

B.1.1 Cattle Analysis- COHYST



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MEMORANDUM

To: POAC Technical Committee and Administrators

From: Marc Groff

Date: 8/7/2017

Re: Robust Review Cattle Number Summary – COHYST Modeling Area

Executive Summary

Task 1 of the current Robust Review Scope of Work (SOW) includes developing model runs which would incorporate changes to cattle on feed numbers over the 1997 baseline condition. At the time the SOW was developed, there was concern that cattle numbers across the Robust Review modeling domain may have increased significantly enough between 1997 and 2013 to impact results from the modeling effort. Prior to developing model input files for this scenario, the technical team developed estimates of how consumption would change based on changes in cattle population from 1997. The primary data source for this estimation effort was National Agricultural Statistics Service (NASS). Unfortunately, NASS did not request information related to the number of cattle on feed as part of its 1997 survey; however, NASS has requested total cattle inventory numbers continuously from 1997 through 2013. For this reason, the consumption estimates for the COHYST region are based on changes to total cattle (including calves) population estimates. The consumption related specifically to cattle on feed would be some fraction of the total estimated numbers provided below in Table ES-1.

Table ES-1. Estimated Change in Annual Water Consumption From 1997 Baseline Condition (Acre-Feet)

NRD	Average Difference	High Value (Year)	Low Value (Year)
CPNRD	-297	102 (1999)	-610 (2004)
TBNRD	-22	78 (2007)	-101 (2003 & 2005)
TPNRD	52	176 (2013)	-44 (2003)

For context, the average annual estimated consumption by crops of pumped ground water between 1985 and 2010 within the Twin Platte NRD portion of the COHYST model alone exceeded 245,000 acre-feet per year. The magnitude of the differences summarized in Table ES-1 are not likely to be noticeable in the overall modeling results. **For this reason, it is recommended that modeling files related to identifying impacts resulting from changes to cattle on feed numbers not be developed for further analysis as part of the Robust Review.**

Introduction

Task 1 of the current Robust Review SOW includes developing model runs which would incorporate changes to cattle on feed numbers over the 1997 baseline condition. At the time the SOW was developed, there was concern that cattle numbers across the Robust Review modeling domain may have increased significantly enough between 1997 and 2013 to impact results from the modeling effort. Prior to developing model input files which would be designed to account for impacts related to change in cattle on feed numbers, the technical team developed estimates of the expected changes in consumption related to the changes in cattle populations. This memorandum documents the methods used to develop that estimate over the COHYST modeling area of Robust Review project domain.

Methods

To estimate changes to water consumption related to changes in cattle on feed numbers, the general approach used in this analysis was to estimate consumption as a function of population. In October of 2008, the Nebraska Department of Natural Resources (DNR) used a similar approach in developing a document which examined cattle population changes from 1992 through 2007. That work was based on population estimates from the National Agricultural Statistics Service (NASS) and also identified a daily water use rate for cattle of 7 gallons per head (gph) per day.

To maintain consistency with that past work, information from NASS was again used for this analysis along with the daily water use rate of 7 gph. Unfortunately, NASS did not request information specifically related to the number of cattle on feed as part of its 1997 survey. NASS has, however, continuously from 1997 through 2013 requested information on total cattle (including calves) inventory. This appears to be the information summarized in the 2008 DNR analysis and was selected for use in this analysis. Figure 1 provides a screen shot of the query submitted via the web to NASS which returned the information used for this analysis.

The NASS information is aggregated at a county level basis. To develop summaries of the information by NRD, it was assumed that the cattle population statistics represented within the NASS dataset were uniformly distributed across a county. Information to suggest a different distribution or specific locations within a county where the estimated cattle numbers were located was not available. Using the uniform distribution assumption, it was possible to estimate cattle populations by NRD based on the percentage of a given county located within a given NRD. The county population statistic was distributed based on the percentage of a given county's area within a given NRD. Figure 2 shows the respective boundaries of the COHYST modeling boundary, NRD boundaries, and county boundaries within the focus area of this memo. Standard GIS techniques were used to determine the percentage of a given county within a given NRD.

After estimating the annual total number of cattle (including calves) per NRD, the population change relative to 1997 was calculated and an annual estimated change in water consumption was computed by multiplying the change in the number of head times 7 gph and converting to units of acre-feet to be consistent with the units used in other publications. The specific formula used was:

Eqn 1: *Population Change * 7 gph/day * 3.06889E-06 Acre-Feet/gal * 362.25 days/year*

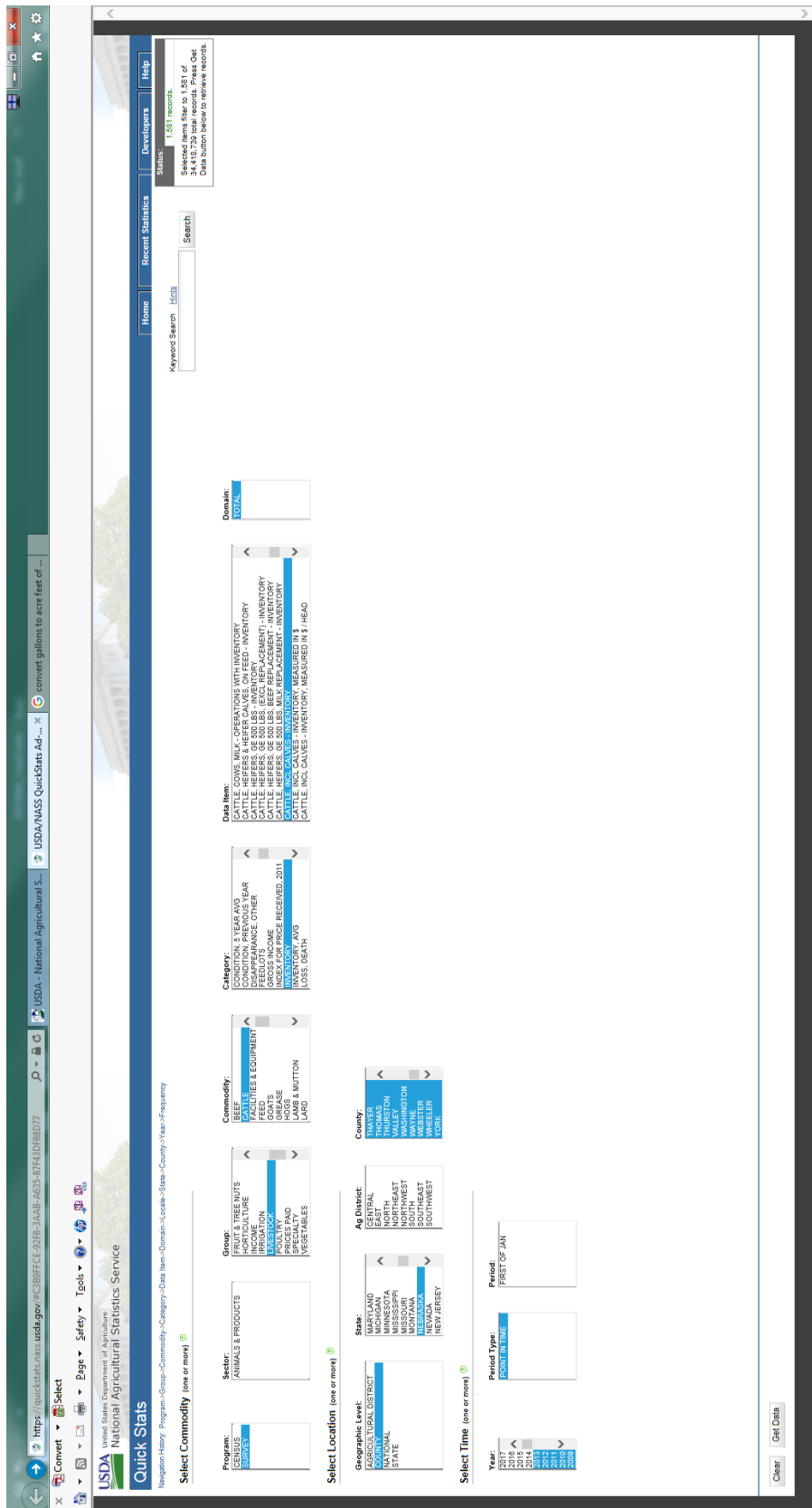


Figure 1: Web Query Screen Shot

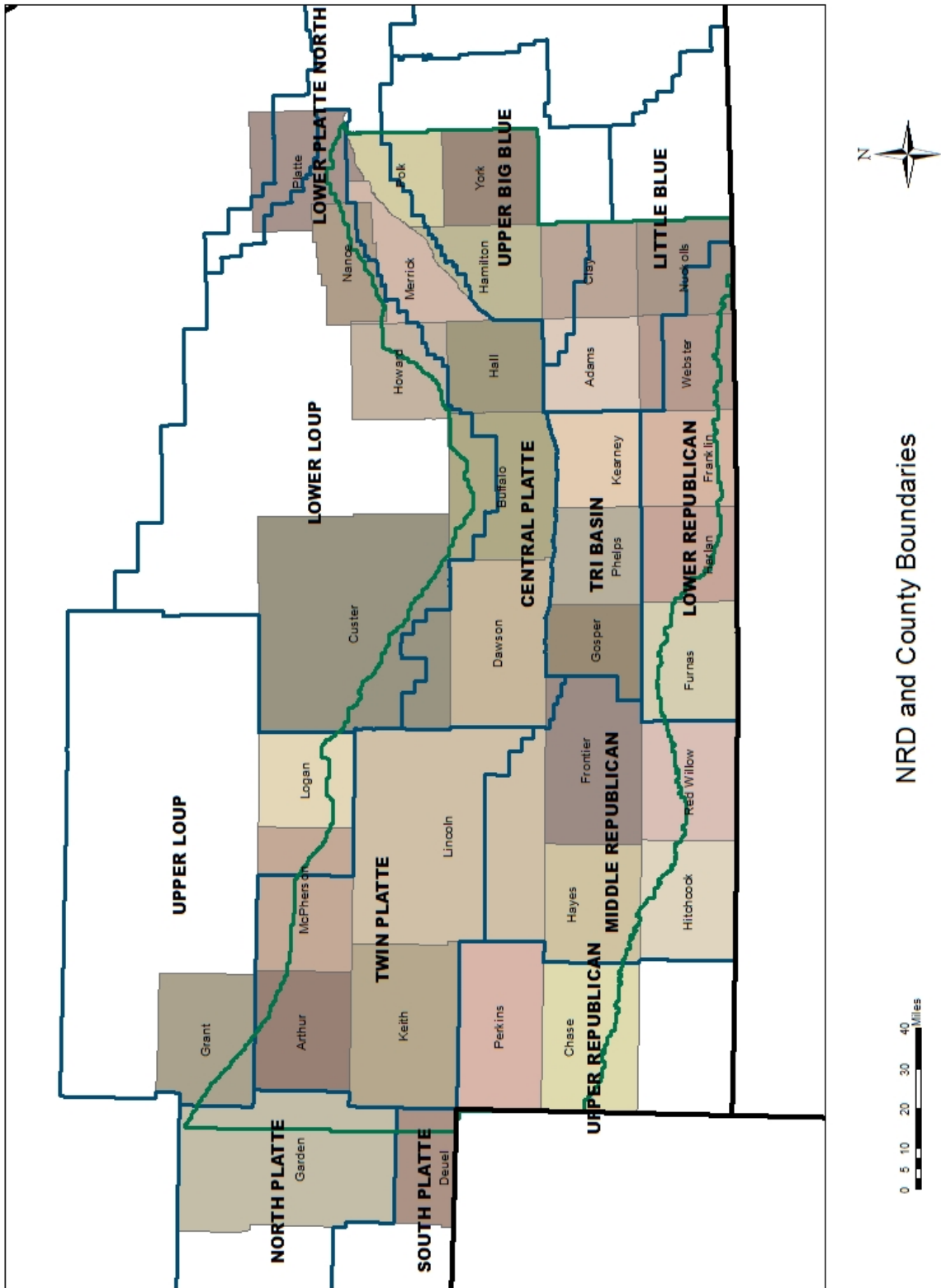


Figure 2: COHYST Model, County and NRD Boundaries

Results

Table 1 below summarizes the results of this analysis.

Table 1. Estimated Change in Annual Water Consumption From 1997 Baseline Condition (Acre-Feet)

NRD	Average Difference	High Value (Year)	Low Value (Year)
CPNRD	-297	102 (1999)	-610 (2004)
TBNRD	-22	78 (2007)	-101 (2003 & 2005)
TPNRD	52	176 (2013)	-44 (2003)

Table 1 was built up using the process described in the Methods section. Following are a series of tables which trace the process through those steps.

The results of the web query shown on Figure 1 for counties within the COHYST area of the Robust Review domain are shown on Table 2.

The estimates of cattle population by NRD developed from that information are shown on Tables 3-5. The percentages used to distribute each county's estimate to the NRD estimate is included on the table.

Table 6 lists the annual change in cattle populations by NRD from the 1997 baseline condition.

Table 7 lists the annual change in water use by NRD resulting from the cattle population changes shown on Table 6 and Eqn 1 discussed in the Methods section. The summaries presented above on Table 1 were taken from Table 7.

Table 2: Summary Of Nebraska Total Cattle Inventory (Including Calves) - Platte Basin COHYST Model Area

Source: Annual National Agricultural Statistics Service Surveys from 1997 through 2013

County	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
ARTHUR	38,000	38,000	37,000	36,000	35,000	33,000	30,000	30,000	33,000	33,000	36,000	31,500	31,000	30,500	31,000	31,000	25,500
BUFFALO	116,000	116,000	118,000	116,000	114,000	106,000	103,000	100,000	100,000	106,000	108,000	100,000	98,000	98,000	98,000	100,000	105,000
CUSTER	285,000	292,000	294,000	292,000	292,000	282,000	285,000	277,000	279,000	290,000	306,000	300,000	295,000	290,000	290,000	300,000	290,000
DAWSON	250,000	253,000	256,000	252,000	251,000	240,000	215,000	213,000	212,000	227,000	237,000	220,000	215,000	215,000	215,000	220,000	240,000
FRONTIER	72,000	79,000	79,000	72,000	66,000	60,000	55,000	57,000	59,000	61,000	64,000	58,000	57,000	57,000	57,000	58,000	57,000
GOSPER	36,000	33,000	33,000	32,000	30,000	28,000	26,000	27,000	27,000	29,000	28,000	25,000	24,500	24,500	24,000	25,000	27,000
HALL	80,000	79,000	81,000	79,000	80,000	77,000	77,000	74,000	72,000	77,000	81,000	85,000	84,000	84,000	83,000	85,000	69,000
HAMILTON	40,000	42,000	39,000	38,000	41,000	44,000	46,000	43,000	43,000	43,000	39,000	32,500	32,000	31,500	31,500	32,000	41,000
HOWARD	73,000	74,000	75,000	78,000	80,000	76,000	72,000	70,000	73,000	79,000	79,000	82,000	80,000	80,000	80,000	81,000	80,000
KEARNEY	85,000	90,000	86,000	83,000	83,000	83,000	82,000	77,000	77,000	78,000	81,000	80,000	78,000	78,000	78,000	80,000	82,000
KEITH	78,000	80,000	75,000	72,000	69,000	64,000	58,000	56,000	54,000	55,000	53,000	54,000	53,000	52,000	52,000	54,000	55,000
LINCOLN	189,000	206,000	202,000	204,000	211,000	210,000	215,000	225,000	228,000	235,000	227,000	245,000	240,000	240,000	240,000	245,000	270,000
MCPHERSON	38,000	41,000	41,000	42,000	43,000	42,000	43,000	43,000	43,000	42,000	45,000	42,000	41,000	41,000	41,000	42,000	36,500
MERRICK	81,000	80,000	79,000	78,000	73,000	66,000	60,000	63,000	66,000	70,000	69,000	58,000	57,000	57,000	57,000	58,000	45,000
NANCE	43,000	41,000	39,000	38,000	37,000	36,000	35,000	37,000	39,000	40,000	37,000	33,500	33,000	32,500	32,500	33,000	28,000
PHELPS	158,000	165,000	164,000	163,000	163,000	162,000	158,000	163,000	162,000	168,000	180,000	175,000	175,000	170,000	170,000	175,000	165,000
PLATTE	85,000	86,000	82,000	80,000	80,000	80,000	80,000	80,000	85,000	89,000	101,000	120,000	120,000	120,000	120,000	120,000	125,000
POLK	65,000	64,000	65,000	67,000	65,000	60,000	56,000	55,000	58,000	62,000	68,000	78,000	77,000	76,000	76,000	78,000	69,000
Total	1,812,000	1,859,000	1,845,000	1,822,000	1,813,000	1,749,000	1,696,000	1,690,000	1,710,000	1,784,000	1,839,000	1,819,500	1,790,500	1,777,000	1,776,000	1,817,000	1,810,000

Table 3
Annual Estimated Head of Cattle within the Central Platte NRD

Year	BUFFALO	CUSTER	DAWSON	FRONTIER	HALL	HAMILTON	HOWARD	NANCE	PHELPS	PLATTE	POLK	Total
1997	74,240	31,350	250,000	71,280	79,200	3,600	6,570	40,420	18,960	3,400	27,300	606,320
1998	74,240	32,120	253,000	78,210	78,210	3,780	6,660	38,540	19,800	3,440	26,880	614,880
1999	75,520	32,340	256,000	78,210	80,190	3,510	6,750	36,660	19,680	3,280	27,300	619,440
2000	74,240	32,120	252,000	71,280	78,210	3,420	7,020	35,720	19,560	3,200	28,140	604,910
2001	72,960	32,120	251,000	65,340	79,200	3,690	7,200	34,780	19,560	3,200	27,300	596,350
2002	67,840	31,020	240,000	59,400	76,230	3,960	6,840	33,840	19,440	3,200	25,200	566,970
2003	65,920	31,350	215,000	54,450	76,230	4,140	6,480	32,900	18,960	3,200	23,520	532,150
2004	64,000	30,470	213,000	56,430	73,260	3,870	6,300	34,780	19,560	3,200	23,100	527,970
2005	64,000	30,690	212,000	58,410	71,280	3,870	6,570	36,660	19,440	3,400	24,360	530,680
2006	67,840	31,900	227,000	60,390	76,230	3,870	7,110	37,600	20,160	3,560	26,040	561,700
2007	69,120	33,660	237,000	63,360	80,190	3,510	7,110	34,780	21,600	4,040	28,560	582,930
2008	64,000	33,000	220,000	57,420	84,150	2,925	7,380	31,490	21,000	4,800	32,760	558,925
2009	62,720	32,450	215,000	56,430	83,160	2,880	7,200	31,020	21,000	4,800	32,340	549,000
2010	62,720	31,900	215,000	56,430	83,160	2,835	7,200	30,550	20,400	4,800	31,920	546,915
2011	62,720	31,900	215,000	56,430	82,170	2,835	7,200	30,550	20,400	4,800	31,920	545,925
2012	64,000	33,000	220,000	57,420	84,150	2,880	7,290	31,020	21,000	4,800	32,760	558,320
2013	67,200	31,900	240,000	56,430	68,310	3,690	7,200	26,320	19,800	5,000	28,980	554,830
% in NRD	64%	11%	100%	4%	99%	9%	9%	94%	12%	4%	42%	

Table 4
Annual Estimated Head of Cattle within the Tri-Basin NRD

Year	GOSPER	KEARNEY	PHELPS	Total
1997	36,000	85,000	158,000	279,000
1998	33,000	90,000	165,000	288,000
1999	33,000	86,000	164,000	283,000
2000	32,000	83,000	163,000	278,000
2001	30,000	83,000	163,000	276,000
2002	28,000	83,000	162,000	273,000
2003	26,000	82,000	158,000	266,000
2004	27,000	77,000	163,000	267,000
2005	27,000	77,000	162,000	266,000
2006	29,000	78,000	168,000	275,000
2007	28,000	81,000	180,000	289,000
2008	25,000	80,000	175,000	280,000
2009	24,500	78,000	175,000	277,500
2010	24,500	78,000	170,000	272,500
2011	24,000	78,000	170,000	272,000
2012	25,000	80,000	175,000	280,000
2013	27,000	82,000	165,000	274,000
% in NRD	100%	100%	100%	

Table 5
Annual Estimated Head of Cattle within the Twin Platte NRD

Year	ARTHUR	KEITH	LINCOLN	MCPHERSON	Total
1997	38,000	78,000	137,970	25,460	279,430
1998	38,000	80,000	150,380	27,470	295,850
1999	37,000	75,000	147,460	27,470	286,930
2000	36,000	72,000	148,920	28,140	285,060
2001	35,000	69,000	154,030	28,810	286,840
2002	33,000	64,000	153,300	28,140	278,440
2003	30,000	58,000	156,950	28,810	273,760
2004	30,000	56,000	164,250	28,810	279,060
2005	33,000	54,000	166,440	28,810	282,250
2006	33,000	55,000	171,550	28,140	287,690
2007	36,000	53,000	165,710	30,150	284,860
2008	31,500	54,000	178,850	28,140	292,490
2009	31,000	53,000	175,200	27,470	286,670
2010	30,500	52,000	175,200	27,470	285,170
2011	31,000	52,000	175,200	27,470	285,670
2012	31,000	54,000	178,850	28,140	291,990
2013	25,500	55,000	197,100	24,455	302,055
% in NRD	100%	100%	73%	67%	

Table 6
Annual Change in Total Head of Cattle From 1997 Basline Conditions

Year	Central Platte NRD	Tri-Basin NRD	Twin Platte NRD	3 NRD Area
1997	0	0	0	0
1998	8,560	9,000	16,420	33,980
1999	13,120	4,000	7,500	24,620
2000	-1,410	-1,000	5,630	3,220
2001	-9,970	-3,000	7,410	-5,560
2002	-39,350	-6,000	-990	-46,340
2003	-74,170	-13,000	-5,670	-92,840
2004	-78,350	-12,000	-370	-90,720
2005	-75,640	-13,000	2,820	-85,820
2006	-44,620	-4,000	8,260	-40,360
2007	-23,390	10,000	5,430	-7,960
2008	-47,395	1,000	13,060	-33,335
2009	-57,320	-1,500	7,240	-51,580
2010	-59,405	-6,500	5,740	-60,165
2011	-60,395	-7,000	6,240	-61,155
2012	-48,000	1,000	12,560	-34,440
2013	-51,490	-5,000	22,625	-33,865

Table 7
Estimated Annual Change in Water Consumption From 1997 Basline Conditions (Acre-Feet)

Year	Central Platte NRD	Tri-Basin NRD	Twin Platte NRD	3 NRD Area
1997	0	0	0	0
1998	67	70	128	264
1999	102	31	58	192
2000	-11	-8	44	25
2001	-78	-23	58	-43
2002	-306	-47	-8	-361
2003	-577	-101	-44	-722
2004	-610	-93	-3	-706
2005	-589	-101	22	-668
2006	-347	-31	64	-314
2007	-182	78	42	-62
2008	-369	8	102	-259
2009	-446	-12	56	-401
2010	-462	-51	45	-468
2011	-470	-54	49	-476
2012	-374	8	98	-268
2013	-401	-39	176	-264
Average	-297	-22	52	-267