OPUHA WATER LTD
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# Board Paper
# June 2014

**Title: Hydro generation option within the Downstream Weir Upgrade**

## Purpose

This paper presents, for consideration of the Board, the proposal to include a hydro generation option within the upgrade of the Downstream Weir.

This hydro proposal is conditional on the progress of the Downstream Weir Upgrade which is the subject of a separate, concurrent Board paper.

This proposal represents a major capital expenditure for the company.

A report outlining the hydro options prepared by the project engineers, Tonkin & Taylor (T&T), accompanies this paper.

## Background

A new spillway structure is proposed for the Downstream Weir to increase the flooding handling capacity and reduce the frequency of the overflow embankment operating.

When options for modifying the weir were considered, it was recognised that building a separate structure as is currently proposed, offered an opportunity to install a small hydro generation facility that would harness much of the energy that is currently dissipated through the throttled release of water through the weir gate into the Opuha River. Preliminary assessments indicated that a facility with a capacity of up to 450kW could be operated at the weir with around 2,000 MWh annual generation.

In conjunction with the development of the design of the new spillway structure, a study was initiated to assess the options and viability for incorporating a hydro facility. It was always considered that the prospect of incorporating a generation facility during construction of the main spillway structure was likely to provide the most cost effective opportunity – compared with subsequently modifying the structure as part of a new project.

Mechanical Technology Ltd (MTL) were engaged to provide specific hydro mechanical and electrical advice for the hydro study. MTL have a track record of developing and installing small to medium hydro installations in New Zealand and off-shore. They are a New Zealand company based in Auckland. Tonkin & Taylor were providing the civil engineering input to the project in their lead role on the spillway development and were retained to manage the hydro study as well.

An early assessment of likely operating conditions, energy yield and plant options for a hydro installation were positive but it was apparent that the economic case was marginal and very sensitive to assumed electricity price as well as construction costs.

Plant supply costs were sought from overseas and locally – there are two manufacturers of hydro plant based in Christchurch (which is both unusual since, globally, hydro plant manufacture tends to be dominated by very large engineering firms with large manufacturing plants, almost exclusively in the northern hemisphere). From this early investigation, it was apparent that the plant from overseas suppliers was generally more expensive and unlikely to be economic.

The two local manufacturers provided quite a contrast in their respective plant offerings – HydroWorks are a high technology firm with specialist capability in the design and manufacture of high end hydro machines. They have been promoting a line of hydro generators suited specifically for installation in irrigation races as they saw a market opportunity within New Zealand. The other supplier, Crosstech, specialise in the design and construction of a relatively low technology type of hydro turbine. They have supplied a number of turbines into the irrigation and farming industry in New Zealand both for electricity generation as well as direct pumping. There is one of their small units in operation within the Kakahu scheme where the Crosstech turbine utilises pressurised water from the main Kakahu pipeline to drive a pump that supplies high pressure water suitable for spray irrigation.

In May this year, a one day workshop was convened with all the key participants involved (OWL, T&T and MTL) to try and identify the best hydro option. The workshop included presentations from HydroWorks and Crosstech. One of the key issues to come out of the workshop was the perceived technology risk associated with the HydroWorks plant. While the proposed plant uses established hydro design concepts, the proposed plant would be the first to be manufactured by HydroWorks and includes some key aspects of the proposed powertrain that, while not radical in design, do introduce some uncertainty. HydroWorks are aware of these concerns and have addressed this by undertaking to have an exchangeable spare unit available to minimise any downtime associated with an unplanned problem or failure. The Crosstech unit, on the other hand, is proven and robust – albeit that a unit of the size proposed has not be built by Crosstech to date.

As a result of the workshop, we have revisited one of the overseas supply options for plant very similar to the Crosstech proposal, but offering a larger size unit than Crosstech can supply. These machines from Ossberger of Germany are renowned for their ruggedness and reliability. Their performance and cost fall between the two local offerings.

The accompanying report from Tonkin & Taylor presents the outcome of the hydro study where the three plant options have been considered.

The economic assessment of the three options is reasonably close even though they each provide reasonably different propositions. As indicated in the T&T report, selection of an option requires a trade-off of capacity, O&M ‘risk’ and preference for local manufacture.

## Economic Assessment

It has always been considered that the hydro development option needed to ‘stand on its own’ as far as economic merit. There are some cost ‘savings’ for the hydro proposal that arise from potentially carrying out the installation concurrent with the construction of the new spillway structure. These are essentially the project ‘overheads’ associated with the establishment and mobilisation of the site construction works, including isolation (dewatering) of the works site, and the fact that construction of the hydro facility would only require ‘incremental’ civil works for, for instance, excavation through the main embankment.

In assessing the hydro option, it is only the incremental costs that have been attributed to the proposal with the ‘overhead’ costs that would be incurred already for the spillway construction, being attributed to that project. We have not carried out an assessment of the likely cost of doing the hydro installation, from scratch, at a later date as this would almost certainly be uneconomic due to the additional project and civil costs involved.

The economic assessment has required quantification of several key operational parameters – namely flow rate and head available to determine the likely generation output – as well as confirmation of costs of main plant and equipment and construction. Revenue is also critically dependent on assumed future electricity price.

The T&T report details the basis for derivation of most of these parameters and identifies that the flow records from recent years provide a better economic result than the long term average.

The assumptions around future electricity price are quite subjective. No specific investigation or analysis has been carried out to derive an electricity price as it was felt there is a reasonable understanding of this aspect of the market within Opuha already. Initially a reasonably conservative figure of $65/MWh was used in the analysis and, more recently a base case figure of $80/MWh has been used. The results of the analysis using these assumptions is presented in the T&T report. Additional to the generation revenue is the transmission rebate that is available to generators embedded within a local distribution network that is referred to as ACOT payments (Avoided Cost Of Transmission). OWL already benefit from this with the main generator. These benefits would be available for this new facility (potentially $30k per annum) however there are a couple of aspects to be taken into account. Firstly, the Electricity Commission is investigating alternative transmission pricing regimes that would eliminate ACOT payments. OWL is part of a national group that is actively opposing these changes. Secondly, the arrangement we have with Alpine Energy for ACOT payments for the main power station has been derived as a result of the negotiations over their transmission charging whereby we share the ACOT payments 50/50 with Alpine Energy. I do not think this arrangement should be extended to this new installation and we should get 100% in this case, however I have not canvassed Alpine Energy specifically on it. Finally, the amount of ACOT payments in any year depend on the plant performance in the previous year and relies on the plant actually generating during the highest peak periods. Given that the new plant is expected to be operating with very high plant factor (water is released from the weir continuously), it is reasonable to assume that the facility would 'score' with the ACOT process.

These ACOT payments have not been included in the economic assessment to date and as presented in the T&T report. An update of the economic results, accounting for the potential ACOT payments is presented below.

**Economic Assessment – Summary Table**

| | Ossberger | Crosstech | HydroWorks |
|---|---|---|---|
| **As Reported** | | | |
| IRR (35 years) | 8.1% | 8.3% | 8.6% |
| Payback period | 11.2 yr | 11.2 yr | 10.3 yr |
| **Incl. Annual ACOT Payment** | $30,000 | $20,000 | $30,000 |
| IRR (35 years) | 9.8% | 10.0% | 10.3% |
| Payback Period | 9.5 yr | 9.6 yr | 8.9 yr |

OWL has not established economic parameters or 'hurdles' for investment decision making. In the absence of agreed parameters, I suggest a reasonable default is an IRR at our cost of capital – or probably our incremental or new cost of capital. At present our weighted average cost of capital (WACC) is approximately 8.15%. Our current cost of new borrowing is less than this at approximately 4.7%. On this basis, the hydro proposal is a viable option for Opuha.

Each of the options are sensitive to variability in assumed costs and revenues and the table in section 3.2 of the T&T report indicate the results of sensitivities to electricity price, project costs and future flow availability. The HydroWorks proposal is more sensitive to electricity price assumptions (this can be both upside and downside risk). The Ossberger is considered to have the lower project cost and performance variation risk because it is very mature technology.

## Discussion

The three options considered each have differentiating features. On face value, the economic assessment results would suggest that the HydroWorks option is the better investment. The tubular Kaplan turbine proposed by HydroWorks is more efficient than the crossflow machines and will yield more energy on an instantaneous and long term basis. There is, however, concern about the level of complexity and new technology that is inherent in the HydroWorks proposal. The DSW hydro installation is by no means our 'main-game-in-town' – OWL is principally an irrigation company with hydro generation interests. The location of the plant is reasonably remote and access is not straightforward so I believe the selection of a high reliability, low maintenance option is important. HydroWorks are aware of our sensitivity to this and have offered the 100% available spare unit that could, supposedly, be exchanged within a day in the event of an unforeseen plant breakdown. There remains however, a much higher level of dependence on on-going, external specialist technical support for this installation. Eventually (post-'warranty'), TrustPower could provide a reasonable level of support in conjunction with the main power station, however the project cannot tolerate a very high O&M cost.

The Crosstech machines are manufactured in Christchurch. The company is a one person entity (Graeme Martin) which introduces some risk as far as on-going support being reliant on Graeme's availability. Graeme designs and manufactures turbines himself (he is a very clever man!) and has a number of units in service within Canterbury. The largest machine he has built is operating within the Mayfield Hinds scheme and generates approximately 200kW. Graeme has indicated that unit he has proposed for Opuha is the largest he would be comfortable in building (the limitation being the length of the turbine rotor). Apart from the custom built turbine, the Crosstech installation utilises very standard equipment (gearbox, generator, auxiliary equipment). The low technology nature of the main equipment and use of standard ancillary equipment, does help to mitigate the risk of reliance on Graeme himself for support and service. The Crosstech machine does have a lower efficiency that the other plant offered, even though it is fundamentally the same as the Ossberger. This is because the Ossberger incorporates a secondary level of flow regulation and control that improves the efficiency at low loads. Graeme has indicated that he would spend some time looking to improve the efficiency of his unit through refinement of the flow control valve, but that he would not be willing to incorporate a secondary flow regulation like the Ossberger design because of the risk to reliability.

The Ossberger is a well proven design and the machines have a reputation globally for robustness and reliability. The efficiency is lower than can be achieved with the Kaplan design of HydroWorks which is ideally suited to situations where both head and flow can vary. The Ossberger does incorporate a secondary flow regulation arrangement that helps to improve the efficiency across the operating range. I have visited an Ossberger installation in Canterbury and discussed the operation with the owner. His comments are consistent with other references – excellent reliability and low maintenance. The overseas (European) supply results in a cost premium, with the Ossberger costs very similar to the HydroWorks proposal even though the generation is estimated to be approximately 13% lower. The lower on-going O&M costs improve the overall economics of the lower efficiency Ossberger. It is over

twelve months since we received the proposal from Ossberger and we have recently lodged another enquiry to confirm prices and performance based on the current design parameters.

## Conclusion and Recommendation

Three options for a mini hydro generation facility at the downstream weir have been investigated. The three options each have different attributes and features and offer varying degrees of uncertainty at this project evaluation stage. Two are local manufacture but each represent quite different levels of maturity as far as technology and performance.

The high technology proposal from HydroWorks provides the best business case with its higher efficiency and higher output however it is considered to have some uncertainty and risk regarding reliability and on-going O&M requirements. This is a subjective view that will be challenged by HydroWorks.

The Crosstech machine is recognised as very robust, low-technology which offers a reliable, low capital and O&M cost option. The fact that the turbine is designed and built by a one-person company does introduce some concern over future support but this is substantially off-set by our confidence in managing the low technology equipment. The proposal is limited in size of the turbine and therefore does not harness as much energy as the other options that are not size constrained.

The Ossberger machine is proven technology and provides a high degree of confidence in performance and future O&M requirements. The fundamental design does not provide the same efficiency that can be obtained through alternative designs, but this efficiency penalty is offset to some degree by the lower operating costs.

For either of the crossflow machines (Crosstech and Ossberger) I would propose that we undertake a more detailed optimisation to identify the best unit size/model for the DSW application. It is recommended that a hydro generation option be incorporated into the upgrade of the downstream weir.

Given the nature of Opuha Water's business and the location of the proposed installation, a high reliability, proven technology option is preferred and, on this basis, the Ossberger option is recommended.

## Recommendation

I recommend that that the Board approve the development of a hydro proposal in the downstream weir upgrade.

It is further recommended that the Ossberger option be considered as the best option with a total project cost of $1.85m.

Tony McCormick
Chief Executive
24th June 2014

**Attached**

1. Report from Tonkin & Taylor on hydrogenation opportunity.