Upgrade of Mangamahoe Dam Spillway

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Introduction

The Mangamahoe Dam is located on the Mangamahoe stream, a tributary of the Waiwhakaiho River, eight kilometres southeast of New Plymouth. The Waiwhakaiho flows through New Plymouth in a fairly deeply incised valley until it reaches the industrial section of Fitzroy, on the eastern extremity of the New Plymouth. Here valley widens out and there are some light industrial buildings within the flood plain. The consent permits up to 7 cubic metres per second to be diverted from the Waiwhakaiho into the reservoir, the 4.4MW power station is located fifteen hundred metres north of the dam where the discharge is returned to the Waiwhakaiho. The dam was constructed as a central concrete core wall supported by earthfill shoulders, 25 metres high and 155 metres long in 1930 and 1931. The dam is considered high potential impact by the criteria in the New Zealand Dam Safety Guidelines.

Design

The ogee crest spillway on the right abutment has a crest length of 30.5 metres and a total freeboard of 2.33 metres to the current crest level. These dimensions give the spillway crest a capacity of 195 cubic metres per second. The chute is concrete lined with 2.1metre high side walls downstream of the headwall. The chute width reduces from 30.5 metres to 3.66 metres within 30 metres of the crest. The diagram below shows the water surface profiles for various floods flowing along the original spillway return channel.

Figure.1 Peak water levels for the existing spillway configuration

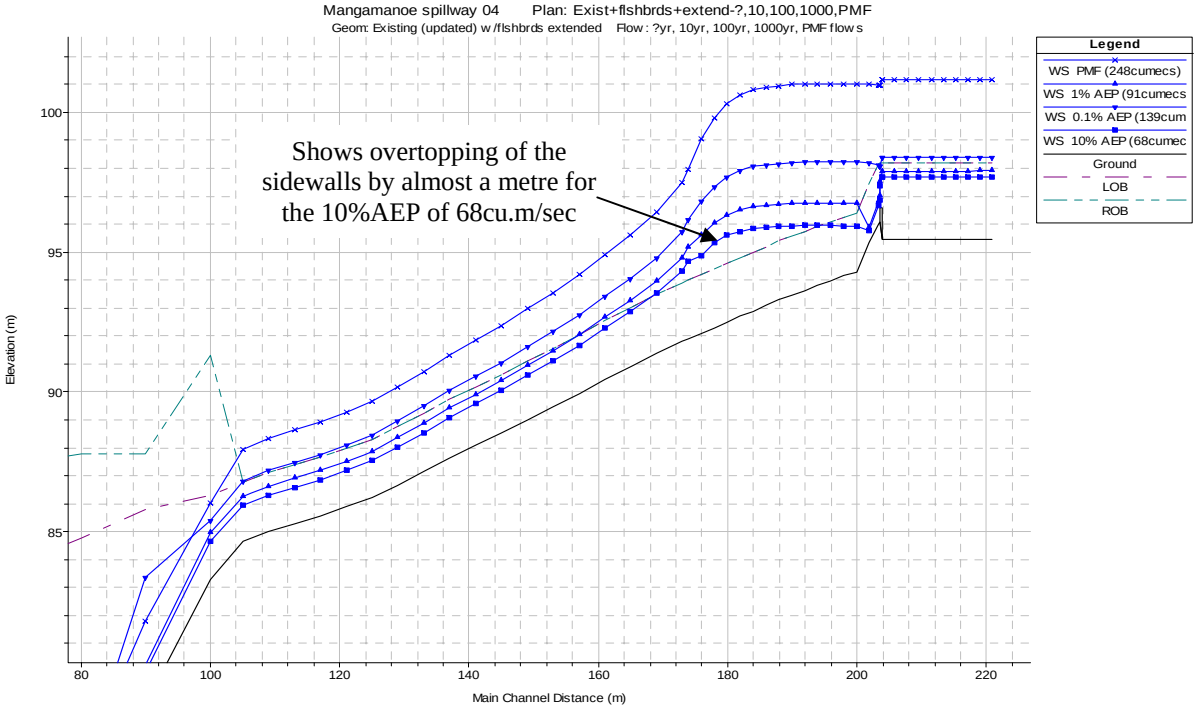
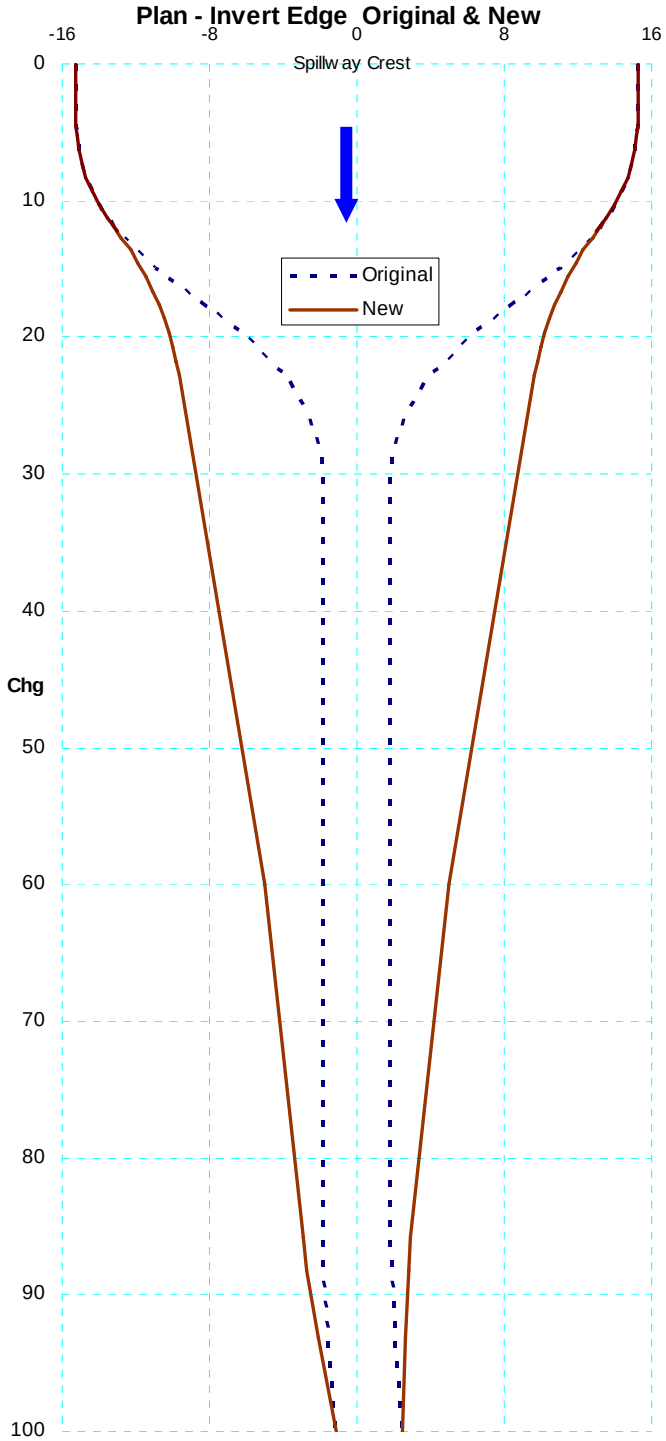


Figure 2 : Modelling of existing spillway

It was estimated that a flow of 40 cubic metres per second would begin to overtop the side walls where it reaches the base width of 3.66 metres. Three options were considered to remedy the problem; widen existing channel, new channel on right abutment and new auxiliary spillway on the saddle dam. The widening of the existing channel was chosen. The principal design criteria for the upgrade was for the spillway chute to contain the 0.1%AEP without overtopping. A significant challenge was flood control during construction as significant lowering of the reservoir was constrained by the need to maintain the city water supply. Analysis of several 100mm in 24 hour rainfall events indicated that the lowered reservoir could contain the resulting inflows

This diagram shows the change to the plan profile of the invert which has been made.



Construction

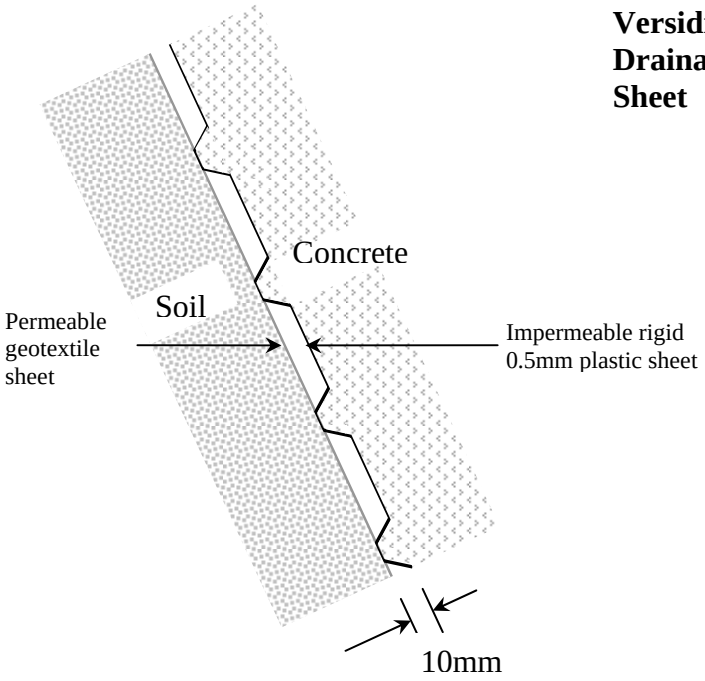
It was interesting to see that the original lining where it was placed against fill had been poured against a dry stone wall which had been placed on the side of the fill. The bulk, 90%, of the sidewall was placed against excavated surfaces and the consistency of thickness was remarkable.

Photo 1 : Demolition of the existing sidewalls

The ash material forming the foundations of the channel was, as predicted by the investigations dry and firm and no special areas of undercutting were required. In order to protect the invert from becoming too soft in the event of rain 50mm of undercut was replaced with drainage material.

Photo 2 : Original Lining removed.

Due to the proximity of the true right side to the steep slope of the right abutment and the potential for uplift along the remainder of the channel it was decided to use a manufactured drainage layer against the sidewalls as shown below.



The shuttering for the side walls which are 2.4 metres long down the slope required some stiff bracing. The top edge and working surface was protected with a sheet of PVC. Perhaps Hessian would have been the material of choice back in 1930.

Photo 3 : Curved sidewall ready to pour

Whitaker Civil Engineering Ltd. completed the project in 10 weeks at the Contract price to very high standards. They were a little lucky in that almost all the rain fell at night and they scarcely lost more than half a day due to weather conditions.

Photo 4 : Only grass planting and hydroseeding remaining

Photo 5 : True right side cut to be hydroseeded.

Photo 5 : True right side cut after hydroseeding.

The spillway is now capable of passing floods of 0.1%AEP with almost no side spillage. The shape and geometry at the downstream end where the curve starts are too complex to model with anything less than a finite element programme or a physical model and given the uncertainties inherent in flood forecasting it was not considered cost effective to carry out either of those options.

Conclusion

A project without direct economic benefit carried out by a responsible private sector utility to reduce risk not only to their asset but to the community at large.

Client	Consultant	Contractor
TrustPower Ltd	Riley Consultants Ltd	Whitaker Civil Engineering Ltd.