Waimea Water Augmentation Committee

Financial and Economic Assessment of Water Augmentation in the Waimea Catchment

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Northington Partners
INVESTMENT BANKERS

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1.0 INTRODUCTION

In 2007 Tonkin & Taylor Ltd and its sub-consultants completed a Phase 1 pre-feasibility evaluation of a number of options to provide water storage for long-term irrigation and community supplies in the Waimea Basin area of the Tasman District. The evaluation was undertaken on behalf of the Waimea Water Augmentation Committee ("**WWAC**"). The overall principle of the study was to identify and develop a water augmentation scheme to capture excess water for storage, with water released back into the Waimea River system during periods of high water demand and/or low natural water flows to augment those supplies, either directly or via recharging of the groundwater system.

The outcome of that Phase 1 study was to focus feasibility investigations on a water storage dam and reservoir site located in the upper Lee River catchment, a tributary of the Waimea River.

In 2007 WWAC initiated Phase 2 of the study, to take the Lee investigation programme to a feasibility level. Northington Partners Limited ("**Northington Partners**") has been engaged to provide a preliminary financial and economic assessment of the identified water storage option. The overall objective of the analysis summarised in this report is to assess the high-level economic feasibility of the proposed development on the basis of the following three factors:

- **Capital Cost of Augmentation** The capital cost of the proposed augmentation option is estimated on a per hectare basis. Using some standard assumptions for scheme funding and the repayment period, total capital costs are also expressed as an equivalent annual charge per hectare. Costs expressed on this basis can be used as a convenient benchmark for assessing the affordability of the proposed scheme.

- **Cost Benefit Analysis for Irrigation Users** Water resources on the Waimea Plains are currently over-allocated. Without an investment in storage for augmentation, both the current volume of allocation and security of the allocation for existing water users will continue to be threatened and new users' water demands will be unable to be accommodated. There is also the potential that a minimum flow requirement could be imposed for the Waimea River system under the Resource Management Act (RMA), either through the Tasman Resource Management Plan process (and associated decisions including (potentially) courts of law), or through the imposition of a national environmental standard. Accordingly, for the purposes of this assessment, we have assumed that irrespective of whether or not the scheme goes ahead, there is a requirement to maintain a minimum flow of 1,100 l/sec in the Waimea River at the Appleby Bridge (based on recent ecological assessments undertaken by Cawthron Institute for WWAC). This would result in existing users either having their allocations cut back or being subject to more frequent rationing. A high level assessment has therefore been undertaken of the effect on water users under both of these scenarios. The financial impact of the restrictions can be compared directly to the indicative charges levied to irrigators to determine whether their investment in the scheme is financially worthwhile.

- **Regional Impact of Non-Augmentation** If the scheme does not proceed, the regional economic impacts will be twofold. Restrictions on access to water will reduce aggregate agricultural and horticultural output from the catchment area, not only from existing irrigators but also from the adjoining dryland areas that could potentially be serviced by the scheme. The security of the current urban water supply may also be affected. In addition, the region will be affected by the 'lost opportunity' cost associated with the inability to meet future demand from urban and industrial uses that is currently allowed for in the scheme design.

Water demand and the required dam storage volume has to date been estimated on the basis of "hectare equivalents", with the benchmark based on demand for pasture production with an assumed irrigation requirement of 30 mm/wk (300 m^3/ha/wk). This standardisation process takes account of the differing water volumes required for different land uses, as well as allowing the demand for future urban and industrial uses to be expressed on a consistent basis with irrigation demand.

The assumed area equivalents for this stage of the analysis are set out below. The areas have been determined as part of a consultative process by the WWAC Committee, with the initial goal of "future-proofing" the development by providing for a significant amount of water demand that may arise as far as 50-100 years into the future.

Table 1: Assumed Water Demand

Water Demand Component	Gross Area (Hectares)	Area Equiv. (Hectares)
Existing Irrigation Area – Waimea Plains	3,800	3,800
Potential New Irrigation Area – Waimea Plains	1,500	1,500
Potential New Irrigation Area – Wai-iti	300	300
Potential New Irrigation Area - Rabbit Island	250	250
Existing TDC Urban and Industrial Use	NA	620
Allowance for Future TDC Urban and Industrial Use (100 Yr Horizon)	NA	780
Allowance for Future Regional Supply	NA	515
Total	**5,850**	**7,765**

As with the pre-feasibility analysis, indicative capital costs are allocated between potential users on the basis of the estimated number of area equivalents. As the investigations continue and more accurate data are available, the indicative costs for prospective users should be estimated on a basis more in line with the likely charging regime.

2.0 FINANCIAL ASSESSMENT OF PROPOSED AUGMENTATION OPTION

2.1 INTRODUCTION

This section assesses the indicative costs for water users under a range of assumptions:

(i) The "Design Base Case" assumes the construction of a water supply reservoir with a storage volume of approximately 13 million m^3, and considers annual costs under various scenarios related to the assumed number of water users (expressed as hectare equivalents);

(ii) We assess the impact on the indicative costs to water users if provision is incorporated in the scheme for hydro-power (as well as water supply);

(iii) We also assess the impact on the indicative costs to water users if reductions are made to the reservoir storage volume on the basis that the scheme is redesigned to service a smaller number of hectare equivalents.

2.2 INDICATIVE COSTS FOR WATER USERS – DESIGN BASE CASE RESULTS

Indicative charges for prospective users of the augmentation scheme have been determined using a series of high level assumptions. Key assumptions for the "Design Base Case" are outlined in Table 2.

Table 2: Design Base Case Assumptions for Economic Analysis

Assumption Name	Discussion	Adopted Value
Total Capital Cost	Cost estimates provided by Tonkin and Taylor and WWAC. The adopted value includes: • design and construction of the dam and associated structures ($38.1 million) • an allowance for land purchase and access replacement ($2 million) • environmental mitigation package ($1 million), • obtaining resource consents ($0.5 million). Excludes any costs associated with piped delivery from dam or any other water distribution infrastructure. For any given percentage change in capital costs, the indicative annual charges will change by about the same percentage amount.	$41,600,000
Construction Period	The assumed period between the commencement of construction and the commissioning of the scheme. Total construction cost is assumed to be evenly spread over the full period.	2 Years

Table 2 (Continued): Design Base Case Assumptions for Economic Analysis

Assumption Name	Discussion	Adopted Value
Funding Method and Cost	Funding period set equal to the initial consent period for the dam, assumed to be 25 years. Because the maximum permissible consent period under the RMA is 35 years, the choice of a 25 year repayment period can be considered conservative. Interest cost is set equal to the assumed long-term cost of TDC borrowing.	7.2%
Taxation Treatment	We assume that the assets are owned by a separate tax paying entity subject to the standard corporate tax regime. Revenue is derived from annual payments paid by scheme participants, and the tax liability is partially reduced by the standard depreciation claim. Tax losses at the beginning of the repayment period are carried forward and utilised toward the end of the period when the irrigation entity generates positive taxable income.	
Operating Costs	Based on a preliminary estimate of $400k per annum, representing $300k for repairs and maintenance and $100k for scheme administration. The operating charge per hectare decreases as the area assumed to be serviced by the scheme increases.	$400,000
Cost Allocation for Environmental Flows	As discussed below	30%

The assessment of the cost allocation between consumptive uses (irrigation, urban, and industrial users) and non-consumptive uses (environmental flows) is multi-faceted and subject to a number of fundamental assumptions, including the adopted baseline situation, relative priorities and the design drought standard. In this study, results of hydrological modelling undertaken by Tonkin and Taylor have been used to provide an indication of a reasonable split between abstractive and in-stream requirements. The estimate is based on the following considerations:

- that the assumed base case for provision of a minimum in-stream environmental flow (as measured at Appleby Bridge) is 600 ℓ/sec; incorporation of this scenario in the reservoir storage modelling indicates a storage requirement of approximately 8.2 million m^3 based on meeting unrestricted demand in the design drought;

- WWAC has elected to provide an enhanced in-stream environmental flow (as measured at Appleby Bridge) of 1100ℓ/sec; incorporation of this scenario in the reservoir storage modelling indicates a storage requirement of approximately 12 million m^3 (live storage only) based on meeting unrestricted demand in the design drought.

Therefore, the incremental storage capacity required for environmental flow reasons is 3.8 million m^3, which is equivalent to approximately 30% of the overall live storage volume.

Indicative charges are expressed on the basis of total capital cost per hectare as well as an equivalent annual charge per hectare. Initially, estimates have been determined for the following three charging scenarios:

(i) **Scenario 1: User Base Case** Costs are assumed to be met by existing irrigators, the TDC (for both its present and future consumptive demand), as well as other land owners who are within the "Zone of Effect[1]" who do not currently have a water permit. The total User Base Case area therefore consists of current irrigators (3,800 ha), the un-irrigated area within the Zone of Effect (in the order of 475 ha out of the 1,500 ha on the Waimea Plains), existing TDC urban and industrial use (620 ha), and the allowance for future TDC urban and industrial use (780 ha). This is the area equivalent of 5,675 hectares.

(ii) **Scenario 2: User Base Case Plus Future Regional Supply** All costs are met by User Base Case consumptive water users (5,675 hectares) and the entity responsible for future regional supply (515 ha). Total effective demand equals 6,190 hectares.

(iii) **Scenario 3: All Potential Users** Annual charges are estimated on the basis that the capital cost is evenly allocated among all users listed in Table 1. Total effective demand equals 7,765 hectares.

Assuming 70% of total cost is met by consumptive users, the indicative capital costs and annual charges for each of the three scenarios are as presented in Table 3. Note that Table 3 presents two options for Charges to Irrigators – either a one-off payment (Capital Cost per Hectare plus an Annual Operating Charge) or an overall Annual Charge (Fixed and Operating).

Table 3: Indicative Annual Costs for Design Base Case Scenarios

	Scenario 1 User Base Case	Scenario 2 User Base Case + Future Regional Supply	Scenario 3 All Potential Users
Effective Hectares	5,675	6,190	7,765
Charges to Irrigators (Option 1)			
Capital Cost per Hectare[1]	$5,130	$4,700	$3,750
Annual Operating Charges	$70	$65	$50
Charges to Irrigators (Per Hectare per Year) (Option 2)			
Annual Fixed Charge	$510	$465	$370
Annual Operating Charges	$70	$65	$50
Total Annual Charges (Pre-tax)	$580	$530	$420
Community Charges (Total Annual Charge)			
Environmental Flow ($000)	$1,090	$1,090	$1,090
TDC – Current and Future Urban / Industrial ($000)	$810	$745	$590
Future Regional Supply ($000)	-	$275	$220
Total Annual Charges ($000)	$1,900	$2,110	$1,900

[1] The capital cost per hectare represents the one-off cost to water users who choose to pay all capital charges in an upfront lump sum instead of making annual payments. Users choosing to pay on this basis will still be required to pay the Annual Operating Charge.

[1] The Zone of Effect is defined by Fenemor and Bealing (2009) as the area that comprises the parts of the aquifers where (i) increased river flow is predicted to raise the water table or piezometric levels of the aquifers during a design drought year; or (ii) which already have adequate well yields even if the water table is not projected to rise; or (iii) which have adequate reticulation to supply part of the projected water demand for other schemes (e.g. Waimea East and Redwoods Valley).

These results can be interpreted in a number of ways when attempting to determine the high-level feasibility of the scheme. Perhaps the most useful result to concentrate on is the estimated annual charge per hectare; this provides the cost benchmark against which to compare the economic benefit that water users will derive from access to a reliable water source.

While the average benefits of irrigation are reflected to some degree by the opportunity cost analysis summarised in Section 3.0, we suggest that some caution should be exercised when interpreting these results. Irrigation benefits can vary considerably from property to property on the basis of land use, soil type, and the intensity of the adopted farming system. It is also very difficult to fully incorporate into this analysis one of the main advantages of irrigation relating to the large reductions in year to year production variability. The economic feasibility of the scheme is ultimately a judgement for each potential scheme participant based on their evaluation of the indicative scheme costs compared to the overall benefits of the scheme.

Cost per hectare for consumptive users obviously decreases as the costs are spread over a larger area. The indicative charges are significantly lower if all potential users are part of the scheme from day one; i.e. a reduction from $580 to $420 per hectare per year. Factors that may affect whether potential users will join the scheme (particularly under Scenario 3), and the implications of varying uptake are as follows:

- Delivery of water to irrigable areas outside of the Zone of Effect will require a substantial investment in distribution infrastructure. Landcare Research and Agfirst have prepared a pre-feasibility design of a reticulation system to service approximately 1,275 hectares outside of the Zone of Effect (see accompanying report “Enhancing Water Distribution from the Waimea Water Augmentation Project”);

- The average capital cost per hectare for distribution (estimated by Landcare / Agfirst) is approximately $4,700. If the new potential irrigators beyond the Zone of Effect are charged for the full costs of both the scheme and distribution infrastructure, the overall capital cost to those users would be more than double the capital costs to those irrigators within the Zone of Effect. Assuming that the investment in distribution infrastructure is funded on the same basis as the scheme itself, total annual costs for the potential irrigators outside of the Zone of Effect would be in the vicinity of $830 per hectare (in the best case scenario where all potential users join the scheme)[2], although this will vary depending on which distribution systems are implemented;

- At least some of the current landowners could regard these charges as too expensive and may elect not to join the scheme. If some of these potential users do not join the scheme, the capital and on-going servicing costs for the remaining potential users will increase commensurately; in the worst case scenario where all of the potential new irrigators outside of the Zone of Effect withdraw, the indicative annual charge would increase from $420 per hectare to $530 per hectare (as represented by Scenario 2 in Table 3 above).

It is therefore in the best interests of all prospective users to ensure that the pool of participants is as large as possible. On the assumption that a large number of the potential irrigators outside of the Zone of Effect may not join the scheme if they are charged the full allocation for the scheme capital costs (as well as reticulation costs), we suggest that some discount is considered in order to encourage greater uptake. Table 4 sets out two additional scenarios in which we assume the new irrigators outside of the Zone of Effect[3] are charged either 25% (Scenario 2a) or 50% (Scenario 2b) of the pro-rata capital cost of the scheme.

[2] The $830 / hectare estimate is based on the estimated cost of $420 per hectare for scheme charges (under Scenario 3) plus an estimated annual charge of $410 per hectare to service the $4,700 cost of the distribution infrastructure.

[3] This area amounts to 1,575 hectares, determined by subtracting the 475 hectares currently unirrigated but within the Zone of Effect from the total of 2,050 hectares of potentially irrigable land that can be serviced by the scheme.

Table 4: Indicative Annual Costs for Partial Contributions by Users

	Scenario 2 User Base Case + Future Regional Supply	Scenario 2a User Base Case + Future Regional Supply + New Irrigators (25%)	Scenario 2b User Base Case + Future Regional Supply + New Irrigators (50%)	Scenario 3 All Potential Users
Effective Hectares	6,190	6,585[1]	6,980[1]	7,765
Charges to Irrigators (Option 1)				
Capital Cost per Hectare (one-off payment)	$4,700	$4,420	$4,170	$3,750
Annual Operating Charges	$65	$60	$55	$50
Charges to Irrigators (Per ha/yr) (Option 2)				
Annual Fixed Charge	$465	$440	$415	$370
Annual Operating Charges	$65	$60	$55	$50
Total Annual Charges (Pre-tax)	$530	$500	$470	$420
Community Charges (Annual)				
Environmental Flow ($000)	$1,090	$1,090	$1,090	$1,090
TDC – Current and Future Urban / Industrial ($000)	$745	$700	$660	$590
Future Regional Supply ($000)	$275	$255	$240	$220
Total Annual Charges ($000)	$2,110	$2,045	$1,990	$1,900

[1] If all potential new irrigators outside of the Zone of Effect (1,575 equivalent hectares) pay 25% of the capital cost, the effect on the cost estimates is equivalent to the outcome for a scenario in which 25% of the potential irrigation users pay the full charge. We have modelled these scenarios using the latter approach; equivalent hectares for Scenario 2a is calculated as 6,190 + (25% * 1,575) = 6,585 and for Scenario 2b as 6,190 + (50% * 1,575) = 6,980 (both rounded).

For clarity, we note that the results should be interpreted as follows:

- The indicative costs listed in Table 4 for irrigators apply for users **within** the Zone of Effect. That is, these users would pay total annual charges of $500 per hectare per year under Scenario 2a and $470 per hectare per year under Scenario 2b;

- Indicative charges for new irrigators **outside** of the Zone of Effect would be either 25% (ie $125 for Scenario 2a) or 50% (ie $250 for Scenario 2a) of this total cost. As well as the indicated scheme charges, irrigators outside of the Zone of Effect would have to pay for the distribution infrastructure needed to service their properties.

We also note that numerous other cost allocation scenarios may be considered before the final charging regime is adopted. For example, it may be argued that it is equitable for those potential irrigators within the Zone of Effect who currently do not hold water permits to be charged a premium over the charges levied to existing permit holders within the Zone of Effect. If this framework were implemented, the indicative annual charges for existing irrigators would be lower than those presented above. However, given the relative areas within the Zone of Effect (3,800 equivalent hectares for existing irrigators versus 475 equivalent hectares for potential new irrigators), the magnitude of any potential reduction is unlikely to be material.

These scenarios predictably provide indicative annual charges for users within the Zone of Effect that fall between the results reported for Scenario 2 and Scenario 3. Given that it is not currently known how many potential irrigators outside of the Zone of Effect may join the scheme, we suggest that the indicative annual charge for Scenario 2b provides a more realistic basis on which all potential users within the Zone of Effect can assess the feasibility of the scheme.

2.3 IMPACT OF HYDRO POWER DEVELOPMENT

The proposed augmentation scheme potentially includes a small-scale hydro electric generation plant. A high level assessment of the optimal hydro scheme design has been provided by Tonkin and Taylor, along with an estimate of initial capital costs ($4.25 million), generation capacity (approximately 1MW) and future projections for net revenue. Based on this preliminary information, we estimate that the realisable value of the hydro scheme when completed will be approximately $2.2 million - $3.5 million. This value is based on current expectations for future wholesale electricity prices and is therefore sensitive to any changes to output prices that may take place over the assumed five year period before the plant is commissioned.

In order to establish the indicative impact that the hydro development may have on annual charges for all prospective scheme users, we assume that the hydro opportunity is sold to a third-party as soon as the scheme is completed. We also assume that proceeds from the sale are used to reduce the effective capital cost that must be funded by all scheme users. The results presented in Table 3 and Table 4 are replicated below in Table 5 after reducing the estimated capital costs by the indicative $2.85 million mid-point value of the hydro plant.

Indicative annual charges for irrigation users reduce by between $25 and $30 per hectare compared to the Design Base Case scenario summarised in the previous section. While this estimated cost reduction is certainly non-trivial, we suggest that the potential hydro development is unlikely to materially affect the overall feasibility assessment of the augmentation scheme.

Table 5: Indicative Annual Costs Accounting for the Value of the Hydro Scheme

	Scenario 1 User Base Case	Scenario 2 User Base Case + Future Regional Supply	Scenario 2a User Base Case + Future Regional Supply + New Irrigators (25%)	Scenario 2b User Base Case + Future Regional Supply + New Irrigators (50%)	Scenario 3 All Potential Users
Effective Hectares	5,675	6,190	6,585	6,980	7,765
Capital Cost per Hectare	$4,780	$4,380	$4,120	$3,890	$3,490
Charges to Irrigators (Per ha/yr)					
Annual Fixed Charge	$475	$435	$410	$385	$345
Annual Operating Charges	$70	$65	$60	$55	$50
Total Annual Charges (Pre-tax)	$545	$500	$470	$440	$395
Community Charges (Annual)					
Environmental Flow ($000)	$1,020	$1,020	$1,020	$1,020	$1,020
TDC Urban / Industrial ($000)	$760	$700	$655	$620	$555
Future Regional Supply ($000)	$0	$255	$240	$230	$205
Total Annual Charges ($000)	$1,780	$1,975	$1,915	$1,870	$1,780

2.4 IMPACT OF VARIATIONS TO SCHEME DESIGN

The indicative total capital costs and annual charges presented in Section 2.1 for the Design Base Case are higher than those generated in the Phase I study. WWAC has therefore requested a high level investigation of the potential cost savings that may be possible if a number of scheme variations are implemented. The variations considered are summarised in Table 6 based on information provided by Tonkin and Taylor (memorandum dated 4 December 2009, attached as Appendix G to the accompanying Engineering Feasibility Report)-. These are compared with the costs for the assumed Design Base Case.

Table 6: Possible Variations to Scheme Design and Associated Cost Saving

Variation		Discussion	Assumed Reduction in Capital Cost
1	Reduction in Construction Culverts	The Design Base Case allows for the provision of 3 diversion culverts during construction of the storage dam. It is possible that the construction could be completed with 2 culverts (subject to further engineering investigation).	$2.6 million
2	No Allowance for Future Regional Supply	The base case allowance for future regional supply (515 hectare equivalents) requires an increase in storage volume of 2.12 million cubic metres. Given uncertainty over who will pay for this additional storage, current users will pay less for the scheme in some circumstances if this potential demand is not incorporated into the scheme design, and the dam height and size is reduced commensurately.	$2.9 million
3	Reduced Allowance for New Irrigation	The base case dam design allows for sufficient volume to potentially irrigate an additional 2,050 hectares. This variation considers the potential reduction in total capital costs if the required reservoir volume is reduced by the storage required for 1,500 hectares; this equates to a further 2.1 million cubic metres over and above the removal of the future regional supply[4]., and may be considered if WWAC determines that the uptake outside of the Zone of Effect is likely to be insufficient.	$2.0 million

With all else being equal, reductions in total capital costs result in the same proportional decrease in the annual fixed charges for the scheme[5]. That means that the potential reduction in annual charges resulting from a reduction in construction culverts will be approximately 6.25% ($2.6m / $41.6m) of the base case annual charges. This reduction will apply across all five of the potential usage scenarios, as summarised in Table 7.

[4] The order in which the water demand components are removed has an effect on the live storage reduction attached to that particular component. In the case of Variations 2 and 3 therefore, the reduction in storage volume is (coincidentally) similar despite the difference in hectares.

[5] The reduction in total estimated charges (annual fixed charge plus operating charges) is slightly lower than the percentage decrease in capital costs because the estimated operating charges do not vary with capital costs.

Table 7: Indicative Annual Costs – Design Base Case and Variation 1 (Two Culverts During Construction)

	Scenario 1 User Base Case	Scenario 2 User Base Case + Future Regional Supply	Scenario 2a User Base Case + Future Regional Supply + New Irrigators (25%)	Scenario 2b User Base Case + Future Regional Supply + New Irrigators (50%)	Scenario 3 All Potential Users
Design Base Case - Annual Charges	$580	$530	$500	$470	$420
Variation 1 – Annual Charges	$545	$500	$470	$445	$400
Potential Annual Reduction (Per ha)	$35	$30	$30	$25	$20

The potential impact of the variations relating to storage volume and therefore size of the dam cannot be analysed in the same way because these variations affect the maximum number of potential users of the scheme. Thus, while aggregate capital costs may be reduced by each variation, the annual charge per user per hectare is also affected by the number of users who potentially contribute to meeting the costs of the scheme.

In the case of Variation 2 which eliminates the allowance for future regional demand, the cost-benefit analysis for the User Base Case is straight forward; Base Case Users are only better off under this variation if the pro-rata costs of providing the additional storage were not funded by a third party (i.e. the charges associated with the 515 hectare equivalents are not paid by an appropriate local authority[6]). This outcome arises as follows:

- The capital cost saving of $2.9 million requires the sacrifice of 515 hectare equivalents in terms of the maximum command area (and number of potential hectare equivalents) for the entire scheme;
- This equates to a total capital cost of $5,630 per hectare equivalent, of which $3,940 is allocated to consumptive users (based on the 30% / 70% allocation to environmental and consumptive uses, respectively);
- No matter how many other users join the scheme, the cost reduction per equivalent hectare of $3,940 is almost always lower than the average cost per hectare assuming that the allowance for future regional supply is eliminated[7];
- All other potential users of the scheme (existing irrigators, potential new irrigators, and the TDC) are therefore better off by the inclusion of the future regional supply because the incremental cost of meeting this demand lowers the average cost per hectare for the whole scheme (assuming a third party funds the additional storage). Annual average charges to consumptive users are consequently lower as well.

In order to analyse the incremental impact of reducing dam volume for irrigation purposes (with no other changes), we assume that the capital cost saving is also $2.9 million. This is higher than the $2.0 million estimate included in Table 6, but reflects the likely cost saving if the storage volume is only reduced for the

[6] This relates to Scenario 1 of the Design Base Case, where all costs of the scheme are paid for by the User Base Case (irrigators and TDC) with no contribution from the entity that has the potential use of the future regional supply.

[7] The average capital cost per hectare is slightly lower when the future regional supply is eliminated and all other potential users join the scheme. However, the annual charges per hectare are virtually the same under both scenarios.

1,500 hectares of irrigation. That is, we assess the incremental impact on costs of reducing the storage volume for irrigation assuming that the volume requirements for future regional supply are still met.

Table 8 sets out some summary costs comparing the indicative annual charges under the Design Base Case with those assuming the implementation of Variation 3. The usage scenarios are obviously not consistent in both cases because Variation 3 involves the elimination of 1,500 hectares of potential demand. Under this case, Scenario 2a, Scenario 2b, and Scenario 3 are all the same and simply assume that a total of 550 hectare equivalents of new irrigable area are serviced. This is based on a total of 2,050 hectares of new potential irrigation as assumed in the Design Base Case, less the 1,500 hectares of storage volume that is eliminated under this variation.

When compared to the Design Base Case, the outcomes are straight forward:

- In scenarios where the assumed contribution from new irrigation users is low or non-existent (Scenario 1, Scenario 2, and Scenario 2a), the indicative annual charges for existing users will be lower if the storage volume for 1,500 hectare equivalents is eliminated. If the storage volumes are not reduced, existing users will effectively pay for the cost of providing significant volume that may not be taken up;

- The incremental cost of the additional storage volume is worthwhile from the existing users' point of view if the additional volume is paid for by new users. This conclusion is based on the fact that the indicative annual charges under Scenario 2b and Scenario 3 of the Design Base Case are lower than the minimum indicative charges for Variation 3.

Table 8: Indicative Annual Costs – Base Case and Variation 3 (Eliminate Storage for 1,500 Hectares)

	Scenario 1 User Base Case	Scenario 2 User Base Case + Future Regional Supply	Scenario 2a User Base Case + Future Regional Supply + New Irrigators (25%)	Scenario 2b User Base Case + Future Regional Supply + New Irrigators (50%)	Scenario 3 All Potential Users
Design Base Case					
Effective Hectares	5,675	6,190	6,585	6,980	7,765
Capital Cost per Hectare	$5,130	$4,700	$4,420	$4,170	$3,750
Charges to Irrigators (Per ha/yr)					
Annual Fixed Charge	$510	$465	$440	$415	$370
Annual Operating Charges	$70	$65	$60	$55	$50
Total Annual Charges (Pre-tax)	$580	$530	$500	$470	$420
Variation 3					
Effective Hectares	5,675	6,190	6,265	6,265	6,265
Capital Cost per Hectare	$4,770	$4,380	$4,320	$4,320	$4,320
Charges to Irrigators (Per ha/yr)					
Annual Fixed Charge	$475	$435	$430	$430	$430
Annual Operating Charges	$70	$65	$65	$65	$65
Total Annual Charges (Pre-tax)	$545	$500	$495	$495	$495

2.5 SUMMARY OF INDICATIVE ANNUAL CHARGES

The information provided to date in relation to capital costs, storage volumes, hydro potential, and potential users creates the potential for a myriad of possible scenarios and indicative annual charges. At this stage of the feasibility assessment, we suggest that it is most appropriate to concentrate on the indicative charges relating to the estimated capital cost for the full storage capacity net of the estimated value of the hydro opportunity. The net capital cost for this scenario is $38.75 million ($41.60 million less $2.85 million), with indicative annual charges as set out in Table 5. We summarise these results as follows:

- The indicative annual charges per hectare for consumptive users range from $395 to $545, depending on the number of hectare equivalents that are serviced by the scheme;
- Annual charges will reduce by $20-$35 per hectare if WWAC chooses to reduce the number of diversion culverts (as required during the dam construction phase) from three to two;
- Annual charges for the User Base Case can be reduced by eliminating some of the planned storage volume of the dam, and these reductions will be optimal if uptake from potential new users does not reach certain levels. That is:
  - If the allowance for future regional supply (515 hectare equivalents) is not fully funded at the inception of the scheme (either by an upfront payment or commitment to an annual charge), the associated storage volume and construction costs should be eliminated to minimise the on-going annual charges for all other potential users;
  - Unless uptake (or funding) for approximately 50% or more of the potential new irrigation area (2,050 hectare equivalents) can be secured, the associated storage volume and construction costs should be eliminated to minimise the on-going annual charges for all other potential users.

Future charges per hectare for all users are clearly a function of the overall uptake of the scheme. Further work on the optimisation of the scheme design and storage volume can only be completed once all potential users have been consulted and, on the basis of the indicative charges determined here, have provided some feedback on the likely uptake at these cost levels.

3.0 INDICATIVE COST-BENEFIT ANALYSIS FOR IRRIGATORS

3.1 ASSUMED WATER RESTRICTIONS

Section 2.0 sets out the indicative charges for all users of the proposed scheme. This section summarises a high level assessment of the potential benefits that current irrigators will derive from the scheme, primarily based on the financial impact that may arise if the scheme does not proceed. As noted earlier, for this assessment the assumption has been made that irrespective of whether or not the scheme proceeds, the minimum flow requirement in the Waimea River at the Appleby Bridge would be 1,100 l/sec.

Given the large number of existing irrigators and the wide range of current land uses, the analysis is necessarily general. It is also made more difficult by the fact that although many of the potential participants in the scheme already have access to water, this access is subject to seasonal restrictions, and the fact remains that the Waimea Basin water resources are currently significantly over-allocated. The financial impact of non-augmentation is therefore critically dependent on the nature of the response that is put in place to deal with the over-allocation.

In the event of a water shortage without the augmentation scheme, we understand that there are two broad allocation response options:

1. A worst-case scenario where the total volume allocated to water permits is reduced (Scenario A);

2. Continuation of the current regime whereby rationing is imposed more often on all existing users (Scenario B).

The potential effects of these two options are described separately in Section 3.2. While the outcome for irrigators under Scenario A is straightforward (and immediate), the impact of the restrictions under Scenario B is less obvious and has been assessed using analysis contained in the following two reports (attached in Appendix 1):

(i) **Modelling Water Rationing for the Waimea Plains** Prepared by Landcare Research, this report examines the likely water restrictions that might practically be imposed on existing irrigators for both an "average" summer and 25-27 year droughts if the minimum flow were 1,100 l/sec at Appleby Bridge.

(ii) **Economic Impacts of Water Restrictions on Standard Crop Types** This report was prepared by Agfirst Consultants (Nelson). It estimates the likely reduction in on-farm surplus that will occur for the main crop types grown on the Waimea Plains under the water restriction scenarios described in the Landcare Research report.

Given the general nature of this study, the loss estimates are based on a simplified framework that is designed to provide the order of magnitude for the economic impact from non-augmentation. We have arbitrarily chosen to concentrate on just one drought return period, and it is not possible to easily extrapolate the estimated data to determine the potential impact of non-augmentation under different seasonal conditions.

3.2 ECONOMIC IMPACT OF NON-AUGMENTATION

3.2.1 Scenario A: Cancellation of Water Allocations

In this 'worst case' scenario, it is assumed that maintenance of the increased minimum flow of 1,100 l/sec would be implemented by TDC through cancellation of sufficient current water allocations to maintain the current security of supply - a 35% cut in allocations during a 10 year drought. Based on work undertaken for TDC by GNS Science, this is estimated to require a cut in current allocations of approximately 70% (J.Thomas, pers. comm.). It is assumed such cuts would apply only to irrigation consents, because allocations for urban and industrial use would have higher priority for continuation.

Intensive land uses will clearly no longer be viable under this scenario for land owners who lose access to their water allocations, resulting in the prospect of considerable losses in capital values. These losses will reflect the difference between the current capital values of the land and improvements used for the horticultural crops and the value of the land in its next best alternative use. In order to establish the potential magnitude of the aggregate value loss across all current irrigators, we make the following simplifying assumptions:

- The affected area that is currently used for apples, kiwifruit, and grapes is by necessity converted to dryland pastoral uses. Based on a 70% reduction in total water allocations, the irrigable area is reduced from 3,800 hectares to 705 hectares[8] and we assume that the reduction is applied to all land uses on a pro-rata basis;
- Current values for pastoral land within the Zone of Effect are underpinned by demand for rural - residential purposes, at around $70,000 - $80,000 per hectare.
- If however there are large scale conversions from other land uses, we assume that the increase in supply will have a negative effect on land values. For the purposes of this analysis, we assume a baseline pastoral value of $50,000 per hectare. We suggest that this value is still considerably higher than the productive value of the land for pastoral uses (with no access to a reliable water supply).

Table 9 summarises the results of this analysis.

Table 9: Aggregate Estimate of Capital Value Loss Under Non-Augmentation

Land Use	Assumed Reduction in Irrigated Area	Assumed Capital Value Per Hectare (Current Use)	Estimated Capital Value Loss Per Hectare (Based on Pastoral Values of $50,000 / ha)	Aggregate Capital Loss (Based on Residual Value of $50,000 / ha) ($000)
Pasture	1,181	$80,000	$30,000	$35,430
Apples	1,319	$120,000	$70,000	$92,330
Kiwifruit	147	$100,000	$50,000	$7,350
Grapes	448	$120,000	$70,000	$31,360
Total	3,095			$166,470

[8] As set out in Table 1, the current total use amounts to 4,420 equivalent hectares (3,800 hectares for irrigation and 620 hectares for current TDC use). A 70% reduction in water allocation will affect 3,095 hectares, leaving just 705 irrigable hectares based on the assumption that the total reduction is applied to irrigation use only.

The estimate of aggregate capital value loss for existing irrigators without augmentation is approximately $165 million. The indicative value loss under these assumptions is over five times higher than the aggregate capital cost estimate allocated to consumptive users for the proposed scheme construction. In fact, depending on the number of other consumptive users that join the scheme (new irrigators and TDC), the existing irrigators may be required to contribute as little as $15 million to build the scheme. The net benefit for existing irrigators under this scenario in total value terms is therefore very compelling: an investment of $15 million is required to avoid a total capital loss of $165 million.

Another way to express the potential loss of regional income under this scenario considers the annual reduction in on-farm profitability that would result if there is a 70% reduction in the water allocation. Our high level estimate of this loss is based on the following broad assumptions:

- Agfirst Consultants estimate that the total profitability (EBT) from the 3,800 hectares under the existing land use mix at current output prices is approximately $30.2 million, assuming there are no water limitations;
- As discussed above, a 70% reduction in water allocation will result in the irrigable area decreasing from 3,800 hectares to 705 hectares;
- We assume that the land use mix on the remaining 705 hectares will be the same as that for the existing 3,800 hectares, and that the new unirrigated area of 3,095 hectares will be used for dryland pastoral uses;
- Assumed profitability from dryland farming is based on 75% of the current profitability for irrigated dairying, which Agfirst Consultants estimate at an average of $3,000 per hectare.

On this basis, we estimate that the total annual loss under this non-augmentation scenario would be approximately $17.5 million. Over a 25 year period the aggregate losses would amount to about $440 million[9].

3.2.2 Scenario B: Increased Water Rationing for Existing Allocations

The second scenario assumes that in the absence of a water augmentation scheme but with the target minimum Waimea River flow still raised to 1,100 l/sec, TDC would implement more severe rationing cuts based on the current 3-step regime in order to comply with the increased minimum flow requirements. This level of rationing has been modelled by Landcare Research and Agfirst Consultants as reported in Appendix 1.

Landcare Research based its modelling of possible water restrictions on the river flow records for seasons that are thought to represent both an average summer (2004/05) and a drought with a probability of occurrence of 1 in 25 years (the 1982/83 and 2000/01 years[10]). Assuming a target minimum flow of 1,100 l/sec was imposed, the river flow records were then used to simulate the frequency and duration of water restrictions that might practically be imposed on irrigators under the assumed hydrological conditions. Table 10 sets out the number of days that water rationing would have been imposed for each of the selected annual records.

[9] We note that the aggregate loss estimate of $440 million over 25 years is broadly consistent with the total estimate of capital value loss estimated above ($166 million). The immediate capital value loss can be interpreted as an approximation of the total loss of future profitability from the land when expressed in present value terms. At an interest rate of 10%, the total present value of a $17.5 million annual loss over 25 years is approximately $160 million.

[10] The definition of the drought return period depends on the timing, severity and duration of the water shortages. The 1982/83 year actually represents a 25-33 year drought and the 2000/01 season is described as a 27-85 year drought, based respectively on weekly low flows at Wairoa Gorge and modelled reservoir drawdowns. The first number corresponds best to the frequency of an agricultural drought (Andrew Fenemor, pers. comm.)

Table 10: Summary Results of Water Rationing Modelling (Restricted Days)

Water Flow Scenario	Severity of Restriction Step 1 (20% Cut)	Step 2 (35% Cut)	Step 3 (50% Cut)	Total
Average Year (2004/05)	12	0	0	12
25-33 Year Drought (1982/83)	74	14	26	114
27-85 Year Drought (2000/01)	39	17	38	94

As pointed out by Landcare Research, this 'shared suffering' approach would not maintain the 1,100 l/sec minimum flow during a severe drought unless a complete cessation of water take is imposed, and at a 25 year drought frequency a complete 'cease take' would likely happen for most of the month of March. However, Scenario B has not assumed that restrictions would go beyond 50% of current allocations (Step 3 rationing) hence its description as a 'pragmatic' scenario.

Comparing the economic consequences of Scenarios A and B will provide irrigation water users with information upon which they can better judge the benefits and affordability of the proposed scheme.

Cost of Lost Production

Agfirst Consultants used the water restriction data to estimate the likely reduction in net farm surplus (measured on an Earnings Before Tax ("**EBT**") basis) for the predominant land uses within the irrigable area. As expected, for any irrigation season drier than an average year, the assumptions incorporated into Scenario B give rise to a major impact on the profitability of all land uses.

Summary results are presented in Table 11 for the two data sets derived from the 1 in 25-year drought scenario. These show that, with the exception of pasture, the impact of the water restrictions is dependent on the timing of the water restrictions. For example, the impact of the simulated water restrictions on kiwifruit and grape profitability is considerably higher using the data from the 2000/01 season because the severe water shortages occur closer to the critical pre-harvest period. These impacts are especially evident for crops grown on lighter soils.

Table 11: Incremental Losses for 1 in 25 Year Drought (EBT / ha)

	25 – 33 Year Drought (1982/83)		27 – 85 Year Drought (2000/01)	
Crop Type	Light Soils	Heavy Soils	Light Soils	Heavy Soils
Pasture	$1,800	$1,800	$1,800	$1,800
Apples	$6,740	$5,220	$8,710	$6,740
Kiwifruit	$4,430	$2,920	$8,390	$2,925
Grapes	$2,850	$2,030	$7,070	$2,850

While these results provide a high level indication of the cost of non-augmentation, the analysis is clearly subject to a series of assumptions and limitations. This analysis shows that the timing of the water rationing can be just as important for irrigators as the frequency of the restrictions. A growing season with a relatively high number of restricted days may have a limited impact on the economic output from the irrigated area compared to a year in which a small number of restrictions are concentrated into a critical part of the growing season. The total economic cost for any particular drought return period can therefore only be estimated within a large range.

The estimates relate to drought events that are relatively rare when considered in the context of historical water flow records. While we have considered the potential impacts of both an average season and a 1 in 25-year drought, the results cannot be easily extrapolated to determine the economic cost of non-augmentation for a season with water restrictions falling between these two points. The costs are certainly not expected to be linearly related to the level of water rationing. However, based on Scenario B assumptions, Agfirst Consultants suggest that significant economic costs may begin to be experienced under restrictions relating to a 1 in 5-year drought.

A relatively crude approximation of the aggregate economic cost of non-augmentation over a 25 year period can however be made on the basis of the available data. For this high level analysis we assume that the economic impact of water restrictions is negligible for anything less severe than a 1 in 5 year drought, and that the costs of a lower frequency drought can be linearly interpolated between zero and the estimated cost of the 1 in 25 year drought reported earlier. On this basis, the expected aggregate impact of non-augmentation over a 25 year period for each land use type is summarised in Table 12.

Table 12: Total and Average Losses Over 25 Year Period (EBT / ha)

	Average Annual Cost Per Hectare (25 Year Period)		Aggregate Cost Per Hectare (25 Year Period)	
Crop Type	**Low**	**High**	**Low**	**High**
Pasture	$560	$560	$13,950	$13,950
Apples	$1,855	$2,395	$46,345	$59,870
Kiwifruit	$1,140	$1,755	$28,480	$43,845
Grapes	$755	$1,540	$18,910	$38,440

When the average annual cost estimates set out in Table 12 are compared to the indicative annual charges for the proposed scheme (as summarised in Section 2.0), the financial benefit of the scheme for the horticultural land uses is generally compelling. Even at the top end of the potential annual scheme charges (around $500 per hectare), the estimated benefit of avoiding the impact on non-augmentation exceeds the anticipated cost. In the case of apples for example, the average annual avoided loss with augmentation ranges between $1,855 and $2,395 per hectare, more than three times the most conservative estimate of the expected annual charge per hectare.

Although the value proposition for pastoral uses is less clear cut, our analysis indicates that the average annual cost of non-augmentation for pastoral farmers ($560) still exceeds the top end of the indicative annual charge for the scheme.

Impact on Asset Values

Significant land use changes may be contemplated if the estimated costs outlined in this report are experienced (or are perceived to be possible) within a short time period, even under the less extreme water restrictions assumed in Scenario B. We note that the severity of the possible water restrictions modelled for the 25-year drought situation assume that the TDC will relent on the minimum flow requirements in extreme drought conditions and limit the restrictions to 50% reductions. Under prolonged drought conditions, the hydrological modelling indicates that cuts of up to 100% may be needed to strictly enforce the 1,100 l/sec minimum flow.

Given the considerable uncertainty over the likely long-term response to water restrictions, we suggest that the significant land use changes anticipated under Scenario A could also arise under Scenario B, although the reversion to dryland farming would likely be more gradual. If the intensive land uses were not sustainable, the eventual capital value losses under Scenario B would potentially exceed the $160 million estimate contained in Table 9 because the entire area currently irrigated would be affected.

4.0 REGIONAL IMPACT OF NON-AUGMENTATION

4.1 AGGREGATE IMPACT ON IRRIGATORS

4.1.1 Loss of Production From Area Currently Irrigated

The aggregate impact of non-augmentation on existing irrigators can be assessed in several ways. Under Scenario A, the assumed reduction in water permits will have an immediate and enduring impact on the land use intensity for a large part of the area that is currently irrigated. In these circumstances, the aggregate economic impact can be estimated on the basis of the capital loss that will result from the land use changes that will be imposed by the loss of access to water. Our estimate of this value (approximately $165 million) is summarised above in Table 9.

Under Scenario B, the impact of the assumed water restrictions are unlikely to be as immediate or catastrophic and can be reasonably considered in terms of the loss in aggregate profitability. The total economic impact of a 1 in 25-year drought is estimated by combining the per hectare losses presented in Table 11 with the crop area estimates produced by Agfirst Consultants. The results are set out in Table 13.

Table 13: Estimated Economic Losses of 1 in 25 Year Drought for Current Irrigable Area (3,800 ha) for Scenario B

	25 – 33 Year Drought (1982/83 Data)			27 – 85 Year Drought (2000/01 Data)		
Crop Type	Light Soils ($000s)	Heavy Soils ($000s)	Total ($000s)	Light Soils ($000s)	Heavy Soils ($000s)	Total ($000s)
Pasture	$1,080	$1,530	**$2,610**	$1,080	$1,530	**$2,610**
Apples	$5,763	$3,993	**$9,756**	$7,447	$5,156	**$12,603**
Kiwifruit	$420	$248	**$669**	$797	$248	**$1,046**
Grapes	$912	$467	**$1,379**	$2,262	$655	**$2,916**
All Crops	$8,175	$6,238	**$14,414**	$11,586	$7,590	**$19,176**

The indicative total costs of a 1 in 25 year drought implied by the test data range between approximately $14.4 million and $19.1 million. This is an estimate of the total value of lost production from the 3,800 hectare equivalents that are currently irrigated using water from the Waimea River. The results are dominated by the impact of water restrictions on apple production and could vary significantly depending on the timing of the restrictions during the growing season. When expressed on a proportional basis, the potential losses are clearly significant. Given that the estimated total earnings from the irrigated area in a normal year are approximately $30.2 million, the estimated losses represent between 45% and 65% of average earnings (based on current production costs and output prices).

Table 14 sets out similar estimates of total loss (for Scenario B) based on our analysis of the average annual impact of non-augmentation reported in Table 12. While the apparent impact of non-augmentation is obviously less dramatic when assessed on an average basis, the results are still significant; the estimates of the total average annual loss of profitability ranges between $4.4 million and $5.8 million, representing between 15% and 20% of the estimated total profitability in a normal year.

Table 14: Estimated Average Economic Losses for Current Irrigable Area (3,800 ha) for Scenario B

Crop Type	Aggregate Average Loss Per Annum 25 – 33 Year Drought (1982/83 Data) ($000s)	Aggregate Average Loss Per Annum 27 – 85 Year Drought (2000/01 Data) ($000s)
Pasture	$809	$809
Apples	$3,003	$3,879
Kiwifruit	$205	$315
Grapes	$416	$846
All Crops	$4,433	$5,849

4.1.2 Opportunity Cost of Un-irrigated Land

Setting aside any issues regarding the eventual irrigation uptake in the areas outside of the Zone of Effect, non-augmentation will give rise to an opportunity cost associated with the identified land that is currently not irrigated. A high level estimate of that cost can be determined using either of the two approaches adopted in relation to the area that is currently irrigated; that is, based on the additional production that may be derived from the irrigated land or simply reflecting the difference between the values of irrigated and non-irrigated land.

Again, the estimates can only be established at a very high level. We do not have sufficient information regarding the un-irrigated area to accurately determine the likely land use that will be adopted under irrigated farming systems, or whether the level of production that can be generated from this area is comparable to the estimates provided for the land that is currently irrigated. However, we suggest that a useful ballpark estimate can be derived from the available financial data used to assess the impact of non-augmentation on the irrigated land.

Table 15 summarises the estimated opportunity cost for the 2,050 hectares of potentially irrigable land. Our estimates are based on the simplifying assumption that the eventual land use under irrigation for the dryland area matches the current land use mix for the 3,800 hectares that are currently irrigated. The analysis also assumes:

- All of the dryland area is currently used for low-intensity pastoral farming;
- Total revenue per hectare for dryland pastoral use is 75% of the estimated revenue from irrigated pasture. Based on current returns for dairy farming, we assume a baseline revenue of $5,400 / hectare (900 kg MS / ha, payout of $6.00 / kg MS);
- Gross revenues for horticultural land uses under irrigation are based on the forecast revenue levels for the current financial year. As advised by Agfirst Consultants, the values for apples, kiwifruit, and grapes are $39,000, $56,000 and $20,000 respectively.

Table 15: Estimated Opportunity Cost for Future Irrigable Area (2,050 ha)

	Aggregate Revenue ($000s)
Under Non-Irrigated Pastoral Use	$11,070
Irrigated Land Use	$51,150
Incremental Output	$40,080

Our simplified analysis shows that the incremental annual farm gate revenue from the irrigable area could be approximately $40 million (based on current product prices). Achieving the increased level of output will of course require considerable additional investment in the assets needed to support the more intensive land use, and will take some time.

A similarly simple analysis can be used to estimate the indicative total uplift in land values for the 2,050 hectares of potentially irrigable land. This is summarised below in Table 16. The increase in value is based on land value rather than capital value, recognising the fact that the capital values for each land use class (as set out in Table 9) will only result from further significant investment in improvements. The incremental value of the access to water is captured in the estimated increase in land value of $20,000 per hectare.

Table 16: Estimated Increase in Land Values for Future Irrigable Area (2,050 ha)

Crop Type	Aggregate Land Value ($000s)
Non-Irrigated Pastoral Use ($30,000 / ha)	$61,500
Irrigated Land ($50,000 / ha)	$102,500
Incremental Increase in Land Values	$41,000

4.2 AGGREGATE IMPACT ON URBAN AND INDUSTRIAL USERS

Non-augmentation will potentially affect both existing and new users.

- TDC's current water allocation for urban and industrial use amounts to approximately 27,000 m^3 / day, or 620 hectare equivalents. We understand that there are three significant industrial users and that the remainder of the water is used for domestic purposes. Water restrictions in dry years affect both groups of users.

- The base case dam design allows for future urban / industrial demand equating to a total of 1,295 hectare equivalents. Of that, 780 hectare equivalents represent the 100-year demand projection for the Tasman District (over and above existing demand) and the remaining 515 hectare equivalents relate to "future regional demand" (based on information provided by the Nelson City Council).

It is extremely difficult to accurately quantify the potential economic impact of non-augmentation on both groups of users. In terms of the existing users, the physical and financial impacts of water restrictions are not directly observable, especially for domestic users for whom the restrictions do not impose any obvious economic costs. The TRMP provides for lower level rationing of community supplies than for irrigation: the community rationing steps are 10%, 17.5% and 25% compared with those for other users of 20%, 35% and 50% of allocations. Although we do not have access to the information required to assess the financial impact on current industrial users (e.g. freezing works, apple cannery, MDF plant), we are aware that the TDC has a contractual commitment to supply water to industrial users, and that penalties apply in the event that these commitments cannot be met. This situation therefore has financial implications for both the industrial users and TDC. We have not assessed the extent to which the effect on industrial users could be mitigated by changes to the production process that improve the efficiency of water use, reductions in processing during periods of water shortage, as well as the imposition of more severe restrictions on domestic users to ensure a sufficient supply is maintained for industrial users. However, we conclude that there will likely be some significant economic impact of non-augmentation on existing urban / industrial users and consequentially on the TDC but it is difficult to quantify.

Quantifying the opportunity cost of non-augmentation on future new urban / industrial users is also difficult given the relative lack of detailed information that is available at this stage of the scheme development. In this respect we note:

- The future demand projections have been based on a very coarse assessment of regional growth, and do not consider any detailed breakdown of specific requirements for urban and industrial development. The source, location and specific nature of the projected industrial demand is unknown;
- The timeframe contemplated for the future urban / industrial demand is very long (100 years). However the impact of non-augmentation on current regional water requirements could already be relatively significant during a severe drought;
- The ultimate value of the augmentation scheme on future urban / industrial development is dependent on the costs associated with providing access to water from alternative sources. Assuming that alternative water sources could be developed if the augmentation scheme did not proceed, the economic benefit of the scheme should be based on the cost advantages that this scheme provides.

That is, it is not reasonable to assess the opportunity cost of non-augmentation on the assumption that the economic development that can be supported by the augmentation scheme would not be achieved if this particular scheme did not proceed. However, we understand that TDC has investigated potential sources in the past, concluded that the options are limited, and likely to be significantly more expensive than the current scheme (J Cuthbertson and J Thomas, TDC, pers. comm.). We have therefore assumed that the water demand could be met by other sources, but at a much greater cost than that which has been provisionally allocated to future urban / industrial demand under the current augmentation scheme.

We develop these issues further by concentrating on the future urban / industrial demand projection for the Tasman District. The projection equates to total new demand of approximately 33,500 m^3 / day (780 hectare equivalents), and is based on very high level assumptions by the TDC in relation to potential increases in urban dwellings and industrial use. Projected future industrial demand necessarily relates to unspecified uses because it is clearly not possible to accurately predict the timing or nature of new industry that may be established within the region over the next 100 years. If for simplicity we assume that all of the future demand is used for urban growth, then the impact of the allowance for the additional 33,000 m^3 / day can be addressed as set out in Table 17.

Table 17: Analysis of Future Urban / Industrial Demand

	Adopted Value	Source
Assumed Total Peak Demand	33,000 m^3 / day	TDC
Average Demand per Dwelling	2.00 m^3 / day	TDC
Number of New Potential Dwellings	20,000	
Assumed Number of Occupants / Dwelling	2.5	TDC / Statistics New Zealand
Potential Increase in Population	50,000	
Estimated GDP per Capita	$34,000	"Tracking the Nelson Regional Economy", Nelson Regional EDA, July 2009

The proposed augmentation scheme is expected to provide sufficient water for an additional 20,000 allotments, equating to a 50,000 increase in the population. On the face of it, the increase in population will give rise to a substantial increase in regional GDP of $1.7 billion once the full population increase has been achieved (based on the current GDP per capita and the potential increase in population). However, notwithstanding the numerous methodological issues associated with this crude analysis, the true opportunity cost of the proposed augmentation scheme should be referenced solely to the differential between the costs of this scheme and the likely costs of the next cheapest alternative.

We are not in a position to determine what the costs of an alternative scheme may be. However we note that in terms of the cost of supplying water from the proposed augmentation scheme, using the information from Table 1 (assumed water demand for existing TDC and future TDC urban/industrial use) and Table 3 (Capital Cost per Hectare under Option 1), the cost to meet urban / industrial demand in the Tasman District under the base case scenario would be between $5.2 million and $7.2 million (depending on assumptions as to the total number of participating users as per Table 3). This cost estimate takes into account the existing over-allocation issue and the future demands for the District (ie total of 1400 hectare equivalents).

If just the future TDC urban/industrial demand is taken into account (ie 780 hectare equivalents), the cost would be between $3.0 million and $4.0 million (again depending on assumptions as to the total number of participating users).

Even if the cost of the next cheapest water supply alternative is significantly higher than either of these estimates, the magnitude of the apparent economic benefit of the proposed augmentation scheme is far lower than may be suggested from the type of simple analysis set out above (which implicitly assumes that the urban / industrial growth will not be realised at all without the completion of the augmentation scheme).

For example, if the cost of an alternative supply were determined to be 10 times the cost of the proposed augmentation scheme, the economic benefit of the proposed scheme lies in a range between $52 million and $72 million.

5.0 SUMMARY AND CONCLUSIONS

This report summarises three main aspects of the economic analysis that has been applied to the proposed Waimea augmentation scheme. The analysis is based on the feasibility level assessment of the total capital costs required for the identified storage site and makes a number of critical assumptions relating to the potential scheme users and capital structure.

The main conclusions that can be drawn from the analysis are as follows:

- **Affordability of Augmentation** The likely costs of the scheme for each user are dependent on which groups of consumptive users are included in the charging base, and the extent to which the costs of meeting the enhanced environmental minimum flows are met by the community as a whole. Assuming that 70% of the capital costs are evenly allocated among all potential future users of the scheme (with the remaining 30% covered by the Tasman District community at large), the range of indicative annual charges is between \$420 and \$580 per hectare. Final outcomes within the range are largely dependent on the eventual scheme uptake by potential users and the charging structure that is adopted.

- **Opportunity Cost of Non-Augmentation** In order to respond to the existing situation of over-allocation, either a reduction in water allocation or increased water rationing will be required.

    - In the worst case scenario, water allocations may be reduced to a level which leaves sufficient water to irrigate just 705 hectares of the 3,800 hectares that are currently irrigated. For the properties which no longer have access to water, there would be an immediate and substantial capital value loss resulting from the forced shift to dryland farming. Based on a set of very broad assumptions, we estimate that the aggregate loss will be approximately \$165 million. The estimated total reduction in farm gate profitability (EBT) is approximately \$17.5 million per year under this scenario.

    - Although the continuation of the current water rationing scheme (if feasible) will have a less catastrophic impact, the indicative financial costs are still significant. Based on current land use and return levels, the indicative cost of a 1 in 25 year drought is estimated between \$14.4 million and \$19.1 million, depending on the timing of the water shortages. These estimated losses represent between 45% and 65% of total net earnings from the irrigated land during an "average" year.

    Given that the estimated maximum capital cost allocation to existing irrigators under the proposed scheme is approximately \$22.5 million, the cost-benefit assessment for users when viewed on this basis is quite compelling.

- **Regional Impact of Non-Augmentation** While a comprehensive assessment of the potential regional impacts of non-augmentation is more difficult to estimate, we conclude that the consequences for the Tasman District will be significant, affecting three broad groups:

    (i) Existing Irrigators: The worst case scenario outlined above results in an aggregate loss of value of approximately \$165 million for the existing irrigators;

    (ii) Potential New Irrigators: Based on some very high level analysis, we estimate that the lost output from the land that is potentially irrigable by the scheme is around \$40 million per annum.

(iii) Urban and Industrial Users: We suggest that there would be significant effects on both industrial users and on TDC. We also suggest that the opportunity cost of non-augmentation for these users is best measured as the increased cost of delivering the required water using the next best alternative. While we are not in a position to accurately assess this potential cost, we understand that it is likely to be considerably higher than the proposed Lee scheme.

The indicative annual costs and perceived affordability of the proposed scheme must be determined as part of an iterative process. Once WWAC has received feedback in relation to the likely uptake by various users, it will be in a better position to assess whether any changes to the proposed storage volumes are necessary and the degree to which those changes will affect the annual charges for participating users. This process is particularly dependent on confirmation of the following factors:

(i) The 30% allocation of total capital costs to environmental flows;

(ii) The likely uptake by potential new irrigators outside of the Zone of Effect and the charging regime that may be applied for these users. As discussed earlier, although it may be necessary to offer some discount to these potential irrigators to secure sufficient uptake, doing so will be in the best interests of all potential users if the uptake reaches a satisfactory level;

(iii) The entity which will pay for the provision of the allowance for future regional supply.

Modelling of Water Rationing for Maintaining Increased Minimum Flows in the Waimea River

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Contents

1. Background

This brief report builds on work carried out for Phase 1 of the Waimea Water Augmentation project. That work, reported in Landcare Research report LC0607/031 (Fenemor 2006), developed a hydrological model based on 48 years of river flows at Wairoa Gorge to predict approximately when water rationing cuts of up to 50% of allocations would have been necessary to maintain a residual flow of 800 l/sec.

This updated report for Phase 2 of the water augmentation project uses a relationship developed by Tonkin and Taylor between Wairoa Gorge flow, Waimea Plains groundwater pumpage and low flows in the lower Waimea River to model the level of water rationing that would be required if the target minimum residual flow specified in the Tasman Resource Management Plan (TRMP) were raised from the previous 225 l/sec to 1100 l/sec, for the Waimea River near Appleby Bridge.

The results have been used as an input into the economic assessment of the costs to water users of maintaining a minimum flow above 1100 l/sec, if the Waimea Water Augmentation project did not proceed and if the current approach of staged rationing of water users were imposed, aimed at maintaining river flows at this level.

The updated model predictions for a 25-year drought (1982-83) and an average summer (2004-05) have been used by Agfirst Consultants (John Bealing) to estimate the production losses which could arise from irrigation restrictions on pasture, apples/kiwifruit, and grapes/olives. Those losses are then factored into an overall economic assessment by Northington Partners (Greg Anderson) of the 'non-augmentation' option.

2. Method and Assumptions

The same assumptions apply in this modelling as in the earlier work, except that rationing restrictions are modelled here for assumed minimum flows of 1100 l/sec, and 800 l/sec.

In addition, instead of using an empirical relationship between Wairoa Gorge flow and minimum flow in the Waimea River from the two modelled years, this relationship is derived from Tonkin & Taylor and GNS river-aquifer model data for the entire modelled period 1958-2007. Using the data from the full period of river flow records is consistent with the approach used by Tonkin & Taylor for reservoir sizing.

As noted in the earlier report (Fenemor 2006): *The relationship between natural Wairoa Gorge river flows and the minimum flow down river in the Waimea River is not simple nor linear. It depends on factors including Wai-iti tributary inflows, groundwater pumpage, time of season and riverbed morphology. To understand these linkages, a groundwater flow model was developed for the Waimea Plains in the 1980s (Fenemor, 1988) and has since been upgraded for 2001 conditions (Hong, 2003). While the resources required were beyond the scope of this project, the groundwater model could be calibrated over a longer period and run to simulate Waimea River low flows under current irrigation and no irrigation scenarios to give a detailed assessment of likely frequency of water rationing. A simpler modelling approach has been adopted here, recognizing that the error margins in this estimation are probably similar to those associated with the economic analysis itself.*

The natural flow record for the Wairoa River at Wairoa Gorge has been used to generate a spreadsheet of periods when rationing is predicted to have been at Step 1 (20% cut in allocations), Step 2 (35% cut in allocations) and Step 3 (50% cut in allocations) for the entire period of record from 1958 to November 2007.

Similar assumptions apply as in the earlier work, except the method for calculating Wairoa Gorge flows corresponding to minimum flows, as described above.

There are two potential responses that the TDC could take if these higher minimum flows were to be adopted:

(i) Maintain the target security of supply stated in the TRMP (a 35% cut in allocations during a 10 year drought) by reducing allocation limits for each Waimea water management zone. This would require allocations to be reduced on current water permits across the Waimea basin.

(ii) Maintain allocations for current water permits, and allocation limits in the TRMP but reduce the security of supply by imposing earlier water rationing to maintain the higher minimum flow.

In this report, the more pragmatic and possibly more politically acceptable second option is modelled, rather than widespread cancellation of existing water permits.

3. The Water Rationing Model

There are two steps to the modelling. Firstly the Wairoa Gorge flows corresponding to Waimea River flows of 1100 and 800 l/sec respectively are calculated. Then a rationing regime is applied to the 1958-2007 Wairoa Gorge flow record to calculate when those Wairoa Gorge threshold flows would have triggered rationing, and for what periods of time.

For the first step, we use the following regression equation from Tonkin & Taylor (D Leong, pers. comm.) between daily flow losses to groundwater between the Wairoa Gorge and Appleby:

$$Q_{loss} = -1.3x10^{-4}\ Q_{gw}^{2} + 1.03Q_{gw} - 234 \text{ l/sec} \quad \ldots(1)$$
$$\text{for } Q_{gw} > 234 \text{ l/sec}$$

where Q_{loss} is the flow loss, and Q_{gw} is the total groundwater pumpage that day as used in the GNS river-aquifer model.

Thus the flow at Appleby $Q_{Appleby}$ is:

$$Q_{Appleby} = Q_{Gorge} - Q_{WEIC} - Q_{loss} \quad \ldots(2)$$

where Q_{Gorge} is Wairoa river flow at the gorge, and Q_{WEIC} is the irrigation water take that day at the Waimea East Irrigation Company intake in the gorge, as calculated from the Landcare Research irrigation scheduling model.

Using the Tonkin & Taylor spreadsheet of 1958-2007 flow data shows that for the target minimum flow $Q_{Appleby}$ of 1100 l/sec, the net flow at Wairoa Gorge ($Q_{Gorge} – Q_{WEIC}$) would have been 2802 l/sec. For the previous target minimum flow $Q_{Appleby}$ of 800 l/sec, the net flow at Wairoa Gorge would have been 2557 l/sec.

For the second modelling step, the TIDEDA PSIM routine was written (Appendix 1) and run by hydrologist Martin Doyle of TDC on the 1958-2007 Wairoa Gorge flow data. The logic of the PSIM routine and its interpretation are as follows:

- For the 1100 l/sec minimum flow, rationing would be triggered, in accordance with the current TDC 3-step rationing regime, whenever Wairoa Gorge flow falls below 3000 l/sec. The buffer between the 3000 l/sec trigger and the 2800 l/sec target for maintaining 1100 l/sec downstream is small, of the order of 1-2 days flow recession. Based on typical flow recession curves for Wairoa Gorge, to allow 2 weeks lead-in for a target flow of 2800 l/sec would require rationing to be triggered somewhere in the range of flows 4200-5800 l/sec. These flows occur so often in summer that it is considered unlikely that the Council would set such a high rationing trigger, so instead the 3000 l/sec trigger has been used. Similarly, for the 800 l/sec minimum flow, rationing is assumed to be triggered at 2557+200 l/sec, i.e. 2757 l/sec.

- Rationing is assumed to operate in a similar manner to the current regime, whereby Step 1 lasts 2 weeks, Step 2 lasts 2 weeks, and Step 3 is ongoing for as long as natural Wairoa Gorge flow remains below 3000 l/sec.

- It is likely under prolonged drought conditions that Step 3 (50%) rationing would not be sufficient to retain a minimum flow of 1100 l/sec and that the Council would in those situations impose even higher rationing cuts – probably up to 100% – if it wanted to strictly maintain the 1100 l/sec minimum. Such draconian cuts may not be politically tenable, which is why the assumption of ongoing Step 3 (50%) cuts has been adopted. This is a continuation of the Council's current 'shared suffering' approach in which both river instream values and out-of-stream water users share the effects of limited water availability.

- After running the model to generate a time series of rationing periods, all those of less than 24 hours duration have been ignored. These largely arise because of fluctuations in the original chart recorded flow data which are not real. Also rationing is normally only triggered after ongoing declines in river flows of more than just a day.

- The irrigation season runs November-April inclusive so any cuts predicted outside this period are also ignored in the analysis.

4. Results

The Phase 1 work indicated, based on the GNS groundwater model with 1982-83 and 2000-01 data, that a flow in the Waimea River of 800 l/sec near Appleby corresponds roughly to a Wairoa Gorge flow of 2800 l/sec.

Using this new regression based approach, the Wairoa Gorge flow of 2802 l/sec corresponding to a minimum flow of 1100 l/sec is almost the same flow as calculated in the earlier report for a minimum flow of 800 l/sec. Thus, this method will predict the same rationing to maintain 1100 l/sec minimum flow as the earlier method predicted for 800 l/sec.

The brief calls for analysis for 1982-83 (a 25 year drought), or 2000-01 (a 27 year drought) plus an average summer. For the average summer, 2004-05 has been selected. Modelled rationing for these three summers has been extracted from the output data from the PSIM routine (and available in Appendix 2 of the earlier report) to provide the modelled water rationing data in Table 1 for a minimum flow of 1100 l/sec.

Using the new calculation method, modelled rationing data for a minimum flow of 800 l/sec have also been redone and these results are shown in Table 2.

Table 1: Modelled Water Rationing for 1982-83, 2000-01 and 2004-05 summers for a target minimum Waimea River flow of **1100 l/sec**

Date that the period ended	Rationing duration (total days for this period if>24hrs)	Max rationing step reached	Date start rationing Step 1 (20%) yymmdd	Days at Step1 rationing (20% cut)	Date start rationing step 2 (35%) yymmdd	Days at Step 2 rationing (35% cut)	Date start rationing step 3 (50%) yymmdd	Days at Step 3 rationing (50% cut)
25 year drought: 1982-83								
11/11/1982	8	1	821104	8				
19/11/1982	5	1	821114	5				
27/11/1982	7	1	821120	7				
29/11/1982	2	1	821127	2				
12/12/1982	12	1	821130	12				
21/12/1982	6	1	821215	6				
25/12/1982	1	1	821224	1				
5/01/1983	7	1	821229	7				
13/01/1983	4	1	830109	4				
29/03/1983	60	3	830128	14	830211	14	830225	32
7/04/1983	8	1	830330	8				
14/04/1983	3	1	830412	3				
27 year drought: 2000-01								
10/12/2000	5	1	001206	5				
28/12/2000	2	1	001225	2				
16/01/2001	3	1	010113	3				
26/01/2001	8	1	010118	8				
3/04/2001	66	3	010127	14	010210	14	010224	38
22/04/2001	17	2	010404	14	010418	3		
Average year: 2004-05								
11/02/2005	2	1	050209	2				
7/03/2005	3	1	050303	3				
25/03/2005	12	1	050313	12				

Table 2: Modelled Water Rationing for 1982-83, 2000-01 and 2004-05 summers for a target minimum Waimea River flow of **800 l/sec**

Date that the period ended	Rationing duration (total days for this period if>24hrs)	Max rationing step reached	Date start rationing Step 1 (20%) yymmdd	Days at Step1 rationing (20% cut)	Date start rationing step 2 (35%) yymmdd	Days at Step 2 rationing (35% cut)	Date start rationing step 3 (50%) yymmdd	Days at Step 3 rationing (50% cut)
25 year drought: 1982-83								
11/11/1982	7	1	821105	7				
19/11/1982	4	1	821116	4				
27/11/1982	7	1	821120	7				
29/11/1982	2	1	821128	2				
1/12/1982	1	1	821130	1				
4/12/1982	3	1	821201	3				
11/12/1982	7	1	821204	7				
21/12/1982	6	1	821215	6				
5/01/1983	6	1	821230	6				
13/01/1983	3	1	830109	3				
24/03/1983	54	3	830130	14	830213	14	830227	26
29/03/1983	4	1	830325	4				
7/04/1983	8	1	830330	8				
14/04/1983	2	1	830413	2				
27 year drought: 2000-01								
10/12/2000	3	1	001208	3				
28/12/2000	1	1	001227	1				
15/01/2001	1	1	010114	1				
26/01/2001	6	1	010120	6				
3/04/2001	66	3	010127	14	010210	14	010224	38
22/04/2001	17	2	010404	14	010418	3		
Average year: 2004-05								
6/03/2005	2	1	050304	2				
17/03/2005	3	1	050315	3				
25/03/2005	7	1	050317	7				

5. Conclusions and Interpretation

This model has shown that if the current TDC approach of staged rationing of water users of up to 50% cuts in water allocations aimed at maintaining a minimum flow in the Waimea River of 1100 l/sec were implemented, the total days of water rationing would have been 123 days in the 1982-83 summer, 101 days in 2000-01 and 17 in the average 2004-05 summer. For both the 1982-83 and 2000-01 summers (25 and 27 year droughts respectively), water rationing would have been at or above 50% of allocations for all of March.

Using this same method and calculating the total days of water rationing for maintaining a 800 l/sec minimum river flow, there would have been 114 days in the 1982-83 summer, 94 days in 2000-01 and 12 in the average 2004-05 summer.

There is little difference in the durations of water rationing for both 1100 and 800 l/sec scenarios. The lengthy durations without full allocations of irrigation water suggest that rationing in years drier than an average summer would have very severe economic impacts on irrigators.

If the TDC decided to absolutely maintain a minimum flow of 1100 l/sec, even more severe water rationing would be required, and/or the Council would need to cancel water permits to bring total allocations down to sustainable levels.

Agfirst Consultants and Northington Partners have used modelled data to quantify the economic impacts of not proceeding with water augmentation.

6. References

Fenemor, A.D. 1988. A Three-dimensional Model for Management of the Waimea Plains Aquifers, Nelson. Publication No. 18 of DSIR Hydrology Centre, 133 pp.

Fenemor, A.D. 2006. Modelling Water Rationing for the Waimea Plains. Landcare Research contract report LC0607/031 for the Waimea Water Augmentation Committee. 24pp.

Hong, T. 2003. Effects of abstraction on groundwater levels and river flows in the Waimea Plains: modelling and management scenario simulations for droughts inclusive of various Waimea East Irrigation Scheme (WEIS) pumping scenarios. Client report 2003/69 for Tasman District Council. Institute of Geological and Nuclear Sciences Ltd. 27pp.

7. Acknowledgements

Many thanks to the unflappable Martin Doyle, hydrologist at Tasman District Council for providing the flow data, and processing it using the Tideda process PSIM.

8. Appendix

TIDEDA PSIM routine for modelling initiation and duration of water rationing steps

```
                                                  W_Ration.sim
$$$ A PSIM to calc how often restrictions would occur in the
$$$ lower Waimea River, written MCD 19/9/2006.
$$$ When flow drops below 3,000 l/s it measures how many hourly steps occur
$$$ till either flow goes above 3000 again, or 14 days are exceeded.
$$$ If 14 days are exceeded, then ration step 2 starts and time is measured
$$$ till flow exceeds 3,000 l/s or another 14 days occurs.  The third
$$$ rationing period is only broken by a rise above 3000 l/s.
$$$ A mean flow for each period is filed
$$$
$$$ Run on an hourly averaged timestep.

get FLOW
Time DATE HOUR
COUNTER = COUNTER + 1
if Flow gt 3000 goto RATIONZERO
if COUNTER lt 338 goto RATION1
if COUNTER lt 674 goto RATION2
goto RATION3

RATION1:
TOTEFLOW = TOTEFLOW + FLOW
MEANFLOW1 = TOTEFLOW/(COUNTER)
if COUNTER gt 1 2
DATESTART = DATE
TIMESTART = HOUR
DATE1 = DATE
TIME1 = HOUR
RATION = 1
skip 999

RATION2:
TOTEFLOW = TOTEFLOW + FLOW
MEANFLOW2 = (TOTEFLOW - (MEANFLOW1*336))/(COUNTER-336)
DATE2 = DATE
TIME2 = HOUR
RATION = 2
skip 999

RATION3:
TOTEFLOW = TOTEFLOW + FLOW
MEANFLOW3 = (TOTEFLOW - (MEANFLOW1*336)-(MEANFLOW2*336))/(COUNTER-672)
RATION = 3
skip 999

RATIONZERO:
if COUNTER gt 1 goto OUTPUT
RATION = 0
COUNTER = 0
TOTEFLOW = 0
MEANFLOW1 = 0
MEANFLOW2 = 0
MEANFLOW3 = 0
skip 999

OUTPUT:
put COUNTER RATION DATESTART TIMESTART MEANFLOW1 DATE1 TIME1 MEANFLOW2 DATE2 TIME2 MEANFLOW3
RATION = 0
COUNTER = 0
TOTEFLOW = 0
MEANFLOW1 = 0
MEANFLOW2 = 0
MEANFLOW3 = 0
```

22/10/2009

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WAIMEA WATER AUGMENTATION PROJECT - ECONOMIC ASSESSMENT OF THE NON-AUGMENTATION (Do-Nothing) SCENARIO.

This report follows on from the up-dated river data supplied by Andrew Fenemor of Landcare Research on 28th August 2009.

Scenario

- That the current minimum in-stream requirement of 500 l/s at the Appleby Bridge is raised to 1100 l/s.
- That the allocation response to this is a reduction of security of supply (rather than a reduction in water permits issued).

The economic assessment of the non-augmentation scenario is to:

- Assess the change in value of production from the currently irrigated areas of the Waimea Plains that would result from the above assumptions (i.e. from there being bigger irrigation cuts in drier years, so as to maintain the low flow in the river at 1100 l/s instead of the existing 500 l/s).

The number of days and the level of rationing arrived at are based on the "revised" hydrological records for the two dry summers of 1982/83 and 2000/01, and for the "average" summer of 2004/05. If this report is compared to the earlier report (with the same title, dated 20/10/2006), then only minor changes are apparent in the days of restriction, but more significant changes in the returns for the crops considered, as these are largely dependant on world markets, so change from year to year.

Process

The hydrological data (provided by Andrew Fenemor) showed the same number of days with water restriction for the new minimum river flow of 1100 l/s as was the case with the earlier report when the minimum flow was only 800 l/s. This being the situation, there was no need to get growers to reconsider the relative loss in crop production, but given we are now a further two years down the track, dollar values of various crops will have changed along with market changes. The numbers affected by these changes have been revised, and are included below. The objective was to arrive at a dollar loss figure for a range of crops, and for these losses to be multiplied by the area that each crop represented. When the various crop losses were combined, we would arrive at the dollar loss that the Waimea Plains might forgo, if we experienced these various drought scenarios this summer.

In the earlier report we had a discussion as to if the TDC had ever gone beyond the 3-step rationing point, and Joseph Thomas said that they had gone to an additional 10% cut (giving a total cut of 60% of allocation). The scenarios from Landcare do not go beyond a 50% cut. In 2000/2001, the river went dry at the Appleby Bridge. I presume that if the TDC had a requirement to leave a minimum of 1100 l/s in the Waimea River at a point near the Appleby Bridge, and we had another 2000/2001 year summer river flow, then Council would have to impose an even more restrictive rationing regime this year than they did in 2000/2001. If this was the case, then we could get the situation that some/many irrigators, especially those growing other than pasture crops, might decide that the financial risks attached in growing their crops were too great, and they may then make the decision to stop growing these crops & either reverted to pasture, or some less demanding water crop (possibly grapes). This might mean a financial reduction from kiwifruit or apples, down to irrigated pasture and maybe dairying. Another option could be to swap to a crop that could still produce good quality/yield despite a big water reduction (such as grapes).

In light of some of the comments above, the losses suggested below may be less than could happen in such a water short event. Another outcome from a bad drought that is often hard to place a cost on is the carryover effect into the next crop (the year following the drought). Also two successive drought years have the potential to be worse than the same two droughts that may be separated by a couple of wetter than average years. The timing of when a drought hits the region will effect some crops more than others. An early drought (October to December) will have a much bigger impact on dairy production than would be the more common February to April drought.

Crop Areas

The following crop areas have been revised since the 2006 report to reflect recent changes:

	2006	2008
Pasture	= 1,600 ha	1450 ha
Apples, KF, et al	= 1,850 ha	1800 ha
Grapes & Olives	= 350 ha	550 ha
Total	= 3,800 ha	3,800 ha

Market gardening (including especially glass house growers, and within that group especially hydroponics growers) is a crop not mentioned above, but is one that has the potential to be significantly affected in a bad drought. These are included in with the Apples and KF so should be catered for.

In coming up with the possible losses for the above crops, we have also tried to allow for the fact that these crops are grown over a range of soil types. The assessment of crops by soil moisture holding capacity was taken as:

	Soil Type (By Soil Moisture Holding Capacity in mm)			
	38 mm	**78 mm**	**130 mm**	
Pasture	500 ha	100 ha	850 ha	
Apples, KF et al	760 ha	190 ha	850 ha	
Grapes Olives	300 ha	20 ha	230 ha	
Totals	**1560 ha**	**310 ha**	**1930 ha**	**= 3,800 ha.**

Generally speaking, droughts are felt more immediately and most severely in the lower soil moisture-holding soils first, and take longer to have an effect on the heavy soils. However, in a very bad/prolonged drought, all soils will be affected, and the heavy clay soils (and high organic matter soils, if we had them), can take time, and be difficult to re-wet.

Financial Losses from Rationed Water

I have approached several people to try and arrive at a likely loss of income from the restriction in water that would result from the sample droughts and "average year" figures from Landcare's hydrological data.

Steven Spark and Grant McKay both Horticultural Consultants with Agfirst Motueka have supplied the horticultural losses. Table 1 that follows have the three main crops covered for both last year and the current year. I have included development costs, should you want to consider that the reduced irrigation water might lead to some growers pulling out their current crops and moving in to a crop that uses less water. Note that there would also be a gap of several years before the new crop returned the sort of income streams shown under the Net figures. The table also includes gross crop figures, as if a grower moved out of apples and went into pasture, then the gross dollars would be lost to the district each year that pasture was grown instead of the apples.

Steven Spark's commentary is attached as Appendix A.

Table 1

Horticultural Crop Development Costs Together with Annual Per Hectare Gross & Net Dollar Returns

		Returns / Ha Forecast Actual 2008/09		Returns / Ha Forecast 2009/10	
Crop	**$/ha development**	**$Gross**	**$Net (EBT)**	**$Gross**	**$Net (EBT)**
Kiwifruit	$ 50,000	$ 36,668	$ 5,197	$ 39,206	$ 8,348
Apples	$ 55,000	$ 52,404	$ 9,329	$ 56,496	$ 10,852
Grapes	$ 55,000	$ 19,268	$ 6,452	$ 20,030	$ 8,111
Olives	$ 7,000				

Notes:

EBT = Earnings before Interest and Tax
Development $ is variable e.g. Grapes contouring etc.

2008/09 Sourced from MAF monitoring

2009/10 have built in returns on what we are seeing currently

Olives not sure if this is a suitable crop

The other grower I have sought comments from is in the Augmentation Study Group.

Murray King (Dairy Farming) has updated his previous figures (shown in brackets).

> Gross Margin per hectare for dairy farming (after deducting costs) for 2009 = $3,000/ha (2006 = $2,100/ha). Note that Murray has based these figures on a $3,000 cost of production and a $5/kg solids payout for this year. Dairy farms will experience more significant dollar losses with early feed shortages [as their peak-milk production is probably late October to early December where as apple and Kiwifruit losses will be worst later in the season (late February to April for Kiwifruit)].
>
> Murray King feels that losses for the two significant drought years (1982/83 and 2000/01) would be about $1800/ha (2006 it was $1,250/ha).

John Bealing
Engineering Consultant
Agfirst

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APPENDIX A

WAIROA RIVER WATER RESTRICTIONS

1. Average Year

Comparing the 2008/09-year as average, I can see no major impact on either horticultural crop, as 20% should be manageable for all producers. Kiwifruit, apples and viticulture will not suffer any detrimentals from a 20% restriction. Apples and Viticulture commence harvesting in February and March and water could be switched to non-harvested varieties to satisfactorily complete harvesting.

No major impact is expected next season providing the vines/trees were healthy at leaf fall, which I would expect in this scenario.

Net EBT in 'Average year' based on the 2008/09 return

Soil Type	Kiwifruit	Apples	Grapes
30mm/week	$9,981	$11,633	$9,529
35mm/week	$9,981	$11,633	$9,529

2. 25-33 year drought

This situation is a bit more critical. 20% restrictions starting early in November and progressing on to 40% restrictions in mid February till early April will impact upon the main crops grown. The early deficits would suggest not enough soil moisture is available to sustain the crops over the early summer period. I would assume kiwifruit size to suffer 10% and for overall yield to be 12% lower for kiwifruit. However, this deficit could have a small increase in dry matter which would increase the taste (TZG) profile and slightly affect the reduction in fruit size. This would lower the Net EBT (based on the 2008/09), to $5,550/ha on the lighter 35 mm/week soils, and a lesser affect on the heavier soils (5% smaller size and 8% crop reduction) to $7,056.

Viticulture is better suited to early restrictions as minimal water reduces canopy growth and can improve wine quality providing ample water is available at harvest time. This scenario indicates water restrictions would still be in place over harvest; therefore grape quality would suffer with the 40% restrictions at harvest. Viticulturist may be able to manage this by irrigating the early harvested varieties then switching water over to the late harvested varieties. However it is becoming more common to plant fewer varieties (mainly Sauvignon Blanc) and this makes this strategy not always possible. Therefore I would expect at least a 10% reduction in yield due to smaller berry size. Grape quality is more complex and depending on how viticulturists handle the restrictions, only a small reduction in wine quality (price 5% lower), providing the vines are not pushed too far. On the lighter soils (35 mm/week) this would reduce Net EBT to $6,682/ha and on the heavier soils a lesser reduction of Net EBT to $7,496/ha.

Apples and pear size would be reduced by 10% with this type of restriction. Mostly because of the length or number of weeks a restriction has been in place. Growers would have had to achieve a very successful chemical thinning program to keep this size reduction at only 10%. Some years this is not always possible if temperatures are cooler than normal at the critical chemical thinning time of September/October. Extra hand thinning costs would be required to remove small fruit throughout the season. This would necessitate at least a 10-15% reduction in crop load to maintain fruit size. The Net EBT would be $4,891/ha on the lighter soils (35mm/week). The heavier soils (30mm/week) will be less affected $6,409/ha.

In extreme dry years, trees react differently. It was noticeable than some trees (Cox Orange Pippin and Royal Gala) tend to have a lighter return bloom following a dry year. I would expect this under this scenario production could be 10-20% lower for these varieties the next season.

Net EBT in "25-33 year drought" /ha

Soil Type	Kiwifruit	Apples	Grapes
30mm/week	$7,056	$6,409	$7,496
35mm/week	$5,550	$4,891	$6,682

3. <u>27-85 year drought</u>

This situation provides a greater number of third stage restrictions however the number of stage 1 and 2 cuts is less than the '25-33 year drought'. The fact that there are fewer restriction days is offset by the severity of the stage 3 restrictions. Growers would not have had the early warnings to set appropriate tree crop loads as in section 2 and therefore would find themselves in a potential over cropping situation with limited water to finish the crop at harvest. Because the heavier soils have a greater buffering capacity, I would expect the losses to be the same as in the '25-33 year drought' (5% smaller size and 8% crop reduction) to return a Net EBT of $7,056/ha. The lighter soils would suffer greater reduction to the Net EBT ($1,589/ha) as fruit size would be 10% smaller and crop yield 12% lower. Some of this may be offset by higher dry matter. Kiwifruit can gain size in autumn prior to harvest if satisfactory rain occurs in late April early May, however sufficient rain cannot always be counted on.

Net EBT in "27-85 year drought" /ha

Soil Type	Kiwifruit	Apples	Grapes
30mm/week	$7,056	$4,891	$6,682
35mm/week	$1,589	$2,923	$2,461

On the heavier soils, apples would experience an estimated reduction of Net EBT $4,891 as per the '25-33 year drought' (10% smaller size and 8% crop reduction). The lighter soils would suffer a greater reduction in fruit size (as much as 15%) and reduced yield of 20% because of the late notice of water restrictions. Crops would have been set, but water restrictions would not enable them to be finished. The lighter soils do not have the buffering capacity. This would reduce Net EBT to $2,293/ha.

As for the other crops, Grapes should be capable of achieving only small reductions in yield s and quality on the heavier soils as per the ‘25-33 year drought’ section. Net EBT for the heavier soils $6,682/ha. However the lighter soils would have greater loss in yield (20%) due to smaller berry size and potentially a 20% reduction in quality (price). Net EBT for the lighter soils is $2,461/ha. This price reduction is subjective as some poor quality grapes may not get harvested due to oversupply.

Footnote: the returns for apples, grapes and kiwifruit are very dependent on exchange rates which were very favourable in 2008/09. The effect on Net EBT due to water restrictions would have a more significant reduction if less favourable exchange rates or lower market returns had eventuated. Generally 2008/09 was a good year for grower returns.

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