IPENZ
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ENGINEERING HERITAGE NEW ZEALAND

IPENZ Engineering Heritage Register Report

Raurimu Spiral

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Aerial view of Raurimu Spiral on the Main Trunk railway line between Auckland and Wellington, with Raurimu township at the bottom left. Photograph taken 24 January 1957 by Whites Aviation. Alexander Turnbull Library (ATL), ID: WA-42886-F

Contents

A. General information

Name: Raurimu Spiral

Alternative names: The Spiral; Tunnel No.4; Tunnel No. 5; Tunnel No. 16; Tunnel No. 17

Location:

North Island Main Trunk railway

Raurimu

Ruapehu

Geo-reference: Latitude: -39.119, Longitude: 175.401

Legal description: *NZ Gazette* 1909, p.6

Access information: The spiral can be partially viewed from the Raurimu Spiral Scenic Reserve next to State Highway 4 at Raurimu. NIMT trains also pass through the Raurimu Spiral.

Location map courtesy of GoogleMaps

City/District Council: Ruapehu District Council

IPENZ category: Engineering Work

IPENZ subcategory: Rail Transportation

IPENZ Engineering Heritage number: 2173

Date registered: 24 April 2012

Other IPENZ recognition: IPENZ Engineering Heritage Recognition Plaque (2009, yet to be installed)

Other heritage recognition:

- *New Zealand Historic Places Trust*: Category 1 historic place (Register no. 7588)
- *Local Authority District Plan*: Ruapehu District Plan Proposed June 2010. Ref 119 in Appendix 4: Schedule A Heritage Buildings (Last Amended: 01 Jun 2010)

B. Description

Summary

The Raurimu Spiral is considered an engineering masterpiece. In 1898, its design cemented the route of the North Island Main Trunk (NIMT) railway through the Central Plateau. Engineer Robert West Holmes' (1856-1936) design for the Raurimu Spiral provided an inspired solution to the steep descent from just above Raurimu township.

In 1870 plans were put forward to connect Auckland to Wellington via railway. This plan included traversing the Central Plateau. In the 1880s and 1890s surveys were completed to find possible routes through the central North Island where a steep drop in the landscape at the edge of the Central Plateau proved particularly problematic. Holmes was eventually given the task of plotting the NIMT route between National Park and Raurimu because the most recent solution to navigating the descent was too costly.

However, Holmes' subsequent design for the Raurimu Spiral would allow the sudden drop in altitude to take place while maintaining a manageable 1 in 50 gradient (two per cent), and comparatively cheaply. In its descent from the Central Plateau, the Raurimu Spiral consists of two tunnels (385 metres (m) and 96 m each), which allow the track to overlap and wind around in a circle, before exiting through two quarter turns and a horseshoe bend just south of Raurimu Station. Up-and-coming Public Works Department (PWD) engineer, Peter Keller (1880-1961), refined Holmes' design slightly using the newly instigated PWD policy of transition curves.

Upon completion the NIMT became important to New Zealand's economic development, and was also socially significant. The Raurimu Spiral is considered a feat of engineering ingenuity and the success of this solution contributed to the on-going effectiveness of the NIMT. Despite advances in technology and materials in the century since its completion, no feasible alternative to the Spiral has been found. Therefore, the Raurimu Spiral is a lasting tribute to Holmes' engineering achievements and is of considerable engineering heritage importance.

Historical narrative

The NIMT's construction was arguably New Zealand's most significant engineering feat of the late 19th and early 20th centuries. Among the NIMT's component parts of the NIMT is the Raurimu Spiral, which is considered an icon of railway engineering in New Zealand. This series of bends and tunnels epitomises engineering ingenuity.[1]

In 1863, with the railway from Auckland to Drury, preliminary work began on what would evolve into the arterial rail route through the North Island.[2] In 1870 the Public Works Department (PWD) was established, and under this department a direct rail link between the North Island's two main centres, Auckland and Wellington, was to become a reality, albeit over a prolonged period. Progress from Auckland coincided with construction north from Wellington. By 1880 the railheads approached Te Awamutu and Marton. The approximate 322 kilometre (km) section between these towns crossed the King Country and the Central Plateau.[3] This section proved the most problematic to traverse with a railway because the terrain was a notched landscape of varying soil and ground conditions, and was crisscrossed with numerous rivers. This contributed to the NIMT not being completed until decades later, in late 1908.[4]

John Rochfort (1832-1893) began his mammoth survey expedition to locate the NIMT route in 1882.[5] However, the problem of the descent at the edge of the Central Plateau seems to have been glossed over,[6] so further surveys were conducted. In 1887, Browne, Beere, and Turner produced an alternative, but this would have necessitated many more major, and expensive, viaducts. This cost and indecision provided fuel for those campaigning to take the railway through Taranaki rather than the central North Island.[7]

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[1] Roy Sinclair, *Journeying with Railways in New Zealand,* Auckland, 1997, pp. 54, 260; Rosslyn Noonan, *By Design: A brief history of the Public Works Department Ministry of Works, 1870-1970*, Wellington , 1975, p.312

[2] Roy Sinclair, *Rail: The great New Zealand adventure*, Wellington, 1987, p. 16

[3] Neill Atkinson, 'Railways - Main trunk lines', Te Ara - the Encyclopedia of New Zealand, URL: http://www.TeAra.govt.nz/en/railways/2 (updated 30 June 2011)

[4] Robin Bromby, *Rails that Built a Nation: An encyclopedia of New Zealand railways*, Wellington, 2003, p.21; A. L. R. Merrifield, 'New Zealand's North Island main trunk railway: 1870-1908,' *Proceedings of the Institution of Civil Engineers, Engineering History and Heritage*, Vol. 162:4 (2009), p.207

[5] *The Pioneer Land Surveyors of New Zealand, Part IV: Biographical Notes*, pp.455-56. URL: http://www.surveyors.org.nz/sites/all/files/PART%20IV%20THE%20PIONEER%20LAND%20SURVEYORS%20OF%20NEW%20ZEALAND.pdf (accessed 19 December 2011)

[6] R. S. Fletcher, *Single Track: The construction of the North Island Main Trunk Railway,* Auckland, 1978, pp. 145-146

[7] Bill Pierre, *North Island Main Trunk; An illustrated history*, Wellington, 1981, p.37

A solution, which would confirm the Central North Island route, was elusive until Robert West Holmes' (1856-1936) had a eureka moment in 1898.[8] Holmes had been working in the area locating the railway north from Ohakune to Waimarino from 1897.[9] Accompanying him was John Davinci Louch (1854-1937), who had been the Government Engineer at Pahiatua.[10] The spiral form was recognised as a viable solution to a steep drop by railway engineers in the late 19th century. However, Holmes' realisation of its suitability at Raurimu was an inspired idea which is remarkable for having been formulated before techniques such as aerial surveying were available.[11] Much to the relief of the Government, Holmes' (1856-1936) elegant solution to the challenge posed by the landscape provided a relatively cheap solution while still closely following Rochfort's initial survey route.[12]

Holmes had joined the PWD in 1872 as a draughtsman, but soon after became an engineering cadet. He then progressed through the PWD ranks, becoming the Resident Engineer in New Plymouth in 1879, and holding similar positions elsewhere in the North Island, which seem to have developed his experience in railway location. At the time the Raurimu Spiral was under construction, Holmes was the PWD Superintending Engineer, before succeeding Peter Seton Hay (1852/53-1907) as Engineer-in-Chief in 1907.[13] Holmes is one of the few people said to have been present at the ceremonies which officially launched (1885) and finished the NIMT (1908).[14] Later in his career, Holmes became the first President of the New Zealand Society of Civil Engineers in 1914.[15]

The Raurimu Spiral was part of the Makaretu Section of the NIMT's construction. By 1905 the construction south from Taumarunui was approaching, and because it was a significant task the Raurimu Spiral's construction began in advance of Raurimu becoming the railhead.[16] The realisation of Holmes' plan began with the pegging out of the Raurimu Spiral. Very few changes to Holmes' drawn plans were made as result of this practical process. However, up-and-coming PWD engineer Peter Keller (1880-1961) felt that the circle feature in Holmes' plan could potentially, and unnecessarily, increase wear on the track and hinder the passage of trains. The previous year (1904) Keller had gained experience in this type of work as he was involved in laying

[8] Noonan, pp.312, 314; Merrifield, p.213

[9] Pierre, p.43

[10] 'North Island Trunk Railway,' *Colonist*, 4 March 1898, p.3

[11] Noonan, p.312; Pierre, p.45

[12] Fletcher, p. 157

[13] F. W. Furkert, *Early New Zealand Engineers*, Wellington, 1953, pp.192-93

[14] *Feilding Star*, 10 November 1908, p.2

[15] Sinclair, 1987, p.47

[16] F. K. Roberts, *A Compendium of Railway Construction, Part Two: North Island Main Trunk*, Wellington, 1990, p.24

out of the Holmes' Turangarere Horseshoe at the opposite end of the Central Plateau. At Raurimu, Keller experimented to ease the demands the circle feature would impose on the track and trains by joining Holmes' two 166 m curves with a 246 m radius bend rather than the straight Holmes proposed. Excited by the idea Keller pegged this out before referring the matter to senior engineers. Fortunately, his initiative was rewarded with their support and his amendment was approved.[17] The Railways Department had only recently introduced a policy of using transition curves to overcome the lurching which occurred as trains went from a straight to a curved track. Keller had been involved in the process of designing and setting out these transition curves, and it is suggested that this experience was what inspired his thinking in relation to the Raurimu Spiral.[18]

Figure 1: A steam locomotive pulling a goods train ascending the Raurimu Spiral, on the North Island Main Trunk Line, 1917. Godber, Albert Percy, 1875-1949: Collection of albums, prints and negative. ATL, ID: APG-0478-1/2-G

Constructed between 1905 and 1907, the Raurimu Spiral was a critical link in the push to finish the NIMT. The heavy earthworks at Raurimu were undertaken by co-operative system workers with only the aid of picks, shovels and horse power. The co-operative system sectioned the railway into small parts that groups men would complete, using materials and equipment provided by the PWD, and supervised by an elected headman. An advantage of the co-operative system was that the PWD

[17] Pierre, p.49

[18] Merrifield (2009), p.213

had tighter control over the quality of work and the work was generally completed comparatively cheaply. In the early 1890s contractors were still widely used to construct government buildings and structures. However, in 1896 a departmental Circular Memorandum reminded all engineers that wherever practicable works were to be carried out on the co-operative principle."[19] Therefore, after the Makohine Viaduct was initiated using this system in 1896 the majority of the work on the NIMT was undertaken in this way.[20]

Despite innovations in technologies and materials over the last century, no viable alternative to Holmes' concept has been found. Of course in the early 20th century even the manageable gradient of the Raurimu Spiral was a challenge to steam locomotives. It could take approximately 40 minutes for a goods train to ascend, for example.. However, this time was halved when high-powered diesel locomotives were introduced in the 1950s and continued to be reduced as successful generations of locomotive were introduced.[21]

The completed NIMT was heralded as an engineering feat, and this on-going admiration has been expressed in the many books on the subject. Within the NIMT some components like the Raurimu Spiral have been singled out and acknowledged as important. In 1980, the Raurimu Scenic Reserve was created and in 1986 the New Zealand Historic Places Trust (NZHPT) established a look-out for visitors so they could see a portion of the Raurimu Spiral. At this time the Taumarunui Rotary Club installed a plaque in honour of the "world famous engineering achievement."[22] The Raurimu Spiral is a key aspect of the NIMT, which is internationally recognised as an engineering achievement. In 1997 IPENZ and the American Society of Civil Engineers acknowledged the NIMT's significance with a plaque. A few years later, in 2005, the Raurimu Spiral's national heritage importance was recognised when the NZHPT registered it as a Category I historic place, and subsequently as part of the NIMT Historic Area.[23]

[19] Noonan, p.78

[20] Ibid., pp.78-79; Pierre, p.40

[21] Pierre, p.241

[22] Raurimu Spiral Reserve Plaque, 2008. Photograph, Rob Aspden. IPENZ

[23] Raurimu Spiral, New Zealand Historic Places Trust Register, URL: http://www.historic.org.nz/TheRegister/RegisterSearch/RegisterResults.aspx?RID=7588 (accessed 12 December 2011); North Island Main Trunk (NIMT) Historic Area, New Zealand Historic Places Trust Register, http://www.historic.org.nz/TheRegister/RegisterSearch/RegisterResults.aspx?RID=7793 (accessed 28 November 2011)

Social narrative

The NIMT's development benefitted and opened part of the North Island in particular, but had wide ranging effects on the economy and society in general. Improvements were noted within travel, communications and infrastructure across areas of country which had previously been closed to European settlement, as the railway's progression saw auxiliary roads and telegraph wires developed aside the rail tracks.[24]

Figure 2: English railway workers erecting camp at Raurimu, ca 1906. Tibbutt, Alfred George: Main Trunk Railway photographs. ID: PA1-q-244-06

As the NIMT's construction progressed south from Auckland and north from Wellington, small on-site camps where the workers were based sprang up and moved as the work did.[25] The temporary nature of most of the camps meant that little evidence remains today.[26] However, whenever there was a major railway component that took several years to complete, some semi-permanent, or even permanent, facilities usually coincided. This was the case in Raurimu where the substantial earthworks required an extended period to complete.[27] As work progressed,

[24] Kate Hill, *Raurimu Frontier Town 1900-1925: A Social Archaeological Perspective.* Auckland, 1999, p. 3

[25] Ibid., p. 19

[26] Ibid., p. 22

[27] Ibid., pp. 1-2

Raurimu's population increased reaching between 1500 and 2000.[28] Raurimu soon took on the character of a settlement rather than a camp because of the establishment of permanent structures, such a public houses, general stores and a school.[29]

The NIMT thus had local social importance as the reason for Raurimu township's establishment. The town continued to prosper after the completion of the railway's completion because as the construction workers moved out railway support staff and other settlers moved in. The surrounding area, now made accessible because of the NIMT, was used for farming and forestry. As these thrived Raurimu's population also grew.[30] After a brief transition period from 1908 to 1910, forestry boomed and a sawmill was built. Around that time the last of the canvas structures were also removed. The timber industry, with its reliance on railway transport, was important to the local economy and therefore when this went into decline in the mid to late 20th century, so did Raurimu.[31] In 2006 the population of the town was 552, although because of its proximity to the Mount Ruapehu ski-fields in the late 20th century Raurimu began to develop as a holiday town. Passenger trains, however, no longer stop there.[32]

Raurimu is also visited as a place to break a journey along the highway and has a viewing point for those interested in the Raurimu Spiral. The Raurimu Spiral is praised as one of the main and best known highlights on the Overlander train's NIMT journey between Auckland and Wellington.[33] Indeed, even before it was completed, the Raurimu Spiral was touted as one of New Zealand's famous engineering feats.[34]

[28] Hill, p. 37. For example in late 1906 it was reported that approximately 1,000 men were employed specifically on the two tunnels of the Raurimu Spiral, 'Public Works Statement,' *Otago Witness*, 24 October 1906, p.26

[29] Hill, pp. 1-2

[30] Ibid., p. 31

[31] Kerryn Pollock, 'King Country places - National Park,' Te Ara - the Encyclopedia of New Zealand. URL: http://www.TeAra.govt.nz/en/king-country-places/8 (updated 7 December 2011

[32] Pollock; 'Quick Stats about Raurimu,' Statistics New Zealand. URL: http://www.stats.govt.nz/Census/2006CensusHomePage/QuickStats/AboutAPlace/SnapShot.aspx?ParentID=&type=&p=y&printall=true&tab=Households&id=3532601 (accessed 13 December 2011)

[33] Sinclair, 1997, p.261; G. B. Churchman and T. Hurst, *The Railways of New Zealand: A journey through history*, Auckland, 1990, p.126

[34] 'Some Engineering Feats,' *Poverty Bay Herald*, 28 November 1906, p.5

Physical narrative

Completed in 1908, the Raurimu spiral is “considered the most outstanding feature on the New Zealand Railway system, even more so than the 8 km Otira Tunnel through the Southern Alps.”[35]

During the NIMT’s construction, Holmes acknowledged the “very great difficulty” in locating the route for the railway “southward from Waiouru and northward from Waimarino [National Park], because the country falls away very rapidly from these points. This necessitated special artifices to obtain sufficient length of line for the required grades. The loop at Turangarere and the spiral at Raurimu were needed for these purposes.”[36]

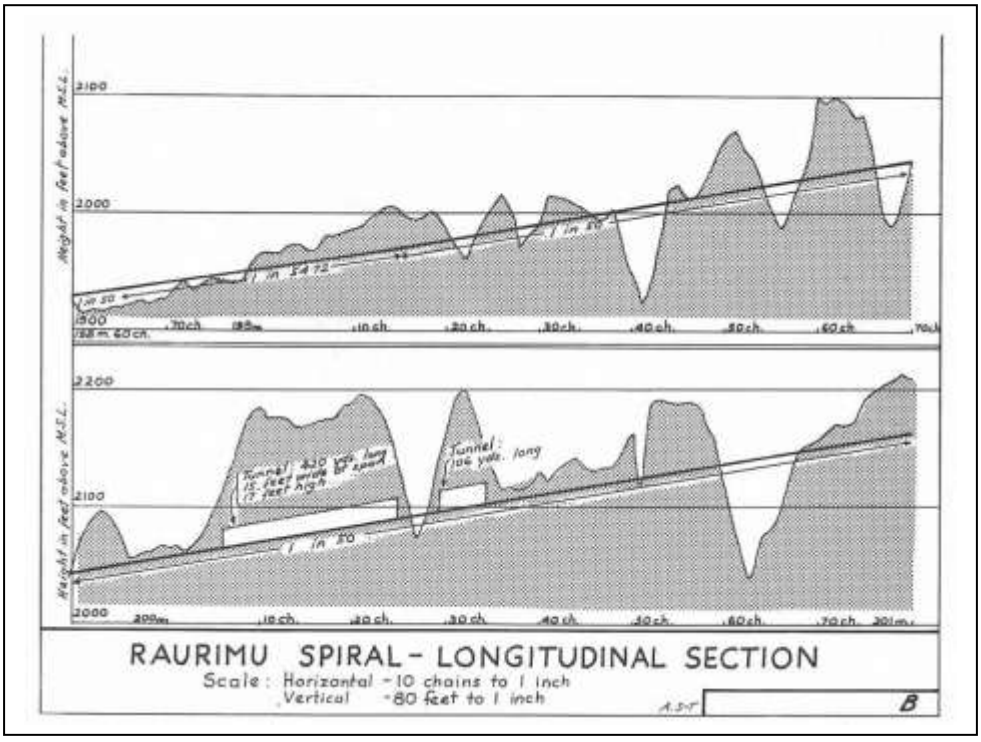

Figure 3: Raurimu Spiral – Longitudinal Section. Pierre, p.47. Pierre notes that all of the physical features above the gradient resulted in cuttings or tunnels, and correspondingly all those below meant embankments were created.

The Raurimu Spiral was created through a series of culverts, ten cuttings and two tunnels. Embankments were also created; the biggest one was close to the summit and 34 m high. These elements come together to help form one horseshoe bend, two quarter turns, and a circle of track at the summit. Maintaining a grade of 1 in 50, the

[35] Sinclair, 1997, p. 269
[36] ‘The Levels,’ *Hawera and Norrmanby Star*, 7 August 1908, p.2

Raurimu Spiral adds six km of track to the 5.5 km direct route from National Park to Raurimu.[37]

The track ascends from Raurimu Station towards the southeast before a 151 m radius horseshoe bend brings the track back to a northwest orientation. After a straight there are two bends, the same radius as the horseshoe bend. The first bend orients the track east until the track is then taken around an opposing turn and directed south. The railway then enters the first (385 m) tunnel.[38] This is one of the longest remaining tunnels on the NIMT.[39] The sinuous route continues towards the west and enters the second (96 m) tunnel. The ascent is completed with the circle that takes the track around and over the first tunnel, before heading southeast towards National Park. This circle is comprised of two 166 m curves with a 246 m radius bend joining them.

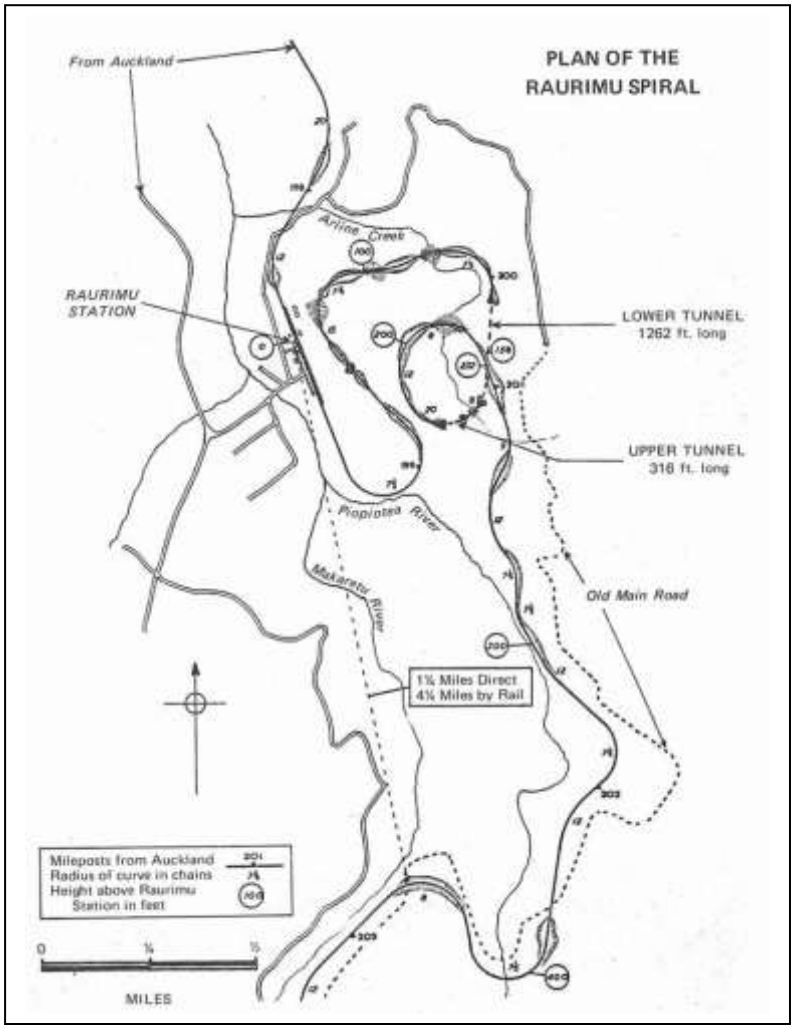

Figure 4: Plan of Raurimu Spiral. Troup, p.149

[37] Pierre, p.47; Troup, p.149

[38] These radius measurements are conversions from chains into metres of the information provided by Troup (see Figure 4)

[39] Roberts, p.63

The design of the Raurimu Spiral has stood the test of time. Since its completion in 1908, the Raurimu Spiral's form has been altered little other than through the actions undertaken to maintain the railway, and upgrades during extensive programmes, like the NIMT's electrification in the 1980s. As a result of this project, the two tunnels were lowered *circa* 1986.[40] In recent times some sections of track have been realigned slightly because of erosion.[41]

Key physical dates

1905 Construction commenced
1906 Tunnels began
1907 Construction complete
1986 Tunnels lowered

[40] W.J. Jones to Group Manager, Freight Business Group, 21 November 1985. Archives New Zealand, AAEB W3438 56/22/247/22 pt1

[41] A. L. R. Merrifield, 'Raurimu Spiral: North Island Main Trunk Railway Line,' IPENZ National Heritage Committee Report, 2008, n.p.

C. Assessment of significance

The completion of the NIMT relied upon finding an answer to the sudden change in altitude at the north edge of the Central Plateau. The result, the Raurimu Spiral, is an exceptional example of engineering problem solving and ingenuity. Robert West Holmes' masterpiece displayed creativity in overcoming the challenge. The NIMT is widely acknowledged as one of the major engineering feats in New Zealand's history, and the Raurimu Spiral epitomises the engineering within the NIMT. The Raurimu Spiral is widely recognised as an engineering achievement and it continues to be one of the most significant, and well-known, landmarks along the NIMT.

Therefore, the Raurimu Spiral is of sufficient engineering heritage significance to merit inclusion within the IPENZ Engineering Heritage Register.

D. Supporting information

List of supporting information

Link to: North Island Main Trunk (NIMT) Historic Area, New Zealand Historic Places Trust Register, http://www.historic.org.nz/TheRegister/RegisterSearch/RegisterResults.aspx?RID=7793 (accessed 28 November 2011)

Link to: Raurimu Spiral, New Zealand Historic Places Trust Register, http://www.historic.org.nz/TheRegister/RegisterSearch/RegisterResults.aspx?RID=7588&m=advanced

Link to: Robert W. Holmes, IPENZ Engineering Heritage, Engineer Biographies, URL: www.ipenz.org.nz/heritage/bio-detail.cfm?id=9

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