Waimea Water Augmentation Committee

Preliminary Economic Assessment of Water Augmentation in the Waimea Catchment

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Crighton Anderson

Corporate Finance

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1.0 INTRODUCTION

The Waimea Water Augmentation Committee ("WWAC") has commissioned Tonkin and Taylor to undertake a study of water storage in the upper part of the Wairoa/Lee catchments in Tasman District. The overall scope of the study was to address the recurrent water shortages experienced on the Waimea Plains and to investigate enhancing water availability for consumptive and environmental benefits downstream on the Waimea Plains and surrounds. The first phase of the study has gone through a staged process including investigation of storage site options, and WWAC has now identified Site 11 (Lee) as the preferred option for possible storage.

Crighton Anderson Corporate Finance ("Crighton Anderson") has been engaged to provide a preliminary economic assessment of the preferred water storage option. The assessment is based on input data that has been generated as part of the pre-feasibility level investigations and which is provided on an indicative basis only. 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 two 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.

- **Opportunity Cost of Non-Augmentation** Without an investment in storage for augmentation, any proposed future increases to the minimum flow requirements for the Waimea River will lead to a reduction in the security of supply for existing water users. For the purposes of this assessment, we have assumed that all existing irrigators would face water restrictions to maintain a minimum flow of 800 l/sec in the Waimea River at the Appleby Bridge. Indicative estimates of the economic cost of possible water restrictions for a number of land uses are determined using a series of high-level assumptions regarding the severity and frequency of the restrictions.

Under the Tasman District Council's present water management system, the Waimea River system provides irrigation water to approximately 3,800 hectares. It is estimated that a further 1,500 hectares within the Waimea Plains area is irrigable land. The augmentation scheme could also potentially support another 300 hectares in the lower Wai-iti Valley that is not covered by the existing Kainui scheme. This gives a total irrigable area of 5,600 hectares.

The existing irrigable area has a variety of soil types and supports a range of alternative land uses, with approximate areas as set out in Table 1.

Table 1: Current Land Use and Soil Types (Hectares)

	Soil Type (By Soil Moisture Holding Capacity)			
Land Use	**38 mm**	**78 mm**	**130 mm**	**Total**
Pasture	600	100	900	1,600
Apples, Kiwifruit	760	190	900	1,850
Grapes, Olives	200	20	130	350
Total	1,560	310	1,930	3,800

Water demand per hectare is a function of both soil type and land use. Lighter soil types obviously require a higher volume of water per hectare to support any particular land use, while pasture requires up to three times the volume of water compared to grape production. These differences between water demand per hectare are brought to account by determining “area equivalents” that take account of the estimated areas of differing soil types and by conservatively assuming that all of the irrigable area is in pasture production. Pasture production is assumed to require a water allocation of 35 mm/ha/week.

Area equivalents determined on this basis are presented in Table 2, along with the demand estimated by the Tasman District Council (“TDC”) for existing and future urban / industrial uses.

Table 2: Assumed Water Demand (in Hectare Equivalents)

	Gross Area (Hectares)	Area Equivalents (Hectares)
Existing Irrigation Area	3,800	3,265
Potential New Irrigation Area	1,500	1,285[1]
Potential New Irrigation Area in Lower Wai-iti	300	255[1]
Existing TDC Urban and Industrial Use	NA	420
Allowance for Future Urban and Industrial Use (Tasman District)	NA	400
Allowance for Future Regional Need	NA	440
	5,300	6,065

[1] Conversion of gross area to net area for these components has been determined by applying the conversion ratio implied by the calculation for the 3,800 hectares that are currently irrigated. This approach assumes that the soil types and land uses on the new irrigable areas are broadly consistent with those on the existing irrigated area.

For this first stage of the 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. We suggest that this will consider actual water usage, or if that is unavailable, the estimated soil and crop needs, rather than the area irrigated.

2.0 AN ECONOMIC ASSESSMENT OF PROPOSED AUGMENTATION OPTION

2.1 POTENTIAL OWNERSHIP STRUCTURES

The level of charges may be influenced to some degree by the chosen ownership structure for the scheme. A general summary of the ownership alternatives is presented in Appendix I, with a brief description of the main considerations for ownership by either a Local Authority or some other public entity, as well as a private entity.

Given the scale and nature of the proposed Waimea scheme, the council or private ownership alternatives are likely to be most appropriate in this case. Among the key characteristics that must be appropriately accounted for in the chosen structure are:

- **Public / Private Water Demand** It is proposed that the water storage will be used to both enhance the security of supply for consumptive users as well as allow for a provision of greater minimum flows within the Waimea River. Consumptive users are also split between private land owners and the TDC on behalf of the community (both for community consumptive water use, and other community benefits). One of the most important requirements of the chosen structure will be to allow for a fair and transparent allocation of capital and operating costs between the scheme participants.

- **Existing / New Irrigators** It is currently proposed that the scheme will not only improve security of supply for existing irrigators, but will also provide new supply to 2,380 area equivalents (1,540 hectares for irrigation, 400 hectares for future demand by urban and industrial uses, and 440 hectares for future regional supply). If a differential charging regime is deemed to be appropriate for the existing and new irrigators, then the ownership structure of the scheme must be capable of reflecting these differences.

2.2 INDICATIVE COSTS FOR WATER USERS

2.2.1 Base Case Results

Indicative charges for prospective users of the augmentation scheme have been determined using a series of high level assumptions. Key assumptions are outlined in Table 3.

Table 3: Base Case Assumptions for Economic Analysis

Assumption Name	Discussion	Adopted Value
Total Capital Cost	Preliminary estimates provided by Tonkin and Taylor and TDC. The adopted value is based on a pre-feasibility investigation level estimate between $20 and $25 million, plus an allowance for land purchase. Excludes any costs associated with piped delivery from dam or any other distribution infrastructure. For any given percentage change in capital costs, the indicative annual charges will change by about the same percentage amount.	$23,000,000
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
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. Total cost debt funded at an assumed cost of 100 basis points over 90-day Bank Bill rate (currently 7.7%).	8.70%
Taxation Treatment	We assume that the assets are owned by a separate tax paying entity subject to standard corporate tax. Company revenue is derived from annual payments paid by scheme participants, and 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 company generates positive taxable income.	
Cost Allocation for Environmental Flows	The proposed storage dam has been designed to meet environmental requirements via the imposition of a minimum flow in the Waimea River. Based on preliminary security of supply targets and some limited hydrological modelling, an initial estimate has been made of the proportion of the dam capacity that is needed to meet the environmental requirements. This can be used to determine the proportion of the total capital cost that should be met by the consumptive users, and the proportion that should be paid for by the wider community. The initial estimate of an appropriate split is 70% consumptive users / 30% environmental flows.	30%

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 four charging regimes:

(i) **Existing Irrigation Users** Costs are assumed to be met by existing irrigators only. This is the equivalent of apportioning costs over an area of 3,265 hectares.

(ii) **All Existing Users** All costs are met by existing consumptive water users (existing irrigators (3,265 hectares) plus urban / industrial demand (420 hectares)). Total effective demand equals 3,685 hectares, when expressed on the basis of water demand equal to 35 mm/ha/wk.

(iii) **Existing Irrigation Users Plus New Irrigation** Costs are uniformly allocated between existing irrigators (3,265 hectares) and new irrigators (1,540 hectares). Total effective demand equals 4,805 hectares.

(iv) **All Potential Users** Annual charges are estimated on the basis that the capital cost is evenly allocated among all users listed in Table 2. Total effective demand equals 6,065 hectares.

Using the 70% allocation of total cost to consumptive users as a base case[1], the indicative capital costs are presented in Table 4.

Table 4: Indicative Costs for Base Case Cost Sharing Scenarios

	Existing Irrigation Users	All Existing Users	Existing Irrigation Users Plus New Irrigation	All Potential Users
Effective Hectares	3,265	3,685	4,805	6,065
Capital Cost per Hectare	$4,930	$4,370	$3,350	$2,655
Equivalent Annual Charge per Hectare	$565	$500	$380	$305

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 decision for each potential scheme participant based on their evaluation of the indicative scheme costs.

For comparison purposes, the next section briefly summarises the indicative annual cost of participating in two other irrigation schemes that we have been involved in recently.

2.2.2 Comparative Cost Data

Indicative charges for two new and proposed schemes in North Otago and South Canterbury are presented in Table 5. The North Otago Irrigation Company has recently commissioned the first stage of a two-stage scheme that will eventually irrigate 20,000 hectares. Stage I covers 10,000 hectares of land that is predominantly used for pastoral production. Hunter Downs is a scheme concept that was announced early in 2006 to irrigate up to 40,000 hectares in a catchment area between the north bank of the Waitaki River and Otipua, just south of Timaru. The proposed scheme is currently at the consenting stage, and the potential costs are therefore very preliminary in nature.

In both cases, participating farmers are assumed to contribute to the initial capital cost of constructing the schemes and this has an impact on the ongoing charges that need to be levied to meet debt repayment requirements. In order to make the indicative charges for these schemes comparable to the estimated charges for the proposed Waimea scheme, the figures presented in Table 5 have been recalculated on the basis that the full capital costs have been financed using bank debt (with no capital contribution from the scheme participants).

[1] The capital cost allocated to the provision of the environmental flows is approximately $6.9 million. If this cost was financed on the same terms as assumed for consumptive users, the annual servicing charge would be approximately $685,000 over a 25 year repayment period.

The other relevant benchmark relates to the Wai-iti water augmentation scheme. Payment for this scheme is made by water users through a TDC rate on the weekly water allocation on their water permit; for irrigators, this corresponds to a charge per hectare of water allocation for irrigation, as all users have the same per hectare allocation in the Wai-iti. Existing Wai-iti water permit holders are to be rated at approximately $250 (excl GST)/ha/year – increasing in years 4-30 to $280 - while new water users will pay this rate plus an up-front single capital contribution of $1,060/ha. These costs will repay a 30-year loan for scheme costs, plus the ongoing Operating & Maintenance costs.

Table 5: Indicative Annual Charges For Other Schemes (Per Hectare)

	Waimea (All Potential Users)		North Otago Irrigation Company[1]	Hunter Downs[2]	Wai-iti (Existing User)[3]	Wai-iti (New User)[4]
Annual Fixed Charge			$470	$560		
Recovery of Operating Expenses			$250	$100		
Total Annual Charges	$305		$720	$660	$280	$380

[1] Estimated costs based on information contained in the prospectus, issued prior to the commencement of construction.

[2] Based on capital costs assessed to a pre-feasibility level.

[3] Total charge includes repayment of capital cost and provision for operating and maintenance costs.

[4] Based on the annual charge for existing users plus an additional charge of $100 / ha to service the capital cost of $1,060 per hectare (assuming a 30 year repayment term)

The annual charges for both North Otago and Hunter Downs are considerably higher than the indicative costs for the Waimea augmentation. Assuming the costs are met by all potential users of the Waimea scheme, the indicative annual charge of $305 is also reasonably consistent with the charges levied on existing irrigators using the Wai-iti scheme. While these simple comparisons help to place the cost of the proposed Waimea scheme in context, we also note that there are some significant differences between the schemes. We note that:

- The North Otago and Hunter Downs schemes will irrigate areas that were previously farmed as dryland with little or no previous access to water. We expect that dryland farmers will have a far higher propensity to pay compared to the consumptive users that currently have access to water on the Waimea Plains. Having said that, the more intensive land use on the Waimea Plains will almost certainly increase the ability of the existing Waimea irrigators to pay.

- The indicative annual charges for the proposed Waimea scheme do not include operating costs. We would expect however that the likely costs for the proposed scheme are relatively minor in comparison to the North Otago and Hunter Downs schemes, both of which are reliant on substantial pumping charges and electricity use.

- The Waimea scheme is costed on a run-of-river basis which means users may face additional on-farm costs for pumping and reticulation, even if water is piped to the mouth of Wairoa Gorge. New irrigators will definitely face the costs of establishing on-farm infrastructure.

2.2.3 Indicative Costs for Other Allocation Methods

The indicative base case costs presented in Table 4 are reliant on some relatively arbitrary assumptions relating to the assumed structure of the scheme. The most important structural assumptions, and the impact that each would have on the indicative costs are outlined below. In each case the cost comparison is limited to the scenario in which all potential consumptive users are included in the cost allocation (i.e. an area equivalent total of 6,065 hectares).

Extent of Construction

Base case estimates for scheme costs only consider the capital cost of the storage dam and related structures. The cost of delivering piped water from the proposed dam site to the Wairoa Gorge / Waimea East Irrigation intake has been estimated at $6.5 million. Indicative scheme costs per hectare that incorporate the piped delivery option are presented in Table 6.

Table 6: Indicative Scheme Costs – Piped Delivery

	Capital Cost Per Hectare	Equivalent Annual Charge per Hectare
Base Case	$2,655	$305
Piped Delivery Option[1]	$3,405	$390
Incremental Cost	$750	$85

[1] Only costed to Wairoa Gorge / Waimea East irrigation intake, and excludes reticulation costs over the Waimea Plains.

Cost Allocation to Consumptive Users

High level modelling indicates that a reasonable split of the total cost of the scheme between consumptive users and environmental flows is 70% / 30%. This ratio represents the relative proportion of the storage capacity that is needed to meet the consumptive and environmental uses for a drought return period of 25 years. This estimate is based on limited modelling and is dependent on the methodology that is ultimately determined to be most appropriate for assessing a fair cost allocation between the two water uses.

Table 4 gave the indicative costs assuming consumptive users pay for 70% of the scheme. Table 7 presents the indicative costs of the scheme under the assumption that 100% of the initial capital expenditure is paid for by consumptive users (i.e. there is no community contribution for the environmental flow proportion).

Table 7: Indicative Scheme Costs – 100% Allocation to Consumptive Users

	Capital Cost Per Hectare	Equivalent Annual Charge per Hectare
Base Case (70% cost allocated to consumptive users)	$2,655	$305
100% Allocation to Consumptive Users	$3,790	$435
Incremental Cost to Consumptive Users	$1,135	$130

Depreciation

The taxation benefit derived from depreciating the capital invested in the scheme is not immediately available to the scheme participants. Instead, the depreciation claims are assumed to be made by the company that owns the assets. Because the company is not in a tax paying position until the end of the assumed 25 year repayment period, the tax benefits are delayed and the estimated annual charge is therefore higher than it would otherwise be.

Immediate access to the depreciation claims can have a significant impact on post-tax costs for schemes with high capital costs and significant investment in rapidly depreciating assets. For example, the annual effective cost for participants in the North Otago scheme will be reduced by approximately $60 per hectare if the ownership structure is changed so that the large depreciation claims available in the early years of the scheme can be passed directly to the individual irrigators. This benefit is significant because of the large investment in plant and machinery (pumping equipment) that can be depreciated for tax purposes over a short period of time.

The potential benefit for the Waimea augmentation scheme will be lower because the majority of the capital investment relates to civil works and structures that are depreciated over a far longer period. The limited impact of this factor is presented in Table 8.

Table 8: Indicative Scheme Costs – Depreciation Claim Passed to Scheme Participants

	Capital Cost Per Hectare	Equivalent Annual Charge per Hectare
Base Case	$2,655	$305
Depreciation Claim Passed to Scheme Participants	$2,655	$290
Incremental Cost	$0	($15)

Implementation of an ownership structure that will allow users to directly access the depreciation claim is not straight forward. The additional complication of pursuing this ownership alternative is unlikely to be worthwhile based on the relatively minor financial benefits that will accrue.

3.0 INDICATIVE OPPORTUNITY COST OF NON-AUGMENTATION

This section presents a high level assessment of the potential economic loss that current irrigators may suffer if the augmentation scheme does not proceed. In this assessment it has also been assumed that at some time in the future the current minimum environmental flow is increased. The indicative values are based on analysis contained in the following two reports:

(i) **Modelling Water Rationing for the Waimea Plains** This report was prepared by Andrew Fenemor of Landcare Research and examines the likely water restrictions that would be imposed on existing irrigators for both an "average" summer and a 25 year drought. An abridged copy of the report is provided in Appendix II.

(ii) **Economic Impacts of Water Restrictions on Standard Crop Types** This report was prepared by John Bealing from Agfirst Consultants. 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. The report is attached as Appendix III.

Given the preliminary 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.

Our analytical framework is based on the following key assumptions:

- **Minimum Environmental Flows** The original and currently operative minimum flow requirement in the Waimea Water Management Plan was 225 l/sec at the Appleby Bridge. Although the minimum flow was raised to 500 l/sec when the Tasman Resource Management Plan ("TRMP") water rules were notified in 2001, the 500 l/sec minimum flow target is still under contest by submitters. The TDC now has ecological data that suggests that this level is inadequate, and the Waimea water augmentation study has identified that more appropriate minimum flows may be as high as 1,300 l/sec. The water rationing modelling conducted by Landcare Research for this economic assessment adopts a minimum flow of 800 l/sec based on an objective assessment as to what could emerge as a realistic outcome under a Resource Management Act process to change the minimum flow requirements set out in the Tasman Resource Management Plan (i.e. in the absence of any Waimea augmentation scheme).

- **Water Allocation Response** The assumed allocation response in the event of a water shortage is that the security of supply to all existing permit holders will be reduced, rather than a reduction in the total volume allocated to water permits.

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[2]). Assuming a minimum flow of 800 l/sec was imposed, the water records were then used to simulate the frequency and duration of water restrictions that would be imposed on irrigators under the assumed hydrological conditions. Table 9 sets out the number of days that water rationing would have been imposed for each of the selected annual records.

[2] 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.

Table 9: Summary Results of Water Rationing Modelling (Restricted Days)

	Severity of Restriction			
Water Flow Scenario	**Step 1 (20% Cut)**	**Step 2 (35% Cut)**	**Step 3 (50% Cut)**	**Total**
Average Year (2004/05)	17	0	0	17
25-33 Year Drought (1982/83)	77	14	32	123
27-85 Year Drought (2000/01)	46	17	38	101

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. While the results of the relatively mild restrictions implied by an average season are expected to have a negligible impact on the profitability of all land uses, the impact of a 1 in 25-year drought is significant.

Summary results are presented in Table 10 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 apple 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 10: 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	$1,250	$1,250	$1,250	$1,250
Apples	$7,670	$5,186	$15,917	$7,670
Kiwifruit	$5,846	$4,516	$7,736	$4,516
Grapes	$1,903	$1,062	$7,382	$1,903

The total economic impact of a 1 in 25-year drought is estimated by combining the per hectare losses presented in Table 10 with the crop area estimates shown in Table 1. The results are set out in Table 11.

Table 11: Estimated Economic Losses (NZD 000's) of 1 in 25 Year Drought for Current Irrigable Area (3800 ha)

	25 – 33 Year Drought (1982/83 Data)			27 – 85 Year Drought (2000/01 Data)		
Crop Type	**Light Soils**	**Heavy Soils**	**Total**	**Light Soils**	**Heavy Soils**	**Total**
Pasture	$875	$1,125	**$2,000**	$875	$1,125	**$2,000**
Apples	$6,557	$4,201	**$10,759**	$13,609	$6,213	**$19,822**
Kiwifruit	$555	$407	**$962**	$735	$406	**$1,141**
Grapes	$419	$138	**$557**	$1,624	$247	**$1,871**
All Crops	$8,407	$5,870	**$14,277**	$16,843	$7,992	**$24,835**

The indicative aggregate costs of a 1 in 25 year drought implied by the test data range between approximately $14.3 million and $24.8 million. This is an estimate of the aggregate value of lost production from the 3,265 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 aggregate earnings from the irrigated area in a normal year is approximately $32.3 million, the estimated losses represent between 45% and 75% of average earnings (based on current production costs and output prices).

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. Some of the key considerations are as follows:

- 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; Agfirst Consultants suggest that significant economic costs may only be experienced for restrictions relating to a 1 in 15-year drought or worse. Assessing the likely economic impacts for these intermediate drought return periods is beyond the scope of the current phase of investigations.

- 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 15 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 falls in a range between approximately $80 million and $135 million.

- 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 aggregate economic cost for any particular drought return period can therefore only be estimated within a large range.

- 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. 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 800 l/sec minimum flow. Economic impacts on consumptive water users may therefore be more significant than indicated by this preliminary modelling.

- This high level analysis does not consider the potential regional economic opportunity cost of non-augmentation in relation to residential and industrial development. In our view there is insufficient information available to allow a meaningful estimate. However, we note that the allowance for future urban and industrial use (in both the Tasman District and the region as a whole) amounts to a total of 840 hectare equivalents, based on expected demand for approximately 15,000 new residential allotments and some 65 hectares of new industrial development. Economic growth associated with this anticipated development over the 40-50 year planning period is clearly significant for the Tasman District.

4.0 SUMMARY AND CONCLUSIONS

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

The two main conclusions that can be drawn from the preliminary 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 (via the TDC). 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 annual charge will be approximately $305 per hectare. It is important to emphasise that this indicative charge is based on a preliminary estimate of the total capital cost for the scheme ($23.0 million including land). Any change in the estimated capital costs will result in about the same percentage change in the indicative annual charge.

  However, based on the information available to date, the preliminary estimate of the annual charge for this scheme compares favourably to other schemes that have been initiated recently, and is relatively consistent with charges for existing irrigators using the Wai-iti augmentation scheme.

- **Opportunity Cost of Non-Augmentation** A limited set of hydrological data has been used to determine the possible impact of non-augmentation on agricultural and horticultural production in the event that minimum flows in the Waimea River are increased. Based on current land use and return levels, the indicative cost of a 1 in 25 year drought is estimated between $14.3 million and $24.8 million, depending on the timing of the water shortages. These estimated losses represent between 45% and 75% of aggregate net earnings from the irrigated land during an “average” year. Given the significance of this potential economic impact, non-augmentation may well lead to considerable changes to the existing balance of land use.

APPENDIX I – ALTERNATIVE SCHEME OWNERSHIP STRUCTURES

Table 12: Ownership Structure Comparison

	Council	**Private**	**Public**
General Description	Owned and operated by the local District Council similar to urban water supplies. Construction and operation funded by rates from the area of benefit. The security of cash flow provided by the Council's ability to levy rates results in a relatively low cost of capital.	The irrigation scheme would be owned and operated by a distinctly 'closed' entity that serves to benefit a defined group of people. The aims and objectives of ownership in the entity would be very similar for all shareholders and the direct benefits would accrue to the private owners of the entity. This closed entity can be in the form of: • A Co-operative Company • An Incorporated Society • A Partnership Under the co-operative structure the shareholders in the entity are also the consumers of the service provided. Owners and participants in the scheme are generally easily identified. This results in a very simple organisational structure with a very distinct irrigation community.	The irrigation entity would be a public company and shares could be owned by the public at large. As a result, ownership can extend beyond the irrigation community that receives the direct benefits from the scheme. There tends to be greater emphasis on achieving a competitive return on the capital invested by the shareholders. It therefore becomes important that the entity is profitable. The key benefit of this type of structure is that capital is sourced from a wider pool than just the consumers of the irrigation service.
The assets owned by the entity Land and Earthworks Plant and Machinery Water Rights	Council ownership of assets is straightforward. The tax advantage of depreciation of the plant and machinery cannot be used.	The co-operative structure is ideal for owning assets that are used solely for the scheme. Transfer of existing water rights is more straightforward to a cooperative as the existing owners can see that they will be used solely for their benefit. Appropriate compensation can still be an issue.	A public company can easily hold assets for a number of purposes. This can mean that assets for use of the scheme can become confused with assets used for other purposes. Transfer of existing rights is more difficult than to a cooperative as the existing owner may have concerns about how the rights will be used.

	Council	Private	Public
Effect on take up	Payment for the scheme via rates may result in a take or pay situation for the potential users of the scheme. This will result in high take up. Inefficient use of the water can result unless there is a usage charge consistent with the marginal cost of supply.	Potential users of the scheme have a strong incentive to join the company, either to secure water rights or to protect their existing interests. Forfeiture of existing water rights on joining the scheme can be a disincentive. Uncertainty in the schemes likelihood of proceeding and ongoing viability can also affect take up in the co-operative's shares.	Potential users of the scheme have less incentive to join the company, but the same incentive to use the scheme's services as a cooperative.
Financing - Equity raising - The ability to obtain debt financing.	Significant equity can be provided by the Council for reasonably sized projects. As the Council can use the rating system to guarantee cash flow, loan finance will tend to be cheaper.	Equity will need to be raised from the users of the scheme. This can be difficult for some potential users who must meet on farm commitments as well as the cooperative's requirements. Debt can be difficult to raise for a cooperative. Underwriting of the debt by Council has been used, as in the case of the Waimakariri Irrigation Scheme	The key advantage of this structure is the potential to raise equity from a wider base. Lending institutions may favour this structure over that of a cooperative.
The ongoing financial viability of the entity	There would be no issue with ongoing financial viability of the entity.	Because of the long term nature of the physical assets of the entity and the substantial level of debt finance that will require servicing it will be very important for the entity to maintain financial stability and liquidity. By linking ownership in the scheme to the land in the scheme command area the entity can ensure that long term commitment to the scheme is maintained, despite changes that may occur to the land ownership and land use over the years. The use of a supply contract would further help to create certainty by maintaining a continuity of equity and involvement in the irrigation scheme.	The degree of risk would vary according to the nature of supply agreements and the nature of the physical assets. Under this structure there is a defined need for entity to be profitable and maintain a competitive return on shareholders funds. The pricing structure for the user charges needs greater consideration to ensure they adequately reflect value.

	Council	Private	Public
Taxation issues	As Council's do not pay tax there are few tax issues. Schemes with relatively high plant and machinery cannot receive the benefit of the depreciation tax shield.	The principle objective would be for the entity to break-even, although this would be subject to any decision relating to building up reserves. An issue may be the distribution of rebates to company members. Such rebates are generally deductible to the company and assessable to the shareholder.	Taxation issues are most prevalent under this structure, mainly because there are many more options to the structure. More care is required in the company's structure and dealings.
Ownership and control	The Council maintains both ownership and control, subject only to the normal influences on Council operation. The lack of direct control by scheme users can be seen as a negative by the scheme users.	Ownership of the entity remains with a pre-defined set of landowners within the command area of the irrigation scheme. Such a strong link between the ownership and control of the entity provides security for those involved in the scheme as they have the ability to maintain a security of supply and manage the day to day operations of the scheme in a manner consistent with their community objectives. Generally landowners find this structure suitable because it allows them to achieve their goals of controlling the costs of supplying the water and ensuring the security of supply.	This entity structure has the ability to incorporate as many possible landowners within the command area of the irrigation scheme, whilst still allowing for outside investors by allowing potential irrigators the right of first refusal on the shares being offered. The ownership is therefore much broader and encompasses a much wider variety of shareholders. As raised earlier, the establishment of first right of refusal or preferential share rights can maintain a control structure suitable to the needs of the shareholders, taking into account the need to include as many potential irrigators in the scheme.
Future opportunities and development within the scheme and its owners	Subject to Council decision processes expansion or change to the scheme is easily accommodated.	Under this entity structure concerns for how to incorporate future expansions of the scheme, a transfer of landholdings or the subdivision of land within the irrigation command area must be dealt with in advance. Given the closed and restricted nature of the co-operative entity, changes that will affect land holdings will in turn affect the shareholding in the company where the rights to receive water are based on the area of land held. The eventual entity structure must therefore enable flexibility for shareholders to come and go as well as allowing for an increase in the size of the shareholding.	This structure is amenable to change and can easily accommodate expansion of the scheme in the future.

APPENDIX II – LANDCARE RESEARCH REPORT

Modelling Water Rationing for the Waimea Plains

Andrew Fenemor

Landcare Research
Private Bag 6, Nelson 7042
New Zealand

Landcare Research Contract Report: LC0607/031

PREPARED FOR:
Waimea Water Augmentation Committee
c/- Tonkin and Taylor Ltd
P O Box 2083
Wellington

DATE: October 2006

ISO 14001

Reviewed by:	*Approved for release by:*
Tim Davie Scientist Landcare Research	Alison Collins Science Leader Soil Landscape Responses

Contents

1. Background

This small project is a contribution to the economic assessment of the option of no water augmentation scheme being pursued for the Waimea Plains, but with the expectation that water rationing could be implemented to maintain a higher residual flow in the Waimea River of 800 litres per second.

The project 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 that residual flow.

Model predictions for a 25-year drought (1982-83) and an average summer (2004-05) have then been passed to Agfirst Consultants (John Bealing) to estimate the production losses which could arise from irrigation restrictions on pasture, apples, and grapes/olives. Those losses are then factored into an overall economic assessment by Crighton Anderson & Co of the costs incurred for both irrigation and urban water use over a 20 year period.

2. Methods

The brief for the economic work dated 1 September 2006 (Appendix 1) is based on two main assumptions:

It is assumed that the over-allocation of water from the Waimea water system will increase over time, as a result of a future increase in the instream minimum flow requirements. The following assumptions are made:

- *That the current operative minimum instream requirement of 225 l/sec at the Appleby Bridge is increased to 800 l/sec*
- *That the allocation response to this is a reduction in security of supply (rather than reduction in water permits issued).*

The assumption behind the non-augmentation option is at the worst-case end of the spectrum of options. The assumption is that water rationing would be imposed on water users to maintain a minimum flow of 800 l/sec in the Waimea River. This flow has been adopted for the purposes of calculating the effects of the non-augmentation scenario for the economic assessment for the following reasons:

- The original and currently operative minimum flow requirement in the Waimea Water Management Plan was 225 l/sec, and this was raised to 500 l/sec when the Tasman Resource Management Plan (TRMP) water rules were notified in 2001. The 500 l/sec minimum flow target is still under contest by submitters.

- TDC now has ecological information that suggests that this flow is not adequate (the Waimea water augmentation study has identified more appropriate minimum flows in the range of 500 l/sec to 1300 l/sec measured at the Appleby Bridge).
- In the absence of the augmentation project it is reasonable to assume that at some stage in the future there may be a change to the TRMP minimum flow requirement.
- It appears reasonable to assume that such a process under the Resource Management Act would result in a compromise flow being adopted (somewhere between the existing figure and the range of recommended figures)
- 800 l/sec has been adopted for the purposes of the current assessment as being a probable outcome scenario.
- The moratorium on any further granting of water permits across the Waimea Basin is expected to continue.

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 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 2006.

3. Assumptions

The model has been built based on these assumptions:

1. The GNS groundwater model indicates based on 1982-83 and 2000-01 data that a river flow of 800 l/sec near Appleby corresponds roughly to a Wairoa Gorge flow of 2800 l/sec. This is a very approximate assumption for the reasons given above.

2. 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 800 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.

3. 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 800 l/sec and that the Council would in those situations impose even higher rationing cuts – probably up to 100% - if it wanted to maintain the 800 l/sec minimum. Such draconian cuts may not be implemented, which is why the assumption of ongoing Step 3 (50%) cuts has been adopted.

4. Having run the model to generate a timeseries 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.

5. The irrigation season runs November-April inclusive so any cuts predicted outside this period are ignored.

4. Results

The spreadsheet of cuts for the entire 48 years of flow data is attached in Appendix 2 as *Modelled Water Rationing Steps based on Wairoa Gorge flows for 1958-2006*. Columns in the spreadsheet are:

Date and time of end of this period of rationing
Duration of this whole period of rationing (hrs)
Maximum rationing step reached (1,2 or 3)
Three columns showing Start date and time for this rationing step and mean Wairoa Gorge flow during that step, for Steps 1, 2, and 3 if reached in that event.

This data could be used to assess potential economic losses arising for these levels of rationing over any period of up to the full 48 years of record.

The brief calls for analysis for 1982-83 (a 25-33 year drought[1]), or 2000-01 (a 27-85 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 Appendix 2 to provide this summary data for the economic analysis:

Table 1: Modelled Water Rationing for 1982-83, 2000-01 and 2004-05 summers

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	Date start rationing step 2 (35%) yymmdd	Date start rationing step 3 (50%) yymmdd

[1] Fenemor 2006: Waimea Water Augmentation Project: Review of Catchment Modelling and Storage Requirement. Landcare Research Contract Report LC0304/103 for Tonkin and Taylor Ltd.

11/11/1982	8	1	821104		
19/11/1982	5	1	821114		
27/11/1982	7	1	821120		
29/11/1982	2	1	821127		
12/12/1982	12	1	821130		
21/12/1982	6	1	821215		
25/12/1982	1	1	821224		
5/01/1983	7	1	821229		
13/01/1983	4	1	830109		
29/03/1983	60	3	830128	830211	830225
7/04/1983	8	1	830330		
14/04/1983	3	1	830412		
10/12/2000	*5*	*1*	*001206*		
28/12/2000	*2*	*1*	*001225*		
16/01/2001	*3*	*1*	*010113*		
26/01/2001	*8*	*1*	*010118*		
3/04/2001	*66*	*3*	*010127*	*010210*	*010224*
22/04/2001	*17*	*2*	*010404*	*010418*	
11/02/2005	2	1	050209		
7/03/2005	3	1	050303		
25/03/2005	12	1	050313		

5. Conclusions and Interpretation

Based on this model, the total days of water rationing days would have been 123 days in the 1982-83 summer, 101 days in 2000-01 and 17 in the average 2004-05 summer. Note that the higher frequency drought of 2000-01 would have had slightly fewer days of rationing because of the pattern of rainfalls during that period, but it would have had longer at Step 3 50% restrictions (which started on almost the same day at the end of January).

The brief calls for comment on what other responses the Council could implement in the event of water augmentation not proceeding. In order of economic impact, I consider these to be:

- Adopt the currently proposed 500 l/sec target minimum flow for the Waimea River, with water users faced with the continuing lower level of supply security than they would like.
- Carry out a 'bona fide' review of all water permits across the Waimea Plains to remove all unused allocations and reduce allocation limits accordingly (i.e. no re-allocation, but a slight increase in supply security for water users)
- An across-the-board reduction in allocations on water permits to achieve an agreed level of supply security which is higher than currently, in conjunction with implementation of a flexible water trading regime to allow transfers to highest value water uses
- Investigation and implementation of smaller scale water augmentation measures, such as the building of rock weirs in the Wairoa and Waimea Rivers to enhance aquifer recharge and storage; artificial aquifer recharge via pumped recharge wells; construction of Motutere Gravel gully dams for water augmentation in sites already investigated including Teapot Valley, and possibly Eves Valley.

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.

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

Thanks to Martin Doyle, hydrologist at Tasman District Council for providing the flow data, and processing it using the Tideda process PSIM. Thanks also to Sally Marx at Tonkin and Taylor in Wellington for comments on the draft report.

Appendix 1 Project Brief (Sally Marx, Tonkin & Taylor Ltd)

SCOPE OF ECONOMIC ASSESSMENT

To assist Tonkin & Taylor (T&T) to undertake a feasibility study for the Waimea Water Augmentation Committee (WWAC) of water augmentation in the Waimea Catchment, Tasman District.

Specifically to undertake a high-level economic analysis of the preferred water harvesting and storage option, as follows.

The work involves working closely with T&T on the project in a collaborative way and to T&T's direction.

1. Objective

To provide an economic analysis of the preferred water storage option to enable a determination of the economic feasibility of the augmentation project, with particular emphasis on the indicative cost of water on a per hectare basis. The assessment is also to estimate (high level estimation) the economic implications of no augmentation (ie should the project not proceed).

2. Background

WWAC is undertaking a study into potential water storage reservoirs to augment flows in the Waimea River for irrigation and instream demands. Following a staged selection process, WWAC decided in August 2006 to focus future investigations on Site 11 – Upper Lee River (grid reference N28: 234715).

T&T will now complete an indicative capital costing for the project (including infrastructure replacement). This information will be provided to Crighton Anderson to enable the economic analysis to be completed.

3. Scope of Work

3.1 Augmentation

Scope

The analysis is to identify:

- The cost of the project expressed per hectare of irrigable land. This is to be presented for four cases covering:
  - Existing irrigated area
  - Existing plus potential new irrigated area
  - Each of the above two cases incorporating a provision for 'future regional water need'

- The effects of incorporating depreciation in the above costings; ie the cost per hectare with and without depreciation

- The costs per hectare for the above cases assuming consumptive users pay for the entire scheme, compared with cost per hectare assuming a split payment (consumptive users pay for consumptive portion; community pays for environmental flows)

- The options for ownership and operating structure for the irrigation scheme, and the impacts of the alternatives on indicative irrigation costs.

Note: the analysis **excludes**:

- an assessment of on-farm benefits

- an assessment of district or regional economic effects arising from the scheme.

Information Provision/Task Responsibility

- Land purchase costs for scheme development (TDC)
- Current irrigated area, by 3-4 crop types (AgFirst – received)
- New irrigable areas, by 3-4 crop types (AgFirst – received)
- Provision for future regional needs (TDC – received)
- Construction costs (including infrastructure replacement) (T&T – A Pickens)
- Construction timeframe (T&T – A Pickens)
- Proportion of water demand required for consumptive use cf proportion for environmental flows (T&T – D Leong)

3.2 Non-augmentation ("do-nothing" scenario)

Scope

It is assumed that the over-allocation of water from the Waimea water system will increase over time, as a result of a future increase in the instream minimum flow requirements. The following assumptions are made:

- That the current minimum instream requirement of 500 l/sec at the Appleby Bridge is increased to 800 l/sec

- That the allocation response to this is a reduction in security of supply (rather than 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 area of the Waimea Plains that would result from the above assumptions (ie from the more limited irrigation scenario).

- This assessment is to be based on the hydrological record of two summer periods:

  - Either the 1982/83 summer or 2000/01 summer (representing drought conditions)

  - ➢ An 'average' summer.

- From these hydrological records, identify when flow restrictions would commence, at what level of restriction, and for what duration.

- Based on the above restrictions, evaluate the potential loss in income (based on production quantity and quality) for three crops (pasture, apples, grapes/olives). Validating these losses may require consultation with an irrigator in each landuse category.

- The resulting aggregate losses over a 20 year period are to be assessed.

- Assess the approximate restriction in economic growth rate arising from no additional provision for water for future urban supply from the augmentation scheme.

- Report the assumptions made in the above analysis.

- Brief comment on what other response options may exist (ie alternatives to accepting instream flow requirement of 800 l/sec).

Information Provision/Task Responsibility

- Capital cost of planting range of crops (AgFirst)
- Current $/hectare produced by various crops (AgFirst)
- Hydrological modelling (A Fenemor in conjunction with TDC hydrologist)
- Identification of when flow restrictions would commence at what level of restriction, and for what duration(AgFirst)
- Evaluation of losses in income (AgFirst)
- Assessment of aggregate losses based on above (Crighton Anderson)

4. Information Provision

The information noted above is to be provided to Crighton Anderson (via the Project Manager Sally Marx) by each of the nominated parties.

5. Output

The output from this work will be a report prepared by Crighton Anderson outlining the work undertaken, methods used, and the results, including a summary and comparative evaluation of the various cases.
The report should also outline any recommendations for further work that may be required to confirm or quantify the analysis.

Appendix 2 Modelled Water Rationing Steps based on Wairoa Gorge flows for 1958-2006

Date and time that the period ended	Duration of Rationing (hours, for periods >24hrs)	Max Rationing step reached (1=20% cut; 2=35% cut; 3=50% cut)	Date Start (yymmdd)	Time Start (hhmmss)	Mean flow rationing Step 1 (l/sec)	Date start Step 2 start	Time start Step 2 start	mean flow rationing Step 2	Date start Step 3	Time start Step 3	mean flow rationing Step 3
22/04/1958 02:00	301	1	580409	140000	2732						
29/01/1959 18:00	101	1	590125	140000	2857						
10/02/1959 01:00	223	1	590131	190000	2571						
20/02/1959 20:00	138	1	590215	30000	2573						
8/03/1959 17:00	351	2	590222	30000	2241	590308	30000	2060			
1/12/1959 00:00	92	1	591127	50000	2756						
6/12/1959 04:00	95	1	591202	60000	2666						
8/12/1959 17:00	46	1	591206	200000	2833						
5/01/1960 10:00	40	1	600103	190000	2901						
25/01/1960 03:00	403	2	600108	90000	2581	600122	90000	2382			
9/03/1960 01:00	308	1	600225	60000	2474						
17/12/1960 14:00	63	1	601214	240000	2866						
30/12/1960 03:00	185	1	601222	110000	2477						
17/01/1961 09:00	393	2	610101	10000	2198	610115	10000	1827			
28/02/1961 01:00	22	1	610227	40000	2851						
25/10/1961 16:00	44	1	611023	210000	2862						
13/12/1961 09:00	60	1	611210	220000	2690						
30/12/1961 13:00	399	2	611213	230000	2060	611227	230000	1729			

Date and time that the period ended	Duration of Rationing (hours, for periods >24hrs)	Max Rationing step reached (1=20% cut; 2=35% cut; 3=50% cut)	Date Start (yymmdd)	Time Start (hhmmss)	Mean flow rationing Step 1 (l/sec)	Date start Step 2 start	Time start Step 2 start	mean flow rationing Step 2	Date start Step 3	Time start Step 3	mean flow rationing Step 3
12/02/1962 05:00	62	1	620209	160000	2738						
17/02/1962 06:00	96	1	620213	70000	2754						
3/03/1962 20:00	337	1	620217	200000	2096						
7/04/1962 00:00	47	1	620405	20000	2934						
9/04/1962 22:00	40	1	620408	70000	2838						
26/12/1962 11:00	70	1	621223	140000	2766						
7/01/1963 03:00	105	1	630102	190000	2725						
8/02/1963 21:00	548	2	630117	20000	2218	630131	20000	2036			
27/03/1963 08:00	40	1	630325	170000	2771						
5/11/1963 12:00	86	1	631101	230000	2285						
26/11/1963 00:00	94	1	631122	30000	2685						
2/12/1963 22:00	135	1	631127	80000	2183						
2/01/1964 09:00	647	2	631206	110000	2055	631220	110000	1634			
8/01/1964 05:00	112	1	640103	140000	1990						
18/02/1964 20:00	447	2	640131	60000	2167	640214	60000	1891			
27/02/1964 09:00	143	1	640221	110000	2377						
27/04/1964 02:00	640	2	640331	110000	2325	640414	110000	1779			
1/11/1965 12:00	35	1	651031	20000	2933						
29/03/1966 16:00	303	1	660317	20000	2540						
1/03/1967 04:00	241	1	670219	40000	2665						

Date and time that the period ended	Duration of Rationing (hours, for periods >24hrs)	Max Rationing step reached (1=20% cut; 2=35% cut; 3=50% cut)	Date Start (yymmdd)	Time Start (hhmmss)	Mean flow rationing Step 1 (l/sec)	Date start Step 2 start	Time start Step 2 start	mean flow rationing Step 2	Date start Step 3	Time start Step 3	mean flow rationing Step 3
10/03/1967 09:00	188	1	670302	140000	2537						
23/03/1967 19:00	46	1	670321	220000	2757						
8/02/1968 11:00	47	1	680206	130000	2871						
1/03/1968 06:00	198	1	680222	10000	2597						
8/03/1968 17:00	174	1	680301	120000	2326						
1/04/1968 07:00	55	1	680330	10000	2885						
25/03/1969 14:00	44	1	690323	190000	2935						
3/04/1969 12:00	145	1	690328	120000	2699						
11/11/1969 05:00	66	1	691108	120000	2868						
21/11/1969 08:00	27	1	691120	60000	2870						
28/02/1970 08:00	680	3	700131	10000	2539	700214	10000	1632	700228	10000	2010
7/03/1970 17:00	55	1	700305	110000	2736						
14/12/1970 09:00	129	1	701209	10000	2832						
4/01/1971 13:00	408	2	701218	140000	2631	710101	140000	2613			
1/02/1971 08:00	337	1	710118	80000	2427						
23/02/1971 07:00	512	2	710201	240000	1983	710215	240000	1680			
25/03/1971 11:00	225	1	710316	30000	2570						
13/04/1971 13:00	275	1	710402	30000	2386						
21/12/1971 02:00	93	1	711217	60000	2812						
31/12/1971 07:00	229	1	711221	190000	2532						

Date and time that the period ended	Duration of Rationing (hours, for periods >24hrs)	Max Rationing step reached (1=20% cut; 2=35% cut; 3=50% cut)	Date Start (yymmdd)	Time Start (hhmmss)	Mean flow rationing Step 1 (l/sec)	Date start Step 2 start	Time start Step 2 start	mean flow rationing Step 2	Date start Step 3	Time start Step 3	mean flow rationing Step 3
29/01/1972 05:00	107	1	720124	190000	2901						
24/02/1972 23:00	487	2	720204	170000	2426	720218	170000	1972			
4/03/1972 22:00	187	1	720226	40000	1783						
24/03/1972 21:00	99	1	720320	190000	2743						
17/12/1972 17:00	53	1	721215	130000	2870						
11/01/1973 18:00	60	1	730109	70000	2724						
4/03/1973 08:00	1197	3	730113	120000	2484	730127	120000	1910	730210	120000	1412
10/03/1973 09:00	56	1	730308	20000	2442						
16/03/1973 09:00	130	1	730310	240000	2079						
20/04/1973 18:00	829	3	730317	60000	1910	730331	60000	1451	730414	60000	1559
22/10/1973 07:00	147	1	731016	50000	2592						
18/12/1973 07:00	96	1	731214	80000	2579						
24/01/1974 07:00	58	1	740121	220000	2888						
4/02/1974 19:00	254	1	740125	60000	2198						
15/03/1974 19:00	94	1	740311	220000	2681						
3/04/1974 15:00	345	2	740320	70000	2287	740403	70000	1935			
9/01/1975 03:00	406	2	741223	60000	2529	750106	60000	2266			
16/01/1975 02:00	130	1	750110	170000	2369						
19/01/1975 13:00	27	1	750118	110000	2667						
9/01/1976 12:00	84	1	760106	10000	2765						

Date and time that the period ended	Duration of Rationing (hours, for periods >24hrs)	Max Rationing step reached (1=20% cut; 2=35% cut; 3=50% cut)	Date Start (yymmdd)	Time Start (hhmmss)	Mean flow rationing Step 1 (l/sec)	Date start Step 2 start	Time start Step 2 start	mean flow rationing Step 2	Date start Step 3	Time start Step 3	mean flow rationing Step 3
22/03/1976 20:00	201	1	760314	120000	2728						
28/03/1976 14:00	72	1	760325	150000	2772						
10/04/1977 11:00	244	1	770331	80000	2795						
4/02/1978 20:00	238	1	780125	230000	2637						
16/02/1978 16:00	234	1	780206	230000	2380						
3/03/1978 03:00	315	1	780218	10000	2160						
19/03/1978 22:00	383	2	780303	240000	1981	780317	240000	1923			
28/03/1978 05:00	184	1	780320	140000	2143						
14/04/1978 21:00	319	1	780401	150000	2302						
7/12/1978 04:00	28	1	781206	10000	2997						
28/01/1979 07:00	172	1	790121	40000	2663						
5/02/1979 04:00	141	1	790130	80000	2516						
15/02/1979 00:00	151	1	790208	180000	2540						
15/03/1979 20:00	200	1	790307	130000	2783						
20/01/1981 13:00	523	2	801229	190000	2499	810112	190000	2005			
2/03/1981 22:00	888	3	810124	230000	2181	810207	230000	1665	810221	230000	1410
8/03/1981 20:00	97	1	810304	200000	2344						
19/02/1982 07:00	464	2	820130	240000	2510	820213	240000	2009			
24/02/1982 03:00	82	1	820220	180000	2444						
24/03/1982 02:00	223	1	820314	200000	2634						

Date and time that the period ended	Duration of Rationing (hours, for periods >24hrs)	Max Rationing step reached (1=20% cut; 2=35% cut; 3=50% cut)	Date Start (yymmdd)	Time Start (hhmmss)	Mean flow rationing Step 1 (l/sec)	Date start Step 2 start	Time start Step 2 start	mean flow rationing Step 2	Date start Step 3	Time start Step 3	mean flow rationing Step 3
31/03/1982 12:00	169	1	820324	120000	2265						
29/04/1982 19:00	143	1	820423	210000	2709						
11/11/1982 23:00	186	1	821104	60000	2620						
19/11/1982 18:00	119	1	821114	200000	2547						
27/11/1982 03:00	166	1	821120	60000	2259						
29/11/1982 17:00	42	1	821127	240000	2542						
12/12/1982 00:00	279	1	821130	100000	2374						
21/12/1982 10:00	152	1	821215	30000	2406						
25/12/1982 21:00	28	1	821224	180000	2872						
5/01/1983 08:00	162	1	821229	150000	2490						
13/01/1983 07:00	103	1	830109	10000	2488						
29/03/1983 14:00	1434	3	830128	210000	2269	830211	210000	1714	830225	210000	1488
7/04/1983 12:00	185	1	830330	200000	1631						
14/04/1983 17:00	61	1	830412	50000	2651						
15/11/1984 10:00	70	1	841112	130000	2899						
18/04/1985 22:00	670	2	850322	10000	2705	850405	10000	2410			
26/04/1986 02:00	50	1	860424	10000	2855						
12/02/1987 10:00	50	1	870210	90000	2746						
23/02/1987 22:00	54	1	870221	170000	2767						
2/03/1987 17:00	67	1	870227	230000	2761						

Date and time that the period ended	Duration of Rationing (hours, for periods >24hrs)	Max Rationing step reached (1=20% cut; 2=35% cut; 3=50% cut)	Date Start (yymmdd)	Time Start (hhmmss)	Mean flow rationing Step 1 (l/sec)	Date start Step 2 start	Time start Step 2 start	mean flow rationing Step 2	Date start Step 3	Time start Step 3	mean flow rationing Step 3
9/03/1987 21:00	106	1	870305	120000	2565						
3/02/1988 06:00	108	1	880129	190000	2643						
23/03/1989 21:00	133	1	890318	90000	2669						
15/01/1990 15:00	72	1	900112	160000	2875						
17/01/1990 11:00	44	1	900115	160000	2703						
29/01/1990 09:00	113	1	900124	170000	2716						
8/02/1990 14:00	79	1	900205	80000	2763						
10/03/1990 01:00	679	3	900209	190000	2338	900223	190000	1710	900309	190000	2681
20/03/1990 01:00	36	1	900318	140000	2824						
9/04/1990 16:00	353	2	900325	240000	2251	900408	240000	2466			
18/04/1990 17:00	200	1	900410	100000	2227						
24/04/1990 00:00	109	1	900419	120000	2458						
11/11/1990 21:00	52	1	901109	180000	2884						
7/01/1991 20:00	99	1	910103	180000	2642						
16/01/1991 18:00	152	1	910110	110000	2423						
21/01/1991 05:00	68	1	910118	100000	2700						
14/03/1991 09:00	161	1	910307	170000	2676						
27/03/1991 18:00	240	1	910317	190000	2494						
3/04/1991 03:00	58	1	910331	180000	2811						
27/11/1991 04:00	93	1	911123	80000	2665						

Date and time that the period ended	Duration of Rationing (hours, for periods >24hrs)	Max Rationing step reached (1=20% cut; 2=35% cut; 3=50% cut)	Date Start (yymmdd)	Time Start (hhmmss)	Mean flow rationing Step 1 (l/sec)	Date start Step 2 start	Time start Step 2 start	mean flow rationing Step 2	Date start Step 3	Time start Step 3	mean flow rationing Step 3
29/12/1991 21:00	152	1	911223	140000	2459						
8/03/1992 10:00	90	1	920304	170000	2797						
16/03/1992 16:00	124	1	920311	130000	2492						
12/02/1993 09:00	138	1	930206	160000	2649						
20/02/1993 21:00	198	1	930212	160000	2364						
30/03/1993 12:00	36	1	930329	10000	2955						
27/08/1993 17:00	68	1	930824	220000	2794						
4/09/1993 06:00	106	1	930830	210000	2784						
20/02/1994 04:00	319	1	940206	220000	2306						
21/04/1994 10:00	152	1	940415	30000	2754						
26/04/1994 13:00	61	1	940424	10000	2646						
30/12/1994 15:00	99	1	941226	130000	2859						
8/01/1995 20:00	179	1	950101	100000	2384						
19/01/1995 17:00	93	1	950115	210000	2651						
22/01/1995 18:00	53	1	950120	140000	2535						
30/12/1996 22:00	93	1	961227	20000	2847						
11/01/1997 03:00	218	1	970102	20000	2573						
19/01/1997 21:00	45	1	970118	10000	2873						
4/02/1997 21:00	361	2	970120	210000	2218	970203	210000	2360			
11/02/1997 17:00	58	1	970209	80000	2709						

Date and time that the period ended	Duration of Rationing (hours, for periods >24hrs)	Max Rationing step reached (1=20% cut; 2=35% cut; 3=50% cut)	Date Start (yymmdd)	Time Start (hhmmss)	Mean flow rationing Step 1 (l/sec)	Date start Step 2 start	Time start Step 2 start	mean flow rationing Step 2	Date start Step 3	Time start Step 3	mean flow rationing Step 3
24/02/1997 13:00	256	1	970213	220000	2229						
6/03/1997 03:00	132	1	970228	160000	2426						
22/03/1997 00:00	209	1	970313	80000	2481						
6/04/1997 13:00	108	1	970402	20000	2787						
8/04/1997 10:00	32	1	970407	30000	2714						
15/11/1997 16:00	426	2	971028	230000	2564	971111	230000	2370			
29/11/1997 09:00	199	1	971121	30000	2344						
16/12/1997 10:00	292	1	971204	70000	2188						
20/12/1997 22:00	44	1	971219	30000	2720						
16/01/1998 19:00	194	1	980108	180000	2528						
23/01/1998 17:00	145	1	980117	170000	2311						
28/01/1998 12:00	98	1	980124	110000	2553						
14/02/1998 01:00	232	1	980204	100000	2273						
17/02/1998 11:00	58	1	980215	20000	2385						
23/04/1998 17:00	64	1	980421	20000	2824						
14/01/1999 08:00	224	1	990105	10000	2653						
31/01/1999 02:00	62	1	990128	130000	2911						
20/02/1999 22:00	216	1	990211	230000	2618						
27/02/1999 01:00	130	1	990221	160000	2304						
5/03/1999 18:00	35	1	990304	80000	2874						

Date and time that the period ended	Duration of Rationing (hours, for periods >24hrs)	Max Rationing step reached (1=20% cut; 2=35% cut; 3=50% cut)	Date Start (yymmdd)	Time Start (hhmmss)	Mean flow rationing Step 1 (l/sec)	Date start Step 2 start	Time start Step 2 start	mean flow rationing Step 2	Date start Step 3	Time start Step 3	mean flow rationing Step 3
30/03/2000 09:00	40	1	000328	180000	2948						
2/04/2000 19:00	25	1	000401	190000	2896						
10/12/2000 23:00	119	1	001206	10000	2766						
28/12/2000 06:00	57	1	001225	220000	2799						
16/01/2001 16:00	74	1	010113	150000	2818						
26/01/2001 07:00	180	1	010118	200000	2474						
3/04/2001 03:00	1579	3	010127	90000	2028	010210	90000	1664	010224	90000	1432
22/04/2001 02:00	417	2	010404	180000	1524	010418	180000	1328			
15/03/2002 00:00	176	1	020307	170000	2705						
18/03/2002 16:00	82	1	020315	70000	2586						
30/03/2002 08:00	39	1	020328	180000	2940						
6/04/2002 08:00	119	1	020401	100000	2585						
25/04/2002 04:00	347	2	020410	180000	2334	020424	180000	2307			
21/05/2002 18:00	304	1	020509	30000	2418						
20/02/2003 03:00	544	2	030128	120000	2304	030211	120000	1997			
3/03/2003 09:00	253	1	030220	210000	1974						
29/03/2003 17:00	555	2	030306	150000	1929	030320	150000	1663			
24/12/2003 02:00	156	1	031217	150000	2666						
28/12/2003 07:00	89	1	031224	150000	2516						
7/01/2004 03:00	145	1	040101	30000	2436						

Date and time that the period ended	Duration of Rationing (hours, for periods >24hrs)	Max Rationing step reached (1=20% cut; 2=35% cut; 3=50% cut)	Date Start (yymmdd)	Time Start (hhmmss)	Mean flow rationing Step 1 (l/sec)	Date start Step 2 start	Time start Step 2 start	mean flow rationing Step 2	Date start Step 3	Time start Step 3	mean flow rationing Step 3
19/01/2004 14:00	140	1	040113	190000	2465						
28/01/2004 06:00	137	1	040122	140000	2377						
8/04/2004 09:00	79	1	040405	30000	2915						
11/02/2005 16:00	45	1	050209	200000	2890						
7/03/2005 02:00	79	1	050303	200000	2733						
25/03/2005 02:00	286	1	050313	50000	2560						
25/10/2005 07:00	73	1	051022	70000	2858						
31/10/2005 04:00	129	1	051025	200000	2493						
7/11/2005 08:00	154	1	051031	230000	2304						
15/11/2005 04:00	185	1	051107	120000	2102						
21/11/2005 17:00	125	1	051116	130000	2255						
24/11/2005 16:00	48	1	051122	170000	2520						
6/12/2005 22:00	256	1	051126	70000	2076						
10/12/2005 03:00	62	1	051207	140000	2189						
15/12/2005 02:00	98	1	051211	10000	2618						
4/01/2006 07:00	181	1	051227	190000	2475						
14/01/2006 10:00	193	1	060106	100000	2263						
19/01/2006 02:00	100	1	060114	230000	2179						
24/01/2006 21:00	94	1	060120	240000	2302						
6/02/2006 04:00	57	1	060203	200000	2827						

Date and time that the period ended	Duration of Rationing (hours, for periods >24hrs)	Max Rationing step reached (1=20% cut; 2=35% cut; 3=50% cut)	Date Start (yymmdd)	Time Start (hhmmss)	Mean flow rationing Step 1 (l/sec)	Date start Step 2 start	Time start Step 2 start	mean flow rationing Step 2	Date start Step 3	Time start Step 3	mean flow rationing Step 3
8/02/2006 08:00	30	1	060207	30000	2669						
3/04/2006 05:00	882	3	060225	120000	2279	060311	120000	1842	060325	120000	1700
7/04/2006 07:00	29	1	060406	30000	2698						

APPENDIX III – AGFIRST CONSULTANTS REPORT

AGFIRST CONSULTANTS

20/10/2006

153 Tasman Street
NELSON

Greg Anderson & Sally Marx
Via Tonkin & Taylor Ltd
P O Box 2083
WELLINGTON

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

This report follows on from the river data supplied by Andrew Fenemor of Landcare Research.

Scenario

- That the current minimum in-stream requirement of 500 l/s at the Appleby Bridge is raised to 800 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 the more limited irrigation scenario).

The assessments were based on the hydrological records for the two dry summers of 1982/83 and 2000/01, and for the "average" summer of 2004/05.

Process

The hydrological data provided by Andrew Fenemor was arranged in a different manner, so that it would be easier for farmers to assess the years being investigated, and to put a figure on what they felt the losses would be for the different years being studied. (Attached as Appendix A.) 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 scenarios this summer.

I placed the drought records in front of three different parties, explained how the figures were arranged, and asked for their assessment of losses for the crops that they had experience with (Appendix A).

1

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We had some 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 Andrew 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 800 l/s in the Waimea River at the Appleby Bridge, and we then had another 2000/01 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 that they stopped 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 a crop, despite a big water reduction (possibly grapes).

In light of some of the comments above, the losses suggested below may be less than could happen in such an event. Another outcome from a bad drought that is often hard to place a cost on is the carryover effect into the next crop. 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.

Crop Areas

The following crop areas have been used in other reports:

Pasture	= 1,600 ha
Apples, KF, et al	= 1,850 ha
Grapes & Olives	= 350 ha
Total	= 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 include in with the Apples and KF, so should be well catered for here.

In coming up with the possible losses for the above crops, we have tried to also allow for the fact that these crops are also 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	600 ha	100 ha	900 ha	
Apples, KF et al	760 ha	190 ha	900 ha	
Grapes Olives	200 ha	20 ha	130 ha	
Totals	1560 ha	310 ha	1930 ha	= 3,800 ha.

2

Generally speaking, droughts are felt quickest 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 rewet.

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 Andrews'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 would use this years figures, as they will be closer to a normal year. Last year was a very low year for crop returns. 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 B

Table 1

		Returns / Ha Forecast Actual 2005/06		Returns / Ha Forecast 2006/07	
Crop	**$/ha development**	**$Gross**	**$Net (EBT)**	**$Gross**	**$Net (EBT)**
Kiwifruit	$ 45,000	$ 30,560	-$ 45	$ 47,376	$ 16,556
Apples	$ 45,000	$ 35,203	-$ 9,329	$ 59,541	$ 14,254
Grapes	$ 55,000	$ 23,336	$ 9,776	$ 23,315	$ 9,468
Olives	$ 7,000				

Notes:

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

2005/06 Sourced from MAF monitoring

2006/07 have built in returns on what we are seeing currently

Olives not sure if this is a suitable crop

The other growers I have sought comments from are both in the Augmentation Study Group.

3

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Murray King (Dairy Farming) has supplied the following figures: -

> Gross Margin per hectare for dairy farming (after deducting costs) of $2,100/ha. 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's first impression was that losses for the two significant drought years (1982/83 and 2000/01) would be about $750/ha. He later revised this figure upwards to $1,250/ha.

John Bealing
Engineering Consultant
Agfirst

JB: C:MYDOCUMENTS\TYPING\IRRIGATION\AUGMENTATIONT&TECONASSESDATA1206.DOC

4

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WAIROA RIVER WATER RESTRICTIONS

1. "Average Year"

Comparing the 2004/05-year as an 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 detrimental effects 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 2006/07 return

Soil Type	Kiwifruit	Apples	Grapes
30mm/week	$10,256	$14,254	$9,468
35mm/week	$10,256	$14,254	$9,468

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 will suffer 10% and for overall yield to be 12% lower for kiwifruit. This would lower the Net EBT, (based on the 2006/07), to $4,410/ha on the lighter 35 mm/week soils, and a lesser effect on the heavier soils (5% smaller size and 8% crop reduction) to $5,740. If rain occurred in April prior to harvest, I would also expect an increase in fruit storage (5%) losses as kiwifruit do not store well most years when grown under dry drought conditions, followed by rain prior to harvest. Fruit firmness in coolstore would also be severely compromised and fruit would have to be shipped to market 1-2 months earlier than normal to meet the in market requirements for minimum flesh firmness. This could reduce grower returns by 30 cents per tray or -$1800/ha.

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. Viticulturists 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. Depending on how viticulturists handle the restrictions, there could only be a small reduction in wine quality (price 5% lower) providing the vines are not

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pushed too far. On the lighter soils (35 mm/week) this would reduce Net EBT to $7,565/ha and on the heavier soils a lesser reduction of Net EBT to $8,406/ha.

Apple 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 $6,584/ha on the lighter soils (35mm/week). The heavier soils (30mm/week) will be less affected at $9,068/ha.

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

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

Soil Type	Kiwifruit	Apples	Grapes
30mm/week	$5,740	$9,068	$8,406
35mm/week	$4,410	$6,584	$7,565

3. "27-85 year drought"

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 would therefore 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 $5,740/ha. The lighter soils would suffer greater reduction to the Net EBT ($2,520/ha) as fruit size would be 10% smaller and crop yield 12% lower. 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	$5,740	$6,584	$7,565
35mm/week	$2,520	-$1,663	$2,086

6

On the heavier soils, apples would experience an estimated reduction of Net EBT $6,584 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 a 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 -$1663/ha.

As for the other crops, grapes should be capable of achieving only small reductions in yields and quality on the heavier soils as per the "*25-33 year drought*" section. Net EBT for the heavier soils $7,565/ha. However the lighter soils would have greater loss in yield (20%) due to smaller berry size and potentially a 15% reduction in quality (price). Net EBT for the lighter soils is $2,086/ha.

Steven Spark
Horticultural Consultant
Agfirst

Augmentation Study
Sept 2006

Wairoa River
Water Restrictions When Flow Below 800 L/S

Year	Month	Day 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
82/83	Nov				1	1	1	1	1	1	1	1	1	1	1	1	1				1	1	1	1	1	1	1
	Dec	1	1	1	1	1	1	1	1	1	1	1/2				1	1	1	1	1	1				1		
	Jan	1	1	1	1					1	1	1	1														
	Feb	1	1	1	1	1	1	1	1	1	1	12	12	12	12	12	12	12	12	12	12	12	12	12	12	123	123
	Mar	123	123	123	123	123	123	123	123	123	123	123	123	123	123	123	123	123	123	123	123	123	123	123	123	123	123
	Apr	1	1	1	1	1	1						1	1	1/2												
00/01	Dec						1	1	1	1	1															1	1
	Jan													1	1	1			1/2	1	1	1	1	1	1	1	
	Feb	1	1	1	1	1	1	1	1	1	12	12	12	12	12	12	12	12	12	12	12	12	12	12	123	123	123
	Mar	123	123	123	123	123	123	123	123	123	123	123	123	123	123	123	123	123	123	123	123	123	123	123	123	123	123
	Apr	123	123		1	1	1	1	1	1	1	1	1	1	1	1	1	1	12	12	12						
04/05	Feb									1	1																
	Mar			1	1	1								1	1	1	1	1	1	1	1	1	1	1	1		
	Apr																										

1 represents a first stage water restricition, or 20% (1mm/day with an allocation of 5 mm/day)
12 " " second " " " " 35% (1.7 mm/day " " " " " ")
123 " " third " " " " 50% (2.5 mm/day " " " " " ")

WITH A 30 MM/WEEK ALLOCATION

ET figures, on average are: -		Water Allocation	Restriction by Stage (mm/day) Gives 1	Shortfall	12	Shortfall	123	Shortfall
Nov	4 mm/day	4.3 mm/day	3.5	0.5	2.8	1.2	2.2	2.1
Dec	4.6 "	"	"	1.1	"	1.8	"	2.4
Jan	4.8 "	"	"	1.3	"	2	"	2.6
Feb	4.2 "	"	"	0.7	"	1.4	"	2
Mar	3.0 "	"	"	+0.5	"	0.2	"	0.8
April	2.0 "	"	"	"+1.5	"	+0.8	"	+0.2

27	28	29	30	31	Days of Stage Cuts 1	2	3		30mm/week Approx Deficit 1 (mm)	12	123	Total Deficit	35 mm/week Approx Deficit 1	12	123	
1	1		1	XXX	**23**			Nov	23				0			
		1	1	1	**21**			Dec	22.6				12.3			
	1	1	1	1	**12**			Jan	15.6				9.6			
123	123	XXX	XXX	XXX	**10**	**14**	**4**	Feb	7	19.6	8		2	13.3	6.8	
123	123		1	1	**2**		**28**	Mar	0		22.4		0		14	
					7			Apr	0				0			
					76	**16**	**35**		**68**	**20**	**30**	**118**	**24**	**13**	**21**	**58**
					Considered a 25 - 33 year drought.											
					7			Dec	7.7				4.2			
1	1	1	1	1	**15**			Jan	19.5				12			
123	123	XXX	XXX	XXX	**9**	**14**	**5**	Feb	6.3	19.6	10		1.8	13.3	8.5	
123	123	123	123	123			**31**	Mar	0		24.8		0		15.5	
					14	**3**	**2**	Apr	0		0		0	0	0	
					45	**17**	**38**		**34**	**20**	**35**	**88**	**18**	**13.3**	**24**	**55**
					Considered a 27 - 85 year drought											
					2			Feb	1.4				0.4			
					15			March	0				0			
					17	**0**	**0**		**1**	**0**	**0**	**1**	**0.4**	**0**	**0**	**0.4**
					Considered an "Average Year".											

Note: No Allowance made for Crop Factor

WITH A 35 MM/WEEK ALLOCATION

ET figures, on average are: -		**Water Allocation**	**Restriction by Stage (mm/day) Gives 1**	**Shortfall**	**12**	**Shortfall**	**123**	**Shortfall**
Nov	4 mm/day	5 mm/day	4	0	3.25	0.75	2.5	1.5
Dec	4.6 "	"	"	0.6	"	1.35	"	2.1
Jan	4.8 "	"	"	0.8	"	1.55	"	2.3
Feb	4.2 "	"	"	0.2	"	0.95	"	1.7
Mar	3.0 "	"	"	+1	"	+0.25	"	0.5
April	2.0 "	"	"	"+2	"	+1.25	"	+0.5