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Arapuni sick : a million's worth
of medicines : what then? / by H.
Hill.

Arapuni Sick.

A Million's Worth
of Medicines.

What Then?

By H. Hill, B.A., F.G.S.

HAWKE'S BAY, NEW ZEALAND :

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ARAPUNI SICK.

A MILLION'S WORTH OF MEDICINES.

What Then ?

(To the Editor.)

Sir,—Three Parliamentary papers on matters connected with the Arapuni hydro-electric power development and the sudden stoppage of the working on June 7th last, have been issued for public information since Parliament opened its recent session.

It is hardly necessary to say that the papers are of great public importance to every member of the community seeing they have reference to the Arapuni undertaking from the time when the initial works began to the time in June last, when the works closed down owing to the appearance of certain unexpected defects.

The three papers are thus related:—

1. "Statement made by the Hon. W. B. Taverner, Minister of Public Works, whose report embraces official information supplied by Mr. F. W. Furkert, engineer-in-chief of the Public Works and other technical officers of his department."

2. A Special Geological report bearing date September 30th, and headed "Arapuni hydro-electric power works." The report is signed I. Henderson, P. Marshall and J. A. Bartrum."

3. "Professor Hornell's report relating to the damage that took place at Arapuni hydro-electric power station on the 7th June, 1930."

In summary form the Hon. Mr. Taverner's report and that of the geologists are given below. Professor Hornell's report calls for no remark as he bases all his recommendations on information supplied by reports 1 and 2.

Minister's Report.

Mr. Taverner states that at 7 a.m., Saturday, June 7th, water was noticed on the floor of the battery-room behind the power-house.

Crack.

That when the officer at the pump end of the penstock was communicated with he found a crack 2 inches wide between the Spillway and the structure near it. Water was found issuing from a number of places behind the power-house.

Cracks.

That a second crack was discovered running from the first through the hill between the old gorge of the Waikato river and headrace. That the extent of the flows and general movements decided the authorities to lower the water to avoid overflowing Spillway, and to enable a better examination of the conditions being made. The gates in the Diversion channel were then opened.

June 15.

That the Minister after an inspection of the working conditions with the engineers, decided to have the water lowered until the head-race was dry.

Cracks.

That following a further examination numerous cracks were found, down which water disappeared in quantity.

Leakages.

That after the water had been drawn off from the head-race, the leakages

'seen behind the power-house and elsewhere,' decreased and on the 17th had ceased altogether.

That a similar lessening of flow in the power-house where water was seeping on the 7th inst. ceased.

Movements of Rock.

That following tests for rock movements it was discovered that a movement had occurred, "definite in the direction from the penstock to the tail-race, that is in the direction of the Gorge.

Power-house Turbines Moved.

When the Hon. Mr. Taverner made his first visit to Arapuni, which was on June 9th, it was observed that some movement in connection with the power-house had taken place: "the turbines being slightly out of true level."

Suspension Bridge.

That the "high level suspension bridge spanning the gorge had sagged and

That the heavy traffic low level bridge near the power-house indicated that some kind of movement had taken place in the structure.

The Minister, states the report, "supports the theory that the movements were towards the Gorge."

Power-house Cracks.

On June 20th small cracks were reported on the floor of Number 2 Unit, and soon after cracks were reported as "visible round all the three machines and extended from the upper machine floor down approximately to the top of the turbine and scroll cases."

Slips and Falls of Rock Material.

Following the emptying of the lake it was found after the water had been diverted and the lake drained, that slips and great falls of material occurred "from the cliff wall above the intake to the diversion tunnel," and the latter became blocked three times."

All the defects enumerated occurred within 12 months of the opening of Arapuni and after reports had been made again and again, that the stability of the land warranted the construction of hydro-electric buildings.

The Minister's report to the House of Representatives concludes with a reference to the appointment of a technical committee consisting of the head of the Industrial Research Department (Dr. Marsden), Dr. Henderson, Director of the Geological Survey, Dr. Marshall a member of the Research staff, and Professor Bartrum, of the Auckland University College.

They were authorised by the Minister "to examine the position as it appeared at Arapuni and make a joint report thereon."

That report is contained in paper D.I.B. All the defects reported by the Minister as having taken place at Arapuni are manifestly due to the instability of the area on which the buildings stand.

It is the rocks that have given way, and have failed to stand the tests which the engineers required in order to make the developmental works successful. The place was selected because of the reported suitability of the site and the stability of the rocks. Yet within 12 months of the commencement of operations the works were closed down, not because of defects in machinery, but as the direct outcome of dangers having their origin in the porosity and water saturation of the country brought into use.

The report D.I.B. of the professional experts, deserves the most careful study and every visitor to Arapuni should possess a copy of the report, pass over the ground from the power-house to the lake by way of the Spillway, and end by reading the last paragraph of the geologists' special report.

Four geological formations are given as representing the beds to be seen on each side of the Gorge, the river flowing below, the thickness of each formation is said to be from the top downwards:

- (a) 50 feet of unconsolidated sands and gravel.
- (b) 50 feet of much jointed columns rhyolite tuff.
- (c) From 90 to 100 feet of massive pumice breccia.
- (d) Unknown thickness of tuffaceous clays, sands and breccia.

The rock characters of the formations (a), (b), (c) hardly support the view that the ground chosen for buildings and so on, should be firm, with a solid

foundation. But let the geologists speak for themselves:

The first or upper group of beds are said to be "unconsolidated sands and gravels," and "need no further consideration," is the remark made concerning them! Why "no further consideration," when stability and security are indispensable in the case of a great undertaking like the Arapuni hydro-electric development works. The second (b) and third (c) formations are relatively strong rocks"! They are porous rocks and when dry readily absorb water, the joints in them allow the passage of water."

Weathering accentuates these joints, which are conspicuous in the faces of the cliffs. The report continues: "Between the columnar rhyolitic tuff and the pumice breccia are a few feet of weak beds consisting of a poorly consolidated silty phase of the columnar tuff and thin beds of gravel, sand and clay." These weak beds, especially the old soil, are decidedly impervious. The upper few feet of the lowest set of beds consists of indurated clays. The power-house is built on these beds, of which only a small area is exposed."

A novice reading through these statements and knowing how important it is to have firm and solid foundations would find some difficulty in reconciling the beds enumerated as supplying all the necessary land of a sufficient stability on which to erect buildings demanding strong foundations and security from erosive influences.

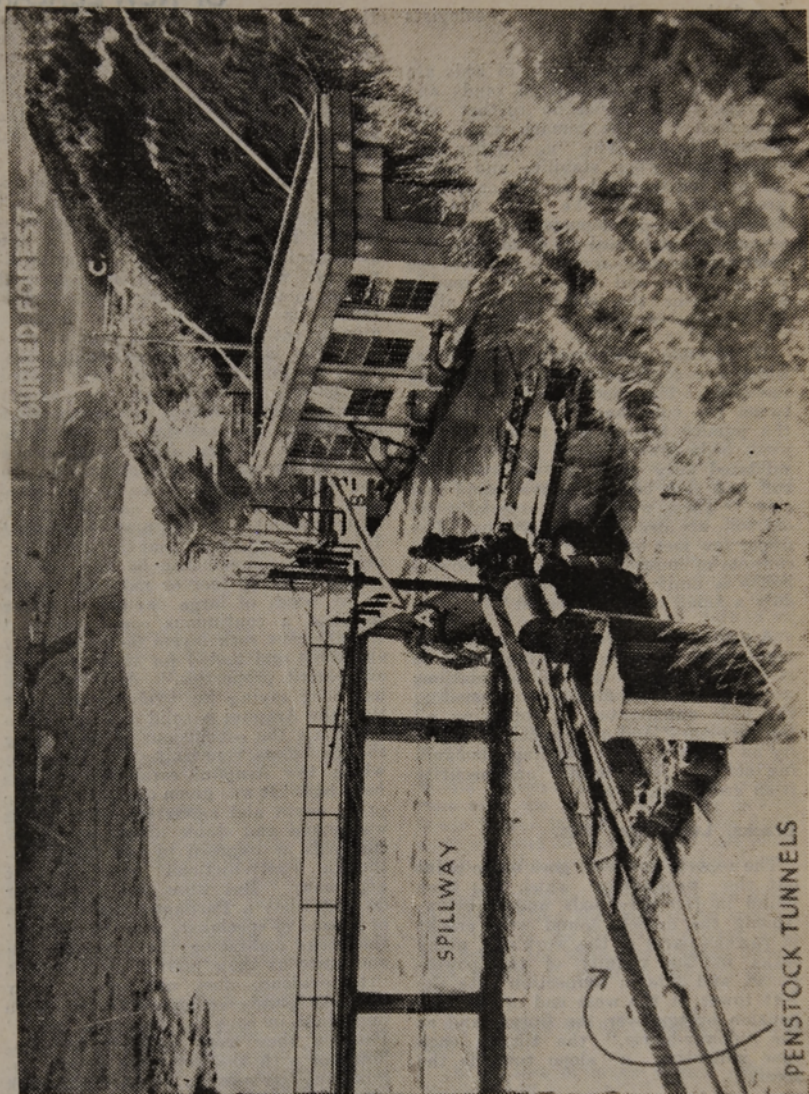
Cracks, Leaks and Tilts.

The report, however, goes on to point out the weaknesses which had been found in the very beds under review. Among the defects found were cracks in various parts of the workings, many leaks in the vicinity of the power-house, and tilts in connection with the 70ft tower at the west end of the suspension bridge over the Gorge, and at the "power-house," the tilt in each case indicating a slope towards the river.

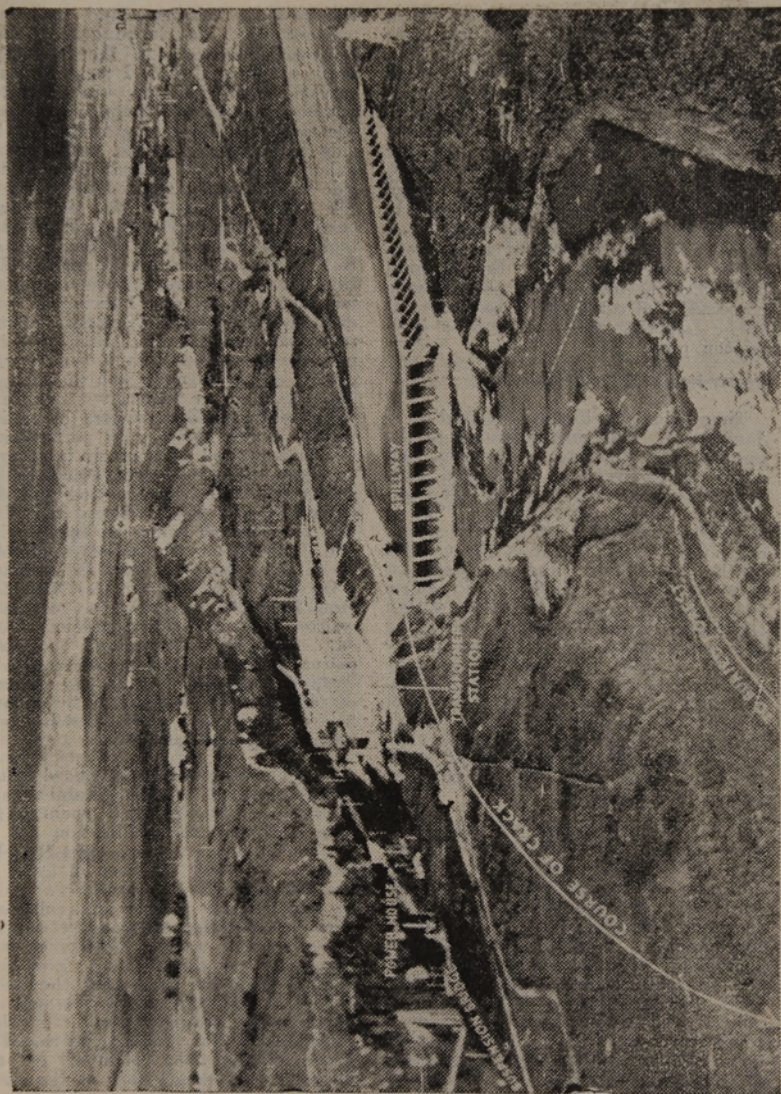
It does not appear to have been a difficult matter for the geological experts to discover the many traces of weakness over various parts of the area at Arapuni, where it had been supposed there was solid and safe country to occupy. It is assumed the experts were aware of the reports already extant as to the stability of the country.

Less than twelve months had passed since Arapuni had been pronounced sound in every particular and many were the well-deserved praises bestowed on all who had been concerned with the construction of what was at the time the greatest hydro-electrical undertaking in the Dominion.

The results of a re-survey of the existing conditions at Arapuni have not clarified the outlook as to future dangers. The suggestions made by the geological experts as to the possibilities of weaknesses having appeared owing to the engineering works undertaken, or of possible earth tremors, give no satisfaction to an anxious public. The instability of existing conditions are known to all who have visited the locality but after so much expert inquiry and so many assurances that everything was satisfactory but little consolation comes from suggestions such as the experts now offer. We are now told that "the cause of the fracture must be definitely ascertained so that remedial measures may be taken." It is thus suggested "that the strata beneath the power-house be explored to a depth of 100 feet or more by shafts or by bores of large enough diameter to yield a continuous core, and that the different rock layers be geologically examined and tested for their strength and elastic properties." And pray who has been saying for twelve years past that the Arapuni is solid and safe? The above are the conclusions arrived at by the geologists concerning the rocks on which the Arapuni establishment has been built! It was given out in the public press again and again that everything was sound and stable above and below the beds as exposed in the Gorge, although contradictions were insistent and many. But what can a Minister do and what a Parliament in the face of a band of specialists who "re-survey" the rocks embracing the Arapuni area and state as their mature opinion that "the evidence does not clearly show that the purely geological factors were important in causing the crack (sic)." Possibly they were sufficient in combination with the definitely known engineering stresses to rupture the rock already weakened by erosion of the channel forming the headrace and by the engineering excavations. But here comes the rub. "The cause of the fracture," continues the report, "must be definitely ascertained so that remedial measures may be taken." And who is to discover the cause of the fracture? And who is to apply the remedy? Surely the experts who were



DOWNSTREAM OVER THE SPILLWAY.—The small building houses equipment for controlling the water flow through the penstocks to the powerhouse. The crack begins in the concrete buttress in front of the control house and follows the direction of A to C and at B is two inches wide. When the "headrace" (the course above the spillway) is emptied of water—by releasing the lake water held by the dam proper through the diversion tunnel—the possibilities of a fault extending upstream will be fully investigated.



ARAPUNI TROUBLE FROM THE AIR.—The 200ft. gorge is to the left and the new course of the Waikato to the right. Between them is a ridge on which the transformers stand; the powerhouse is below these in the gorge. The spillway maintains twenty feet of water about the heads of the penstocks, A, which carry water down to the power station. It was at A that the fissure was discovered. It extends in the direction indicated towards the waterfall and the old forest. Note the distance between the spillway and the dam proper.

on the job should have discovered a cause when so many lines of weakness were in evidence? "We suggest," continue the experts "that the strata beneath the power-house be explored to the depth of 100 feet or more by shafts or by bores of large enough diameter to yield a continuous core, and that the different rock layers be geologically examined and tested for their strength and elastic properties." Statements like these suggest a lack of information such as anyone interested in a great public undertaking as the Arapuni hydro-electric installation should have possessed and could easily have obtained by following the Auckland or Wellington press.

Power-house Difficulties.

Thus the Auckland "Herald" of January 28, 1927, has reference to the power-house difficulty at Arapuni and refers to excavations which had been made below the river level for the foundations of the power-house. "Is it possible to imagine that the contractors did not test to 100 feet in the vicinity of the power-house, and are there expert geologists to-day who will affirm that solid rock can be reached within the limits of the Arapuni undertaking at a depth of 100 feet from the surface of the river? Why tests have been made within the limits of the Arapuni workings to a depth exceeding 220 feet and nothing beyond volcanic materials were found almost as fine and as varied as the sands found to-day at Rainbow Mountain, near Wai-o-tapu, and known as kakaramea.

But what are people to think of undertakings and politics when headings such as the following appear in a leading newspaper of the N. Island. "Security of Arapuni Dam", "Site tested and proved safe", "No reasons for anxiety", "Critic's information incomplete." This is the heading in the N.Z. Herald, Saturday, December 22nd, 1928, with an article covering the above points. The information as far as I could learn was in reply to a criticism upon Arapuni works then in progress of construction by Mr. R. W. Holmes but which I had not seen when I bought a copy of the Herald. At the time I was travelling on the Main Trunk railway from Napier to Hamilton and Taupo intending to call at Arapuni by the way. With a party of ladies and gentlemen from Melbourne I visited various places of interest among which were the dam and the spillway. A geologist accustomed to

the volcanic country could read in a moment what was looming in connection with the area in the immediate track of the spillway. I picked up and carried away with me six or seven pounds by weight, of pumice rock from the side of the spillway and it is beside me now as I write. Long before, I had visited the gorge: entered the side test tunnels: crossed the river on the swing bridge to the left bank: climbed to the top of the terrace and took a general survey of the country. But my experiences on Christmas Eve 1928 more than ever before, convinced me that trouble was brewing in connection with (a) the softness of the rock materials at Arapuni, (b) the porosity of the rocks and (c) the uncertain factor about which no thought appears to have been given viz., the effect of impounding waters in an immense porous basin, with porous sides and bottom, and particularly in an area of some seven or eight square miles and which had been drained and dry for many long years. These were factors that loomed before me in my mind and I wrote on my return to Napier as to the future prospects of Arapuni.

On May 27th, 1929, "The New Zealand Herald", published a very well written and interesting account headed, "Arapuni Dominion's greatest power scheme." It is there stated why Arapuni "was selected as the outcome of exhaustive investigations by a number of experts." Direct reference is made to Arapuni as follows:

"Last year doubts were raised in the public mind as to the suitability and stability of the Arapuni country for dam works by the publication of a statement in the name of R. W. Holmes a former engineer in Chief of the Public Works department. . . As to stability Mr Holmes was obsessed with the idea that the country was full of earthquake cracks. Geological evidence? and engineers and geologists worked hand in hand and they concluded, "that the gorge was cut by water in the ordinary way. . . They estimate that for 10,000 years the Waikato followed the channel of the gorge." Statements such as the above cannot be supported by any direct evidence whatever. Geologists and engineers alike know as much about the time when Lake Taupo and the Waikato Valley country were fissured and washed, as they certainly were fissured and washed, by floods of hot and cold water: as they do of the time when other eruptions will occur at Maungatautari Vol. or Mount Tauhara near

Taupo, or at Ngauruhoe or Ruapehu, to the south of the lake. A knowledge of the geology of the volcanic country with its interesting legendary suggestive of volcanic changes, should have suggested caution as to the length of time the Waikato river has flowed through the Arapuni Gorge. Hachstetter in 1859 was in the vicinity of Arapuni and Maungatautari and remarks how the Valley was filled. He was followed in 1888 by L. Cussen, whose excellent account of the "Waikato River Basins," with map and plate of ancient land surfaces show of what materials the greater part of the Waikato basin is composed. See Vol. XXI. Tran. N.Z. Inst. pp406—416. But a much better insight of the Taupo and Waikato country is obtained from the writings of the two earliest scientific visitors to the central area of the N. Island.

Bidwell visited the Upper Waikato, Taupo and the Volcanoes to the South of the lake in March, 1839, and he says in "Rambles in New Zealand," p 28, "All the small rivers I have seen in the country appear to have no valley, but to have the course excavated perpendicularly out of the plain to a great depth." (Earthquake fissures?). Again "Although I do not think the growth of potatoes sufficient to account for the absence of forest over a great part of the country, perhaps more than half, yet it is certain the wood has decreased for some cause or other within no great distance of time, as I constantly found logs of wood and roots lying in the wet ground of the barren moors."

Dr. Diffenbach. Vol. 1. p. 330.

Dr. Diffenbach who visited the volcanic country in 1840-41 from Kawhai by way of the Waikato and Takaanu says: Vol. 1, p.330:—

"If I wished to describe the country through which we passed, I could not do better than by saying it resembled a land over which a flood had swept, leaving it torn in many places, ridged with terraces. How considerable must have been the volcanic eruption that pumice stone and lapilli! These show where they are exposed in section a uniform character throughout and seem not to have been the work of any subsequent eruption. From the slight degree of decomposition which had taken place in these lapilli, I should imagine they must have been ejected at a comparatively recent date." Clearly the

first two scientists from Europe who traversed the Taupo and Waikato country had no visions of 10,000 years having passed by in the making of river basins and earthquake cracks, such as they encountered this year. The cheery account in the "New Zealand Herald" related above, as to the prospects at Arapuni was not to continue for any length of time. The Arapuni undertaking was ready for operating at the beginning of July, 1929, and juice was supplied to Auckland city amid rejoicings and congratulations. But on August 22, there appeared in the "Dominion" newspaper the following: "Grave trouble at Arapuni." "Heavy erosion at overflow fall." "Rapid wear threatens spillway." "Remedy involves serious alternative."

As already related in the Minister's statement of occurrences at Arapuni on June 7, last, there was at the opening in the previous July cause for congratulation at the accomplishment of so great an undertaking in the island, but now it turned to the story of the "house built upon sand." The caution that had been given by the Public Works Engineer-in-Chief as to Arapuni in 1917, showed that the physical conditions thereabouts called for additional investigation, and he suggested further inquiries as to the possibility of utilising the Kaituna river or the Waikato river at the Aratatia rapids. To the suggestion Mr Parry said that "neither compares favourably with the Arapuni development as regards capital cost per horse power developed **provided, of course, that no abnormal difficulties are encountered.**" And this was, and is, the crux of the whole business. The Arapuni area, embracing the gorge and adjacent ground, contains materials that can only be understood by extending a geological survey for miles to the upper sources of the Waihou (Thames) and its former connection with the Waikato further to the S. East.

It was after the report by Mr Parry giving favourable approval to the Arapuni proposal, provided "no abnormal difficulties are encountered," that the question was referred to the Mines Department for a special geological report. The late Mr P. Morgan was then in charge as director of the geological survey, and Dr Henderson was authorised to make a survey at Arapuni. His report appears in Vol. 1. No 1 of the New Zealand Journal of Science, and

it forms the basis of the special report, No 2, which the Hon. Mr Faverner authorised to be prepared by Messrs Henderson, Marshall, and Bartrum, following the Arapuni catastrophe of June. The report clearly satisfied the authorities that Arapuni offered better advantages than either of the other places suggested.

Since the work began in 1924 over £2,000,000 was spent up to March last year. The final work has been finished by the Public Works, following the abandonment of the contract by Sir W. G. Armstrong Whitworth, Limited.

Many and unexpected difficulties, unanticipated and unthought of by either engineers or geologists have suddenly appeared, showing instability where stability was reported to exist. The percolation of water through the non-consolidated pumice material where uneven bedding exists and where the composition of the beds differs in an unexpected manner, has brought about movements of all the beds in the immediate area of the gorge. In one of the drives near the powerhouse, from which pumice was being tilted into a lorry at the date of my visit on September 9, the pumice was completely saturated with water and showed that all adjacent beds were saturated from causes that in my view can be readily traced.

The conditions existing at the closing down of Arapuni when machinery, bridges, rocks and roadways had suffered remarkable changes, since the work

of hydro-electric production began in July last year, offers the further suggestion whether the surface area in the immediate vicinity of the dam and head race was weakened by the incessant working of the machinery for so long a period. From appearances it would seem that all the upper beds are resting on a saturated base having the qualities of a quicksand. My acquaintance with the country leads me to suppose that the soft volcanic deposits are of great depth and that water passes through them like an underground river or after the manner of flows in an artesian water area like the Heretaunga plains. Whether the surface area in the immediate vicinity of the dam and head-race was weakened by the incessant working of the machinery is suggested for further inquiry. From appearances it would seem that all the upper beds are resting on a saturated base having the qualities of a quicksand. My acquaintance with the country leads me to suppose that the soft volcanic deposits are of great depth and that water passes through them after the manner of flows in artesian beds.

Arapuni has many wounds to be healed and if Professor Hornell can bring things back to normal he will deserve well of this country. Like a good physician he recommends what plans to adopt to remedy existing conditions, and it remains with the officers of the Public Works to carry them out as recommended should the report be adopted by Government.

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