia Dam was only poured in 1927 after the cut-off trench had been carefully excavated using pneumatic tools.<sup>37</sup> Explosives were not used in this instance to prevent damage to adjacent rock structures.

As with the earlier dams, in December 1926 flooding affected the preparations for the Upper Huia Dam. This heavy rain washed away much of the tramway and caused the reconsideration of the spillway allowances, resulting in the design for the spillway being enlarged.<sup>38</sup> The Waitakere and Upper Nihotupu Dams had been severely tested by this flooding, with the Waitakere Dam being described as a “miniature Niagara.”<sup>39</sup>



**Figure 5:** Huia Dam with spillway overflowing. Charles Cecil Roberts, 1933. J. T. Diamond Collection 3913 (7B). Auckland Libraries, West Auckland Research Centre

By contrast the summer of 1927-28 was incredibly dry. This motivated the Council to order double shifts of work on the Upper Huia Dam because they were anxious about the city running out of water.<sup>40</sup> Construction seems to have continued reasonably

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<sup>36</sup> Offer, p.74; Mead, 1931, pp.150-53

<sup>37</sup> Offer, p.74

<sup>38</sup> Mead, 1931, p.161-62

<sup>39</sup> ‘News of the Day,’ *Evening Post*, 25 May 1926, p.6

<sup>40</sup> Mead, 1931, p.154

fluidly from then on and Mayor George Baidon (1868-1946) opened the Upper Huia Dam on 7 December 1929.<sup>41</sup> It was estimated that the project, including the tramway, piping and other aspects of the system, cost the Council around £233,000.<sup>42</sup>

#### *Lower Nihotupu Dam*

Mr Bush had proposed a Lower Nihotupu Dam as early as 1915. Following the completion of the Upper Nihotupu Dam in 1923, the Council adopted a policy of progressive utilisation of the Upper Huia, Lower Nihotupu and Lower Huia catchments. Preliminary investigations for the Lower Nihotupu Dam had been undertaken in 1929, including a contour survey and test shafts at 30 m intervals to rock foundations along the proposed dam centre line. Work did not progress much further over the next few years because of the Great Depression and then the outbreak of World War Two. However, water supply became a pressing issue though during the very dry summer of 1942-43 and the completion of the Lower Nihotupu Dam became a matter of urgency.<sup>43</sup>

Cyril Firth (1903-2003) carried out the geological investigations and designed the Lower Nihotupu rolled fill earth dam; the first dam of this type in New Zealand. Mr Firth completed a Master of Science degree in geology, his thesis describing the geology of the Hunua Ranges. After working as an engineer at Manukau and Fanklin County Councils, in 1939 He joined Superior Oil Company prospecting in Taranaki. Based on this experience he was seconded for Government oil exploration in the lower North Island during World War Two. Subsequently, he joined Auckland City Council Waterworks Department in 1943 and later became the Waterworks Engineer and Director of Auckland Regional Authority (ARA). His knowledge of geology was passed on to many engineers who learned their skills at Auckland University School of Engineering where he lectured part-time.<sup>44</sup> Indeed, the work on the Lower Nihotupu Dam spurred interest in the field of soil mechanics and soon after the structure was completed the subject of engineering geology began to be taught at the School of Engineering.<sup>45</sup>

Soil mechanics, and the implications for earth dams, were being investigated internationally after World War One. However, it was not until the 1940s that the finer

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<sup>41</sup> Offer, p.76

<sup>42</sup> Mead, 1931, pp.159-60

<sup>43</sup> A. D. Mead, 'The Lower Nihotupu Water Supply for the City of Auckland,' *Proceedings of the New Zealand Institute of Engineers*, Vol.35, Wellington, 1949, pp.289-92

<sup>44</sup> La Roche

<sup>45</sup> *Engineering to 1990*, IPENZ, Wellington, 1990, p.9

points of earth dam theory had been worked out.<sup>46</sup> The Lower Nihotupu site soil tests showed Mr Firth that ample water tightness would be gained through controlled soil grading, moisture content and compaction. A more traditional multiple arch concrete gravity dam was also designed for the project. Tenders were called for both designs, and in February 1945 Downer and Company Limited were awarded the contract to build an earth dam. Downer's tender price of £286,412 was 10 per cent less than the lowest tendered price for the concrete dam.<sup>47</sup> An alternative to the earth dam on this scale had not been constructed in New Zealand prior to the Lower Nihotupu Dam. This was why the Council felt it appropriate to have a back-up concrete dam design. An earth dam became possible by the late 1940s due to developments in soil mechanics knowledge, and heavy machinery able to construct true to specifications.<sup>48</sup>

The dam was officially opened by the Mayor John Andrew Charles Allum (1889-1972) on 4 December 1948.<sup>49</sup> Mr Mead later presented a paper on the dam to the New Zealand Institute of Engineers in 1949 which generated a lot of discussion, with the audience keen to learn further particulars on this ground-breaking project.<sup>50</sup>

Alternative sources to the Waitakere Ranges for Auckland's water began to be pursued in the period after World War Two. The Hunua Ranges had long been considered as a potential source of water, and as such work commenced on a dam at Cosseys Creek in 1946.<sup>51</sup> However, staff and material shortages delayed its completion until 1956. To keep ahead of water supply requirements, there followed a steady construction of roll-fill earth dams: the Upper Mangatawhiri Dam was completed in 1965, Lower Huia in 1971, Wairoa in 1975 and Mangatangi in 1977.<sup>52</sup> All of these structures were completed after the management of Auckland's water supply was transferred to the ARA in 1967.<sup>53</sup>

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<sup>46</sup> N. Smith, *A History of Dams*, Secaucus, New Jersey, 1972, p.225-26

<sup>47</sup> Mead, 1949, p.292; *Evening Post*, 18 November 1944, p.4; 'Water Supply Dam,' *Evening Post*, 23 February 1945, p.3

<sup>48</sup> Offer, p.93

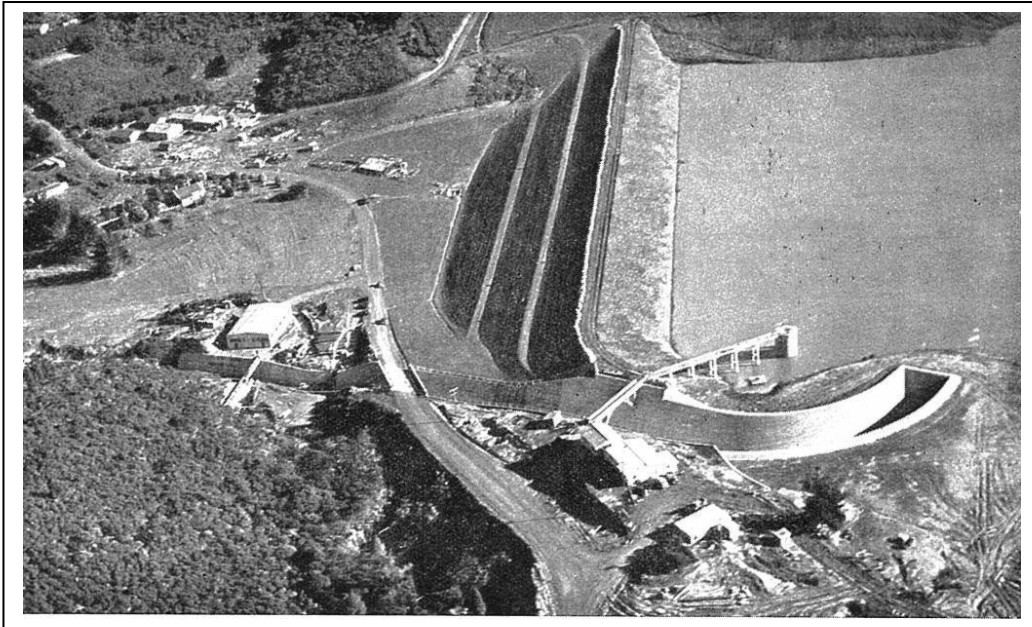
<sup>49</sup> La Roche

<sup>50</sup> Mead, 1949, pp.332-43

<sup>51</sup> 'Future Water Supply Schemes for Auckland,' *New Zealand Engineering*, Vol.3:9 (September), 1948, p.880

<sup>52</sup> Bush, 1971, pp.359-60; 'Dams in the Hunua and Waitakere Ranges,' Watercare Services Limited, URL: <http://www.watercare.co.nz/about-watercare/our-services/hunua-and-waitakere-dams-water/Pages/default.aspx> (accessed 2 August 2011)

<sup>53</sup> G. W. A. Bush, *Advance in Order: The Auckland City Council from centenary to reorganisation, 1971-1989*, Auckland, 1991, p.82



**Figure 6:** Embankment completed, finishing details in progress, reservoir partly filled, July 1948. Mead, 1949, p.328

### *Lower Huia Dam*

Despite a shift in focus to the Hunua Ranges, the reservoirs in the Waitakere Ranges still played an essential role in Auckland's water supply, and there was still another option for extending the system. Indeed, in 1963 the Council committed to constructing the last major Waitakere Ranges dam at Lower Huia, on the advice of City Engineer Arthur Dickson.

In 1965, as Upper Mangatawhiri project in the Hunua ranges was nearing completion, Don Wilson was transferred to the Lower Huia project as Resident Engineer and District Engineer for the Waitakere Ranges. The first major task on the project was to construct a diversion tunnel designed by council engineers Dave Hoyle and Charles Henson. Mr Wilson was responsible for the design of the dam itself with advice from consultant Peter Taylor and Mr Firth. Mr Wilson's deputy, Jack Clapperton, undertook the dam abutment and foundation drainage design. An innovation included in the dam's design was a two metre-wide chimney drain of graded scoria and a perforated concrete pipe collector drain at the base. This drain took any seepage to a measuring chamber. Mr Wilson's design of the energy dissipator for the spillway outlet structure was model tested at Auckland University by Professor Arved Raudkivi. Also introduced were special pizometers to measure pore pressures within the dam's core.

Contractors, Green and McCahill, commenced work in early in 1967 on the £1.2 million project. As was historically the case with its Waitakere Ranges predecessors, the Lower Huia Dam's construction was hampered by heavy rainfall during the first year. As a result special arrangements were made during construction to ensure the

embankment was shaped in a way which meant it could be quickly sealed off and shielded from rain. By March 1971 the embankment was completed and the official opening ceremony was held on 30 September 1971.<sup>54</sup>

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<sup>54</sup> Bush, 1971, p.360; La Roche

## Social narrative

Dams were constructed in New Zealand from early in the history of earnest European settlement. There were a number of uses in the early period for this type of human intervention to control water, such as in gold extraction or providing water supplies for the populous. These usually small structures were prolific, numbering in the thousands nationally. However, the public infrastructure functions of dams expanded in the early 20<sup>th</sup> century to include large scale structures for hydro-electric power generation. These became possible because of technological developments and greater understanding of how concrete could be utilised.<sup>55</sup>

As a basic societal necessity, pressures on the existing early water supply grew as the population of New Zealand did. This was a particular concern in Auckland, which has long been this country's largest city, but water supply development was also underway in Wellington and other centres during the late 19<sup>th</sup> and early 20<sup>th</sup> centuries.<sup>56</sup> Water supply became the responsibility of local authorities nationally reasonably early, along with other essential services, such as sewage and refuse disposal.<sup>57</sup> Of course, aside from being important personally because of the provision for drinking water, adequate water supply systems were especially important in industry, as well as for activities like fire fighting.<sup>58</sup>

In particular, the population density in Auckland led to the construction of the first dam in the Waitakere Ranges. The gradual expansion into a group of dams reflects the on-going growth of the region during the 20<sup>th</sup> century. The catchment in the ranges quickly became the major source of water for the city.<sup>59</sup> The Waitakere Ranges Water Supply System remains an important asset for Auckland amongst other sources which began to be incorporated into Auckland's water supply from the mid - 20<sup>th</sup> century.

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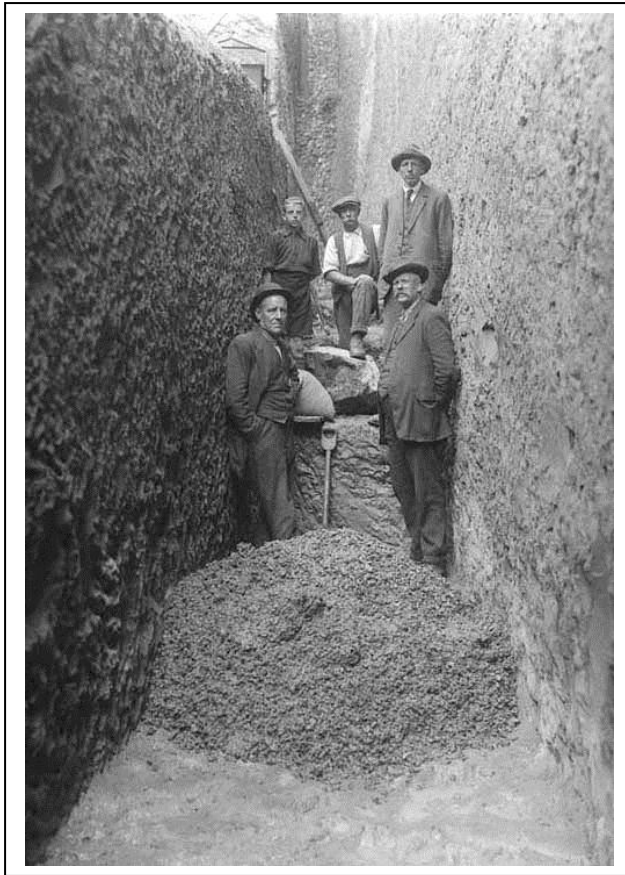
<sup>55</sup> Offer , pp.13, 16

<sup>56</sup> Ibid., p.38

<sup>57</sup> Bush, 1991, p.70

<sup>58</sup> Offer, p.16

<sup>59</sup> Barr, p.103



**Figure 7:** The inside of the cut off trench at the construction site of the Upper Nihotupu Dam, 1914-1923. Walter Ernest Bush (City Engineer) seen on top right. Sir George Grey Special Collections, Auckland Libraries, 1-W1814

While such structures benefitted society at large, they also affected the population in the immediate vicinity. For example, the Waitakere Dam's construction is said to have created flood prone areas where drainage was not previously an issue. This is said to have been one of the motivating factors for the, albeit relatively small, Waitakere Ranges Māori population to move elsewhere.<sup>60</sup> Conversely the construction of the Lower Nihotupu and Huia Dams provided good employment opportunities, drawing young families to the area. When these projects were completed the associated residents usually moved on, although worker settlements then became "haven[s] for the retired or holiday makers."<sup>61</sup>

The major water supply structures in the Waitakere Ranges are set within a large reserve known as the Waitakere Regional Park. From the early 20<sup>th</sup> century 10,000 acres (4047 hectares) of land was acquired by the local authority. This was done to protect the water supply from contamination, but recreational potential was also

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<sup>60</sup> MacDonald, p.42

<sup>61</sup> Ibid., p.97

recognised.<sup>62</sup> Indeed, it has been posited that had the Waitakere Ranges not been identified for its water catchment, there would have been no need for protecting the surrounding area, and the forest would most likely have been denuded to make way for farming.<sup>63</sup> Today there is still a recreational focus in the Waitakere Ranges, with the dams, reservoirs, and other structures, now attractions for users of the park's many walking tracks.<sup>64</sup> Another popular feature is the Rain Forest Express. This train ride uses the track constructed during the building of the Upper Nihotupu Dam.<sup>65</sup>

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<sup>62</sup> Barr, p.125; 'The Waitakere Reserve,' *Evening Post*, 30 December 1937, p.8; Bush, 1971, p.169

<sup>63</sup> Reidy, p.316

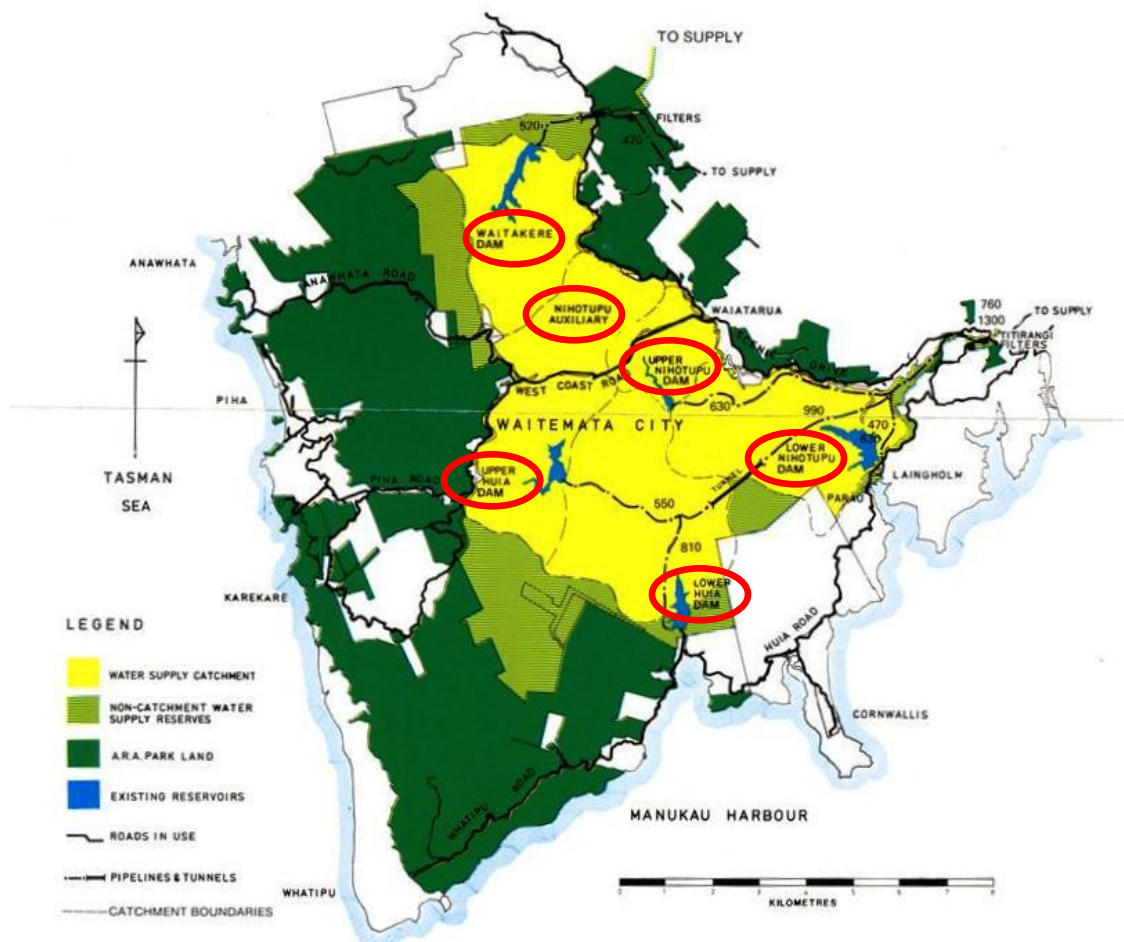
<sup>64</sup> 'Waitakere Ranges,' Auckland Regional Council, URL: <http://www.arc.govt.nz/parks/our-parks/parks-in-the-region/waitakere-ranges/> (accessed 2 August 2011)

<sup>65</sup> 'Rain Forest Express,' Watercare Services Limited, URL: <http://www.watercare.co.nz/community/rain-forest-express/Pages/default.aspx> (accessed 2 August 2011)

## Physical narrative

The main physical components of engineering importance in the Waitakere Ranges Water Supply System are the five dams which continue to be used. These are individually discussed below. While building, like the filter stations, and the networks of bridges, aqueducts, tunnels and pipeline are not detailed in this section, these are acknowledged as being intrinsic parts of the Waitakere Ranges Water Supply System's operational effectiveness. Likewise, the tramways and tracks associated with the dams, remnants of earlier dams, quarries, and the work camps, are recognised for their part in the system's history.<sup>66</sup>

### WAITAKERE HEADWORKS



**Figure 8:** Map of Waitakere Ranges showing locations of the Waitakere Ranges Water Supply dams and reservoirs. Auckland Regional Authority Bulk Water Department Water Supply Headworks leaflet

<sup>66</sup> Many sites associated with the history of water supply structures in the Waitakere Ranges are detailed in B. W. Hayward and J. T. Diamond, 'Historic Archaeological Sites of the Waitakere Ranges, West Auckland, New Zealand,' Auckland Regional Authority, 1978

### *Waitakere Dam*

This gravity mass concrete dam with central spillway, completed in 1910, had an original height of 20.4 m, but this was raised to 25.3 m in 1927. This drastically increased the capacity of the reservoir, to 1.85 million cubic metres (m<sup>3</sup>), and meant the Waitakere Dam became the same height as the Upper Nihotupu Dam, which had been built by this time. The Waitakere Dam 175 m long. The dam is accessible via a walking track leading off of Scenic Drive, with a car park located opposite house numbers 765 to 775.

Concrete had been used in small dams and weirs around New Zealand in the closing decades of the 19<sup>th</sup> century. However, it was not until the early 20<sup>th</sup> century that large scale concrete gravity dams were constructed, starting with structures like the Upper Karori Dam (1908) in Wellington, and the Waitakere Dam. However, in a move common for this type of dam, large rocks known as “plums” or “displacers” were imbedded in the concrete as it was poured. This reduced the volume of concrete required and the overall cost of the dam.<sup>67</sup>

It has been noted the Waitakere Dam “has features that characterise the concrete gravity dams built in New Zealand in the first three decades of this [the 20<sup>th</sup>] century.”<sup>68</sup> The Waitakere Dam’s most obvious typical aspect was its curved design, because this was thought to provide greater stability. In 1995 Messrs Riley, Gregory and Wymer, worked on strengthening the Waitakere Dam by drilling down to the foundation rock strata and tying the dam to the rock with prestressed cables. This project also involved pinning the 1927 addition to the original dam with stressed bars and cables.<sup>69</sup>

### *Upper Nihotupu Dam*

Like the Waitakere Dam, the Upper Nihotupu Dam (completed 1923) is a gravity mass concrete structure, with blue stone “plums” embedded in it. Its 162 m length is shorter than the Waitakere Dam. However, the reservoir’s capacity of 2.36 million m<sup>3</sup> outstrips the Waitakere Dam Reservoir. The Upper Nihotupu Dam, like the Waitakere Dam, is curved in design with a radius of 137 m. The dam tapers from a 31 m base width to 3.7 m across its top.<sup>70</sup> The dam and reservoir are accessible using various Waitakere Ranges walking tracks, like the Huia Dam and Nugget tracks.

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<sup>67</sup> Offer, pp.66, 202; New Zealand Historic Places Trust, Upper Karori Dam, Category II historic place (Record no.7749

<sup>68</sup> Offer, p.68

<sup>69</sup> Ibid.

<sup>70</sup> Barr, p.101

In 2009 Brian Perry Civil undertook work at the dam on behalf of Watercare Services Limited. This project involved upgrading the intake valves so they could be operated remotely. Other works included a new concrete valve chamber at the base of the dam.<sup>71</sup> The Upper Nihotupu Dam Upgrade was awarded a Hynds Environmental Award.<sup>72</sup>

### Upper Huia Dam

Although a similar length to the earlier dams in the Waitakere Ranges Water Supply System, the Upper Huia Dam (completed 1929) is 36.6 m high, has a greater reservoir capacity of 2.44 million m<sup>3</sup>, and is straight rather than curved.

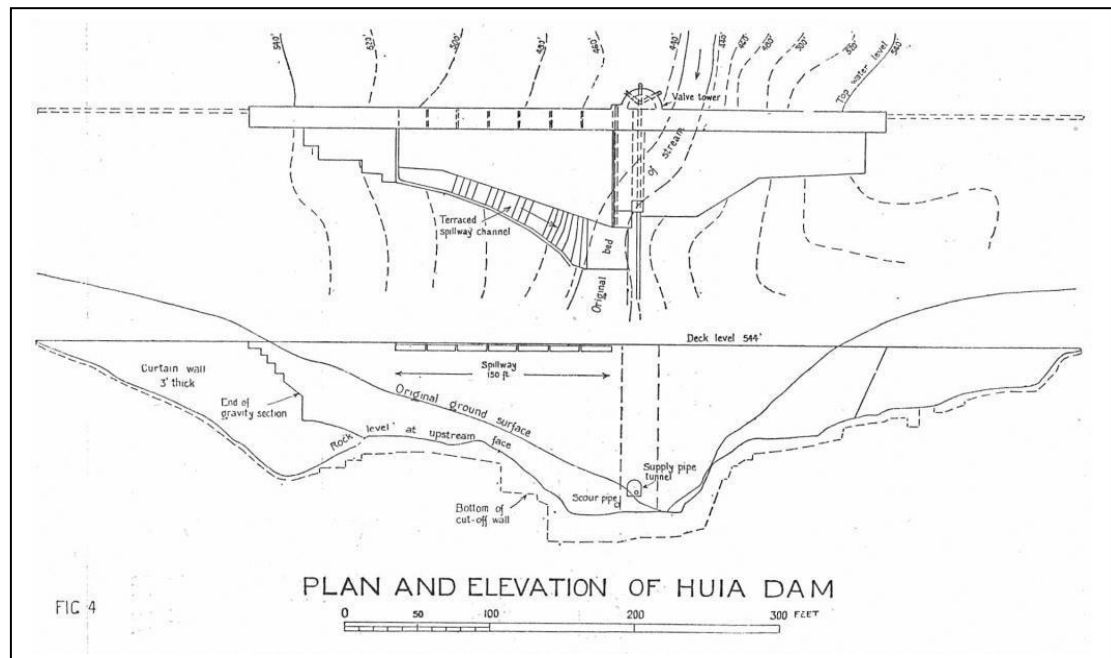


Figure 9: Plan and elevation of Huia Dam, circa 1931. Mead, 1931, p.165

The Upper Huia Dam completed the trio of Waitakere Ranges concrete gravity dams, and was the last of this type built for Auckland's water supply system. There was a general move away from concrete gravity dams in New Zealand around this period because of a shift in engineering practice. An empirical approach to dam design was

<sup>71</sup> 'A remote possibility,' July 2009, Fletcher Construction, URL: [http://www.fletcherconstruction.co.nz/article.php?article\\_id=333](http://www.fletcherconstruction.co.nz/article.php?article_id=333) (accessed 2 August 2011)

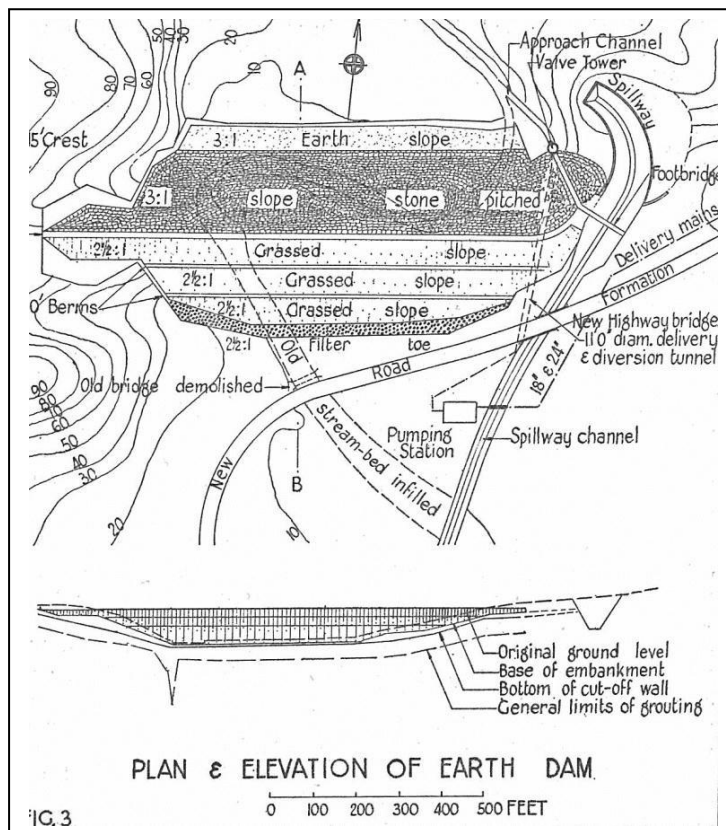
<sup>72</sup> 'Hynds Environmental Award – Upper Nihotupu Dam Upgrade,' Brian Perry Civil, URL: <http://www.brianperrycivil.co.nz/News.php?id=17&heading=Hynds%20Environmental%20Awards%20-%20Upper%20Nihotupu%20Dam%20Upgrade> (accessed 2 August 2011)

replaced by “rational design methods”, driven by “the cost reduction brought about by large earth-moving machinery”.<sup>73</sup>

The Huia Filter Station was also completed in 1929 as part of the project, with capacity incorporated to allow for future water supply system expansion, such as when the Lower Nihotupu Dam was completed.<sup>74</sup>

#### *Lower Nihotupu Dam*

This earth dam was innovative and a next important step in the evolution of New Zealand dam construction.<sup>75</sup> An advantage of the Lower Nihotupu Dam, and following earth dams, was the greater distance it could span compared with previous dams.<sup>76</sup> For example, the Lower Nihotupu Dam is a similar height to the other Waitakere Ranges dams (24.7 m), but it is 381 m long. The length of this dam is more than double that of the earlier structures. The reservoir capacity behind the three grassed terraces of the Lower Nihotupu Dam is 4.8 million m<sup>3</sup>.



**Figure 10:** Plan and elevation of earth dam. Mead, 1949, p.293

<sup>73</sup> Offer, p.76

<sup>74</sup> Mead, 1949, pp.325-26

<sup>75</sup> Offer, pp.92-93

<sup>76</sup> Ibid., p.93

The dam's concreted spillway and valve tower are on the eastern side of the structure. A small concrete arch pedestrian bridge spans the spillway, providing access to the valve tower, and a reinforced concrete road bridge also crosses the channel. All these features were built in concert with the dam.<sup>77</sup> Huia Road crosses in front of the dam just prior to Parau, and Lower Nihotupu Road travels north beside the reservoir from its intersection with Huia Road.

#### *Lower Huia Dam*

The Lower Huia Dam continued the tradition established in New Zealand by the Lower Nihotupu Dam, being a long (366 m) earth dam. However, at 39.6 m high it is nearly 15 m taller than its counterpart. Therefore, the Lower Huia Dam is the largest of all the Waitakere Ranges dams. Consequently so is its reservoir at 6.6 million m<sup>3</sup>. The size of this structure is reflective of New Zealand' on-going technology and dam design development. The dam and reservoir can be viewed from Huia Dam Road.

#### *Key physical dates*

1910	Waitakere Dam completed
1921	Auxiliary Nihotupu Dam completed
1923	Upper Nihotupu Dam completed
1926-27	Waitakere Dam raised 5 m
1927	Waitakere and Nihotupu Filter Stations constructed
1929	Upper Huia Dam completed and Huia Filter Stations constructed
1948	Lower Nihotupu Dam completed
1971	Lower Huia Dam completed
1990s	Waitakere Dam strengthened

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<sup>77</sup> Mead, 1949, p.301

## C. Assessment of significance

The upland water catchment in the Waitakere Ranges has been utilised since the early 20<sup>th</sup> century. Since then the Waitakere Ranges Water Supply System has been of considerable significance in New Zealand, being integral to the social and economic development and expansion of Auckland, this country's most populous area. This gravitational system and its impressive dams are associated with many leading New Zealand engineers, including: Hugh Munro Wilson, James Carlaw, Walter Ernest Bush, Arthur D Mead, Cyril Firth, Don Wilson and others.

The group of water supply dams also demonstrates the changing face of dam building in New Zealand, as technologies advanced and innovative engineering theory was put into practice. The Waitakere Dam was one of the earliest large scale concrete gravity dams in New Zealand. This became a characteristic New Zealand dam type, of which the Upper Nihotupu and Huia Dams are other Waitakere Range Water Supply System examples. Similarly, the Lower Nihotupu Dam is of particular national engineering importance as the first substantial earth dam, a form which became popular and developed further in the mid to late 20<sup>th</sup> century with structures like the Lower Huia Dam.

Therefore, the Waitakere Water Supply System is of sufficient engineering heritage significance to merit inclusion on the IPENZ Engineering Heritage Register.

## D. Supporting information

### List of supporting information

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