A History

of the

Victoria Battery Concentrates Tailings Stack

1906 – 2022

Victoria Battery Concentrates Tailings Stack 2022

Prepared for the Department of Conservation

Eric Lens, June 2022

Victoria Battery Concentrates Tailings Stack

Table of Contents

Executive Summary

The Waihi Gold Mining Company established the Victoria Battery in 1897/98. 100 stamps commenced dry crushing early March 1898. A further 100 stamps were added, and the whole battery started wet crushing early August 1902.

The highly mineralised component of the ore, rich in gold and silver, needed to be extracted from the general crushed ore and treated separately. This is called concentration, and produced concentrates. A Concentrates Treatment Plant (CPT) was established, first an experimental plant in 1901, and a permanent plant in 1905, treating the concentrates from all three batteries (Victoria, Waihi, and Union). The tailings (waste) of the CTP were initially saved for possible future reprocessing. They were at first stacked beside the CTP, but in 1906 these were moved to the site beside the tramway, some 500m from the battery. How the tailings were transported is unknown.

This site became full in late 1907; no further tailings were added, or saved elsewhere.

Superintendent H. P. Barry felt that "We have very little hope of ever being able to treat these tailings at a profit" [1].

However, there is some evidence to suggest that some of these tailings were reprocessed; at the end of the Waihi miners' strike of 1912, when the ore supply from Martha mine was still low, and also in the early 1940s, as ore production from the mine dwindled.

Introduction

The Waihi Gold Mining Company established the Victoria Battery in 1897/98.

Waihi ore (and Hauraki in general) was difficult ore. Refractory, with gold finely divided and often intimately bound to sulphide minerals. Ore roasting and dry crushing followed by cyanidation had been established as best practice at the Waihi Battery, and thus this was the process set up at the new Victoria Battery. Huge ore roasting kilns were built, with vast quantities of firewood required. Miners and battery hands were maimed by "the dust" (phthisis or silicosis).

100 stamps started dry crushing on March 2nd, 1898.

Experiments in wet crushing, over many years, were on going. The increasingly mineralised ore found at depth in Martha mine added to the pressure to convert.

In May 1899 a start was made to erect a further 100 stamps which were to be wet crushing.

By mid January 1900 the 100 wet stampers were fully operational[2]. The original 100 dry stampers were converted during 1902[3].

The change to wet crushing, and the more mineralised nature of the ore required changes to the battery flow sheet.

Concentrates

Superintendent H. P. BARRY, in his annual report, reported thus for the year 1899:

> A series of experiments has been carried out during the year, the results of which have demonstrated that a fair extraction by wet crushing can be obtained.
>
> The process which has finally been selected, is that of wet crushing with water, separation of the sands and slimes by means of spitzkasten. A separate treatment being advisable for the

[1] SUPERINTENDENTS ANNUAL REPORT. FOR 1907. Waihi, l3th February, 1908.
[2] SUPERINTENDENTS ANNUAL REPORT. Waihi, 27th January, 1902. (For the year 1901)
[3] SUPERINTENDENTS ANNUAL REPORT. WAIHI, 24th January, 1903. (For the year 1902)

> higher grade heavily mineralised ore, chiefly found in the eastern block on the Martha Reef, this ore after being wet crushed, will be passed over vanners (six of which have been ordered), and a concentrate taken out.[4]

During 1901 a small experimental plant was established to test the separate treatment of the concentrates.

> Towards the end of the year the treatment of 10 tons of concentrates was commenced in the small concentrate plant which has been erected. The plant consists of a Mc.Kay Pan for re-grinding the concentrates, and two agitators.
>
> The treatment has not been completed. The object is to see whether a saving can be effected by treating our own concentrates instead of sending them to Australia as is done at present.[5]

So the plan is to separate out a concentrates stream and treat this separately, so that concentrates don't have to be sent to Australia or England for processing.

The process that has been (or will be) adopted is:

- The ore is wet crushed to fine sand by the stampers (later, when tube mills are used for all the ore, a coarser sand is produced by the stampers).
- The fine sand (often called pulp) is run over mercury amalgam plates to catch the larger particles of free gold.
- From the plates the pulp is sent to the vanners or Wilfley tables where a "concentrate" (by specific gravity) is taken off. These are the heavier, mineralised particles of the pulp, which don't respond well to the run of the mill cyaniding.
- The concentrates are treated in the Concentrates Treatment Plant (CTP), the rest of the pulp (the tails from the vanners) going through the general battery process – sands and slimes. Fine grinding, and in later years very fine grinding, followed by air agitation in tall tanks will be adopted in the CTP.
- For some time these concentrates proved difficult to process successfully, a percentage of the values remaining. So initially the tailings of the CPT, very finely ground concentrates, were saved.
- The flow chart of the battery, with these three processes (concentrates, sands and slimes), remains for the life of the battery.
- See the extract from John Bacon, the last battery superintendent, at page 46.

What are concentrates?

The heavily mineralised component of the finely crushed ore comprised largely of iron sulphide (FeS_2 or iron pyrites) and quartz (silica). This material held considerable gold tightly bound in the crystal structure, where cyanide had difficulty dissolving it. As this material was heavier than the bulk of the ore, it could be separated by specific gravity.

Vanners and Wilfley tables were devices which were able to do this from the stream of finely crushed ore or pulp. Concentrates were commonly produced on many goldfields.

E. G. Banks gives the composition of the concentrates as 35% sulphur, 32% iron, 28% silica, with small traces of other metals and minerals.[6] John Bacon gives the same composition at the end of the

[4] SUPERINTENDENTS ANNUAL REPORT. WAIHI, 23rd February, 1900. (For the year 1899)
[5] SUPERINTENDENTS ANNUAL REPORT.Waihi,27th January, 1902. (For the year 1901)
[6] Milling and Treatment at the Waihi Mine, New Zealand. By E. G. Banks. Paper No. 221

battery life[7], and this also matches closely the analysis of the tailings detailed in the WRC 2009 DM1498933 Waikino Tailings Dam Detailed Site Investigation Report.

Concentrates Treatment Plant

A small experimental plant was erected in 1901, but during 1902

> Several small lots of concentrates have been treated in the plant erected for this purpose. The results so far obtained have not been quite satisfactory.[8]

During 1903 the plant was completed, with tube mill, 10 steel agitating vats and V boxes.

> A series of trials of the treatment of concentrates at the Victoria Mill instead of shipping them, have been carried out for some months.
>
> A complete unit of plant was erected and experiments made with grinding…
>
> Work in connection with the whole plant has just been completed.[9]

During 1904 the directors reported:

> In order to deal with the increase in the mineralized ore, the concentration plant at the Victoria Mill (which up to the present has only been adapted to 30 stamps) will be extended to treat the product of the remaining 170 stamps.[10]

Barry reported:

> Soon after the commencement of the year a start was made to treat the Concentrates in the Plant erected for that purpose at the Victoria Mill, and within a few months the whole of the Concentrates produced at the three mills were sent to that Plant for treatment instead of shipping them to Smelting Works in Australia or England, as had previously been done…
>
> The tailings are being conserved.
>
> The working arrangements of this plant have proved to be satisfactory. The Concentrates are ground in a Tube Mill and subsequently agitated by means of compressed air, with cyanide solution in ten 6 feet diameter vats.[11]

To date, only 30 stamps at the Victoria Battery have been crushing mineralized ore, the pulp passed over 8 Vanners, amalgamated copper plates (mercury plates; would also explain the elevated mercury levels found in the analysis of the tailings by WRC), and subsequently sent to the Concentrates Treatment Plant (CTP). The concentrates from the Waihi and Union batteries were also treated here.

"The tailings are being conserved" suggests unhappiness with the extraction rate that the CTP was achieving. Maybe when the process is sufficiently improved the tailings can be reprocessed. In 1907 the extraction rate was Gold: 95.7 per cent., Silver: 94.3 per cent[12].

We will soon see where these tailings are accumulating.

Reporting on 1905, Barry records:

> The decision to extend the vanner plant, so as to embrace the product from the whole 200 stamps, has been given effect to, and the work has been in hand for several months past, and the large plant for this purpose is nearing completion and should be brought into use within a few weeks.

[7] John Bacon on the Victoria Mill and Waikino
[8] SUPERINTENDENTS ANNUAL REPORT. WAIHI, 24th January, 1903.
[9] SUPERINTENDENTS ANNUAL REPORT FOR 1903 Waihi, 21st January, 1904
[10] REPORT OF THE DIRECTORS. 17th April, 1905.
[11] SUPERINTENDENTS ANNUAL REPORT FOR 1904. Waihi, 25th January, 1905
[12] SUPERINTENDENTS ANNUAL REPORT. FOR 1907. Waihi, l3th February, 1908.

This plant is in a different position from the small vanner plant now in use.

A large two storey building has been erected, the necessary copper plate-tables, which are situated on the top floor, have been put in, and the "Wilfley" vanners, 25 in number, have been procured and erected on the ground floor….

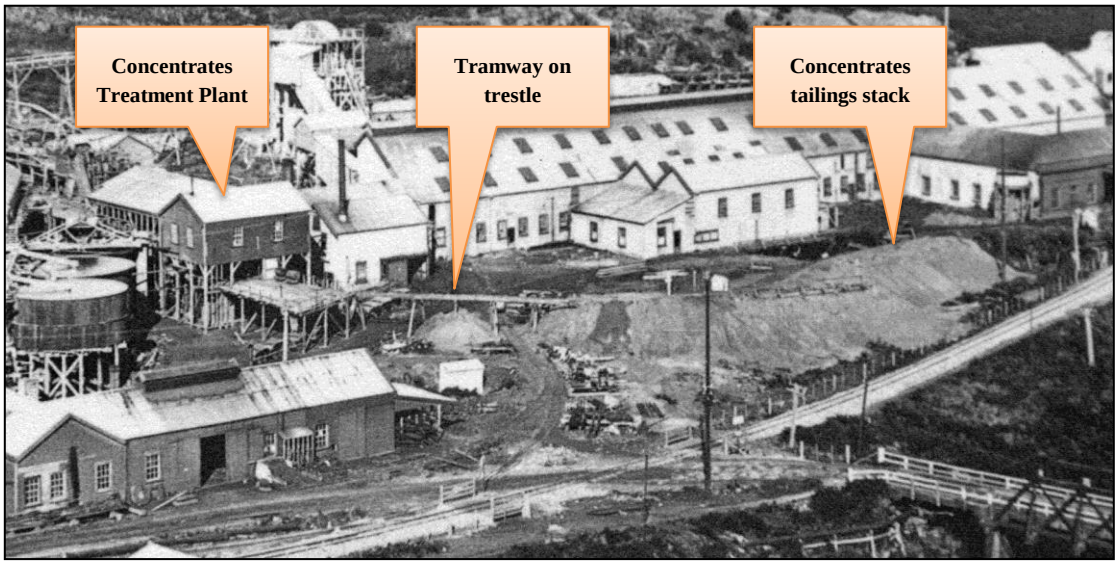
The tailings from this plant are still being conserved.[13]

1906

The most suitable position for the extension of the vacuum slimes plant and agitators required for the treatment of the increased product, which should amount to about 5,000 tons per month, was occupied by the **concentrates tailings dump, consequently these have been removed**…

The tailings from this plant are still being conserved.[14]

The vacuum slimes plant is the area east of the current air agitation tanks bases; the roadway passes through it. The new CTP was up the slope towards the present Transformer House.



The new CTP can be seen middle left, with tramway on trestles delivering tailings to the heap or stack. Note that they are dry enough to stack. Government railway in foreground. Circa early 1906. Stubbs.

It is this area that will be required for the vacuum slimes plant and B&M tanks.

The image shows the stacked tailings, dry enough to pile up.

To remove these tailings, a tender was advertised 4 July 1906, Waihi Daily Telegraph.

[13] SUPERINTENDENTS ANNUAL REPORT FOR 1905. Waihi, 18th January, 1906.
[14] SUPERINTENDENTS ANNUAL REPORT. FOR 1906. Waihi, 17th January, 1907.

WAIHI GOLD MINING CO., Ltd

Tenders will be received up to noon o FRIDAY, 6th July, for the REMOVAL AND DEPOSITING of about 4000 yards of CONCENTRATES TAILINGS at the VICTORIA MILL, WAIKINO.

Specifications to be seen at the Company's Offices, Waihi and Waikino.

H. P. BARRY,
Suprintendent.

WAIHI GOLD MINING CO., Ltd Tenders will be received up to noon on FRIDAY, 6th July, for the REMOVAL AND DEPOSITING of about 4000 yards of CONCENTRATES TAILINGS at the VICTORIA MILL, WAIKINO. Specifications to be seen at the Company's Offices, Waihi and Waikino. H. P. BARRY, Superintendent.[15]

The tailings accumulated at the battery were moved to, presumably[16], the site beside the rakeline where we see them today. Moving "about 4000 yards", 3,000 cubic metres, maybe 10,350 tonnes[17], is a mighty undertaking. How was it done?

Concentrates Tailings Stack beside the tramway

By the end of 1906 the tailings beside the CTP have been removed, relocated to the stack beside the tramway. The image(s) of the tailings stacked at the battery show piles of tailings, i.e. dry enough to stack, not a slurry.

The stacking site chosen was probably the nearest vacant site available, a swale between the tramway and the water race. It appears that no permission from the Mining Warden was asked for, or was not required.

No description of the transportation method has been found, but a hint may be seen in some photographs of the new stack. They show what looks like a cutting angling across the slope above the tramway but below the water race. Certainly the vegetation was cleared below this line. The images also hint at tailings being mounded up.

It appears that the tailings were mounded up from the high side (water race side), and not tipped out of ore trucks on the tramway. Were the tailings transferred from ore trucks to cart to be pulled up the cutting, by horse or winch? Or tipped from trucks, and somehow redistributed onto the stack by hand or beast?

A temporary siding off the tramway?

Would a contractor have been given use of a locomotive and ore trucks anyway?

Horse and cart, using the tramway as an access road?

The tailings stack at the battery was removed, and the newly produced tailings must have been transported to the new stack as well. But after little more than a year, the saving and deposit of tailings ceases. October 1907:-

[15] https://paperspast.natlib.govt.nz/newspapers/WHDT19060704.2.49.5
Waihi Daily Telegraph, Volume VI, Issue 1675, 4 July 1906, Page 3
[16] No concise description has been found.
[17] Using a bulk density of 3.45, as suggested by the K. Hay report, March 1998

> Owing to our available stacking ground being full, we have, since October, been unable to continue conserving the tailings, the actual cost of conveying them to the nearest site, about a mile distant, being prohibitive. [18]

It may be that "The nearest site, about a mile distant" is not describing the current site, which is half that distance, but a possible other site that had been considered.

> We have very little hope of ever being able to treat these tailings at a profit, but are making every endeavour so to increase the extraction on the concentrates, that this question of the value of the tailings will become of less importance.[19]

What quantity of tailings were stacked?

Barry reports for 1907 "A total of 5,581.14 tons were treated during the year"[20]. The time from starting (say end July 1906) to finishing the stack (October 1907) was 14 or 15 months. This figure of 5,581 tons, times 15/12 (6,976 tons), would roughly represent the tailings added to the 4000 yards (3000 m^3, 10350 tonnes) moved from the battery stack.

The calculations below, based on the assumption that Barry was quoting short tons, suggest that roughly 16,700 tonnes were dumped at the tailings stack beside the tramway. More if Barry was using long tons (2240 lb).

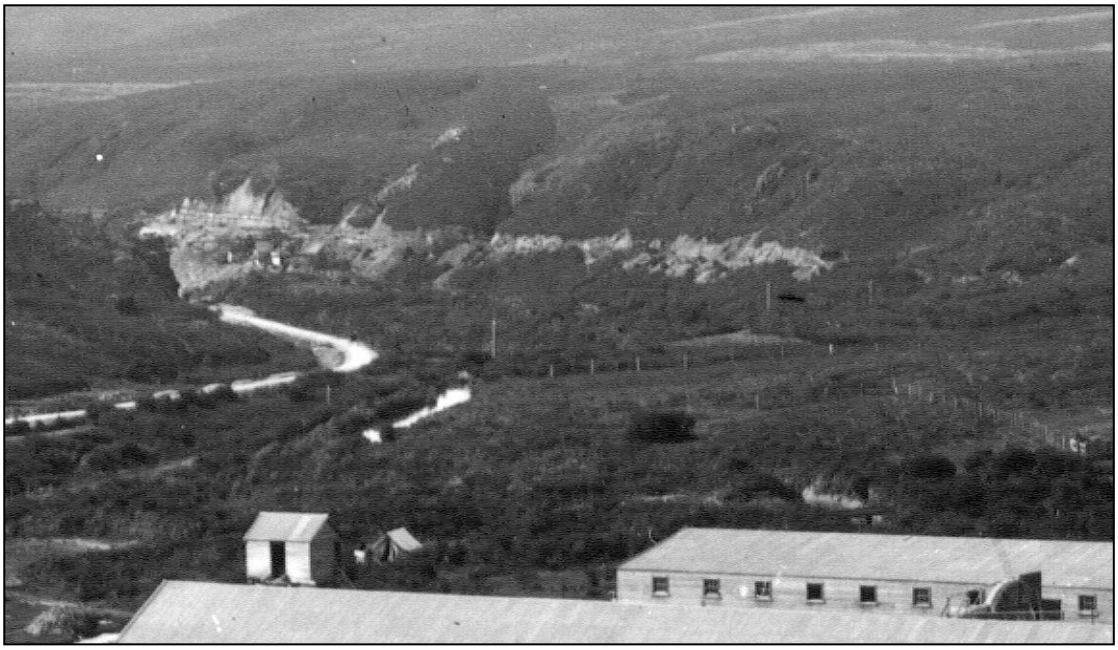
	Yards	**Tons** **Short ton, 2000lb[21]**	**Cubic metres**	**Tonnes** **1000 kg**
Moved from the battery "about 4000 yards"[22]	4000		c. 3000	10,350
"A total of 5,581.14 tons were treated during the year"[23]. End July 1906 to October 1907, so say 15 months		5,581x15/12= 6,976 tons, or 13,952,000 lb	1,834	6,328
Material stacked			4,834 m^3	16,678 tonnes

However, it seems likely that tailings were recovered and reprocessed. The tailings currently beside the tramway may be only a remnant.

[18] SUPERINTENDENTS ANNUAL REPORT. FOR 1907. Waihi, l3th February, 1908.
[19] SUPERINTENDENTS ANNUAL REPORT. FOR 1907. Waihi, l3th February, 1908.
[20] SUPERINTENDENTS ANNUAL REPORT. FOR 1907. Waihi, l3th February, 1908.
[21] "To end of 1904 all calculations are on long tons (2240 lb.) From 1905 all calculations are on short tons (2000lb.)" Milling and Treatment at the Waihi Mine, New Zealand. By E. G. Banks. Paper No. 221
[22] https://paperspast.natlib.govt.nz/newspapers/WHDT19060704.2.49.5
Waihi Daily Telegraph, Volume VI, Issue 1675, 4 July 1906, Page 3
[23] SUPERINTENDENTS ANNUAL REPORT. FOR 1907. Waihi, l3th February, 1908.

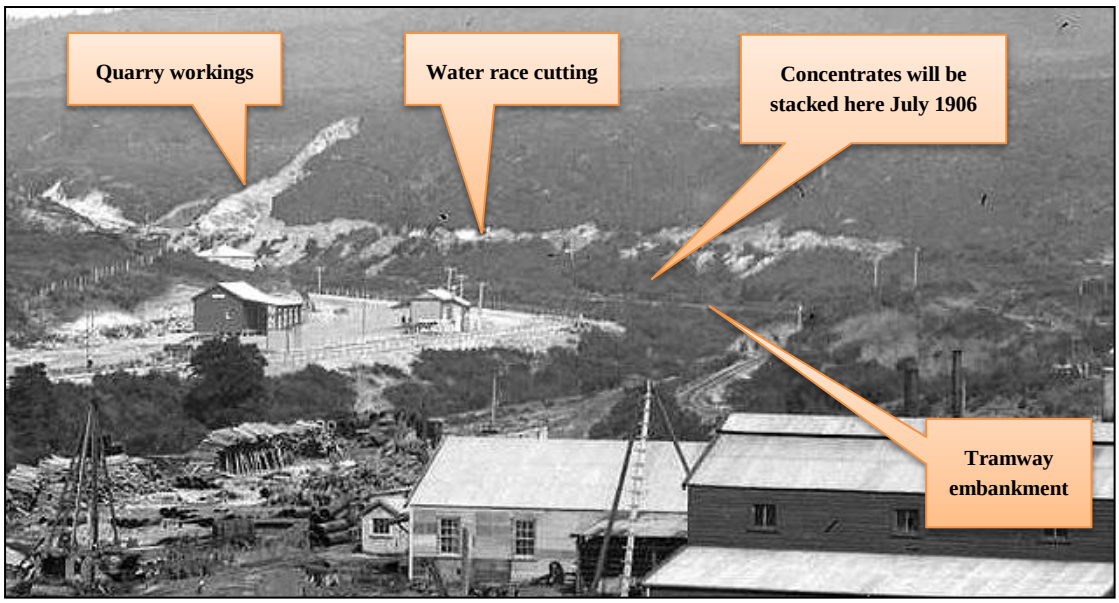
Photographic Evidence

Uncropped images may be found in the Appendices page 25.



Victoria Battery, eastern end, looking south east up the Ohinemuri River valley.

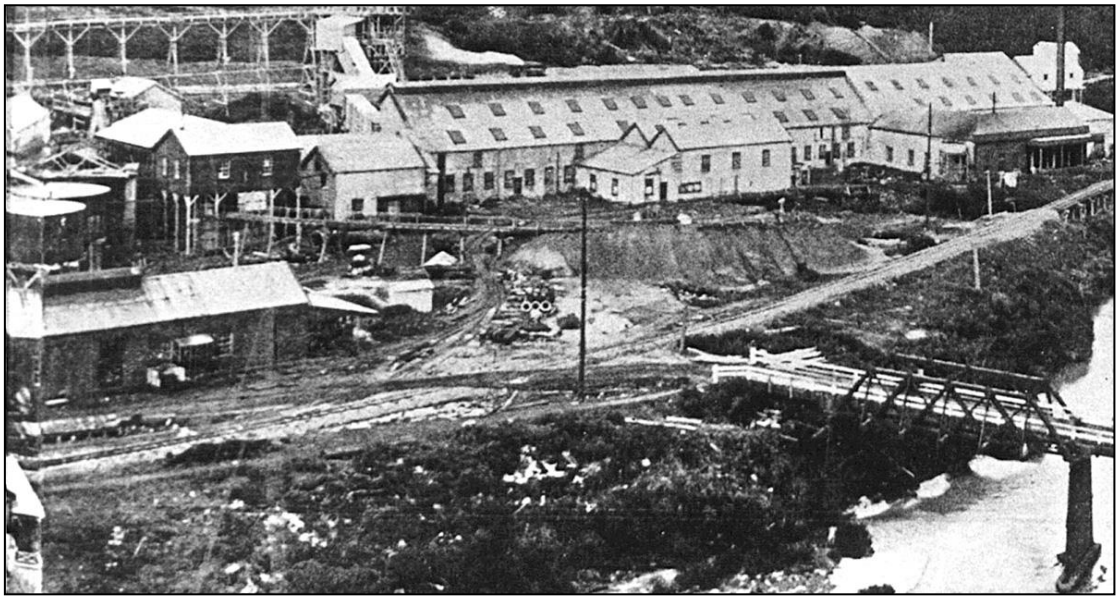
No Government railway, so <u>pre 1905</u>. The water race can be seen in the distance, no sign of stacked concentrates tailings. The highway middle left. The quarry and its waste heap above that. DoC Thames.



Railway sidings at the Victoria Battery, Waikino, February-March 1906.

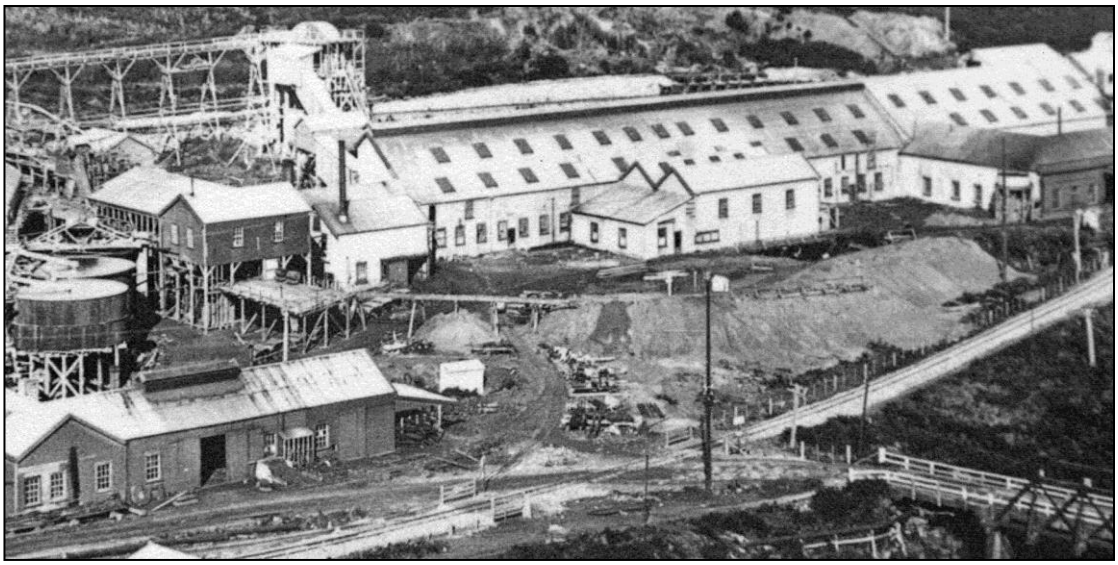
Waikino railway station mid left. No sign of the concentrates tailings, they would arrive after July 1906 (see below).

2-V1278 Auckland Library, Vaile Collection.
https://kura.aucklandlibraries.govt.nz/digital/collection/photos/id/105722/



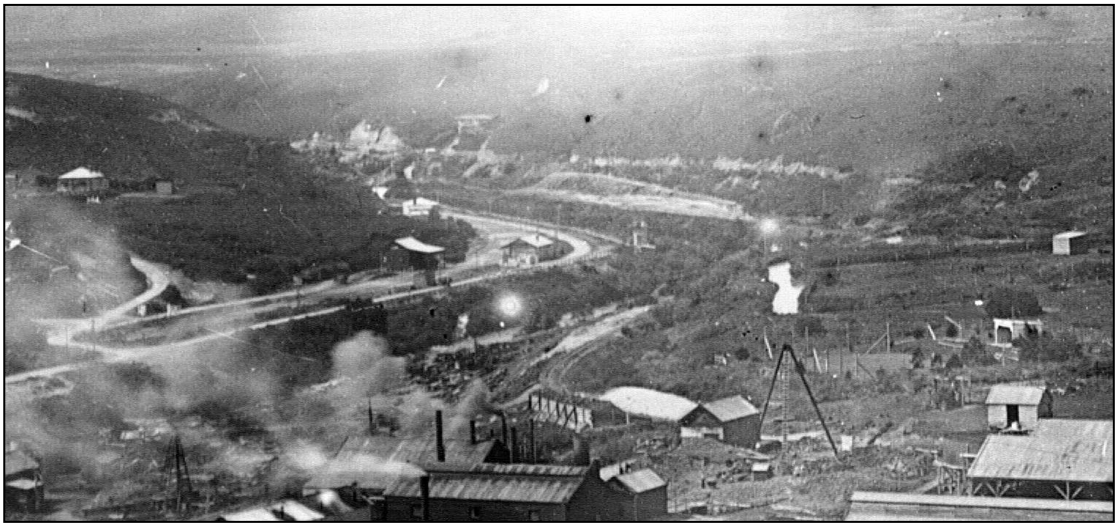
Victoria Mill, on the Ohinemuri River, Waikino. Auckland Weekly News 27.07.1905.

The new CTP can be seen top left, with tramway on trestles delivering tailings to the heap or stack. Note that they are dry enough to stack. Government railway in foreground.

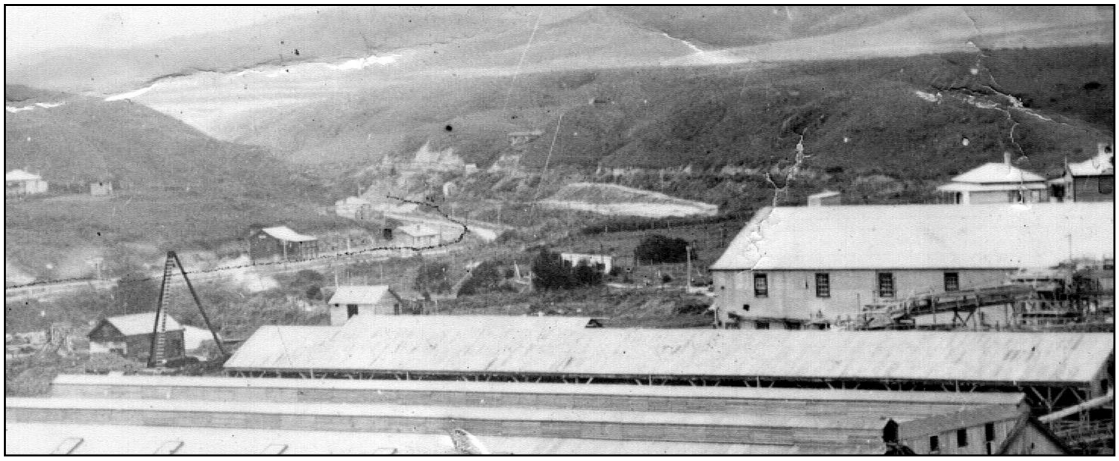


The same view as above, the tailings stack has grown. It is this area that will be required for the vacuum slimes plant and B&M tanks. Circa early 1906. Stubbs.

The images of the tailings stack below are all from a great distance. No close up images are known.

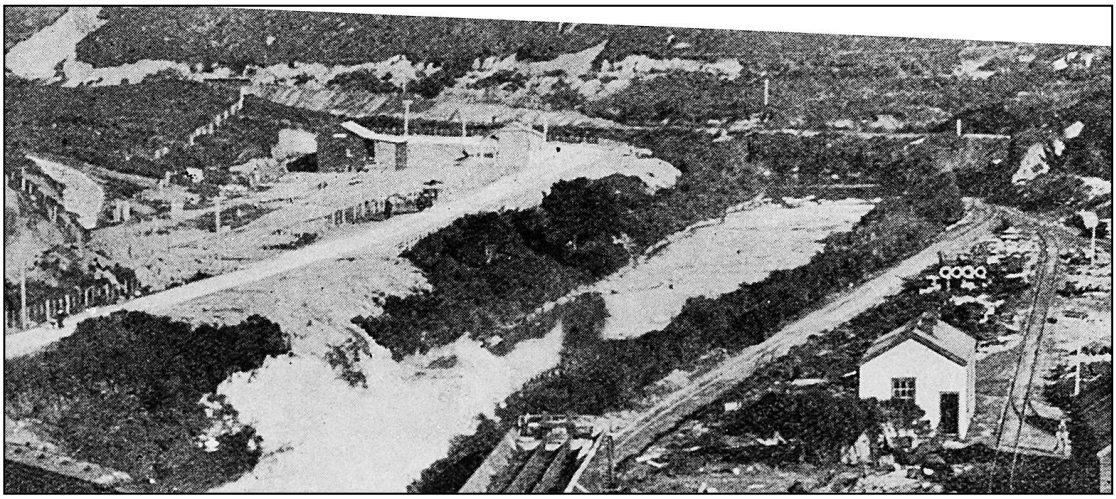


Victoria Battery post Producer Gas Plant. So after 1907. The tailings stack at image centre, below the water race cutting. There appears to be an angled bench cut into the slope, and tailings piled up at the right hand end of the stack. The large white blob centre right appears to be a reflection of the sky on the water race. DoC Thames.



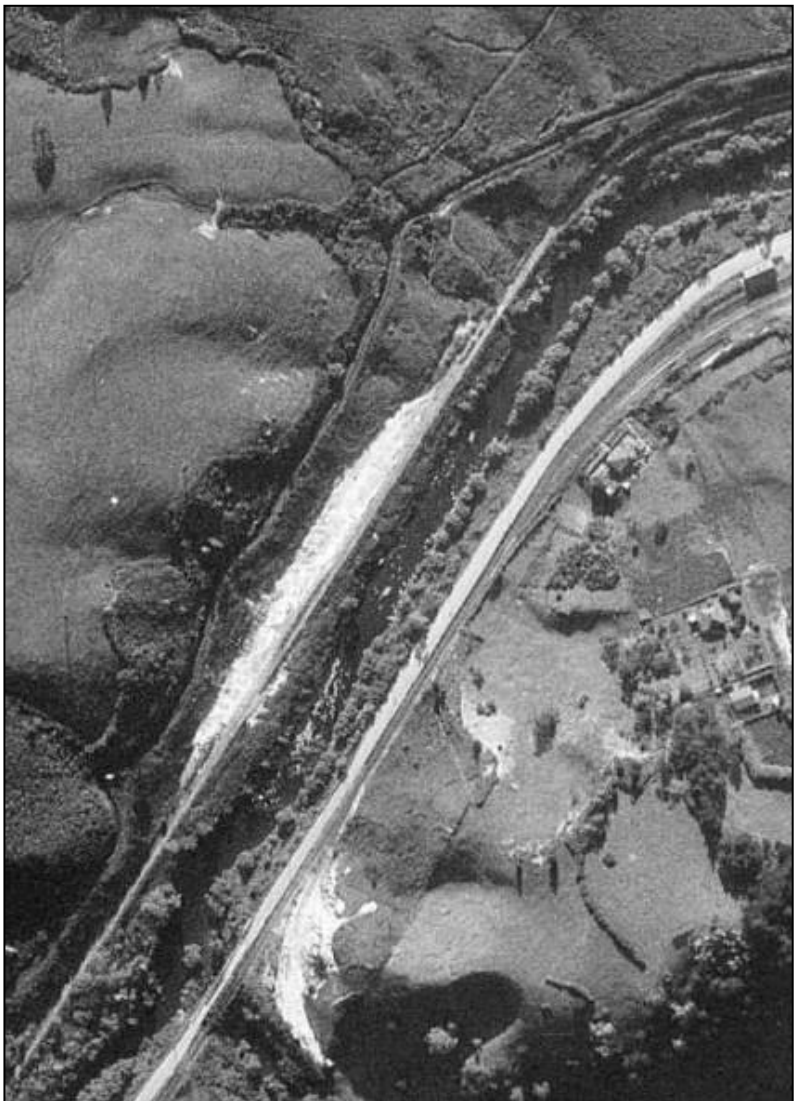
Victoria Battery post Producer Gas Plant. Date not determined.

Tailings stack at centre in distance. Waikino Tavern photo.



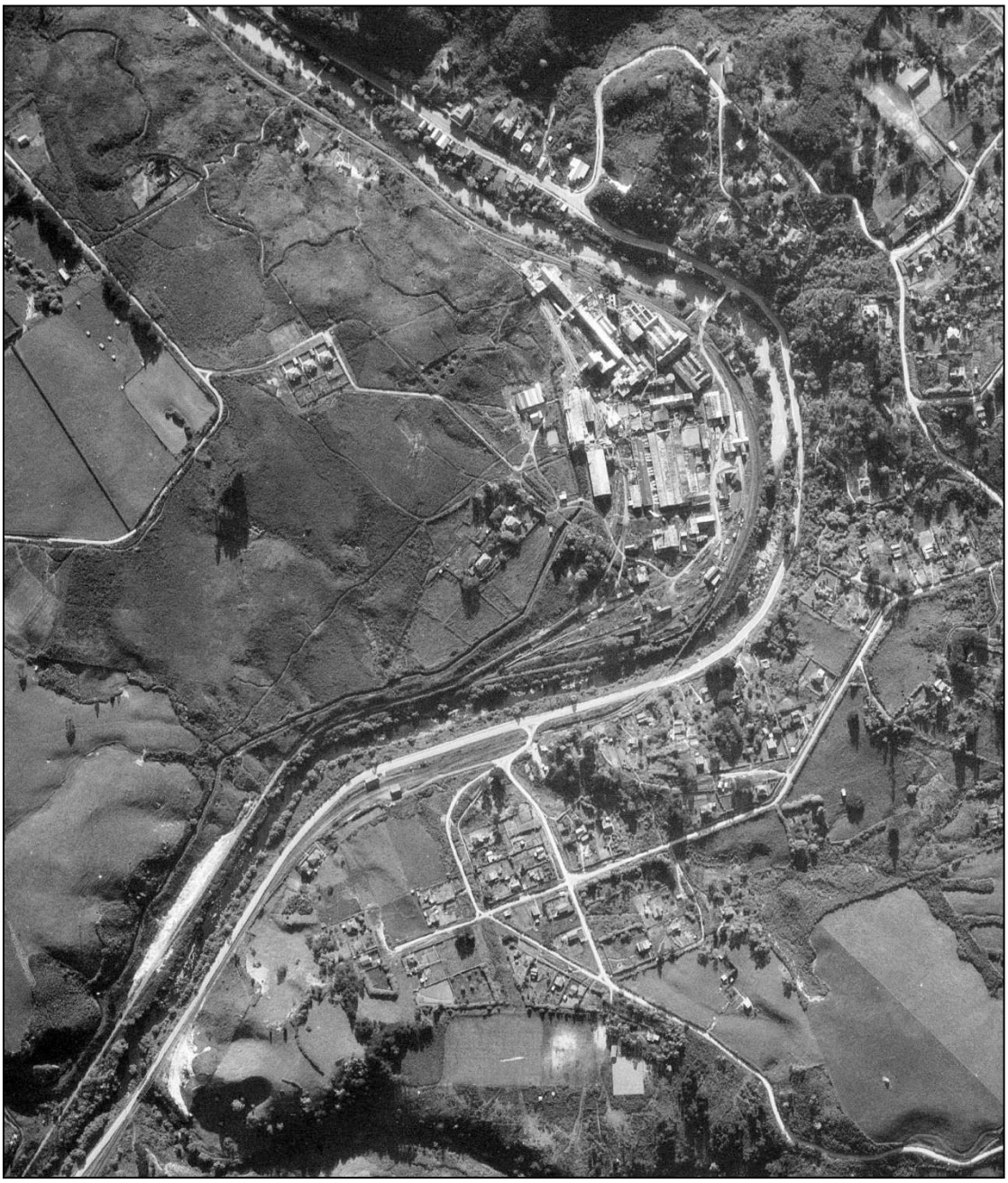
Train on rail bridge at Victoria Battery. Date not determined.

Tailings stack at top leftish. Note how they appear stacked up. John Agnew via Bowater.



The tailings stack in 1942. It appears the surface of the tailings are recently disturbed, and tailings have been spread/spilled on to the tramway. Have tailings been recently removed?

Photo 487/25. Sourced from https://retrolens.nz and licensed by LINZ CC-BY 3.0



The tailings stack and Victoria Battery in 1942.

Photo 487/25. Sourced from https://retrolens.nz and licensed by LINZ CC-BY 3.0

Tailings Reprocessed?

No direct evidence of reprocessing the concentrates tailings has been found. However it does seem likely.

1912

The 1912 Waihi miners' strike brought the mine and batteries to a halt. Towards the end of the strike the Company was able to man some operations, but ore output from the mine was low. The snippet below suggests concentrates tailings were reworked.

New Zealand Herald, 23 September 1912

> The New Waikino Union, Waikino, Mr. Walsh said, is no longer to be regarded as having any serious part in the strike. The federationists have practically given it up, and **the batteries are working on concentrates**.[24]

"Batteries" being Victoria and Waihi.

1940s

The 1942 aerial photograph shows possible activity at the concentrates tailings stack. The Waihi Daily Telegraph, 31 July 1942 has the following:

> Battery Worker Injured
>
> Caught between a concentrates truck and one of the company's locomotives, Mr W. Jones, an employee of the Martha Gold Mining- Co. Ltd., at its Victoria battery at Waikino, suffered a crushed hip in the course of his work last Tuesday. The injured man was admitted to the Waihi Hospital. His condition is not serious, and he is making satisfactory progress.[25]

"Concentrates truck and one of the company's locomotives" may describe activity at the stack.

Modern attempts

Two attempts to "mine" the tailings both involve Keith Hay. Both have failed to date.

1998

The WRC 2009 DM1498933 Waikino Tailings Dam Detailed Site Investigation Report includes the Report on Waikino Tailings Deposit, Mining Permit 41-361, by K. R. Hay 1998. This report discusses the gold and silver resources of the tailings, and a wish to mine them under a mining permit.

2012

Keith Hay tries again.

> An application to mine a century-old stockpile of gold worth almost $13 million on the proposed Hauraki Rail Trail path and bordering the Ohinemuri River has alarmed nearby residents.
>
> Miner Alan Death and geologist Keith Hay lodged the proposal with New Zealand Petroleum and Minerals on September 10, after being involved with a failed attempt to extract it nearly 20 years ago…

[24] https://paperspast.natlib.govt.nz/newspapers/NZH19120923.2.92
New Zealand Herald, Volume XLIX, Issue 15105, 23 September 1912, Page 8
[25] https://paperspast.natlib.govt.nz/newspapers/WHDT19420731.2.11
Waihi Daily Telegraph, Volume XXXI, Issue 8802, 31 July 1942, Page 2

Paeroa resident Peter Davison was one of five shareholders, alongside Death and Hay, who had a prospecting licence on the land.

He said it's a small area yet there's "a lot" of gold-rich sulfide ore there.

The venture ran out of steam because it was uneconomical to extract the ore and process it, but Mr Davison estimated there to be $3m worth of gold at the site - in today's prices that's close to $13m. [26]

2013

A pair of goldmining mates from Western Australia have been given the green light to take 10,000 tonnes of a century-old tailings dump beside the Ohinemuri River and the popular Hauraki Rail Trail route.

Alan Death and Keith Hay have been granted exclusive rights to dig up gold and silver on the 3.6ha rectangle of land at Waikino.

But Mr Death, who was born in Waihi, said it won't be a case of two Aussies flying in, taking the gold, then vanishing.

"It's not actually mining, it's just digging something up," Mr Death said from his home in Quindalup, Western Australia. "It's close to the surface, but it's right beside a river. It's not as easy as one might think."

It's understood the Waihi Gold Company originally extracted the ore from Martha Mine and transported it by rail to the Victoria Battery processing factory where it was stockpiled in a hollow next to the river.

The factory's ghostly ruins remain just a couple of hundred metres upstream of the mining permit area.

Mr Death said sampling suggested there was 10,000 tonnes of ore at the site.

And it contains about nine grams of gold and 100 grams of silver per tonne - that equates to nearly $5 million of gold and about $900,000 of silver at current prices. But the recovery rate would be about 40 per cent because the gold is wrapped up in "sulphides", meaning it's hard to extract. [27]

[26] https://www.stuff.co.nz/business/7750187/Ore-stockpile-a-golden-opportunity
[27] https://www.stuff.co.nz/waikato-times/news/8700776/Aussie-miners-cleared-to-dig-by-Hauraki-Rail-Trail-route

Time Line

1898 Feb.	Victoria Battery starts. Full 100 stamps on March 2nd.
1900	By mid January 1900 the 100 wet stampers were fully operational.
1901	Experimental Concentrates Treatment Plant (CPT) was established.
1902	The whole battery starts wet crushing early August.
1905	New CTP built, treating the concentrates from the whole 200 stampers at Victoria, and from the Waihi and Union batteries. The tailings are conserved.
1906	July onwards. The conserved concentrates tailings stored at the battery are removed to the tailings stack beside the tramway.
1907	October. The saving and deposit of concentrates tailings ceases.
1912/13	Towards the end of the 1912 miners' strike the Company may have reworked some of the concentrates tailings.
1940s	The 1942 aerial photograph shows possible activity at the concentrates tailings stack. Tailings taken for reprocessing?
1998	Keith Hay proposes extracting the tailings.
2012	Keith Hay and Alan Death propose another attempt.

The Site Today

A site visit was undertaken on 8 June 2022 with Neville Ritchie. The site was found to be a wilderness of fallen and felled timber, holding water. No attempt was made to venture on to the tailings as it was considered unsafe to do so.

We were able to confirm that the sketch maps of K. Hay fairly approximated the tailings extent, appearing to be around 20m at their widest point. The tailings are directly adjacent to the old tramway, now Hauraki Rail Trail. The tramway crosses an un-named stream, now dubbed "Culvert Stream"[28], as it flows through a box shaped concrete culvert.

The battery low level water race tracks the tramway behind the tailings approximately 10m up slope. A concrete byewash structure exists where the water race meets the "Culvert Stream", and there is a quarry site above the water race about 100m south east of the upstream end of the tailings. All these features were integral to the Victoria Battery, and were constructed circa 1897.

[28] WRC 2009 DM1498933 Waikino Tailings Dam Detailed Site Investigation Report.

GPS co-ordinates were captured to assist locating old aerial photographs in the GIS.

Locating features	**GPS NZTM2000**	
"Culvert Stream" bridge	E 1845979	N 5855393
South eastern most end of tailings	E 1846209	N 5855248

Distance between these points: 270m

The Waikato Regional Council document: **Waikino Tailings, Detailed Site Investigation Report**[29], in addition to providing chemical analyses of the tailings, contains a copy of **Report on Waikino Tailings Deposit, Mining Permit 41-361, by K. R. Hay 1998**. It contains two sketch maps reproduced below.

Some details in this report are of interest.

> Approximately 11,000 tonnes of gold and silver bearing sulphide concentrate was dumped by the Waihi Gold Mining Company into an elongate depression beside their tram line in 1903.

No source for the estimate of 11,000 tonnes is given, but it is not very different to the 4000 yards (3000m^3, c.10,350 tons[30]) that was shifted from the battery in 1906. We now know the tailings were dumped in 1906, not 1903.

> The concentrate is contained in an elongate depression approximately 200m long and up to 16m wide…
>
> The deposit is confined by a timber dam in the down-stream or western end.[31]

The timber dam has not been verified.

A table gives an estimate of volume of tailings as 3270m^3, or 11281 tonnes.

[29] WRC 2009 DM1498933 Waikino Tailings Dam Detailed Site Investigation Report
[30] Using a bulk density of 3.45, as suggested by the K. Hay report, March 1998
[31] Report on Waikino Tailings Deposit, Mining Permit 41-361, by K. R. Hay 1998

WAIKINO TAILINGS DEPOSIT - RESOURCE ESTIMATE

Section	Area (m^2)	Length (m)	Volume (m^3)	Mass* (tonnes)	Grade Au (g/t)	Contained Au (Kg)
A-A'	18	40	720	284	9.35	23.23
B-B'	24	50	1200	4140	8.00	33.12
C-C'	15	50	750	2587	9.20	23.80
D-D'	12	50	600	2070	9.05	18.73
Total			3270	11281		98.88
Average					8.8	

* Using calculated bulk density of 3.45

The table doesn't make sense unless we assume that the area column is the cross-sectional area at the section lines. The calculated figure is remarkably close to the amount (4000 yards) initially dumped by the Company.

Calculations made earlier (see page 8) suggest roughly 16,700 tonnes dumped at the tailings stack.

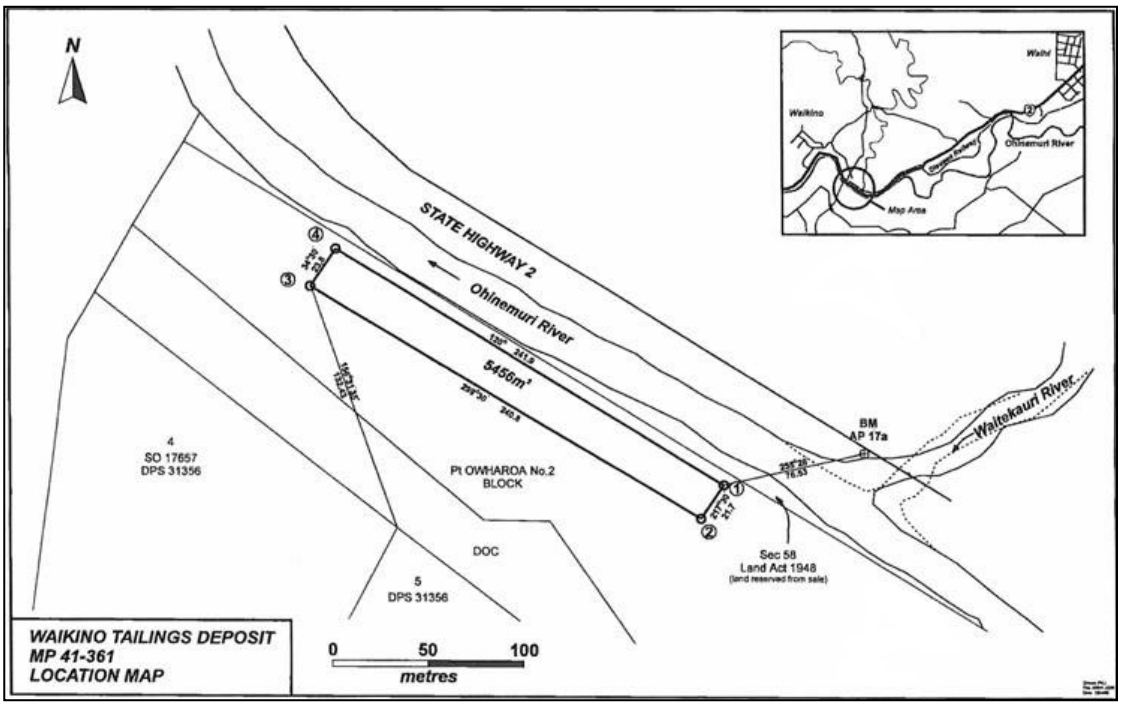
Photographs show that tailings were piled up, well up the side of the slope and above the level of the tramway, and there is some evidence that tailings were removed later for reprocessing.

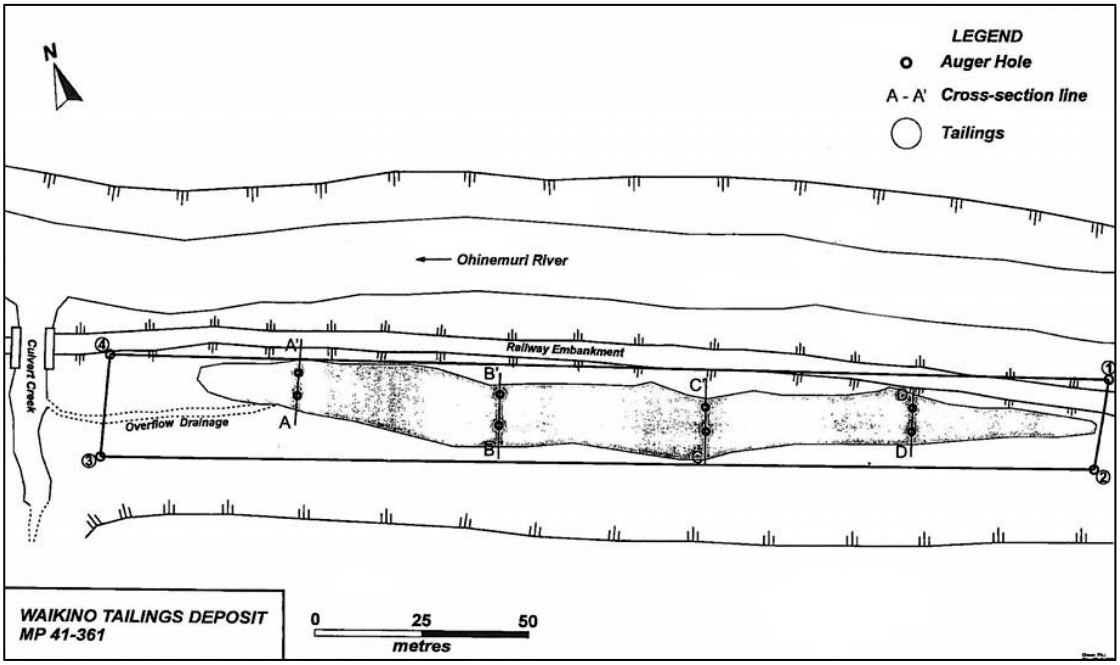
Maybe there are not 11,000 tons of tailings still here, but only a remnant left behind.

Note:

The Waikino Tailings, Detailed Site Investigation Report also makes reference to a report by H. Neale, 1990; Neale, H. et al, 1990. Report to the Minister of Conservation on Prospecting Licence Application 31-2665. Unpublished Report.

Maps from: Report on Waikino Tailings Deposit, Mining Permit 41-361, by K. R. Hay 1998[32]

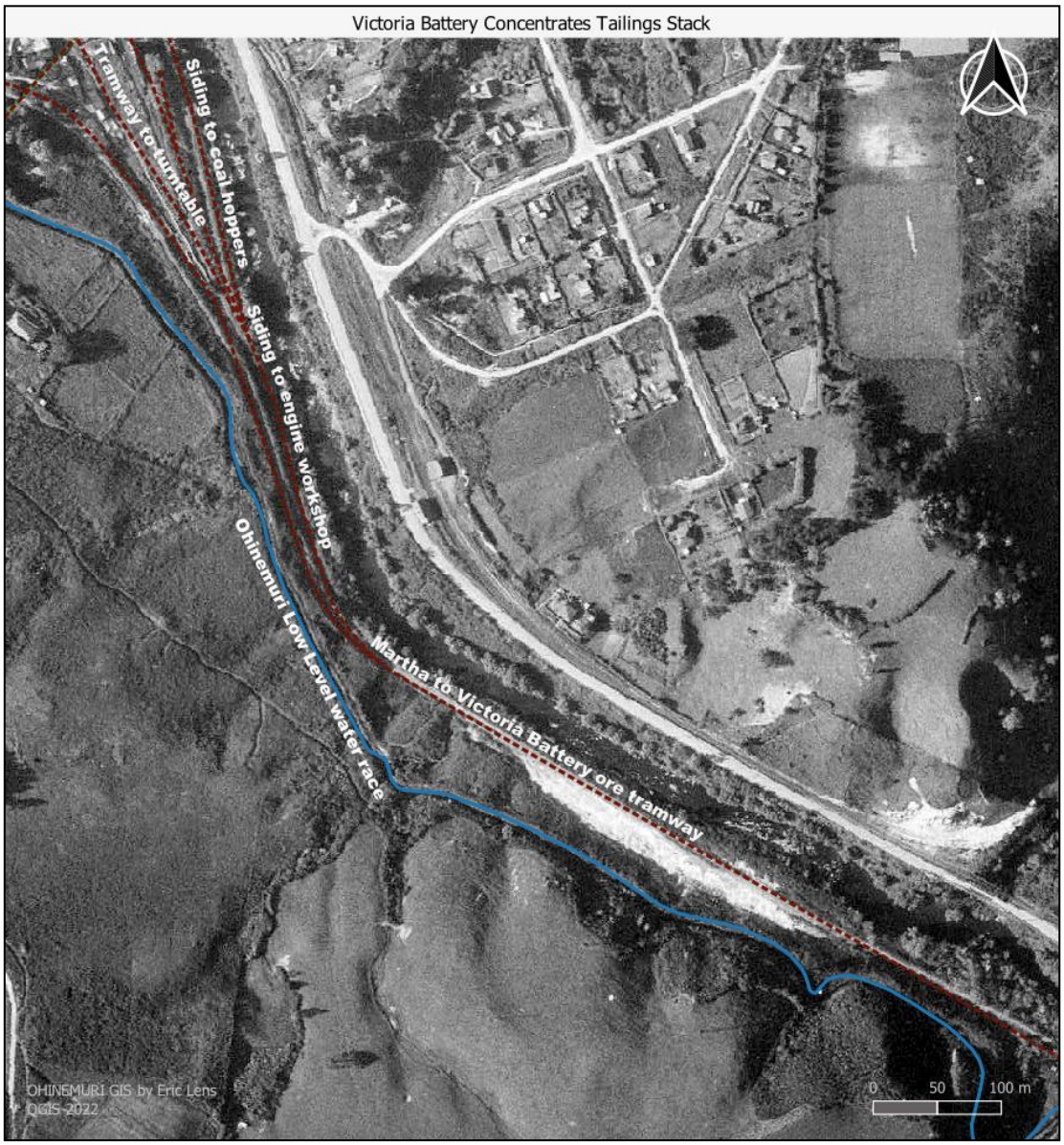




[32] Reproduced in: WRC 2009 DM1498933 Waikino Tailings Dam Detailed Site Investigation Report.

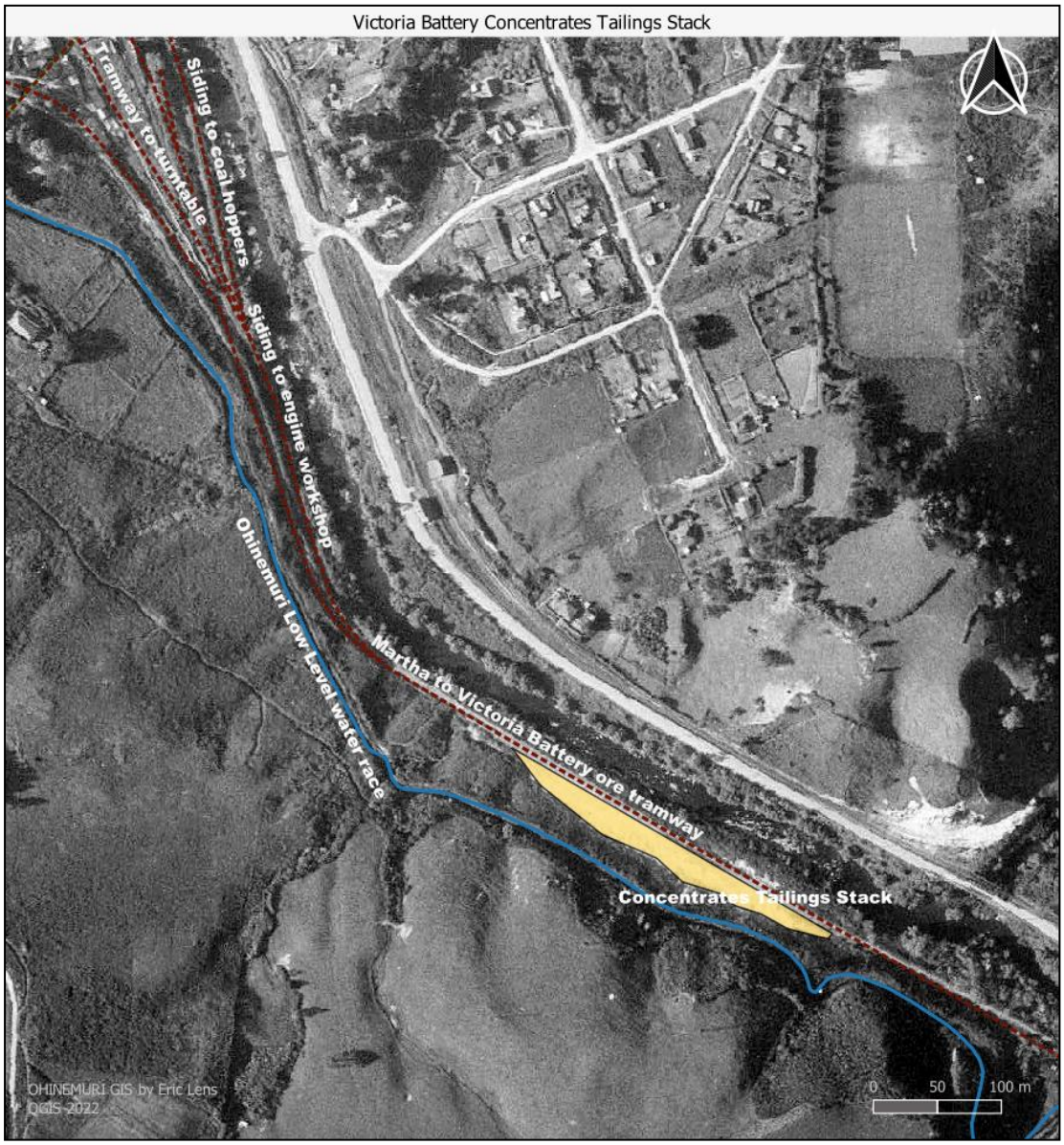
Location Map

GIS images



1942 image[33] with tramway, and water race overlaid.

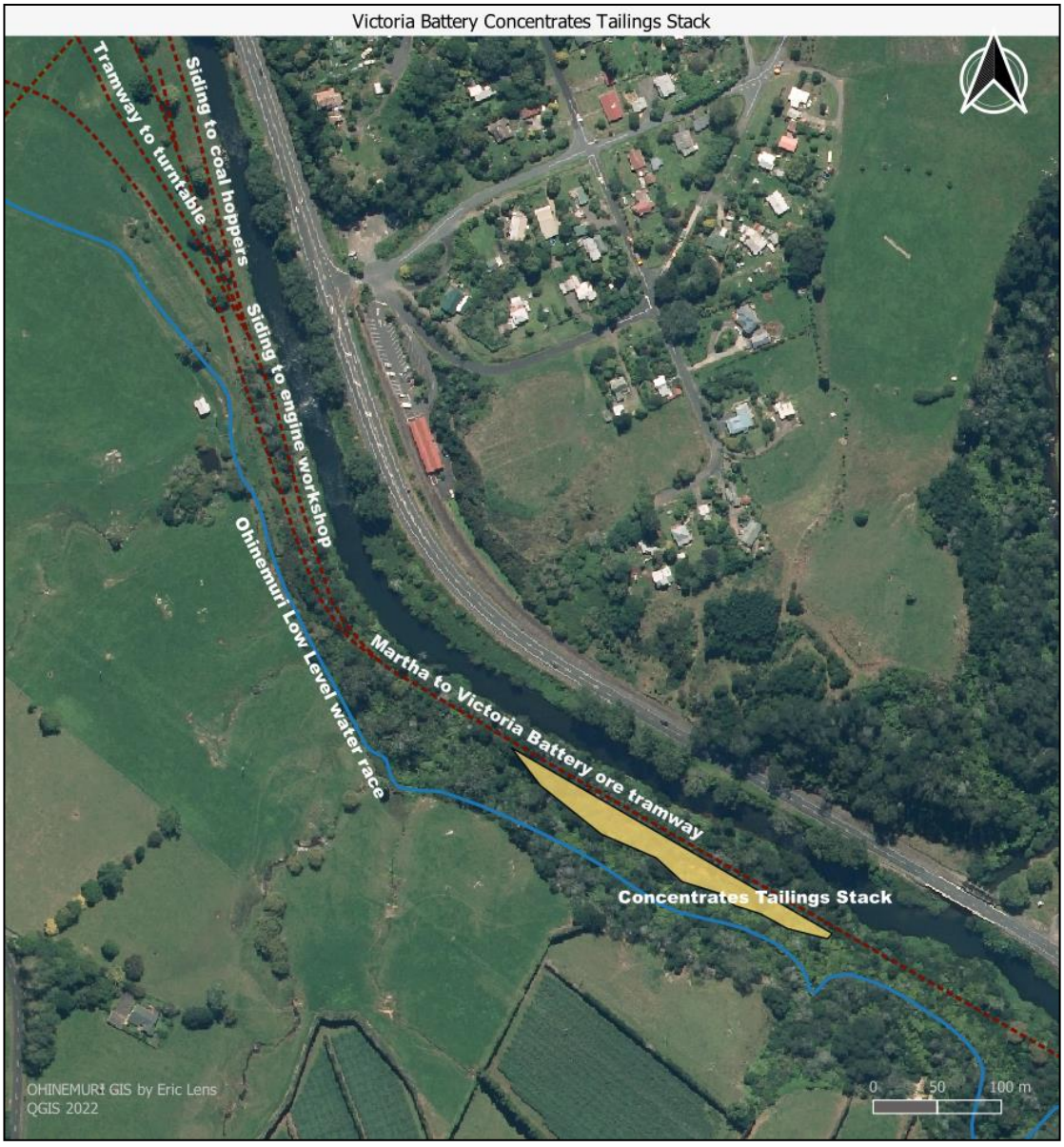
[33] 1942 Photo 487/25. Sourced from https://retrolens.nz and licensed by LINZ CC-BY 3.0



1942 image[34] with concentrates tailings stack, tramway, and water race overlaid.

The representation of the stack shown here is based on the extents visible in the 1942 photograph. The GIS reports the area of the tailings stack shown above as 3023 m^2.

[34] 1942 Photo 487/25. Sourced from https://retrolens.nz and licensed by LINZ CC-BY 3.0



2013 image[35] with concentrates tailings stack, tramway, and water race overlaid.

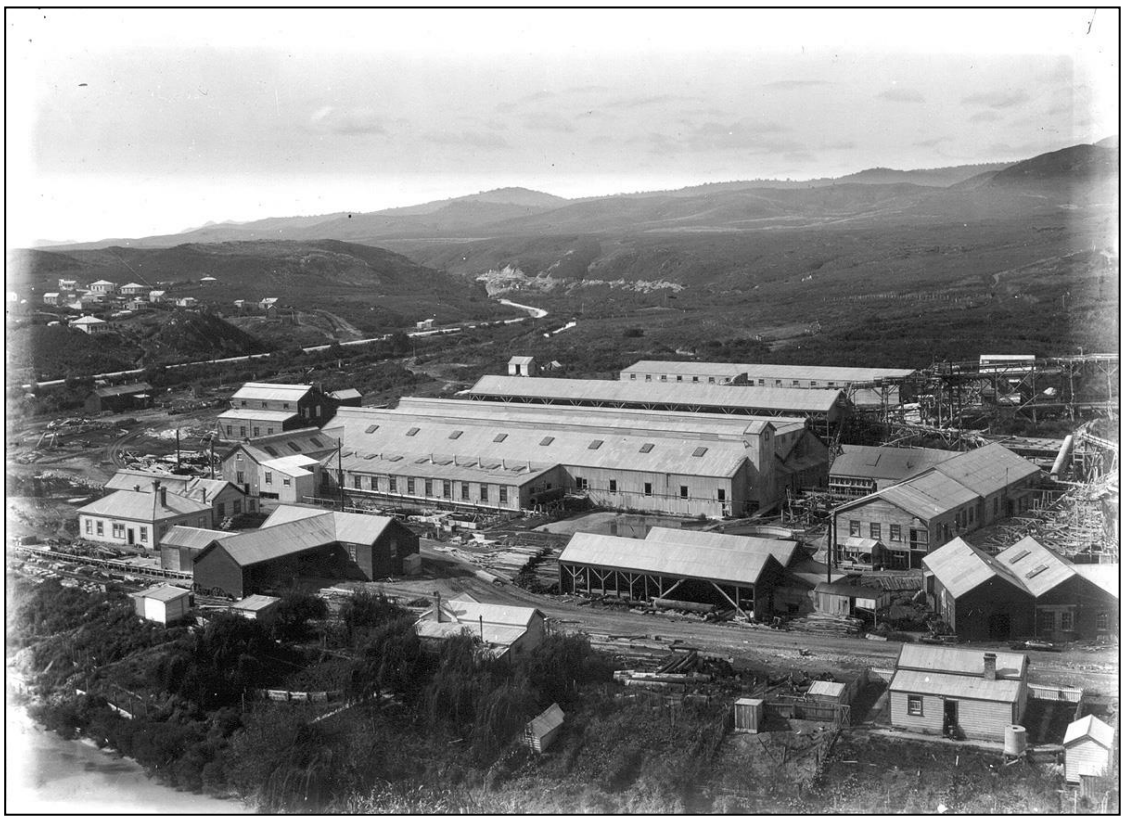
[35] Waikato 0.5m Rural Aerial Photos (2012-2013)

Open Street Map with concentrates tailings stack overlaid.

Appendices

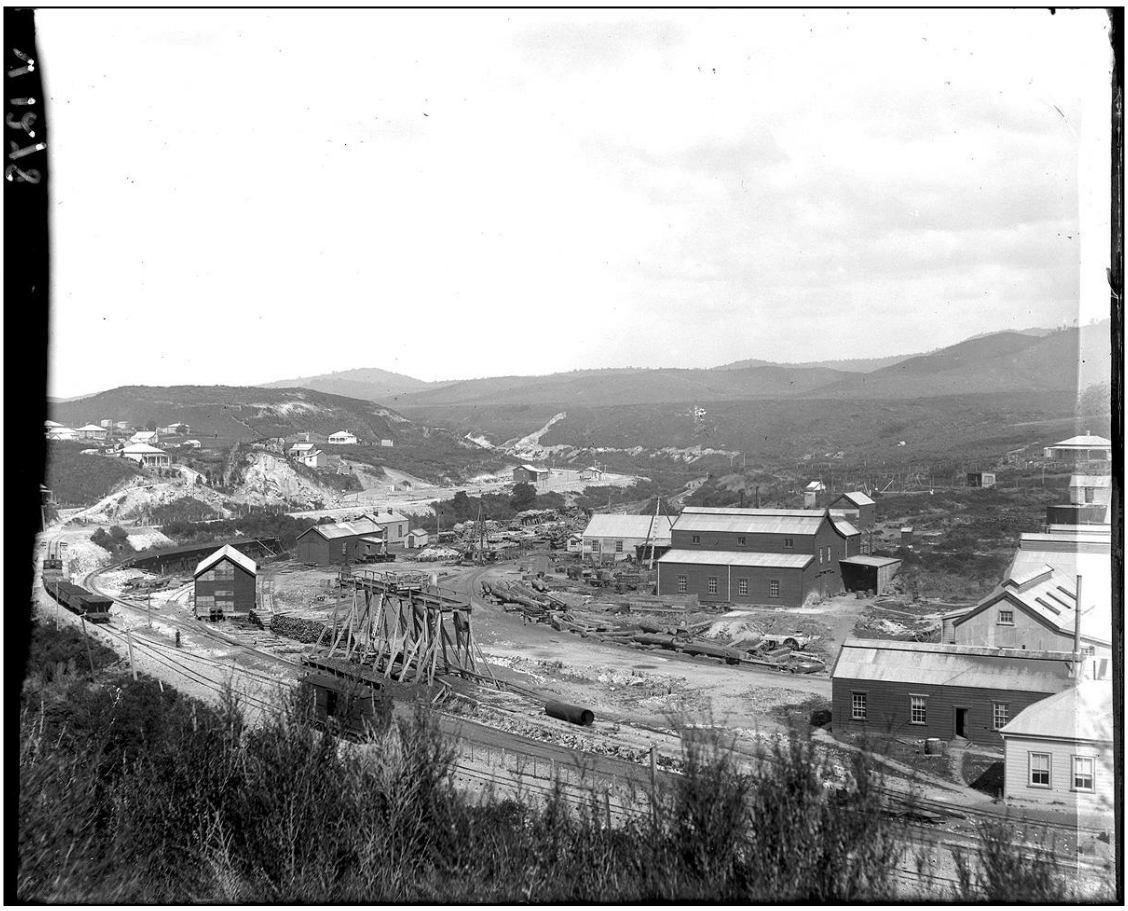
Presented in these appendices are full versions of the historic images, and extracts from some relevant texts.

Full Images



Victoria Battery, eastern end, looking south east up the Ohinemuri River valley.

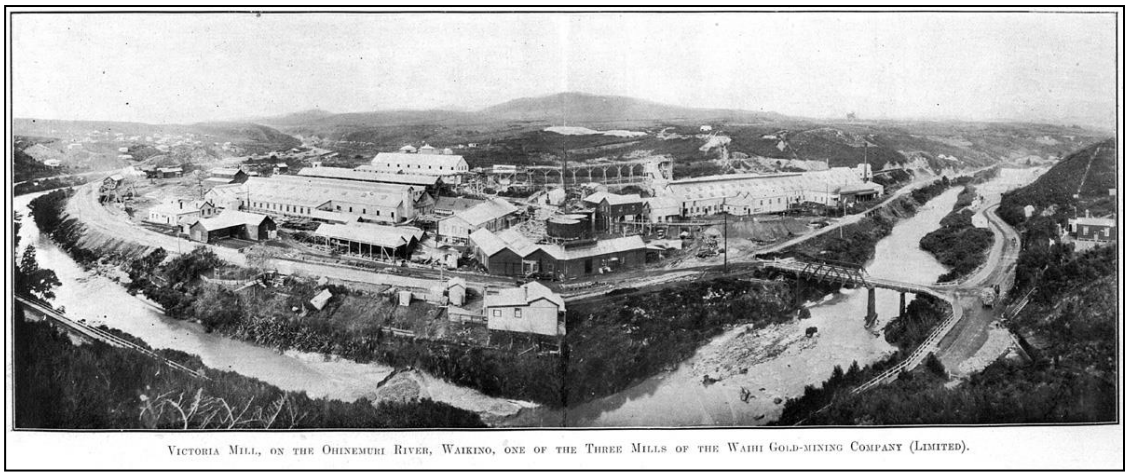
No Government railway, so pre 1905. The water race can be seen in the distance, no sign of the concentrates tailings. DoC Thames.



Railway sidings at the Victoria Battery, Waikino, February-March 1906.

This is a wonderfully precise date, showing the Government railway, but no Producer Gas Plant (1907). No sign of the concentrates tailings

2-V1278 Auckland Library, Vaile Collection.
https://kura.aucklandlibraries.govt.nz/digital/collection/photos/id/105722/

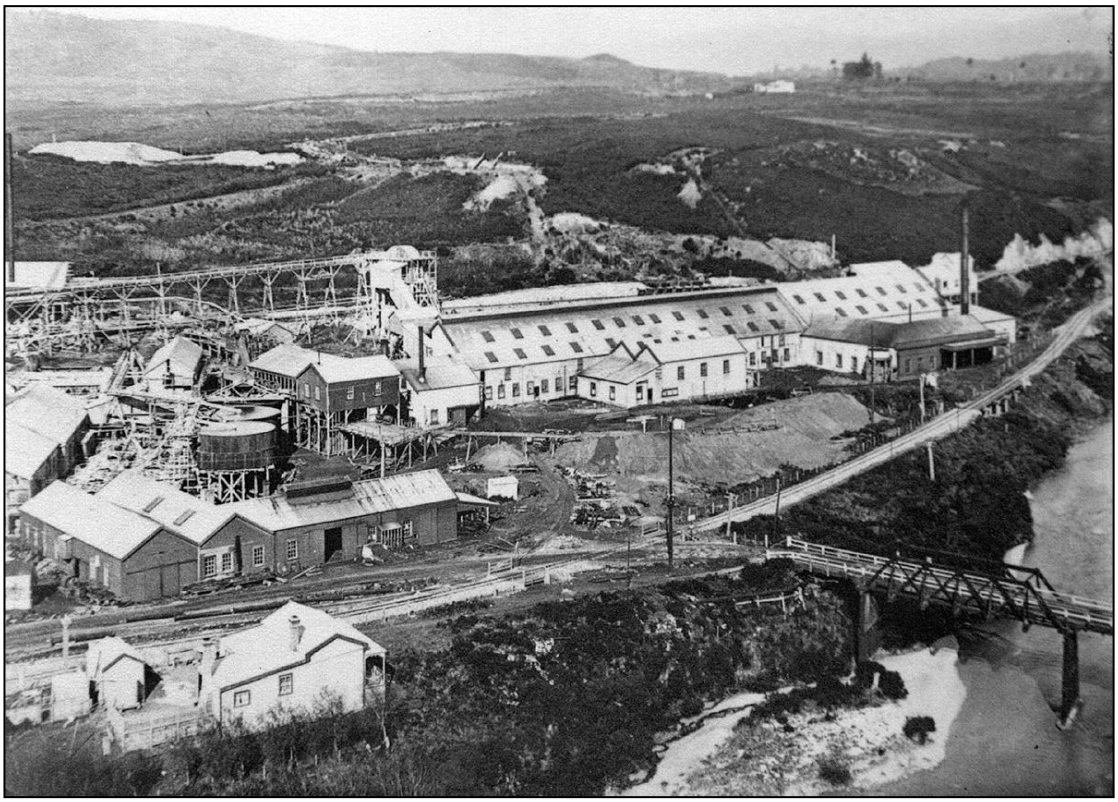


Victoria Mill, on the Ohinemuri River, Waikino, one of the Three Mills of the Waihi Gold-mining Company (Limited).

Victoria Mill, on the Ohinemuri River, Waikino. Auckland Weekly News 27.07.1905.

The new CTP can be seen at middle. Govermnent railway in foreground.

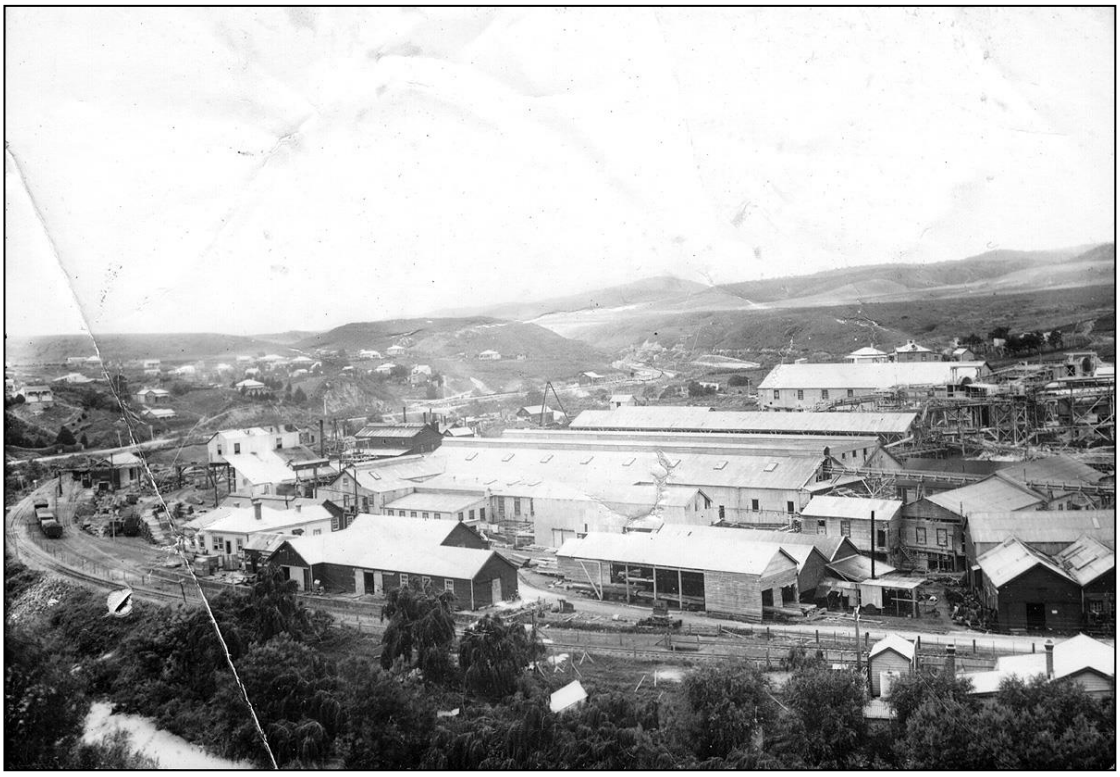
This image also appears in: AJHR 1907 SESSION I, C-03.
https://paperspast.natlib.govt.nz/parliamentary/AJHR1907-I.2.2.2.7



Similar view as above, the tailings stack has grown (middle right). It is this area that will be required for the vacuum slimes plant and B&M tanks. Stubbs

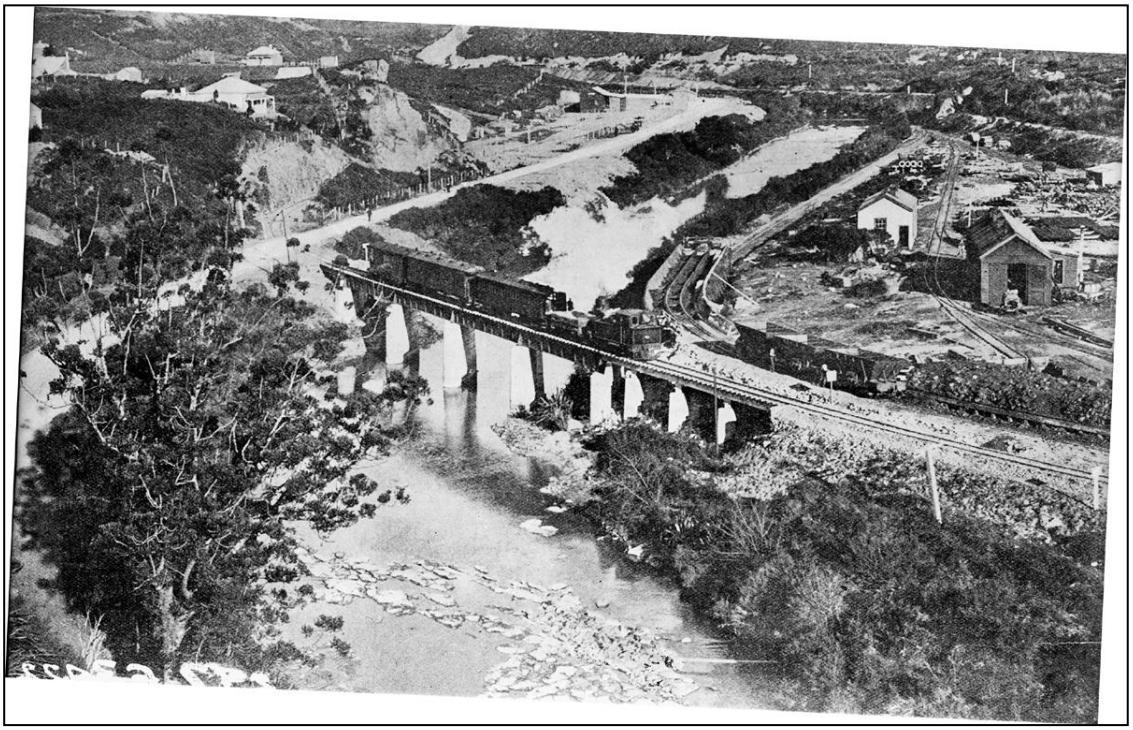
Victoria Battery post Producer Gas Plant (white angled roof left of centre bottom). So after 1907.

Note the tailings stack at image centre. DoC Thames.



Victoria Battery post Producer Gas Plant. Date not determined.

Tailings stack at right centre in distance. Waikino Tavern.



Train on rail bridge at Victoria Battery. Date not determined.

Tailings stack at top centre in distance. John Agnew via Bowater.

1942 Photo 487/25.

Sourced from https://retrolens.nz and licensed by LINZ CC-BY 3.0

Milling and Treatment at the Waihi Mine, New Zealand.

By E. G. Banks. Paper No. 221

Paper presented at the Australasian Institute of Mining Engineers, Thames New Zealand 1911.

[These are snippets extracted from the document]

[Discussing treatment experiments at the Victoria Battery] The most promising results were obtained by wet crushing, plate amalgamation, concentration, and cyanide. In the first experiments the sand and slime were treated together in an agitator, the solution being separated by decantation; but later experience showed that it was more profitable to treat sand and slime separately.

By September, 1900, 50 stamps were crushing wet at Victoria mill through 40 mesh screens. The ore crushed by these stamps was only lightly mineralized, and the pulp was not passed over amalgamation tables or concentrators, but was separated into sand and slime, the sand being collected in large steel tanks, in which it was given a preliminary wash with weak solution, then transferred to the large concrete tanks (40ft. by 50ft. by 4ft.) for final treatment. The slime was collected and thickened in 14ft. deep steel tanks, and from these was drawn into agitators and cyanided for 24 to 30 hours and then filter-pressed. By the end of 1901, 30 stamps and 8 Union vanners were running on sulphide ore. The concentrates produced were shipped to smelters in England and Australia…

In January, 1901, a further 50 stamps were crushing wet, and in August, 1902, the 200 stamps comprising the Victoria mill were wet-crushing. Early in this year (1901) 20 stamps at the Victoria mill were set apart for dealing with the more heavily mineralized ore, the pulp being passed over amalgamated plates and six Union vanners, and then joining the pulp from the stamps on lightly mineralized ore.

By the end of 1901, 30 stamps and 8 Union vanners were running on sulphide ore. The concentrates produced were shipped to smelters in England and Australia…

Amalgamation.- The plates are contained in a building which is reserved solely for amalgamation work, and to which only the amalgamators have access, unless by special permit. The plates are 12 ft. by 6 ft. muntz-metal sheets, set at a fall of 1½ in 12. They are kept fairly "hard," and about once a month are steamed and scaled, the upper 2 ft. or 3 ft. having quite 1/16 in. scale of hard amalgam. All of which is readily removed by a steel scraper after 20 minutes' steaming.

Muntz-metal is preferred to copper, because the amalgam scale does not adhere so firmly, and after the plate has been scaled it quickly works into good condition again. Very perfect amalgamation is not aimed at, as any fine free gold escaping the plates is easily accounted for by the cyanide plant. The average recovery by amalgamation is – gold, 29%; silver, 5%.

The pulp is distributed to the plates from a V-shaped tank fitted with as many 2-in. discharge pipes as there are plates; each plate can deal with about 30 tons of ore per day. The plates are rubbed up twice each shift, and the amalgam removed every 8 hours. When the pulp-flow is cut off from a plate it is run into a return launder back to the main elevator wheels, and so distributed evenly over all the other plates. A Berdan pan is used for cleaning the amalgam and grinding the product from the traps. A centrifugal machine is used to separate the excess mercury; it works well, and leaves the amalgam in a powdery condition. The total cost of operating the amalgamating plant is slightly over 1d. per ton of ore.

It is sometimes said that it would be more profitable to cut out amalgamation and rely on the cyanide plant to save the gold. No doubt the cyanide plant would do so; but with the necessary amalgamation plant in existence, and operating at such a low cost, it is considered better to continue amalgamation and avoid the accumulation of very rich concentrate in all wheel pits and launders.

Concentration and Cyanidation of Concentrate. Union vanners and Wilfley tables are both used. The former give a lower tail value (especially in the silver), but the latter have a much greater capacity, and, as close concentration is not required, they are preferable, being cheaper in first cost and more economical to run.

Concentration after tube mill grinding is not usually considered good practice; but with the Waihi ore it is found that, provided the coarser portion of the sulphides is separated by the vanners, it does not matter if the very fine sulphides escape to the cyanide plant.

The average percentage of concentrates produced is 1.5, and an analysis shows as follows:-

	%
Sulphur	35.00
Iron	32.43
Copper	.05
Arsenic	.10
Lead	.32
Zinc	2.05
Manganese	1.02
Lime	.85
Magnesia	trace
Silica	27.65
Loss, &c.	.55
Total	100.00

The concentrate from each mill is sent to the concentrate treatment plant daily. It is shovelled from the collecting boxes into tubs holding about 600 lb. weight (wet), and kept under water until delivered at the treatment plant.

The tubs are made from two oil barrels strengthened with iron bands, which terminate in two lugs for convenience in handling. One vanner-man per shift attends to 30 Union vanners or Wilfley tables, and there is also a foreman on the day shift who attends to most of the repair work.

The average recovery by concentration is – gold, 22%; silver, 28%.

The concentrate from the three mills [Victoria, Waihi, and Union] is treated together, and a rough valuation of the output from each mill is obtained by bore sampling each tub. This valuation is required in order to allocate to each mill its proportion of the bullion recovered.

The concentrate treatment plant is situated at Victoria mill. On arrival at the plant the output of each mill is weighed. **The monthly total is about 500 tons**.

The grinding is accomplished in two tube mills- one 18 ft. by 4 ft. 9 in., and one 19 ft. 6 in. by 4 ft.- and the concentrate is sluiced from tubs into the head boxes of the mills, slaked lime being added into the proportion of 10 lb. per ton. From the mills the pulp is elevated to a V sizing box, 3 ft. 2 in. x 3 ft. 2 in. x 6 ft. deep, the sides being vertical for the first 2 ft. 6 in. The coarse delivers through a 7/8 in. nozzle and returns to the mills, and the fine overflow passes to the thickening boxes, by which the moisture is reduced to 7 water to 1 of dry concentrate. The concentrate is given from 8 to 10 days' air agitation in 23 conical-bottom tanks 16 ft. by 6 ft., which are worked in series. The solution is kept at

an average strength of .4% KCy. The sodium salt is used, the average consumption being 16 lb. per ton, which represents .25 lb. per ton of original ore.

The solution is separated by filter-pressing. The number of men required to work the plant is 3 each shift, and the cost, inclusive of labour, repairs and renewals, power, transport, cyanide, zinc, flints, and sundry, is about 25s. per ton. This represents about 5d. per ton of original ore. The bullion is precipitated by the zinc filament method, no trouble being ever experienced in obtaining good precipitation.

Prior to 1904 the concentrate was bagged and shipped to smelters in England and Australia. The charges, all told amounted to about £8 per ton. Local treatment has given uniformly good results, as shown by the following figures:-

Year	Tons	Gold	Silver	Extraction.	
		Per ton	Per ton	Gold	Silver
		Ounces	Ounces	%	%
1904	1992	7.65	98.25	95.1	92.0
1905	3719	6.65	96.35	95.5	93.3
1906	4692	5.68	81.00	95.6	94.7
1907	5581	5.40	66.75	95.7	94.3
1908	6061	5.44	66.00	96.3	93.0
1909	6339	5.60	63.30	96.3	93.5

A somewhat higher extraction can be obtained by finer grinding and the use of stronger solution, but the increased recovery would not cover the extra cost.

Superintendent's Annual Reports to the Directors, Waihi Gold Mining Company

These are snippets extracted from the annual reports.

(HP Barry: Waihi Gold Mining Company's Superintendent from 1891 to 1915 (McAra, p 146))

For the year 1899

SUPERINTENDENT'S ANNUAL REPORT.

WAIHI, 23rd February, 1900.

A series of experiments has been carried out during the year, the results of which have demonstrated that a fair extraction by wet crushing can be obtained.

The process which has finally been selected, is that of wet crushing with water, separation of the sands and slimes by means of spitzkasten, the sands passing to large intermediate vats (where a further separation can be effected by means of annular launders), being trucked thence to the leaching vats , the slimes passing to collecting vats, thence to agitators, and being finally dealt with by means of filter presses.

A separate treatment being advisable for the higher grade heavily mineralised ore, chiefly found in the eastern block on the Martha Reef, this ore after being wet crushed, will be passed over vanners (six of which have been ordered), and a concentrate taken out.

H. P. BARRY, Superintendent.

For the year 1900

SUPERINTENDENTS ANNUAL REPORT.

WAIHI, 19th February, 1901.

VICTORIA MILL—WET CRUSHING.

The extension of the Victoria Mill by the erection of 100 head of stamps for wet crushing, which was commenced in May, 1899, was so far concluded as to enable 50 stamps to start towards the end of September

For the year 1901

SUPERINTENDENTS ANNUAL REPORT.

Waihi,27 th January, 1902

Early in the year 20 head of stamps were put on to mineralised ore, the product passing over six Union Vanners.

Later on in the year two more Union Vanners were erected, and an additional ten head were employed in crushing mineralised ore.

Experiments were also made with concentrating with both a "Wilfley" and "Dodd" Concentrator, but these machines proved to be less suitable than the Union Vanners for dealing with this particular ore.

In comparing the actual recovery with that according to assay it must be borne in mind that no estimate has been taken into consideration of stocks of pulp, sands, slimes, concentrates in course of treatment, bullion in solution in vats, and precipitator boxes, or amalgam on plates in the wet crushing mill.

Towards the end of the year the treatment of 10 tons of concentrates was commenced in the small concentrate plant which has been erected. The plant consists of a Mc. Kay Pan for re-grinding the concentrates, and two agitators.

The treatment has not been completed. The object is to see whether a saving can be effected by treating our own concentrates instead of sending them to Australia as is done at present.

There is at present no difficulty in obtaining sufficient oxidised ore from the Mine on which to run the dry crushing stamps at the Victoria Mill. The cost of that process compared with. the wet crushing process also is not unfavourable.

H. P. BARRY, Superintendent.

For the year 1902

REPORT OF THE DIRECTORS

THE MILLS.

During the year the conversion of the remaining stamps at the Victoria Mill from dry to wet crushing was completed, the whole 200 are now wet crushing. The Union Mill of 40 stamps, which was acquired by the purchase of the **Union-Waihi** Company's property, was put in order, the necessary tramway completed, and crushing started on **15th September**. The Waihi Mill, 90 stamps, was run entirely on dry crushing during the year, being prepared during the same time for conversion to wet crushing. This was completed in January of this year, and now the whole 330 head are engaged in wet crushing.

SUPERINTENDENTS ANNUAL REPORT.

WAIHI, 24th January, 1903.

VICTORIA MILL, WAIKINO (200 STAMPS).

At the commencement of the year 100 stamps at this Mill were dry crushing and 100 stamps wet crushing. On the 5th April 50 of the dry crushing stamps were stopped, and re-started wet crushing on the 10th April. On the 31st July the remaining 50 dry crushing stamps were stopped and started again on the 5th August, on which date the whole Mill of 200 stamps were wet crushing.

During the whole year 30 stamps have been at work on mineralised ore and crushed a total of 19,532 tons, which is included in the above total of 107,833 tons.

Several small lots of concentrates have been treated in the plant erected for this purpose. The results so far obtained have not been quite satisfactory. It has been difficult to give them the uninterrupted treatment and close attention necessary owing to the work of conversion of the plant from dry to wet crushing, which has entailed a great deal of work. It is expected, however, that with some further tests the satisfactory treatment of the concentrates can be accomplished at the works.

H P. BARRY, Superintendent.

For the year 1903

SUPERINTENDENTS ANNUAL REPORT FOR 1903

Waihi, 21st January, 1904

During the whole year 30 stamps with the necessary vanner plant were at work on mineralised ore, and crushed a total of 20,780 tons, which is included in the tonnage shown above.

Formerly these stamps were of 1,250 lbs. weight, but after some months run during the year they were lightened, the wear and tear on the mortar boxes when crushing this class of ore being very severe.

CONCENTRATES TREATMENT PLANT.

A series of trials of the treatment of concentrates at the Victoria Mill instead of shipping them, have been carried out for some months.

A complete unit of plant was erected and experiments made with grinding by means of McKay pans, Krupp ball mill, and Huntingdon mill. The experiments demonstrated the superiority of McKay pans for this purpose, but experience gained in other parts of the world tended to prove that tube mills were superior to the above as being the best machines for fine grinding, consequently, a tube mill was ordered and the necessary treatment plant designed, and concrete foundation work gone on with.

Tenders were called for ten steel agitating vats 6-ft in diameter and 15-ft. 9-ins. in depth, and the vats have since been received and erected upon timber trestling, and the necessary V boxes were constructed.

The Tube Mill came to hand in October, and was erected, and the shafting for driving it and the air compressor and pumps was installed. A pressure tank was also installed.

An order was placed for a second-hand Dehne Filter Press (1 ton capacity) for this plant at a satisfactory price.

Work in connection with the whole plant has just been completed.

H. P. BARRY, Superintendent.

For the year 1904

REPORT OF THE DIRECTORS

In order to deal with the increase in the mineralized ore, the concentration plant at the Victoria Mill (which up to the present has only been adapted to 30 stamps) will be extended to treat the product of the remaining 170 stamps.

SUPERINTENDENTS ANNUAL REPORT FOR 1904.

Waihi, 25th January, 1905

Soon after the commencement of the year a start was made to treat the Concentrates in the Plant erected for that purpose at the Victoria Mill, and within a few months the whole of the Concentrates produced at the three mills were sent to that Plant for treatment instead of shipping them to Smelting Works in Australia or England, as had previously been done.

A total of 1,992,19 tons of Concentrates were treated at the Victoria Mill and produced 149,915.0 ozs. of a value of £53,835 16s. 8d.

During the whole year 30 stamps, with the necessary vanner plant, crushed a total of 21,724 tons of mineralised ore, which is included in the tonnage shown above.

As it is now becoming increasingly difficult to keep separate the supply of oxidised and mineralised ore it will be necessary in the near future to extend the vanner plant so that a concentrate may be taken out of the whole of the output at this Mill; plans of this proposed extension of plant, embracing two tube mills, have been prepared.

The extraction obtained at this Mill fell off consistently during the last eight months of the year, chiefly due to a change in the nature of the ore, which to enable a better extraction to be obtained, must now be concentrated. As mentioned above, plans for the necessary plant have been prepared and quotations for the necessary vanners obtained.

CONCENTRATES TREATMENT PLANT (Victoria Mill).

The concentrates produced at the three Mills are forwarded for treatment at this plant.

A total of 1,992.19 tons of Concentrates were treated during the year value, approximately, of £42 per ton.

The average assay contents before and after treatment were as follows:— gold. silver.

Ozs. Dwts. Grs. Ozs. Dwts. Grs. Heads 7 13 3 98 4 2i

Tails ... ... o 7 i3 7 i8 18

The tailings are being conserved.

The working arrangements of this plant have proved to be satisfactory. The Concentrates are ground in a Tube Mill and subsequently agitated by means of compressed air, with cyanide solution in ten 6 feet diameter vats.

The system of zinc fume precipitation is in use.

Prior to the Tube Mill being used for grinding Concentrates, experiments were carried out so as to see what increased output could be obtained from its use in connection with stamps for reducing the ore to the required fineness.

The erection of the **Coal Hoppers** at the Victoria Mill in connection with the Government Railway is nearing completion.

H. P. BARRY, Superintendent.

For the year 1905

SUPERINTENDENTS ANNUAL REPORT FOR 1905.

Waihi, 18th January, 1906.

The whole of the mineralised ore crushed at the Victoria and Union Mills (54,849 tons) and part of that crushed at the Waihi Mill was passed over amalgamated copper plates and vanners before being cyanided and the balance was cyanided direct.

The average value of the Bullion was 12s. 6d. per ounce, or 1s. 7d. lower than during the preceding year. This is due to three causes :—

(1.) A higher value of silver in the ore.

(2.) A better extraction of the silver contents in the ore treated.

(3.) A larger portion of the Concentrates having been treated locally.

During the whole year 30 of the stamps, with the necessary vanner plant, were at work on mineralised ore, crushing a total of 26,721 tons, which is included in the tonnage shown above.

The decision to extend the vanner plant, so as to embrace the product from the whole 200 stamps, has been given effect to, and the work has been in hand for several months past, and the large plant for this purpose is nearing completion and should be brought into use within a few weeks.

This plant is in a different position from the small vanner plant now in use.

A large two storey building has been erected, the necessary copper plate-tables, which are situated on the top floor, have been put in, and the "Wilfley" vanners, 25 in number, have been procured and erected on the ground floor.

The necessary iron tanks, launders, and elevator wheels required in connection with this plant have been constructed and erected in position, only the smaller details still remaining to be dealt with.

The vanners will be driven by means of a steam engine which was not in use, and which has been transferred and re-erected in position.

Concentrates Treatment Plant (Victoria Mill).

As the tonnage of Concentrates produced at the three Mills and which is forwarded for treatment in this plant (situated at the Victoria Mill) has been increasing and will still further increase in the near future, it has been necessary to make some additions to the existing plant.

Early in the year two more agitating vats 15 feet in height by 6 feet in diameter were added, and later on in the year a further seven vats of the same size have been erected.

The treatment plant has been roofed in.

A second tube mill obtained locally and fitted up at the Victoria Mill has been added to the plant and erected in position.

CONCENTRATES TREATMENT PLANT.—

All the concentrates produced at the three mills, with the exception of the small shipments previously referred to, have been forwarded for treatment at this plant.

A total of 3,719.47 tons were treated during the year, of a value of ^"37 I is. ^d. per ton.

The average assay contents before and after treatment were as follows :_

	GOLD.	SILVER. ozs. dwts. grs.	ozs. dwts. grs.
Heads	6 13 i	96 7 5	
Tails	o 6 i	6 ' 9 19	

The tailings from this plant are still being conserved.

A complete clean-up was made about the middle of the year, the theoretical and actual recovery agreeing very closely.

The additions made to the plant itself have been previously referred to.

In making a comparison of costs at the Mine between this Company and other gold mining companies in different parts of the world, in which respect this Company does not compare unfavourably, it must be borne in mind that a considerable proportion of the total value contained in the ore is due to the presence of silver as well as gold, increasing the expense of cyanide treatment; that the whole of the pulp (sands and slimes) is subjected to a chemical treatment; that during 1905 about half of the ore has required, and in future the whole of the ore will require, concentration; that the concentrates are treated on the spot and appear in the costs incurred at the Mine, and the bullion is also subjected to Acid Treatment on the spot, the gold and silver being despatched in such a condition that no further treatment is necessary.

A short line connecting the Government Railway line with the **Company's coal hoppers at the Victoria Mill** has been constructed.

H. P. BARRY, Superintendent.

For the year 1906

SUPERINTENDENTS ANNUAL REPORT. FOR 1906.

Waihi, 17th January, 1907.

By the end of 1905 the re-arrangements and additional plant required for concentrating the whole of the product from the mills were well forward, two tube mills with the necessary engine and boiler power were also in process of erection.

The most suitable position for the extension of the vacuum slimes plant and agitators required for the treatment of the increased product, which should amount to about 5,000 tons per month, was occupied by the concentrates tailings dump, consequently these have been removed.

CONCENTRATES TREATMENT PLANT, VICTORIA MILL.—

The tonnage of concentrates handled at this plant shows a considerable increase over the preceding year.

The second tube mill, which had been erected, was brought into use during the year under review, and another filter press was also added to the Plant.

Concentrates Treatment Plant, Victoria Mill.

All the concentrates produced at the three mills have been forwarded for treatment at this plant.

A total of 4,692.15 tons were treated during the year, of a value of £^i 19^, 6d. per ton.

The tailings from this plant are still being conserved.

The plant has worked satisfactorily, the theoretical and actual recoveries agreeing reasonably.

H. P. BARRY, Superintendent.

For the year 1907

SUPERINTENDENTS ANNUAL REPORT. FOR 1907.

Waihi, l3th February, 1908.

Concentrates Treatment Plant—

This has been increased by the addition of a standard size tube mill, six more agitator vats, and a 3 ft. 6 in. Martin filter press is being erected in place of the small central filled Dehne press.

Concentrates Treatment Plant, Victoria Mill—

All the concentrates produced at the three mills have been forwards treatment to this plant.

A total of 5,581.14 tons were treated during the year of a value £29 7s. 6d. per ton.

The average assay contents before and after treatment were as follows:

	gold.			silver.		
	ozs.	dwts.	grs.	ozs.	dwts.	grs.
Heads	5	8	2	66	14	15
Tails	0	4	16	3	15	23
Extraction	95.7 per cent.			94.3 per cent.		

Owing to our available stacking ground being full, we have, since October, been unable to continue conserving the tailings, the actual cost of conveying them to the nearest site, about a mile distant, being prohibitive.

We have very little hope of ever being able to treat these tailings at a profit, but are making every endeavour so to increase the extraction on the concentrates, that this question of the value of the tailings will become of less importance…

Producer Gas and Tube Mill Plants—

The main portions of these plants have been completed.

Everything in connection with the producers and gas engines is working satisfactorily.

For the year 1908

SUPERINTENDENTS ANNUAL REPORT. FOR 1908.

Waihi, 10th February, 1909.

Concentrates Treatment Plant, Victoria Mill-

All the concentrates produced at the three mills have been forwarded for treatment to this plant.

A total of 6,061.26 tons were treated during the year of a value of £29 17s. 3d. per ton.

The average assay contents before and after treatment were as follows:—

GOLD. SILVER. ozs. dwts. grs. Ozs. dwts. grs. Head ... ... 5 10 19 65 19 0 per ton (2,000 Ibs.)

Tail ... ... 0 4 3 4 12 23 „ „

Extraction ... ... 96.28 per cent. 92.95 per cent.

H. P. BARRY. Superintendent

For the year 1909

SUPERINTENDENTS ANNUAL REPORT FOR YEAR ENDED 31st DEC, 1909.

Waihi, 10th February, 1910.

Concentrates Treatment Plant, Victoria Mill—

All the concentrates produced at the three Mills have been forwarded for treatment to this plant.

A total of 6,339.5 tons were treated during the year of a value of £29 17s. 8d. per ton.

The average assay contents before and after treatment were as follows:—

GOLD. SILVER. ozs. dwts. grs. ozs. dwts. grs.

Head 5 12 4 63 5 11

Tail 0 4 4 4 2 17

Extraction... ... 96.3 percent. 93.5 percent.

H. P. BARRY, Superintendent.

For the year 1910

SUPERINTENDENTS ANNUAL REPORT FOR YEAR ENDED 31st DEC. 1910.

Waihi, 17th February, 1911

Concentrates Treatment Plant, Victoria Mill-

All the concentrates produced at the three Mills have been forwarded for treatment to this plant.

A total of 7,116.23 tons were treated during the year of a value of £24 7s. 5d. per ton.

The average assay contents before and after treatment were as follows:—

	GOLD.			SILVER. ozs.	dwts.	grs.
Head	4	13	8	47	14	1
Tail	0	4	8	3	7	23
Extraction... ...	95-4 percent..			92.9 percent.		

H. P. BARRY, Superintendent.

For the year 1911

METALLURGICAL REPORT FOR YEAR ENDED 31st DECEMBER, 1911.

Waihi, 20th February, 1912.

H. P. Barry, esq.,

Superintendent.

The proportion of ore treated as sand was ... 18.63 % „ „ „ „ slime „ ... 80.09 % „ „ „ „. „ concentrate was 1.28 % -

All the concentrate was sent to the Concentrates Treatment Plant. Only about 35 per cent. of the ore pulp was sent over the plates, and vanners.

The staff on the plates was reduced early in the year, but the efficiency was not impaired; the percentage recovered by amalgamation was slightly higher than during the previous year.

The work of the concentration plant (Wilfley tables) has had special attention ; the quantity percentage of concentrates has been decreased, but the value percentage (in spite of lower head assay) has increased. This was achieved by cutting out a low grade middling product which is returned to the tube mill plant. This has helped to reduce the general treatment cost, the lesser quantity of concentrate enabling us to reduce cost at concentrates treatment plant.

McAra

(Extract from **Gold Mining at Waihi**, 1878-1952, JB McAra)

1897: RAPID DEVELOPMENT

The year 1897 was marked by rapid acceleration of mining and ore-treatment, in particular construction work on the new battery at Waikino (then generally known as Owharoa)…

Ore sent to the battery [Waihi Battery] was from the Welcome reef 21,691 tons, and from the Martha reef 16,704 tons; ore treated for the year was 34,410 tons of an actual value of £3 16s. 8.6d., yielding 29,722.53 ounces of gold and 63,885 ounces of silver, giving a total from the mill of £132,021 143., plus £3069 10s. from 2522 tons of tailings treated, while **concentrates sold brought £109 11s. 6d.,** making a grand total of £135,200 16s. 6d., silver being valued at two shillings and threepence an ounce and gold at four guineas an ounce. (page 106-107)

1902: RESERVES FOR MANY YEARS

Production for the year increased by 20,160 tons to 179,485 tons dry weight; 65,498 tons by dry crushing and 113,987 by wet crushing; 847.22 tons of concentrates, assay value £48,632, was shipped to Australia for treatment. (page 126)

1902-10

SHAFT-SINKING, PUMPING AND OTHER DEVELOPMENTS

One of the developments which helped to bring about the adoption of wet crushing, and enhanced the stamp output, was the idea of separation and separate treatment of the concentrates with which a large proportion of the gold was associated. This was done at first by the introduction of Union vanners and later Wilfley tables to remove the sulphides and heavy fraction. Before reaching these concentrators, the pulverised ore passed over a large area of amalgamating-tables, which were installed on the floor above the concentrators. As the bulk of the free gold was caught on the mercury-coated, copper, amalgamating-plates, and nearly all the sulphide minerals on the Wilfley tables, there remained only a small percentage of the values in the pulp for treatment with cyanide.

Separation of coarse and fine sections of the pulverised ore by hydraulic classification in sand-cones, vee-boxes and the like also helped to reduce the treatment time and improve the extraction ratio, making it possible to enlarge the screen mesh on the stamp mortar-boxes to one-tenth of an inch, eventually increasing stamp duty to about six tons per stamp per day (compared with 2.4 tons in 1903).

At first the concentrates, a relatively small ratio of two or three per cent, were shipped overseas for treatment and the returns from them were small, but in 1904 the Waihi Company treated 1992 tons of concentrates at Waikino which returned £53,836. (page 141-142)

ORE TREATMENT & GOLD RECOVERY AT WAIKINO

Concentration. From the overflow of the mill return-boxes the ore went to the Wilfley concentrating tables via a distributor which regulated the flow of pulp to the twenty-nine large shaking tables installed in what was known as the vanner room, because the Union vanners had originally been there.

For many years there was an amalgamating room on the floor above the Wilfley room but it was eventually done away with; its main purpose seems to have been to remove the free gold from the circuit at as early a stage as possible — a desirable security measure. The room contained about thirty, twelve-by-six-foot wide, Muntz-metal, amalgamating tables which were coated with mercury and over which the finely-ground ore was distributed from two-inch-diameter pipes, one to each table. The gold and silver amalgam was removed from the plates every eight hours and the plates were rubbed up twice a shift. There were two mercury traps to each plate and a Berdan pan was used for cleaning the

amalgam. Excess mercury was efficiently removed by a centrifugal machine. Twenty-nine per cent of the gold content and five per cent of the silver was recovered by amalgamation. The plates were scaled at monthly intervals. The ground pulp from the tube-mills on its way to the Wilfley tables was distributed from the old amalgamating floor to the Wilfley tables on the ground floor by small, open, wooden launders and fed on to the tables with the required quantity of water.

The tables were about fifteen feet long by about six feet wide, made with a true surface. They were covered with heavy linoleum, on which thin tapering riffles made from narrow strips of wood about six inches apart were fastened lengthwise. The table had a variable tilt towards the discharge side and the pulp entered the distribution trough at the high side, flowing across the table in a thin layer, while a longitudinal reciprocating movement was imparted to the table by the pitman toggle mechanism at the intake end. This motion, at the rate of about two hundred a minute, was a comparatively slow forward thrust with a sharp spring-operated return which caused the heavy particles of iron pyrites and other metallic sulphides, which sank and lodged against the riffles, to move along towards the far end of the table with each jerk, while an evenly-distributed flow of water washed away the lighter materials before the concentrate was discharged into the tub at the end of the table. As can be imagined, it was a very large building to house nearly thirty tables. It was floored with concrete so that any spillage could be recovered by hosing down to the pumps. The table-operating-mechanisms were driven by two long shaftings running the length of the building on either side; they had plain bearings and flat belts were used for transmission. Belts often broke, and it was not uncommon for bearings to heat up, so lubrication was quite a problem.

The concentrates were dug out of the wooden boxes at the end of the tables into large drums, twice a shift, by the single operator. Each morning the day's production, about twenty tons, was loaded on to flat-topped rail-waggons and hauled by the locomotive to the concentrate treatment plant. (page 219-220)

Extracts from Mines Statements

AJHR

1904

Largely for 1903 year

Inspector of Mines

Waihi Goldmining Co.

Victoria Mill (200 stamps).—A third turbine of 100-horse power which was in stock, has been erected, and was brought into use during the month of August. Since then very little steam-power has been required. A mechanical chain-grate stoker was obtained from England, and has now arrived at the Victoria Mill. Several machine tools have been added to the machine-shop. **A series of trials for the treatment of concentrates at the Victoria Mill, instead of shipping them, have been carried out for some months**. Tenders were called for ten steel agitating-vats 6 ft. in diameter and 15 ft. 9 in. in depth. The vats have since been received, and erected upon timber trestling and the necessary V boxes were constructed. The tube-mill came to hand in October, and was erected. The shafting for driving it, and an air-compressor and pumps, together with a pressure-tank were also installed. Work in connection with the whole plant has just been completed.[36]

1905

Largely for 1904 year

Mr. James Coutts, Inspector of Mines, Thames, to the Under-Secretary for Mines, Wellington. Sir, — Office of Inspector of Mines, Thames, 18th February, 1905.

A total of 1,99219 tons of concentrates was treated at the Victoria Mill and produced 149,915 oz., of a value of £53,835 16s. 8d.[37]

[36] https://paperspast.natlib.govt.nz/parliamentary/AJHR1904-I.2.1.4.3
BIBLIOGRAPHIC DETAILS
THE GOLDFIELDS OF NEW ZEALAND: REPORT ON ROADS, WATER-RACES, MINING MACHINERY, AND OTHER WORKS IN CONNECTION WITH MINING., Appendix to the Journals of the House of Representatives, 1904 Session I, C-03 Page 42. Page 45 has images of the CTP under construction.
[37] https://paperspast.natlib.govt.nz/parliamentary/AJHR1905-I.2.1.4.3/1
THE GOLDFIELDS OF NEW ZEALAND: REPORT ON ROADS, WATER-RACES, MINING MACHINERY, AND OTHER WORKS IN CONNECTION WITH MINING., Appendix to the Journals of the House of Representatives, 1905 Session I, C-03 Page 31

Isdale

Waikino And The Victoria Battery, Alistair M. Isdale, BA. 2000

Extracts from**: Waikino And The Victoria Battery, Alistair M. Isdale, BA. 2000**

The "WAIHI BOROUGH COUNCIL DIAMOND JUBILEE 1902-1962, has an account I contributed of events following the winding up of the Martha Gold-Mining Company, on July 9, 1955, in London. "The Victoria Battery site at WAIKINO was taken over by Mr. I. Gerrand for cleaning up scrap metal and gold and silver residues. He also disposed of most of the buildings.....Towards the end of 1959 Mr. Gerrand's interests at WAIKINO were purchased by a Canadian Company, South Pacific Mines Ltd."

1960

"During 1960 and 1961-2, further cleaning up of gold and silver residues was carried out at Waikino on a pilot-plant basis, it being intended to erect a large plant at WAIKINO to **treat sand tailings from the banks of the Ohinemuri River** in conjunction with WAIKINO battery residues and some better grade surface ore left standing at the old Martha Mine."

RECENT MINING ACTIVITIES IN THE OHINEMURI DISTRICT

By A. M. ISDALE, B.A.

(Secretary, Thames-Hauraki Historical Society).

Following the winding-up of the Martha Gold-Mining Coy., in July 9th, 1955, the Martha Mine area was made a wildlife sanctuary and the Victoria Battery site at Waikino was taken over Mr I. Gerrand for cleaning up scrap metal and gold and silver residues. He also disposed of most of the buildings. From 1955 to 1960 Messrs Frewin Bros. carried out cleaning up operations for gold and silver residues on the old Martha refinery site at Waihi.

Towards the end of 1959 Mr Gerrand's interests at Waikino were purchased by a Canadian company, South Pacific Mines Ltd., which during 1959-60 also acquired rights to tailing on the banks of the Ohinemuri River between Mackaytown and Paeroa, and between Waikino and Waihi. Union Hill at Waihi was likewise taken up, together with Martha Hill, which was gazetted available for mining again. Two prospecting licences were pegged at Maratoto.

During 1960 and 1961-62 further cleaning up of gold and silver residues was carried on at Waikino on a pilot-plant basis, it being intended to erect a large plant at Waikino to treat sand tailings from the banks of the Ohinemuri River in conjunction with Waikino battery residues and some better grade surface ore left standing at the old Martha Mine.

During 1960 Pacific Western Alloys Inc., a Californian company managed by the officials of South Pacific Mines, took up prospecting licences in the Maratoto-Komata-Waitekauri area and carried out preliminary prospecting.

During 1960 an assay office was set up by South Pacific at Waikino, in addition to the one at Thames, the Waikino office later that year taking over all assay work for company operations in the Thames, Te Aroha and Ohinemuri districts.

1961 a small cyanide plant was added at Waikino, under the supervision of the Mill Superintendent, Mr D. M. Haszard of Waihi. Also a change-over was made from sending Waikino gold-bearing concentrates overseas, gold-silver bullion being melted and cast into bars on the spot.

During 1962 pilot-plant operations at Waikino were completed and at the time of writing the chief activity at Waikino, pending erection of the projected large sands-treatment plant, is the assaying of samples from Te Aroha.

In addition to the above, during 1959-62, several other companies, some with headquarters overseas, took up large areas in the Ohinemuri district, and areas were also pegged by individuals. 1961-62 New Zealand Mines Ltd., a company registered in U.S.A. carried out "diamond drilling in the Waihi area following geophysical and geochemical surveys." One bore was at the western entrance to Waihi.

The direct quotation just above is from one of the Government Mines Statements, to which considerable acknowledgement is due.

THE INTRODUCTION OF THE CYANIDE TREATMENT IN THE WAIHI GOLDFIELD

By G. H. WORTH

Almost the last chapter in the Company's history was the shovelling up and delivering to the Waikino Mill of the two paddocks of tailings that had lain overgrown with vegetation of all kinds for 60 to 70 years.

Wilfley tables

Discharge from the tube mills was lifted by an elevator wheel to a set of 14 classifier V-boxes. The overflow from these, ground fine enough for 75 percent to pass through 200 mesh screens, passed on to feed 28 Wilfley concentrating tables. Underflow from the classifiers returned to the tube mills for regrinding.

The Wilfley tables were installed on the ground floor of the vanner shed, so called because at one time it housed a set of concentrators, in the form of endless rubber belts, called vanners. The vanner shed was a double storied building. The top floor once housed amalgamation plates but in 1948 its emptiness echoed only memories of the period prior to the first world war when amalgamation was practised at the battery. While the Wilfley tables were far more efficient concentrators than vanners they recovered only about 25 percent of the gold and 14 percent of the silver in the ore.

The Wilfley tables removed 2 percent of the total feed in the form of concentrates. Feed to each table spread across a set of tapered wooden riffles nailed to a linoleum covered deck. An eccentric mechanism imparted a bumping, shaking motion to the table. A cross flow of a film of water further helped to stratify a band of concentrates at one corner of the riffles from where it was directed by a moveable tin scoop into a wooden holding trough. At times a fine ribbon of free gold and silver was visible on the tables at the edge of the broader band of black concentrates. The gold and silver was closely associated with the pyritic concentrate minerals. Each tiny grain of iron pyrites had gold and silver attached to it.

It was the job of the vanner shed operator to shovel the concentrates from the wooden troughs at the front of the tables into 40 gallon drums fitted with reinforcing hoops. Each drum was equipped with lugs to facilitate the lift from the concrete floor to the open top trolleys, using a chain operated hoist. The full drums of concentrates were hauled along a tramline to the adjacent Concentrates Treatment Plant (CTP). The battery horse, driven by Bill James, performed this task. From 10 to 15 tons of concentrate were produced every 24 hours with an assay value of 3 ounces of gold and 13 ounces of silver to the ton. Each trolley load of concentrates was weighed on a weigh-bridge.

Concentrates Treatment Plant (CTP)

At the CTP a drum of concentrates was positioned into a tipping cradle and a fine jet of water fed the concentrates into a tube mill loaded with 1 inch diameter pebbles. The rate of feed was from 20 to 30 minutes for each drum. The tube mill operated in closed circuit with two steel classifying cones. The tube mill discharge was elevated to the cones by a centrifugal pump. The underflow from the cones returned to the tube mill for regrinding until the material was fine enough to pass through a 325 mesh screen. This finer grinding ensured that the gold and silver became detached from the host crystals of iron pyrites.

The overflow from the two classifier cones at –325 mesh passed on to a set of 5 V-boxes where it was thickened to a consistency of 60 percent solids to 40 percent water before being fed to the first in a series of 23 Brown agitators. Sodium cyanide, at a ratio of 10 pounds of cyanide and protective lime, at a ratio of 24 pounds of lime per ton of concentrates was added to the first agitator. The CTP agitators were fabricated from ¼ inch steel plate, lined with 3 inches thickness of concrete. The total height of each agitator was 16 feet and its volume was 303 cubic feet.

Compressed air was introduced deep into the agitator by a ½ inch pipe. The air served two purposes. Firstly, it kept the pulp in motion and prevented the solids from settling up in the conical base of the agitator. Secondly, air was essential for the provision of oxygen to the chemical process whereby the cyanide selectively combined with the gold and silver in solution while ignoring the **67 percent of iron pyrites and 28 percent of silica** that comprised the bulk of the concentrates in the agitator.

The chemical reaction between gold and cyanide may be written as:

$$4\,Au + 8\,NaCN + O_2 + 2H_2O = 4\,NaAu(CN)_2 + 4\,NaOH$$

gold cyanide oxygen water sodium gold cyanide caustic soda

Each agitator was equipped with a 4 inch pipe suspended vertically inside and overlapping at the top into the next agitator. Compressed air, introduced into the base of the 4 inch pipe, made it an air lift that decanted the contents of one agitator into the next. It took 3 weeks for the contents of No.1 agitator to be decanted into No. 23 and that was the time necessary for a satisfactory extraction of the precious metals from the concentrates. Extraction of the gold was an efficient 97.5 percent while 94 percent of the silver was recovered.

Victoria Battery Flow Sheet

Treatment before 1912 - Grinding to 70% through 200 mesh, followed by plate amalgamation, then Wilfley table concentration. The Wilfley table concentrates were reground and cyanided in the concentrates treatment plant.

The Wilfley table tailings were then classified into –

(a) Sands - cyanided by a percolation method.

(b) Slimes - cyanided by an agitation method.

Treatment from 1912 to 1947 - Amalgamation practice ceased on 12th May 1912, and the flowsheet was continued as before to produce Wilfley table concentrates, sands and slimes for cyanide treatment in separate sections for each product.

Newspapers

Waihi Daily Telegraph, Volume VI, Issue 1675, 4 **July 1906**

WAIHI GOLD MINING CO., Ltd Tenders will be received up to noon on FRIDAY, 6th July, for the REMOVAL AND DEPOSITING of about 4000 yards of CONCENTRATES TAILINGS at the VICTORIA MILL, WAIKINO. Specifications to be seen at the Company's Offices, Waihi and Waikino. H, P. BARRY, Superintendent.[38]

WAIHI GOLD MINING CO., LTD

Tenders will be received up to noon o FRIDAY, 6th July, for the REMCVAL AND DEPOSITING of about 4000 yards of CONCENTRATES TAILINGS at the VICTORIA MILL, WAIKINO.

Specifications to be seen at the Company's Offices, Waihi and Waikino.

H. P. BARRY,
Suprintendent.

New Zealand Herald, Volume XLIX, Issue 15105, 23 **September 1912**, Page 8

The New Waikino Union. Waikino, Mr. Walsh said, is no longer to be regarded as having any serious part in the strike. The federationists have practically given it up, and **the batteries are working on concentrates**.[39]

Waihi Daily Telegraph, Volume XXXI, Issue 8802, 31 July 1942, Page 2

Battery Worker Injured

Caught between a **concentrates truck and one of the company's locomotives**, Mr W. Jones, an employee of the Martha Gold Mining- Co. Ltd., at its Victoria battery at Waikino, suffered a crushed hip in the course of his work last Tuesday. The injured man was admitted to the Waihi Hospital. His condition is not serious, and he is making satisfactory progress.[40]

A good contemporary description of the battery and process:-

https://paperspast.natlib.govt.nz/newspapers/NZH19081029.2.88

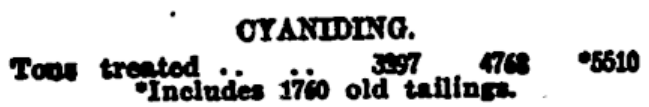
New Zealand Herald, Volume XLV, Issue 13893, 29 October 1908, Page 6

[38] https://paperspast.natlib.govt.nz/newspapers/WHDT19060704.2.49.5
Waihi Daily Telegraph, Volume VI, Issue 1675, 4 July 1906, Page 3
[39] https://paperspast.natlib.govt.nz/newspapers/NZH19120923.2.92
New Zealand Herald, Volume XLIX, Issue 15105, 23 September 1912, Page 8

[40] https://paperspast.natlib.govt.nz/newspapers/WHDT19420731.2.11
Waihi Daily Telegraph, Volume XXXI, Issue 8802, 31 July 1942, Page 2

Old tailings?

https://paperspast.natlib.govt.nz/newspapers/NZH19130530.2.35


CYANIDING.

Tons treated 3997 4768 *5510

*Includes 1760 old tailings.

New Zealand Herald, Volume L, Issue 15315, 30 May 1913, Page 5

Ore stockpile a golden opportunity

Matt Bowen 05:00, Oct 01 2012

An application to mine a century-old stockpile of gold worth almost $13 million on the proposed Hauraki Rail Trail path and bordering the Ohinemuri River has alarmed nearby residents.

Miner Alan Death and geologist Keith Hay lodged the proposal with New Zealand Petroleum and Minerals on September 10, after being involved with a failed attempt to extract it nearly 20 years ago.

If successful, the permit would grant a five-year window to take gold and silver on the 3.6ha strip of Conservation Department land.

But due to its proximity to the river it would highly likely need resource consent from the Waikato Regional Council.

The council understands the ore was dumped there about 1903.

Regional Council spokesman Stephen Ward said they investigated the tailings dam in 2009.

The study indicated there were high levels of heavy metals in the tailings, but there was "no significant discharge" from it.

It was subsequently classified as "contaminated" and warning signs erected.

Waihi resident Ruth Ordish said the mining application would cause widespread concern and was a "very sad thing".

"Those tailings, although considered a contaminated site, are relatively stable at present," she said.

"Any interference with them at all will jeopardise their containment, and as they are immediately adjacent the Ohinemuri River, jeopardise the river, the water quality and the surrounding ecology."

Hauraki District Council community services manager Steve Fabish said the rail trail, part of Prime Minister John Key's $50m national cycleway, is planned to cross the ore dump on its way from Waikino to Waihi.

They're planning to put the track on the surface with minimal disturbance, he said.

He was unaware of the application to mine it and so was the regional council.

It's understood the Waihi Gold Company originally extracted the ore from Martha Mine in Waihi and transported it by rail to the Victoria Battery processing factory where it was stockpiled in a hollow alongside the river.

The superintendent's annual report for 1907 states: "We have very little hope of ever being able to treat these tailings at a profit."

Victoria Battery was once the largest quartz ore processing plant in Australasia and one of the biggest industrial sites in New Zealand in the early 1900s.

At the time it was the country's largest producer of gold - 10 times more than the next largest battery.

Mr Death and Mr Hay were involved in an aborted attempt to dig up the gold in the early 1990s via their company Victoria Sands Ltd.

Paeroa resident Peter Davison was one of five shareholders, alongside Death and Hay, who had a prospecting licence on the land.

He said it's a small area yet there's "a lot" of gold-rich sulfide ore there.

The venture ran out of steam because it was uneconomical to extract the ore and process it, but Mr Davison estimated there to be $3m worth of gold at the site - in today's prices that's close to $13m.

"It'll be good for the area," he said. "Obviously being right by the river, you'd think there'd be some leaching into it."[41]

Aussie miners cleared to dig by Hauraki Rail Trail route

Matt Bowen 09:24, May 22 2013

A pair of goldmining mates from Western Australia have been given the green light to take 10,000 tonnes of a century-old tailings dump beside the Ohinemuri River and the popular Hauraki Rail Trail route.

Alan Death and Keith Hay have been granted exclusive rights to dig up gold and silver on the 3.6ha rectangle of land at Waikino.

But Mr Death, who was born in Waihi, said it won't be a case of two Aussies flying in, taking the gold, then vanishing.

"It's not actually mining, it's just digging something up," Mr Death said from his home in Quindalup, Western Australia. "It's close to the surface, but it's right beside a river. It's not as easy as one might think."

It's understood the Waihi Gold Company originally extracted the ore from Martha Mine and transported it by rail to the Victoria Battery processing factory where it was stockpiled in a hollow next to the river.

The factory's ghostly ruins remain just a couple of hundred metres upstream of the mining permit area.

Mr Death said sampling suggested there was 10,000 tonnes of ore at the site.

And it contains about nine grams of gold and 100 grams of silver per tonne - that equates to nearly $5 million of gold and about $900,000 of silver at current prices. But the recovery rate would be about 40 per cent because the gold is wrapped up in "sulphides", meaning it's hard to extract.

Just getting the stuff out would be tough, Mr Death said.

They have to negotiate access with the Conservation Department, get resource consent, dig it out without contaminating the river, transport the ore via trucks and find a mill willing to process it.

All of that costs and, with gold prices down, it could stop the project in its tracks.

Then there's the nearby Hauraki Rail Trail section of track from Waikino to Waihi that is under construction and due for completion in October.[42]

[41] https://www.stuff.co.nz/business/7750187/Ore-stockpile-a-golden-opportunity
[42] https://www.stuff.co.nz/waikato-times/news/8700776/Aussie-miners-cleared-to-dig-by-Hauraki-Rail-Trail-route