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TO: **Andrew Graham, HDR Engineering, Inc**
CC: **Bob Montgomery, Anchor QEA, and Ann Root, ESA Adolfson**
FROM: **Ernie Niemi and Mark Buckley**[1]
SUBJECT: **MARKET-BASED REALLOCATION OF WATER RESOURCES**

This memo summarizes our draft assessment of the *Market-Based Reallocation of Water Resources* element of the Integrated Plan (subtask 4.4 of the scope of work). It first briefly describes the amounts of market-based reallocation expected under the baseline scenario without implementation of the Integrated Plan. Then it summarizes the amount of water that potentially could be reallocated under the market-based reallocation element of the Integrated Plan scenario, which would entail additional measures to encourage and facilitate water transfers. The analysis focuses on this element in isolation, without interactions with other elements of the Integrated Plan.

A. Preliminary Baseline Estimates of Market-Based Activity without the Integrated Plan

The analysis first estimates the market-based reallocation of water that likely would occur without implementation of the Integrated Plan. This scenario embodies some important general assumptions. Sufficient voluntary transfers from agriculture will occur so water shortages do not constrain municipal/domestic growth. Current or foreseeable economic trends, as forecasted by local and state governments, will continue over the study period. Current and foreseeable trajectories of ecosystem health continue, with increasing regulatory protections for water quality, at-risk species, and their habitats. Consumer-oriented demands for environmental uses of water, to improve the quality of life for residents and visitors, will grow faster than producer-oriented demands associated with irrigated agriculture.

Table 1 presents current expectations of the amounts of water that likely will be transferred as part of the baseline scenario without the Integrated Plan. It shows five different types of water transfer. The first four types entail the permanent purchase, or long-term lease of water in addition to amounts purchased in the past. This outcome might materialize, for example, if a current water-right holder sells the water right to another party. It also might arise if a single irrigator or a group of irrigators agree to fallow land on a rotational basis and contract to convey the water not consumed to another party. The fifth type of water transfer would occur in a manner similar to what has occurred in the past in the past during years of declared

[1] We gratefully acknowledge the assistance of Bob Montgomery, Adam Hill, and Ann Root, but ECONorthwest is solely responsible for this analysis.

drought—especially years when the drought is severe enough that those with proratable water rights receive less than 50 percent of their entitlements—and irrigators in districts with nonproratable entitlements lease their water rights to irrigators in districts with proratable entitlements.

Table 1. Preliminary Estimates of Market Activity under the Baseline Scenario (without the Integrated Plan), 2011–2020 and 2021–2040

Type of Transfer	Water Transferred Annually (ac-ft) 2011–2020	Water Transferred Annually (ac-ft) 2021–2040	Expected Price[a] (2010 dollars per ac-ft)
Permanent Purchase (or Long-Run Lease) of Water			
1. Irrigators selling to domestic and municipal users to mitigate for impacts from past and future post-1905 development	10,000 – 40,000	10,000 – 40,000 (<50,000 total)	$2,500 – $30,000
2. Tributary irrigators selling or leasing to environmental purchasers	5,000	5,000	$700 – $2,000
3. Upper-basin irrigators with lower value crops selling to lower-basin irrigators with higher value crops	<1,000	2,000	$1,000 – $3,500
4. Irrigators in a district selling to other irrigators in the district	Unknown[b]	Unknown[b]	$1,000 – $3,500
Annual Lease of Water			
5. Irrigators leasing to other irrigators during years of declared drought	40,000	Same[c]	$125-$150

[a] The indicated amounts for #1–4 estimate the price of purchasing a senior water right. For #5, the amount represents the price of leasing a district's senior water right during a severe drought year.

[b] Data on the amounts of water transferred among irrigators within a district generally are not available.

[c] Assumes the amount transferred during 2021–2040 will be the same as during the previous decade.

The first line of the table shows the water transfers associated with a mitigation requirement to offset consumptive loss by all post-1905 domestic, group domestic, and municipal use of surface water or groundwater. The table shows that, by 2020, irrigators will sell water rights sufficient to transfer 10,000 – 40,000 ac-ft of water per year (consumptive use) for residential development. This estimate reflects an assumption that post-1905 development in the basin, both past and future, will be required to mitigate the impacts of groundwater and surface water use on surface water rights, as well as Ecology's current assessment of the potential mitigation requirements.[2] By 2040, still more transfers will occur to mitigate for residential development, with the total for the 2011-2040 period being less than 50,000 ac-ft of water per year. The mitigation likely will entail the purchase of water rights to satisfy requirements that municipal and industrial (M&I) water users have secure water supplies. Recently, small transactions to mitigate the impacts of residential development have occurred with prices equivalent to about

[2] Bob Barwin, Environmental Engineer, Water Resources Program, Department of Ecology, Central Regional Office. Personal communication.

$30,000 per acre-foot. As the market broadens, the price likely will fall, to about $2,500 per acre-foot.

The next two lines of the table reflect an assumption that, by 2040, sales or leases of water rights on tributaries will increase the supply for environmental use by about 5,000 acre-feet and shift less than 3,000 acre-feet of water from irrigating low-value crops in the upper basin to irrigating high-value crops in the lower basin. These numbers represent consumptive use. The bottom line of Table 1 indicates that, during severe drought years, some irrigators will lease water rights to other irrigators, transferring about 40,000 acre-feet. This number represents a mixture of water measured at changes in the point of diversion as well as diverted water shifted from one point of use to another.

B. Preliminary Estimates of Market-Based Activity Under the Integrated Plan's Market-Based Reallocation Element

This section estimates the potential market-based activity that might take place by 2040 if the Integrated Plan brings about a fully functioning water market in the Yakima River basin. If the Integrated Plan leads to a market that is less than fully functional, the amount of water transferred and the impact on irrigators' net earnings would fall short of the estimates presented below. Thus, the estimates represent the likely upper bound of market-based opportunities to mitigate the potential effects on irrigators of severe drought during the study period.

The estimates below assume that only the market-based reallocation element of the Integrated Plan is implemented, absent implementation of additional water-storage or water-supply projects. With a fully-functioning market, water-right holders would sell or lease their rights from lower-value to higher-value uses, so the potential increase in value of incremental transfers is roughly equal across uses. This scenario reflects an assumption that underlying economic trends and forces (population growth, etc.) are the same as in the baseline scenario. The appendix describes the details of the analysis, which updates the data, assumptions, and findings of previous research.[3] The core of the analytical model comes from researchers at the

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[3] Vano J.A., M.J. Scott, N. Voisin, C.O. Stockle, A.F. Hamlet, K.E. Mickelson, M. McGuire Elsner, and D.P. Lettenmaier. 2009. "Climate Change Impacts on Water Management and Irrigated Agriculture in the Yakima River Basin, Washington, USA." Chapter 3 in *The Washington Climate Change Impacts Assessment: Evaluating Washington's Future in a Changing Climate*, ed. M. McGuire Elsner, J/ Littell, L. Whitely Binder, pp. 132-163. The Climate Impacts Group, University of Washington, Seattle, WA.

Willey, Z. and A. Diamant. 1994. Restoring the Yakima River's Environment: Water Marketing and Instream Flow Enhancement in Washington's Yakima River Basin. Environmental Defense Fund. March.

Huppert, D. et al. 2004. *Economics of the Columbia River Initiative*. Washington Department of Ecology and CRI Economics Advisory Committee. January 12.

Williams, G.W. and O. Capps, Jr. 2005. *An Assessment of Future Markets for Crops Grown Along the Columbia River: Economic Implications of Increases in Production Resulting from New Agricultural Water Rights Under the Columbia River Initiative.* Texas Agribusiness Market Research Center and American Rivers, Inc. September.

Northwest Economic Associates. 1997. *The Economic Benefits of Enhanced Water Supplies in the Yakima River Basin*. Tri-County Water Resource Agency. April 8.

PNW National Laboratory, with adjustments reflecting current understanding of water supplies, rights, uses, and conveyance losses.[4] The analysis focuses on five entities: Roza Irrigation District (Roza), Wapato Division (Wapato), Kittitas Reclamation District (Kittitas), Sunnyside Valley Irrigation District (Sunnyside), and Yakima-Tieton Irrigation District (Tieton).[5] To facilitate the presentation, the following discussion refers to each one as a district.

Table 2 summarizes the aggregate amounts of water that would be transferred annually under conditions associated with a fully functioning water market. These conditions likely would include competition between buyers and sellers, market participants having full access to market information and financial capital, and limited institutional or other impediments to transactions. The data in the table show that transfers from agricultural sellers to domestic and municipal users, and to the environment would be the same as in the baseline scenario, without implementation of the Integrated Plan. Transfers from agricultural sellers to agricultural buyers would increase, primarily through intra-district trades. To illustrate the upper bound on the potential for market-based reallocation of water to mitigate the effects of severe drought, the results in Table 2 rest on two key assumptions: that the drought would reduce the water available to proratable irrigators to 40 percent of their full entitlement, and that the price of water would be zero. The center column shows the amounts under the assumption that agricultural producers purchasing or leasing water rights would face no limitations, i.e., they could continue buying water at no cost until they satisfied their crop-irrigation requirement. Under this assumption, about 330,000 acre-feet of water could be transferred through agriculture-to-agriculture trades before exhausting all opportunities for moving water from a crop with lower net earnings per acre-foot to a crop with higher net earnings. Most of the trades, about 260,000 acre-feet, would occur between irrigators within the same district. The remainder would occur through inter-district trades, with the assumption that such trades would occur only among Roza, Kittitas, and Sunnyside Districts. The right column shows analogous projections, assuming that buyers would not exceed 70 percent of their crops' irrigation requirement.[6] With this assumption, transfers would total about 200,000 acre-feet, with intra-district trades accounting for 160,000 acre-feet.

Scott, M.J, et al. 2004. "Water Exchanges: Tools to Beat El Niño Climate Variability in Irrigated Agriculture." *Journal of the American Water Resources Association* 40 (1): 15-31.

Northwest Economic Associates. 2004. *The Economic Impacts of Enhanced Water Supplies in the Yakima River Basin*. Benton County. March 23.

[4] HDR and Anchor QEA. 2010. *Water Needs for Out-of-Stream Uses.* Yakima River Basin Study, Pacific Northwest Region. U.S. Department of Interior, Bureau of Reclamation. July.

[5] The analysis does not include Kennewick Irrigation District because it typically does not experience reduced water availability during a severe drought that affects other districts.

[6] The irrigation community has consistently identified a goal of obtaining 70 percent of entitlements during drought years. HDR and Anchor QEA. 2010. *Water Needs for Out-of-Stream Uses.* Yakima River Basin Study, Pacific Northwest Region. U.S. Department of Interior, Bureau of Reclamation. July. p. 5.

Table 2. Preliminary Estimates of Potential Market Activity with the Integrated Plan's Market-Based Water Reallocation Element During a Severe Drought Year (Proratable Supply = 40% of Total Entitlement)

	Water Transferred Annually (ac-ft)	
Type of Transfer	Maximum	Buyers Capped at 70% of Crop Irrigation Requirements
1. Agriculture to domestic and municipal	<50,000 total	<50,000 total
2. Agriculture to environment	5,000	5,000
3. Agriculture to agriculture[a]		
Intra-district only	260,000	160,000
Intra- and inter-district	330,000	200,000

Source: ECONorthwest.

[a] Agriculture-to-agriculture transfers include the amounts reported in Table 1, lines 4 and 5. Inter-district trades occur among Roza, Kittitas, and Sunnyside Districts only. Assumes price equals zero.

Tables 3 and 4 illustrate the potential gains in net farm earnings possible through intra-district water transfers during a year with severe drought, in which the water available for proratable irrigators falls to 40 percent of their total entitlement. The district-specific analysis focuses on intra-district transfers because, although the model used in the analysis can calculate the overall level of inter-district transfers, as indicated in Table 2, it lacks the capacity to disaggregate the transfers on a district-to-district basis. Net farm earnings reflect the estimated crop receipts from irrigated crops minus the estimated variable costs other than the amounts, if any, paid in market-based transaction involving the reallocation of water. Fixed costs are excluded from the calculation because the analysis focuses on a single-year, severe drought, which likely would be too transitory to alter irrigators' long-run investment decisions. Table 3 shows the potential effects of drought on net farm earnings, by district, if no market-based reallocation of water occurs. The first three columns of data indicate the acreage under crop production in each district and, based on the estimated crop mix, the amount of water demanded to satisfy crop-irrigation requirements for each crop, distinguishing between nonproratable and proratable irrigators. The overall water demand is (670,000 + 1,000,000 =) 1,700,000 acre-feet.[7] The next-to-last column shows the estimated net farm earnings for each district, assuming water demand is fully satisfied during non-drought conditions. The last column shows the analogous net farm earnings, assuming drought conditions curtail proratable irrigators to 40 percent of their total, non-drought entitlement, but maintain the same mix of crops and engage in no trades to alleviate the effects of the drought. Under these assumptions, net earnings during a severe drought would fall to $190 million, or 68 percent of the non-drought total, $280 million.

[7] Throughout this report, numbers are rounded to two decimal places.

Table 3. Preliminary Estimates of Potential Water Demand and Irrigators' Net Earnings with No Market-Reallocation of Water Resources, by District

District	Total Acres	Water Demand (ac-ft) Nonproratable	Water Demand (ac-ft) Proratable	Annual Net Farm Earnings ($mil) Non-Drought	Annual Net Farm Earnings ($mil) Severe Drought,[a] No Trading
Roza	72,000	-	320,000	$94	$38
Wapato Division	110,000	310,000	250,000	$77	$56
Kittitas	56,000	-	290,000	$9	$4
Sunnyside	99,000	290,000	140,000	$65	$52
Tieton	22,000	76,000	3,000	$39	$38
Total	**360,000**	**670,000**	**1,000,000**	**$280**	**$190**

Source: ECONorthwest. Totals may not equal the sum of district numbers because of rounding.

[a] Severe drought conditions provide proratable irrigators with 40 percent of their full entitlement.

Table 4 shows the potential for intra-district transfers of water to alleviate the effects of severe drought on agricultural earnings, assuming that the Integrated Plan results in a fully functional water market. The results in also embody an assumption that buyers would not have to pay a price for the water they acquire. Thus, the numbers in Table 4 represent the upper bound of the potential for intra-district, market-based reallocation to alleviate the economic losses from reduced water availability during a severe drought. With maximum trading, irrigators would exhaust opportunities within each district to move water from a crop with lower net earnings per acre-foot to one with higher earnings, 260,000 acre-feet would be traded, the districts' net farm earnings would rise to $240 million from $190 million with no trading, and the overall loss from severe drought would be ($280 - $240 =) $40 million. If buyers capped their acquisitions to no more than 70 percent of their crops' irrigation requirements, irrigators would trade 160,000 acre-feet, the districts' overall net earnings would rise to $220 million from $190 million with no trading, and the overall loss from severe drought would be ($280 - $220 =) $60 million.

Table 4 also shows that about 130,000 acres would be fallowed in each scenario. This acreage is roughly the same as would be fallowed during a severe drought year with no trading and individual farmers used the available water to fully irrigate as many acres of each crop as the available water would allow. Water trading would have little effect on fallowed acreage insofar as it entails transferring water from one acre, growing a lower-value crop to another acre, growing a higher-value crop. Depending on the crops involved, sometimes the transfer would result in a slight increase in acreage irrigated and sometimes a slight decrease, with the overall effect remaining small.

Allowing inter-district trades among Roza, Kittitas, and Sunnyside Districts would increase the impact of market-based reallocation on net farm earnings, relative to the amounts shown in Table 4. With maximum trading, net farm earnings would equal $270 million. They would equal $230 million if buyers do not acquire water in excess of 70 percent of crop-irrigation requirements.

Table 4. Preliminary Estimates of Water Traded, Net Earnings, and Fallowed Acreage with a Fully Functional Water Market and Zero Price,[a] by District

	Maximum Trading[b]			Buyers Capped at 70%[c]		
District	Water Traded (ac-ft)	Net Farm Earnings ($mil)	Fallowed Acreage (acres)	Water Traded (ac-ft)	Net Farm Earnings ($mil)	Fallowed Acreage (acres)
Roza	55,000	$56	43,000	55,000	$56	45,000
Wapato Division	110,000	$75	32,000	57,000	$67	30,000
Kittitas	30,000	$7	34,000	16,000	$6	34,000
Sunnyside	66,000	$64	19,000	36,000	$59	19,000
Tieton	2,000	$39	1,000	1,000	$39	1,000
Total	**260,000**	**$240**	**130,000**	**160,000**	**$220**	**130,000**

Source: ECONorthwest. Totals may not equal the sum of district numbers because of rounding.

[a] Assumes buyers do not pay for acquired water.

[b] Assumes that irrigators would trade water from crops with lower net earnings to crops with higher net earnings under the "Maximum Trading" scenario.

[c] Assumes buyers do not acquire water in excess of 70 percent of crop-irrigation requirements.

Table 5 shows findings, analogous to those in Table 4, but with an assumption that irrigators acquiring water would pay $150 per acre-foot, the upper bound price shown in Table 1, to acquire water. Under this condition, the analysis assumes that only irrigators growing a crop with net earnings greater than this price would acquire water to offset a decrease in water availability. The appendix shows that only six crops satisfy this condition: other vegetables, wine grapes, apples, other grains, hops, and potatoes. The numbers in Table 5 show diminished ability to mitigate the impacts of severe drought, relative to Table 4. With maximum trading, irrigators would exhaust opportunities within each district to move water from a crop with lower net earnings per acre-foot to one with higher earnings, 130,000 acre-feet would be traded, the districts' net farm earnings would rise to $230 million from $190 million with no trading, and the overall loss from severe drought would be ($280 - $230 =) $50 million. If buyers capped their acquisitions to no more than 70 percent of their crops' irrigation requirements, irrigators would trade 90,000 acre-feet, the districts' overall net earnings would rise to $220 million from $190 million with no trading, and the overall loss from severe drought would be ($280 - $220 =) $60 million. The number of acres fallowed in each case would total about 130,000 acres.

To complete the water transactions, the model assumes buyers would, on average, pay sellers $150/ac-ft. With maximum trading, (130,000 ac-ft x $150/ac-ft =) $20 million would change hands; with buyers capping their acquisitions to no more than 70 percent of their crops' irrigation requirements, (90,000 ac-ft x $150/ac-ft =) $14 million would change hands. With buyers having to pay $150 per acre-foot, the overall level of trading would decline, relative to the scenario represented in Table 4, which assumed no transactions costs. Buyers would see their net farm earnings decline, but sellers would see theirs rise by the same amount, all else equal.

Table 5. Preliminary Estimates of Water Traded, Net Earnings, and Fallowed Acreage with a Fully Functional Water Market and Price of $150/ac-ft,[a] by District

	Maximum Trading[b]			Buyers Capped at 70%[c]		
District	Water Traded (ac-ft)	Net Farm Earnings ($mil)	Fallowed Acreage (acres)	Water Traded (ac-ft)	Net Farm Earnings ($mil)	Fallowed Acreage (acres)
Roza	55,000	$57	43,000	55,000	$55	44,000
Wapato Division	44,000	$71	30,000	22,000	$64	30,000
Kittitas	7,000	$6	33,000	4,000	$5	33,000
Sunnyside	19,000	$60	22,000	10,000	$56	19,000
Tieton	2,000	$39	1,000	1,000	$39	1,000
Total	**130,000**	**$230**	**130,000**	**90,000**	**$220**	**130,000**

Source: ECONorthwest. Totals may not equal the sum of district numbers because of rounding.

[a] Assumes buyers pay $150/acre-foot for acquired water, and that irrigators buy water only for crops with net earnings greater than $150/ac-ft: other vegetables, wine grapes, apples, other grains, hops, and potatoes.

[b] Assumes that irrigators would trade water from crops with lower net earnings to crops with higher net earnings under the "Maximum Trading" scenario.

[c] Assumes buyers do not acquire water in excess of 70 percent of crop-irrigation requirements.

Allowing inter-district trades among Roza, Kittitas, and Sunnyside Districts would increase the impact of market-based reallocation on net farm earnings, relative to the amounts shown in Table 5. With maximum trading, net farm earnings would equal $260 million. They would equal $230 million if buyers do not acquire water in excess of 70 percent of crop-irrigation requirements.

The actual impacts of the market-reallocation element of the Integrated Plan might be larger or smaller than those shown above. The impacts might be smaller, for example, if programs, policies, and actions to implement the element are not successful in resolving the cultural, institutional, hydrological, and operational constraints that currently inhibit the development of a fully functioning market. The impacts on farmers' net earnings might be larger or smaller than shown above, depending on changes in the prices for different crops and on how farmers react to changes in crop prices, operating costs, climate, and other factors. The results presented above do, however, apply a consistent set of data and assumptions to the different scenarios, and present a preliminary assessment of the potential for market-based reallocation to mitigate the potential impacts of severe drought on irrigators' net farm earnings.

Appendix: Details of the Analysis

This appendix describes the methods, data, and assumptions incorporated into the analysis of the Market Reallocation element of the Integrated Plan.

The analysis employs a spreadsheet model that estimates the net earnings per acre-foot, by crop, for a specified level of water availability and shifts water from a lower-valued crop to a higher-valued crop until, within specified constraints, it exhausts all possibilities to increase net earnings. The model is adapted from one developed by researchers at the Pacific Northwest National Laboratory, who used it to describe opportunities for marked-based transfers to mitigate the impacts of drought on agricultural production in the Yakima River basin and to increase the overall value of agricultural earnings derived from the basin's water resources. They also used the model to investigate the potential impacts of anticipated changes in climate on the value of agricultural production and the ability of market-based transfers to mitigate adverse impacts.

The model considers the 17 crops shown in Table A-1. The table also shows inputs to the model for each crop, and traces the calculation of net earnings per acre-foot, by crop. Inputs to the model come from at the PNW National Laboratory, and from the original data sources—such as the individual districts, the Washington State Dept. of Agriculture—underlying an earlier report prepared for this project, on the out-of-stream needs for water in the basin. The numbers in the table reflect the most current data available; for most variables, the data have been updated to at least 2008. In some instances, data were not available for each crop; gaps in the data were filled with data for a similar crop, following the pattern of substitutions adopted by the researchers at the PNW National Laboratory.[8] The analysis assumes that these substitutions reasonably represent the characteristics of the different crops. The analysis also assumes that the characteristics of the different crops and, hence, the net earnings, will remain constant during the study period. In actuality, some irrigators in the basin likely will alter the mix of crops and experience variation in variable costs, crop prices, and crop-irrigation requirements. The net earnings likely will increase for some crops and decrease for others.

The estimates of net earnings reflect the estimated average value for each crop's full irrigation requirement. The analysis assumes that this value applies to changes water availability. For some crops, it may be possible to estimate the change in net earnings associated with incremental changes in water availability, but the activities necessary to acquire the necessary data and integrate them into the spreadsheet model lie outside the scope of this project. Actual willingness to pay for water may be higher than the average, especially as water availability declines to levels that threaten the survival of perennial crops.

The spreadsheet model simulates market-based reallocation of water on an crop-by-crop basis. If it sees that an acre with a given crop has water while another acre with higher net earnings per acre-foot is experiencing a water shortage, the model transfers the water from the one to the other. It continues this process until no more crop-to-crop transfers are possible.

[8] Following the process adopted by the researchers at the PNW National Laboratory, we are seeking validation of the inputs and net-earnings estimates through a review by one or more of the basin's irrigation managers.

Table A-1. Net Earnings per Acre-Foot, by Crop, and Inputs to the Calculation

Crop	Output Units	(1) Variable Cost ($/ac)	(2) Avg Yield (units/ac)	(3) Avg Price ($/unit)	(4)[a] Net Farm Earnings ($/ac)	(5) Water demand (ac-ft/ac)	(6)[b] Net Farm Earnings ($/ac-ft)
Other Vegetables	cwt/ac	$2,037	500.0	$12	$3,960	3.8	$1,050
Wine Grapes	t/ac	$1,949	4.0	$919	$1,730	3.5	$490
Apples	t/ac	$6,453	16.1	$537	$2,170	5.4	$400
Other Grain	bu/ac	$563	141.5	$14	$1,430	3.5	$410
Hops	lb/ac	$2,489	1976.2	$2	$1,120	4.0	$280
Potatoes	cwt/ac	$2,037	546.1	$6	$940	4.8	$200
Concord Grapes	t/ac	$1,071	8.6	$185	$520	3.7	$140
Miscellaneous	bu/ac	$323	200.0	$4	$480	4.5	$110
Other Tree Crops	t/ac	$6,453	13.6	$510	$480	5.7	$80
Sweet Corn	cwt/ac	$427	193.9	$4	$260	3.2	$80
Asparagus	cwt/ac	$1,817	37.2	$59	$360	4.7	$80
Mint	lb/ac	$1,217	124.9	$13	$390	6.0	$70
Other Hay	t/ac	$323	4.7	$115	$220	5.4	$40
Timothy Hay	t/ac	$327	3.8	$124	$140	5.6	$30
Wheat	bu/ac	$323	103.4	$4	$90	3.8	$20
Alfalfa Hay	t/ac	$547	5.6	$98	$1	5.2	$0.1
Pasture	t/ac	$323	4.7	$51	$(80)[c]	4.5	$(20)[c]

Source: ECONorthwest, with data from the PNW National Laboratory; and from original data sources reported in HDR and Anchor QEA. 2010. *Water Needs for Out-of-Stream Uses.*

[a] [Column (2) times column (3)] minus column (1). Numbers reflect rounding

[b] Column (4) ÷ column (5). Numbers reflect rounding

[c] Numbers in parentheses represent a net loss.

The market-reallocation component of the model addresses three alternatives for intra-district water transfers. In the first, it simulates the maximum level of trading, if irrigators took advantage of every opportunity to move water from a crop with lower net earnings to one with higher net earnings. In the second alternative, the model caps the transfers so that a higher-valued acre that begins with less than full water availability would acquire no more than is need to satisfy 70 percent of the crop's full irrigation requirement. In the third alternative, the model assumes that irrigators acquiring water would have to pay $150 per acre-foot, the upper bound of the price indicated in Table 1. At this price, the analysis assumes an irrigator would not acquire water unless the net earnings per acre-foot, shown in Table A-1, exceeded $150.

Table A-1 identifies only six crops that exceed this limit: other vegetables, wine grapes, apples, other grains, hops, and potatoes.

For inter-district trades, the market-reallocation component of the model first aggregates all the districts and then transfers water on an crop-to-crop basis. The model does not have the capability to disaggregate the results to show the transfers for each district-to-district pair.