MINUTES OF THE NOVEMBER 8, 2011
BOARD OF DIRECTORS MEETING OF
NORTH PLAINS GROUNDWATER CONSERVATION DISTRICT

The Board of Directors of North Plains Groundwater Conservation District met in regular session November 8, 2011 at 9:30 a.m. in the Board Room of the District office at 603 East First Street in Dumas, Texas. The following persons were present:

Members Present:

Daniel L. Krienke;
Bob Zimmer
Gene Born;
Phil Haaland;
Brian Bezner; and,
Harold Grall.

Staff Present during part or all of the meeting:

Steve Walthour, General Manager;
Dale Hallmark, Assistant General Manager/District Hydrologist;
Kirk Welch, Assistant General Manager
Kristen Alwan, Executive Assistant;
Karen Mannis, Permitting Specialist; and
Odell Ward, Natural Resource & GIS Specialist 2.

Others present during part or all of the meeting:

George Freeman;
Bert Jr. Allard;
Sabrina Leven;
Louis Leven;
Nathan Sargent;
Enviro Ag Engineering;
Leon Mitchell;
Steve Amosson;
F. Keith Good, Attorney; and,
Claire Y. Walsh, Attorney.

President Zimmer declared a quorum present and called the meeting to order at 9:38 a.m.

Gene Born gave the invocation and Bob Zimmer led the pledge.

At 9:40 a.m., the meeting was recessed to conduct a Public Hearing on whether to tax or exempt goods-in-transit pursuant to Section 1-n(d), Article VIII, Texas Constitution, and Texas Tax Code Section 11.253(j-1). Keith Good, the attorney for the District, explained the Legislative change to the Tax Code regarding the continued ad valorem taxation of goods-in-transit, and the purpose of such laws. Burt Jr. Allard appeared and addressed the Board regarding the taxation of goods-in transit. The President of the Board closed the Public Hearing at 9:46 a.m.

The regular Board Meeting was reconvened at 9:47 a.m.

President Zimmer asked if there were persons present who desired to make Public Comment. No public comment was received.

Phil Haaland moved to approve items 2a, 2b and 2c of the Consent Agenda, consisting of the approval of the Minutes of the October 18, 2011 Board of Directors Meeting; the approval of un-audited District expenditures from October 1, 2011 through October 31, 2011, including the General Manager's Expense and Activity Report; and the approval of payment of professional services and out of pocket expenses to Lemon, Shearer, Phillips & Good, P.C. in the amount of $6,516.00 for October 1, 2011 through October 31, 2011. Danny Krienke seconded the motion and the motion was unanimously approved by the Board.

The Board considered whether to tax or exempt goods-in-transit pursuant to pursuant to Section 1-n(d), Article VIII, Texas Constitution, and Texas Tax Code Section 11.253(j-1).

It was reported that in the 2007 session, the Texas Legislature passed Tax Code Section 11.253 or the "Goods-in-Transit" exemption as it is more commonly known. This legislation implemented a constitutional amendment that was passed several years before. This legislation was very similar to the "Freeport exemption" passed many years ago, but it had a potentially larger impact as time passed.

During the 2011 special session, the legislature acted to significantly limit the applicability of section 11.253. This exemption now applies only to goods that are stored in a public warehouse owned by someone other than the owner of the goods. The law no longer exempts goods that are in a location for assembly, manufacturing, fabrication or processing, as was the case under the law passed in 2007. The legislature revised and narrowed the law to address the author's issue: competition between Texas and New Mexico warehouse facilities. New Mexico does not tax such goods at all, so New Mexico warehouse owners had a competitive advantage.

This update to the law requires that the District act within a narrow window of time if the District wants to continue to tax these goods for 2012. The update provides that **the District must take action after October 1, 2011 but before December 31, 2011,** if the District wants to continue to tax such goods in 2012. The District may later elect to tax such goods for subsequent years if the District fails to act this year.

The General Manager recommended that it is in the best interests of the District, for the District to continue to tax goods-in-transit in Lipscomb, Ochiltree, Hansford, Sherman, Dallam, Hutchinson, Moore and Hartley Counties, Texas.

Danny Krienke moved that the Board adopt the following Resolution as to the continued ad valorem taxation of goods-in-transit:

WHEREAS, the 82nd Texas Legislature in Special Session, enacted Senate Bill 1, to take effect on September 1, 2011, which would require a taxing unit to take action, in the required manner, after October 1, 2011, to provide for the taxation of goods-in-transit; and

WHEREAS, Tex. Tax Code §11.253(j-1) as amended allows the governing body of a taxing unit, after conducting a public hearing, to provide for the continued taxation of such goods-in-transit; and

WHEREAS, the North Plains Groundwater Conservation District (hereinafter sometimes referred to as "District") has conducted a public hearing as required by Section 1-n (d), Article VIII, Texas Constitution, and Tex. Tax Code §11.253(j-1) and the District is of the opinion that it is in the best interests of the District to continue to tax such goods-in-transit;

NOW THEREFORE, BE IT RESOLVED BY THE BOARD OF DIRECTORS OF NORTH PLAINS GROUNDWATER CONSERVATION DISTRICT that goods-in-transit, as defined by Texas Tax Code Section 11.253(a)(2), as amended by Senate Bill 1,

enacted by the 82nd Texas Legislature in Special Session, shall remain subject to taxation by **NORTH PLAINS GROUNDWATER CONSERVATION DISTRICT.**

Harold Grall seconded the motion to adopt the foregoing Board Resolution and it was unanimously approved by the Board.

Wesley Spurlock arrived to participate in the meeting at 9:53 a.m.

Steve Amosson made a presentation to the Board entitled "Evaluation of Changing Land Use and Potential Water Conservation Strategies", a copy of which is attached hereto as Exhibit "A" and incorporated herein for all purposes.

Brian Bezner moved to withdraw item 3c., approval of Water Well Permits, from the Agenda until the next monthly meeting of the Board. Gene Born seconded the motion and it was unanimously approved by the Board.

Phil Haaland moved to propose a new District Rule 3.4 identical to the draft presented to the Board, except with a five-year Conservation Reserve utilization period, and to direct general counsel and the general manager to provide proper public notice and coordinate a Public Hearing to gather public input so the Board may consider the proposal and public comment regarding the proposal in January or February, 2012. Harold Grall seconded the motion and it was unanimously approved by the Board.

General Manager Walthour stated that in October, Texas House Speaker, Joe Straus, issued his interim charges to the members of the House of Representatives and the Lieutenant Governor, David Dewhurst, issued select interim charges to the members of the Senate. The Speaker's interim charges to study ways to attract more manufacturing jobs and build on economic development efforts; enhance public and higher education; improve wildfire response and address water needs made more critical by the drought; improve the state's transportation infrastructure; reduce state debt; and make government more efficient and effective. The Lieutenant Governor released a partial list of charges related to drought and wildfire preparedness. Staff anticipates the Lieutenant Governor will release the rest of the Senate's interim charges either later this year or the beginning of the next calendar year. House and Senate committees will conduct comprehensive studies of the issues outlined in the interim charges during the 15 months between now and the next legislative session. The findings will ultimately form the foundation of legislation to be considered during the 83rd Legislative session in 2013.

On Tuesday, November 1st, the Senate Committee on Natural Resources met jointly with the Senate Committee on Agriculture & Rural Affairs and took invited testimony on Interim Charge number one, relating to the ongoing drought conditions in the state.

On Wednesday, November 2nd, the House Natural Resources Committee met to discuss Interim Charge Number 1, relating to the ongoing statewide drought and the performance of state, regional, and local entities in addressing it; to examine the impact of the drought on the state water plan, including an evaluation of how well the state's existing water resources can meet demand, the need for additional funding sources to implement the plan, and the effectiveness of current drought planning and drought management policies; to identify short-term and long-term strategies to help the state better cope with drought and assess any obstacles, including state and federal regulations; and the implementation of these strategies.

President Zimmer discussed the 5.2 billion dollar loss for agricultural crops in 2011 and stated that it is considered a statewide crisis.

In October, the Board directed the General Manager to provide some examples of spacing and well density if the District adopted a 3.75 gallon per minute per acre rule ("3.75 GPM Rule"). The Staff developed diagrams to illustrate different well configurations based on the 3.75 GPM Rule and the contemplated well spacing

classification. The Table below shows the well density of the different well classifications based on a 640 acre tract and a 1600 acre tract of water rights without applying the District's current well density rule of one well per 80 acres. The General Manager is not contemplating dropping the 1 well per 80-acre Rule; therefore this table is for illustration and discussion purposes only.

Pumping Capacity of Proposed Well (GPM)	Classification of Proposed Well	Minimum Distance From Nearest Well or Authorized Well Site	Minimum Distance from Property Line	Midpoint of Well Class (GPM)	640 Acre Density	1600 Acre Density
000 –017.5	S	100 Yards	50 Feet	NA	NA	NA
017.5 – 0100	A	150 Yards	75 Yards	58.8	40.9	102.1
101 – 0400	B	250 Yards	125Yards	250	9.6	24.0
401 – 0800	C	400 Yards	200 Yards	600	4.0	10.0
801 – 1200	D	500 Yards	250 Yards	1000	2.4	6.0
1201 – 1500	E	600 Yards	300 Yards	1350	1.8	4.4
1501 – 1800	F	700 Yards	350 Yards	1650	1.5	3.6

Dale Hallmark, District Hydrologist, and Assistant General Manager, and Odell Ward, Natural Resource & GIS Specialist 2 presented diagrams to the Board to facilitate the discussion of the following:

In applying a 3.75 GPM Rule to our current groundwater management method:

- Does the District keep its one Well per 80 acre Rule?
- Does the 3.75 GPM Rule apply to both new and replacement wells?
- How does the 3.75 GPM Rule limitation apply to pooling groundwater rights?
  - Can a property be pooled that would exceed the 3.75 GPM Rule limitation? and,
  - If existing properties are grandfathered for existing Wells, when does the 3.75 GPM Rule start applying?

The Board next discussed its 200-12 Demonstration Program. In October, the District requested that the NRCS representative in the area assist in soliciting grower cooperators for the upcoming and future seasons, the Agricultural Committee met regarding the District's protocols and the Conservation Innovation Grant (CIG) Team met by teleconference to discuss administrative and technical issues as follows:

1. NRCS Reporting Dates;
2. Contracting Process;
3. Technologies and Contracts (What's in the fields, modeling etc....);
4. Solicitation for Grower Cooperators; and
5. Public Outreach.

The following 200-12 Grower Protocols were presented to the Board:

Grower 200-12 Corn Demonstration Protocols

1. *A minimum of 120 acres are required for each field scale demonstration. At $50/acre =$6000.*
2. *Equal acres of* ***managed*** *(12") and* ***control*** *(normal) irrigation for comparison are needed.*
3. *A minimum of 4 gallons per minute per acre must be fully committed to the project.*

4. *No pre water is preferred on **managed** acres. Any applied will count in 12 inches.*
5. *Employ/utilize intense pre- and in-season fertility services/management from professional consultants that ensures adequate nutrients for 200-12 corn production.*
6. *Monitor/control insects, weeds, diseases and other by applying normal practice and recommended chemicals to maintain 200-12 yield potential.*
7. *Provide hybrid, planting, harvest, fertilizer, insecticide, yield and other information that documents 200-12 corn production management. Grower will select one primary hybrid for each field. Limited planter width rows/passes of promising hybrids allowed.*
8. *Provide 200-12 **managed** and comparative **control** corn yield using National Corn Growers Association formula by individual truck load weight and corresponding moisture content. Submit summed adjusted load weights. Use *NCGA yield formula: Yield Adjustment = Elevator weight x (Elevator % moisture – 15.5% x 1.2)*
9. *Utilize current or establish effective residue management practices.* ***Measurement instruments in cooperation with District(District will provide & install)***
10. *A water meter will measure irrigation, be read weekly and recorded by District personnel.*
11. *A rain gauge located at the site will be read and recorded weekly by district.*
12. *Soil moisture sensor gypsum blocks installed at 1, 2, 3, 4, and 5 feet, in **managed** and **control**, read and recorded weekly by district to identify net soil water used by the crop.*
13. *One advanced technology soil moisture probe installed in each of the **managed** and **control** acreages to provide timely irrigation management for grower and district personnel. (Aquaspy or others)*
14. *PivoTrac monitoring including rain back-up is required to track/follow actual irrigation.*
15. *Participate in two day grower education training meetings held by NPGCD as well as field days/tours/meetings when needed to share field demonstration results.*
16. *Collectively prepare an annual report of the demonstration results*
17. *Utilize the TACW Resource Allocation Tool as a pre-season planning aid.*
18. *Use and update the TACW Irrigation Scheduling program weekly or more to help estimate crop water use and develop an irrigation timing regime.*

It was reported that Harold Grall was the last to harvest his 200-12 crop. The results of all 200-12 participants are currently being analyzed by Leon New and the District Staff for inclusion in the District's 2012 report.

The District is already receiving requests to make presentations regarding the District's 200-12 Demonstration Project and the Texas High Plains Initiative for Strategic and Innovative Irrigation Management and Conservation.

Nathan Sargent and Leon Mitchell, Esq. discussed Rule 1.37 and Rule 3.3 and the application of said Rules to the East One-half (E/2) of the William Neil Survey, Hutchinson County, Texas with the Board.

At 12:40 p.m. the Board recessed for lunch and reconvened at 1:50 p.m.

Danny Krienke moved to go into Executive Session in compliance with the Texas Open Meetings Act, Chapter 551 of the Texas Government Code, §551.071 for consultation with Keith Good of Lemon, Shearer, Phillips & Good, P. C. concerning attorney-client privileged matters involving legal counsel's consultation with the Board concerning compliance matters regarding well spacing. Brian Bezner seconded the motion and it was unanimously approved by the Board.

Executive Session: At 2:13 p.m. the Board went into Executive Session to consult with Keith Good regarding attorney-client privileged matters. At 2:31 p.m., Director Brian Bezner recused himself from the Executive Session. At 2:36 p.m. Director Harold Grall moved that the Board reconvene into regular session. Wesley Spurlock seconded the motion and it was unanimously approved by the Board.

Danny Krienke moved to authorize the General Manager and the District's General Counsel to attempt to enter into Compromise Settlement Agreements with parties that were not in compliance with District Rule 11, subject to the Board's Approval. Wesley Spurlock seconded the motion and it was unanimously approved by the Board.

Steve Walthour presented the General Manager's Report, including information concerning upcoming meetings and conferences; the General Manager's activity summary; and the District activity summary.

By consensus, the Board set its next regular Board meeting for January 17, 2012 at 9:30 a.m.

Phil Haaland moved to adjourn the meeting. Brian Bezner seconded the motion and it was unanimously approved by the Board. President Zimmer declared the meeting adjourned at 2:57 p.m.

Bob B. Zimmer, President

Brian Bezner, Secretary

Evaluation of Changing Land Use and Potential Water Conservation Strategies:

North Plains Groundwater Conservation District

Phase One Report

Prepared by:

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Phil Johnson, Texas Tech University
Jeff Johnson, Texas Tech University

October 28, 2011

Introduction

The North Plains Groundwater Conservation District (NPGCD) is facing critical decisions regarding potential water conservation policies. It has been projected through the planning efforts set forth in Senate Bills 1, 2, and 3 that the four western counties of the district will have difficulty in meeting the Desired Future Condition (DFC) of having 40% of the groundwater remaining in 50 years. Evaluation of the economic implications from changing land use, alternative water conservation strategies being considered, and/or the impacts of potential water policies originating from the state or federal government can aid the district in making important policy decisions.

The objective of this study is to evaluate the short and long-term implications of changing land use and alternative water conservation strategies being considered by the NPGCD. Specifically, changing land use and water conservation strategies identified by the district will be evaluated using computer models that project saturated thickness, irrigated acreage, producer gross margin, and impacts on the regional economy. The results of different scenarios are compared to a *status quo* baseline scenario to evaluate their impacts. A total of four policy alternatives identified by the NPGCD will be evaluated relative to the baseline with the first two being completed in the fall of 2011 (Phase One), and the remaining two scenarios completed by September 2013 or earlier (Phase Two).

The baseline scenario assumes no water conserving policy is included, no projected changes in irrigated acreage occur, and producers operate in an unregulated profit maximizing manner. The baseline projections developed in the previous contract with the district were updated with respect to input parameters. Two scenarios identified in the June 7, 2011 NPGCD Board meeting were evaluated in Phase One related to potential changing land use within the district: an increase in irrigated acreage in the western four counties and an increase in irrigated acreage in the eastern four counties. In both scenarios, a sensitivity analysis on the number of irrigated acres added was performed to provide a broader picture of potential impacts. An additional scenario was analyzed to evaluate the impact of varying discount rates on the value of future agricultural production. The detailed alternative scenarios included in the analysis were the following:

1) **Increased Irrigated Acres in Western Counties:** The increase in permit requests to drill new wells, leading to an expansion in irrigated acreage in the western counties (Dallam, Hartley, Moore, and Sherman), could dramatically affect the district's ability to meet the DFC. In this scenario, the impact on saturated thickness, producer income, and the regional economy of a 20% increase in irrigated acreage starting in 2010 was analyzed in each of the western counties over a 50-year time horizon. In addition, sensitivity analyses were performed, increasing irrigated acreage 10%, 30%, and 40% in each of the four counties to provide a broader picture of potential impacts.

2) **Increased Irrigated Acres in Eastern Counties:** Significant water supplies exist in the eastern four counties (Hansford, Hutchinson, Lipscomb, and Ochiltree) with relatively lower irrigation demand compared to the western

counties. These conditions, coupled with high commodity prices and an increasing presence of the dairy industry in the district, suggest that a future increase in irrigation in the eastern counties is probable. In this scenario, the impact on saturated thickness, producer income, and the regional economy of a 20% increase in irrigated acreage starting in 2010 was analyzed in each of the eastern counties over a 50-year time horizon. Again, sensitivity analyses were performed, increasing irrigated acreage 10%, 30%, and 40% in each of the four counties to provide a broader picture of potential impacts.

3) **Alternative Discount Rates:** A 3% discount rate has been utilized in the previous, as well as, current study to convert future returns to present day values. The 3% rate corresponds to a real rate of return that is commonly used in this type of analysis. However, some water planners feel that this rate should be 0% or even negative, suggesting the value of water saved for future use is as important as or more important than current consumption. The objective of this scenario is to illustrate how modifying the discount rate can affect the results of policy analysis. Results from the baseline scenario and Scenario I which analyzed an increase in irrigated acreage of 20% in the western counties are compared utilizing 3%, 0%, and -3% discount rates to demonstrate the implications.

Data and Methods

Study Area

The study area is the region overlying the Ogallala Aquifer in the NPGCD. The specific counties included in the analysis are Dallam, Hartley, Moore, and Sherman Counties in the western portion of the district and Hansford, Hutchinson, Ochiltree, and Lipscomb Counties in the eastern portion, Figure 1.

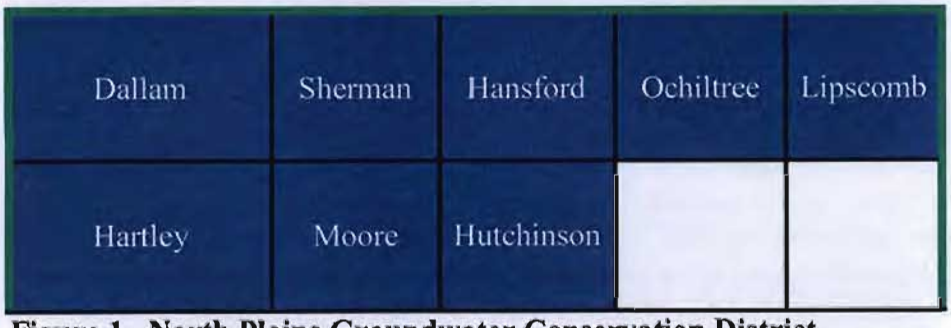

Figure 1. North Plains Groundwater Conservation District

Methods

There are two types of economic models that were used in the policy analyses. Economic optimization models (Brooke et al., 1998) for each of the eight counties in the study area were used to estimate changes in the aquifer and producer gross margin over a 50-year planning period. Socioeconomic models were used to evaluate changes in the regional economy and

regional employment based on the aggregate results from the county optimization models (MIG, 2009).

The county optimization models begin with the initial county values for crop acreage, irrigated acreage, average saturated thickness, and depth to water. Given the initial conditions, the models estimate the level of crop production and water use that optimize gross margin over a 50-year planning period. Gross margin is defined as the total of revenue less cash expenses. Gross margin differs from net returns in that it does not include fixed expenses. The results of the model include changes in crop acres, irrigated acres, and gross margin over the planning horizon.

The underlying assumptions for the model include county, aquifer, and crop parameters. The parameters for each county include the number of acres planted in each crop, the number of irrigated acres (Farm Service Agency, 2008-2010), and the percentage of the county overlying the Ogallala Aquifer. The aquifer characteristics for each county include the average saturated thickness, depth to water, specific yield, and recharge. Initial saturated thickness estimates were provided by the NPGCD (2011) while a slight modification was made to Moore County saturated thickness (from 196 feet to 167 feet) using Texas Tech Universities' Center for Geospatial Technology (2011) estimates. It was felt that this value more accurately reflects the saturated material which exists for irrigation purposes.

The crop parameters for each crop include crop price, cost of production, and crop yield. Texas AgriLife Extension Service (2010) crop budgets were utilized to obtain three-year average crop prices and costs of production. Crop yield was determined by a production function which estimates yield as a response to applied water. Each crop in each county has a unique production function. As available water decreases, the crop yield decreases in response to reduced irrigation. The production functions were estimated with the aid of Leon New (2010) and are based on field-level observations of the relationships between crop yield and irrigation water applied. Cost of pumping was calculated using the energy price and energy requirement due to the changing depth to water over the planning period. One of the unique aspects of this model is that water demand incorporates costs of pumping, changes in depth to water, changing crop yields, and potential changes to crop mix as they respond to changing water availability over time.

The results of the county optimization models were aggregated into sub-regional results for the socioeconomic analyses to forecast the effects of the policies on overall economic activity in the NPGCD study area. These models capture the often-cited "spillover effects" of changes in water availability on other economic sectors linked directly and indirectly to irrigated crop production. Models to evaluate the baseline socioeconomic impacts on the overall study area and impacts of the alternative scenarios analyzed used the input-output model, IMpact analysis for PLANning (IMPLAN). Input-output modeling is a method used to understand the linkages between elements of an economy and estimate the impacts of changes in the economy.

To measure impacts, the IMPLAN model produces multipliers which estimate the total economic impact of expenditures within an economy. These impacts are referred to as direct, indirect, and induced effects. An example of these effects is when a producer pays to have his crop custom harvested (direct effect). Then, the custom harvester purchases additional

equipment (indirect effect). As a result of profits received, the producer and the custom harvester can spend money at the local grocery store (induced effect). The IMPLAN model contains comprehensive and detailed data coverage of the entire U.S. by county and the ability to incorporate user-supplied data at each stage of the model building process. In addition, particular crop production costs for each crop were input into the model to get more detailed and region-specific results. These models generated the impact projections of employment, regional income, and industry output for the study area.

Modeling Modifications from Recent Reports

Several updates/changes were made to the models used in the analysis compared to the previous study. Frist, the projected planning horizon was reduced from 60 years to 50 years to be consistent with the length of time established to reach a specified DFC. Second, crop acreage data was updated through 2010 utilizing Farm Service Agency (2008-2010) records. Previously, a five year average of crop acreage data was used in the models. In the current study, three year averages of crop acreages were utilized to be more responsive to recent changes in acreage. Maximum Allowable Groundwater (MAG) estimates provided by the Texas Water Development Board were replaced by a three year average of water use provided by the district (North Plains Groundwater Conservation District, 2011). Finally, the data in the IMPLAN model for the region was updated and the analysis expanded to include forward linked sectors in addition to the traditional backward linked sectors to reflect more accurately the total impact on the regional economy.

Phase One Results

The results of Phase One are presented in four sections. The first includes the baseline modeling output from 2010-2059 for each of the eight counties in the NPGCD. The projections include saturated thickness, number of irrigated acres, and gross margin ($/acre) for each county. In addition, baseline regional output, value added, and employment are estimated for the four western and four eastern counties. Results for Scenario I are presented in section two where the number of irrigated acres was increased in each of the four western counties within the NPGCD by 20%. A sensitivity analysis was performed increasing irrigated acreage 10%, 30%, and 40%. *It was felt that the 10% and 30% increase did not enhance the results significantly; therefore, these levels of sensitivity were not included in the report.* The results from Scenario II are provided in section three where the number of irrigated acres was increased for each of the eastern four counties within the NPGCD by 20% and 40%. The impact of using alternative discount rates (-3%, 0% and 3%) is evaluated for the 20% increase in irrigated acreage in comparison with the baseline for in the western counties. Results of this sensitivity analysis are presented in section four. Detailed county level results for the baseline, Scenario I, and Scenario II are presented in Appendices A through C.

Baseline

The baseline county level results established the *status quo* projections by which the 20% and 40% increase in irrigated acres in Scenarios I and II were compared. Under the baseline scenario, no water conserving policy is included, no projected changes in irrigated acreage are assumed, and producers operate in an unregulated profit maximizing manner. The initial values for each county include the allowable annual pumping, average acreage estimates, and other economic variables as indicated in the methods section.

The aquifer drawdown of the western counties of the district was significant under the baseline scenario as illustrated in Table 1. Saturated thickness begins at 147 feet, 145 feet, 167 feet, and 173 feet and declines to 54 feet, 53 feet, 81 feet, and 77 feet by year 50 in Dallam, Hartley, Moore, and Sherman Counties, respectively, due to continued aquifer depletion. Saturated thickness declines by 63% in Dallam and Hartley Counties and by 51% and 55% in Moore and Sherman Counties, respectively. Dallam and Hartley Counties are projected to have the largest percentage change in saturated thickness, while Sherman County is projected to have the biggest total change in saturated thickness with a decline of 96 feet over the 50-year horizon. The eastern counties of the district have relatively less irrigated land which allows a slower rate of aquifer decline over the planning horizon. Hansford and Hutchinson Counties are expected to have some drawdown in the saturated thickness, starting at 189 feet and 154 feet and dropping more than 30 feet to 155 feet and 115 feet, respectively. Lipscomb and Ochiltree Counties are dryland intensive and show very little change in the aquifer over the planning horizon. The percentage decline in saturated thickness is no greater than 25% or 39 feet in any eastern county over the 50-year period.

The large drawdown of the aquifer for the western counties of the district affects both the number of irrigated acres, as well as, the gross margin per acre. Irrigated acres start at 222,563 acres, 224,576 acres,145,043 acres, and 188,144 acres in Dallam, Hartley, Moore, and Sherman Counties, respectively. As shown in Table 2, Dallam and Hartley Counties reduce irrigated acres over the 50-year time horizon by nearly half while Moore and Sherman can sustain irrigated production longer as their saturated thickness is comparatively higher in year 50. Irrigated acreage also declines in the eastern counties of the district; however, the magnitude of decline is not as great due to the smaller number of irrigated acres. Irrigated acreage begins at 135,347 acres, 39,364 acres, 29,449 acres, and 61,507 acres for Hansford, Hutchinson, Lipscomb, and Ochiltree Counties, respectively. The largest drop in irrigated acres over the 50-year period for the eastern counties occurs in Ochiltree County with a decline of 23%.

The western counties which exhibit the largest decreases in saturated thickness including Dallam, Hartley, and Sherman Counties, also have the largest declines in gross margin per acre. Dallam County begins with a gross margin of $311.53 in year one which decreases to $151.41 by year 50. Hartley and Sherman Counties have gross margins of $414.42 and $310.08 in year one which decline to $135.81 and $267.21 by year 50, respectively, Table 3. On the other hand, gross margin per acre increases in Moore County and the eastern counties over the time period. The increase in profitability through time in these counties is due to the optimization process within the model choosing the crop mix which maximizes profit over the 50-year planning horizon. Given that these counties can reasonably sustain irrigated land over the time horizon,

the model converts existing irrigated crop mixes to a more profitable crop mix. For example, the gross margin per acre in Moore County increased from $231.90 in year one to $334.45 by year 50, as irrigated corn acres are converted to irrigated cotton. This increase in gross margin is possible even as the saturated thickness declines. It should be noted that these changes in crop mix are highly dependent upon the assumptions made within the model. The focus of the model remains upon the marginal difference between the baseline results and the alternative scenarios evaluated. Detailed county results of saturated thickness, irrigated acreage, and gross margin are located in Appendix A.

The results presented in Table 4 represent the cumulative net present value of regional economic impacts over the 50-year time horizon. The IMPLAN analysis captures the impact on the regional economy of changes in crop production in the western and eastern counties of the NPGCD. The value of irrigated and dryland crops through backward and forward linkages in the economy is estimated at $49 billion in industry output, $17 billion in value added, and the creation of an annual average of 5,000 jobs over the 50-year time period under the baseline scenario for the western counties. The eastern counties do not have the magnitude of impacts to the economy as the western counties as the value of agricultural crop production is approximately half at $23 billion in industry output, $7 billion in value added, and an annual average of 2,400 jobs.

Table 1. NPGCD Baseline County Saturated Thickness (feet)[1] for Selected Years of the Time Horizon

County	Year 1	Year 10	Year 20	Year 30	Year 40	Year 50
West						
Dallam	147.00	127.28	105.36	83.45	65.56	54.03
Hartley	145.00	122.93	98.41	76.92	63.02	53.40
Moore	167.00	151.23	133.71	116.19	98.67	81.14
Sherman	173.00	154.87	134.72	114.57	94.42	77.48
East						
Hansford	189.00	182.81	175.94	169.06	162.19	155.31
Hutchinson	154.00	146.80	138.81	130.81	122.82	114.82
Lipscomb	215.00	213.60	212.05	210.50	208.94	207.39
Ochiltree	214.00	212.48	210.80	209.12	207.43	205.75

[1] Averages are weighted by the area overlying the aquifer in each county.

Table 2. NPGCD Baseline County Irrigated Acres for Selected Years of the Time Horizon

County	Year 1	Year 10	Year 20	Year 30	Year 40	Year 50
West						
Dallam	222,563	222,563	221,117	190,642	155,768	127,274
Hartley	224,576	224,576	219,313	179,195	146,415	119,632
Moore	145,043	133,612	132,096	130,857	129,845	129,018
Sherman	188,144	188,144	188,144	188,144	180,171	147,213
East						
Hansford	135,347	122,454	117,698	113,812	110,636	108,042
Hutchinson	39,364	39,112	38,091	37,256	36,574	36,017
Lipscomb	29,449	25,229	24,473	23,856	23,352	22,940
Ochiltree	61,507	52,119	50,558	49,283	48,241	47,390

Table 3. NPGCD Baseline Gross Margin ($/acre)[1] by County for Selected Years of the Time Horizon

County	Year 1	Year 10	Year 20	Year 30	Year 40	Year 50
West						
Dallam	$311.53	$341.18	$367.91	$380.45	$237.89	$151.41
Hartley	$414.42	$444.43	$467.49	$321.29	$202.18	$135.81
Moore	$231.90	$260.70	$285.50	$305.51	$321.58	$334.45
Sherman	$310.08	$335.05	$357.53	$375.46	$387.73	$267.21
East						
Hansford	$140.52	$166.08	$188.94	$207.55	$222.69	$235.00
Hutchinson	$160.76	$184.89	$206.86	$224.73	$239.24	$251.00
Lipscomb	$143.36	$170.77	$193.27	$211.64	$226.63	$238.86
Ochiltree	$134.82	$162.06	$185.48	$204.61	$220.22	$232.98

[1] The average is based on the total irrigated and dryland net revenue (at time = t) divided by total irrigated and dryland cropland acres.

Table 4. NPGCD 50-Year Regional Economic Impacts[1] by West and East Regions

	Direct	Indirect	Induced	Total
West				
Output[2]	$30,250	$16,764	$2,388	$49,402
Value Added[2]	$9,827	$6,120	$1,419	$17,365
Employment[3]	2,392	2,183	377	4,952
East				
Output[2]	$13,975	$8,138	$1,145	$23,257
Value Added[2]	$3,952	$3,142	$680	$7,774
Employment[3]	1,112	1,145	179	2,436

[1] Impacts include both forward-linked and backward-linked effects.
[2] Millions of dollars – discounted at 3% over the 50-year time horizon.
[3] Average annual employment.

Scenario I: Increased Irrigated Acres in Western Counties

As with the previous studies, the western counties of the district are most vulnerable to policy, agronomic, and economic shocks. As indicated in Table 5 and Figure 2, when irrigated acres are increased by 20% the saturated thickness at the end of the planning horizon declines an additional 18.7%. This additional decline in the aquifer nearly doubles (30.1%) as irrigated acres are increased to 40% above the baseline. This decrease in saturated thickness is also reflected in a drop in irrigated acres and gross margin over the time horizon. The initial increase in irrigated acreage puts a burden on the ability to irrigate in the future causing a conversion to dryland resulting in a decline in irrigated acreage relative to the baseline of 7.6% and 8.6% for the 20% and 40% scenarios, respectively, Table 6. The decline in the revenue potential of the western counties in the 20% and 40% scenarios is significant. In the 20% scenario, gross margin per acre declines 45.5% below the baseline and by 72.3% in the 40% increase scenario, Table 7. Detailed county results of saturated thickness, irrigated acreage, and gross margin are in Appendix B.

The regional economy would benefit from increases in irrigated acres, as indicated in Table 8, even though average gross margin per acre declines in the later part of the planning horizon. The net impact to regional economic output and employment increased by as much as 15% over the baseline when irrigated acres were increased 20% and by 21% over the baseline when irrigated acres were increased by 40% due to short run gains in average gross margin per acre. As seen in Figure 3, these benefits are pronounced in the early years of the planning horizon, however, as the aquifer is depleted and dryland acres increase, the economy suffers. These results indicate that increases in irrigated acreage can have significant impacts on the rates of decline of the aquifer in the western counties and the ability for the NPGCD to reach DFC status.

Table 5. NPCGD West Region Saturated Thickness (feet)[1] for Selected Years of the Time Horizon

Policy Scenario	Year 1	Year 10	Year 20	Year 30	Year 40	Year 50
Baseline	155.75	136.29	114.66	94.01	76.94	63.78
20% Increase Irrigated Acres	155.75	130.02	102.41	79.39	62.87	51.85
Change from Baseline	*0.0%*	*-4.6%*	*-10.7%*	*-15.6%*	*-18.3%*	*-18.7%*
40% Increase Irrigated Acres	155.75	124.71	92.65	68.72	54.04	44.60
Change from Baseline	*0.0%*	*-8.5%*	*-19.2%*	*-26.9%*	*-29.8%*	*-30.1%*

[1] Averages are weighted by the area overlying the aquifer in each county.

Table 6. NPCGD West Region Irrigated Acres for Selected Years of the Time Horizon

Policy Scenario	Year 1	Year 10	Year 20	Year 30	Year 40	Year 50
Baseline	196,642	194,033	191,987	173,513	153,711	130,826
20% Increase Irrigated Acres	235,982	232,840	209,034	180,673	147,994	120,922
Change from Baseline	*20.0%*	*20.0%*	*8.9%*	*4.1%*	*-3.7%*	*-7.6%*
40% Increase Irrigated Acres	275,312	254,296	219,231	179,127	146,360	119,587
Change from Baseline	*40.0%*	*31.1%*	*14.2%*	*3.2%*	*-4.8%*	*-8.6%*

Table 7. NPCGD West Region Gross Margin ($/acre)[1] for Selected Years of the Time Horizon

Policy Scenario	Year 1	Year 10	Year 20	Year 30	Year 40	Year 50
Baseline	$318.59	$346.95	$371.24	$353.80	$286.10	$218.67
20% Increase Irrigated Acres	$346.86	$376.03	$360.80	$284.50	$187.36	$119.10
Change from Baseline	*8.9%*	*8.4%*	*-2.8%*	*-19.6%*	*-34.5%*	*-45.5%*
40% Increase Irrigated Acres	$357.92	$376.31	$335.27	$208.10	$108.28	$60.51
Change from Baseline	*12.3%*	*8.5%*	*-9.7%*	*-41.2%*	*-62.2%*	*-72.3%*

[1] The average is based on the total irrigated and dryland net revenue (at time = t) divided by total irrigated and dryland cropland acres.

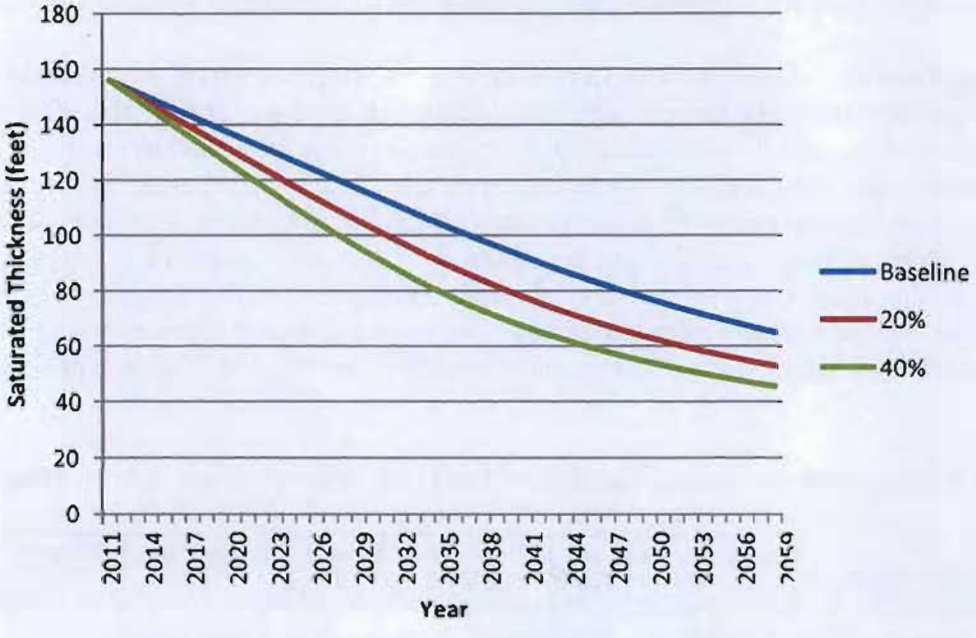

Figure 2. NPCGD West Region Weighted Average Saturated Thickness (feet)

Table 8. NPCGD West Region 50-Year Regional Economic Impacts[1]

	Direct	Indirect	Induced	Total	Change From Baseline	% Change From Baseline
Baseline						
Output[2]	$30,250	$16,764	$2,388	$49,402		
Value Added[2]	$9,827	$6,120	$1,419	$17,365		
Employment[3]	2,392	2,183	377	4,952		
20% Increase Irrigated Acres						
Output[2]	$35,160	$19,014	$2,744	$56,918	$7,515	15%
Value Added[2]	$11,904	$6,772	$1,630	$20,306	$2,941	17%
Employment[3]	2,892	2,351	435	5,679	726	15%
40% Increase Irrigated Acres						
Output[2]	$36,961	$19,853	$2,881	$59,695	$10,293	21%
Value Added[2]	$12,654	$7,003	$1,712	$21,369	$4,004	23%
Employment[3]	3,134	2,395	457	5,987	1,034	21%

[1] Impacts include both forward-linked and backward-linked effects.
[2] Millions of dollars – discounted at 3% over the 50-year time horizon.
[3] Average annual employment.

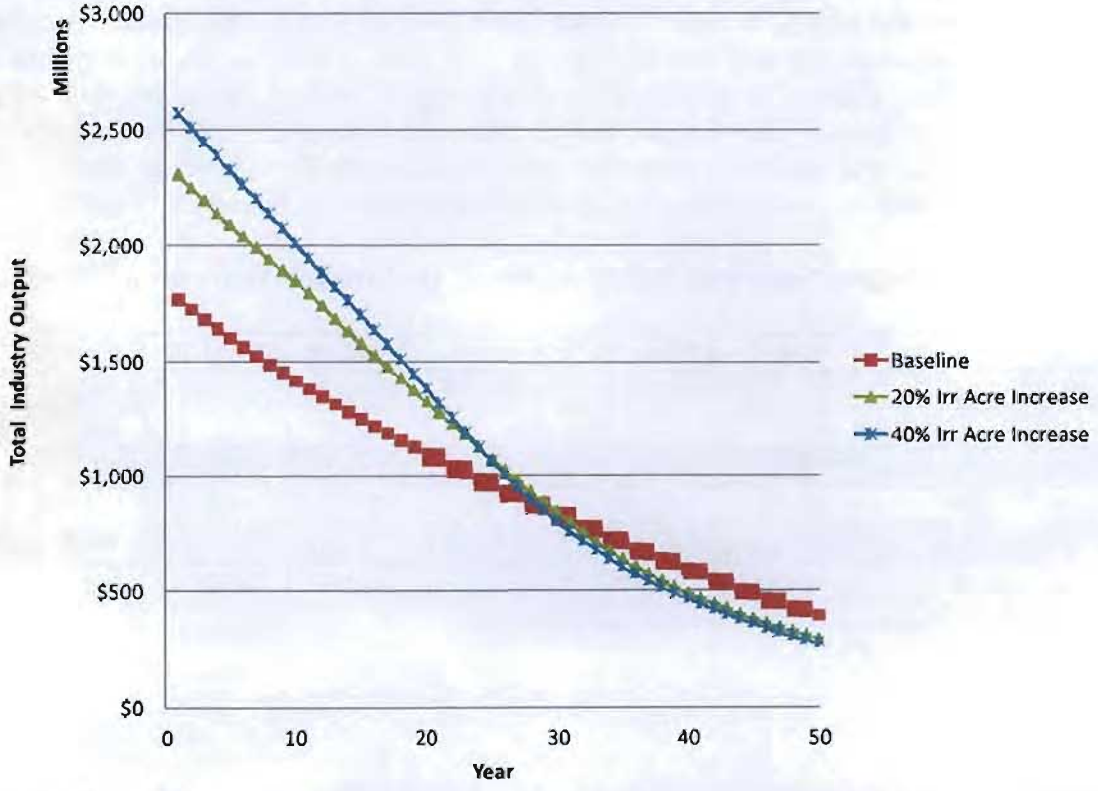

Figure 3. NPCGD West Region Total Industry Output Impacts for a 50-year Planning Horizon

Scenario II: Increased Irrigated Acres in Eastern Counties

The eastern counties within the NPGCD are relatively more dryland intensive than the western counties, with large dryland wheat and cattle operations being typical of the region. The eastern counties, having a limited amount of irrigated acreage relative to water availability, are able to sustain the shocks of increasing irrigated acreage better than the western counties. The eastern counties, unlike the western counties, gain from an economic perspective throughout the planning horizon. However, when irrigated acres are increased by 20%, the saturated thickness at the end of the planning horizon declines an additional 3.6%, Table 9 and Figure 4. This additional decline in the aquifer nearly doubles (7.7%) as initial irrigated acres are increased to 40% above the baseline. The increase of 20% and 40% in irrigated acres is able to be sustained throughout the time horizon relative to the baseline, Table 10. The revenue potential of the eastern counties is enhanced in the 20% and 40% scenarios, as the increased acreage results in higher levels of production on more acres, thus increasing the amount of average gross margin per farmland acre, Table 11. In the 20% scenario the increase in gross margin per acre is 6.3% above the baseline and almost 13% above the baseline in the 40% acreage scenario in year 50. These results indicate that increases in irrigated acreage in the eastern counties within the NPGCD only slightly decrease the overall weighted saturated thickness, but allow greater farmland returns. Detailed county results of saturated thickness, irrigated acreage, and gross margin are located in Appendix C.

Increasing irrigated acreage either 20% or 40% adds substantially to the regional economy. The 20% increase adds $2.8 billion in output and $843 million in value added over the time horizon while increasing related employment by 239 jobs, Table 12. Increasing initial irrigated acreage by 40% slightly more than doubles the impact relative to the baseline with output, value added production and annual employment increasing 22%, 23% and 21%, respectively. Temporally, the regional economy improves through the planning horizon as illustrated in Figure 5; however, gains relative to the baseline narrow significantly by year 50.

Table 9. NPCGD East Region Saturated Thickness (feet)[1] for Selected Years of the Time Horizon

Policy Scenario	Year 1	Year 10	Year 20	Year 30	Year 40	Year 50
Baseline	201.47	198.08	194.31	190.54	186.77	183.00
20% Increase Irrigated Acres	201.47	196.87	191.76	186.65	181.54	176.43
Change from Baseline	*0.0%*	*-0.6%*	*-1.3%*	*-2.0%*	*-2.8%*	*-3.6%*
40% Increase Irrigated Acres	201.47	195.48	188.82	182.16	175.50	168.84
Change from Baseline	*0.0%*	*-1.3%*	*-2.8%*	*-4.4%*	*-6.0%*	*-7.7%*

[1] Averages are weighted by the area overlying the aquifer in each county.

Table 10. NPCGD East Region Irrigated Acres for Selected Years of the Time Horizon

Policy Scenario	Year 1	Year 10	Year 20	Year 30	Year 40	Year 50
Baseline	86,945	77,672	74,908	72,650	70,805	69,297
20% Increase Irrigated Acres	104,334	93,207	89,890	87,180	84,966	83,156
Change from Baseline	*20.0%*	*20.0%*	*20.0%*	*20.0%*	*20.0%*	*20.0%*
40% Increase Irrigated Acres	121,723	109,009	105,139	101,977	99,394	97,283
Change from Baseline	*40.0%*	*40.3%*	*40.4%*	*40.4%*	*40.4%*	*40.4%*

Table 11. NPCGD East Region Gross Margin ($/acre)[1] for Selected Years of the Time Horizon

Policy Scenario	Year 1	Year 10	Year 20	Year 30	Year 40	Year 50
Baseline	$141.18	$167.35	$190.27	$208.96	$224.18	$236.58
20% Increase Irrigated Acres	$150.42	$178.28	$202.58	$222.38	$238.49	$251.58
Change from Baseline	*6.5%*	*6.5%*	*6.5%*	*6.4%*	*6.4%*	*6.3%*
40% Increase Irrigated Acres	$161.21	$190.28	$215.78	$236.53	$253.39	$267.07
Change from Baseline	*14.2%*	*13.7%*	*13.4%*	*13.2%*	*13.0%*	*12.9%*

[1] The average is based on the total irrigated and dryland net revenue (at time = t) divided by total irrigated and dryland cropland acres.

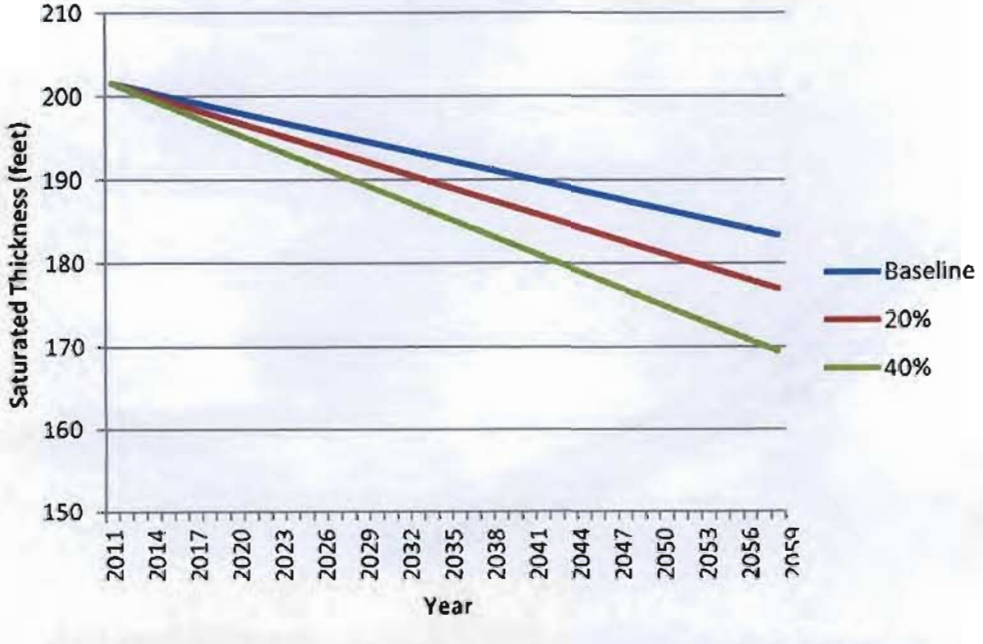

Figure 4. NPCGD East Region Weighted Average Saturated Thickness (feet)

Table 12. NPCGD East Region 50-Year Regional Economic Impacts[1]

	Direct	Indirect	Induced	Total	Change From Baseline	% Change From Baseline
Baseline						
Output[2]	$13,975	$8,138	$1,145	$23,257		
Value Added[2]	$3,952	$3,142	$680	$7,774		
Employment[3]	1,112	1,145	179	2,436		
20% Increase Irrigated Acres						
Output[2]	$15,353	$8,937	$1,261	$25,551	$2,294	10%
Value Added[2]	$4,442	$3,426	$749	$8,617	$843	11%
Employment[3]	1,229	1,248	198	2,675	239	10%
40% Increase Irrigated Acres						
Output[2]	$17,025	$9,867	$1,392	$28,285	$5,028	22%
Value Added[2]	$5,002	$3,755	$827	$9,584	$1,810	23%
Employment[3]	1,360	1,365	218	2,943	507	21%

[1] Impacts include both forward-linked and backward-linked effects.
[2] Millions of dollars – discounted at 3% over the 50-year time horizon.
[3] Average annual employment.

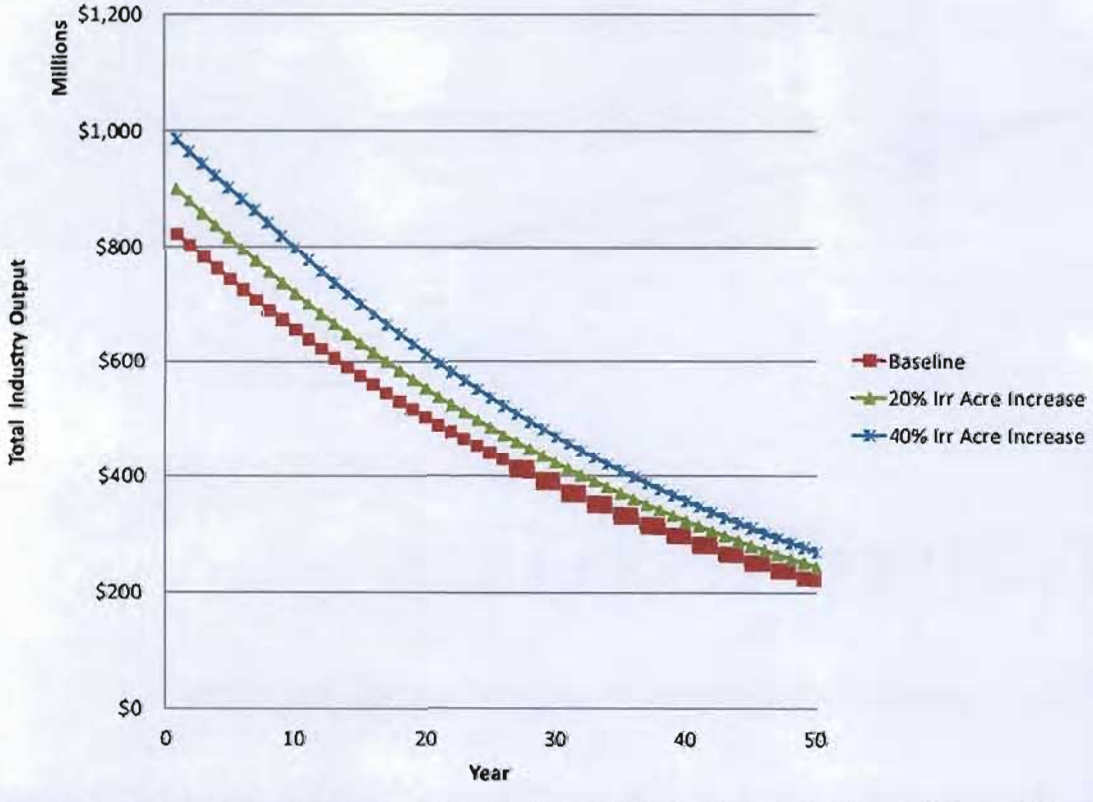

Figure 5. NPCGD East Region Total Industry Output Impacts for a 50-year Planning Horizon

Scenario III: Alternative Discount Rates

Developing policies to conserve water involves weighing short-term costs against the long-term benefits of having the water available for future generations. However, the magnitude of costs and benefits can vary widely depending on the discount rate used in the analysis. What is a *discount rate*? The value of future water consumption is discounted because the perception is that individuals obtain more satisfaction from using the resource today rather than in the future. For example, an individual would rather have a dollar to spend today than a dollar to spend next year. Thus, future values of the resource are discounted in order to make comparisons of costs and benefits at a single point in time. A dollar to spend next year would be worth only $0.97 in terms of dollars today using a discount rate of 3%.

A 3% discount rate has been utilized in the previous and current study to convert future returns to present day values. The 3% rate corresponds to a real rate of return that is commonly used in this type of analysis where social or community resources are evaluated. However, some water planners feel that this rate should be 0% or even negative suggesting the value of water saved for future use is as important as or potentially more important than current water consumption. The objective of this scenario is to illustrate how modifying the discount rate can affect the results of policy analysis. Results from the baseline scenario and Scenario I which analyzed an increase in irrigated acreage of 20% in the western counties are compared utilizing 3%, 0%, and -3% discount rates to demonstrate the implications.

Three alternative discount rates were compared to detect the differences in regional economic impacts from agricultural crop production under the baseline scenario and the 20% increase in irrigated acreage scenario, Figure 6. The typical 3% discount rate is represented by the blue lines. These results were presented previously under Scenario I in Figure 3. A 0% discount rate is represented by the red lines and the -3% discount rate is represented by the green lines. Logically, the positive discount rate of 3% reflects a belief that current consumption is preferred over future consumption. The 0% discount rate means that current and future consumption are valued equally. The -3% discount reveals that future consumption is worth more than current consumption.

The regional economic impacts under the baseline scenario are represented with solid lines while the 20% increase in irrigated acres is depicted by the dashed lines. The difference in area between these lines under each discount rate can be used to make a comparison between discount rates, especially in the latter years. Scenario I, where irrigated acreage increases 20%, has larger impacts to the economy early in the planning horizon and smaller economic impacts later in the time period when compared to the baseline under all discount rates due to aquifer depletion. In addition, the baseline scenario intersects the 20% increase in irrigated acres scenario at approximately year 30. Thus, discount rates can be compared by focusing on the area of difference between scenarios from year 30 to year 50. Under a discount rate of 3%, the two blue lines almost converge during this time period, meaning the future value of water through agricultural production to the regional economy under both scenarios is approximately the same. However, as we decrease the discount rate to 0%, the magnitude of the area difference between the red lines from year 30 to year 50 increases, indicating that when current and future consumption is valued equally, the 20% increase in irrigated acreage will have more of a

negative impact to the regional economy when compared to the baseline. With a negative discount rate of 3%, these negative impacts (area difference between the solid and dashed green lines) become even more prevalent. The largest area difference occurs under this discount rate.

The choice of which discount rate to use depends on many factors. A person's or organization's own beliefs, goals, age, and other factors can determine what discount rate they are comfortable using. Also, the nature of the resource which is being managed can also affect the discount rate. This scenario demonstrates how important the selection of a discount rate is and how different the results of policy analysis can appear under alternative rates.

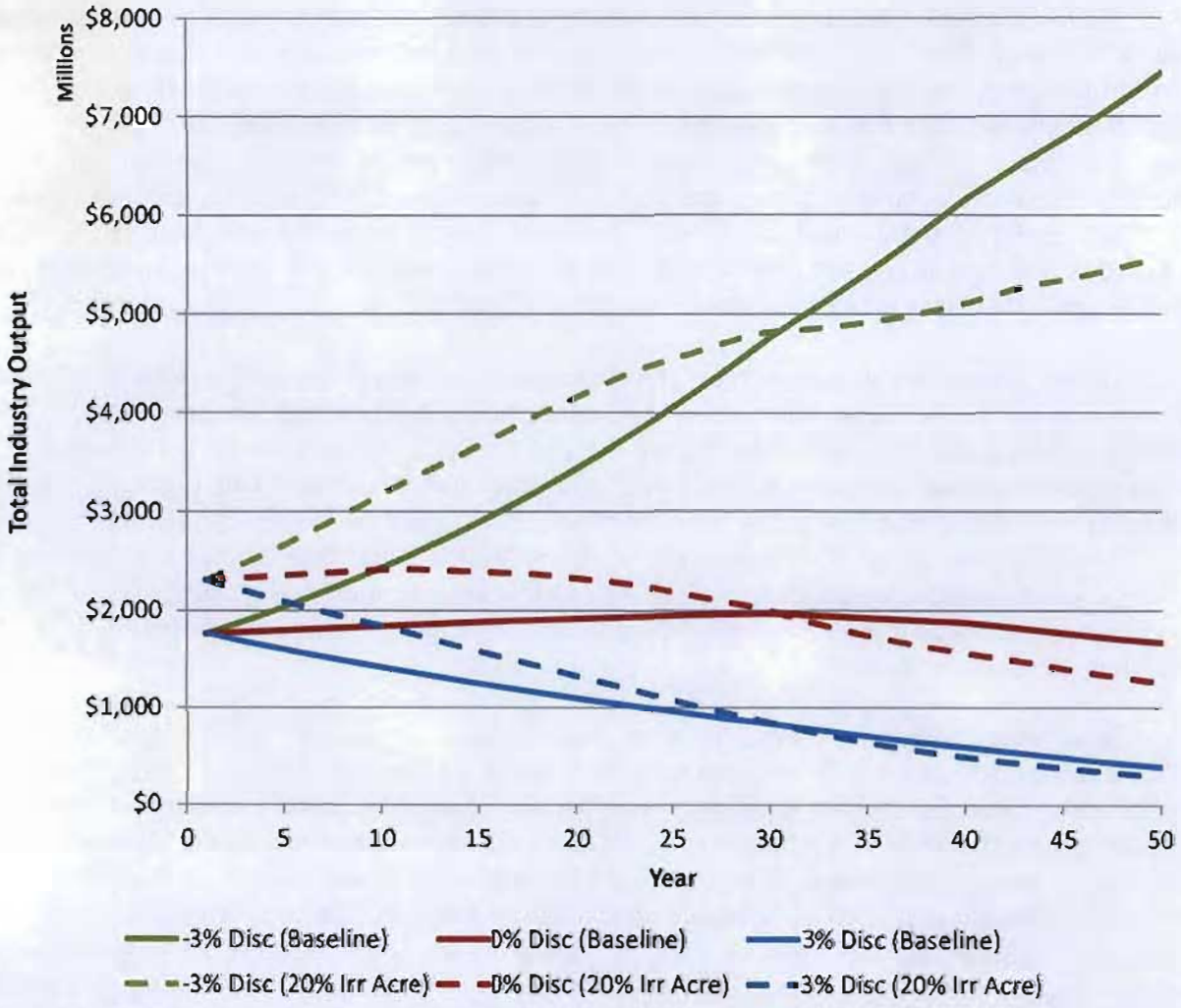

Figure 6. NPCGD West Region Total Industry Output Impacts over a 50-year Planning Horizon Utilizing Alternative Discount Rates

Summary and Conclusions

Current commodity prices in conjunction with technological advancements throughout the farm structure could allow landowners in the NPGCD to expand their current irrigated acreage. In this study, the objective was to evaluate the potential impacts to the aquifer and the regional economy from irrigated acreage increasing throughout the district. The first step in the analysis was to estimate a *status quo* baseline over a 50-year time horizon in which no water conserving policy is included, no projected changes in irrigated acreage are assumed, and producers operate in an unregulated profit maximizing manner. Then, three separate scenarios were evaluated. The first estimated the impacts of increasing irrigated acreage by 20% and 40% over the baseline values for the four western counties within the NPGCD. A second scenario evaluated the impacts of increasing irrigated acreage by 20% and 40% in the eastern four counties of the NPGCD. For these scenarios, county optimization models projected saturated thickness, irrigated acreage, and gross margin per acre over a 50-year planning horizon while the input-output model (IMPLAN) estimated the impact on the regional economy in terms of output, value added production, and employment. Finally, a third scenario was added to illustrate how the magnitude of these impacts changes with the discount rate chosen.

The baseline scenario established the *status quo* projections by which the 20% and 40% increase in irrigated acres scenarios were compared. Saturated thickness of the western counties started with an average saturated thickness of 156 feet which declined to 64 feet by year 50. As saturated thickness declined, the number of irrigated acres also decreased from a total of 196,642 irrigated acres in year one of the analysis to 130,826 by the end of the planning horizon. Gross margin also declined from $318.59 per acre year one to $218.67 by year 50. Agricultural production under the baseline in the western counties generates impacts to the NPGCD Region of $49.4 billion in output, $17.4 billion in value added, and an annual average of almost 5,000 jobs. The eastern counties of the district started with an average saturated thickness of 201 feet, 86,945 irrigated acres, and gross margin of $141.18 per acre which ended at 183 feet, 69,297 acres, and $236.58 per acre by year 50, respectively. Agricultural production under the baseline in the eastern counties generates impacts to the NPGCD Region of $23.3 billion in output, $7.8 billion in value added, and an annual average of more than 2,400 jobs.

The results of the first scenario indicate that the western counties within the NPGCD will be affected by a 20% and 40% increase in irrigated acreage. The additional burden placed upon the aquifer caused by an increase of 20% in the initial irrigated land draws down the ending saturated thickness an additional 18.7% compared to the baseline, leading to a weighted average of 52 feet by year 50 of the time horizon. The additional 12 foot drop in saturated thickness from depletion of the water resource causes a further reduction in irrigated acreage of 7.6%. Early in the planning horizon, gross margin increased, however, the rapid drawdown in water availability and decreasing irrigated acreage caused gross margin per acre to decline 45.5% by year 50. The scenario with a 40% increase in irrigated acreage magnified the outcomes. Saturated thickness dropped 30.1%, irrigated acreage declined 8.6% and gross margin per acre declined 72.3% compared to the baseline by the end of the planning horizon. Overall, these scenarios resulted in a positive impact to the region's economy over the planning horizon. Industry output and value added rose 15% and 17%, respectively, under the 20% increase scenario with annual average employment increasing 15% relative to the baseline. The 40% scenario results in industry output,

value added, and employment increasing 21%, 23%, and 21%, respectively. However, the benefits to the regional economy occur early in the time horizon. Industry output, value added, and employment are less than the baseline in the latter years of the planning horizon.

The second scenario evaluated how a 20% and 40% increase in irrigated land area would impact the eastern counties within the NPGCD. The results of this scenario are much different than Scenario I in that the eastern counties of the district can sustain and thrive from these increases and still meet the specified DFC. This is due to the smaller amount of irrigated acres (compared to the western counties) relative to the availability of underground water reserves within the four eastern counties. This region of the NPGCD does not exhibit the high rates of decline for the aquifer as observed in the western counties. The weighted average of saturated thickness for these counties only declines by an additional 3.6% and 7.7% compared to the baseline by year 50 when the irrigated land is increased 20% and 40%, respectively. The region was able to sustain the increase in irrigated acreage through the entire planning horizon at either level of irrigated acreage increase. The increase in irrigated acreage improved gross margin per acre 6.3% and 12.9% for the 20% and 40% scenarios, respectively. Additional irrigated acreage has a positive impact on the eastern region's economy. Industry output, value added, and average annual employment increase 10%, 11%, and 10% under the 20% scenario and 22%, 23%, and 21% with the 40% scenario, respectively. Overall, the results of these scenarios prove to be an economic benefit to the eastern counties of the NPGCD despite some loss in saturated thickness.

The third scenario illustrates the impact of alternative discount rates by comparing the baseline to the 20% increase in irrigated acreage scenario for the western counties utilizing discount rates of 3%, 0%, and -3%. Discounting allows the future impacts to the economy to be converted to present day dollars. The analysis within this paper, as well as previous studies, assumed a discount rate of 3%, which is typically an acceptable real rate of return on an asset. The district may want to consider an alternative rate such as 0% meaning that current and future consumption are valued equally or -3% which reflects that future consumption is worth more than current consumption. Results indicate that as the discount rate moves from 3% to -3%, the magnitude of the difference between the baseline and the 20% increase in irrigated acres scenario becomes more prevalent, especially in the latter years of the time horizon.

Given the current economic environment, there exist incentives for landowners to either convert existing dryland acres or break out new rangeland for irrigated purposes. It can be concluded from this analysis that a 20% or a 40% increase in irrigated land in the western four counties of the NPGCD will make it extremely difficult to reach the DFC. While the increase in economic activity will benefit the regional economy as a result of greater farmland returns, this will only be short lived as the aquifer will deplete at a much faster rate, causing large and rapid conversions to dryland and decreasing the profit potential of farmland acres. Conversely, the eastern four counties of the NPGCD appear to be able to sustain either a 20% or 40% increase in irrigated land and still meet the DFC. Increases in irrigated acreage in the eastern counties will increase aquifer depletion somewhat but do lead to gains in the region's economy. It should be noted that any increase in irrigated acreage should to be closely monitored because of potential impact regardless of where it occurs in the NPGCD. The discount rate used in any analysis affects the results and the board needs to evaluate the appropriate rate to be used for the NPGCD considering the organization's own beliefs and goals.

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Appendix A:

Estimated Saturated Thickness, Irrigated Acreage, and Gross Margin for the Baseline Scenario by County and Year

SATURATED THICKNESS (FEET)								
Year	Dallam	Hartley	Moore	Sherman	Hansford	Hutchinson	Lipscomb	Ochiltree
2010	147.0	145.0	167.00	173.0	189.0	154.0	215.0	214.0
2011	144.8	142.5	165.25	171.0	188.3	153.2	214.8	213.8
2012	142.6	140.1	163.50	169.0	187.6	152.4	214.7	213.7
2013	140.4	137.6	161.74	167.0	186.9	151.6	214.5	213.5
2014	138.2	135.2	159.99	164.9	186.3	150.8	214.4	213.3
2015	136.0	132.7	158.24	162.9	185.6	150.0	214.2	213.2
2016	133.9	130.3	156.49	160.9	184.9	149.2	214.1	213.0
2017	131.7	127.8	154.73	158.9	184.2	148.4	213.9	212.8
2018	129.5	125.4	152.98	156.9	183.5	147.6	213.8	212.7
2019	127.3	122.9	151.23	154.9	182.8	146.8	213.6	212.5
2020	125.1	120.5	149.48	152.9	182.1	146.0	213.4	212.3
2021	122.9	118.0	147.73	150.8	181.4	145.2	213.3	212.1
2022	120.7	115.6	145.97	148.8	180.8	144.4	213.1	212.0
2023	118.5	113.1	144.22	146.8	180.1	143.6	213.0	211.8
2024	116.3	110.7	142.47	144.8	179.4	142.8	212.8	211.6
2025	114.1	108.2	140.72	142.8	178.7	142.0	212.7	211.5
2026	111.9	105.8	138.97	140.8	178.0	141.2	212.5	211.3
2027	109.7	103.3	137.21	138.7	177.3	140.4	212.4	211.1
2028	107.6	100.9	135.46	136.7	176.6	139.6	212.2	211.0
2029	105.4	98.4	133.71	134.7	175.9	138.8	212.0	210.8
2030	103.2	96.0	131.96	132.7	175.3	138.0	211.9	210.6
2031	101.0	93.5	130.20	130.7	174.6	137.2	211.7	210.5
2032	98.8	91.1	128.45	128.7	173.9	136.4	211.6	210.3
2033	96.6	88.7	126.70	126.7	173.2	135.6	211.4	210.1
2034	94.4	86.5	124.95	124.6	172.5	134.8	211.3	210.0
2035	92.2	84.4	123.20	122.6	171.8	134.0	211.1	209.8
2036	90.0	82.4	121.44	120.6	171.1	133.2	211.0	209.6
2037	87.8	80.5	119.69	118.6	170.4	132.4	210.8	209.5
2038	85.6	78.7	117.94	116.6	169.8	131.6	210.7	209.3
2039	83.4	76.9	116.19	114.6	169.1	130.8	210.5	209.1
2040	81.3	75.3	114.43	112.6	168.4	130.0	210.3	208.9
2041	79.1	73.7	112.68	110.5	167.7	129.2	210.2	208.8
2042	77.1	72.1	110.93	108.5	167.0	128.4	210.0	208.6
2043	75.2	70.7	109.18	106.5	166.3	127.6	209.9	208.4
2044	73.4	69.3	107.43	104.5	165.6	126.8	209.7	208.3
2045	71.7	67.9	105.67	102.5	164.9	126.0	209.6	208.1
2046	70.1	66.6	103.92	100.5	164.3	125.2	209.4	207.9
2047	68.5	65.4	102.17	98.5	163.6	124.4	209.3	207.8
2048	67.0	64.2	100.42	96.4	162.9	123.6	209.1	207.6
2049	65.6	63.0	98.67	94.4	162.2	122.8	208.9	207.4
2050	64.2	61.9	96.91	92.4	161.5	122.0	208.8	207.3
2051	62.9	60.8	95.16	90.5	160.8	121.2	208.6	207.1
2052	61.6	59.8	93.41	88.6	160.1	120.4	208.5	206.9
2053	60.4	58.8	91.66	86.8	159.4	119.6	208.3	206.8
2054	59.2	57.8	89.90	85.1	158.8	118.8	208.2	206.6
2055	58.1	56.9	88.15	83.5	158.1	118.0	208.0	206.4
2056	57.0	56.0	86.40	81.9	157.4	117.2	207.9	206.3
2057	56.0	55.1	84.65	80.4	156.7	116.4	207.7	206.1
2058	55.0	54.2	82.90	78.9	156.0	115.6	207.5	205.9
2059	54.0	53.4	81.14	77.5	155.3	114.8	207.4	205.7
% at 50	36.8%	36.8%	48.6%	44.8%	82.2%	74.6%	96.5%	96.1%

IRRIGATED ACREAGE								
Year	Dallam	Hartley	Moore	Sherman	Hansford	Hutchinson	Lipscomb	Ochiltree
2010	222,563	224,576	145,043	188,144	135,347	39,364	29,449	61,507
2011	222,563	224,576	142,142	188,144	132,640	39,364	28,860	60,277
2012	222,563	224,576	139,299	188,144	129,987	39,364	28,283	59,071
2013	222,563	224,576	136,513	188,144	127,388	39,364	27,717	57,890
2014	222,563	224,576	134,493	188,144	125,218	39,364	27,163	56,732
2015	222,563	224,576	134,310	188,144	124,643	39,364	26,620	55,597
2016	222,563	224,576	134,130	188,144	124,079	39,364	26,087	54,486
2017	222,563	224,576	133,954	188,144	123,527	39,342	25,565	53,396
2018	222,563	224,576	133,782	188,144	122,985	39,226	25,313	52,328
2019	222,563	224,576	133,612	188,144	122,454	39,112	25,229	52,119
2020	222,563	224,576	133,447	188,144	121,934	39,001	25,146	51,948
2021	222,411	224,576	133,284	188,144	121,425	38,891	25,065	51,781
2022	222,238	224,576	133,125	188,144	120,925	38,784	24,986	51,617
2023	222,068	224,576	132,969	188,144	120,436	38,679	24,908	51,457
2024	221,901	224,576	132,816	188,144	119,956	38,576	24,832	51,299
2025	221,738	224,576	132,666	188,144	119,486	38,475	24,757	51,145
2026	221,578	224,576	132,519	188,144	119,025	38,376	24,684	50,994
2027	221,421	224,576	132,375	188,144	118,574	38,279	24,612	50,846
2028	221,267	223,789	132,234	188,144	118,131	38,184	24,542	50,701
2029	221,117	219,313	132,096	188,144	117,698	38,091	24,473	50,558
2030	220,969	214,927	131,961	188,144	117,273	38,000	24,406	50,419
2031	220,825	210,628	131,828	188,144	116,857	37,910	24,340	50,282
2032	219,602	206,416	131,698	188,144	116,449	37,823	24,275	50,148
2033	215,210	202,287	131,570	188,144	116,049	37,737	24,211	50,017
2034	210,906	198,242	131,445	188,144	115,657	37,652	24,149	49,889
2035	206,687	194,277	131,323	188,144	115,273	37,570	24,088	49,763
2036	202,554	190,391	131,203	188,144	114,896	37,489	24,028	49,639
2037	198,503	186,583	131,085	188,144	114,527	37,410	23,970	49,518
2038	194,533	182,852	130,970	188,144	114,166	37,332	23,912	49,399
2039	190,642	179,195	130,857	188,144	113,812	37,256	23,856	49,283
2040	186,829	175,611	130,747	188,144	113,464	37,182	23,801	49,169
2041	183,093	172,099	130,638	188,144	113,124	37,109	23,747	49,058
2042	179,431	168,657	130,532	188,144	112,791	37,037	23,694	48,948
2043	175,842	165,283	130,428	188,144	112,464	36,967	23,642	48,841
2044	172,325	161,978	130,326	188,144	112,144	36,898	23,591	48,736
2045	168,879	158,738	130,226	188,144	111,830	36,831	23,541	48,633
2046	165,501	155,563	130,127	188,144	111,522	36,765	23,492	48,532
2047	162,191	152,452	130,031	187,600	111,221	36,700	23,445	48,433
2048	158,947	149,403	129,937	183,848	110,926	36,637	23,398	48,336
2049	155,768	146,415	129,845	180,171	110,636	36,574	23,352	48,241
2050	152,653	143,487	129,755	176,568	110,352	36,513	23,307	48,148
2051	149,600	140,617	129,666	173,036	110,074	36,454	23,263	48,057
2052	146,608	137,805	129,579	169,576	109,802	36,395	23,219	47,968
2053	143,676	135,049	129,494	166,184	109,535	36,338	23,177	47,880
2054	140,802	132,348	129,411	162,861	109,273	36,282	23,135	47,794
2055	137,986	129,701	129,329	159,603	109,017	36,227	23,095	47,710
2056	135,226	127,107	129,249	156,411	108,766	36,173	23,055	47,628
2057	132,522	124,565	129,170	153,283	108,519	36,120	23,016	47,547
2058	129,872	122,073	129,093	150,217	108,278	36,068	22,977	47,468
2059	127,274	119,632	129,018	147,213	108,042	36,017	22,940	47,390

GROSS MARGIN ($/ACRE)								
Year	Dallam	Hartley	Moore	Sherman	Hansford	Hutchinson	Lipscomb	Ochiltree
2010	311.53	414.42	231.90	310.08	140.52	160.76	143.36	134.82
2011	315.12	418.07	235.89	313.11	143.79	163.68	147.04	138.29
2012	318.63	421.63	239.59	316.07	146.93	166.54	150.55	141.65
2013	322.07	425.12	243.01	318.96	149.92	169.33	153.90	144.89
2014	325.43	428.52	246.16	321.79	152.77	172.07	157.09	148.02
2015	328.72	431.85	249.19	324.56	155.55	174.75	160.12	151.04
2016	331.94	435.10	252.16	327.27	158.26	177.36	162.98	153.95
2017	335.09	438.28	255.07	329.92	160.92	179.93	165.69	156.75
2018	338.17	441.39	257.91	332.51	163.53	182.43	168.26	159.45
2019	341.18	444.43	260.70	335.05	166.08	184.89	170.77	162.06
2020	344.13	447.40	263.42	337.53	168.59	187.30	173.23	164.62
2021	347.01	450.30	266.09	339.96	171.04	189.65	175.65	167.13
2022	349.83	453.13	268.70	342.33	173.44	191.96	178.01	169.59
2023	352.59	455.90	271.26	344.65	175.79	194.23	180.32	172.00
2024	355.28	458.60	273.76	346.92	178.10	196.44	182.59	174.36
2025	357.92	461.24	276.21	349.14	180.35	198.61	184.82	176.68
2026	360.50	463.82	278.61	351.31	182.57	200.74	186.99	178.95
2027	363.03	466.35	280.96	353.43	184.73	202.82	189.13	181.17
2028	365.50	468.30	283.26	355.50	186.86	204.86	191.22	183.35
2029	367.91	467.49	285.50	357.53	188.94	206.86	193.27	185.48
2030	370.27	466.16	287.70	359.51	190.98	208.82	195.28	187.57
2031	372.58	464.33	289.86	361.45	192.97	210.74	197.25	189.62
2032	374.83	445.80	291.97	363.34	194.93	212.61	199.18	191.63
2033	376.78	426.30	294.03	365.20	196.84	214.45	201.07	193.60
2034	378.35	407.22	296.05	367.01	198.72	216.26	202.92	195.53
2035	379.54	388.68	298.02	368.77	200.56	218.02	204.73	197.42
2036	380.34	370.77	299.95	370.50	202.36	219.75	206.51	199.27
2037	380.76	353.54	301.85	372.19	204.13	221.44	208.26	201.08
2038	380.80	337.05	303.70	373.84	205.86	223.10	209.96	202.86
2039	380.45	321.29	305.51	375.46	207.55	224.73	211.64	204.61
2040	368.21	306.28	307.28	377.03	209.21	226.32	213.28	206.31
2041	351.20	292.01	309.01	378.57	210.83	227.87	214.88	207.99
2042	334.72	278.48	310.71	380.08	212.42	229.40	216.46	209.63
2043	318.85	265.65	312.36	381.55	213.98	230.89	218.00	211.24
2044	303.63	253.51	313.99	382.98	215.51	232.36	219.51	212.81
2045	289.10	242.03	315.57	384.39	217.01	233.79	220.99	214.35
2046	275.27	231.19	317.13	385.76	218.47	235.20	222.45	215.87
2047	262.13	220.95	318.64	387.01	219.91	236.57	223.87	217.35
2048	249.67	211.29	320.13	387.56	221.31	237.92	225.26	218.80
2049	237.89	202.18	321.58	387.73	222.69	239.24	226.63	220.22
2050	226.75	193.60	323.00	375.03	224.04	240.53	227.97	221.62
2051	216.23	185.51	324.39	360.86	225.36	241.79	229.28	222.99
2052	206.32	177.90	325.75	347.23	226.65	243.03	230.56	224.33
2053	196.97	170.74	327.08	334.17	227.92	244.24	231.82	225.64
2054	188.16	164.00	328.38	321.66	229.16	245.43	233.06	226.92
2055	179.88	157.66	329.65	309.70	230.38	246.59	234.27	228.18
2056	172.08	151.69	330.89	298.29	231.57	247.73	235.45	229.42
2057	164.76	146.07	332.10	287.42	232.74	248.84	236.61	230.63
2058	157.88	140.79	333.29	277.06	233.88	249.94	237.75	231.82
2059	151.41	135.81	334.45	267.21	235.00	251.00	238.86	232.98

Appendix B:

Estimated Saturated Thickness, Irrigated Acreage, and Gross Margin for the 20% Increase in Irrigated Acreage Scenario by County and Year

SATURATED THICKNESS (FEET)								
Year	Dallam	Hartley	Moore	Sherman	Hansford	Hutchinson	Lipscomb	Ochiltree
2010	147.0	145.0	167.00	173.0	189.0	154.0	215.0	214.0
2011	144.2	141.7	164.68	170.4	188.1	152.9	214.8	213.8
2012	141.3	138.3	162.37	167.7	187.1	151.8	214.6	213.5
2013	138.5	135.0	160.05	165.1	186.2	150.8	214.4	213.3
2014	135.7	131.7	157.73	162.5	185.3	149.7	214.2	213.1
2015	132.9	128.4	155.42	159.9	184.4	148.6	214.0	212.8
2016	130.0	125.0	153.10	157.2	183.4	147.5	213.7	212.6
2017	127.2	121.7	150.79	154.6	182.5	146.4	213.5	212.4
2018	124.4	118.4	148.47	152.0	181.6	145.4	213.3	212.1
2019	121.6	115.1	146.15	149.4	180.6	144.3	213.1	211.9
2020	118.7	111.7	143.84	146.7	179.7	143.2	212.9	211.7
2021	115.9	108.4	141.52	144.1	178.8	142.1	212.7	211.4
2022	113.1	105.1	139.20	141.5	177.9	141.0	212.5	211.2
2023	110.3	102.0	136.89	138.9	176.9	139.9	212.3	210.9
2024	107.4	98.9	134.57	136.2	176.0	138.9	212.1	210.7
2025	104.6	95.9	132.26	133.6	175.1	137.8	211.9	210.5
2026	101.8	92.9	129.94	131.0	174.1	136.7	211.7	210.2
2027	98.9	90.1	127.62	128.3	173.2	135.6	211.4	210.0
2028	96.1	87.4	125.31	125.7	172.3	134.5	211.2	209.8
2029	93.3	84.8	122.99	123.1	171.4	133.5	211.0	209.5
2030	90.5	82.4	120.67	120.5	170.4	132.4	210.8	209.3
2031	87.6	80.1	118.36	117.8	169.5	131.3	210.6	209.1
2032	84.8	77.9	116.04	115.2	168.6	130.2	210.4	208.8
2033	82.1	75.9	113.73	112.6	167.6	129.1	210.2	208.6
2034	79.5	73.9	111.41	110.0	166.7	128.1	210.0	208.4
2035	77.1	72.1	109.09	107.3	165.8	127.0	209.8	208.1
2036	74.8	70.3	106.78	104.7	164.9	125.9	209.6	207.9
2037	72.6	68.6	104.46	102.1	163.9	124.8	209.4	207.7
2038	70.6	67.1	102.14	99.4	163.0	123.7	209.2	207.4
2039	68.7	65.5	99.83	96.8	162.1	122.6	208.9	207.2
2040	66.9	64.1	97.51	94.3	161.1	121.6	208.7	207.0
2041	65.2	62.7	95.20	91.8	160.2	120.5	208.5	206.7
2042	63.5	61.4	92.88	89.5	159.3	119.4	208.3	206.5
2043	62.0	60.1	90.56	87.4	158.4	118.3	208.1	206.3
2044	60.5	58.9	88.25	85.3	157.4	117.2	207.9	206.0
2045	59.1	57.7	85.93	83.3	156.5	116.2	207.7	205.8
2046	57.8	56.6	83.61	81.4	155.6	115.1	207.5	205.6
2047	56.5	55.5	81.31	79.6	154.6	114.0	207.3	205.3
2048	55.3	54.5	79.14	77.9	153.7	112.9	207.1	205.1
2049	54.1	53.5	77.08	76.2	152.8	111.8	206.9	204.8
2050	53.0	52.5	75.12	74.6	151.9	110.8	206.6	204.6
2051	51.9	51.6	73.27	73.1	150.9	109.7	206.4	204.4
2052	50.9	50.7	71.50	71.7	150.0	108.6	206.2	204.1
2053	49.9	49.8	69.82	70.3	149.1	107.5	206.0	203.9
2054	48.9	49.0	68.22	68.9	148.2	106.4	205.8	203.7
2055	48.0	48.2	66.69	67.6	147.2	105.3	205.6	203.4
2056	47.1	47.4	65.23	66.4	146.3	104.3	205.4	203.2
2057	46.3	46.6	63.83	65.2	145.4	103.2	205.2	203.0
2058	45.5	45.9	62.49	64.0	144.4	102.1	205.0	202.7
2059	44.7	45.2	61.21	62.9	143.5	101.0	204.8	202.5
% at 50	30.4%	31.2%	36.7%	36.4%	75.9%	65.6%	95.2%	94.6%

IRRIGATED ACREAGE								
Year	Dallam	Hartley	Moore	Sherman	Hansford	Hutchinson	Lipscomb	Ochiltree
2010	267,076	269,492	174,099	225,773	162,416	47,236	35,339	73,809
2011	267,076	269,492	170,617	225,773	159,168	47,236	34,632	72,333
2012	267,076	269,492	167,205	225,773	155,984	47,236	33,940	70,886
2013	267,076	269,492	163,861	225,773	152,865	47,236	33,261	69,468
2014	267,076	269,492	161,395	225,773	150,262	47,236	32,596	68,079
2015	267,076	269,492	161,175	225,773	149,571	47,236	31,944	66,717
2016	267,076	269,492	160,959	225,773	148,895	47,236	31,305	65,383
2017	267,076	269,492	160,748	225,773	148,232	47,211	30,679	64,075
2018	267,076	269,492	160,541	225,773	147,582	47,071	30,375	62,794
2019	267,076	269,492	160,338	225,773	146,945	46,935	30,274	62,543
2020	267,076	264,102	160,139	225,773	146,321	46,801	30,175	62,338
2021	265,383	258,820	159,944	225,773	145,709	46,669	30,078	62,137
2022	260,075	253,644	159,753	225,773	145,110	46,541	29,983	61,941
2023	254,873	248,571	159,565	225,773	144,523	46,414	29,890	61,748
2024	249,776	243,599	159,382	225,773	143,947	46,291	29,798	61,559
2025	244,780	238,727	159,202	225,773	143,383	46,170	29,709	61,374
2026	239,885	233,953	159,026	225,773	142,830	46,051	29,621	61,193
2027	235,087	229,274	158,853	225,773	142,289	45,935	29,535	61,015
2028	230,385	224,688	158,684	225,773	141,758	45,821	29,451	60,841
2029	225,778	220,195	158,518	225,773	141,237	45,709	29,368	60,670
2030	221,262	215,791	158,355	225,773	140,727	45,599	29,287	60,503
2031	216,837	211,475	158,196	225,773	140,228	45,492	29,208	60,339
2032	212,500	207,245	158,040	225,773	139,738	45,387	29,130	60,178
2033	208,250	203,100	157,887	224,261	139,258	45,284	29,054	60,020
2034	204,085	199,038	157,737	219,776	138,788	45,183	28,979	59,866
2035	200,003	195,058	157,590	215,381	138,327	45,084	28,906	59,715
2036	196,003	191,157	157,446	211,073	137,875	44,987	28,834	59,567
2037	192,083	187,333	157,305	206,851	137,433	44,892	28,764	59,421
2038	188,242	183,587	157,166	202,714	136,999	44,799	28,695	59,279
2039	184,477	179,915	157,031	198,660	136,574	44,707	28,627	59,140
2040	180,787	176,317	155,840	194,687	136,157	44,618	28,561	59,003
2041	177,172	172,790	152,723	190,793	135,749	44,530	28,496	58,869
2042	173,628	169,335	149,668	186,977	135,349	44,444	28,433	58,738
2043	170,156	165,948	146,675	183,238	134,957	44,360	28,370	58,609
2044	166,752	162,629	143,742	179,573	134,572	44,278	28,309	58,483
2045	163,417	159,376	140,867	175,982	134,196	44,197	28,250	58,359
2046	160,149	156,189	138,049	172,462	133,827	44,118	28,191	58,238
2047	156,946	153,065	135,288	169,013	133,465	44,040	28,134	58,120
2048	153,807	150,004	132,583	165,632	133,110	43,964	28,077	58,003
2049	150,731	147,004	129,931	162,320	132,763	43,889	28,022	57,889
2050	147,716	144,064	127,332	159,073	132,423	43,816	27,968	57,778
2051	144,762	141,182	124,786	155,892	132,089	43,744	27,915	57,668
2052	141,867	138,359	122,290	152,774	131,762	43,674	27,863	57,561
2053	139,029	135,591	119,844	149,719	131,442	43,605	27,812	57,456
2054	136,249	132,880	117,447	146,724	131,128	43,538	27,762	57,353
2055	133,524	130,222	115,098	143,790	130,820	43,472	27,714	57,252
2056	130,853	127,618	112,796	140,914	130,519	43,407	27,666	57,153
2057	128,236	125,065	110,540	138,096	130,223	43,344	27,619	57,056
2058	125,672	122,564	108,330	135,334	129,933	43,282	27,573	56,961
2059	123,158	120,113	106,163	132,627	129,650	43,221	27,528	56,868

GROSS MARGIN ($/ACRE)								
Year	Dallam	Hartley	Moore	Sherman	Hansford	Hutchinson	Lipscomb	Ochiltree
2010	333.13	464.76	250.23	332.75	150.98	176.04	152.39	140.69
2011	336.87	468.37	254.41	335.95	154.50	179.16	156.45	144.35
2012	340.52	471.89	258.29	339.08	157.86	182.21	160.33	147.88
2013	344.10	475.32	261.87	342.13	161.07	185.20	164.03	151.29
2014	347.59	478.67	265.15	345.12	164.13	188.11	167.54	154.58
2015	351.01	481.95	268.30	348.05	167.10	190.97	170.88	157.74
2016	354.35	485.14	271.38	350.90	170.00	193.76	174.03	160.79
2017	357.62	488.25	274.39	353.70	172.85	196.49	177.01	163.71
2018	360.81	491.29	277.34	356.43	175.64	199.16	179.84	166.52
2019	363.93	494.25	280.23	359.10	178.37	201.78	182.60	169.24
2020	366.99	492.47	283.05	361.71	181.05	204.34	185.31	171.91
2021	369.96	484.08	285.82	364.26	183.67	206.85	187.96	174.52
2022	372.61	472.23	288.52	366.75	186.24	209.31	190.55	177.08
2023	374.86	460.55	291.17	369.19	188.75	211.72	193.10	179.59
2024	376.72	449.02	293.76	371.57	191.22	214.08	195.59	182.04
2025	378.18	437.65	296.29	373.90	193.63	216.39	198.04	184.45
2026	379.24	426.42	298.77	376.17	196.00	218.65	200.43	186.81
2027	379.91	413.43	301.19	378.39	198.31	220.87	202.78	189.12
2028	380.18	390.49	303.56	380.56	200.58	223.04	205.08	191.39
2029	380.05	368.04	305.88	382.68	202.80	225.17	207.33	193.61
2030	379.53	346.31	308.15	384.75	204.98	227.25	209.54	195.79
2031	378.53	325.44	310.37	386.77	207.11	229.29	211.70	197.92
2032	369.13	305.52	312.54	388.75	209.20	231.28	213.82	200.01
2033	350.51	286.60	314.66	390.41	211.25	233.24	215.90	202.06
2034	330.49	268.70	316.74	391.25	213.25	235.15	217.94	204.06
2035	311.00	251.82	318.77	391.70	215.21	237.03	219.93	206.03
2036	292.24	235.93	320.76	391.76	217.14	238.86	221.89	207.96
2037	274.30	221.02	322.70	391.43	219.02	240.66	223.80	209.85
2038	257.26	207.03	324.60	390.71	220.86	242.42	225.68	211.70
2039	241.14	193.92	326.45	381.70	222.67	244.14	227.52	213.51
2040	225.95	181.65	328.25	364.71	224.44	245.83	229.32	215.29
2041	211.67	170.19	329.78	348.16	226.17	247.48	231.08	217.03
2042	198.29	159.49	330.99	332.15	227.87	249.10	232.81	218.73
2043	185.76	149.51	331.88	316.75	229.53	250.69	234.51	220.40
2044	174.04	140.19	332.44	302.00	231.16	252.24	236.17	222.04
2045	163.11	131.46	332.69	287.93	232.75	253.76	237.80	223.65
2046	152.91	123.30	331.15	274.53	234.31	255.24	239.39	225.22
2047	143.41	115.68	319.15	261.81	235.84	256.70	240.96	226.76
2048	134.57	108.58	307.33	249.75	237.34	258.12	242.49	228.27
2049	126.35	101.96	295.81	238.34	238.80	259.52	243.99	229.75
2050	118.68	95.81	284.67	227.56	240.24	260.88	245.46	231.20
2051	111.52	90.09	273.97	217.38	241.64	262.22	246.90	232.62
2052	104.83	84.78	263.75	207.78	243.02	263.53	248.31	234.02
2053	98.60	79.85	254.01	198.72	244.37	264.81	249.69	235.38
2054	92.80	75.29	244.77	190.19	245.69	266.07	251.05	236.72
2055	87.41	71.07	236.02	182.15	246.98	267.29	252.37	238.03
2056	82.41	67.18	227.76	174.59	248.25	268.49	253.67	239.31
2057	77.76	63.58	219.97	167.48	249.49	269.67	254.95	240.57
2058	73.46	60.27	212.65	160.80	250.70	270.82	256.20	241.80
2059	69.48	57.23	205.77	154.52	251.89	271.95	257.42	243.01

Appendix C:

Estimated Saturated Thickness, Irrigated Acreage, and Gross Margin for the 40% Increase in Irrigated Acreage Scenario by County and Year

SATURATED THICKNESS (FEET)								
Year	Dallam	Hartley	Moore	Sherman	Hansford	Hutchinson	Lipscomb	Ochiltree
2010	147.0	145.0	167.00	173.0	189.0	154.0	215.0	214.0
2011	143.5	141.2	164.09	169.7	187.8	152.6	214.7	213.7
2012	140.0	137.3	161.17	166.5	186.6	151.2	214.4	213.4
2013	136.5	133.5	158.26	163.2	185.4	149.8	214.1	213.1
2014	133.1	129.7	155.35	159.9	184.2	148.5	213.8	212.8
2015	129.6	125.8	152.43	156.7	183.1	147.1	213.5	212.5
2016	126.1	122.0	149.52	153.4	181.9	145.7	213.2	212.1
2017	122.6	118.2	146.61	150.1	180.7	144.3	212.9	211.8
2018	119.1	114.3	143.69	146.9	179.5	142.9	212.6	211.5
2019	115.6	110.6	140.78	143.6	178.3	141.5	212.3	211.2
2020	112.2	107.0	137.87	140.3	177.1	140.1	212.1	210.9
2021	108.7	103.4	134.95	137.1	175.9	138.7	211.8	210.6
2022	105.2	100.0	132.04	133.8	174.7	137.4	211.5	210.3
2023	101.7	96.6	129.13	130.5	173.5	136.0	211.2	210.0
2024	98.2	93.4	126.21	127.3	172.3	134.6	210.9	209.7
2025	94.8	90.3	123.30	124.0	171.2	133.2	210.6	209.4
2026	91.4	87.2	120.39	120.7	170.0	131.8	210.3	209.1
2027	88.2	84.3	117.47	117.5	168.8	130.4	210.0	208.7
2028	85.1	81.5	114.56	114.2	167.6	129.0	209.7	208.4
2029	82.0	78.8	111.64	110.9	166.4	127.6	209.4	208.1
2030	79.1	76.4	108.73	107.7	165.2	126.3	209.1	207.8
2031	76.3	74.1	105.82	104.4	164.0	124.9	208.8	207.5
2032	73.7	71.9	102.90	101.1	162.8	123.5	208.5	207.2
2033	71.3	69.9	99.99	98.0	161.6	122.1	208.2	206.9
2034	69.0	68.0	97.08	94.9	160.4	120.7	207.9	206.6
2035	66.9	66.2	94.16	92.0	159.3	119.3	207.6	206.3
2036	64.9	64.4	91.25	89.3	158.1	117.9	207.3	206.0
2037	63.0	62.8	88.34	86.8	156.9	116.5	207.0	205.6
2038	61.2	61.2	85.48	84.4	155.7	115.2	206.7	205.3
2039	59.5	59.8	82.69	82.1	154.5	113.8	206.4	205.0
2040	57.9	58.4	80.07	80.0	153.3	112.4	206.2	204.7
2041	56.4	57.0	77.61	78.0	152.1	111.0	205.9	204.4
2042	55.0	55.7	75.30	76.0	150.9	109.6	205.6	204.1
2043	53.7	54.5	73.12	74.2	149.7	108.2	205.3	203.8
2044	52.4	53.4	71.07	72.4	148.5	106.8	205.0	203.5
2045	51.1	52.2	69.13	70.8	147.4	105.5	204.7	203.2
2046	50.0	51.2	67.30	69.2	146.2	104.1	204.4	202.9
2047	48.9	50.1	65.56	67.7	145.0	102.7	204.1	202.6
2048	47.8	49.1	63.91	66.2	143.8	101.3	203.8	202.2
2049	46.8	48.2	62.35	64.8	42.6	99.9	203.5	201.9
2050	45.8	47.3	60.86	63.5	141.4	98.5	203.2	201.6
2051	44.9	46.4	59.44	62.2	140.2	97.1	202.9	201.3
2052	44.0	45.6	58.08	61.0	139.0	95.7	202.6	201.0
2053	43.1	44.7	56.79	59.8	137.8	94.4	202.3	200.7
2054	42.3	44.0	55.56	58.7	136.6	93.0	202.0	200.4
2055	41.5	43.2	54.37	57.6	135.5	91.6	201.7	200.1
2056	40.7	42.5	53.24	56.5	134.3	90.2	201.4	199.8
2057	40.0	41.8	52.16	55.5	133.1	88.8	201.1	199.5
2058	39.3	41.1	51.11	54.5	131.9	87.4	200.8	199.2
2059	38.6	40.4	50.11	53.6	130.7	86.0	200.5	198.8
% at 50	26.2%	27.9%	30.0%	31.0%	69.2%	55.9%	93.3%	92.9%

IRRIGATED ACREAGE								
Year	Dallam	Hartley	Moore	Sherman	Hansford	Hutchinson	Lipscomb	Ochiltree
2010	311,589	314,407	203,116	263,402	189,485	55,109	41,228	86,110
2011	311,589	314,407	199,054	263,402	185,695	55,109	40,403	84,388
2012	311,589	314,407	195,073	263,402	181,981	55,109	39,595	82,700
2013	311,589	314,407	191,171	263,402	178,342	55,109	39,178	81,046
2014	308,504	309,876	188,294	263,402	175,305	55,109	39,047	79,425
2015	302,333	303,679	188,037	263,402	174,500	55,109	38,920	77,837
2016	296,287	297,605	187,786	263,402	173,710	55,109	38,794	76,280
2017	290,361	291,653	187,539	263,402	172,937	55,079	38,671	74,754
2018	284,554	285,820	187,297	263,402	172,179	54,917	38,551	73,259
2019	278,863	280,104	187,060	263,402	171,436	54,757	38,433	72,967
2020	273,285	274,502	186,828	263,402	170,708	54,601	38,317	72,728
2021	267,820	269,012	186,601	263,402	169,994	54,447	38,204	72,494
2022	262,463	263,631	186,378	263,402	169,295	54,297	38,093	72,264
2023	257,214	258,359	186,159	263,402	168,610	54,150	37,984	72,040
2024	252,070	253,192	185,945	261,495	167,938	54,006	37,878	71,819
2025	247,028	248,128	185,735	256,265	167,280	53,865	37,773	71,603
2026	242,088	243,165	185,530	251,139	166,635	53,726	37,671	71,392
2027	237,246	238,302	185,328	246,117	166,003	53,590	37,570	71,184
2028	232,501	233,536	183,182	241,194	165,384	53,457	37,472	70,981
2029	227,851	228,865	179,519	236,370	164,777	53,327	37,375	70,782
2030	223,294	224,288	175,928	231,643	164,182	53,199	37,281	70,587
2031	218,828	219,802	172,410	227,010	163,599	53,074	37,188	70,395
2032	214,452	215,406	168,961	222,470	163,028	52,951	37,098	70,208
2033	210,163	211,098	165,582	218,020	162,468	52,831	37,009	70,024
2034	205,959	206,876	162,271	213,660	161,919	52,713	36,922	69,844
2035	201,840	202,738	159,025	209,387	161,381	52,598	36,836	69,668
2036	197,803	198,684	155,845	205,199	160,854	52,485	36,753	69,495
2037	193,847	194,710	152,728	201,095	160,338	52,374	36,671	69,325
2038	189,970	190,816	149,673	197,073	159,832	52,265	36,590	69,159
2039	186,171	186,999	146,680	193,132	159,336	52,159	36,511	68,997
2040	182,448	183,259	143,746	189,269	158,850	52,054	36,434	68,837
2041	178,799	179,594	140,871	185,484	158,373	51,952	36,359	68,681
2042	175,223	176,002	138,054	181,774	157,907	51,852	36,284	68,528
2043	171,718	172,482	135,293	178,139	157,449	51,754	36,212	68,378
2044	168,284	169,033	132,587	174,576	157,001	51,657	36,141	68,230
2045	164,918	165,652	129,935	171,084	156,561	51,563	36,071	68,086
2046	161,620	162,339	127,336	167,663	156,131	51,471	36,002	67,945
2047	158,387	159,092	124,790	164,309	155,709	51,380	35,935	67,807
2048	155,220	155,910	122,294	161,023	155,295	51,291	35,870	67,671
2049	152,115	152,792	119,848	157,803	154,890	51,204	35,805	67,538
2050	149,073	149,736	117,451	154,647	154,493	51,119	35,742	67,408
2051	146,091	146,742	115,102	151,554	154,104	51,035	35,680	67,280
2052	143,170	143,807	112,800	148,523	153,722	50,953	35,620	67,155
2053	140,306	140,931	110,544	145,552	153,349	50,873	35,561	67,032
2054	137,500	138,112	108,333	142,641	152,982	50,794	35,502	66,912
2055	134,750	135,350	106,166	139,788	152,623	50,717	35,445	66,794
2056	132,055	132,643	104,043	136,993	152,272	50,642	35,390	66,679
2057	129,414	129,990	101,962	134,253	151,927	50,568	35,335	66,566
2058	126,826	127,390	99,923	131,568	151,589	50,495	35,281	66,455
2059	124,289	124,842	97,925	128,936	151,258	50,424	35,229	66,346

GROSS MARGIN ($/ACRE)								
Year	Dallam	Hartley	Moore	Sherman	Hansford	Hutchinson	Lipscomb	Ochiltree
2010	350.65	456.83	265.82	351.50	160.23	189.56	189.46	146.18
2011	354.48	460.66	270.16	354.82	163.97	192.85	193.24	150.01
2012	358.22	464.40	274.16	358.06	167.53	196.06	196.80	153.71
2013	361.88	468.05	277.85	361.22	170.93	199.20	200.18	157.28
2014	365.36	469.42	281.21	364.32	174.16	202.27	203.47	160.71
2015	368.43	469.45	284.44	367.34	177.29	205.28	206.69	164.01
2016	371.08	468.94	287.60	370.30	180.36	208.22	209.86	167.18
2017	373.32	467.87	290.68	373.18	183.37	211.09	212.95	170.22
2018	375.15	458.51	293.70	376.00	186.31	213.90	215.99	173.14
2019	376.58	446.61	296.66	378.76	189.20	216.65	218.96	175.95
2020	377.59	434.86	299.55	381.45	192.02	219.35	221.88	178.72
2021	378.20	423.26	302.37	384.08	194.79	221.98	224.73	181.42
2022	378.41	411.80	305.14	386.65	197.50	224.57	227.53	184.07
2023	378.20	400.47	307.84	389.15	200.15	227.10	230.27	186.67
2024	373.38	389.26	310.48	391.24	202.75	229.58	232.96	189.22
2025	363.42	378.16	313.06	392.40	205.30	232.00	235.59	191.71
2026	353.57	367.16	315.59	393.15	207.79	234.38	238.17	194.16
2027	343.83	347.73	318.06	393.51	210.23	236.71	240.70	196.55
2028	334.18	323.23	320.43	393.46	212.63	238.99	243.18	198.90
2029	324.62	299.69	322.49	393.01	214.97	241.22	245.60	201.20
2030	308.99	277.27	324.22	392.16	217.26	243.40	247.98	203.46
2031	286.68	256.06	325.62	390.90	219.51	245.54	250.31	205.67
2032	265.24	236.11	326.68	382.48	221.71	247.63	252.59	207.83
2033	244.87	217.42	327.41	369.35	223.86	249.68	254.83	209.95
2034	225.66	199.97	327.81	349.96	225.97	251.69	257.02	212.03
2035	207.64	183.69	327.88	330.94	228.04	253.65	259.17	214.07
2036	190.82	168.53	327.61	312.50	230.07	255.57	261.27	216.06
2037	175.17	154.46	323.64	294.76	232.05	257.45	263.33	218.02
2038	160.64	141.41	318.04	277.82	233.99	259.30	265.35	219.94
2039	147.17	129.31	306.35	261.72	235.89	261.10	267.33	221.81
2040	134.71	118.05	293.05	246.48	237.75	262.87	269.27	223.65
2041	123.21	107.57	279.93	232.11	239.57	264.60	271.17	225.46
2042	112.60	97.83	267.18	218.58	241.36	266.29	273.03	227.22
2043	102.82	88.79	254.92	205.88	243.10	267.94	274.85	228.95
2044	93.73	80.43	243.21	193.98	244.81	269.56	276.64	230.65
2045	85.30	72.70	232.10	182.81	246.49	271.15	278.39	232.31
2046	77.49	65.56	221.61	172.36	248.13	272.70	280.10	233.94
2047	70.28	58.99	211.75	162.59	249.73	274.22	281.78	235.54
2048	63.62	52.94	202.50	153.46	251.30	275.71	283.43	237.10
2049	57.50	47.39	193.86	144.95	252.84	277.16	285.04	238.63
2050	51.87	42.30	185.79	137.01	254.35	278.59	286.62	240.13
2051	46.70	37.64	178.25	129.58	255.83	279.98	288.17	241.60
2052	41.96	33.39	171.22	122.62	257.27	281.34	289.68	243.05
2053	37.64	29.51	164.67	116.11	258.68	282.68	291.17	244.46
2054	33.69	25.99	158.58	110.03	260.07	283.98	292.63	245.84
2055	30.09	22.79	152.93	104.37	261.42	285.26	294.05	247.20
2056	26.83	19.90	147.70	99.09	262.75	286.51	295.45	248.53
2057	23.87	17.29	142.82	94.18	264.05	287.73	296.82	249.83
2058	21.19	14.95	138.29	89.61	265.32	288.93	298.16	251.10
2059	18.78	12.86	134.07	85.37	266.56	290.10	299.47	252.35