Appendix C
Estimates of Climate Change Effects on Crop Irrigation Requirements

Estimates of Climate Change Effects on Crop Irrigation Requirements

Introduction

The University of Washington (UW) Climate Impacts Group published estimates of future crop water demands for two important crops in the Yakima River Basin: cherries and apples (UW, 2009). The net irrigation requirements for apples under climate change conditions was predicted in the UW study to decrease by 20% by the 2040s because of a shorter fruit-growing season even though temperatures would increase and precipitation would slightly decrease. The reduction in net irrigation requirement for cherries in the 2040s was even greater than apples. The Out-of-Stream Water Needs Subcommittee which contains irrigation district managers and tree fruit growers did not believe this to be accurate because of water needs for cooling and groundcover in orchards. In addition the subcommittee noted that limiting the analysis to apples and cherries does not account for the full range of crops grown in the Yakima River Basin. Therefore the subcommittee asked the consultant team to develop another estimate.

This estimate of future water needs under climate change conditions is a preliminary estimate and is based upon available data and reports. Since estimates of water needs for agriculture contained in the Out-of-Stream Water Needs Technical Memorandum are based upon the Washington Irrigation Guide (WIG) (U.S. Department of Agriculture, 1985), the WIG is also used in this estimate to ensure consistency in the calculations.

The estimates of future water use will be used in the RiverWare model to test the effectiveness of the Integrated Water Resource Management Plan in meeting the challenges of changing runoff patterns and water demands. We understand that a much more comprehensive analysis of future water needs will be performed by Washington State University (WSU) as part of their contract with Washington State Department of Ecology (Ecology) for the Columbia River Water Supply Investment Plan: A strategy to develop water supply to meet water demand through 2030.

Methodology

The consultant team did not have access to the detailed modeling that predicted future crop water needs for the UW study and therefore could not review its methodology. Since this study is supposed to use existing, published information and budget was not available for the type of modeling used in the UW study a simpler approach was used. This approach compares the UW estimates of current and future potential evapotranspiration (PET) for a reference crop of short grass and applies the ratio of those PETs to the irrigation requirements listed in the Washington State Irrigation Guide (WIG) (U.S. Department of Agriculture, 1985) for both short grass and other crops that are grown in the Yakima River Basin..

The specific steps followed are summarized below.

1. We obtained estimates of current and future potential evapotranspiration (PET) rates for the standard reference crop of short grass from the UW study for locations in the Yakima River basin.
2. We obtained estimates of future precipitation rates from University of Washington (UW) study for locations in the Yakima River basin to compare to existing rates.
3. We estimated future effective precipitation rates using current estimates of effective precipitation in the WIG. The effective precipitation is defined as the amount of precipitation that enters the soil and becomes available to the plant for growth. It is less than total precipitation because of surface evaporation of small amounts of rainfall and runoff or deep percolation of larger amounts of rainfall.
4. We estimated future irrigation requirements for various crops by multiplying estimates of ET for those crops obtained from WIG by the ratio of future to current PET of the reference crop and subtracting the future effective precipitation. We did not change the growing season and it is the same as listed in WIG. We multiplied the future irrigation requirements for each crop by their acreage in each Yakima Project district to obtain a weighted estimate of future water needs. That estimate was then compared to estimates of current water needs to estimate the percentage increase in future water needs. Changes in crop mix due to climate change and market forces are not considered in this estimate.

The result of these calculations is an estimate of the percentage increase in out-of-stream water needs by district in the Yakima Project. We will use this estimate to adjust the demands in the RiverWare model to represent potential future demands under the climate change scenario selected for this study. The estimate is based upon averaged climatic conditions including precipitation predicted for the 2040s. Crop water needs will vary from year to year based upon climate conditions so this estimate should be viewed as being only indicative of potential water demands.

The results provided below show in detail calculations performed for the Sunnyside weather station. The same procedure was followed for other weather stations that represent crop water demands in the Yakima River Basin, as described in Section 3.4 of the Water Needs for Out-of Stream Uses Technical Memorandum.

Current and Future PET for Sunnyside

Current and future PET rates for Sunnyside were estimated using UW's monthly grid climate change model data. Using the full period of record (Water Years 1926-2006), average monthly PET rates were computed by UW for current and future conditions for the short grass reference crop. The current PET rates are based on the historical model, and the future PET rates are based on the 2040s (2030-2059) "moderate effect" climate change model (Model 6 – HAD-CM B1) selected for the Yakima Basin Study RiverWare model run. Table 1 presents the estimated PET rates for the Sunnyside station. The PET calculated by UW is equal to the reference ET for short grass.

Table 1. Estimated Monthly Potential Evapotranspiration Rates for Reference Crop (Short Grass) – Sunnyside Station (UW Study)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Current PET	1.19	1.86	3.24	4.47	6.03	6.84	7.72	6.46	4.25	2.65	1.70	1.19	47.61
Future PET	1.21	1.80	3.20	4.46	6.26	7.20	8.38	7.10	4.65	2.73	1.68	1.16	49.83
Ratio	102%	97%	99%	100%	104%	105%	108%	110%	109%	103%	99%	97%	105%

Note: PET values in inches

Note: Data from UW (2009) Study, Future represents 2040s rate using "moderate effect" climate change model

Current and Future Precipitation for Sunnyside

Current and future precipitation rates for Sunnyside were estimated using UW's monthly grid climate change model data. Using the full period of record (Water Years 1926-2006), average monthly precipitation rates were computed by UW for current and future conditions. The current precipitation rates are based on the historical model, and the future precipitation rates are based on the 2040s (2030-2059) "moderate effect" climate change model (Model 6 – HAD-CM B1). Table 2 presents the estimated precipitation rates for the Sunnyside station.

Table 2. Estimated Monthly Precipitation Rates – Sunnyside Station (UW Study)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Current	0.92	0.62	0.64	0.53	0.50	0.45	0.15	0.29	0.51	0.60	0.89	1.13	7.24
Future	0.88	0.64	0.73	0.46	0.42	0.33	0.15	0.17	0.24	0.68	1.07	1.10	6.87
Difference	-0.04	0.02	0.09	-0.07	-0.08	-0.12	0.00	-0.12	-0.27	0.08	0.18	-0.03	-0.37

Note: All values in inches

Note: Data from UW (2009) Study, Future represents 2040s rate using "moderate effect" climate change model

Change in Effective Precipitation Rates

Future effective precipitation rates were estimated by using the ratio of effective to total precipitation that is contained in the WIG and applying that ratio to future precipitation estimates. Because the estimates of future precipitation rates are slightly less than current rates this methodology should give slightly conservative results (lower effective precipitation values leading to slightly higher crop irrigation requirements). That is because at lower precipitation rates, a greater percentage of the precipitation can be effective. Table 3 gives the monthly total precipitation and effective precipitation rates from the WIG.

Table 3. Monthly Precipitation Rates – Sunnyside Station (WIG)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Total	1.03	0.58	0.42	0.51	0.53	0.45	0.20	0.30	0.37	0.49	0.83	0.99	6.70
Effective	0.00	0.23	0.27	0.38	0.45	0.42	0.20	0.28	0.29	0.32	0.16	0.00	3.00
Ratio	0%	40%	64%	75%	85%	93%	100%	93%	78%	65%	19%	0%	45%

Note: All values in inches

Source of data: WIG (US Department of Agriculture, 1985)

Table 4 gives the estimated change in effective precipitation based on the change in precipitation rates shown in Table 2 and the percentage of effective precipitation from Table 3.

Table 4. Estimated Change in Effective Precipitation Rates – Sunnyside Station

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Change in Precipitation	-0.04	0.02	0.09	-0.07	-0.08	-0.12	0.00	-0.12	-0.27	0.08	0.18	-0.03
Ratio of Effective to Total	0%	40%	64%	75%	85%	93%	100%	93%	78%	65%	19%	0%
Change in Effective Precipitation	0.00	0.01	0.06	-0.05	-0.07	-0.11	0.00	-0.11	-0.21	0.05	0.03	0.00

Note: Precipitation values in inches

Estimated Future Irrigation Requirements

The procedure for estimating Crop Irrigation Requirements (CIRs) is to estimate the crop ET and subtract the effective precipitation. Crop ET is estimated by multiplying the ET for a reference crop by coefficients that represent the difference in water demand by month for various crops. WIG estimates of crop irrigation requirements factor in those coefficients. Previous calculations of CIRs for the Yakima River Basin Study that are contained in the Out-of-Stream Water Needs Technical Memorandum were performed using data from WIG. To be consistent with those calculations, WIG data was used in this memo and adjusted by our estimate of change in ET due to climate change.

For this estimate of future water demands, we assumed crop coefficients that currently exist will remain the same in the future and the season of use listed in WIG for each crop does not change. . The future ET for each crop was then estimated by multiplying the current crop ET provided by WIG by the ratio of future to current PET of the reference crop provided by UW. That ratio is shown on a monthly basis in Table 1. The results of that calculation are shown in Table 5.

Table 5. Estimated Current and Future ET for Reference Crop (Short Grass)– within Irrigation Season – Sunnyside Station (using WIG data)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Current (WIG)	0.00	0.00	0.00	0.91	6.70	8.08	9.85	8.12	5.32	2.11	0.00	0.00	41.09
Multiplier	1.02	0.97	0.99	1.00	1.04	1.05	1.08	1.10	1.09	1.03	0.99	0.97	
Future	0.00	0.00	0.00	0.91	6.97	8.48	10.64	8.93	5.80	2.17	0.00	0.00	43.90

Note: All values in inches

Irrigation season assumed to be same as WIG (April 23 to October 27 for this crop)

The future CIRs were estimated by adjusting crop ETs in WIG for all crops in the Yakima River basin and subtracting effective precipitation. For partial months (at the beginning and end of the irrigation season), a prorated effective precipitation rate was used. For example, if the irrigation season for a crop ends October 14, then 45 percent (14/31) of the effective precipitation for October was used to calculate the future CIR for October. Table 6 presents the estimated future CIRs for the Sunnyside station.

Table 6

Estimated Future Crop Irrigation Requirements - Sunnyside Station

Crop Type	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Total	Current	Difference	% Difference
Caneberry		1.49	6.92	9.88	12.62	10.09	4.87	0.69	46.56	42.91	3.65	8.5%
Currant		1.49	6.92	9.88	12.62	10.09	4.87	0.69	46.56	42.91	3.65	8.5%
Barley	0.78	3.87	7.61	9.24	4.32				25.82	24.56	1.26	5.1%
Corn, Field			1.50	4.74	11.27	10.09	4.73		32.33	29.31	3.02	10.3%
Oat	0.78	3.87	7.61	9.24	4.32				25.82	24.56	1.26	5.1%
Rye	0.78	3.87	7.61	9.24	4.32				25.82	24.56	1.26	5.1%
Triticale	0.78	3.87	7.61	9.24	4.32				25.82	24.56	1.26	5.1%
Wheat	1.37	4.81	7.61	7.60	1.61	1.15	0.71	0.95	25.81	24.35	1.46	6.0%
Green Manure	0.78	3.87	7.61	9.24	4.32				25.82	24.56	1.26	5.1%
Alfalfa, Hay		0.77	6.21	7.76	9.95	8.31	5.46	1.74	40.22	37.02	3.20	8.6%
Alfalfa/Grass, Hay		0.77	6.21	7.76	9.95	8.31	5.46	1.74	40.22	37.02	3.20	8.6%
Clover, Hay		0.86	6.92	8.61	11.01	9.20	6.04	1.97	44.62	41.13	3.49	8.5%
Grass, Hay		0.86	6.92	8.61	11.01	9.20	6.04	1.97	44.62	41.13	3.49	8.5%
Hay/Silage, Unknown		0.86	6.92	8.61	11.01	9.20	6.04	1.97	44.62	41.13	3.49	8.5%
Sorghum				3.11	9.19	9.65	5.55	0.30	27.81	25.13	2.68	10.7%
Sudangrass		0.86	6.92	8.61	11.01	9.20	6.04	1.97	44.62	41.13	3.49	8.5%
Timothy		0.86	6.92	8.61	11.01	9.20	6.04	1.97	44.62	41.13	3.49	8.5%
Hops		0.36	3.09	6.91	9.95	13.22			33.54	30.76	2.78	9.0%
Watermelon									16.49	15.17	1.32	8.7%
Mint		0.36	3.09	4.79	11.55	10.55	6.92	2.09	39.34	35.94	3.40	9.5%
Pasture									32.03	29.47	2.56	8.7%
Wildlife Feed			1.50	4.74	11.27	10.09	4.73		32.33	29.31	3.02	10.3%
Apple		0.48	5.52	9.46	13.15	10.98	6.92	1.74	48.25	44.37	3.88	8.7%
Apricot	0.14	1.72	5.18	8.61	12.09	10.09	6.34	1.50	45.67	42.05	3.62	8.6%
Cherry		1.06	5.52	9.46	13.15	10.98	6.92	1.74	48.83	44.93	3.90	8.7%
Nectarine/Peach		1.54	5.18	8.61	12.09	10.09	6.34	1.50	45.34	41.71	3.63	8.7%
Orchard, Unknown		0.48	5.52	9.46	13.15	10.98	6.92	1.74	48.25	44.37	3.88	8.7%
Pear		0.90	5.18	8.61	12.09	10.09	6.34	1.50	44.71	41.09	3.62	8.8%
Plum		0.90	5.18	8.61	12.09	10.09	6.34	1.50	44.71	41.09	3.62	8.8%
Driving Range		0.82	6.57	8.19	10.48	8.75	5.75	1.85	42.41	39.07	3.34	8.6%
Golf Course		0.82	6.57	8.19	10.48	8.75	5.75	1.85	42.41	39.07	3.34	8.6%
Sod Farm		0.82	6.57	8.19	10.48	8.75	5.75	1.85	42.41	39.07	3.34	8.6%
Asparagus									32.55	29.96	2.60	8.7%
Bean, Dry				3.78	11.95	8.89	0.49		25.10	22.66	2.44	10.8%
Bean, Green				3.11	8.94	8.38			20.43	18.56	1.87	10.1%
Corn, Sweet			1.50	6.15	12.08	3.20			22.92	21.02	1.90	9.1%
Cucumber				2.92	7.30	8.31	5.34	0.44	24.32	21.93	2.39	10.9%
Market Crops			1.50	4.11	10.26	9.65	4.80	0.06	30.37	27.52	2.85	10.3%
Onion		2.56	6.70	8.61	10.86	6.99			35.73	33.20	2.53	7.6%
Potato			1.50	5.23	11.94	9.86	3.22		31.75	28.80	2.95	10.2%
Pumpkin				2.92	7.30	8.17	1.61		20.00	17.93	2.07	11.6%
Squash				2.92	7.30	8.17	1.61		20.00	17.93	2.07	11.6%
Tomato			1.50	4.11	10.26	9.65	4.80	0.06	30.37	27.52	2.85	10.3%
Vegetable, Unknown			1.50	4.11	10.26	9.65	4.80	0.06	30.37	27.52	2.85	10.3%
Grape, Concord			1.63	5.64	8.88	7.86	4.87	1.15	30.04	27.34	2.70	9.9%
Grape, Wine			1.63	5.64	8.88	7.86	4.87	1.15	30.04	27.34	2.70	9.9%

Note: All values in inches

The results in Table 6 show a range of 5 percent to 12 percent higher annual irrigation requirements for future conditions at the Sunnyside station. Similar results occur for the other four stations used in Section 3.4 of the Water Needs Technical Memorandum (Ellensburg, Wapato, Yakima and Richland). Those results are appended to this memo.

Estimated Increase in Future Irrigation Requirements

The crop acreage in each of the six Yakima Project districts was multiplied by the future CIRs for each crop and used to calculate a District-wide weighted average CIR under future climate change conditions. The future weighted-average CIR was then compared to the current CIR to estimate the increase in CIRs for Yakima Project districts under climate change conditions.

Table 7 summarizes the results for each district. Detailed spreadsheet calculations are provided in Appendix C attachments for both current and future CIRs. The increases range from 7.8% for KID to 9.8% for KRD. These CIRs represent only the consumptive use of crops district-wide, and do not include seepage and evaporation losses that occur on-farm and district wide.

Table 7. Summary of Weighted Current and Future CIR

District	Current CIR (ft)	Future CIR (ft)	Percent Increase
KRD	2.51	2.75	9.8%
Roza	2.97	3.24	9.0%
WIP	2.78	3.03	8.7%
SVID	2.72	2.97	9.2%
YTID	2.61	2.84	8.9%
KID	2.96	3.19	7.8%

The percentage increase listed in Table 7 will be used to adjust consumptive use estimates for each irrigation district in the RiverWare model. A similar adjustment will be made to the consumptive portion of municipal demands in the RiverWare model, since consumptive use in the municipal demand sector is largely due to outdoor irrigation.

Using the estimates in Table 7 and district acreage data, the estimated increase in consumptive use is presented in Table 8.

Table 8. Estimated Increase in Consumptive Use Under Climate Change Conditions

District	Current CIR (ft)	Future CIR (ft)	Increase in CIR (ft)	Irrigated Land (ac)	Increase (ac-ft)
KRD	2.51	2.75	0.24	55,516	13,000
Roza	2.97	3.24	0.27	72,491	20,000
WIP	2.78	3.03	0.25	109,115	27,000
SVID	2.72	2.97	0.25	99,243	25,000
YTID	2.61	2.84	0.23	27,900	6,000
KID	2.96	3.19	0.23	18,441	4,000
Totals					95,000

The total estimated increase in consumptive use for Yakima Project irrigation districts is approximately 95,000 acre-feet per year. That estimate assumes current cropping patterns will

continue in the future and therefore does not account for potential responses to climate change and additional water shortfalls by Yakima River basin water users. The estimate also assumes a full water supply is available for all currently irrigated crops; in drought years less water would be available and the increase in consumptive use would be less.

Appendix C Attachments

C-1 – Summary Tables – Ellensburg Station

C-2 – Summary Tables – Yakima Station

C-3 – Summary Tables – Wapato Station

C-4 – Summary Tables – Richland Station

C-5 – Estimated KRD Future Irrigation Requirements

C-6 – Estimated Roza Future Irrigation Requirements

C-7 – Estimated WIP Future Irrigation Requirements

C-8 – Estimated SVID Future Irrigation Requirements

C-9 – Estimated YTID Future Irrigation Requirements

C-10 – Estimated KID Future Irrigation Requirements

Attachment C-1
Summary Tables – Ellensburg Station

Table 1. Estimated Monthly Potential Evapotranspiration Rates for Reference Crop (Short Grass) – Ellensburg Station (UW Study)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Current PET	0.81	1.51	3.38	4.43	5.59	6.29	7.21	6.06	3.92	2.67	1.93	1.08	44.86
Future PET	0.88	1.58	3.36	4.32	5.69	6.64	7.86	6.72	4.29	2.61	1.93	1.21	47.09
Ratio	109%	105%	99%	98%	102%	106%	109%	111%	109%	98%	100%	113%	105%

Note: PET values in inches

Note: Data from UW (2009) Study, Future represents 2040s rate using "moderate effect" climate change model

Table 2. Estimated Monthly Precipitation Rates – Ellensburg Station (UW Study)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Current	1.29	0.92	0.81	0.58	0.55	0.62	0.28	0.31	0.49	0.65	1.07	1.54	9.11
Future	1.18	0.92	0.90	0.51	0.46	0.46	0.23	0.19	0.24	0.78	1.24	1.51	8.62
Difference	-0.11	0.00	0.09	-0.07	-0.09	-0.16	-0.05	-0.12	-0.25	0.13	0.17	-0.03	-0.49

Note: All values in inches

Note: Data from UW (2009) Study, Future represents 2040s rate using "moderate effect" climate change model

Table 3. Monthly Precipitation Rates – Ellensburg Station (WIG)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Total	1.20	1.14	0.67	0.51	0.54	0.59	0.34	0.61	0.64	0.54	1.21	1.59	9.58
Effective	0.00	0.09	0.42	0.36	0.44	0.52	0.33	0.55	0.48	0.33	0.00	0.00	3.51
Ratio	0%	8%	63%	71%	81%	88%	97%	90%	75%	61%	0%	0%	37%

Note: All values in inches

Source of data: WIG (US Department of Agriculture, 1985)

Table 4. Estimated Change in Effective Precipitation Rates – Ellensburg Station

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Change in Precipitation	-0.11	0.00	0.09	-0.07	-0.09	-0.16	-0.05	-0.12	-0.25	0.13	0.17	-0.03
Ratio of Effective to Total	0%	8%	63%	71%	81%	88%	97%	90%	75%	61%	0%	0%
Change in Effective Precipitation	0.00	0.00	0.06	-0.05	-0.07	-0.15	-0.05	-0.11	-0.18	0.08	0.00	0.00

Note: Precipitation values in inches

Table 5. Estimated Current and Future ET for Reference Crop (Short Grass)– within Irrigation Season – Ellensburg Station (using WIG data)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Current (WIG)	0.00	0.00	0.00	0.00	3.34	7.32	9.65	7.98	4.71	0.75	0.00	0.00	33.75
Multiplier	1.09	1.05	0.99	0.98	1.02	1.06	1.09	1.11	1.09	0.98	1.00	1.13	
Future	0.00	0.00	0.00	0.00	3.41	7.76	10.52	8.86	5.13	0.74	0.00	0.00	36.42

Note: All values in inches

Irrigation season assumed to be same as WIG (May 13 to October 14 for this crop)

Attachment C-1
Summary Tables - Ellensburg Station

Table 6
Estimated Future Irrigation Requirements - Ellensburg Station

Crop Type	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Total	Current	Difference	% Difference
Caneberry		0.26	6.20	8.89	12.35	9.74	4.08	0.14	41.66	38.11	3.55	9.3%
Currant		0.26	6.20	8.89	12.35	9.74	4.08	0.14	41.66	38.11	3.55	9.3%
Barley	0.02	2.20	6.14	8.50	10.77	1.89			29.52	27.44	2.08	7.6%
Corn, Field			0.08	3.02	8.31	9.72	5.34	0.33	26.80	23.98	2.82	11.8%
Oat	0.02	2.20	6.14	8.50	10.77	1.89			29.52	27.44	2.08	7.6%
Rye	0.02	2.20	6.14	8.50	10.77	1.89			29.52	27.44	2.08	7.6%
Triticale	0.02	2.20	6.14	8.50	10.77	1.89			29.52	27.44	2.08	7.6%
Wheat	0.04	3.48	6.81	8.50	7.95	0.53	0.30	0.57	28.18	26.31	1.87	7.1%
Green Manure	0.02	2.20	6.14	8.50	10.77	1.89			29.52	27.44	2.08	7.6%
Alfalfa, Hay			3.01	6.96	9.71	7.97	4.59	0.51	32.76	29.76	3.00	10.1%
Alfalfa/Grass, Hay			3.01	6.96	9.71	7.97	4.59	0.51	32.76	29.76	3.00	10.1%
Clover, Hay			3.35	7.73	10.77	8.86	5.11	0.59	36.40	33.14	3.26	9.8%
Grass, Hay			3.35	7.73	10.77	8.86	5.11	0.59	36.40	33.14	3.26	9.8%
Hay/Silage, Unknown			3.35	7.73	10.77	8.86	5.11	0.59	36.40	33.14	3.26	9.8%
Sorghum				1.25	6.06	9.01	5.28	0.33	21.94	19.56	2.38	12.2%
Sudangrass			3.35	7.73	10.77	8.86	5.11	0.59	36.40	33.14	3.26	9.8%
Timothy			3.35	7.73	10.77	8.86	5.11	0.59	36.40	33.14	3.26	9.8%
Hops			1.46	6.19	9.71	12.84			30.21	27.35	2.86	10.5%
Watermelon									13.43	12.20	1.23	10.1%
Mint			1.46	4.26	11.30	10.19	5.89	0.63	33.72	30.43	3.29	10.8%
Pasture									26.09	23.70	2.39	10.1%
Wildlife Feed			0.08	3.02	8.31	9.72	5.34	0.33	26.80	23.98	2.82	11.8%
Apple			3.44	8.50	12.88	10.63	5.89	0.51	41.85	38.11	3.74	9.8%
Apricot		0.91	4.63	7.73	11.82	9.74	5.37	0.42	40.63	37.10	3.53	9.5%
Cherry		0.09	4.95	8.50	12.88	10.63	5.89	0.51	43.44	39.66	3.78	9.5%
Nectarine/Peach		0.57	4.63	7.73	11.82	9.74	5.37	0.42	40.28	36.76	3.52	9.6%
Orchard, Unknown			3.44	8.50	12.88	10.63	5.89	0.51	41.85	38.11	3.74	9.8%
Pear		0.00	4.39	7.73	11.82	9.74	5.37	0.42	39.47	35.96	3.51	9.8%
Plum		0.00	4.39	7.73	11.82	9.74	5.37	0.42	39.47	35.96	3.51	9.8%
Driving Range			3.17	7.35	10.24	8.41	4.86	0.55	34.58	31.45	3.13	10.0%
Golf Course			3.17	7.35	10.24	8.41	4.86	0.55	34.58	31.45	3.13	10.0%
Sod Farm			3.17	7.35	10.24	8.41	4.86	0.55	34.58	31.45	3.13	10.0%
Asparagus									26.51	24.09	2.43	10.1%
Bean, Dry				1.25	8.69	10.18	2.15		22.27	19.78	2.49	12.6%
Bean, Green				1.25	6.06	8.35	2.26		17.92	15.82	2.10	13.3%
Corn, Sweet			0.08	3.32	10.35	8.61			22.36	20.08	2.28	11.3%
Cucumber				1.25	5.01	7.47	4.59	0.45	18.78	16.70	2.08	12.5%
Market Crops			0.08	2.94	7.14	9.14	5.20	0.23	24.73	22.08	2.65	12.0%
Onion		0.33	3.87	7.72	10.77	8.50	2.72		33.92	30.80	3.12	10.1%
Potato			0.08	3.06	9.47	9.74	5.02	0.17	27.54	24.64	2.90	11.8%
Pumpkin				1.25	5.01	7.47	3.32		17.06	15.04	2.02	13.4%
Squash				1.25	5.01	7.47	3.32		17.06	15.04	2.02	13.4%
Tomato			0.08	2.94	7.14	9.14	5.20	0.23	24.73	22.08	2.65	12.0%
Vegetable, Unknown			0.08	2.94	7.14	9.14	5.20	0.23	24.73	22.08	2.65	12.0%
Grape, Concord			0.08	5.03	8.67	7.52	4.08	0.30	25.68	23.05	2.63	11.4%
Grape, Wine			0.08	5.03	8.67	7.52	4.08	0.30	25.68	23.05	2.63	11.4%

Note: All values in inches

Attachment C-2
Summary Tables – Yakima Station

Table 1. Estimated Monthly Potential Evapotranspiration Rates for Reference Crop (Short Grass) – Yakima Station (UW Study)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Current PET	1.00	1.71	3.00	4.28	5.77	6.58	7.48	6.27	4.07	2.48	1.67	1.12	45.43
Future PET	1.10	1.62	2.99	4.25	5.96	6.93	8.11	6.91	4.46	2.56	1.58	1.16	47.63
Ratio	110%	95%	100%	99%	103%	105%	109%	110%	109%	103%	95%	104%	105%

Note: PET values in inches

Note: Data from UW (2009) Study, Future represents 2040s rate using "moderate effect" climate change model

Table 2. Estimated Monthly Precipitation Rates – Yakima Station (UW Study)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Current	1.37	0.82	0.74	0.57	0.48	0.56	0.27	0.33	0.47	0.59	1.01	1.58	8.79
Future	1.26	0.81	0.82	0.50	0.40	0.42	0.24	0.20	0.23	0.69	1.17	1.53	8.28
Difference	-0.11	-0.01	0.08	-0.07	-0.08	-0.14	-0.03	-0.13	-0.24	0.10	0.16	-0.05	-0.51

Note: All values in inches

Note: Data from UW (2009) Study, Future represents 2040s rate using "moderate effect" climate change model

Table 3. Monthly Precipitation Rates – Yakima Station (WIG)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Total	1.44	0.74	0.65	0.50	0.48	0.60	0.14	0.36	0.33	0.47	0.97	1.30	7.98
Effective	0.00	0.18	0.42	0.36	0.40	0.53	0.14	0.33	0.26	0.30	0.12	0.00	3.04
Ratio	0%	24%	65%	72%	83%	88%	100%	92%	79%	64%	12%	0%	38%

Note: All values in inches

Source of data: WIG (US Department of Agriculture, 1985)

Table 4. Estimated Change in Effective Precipitation Rates – Yakima Station

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Change in Precipitation	-0.11	-0.01	0.08	-0.07	-0.08	-0.14	-0.03	-0.13	-0.24	0.10	0.16	-0.05
Ratio of Effective to Total	0%	24%	65%	72%	83%	88%	100%	92%	79%	64%	12%	0%
Change in Effective Precipitation	0.00	-0.00	0.05	-0.05	-0.07	-0.13	-0.03	-0.12	-0.19	0.06	0.02	0.00

Note: Precipitation values in inches

Table 5. Estimated Current and Future ET for Reference Crop (Short Grass)– within Irrigation Season – Yakima Station (using WIG data)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Current (WIG)	0.00	0.00	0.00	0.84	6.33	7.71	9.56	7.86	5.06	1.93	0.00	0.00	39.29
Multiplier	1.10	0.95	1.00	0.99	1.03	1.05	1.09	1.10	1.09	1.03	0.95	1.04	
Future	0.00	0.00	0.00	0.83	6.52	8.10	10.42	8.65	5.52	1.99	0.00	0.00	42.03

Note: All values in inches

Irrigation season assumed to be same as WIG (April 23 to October 27 for this crop)

Attachment C-2
Summary Tables - Yakima Station

Table 6
Estimated Future Irrigation Requirements - Yakima Station

Crop Type	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Total	Current	Difference	% Difference
Caneberry		1.37	6.53	9.35	12.34	9.74	4.63	0.60	44.56	41.02	3.54	8.6%
Currant		1.37	6.53	9.35	12.34	9.74	4.63	0.60	44.56	41.02	3.54	8.6%
Barley	0.51	3.60	7.18	8.73	4.27				24.29	23.06	1.23	5.3%
Corn, Field			1.46	4.46	11.05	9.74	4.50		31.21	28.22	2.99	10.6%
Oat	0.51	3.60	7.18	8.73	4.27				24.29	23.06	1.23	5.3%
Rye	0.51	3.60	7.18	8.73	4.27				24.29	23.06	1.23	5.3%
Triticale	0.51	3.60	7.18	8.73	4.27				24.29	23.06	1.23	5.3%
Wheat	1.06	4.45	7.18	7.16	1.62	1.05	0.68	0.88	24.07	22.67	1.40	6.2%
Green Manure	0.51	3.60	7.18	8.73	4.27				24.29	23.06	1.23	5.3%
Alfalfa, Hay		0.71	5.88	7.32	9.74	8.02	5.19	1.56	38.41	35.31	3.10	8.8%
Alfalfa/Grass, Hay		0.71	5.88	7.32	9.74	8.02	5.19	1.56	38.41	35.31	3.10	8.8%
Clover, Hay		0.80	6.53	8.13	10.78	8.87	5.74	1.78	42.62	39.25	3.37	8.6%
Grass, Hay		0.80	6.53	8.13	10.78	8.87	5.74	1.78	42.62	39.25	3.37	8.6%
Hay/Silage, Unknown		0.80	6.53	8.13	10.78	8.87	5.74	1.78	42.62	39.25	3.37	8.6%
Sorghum				2.87	9.03	9.31	5.27	0.26	26.74	24.10	2.64	11.0%
Sudangrass		0.80	6.53	8.13	10.78	8.87	5.74	1.78	42.62	39.25	3.37	8.6%
Timothy		0.80	6.53	8.13	10.78	8.87	5.74	1.78	42.62	39.25	3.37	8.6%
Hops		0.33	2.93	6.51	9.74	12.77			32.28	29.51	2.77	9.4%
Watermelon									15.75	14.47	1.27	8.8%
Mint		0.33	2.93	4.47	11.31	10.17	6.57	1.88	37.66	34.34	3.32	9.7%
Pasture									30.59	28.12	2.47	8.8%
Wildlife Feed			1.46	4.46	11.05	9.74	4.50		31.21	28.22	2.99	10.6%
Apple		0.43	5.22	8.94	12.86	10.61	6.57	1.56	46.19	42.42	3.77	8.9%
Apricot	0.06	1.58	4.90	8.13	11.82	9.74	6.02	1.35	43.60	40.09	3.51	8.8%
Cherry		0.96	5.22	8.94	12.86	10.61	6.57	1.56	46.71	42.93	3.78	8.8%
Nectarine/Peach		1.39	4.90	8.13	11.82	9.74	6.02	1.35	43.35	39.82	3.53	8.9%
Orchard, Unknown		0.43	5.22	8.94	12.86	10.61	6.57	1.56	46.19	42.42	3.77	8.9%
Pear		0.81	4.90	8.13	11.82	9.74	6.02	1.35	42.77	39.26	3.51	9.0%
Plum		0.81	4.90	8.13	11.82	9.74	6.02	1.35	42.77	39.26	3.51	9.0%
Driving Range		0.75	6.20	7.72	10.26	8.44	5.46	1.67	40.51	37.27	3.24	8.7%
Golf Course		0.75	6.20	7.72	10.26	8.44	5.46	1.67	40.51	37.27	3.24	8.7%
Sod Farm		0.75	6.20	7.72	10.26	8.44	5.46	1.67	40.51	37.27	3.24	8.7%
Asparagus									31.09	28.58	2.51	8.8%
Bean, Dry				3.51	11.69	8.57	0.45		24.21	21.77	2.44	11.2%
Bean, Green				2.87	8.78	8.07			19.72	17.82	1.90	10.7%
Corn, Sweet			1.46	5.80	11.82	3.09			22.17	20.24	1.93	9.5%
Cucumber				2.69	7.20	8.02	5.08	0.37	23.37	21.01	2.36	11.2%
Market Crops			1.46	3.87	10.06	9.31	4.57	0.03	29.30	26.50	2.80	10.6%
Onion		2.44	6.33	8.13	10.63	6.74			34.27	31.78	2.49	7.8%
Potato			1.46	4.94	11.67	9.51	3.06		30.64	27.72	2.92	10.5%
Pumpkin				2.69	7.20	7.88	1.51		19.29	17.22	2.07	12.0%
Squash				2.69	7.20	7.88	1.51		19.29	17.22	2.07	12.0%
Tomato			1.46	3.87	10.06	9.31	4.57	0.03	29.30	26.50	2.80	10.6%
Vegetable, Unknown			1.46	3.87	10.06	9.31	4.57	0.03	29.30	26.50	2.80	10.6%
Grape, Concord			1.55	5.28	8.71	7.57	4.63	1.02	28.78	26.13	2.65	10.1%
Grape, Wine			1.55	5.28	8.71	7.57	4.63	1.02	28.78	26.13	2.65	10.1%

Note: All values in inches

Table 1. Estimated Monthly Potential Evapotranspiration Rates for Reference Crop (Short Grass) – Wapato Station (UW Study)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Current PET	1.09	1.80	3.11	4.35	5.90	6.73	7.64	6.38	4.18	2.60	1.76	1.20	46.74
Future PET	1.21	1.72	3.10	4.32	6.09	7.08	8.28	7.01	4.56	2.66	1.67	1.24	48.97
Ratio	111%	96%	100%	99%	103%	105%	108%	110%	109%	102%	95%	104%	105%

Note: PET values in inches

Note: Data from UW (2009) Study, Future represents 2040s rate using "moderate effect" climate change model

Table 2. Estimated Monthly Precipitation Rates – Wapato Station (UW Study)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Current	1.33	0.79	0.71	0.50	0.46	0.54	0.22	0.31	0.42	0.58	0.96	1.43	8.26
Future	1.21	0.79	0.79	0.44	0.38	0.40	0.20	0.19	0.21	0.68	1.11	1.38	7.78
Difference	-0.12	0.00	0.08	-0.06	-0.08	-0.14	-0.02	-0.12	-0.21	0.10	0.15	-0.05	-0.48

Note: All values in inches

Note: Data from UW (2009) Study, Future represents 2040s rate using "moderate effect" climate change model

Table 3. Monthly Precipitation Rates – Wapato Station (WIG)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Total	1.20	0.64	0.56	0.51	0.45	0.53	0.19	0.36	0.34	0.43	0.93	1.10	7.24
Effective	0.00	0.23	0.37	0.37	0.39	0.49	0.19	0.34	0.27	0.28	0.15	0.00	3.11
Ratio	0%	36%	66%	73%	87%	92%	100%	94%	79%	65%	16%	0%	43%

Note: All values in inches

Source of data: WIG (US Department of Agriculture, 1985)

Table 4. Estimated Change in Effective Precipitation Rates – Wapato Station

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Change in Precipitation	-0.12	0.00	0.08	-0.06	-0.08	-0.14	-0.02	-0.12	-0.21	0.10	0.15	-0.05
Ratio of Effective to Total	0%	36%	66%	73%	87%	92%	100%	94%	79%	65%	16%	0%
Change in Effective Precipitation	0.00	0.00	0.05	-0.04	-0.07	-0.13	-0.02	-0.12	-0.17	0.06	0.02	0.00

Note: Precipitation values in inches

Table 5. Estimated Current and Future ET for Reference Crop (Short Grass)– within Irrigation Season – Wapato Station (using WIG data)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Current (WIG)	0.00	0.00	0.00	0.93	6.94	8.30	10.29	8.46	5.48	2.16	0.00	0.00	42.56
Multiplier	1.11	0.96	1.00	0.99	1.03	1.05	1.08	1.10	1.09	1.02	0.95	1.04	
Future	0.00	0.00	0.00	0.92	7.15	8.72	11.11	9.31	5.97	2.20	0.00	0.00	45.38

Note: All values in inches

Irrigation season assumed to be same as WIG (April 23 to October 27 for this crop)

Attachment C-3
Summary Tables - Wapato Station

Table 6
Estimated Future Irrigation Requirements - Wapato Station

Crop Type	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Total	Current	Difference	% Difference
Caneberry		1.51	7.19	10.12	13.22	10.47	4.99	0.74	48.23	44.55	3.68	8.3%
Currant		1.51	7.19	10.12	13.22	10.47	4.99	0.74	48.23	44.55	3.68	8.3%
Barley	0.69	3.95	7.91	9.45	4.56				26.56	25.27	1.29	5.1%
Corn, Field			1.58	4.78	11.81	10.47	4.84		33.48	30.39	3.09	10.2%
Oat	0.69	3.95	7.91	9.45	4.56				26.56	25.27	1.29	5.1%
Rye	0.69	3.95	7.91	9.45	4.56				26.56	25.27	1.29	5.1%
Triticale	0.69	3.95	7.91	9.45	4.56				26.56	25.27	1.29	5.1%
Wheat	1.29	4.91	7.91	7.77	1.71	1.15	0.72	1.02	26.47	25.04	1.43	5.7%
Green Manure	0.69	3.95	7.91	9.45	4.56				26.56	25.27	1.29	5.1%
Alfalfa, Hay		0.80	6.48	7.93	10.43	8.61	5.59	1.80	41.64	38.42	3.22	8.4%
Alfalfa/Grass, Hay		0.80	6.48	7.93	10.43	8.61	5.59	1.80	41.64	38.42	3.22	8.4%
Clover, Hay		0.89	7.19	8.80	11.55	9.54	6.19	2.04	46.20	42.69	3.51	8.2%
Grass, Hay		0.89	7.19	8.80	11.55	9.54	6.19	2.04	46.20	42.69	3.51	8.2%
Hay/Silage, Unknown		0.89	7.19	8.80	11.55	9.54	6.19	2.04	46.20	42.69	3.51	8.2%
Sorghum				3.12	9.63	10.00	5.67	0.32	28.75	26.02	2.73	10.5%
Sudangrass		0.89	7.19	8.80	11.55	9.54	6.19	2.04	46.20	42.69	3.51	8.2%
Timothy		0.89	7.19	8.80	11.55	9.54	6.19	2.04	46.20	42.69	3.51	8.2%
Hops		0.38	3.26	7.06	10.43	13.72			34.84	31.95	2.89	9.1%
Watermelon									17.07	15.75	1.32	8.4%
Mint		0.38	3.26	4.88	12.10	10.94	7.08	2.15	40.79	37.35	3.44	9.2%
Pasture									33.16	30.59	2.57	8.4%
Wildlife Feed			1.58	4.78	11.81	10.47	4.84		33.48	30.39	3.09	10.2%
Apple		0.49	5.76	9.67	13.77	11.40	7.08	1.80	49.98	46.06	3.92	8.5%
Apricot	0.11	1.75	5.41	8.80	12.66	10.47	6.48	1.57	47.25	43.61	3.64	8.4%
Cherry		1.08	5.76	9.67	13.77	11.40	7.08	1.80	50.57	46.64	3.93	8.4%
Nectarine/Peach		1.57	5.41	8.80	12.66	10.47	6.48	1.57	46.96	43.30	3.66	8.5%
Orchard, Unknown		0.49	5.76	9.67	13.77	11.40	7.08	1.80	49.98	46.06	3.92	8.5%
Pear		0.92	5.41	8.80	12.66	10.47	6.48	1.57	46.31	42.66	3.65	8.6%
Plum		0.92	5.41	8.80	12.66	10.47	6.48	1.57	46.31	42.66	3.65	8.6%
Driving Range		0.84	6.84	8.37	10.98	9.07	5.88	1.92	43.90	40.54	3.36	8.3%
Golf Course		0.84	6.84	8.37	10.98	9.07	5.88	1.92	43.90	40.54	3.36	8.3%
Sod Farm		0.84	6.84	8.37	10.98	9.07	5.88	1.92	43.90	40.54	3.36	8.3%
Asparagus									33.70	31.09	2.61	8.4%
Bean, Dry				3.82	12.51	9.20	0.46		25.99	23.47	2.52	10.7%
Bean, Green				3.12	9.37	8.69			21.18	19.20	1.98	10.3%
Corn, Sweet			1.58	6.25	12.65	3.32			23.81	21.80	2.01	9.2%
Cucumber				2.92	7.65	8.61	5.47	0.44	25.09	22.66	2.43	10.7%
Market Crops			1.58	4.14	10.73	10.00	4.91	0.05	31.43	28.53	2.90	10.2%
Onion		2.61	6.97	8.80	11.39	7.25			37.01	34.41	2.60	7.6%
Potato			1.58	5.30	12.50	10.22	3.28		32.89	29.87	3.02	10.1%
Pumpkin			0.00	2.92	7.65	8.47	1.61		20.65	18.52	2.13	11.5%
Squash			0.00	2.92	7.65	8.47	1.61		20.65	18.52	2.13	11.5%
Tomato			1.58	4.14	10.73	10.00	4.91	0.05	31.43	28.53	2.90	10.2%
Vegetable, Unknown			1.58	4.14	10.73	10.00	4.91	0.05	31.43	28.53	2.90	10.2%
Grape, Concord			1.75	5.75	9.31	8.15	4.99	1.21	31.16	28.42	2.74	9.6%
Grape, Wine			1.75	5.75	9.31	8.15	4.99	1.21	31.16	28.42	2.74	9.6%

Note: All values in inches

Table 1. Estimated Monthly Potential Evapotranspiration Rates for Reference Crop (Short Grass) – Richland Station (UW Study)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Current PET	1.22	1.68	2.93	4.19	5.86	6.62	7.41	6.11	4.13	2.44	1.44	1.14	45.17
Future PET	1.23	1.65	2.90	4.21	6.07	6.95	7.97	6.66	4.48	2.57	1.38	1.09	47.14
Ratio	101%	98%	99%	100%	103%	105%	108%	109%	109%	105%	95%	96%	104%

Note: PET values in inches

Note: Data from UW (2009) Study, Future represents 2040s rate using "moderate effect" climate change model

Table 2. Estimated Monthly Precipitation Rates – Richland Station (UW Study)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Current	1.02	0.73	0.70	0.51	0.55	0.41	0.19	0.26	0.33	0.56	0.97	1.10	7.32
Future	0.99	0.76	0.80	0.45	0.49	0.32	0.20	0.18	0.19	0.62	1.18	1.10	7.27
Difference	-0.03	0.03	0.10	-0.06	-0.06	-0.09	0.01	-0.08	-0.14	0.06	0.21	0.00	-0.05

Note: All values in inches

Note: Data from UW (2009) Study, Future represents 2040s rate using "moderate effect" climate change model

Table 3. Monthly Precipitation Rates – Richland Station (WIG)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Total	1.03	0.69	0.50	0.42	0.53	0.44	0.14	0.32	0.28	0.46	0.91	1.06	6.78
Effective	0.00	0.27	0.33	0.32	0.46	0.42	0.14	0.31	0.23	0.31	0.20	0.00	2.98
Ratio	0%	39%	66%	76%	87%	95%	100%	97%	82%	67%	22%	0%	44%

Note: All values in inches

Source of data: WIG (US Department of Agriculture, 1985)

Table 4. Estimated Change in Effective Precipitation Rates – Richland Station

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Change in Precipitation	-0.03	0.03	0.10	-0.06	-0.06	-0.09	0.01	-0.09	-0.14	0.06	0.21	0.00
Ratio of Effective to Total	0%	39%	66%	76%	87%	95%	100%	97%	82%	67%	22%	0%
Change in Effective Precipitation	0.00	0.01	0.07	-0.05	-0.05	-0.08	0.01	-0.09	-0.12	0.04	0.05	0.00

Note: Precipitation values in inches

Table 5. Estimated Current and Future ET for Reference Crop (Short Grass)– within Irrigation Season – Richland Station (using WIG data)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Current (WIG)	0.00	0.00	0.00	0.97	7.05	8.47	10.45	8.67	5.72	2.34	0.00	0.00	43.67
Multiplier	1.01	0.98	0.99	1.00	1.03	1.05	1.08	1.09	1.09	1.05	0.95	0.96	
Future	0.00	0.00	0.00	0.97	7.26	8.89	11.29	9.45	6.23	2.46	0.00	0.00	46.55

Note: All values in inches

Irrigation season assumed to be same as WIG (April 23 to October 27 for this crop)

Attachment C-4
Summary Tables - Richland Station

Table 6
Estimated Future Irrigation Requirements - Richland Station

Crop Type	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Total	Current	Difference	% Difference
Caneberry		1.66	7.25	10.33	13.34	10.64	5.16	0.85	49.24	45.81	3.43	7.5%
Currant		1.66	7.25	10.33	13.34	10.64	5.16	0.85	49.24	45.81	3.43	7.5%
Barley	0.76	4.20	7.98	9.66	4.59				27.20	25.99	1.21	4.6%
Corn, Field			1.55	4.89	11.92	10.64	5.03		34.03	31.26	2.77	8.9%
Oat	0.76	4.20	7.98	9.66	4.59				27.20	25.99	1.21	4.6%
Rye	0.76	4.20	7.98	9.66	4.59				27.20	25.99	1.21	4.6%
Triticale	0.76	4.20	7.98	9.66	4.59				27.20	25.99	1.21	4.6%
Wheat	1.40	5.22	7.98	7.93	1.71	1.18	0.77	1.12	27.32	25.97	1.35	5.2%
Green Manure	0.76	4.20	7.98	9.66	4.59				27.20	25.99	1.21	4.6%
Alfalfa, Hay		0.86	6.53	8.10	10.53	8.76	5.78	2.02	42.58	39.56	3.02	7.6%
Alfalfa/Grass, Hay		0.86	6.53	8.10	10.53	8.76	5.78	2.02	42.58	39.56	3.02	7.6%
Clover, Hay		0.95	7.25	8.99	11.65	9.71	6.41	2.29	47.25	43.94	3.31	7.5%
Grass, Hay		0.95	7.25	8.99	11.65	9.71	6.41	2.29	47.25	43.94	3.31	7.5%
Hay/Silage, Unknown		0.95	7.25	8.99	11.65	9.71	6.41	2.29	47.25	43.94	3.31	7.5%
Sorghum				3.20	9.72	10.17	5.88	0.39	29.36	26.89	2.47	9.2%
Sudangrass		0.95	7.25	8.99	11.65	9.71	6.41	2.29	47.25	43.94	3.31	7.5%
Timothy		0.95	7.25	8.99	11.65	9.71	6.41	2.29	47.25	43.94	3.31	7.5%
Hops		0.41	3.24	7.22	10.53	13.96			35.36	32.73	2.63	8.0%
Watermelon									17.45	16.22	1.24	7.6%
Mint		0.41	3.24	5.00	12.21	11.12	7.33	2.41	41.73	38.51	3.22	8.4%
Pasture									33.91	31.50	2.40	7.6%
Wildlife Feed			1.55	4.89	11.92	10.64	5.03		34.03	31.26	2.77	8.9%
Apple		0.55	5.79	9.89	13.90	11.59	7.33	2.02	51.08	47.40	3.68	7.8%
Apricot	0.14	1.92	5.43	8.99	12.78	10.64	6.71	1.77	48.39	44.97	3.42	7.6%
Cherry		1.21	5.79	9.89	13.90	11.59	7.33	2.02	51.74	48.04	3.70	7.7%
Nectarine/Peach		1.76	5.43	8.99	12.78	10.64	6.71	1.77	48.09	44.65	3.44	7.7%
Orchard, Unknown		0.55	5.79	9.89	13.90	11.59	7.33	2.02	51.08	47.40	3.68	7.8%
Pear		1.03	5.43	8.99	12.78	10.64	6.71	1.77	47.37	43.95	3.42	7.8%
Plum		1.03	5.43	8.99	12.78	10.64	6.71	1.77	47.37	43.95	3.42	7.8%
Driving Range		0.90	6.89	8.55	11.09	9.23	6.10	2.16	44.91	41.75	3.16	7.6%
Golf Course		0.90	6.89	8.55	11.09	9.23	6.10	2.16	44.91	41.75	3.16	7.6%
Sod Farm		0.90	6.89	8.55	11.09	9.23	6.10	2.16	44.91	41.75	3.16	7.6%
Asparagus									34.46	32.02	2.44	7.6%
Bean, Dry				3.90	12.62	9.37	0.42		26.31	24.10	2.21	9.2%
Bean, Green				3.21	9.46	8.84			21.51	19.76	1.75	8.9%
Corn, Sweet			1.55	6.38	12.77	3.35			24.05	22.27	1.78	8.0%
Cucumber				3.00	7.71	8.76	5.66	0.53	25.66	23.47	2.19	9.3%
Market Crops			1.55	4.24	10.83	10.17	5.09	0.08	31.97	29.35	2.62	8.9%
Onion		2.77	7.02	8.99	11.49	7.37			37.65	35.24	2.41	6.8%
Potato			1.55	5.42	12.62	10.40	3.39		33.38	30.68	2.70	8.8%
Pumpkin				3.00	7.71	8.60	1.63		20.95	19.09	1.86	9.7%
Squash				3.00	7.71	8.60	1.63		20.95	19.09	1.86	9.7%
Tomato			1.55	4.24	10.83	10.17	5.09	0.08	31.97	29.35	2.62	8.9%
Vegetable, Unknown			1.55	4.24	10.83	10.17	5.09	0.08	31.97	29.35	2.62	8.9%
Grape, Concord		0.05	1.72	5.89	9.40	8.29	5.16	1.38	31.89	29.33	2.56	8.7%
Grape, Wine		0.05	1.72	5.89	9.40	8.29	5.16	1.38	31.89	29.33	2.56	8.7%

Note: All values in inches

Attachment C-5 Estimated KRD Future Irrigation Requirements					
Crop Type	**% Acreage**	**Current CIR**	**Weighted CIR**	**Increase in CIR**	**Weighted Increase**
Timothy	53.3%	33.14	17.67	3.26	1.74
Pasture	23.7%	23.70	5.61	2.39	0.56
Grass, Hay	6.5%	33.14	2.15	3.26	0.21
Alfalfa, Hay	3.2%	29.76	0.95	3.00	0.10
Wheat	3.1%	26.31	0.81	1.87	0.06
Oat	3.1%	27.44	0.84	2.08	0.06
Corn, Sweet	2.5%	20.08	0.49	2.28	0.06
Sudangrass	1.9%	33.14	0.61	3.26	0.06
Apple	1.0%	38.11	0.38	3.74	0.04
Alfalfa/Grass, Hay	0.6%	29.76	0.18	3.00	0.02
Barley	0.5%	27.44	0.13	2.08	0.01
Pear	0.3%	35.96	0.11	3.51	0.01
Potato	0.2%	24.64	0.04	2.90	0.00
Cherry	0.2%	39.66	0.06	3.78	0.01
Golf Course	0.1%	31.45	0.04	3.13	0.00
Grape, Wine	0.0%	23.05	0.00	2.63	0.00
Market Crops	0.0%	22.08	0.00	2.65	0.00
Onion	0.0%	30.80	0.00	3.12	0.00
Total			30.09		2.94
% Increase					9.8%

Note: All values in inches

Attachment C-6 Estimated Roza Future Irrigation Requirements					
Crop Type	**% Acreage**	**Current CIR**	**Weighted CIR**	**Increase in CIR**	**Weighted Increase**
Apple	33.6%	44.37	14.90	3.88	1.30
Grape, Wine	16.8%	27.34	4.60	2.70	0.45
Grape, Concord	16.7%	27.34	4.56	2.70	0.45
Cherry	7.4%	44.93	3.31	3.90	0.29
Hops	5.0%	30.76	1.53	2.78	0.14
Alfalfa, Hay	4.0%	37.02	1.49	3.20	0.13
Pear	3.5%	41.09	1.44	3.62	0.13
Corn, Field	3.2%	29.31	0.92	3.02	0.10
Wheat	1.9%	24.35	0.45	1.46	0.03
Sorghum	2.0%	25.13	0.51	2.68	0.05
Nectarine/Peach	1.0%	41.71	0.42	3.63	0.04
Triticale	1.0%	24.56	0.25	1.26	0.01
Asparagus	0.9%	29.96	0.27	2.60	0.02
Apricot	0.4%	42.05	0.15	3.62	0.01
Alfalfa/Grass, Hay	0.4%	37.02	0.16	3.20	0.01
Green Manure	0.4%	24.56	0.10	1.26	0.01
Caneberry	0.3%	42.91	0.14	3.65	0.01
Corn, Sweet	0.2%	21.02	0.05	1.90	0.00
Rye	0.2%	24.56	0.06	1.26	0.00
Mint	0.2%	35.94	0.07	3.40	0.01
Squash	0.2%	17.93	0.03	2.07	0.00
Grass, Hay	0.2%	41.13	0.06	3.49	0.01
Pumpkin	0.1%	17.93	0.02	2.07	0.00
Potato	0.1%	28.80	0.03	2.95	0.00
Pasture	0.1%	29.47	0.03	2.56	0.00
Tomato	0.1%	27.52	0.02	2.85	0.00
Plum	0.1%	41.09	0.03	3.62	0.00
Barley	0.1%	24.56	0.01	1.26	0.00
Hay/Silage, Unknown	0.0%	41.13	0.01	3.49	0.00
Market Crops	0.0%	27.52	0.00	2.85	0.00
Total			35.64		3.22
% Increase					9.0%

Note: All values in inches

Attachment C-7 Estimated WIP Future Irrigation Requirements					
Crop Type	**% Acreage**	**Current CIR**	**Weighted CIR**	**Increase in CIR**	**Weighted Increase**
Corn, Field	21.1%	30.39	6.41	3.09	0.65
Wheat	14.6%	25.04	3.65	1.43	0.21
Hops	14.3%	31.95	4.57	2.89	0.41
Alfalfa, Hay	12.1%	38.42	4.64	3.22	0.39
Apple	9.7%	46.06	4.49	3.92	0.38
Mint	8.8%	37.35	3.28	3.44	0.30
Grape, Concord	4.6%	28.42	1.31	2.74	0.13
Alfalfa/Grass, Hay	1.7%	38.42	0.65	3.22	0.05
Pasture	1.8%	30.59	0.56	2.57	0.05
Asparagus	1.7%	31.09	0.53	2.61	0.04
Grass, Hay	1.3%	42.69	0.55	3.51	0.05
Nectarine/Peach	1.1%	43.30	0.48	3.66	0.04
Potato	1.1%	29.87	0.32	3.02	0.03
Pear	1.0%	42.66	0.44	3.65	0.04
Corn, Sweet	0.8%	21.80	0.19	2.01	0.02
Onion	0.8%	34.41	0.26	2.60	0.02
Market Crops	0.7%	28.53	0.20	2.90	0.02
Cherry	0.7%	46.64	0.32	3.93	0.03
Bean, Dry	0.6%	23.47	0.14	2.52	0.02
Sorghum	0.5%	26.02	0.12	2.73	0.01
Squash	0.2%	18.52	0.04	2.13	0.00
Oat	0.1%	25.27	0.04	1.29	0.00
Timothy	0.1%	42.69	0.05	3.51	0.00
Golf Course	0.1%	40.54	0.04	3.36	0.00
Plum	0.1%	42.66	0.03	3.65	0.00
Apricot	0.1%	43.61	0.03	3.64	0.00
Cucumber	0.1%	22.66	0.02	2.43	0.00
Tomato	0.1%	28.53	0.02	2.90	0.00
Pumpkin	0.0%	18.52	0.01	2.13	0.00
Vegetable, Unknown	0.0%	28.53	0.01	2.90	0.00
Bean, Green	0.0%	19.20	0.01	1.98	0.00
Watermelon	0.0%	15.75	0.00	1.32	0.00
Grape, Wine	0.0%	28.42	0.00	2.74	0.00
Driving Range	0.0%	40.54	0.00	3.36	0.00
Total			33.41		2.91
% Increase					8.7%
Note: All values in inches					

Attachment C-8 Estimated SVID Future Irrigation Requirements					
Crop Type	**% Acreage**	**Current CIR**	**Weighted CIR**	**Increase in CIR**	**Weighted Increase**
Grape, Concord	21.3%	27.34	5.82	2.70	0.57
Corn, Field	19.1%	29.31	5.64	3.02	0.58
Alfalfa, Hay	12.5%	37.02	4.61	3.20	0.40
Hops	11.2%	30.76	3.44	2.78	0.31
Cherry	8.0%	44.93	3.58	3.90	0.31
Apple	6.9%	44.37	3.04	3.88	0.27
Wheat	3.0%	24.35	0.72	1.46	0.04
Asparagus	2.7%	29.96	0.81	2.60	0.07
Alfalfa/Grass, Hay	2.4%	37.02	0.90	3.20	0.08
Grape, Wine	2.0%	27.34	0.56	2.70	0.06
Mint	1.8%	35.94	0.65	3.40	0.06
Sorghum	1.4%	25.13	0.35	2.68	0.04
Triticale	1.3%	24.56	0.34	1.26	0.02
Grass, Hay	1.4%	41.13	0.56	3.49	0.05
Pear	1.3%	41.09	0.52	3.62	0.05
Pasture	1.2%	29.47	0.34	2.56	0.03
Squash	0.4%	17.93	0.07	2.07	0.01
Oat	0.3%	24.56	0.08	1.26	0.00
Plum	0.3%	41.09	0.12	3.62	0.01
Golf Course	0.3%	39.07	0.10	3.34	0.01
Barley	0.2%	24.56	0.05	1.26	0.00
Rye	0.2%	24.56	0.04	1.26	0.00
Nectarine/Peach	0.2%	41.71	0.07	3.63	0.01
Watermelon	0.2%	15.17	0.02	1.32	0.00
Market Crops	0.1%	27.52	0.04	2.85	0.00
Caneberry	0.1%	42.91	0.06	3.65	0.00
Green Manure	0.1%	24.56	0.01	1.26	0.00
Apricot	0.0%	42.05	0.02	3.62	0.00
Pumpkin	0.0%	17.93	0.01	2.07	0.00
Corn, Sweet	0.0%	21.02	0.01	1.90	0.00
Currant	0.0%	42.91	0.01	3.65	0.00
Driving Range	0.0%	39.07	0.00	3.34	0.00
Orchard, Unknown	0.0%	44.37	0.00	3.88	0.00
Total			32.62		2.99
% Increase					9.2%
Note: All values in inches					

Attachment C-9 Estimated YTID Future Irrigation Requirements					
Crop Type	**% Acreage**	**Current CIR**	**Weighted CIR**	**Increase in CIR**	**Weighted Increase**
Apple	80.1%	31.82	25.49	2.83	2.27
Pear	7.9%	29.45	2.32	2.64	0.21
Cherry	4.7%	32.20	1.50	2.84	0.13
Alfalfa/Grass, Hay	3.8%	26.48	1.02	2.33	0.09
Grass, Hay	1.1%	29.44	0.31	2.53	0.03
Golf Course	0.9%	27.95	0.26	2.43	0.02
Alfalfa, Hay	0.6%	26.48	0.15	2.33	0.01
Sod Farm	0.4%	27.95	0.12	2.43	0.01
Caneberry	0.3%	30.77	0.08	2.65	0.01
Barley	0.1%	17.30	0.02	0.92	0.00
Nectarine/Peach	0.1%	29.87	0.02	2.65	0.00
Orchard, Unknown	0.0%	31.82	0.02	2.83	0.00
Grape, Wine	0.0%	19.60	0.01	1.99	0.00
Total			31.31		2.78
% Increase					8.9%
Note: All values in inches					

Attachment C-10 Estimated KID Future Irrigation Requirements					
Crop Type	**% Acreage**	**Current CIR**	**Weighted CIR**	**Increase in CIR**	**Weighted Increase**
Grape, Wine	25.8%	29.33	7.57	2.56	0.66
Apple	15.5%	47.40	7.35	3.68	0.57
Alfalfa, Hay	15.5%	39.56	6.13	3.02	0.47
Wheat	11.8%	25.97	3.05	1.35	0.16
Cherry	8.0%	48.04	3.82	3.70	0.29
Asparagus	3.7%	32.02	1.18	2.44	0.09
Alfalfa/Grass, Hay	3.6%	39.56	1.41	3.02	0.11
Corn, Field	3.5%	31.26	1.10	2.77	0.10
Potato	2.8%	30.68	0.87	2.70	0.08
Corn, Sweet	2.6%	22.27	0.58	1.78	0.05
Pasture	2.0%	31.50	0.62	2.40	0.05
Pumpkin	1.9%	19.09	0.36	1.86	0.03
Golf Course	1.8%	41.75	0.73	3.16	0.06
Pear	0.8%	43.95	0.37	3.42	0.03
Grass, Hay	0.6%	43.94	0.27	3.31	0.02
Plum	0.1%	43.95	0.05	3.42	0.00
Nectarine/Peach	0.1%	44.65	0.04	3.44	0.00
Total			35.51		2.76
% Increase					7.8%

Note: All values in inches