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Managing Water in the West

Irrigated Agriculture Economics Technical Report

For the Secretarial Determination on Whether to Remove Four Dams on the Klamath River in California and Oregon

U.S. Department of the Interior
Bureau of Reclamation
Technical Service Center
Denver, Colorado

September 2011

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The U.S. Department of the Interior protects America's natural resources and heritage, honors our cultures and tribal communities, and supplies the energy to power our future.

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Acronyms and Abbreviations

BCA	Benefit Cost Analysis
BO	Biological Opinion
KB_HEM	Klamath Basin Hydroeconomic Model
KBRA	Klamath Basin Restoration Agreement
NED	National Economic Development
P&Gs	*Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies*
PV	present value
Reclamation	Bureau of Reclamation
RED	Regional Economic Development

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1.1 INTRODUCTION

The purpose this report is to discuss the irrigated agricultural benefits and the inputs used to estimate the regional economic impacts stemming from irrigated agricultural as they relate to the Klamath Dam removal. A description of the estimated irrigated agriculture benefits are in the National Economic Development (NED) Benefit Cost Analysis (BCA) analysis discussed in the Economics and Tribal Summary Technical Report (Reclamation, 2011b). The Regional Economic Development (RED) analysis, also discussed in Reclamation, (2011b), uses inputs discussed in this report to estimate regional impacts stemming from irrigated agriculture.

The alternatives discussed in Reclamation (2011b) are Alternative 1 – No Action, Alternative 2 – Full Facility Removal of Four Dams, and Alternative 3 – Partial Facility Removal of four dams. This report refers to Alternative 1 as no action and Alternatives 2 and 3 as the action alternatives because the hydrology used in this analysis is the same for Alternatives 2 and 3.

Discussed below are both 1) the model used to estimate the NED benefits that were used in the BCA, the Klamath Basin Hydroeconomic Model (KB_HEM), and 2) the estimated NED benefits. Following the discussion of the NED analysis is a discussion of the inputs related to irrigated agriculture used in the RED analysis. Two appendixes follow the main report, one appendix describes the KB_HEM model and the last appendix describes the farm budgeting methodology and results which are used in the NED calculation.

1.1.1 Irrigated Agricultural Benefits used in the National Economic Development (NED) Benefit Cost Analysis (BCA)

This section describes the estimation of irrigated agricultural benefits used within the NED BCA described in the Economics and Tribal Summary Technical Report (Reclamation, 2011b). The NED agricultural benefits were measured in accordance with the *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies*, March 10, 1983 (P&Gs).

1.2 METHODOLOGY AND ASSUMPTIONS

The average discounted benefits for the No Action and the action alternatives are calculated using the following inputs.

- Hydrology for No Action and action alternatives (e.g., an estimate of the annual volume of water available to irrigated agricultural over a 50-year modeling period for all three alternatives. Note the hydrology was estimated for Dams in which is used for the No Action Alternatives, and Dams out which is used to measure impacts for Alternatives 2 and 3).

- The estimated benefit values by acre for each crop in the Klamath Basin Hydro-economic Model (KB_HEM).

- The estimated cropping pattern for each year based on the estimate the volume of water available for irrigation.

- Discount rate for calculation of the annual estimated revenues.

The annual estimated benefit values by crop are multiplied by the KB_HEM cropping patterns, resulting in 50 total annual net farm revenue estimates (one for each year for each hydrologic trace) for both the No Action and action alternatives. Once the annual net farm revenue estimates are calculated the net farm revenue for No Action Alternative is subtracted from the action alternative annual net farm revenue estimates, this equals the annual net benefits for the action alternative. The present value (PV) of the annual net benefits is calculated for each of the hydrologic traces, resulting in 49 estimates of the PV of the net revenue. The average of the PVs is then calculated, which equals the NED benefit for the action alternative. The inputs used to estimate the PV, starting with the hydrology assumptions, are summarized below.

1.2.1 Hydrology

The surface water used in KB_HEM is based on the hydrology modeling described in Reclamation 2011a. The No Action Alternative uses the Biological Opinions (BOs) under which the Klamath Project now operates. The latest Fish Wildlife Service BO is dated April 2, 2008, and the National Marine Fisheries Service BO is dated March 15, 2010. The action alternative uses the criteria for the Klamath Basin Restoration Agreement (KBRA).

Future hydrologic conditions, for example the timing of drought years, are variable and uncertain. The historical hydrologic record represents only one possible outcome from the distribution of possible future hydrologic conditions. The term “trace” is used to describe an artificially constructed sequence of future hydrologic data. Multiple future traces, representing a range of surface water availability were used to drive the KB_HEM model, allowing for a wide range of possible annual results.

KB_HEM uses the indexed sequential hydrology runs described in Reclamation, 2011a. The indexed sequential modeling type is a hydrograph created by replicating the historical hydrology. The indexed sequential method in this analysis uses a simulation period starting in the water year 2012 (October 1, 2011) and contains 50 water years, using every historical year as a starting year.

1.2.2 Per Acre Benefit Values by Crop

A farm budget application, developed by Reclamation, was used to measure net farm income for the two conditions: 1) with a full supply of irrigation and 2) without irrigation water or dryland conditions. The derivation of the "with and without" irrigation water net farm revenue by crop is discussed in appendix 2 of this report. The difference between the net farm revenue with a full water supply and the net farm revenue for dryland conditions equals the benefits value by crop. The benefit values by crop are summarized in table 1.2-1.

Table 1.2-1.—Per acre benefit values by crop

	Potatoes	Onions (other)	Alfalfa	Wheat	Barley (spring grain)	Pasture
Annual per acre benefits	**$1,904.21**	**$969.51**	**$365.01**	**$235.91**	**$121.60**	**$159.00**

1.2.3 Estimated Cropping Patterns

The KB_HEM model aggregates the crop-types grown on Project land into six representative crops. The majority of Project land is utilized growing alfalfa hay, followed by irrigated pasture, wheat, small grains, potatoes and other. Table 1.2-2 shows the crop acres grown in a 'full-surface water' year and the drought years on lands within the Klamath Project, as estimated using the hydrology model, for the No Action Alternative. In general, cropping patterns under the No Action Alternative remain relatively constant except for the drought years; 2027, 2043, 2045 and 2052, where the estimated surface water availability for each of those years are 65 percent or less of agricultural demand, and as a result are the years with the least amount of estimated acres in production. In a full water year alfalfa hay is estimated to be grown on approximately 79.8 thousand acres, or approximately 42.5 percent of the total acres in production (187.9 acres). In the drought year represented by 2043 the estimated land in production of alfalfa hay falls to 29.8 thousand acres, which is approximately 52.0 percent of the total land in production in that year.

Table 1.2-3 shows the crop acres grown in a 'full-surface water' year and the drought years, as estimated using the hydrology model, for the action alternative.

Table 1.2-2.—Estimated crop acres for the Klamath Project by representative crop for full-water year and drought years for the No Action Alternative, using the '1961' hydrology (acres in 000s)

Representative crops	Full-surface water year	Estimated crop acres for drought years (assuming '1961' hydrology)				
	2012 (000s acres)	2027 (000s acres)	2043 (000s acres)	2045 (000s acres)	2052 (000s acres)	2059 (000s acres)
Alfalfa hay	79.8	69.8	29.8	51.5	65.9	72.6
Irrigated pasture	43.4	25.7	1.2	4.7	15.8	28.6
Wheat	30.9	27.8	5.2	14.9	24.2	29.2
Small grains	13.4	9.0	4.2	4.2	6.4	10.7
Potato	12.8	12.6	10.9	11.7	12.4	12.7
Other	7.5	7.4	6.0	6.6	7.2	7.5
Total	**187.9**	**152.3**	**57.2**	**93.6**	**132.0**	**161.2**

Source: KB_HEM estimated gross farm revenue by IMPLAN crop sectors.

Table 1.2-3.—Estimated crop acres by representative crop for full-water year and drought years for the action alternative, using the '1961' hydrology (acres in 000s)

Representative crops	Full-surface water year	Estimated crop acres for drought years (assuming '1961' hydrology)				
	2012 (000s acres)	2027 (000s acres)	2043 (000s acres)	2045 (000s acres)	2052 (000s acres)	2059 (000s acres)
Alfalfa hay	79.8	79.8	78.9	79.8	79.8	79.8
Irrigated pasture	43.4	43.3	36.5	43.3	43.3	43.3
Wheat	30.9	31.0	30.7	31.0	31.0	31.0
Small grains	13.4	13.4	13.0	13.4	13.4	13.4
Potato	12.8	12.8	12.8	12.8	12.8	12.8
Other	7.5	7.5	7.5	7.5	7.5	7.5
Total	**187.9**	**187.8**	**179.5**	**187.8**	**187.8**	**187.8**

Source: KB_HEM estimated gross farm revenue by IMPLAN crop sectors.

In general, cropping patterns under the No Action Alternative remain relatively constant even during the drought years; 2027, 2043, 2045 and 2052, because the surface water availability for each of those years are approximately 80.0 percent or more of agricultural demand. Compared to the No Action Alternative the estimated cropping patterns under the action alternative are relatively constant.

1.2.4 Surface Water Availability

Figure 1.2-1 shows the surface water availability for one of the hydrologic modeling scenarios ('1961') under both the No Action and the action alternatives. In many years the action alternative surface water supply is estimated to be less than the baseline surface water supply (Reclamation, 2011a), however the surface water supply under the action alternative is nearly always at least 80.0 percent of agricultural demand for irrigation water. The only exception to that is in 2018, when the estimate of surface water is approximately 75.0 percent of full surface deliveries. Whereas the reduction in surface water supply of the No Action Alternative is frequently close to 100.0 percent of full surface water deliveries there are five years in the project analysis period when surface water deliveries are 65.0 percent or lower – as low as 20.0 percent – namely, the years 2027, 2043, 2045, 2052 and 2057.

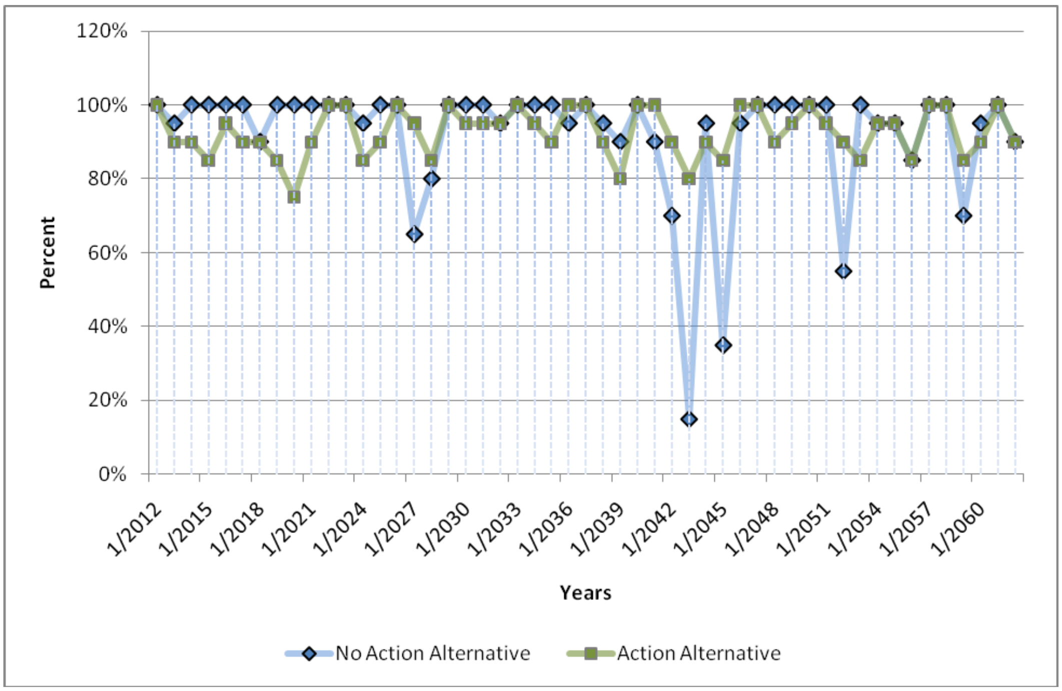

Figure 1.2-1.—Percent of surface water availability, No Action Alternative and action alternative, for the 50-year project period.

In figure 1.2-1 drought years are estimated to occur in 2027, 2043, 2045, 2052 and 2059, during the last half of the 50-year modeling period. However a different hydrologic trace would estimate different years for the drought. For example, the "1986" hydrologic trace estimates these droughts would occur within the first 10 years of the modeling period (see figure 1.2-2). The occurrence of the drought years impacts the total net PV calculation, described below. The comparison of "1961" to "1986" hydrologic trace shows that the occurrence of relatively low surface water deliveries varies over the project analysis period for various hydrologic traces. For example, under the "1961" hydrologic trace, years with relatively lower surface water deliveries occur approximately half way through the project analysis period, in years 2043, 2045 and 2052. In comparison under the "1986" hydrologic trace the years with relatively less surface water deliveries occur at the beginning of the project-analysis period, in 2017, 2019 and 2037.

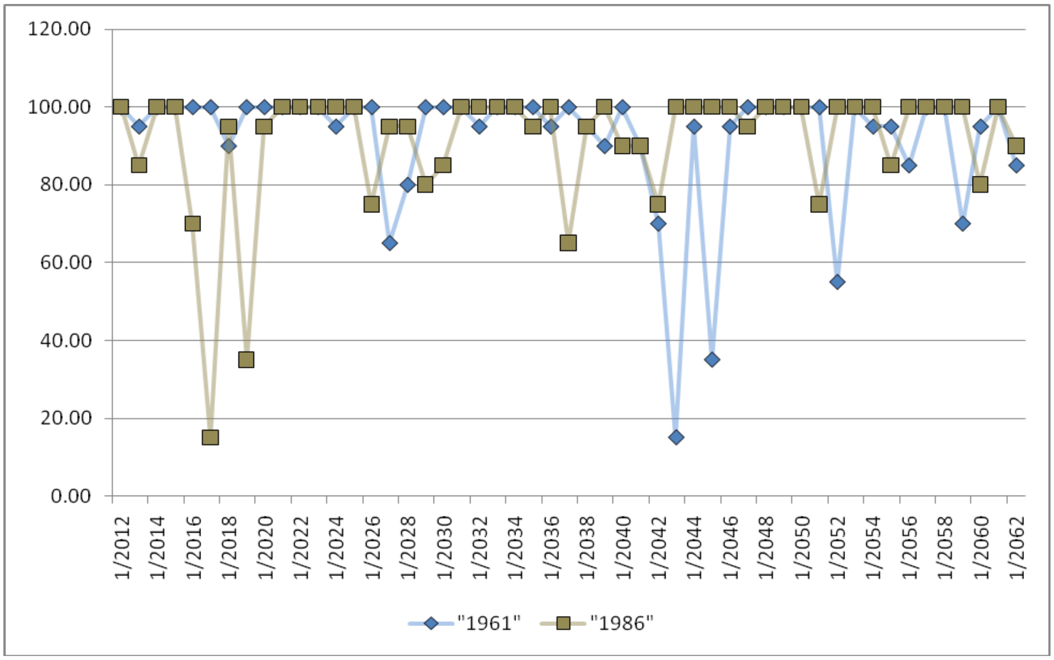

Figure 1.2-2.—Comparison of the percent of surface water availability for two hydrologic traces in the No Action Alternative.

The occurrence of the years with relatively lower surface water deliveries impacts the net PV calculation. When relatively lower surface water deliveries occur later in the project-analysis period the impact on total PV net benefits is less than when those lower surface water deliveries occur early in the project-analysis period.

1.2.5 Discounting the Annual Net Benefits

The Federal discount rate of 4.125%,[1] as required by the P&Gs, was used to discount the estimated annual net benefits calculated by multiplying the estimated crops acres by the per acre net benefits Each year's estimated annual benefit is discounted using the Federal discount rate so that all benefits are stated in 2012 dollars. Once stated in 2012 dollars the estimated annual benefits can be summed over the 50-year modeling period. Discounting the annual benefit calculations implies that a dollar today is worth more than a dollar in the future. Discounting has the effect of reducing the impact of relatively drier years that occur later in the 50-year modeling analysis period. For example the estimate of the net PV of

[1] Change in Discount Rate for Water Resources Planning. 75 FR 82066. (29 December 2010).

benefits under the '1961' hydrologic trace will have a higher net PV than the benefits estimated under the '1986' hydrologic trace. This is due to the fact that the discounted benefit estimated during the drought years is discounted later in the 50-year modeling period, than the drought years of the '1986' hydrologic trace, which occur earlier in the 50-year project modeling period.

2.1 IRRIGATED AGRICULTURE ECONOMIC BENEFIT VALUE RESULTS

A range of estimates of the NED irrigated agriculture benefits for both the No Action Alternative and the action alternative are summarized in table 2.1-1. As can be seen in table 2.1-1 the average benefits discounted, using the Federal discount rate of 4.125, over the 50 year analysis period, under the No Action Alternative is $1,578.9 ($ millions). The average benefits, discounted, using the Federal discount rate of 4.125 over the 50 year analysis period under the action alternative is $1,608.8 ($ millions). The benefit value used in the BCA calculation summarized in Reclamation (2011) is $29.9 ($ millions) which is the difference between the average No Action Alternative benefit value and the average of the action alternative benefits value. Also displayed in table 2.1-1 are the minimum and maximum benefit values for the No Action and action alternatives. The range in benefit values is a function of the varying hydrologic traces (see figure 1.2-2) used and discounting. The timing of drought years varies in each hydrologic trace. Discounting has the effect of reducing the impact of relatively drier years that occur later in the 50-year modeling analysis period.

Table 2.1-1.—Summary of average, minimum and maximum discounted benefits for No Action and action alternative

	No Action Alternative	Action (Full and Partial Replacement) Alternatives	Change from no action
Discounted on-project benefits	Millions of $		
Average discounted benefits stream over 50 years	$1,578.9	$1,608.8	$29.9
Minimum discounted benefits stream over 50 years	$1,595.9	$1,611.8	$15.9
Maximum discounted benefits stream over 50 years	$1,550.6	$1,600.3	$49.7

3.1 ESTIMATED GROSS FARM REVENUE USED IN THE REGIONAL ECONOMIC DEVELOPMENT (RED) IMPACT ANALYSIS

This section describes the estimation of gross farm revenue used to estimate economic impacts within the regional economic impact analysis described in the Economics and Tribal Summary technical report (Reclamation, 2011b).

3.1.1 Methodology and Assumptions

The results are estimated based on the estimates of the annual change in gross revenue, water use and cropping patterns assuming a range of surface water availability (see Attachment xx, Klamath Basin Economic and Hydrologic Model (KBHEM) of On-Farm Behavior). The annual estimates of on-farm net revenue from the KB_HEM model were matched with the appropriate estimate of annual surface water availability, over the 50-year period of record.

The RED analysis uses 1961 trace from the hydrology modeling to measure gross farm income. This trace represents the simulated surface water allocations to agriculture for the years 2012 through 2062 with 1961 being the start year. Essentially this trace mimics the historical period of 1961 through 2009. Unlike the NED agricultural benefit analysis where all the traces where used, one trace is a sufficient representation for the RED analysis.

Combining the annual estimates of land use and revenue by crop with the estimated surface water availability, using the 1961 trace, over the 50-year period of record produces the comparison of the action alternative to the No Action Alternative.

3.1.2 KB_HEM Results – Surface Water

Figure 3.1-1 shows the surface water availability for the 1961 trace. In many years, the action alternative supply is less than the baseline; however, the reduction in surface water supply under the action alternative is nearly always less than 20.0 percent. The only exception to that is in 2018, when the estimate is approximately 25.0 percent of full surface deliveries.

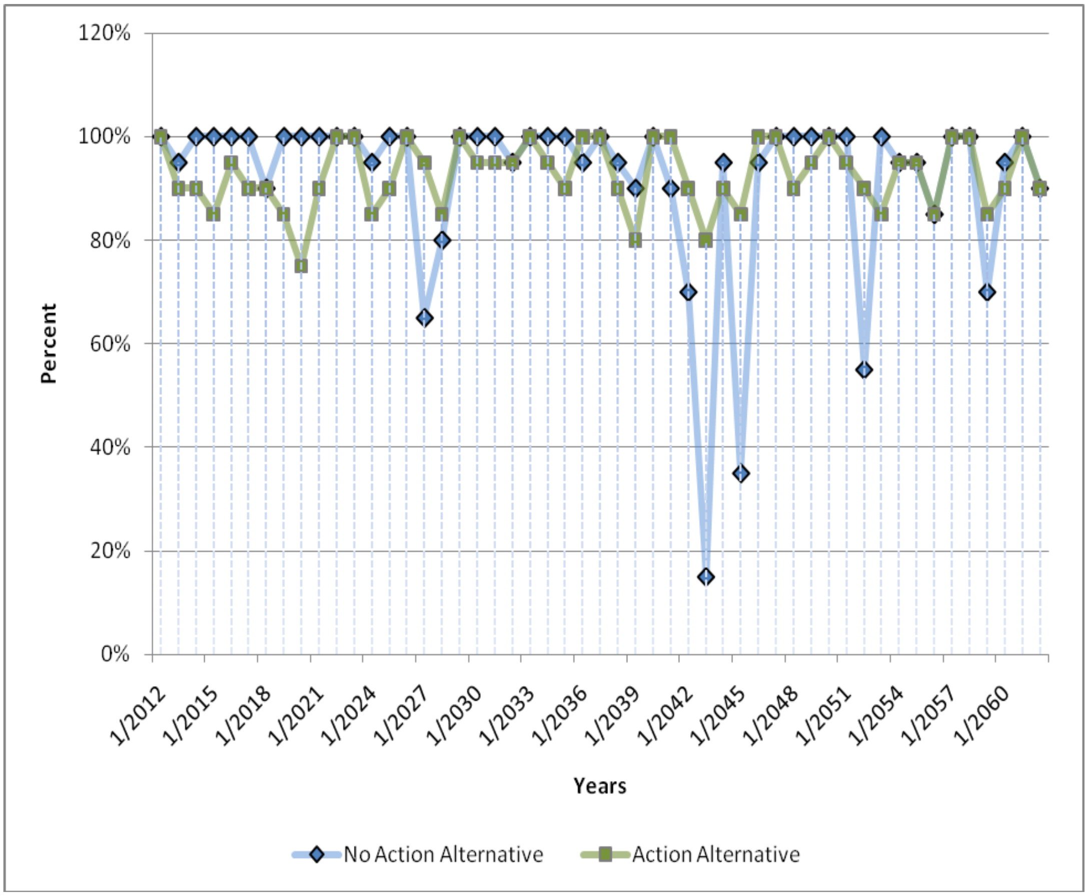

Figure 3.1-1.—Percent of surface water availability, No Action Alternative and action alternative, for the 50-year period of record.

The No Action Alternative has fewer years with reductions in surface water supplies; however, the years in which there is a reduction, the reduction is greater than under the action alternative. For example, in the years 2027, 2043, 2045, 2062, and 2069 the reduction in surface water available for agriculture is greater under the No Action Alternative than under the action alternative.

3.1.3 KB_HEM Results – Gross Farm Revenue

KB_HEM estimates of gross farm revenue for the 50 year hydrologic period are shown in figure 3.1-2. Under the action alternative with KBRA, gross farm revenue is less than the No Action Alternative in 5 years in the 50 year period of record. The reason there are relatively few years in which gross farm revenue under the action alternative or KBRA is less than under the No Action Alternative is due to the size of the shortage and groundwater substitution. Surface water shortages less than or equal to 15.0 percent are replaced with groundwater supplies.

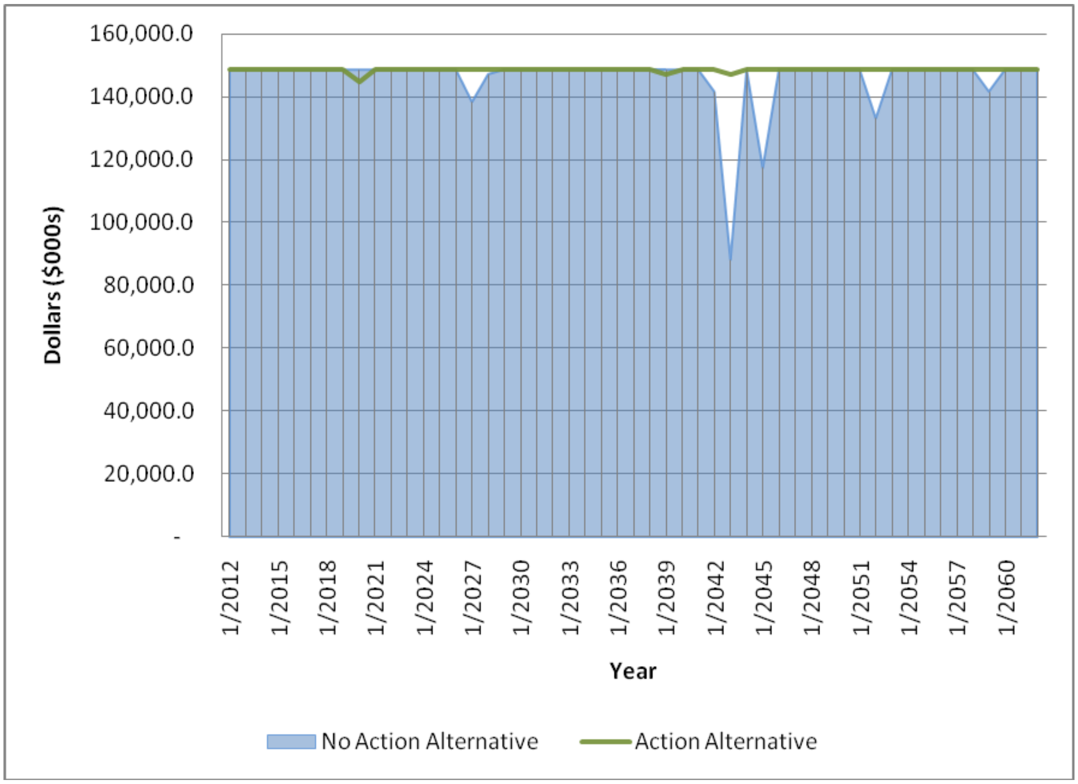

Figure 3.1-2.—Gross farm revenue, for No Action and action alternatives, for the 50-year analysis period.

Gross farm revenue for the action alternative with KBRA is less than under the No Action Alternative in the simulated years of 2027, 2043, 2045, 2052, and 2059 which correspond to the years 1975, 1992, 1994, 2001, and 2008 in the historical period of record. In all other years gross farm revenue is equal under both alternatives. Gross farm revenues for the No Action and action alternatives are shown in tables 3.1-1 and 3.1-2.

Table 3.1-1.—Gross farm revenue estimated for drought years by IMPLAN crop sectors for the No Action Alternative

IMPLAN crop sectors	Gross farm revenue for drought years ($/1,000)				
	2027	2043	2045	2052	2059
Grains	19,189.3	4,518.8	11,462.3	17,077.6	20,300.2
Vegetables	60,674.6	55,965.8	58,561.6	60,127.0	60,790.8
All other (hay and pasture)	58,387.0	27,640.3	47,250.1	55,815.4	60,456.8
Total	**138,250.9**	**88,124.9**	**117,274.0**	**133,020.0**	**141,547.8**

Source: KB_HEM estimated gross farm revenue by IMPLAN crop sectors.

Table 3.1-2.—Gross farm revenue estimated for drought years by IMPLAN crop sectors for the action alternative

IMPLAN crop sectors	Gross farm revenue for drought years ($/1,000)				
	2027	**2043**	**2045**	**2052**	**2059**
Grains	21,856.5	21,663.9	21,856.5	21,856.5	21,856.5
Vegetables	60,993.3	60,966.1	60,993.3	60,993.3	60,993.3
All other (hay and pasture)	65,687.6	64,438.7	65,687.6	65,687.6	65,687.6
Total	**148,537.4**	**147,068.7**	**148,537.4**	**148,537.4**	**148,537.4**

Source: KB_HEM estimated gross farm revenue by IMPLAN crop sectors.

The gross farm revenue estimates shown in tables 3.1-1 and 3.1-2 where run through IMPLAN to estimate the regional impacts for each alternative, these results are presented in the Benefit Cost and RED Technical Report (Reclamation, 2011c).

3.1.4 KB_HEM Results – Groundwater

The difference in the annual average amount of groundwater pumped (and precipitation available for ETc) under the action alternative compared to the baseline scenario is approximately 14.3 thousand acre feet annually. The difference between the costs of groundwater and surface water supplies under action alternative is estimated to be approximately $4.70/af in California and $2.14/af in Oregon. This estimate of the cost difference is based on the additional lift required to pump groundwater compared to the cost of pressurizing surface water for delivery. The difference in lift in feet (dynamic head) is assumed to be 25.0. Blended the cost of groundwater, over the two states, the average annual cost of pumping groundwater is estimated to be $178.0 thousand. The average annual cost of pumping estimate is used to estimate the regional economic impacts as described in the Benefit Cost and RED Technical Report (Reclamation, 2011c).

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Appendices

1 Model Background and Methodology
2 Benefit Values by Crop

Appendix 1

Model Background and Methodology

APPENDIX 1 – MODEL **BACKGROUND** AND METHODOLOGY

An economic model of on-farm decision making, called the Klamath Basin Hydrologic and Economic model (KB_HEM), is used to estimate the on-farm response to a change in annual surface water delivery for irrigation. The on-farm response is measured as a change in; 1) acres in production 2) cropping patterns and 3) a change in groundwater pumping. The model assumes growers maximize annual on-farm profit given a specified volume of water for irrigation.

The modeling methodology used to develop KB_HEM is Positive Mathematical Programming (PMP) modeling methodology (Howitt, 1995a, 1995b; Howitt, et al., 2009). The PMP methodology has been used in the past to estimate the impact of changes in resource availability and/or policies to on-farm decisions in the Klamath Project and throughout the West Burke 2004. The KB_HEM model was developed with funds from the USBR by researchers at Oregon State University and University of California, Davis, (Burke, 1999).

The model is run in three steps: 1)estimation of model parameters 2) calibration of the model and 3) estimation of on-farm response to a change in inputs, such as surface water availability and electrical rates. Each of these three steps is described below (see Burke 1999 for a complete description of the economic theory behind the model).

The first step estimates model parameters using the observed values of inputs (e.g., the amount of land in production by crop, surface water deliveries, cost of production by crop, crop prices, electric rates, etc.). These observed values are used to develop the No Action Alternative and described in detail in the section below entitled Model Data. For example the five year average of cropping patterns on Project lands is used to represent both total acres in production and cropping patterns for the No Action Alternative. The volume of surface water available for the No Action Alternative for Project Lands is derived from the Reclamation model (Reclamation, 2011), and described in section 1.2.1, Hydrology.

The second step is the calibration phase of the model, when the estimated model parameters are used with the baseline resource inputs to verify that the model estimates the initial observed values. The calibration phase returns estimates of the amount of on-farm crop revenue and profit used for the No Action Alternative.

In the third step of the model the values of inputs to production are changed. Under the action alternative, surface water deliveries to Project growers change as do the electric rates charged growers for power. The results of the model used to describe the impact of the action alternative are measured as changes from the No Action Alternative's 1) cropping patterns, 2) acres in production, 3) on-farm revenue and 4) groundwater pumping.

The modeling methodology is based on the economic assumption that growers allocate limited resources (e.g., land, applied water, variable costs, and labor), across various crops, in order to maximize on-farm profit. A key assumption of the methodology is that land quality is heterogeneous e.g., some land has higher per acre yield than other land. Varying per acre yield could be due to any number of factors, such as soil, water, micro climates, etc. Combined with the profit maximizing assumption, the assumption of varying land quality, implies that the farmer chooses to bring the highest-quality land into production first, followed by land of continually decreasing quality, until the last acre of land placed into production has a marginal return of zero. Conversely, if land is removed from production, the least productive land is the first to be removed from production. Therefore varying quality in land results in increasing average per acre crop yield as land is removed from production.

On-farm revenue is calculated as average per acre crop yield multiplied by crop price. Therefore, increasing average per acre crop yield decreases the rate at which on-farm revenue is reduced as land is removed from production, In other words, if land in production is reduced by five percent (based on a reduction in the amount of irrigation water deliveries), on-farm revenues would be reduced *by less than five percent* because the **average** per acre crop yield is increasing (assuming crop price remains constant).

For example, assume potatoes are grown on 100 acres of land, and that the yield per acre is 22.5 tons on 50 acres and the yield per acre on the other 50 acres is 23.5 tons. The average yield per acre for the entire 100 acres is 23.0 tons per acre. If land in production is reduced by 10 percent, then the profit maximizing assumption of the model simulates an on-farm decision which removes 10 acres of the land with the lower yield, e.g., the land which generally yields 22.5 tons per acre yield. The full 50 acres that yields 23.5 tons per acres remains in production. The average yield for all 90 acres is 23.05 tons per acre, a slight increase (0.05% per acres) over the average per acre yield of 23.0 tons per acre when all 100 acres where in production. Assuming constant prices this increase in average yield results in estimates of on-farm gross revenue that decrease at a slower rate than the rate at which land is removed from production.

The KB_HEM model is constructed to replicate other types of on-farm decisions in the face of changing surface water availability, such as groundwater substitution For example, if the amount of surface water deliveries for irrigation is changed the KB_HEM model substitutes groundwater in place of the reduced amount of surface water deliveries.

The No Action Alternative cost of groundwater pumping was estimated to be $5.12/acre foot pumped and $11.26/acre foot pumped based on electricity costs of $0.05/Kwh and $0.11/Kwh respectively, under the action alternative. Where the per Kwh cost of electricity in Oregon is estimated to be $0.05, in California the cost is $0.11 (per. com., Klamath Water and Power Agency, from Klamath Basin AO, 2011). The cost of pumping water is based on the following equation:

$$kWh/AF = 1.0241 * TDH / OPE$$

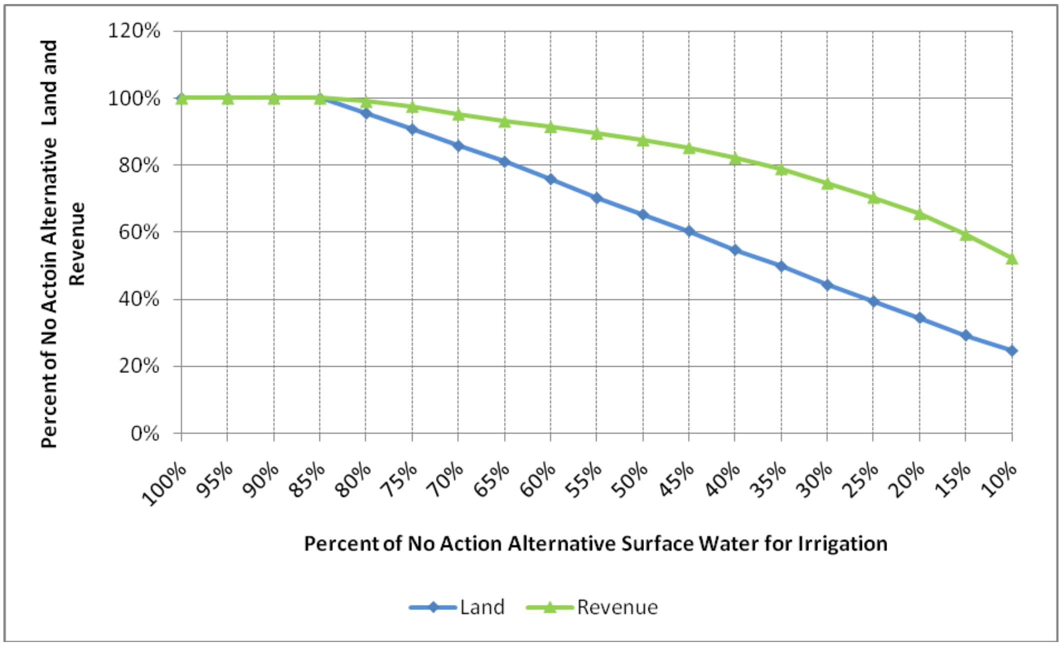
where:

kWh/AF	=	KiloWatt-hours required to pump an acre-foot of water through the irrigation system
TDH	=	Total dynamic head required by the system in feet, assumed to be 60 feet
OPE	=	Overall pumping plant efficiency as a decimal, assumed to be 60 percent

For crop selection, when the amount of irrigation water is reduced the profit maximization model assumption reduces the amount of acres of land in production of the least profitable crop first. However, the model does not simulate removing all of the lowest value crop before a higher value crop is removed from production. Rather, based on the observation of crop diversification, rotation and cultural factors, the model simulates on-farm decisions that retain a diversification of observed crops, at various levels of production based on the availability of other inputs such as groundwater.

Figure 1 presents an example of the model assumptions discussed above, e.g., how estimates of land in production and on-farm revenue fall at a slower rate than changes in surface water deliveries. Output from the model is presented below. Figure 1 shows the estimated on-farm response to reductions in surface water for irrigation on the Klamath Project. The horizontal axis shows the percent of No Action Alternative surface water that is available for delivery to the Project lands. The vertical axis shows estimates of land in production and revenue generated for the varying levels of surface water deliveries.

It was assumed that additional groundwater could substitute for the first 15 percent reduction in surface water (details of the details of the groundwater pumping and surface water can be found below under the Model Inputs section). As a result of this groundwater substitution the estimated land in production and on-farm revenue does not begin to fall under the No Action Alternative until surface water deliveries are reduced below 85.0 percent full surface water delivers under the No Action Alternative. When surface water is estimated to be 80.0 percent of full surface water deliveries under the No Action Alternative the



Source: KB_HEM model output.

Figure 1.—KB_HEM estimates of the percent of land in production and on-farm revenue generated under varying volumes of surface irrigation water.

land in production is estimated to be 96.0 percent of total land in production under the No Action Alternative and on-farm revenue is estimated to be 99.0 percent of the No Action Alternative. Similarly when surface water is 65.0 percent of No Action Alternative land in production is 81.0 percent of No Action Alternative and on-farm revenue is 93.0 percent of No Action Alternative.

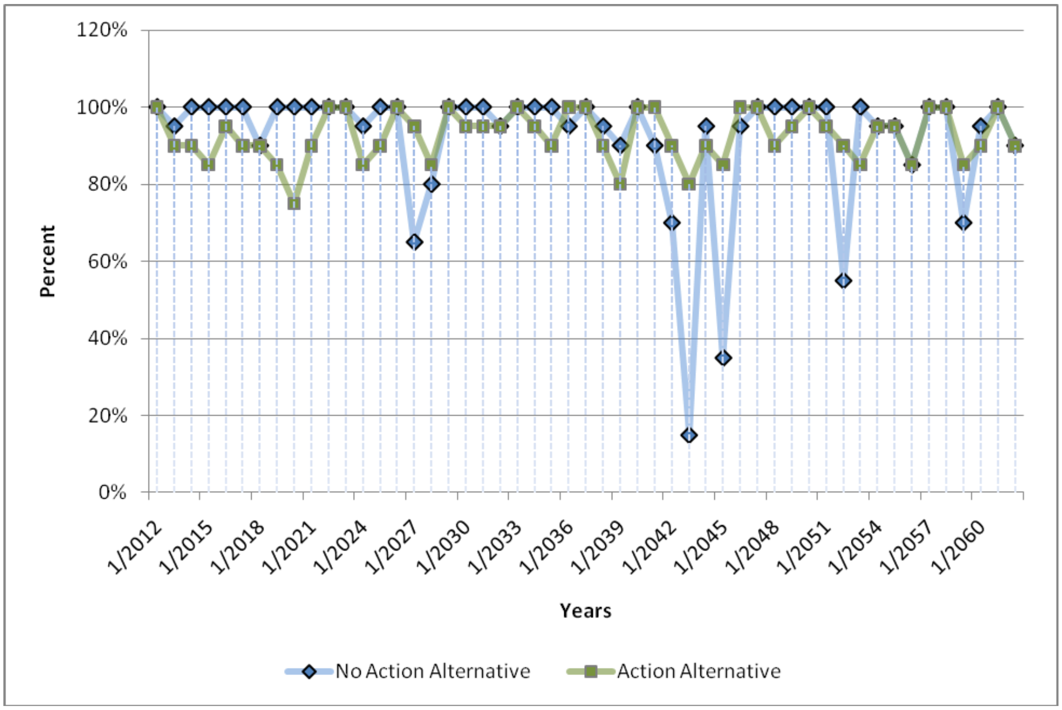
Model Data

Hydrology

The action alternative proposes to change the amount of surface water delivered, and the degree of certainty of those deliveries, to the Klamath Project for irrigation. Groundwater is also available to many of the Project growers and can be used as a substitute if surface water deliveries are not available. Additionally precipitation may meet part of the agricultural demand for irrigation. The following describes the assumptions used in KB_HEM for both surface water and groundwater availability.

Surface Water

The data for the surface water deliveries of water to the Project lands were obtained from Reclamation (Reclamation, 2011). Figure 2 compares the estimated percent of surface water deliveries under both the No Action

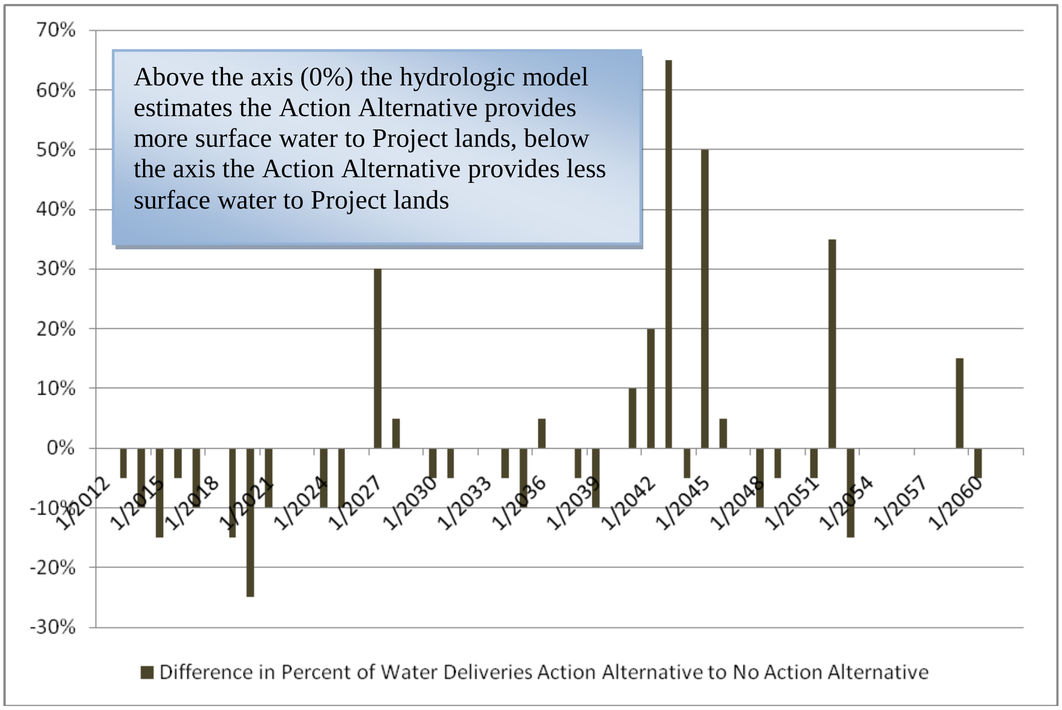


Source: Data obtained from Reclamation (2011).

Figure 2.—Estimated water deliveries to the Klamath Project, as a percent of estimated agricultural demand, No Action Alternative and the action alternative.

Alternative and the action alternative, measured as a percent of estimated No Action Alternative agricultural demand for water. The horizontal axis in figure 2 is the 52-year hydrologic modeling period. As can be seen from figure 2, the percent of agricultural demand that is met by surface water deliveries under the No Action Alternative has a larger variance than the estimate of volumes under the action alternative scenario. For example in nearly every year of the project period from 9/2012 through 9/2022 the estimated amount of agricultural surface water supply is greater under the No Action Alternative than the estimated volume of surface water supply for the same period of time under the action alternative by between 3.0 percent and just over 20.0 percent.

Figure 3 shows the *difference* in percent of estimated surface water deliveries of the action alternative and No Action Alternative. Above the 0.0 percent axis the Action Alternative is estimated to provide more surface water than under the No Action Alternative, below the No Action Alternative the action alternative is estimated to provide less water than under the No Action Alternative. As can be seen by figure 3 under the action alternative water deliveries are lower in twenty two years of the 50-year hydrologic forecast; and the percent difference in water supplies is nearly always less than 20.0 percent of agricultural demand. In ten of the years of the 50-year hydrologic forecast the action alternative provides more water than under the No Action Alternative, and those are years when the estimated No Action Alternative supplies are relatively low. In five of those



Source: Data obtained from Reclamation (2011).

Figure 3.—Difference in the estimated water deliveries, as a percent of estimated agricultural demand, No Action Alternative and the action alternative.

years, the action alternative water supply is estimated to be between 30.0 percent and 60.0 percent greater than No Action Alternative. The remaining 18 years of the 50-year hydrologic projection the volume of water deliveries under the action alternative and No Action Alternative are not significantly different from each other.

Groundwater

The volume of groundwater (and/or precipitation) available to meet irrigation demands is estimated as the amount of water needed to meet crop demand that is greater than the estimated volume of surface water delivered to Project lands under the No Action Alternative. The estimate is calculated by subtracting the estimated crop water demand (ETc) of the observed 5-year average of acres in production (approximately 187.7 thousand acres) from the estimated surface water deliveries to the project. The ETc of the observed 5-year average of crops is approximately 435.0 thousand acre feet (taf) (see section 2.2.3, Crop Water Demand). The estimated average of surface water deliveries under the No Action Alternative is 360.5 taf, a difference is 74.5 taf. Groundwater and/or precipitation are assumed to have been used to meet the 74.5 taf difference. Table 1 summarizes the annual average, minimum and maximum estimated volumes of surface water deliveries and groundwater pumping under the No Action and action alternatives.

Table 1.—Summary statistics for water availability, No Action Alternative and action alternatives

Model resource input	Water availability over the 50-year analysis period	
	No Action Alternative (thousand acre feet)	Action alternative (thousand acre feet)
Annual surface water deliveries		
Average (a)	360.5	373.8
Minimum (a)	64.4	316.4
Maximum (a)	431.5	421.4
Annual groundwater pumping and/or precipitation		
Average (a)	113.5	127.8
Minimum (a)	93.5	93.5
Maximum (a)	174.5	174.5

Source: Data obtained from Reclamation (2011).
(a) Statistics were calculated first by averaging the annual estimates of each of the scenarios, e.g., '1961', '1962', etc. Then, the average, minimum, and maximum were calculated using the averages of the scenarios.

Crop Acres and Aggregation

Table 2 summarizes the crop acreages reported on Reclamation's Klamath Project for the years 2005-2009. Table 2 also shows how the crops were aggregated into representative crops discussed below It should be noted the fallow acreage shown in the summary include both land that was fallowed for crop rotational purposes as well as land that was part of the Water Use Mitigation Program. The Water Use Mitigation Plan is managed by the Klamath Water and Power Agency.

The KB_HEM model currently aggregates the crops grown on Reclamation's Klamath Project into 6 representative crops out of about 35 crops grown. The representative crops are; 1) Small Grains, 2) Wheat, 3) Alfalfa, 4) Irrigated Pasture, 5) Potatoes, and 6) Onions. Crop aggregation is the process by which the crops grown in the Klamath Project, and reported in Reclamation's Crop Reports, are grouped into representative crops. For example the four crops 1) wheat, 2) corn, 3) oats and 4) other cereals, are aggregated into the representative crop of 'wheat.' Crops are aggregated based on the availability of data on crop prices, production costs, yields, and water requirements. KB_HEM's aggregation is shown in table 2.

Table 2.—Harvested crop acres reported for Reclamation's Klamath Project (2005-2009) and representative cropping pattern

Representative crop	All crops	Average		2005	2006	2007	2008	2009
Small grains		**13,431**	**6.9%**	**10,962**	**13,952**	**14,083**	**16,216**	**11,943**
	Feed barley			10,962	13,674	14,083	11,827	8,430
	Malt barley				278		4,389	3,513
Wheat		**30,950**	**15.9%**	**35,401**	**28,114**	**25,719**	**30,311**	**35,206**
	Wheat			31,716	24,163	22,172	27,290	31,563
	Oats			2,679	3,334	2,947	2,774	2,809
	Other cereals			1,006	617	600	247	834
	Corn				12	42	7	5
Alfalfa		**79,768**	**40.9%**	**77,104**	**81,587**	**82,933**	**79,561**	**77,654**
	Alfalfa			55,197	61,619	65,851	63,701	61,336
	Other hay			21,032	18,968	17,082	15,710	15,918
	Silage			875	1,000		150	400
Irrigated pasture		**43,197**	**22.0%**	**40,046**	**42,973**	**43,554**	**44,846**	**44,564**
	Irrigated pasture			40,046	42,880	43,409	44,846	44,564
	Other forage				93	145		
Potatoes		**12,814**	**6.6%**	**11,427**	**15,869**	**11,861**	**12,126**	**12,789**
	Chip potatoes			7,450	5,890	2,640	2,430	6,688
	Fresh potatoes			3,727	9,549	8,941	9,556	5,951
	Potato seed			250	430	280	140	150

Table 2.—Harvested crop acres reported for Reclamation's Klamath Project (2005-2009) and representative cropping pattern

Representative crop	All crops	Average		2005	2006	2007	2008	2009
Onions		**7,526**	**3.9%**	**6,655**	**7,577**	**8,041**	**7,440**	**7,917**
	Onions			2,863	3,239	3,618	3,441	3,533
	Peppermint			2,394	2,922	2,846	2,682	3,200
	Horseradish			913	734	810	436	421
	Strawberry			413	259	176	536	505
	Turf			44	50	40	39	40
	Apples						2	2
	Grapes				2	2	4	
	Greens						79	
	Garlic						38	
	Spinach					79		
	Carrots				21			
	Broccoli			11				
	Cabbage			17	65			
	Squash						17	
	Other vegetables							5
	Canola					382	12	
	Asparagus						1	11
	Sweet Corn							3
	Lettuce					88		
	Peas				285		153	182
	Raspberry							15

Table 2.—Harvested crop acres reported for Reclamation's Klamath Project (2005-2009) and representative cropping pattern

Representative crop	All crops	Average		2005	2006	2007	2008	2009
Fallow		**7,374**	**3.8%**	**11,711**	**5,949**	**7,746**	**6,500**	**4,962**
	Fallow			11,711	5,949	7,746	6,500	4,962
	Total harvested	**187,686**		**181,595**	**190,072**	**186,191**	**190,500**	**190,073**
	Total harvested plus fallow	**195,060**		**193,306**	**196,021**	**193,937**	**197,000**	**195,035**

Source: Bureau of Reclamation, Klamath Basin Area Office, Crop Statistics.

Crop Water Demand (Evapotransporation and Applied Water)

Table 3 shows the assumptions of the per acre ETc and applied water demand, by representative crop, used in the model. Estimates for the demand for groundwater and/or precipitation are arrived at as the difference between the total ETc and the ETc of surface water irrigation. Combined with an assumption about field-level irrigation efficiency the ETc estimates produce the demand for applied water by crop. The average field-level irrigation efficiency used in the model is 68.0 percent (Burke, 1999).

Table 3.—Evapotranspiration and applied water assumptions for the representative crops used in KB_HEM (acre-feet per acre)

Crop	Crop evapotranspiration			Applied water		
	Surface irrigation	Groundwater and/or precipitation	Total	Surface irrigation	Groundwater and/or precipitation	Total
Alfalfa hay	2.02	0.68	2.7	3.0	1.0	4.0
Irrigated pasture	2.12	0.48	2.6	3.1	0.7	3.8
Other	1.7	0.3	2	2.5	0.4	2.9
Potato	1.88	0.27	2.15	2.8	0.4	3.2
Small grain	1.68	0.27	1.95	2.5	0.4	2.9
Wheat	1.5	0.25	1.75	2.2	0.4	2.6

Source: Burke 1999.

Crop Yields and Prices

The crop yields used to calculate gross farm revenue are shown in tables 4 and 5. Crop yields are based on published county yield data for the three counties represented by the project. The yields used for the California land are a weighted average yield between Modoc and Siskiyou counties with the exception of the feed barley yield where a Modoc county yield was used. The California Agricultural Commissioner's reports are the source of the California yield data. The yields for the Oregon land were obtained from USDA National Agricultural Statistics Service for Klamath county OR. The irrigated pasture yield was based on interviews with knowledgeable individuals in the Klamath Basin conducted in 2005. For the purposes this study it is assumed that the 2005 pasture yields are similar to those found in the years 2005-2009.

Table 4.—Crop yields for project land located in California

	Small grains* (Ton)	Wheat (Ton)	Irrigated pasture (AUM)	Potato (Ton)	Other (Ton)	Alfalfa hay (Ton)
2005	2.50	3.07	10.00	22.30	24.57	5.42
2006	2.50	2.73	10.00	22.29	25.00	5.42
2007	2.50	3.10	10.00	23.95	26.05	5.27
2008	2.75	3.25	10.00	23.19	24.20	5.27
2009	2.75	3.40	10.00	23.99	24.79	5.98
Average	**2.60**	**3.11**	**10.00**	**23.15**	**24.92**	**5.47**

Source: California County Agricultural Commissioner Reports.
*Modoc County.

Table 5.—Crop yields for project land located in Oregon

	Small grains (BU)	Wheat (BU)	Irrigated pasture (AUM)	Potato (CWT)	Other (Ton)	Alfalfa hay (Ton)
2009	71.00		10.00	450.00	24.57	4.80
2008	95.00	89.50	10.00	430.00	25.00	4.55
2007	104.50	86.00	10.00	475.00	26.05	4.40
2006	77.50	94.50	10.00	485.00	24.20	4.60
2005	73.00	91.50	10.00	480.00	24.79	4.70
Average	**84.20**	**90.38**	**10.00**	**464.00**	**24.92**	**4.61**

Source: USDA National Agricultural Statistics. County – Crops Quick Stats.

As with yields, prices are another key component use to compute gross farm revenue. The prices are taken from the California Agricultural Commissioner's Reports which are published annually. These prices are used for both the California and Oregon lands because they are published on a county basis versus state level. The prices are summarized in table 6.

Table 6.—Weighted average prices for Modoc and Siskiyou Counties

	Small grains ($/Ton)	Wheat ($/Ton)	Irrigated pasture ($/AUM)	Potato ($/Ton)	Other ($/Ton)	Alfalfa ($/Ton)
2005	82.00	103.47	14.5	159.89	99	128.94
2006	120.00	136.06	15.4	99.43	99	135
2007	164.99	272.	16.5	129.36	110	140
2008	300.02	225	16.5	155.96	126	200
2009	300.02	200.24	17.8	127.57	128.60	154.71
Average	**193.41**	**187.35**	**16.14**	**134.44**	**112.52**	**151.73**

Sources: USDA National Agricultural Statistics, California County Agricultural Commissioner Reports, various years expect for irrigated pasture which came from USDA National Agricultural Statistics. County – Crops Quick Stats.

Variable Costs of Production

The KB_HEM model uses variable costs of production to evaluate changes in cropping patterns between alternatives. The variable costs of production are summarized in table 7 below. These costs include all variable costs such as fertilizer, seed, chemicals, fuel, labor, etc. California and Oregon crop extension budgets were used to estimate these costs. Many of the extension budgets have not been updated by the cooperative extension services, therefore these costs are indexed to 2008 dollars.

Table 7.—Variable per acre costs (2008 $)

Alfalfa	228.26
Onions	1765.27
Potatoes	2145.8
Irrigate pasture	194.33
Small grains	459.59
Wheat	523.27

Source: Orloff, Steve B., L., Karen M Klonsky, and Pete Livingston, 2008 (Alfalfa), Carlson, Harry L., Karen M Klonsky, and Pete Livingston, 2008 (Onions), Carlson, Harry L., Karen M Klonsky, and Pete Livingston, 2008 (Pototoes), Lile David F., Daniel B. Marcum, Donald L. Lancster, Karen M Klonsky, and Pete Livingston, 2008 (Pasture), Turner, Brenda, and Mylen Bohle, 1995 (Barley), Eleveld, Bart, Rodney Todd, William Riggs, 1999 (wheat).

Annual Estimates

Figure 4 shows the estimated annual number of Project acres in production over a range of estimates of surface water deliveries. At 100.0 percent of full surface water deliveries the number of acres in production is just under 190.0 thousand. The assumption that growers utilize groundwater, and/or precipitation is available, to meet irrigation demand results in acres in production remaining close to 190.0 thousand until surface water deliveries fall to 85.0 percent of full deliveries. After surface water delivers fall below 85.0 percent of full agricultural supply the assumption that annual groundwater pumping on Project lands is constrained to just less than 174.5 taf results in a reduction in land in production. For example, when surface water delivers fall to 50.0 percent of full water deliveries the number of acres in production is estimated to be just over 120.0 thousand, a reduction of Project acres in production of 37.0 percent.

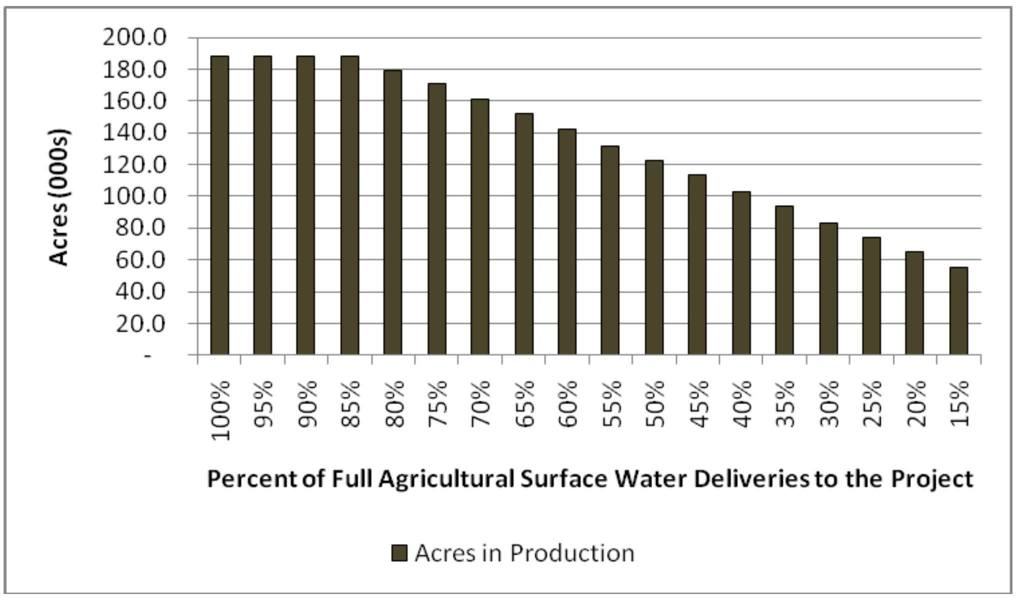
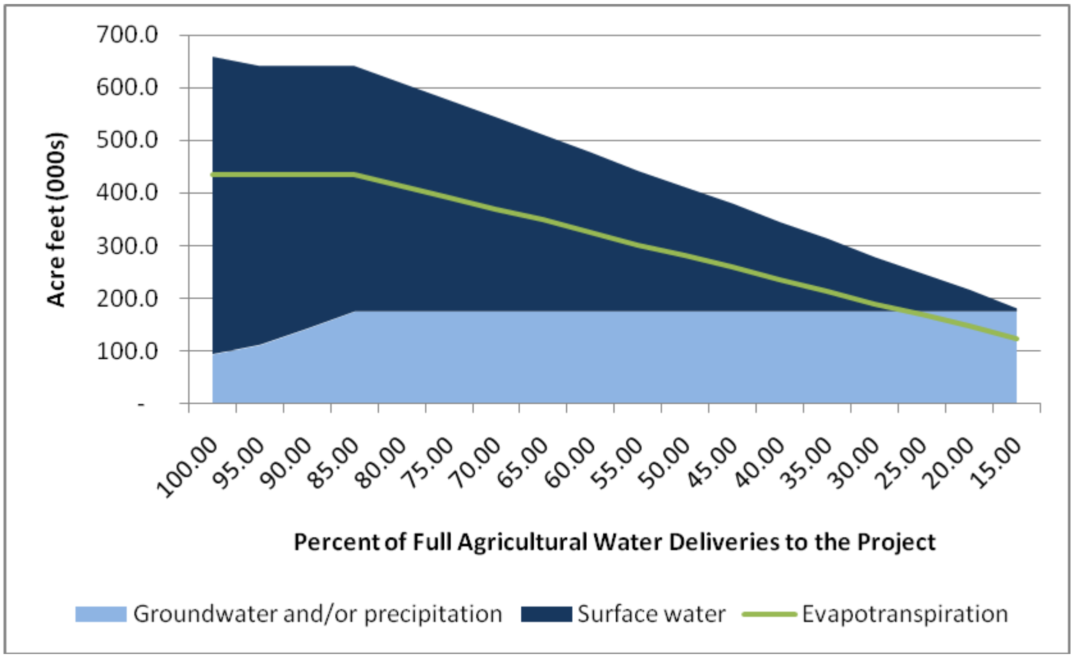


Figure 4.—Estimated acres of project land in production for various volume of surface water deliveries.

Figure 5 shows the estimated annual volume of applied water (groundwater and/or precipitation and surface water) and crop ETc over the range of surface water deliveries. At 100.0 percent of full surface water total ETc is estimated to be 435.0 taf. The estimated volume of surface water delivered under the No Action Alternative is just over 360.5 taf (Reclamation, 2011), a difference of 75.0 taf. Assuming a field-level irrigation efficiency rate of 68.0% the total surface water applied water on fields within the project is approximately 640.0 taf. The difference between ETc demand and estimated deliveries of surface water is assumed to be met with groundwater and/or precipitation. The estimated No Action Alternative amount of groundwater pumping and/or precipitation is approximately 113.0 taf.



Source: KB_HEM model output.

Figure 5.—Applied groundwater, surface water and crop evapotranspiration on project lands over a range of surface water supply deliveries.

As surface water deliveries to project lands falls, the amount of groundwater pumped and/or precipitation available to meet demand increases up until the assumed maximum volume of approximately 174.5 taf. After that volume, as surface water deliveries continue to fall, ETc begins to fall also due to a reduction in acres in production. When surface water deliveries are 50.0% of full supply ETc is just over 400.0 taf, or approximately 65.0 percent of fully supply.

Figure 6 shows the Project crop revenue, by crop, over a range of surface water deliveries. When surface water deliveries are 100.0 percent the crop revenue is just under $150.0 million. Crop revenue decreases at a rate less than the rate at which surface water deliveries decrease. When surface water deliveries are 15.0 percent of full agricultural deliveries the total annual crop revenue is estimated to be over 85.0 million, or a decrease of 59.0 percent. Acres of wheat and irrigated pasture are reduced relatively faster than other, higher valued crops like potatoes. However, nearly all the crops except pasture remain in production over the range of surface water reductions.

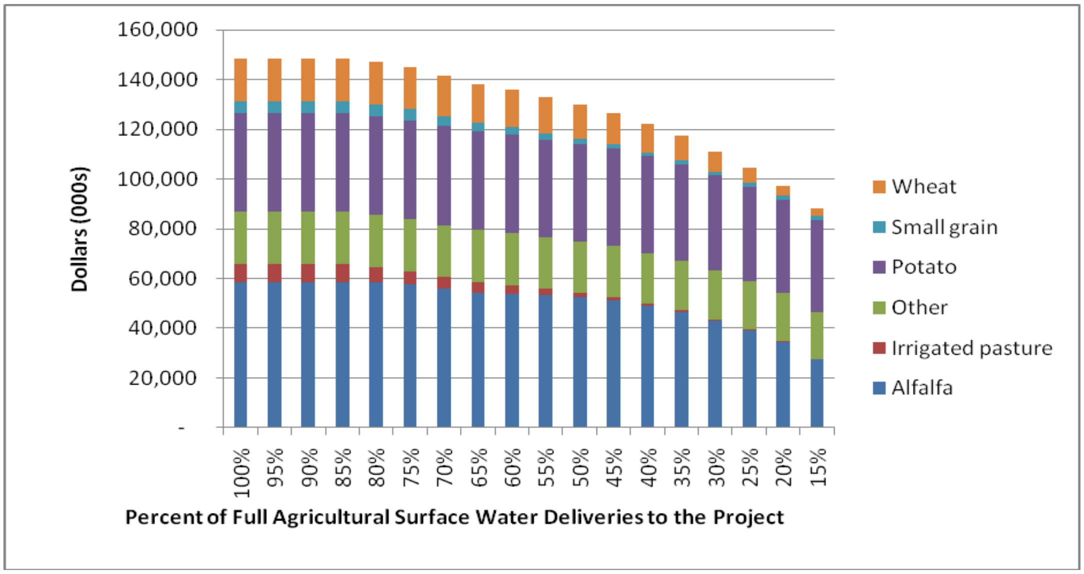


Figure 6.—Annual revenue estimates over range of surface water deliveries, by crop.

Appendix 2

Benefit Values by Crop

Appendix 2 – Benefit Values by Crop

The objective of this analysis was to measure the net farm income for land located within Reclamation's Klamath Project under two conditions; 1) with a full water supply of irrigation and 2) without irrigation water or dryland conditions. The NED agricultural benefit values, discussed earlier, are determined by taking the difference between net farm income generated from crops grown with irrigation and dryland crops grown without irrigation. The following discusses the methodology and assumptions and results of the farm budget analysis.

Table 1.—Summary of the derivation of per acre benefit values by crop

	Potatoes	Onions (other)	Alfalfa	Wheat	Barley (spring grain)	Pasture
With water net farm revenue[1]	$1,596.61	$661.91	$57.41	-$71.69	-$186.00	-$228.00
Without water net farm revenue[2]	-307.6	-307.6	-307.6	-307.6	-307.6	-387
Benefit values by crop	**$1,904.21**	**$969.51**	**$365.01**	**$235.91**	**$121.60**	**$159.00**

Methodology and Assumptions

A farm budget application, developed by Reclamation, was used to measure net farm income for two conditions; 1) with a full supply of irrigation and 2) without irrigation water or dryland conditions. The purpose of Reclamation's benefits budgets differ from University Extension budgets such as those published by Oregon State University and University of California at Davis. Extension budgets present a short-term financial analysis of the annual costs and returns of farming. This type of information is useful in making short-term managerial decisions such as how many acres to plant, which crops will receive irrigation water in water-short years, and how much funding will be needed for the year. Whereas Reclamation's benefits budgets measure the long term economic costs and returns related to irrigated agriculture which represents the opportunity cost to the nation.

Even though the purpose of economic and financial analyses differ, the base data for both types of analyses is strongly correlated and the two types of budgets look very similar if placed side-by-side. For example, both types of analyses use the same crop inputs such as pre-planting, planting, and harvesting operations, seed, fertilizers, agricultural chemicals applied, farm size, improvements, and buildings. The difference in the two types of budgets is due to the different purpose of each budget.

Reclamation's benefit budget measures an opportunity cost according to economic theory. A long-term planning rate (4.125 percent) is used in the budget as an interest rate. This long-term interest rate is appropriate for measuring economic costs and returns over a 50-year planning horizon. All capital is assumed to be borrowed. When all the capital is borrowed, the analysis can focus on whether investing the capital in this irrigation project is the best use of this capital from a national standpoint. Prices received for crop sales are market-clearing prices exclusive of farm subsidies. Each budget provides a return to land, labor, and capital. These assumptions are necessary to measure the long-term economic costs and returns versus short-term accounting costs and returns. The P&Gs provide a framework for governmental agencies to follow that allows irrigation benefit analyses to satisfy their purpose.

The net farm incomes generated by crops grown with irrigation water were compared to the net farm income resulting from the crops grown without irrigation water. After estimating the net farm income for both conditions, the difference between the two net farm incomes was calculated; this difference is the agricultural benefit. Discussed below are the data used the farm budgets for the both the with irrigation water and without irrigation water conditions.

With Irrigation Farm Budget Results and Data Assumptions

The "with" irrigation project net farm revenue values are estimated for six crops grown within the study area; potatoes, wheat, barley, onions, alfalfa, and irrigated pasture. These crops are selected based on production records collected by Reclamation and USDA's National Agricultural Statistics Service (NASS) and the availability of crop enterprise budgets published by Oregon State University (OSU) or U.C. Davis. Selection of these crops is also discussed in section Crop Acres and Aggregation in appendix 1 of this report.

The "with" irrigation project net farm revenue results, calculated using Reclamation's farm budget application, are presented in table 2. Some of the net farm income values are negative, this does not imply that operators currently receiving water in the Klamath Project are not viable operations, it is a function of imposing P&G assumptions on several farm budget variables such debt equity ratios, crop prices, and interest rates.

Table 2—Farm budget results for the crops grown with a full water supply

Net farm income with irrigation supply	Potatoes	Onions (other)	Alfalfa	Wheat	Barley (spring grain)	Pasture
With water net farm income	$1,596.61	$661.91	$57.41	-$71.69	-$186.00	-$228.00

The data assumptions used in the with irrigation water farm budget calculations are presented below.

Crop Prices

The P&Gs require the using normalized prices if available. The Economic Research Service (ERS) calculates the state level normalized prices. Normalized prices," smooth out the effects of short run seasonal or cyclical variations. The prices are based on five year averages. State-level normalized prices for 2010 were calculated by multiplying the national-level normalized prices by the average ratios of the State-level market prices to the national market prices for 2006-2008. (USDAERS) Normalized prices were used for wheat, small grains (barley), alfalfa hay, and potatoes as shown in table 3.

Table 3—State-level normalized price estimates for commodities, 2010

State	Wheat, all types[1] (Bushel)	Barley[1] (Bushel)	Hay, all types, baled (Ton)	Potatoes (CWT)
California	4.62	3.71	136.03	11.54
Oregon	5.36	3.40	144.68	7.12
Average	**4.99**	**3.56**	**140.36**	**9.33**

Source: Economic Research Service.
[1] Does not include deficiency payments.

Normalized prices were not available for irrigated pasture and onions. For these crops a weighted average price for Siskiyou and Modoc counties were used. The prices were published in the annual California Agricultural Commissioner's Reports. These prices are used for both the California and Oregon lands because they are published on a county basis versus state level. A three year average price is normally used in benefits budgets however to be consistent with the prices used in the KB_HEM model a five year average price was used in the budgets. The prices are summarized in table 4.

Table 4.—Prices for irrigated pasture and onions

Price	$/AUM	$/TON
	IRR_PAS	Other (onions)*
2005	14.5	99
2006	15.4	99
2007	16.5	110
2008	16.5	126
2009	17.8	128.605
Average	**16.14**	**112.52**

Sources: USDA National Agricultural Statistics, California County Agricultural Commissioner Reports, various years expect for irrigated pasture which came from USDA National Agricultural Statistics. County – Crops Quick Stats.

* Other (onions) Average Price of Modoc and Siskiyou County.

Crop Yields

Crop yields are based on published county yield data published by the California Agricultural Comissioner's reports (http://www.nass.usda.gov/ Statistics_ by_State/California/Publications/AgComm/Detail/index.asp). A weighted average yield of Siskiyou and Modoc counties were used except for small grains where only a Modoc county yield was available. The CA yields are higher than those published for Klamath county Oregon. The use of higher yields for the benefits budgets is justified based on future changes in technology. The irrigated pasture yield was based on interviews with knowledgeable individuals in the Klamath Basin conducted in 2005. For the purposes this study it is assumed that the 2005 pasture yields are similar to those found in the years 2005-2009 Yields are shown in table 5.

Table 5.—Weighted average yields Siskiyou and Modoc Counties (except for small grains)

Year	Small grains* (Ton)	Wheat (Ton)	Irrigated pasture (AUM)	Potato (Ton)	Other (Ton)	Alfalfa hay (Ton)
2005	2.50	3.07	10.00	22.30	24.57	5.42
2006	2.50	2.73	10.00	22.29	25.00	5.42
2007	2.50	3.10	10.00	23.95	26.05	5.27
2008	2.75	3.25	10.00	23.19	24.20	5.27
2009	2.75	3.40	10.00	23.99	24.79	5.98
Average	**2.60**	**3.11**	**10.00**	**23.15**	**24.92**	**5.47**

Source: USDA National Agricultural Statistics, California County Agricultural Commissioner Reports.
* Modoc County.

Variable Crop Expenses

The crop expenses (seed, fertilizer, chemicals, fuel etc) used in this analysis were based data taken from the University of California and Oregon State University extension budgets. The extension budgets are representative of typical growing conditions and farm sizes. All expenses are indexed to 2010 dollars.

Machinery Costs

New machinery costs are used in this analysis. Machinery prices are taken from the university extension budgets and indexed to current prices.

Labor Inputs

These budgets assume the following for labor expenses. The operator labor rate is $19.14. Hired and family labor is charged at $9.00 per hour. The operator, hired, and family labor rates were taken from the UC Davis crop enterprise budgets. Social security coverage is calculated for hired labor at percent.

Property Taxes and Land Values

Property taxes in California are paid on land, buildings, machinery, and vehicles. Tax codes in California allow counties to charge a base tax rate of 1 percent of assessed property values for lands enrolled in the Williamson Land Act. It is assumed that all lands are enrolled for this analysis. Property values for irrigated agricultural land are estimated to be $1,800 in this study.

Telephone and Electricity

The average yearly cost for telephone usage was estimated at $452 per year. Electricity rates were estimated at $808 per year.

Returns to Family Farm

The factors of production include Return to Labor and Return to Management. Each of these is discussed below.

Return to labor. A return to the labor of the farm operator and family is deducted from the net farm income. The farm operator's labor is normally valued at the current wage rate for supervisory farm labor in the project area. Labor performed by the farm operator's family is valued at the same wage rate as hired farm labor.

Return to management. An allowance of 6 percent of net farm income is made for the farm operator's management ability over and above the labor rate. The return to management represents an opportunity cost to the farm operator. In other words, the return to management represents the farm operator's ability to earn income by applying his/her management skills in another management operation.

Without Water Budget Data

Farm budgets for the without water conditions were estimated for dryland pasture and wheat. The irrigated pasture and irrigated wheat budgets were converted to dryland budgets to represent the without water conditions. It is assumed that without irrigation water the land in the Klamath Project would theoretically grown dryland wheat and pasture. The net farm income includes all investment costs associated with growing irrigated pasture and irrigated wheat for purposes of calculating the NED benefit values. The results of the without water net farm income for dryland pasture and wheat are shown in table 6. Note because of the assumptions required by the P&Gs some of the net farm income values are negative, this does not imply that operators currently receiving water in the Klamath Project are not viable operations.

Table 6.—Farm budget results for pasture and wheat grown under dryland conditions

	Dryland wheat	Dryland pasture
Without water net farm income	-307.6	-387

The input data used in the with water budgets discussed above applies to the without water budgets with the exception of yields.

The yield used for dryland wheat was 1 ton per acre. The dryland pasture yields were assumed to be 1.6 tons per acre.