LIST OF APPENDICES

2011 Plan

APPENDIX A

DB 12 SUMMARY TABLES

Region A Water User Group Population Projections

WUG Name	County	Basin	P2010	P2020	P2030	P2040	P2050	P2060
CLAUDE	ARMSTRONG	RED	1,327	1,369	1,322	1,268	1,255	1,219
COUNTY-OTHER	ARMSTRONG	RED	844	871	841	806	798	775
COUNTY-OTHER	CARSON	CANADIAN	338	342	340	328	299	271
COUNTY-OTHER	CARSON	RED	844	853	846	819	744	676
GROOM	CARSON	RED	589	595	591	572	520	472
HI TEXAS WATER COMPANY	CARSON	CANADIAN	494	499	495	479	435	395
PANHANDLE	CARSON	RED	2,599	2,626	2,605	2,521	2,291	2,081
SKELLYTOWN	CARSON	CANADIAN	612	619	614	594	540	490
WHITE DEER	CARSON	CANADIAN	395	399	395	383	348	316
WHITE DEER	CARSON	RED	670	677	671	649	590	536
CHILDRESS	CHILDRESS	RED	6,918	7,033	7,132	7,167	7,170	6,987
COUNTY-OTHER	CHILDRESS	RED	929	944	958	962	963	938
COUNTY-OTHER	COLLINGSWORTH	RED	895	898	842	766	709	613
WELLINGTON	COLLINGSWORTH	RED	2,239	2,241	2,187	2,114	2,058	1,965
COUNTY-OTHER	DALLAM	CANADIAN	1,170	1,262	1,320	1,334	1,306	1,245
DALHART	DALLAM	CANADIAN	5,118	5,518	5,770	5,833	5,711	5,447
TEXLINE	DALLAM	CANADIAN	563	607	634	641	628	599
CLARENDON	DONLEY	RED	1,974	1,974	1,974	1,974	1,974	1,974
COUNTY-OTHER	DONLEY	RED	1,790	1,720	1,562	1,401	1,264	1,052
COUNTY-OTHER	GRAY	CANADIAN	2,321	2,304	2,239	2,151	2,020	1,892
COUNTY-OTHER	GRAY	RED	1,058	1,050	1,020	981	921	863
LEFORS	GRAY	RED	545	540	525	505	474	444
MCLEAN	GRAY	RED	809	802	780	750	704	659
PAMPA	GRAY	CANADIAN	17,430	17,292	16,807	16,155	15,167	14,206
COUNTY-OTHER	HALL	RED	1,267	1,358	1,416	1,368	1,388	1,303
MEMPHIS	HALL	RED	2,483	2,474	2,468	2,473	2,471	2,480
COUNTY-OTHER	HANSFORD	CANADIAN	1,388	1,663	1,898	2,152	2,301	2,433
GRUVER	HANSFORD	CANADIAN	1,169	1,178	1,186	1,195	1,200	1,204
SPEARMAN	HANSFORD	CANADIAN	3,142	3,307	3,448	3,601	3,690	3,769
COUNTY-OTHER	HARTLEY	CANADIAN	3,033	3,135	3,189	3,208	3,168	3,006
DALHART	HARTLEY	CANADIAN	2,664	2,754	2,800	2,818	2,782	2,640
CANADIAN	HEMPHILL	CANADIAN	2,330	2,340	2,262	2,178	2,120	2,015
COUNTY-OTHER	HEMPHILL	CANADIAN	814	818	791	762	741	705

Region A Water User Group Population Projections

WUG Name	County	Basin	P2010	P2020	P2030	P2040	P2050	P2060
COUNTY-OTHER	HEMPHILL	RED	352	353	341	329	320	304
BORGER	HUTCHINSON	CANADIAN	14,580	14,780	14,574	14,096	13,314	12,641
COUNTY-OTHER	HUTCHINSON	CANADIAN	308	314	310	299	283	268
FRITCH	HUTCHINSON	CANADIAN	2,269	2,300	2,268	2,194	2,072	1,968
HI TEXAS WATER COMPANY	HUTCHINSON	CANADIAN	3,079	3,121	3,077	2,976	2,811	2,669
STINNETT	HUTCHINSON	CANADIAN	1,974	2,001	1,973	1,908	1,802	1,711
TCW SUPPLY INC	HUTCHINSON	CANADIAN	2,110	2,139	2,109	2,040	1,927	1,830
BOOKER	LIPSCOMB	CANADIAN	1,318	1,345	1,305	1,267	1,250	1,189
COUNTY-OTHER	LIPSCOMB	CANADIAN	1,766	1,804	1,749	1,699	1,675	1,595
CACTUS	MOORE	CANADIAN	2,600	3,000	3,000	3,000	3,000	3,000
COUNTY-OTHER	MOORE	CANADIAN	3,307	4,534	5,970	7,110	7,805	8,223
DUMAS	MOORE	CANADIAN	14,884	16,123	17,216	18,084	18,613	18,931
FRITCH	MOORE	CANADIAN	21	34	45	54	59	62
SUNRAY	MOORE	CANADIAN	2,237	2,550	2,826	3,045	3,178	3,258
BOOKER	OCHILTREE	CANADIAN	9	9	9	9	9	9
COUNTY-OTHER	OCHILTREE	CANADIAN	1,223	1,223	1,223	1,223	1,223	1,223
PERRYTON	OCHILTREE	CANADIAN	8,453	9,208	9,769	10,148	10,334	10,571
COUNTY-OTHER	OLDHAM	CANADIAN	1,031	1,053	979	862	749	606
COUNTY-OTHER	OLDHAM	RED	296	303	281	248	216	174
VEGA	OLDHAM	CANADIAN	995	1,017	944	832	724	584
AMARILLO	POTTER	CANADIAN	62,656	67,364	71,767	76,781	82,253	86,738
AMARILLO	POTTER	RED	44,660	48,016	51,155	54,729	58,629	61,826
COUNTY-OTHER	POTTER	CANADIAN	12,019	16,206	20,121	24,578	29,444	33,433
COUNTY-OTHER	POTTER	RED	8,245	11,117	13,803	16,862	20,200	22,936
AMARILLO	RANDALL	RED	80,688	88,117	95,065	102,976	111,611	118,760
CANYON	RANDALL	RED	14,227	15,684	17,047	18,599	20,293	21,695
COUNTY-OTHER	RANDALL	CANADIAN	70	87	101	119	137	153
COUNTY-OTHER	RANDALL	RED	21,376	26,384	31,068	36,401	42,222	47,041
HAPPY	RANDALL	RED	66	100	132	168	207	239
LAKE TANGLEWOOD	RANDALL	RED	993	1,174	1,344	1,537	1,748	1,923
COUNTY-OTHER	ROBERTS	CANADIAN	293	302	271	227	197	177
COUNTY-OTHER	ROBERTS	RED	20	20	18	15	13	12
MIAMI	ROBERTS	CANADIAN	617	633	568	477	412	372

Region A Water User Group Population Projections

WUG Name	County	Basin	P2010	P2020	P2030	P2040	P2050	P2060
COUNTY-OTHER	SHERMAN	CANADIAN	1,297	1,405	1,447	1,490	1,528	1,547
STRATFORD	SHERMAN	CANADIAN	2,172	2,365	2,439	2,515	2,582	2,617
COUNTY-OTHER	WHEELER	RED	1,795	1,796	1,785	1,805	1,799	1,766
SHAMROCK	WHEELER	RED	1,963	1,963	1,954	1,970	1,966	1,941
WHEELER	WHEELER	RED	1,374	1,374	1,373	1,374	1,374	1,373

Region A Water User Group Demand
(Ac-ft per Year)

WUG Name	County	Basin	CNWD2010	CNWD2020	CNWD2030	CNWD2040	CNWD2050	CNWD2060
CLAUDE	ARMSTRONG	RED	262	270	261	250	247	240
COUNTY-OTHER	ARMSTRONG	RED	109	112	108	104	103	100
IRRIGATION	ARMSTRONG	RED	5,118	4,688	4,544	4,305	3,827	3,349
LIVESTOCK	ARMSTRONG	RED	566	670	673	677	681	685
MINING	ARMSTRONG	RED	13	12	12	12	12	12
COUNTY-OTHER	CARSON	CANADIAN	73	74	74	71	65	59
COUNTY-OTHER	CARSON	RED	183	185	184	178	162	147
GROOM	CARSON	RED	142	143	142	138	125	114
HI TEXAS WATER COMPANY	CARSON	CANADIAN	55	55	55	53	48	44
IRRIGATION	CARSON	CANADIAN	13,960	11,693	11,397	10,797	8,638	8,397
IRRIGATION	CARSON	RED	44,815	37,537	36,585	34,660	27,730	26,958
LIVESTOCK	CARSON	CANADIAN	295	346	348	350	353	355
LIVESTOCK	CARSON	RED	312	365	368	370	372	375
MANUFACTURING	CARSON	RED	591	669	735	797	849	920
MINING	CARSON	CANADIAN	975	942	929	918	907	893
MINING	CARSON	RED	486	470	464	458	453	446
PANHANDLE	CARSON	RED	574	579	575	556	506	459
SKELLYTOWN	CARSON	CANADIAN	106	107	106	102	93	85
WHITE DEER	CARSON	CANADIAN	61	61	61	59	53	48
WHITE DEER	CARSON	RED	103	104	103	100	91	82
CHILDRESS	CHILDRESS	RED	1,457	1,481	1,502	1,509	1,510	1,471
COUNTY-OTHER	CHILDRESS	RED	196	199	202	203	203	198
IRRIGATION	CHILDRESS	RED	7,418	5,519	5,350	5,068	4,505	3,942
LIVESTOCK	CHILDRESS	RED	368	470	472	473	475	477
MINING	CHILDRESS	RED	17	16	16	16	16	16
COUNTY-OTHER	COLLINGSWORTH	RED	234	234	220	200	185	160
IRRIGATION	COLLINGSWORTH	RED	28,693	21,907	21,236	20,118	17,883	15,648
LIVESTOCK	COLLINGSWORTH	RED	461	564	566	569	571	574
WELLINGTON	COLLINGSWORTH	RED	456	457	446	431	420	401
COUNTY-OTHER	DALLAM	CANADIAN	181	195	204	206	202	192
DALHART	DALLAM	CANADIAN	1,319	1,422	1,487	1,503	1,471	1,403
IRRIGATION	DALLAM	CANADIAN	292,031	283,315	274,642	260,187	231,278	202,368
LIVESTOCK	DALLAM	CANADIAN	3,509	4,654	4,996	5,373	5,788	6,246
TEXLINE	DALLAM	CANADIAN	211	227	237	240	235	224

Region A Water User Group Demand
(Ac-ft per Year)

WUG Name	County	Basin	CNWD2010	CNWD2020	CNWD2030	CNWD2040	CNWD2050	CNWD2060
CLARENDON	DONLEY	RED	440	440	440	440	440	440
COUNTY-OTHER	DONLEY	RED	219	210	191	171	154	128
IRRIGATION	DONLEY	RED	32,000	29,676	28,771	27,257	24,228	21,200
LIVESTOCK	DONLEY	RED	1,267	1,268	1,270	1,271	1,273	1,275
MINING	DONLEY	RED	15	14	14	14	14	14
COUNTY-OTHER	GRAY	CANADIAN	351	348	339	325	305	286
COUNTY-OTHER	GRAY	RED	160	159	154	148	139	131
IRRIGATION	GRAY	CANADIAN	5,635	5,065	4,910	4,652	4,135	3,618
IRRIGATION	GRAY	RED	17,070	15,345	14,875	14,092	12,526	10,960
LEFORS	GRAY	RED	86	85	83	80	75	70
LIVESTOCK	GRAY	CANADIAN	211	227	231	235	239	244
LIVESTOCK	GRAY	RED	1,137	1,224	1,243	1,264	1,288	1,313
MANUFACTURING	GRAY	CANADIAN	4,264	4,383	4,451	4,497	4,515	4,334
MCLEAN	GRAY	RED	185	183	178	171	161	151
MINING	GRAY	CANADIAN	85	88	89	90	91	93
MINING	GRAY	RED	1,844	1,911	1,939	1,966	1,992	2,025
PAMPA	GRAY	CANADIAN	3,300	3,273	3,182	3,058	2,871	2,689
STEAM ELECTRIC POWER	GRAY	CANADIAN	2,507	1,409	2,112	2,299	2,952	3,087
COUNTY-OTHER	HALL	RED	353	379	395	382	387	363
IRRIGATION	HALL	RED	16,719	10,731	10,403	9,855	8,760	7,665
LIVESTOCK	HALL	RED	329	330	331	332	334	335
MEMPHIS	HALL	RED	442	441	440	440	440	442
MINING	HALL	RED	15	14	14	14	14	14
COUNTY-OTHER	HANSFORD	CANADIAN	266	319	364	412	441	466
GRUVER	HANSFORD	CANADIAN	325	327	329	332	333	334
IRRIGATION	HANSFORD	CANADIAN	130,694	115,027	111,506	105,637	93,899	82,162
LIVESTOCK	HANSFORD	CANADIAN	3,683	3,956	4,256	4,586	4,948	5,346
MANUFACTURING	HANSFORD	CANADIAN	49	52	54	56	58	62
MINING	HANSFORD	CANADIAN	543	533	529	525	521	516
SPEARMAN	HANSFORD	CANADIAN	707	745	776	811	831	849
COUNTY-OTHER	HARTLEY	CANADIAN	523	541	550	553	546	519
DALHART	HARTLEY	CANADIAN	686	710	721	726	717	680
IRRIGATION	HARTLEY	CANADIAN	294,932	281,648	273,026	258,657	229,917	201,177
LIVESTOCK	HARTLEY	CANADIAN	5,106	7,103	7,731	8,422	9,184	10,024

Region A Water User Group Demand
(Ac-ft per Year)

WUG Name	County	Basin	CNWD2010	CNWD2020	CNWD2030	CNWD2040	CNWD2050	CNWD2060
MANUFACTURING	HARTLEY	CANADIAN	5	5	5	5	5	5
CANADIAN	HEMPHILL	CANADIAN	475	477	461	444	432	411
COUNTY-OTHER	HEMPHILL	CANADIAN	110	111	107	103	100	96
COUNTY-OTHER	HEMPHILL	RED	48	48	46	45	43	41
IRRIGATION	HEMPHILL	CANADIAN	1,259	1,176	1,140	1,080	960	840
IRRIGATION	HEMPHILL	RED	566	529	513	486	432	378
LIVESTOCK	HEMPHILL	CANADIAN	758	761	763	766	770	773
LIVESTOCK	HEMPHILL	RED	518	520	522	524	526	528
MANUFACTURING	HEMPHILL	RED	1	1	1	1	1	1
MINING	HEMPHILL	CANADIAN	1,529	1,529	1,374	1,095	878	702
MINING	HEMPHILL	RED	1,046	1,046	940	749	601	481
BORGER	HUTCHINSON	CANADIAN	2,352	2,384	2,351	2,274	2,148	2,039
COUNTY-OTHER	HUTCHINSON	CANADIAN	56	57	57	55	52	49
FRITCH	HUTCHINSON	CANADIAN	407	412	406	393	371	353
HI TEXAS WATER COMPANY	HUTCHINSON	CANADIAN	341	346	341	330	312	296
IRRIGATION	HUTCHINSON	CANADIAN	43,104	39,971	38,748	36,708	32,630	28,551
LIVESTOCK	HUTCHINSON	CANADIAN	685	689	698	708	720	732
MANUFACTURING	HUTCHINSON	CANADIAN	23,659	25,482	26,969	28,399	29,640	31,708
MINING	HUTCHINSON	CANADIAN	398	393	394	395	396	396
STINNETT	HUTCHINSON	CANADIAN	365	370	365	353	333	316
TCW SUPPLY INC	HUTCHINSON	CANADIAN	603	611	602	583	550	523
BOOKER	LIPSCOMB	CANADIAN	354	362	351	341	336	320
COUNTY-OTHER	LIPSCOMB	CANADIAN	394	402	390	379	373	356
IRRIGATION	LIPSCOMB	CANADIAN	16,956	15,546	15,070	14,277	12,690	11,104
LIVESTOCK	LIPSCOMB	CANADIAN	1,005	1,007	1,028	1,051	1,076	1,104
MANUFACTURING	LIPSCOMB	CANADIAN	89	95	100	104	108	116
MINING	LIPSCOMB	CANADIAN	1,235	1,235	1,114	887	713	574
CACTUS	MOORE	CANADIAN	533	615	615	615	615	615
COUNTY-OTHER	MOORE	CANADIAN	700	960	1,264	1,505	1,652	1,741
DUMAS	MOORE	CANADIAN	2,734	2,962	3,163	3,322	3,419	3,478
FRITCH	MOORE	CANADIAN	4	6	8	10	11	11
IRRIGATION	MOORE	CANADIAN	147,471	135,001	130,869	123,981	110,205	96,430
LIVESTOCK	MOORE	CANADIAN	2,831	3,605	3,931	4,290	4,685	5,120
MANUFACTURING	MOORE	CANADIAN	7,879	8,450	8,914	9,371	9,773	10,436

Region A Water User Group Demand
(Ac-ft per Year)

WUG Name	County	Basin	CNWD2010	CNWD2020	CNWD2030	CNWD2040	CNWD2050	CNWD2060
MINING	MOORE	CANADIAN	700	700	630	567	510	459
STEAM ELECTRIC POWER	MOORE	CANADIAN	200	200	200	200	200	213
SUNRAY	MOORE	CANADIAN	534	608	674	727	758	777
BOOKER	OCHILTREE	CANADIAN	2	2	2	2	2	2
COUNTY-OTHER	OCHILTREE	CANADIAN	181	181	181	181	181	181
IRRIGATION	OCHILTREE	CANADIAN	60,844	51,839	50,252	47,607	42,317	37,028
LIVESTOCK	OCHILTREE	CANADIAN	3,367	3,463	3,605	3,761	3,932	4,119
MINING	OCHILTREE	CANADIAN	1,148	1,148	1,027	818	661	522
PERRYTON	OCHILTREE	CANADIAN	1,960	2,135	2,265	2,353	2,396	2,451
COUNTY-OTHER	OLDHAM	CANADIAN	135	138	128	113	98	79
COUNTY-OTHER	OLDHAM	RED	39	40	37	33	28	23
IRRIGATION	OLDHAM	CANADIAN	3,325	3,073	2,978	2,821	2,508	2,194
IRRIGATION	OLDHAM	RED	910	841	816	773	687	601
LIVESTOCK	OLDHAM	CANADIAN	1,105	1,204	1,206	1,209	1,212	1,214
LIVESTOCK	OLDHAM	RED	49	53	53	53	53	53
MINING	OLDHAM	CANADIAN	151	156	159	162	164	167
MINING	OLDHAM	RED	177	185	188	190	193	197
VEGA	OLDHAM	CANADIAN	242	247	229	202	176	142
AMARILLO	POTTER	CANADIAN	14,107	15,167	16,158	17,287	18,519	19,529
AMARILLO	POTTER	RED	10,055	10,811	11,517	12,322	13,200	13,920
COUNTY-OTHER	POTTER	CANADIAN	1,010	1,361	1,690	2,065	2,474	2,809
COUNTY-OTHER	POTTER	RED	693	934	1,160	1,417	1,697	1,927
IRRIGATION	POTTER	CANADIAN	2,966	2,714	2,632	2,494	2,216	1,940
IRRIGATION	POTTER	RED	3,260	2,983	2,893	2,740	2,436	2,131
LIVESTOCK	POTTER	CANADIAN	455	457	458	460	462	464
LIVESTOCK	POTTER	RED	47	47	47	47	47	47
MANUFACTURING	POTTER	CANADIAN	1,058	1,164	1,254	1,341	1,417	1,521
MANUFACTURING	POTTER	RED	5,730	6,304	6,789	7,263	7,673	8,236
MINING	POTTER	CANADIAN	212	236	252	268	285	297
MINING	POTTER	RED	117	131	140	149	157	165

Region A Water User Group Demand
(Ac-ft per Year)

WUG Name	County	Basin	CNWD2010	CNWD2020	CNWD2030	CNWD2040	CNWD2050	CNWD2060
STEAM ELECTRIC POWER	POTTER	CANADIAN	22,432	25,387	26,804	28,408	30,011	34,115
AMARILLO	RANDALL	RED	18,167	19,839	21,404	23,185	25,129	26,739
CANYON	RANDALL	RED	2,438	2,688	2,922	3,188	3,478	3,718
COUNTY-OTHER	RANDALL	CANADIAN	9	11	13	15	17	19
COUNTY-OTHER	RANDALL	RED	2,706	3,340	3,932	4,608	5,344	5,954
HAPPY	RANDALL	RED	11	17	22	27	33	38
IRRIGATION	RANDALL	CANADIAN	0	0	0	0	0	0
IRRIGATION	RANDALL	RED	22,477	19,900	19,291	18,275	16,245	14,214
LAKE TANGLEWOOD	RANDALL	RED	160	189	217	248	282	310
LIVESTOCK	RANDALL	CANADIAN	0	0	0	0	0	0
LIVESTOCK	RANDALL	RED	2,732	2,741	2,756	2,772	2,789	2,808
MANUFACTURING	RANDALL	RED	605	670	726	778	821	892
MINING	RANDALL	CANADIAN	2	3	3	3	3	3
MINING	RANDALL	RED	16	16	17	18	19	20
COUNTY-OTHER	ROBERTS	CANADIAN	41	42	38	32	28	25
COUNTY-OTHER	ROBERTS	RED	3	3	3	2	2	2
IRRIGATION	ROBERTS	CANADIAN	5,803	5,379	5,214	4,940	4,390	3,842
IRRIGATION	ROBERTS	RED	281	260	252	239	213	186
LIVESTOCK	ROBERTS	CANADIAN	375	375	376	377	378	378
LIVESTOCK	ROBERTS	RED	10	10	10	10	10	10
MIAMI	ROBERTS	CANADIAN	145	149	134	112	97	88
MINING	ROBERTS	CANADIAN	1,232	1,232	1,114	894	709	574
MINING	ROBERTS	RED	38	38	34	28	22	18
COUNTY-OTHER	SHERMAN	CANADIAN	218	236	243	250	257	260
IRRIGATION	SHERMAN	CANADIAN	220,372	200,521	194,437	182,913	163,736	143,269
LIVESTOCK	SHERMAN	CANADIAN	4,933	5,579	5,889	6,230	6,606	7,019
MINING	SHERMAN	CANADIAN	17	16	16	16	16	16
STRATFORD	SHERMAN	CANADIAN	628	683	705	727	746	756
COUNTY-OTHER	WHEELER	RED	277	278	276	279	278	273
IRRIGATION	WHEELER	RED	11,311	9,488	9,198	8,713	7,745	6,777
LIVESTOCK	WHEELER	RED	1,554	1,657	1,660	1,662	1,664	1,667
MINING	WHEELER	RED	2,001	2,001	1,810	1,444	1,148	922
SHAMROCK	WHEELER	RED	312	312	311	313	313	309
WHEELER	WHEELER	RED	291	291	291	291	291	291

Region A Source Availability
(Ac-ft per Year)

Source Name	County	Basin	TA2010	TA2020	TA2030	TA2040	TA2050	TA2060
DOCKUM AQUIFER	ARMSTRONG	RED	21,300	18,600	16,300	14,300	12,500	10,900
LIVESTOCK LOCAL SUPPLY	ARMSTRONG	RED	121	121	121	121	121	121
OGALLALA AQUIFER	ARMSTRONG	RED	51,374	47,666	42,659	37,938	34,185	30,650
OTHER AQUIFER	ARMSTRONG	RED	102	102	102	102	102	102
DIRECT REUSE	CARSON	CANADIAN	0	0	0	0	0	0
DIRECT REUSE	CARSON	RED	67	64	62	61	56	50
DOCKUM AQUIFER	CARSON	CANADIAN	0	0	0	0	0	0
DOCKUM AQUIFER	CARSON	RED	6,200	5,400	4,700	4,200	3,600	3,200
LIVESTOCK LOCAL SUPPLY	CARSON	CANADIAN	125	125	125	125	125	125
LIVESTOCK LOCAL SUPPLY	CARSON	RED	159	159	159	159	159	159
OGALLALA AQUIFER	CARSON	CANADIAN	88,681	80,392	72,084	64,820	58,078	52,091
OGALLALA AQUIFER	CARSON	RED	108,208	98,153	88,409	79,836	71,804	64,245
RED RIVER COMBINED RUN-OF-RIVER IRRIGATION	CARSON	RED	300	300	300	300	300	300
BLAINE AQUIFER	CHILDRESS	RED	62,500	62,500	62,500	62,500	62,500	62,500
DIRECT REUSE	CHILDRESS	RED	146	148	150	151	151	147
LIVESTOCK LOCAL SUPPLY	CHILDRESS	RED	300	300	300	300	300	300
OTHER AQUIFER	CHILDRESS	RED	62	62	62	62	62	62
OTHER LOCAL SUPPLY	CHILDRESS	RED	21	21	21	21	21	21
RED RIVER RUN-OF-RIVER IRRIGATION	CHILDRESS	RED	28	28	28	28	28	28
SEYMOUR AQUIFER	CHILDRESS	RED	1,625	1,625	1,750	1,750	1,750	1,750
BLAINE AQUIFER	COLLINGSWORTH	RED	125,000	125,000	125,000	125,000	125,000	125,000
DIRECT REUSE	COLLINGSWORTH	RED	50	50	50	50	50	50
LIVESTOCK LOCAL SUPPLY	COLLINGSWORTH	RED	750	750	750	750	750	750
OGALLALA AQUIFER	COLLINGSWORTH	RED	1,072	1,071	1,070	1,069	1,068	1,067
OTHER AQUIFER	COLLINGSWORTH	RED	30	30	30	30	30	30
RED RIVER COMBINED RUN-OF-RIVER IRRIGATION	COLLINGSWORTH	RED	867	867	867	867	867	867
SEYMOUR AQUIFER	COLLINGSWORTH	RED	19,400	18,900	17,900	17,900	17,900	17,900
DIRECT REUSE	DALLAM	CANADIAN	430	421	409	391	379	379
DOCKUM AQUIFER	DALLAM	CANADIAN	71,800	62,800	54,900	48,100	42,100	36,800
LIVESTOCK LOCAL SUPPLY	DALLAM	CANADIAN	741	741	741	741	741	741
OGALLALA AQUIFER	DALLAM	CANADIAN	280,136	253,072	225,124	198,739	173,986	151,305
LIVESTOCK LOCAL SUPPLY	DONLEY	RED	1,225	1,225	1,225	1,225	1,225	1,225
OGALLALA AQUIFER	DONLEY	RED	82,762	81,347	76,005	69,672	63,613	58,017
OTHER AQUIFER	DONLEY	RED	71	71	71	71	71	71
RED RIVER COMBINED RUN-OF-RIVER IRRIGATION	DONLEY	RED	195	195	195	195	195	195
CANADIAN RIVER RUN-OF-RIVER IRRIGATION	GRAY	CANADIAN	1	1	1	1	1	1
DIRECT REUSE	GRAY	CANADIAN	246	246	246	246	246	246
DIRECT REUSE	GRAY	RED	230	225	192	185	179	179
LIVESTOCK LOCAL SUPPLY	GRAY	CANADIAN	732	732	732	732	732	732
LIVESTOCK LOCAL SUPPLY	GRAY	RED	2,000	2,000	2,000	2,000	2,000	2,000
OGALLALA AQUIFER	GRAY	CANADIAN	38,827	36,998	35,051	32,396	29,457	26,480
OGALLALA AQUIFER	GRAY	RED	127,809	120,031	108,768	98,250	88,157	79,154
RED RIVER COMBINED RUN-OF-RIVER IRRIGATION	GRAY	RED	33	33	33	33	33	33
BLAINE AQUIFER	HALL	RED	10,000	10,000	10,000	10,000	10,000	10,000

Region A Source Availability
(Ac-ft per Year)

Source Name	County	Basin	TA2010	TA2020	TA2030	TA2040	TA2050	TA2060
DIRECT REUSE	HALL	RED	7	6	6	6	5	5
LIVESTOCK LOCAL SUPPLY	HALL	RED	301	301	301	301	301	301
OTHER AQUIFER	HALL	RED	40	40	40	40	40	40
RED RIVER RUN-OF-RIVER IRRIGATION	HALL	RED	59	59	59	59	59	59
SEYMOUR AQUIFER	HALL	RED	20,500	20,000	19,000	19,000	19,000	19,000
CANADIAN RIVER COMBINED RUN-OF-RIVER IRRIGATION	HANSFORD	CANADIAN	22	22	22	22	22	22
LIVESTOCK LOCAL SUPPLY	HANSFORD	CANADIAN	2,464	2,464	2,464	2,464	2,464	2,464
OGALLALA AQUIFER	HANSFORD	CANADIAN	276,277	258,780	238,529	217,640	195,835	174,892
DOCKUM AQUIFER	HARTLEY	CANADIAN	69,700	61,000	53,400	46,700	40,900	35,800
LIVESTOCK LOCAL SUPPLY	HARTLEY	CANADIAN	1,702	1,702	1,702	1,702	1,702	1,702
OGALLALA AQUIFER	HARTLEY	CANADIAN	398,799	361,195	314,995	273,474	236,815	204,661
LIVESTOCK LOCAL SUPPLY	HEMPHILL	CANADIAN	524	524	524	524	524	524
LIVESTOCK LOCAL SUPPLY	HEMPHILL	RED	364	364	364	364	364	364
OGALLALA AQUIFER	HEMPHILL	CANADIAN	27,130	24,127	23,715	23,586	23,417	23,446
OGALLALA AQUIFER	HEMPHILL	RED	22,779	20,527	20,414	20,198	20,256	20,133
CANADIAN RIVER COMBINED RUN-OF-RIVER IRRIGATION	HUTCHINSON	CANADIAN	98	98	98	98	98	98
DIRECT REUSE	HUTCHINSON	CANADIAN	1,045	1,045	1,045	1,045	1,045	1,045
LIVESTOCK LOCAL SUPPLY	HUTCHINSON	CANADIAN	493	493	493	493	493	493
OGALLALA AQUIFER	HUTCHINSON	CANADIAN	135,941	129,548	119,798	108,985	98,239	87,979
CANADIAN RIVER COMBINED RUN-OF-RIVER IRRIGATION	LIPSCOMB	CANADIAN	66	66	66	66	66	66
DIRECT REUSE	LIPSCOMB	CANADIAN	34	34	34	34	34	34
LIVESTOCK LOCAL SUPPLY	LIPSCOMB	CANADIAN	657	657	657	657	657	657
OGALLALA AQUIFER	LIPSCOMB	CANADIAN	251,789	251,652	247,761	234,999	219,735	203,198
CANADIAN RIVER COMBINED RUN-OF-RIVER IRRIGATION	MOORE	CANADIAN	7	7	7	7	7	7
DIRECT REUSE	MOORE	CANADIAN	547	592	633	664	684	696
DOCKUM AQUIFER	MOORE	CANADIAN	17,400	15,200	13,300	11,600	10,200	8,900
LIVESTOCK LOCAL SUPPLY	MOORE	CANADIAN	981	981	981	981	981	981
OGALLALA AQUIFER	MOORE	CANADIAN	174,410	164,319	142,529	122,138	103,539	86,974
OTHER LOCAL SUPPLY	MOORE	CANADIAN	0	0	0	0	0	0
LIVESTOCK LOCAL SUPPLY	OCHILTREE	CANADIAN	2,506	2,506	2,506	2,506	2,506	2,506
OGALLALA AQUIFER	OCHILTREE	CANADIAN	257,903	236,618	215,489	195,506	176,566	159,017
DOCKUM AQUIFER	OLDHAM	CANADIAN	71,440	61,808	55,332	48,816	43,064	37,980
DOCKUM AQUIFER	OLDHAM	RED	2,960	2,592	2,268	1,984	1,736	1,520
LIVESTOCK LOCAL SUPPLY	OLDHAM	CANADIAN	1,187	1,187	1,187	1,187	1,187	1,187
LIVESTOCK LOCAL SUPPLY	OLDHAM	RED	62	62	62	62	62	62
OGALLALA AQUIFER	OLDHAM	CANADIAN	30,077	29,550	29,316	28,468	28,216	27,749
OGALLALA AQUIFER	OLDHAM	RED	2,615	2,570	2,549	2,476	2,454	2,413
CANADIAN RIVER COMBINED RUN-OF-RIVER	POTTER	CANADIAN	0	0	0	0	0	0
DIRECT REUSE	POTTER	CANADIAN	21,103	24,867	26,530	28,425	30,492	33,469
DIRECT REUSE	POTTER	RED	700	700	700	700	700	700
DOCKUM AQUIFER	POTTER	CANADIAN	2,968	2,592	22,804	20,000	17,536	15,324
DOCKUM AQUIFER	POTTER	RED	4,032	3,528	3,096	2,700	2,364	2,076
LIVESTOCK LOCAL SUPPLY	POTTER	CANADIAN	480	480	480	480	480	480
LIVESTOCK LOCAL SUPPLY	POTTER	RED	36	36	36	36	36	36

Region A Source Availability
(Ac-ft per Year)

Source Name	County	Basin	TA2010	TA2020	TA2030	TA2040	TA2050	TA2060
OGALLALA AQUIFER	POTTER	CANADIAN	34,540	25,599	22,894	20,157	18,126	16,139
OGALLALA AQUIFER	POTTER	RED	6,545	6,287	5,790	5,403	5,090	4,845
DIRECT REUSE	RANDALL	CANADIAN	0	0	0	0	0	0
DIRECT REUSE	RANDALL	RED	700	700	700	700	700	700
DOCKUM AQUIFER	RANDALL	RED	43,500	38,000	33,300	29,100	25,500	22,300
LIVESTOCK LOCAL SUPPLY	RANDALL	CANADIAN	0	0	0	0	0	0
LIVESTOCK LOCAL SUPPLY	RANDALL	RED	511	511	511	511	511	511
OGALLALA AQUIFER	RANDALL	CANADIAN	0	0	0	0	0	0
OGALLALA AQUIFER	RANDALL	RED	74,440	69,663	66,697	60,842	64,746	64,207
OTHER AQUIFER	RANDALL	RED	40	40	37	35	35	35
RED RIVER COMBINED RUN-OF-RIVER IRRIGATION	RANDALL	RED	215	215	215	215	215	215
BAYLOR LAKE/RESERVOIR	RESERVOIR	RED	0	0	0	0	0	0
GREENBELT LAKE/RESERVOIR	RESERVOIR	RED	6,864	6,728	6,592	6,456	6,320	6,181
MEREDITH LAKE/RESERVOIR	RESERVOIR	CANADIAN	30,000	50,000	50,000	50,000	50,000	50,000
PALO DURO LAKE/RESERVOIR	RESERVOIR	CANADIAN	3,958	3,917	3,875	3,833	3,792	3,750
CANADIAN RIVER RUN-OF-RIVER IRRIGATION	ROBERTS	CANADIAN	72	72	72	72	72	72
LIVESTOCK LOCAL SUPPLY	ROBERTS	CANADIAN	500	500	500	500	500	500
LIVESTOCK LOCAL SUPPLY	ROBERTS	RED	15	15	15	15	15	15
OGALLALA AQUIFER	ROBERTS	CANADIAN	328,057	322,556	306,054	285,524	262,825	238,459
OGALLALA AQUIFER	ROBERTS	RED	17,000	16,962	16,855	15,896	14,684	13,474
CANADIAN RIVER COMBINED RUN-OF-RIVER IRRIGATION	SHERMAN	CANADIAN	32	32	32	32	32	32
DOCKUM AQUIFER	SHERMAN	CANADIAN	0	0	0	0	0	0
LIVESTOCK LOCAL SUPPLY	SHERMAN	CANADIAN	699	699	699	699	699	699
OGALLALA AQUIFER	SHERMAN	CANADIAN	316,971	298,567	262,820	229,557	198,809	169,672
BLAINE AQUIFER	WHEELER	RED	32,500	31,250	31,250	31,250	31,250	31,250
DIRECT REUSE	WHEELER	RED	95	95	95	95	95	95
LIVESTOCK LOCAL SUPPLY	WHEELER	RED	1,561	1,561	1,561	1,561	1,561	1,561
OGALLALA AQUIFER	WHEELER	RED	120,205	114,819	112,163	106,500	99,802	92,993
OTHER AQUIFER	WHEELER	RED	334	333	333	332	332	332
RED RIVER COMBINED RUN-OF-RIVER IRRIGATION	WHEELER	RED	603	603	603	603	603	603
SEYMOUR AQUIFER	WHEELER	RED	0	0	0	0	0	0

WUG Name	WUG County	WUG Basin	Source Name	Source County	Source Basin	WS2010	WS2020	WS2030	WS2040	WS2050	WS2060
CLAUDE	ARMSTRONG	RED	OGALLALA AQUIFER	ARMSTRONG	RED	532	479	431	387	347	310
COUNTY-OTHER	ARMSTRONG	RED	OGALLALA AQUIFER	ARMSTRONG	RED	400	400	400	400	400	400
MINING	ARMSTRONG	RED	OGALLALA AQUIFER	ARMSTRONG	RED	82	56	52	53	58	64
IRRIGATION	ARMSTRONG	RED	OGALLALA AQUIFER	ARMSTRONG	RED	5118	4688	4544	4305	3827	3349
LIVESTOCK	ARMSTRONG	RED	LIVESTOCK LOCAL SUPPLY	ARMSTRONG	RED	121	121	121	121	121	121
LIVESTOCK	ARMSTRONG	RED	OGALLALA AQUIFER	ARMSTRONG	RED	547	547	547	547	547	547
LIVESTOCK	ARMSTRONG	RED	OTHER AQUIFER	ARMSTRONG	RED	102	102	102	102	102	102
GROOM	CARSON	RED	OGALLALA AQUIFER	CARSON	RED	166	158	152	150	139	124
PANHANDLE	CARSON	RED	OGALLALA AQUIFER	CARSON	RED	672	641	615	608	562	501
SKELLYTOWN	CARSON	CANADIAN	OGALLALA AQUIFER	CARSON	CANADIAN	357	341	327	323	299	266
WHITE DEER	CARSON	CANADIAN	OGALLALA AQUIFER	CARSON	CANADIAN	250	250	250	250	250	250
WHITE DEER	CARSON	RED	OGALLALA AQUIFER	CARSON	RED	120	120	120	120	120	120
COUNTY-OTHER	CARSON	CANADIAN	OGALLALA AQUIFER	CARSON	CANADIAN	249	237	228	225	208	185
COUNTY-OTHER	CARSON	RED	OGALLALA AQUIFER	CARSON	RED	215	205	197	194	180	160
MANUFACTURING	CARSON	RED	OGALLALA AQUIFER	CARSON	RED	706	756	802	889	963	1024
MINING	CARSON	CANADIAN	OGALLALA AQUIFER	CARSON	CANADIAN	1173	1071	1021	1031	1036	1001
MINING	CARSON	RED	OGALLALA AQUIFER	CARSON	RED	500	500	500	500	500	500
IRRIGATION	CARSON	CANADIAN	DIRECT REUSE	CARSON	CANADIAN	0	0	0	0	0	0
IRRIGATION	CARSON	CANADIAN	OGALLALA AQUIFER	CARSON	CANADIAN	13960	11693	11397	10797	8638	8397
IRRIGATION	CARSON	RED	DIRECT REUSE	CARSON	RED	67	64	62	61	56	50
IRRIGATION	CARSON	RED	OGALLALA AQUIFER	CARSON	RED	44815	37537	36585	34660	27730	26958
IRRIGATION	CARSON	RED	RED RIVER COMBINED RUN-OF-RIVER IRRIGATION	CARSON	RED	300	300	300	300	300	300
LIVESTOCK	CARSON	CANADIAN	LIVESTOCK LOCAL SUPPLY	CARSON	CANADIAN	125	125	125	125	125	125
LIVESTOCK	CARSON	CANADIAN	OGALLALA AQUIFER	CARSON	CANADIAN	550	550	550	550	550	550
LIVESTOCK	CARSON	RED	LIVESTOCK LOCAL SUPPLY	CARSON	RED	159	159	159	159	159	159
LIVESTOCK	CARSON	RED	OGALLALA AQUIFER	CARSON	RED	650	650	650	650	650	650
HI TEXAS WATER COMPANY	CARSON	CANADIAN	OGALLALA AQUIFER	CARSON	CANADIAN	100	100	100	100	100	100
CHILDRESS	CHILDRESS	RED	GREENBELT LAKE/RESERVOIR	RESERVOIR	RED	1457	1481	1502	1509	1510	1471
COUNTY-OTHER	CHILDRESS	RED	GREENBELT LAKE/RESERVOIR	RESERVOIR	RED	196	199	202	203	203	198
COUNTY-OTHER	CHILDRESS	RED	SEYMOUR AQUIFER	CHILDRESS	RED	20	20	20	20	20	20
MINING	CHILDRESS	RED	OTHER LOCAL SUPPLY	CHILDRESS	RED	21	21	21	21	21	21
IRRIGATION	CHILDRESS	RED	BLAINE AQUIFER	CHILDRESS	RED	7218	5319	5150	4868	4305	3742
IRRIGATION	CHILDRESS	RED	DIRECT REUSE	CHILDRESS	RED	146	148	150	151	151	147
IRRIGATION	CHILDRESS	RED	OTHER AQUIFER	CHILDRESS	RED	62	62	62	62	62	62
IRRIGATION	CHILDRESS	RED	RED RIVER RUN-OF-RIVER IRRIGATION	CHILDRESS	RED	28	28	28	28	28	28
IRRIGATION	CHILDRESS	RED	SEYMOUR AQUIFER	CHILDRESS	RED	200	200	200	200	200	200
LIVESTOCK	CHILDRESS	RED	LIVESTOCK LOCAL SUPPLY	CHILDRESS	RED	300	300	300	300	300	300
LIVESTOCK	CHILDRESS	RED	SEYMOUR AQUIFER	CHILDRESS	RED	300	400	400	400	400	400
WELLINGTON	COLLINGSWORTH	RED	SEYMOUR AQUIFER	COLLINGSWORTH	RED	500	500	500	500	500	500
COUNTY-OTHER	COLLINGSWORTH	RED	BLAINE AQUIFER	COLLINGSWORTH	RED	83	83	83	83	83	83
COUNTY-OTHER	COLLINGSWORTH	RED	OTHER AQUIFER	COLLINGSWORTH	RED	6	6	6	6	6	6
COUNTY-OTHER	COLLINGSWORTH	RED	SEYMOUR AQUIFER	COLLINGSWORTH	RED	158	158	158	158	158	158
IRRIGATION	COLLINGSWORTH	RED	BLAINE AQUIFER	COLLINGSWORTH	RED	9600	7400	7100	6800	6000	5300
IRRIGATION	COLLINGSWORTH	RED	DIRECT REUSE	COLLINGSWORTH	RED	50	50	50	50	50	50
IRRIGATION	COLLINGSWORTH	RED	OGALLALA AQUIFER	COLLINGSWORTH	RED	500	500	500	500	500	500
IRRIGATION	COLLINGSWORTH	RED	RED RIVER COMBINED RUN-OF-RIVER IRRIGATION	COLLINGSWORTH	RED	798	798	798	798	798	798
IRRIGATION	COLLINGSWORTH	RED	SEYMOUR AQUIFER	COLLINGSWORTH	RED	18700	14700	14200	13500	12000	10500
LIVESTOCK	COLLINGSWORTH	RED	BLAINE AQUIFER	COLLINGSWORTH	RED	36	36	36	36	36	36
LIVESTOCK	COLLINGSWORTH	RED	LIVESTOCK LOCAL SUPPLY	COLLINGSWORTH	RED	750	750	750	750	750	750
LIVESTOCK	COLLINGSWORTH	RED	OGALLALA AQUIFER	COLLINGSWORTH	RED	23	23	23	23	23	23
LIVESTOCK	COLLINGSWORTH	RED	OTHER AQUIFER	COLLINGSWORTH	RED	24	24	24	24	24	24
LIVESTOCK	COLLINGSWORTH	RED	SEYMOUR AQUIFER	COLLINGSWORTH	RED	26	26	26	26	26	26
DALHART	DALLAM	CANADIAN	OGALLALA AQUIFER	DALLAM	CANADIAN	1319	1422	1487	1503	1471	1403
COUNTY-OTHER	DALLAM	CANADIAN	OGALLALA AQUIFER	DALLAM	CANADIAN	181	195	204	206	202	192
IRRIGATION	DALLAM	CANADIAN	DIRECT REUSE	DALLAM	CANADIAN	430	421	409	391	379	379
IRRIGATION	DALLAM	CANADIAN	DOCKUM AQUIFER	DALLAM	CANADIAN	6806	6806	6806	6806	6806	6806

Region A Water User Group Supply
(Ac-ft per Year)

WUG Name	WUG County	WUG Basin	Source Name	Source County	Source Basin	WS2010	WS2020	WS2030	WS2040	WS2050	WS2060
IRRIGATION	DALLAM	CANADIAN	OGALLALA AQUIFER	DALLAM	CANADIAN	151906	135104	118797	103856	90356	77787
LIVESTOCK	DALLAM	CANADIAN	LIVESTOCK LOCAL SUPPLY	DALLAM	CANADIAN	741	741	741	741	741	741
LIVESTOCK	DALLAM	CANADIAN	OGALLALA AQUIFER	DALLAM	CANADIAN	2768	3913	4255	4632	5047	5505
TEXLINE	DALLAM	CANADIAN	OGALLALA AQUIFER	DALLAM	CANADIAN	250	250	250	250	250	250
CLARENDON	DONLEY	RED	GREENBELT LAKE/RESERVOIR	RESERVOIR	RED	440	440	440	440	440	440
COUNTY-OTHER	DONLEY	RED	GREENBELT LAKE/RESERVOIR	RESERVOIR	RED	219	210	191	171	154	128
COUNTY-OTHER	DONLEY	RED	OGALLALA AQUIFER	DONLEY	RED	180	180	180	180	180	180
MINING	DONLEY	RED	OGALLALA AQUIFER	DONLEY	RED	50	45	44	43	42	42
IRRIGATION	DONLEY	RED	OGALLALA AQUIFER	DONLEY	RED	32000	29676	28771	27257	24228	21200
IRRIGATION	DONLEY	RED	RED RIVER COMBINED RUN-OF-RIVER IRRIGATION	DONLEY	RED	195	195	195	195	195	195
LIVESTOCK	DONLEY	RED	LIVESTOCK LOCAL SUPPLY	DONLEY	RED	1225	1225	1225	1225	1225	1225
LIVESTOCK	DONLEY	RED	OGALLALA AQUIFER	DONLEY	RED	150	150	150	150	150	150
LIVESTOCK	DONLEY	RED	OTHER AQUIFER	DONLEY	RED	71	71	71	71	71	71
LEFORS	GRAY	RED	OGALLALA AQUIFER	GRAY	RED	150	137	87	51	40	34
MCLEAN	GRAY	RED	OGALLALA AQUIFER	GRAY	RED	462	462	462	447	425	400
PAMPA	GRAY	CANADIAN	MEREDITH LAKE/RESERVOIR	RESERVOIR	CANADIAN	944	1375	1337	1285	1206	1130
PAMPA	GRAY	CANADIAN	OGALLALA AQUIFER	GRAY	CANADIAN	1000	750	563	422	317	238
PAMPA	GRAY	CANADIAN	OGALLALA AQUIFER	ROBERTS	CANADIAN	1888	1898	1845	1773	1665	1559
COUNTY-OTHER	GRAY	CANADIAN	OGALLALA AQUIFER	GRAY	CANADIAN	432	432	432	432	432	432
COUNTY-OTHER	GRAY	RED	OGALLALA AQUIFER	GRAY	RED	197	197	197	197	197	197
MANUFACTURING	GRAY	CANADIAN	OGALLALA AQUIFER	GRAY	CANADIAN	4768	4794	4875	5193	5555	5532
MINING	GRAY	CANADIAN	OGALLALA AQUIFER	GRAY	CANADIAN	125	125	125	125	125	125
MINING	GRAY	RED	OGALLALA AQUIFER	GRAY	RED	2500	2500	2500	2500	2500	2500
IRRIGATION	GRAY	CANADIAN	CANADIAN RIVER RUN-OF-RIVER IRRIGATION	GRAY	CANADIAN	1	1	1	1	1	1
IRRIGATION	GRAY	CANADIAN	DIRECT REUSE	GRAY	CANADIAN	246	246	246	246	246	246
IRRIGATION	GRAY	CANADIAN	OGALLALA AQUIFER	GRAY	CANADIAN	5635	5065	4910	4652	4135	3618
IRRIGATION	GRAY	RED	OGALLALA AQUIFER	GRAY	RED	17070	15345	14875	14092	12526	10960
IRRIGATION	GRAY	RED	RED RIVER COMBINED RUN-OF-RIVER IRRIGATION	GRAY	RED	33	33	33	33	33	33
LIVESTOCK	GRAY	CANADIAN	LIVESTOCK LOCAL SUPPLY	GRAY	CANADIAN	732	732	732	732	732	732
LIVESTOCK	GRAY	CANADIAN	OGALLALA AQUIFER	GRAY	CANADIAN	100	100	100	100	100	100
LIVESTOCK	GRAY	RED	LIVESTOCK LOCAL SUPPLY	GRAY	RED	2000	2000	2000	2000	2000	2000
LIVESTOCK	GRAY	RED	OGALLALA AQUIFER	GRAY	RED	200	200	200	200	200	200
STEAM ELECTRIC POWER	GRAY	CANADIAN	OGALLALA AQUIFER	GRAY	CANADIAN	2507	1409	2112	2299	2952	3087
MEMPHIS	HALL	RED	GREENBELT LAKE/RESERVOIR	RESERVOIR	RED	100	100	100	100	100	100
MEMPHIS	HALL	RED	OGALLALA AQUIFER	DONLEY	RED	342	260	200	200	200	200
COUNTY-OTHER	HALL	RED	GREENBELT LAKE/RESERVOIR	RESERVOIR	RED	152	152	152	152	152	152
COUNTY-OTHER	HALL	RED	OGALLALA AQUIFER	DONLEY	RED	85	85	85	85	85	85
COUNTY-OTHER	HALL	RED	SEYMOUR AQUIFER	HALL	RED	192	192	192	192	192	192
MINING	HALL	RED	OTHER AQUIFER	HALL	RED	22	22	22	22	22	22
IRRIGATION	HALL	RED	RED RIVER RUN-OF-RIVER IRRIGATION	HALL	RED	59	59	59	59	59	59
IRRIGATION	HALL	RED	SEYMOUR AQUIFER	HALL	RED	16719	10731	10403	9855	8760	7665
LIVESTOCK	HALL	RED	LIVESTOCK LOCAL SUPPLY	HALL	RED	301	301	301	301	301	301
LIVESTOCK	HALL	RED	OTHER AQUIFER	HALL	RED	18	18	18	18	18	18
LIVESTOCK	HALL	RED	SEYMOUR AQUIFER	HALL	RED	28	28	26	26	26	26
GRUVER	HANSFORD	CANADIAN	OGALLALA AQUIFER	HANSFORD	CANADIAN	400	250	100	50	0	0
SPEARMAN	HANSFORD	CANADIAN	OGALLALA AQUIFER	HANSFORD	CANADIAN	1250	800	500	200	0	0
COUNTY-OTHER	HANSFORD	CANADIAN	OGALLALA AQUIFER	HANSFORD	CANADIAN	413	424	440	487	535	554
MANUFACTURING	HANSFORD	CANADIAN	OGALLALA AQUIFER	HANSFORD	CANADIAN	90	91	93	101	111	120
MINING	HANSFORD	CANADIAN	OGALLALA AQUIFER	HANSFORD	CANADIAN	600	600	600	600	600	600
IRRIGATION	HANSFORD	CANADIAN	CANADIAN RIVER COMBINED RUN-OF-RIVER IRRIGATION	HANSFORD	CANADIAN	22	22	22	22	22	22
IRRIGATION	HANSFORD	CANADIAN	OGALLALA AQUIFER	HANSFORD	CANADIAN	130522	114000	110000	101067	90800	80500
LIVESTOCK	HANSFORD	CANADIAN	LIVESTOCK LOCAL SUPPLY	HANSFORD	CANADIAN	2464	2464	2464	2464	2464	2464
LIVESTOCK	HANSFORD	CANADIAN	OGALLALA AQUIFER	HANSFORD	CANADIAN	1219	1492	1792	2122	2484	2882
DALHART	HARTLEY	CANADIAN	OGALLALA AQUIFER	HARTLEY	CANADIAN	686	710	721	726	717	680
COUNTY-OTHER	HARTLEY	CANADIAN	OGALLALA AQUIFER	HARTLEY	CANADIAN	523	541	550	553	546	519
IRRIGATION	HARTLEY	CANADIAN	OGALLALA AQUIFER	HARTLEY	CANADIAN	113200	101125	89569	78674	68549	59098

Region A Water User Group Supply
(Ac-ft per Year)

WUG Name	WUG County	WUG Basin	Source Name	Source County	Source Basin	WS2010	WS2020	WS2030	WS2040	WS2050	WS2060
LIVESTOCK	HARTLEY	CANADIAN	DOCKUM AQUIFER	HARTLEY	CANADIAN	1161	1161	1161	1161	1161	1161
LIVESTOCK	HARTLEY	CANADIAN	LIVESTOCK LOCAL SUPPLY	HARTLEY	CANADIAN	1702	1702	1702	1702	1702	1702
LIVESTOCK	HARTLEY	CANADIAN	OGALLALA AQUIFER	HARTLEY	CANADIAN	2243	4240	4868	5559	6321	7161
MANUFACTURING	HARTLEY	CANADIAN	OGALLALA AQUIFER	HARTLEY	CANADIAN	5	5	5	5	5	5
CANADIAN	HEMPHILL	CANADIAN	OGALLALA AQUIFER	HEMPHILL	CANADIAN	475	477	461	444	432	411
COUNTY-OTHER	HEMPHILL	CANADIAN	OGALLALA AQUIFER	HEMPHILL	CANADIAN	132	132	132	132	132	132
COUNTY-OTHER	HEMPHILL	RED	OGALLALA AQUIFER	HEMPHILL	RED	90	90	90	90	90	90
MANUFACTURING	HEMPHILL	RED	OGALLALA AQUIFER	HEMPHILL	RED	1	1	1	1	1	1
IRRIGATION	HEMPHILL	CANADIAN	OGALLALA AQUIFER	HEMPHILL	CANADIAN	1259	1176	1140	1080	960	840
IRRIGATION	HEMPHILL	RED	OGALLALA AQUIFER	HEMPHILL	RED	566	529	513	486	432	378
LIVESTOCK	HEMPHILL	CANADIAN	LIVESTOCK LOCAL SUPPLY	HEMPHILL	CANADIAN	524	524	524	524	524	524
LIVESTOCK	HEMPHILL	CANADIAN	OGALLALA AQUIFER	HEMPHILL	CANADIAN	500	500	500	500	500	500
LIVESTOCK	HEMPHILL	RED	LIVESTOCK LOCAL SUPPLY	HEMPHILL	RED	364	364	364	364	364	364
LIVESTOCK	HEMPHILL	RED	OGALLALA AQUIFER	HEMPHILL	RED	450	450	450	450	450	450
MINING	HEMPHILL	RED	OGALLALA AQUIFER	HEMPHILL	RED	1046	1046	940	749	601	481
MINING	HEMPHILL	CANADIAN	OGALLALA AQUIFER	HEMPHILL	CANADIAN	1529	1529	1374	1095	878	702
BORGER	HUTCHINSON	CANADIAN	OGALLALA AQUIFER	HUTCHINSON	CANADIAN	1870	1274	994	729	515	344
BORGER	HUTCHINSON	CANADIAN	OGALLALA AQUIFER	ROBERTS	CANADIAN	1132	2506	2079	1904	1711	1499
FRITCH	HUTCHINSON	CANADIAN	OGALLALA AQUIFER	CARSON	CANADIAN	587	545	506	482	458	419
STINNETT	HUTCHINSON	CANADIAN	OGALLALA AQUIFER	HUTCHINSON	CANADIAN	594	552	512	488	463	425
COUNTY-OTHER	HUTCHINSON	CANADIAN	OGALLALA AQUIFER	HUTCHINSON	CANADIAN	56	57	57	55	52	49
MANUFACTURING	HUTCHINSON	CANADIAN	DIRECT REUSE	HUTCHINSON	CANADIAN	1045	1045	1045	1045	1045	1045
MANUFACTURING	HUTCHINSON	CANADIAN	MEREDITH LAKE/RESERVOIR	RESERVOIR	CANADIAN	1144	1681	1681	1681	1681	1681
MANUFACTURING	HUTCHINSON	CANADIAN	OGALLALA AQUIFER	HUTCHINSON	CANADIAN	20320	21606	22429	23279	24012	25382
MANUFACTURING	HUTCHINSON	CANADIAN	OGALLALA AQUIFER	ROBERTS	CANADIAN	1150	1323	1750	1925	2118	2330
MINING	HUTCHINSON	CANADIAN	OGALLALA AQUIFER	HUTCHINSON	CANADIAN	593	536	506	501	505	487
IRRIGATION	HUTCHINSON	CANADIAN	CANADIAN RIVER COMBINED RUN-OF-RIVER IRRIGATION	HUTCHINSON	CANADIAN	96	96	96	96	96	96
IRRIGATION	HUTCHINSON	CANADIAN	OGALLALA AQUIFER	HUTCHINSON	CANADIAN	28000	27700	27000	26000	25000	23000
LIVESTOCK	HUTCHINSON	CANADIAN	LIVESTOCK LOCAL SUPPLY	HUTCHINSON	CANADIAN	493	493	493	493	493	493
LIVESTOCK	HUTCHINSON	CANADIAN	OGALLALA AQUIFER	HUTCHINSON	CANADIAN	192	196	205	215	227	239
HI TEXAS WATER COMPANY	HUTCHINSON	CANADIAN	OGALLALA AQUIFER	CARSON	CANADIAN	400	400	400	400	400	400
TCW SUPPLY INC	HUTCHINSON	CANADIAN	OGALLALA AQUIFER	HUTCHINSON	CANADIAN	787	730	678	646	613	562
BOOKER	LIPSCOMB	CANADIAN	OGALLALA AQUIFER	LIPSCOMB	CANADIAN	356	364	353	343	338	322
COUNTY-OTHER	LIPSCOMB	CANADIAN	OGALLALA AQUIFER	LIPSCOMB	CANADIAN	473	473	473	473	473	473
MANUFACTURING	LIPSCOMB	CANADIAN	OGALLALA AQUIFER	LIPSCOMB	CANADIAN	120	120	120	120	120	120
MINING	LIPSCOMB	CANADIAN	OGALLALA AQUIFER	LIPSCOMB	CANADIAN	1235	1235	1114	887	713	574
IRRIGATION	LIPSCOMB	CANADIAN	CANADIAN RIVER COMBINED RUN-OF-RIVER IRRIGATION	LIPSCOMB	CANADIAN	66	66	66	66	66	66
IRRIGATION	LIPSCOMB	CANADIAN	OGALLALA AQUIFER	LIPSCOMB	CANADIAN	16956	15546	15070	14277	12690	11104
LIVESTOCK	LIPSCOMB	CANADIAN	LIVESTOCK LOCAL SUPPLY	LIPSCOMB	CANADIAN	657	657	657	657	657	657
LIVESTOCK	LIPSCOMB	CANADIAN	OGALLALA AQUIFER	LIPSCOMB	CANADIAN	348	350	371	394	419	447
CACTUS	MOORE	CANADIAN	OGALLALA AQUIFER	MOORE	CANADIAN	533	615	411	353	306	261
DUMAS	MOORE	CANADIAN	OGALLALA AQUIFER	HARTLEY	CANADIAN	1823	1975	1500	1300	1000	900
DUMAS	MOORE	CANADIAN	OGALLALA AQUIFER	MOORE	CANADIAN	911	600	500	350	200	100
SUNRAY	MOORE	CANADIAN	OGALLALA AQUIFER	MOORE	CANADIAN	534	608	674	700	650	650
COUNTY-OTHER	MOORE	CANADIAN	OGALLALA AQUIFER	MOORE	CANADIAN	700	960	1000	1000	1000	1000
MANUFACTURING	MOORE	CANADIAN	OGALLALA AQUIFER	MOORE	CANADIAN	7706	7650	7881	7975	8055	8369
STEAM ELECTRIC POWER	MOORE	CANADIAN	OGALLALA AQUIFER	MOORE	CANADIAN	125	101	83	72	64	59
MINING	MOORE	CANADIAN	OGALLALA AQUIFER	MOORE	CANADIAN	700	700	630	567	510	459
IRRIGATION	MOORE	CANADIAN	CANADIAN RIVER COMBINED RUN-OF-RIVER IRRIGATION	MOORE	CANADIAN	7	7	7	7	7	7
IRRIGATION	MOORE	CANADIAN	DIRECT REUSE	MOORE	CANADIAN	547	592	633	664	684	696
IRRIGATION	MOORE	CANADIAN	DOCKUM AQUIFER	MOORE	CANADIAN	14100	14100	13300	11600	10200	8900
IRRIGATION	MOORE	CANADIAN	OGALLALA AQUIFER	MOORE	CANADIAN	80500	72212	64504	56716	48993	41407
LIVESTOCK	MOORE	CANADIAN	LIVESTOCK LOCAL SUPPLY	MOORE	CANADIAN	981	981	981	981	981	981
LIVESTOCK	MOORE	CANADIAN	OGALLALA AQUIFER	MOORE	CANADIAN	1850	2624	2950	3309	3704	4139
FRITCH	MOORE	CANADIAN	OGALLALA AQUIFER	CARSON	CANADIAN	4	6	8	10	11	11
BOOKER	OCHILTREE	CANADIAN	OGALLALA AQUIFER	OCHILTREE	CANADIAN	2	2	2	2	2	2

Region A Water User Group Supply
(Ac-ft per Year)

WUG Name	WUG County	WUG Basin	Source Name	Source County	Source Basin	WS2010	WS2020	WS2030	WS2040	WS2050	WS2060
PERRYTON	OCHILTREE	CANADIAN	OGALLALA AQUIFER	OCHILTREE	CANADIAN	3130	3130	3130	3130	3130	3130
COUNTY-OTHER	OCHILTREE	CANADIAN	OGALLALA AQUIFER	OCHILTREE	CANADIAN	386	406	429	474	523	550
MINING	OCHILTREE	CANADIAN	OGALLALA AQUIFER	OCHILTREE	CANADIAN	1148	1248	1027	818	661	522
IRRIGATION	OCHILTREE	CANADIAN	OGALLALA AQUIFER	OCHILTREE	CANADIAN	60844	51839	50252	47607	42317	37028
LIVESTOCK	OCHILTREE	CANADIAN	LIVESTOCK LOCAL SUPPLY	OCHILTREE	CANADIAN	2506	2506	2506	2506	2506	2506
LIVESTOCK	OCHILTREE	CANADIAN	OGALLALA AQUIFER	OCHILTREE	CANADIAN	861	957	1099	1255	1426	1613
VEGA	OLDHAM	CANADIAN	OGALLALA AQUIFER	OLDHAM	CANADIAN	529	529	529	529	529	529
COUNTY-OTHER	OLDHAM	CANADIAN	DOCKUM AQUIFER	OLDHAM	CANADIAN	384	384	384	384	384	384
COUNTY-OTHER	OLDHAM	CANADIAN	OGALLALA AQUIFER	OLDHAM	CANADIAN	160	160	160	160	160	160
COUNTY-OTHER	OLDHAM	RED	OGALLALA AQUIFER	OLDHAM	RED	46	46	45	44	44	44
MINING	OLDHAM	CANADIAN	DOCKUM AQUIFER	OLDHAM	CANADIAN	283	283	283	283	283	283
MINING	OLDHAM	CANADIAN	OGALLALA AQUIFER	OLDHAM	CANADIAN	3	3	3	3	3	3
MINING	OLDHAM	RED	OGALLALA AQUIFER	OLDHAM	RED	232	237	246	263	291	306
IRRIGATION	OLDHAM	CANADIAN	DOCKUM AQUIFER	OLDHAM	CANADIAN	562	562	562	562	562	562
IRRIGATION	OLDHAM	CANADIAN	OGALLALA AQUIFER	OLDHAM	CANADIAN	2763	2511	2416	2259	1946	1632
IRRIGATION	OLDHAM	RED	OGALLALA AQUIFER	OLDHAM	RED	910	841	816	773	687	601
LIVESTOCK	OLDHAM	CANADIAN	DOCKUM AQUIFER	OLDHAM	CANADIAN	180	180	180	180	180	180
LIVESTOCK	OLDHAM	CANADIAN	LIVESTOCK LOCAL SUPPLY	OLDHAM	CANADIAN	1187	1187	1187	1187	1187	1187
LIVESTOCK	OLDHAM	CANADIAN	OGALLALA AQUIFER	OLDHAM	CANADIAN	50	50	50	50	50	50
LIVESTOCK	OLDHAM	RED	LIVESTOCK LOCAL SUPPLY	OLDHAM	RED	62	62	62	62	62	62
LIVESTOCK	OLDHAM	RED	OGALLALA AQUIFER	OLDHAM	RED	20	20	20	20	20	20
AMARILLO	POTTER	CANADIAN	MEREDITH LAKE/RESERVOIR	RESERVOIR	CANADIAN	1402	3167	3217	3313	3420	3449
AMARILLO	POTTER	CANADIAN	OGALLALA AQUIFER	CARSON	CANADIAN	1833	1597	1136	788	500	339
AMARILLO	POTTER	CANADIAN	OGALLALA AQUIFER	CARSON	RED	1833	1821	1790	1704	1620	1505
AMARILLO	POTTER	CANADIAN	OGALLALA AQUIFER	ROBERTS	CANADIAN	9048	8882	8666	8521	8397	8286
AMARILLO	POTTER	RED	MEREDITH LAKE/RESERVOIR	RESERVOIR	CANADIAN	1000	2258	2293	2362	2438	2458
AMARILLO	POTTER	RED	OGALLALA AQUIFER	CARSON	CANADIAN	1306	1138	810	562	357	241
AMARILLO	POTTER	RED	OGALLALA AQUIFER	CARSON	RED	1306	1298	1276	1214	1155	1073
AMARILLO	POTTER	RED	OGALLALA AQUIFER	ROBERTS	CANADIAN	6450	6288	6177	6074	5984	5907
COUNTY-OTHER	POTTER	CANADIAN	DOCKUM AQUIFER	POTTER	CANADIAN	566	566	566	566	566	566
COUNTY-OTHER	POTTER	CANADIAN	OGALLALA AQUIFER	POTTER	CANADIAN	1200	1200	1200	1200	1200	1200
COUNTY-OTHER	POTTER	RED	OGALLALA AQUIFER	POTTER	RED	831	831	831	831	831	831
MANUFACTURING	POTTER	CANADIAN	MEREDITH LAKE/RESERVOIR	RESERVOIR	CANADIAN	514	622	632	669	740	906
MANUFACTURING	POTTER	CANADIAN	OGALLALA AQUIFER	POTTER	CANADIAN	544	542	589	615	642	572
MANUFACTURING	POTTER	RED	MEREDITH LAKE/RESERVOIR	RESERVOIR	CANADIAN	6002	6547	6445	6176	5827	5598
MANUFACTURING	POTTER	RED	OGALLALA AQUIFER	POTTER	RED	145	144	157	164	171	152
STEAM ELECTRIC POWER	POTTER	CANADIAN	DIRECT REUSE	POTTER	CANADIAN	19603	23367	25030	26925	28992	31969
STEAM ELECTRIC POWER	POTTER	CANADIAN	MEREDITH LAKE/RESERVOIR	RESERVOIR	CANADIAN	259	0	0	0	0	0
STEAM ELECTRIC POWER	POTTER	CANADIAN	OGALLALA AQUIFER	POTTER	CANADIAN	2146	2146	2146	2146	2146	2146
STEAM ELECTRIC POWER	POTTER	CANADIAN	OGALLALA AQUIFER	ROBERTS	CANADIAN	424	0	0	0	0	0
MINING	POTTER	CANADIAN	OGALLALA AQUIFER	POTTER	CANADIAN	300	300	300	300	300	300
MINING	POTTER	RED	OGALLALA AQUIFER	POTTER	RED	150	150	150	150	160	165
IRRIGATION	POTTER	CANADIAN	CANADIAN RIVER COMBINED RUN-OF-RIVER	POTTER	CANADIAN	0	0	0	0	0	0
IRRIGATION	POTTER	CANADIAN	DIRECT REUSE	POTTER	CANADIAN	1500	1500	1500	1500	1500	1500
IRRIGATION	POTTER	CANADIAN	OGALLALA AQUIFER	POTTER	CANADIAN	2482	1949	1511	1215	1008	831
IRRIGATION	POTTER	RED	DIRECT REUSE	POTTER	RED	700	700	700	700	700	700
IRRIGATION	POTTER	RED	OGALLALA AQUIFER	POTTER	RED	2626	2353	2266	2116	1815	1510
LIVESTOCK	POTTER	CANADIAN	DOCKUM AQUIFER	POTTER	CANADIAN	13	13	13	13	13	13
LIVESTOCK	POTTER	CANADIAN	LIVESTOCK LOCAL SUPPLY	POTTER	CANADIAN	480	480	480	480	480	480
LIVESTOCK	POTTER	CANADIAN	OGALLALA AQUIFER	POTTER	CANADIAN	50	50	50	50	50	50
LIVESTOCK	POTTER	RED	LIVESTOCK LOCAL SUPPLY	POTTER	RED	36	36	36	36	36	36
LIVESTOCK	POTTER	RED	OGALLALA AQUIFER	POTTER	RED	50	50	50	50	50	50
AMARILLO	RANDALL	RED	MEREDITH LAKE/RESERVOIR	RESERVOIR	CANADIAN	1804	4143	4261	4443	4640	4723
AMARILLO	RANDALL	RED	OGALLALA AQUIFER	CARSON	CANADIAN	2361	2088	1504	1056	679	464
AMARILLO	RANDALL	RED	OGALLALA AQUIFER	CARSON	RED	2361	2381	2370	2285	2199	2060
AMARILLO	RANDALL	RED	OGALLALA AQUIFER	RANDALL	RED	2830	1600	1300	1000	800	600

Region A Water User Group Supply
(Ac-ft per Year)

WUG Name	WUG County	WUG Basin	Source Name	Source County	Source Basin	WS2010	WS2020	WS2030	WS2040	WS2050	WS2060
AMARILLO	RANDALL	RED	OGALLALA AQUIFER	ROBERTS	CANADIAN	8694	9815	10082	10330	10544	10732
AMARILLO	RANDALL	RED	OGALLALA AQUIFER	DEAF SMITH	RED	125	125	100	100	50	14
CANYON	RANDALL	RED	MEREDITH LAKE/RESERVOIR	RESERVOIR	CANADIAN	1000	1000	917	829	753	695
CANYON	RANDALL	RED	OGALLALA AQUIFER	RANDALL	RED	2110	1266	760	456	273	164
HAPPY	RANDALL	RED	DOCKUM AQUIFER	RANDALL	RED	50	50	50	50	50	50
LAKE TANGLEWOOD	RANDALL	RED	OGALLALA AQUIFER	RANDALL	RED	160	189	217	248	282	310
COUNTY-OTHER	RANDALL	CANADIAN	MEREDITH LAKE/RESERVOIR	RESERVOIR	CANADIAN	25	25	22	21	18	16
COUNTY-OTHER	RANDALL	RED	DOCKUM AQUIFER	RANDALL	RED	85	85	85	85	85	85
COUNTY-OTHER	RANDALL	RED	OGALLALA AQUIFER	RANDALL	RED	2982	3250	3250	3250	3250	3250
MANUFACTURING	RANDALL	RED	MEREDITH LAKE/RESERVOIR	RESERVOIR	CANADIAN	300	300	275	249	226	217
MANUFACTURING	RANDALL	RED	OGALLALA AQUIFER	RANDALL	RED	498	480	475	616	643	675
MINING	RANDALL	CANADIAN	OGALLALA AQUIFER	RANDALL	RED	2	3	3	3	3	3
MINING	RANDALL	RED	OGALLALA AQUIFER	RANDALL	RED	16	16	17	18	19	20
IRRIGATION	RANDALL	CANADIAN	DIRECT REUSE	RANDALL	CANADIAN	0	0	0	0	0	0
IRRIGATION	RANDALL	CANADIAN	OGALLALA AQUIFER	RANDALL	CANADIAN	0	0	0	0	0	0
IRRIGATION	RANDALL	RED	DIRECT REUSE	RANDALL	RED	700	700	700	700	700	700
IRRIGATION	RANDALL	RED	OGALLALA AQUIFER	RANDALL	RED	21602	19025	18416	17400	15370	13339
IRRIGATION	RANDALL	RED	RED RIVER COMBINED RUN-OF-RIVER IRRIGATION	RANDALL	RED	175	175	175	175	175	175
LIVESTOCK	RANDALL	RED	DOCKUM AQUIFER	RANDALL	RED	230	230	230	230	230	230
LIVESTOCK	RANDALL	RED	LIVESTOCK LOCAL SUPPLY	RANDALL	RED	511	511	511	511	511	511
LIVESTOCK	RANDALL	RED	OGALLALA AQUIFER	RANDALL	RED	2190	2200	2217	2234	2253	2274
MIAMI	ROBERTS	CANADIAN	OGALLALA AQUIFER	ROBERTS	CANADIAN	541	541	541	541	541	541
COUNTY-OTHER	ROBERTS	CANADIAN	OGALLALA AQUIFER	ROBERTS	CANADIAN	60	60	60	60	60	60
COUNTY-OTHER	ROBERTS	RED	OGALLALA AQUIFER	ROBERTS	RED	5	5	5	5	5	5
MINING	ROBERTS	CANADIAN	OGALLALA AQUIFER	ROBERTS	CANADIAN	1232	1232	1114	894	709	574
MINING	ROBERTS	RED	OGALLALA AQUIFER	ROBERTS	RED	38	38	34	28	22	18
IRRIGATION	ROBERTS	RED	OGALLALA AQUIFER	ROBERTS	RED	281	260	252	239	213	186
LIVESTOCK	ROBERTS	CANADIAN	LIVESTOCK LOCAL SUPPLY	ROBERTS	CANADIAN	500	500	500	500	500	500
LIVESTOCK	ROBERTS	CANADIAN	OGALLALA AQUIFER	ROBERTS	CANADIAN	100	100	100	100	100	100
LIVESTOCK	ROBERTS	RED	LIVESTOCK LOCAL SUPPLY	ROBERTS	RED	15	15	15	15	15	15
LIVESTOCK	ROBERTS	RED	OGALLALA AQUIFER	ROBERTS	RED	10	10	10	10	10	10
IRRIGATION	ROBERTS	CANADIAN	CANADIAN RIVER RUN-OF-RIVER IRRIGATION	ROBERTS	CANADIAN	72	72	72	72	72	72
IRRIGATION	ROBERTS	CANADIAN	OGALLALA AQUIFER	ROBERTS	CANADIAN	5803	5379	5214	4940	4390	3842
STRATFORD	SHERMAN	CANADIAN	OGALLALA AQUIFER	SHERMAN	CANADIAN	1000	1000	1000	1000	1000	1000
COUNTY-OTHER	SHERMAN	CANADIAN	OGALLALA AQUIFER	SHERMAN	CANADIAN	218	236	243	250	257	260
MINING	SHERMAN	CANADIAN	OGALLALA AQUIFER	SHERMAN	CANADIAN	17	16	16	16	16	16
IRRIGATION	SHERMAN	CANADIAN	CANADIAN RIVER COMBINED RUN-OF-RIVER IRRIGATION	SHERMAN	CANADIAN	32	32	32	32	32	32
IRRIGATION	SHERMAN	CANADIAN	OGALLALA AQUIFER	SHERMAN	CANADIAN	147808	131122	114715	99926	86586	74047
LIVESTOCK	SHERMAN	CANADIAN	LIVESTOCK LOCAL SUPPLY	SHERMAN	CANADIAN	699	699	699	699	699	699
LIVESTOCK	SHERMAN	CANADIAN	OGALLALA AQUIFER	SHERMAN	CANADIAN	4234	4880	5190	5531	5907	6320
SHAMROCK	WHEELER	RED	OGALLALA AQUIFER	WHEELER	RED	1248	1248	1248	1248	1248	1248
WHEELER	WHEELER	RED	OGALLALA AQUIFER	WHEELER	RED	318	318	318	318	318	318
COUNTY-OTHER	WHEELER	RED	BLAINE AQUIFER	WHEELER	RED	15	15	15	15	15	15
COUNTY-OTHER	WHEELER	RED	OGALLALA AQUIFER	WHEELER	RED	348	348	348	348	348	348
COUNTY-OTHER	WHEELER	RED	OTHER AQUIFER	WHEELER	RED	22	22	22	22	22	22
MINING	WHEELER	RED	OGALLALA AQUIFER	WHEELER	RED	2001	2001	1810	1444	1148	922
IRRIGATION	WHEELER	RED	BLAINE AQUIFER	WHEELER	RED	15	15	15	15	15	15
IRRIGATION	WHEELER	RED	DIRECT REUSE	WHEELER	RED	95	95	95	95	95	95
IRRIGATION	WHEELER	RED	OGALLALA AQUIFER	WHEELER	RED	11311	9488	9198	8713	7745	6777
IRRIGATION	WHEELER	RED	OTHER AQUIFER	WHEELER	RED	280	280	280	280	280	280
IRRIGATION	WHEELER	RED	RED RIVER COMBINED RUN-OF-RIVER IRRIGATION	WHEELER	RED	580	580	580	580	580	580
LIVESTOCK	WHEELER	RED	BLAINE AQUIFER	WHEELER	RED	19	19	19	19	19	19
LIVESTOCK	WHEELER	RED	LIVESTOCK LOCAL SUPPLY	WHEELER	RED	1561	1561	1561	1561	1561	1561
LIVESTOCK	WHEELER	RED	OGALLALA AQUIFER	WHEELER	RED	250	250	250	250	250	250
LIVESTOCK	WHEELER	RED	OTHER AQUIFER	WHEELER	RED	29	29	29	29	29	29

Region A Water User Group Needs
(Ac-ft per Year)

WUG Name	County	Basin	WNS2010	WNS2020	WNS2030	WNS2040	WNS2050	WNS2060
CLAUDE	ARMSTRONG	RED	270	209	170	137	100	70
COUNTY-OTHER	ARMSTRONG	RED	291	288	292	296	297	300
IRRIGATION	ARMSTRONG	RED	0	0	0	0	0	0
LIVESTOCK	ARMSTRONG	RED	204	100	97	93	89	85
MINING	ARMSTRONG	RED	69	44	40	41	46	52
COUNTY-OTHER	CARSON	CANADIAN	176	163	154	154	143	126
COUNTY-OTHER	CARSON	RED	32	20	13	16	18	13
GROOM	CARSON	RED	24	15	10	12	14	10
HI TEXAS WATER COMPANY	CARSON	CANADIAN	45	45	45	47	52	56
IRRIGATION	CARSON	CANADIAN	0	0	0	0	0	0
IRRIGATION	CARSON	RED	367	364	362	361	356	350
LIVESTOCK	CARSON	CANADIAN	380	329	327	325	322	320
LIVESTOCK	CARSON	RED	497	444	441	439	437	434
MANUFACTURING	CARSON	RED	115	87	67	92	114	104
MINING	CARSON	CANADIAN	198	129	92	113	129	108
MINING	CARSON	RED	14	30	36	42	47	54
PANHANDLE	CARSON	RED	98	62	40	52	56	42
SKELLYTOWN	CARSON	CANADIAN	251	234	221	221	206	181
WHITE DEER	CARSON	CANADIAN	189	189	189	191	197	202
WHITE DEER	CARSON	RED	17	16	17	20	29	38
CHILDRESS	CHILDRESS	RED	0	0	0	0	0	0
COUNTY-OTHER	CHILDRESS	RED	20	20	20	20	20	20
IRRIGATION	CHILDRESS	RED	236	238	240	241	241	237
LIVESTOCK	CHILDRESS	RED	232	230	228	227	225	223
MINING	CHILDRESS	RED	4	5	5	5	5	5
COUNTY-OTHER	COLLINGSWORTH	RED	13	13	27	47	62	87
IRRIGATION	COLLINGSWORTH	RED	955	1,541	1,412	1,530	1,465	1,500
LIVESTOCK	COLLINGSWORTH	RED	398	295	293	290	288	285
WELLINGTON	COLLINGSWORTH	RED	44	43	54	69	80	99
COUNTY-OTHER	DALLAM	CANADIAN	0	0	0	0	0	0
DALHART	DALLAM	CANADIAN	0	0	0	0	0	0
IRRIGATION	DALLAM	CANADIAN	-132,889	-140,984	-148,630	-149,134	-133,737	-117,396
LIVESTOCK	DALLAM	CANADIAN	0	0	0	0	0	0
TEXLINE	DALLAM	CANADIAN	39	23	13	10	15	26

Region A Water User Group Needs
(Ac-ft per Year)

WUG Name	County	Basin	WNS2010	WNS2020	WNS2030	WNS2040	WNS2050	WNS2060
CLARENDON	DONLEY	RED	0	0	0	0	0	0
COUNTY-OTHER	DONLEY	RED	180	180	180	180	180	180
IRRIGATION	DONLEY	RED	195	195	195	195	195	195
LIVESTOCK	DONLEY	RED	179	178	176	175	173	171
MINING	DONLEY	RED	35	31	30	29	28	28
COUNTY-OTHER	GRAY	CANADIAN	81	84	93	107	127	146
COUNTY-OTHER	GRAY	RED	37	38	43	49	58	66
IRRIGATION	GRAY	CANADIAN	247	247	247	247	247	247
IRRIGATION	GRAY	RED	33	33	33	33	33	33
LEFORS	GRAY	RED	64	52	4	-29	-35	-36
LIVESTOCK	GRAY	CANADIAN	621	605	601	597	593	588
LIVESTOCK	GRAY	RED	1,063	976	957	936	912	887
MANUFACTURING	GRAY	CANADIAN	504	411	424	696	1,040	1,198
MCLEAN	GRAY	RED	277	279	284	276	264	249
MINING	GRAY	CANADIAN	40	37	36	35	34	32
MINING	GRAY	RED	656	589	561	534	508	475
PAMPA	GRAY	CANADIAN	532	750	563	422	317	238
STEAM ELECTRIC POWER	GRAY	CANADIAN	0	0	0	0	0	0
COUNTY-OTHER	HALL	RED	76	50	34	47	42	66
IRRIGATION	HALL	RED	59	59	59	59	59	59
LIVESTOCK	HALL	RED	18	17	14	13	11	10
MEMPHIS	HALL	RED	0	-81	-140	-140	-140	-142
MINING	HALL	RED	7	8	8	8	8	8
COUNTY-OTHER	HANSFORD	CANADIAN	147	105	76	75	94	88
GRUVER	HANSFORD	CANADIAN	75	-77	-229	-282	-333	-334
IRRIGATION	HANSFORD	CANADIAN	-150	-1,005	-1,484	-4,548	-3,077	-1,640
LIVESTOCK	HANSFORD	CANADIAN	0	0	0	0	0	0
MANUFACTURING	HANSFORD	CANADIAN	41	39	39	45	53	58
MINING	HANSFORD	CANADIAN	57	67	71	75	79	84
SPEARMAN	HANSFORD	CANADIAN	543	55	-276	-611	-831	-849
COUNTY-OTHER	HARTLEY	CANADIAN	0	0	0	0	0	0
DALHART	HARTLEY	CANADIAN	0	0	0	0	0	0
IRRIGATION	HARTLEY	CANADIAN	-181,732	-180,523	-183,457	-179,983	-161,368	-142,079
LIVESTOCK	HARTLEY	CANADIAN	0	0	0	0	0	0

Region A Water User Group Needs
(Ac-ft per Year)

WUG Name	County	Basin	WNS2010	WNS2020	WNS2030	WNS2040	WNS2050	WNS2060
MANUFACTURING	HARTLEY	CANADIAN	0	0	0	0	0	0
CANADIAN	HEMPHILL	CANADIAN	0	0	0	0	0	0
COUNTY-OTHER	HEMPHILL	CANADIAN	22	21	25	29	32	36
COUNTY-OTHER	HEMPHILL	RED	42	42	44	45	47	49
IRRIGATION	HEMPHILL	CANADIAN	0	0	0	0	0	0
IRRIGATION	HEMPHILL	RED	0	0	0	0	0	0
LIVESTOCK	HEMPHILL	CANADIAN	266	263	261	258	254	251
LIVESTOCK	HEMPHILL	RED	296	294	292	290	288	286
MANUFACTURING	HEMPHILL	RED	0	0	0	0	0	0
MINING	HEMPHILL	CANADIAN	0	0	0	0	0	0
MINING	HEMPHILL	RED	0	0	0	0	0	0
BORGER	HUTCHINSON	CANADIAN	650	1,396	722	359	78	-196
COUNTY-OTHER	HUTCHINSON	CANADIAN	0	0	0	0	0	0
FRITCH	HUTCHINSON	CANADIAN	180	133	100	89	87	66
HI TEXAS WATER COMPANY	HUTCHINSON	CANADIAN	59	54	59	70	88	104
IRRIGATION	HUTCHINSON	CANADIAN	-15,008	-12,175	-11,652	-10,612	-7,534	-5,455
LIVESTOCK	HUTCHINSON	CANADIAN	0	0	0	0	0	0
MANUFACTURING	HUTCHINSON	CANADIAN	0	173	-64	-469	-784	-1,270
MINING	HUTCHINSON	CANADIAN	195	143	112	106	109	91
STINNETT	HUTCHINSON	CANADIAN	229	182	147	135	130	109
TCW SUPPLY INC	HUTCHINSON	CANADIAN	184	119	76	63	63	39
BOOKER	LIPSCOMB	CANADIAN	2	2	2	2	2	2
COUNTY-OTHER	LIPSCOMB	CANADIAN	79	71	83	94	100	117
IRRIGATION	LIPSCOMB	CANADIAN	66	66	66	66	66	66
LIVESTOCK	LIPSCOMB	CANADIAN	0	0	0	0	0	0
MANUFACTURING	LIPSCOMB	CANADIAN	31	25	20	16	12	4
MINING	LIPSCOMB	CANADIAN	0	0	0	0	0	0
CACTUS	MOORE	CANADIAN	0	0	-204	-262	-309	-354
COUNTY-OTHER	MOORE	CANADIAN	0	0	-264	-505	-652	-741
DUMAS	MOORE	CANADIAN	0	-387	-1,163	-1,672	-2,219	-2,478
FRITCH	MOORE	CANADIAN	0	0	0	0	0	0
IRRIGATION	MOORE	CANADIAN	-52,317	-48,090	-52,425	-54,994	-50,321	-45,420
LIVESTOCK	MOORE	CANADIAN	0	0	0	0	0	0
MANUFACTURING	MOORE	CANADIAN	-173	-800	-1,033	-1,396	-1,718	-2,067

Region A Water User Group Needs
(Ac-ft per Year)

WUG Name	County	Basin	WNS2010	WNS2020	WNS2030	WNS2040	WNS2050	WNS2060
MINING	MOORE	CANADIAN	0	0	0	0	0	0
STEAM ELECTRIC POWER	MOORE	CANADIAN	-75	-99	-117	-128	-136	-154
SUNRAY	MOORE	CANADIAN	0	0	0	-27	-108	-127
BOOKER	OCHILTREE	CANADIAN	0	0	0	0	0	0
COUNTY-OTHER	OCHILTREE	CANADIAN	205	225	248	293	342	369
IRRIGATION	OCHILTREE	CANADIAN	0	0	0	0	0	0
LIVESTOCK	OCHILTREE	CANADIAN	0	0	0	0	0	0
MINING	OCHILTREE	CANADIAN	0	100	0	0	0	0
PERRYTON	OCHILTREE	CANADIAN	1,170	995	865	777	734	679
COUNTY-OTHER	OLDHAM	CANADIAN	409	406	416	431	446	465
COUNTY-OTHER	OLDHAM	RED	7	6	8	11	16	21
IRRIGATION	OLDHAM	CANADIAN	0	0	0	0	0	0
IRRIGATION	OLDHAM	RED	0	0	0	0	0	0
LIVESTOCK	OLDHAM	CANADIAN	312	213	211	208	205	203
LIVESTOCK	OLDHAM	RED	33	29	29	29	29	29
MINING	OLDHAM	CANADIAN	135	130	127	124	122	119
MINING	OLDHAM	RED	55	52	58	73	98	109
VEGA	OLDHAM	CANADIAN	287	282	300	327	353	387
AMARILLO	POTTER	CANADIAN	9	300	-1,349	-2,961	-4,582	-5,950
AMARILLO	POTTER	RED	7	171	-961	-2,110	-3,266	-4,241
COUNTY-OTHER	POTTER	CANADIAN	756	405	76	-299	-708	-1,043
COUNTY-OTHER	POTTER	RED	138	-103	-329	-586	-866	-1,096
IRRIGATION	POTTER	CANADIAN	1,016	735	379	221	292	391
IRRIGATION	POTTER	RED	66	70	73	76	79	79
LIVESTOCK	POTTER	CANADIAN	88	86	85	83	81	79
LIVESTOCK	POTTER	RED	39	39	39	39	39	39
MANUFACTURING	POTTER	CANADIAN	0	0	-33	-57	-35	-43
MANUFACTURING	POTTER	RED	417	387	-187	-923	-1,675	-2,486
MINING	POTTER	CANADIAN	88	64	48	32	15	3
MINING	POTTER	RED	33	19	10	1	3	0

Region A Water User Group Needs
(Ac-ft per Year)

WUG Name	County	Basin	WNS2010	WNS2020	WNS2030	WNS2040	WNS2050	WNS2060
STEAM ELECTRIC POWER	POTTER	CANADIAN	0	126	372	663	1,127	0
AMARILLO	RANDALL	RED	8	313	-1,787	-3,971	-6,217	-8,146
CANYON	RANDALL	RED	672	-422	-1,245	-1,903	-2,452	-2,859
COUNTY-OTHER	RANDALL	CANADIAN	16	14	9	6	1	-3
COUNTY-OTHER	RANDALL	RED	361	-5	-597	-1,273	-2,009	-2,619
HAPPY	RANDALL	RED	39	33	28	23	17	12
IRRIGATION	RANDALL	CANADIAN	0	0	0	0	0	0
IRRIGATION	RANDALL	RED	0	0	0	0	0	0
LAKE TANGLEWOOD	RANDALL	RED	0	0	0	0	0	0
LIVESTOCK	RANDALL	CANADIAN	0	0	0	0	0	0
LIVESTOCK	RANDALL	RED	199	200	202	203	205	207
MANUFACTURING	RANDALL	RED	193	110	24	87	48	0
MINING	RANDALL	CANADIAN	0	0	0	0	0	0
MINING	RANDALL	RED	0	0	0	0	0	0
COUNTY-OTHER	ROBERTS	CANADIAN	19	18	22	28	32	35
COUNTY-OTHER	ROBERTS	RED	2	2	2	3	3	3
IRRIGATION	ROBERTS	CANADIAN	72	72	72	72	72	72
IRRIGATION	ROBERTS	RED	0	0	0	0	0	0
LIVESTOCK	ROBERTS	CANADIAN	225	225	224	223	222	222
LIVESTOCK	ROBERTS	RED	15	15	15	15	15	15
MIAMI	ROBERTS	CANADIAN	396	392	407	429	444	453
MINING	ROBERTS	CANADIAN	0	0	0	0	0	0
MINING	ROBERTS	RED	0	0	0	0	0	0
COUNTY-OTHER	SHERMAN	CANADIAN	0	0	0	0	0	0
IRRIGATION	SHERMAN	CANADIAN	-72,532	-69,367	-79,690	-82,955	-77,118	-69,190
LIVESTOCK	SHERMAN	CANADIAN	0	0	0	0	0	0
MINING	SHERMAN	CANADIAN	0	0	0	0	0	0
STRATFORD	SHERMAN	CANADIAN	372	317	295	273	254	244
COUNTY-OTHER	WHEELER	RED	108	107	109	106	107	112
IRRIGATION	WHEELER	RED	970	970	970	970	970	970
LIVESTOCK	WHEELER	RED	305	202	199	197	195	192
MINING	WHEELER	RED	0	0	0	0	0	0
SHAMROCK	WHEELER	RED	936	936	937	935	935	939
WHEELER	WHEELER	RED	27	27	27	27	27	27

Region A Water User Group Potentially Feasible Water Managment Strategy Supply
(Ac-ft per Year)

WUG Name	WUG County	WUG Basin	Project Name	Source Name	Source County	Source Basin	Selected	SS2010	SS2020	SS2030	SS2040	SS2050	SS2060
IRRIGATION	ARMSTRONG	RED	IRRIGATION CONSERVATION	CONSERVATION	ARMSTRONG	RED	Recommended	0	2,170	2,251	2,397	2,478	2,558
IRRIGATION	ARMSTRONG	RED	PRECIPITATION ENHANCEMENT	WEATHER MODIFICATION	ARMSTRONG	RED	Recommended	0	785	785	785	785	785
PANHANDLE	CARSON	RED	DRILL ADDITIONAL GROUNDWATER WELL	OGALLALA AQUIFER	CARSON	RED	Recommended	0	0	600	600	600	600
IRRIGATION	CARSON	CANADIAN	IRRIGATION CONSERVATION	CONSERVATION	CARSON	CANADIAN	Recommended	0	4,096	4,247	4,520	4,672	4,824
IRRIGATION	CARSON	RED	IRRIGATION CONSERVATION	CONSERVATION	CARSON	RED	Recommended	0	13,220	13,710	14,592	15,082	15,571
PANHANDLE	CARSON	RED	MUNICIPAL CONSERVATION	CONSERVATION	CARSON	RED	Recommended	0	17	29	28	25	23
IRRIGATION	CARSON	CANADIAN	PRECIPITATION ENHANCEMENT	WEATHER MODIFICATION	CARSON	CANADIAN	Recommended	0	1,471	1,471	1,471	1,471	1,471
IRRIGATION	CARSON	RED	PRECIPITATION ENHANCEMENT	WEATHER MODIFICATION	CARSON	RED	Recommended	0	4,750	4,750	4,750	4,750	4,750
IRRIGATION	CHILDRESS	RED	IRRIGATION CONSERVATION	CONSERVATION	CHILDRESS	RED	Recommended	0	1,640	1,704	1,819	1,883	1,946
IRRIGATION	CHILDRESS	RED	PRECIPITATION ENHANCEMENT	WEATHER MODIFICATION	CHILDRESS	RED	Alternate	0	620	620	620	620	620
IRRIGATION	COLLINGSWORTH	RED	IRRIGATION CONSERVATION	CONSERVATION	COLLINGSWORTH	RED	Recommended	0	2,879	3,021	3,276	3,418	3,560
IRRIGATION	COLLINGSWORTH	RED	PRECIPITATION ENHANCEMENT	WEATHER MODIFICATION	COLLINGSWORTH	RED	Alternate	1,397	1,397	1,397	1,397	1,397	1,397
TEXLINE	DALLAM	CANADIAN	DRILL ADDITIONAL GROUNDWATER WELL	OGALLALA AQUIFER	DALLAM	CANADIAN	Recommended	0	250	250	250	250	250
IRRIGATION	DALLAM	CANADIAN	IRRIGATION CONSERVATION	CONSERVATION	DALLAM	CANADIAN	Recommended	0	59,275	108,476	121,561	122,958	122,958
TEXLINE	DALLAM	CANADIAN	MUNICIPAL CONSERVATION	CONSERVATION	DALLAM	CANADIAN	Recommended	0	7	12	12	12	11
IRRIGATION	DALLAM	CANADIAN	PRECIPITATION ENHANCEMENT	WEATHER MODIFICATION	DALLAM	CANADIAN	Alternate	0	18,625	18,625	18,625	18,625	18,625
IRRIGATION	DONLEY	RED	IRRIGATION CONSERVATION	CONSERVATION	DONLEY	RED	Recommended	0	2,910	3,031	3,249	3,370	3,490
IRRIGATION	DONLEY	RED	PRECIPITATION ENHANCEMENT	WEATHER MODIFICATION	DONLEY	RED	Recommended	0	1,179	1,179	1,179	1,179	1,179
PAMPA	GRAY	CANADIAN	DRILL ADDITIONAL GROUNDWATER WELL	OGALLALA AQUIFER	GRAY	CANADIAN	Recommended	968	2,581	0	0	0	0
LEFORS	GRAY	RED	DRILL ADDITIONAL GROUNDWATER WELL	OGALLALA AQUIFER	GRAY	RED	Recommended	0	0	0	100	100	100
IRRIGATION	GRAY	CANADIAN	IRRIGATION CONSERVATION	CONSERVATION	GRAY	CANADIAN	Recommended	0	1,310	1,359	1,446	1,494	1,542
IRRIGATION	GRAY	RED	IRRIGATION CONSERVATION	CONSERVATION	GRAY	RED	Recommended	0	3,969	4,116	4,379	4,525	4,672
PAMPA	GRAY	CANADIAN	MUNICIPAL CONSERVATION	CONSERVATION	GRAY	CANADIAN	Recommended	0	15	65	65	65	65
LEFORS	GRAY	RED	MUNICIPAL CONSERVATION	CONSERVATION	GRAY	RED	Recommended	0	3	4	4	4	4
IRRIGATION	GRAY	CANADIAN	PRECIPITATION ENHANCEMENT	WEATHER MODIFICATION	GRAY	CANADIAN	Recommended	0	468	468	468	468	468
IRRIGATION	GRAY	RED	PRECIPITATION ENHANCEMENT	WEATHER MODIFICATION	GRAY	RED	Recommended	0	1,418	1,418	1,418	1,418	1,418
PAMPA	GRAY	CANADIAN	VOLUNTARY TRANSFER FROM OTHER USERS	OGALLALA AQUIFER	ROBERTS	CANADIAN	Recommended	0	0	0	0	1,000	1,000
COUNTY-OTHER	HALL	RED	DRILL ADDITIONAL GROUNDWATER WELL	OGALLALA AQUIFER	DONLEY	RED	Recommended	50	50	50	100	100	100
MEMPHIS	HALL	RED	DRILL ADDITIONAL GROUNDWATER WELL	OGALLALA AQUIFER	DONLEY	RED	Recommended	0	100	100	100	100	100
COUNTY-OTHER	HALL	RED	DRILL ADDITIONAL GROUNDWATER WELL	OGALLALA AQUIFER	BRISCOE	RED	Recommended	100	100	100	100	100	100
IRRIGATION	HALL	RED	IRRIGATION CONSERVATION	CONSERVATION	HALL	RED	Recommended	0	3,220	3,354	3,595	3,728	3,862
MEMPHIS	HALL	RED	MUNICIPAL CONSERVATION	CONSERVATION	HALL	RED	Recommended	0	13	22	22	22	22
IRRIGATION	HALL	RED	PRECIPITATION ENHANCEMENT	WEATHER MODIFICATION	HALL	RED	Alternate	0	1,304	1,304	1,304	1,304	1,304
MEMPHIS	HALL	RED	VOLUNTARY TRANSFER FROM OTHER USERS	GREENBELT LAKE/RESERVOIR	RESERVOIR	RED	Recommended	0	0	100	100	100	100
GRUVER	HANSFORD	CANADIAN	DRILL ADDITIONAL GROUNDWATER WELL	OGALLALA AQUIFER	HANSFORD	CANADIAN	Recommended	0	350	350	350	350	350
SPEARMAN	HANSFORD	CANADIAN	DRILL ADDITIONAL GROUNDWATER WELL	OGALLALA AQUIFER	HANSFORD	CANADIAN	Recommended	0	0	900	900	900	900
IRRIGATION	HANSFORD	CANADIAN	IRRIGATION CONSERVATION	CONSERVATION	HANSFORD	CANADIAN	Recommended	0	24,436	45,264	51,215	51,951	51,951
GRUVER	HANSFORD	CANADIAN	MUNICIPAL CONSERVATION	CONSERVATION	HANSFORD	CANADIAN	Recommended	0	10	16	17	17	17
SPEARMAN	HANSFORD	CANADIAN	MUNICIPAL CONSERVATION	CONSERVATION	HANSFORD	CANADIAN	Recommended	0	22	39	41	42	42
GRUVER	HANSFORD	CANADIAN	PALO DURO RESERVOIR	PALO DURO LAKE/RESERVOIR	RESERVOIR	CANADIAN	Alternate	0	0	116	116	116	116
SPEARMAN	HANSFORD	CANADIAN	PALO DURO RESERVOIR	PALO DURO LAKE/RESERVOIR	RESERVOIR	CANADIAN	Alternate	0	0	271	271	271	271
IRRIGATION	HANSFORD	CANADIAN	PRECIPITATION ENHANCEMENT	WEATHER MODIFICATION	HANSFORD	CANADIAN	Alternate	0	9,811	9,811	9,811	9,811	9,811
IRRIGATION	HARTLEY	CANADIAN	IRRIGATION CONSERVATION	CONSERVATION	HARTLEY	CANADIAN	Recommended	0	53,755	98,786	110,553	111,772	111,772
IRRIGATION	HARTLEY	CANADIAN	PRECIPITATION ENHANCEMENT	WEATHER MODIFICATION	HARTLEY	CANADIAN	Alternate	0	16,255	16,255	16,255	16,255	16,255
IRRIGATION	HEMPHILL	CANADIAN	IRRIGATION CONSERVATION	CONSERVATION	HEMPHILL	CANADIAN	Recommended	0	187	194	207	213	220
IRRIGATION	HEMPHILL	RED	IRRIGATION CONSERVATION	CONSERVATION	HEMPHILL	RED	Recommended	0	41	43	46	47	48
IRRIGATION	HEMPHILL	CANADIAN	PRECIPITATION ENHANCEMENT	WEATHER MODIFICATION	HEMPHILL	CANADIAN	Alternate	0	67	67	67	67	67
IRRIGATION	HEMPHILL	RED	PRECIPITATION ENHANCEMENT	WEATHER MODIFICATION	HEMPHILL	RED	Alternate	0	15	15	15	15	15
FRITCH	HUTCHINSON	CANADIAN	DRILL ADDITIONAL GROUNDWATER WELL	OGALLALA AQUIFER	CARSON	CANADIAN	Recommended	200	200	200	200	200	200
BORGER	HUTCHINSON	CANADIAN	DRILL ADDITIONAL GROUNDWATER WELL	OGALLALA AQUIFER	HUTCHINSON	CANADIAN	Recommended	0	0	336	336	748	500
FRITCH	HUTCHINSON	CANADIAN	DRILL ADDITIONAL GROUNDWATER WELL	OGALLALA AQUIFER	HUTCHINSON	CANADIAN	Recommended	0	200	200	200	200	200
IRRIGATION	HUTCHINSON	CANADIAN	IRRIGATION CONSERVATION	CONSERVATION	HUTCHINSON	CANADIAN	Recommended	0	7,514	14,044	15,905	16,128	16,128
BORGER	HUTCHINSON	CANADIAN	MUNICIPAL CONSERVATION	CONSERVATION	HUTCHINSON	CANADIAN	Recommended	0	24	71	114	107	102
IRRIGATION	HUTCHINSON	CANADIAN	PRECIPITATION ENHANCEMENT	WEATHER MODIFICATION	HUTCHINSON	CANADIAN	Recommended	0	2,965	2,965	2,965	2,965	2,965
MANUFACTURING	HUTCHINSON	CANADIAN	VOLUNTARY TRANSFER FROM OTHER USERS	OGALLALA AQUIFER	HUTCHINSON	CANADIAN	Recommended	0	0	664	664	1,252	1,500
IRRIGATION	LIPSCOMB	CANADIAN	IRRIGATION CONSERVATION	CONSERVATION	LIPSCOMB	CANADIAN	Recommended	0	2,279	2,360	2,506	2,587	2,668
IRRIGATION	LIPSCOMB	CANADIAN	PRECIPITATION ENHANCEMENT	WEATHER MODIFICATION	LIPSCOMB	CANADIAN	Alternate	0	784	784	784	784	784
CACTUS	MOORE	CANADIAN	DRILL ADDITIONAL GROUNDWATER WELL	OGALLALA AQUIFER	MOORE	CANADIAN	Recommended	300	700	350	1,500	1,100	800
COUNTY-OTHER	MOORE	CANADIAN	DRILL ADDITIONAL GROUNDWATER WELL	OGALLALA AQUIFER	MOORE	CANADIAN	Recommended	0	0	500	500	1,000	1,000
DUMAS	MOORE	CANADIAN	DRILL ADDITIONAL GROUNDWATER WELL	OGALLALA AQUIFER	MOORE	CANADIAN	Recommended	0	387	1,163	1,672	2,219	2,500
STEAM ELECTRIC POWER	MOORE	CANADIAN	DRILL ADDITIONAL GROUNDWATER WELL	OGALLALA AQUIFER	MOORE	CANADIAN	Recommended	200	200	200	200	200	200
SUNRAY	MOORE	CANADIAN	DRILL ADDITIONAL GROUNDWATER WELL	OGALLALA AQUIFER	MOORE	CANADIAN	Recommended	0	0	800	800	800	800
IRRIGATION	MOORE	CANADIAN	IRRIGATION CONSERVATION	CONSERVATION	MOORE	CANADIAN	Recommended	0	31,602	59,485	66,995	67,846	67,846
CACTUS	MOORE	CANADIAN	MUNICIPAL CONSERVATION	CONSERVATION	MOORE	CANADIAN	Recommended	0	18	31	31	31	31
COUNTY-OTHER	MOORE	CANADIAN	MUNICIPAL CONSERVATION	CONSERVATION	MOORE	CANADIAN	Recommended	0	29	63	75	83	87

Region A Water User Group Potentially Feasible Water Managment Strategy Supply
(Ac-ft per Year)

WUG Name	WUG County	WUG Basin	Project Name	Source Name	Source County	Source Basin	Selected	SS2010	SS2020	SS2030	SS2040	SS2050	SS2060
DUMAS	MOORE	CANADIAN	MUNICIPAL CONSERVATION	CONSERVATION	MOORE	CANADIAN	Recommended	0	89	158	166	171	174
SUNRAY	MOORE	CANADIAN	MUNICIPAL CONSERVATION	CONSERVATION	MOORE	CANADIAN	Recommended	0	18	34	36	38	39
CACTUS	MOORE	CANADIAN	PALO DURO RESERVOIR	PALO DURO LAKE/RESERVOIR	RESERVOIR	CANADIAN	Alternate	0	0	1,744	1,744	1,744	1,744
DUMAS	MOORE	CANADIAN	PALO DURO RESERVOIR	PALO DURO LAKE/RESERVOIR	RESERVOIR	CANADIAN	Alternate	0	0	1,356	1,356	1,356	1,356
SUNRAY	MOORE	CANADIAN	PALO DURO RESERVOIR	PALO DURO LAKE/RESERVOIR	RESERVOIR	CANADIAN	Alternate	0	0	271	271	271	271
IRRIGATION	MOORE	CANADIAN	PRECIPITATION ENHANCEMENT	WEATHER MODIFICATION	MOORE	CANADIAN	Alternate	0	11,348	11,348	11,348	11,348	11,348
COUNTY-OTHER	MOORE	CANADIAN	VOLUNTARY TRANSFER FROM OTHER USERS	OGALLALA AQUIFER	MOORE	CANADIAN	Recommended	0	0	50	100	100	100
MANUFACTURING	MOORE	CANADIAN	VOLUNTARY TRANSFER FROM OTHER USERS	OGALLALA AQUIFER	MOORE	CANADIAN	Recommended	200	800	1,100	1,400	1,800	2,100
PERRYTON	OCHILTREE	CANADIAN	DRILL ADDITIONAL GROUNDWATER WELL	OGALLALA AQUIFER	OCHILTREE	CANADIAN	Recommended	0	0	0	0	600	1,200
IRRIGATION	OCHILTREE	CANADIAN	IRRIGATION CONSERVATION	CONSERVATION	OCHILTREE	CANADIAN	Recommended	0	17,257	17,899	19,053	19,694	20,335
PERRYTON	OCHILTREE	CANADIAN	MUNICIPAL CONSERVATION	CONSERVATION	OCHILTREE	CANADIAN	Recommended	0	64	113	118	120	123
IRRIGATION	OCHILTREE	CANADIAN	PRECIPITATION ENHANCEMENT	WEATHER MODIFICATION	OCHILTREE	CANADIAN	Alternate	0	6,220	6,220	6,220	6,220	6,220
IRRIGATION	OLDHAM	CANADIAN	IRRIGATION CONSERVATION	CONSERVATION	OLDHAM	CANADIAN	Recommended	0	626	649	692	715	739
IRRIGATION	OLDHAM	RED	IRRIGATION CONSERVATION	CONSERVATION	OLDHAM	RED	Recommended	0	188	195	208	215	222
IRRIGATION	OLDHAM	CANADIAN	PRECIPITATION ENHANCEMENT	WEATHER MODIFICATION	OLDHAM	CANADIAN	Alternate	0	227	227	227	227	227
IRRIGATION	OLDHAM	RED	PRECIPITATION ENHANCEMENT	WEATHER MODIFICATION	OLDHAM	RED	Alternate	0	68	68	68	68	68
COUNTY-OTHER	POTTER	CANADIAN	DRILL ADDITIONAL GROUNDWATER WELL	OGALLALA AQUIFER	POTTER	CANADIAN	Recommended	0	0	0	1,000	1,000	1,000
COUNTY-OTHER	POTTER	RED	DRILL ADDITIONAL GROUNDWATER WELL	OGALLALA AQUIFER	POTTER	RED	Recommended	0	600	600	600	1,200	1,200
IRRIGATION	POTTER	CANADIAN	IRRIGATION CONSERVATION	CONSERVATION	POTTER	CANADIAN	Recommended	0	446	464	496	513	531
IRRIGATION	POTTER	RED	IRRIGATION CONSERVATION	CONSERVATION	POTTER	RED	Recommended	0	490	510	545	564	583
AMARILLO	POTTER	CANADIAN	MUNICIPAL CONSERVATION	CONSERVATION	POTTER	CANADIAN	Recommended	0	455	808	865	925	975
COUNTY-OTHER	POTTER	CANADIAN	MUNICIPAL CONSERVATION	CONSERVATION	POTTER	CANADIAN	Recommended	0	41	85	103	124	140
AMARILLO	POTTER	RED	MUNICIPAL CONSERVATION	CONSERVATION	POTTER	RED	Recommended	0	325	575	615	660	700
COUNTY-OTHER	POTTER	RED	MUNICIPAL CONSERVATION	CONSERVATION	POTTER	RED	Recommended	0	28	58	71	85	96
AMARILLO	POTTER	CANADIAN	POTTER COUNTY WELL FIELD	OGALLALA AQUIFER	POTTER	CANADIAN	Recommended	0	2,500	2,500	2,500	2,500	2,500
AMARILLO	POTTER	RED	POTTER COUNTY WELL FIELD	OGALLALA AQUIFER	POTTER	CANADIAN	Recommended	0	2,500	2,500	2,500	2,500	2,500
AMARILLO	POTTER	RED	POTTER COUNTY WELL FIELD	OGALLALA AQUIFER	POTTER	RED	Recommended	0	800	800	800	800	800
IRRIGATION	POTTER	CANADIAN	PRECIPITATION ENHANCEMENT	WEATHER MODIFICATION	POTTER	CANADIAN	Recommended	0	172	172	172	172	172
IRRIGATION	POTTER	RED	PRECIPITATION ENHANCEMENT	WEATHER MODIFICATION	POTTER	RED	Recommended	0	189	189	189	189	189
AMARILLO	POTTER	CANADIAN	ROBERTS COUNTY WELL FIELD - AMARILLO	OGALLALA AQUIFER	ROBERTS	CANADIAN	Recommended	0	0	0	0	1,200	2,600
AMARILLO	POTTER	RED	ROBERTS COUNTY WELL FIELD - AMARILLO	OGALLALA AQUIFER	ROBERTS	CANADIAN	Recommended	0	0	0	0	0	741
MANUFACTURING	POTTER	CANADIAN	VOLUNTARY TRANSFER FROM OTHER USERS	OGALLALA AQUIFER	POTTER	CANADIAN	Recommended	0	0	200	328	313	225
MANUFACTURING	POTTER	RED	VOLUNTARY TRANSFER FROM OTHER USERS	OGALLALA AQUIFER	POTTER	CANADIAN	Recommended	0	0	444	1,087	1,846	2,638
CANYON	RANDALL	RED	DRILL ADDITIONAL GROUNDWATER WELL	DOCKUM AQUIFER	RANDALL	RED	Recommended	700	1,400	2,100	2,800	2,800	3,800
COUNTY-OTHER	RANDALL	RED	DRILL ADDITIONAL GROUNDWATER WELL	OGALLALA AQUIFER	RANDALL	RED	Recommended	0	0	600	1,200	1,800	2,400
IRRIGATION	RANDALL	CANADIAN	IRRIGATION CONSERVATION	CONSERVATION	RANDALL	CANADIAN	Recommended	0	0	0	0	0	0
IRRIGATION	RANDALL	RED	IRRIGATION CONSERVATION	CONSERVATION	RANDALL	RED	Recommended	0	18,028	18,673	19,835	20,481	21,126
AMARILLO	RANDALL	RED	MUNICIPAL CONSERVATION	CONSERVATION	RANDALL	RED	Recommended	0	595	1,070	1,159	1,256	1,337
CANYON	RANDALL	RED	MUNICIPAL CONSERVATION	CONSERVATION	RANDALL	RED	Recommended	0	80	176	191	208	227
COUNTY-OTHER	RANDALL	RED	MUNICIPAL CONSERVATION	CONSERVATION	RANDALL	RED	Recommended	0	101	197	231	268	299
AMARILLO	RANDALL	RED	POTTER COUNTY WELL FIELD	OGALLALA AQUIFER	POTTER	CANADIAN	Recommended	0	3,667	3,740	3,745	2,861	1,780
IRRIGATION	RANDALL	RED	PRECIPITATION ENHANCEMENT	WEATHER MODIFICATION	RANDALL	RED	Alternate	0	6,251	6,251	6,251	6,251	6,251
AMARILLO	RANDALL	RED	ROBERTS COUNTY WELL FIELD - AMARILLO	OGALLALA AQUIFER	ROBERTS	CANADIAN	Recommended	0	0	0	11,210	10,010	19,079
COUNTY-OTHER	RANDALL	CANADIAN	VOLUNTARY TRANSFER FROM OTHER USERS	OGALLALA AQUIFER	POTTER	CANADIAN	Considered	0	0	0	0	0	0
IRRIGATION	ROBERTS	CANADIAN	IRRIGATION CONSERVATION	CONSERVATION	ROBERTS	CANADIAN	Recommended	0	2,642	2,758	2,968	3,084	3,200
IRRIGATION	ROBERTS	RED	IRRIGATION CONSERVATION	CONSERVATION	ROBERTS	RED	Recommended	0	130	135	146	152	157
IRRIGATION	ROBERTS	CANADIAN	PRECIPITATION ENHANCEMENT	WEATHER MODIFICATION	ROBERTS	CANADIAN	Recommended	0	1,138	1,138	1,138	1,138	1,138
IRRIGATION	ROBERTS	RED	PRECIPITATION ENHANCEMENT	WEATHER MODIFICATION	ROBERTS	RED	Recommended	0	56	56	56	56	56
IRRIGATION	SHERMAN	CANADIAN	IRRIGATION CONSERVATION	CONSERVATION	SHERMAN	CANADIAN	Recommended	0	41,128	77,102	86,803	87,896	87,896
IRRIGATION	SHERMAN	CANADIAN	PRECIPITATION ENHANCEMENT	WEATHER MODIFICATION	SHERMAN	CANADIAN	Alternate	0	14,566	14,566	14,566	14,566	14,566
WHEELER	WHEELER	RED	DRILL ADDITIONAL GROUNDWATER WELL	OGALLALA AQUIFER	WHEELER	RED	Recommended	0	0	0	0	200	200
IRRIGATION	WHEELER	RED	IRRIGATION CONSERVATION	CONSERVATION	WHEELER	RED	Recommended	0	1,676	1,740	1,854	1,917	1,980
WHEELER	WHEELER	RED	MUNICIPAL CONSERVATION	CONSERVATION	WHEELER	RED	Recommended	0	9	15	15	15	15
IRRIGATION	WHEELER	RED	PRECIPITATION ENHANCEMENT	WEATHER MODIFICATION	WHEELER	RED	Recommended	0	615	615	615	615	615

WUG Name	WUG County	WUG Basin	Project Name	Source Name	Capital Cost	AC 2010	AC 2020	AC 2030	AC 2040	AC 2050	AC 2060
IRRIGATION	ARMSTRONG	RED	IRRIGATION CONSERVATION	CONSERVATION	$0	$0	$51,013	$59,783	$63,144	$64,079	$65,015
IRRIGATION	ARMSTRONG	RED	PRECIPITATION ENHANCEMENT	WEATHER MODIFICATION	$0	$0	$4,718	$4,718	$4,718	$4,718	$4,718
COUNTY-OTHER	HALL	RED	DRILL ADDITIONAL GROUNDWATER WELL	OGALLALA AQUIFER	$1,261,200	$145,550	$145,550	$35,600	$35,600	$35,600	$35,600
FRITCH	HUTCHINSON	CANADIAN	DRILL ADDITIONAL GROUNDWATER WELL	OGALLALA AQUIFER	$2,850,300	$311,600	$311,600	$63,100	$63,100	$63,100	$63,100
PANHANDLE	CARSON	RED	DRILL ADDITIONAL GROUNDWATER WELL	OGALLALA AQUIFER	$3,309,300	$0	$0	$441,400	$441,400	$152,900	$152,900
IRRIGATION	CARSON	CANADIAN	IRRIGATION CONSERVATION	CONSERVATION	$0	$0	$96,142	$112,650	$118,959	$120,712	$122,465
IRRIGATION	CARSON	RED	IRRIGATION CONSERVATION	CONSERVATION	$0	$0	$310,345	$363,634	$383,998	$389,657	$395,316
PANHANDLE	CARSON	RED	MUNICIPAL CONSERVATION	CONSERVATION	$0	$0	$8,330	$14,210	$13,720	$12,250	$11,270
IRRIGATION	CARSON	CANADIAN	PRECIPITATION ENHANCEMENT	WEATHER MODIFICATION	$0	$0	$8,843	$8,843	$8,843	$8,843	$8,843
IRRIGATION	CARSON	RED	PRECIPITATION ENHANCEMENT	WEATHER MODIFICATION	$0	$0	$28,546	$28,546	$28,546	$28,546	$28,546
IRRIGATION	CHILDRESS	RED	IRRIGATION CONSERVATION	CONSERVATION	$0	$0	$38,924	$45,668	$48,293	$49,033	$49,772
IRRIGATION	CHILDRESS	RED	PRECIPITATION ENHANCEMENT	WEATHER MODIFICATION	$0	$0	$3,726	$3,726	$3,726	$3,726	$3,726
IRRIGATION	COLLINGSWORTH	RED	IRRIGATION CONSERVATION	CONSERVATION	$0	$0	$72,511	$85,672	$91,280	$92,952	$94,623
IRRIGATION	COLLINGSWORTH	RED	PRECIPITATION ENHANCEMENT	WEATHER MODIFICATION	$0	$0	$8,395	$8,395	$8,395	$8,395	$8,395
TEXLINE	DALLAM	CANADIAN	DRILL ADDITIONAL GROUNDWATER WELL	OGALLALA AQUIFER	$2,304,000	$0	$278,300	$278,300	$77,400	$77,400	$77,400
IRRIGATION	DALLAM	CANADIAN	IRRIGATION CONSERVATION	CONSERVATION	$0	$0	$1,133,156	$1,863,021	$2,238,950	$2,251,368	$2,251,368
TEXLINE	DALLAM	CANADIAN	MUNICIPAL CONSERVATION	CONSERVATION	$0	$0	$3,430	$5,880	$5,880	$5,880	$5,390
IRRIGATION	DALLAM	CANADIAN	PRECIPITATION ENHANCEMENT	WEATHER MODIFICATION	$0	$0	$111,938	$111,938	$111,938	$111,938	$111,938
COUNTY-OTHER	HALL	RED	DRILL ADDITIONAL GROUNDWATER WELL	OGALLALA AQUIFER	$2,522,400	$291,100	$291,100	$71,200	$71,200	$71,200	$71,200
MEMPHIS	HALL	RED	DRILL ADDITIONAL GROUNDWATER WELL	OGALLALA AQUIFER	$1,042,100	$0	$121,200	$121,200	$30,300	$30,300	$30,300
IRRIGATION	DONLEY	RED	IRRIGATION CONSERVATION	CONSERVATION	$0	$0	$70,139	$82,443	$87,356	$88,763	$90,170
IRRIGATION	DONLEY	RED	PRECIPITATION ENHANCEMENT	WEATHER MODIFICATION	$0	$0	$7,084	$7,084	$7,084	$7,084	$7,084
PAMPA	GRAY	CANADIAN	DRILL ADDITIONAL GROUNDWATER WELL	OGALLALA AQUIFER	$1,731,100	$503,000	$503,000	$0	$0	$0	$0
LEFORS	GRAY	RED	DRILL ADDITIONAL GROUNDWATER WELL	OGALLALA AQUIFER	$1,132,500	$0	$0	$0	$132,800	$132,800	$34,100
IRRIGATION	GRAY	CANADIAN	IRRIGATION CONSERVATION	CONSERVATION	$0	$0	$30,725	$35,996	$38,006	$38,563	$39,121
IRRIGATION	GRAY	RED	IRRIGATION CONSERVATION	CONSERVATION	$0	$0	$93,074	$109,040	$115,128	$116,818	$118,508
PAMPA	GRAY	CANADIAN	MUNICIPAL CONSERVATION	CONSERVATION	$0	$0	$7,350	$31,850	$31,850	$31,850	$31,850
LEFORS	GRAY	RED	MUNICIPAL CONSERVATION	CONSERVATION	$0	$0	$1,437	$1,916	$1,916	$1,916	$1,916
IRRIGATION	GRAY	CANADIAN	PRECIPITATION ENHANCEMENT	WEATHER MODIFICATION	$0	$0	$2,814	$2,814	$2,814	$2,814	$2,814
IRRIGATION	GRAY	RED	PRECIPITATION ENHANCEMENT	WEATHER MODIFICATION	$0	$0	$8,523	$8,523	$8,523	$8,523	$8,523
IRRIGATION	HALL	RED	IRRIGATION CONSERVATION	CONSERVATION	$0	$0	$77,599	$91,212	$96,648	$98,205	$99,761
MEMPHIS	HALL	RED	MUNICIPAL CONSERVATION	CONSERVATION	$0	$0	$6,227	$10,538	$10,538	$10,538	$10,538
IRRIGATION	HALL	RED	PRECIPITATION ENHANCEMENT	WEATHER MODIFICATION	$0	$0	$7,838	$7,838	$7,838	$7,838	$7,838
GRUVER	HANSFORD	CANADIAN	DRILL ADDITIONAL GROUNDWATER WELL	OGALLALA AQUIFER	$1,968,500	$0	$256,000	$256,000	$84,000	$84,000	$84,000
SPEARMAN	HANSFORD	CANADIAN	DRILL ADDITIONAL GROUNDWATER WELL	OGALLALA AQUIFER	$3,862,000	$0	$0	$534,600	$534,600	$197,900	$197,900
IRRIGATION	HANSFORD	CANADIAN	IRRIGATION CONSERVATION	CONSERVATION	$0	$0	$502,697	$1,065,552	$1,124,517	$1,072,094	$1,072,094
GRUVER	HANSFORD	CANADIAN	MUNICIPAL CONSERVATION	CONSERVATION	$0	$0	$4,790	$7,664	$8,143	$8,143	$8,143
SPEARMAN	HANSFORD	CANADIAN	MUNICIPAL CONSERVATION	CONSERVATION	$0	$0	$10,538	$18,681	$19,639	$20,118	$20,118
IRRIGATION	HANSFORD	CANADIAN	PRECIPITATION ENHANCEMENT	WEATHER MODIFICATION	$0	$0	$58,965	$58,965	$58,965	$58,965	$58,965
IRRIGATION	HARTLEY	CANADIAN	IRRIGATION CONSERVATION	CONSERVATION	$0	$0	$1,015,512	$1,663,536	$1,994,087	$2,004,925	$2,004,925
IRRIGATION	HARTLEY	CANADIAN	PRECIPITATION ENHANCEMENT	WEATHER MODIFICATION	$0	$0	$97,692	$97,692	$97,692	$97,692	$97,692
IRRIGATION	HEMPHILL	CANADIAN	IRRIGATION CONSERVATION	CONSERVATION	$0	$0	$4,387	$5,140	$5,427	$5,507	$5,587
IRRIGATION	HEMPHILL	RED	IRRIGATION CONSERVATION	CONSERVATION	$0	$0	$968	$1,134	$1,197	$1,215	$1,232
IRRIGATION	HEMPHILL	CANADIAN	PRECIPITATION ENHANCEMENT	WEATHER MODIFICATION	$0	$0	$402	$402	$402	$402	$402
IRRIGATION	HEMPHILL	RED	PRECIPITATION ENHANCEMENT	WEATHER MODIFICATION	$0	$0	$89	$89	$89	$89	$89
BORGER	HUTCHINSON	CANADIAN	DRILL ADDITIONAL GROUNDWATER WELL	OGALLALA AQUIFER	$0	$0	$0	$0	$0	$0	$0
FRITCH	HUTCHINSON	CANADIAN	DRILL ADDITIONAL GROUNDWATER WELL	OGALLALA AQUIFER	$1,156,600	$0	$150,200	$150,200	$49,400	$49,400	$49,400
IRRIGATION	HUTCHINSON	CANADIAN	IRRIGATION CONSERVATION	CONSERVATION	$0	$0	$150,461	$260,610	$318,882	$320,860	$320,860
BORGER	HUTCHINSON	CANADIAN	MUNICIPAL CONSERVATION	CONSERVATION	$0	$0	$11,760	$34,790	$34,790	$34,790	$34,790
IRRIGATION	HUTCHINSON	CANADIAN	PRECIPITATION ENHANCEMENT	WEATHER MODIFICATION	$0	$0	$17,821	$17,821	$17,821	$17,821	$17,821
MANUFACTURING	HUTCHINSON	CANADIAN	VOLUNTARY TRANSFER FROM OTHER USERS	OGALLALA AQUIFER	$0	$0	$0	$0	$0	$0	$0
IRRIGATION	LIPSCOMB	CANADIAN	IRRIGATION CONSERVATION	CONSERVATION	$0	$0	$53,033	$62,070	$65,467	$66,400	$67,334
IRRIGATION	LIPSCOMB	CANADIAN	PRECIPITATION ENHANCEMENT	WEATHER MODIFICATION	$0	$0	$4,710	$4,710	$4,710	$4,710	$4,710
CACTUS	MOORE	CANADIAN	DRILL ADDITIONAL GROUNDWATER WELL	OGALLALA AQUIFER	$0	$0	$0	$0	$0	$0	$0
COUNTY-OTHER	MOORE	CANADIAN	DRILL ADDITIONAL GROUNDWATER WELL	OGALLALA AQUIFER	$3,114,800	$0	$0	$237,000	$237,000	$337,700	$337,700

WUG Name	WUG County	WUG Basin	Project Name	Source Name	Capital Cost	AC 2010	AC 2020	AC 2030	AC 2040	AC 2050	AC 2060
DUMAS	MOORE	CANADIAN	DRILL ADDITIONAL GROUNDWATER WELL	OGALLALA AQUIFER	$7,997,200	$0	$185,218	$556,612	$333,932	$443,179	$499,300
STEAM ELECTRIC POWER	MOORE	CANADIAN	DRILL ADDITIONAL GROUNDWATER WELL	OGALLALA AQUIFER	$1,852,600	$203,300	$203,300	$41,800	$41,800	$41,800	$41,800
SUNRAY	MOORE	CANADIAN	DRILL ADDITIONAL GROUNDWATER WELL	OGALLALA AQUIFER	$3,121,300	$0	$0	$453,700	$453,700	$181,600	$181,600
IRRIGATION	MOORE	CANADIAN	IRRIGATION CONSERVATION	CONSERVATION	$0	$0	$618,799	$1,069,223	$1,294,960	$1,302,526	$1,302,526
CACTUS	MOORE	CANADIAN	MUNICIPAL CONSERVATION	CONSERVATION	$0	$0	$8,820	$15,190	$15,190	$15,190	$15,190
COUNTY-OTHER	MOORE	CANADIAN	MUNICIPAL CONSERVATION	CONSERVATION	$0	$0	$14,210	$30,870	$36,750	$40,670	$42,630
DUMAS	MOORE	CANADIAN	MUNICIPAL CONSERVATION	CONSERVATION	$0	$0	$42,631	$75,682	$79,514	$81,909	$83,346
SUNRAY	MOORE	CANADIAN	MUNICIPAL CONSERVATION	CONSERVATION	$0	$0	$8,622	$16,286	$17,244	$18,202	$18,681
IRRIGATION	MOORE	CANADIAN	PRECIPITATION ENHANCEMENT	WEATHER MODIFICATION	$0	$0	$68,202	$68,202	$68,202	$68,202	$68,202
COUNTY-OTHER	MOORE	CANADIAN	VOLUNTARY TRANSFER FROM OTHER USERS	OGALLALA AQUIFER	$0	$0	$0	$0	$0	$0	$0
MANUFACTURING	MOORE	CANADIAN	VOLUNTARY TRANSFER FROM OTHER USERS	OGALLALA AQUIFER	$0	$0	$0	$0	$0	$0	$0
PERRYTON	OCHILTREE	CANADIAN	DRILL ADDITIONAL GROUNDWATER WELL	OGALLALA AQUIFER	$7,087,000	$0	$0	$0	$0	$728,350	$910,800
IRRIGATION	OCHILTREE	CANADIAN	IRRIGATION CONSERVATION	CONSERVATION	$0	$0	$405,381	$475,026	$501,671	$509,082	$516,494
PERRYTON	OCHILTREE	CANADIAN	MUNICIPAL CONSERVATION	CONSERVATION	$0	$0	$31,360	$55,370	$57,820	$58,800	$60,270
IRRIGATION	OCHILTREE	CANADIAN	PRECIPITATION ENHANCEMENT	WEATHER MODIFICATION	$0	$0	$37,380	$37,380	$37,380	$37,380	$37,380
IRRIGATION	OLDHAM	CANADIAN	IRRIGATION CONSERVATION	CONSERVATION	$0	$0	$14,729	$17,263	$18,235	$18,506	$18,778
IRRIGATION	OLDHAM	RED	IRRIGATION CONSERVATION	CONSERVATION	$0	$0	$4,423	$5,183	$5,475	$5,557	$5,638
IRRIGATION	OLDHAM	CANADIAN	PRECIPITATION ENHANCEMENT	WEATHER MODIFICATION	$0	$0	$1,367	$1,367	$1,367	$1,367	$1,367
IRRIGATION	OLDHAM	RED	PRECIPITATION ENHANCEMENT	WEATHER MODIFICATION	$0	$0	$410	$410	$410	$410	$410
COUNTY-OTHER	POTTER	CANADIAN	DRILL ADDITIONAL GROUNDWATER WELL	OGALLALA AQUIFER	$3,114,800	$0	$0	$0	$473,500	$473,500	$201,900
COUNTY-OTHER	POTTER	RED	DRILL ADDITIONAL GROUNDWATER WELL	OGALLALA AQUIFER	$5,444,600	$0	$374,200	$374,200	$136,900	$511,100	$511,100
IRRIGATION	POTTER	CANADIAN	IRRIGATION CONSERVATION	CONSERVATION	$0	$0	$10,633	$12,482	$13,208	$13,414	$13,619
IRRIGATION	POTTER	RED	IRRIGATION CONSERVATION	CONSERVATION	$0	$0	$11,684	$13,716	$14,513	$14,739	$14,965
AMARILLO	POTTER	CANADIAN	MUNICIPAL CONSERVATION	CONSERVATION	$0	$0	$222,500	$395,100	$423,000	$452,300	$476,800
COUNTY-OTHER	POTTER	CANADIAN	MUNICIPAL CONSERVATION	CONSERVATION	$0	$0	$20,090	$41,650	$50,470	$60,760	$68,600
AMARILLO	POTTER	RED	MUNICIPAL CONSERVATION	CONSERVATION	$0	$0	$158,900	$281,200	$300,700	$322,700	$342,300
COUNTY-OTHER	POTTER	RED	MUNICIPAL CONSERVATION	CONSERVATION	$0	$0	$13,720	$28,420	$34,790	$41,650	$47,040
AMARILLO	POTTER	CANADIAN	POTTER COUNTY WELL FIELD	OGALLALA AQUIFER	$0	$0	$0	$0	$0	$0	$0
AMARILLO	POTTER	RED	POTTER COUNTY WELL FIELD	OGALLALA AQUIFER	$0	$0	$0	$0	$0	$0	$0
IRRIGATION	POTTER	CANADIAN	PRECIPITATION ENHANCEMENT	WEATHER MODIFICATION	$0	$0	$1,035	$1,035	$1,035	$1,035	$1,035
IRRIGATION	POTTER	RED	PRECIPITATION ENHANCEMENT	WEATHER MODIFICATION	$0	$0	$1,138	$1,138	$1,138	$1,138	$1,138
COUNTY-OTHER	RANDALL	CANADIAN	VOLUNTARY TRANSFER FROM OTHER USERS	OGALLALA AQUIFER	$0	$0	$0	$0	$0	$0	$0
MANUFACTURING	POTTER	CANADIAN	VOLUNTARY TRANSFER FROM OTHER USERS	OGALLALA AQUIFER	$0	$0	$0	$0	$0	$0	$0
CANYON	RANDALL	RED	DRILL ADDITIONAL GROUNDWATER WELL	DOCKUM AQUIFER	$9,528,800	$1,546,500	$1,546,500	$715,700	$715,700	$715,700	$715,700
COUNTY-OTHER	RANDALL	RED	DRILL ADDITIONAL GROUNDWATER WELL	OGALLALA AQUIFER	$10,889,220	$0	$0	$374,200	$784,400	$885,300	$1,022,200
IRRIGATION	RANDALL	CANADIAN	IRRIGATION CONSERVATION	CONSERVATION	$0	$0	$0	$0	$0	$0	$0
IRRIGATION	RANDALL	RED	IRRIGATION CONSERVATION	CONSERVATION	$0	$0	$420,111	$491,808	$518,846	$526,291	$533,736
AMARILLO	RANDALL	RED	MUNICIPAL CONSERVATION	CONSERVATION	$0	$0	$291,000	$523,200	$566,800	$614,200	$653,800
CANYON	RANDALL	RED	MUNICIPAL CONSERVATION	CONSERVATION	$0	$0	$38,320	$84,304	$91,489	$99,632	$108,733
COUNTY-OTHER	RANDALL	RED	MUNICIPAL CONSERVATION	CONSERVATION	$0	$0	$48,379	$94,363	$110,649	$128,372	$143,221
IRRIGATION	RANDALL	RED	PRECIPITATION ENHANCEMENT	WEATHER MODIFICATION	$0	$0	$37,570	$37,570	$37,570	$37,570	$37,570
CACTUS	MOORE	CANADIAN	PALO DURO RESERVOIR	PALO DURO LAKE/RESERVOIR	$0	$0	$0	$5,501,800	$5,501,800	$720,400	$720,400
DUMAS	MOORE	CANADIAN	PALO DURO RESERVOIR	PALO DURO LAKE/RESERVOIR	$0	$0	$0	$3,712,100	$3,712,100	$512,800	$512,800
GRUVER	HANSFORD	CANADIAN	PALO DURO RESERVOIR	PALO DURO LAKE/RESERVOIR	$0	$0	$0	$500,200	$500,200	$53,200	$53,200
SPEARMAN	HANSFORD	CANADIAN	PALO DURO RESERVOIR	PALO DURO LAKE/RESERVOIR	$0	$0	$0	$370,400	$370,400	$66,800	$66,800
SUNRAY	MOORE	CANADIAN	PALO DURO RESERVOIR	PALO DURO LAKE/RESERVOIR	$0	$0	$0	$780,900	$780,900	$110,300	$110,300
MEMPHIS	HALL	RED	VOLUNTARY TRANSFER FROM OTHER USERS	GREENBELT LAKE/RESERVOIR	$0	$0	$0	$81,500	$81,500	$81,500	$81,500
IRRIGATION	ROBERTS	CANADIAN	IRRIGATION CONSERVATION	CONSERVATION	$0	$0	$64,579	$76,037	$80,716	$82,075	$83,434
IRRIGATION	ROBERTS	RED	IRRIGATION CONSERVATION	CONSERVATION	$0	$0	$3,172	$3,735	$3,965	$4,032	$4,099
IRRIGATION	ROBERTS	CANADIAN	PRECIPITATION ENHANCEMENT	WEATHER MODIFICATION	$0	$0	$6,836	$6,836	$6,836	$6,836	$6,836
IRRIGATION	ROBERTS	RED	PRECIPITATION ENHANCEMENT	WEATHER MODIFICATION	$0	$0	$336	$336	$336	$336	$336
AMARILLO	POTTER	CANADIAN	ROBERTS COUNTY WELL FIELD - AMARILLO	OGALLALA AQUIFER	$0	$0	$0	$0	$0	$0	$0
PAMPA	GRAY	CANADIAN	VOLUNTARY TRANSFER FROM OTHER USERS	OGALLALA AQUIFER	$0	$0	$0	$0	$0	$0	$0
IRRIGATION	SHERMAN	CANADIAN	IRRIGATION CONSERVATION	CONSERVATION	$0	$0	$806,279	$1,380,839	$1,671,043	$1,680,755	$1,680,755

WUG Name	WUG County	WUG Basin	Project Name	Source Name	Capital Cost	AC 2010	AC 2020	AC 2030	AC 2040	AC 2050	AC 2060
IRRIGATION	SHERMAN	CANADIAN	PRECIPITATION ENHANCEMENT	WEATHER MODIFICATION	$0	$0	$87,541	$87,541	$87,541	$87,541	$87,541
WHEELER	WHEELER	RED	DRILL ADDITIONAL GROUNDWATER WELL	OGALLALA AQUIFER	$2,233,300	$0	$0	$0	$0	$262,200	$262,200
IRRIGATION	WHEELER	RED	IRRIGATION CONSERVATION	CONSERVATION	$0	$0	$39,528	$46,340	$48,962	$49,695	$50,428
WHEELER	WHEELER	RED	MUNICIPAL CONSERVATION	CONSERVATION	$0	$0	$4,410	$7,350	$7,350	$7,350	$7,350
IRRIGATION	WHEELER	RED	PRECIPITATION ENHANCEMENT	WEATHER MODIFICATION	$0	$0	$3,694	$3,694	$3,694	$3,694	$3,694

Region A Wholesale Water Provider Demand
(Ac-ft per Year)

WWP Name	WUG Name	WUG County	WUG Basin	WD2010	WD2020	WD2030	WD2040	WD2050	WD2060
AMARILLO CITY OF	AMARILLO	RANDALL	RED	18,167	19,839	21,404	23,185	25,129	26,739
AMARILLO CITY OF	AMARILLO	POTTER	RED	10,055	10,811	11,517	12,322	13,200	13,920
AMARILLO CITY OF	AMARILLO	POTTER	CANADIAN	14,107	15,167	16,158	17,287	18,519	19,529
AMARILLO CITY OF	CANYON	RANDALL	RED	1,000	1,000	1,000	1,000	1,000	1,000
AMARILLO CITY OF	MANUFACTURING	POTTER	RED	5,730	6,304	6,789	7,263	7,673	8,236
AMARILLO CITY OF	MANUFACTURING	RANDALL	RED	300	300	300	300	300	300
AMARILLO CITY OF	MANUFACTURING	POTTER	CANADIAN	786	865	932	997	1,053	1,131
AMARILLO CITY OF	COUNTY-OTHER	RANDALL	RED	25	25	25	25	25	25
AMARILLO CITY OF	STEAM ELECTRIC POWER	POTTER	CANADIAN	20,286	23,241	24,658	26,262	27,865	31,969
BORGER CITY OF	BORGER	HUTCHINSON	CANADIAN	2,352	2,384	2,351	2,274	2,148	2,039
BORGER CITY OF	COUNTY-OTHER	HUTCHINSON	CANADIAN	56	57	57	55	52	49
BORGER CITY OF	MANUFACTURING	CARSON	RED	450	450	450	450	450	450
BORGER CITY OF	MANUFACTURING	HUTCHINSON	CANADIAN	5,910	6,370	6,740	7,100	7,410	7,930
BORGER CITY OF	TCW SUPPLY INC	HUTCHINSON	CANADIAN	0	0	0	0	0	0
CACTUS CITY OF	CACTUS	MOORE	CANADIAN	533	615	615	615	615	615
CACTUS CITY OF	MANUFACTURING	MOORE	CANADIAN	2,758	2,958	3,120	3,280	3,421	3,587
CACTUS CITY OF	COUNTY-OTHER	MOORE	CANADIAN	70	96	126	151	165	174
CANADIAN RIVER MUNICIPAL WATER AUTHORITY	BORGER	HUTCHINSON	CANADIAN	4,000	5,510	5,510	5,510	5,510	5,510
CANADIAN RIVER MUNICIPAL WATER AUTHORITY	BROWNFIELD	TERRY	COLORADO	2,747	2,905	3,047	3,181	3,185	3,167
CANADIAN RIVER MUNICIPAL WATER AUTHORITY	AMARILLO	RANDALL	RED	42,987	42,987	42,987	42,987	42,987	42,987
CANADIAN RIVER MUNICIPAL WATER AUTHORITY	COUNTY-OTHER	HUTCHINSON	CANADIAN	0	0	0	0	0	0
CANADIAN RIVER MUNICIPAL WATER AUTHORITY	LAMESA	DAWSON	COLORADO	2,528	2,528	2,528	2,528	2,528	2,528
CANADIAN RIVER MUNICIPAL WATER AUTHORITY	LEVELLAND	HOCKLEY	BRAZOS	3,236	3,236	3,236	3,236	2,808	2,808
CANADIAN RIVER MUNICIPAL WATER AUTHORITY	LUBBOCK	LUBBOCK	BRAZOS	31,220	33,091	32,962	32,835	30,707	30,656
CANADIAN RIVER MUNICIPAL WATER AUTHORITY	O'DONNELL	DAWSON	BRAZOS	34	34	34	34	33	33
CANADIAN RIVER MUNICIPAL WATER AUTHORITY	O'DONNELL	LYNN	BRAZOS	288	288	288	288	259	259
CANADIAN RIVER MUNICIPAL WATER AUTHORITY	PAMPA	GRAY	CANADIAN	3,300	3,273	3,182	3,058	2,871	2,689
CANADIAN RIVER MUNICIPAL WATER AUTHORITY	PLAINVIEW	HALE	BRAZOS	3,909	4,281	4,281	4,281	3,881	3,881
CANADIAN RIVER MUNICIPAL WATER AUTHORITY	SLATON	LUBBOCK	BRAZOS	1,369	1,369	1,369	1,369	1,369	1,369
CANADIAN RIVER MUNICIPAL WATER AUTHORITY	TAHOKA	LYNN	BRAZOS	534	534	534	534	460	460
GREENBELT MUNICIPAL & INDUSTRIAL WATER AUTHORITY	CHILDRESS	CHILDRESS	RED	1,457	1,481	1,502	1,509	1,510	1,471
GREENBELT MUNICIPAL & INDUSTRIAL WATER AUTHORITY	CHILLICOTHE	HARDEMAN	RED	61	55	53	51	50	49
GREENBELT MUNICIPAL & INDUSTRIAL WATER AUTHORITY	CLARENDON	DONLEY	RED	440	440	440	440	440	440
GREENBELT MUNICIPAL & INDUSTRIAL WATER AUTHORITY	COUNTY-OTHER	CHILDRESS	RED	196	199	202	203	203	198
GREENBELT MUNICIPAL & INDUSTRIAL WATER AUTHORITY	COUNTY-OTHER	DONLEY	RED	219	210	191	171	154	128
GREENBELT MUNICIPAL & INDUSTRIAL WATER AUTHORITY	COUNTY-OTHER	HALL	RED	152	152	152	152	152	152
GREENBELT MUNICIPAL & INDUSTRIAL WATER AUTHORITY	COUNTY-OTHER	FOARD	RED	68	68	68	68	68	68
GREENBELT MUNICIPAL & INDUSTRIAL WATER AUTHORITY	COUNTY-OTHER	HARDEMAN	RED	210	210	210	210	210	210
GREENBELT MUNICIPAL & INDUSTRIAL WATER AUTHORITY	COUNTY-OTHER	WILBARGER	RED	6	6	6	6	6	6
GREENBELT MUNICIPAL & INDUSTRIAL WATER AUTHORITY	CROWELL	FOARD	RED	332	317	302	289	280	269
GREENBELT MUNICIPAL & INDUSTRIAL WATER AUTHORITY	COUNTY-OTHER	DONLEY	RED	0	0	0	0	0	0
GREENBELT MUNICIPAL & INDUSTRIAL WATER AUTHORITY	MANUFACTURING	HARDEMAN	RED	449	478	509	542	576	576

Region A Wholesale Water Provider Demand
(Ac-ft per Year)

WWP Name	WUG Name	WUG County	WUG Basin	WD2010	WD2020	WD2030	WD2040	WD2050	WD2060
GREENBELT MUNICIPAL & INDUSTRIAL WATER AUTHORITY	MEMPHIS	HALL	RED	100	100	100	100	100	100
GREENBELT MUNICIPAL & INDUSTRIAL WATER AUTHORITY	QUANAH	HARDEMAN	RED	652	612	589	544	511	463
PALO DURO RIVER AUTHORITY	CACTUS	MOORE	CANADIAN	0	0	1,744	1,744	1,744	1,740
PALO DURO RIVER AUTHORITY	DUMAS	MOORE	CANADIAN	0	0	1,356	1,356	1,356	1,352
PALO DURO RIVER AUTHORITY	GRUVER	HANSFORD	CANADIAN	0	0	271	271	271	271
PALO DURO RIVER AUTHORITY	SPEARMAN	HANSFORD	CANADIAN	0	0	116	116	116	116
PALO DURO RIVER AUTHORITY	SUNRAY	MOORE	CANADIAN	0	0	271	271	271	271

Region A Wholesale Water Provider Supplies
(Ac-ft per Year)

WWP Name	WUG Name	WUG County	WUG Basin	Source Name	Source County	Source Basin	WPS2010	WPS2020	WPS2030	WPS2040	WPS2050	WPS2060
AMARILLO CITY OF	AMARILLO	RANDALL	RED	MEREDITH LAKE/RESERVOIR	RESERVOIR	CANADIAN	1,807	4,143	4,261	4,443	4,640	4,723
AMARILLO CITY OF	AMARILLO	RANDALL	RED	OGALLALA AQUIFER	CARSON	CANADIAN	2,361	2,088	1,504	1,056	679	464
AMARILLO CITY OF	AMARILLO	RANDALL	RED	OGALLALA AQUIFER	CARSON	RED	2,361	2,381	2,370	2,285	2,199	2,060
AMARILLO CITY OF	AMARILLO	RANDALL	RED	OGALLALA AQUIFER	RANDALL	RED	2,830	1,600	1,300	1,000	800	600
AMARILLO CITY OF	AMARILLO	RANDALL	RED	OGALLALA AQUIFER	ROBERTS	CANADIAN	8,694	9,815	10,082	10,330	10,544	10,732
AMARILLO CITY OF	AMARILLO	RANDALL	RED	OGALLALA AQUIFER	DEAF SMITH	RED	125	125	100	100	50	14
AMARILLO CITY OF	AMARILLO	POTTER	RED	MEREDITH LAKE/RESERVOIR	RESERVOIR	CANADIAN	1,000	2,258	2,293	2,362	2,438	2,458
AMARILLO CITY OF	AMARILLO	POTTER	RED	OGALLALA AQUIFER	CARSON	CANADIAN	1,306	1,138	810	562	357	241
AMARILLO CITY OF	AMARILLO	POTTER	RED	OGALLALA AQUIFER	CARSON	RED	1,306	1,298	1,276	1,214	1,155	1,073
AMARILLO CITY OF	AMARILLO	POTTER	RED	OGALLALA AQUIFER	ROBERTS	CANADIAN	6,450	6,288	6,177	6,074	5,984	5,907
AMARILLO CITY OF	AMARILLO	POTTER	CANADIAN	MEREDITH LAKE/RESERVOIR	RESERVOIR	CANADIAN	1,402	3,167	3,217	3,313	3,420	3,449
AMARILLO CITY OF	AMARILLO	POTTER	CANADIAN	OGALLALA AQUIFER	CARSON	CANADIAN	1,833	1,597	1,136	788	500	339
AMARILLO CITY OF	AMARILLO	POTTER	CANADIAN	OGALLALA AQUIFER	CARSON	RED	1,833	1,821	1,790	1,704	1,620	1,505
AMARILLO CITY OF	AMARILLO	POTTER	CANADIAN	OGALLALA AQUIFER	ROBERTS	CANADIAN	9,048	8,822	8,666	8,521	8,397	8,286
AMARILLO CITY OF	CANYON	RANDALL	RED	MEREDITH LAKE/RESERVOIR	RESERVOIR	CANADIAN	1,000	1,000	917	829	753	695
AMARILLO CITY OF	MANUFACTURING	POTTER	RED	MEREDITH LAKE/RESERVOIR	RESERVOIR	CANADIAN	5,730	6,304	6,345	6,176	5,827	5,598
AMARILLO CITY OF	MANUFACTURING	RANDALL	RED	MEREDITH LAKE/RESERVOIR	RESERVOIR	CANADIAN	300	300	275	249	226	217
AMARILLO CITY OF	MANUFACTURING	POTTER	CANADIAN	MEREDITH LAKE/RESERVOIR	RESERVOIR	CANADIAN	786	865	732	669	740	906
AMARILLO CITY OF	COUNTY-OTHER	RANDALL	RED	MEREDITH LAKE/RESERVOIR	RESERVOIR	CANADIAN	25	25	22	21	18	16
AMARILLO CITY OF	STEAM ELECTRIC POWER	POTTER	CANADIAN	DIRECT REUSE	POTTER	CANADIAN	19,603	23,241	24,658	26,262	27,865	31,969
AMARILLO CITY OF	STEAM ELECTRIC POWER	POTTER	CANADIAN	MEREDITH LAKE/RESERVOIR	RESERVOIR	CANADIAN	259	0	0	0	0	0
AMARILLO CITY OF	STEAM ELECTRIC POWER	POTTER	CANADIAN	OGALLALA AQUIFER	ROBERTS	CANADIAN	424	0	0	0	0	0
BORGER CITY OF	BORGER	HUTCHINSON	CANADIAN	MEREDITH LAKE/RESERVOIR	RESERVOIR	CANADIAN	0	0	0	0	0	0
BORGER CITY OF	BORGER	HUTCHINSON	CANADIAN	OGALLALA AQUIFER	HUTCHINSON	CANADIAN	1,870	1,274	994	729	515	344
BORGER CITY OF	BORGER	HUTCHINSON	CANADIAN	OGALLALA AQUIFER	ROBERTS	CANADIAN	1,132	2,506	2,079	1,904	1,711	1,499
BORGER CITY OF	COUNTY-OTHER	HUTCHINSON	CANADIAN	OGALLALA AQUIFER	HUTCHINSON	CANADIAN	56	57	57	55	52	49
BORGER CITY OF	MANUFACTURING	CARSON	RED	OGALLALA AQUIFER	CARSON	RED	450	450	450	450	450	450
BORGER CITY OF	MANUFACTURING	HUTCHINSON	CANADIAN	DIRECT REUSE	HUTCHINSON	CANADIAN	1,045	1,045	1,045	1,045	1,045	1,045
BORGER CITY OF	MANUFACTURING	HUTCHINSON	CANADIAN	MEREDITH LAKE/RESERVOIR	RESERVOIR	CANADIAN	1,141	1,681	1,681	1,681	1,681	1,681
BORGER CITY OF	MANUFACTURING	HUTCHINSON	CANADIAN	OGALLALA AQUIFER	HUTCHINSON	CANADIAN	2,574	2,494	2,200	1,980	1,782	1,604
BORGER CITY OF	MANUFACTURING	HUTCHINSON	CANADIAN	OGALLALA AQUIFER	ROBERTS	CANADIAN	1,150	1,323	1,750	1,925	2,118	2,330
CACTUS CITY OF	CACTUS	MOORE	CANADIAN	OGALLALA AQUIFER	MOORE	CANADIAN	533	615	411	353	306	265
CACTUS CITY OF	MANUFACTURING	MOORE	CANADIAN	OGALLALA AQUIFER	MOORE	CANADIAN	2,585	2,158	2,087	1,884	1,703	1,543
CACTUS CITY OF	COUNTY-OTHER	MOORE	CANADIAN	OGALLALA AQUIFER	MOORE	CANADIAN	70	96	84	87	82	74
CANADIAN RIVER MUNICIPAL WATER AUTHORITY	BORGER	HUTCHINSON	CANADIAN	MEREDITH LAKE/RESERVOIR	RESERVOIR	CANADIAN	1,144	1,681	1,681	1,681	1,681	1,681
CANADIAN RIVER MUNICIPAL WATER AUTHORITY	BORGER	HUTCHINSON	CANADIAN	OGALLALA AQUIFER	ROBERTS	CANADIAN	2,282	3,829	3,829	3,829	3,829	3,829
CANADIAN RIVER MUNICIPAL WATER AUTHORITY	BROWNFIELD	TERRY	COLORADO	MEREDITH LAKE/RESERVOIR	RESERVOIR	CANADIAN	850	1,071	1,071	1,071	1,071	1,071
CANADIAN RIVER MUNICIPAL WATER AUTHORITY	BROWNFIELD	TERRY	COLORADO	OGALLALA AQUIFER	ROBERTS	CANADIAN	1,699	1,478	1,478	1,478	1,478	1,478
CANADIAN RIVER MUNICIPAL WATER AUTHORITY	AMARILLO	RANDALL	RED	MEREDITH LAKE/RESERVOIR	RESERVOIR	CANADIAN	12,306	18,062	18,062	18,062	18,062	18,062
CANADIAN RIVER MUNICIPAL WATER AUTHORITY	AMARILLO	RANDALL	RED	OGALLALA AQUIFER	ROBERTS	CANADIAN	24,617	24,925	24,925	24,925	24,925	24,925
CANADIAN RIVER MUNICIPAL WATER AUTHORITY	COUNTY-OTHER	HUTCHINSON	CANADIAN	MEREDITH LAKE/RESERVOIR	RESERVOIR	CANADIAN	2	8,370	8,408	8,460	9,855	9,931
CANADIAN RIVER MUNICIPAL WATER AUTHORITY	COUNTY-OTHER	HUTCHINSON	CANADIAN	OGALLALA AQUIFER	ROBERTS	CANADIAN	1,158	10,950	11,132	11,331	13,383	13,540
CANADIAN RIVER MUNICIPAL WATER AUTHORITY	LAMESA	DAWSON	COLORADO	MEREDITH LAKE/RESERVOIR	RESERVOIR	CANADIAN	843	1,062	1,062	1,062	978	978
CANADIAN RIVER MUNICIPAL WATER AUTHORITY	LAMESA	DAWSON	COLORADO	OGALLALA AQUIFER	ROBERTS	CANADIAN	1,685	1,466	1,466	1,466	1,350	1,350
CANADIAN RIVER MUNICIPAL WATER AUTHORITY	LEVELLAND	HOCKLEY	BRAZOS	MEREDITH LAKE/RESERVOIR	RESERVOIR	CANADIAN	1,079	1,360	1,360	1,360	1,180	1,180
CANADIAN RIVER MUNICIPAL WATER AUTHORITY	LEVELLAND	HOCKLEY	BRAZOS	OGALLALA AQUIFER	ROBERTS	CANADIAN	2,157	1,876	1,876	1,876	1,628	1,628
CANADIAN RIVER MUNICIPAL WATER AUTHORITY	LUBBOCK	LUBBOCK	BRAZOS	MEREDITH LAKE/RESERVOIR	RESERVOIR	CANADIAN	10,667	14,286	14,286	14,286	13,445	13,445
CANADIAN RIVER MUNICIPAL WATER AUTHORITY	LUBBOCK	LUBBOCK	BRAZOS	OGALLALA AQUIFER	ROBERTS	CANADIAN	20,553	18,805	18,676	18,549	17,262	17,211
CANADIAN RIVER MUNICIPAL WATER AUTHORITY	O'DONNELL	DAWSON	BRAZOS	MEREDITH LAKE/RESERVOIR	RESERVOIR	CANADIAN	11	14	14	14	14	14
CANADIAN RIVER MUNICIPAL WATER AUTHORITY	O'DONNELL	DAWSON	BRAZOS	OGALLALA AQUIFER	ROBERTS	CANADIAN	23	20	20	20	19	19
CANADIAN RIVER MUNICIPAL WATER AUTHORITY	O'DONNELL	LYNN	BRAZOS	MEREDITH LAKE/RESERVOIR	RESERVOIR	CANADIAN	96	121	121	121	109	109
CANADIAN RIVER MUNICIPAL WATER AUTHORITY	O'DONNELL	LYNN	BRAZOS	OGALLALA AQUIFER	ROBERTS	CANADIAN	192	167	167	167	150	150
CANADIAN RIVER MUNICIPAL WATER AUTHORITY	PAMPA	GRAY	CANADIAN	MEREDITH LAKE/RESERVOIR	RESERVOIR	CANADIAN	941	1,375	1,337	1,285	1,206	1,130
CANADIAN RIVER MUNICIPAL WATER AUTHORITY	PAMPA	GRAY	CANADIAN	OGALLALA AQUIFER	ROBERTS	CANADIAN	1,883	1,898	1,845	1,773	1,665	1,559
CANADIAN RIVER MUNICIPAL WATER AUTHORITY	PLAINVIEW	HALE	BRAZOS	MEREDITH LAKE/RESERVOIR	RESERVOIR	CANADIAN	1,427	1,799	1,799	1,799	1,631	1,631

Region A Wholesale Water Provider Supplies
(Ac-ft per Year)

WWP Name	WUG Name	WUG County	WUG Basin	Source Name	Source County	Source Basin	WPS2010	WPS2020	WPS2030	WPS2040	WPS2050	WPS2060
CANADIAN RIVER MUNICIPAL WATER AUTHORITY	PLAINVIEW	HALE	BRAZOS	OGALLALA AQUIFER	ROBERTS	CANADIAN	2,482	2,482	2,482	2,482	2,250	2,250
CANADIAN RIVER MUNICIPAL WATER AUTHORITY	SLATON	LUBBOCK	BRAZOS	MEREDITH LAKE/RESERVOIR	RESERVOIR	CANADIAN	456	575	575	575	575	575
CANADIAN RIVER MUNICIPAL WATER AUTHORITY	SLATON	LUBBOCK	BRAZOS	OGALLALA AQUIFER	ROBERTS	CANADIAN	913	794	794	794	794	794
CANADIAN RIVER MUNICIPAL WATER AUTHORITY	TAHOKA	LYNN	BRAZOS	MEREDITH LAKE/RESERVOIR	RESERVOIR	CANADIAN	178	224	224	224	193	193
CANADIAN RIVER MUNICIPAL WATER AUTHORITY	TAHOKA	LYNN	BRAZOS	OGALLALA AQUIFER	ROBERTS	CANADIAN	356	310	310	310	267	267
GREENBELT MUNICIPAL & INDUSTRIAL WATER AUTHORITY	CHILDRESS	CHILDRESS	RED	GREENBELT LAKE/RESERVOIR	RESERVOIR	RED	1,457	1,481	1,502	1,509	1,510	1,471
GREENBELT MUNICIPAL & INDUSTRIAL WATER AUTHORITY	CHILLICOTHE	HARDEMAN	RED	GREENBELT LAKE/RESERVOIR	RESERVOIR	RED	61	55	53	51	50	49
GREENBELT MUNICIPAL & INDUSTRIAL WATER AUTHORITY	CLARENDON	DONLEY	RED	GREENBELT LAKE/RESERVOIR	RESERVOIR	RED	440	440	440	440	440	440
GREENBELT MUNICIPAL & INDUSTRIAL WATER AUTHORITY	COUNTY-OTHER	CHILDRESS	RED	GREENBELT LAKE/RESERVOIR	RESERVOIR	RED	196	199	202	203	203	198
GREENBELT MUNICIPAL & INDUSTRIAL WATER AUTHORITY	COUNTY-OTHER	DONLEY	RED	GREENBELT LAKE/RESERVOIR	RESERVOIR	RED	219	210	191	171	154	128
GREENBELT MUNICIPAL & INDUSTRIAL WATER AUTHORITY	COUNTY-OTHER	HALL	RED	GREENBELT LAKE/RESERVOIR	RESERVOIR	RED	152	152	152	152	152	152
GREENBELT MUNICIPAL & INDUSTRIAL WATER AUTHORITY	COUNTY-OTHER	FOARD	RED	GREENBELT LAKE/RESERVOIR	RESERVOIR	RED	68	68	68	68	68	68
GREENBELT MUNICIPAL & INDUSTRIAL WATER AUTHORITY	COUNTY-OTHER	HARDEMAN	RED	GREENBELT LAKE/RESERVOIR	RESERVOIR	RED	210	210	210	210	210	210
GREENBELT MUNICIPAL & INDUSTRIAL WATER AUTHORITY	COUNTY-OTHER	WILBARGER	RED	GREENBELT LAKE/RESERVOIR	RESERVOIR	RED	6	6	6	6	6	6
GREENBELT MUNICIPAL & INDUSTRIAL WATER AUTHORITY	CROWELL	FOARD	RED	GREENBELT LAKE/RESERVOIR	RESERVOIR	RED	332	317	302	289	280	269
GREENBELT MUNICIPAL & INDUSTRIAL WATER AUTHORITY	COUNTY-OTHER	DONLEY	RED	GREENBELT LAKE/RESERVOIR	RESERVOIR	RED	2,522	2,400	2,268	2,171	2,060	2,051
GREENBELT MUNICIPAL & INDUSTRIAL WATER AUTHORITY	MANUFACTURING	HARDEMAN	RED	GREENBELT LAKE/RESERVOIR	RESERVOIR	RED	449	478	509	542	576	576
GREENBELT MUNICIPAL & INDUSTRIAL WATER AUTHORITY	MEMPHIS	HALL	RED	GREENBELT LAKE/RESERVOIR	RESERVOIR	RED	100	100	100	100	100	100
GREENBELT MUNICIPAL & INDUSTRIAL WATER AUTHORITY	QUANAH	HARDEMAN	RED	GREENBELT LAKE/RESERVOIR	RESERVOIR	RED	652	612	589	544	511	463

Region A Wholesale Water Supplier Needs
(Ac-ft per Year)

WWP Name	WUG Name	WUG County	WUG Basin	R2010	R2020	R2030	R2040	R2050	R2060
AMARILLO CITY OF	AMARILLO	RANDALL	RED	11	313	-1,787	-3,971	-6,217	-8,146
AMARILLO CITY OF	AMARILLO	POTTER	RED	7	171	-961	-2,110	-3,266	-4,241
AMARILLO CITY OF	AMARILLO	POTTER	CANADIAN	9	240	-1,349	-2,961	-4,582	-5,950
AMARILLO CITY OF	CANYON	RANDALL	RED	0	0	-83	-171	-247	-305
AMARILLO CITY OF	MANUFACTURING	POTTER	RED	0	0	-444	-1,087	-1,846	-2,638
AMARILLO CITY OF	MANUFACTURING	RANDALL	RED	0	0	-25	-51	-74	-83
AMARILLO CITY OF	MANUFACTURING	POTTER	CANADIAN	0	0	-200	-328	-313	-225
AMARILLO CITY OF	COUNTY-OTHER	RANDALL	RED	0	0	-3	-4	-7	-9
AMARILLO CITY OF	STEAM ELECTRIC POWER	POTTER	CANADIAN	0	0	0	0	0	0
BORGER CITY OF	BORGER	HUTCHINSON	CANADIAN	650	1,396	722	359	78	-196
BORGER CITY OF	COUNTY-OTHER	HUTCHINSON	CANADIAN	0	0	0	0	0	0
BORGER CITY OF	MANUFACTURING	CARSON	RED	0	0	0	0	0	0
BORGER CITY OF	MANUFACTURING	HUTCHINSON	CANADIAN	0	173	-64	-469	-784	-1,270
BORGER CITY OF	TCW SUPPLY INC	HUTCHINSON	CANADIAN	0	0	0	0	0	0
CACTUS CITY OF	CACTUS	MOORE	CANADIAN	0	0	-204	-262	-309	-350
CACTUS CITY OF	MANUFACTURING	MOORE	CANADIAN	-173	-800	-1,033	-1,396	-1,718	-2,044
CACTUS CITY OF	COUNTY-OTHER	MOORE	CANADIAN	0	0	-42	-64	-83	-100
CANADIAN RIVER MUNICIPAL WATER AUTHORITY	BORGER	HUTCHINSON	CANADIAN	-574	0	0	0	0	0
CANADIAN RIVER MUNICIPAL WATER AUTHORITY	BROWNFIELD	TERRY	COLORADO	-198	-356	-498	-632	-636	-618
CANADIAN RIVER MUNICIPAL WATER AUTHORITY	AMARILLO	RANDALL	RED	-6,064	0	0	0	0	0
CANADIAN RIVER MUNICIPAL WATER AUTHORITY	COUNTY-OTHER	HUTCHINSON	CANADIAN	8	19,921	20,012	20,136	23,455	23,637
CANADIAN RIVER MUNICIPAL WATER AUTHORITY	LAMESA	DAWSON	COLORADO	0	0	0	0	-200	-200
CANADIAN RIVER MUNICIPAL WATER AUTHORITY	LEVELLAND	HOCKLEY	BRAZOS	0	0	0	0	0	0
CANADIAN RIVER MUNICIPAL WATER AUTHORITY	LUBBOCK	LUBBOCK	BRAZOS	0	0	0	0	0	0
CANADIAN RIVER MUNICIPAL WATER AUTHORITY	O'DONNELL	DAWSON	BRAZOS	0	0	0	0	0	0
CANADIAN RIVER MUNICIPAL WATER AUTHORITY	O'DONNELL	LYNN	BRAZOS	0	0	0	0	0	0
CANADIAN RIVER MUNICIPAL WATER AUTHORITY	PAMPA	GRAY	CANADIAN	-476	0	0	0	0	0
CANADIAN RIVER MUNICIPAL WATER AUTHORITY	PLAINVIEW	HALE	BRAZOS	0	0	0	0	0	0
CANADIAN RIVER MUNICIPAL WATER AUTHORITY	SLATON	LUBBOCK	BRAZOS	0	0	0	0	0	0
CANADIAN RIVER MUNICIPAL WATER AUTHORITY	TAHOKA	LYNN	BRAZOS	0	0	0	0	0	0
GREENBELT MUNICIPAL & INDUSTRIAL WATER AUTHORITY	CHILDRESS	CHILDRESS	RED	0	0	0	0	0	0
GREENBELT MUNICIPAL & INDUSTRIAL WATER AUTHORITY	CHILLICOTHE	HARDEMAN	RED	0	0	0	0	0	0
GREENBELT MUNICIPAL & INDUSTRIAL WATER AUTHORITY	CLARENDON	DONLEY	RED	0	0	0	0	0	0

Region A Wholesale Water Supplier Needs
(Ac-ft per Year)

WWP Name	WUG Name	WUG County	WUG Basin	R2010	R2020	R2030	R2040	R2050	R2060
GREENBELT MUNICIPAL & INDUSTRIAL WATER AUTHORITY	COUNTY-OTHER	CHILDRESS	RED	0	0	0	0	0	0
GREENBELT MUNICIPAL & INDUSTRIAL WATER AUTHORITY	COUNTY-OTHER	DONLEY	RED	0	0	0	0	0	0
GREENBELT MUNICIPAL & INDUSTRIAL WATER AUTHORITY	COUNTY-OTHER	HALL	RED	0	0	0	0	0	0
GREENBELT MUNICIPAL & INDUSTRIAL WATER AUTHORITY	COUNTY-OTHER	FOARD	RED	0	0	0	0	0	0
GREENBELT MUNICIPAL & INDUSTRIAL WATER AUTHORITY	COUNTY-OTHER	HARDEMAN	RED	0	0	0	0	0	0
GREENBELT MUNICIPAL & INDUSTRIAL WATER AUTHORITY	COUNTY-OTHER	WILBARGER	RED	0	0	0	0	0	0
GREENBELT MUNICIPAL & INDUSTRIAL WATER AUTHORITY	CROWELL	FOARD	RED	0	0	0	0	0	0
GREENBELT MUNICIPAL & INDUSTRIAL WATER AUTHORITY	COUNTY-OTHER	DONLEY	RED	2,522	2,400	2,268	2,171	2,060	2,051
GREENBELT MUNICIPAL & INDUSTRIAL WATER AUTHORITY	MANUFACTURING	HARDEMAN	RED	0	0	0	0	0	0
GREENBELT MUNICIPAL & INDUSTRIAL WATER AUTHORITY	MEMPHIS	HALL	RED	0	0	0	0	0	0
GREENBELT MUNICIPAL & INDUSTRIAL WATER AUTHORITY	QUANAH	HARDEMAN	RED	0	0	0	0	0	0
PALO DURO RIVER AUTHORITY	CACTUS	MOORE	CANADIAN	0	0	-1,744	-1,744	-1,744	-1,740
PALO DURO RIVER AUTHORITY	DUMAS	MOORE	CANADIAN	0	0	-1,356	-1,356	-1,356	-1,352
PALO DURO RIVER AUTHORITY	GRUVER	HANSFORD	CANADIAN	0	0	-271	-271	-271	-271
PALO DURO RIVER AUTHORITY	SPEARMAN	HANSFORD	CANADIAN	0	0	-116	-116	-116	-116
PALO DURO RIVER AUTHORITY	SUNRAY	MOORE	CANADIAN	0	0	-271	-271	-271	-271

Region A Wholesale Water Provider Potentially Feasible Water Managment Strategy Supply
(Ac-ft per Year)

WWP Name	Project Name	Source Name	Source County	Source Basin	WUG Name	Selected	SS2010	SS2020	SS2030	SS2040	SS2050	SS2060
AMARILLO CITY OF	MUNICIPAL CONSERVATION	CONSERVATION	POTTER	CANADIAN	AMARILLO	Recommended	0	455	808	865	925	975
AMARILLO CITY OF	MUNICIPAL CONSERVATION	CONSERVATION	POTTER	RED	AMARILLO	Recommended	0	325	575	615	660	700
AMARILLO CITY OF	MUNICIPAL CONSERVATION	CONSERVATION	RANDALL	RED	AMARILLO	Recommended	0	595	1,070	1,159	1,256	1,337
AMARILLO CITY OF	POTTER COUNTY WELL FIELD	OGALLALA AQUIFER	POTTER	CANADIAN	AMARILLO	Recommended	0	3,667	3,737	3,741	2,854	1,771
AMARILLO CITY OF	POTTER COUNTY WELL FIELD	OGALLALA AQUIFER	POTTER	CANADIAN	AMARILLO	Recommended	0	2,500	2,500	2,500	2,500	2,500
AMARILLO CITY OF	POTTER COUNTY WELL FIELD	OGALLALA AQUIFER	POTTER	CANADIAN	AMARILLO	Recommended	0	2,500	2,500	2,500	2,500	2,500
AMARILLO CITY OF	POTTER COUNTY WELL FIELD	OGALLALA AQUIFER	POTTER	CANADIAN	CANYON	Recommended	0	0	83	171	247	305
AMARILLO CITY OF	POTTER COUNTY WELL FIELD	OGALLALA AQUIFER	POTTER	CANADIAN	MANUFACTURING	Recommended	0	0	444	1,087	1,846	2,638
AMARILLO CITY OF	POTTER COUNTY WELL FIELD	OGALLALA AQUIFER	POTTER	CANADIAN	MANUFACTURING	Recommended	0	0	25	51	74	83
AMARILLO CITY OF	POTTER COUNTY WELL FIELD	OGALLALA AQUIFER	POTTER	CANADIAN	MANUFACTURING	Recommended	0	0	200	328	313	225
AMARILLO CITY OF	POTTER COUNTY WELL FIELD	OGALLALA AQUIFER	POTTER	CANADIAN	COUNTY-OTHER	Recommended	0	0	3	4	7	9
AMARILLO CITY OF	POTTER COUNTY WELL FIELD	OGALLALA AQUIFER	POTTER	RED	AMARILLO	Recommended	0	800	800	800	800	800
AMARILLO CITY OF	POTTER COUNTY WELL FIELD	OGALLALA AQUIFER	POTTER	RED	AMARILLO	Recommended	0	0	0	0	0	0
AMARILLO CITY OF	ROBERTS COUNTY WELL FIELD - AMARILLO	OGALLALA AQUIFER	ROBERTS	CANADIAN	AMARILLO	Recommended	0	0	0	11,210	10,010	19,079
AMARILLO CITY OF	ROBERTS COUNTY WELL FIELD - AMARILLO	OGALLALA AQUIFER	ROBERTS	CANADIAN	AMARILLO	Recommended	0	0	0	0	0	741
AMARILLO CITY OF	ROBERTS COUNTY WELL FIELD - AMARILLO	OGALLALA AQUIFER	ROBERTS	CANADIAN	AMARILLO	Recommended	0	0	0	0	1,200	2,600
AMARILLO CITY OF	ROBERTS COUNTY WELL FIELD - AMARILLO	OGALLALA AQUIFER	ROBERTS	CANADIAN	CANYON	Recommended	0	0	0	0	0	0
AMARILLO CITY OF	ROBERTS COUNTY WELL FIELD - AMARILLO	OGALLALA AQUIFER	ROBERTS	CANADIAN	MANUFACTURING	Recommended	0	0	0	0	0	0
AMARILLO CITY OF	ROBERTS COUNTY WELL FIELD - AMARILLO	OGALLALA AQUIFER	ROBERTS	CANADIAN	MANUFACTURING	Recommended	0	0	0	0	0	0
BORGER CITY OF	DRILL ADDITIONAL GROUNDWATER WELL	OGALLALA AQUIFER	HUTCHINSON	CANADIAN	BORGER	Recommended	0	0	336	336	748	500
BORGER CITY OF	DRILL ADDITIONAL GROUNDWATER WELL	OGALLALA AQUIFER	HUTCHINSON	CANADIAN	MANUFACTURING	Recommended	0	0	664	664	1,252	1,500
BORGER CITY OF	MUNICIPAL CONSERVATION	CONSERVATION	HUTCHINSON	CANADIAN	BORGER	Recommended	0	24	71	114	107	102
CACTUS CITY OF	DRILL ADDITIONAL GROUNDWATER WELL	OGALLALA AQUIFER	MOORE	CANADIAN	CACTUS	Recommended	300	700	350	1,500	1,100	800
CACTUS CITY OF	DRILL ADDITIONAL GROUNDWATER WELL	OGALLALA AQUIFER	MOORE	CANADIAN	MANUFACTURING	Recommended	200	800	1,100	1,400	1,800	2,100
CACTUS CITY OF	DRILL ADDITIONAL GROUNDWATER WELL	OGALLALA AQUIFER	MOORE	CANADIAN	COUNTY-OTHER	Recommended	0	0	50	100	100	100
CACTUS CITY OF	MUNICIPAL CONSERVATION	CONSERVATION	MOORE	CANADIAN	CACTUS	Recommended	0	18	31	31	31	31
CACTUS CITY OF	PALO DURO RESERVOIR	PALO DURO LAKE/RESERVOIR	RESERVOIR	CANADIAN	CACTUS	Alternate	0	0	1,744	1,744	1,744	1,744
CACTUS CITY OF	PALO DURO RESERVOIR	PALO DURO LAKE/RESERVOIR	RESERVOIR	CANADIAN	MANUFACTURING	Alternate	0	0	0	0	0	0
CANADIAN RIVER MUNICIPAL WATER AUTHORITY	CRMWA ACQUISITION OF WATER RIGHTS	OGALLALA AQUIFER	ROBERTS	CANADIAN	COUNTY-OTHER	Recommended	0	0	0	0	0	0
CANADIAN RIVER MUNICIPAL WATER AUTHORITY	CRMWA ROBERTS COUNTY WELL FIELD	OGALLALA AQUIFER	ROBERTS	CANADIAN	COUNTY-OTHER	Recommended	0	0	15,000	15,000	15,000	15,000
GREENBELT MUNICIPAL & INDUSTRIAL WATER AUTHORITY	DRILL ADDITIONAL GROUNDWATER WELL	OGALLALA AQUIFER	DONLEY	RED	COUNTY-OTHER	Recommended	0	800	800	800	800	800
PALO DURO RIVER AUTHORITY	PALO DURO RESERVOIR	PALO DURO LAKE/RESERVOIR	RESERVOIR	CANADIAN	CACTUS	Recommended	0	0	1,744	1,744	1,744	1,740
PALO DURO RIVER AUTHORITY	PALO DURO RESERVOIR	PALO DURO LAKE/RESERVOIR	RESERVOIR	CANADIAN	DUMAS	Recommended	0	0	1,356	1,356	1,356	1,352
PALO DURO RIVER AUTHORITY	PALO DURO RESERVOIR	PALO DURO LAKE/RESERVOIR	RESERVOIR	CANADIAN	GRUVER	Recommended	0	0	271	271	271	271
PALO DURO RIVER AUTHORITY	PALO DURO RESERVOIR	PALO DURO LAKE/RESERVOIR	RESERVOIR	CANADIAN	SPEARMAN	Recommended	0	0	116	116	116	116
PALO DURO RIVER AUTHORITY	PALO DURO RESERVOIR	PALO DURO LAKE/RESERVOIR	RESERVOIR	CANADIAN	SUNRAY	Recommended	0	0	271	271	271	271

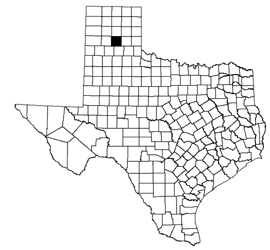
WWP Name	Project Name	Source Name	Source County	Source Basin	Capital Cost	AC2010	AC2020	AC2030	AC2040	AC2050	AC2060
AMARILLO CITY OF	MUNICIPAL CONSERVATION	CONSERVATION	POTTER	CANADIAN	$0	$0	$222,500	$395,100	$423,000	$452,300	$476,800
AMARILLO CITY OF	MUNICIPAL CONSERVATION	CONSERVATION	POTTER	RED	$0	$0	$158,900	$281,200	$300,700	$322,700	$342,300
AMARILLO CITY OF	MUNICIPAL CONSERVATION	CONSERVATION	RANDALL	RED	$0	$0	$0	$0	$0	$0	$0
AMARILLO CITY OF	POTTER COUNTY WELL FIELD	OGALLALA AQUIFER	POTTER	CANADIAN	$128,511,300	$0	$14,375,500	$14,375,500	$3,171,300	$3,171,300	$3,171,300
AMARILLO CITY OF	POTTER COUNTY WELL FIELD	OGALLALA AQUIFER	POTTER	RED	$0	$0	$0	$0	$0	$0	$0
AMARILLO CITY OF	ROBERTS COUNTY WELL FIELD - AMARILLO	OGALLALA AQUIFER	ROBERTS	CANADIAN	$287,377,200	$0	$0	$0	$16,225,100	$16,225,100	$19,922,800
BORGER CITY OF	DRILL ADDITIONAL GROUNDWATER WELL	OGALLALA AQUIFER	HUTCHINSON	CANADIAN	$9,379,200	$0	$0	$628,450	$628,450	$848,050	$848,050
BORGER CITY OF	MUNICIPAL CONSERVATION	CONSERVATION	HUTCHINSON	CANADIAN	$0	$0	$0	$0	$0	$0	$0
CACTUS CITY OF	DRILL ADDITIONAL GROUNDWATER WELL	OGALLALA AQUIFER	MOORE	CANADIAN	$10,893,400	$648,800	$805,600	$330,700	$1,136,300	$1,136,300	$661,400
CACTUS CITY OF	MUNICIPAL CONSERVATION	CONSERVATION	MOORE	CANADIAN	$0	$0	$0	$0	$0	$0	$0
CACTUS CITY OF	PALO DURO RESERVOIR	PALO DURO LAKE/RESERVOIR	RESERVOIR	CANADIAN	$0	$0	$0	$5,501,800	$5,501,800	$720,400	$720,400
CANADIAN RIVER MUNICIPAL WATER AUTHORITY	CRMWA ACQUISITION OF WATER RIGHTS	OGALLALA AQUIFER	ROBERTS	CANADIAN	$88,200,000	$0	$7,690,000	$7,690,000	$0	$0	$0
CANADIAN RIVER MUNICIPAL WATER AUTHORITY	CRMWA ROBERTS COUNTY WELL FIELD	OGALLALA AQUIFER	ROBERTS	CANADIAN	$21,824,000	$0	$0	$3,586,000	$3,586,000	$1,683,000	$1,683,000
GREENBELT MUNICIPAL & INDUSTRIAL WATER AUTHORITY	DRILL ADDITIONAL GROUNDWATER WELL	OGALLALA AQUIFER	DONLEY	RED	$1,865,900	$0	$230,200	$230,200	$67,500	$67,500	$67,500
PALO DURO RIVER AUTHORITY	PALO DURO RESERVOIR	PALO DURO LAKE/RESERVOIR	RESERVOIR	CANADIAN	$114,730,000	$0	$0	$11,531,800	$11,531,800	$1,529,200	$1,529,200

APPENDIX B

ARMSTRONG COUNTY

SUPPLY / DEMAND SUMMARY

Panhandle Water Planning Group
Armstrong County
Supply/Demand Summary



The following narrative describes the source(s) of current water supply for water user groups in Armstrong County. All groundwater supplies are based on the PWPG adopted approach for the respective aquifer. There are no projected shortages in Armstrong County. Based on the findings of the updated Northern Ogallala GAM, Armstrong County is shown to have less available groundwater. Further review of the available supplies with the updated GAM model is needed. Preliminary assessments indicate that no new shortages will be identified.

<u>Claude</u>

- Current supply is water from the Ogallala aquifer
- Projected demands will *not* exceed current supplies by 2060
- There are no projected shortages
- Currently, no strategies are recommended

<u>County-Other</u>

- Current supply is water from the Ogallala and Other aquifers
- Projected demands will *not* exceed current supplies by 2060
- There are no projected shortages
- Currently, no strategies are recommended

<u>Irrigation</u>

- Current supply is water from the Ogallala aquifer
- Projected demands will *not* exceed current supplies by 2060
- There are no projected shortages
- While no shortages are identified, it is recommended that irrigation conservation be implemented

<u>Livestock</u>

- Current supply is water from the Ogallala and Other aquifers and local supply (stock ponds)
- Projected demands will *not* exceed current supplies by 2060
- There are no projected shortages
- Currently, no strategies are recommended

Manufacturing

- There are no demands in this category

Mining

- Current supply is water from the Ogallala aquifer
- Projected demands will *not* exceed current supplies by 2060
- There are no projected shortages
- Currently, no strategies are recommended

Steam Electric Power

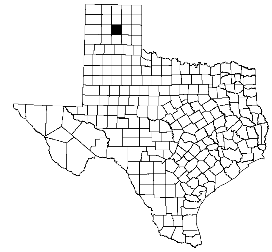
- There are no demands in this category

Water User Group	Current Supplies	Shortage	Proposed Water Management Strategies
Claude	Ogallala aquifer	No	None
County-Other	Ogallala and Other aquifers	No	None
Irrigation	Ogallala aquifers	No	Irrigation conservation
Livestock	Ogallala and Other aquifers and local supply (stock ponds)	No	None
Manufacturing	None	---	---
Mining	Ogallala aquifer	No	None
Steam Electric	None	---	---

Panhandle Water Planning Group

Carson County

Supply/Demand Summary



The following narrative describes the source(s) of current water supply and recommended water management strategies for water user groups in Carson County. All groundwater supplies are based on the PWPG adopted approach for the respective aquifer. The analysis of supplies includes the City of Amarillo and others withdrawing water from Carson County for use elsewhere in the region. Based on the findings of the updated Northern Ogallala GAM, Carson County is shown to have less available groundwater. Initial assessments with the updated GAM supplies indicate that the City of Panhandle will have a shortage beginning in 2030.

<u>County-Other</u>

- Current supply is water from the Ogallala aquifer
- Projected demands will *not* exceed current supplies by 2060
- There are no projected shortages
- Currently, no strategies are recommended

<u>Groom</u>

- Current supply is water from the Ogallala aquifer
- Projected demands will *not* exceed current supplies by 2060
- There are no projected shortages
- Currently, no strategies are recommended

<u>Hi Texas Water Company</u>

- Current supply is water from the Ogallala aquifer
- Projected demands will *not* exceed current supplies by 2060
- There are no projected shortages
- Currently, no strategies are recommended

<u>Irrigation</u>

- Current supply is water from the Ogallala aquifer, reuse from the City of Panhandle and Red River irrigation water rights
- Projected demands will *not* exceed current supplies by 2060
- There are no projected shortages
- While no shortages are identified, it is recommended that irrigation conservation be implemented

Livestock

- Current supply is water from the Ogallala aquifer and local supply (stock ponds)
- Projected demands will *not* exceed current supplies by 2060
- There are no projected shortages
- Currently, no strategies are recommended

Manufacturing

- Current supply is water from the Ogallala aquifer
- Projected demands will *not* exceed current supplies by 2060
- There are no projected shortages
- Currently, no strategies are recommended

Mining

- Current supply is water from the Ogallala aquifer
- Projected demands will *not* exceed current supplies by 2060
- There are no projected shortages
- Currently, no strategies are recommended

Panhandle

- Current supply is water from the Ogallala aquifer
- Projected demands will exceed current supplies by 2030
- The projected shortage is 556 acre-feet per year.
- Recommended strategies are conservation and develop new wells in the Ogallala aquifer.

Skellytown

- Current supply is water from the Ogallala aquifer
- Projected demands will *not* exceed current supplies by 2060
- There are no projected shortages
- Currently, no strategies are recommended

Steam Electric

- There are no demands in this category

White Deer

- Current supply is water from the Ogallala aquifer
- Projected demands will *not* exceed current supplies by 2060
- There are no projected shortages
- Currently, no strategies are recommended

Carson County - Supply/Demand Summary

Water User Group	Current Supplies	Shortage	Proposed Water Management Strategies
County-Other	Ogallala aquifer	No	None
Groom	Ogallala aquifer	No	None
Hi Texas Water Co	Ogallala aquifer	No	None
Irrigation	Ogallala aquifer, reuse and surface water	No	Irrigation conservation
Livestock	Ogallala aquifer and local supply (stock ponds)	No	None
Manufacturing	Ogallala aquifer	No	None
Mining	Ogallala aquifer	No	None
Panhandle	Ogallala aquifer	Yes	Conservation, New wells
Skellytown	Ogallala aquifer	No	None
Steam Electric	None	----	----
White Deer	Ogallala aquifer	No	None

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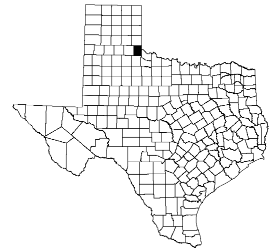
Panhandle Water Planning Group
Childress County
Supply/Demand Summary



The following narrative describes the source(s) of current water supply for water user groups in Childress County. All groundwater supplies are based on the PWPG adopted approach for the respective aquifer. There are no projected shortages in Childress County. Following the narrative is a table summarizing this information.

<u>Childress</u>

- Current supply is water from the Greenbelt Reservoir
- Projected demands will *not* exceed current supplies by 2060
- There are no projected shortages
- Currently, no strategies are recommended

<u>County-Other</u>

- Current supply is water from the Seymour aquifer and Greenbelt Reservoir
- Projected demands will *not* exceed current supplies by 2060
- There are no projected shortages
- Currently, no strategies are recommended

<u>Irrigation</u>

- Current supply is water from the Blaine, Seymour and Whitehorse aquifers and reuse
- Projected demands will *not* exceed current supplies by 2060
- There are no projected shortages
- While no shortages are identified, it is recommended that irrigation conservation be implemented

<u>Livestock</u>

- Current supply is water from the Seymour aquifer and local supply (stock ponds)
- Projected demands will *not* exceed current supplies by 2060
- There are no projected shortages
- Currently, no strategies are recommended

<u>Manufacturing</u>

- There are no demands in this category

Mining

- Current supply is water from local supply
- Projected demands will *not* exceed current supplies by 2060
- There are no projected shortages
- Currently, no strategies are recommended

Steam Electric Power

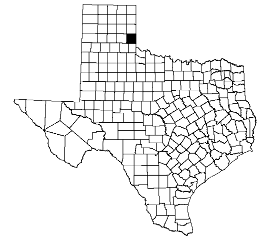
- There are no demands in this category

Water User Group	Current Supplies	Shortage	Proposed Water Management Strategies
Childress	Greenbelt Reservoir	No	None
County-Other	Seymour aquifer and Greenbelt Reservoir	No	None
Irrigation	Blaine, Seymour and Whitehorse aquifers and reuse	No	Irrigation conservation
Livestock	Seymour aquifers and local supply (stock ponds)	No	None
Manufacturing	None	---	---
Mining	Local supply	No	None
Steam Electric	None	---	---

Panhandle Water Planning Group

Collingsworth County

Supply/Demand Summary



The following narrative describes the source(s) of current water supply for water user groups in Collingsworth County. All groundwater supplies are based on the PWPG adopted approach for the respective aquifer. There are no projected shortages in Collingsworth County.

Wellington

- Current supply is water from the Seymour aquifer
- Projected demands will *not* exceed current supplies by 2060
- There are no projected shortages
- Currently, no strategies are recommended

County-Other

- Current supply is water from the Blaine, Seymour and Other aquifers
- Projected demands will *not* exceed current supplies by 2060
- There are no projected shortages
- Currently, no strategies are recommended

Irrigation

- Current supply is water from the Ogallala, Blaine and Seymour aquifers, Red River irrigation water rights and reuse
- Projected demands will *not* exceed current supplies by 2060
- There are no projected shortages
- While no shortages are identified, it is recommended that irrigation conservation be implemented

Livestock

- Current supply is water from the Ogallala, Blaine, Seymour and Other aquifers and local supply (stock ponds)
- Projected demands will *not* exceed current supplies by 2060
- There are no projected shortages
- Currently, no strategies are recommended

Manufacturing

- There are no demands in this category

Mining

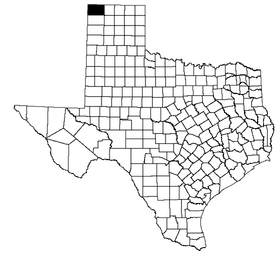
- There are no demands in this category

Steam Electric Power

- There are no demands in this category

Water User Group	Current Supplies	Shortage	Proposed Water Management Strategies
Wellington	Seymour aquifer	No	None
County-Other	Blaine, Seymour and Other aquifers	No	None
Irrigation	Ogallala, Blaine and Seymour aquifers, reuse and Red River water rights	No	Irrigation conservation
Livestock	Ogallala, Blaine, Seymour and Other aquifers and local supply (stock ponds)	No	None
Manufacturing	None	---	---
Mining	None	---	---
Steam Electric	None	---	---

Panhandle Water Planning Group
Dallam County
Strategy Summary



The following narrative describes the source(s) of current water supply and recommended water management strategies for water user groups in Dallam County. All groundwater supplies are based on the PWPG adopted approach for the respective aquifer. Strategies have been identified for all water user groups that have a projected shortage. Based on the findings of the updated Northern Ogallala GAM, Dallam County is shown to have more available groundwater county-wide, but less supply in some areas. Preliminary assessments indicate that even with additional supply, Dallam County irrigation will have a shortage. With the updated GAM results, Texline will have a shortage.

<u>Dalhart</u>

- Current supply is water from the Ogallala aquifer
- Projected demands will *not* exceed current supplies by 2060
- There are no projected shortages
- Currently, no strategies are recommended

<u>Texline</u>

- Current supply is water from the Ogallala aquifer
- Projected demands will exceed current supplies by 2020
- Shortage is estimated at 224 acre-feet per year.
- Recommended strategies are conservation and new wells in Ogallala aquifer.

<u>County-Other</u>

- Current supply is water from the Ogallala aquifer
- Projected demands will *not* exceed current supplies by 2060
- There are no projected shortages
- Currently, no strategies are recommended

<u>Irrigation</u>

- Current supply is water from the Ogallala/Rita Blanca and Dockum aquifers and reuse
- Projected demands will exceed current supplies in 2010
- Shortage occurs in the Canadian River basin
- The recommended water management strategies to meet shortages include NPET, improved irrigation equipment, change in crop types and/or varieties, conversion to dryland, conservation tillage, and biotechnologically developed drought resistant crops.

Livestock

- Current supply is water from the Ogallala/Rita Blanca aquifer and local supply (stock ponds)
- Projected demands will *not* exceed current supplies by 2060
- There are no projected shortages
- Currently, no strategies are recommended

Manufacturing

- There are no demands in this category

Mining

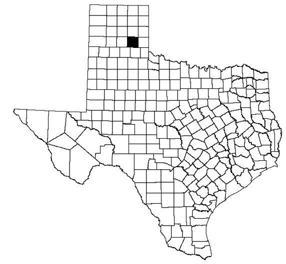
- There are no demands in this category

Steam Electric

- There are no demands in this category

Water User Group	Current Supplies	Shortage	Proposed Water Management Strategies
Dalhart	Ogallala aquifer	No	None
Texline	Ogallala aquifer	Yes	New wells, Conservation
County-Other	Ogallala aquifer	No	None
Irrigation	Ogallala/Rita Blanca and Dockum aquifers and reuse	Yes	Irrigation conservation strategies
Livestock	Ogallala/ Rita Blanca aquifer and local supply (stock ponds)	No	None
Manufacturing	None	---	---
Mining	None	---	---
Steam Electric	None	---	---

Panhandle Water Planning Group
Donley County
Supply/Demand Summary



The following narrative describes the source(s) of current water supply for water user groups in Donley County. All groundwater supplies are based on the PWPG adopted approach for the respective aquifer. There are no projected shortages in Donley County. Based on the findings of the updated Northern Ogallala GAM, Donley County is shown to have less available groundwater. Further review of the available supplies with the updated GAM model is needed. Preliminary assessments indicate that there may be potential small shortages for irrigation needs.

Clarendon

- Current supply is water from the Greenbelt Reservoir
- Projected demands will *not* exceed current supplies by 2060
- There are no projected shortages
- Currently, no strategies are recommended

County-Other

- Current supply is water from the Ogallala aquifer and Greenbelt Reservoir
- Projected demands will *not* exceed current supplies by 2060
- There are no projected shortages
- Currently, no strategies are recommended

Irrigation

- Current supply is water from the Ogallala aquifer and Red River irrigation water rights
- Projected demands will *not* exceed current supplies by 2060
- There are no projected shortages
- While no shortages are identified, it is recommended that irrigation conservation be implemented

Livestock

- Current supply is water from the Ogallala and Other aquifers and local supply (stock ponds)
- Projected demands will *not* exceed current supplies by 2060
- There are no projected shortages
- Currently, no strategies are recommended

Manufacturing

- There are no demands in this category

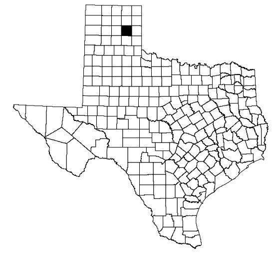
Mining

- Current supply is water from the Ogallala aquifer
- Projected demands will *not* exceed current supplies by 2060
- There are no projected shortages
- Currently, no strategies are recommended

Steam Electric Power

- There are no demands in this category

Water User Group	Current Supplies	Shortage	Proposed Water Management Strategies
Clarendon	Greenbelt reservoir	No	None
County-Other	Ogallala aquifer and Greenbelt reservoir	No	None
Irrigation	Ogallala aquifer and Red River water rights	No	Irrigation conservation
Livestock	Ogallala and Other aquifers and local supply (stock ponds)	No	None
Manufacturing	None	---	---
Mining	Ogallala aquifer	No	None
Steam Electric	None	---	---



Panhandle Water Planning Group
Gray County
Strategy Summary

The following narrative describes the source(s) of current water supply for water user groups in Gray County. All groundwater supplies are based on the PWPG adopted approach for the respective aquifer. Strategies have been identified for all water user groups that have a projected shortage.

<u>Lefors</u>

- Current supply is water from the Ogallala aquifer
- Projected demands will exceed current supplies by 2040
- The recommended strategies are municipal conservation and drill new well in Ogallala aquifer.

<u>McLean</u>

- Current supply is water from the Ogallala aquifer
- Projected demands will *not* exceed current supplies by 2060
- There are no projected shortages
- Currently, no strategies are recommended

<u>Pampa</u>

- Current supply is water from the Ogallala aquifer and CRMWA system
- Projected demands will *not* exceed current supplies by 2060
- There are no projected shortages
- Pampa will develop additional groundwater through new wells and purchase additional supplies from CRMWA.

<u>County-Other</u>

- Current supply is water from the Ogallala aquifer
- Projected demands will *not* exceed current supplies by 2060
- There are no projected shortages
- Currently, no strategies are recommended

<u>Irrigation</u>

- Current supply is water from the Ogallala aquifer, Red River and Canadian River irrigation water rights, and reuse from Pampa.
- Projected demands will *not* exceed current supplies by 2060
- There are no projected shortages
- While no shortages are identified, it is recommended that irrigation conservation be implemented

Livestock

- Current supply is water from the Ogallala aquifer and local supply (stock ponds)
- Projected demands will *not* exceed current supplies by 2060
- There are no projected shortages
- Currently, no strategies are recommended

Manufacturing

- Current supply is water from the Ogallala aquifer
- Projected demands will *not* exceed current supplies by 2060
- There are no projected shortages
- Currently, no strategies are recommended

Mining

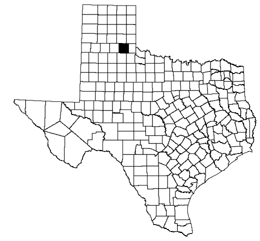
- Current supply is water from the Ogallala aquifer
- Projected demands will *not* exceed current supplies by 2060
- There are no projected shortages
- Currently, no strategies are recommended

Steam Electric

- Current supply is water from the Ogallala aquifer
- Projected demands will *not* exceed current supplies by 2060
- There are no projected shortages
- Currently, no strategies are recommended

Water User Group	**Current Supplies**	**Shortage**	**Proposed Water Management Strategies**
Lefors	Ogallala aquifer	Yes	Municipal conservation and new well in Ogallala
McLean	Ogallala aquifer	No	None
Pampa	Ogallala aquifer and CRMWA system	No	Municipal conservation, new wells in Ogallala and purchase additional water from CRMWA
County-Other	Ogallala aquifer	No	None
Irrigation	Ogallala and reuse	No	Irrigation conservation
Livestock	Ogallala aquifer and local supply (stock ponds)	No	None
Manufacturing	Ogallala aquifer	No	None
Mining	Ogallala aquifer	No	None
Steam Electric	Ogallala aquifer	No	None

Panhandle Water Planning Group
Hall County
Strategy Summary



The following narrative describes the source(s) of current water supply and recommended water management strategies for water user groups in Hall County. All groundwater supplies are based on the PWPG adopted approach for the respective aquifer. Strategies have been identified for all water user groups that have a projected shortage.

Memphis

- Current supply is water from the Ogallala aquifer in Donley County and Greenbelt Reservoir
- Projected demands will exceed current supplies by 2020
- The recommended strategies are municipal conservation, drill new well in Ogallala aquifer and expand supplies from Greenbelt M&IWA.

County-Other

- Current supply is water from the Ogallala (Donley County) and Seymour aquifers and Greenbelt reservoir
- Projected demands will *not* exceed current supplies by 2060; however, water quality concerns were identified for the City of Turkey and quantity concerns for Brice-Lesley WSC.
- Shortages were identified for Turkey and Brice-Lesley WSC (Note: County-Other category does not show a shortage because of the aggregated nature of the category.)
- The recommended strategies are to drill a new well in Ogallala aquifer in Donley County for Brice-Lesley and a new well in Floyd County for Turkey.

Irrigation

- Current supply is water from the Seymour aquifers and Red River irrigation water rights
- Projected demands will *not* exceed current supplies by 2060
- There are no projected shortages
- While no shortages are identified, it is recommended that irrigation conservation be implemented

Livestock

- Current supply is water from the Seymour and Other aquifers and local supply (stock ponds)
- Projected demands will *not* exceed current supplies by 2060
- There are no projected shortages
- Currently, no strategies are recommended

Manufacturing

- There are no demands in this category

Mining (Shortage less than 10AFY)

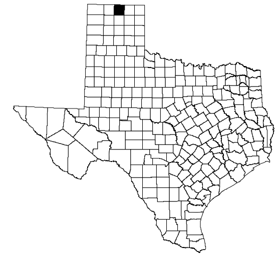
- Current supply is water from Other aquifers
- Projected demands will *not* exceed current supplies by 2060
- There are no projected shortages
- Currently, no strategies are recommended

Steam Electric

- There are no demands in this category

Water User Group	Current Supplies	Shortage	Proposed Water Management Strategies
Memphis	Seymour aquifer and Greenbelt reservoir	Yes	Municipal conservation, New well in Ogallala and increase supplies from Greenbelt reservoir
County-Other	Ogallala and Seymour aquifers and Greenbelt reservoir	Yes	New wells in Ogallala in Donley and Floyd counties
Irrigation	Seymour aquifers and Red River water rights	No	Irrigation conservation
Livestock	Seymour and Other aquifers and local supply (stock ponds)	No	None
Manufacturing	None	---	---
Mining	Other aquifer	No	None
Steam Electric	None	---	---

Panhandle Water Planning Group
Hansford County
Strategy Summary



The following narrative describes the source(s) of current water supply and recommended water management strategies for water user groups in Hansford County. All groundwater supplies are based on the PWPG adopted approach for the respective aquifer. Based on the findings of the updated Northern Ogallala GAM, Hansford County is shown to have more available groundwater. Preliminary assessments indicate that the additional supply may delay or eliminate irrigation shortages in the county. Strategies have been identified for all water user groups that have a projected shortage.

<u>Gruver</u>

- Current supply is water from the Ogallala aquifer
- Projected demands will exceed current supplies by 2020
- The recommended strategies are municipal conservation and drill new well in Ogallala aquifer.
- The recommended alternate strategy is to participate in the Palo Duro Reservoir transmission project.

<u>Spearman</u>

- Current supply is water from the Ogallala aquifer
- Projected demands will exceed current supplies by 2030
- The recommended strategies are municipal conservation and drill new well in Ogallala aquifer.
- The recommended alternate strategy is to participate in the Palo Duro Reservoir transmission project.

<u>County-Other</u>

- Current supply is water from the Ogallala aquifer
- Projected demands will *not* exceed current supplies by 2060
- There are no projected shortages
- Currently, no strategies are recommended

<u>Irrigation</u>

- Current supply is water from the Ogallala aquifer and Canadian River irrigation water rights
- Projected demands will exceed current supplies by 2020
- The recommended water management strategies to meet shortages include NPET, improved irrigation equipment, change in crop types and/or varieties, conversion to dryland, conservation tillage, and biotechnologically developed drought resistant crops.

Livestock

- Current supply is water from the Ogallala aquifer and local supply (stock ponds and irrigation)
- Projected demands will *not* exceed current supplies by 2060
- There are no projected shortages
- Currently, no strategies are recommended

Manufacturing

- Current supply is water from the Ogallala aquifer
- Projected demands will *not* exceed current supplies by 2060
- There are no projected shortages
- Currently, no strategies are recommended

Mining

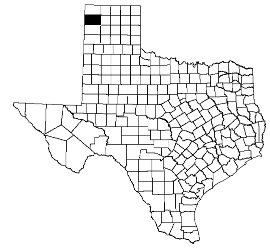
- Current supply is water from the Ogallala aquifer
- Projected demands will *not* exceed current supplies by 2060
- There are no projected shortages
- Currently, no strategies are recommended

Steam Electric

- There are no demands in this category

Water User Group	**Current Supplies**	**Shortage**	**Proposed Water Management Strategies**
Gruver	Ogallala aquifer	Yes	Municipal conservation, New well in Ogallala
Spearman	Ogallala aquifer	Yes	Municipal conservation, New well in Ogallala
County-Other	Ogallala aquifer	No	None
Irrigation	Ogallala aquifer, Canadian River	Yes	Irrigation conservation
Livestock	Ogallala aquifer and local supply (stock ponds)	No	None
Manufacturing	Ogallala aquifer	No	None
Mining	Ogallala aquifer	No	None
Steam Electric	None	---	---

Panhandle Water Planning Group
Hartley County
Strategy Summary



The following narrative describes the source(s) of current water supply and recommended water management strategies for water user groups in Hartley County. All groundwater supplies are based on the PWPG adopted approach for the respective aquifer. Strategies have been identified for all water user groups that have a projected shortage. Based on the findings of the updated Northern Ogallala GAM, Hartley County is shown to have more available groundwater. Preliminary assessments indicate that even with additional supply, Hartley County irrigation will have a shortage.

Dalhart

- Current supply is water from the Ogallala aquifer
- Projected demands will *not* exceed current supplies by 2060
- There are no projected shortages
- Currently, no strategies are recommended

County-Other

- Current supply is water from the Ogallala aquifer
- Projected demands will *not* exceed current supplies by 2060
- There are no projected shortages
- Currently, no strategies are recommended

Irrigation

- Current supply is water from the Ogallala aquifer
- Projected demands will exceed current supplies starting in 2010
- Shortage occurs in the Canadian River basin
- The recommended water management strategies to meet shortages include NPET, improved irrigation equipment, change in crop types and/or varieties, conversion to dryland, conservation tillage, and biotechnologically developed drought resistant crops.

Livestock

- Current supply is water from the Ogallala and Dockum aquifers and local supply (stock ponds)
- Projected demands will *not* exceed current supplies by 2060
- There are no projected shortages
- Currently, no strategies are recommended

Manufacturing

- Current supply is water from the Ogallala aquifer
- Projected demands will *not* exceed current supplies by 2060
- There are no projected shortages
- Currently, no strategies are recommended

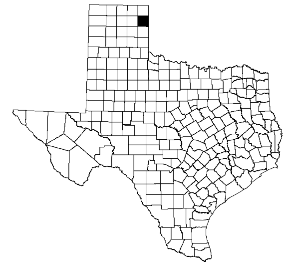
Mining

- There are no demands in this category

Steam Electric

- There are no demands in this category

Water User Group	Current Supplies	Shortage	Proposed Water Management Strategies
Dalhart	Ogallala aquifer	No	None
County-Other	Ogallala aquifer	No	None
Irrigation	Ogallala aquifer	Yes	Irrigation conservation
Livestock	Ogallala and Dockum aquifers and local supply (stock ponds)	No	None
Manufacturing	Ogallala aquifer	No	None
Mining	None	---	---
Steam Electric	None	---	---



Panhandle Water Planning Group
Hemphill County
Supply/Demand Summary

The following narrative describes the source(s) of current water supply for water user groups in Hemphill County. All groundwater supplies are based on the PWPG adopted approach for the respective aquifer. There are no projected shortages in Hemphill County.

Canadian

- Current supply is water from the Ogallala aquifer
- Projected demands will *not* exceed current supplies by 2060
- There are no projected shortages
- Currently, no strategies are recommended

County-Other

- Current supply is water from the Ogallala aquifer
- Projected demands will *not* exceed current supplies by 2060
- There are no projected shortages
- Currently, no strategies are recommended

Irrigation

- Current supply is water from the Ogallala aquifer
- Projected demands will *not* exceed current supplies by 2060
- There are no projected shortages
- While no shortages are identified, it is recommended that irrigation conservation be implemented

Livestock

- Current supply is water from the Ogallala aquifer and local supply (stock ponds)
- Projected demands will *not* exceed current supplies by 2060
- There are no projected shortages
- Currently, no strategies are recommended

Manufacturing

- Current supply is water from the Ogallala aquifer
- Projected demands will *not* exceed current supplies by 2060
- There are no projected shortages
- Currently, no strategies are recommended

Mining

- Current supply is water from the Ogallala aquifer
- Projected demands will *not* exceed current supplies by 2060
- There are no projected shortages
- Currently, no strategies are recommended

Steam Electric Power

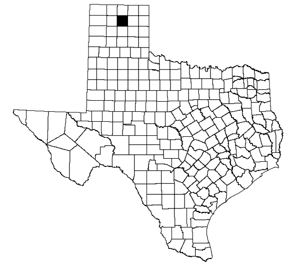
- There are no demands in this category

Water User Group	**Current Supplies**	**Shortage**	**Proposed Water Management Strategies**
Canadian	Ogallala aquifer	No	None
County-Other	Ogallala aquifer	No	None
Irrigation	Ogallala aquifer	No	Irrigation conservation
Livestock	Ogallala aquifer and local supply (stock ponds)	No	None
Manufacturing	Ogallala aquifer	No	None
Mining	Ogallala aquifer	No	None
Steam Electric	None	---	---

Panhandle Water Planning Group

Hutchinson County

Strategy Summary



The following narrative describes the source(s) of current water supply and recommended water management strategies for water user groups in Hutchinson County. All groundwater supplies are based on the PWPG adopted approach for the respective aquifer. Strategies have been identified for all water user groups that have a projected shortage.

<u>Borger</u>

- Current supply is water from the Ogallala aquifer and CRMWA system
- Projected demands will exceed current supplies by 2040 for the city and its customers.
- The recommended strategies are municipal conservation and drill new well in Ogallala aquifer.

<u>Fritch</u>

- Current supply is water from the Ogallala aquifer
- Projected demands will *not* exceed current supplies by 2060
- There are no projected shortages
- Fritch has purchased infrastructure from Hi TX Water Company. Although there are no shortages, it is recommended that Fritch rehabilitate this system and develop additional groundwater from the Ogallala.

<u>Hi Texas Water Company</u>

- Current supply is water from the Ogallala aquifer
- Projected demands will *not* exceed current supplies by 2060
- There are no projected shortages
- Currently, no strategies are recommended

<u>Stinnett</u>

- Current supply is water from the Ogallala aquifer
- Projected demands will *not* exceed current supplies by 2060
- There are no projected shortages
- Currently, no strategies are recommended

<u>TCW Supply Inc.</u>

- Current supply is water from the Ogallala aquifer
- Projected demands will *not* exceed current supplies by 2060
- There are no projected shortages
- Currently, no strategies are recommended

Irrigation

- Current supply is water from the Ogallala aquifer and Canadian River irrigation water rights
- Projected demands will exceed current supplies starting in 2020
- Shortage occurs in the Canadian River basin
- The recommended water management strategies to meet shortages include NPET, improved irrigation equipment, change in crop types and/or varieties, conversion to dryland, conservation tillage, and biotechnologically developed drought resistant crops.

Livestock

- Current supply is water from the Ogallala aquifer and local supply (stock ponds)
- Projected demands will *not* exceed current supplies by 2060
- There are no projected shortages
- Currently, no strategies are recommended

Manufacturing

- Current supply is water from the Ogallala aquifer and sales from Borger (reuse, groundwater and CRMWA system)
- Projected demands will exceed current supplies starting in 2030
- Shortage occurs in the Canadian River basin
- The recommended water management strategies to meet shortages are to increase purchases form Borger.

Mining

- Current supply is water from the Ogallala aquifer
- Projected demands will *not* exceed current supplies by 2060
- There are no projected shortages
- Currently, no strategies are recommended

Steam Electric

- There are no demands in this category

Hutchinson County – Strategy Summary

Water User Group	Current Supplies	Shortage	Proposed Water Management Strategies
Borger	Ogallala aquifer and CRMWA system	Yes	New well in Ogallala and increase supplies from CRMWA
Fritch	Ogallala aquifer	No	Rehabilitate infrastructure and develop new well
Hi Texas Water Company	Ogallala aquifer	No	None
Stinnett	Ogallala aquifer	No	None
TCW Supply Inc.	Ogallala aquifer	No	None
County-Other	Ogallala aquifer	No	None
Irrigation	Ogallala aquifer and local supply	Yes	Irrigation conservation
Livestock	Ogallala aquifer and local supply (stock ponds and irrigation)	No	None
Manufacturing	Ogallala aquifer, reuse, CRMWA system	Yes	Purchase from Borger
Mining	Ogallala aquifer	No	None
Steam Electric	None	---	---

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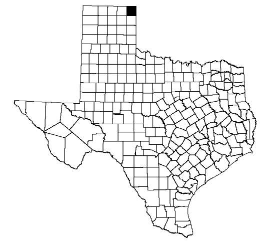
Panhandle Water Planning Group
Lipscomb County
Supply/Demand Summary



The following narrative describes the source(s) of current water supply for water user groups in Lipscomb County. All groundwater supplies are based on the PWPG adopted approach for the respective aquifer. There are no projected shortages in Lipscomb County.

<u>Booker</u>

- Current supply is water from the Ogallala aquifer
- Projected demands will *not* exceed current supplies by 2060
- There are no projected shortages
- Currently, no strategies are recommended

<u>County-Other</u>

- Current supply is water from the Ogallala aquifer
- Projected demands will *not* exceed current supplies by 2060
- There are no projected shortages
- Currently, no strategies are recommended

<u>Irrigation</u>

- Current supply is water from the Ogallala aquifer and Canadian River irrigation water rights
- Projected demands will *not* exceed current supplies by 2060
- There are no projected shortages
- While no shortages are identified, it is recommended that irrigation conservation be implemented

<u>Livestock</u>

- Current supply is water from the Ogallala aquifer and local supply (stock ponds and irrigation)
- Projected demands will *not* exceed current supplies by 2060
- There are no projected shortages
- Currently, no strategies are recommended

<u>Manufacturing</u>

- Current supply is water from the Ogallala aquifer
- Projected demands will *not* exceed current supplies by 2060
- There are no projected shortages
- Currently, no strategies are recommended

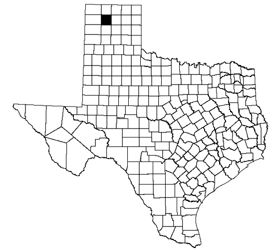
Mining

- Current supply is water from the Ogallala aquifer
- Projected demands will *not* exceed current supplies by 2060
- There are no projected shortages
- Currently, no strategies are recommended

Steam Electric Power

- There are no demands in this category

Water User Group	**Current Supplies**	**Shortage**	**Proposed Water Management Strategies**
Booker	Ogallala aquifer	No	None
County-Other	Ogallala aquifer	No	None
Irrigation	Ogallala aquifer and Canadian River	No	Irrigation conservation
Livestock	Ogallala aquifer and local supply (stock ponds and irrigation)	No	None
Manufacturing	Ogallala aquifer	No	None
Mining	Ogallala aquifer	No	None
Steam Electric	None	---	---



Panhandle Water Planning Group
Moore County
Strategy Summary

The following narrative describes the source(s) of current water supply and recommended water management strategies for water user groups in Moore County. All groundwater supplies are based on the PWPG adopted approach for the respective aquifer. Strategies have been suggested for all water user groups that have a projected shortage. Based on the findings of the updated Northern Ogallala GAM, Moore County is shown to have more available groundwater. Preliminary assessments indicate that even with additional supply, Moore County irrigation will have a shortage.

<u>Cactus</u>

- Current supply is water from the Ogallala aquifer
- Projected demands will exceed current supplies starting in 2010
- The recommended water management strategies to meet shortages include new wells in the Ogallala aquifer and implementation of conservation measures.
- The recommended alternate strategy is to participate in the Palo Duro Reservoir transmission project.

<u>County-Other</u>

- Current supply is water from the Ogallala aquifer
- Projected demands will exceed current supplies starting in 2030
- Shortage occurs in the Canadian River basin
- The recommended water management strategies to meet shortages include new wells in the Ogallala aquifer and implementation of conservation measures.

<u>Dumas</u>

- Current supply is water from the Ogallala aquifer
- Projected demands will exceed current supplies starting in 2020
- The recommended water management strategies to meet shortages include new wells in the Ogallala aquifer and implementation of conservation measures.

<u>Irrigation</u>

- Current supply is water from the Ogallala and Dockum aquifers, Canadian River irrigation rights and reuse
- Projected demands will exceed current supplies starting in 2010
- Shortage occurs in the Canadian River basin
- The recommended water management strategies to meet shortages include NPET, improved irrigation equipment, change in crop types and/or varieties, conversion to dryland, conservation tillage, and biotechnologically developed drought resistant crops.

Livestock

- Current supply is water from the Ogallala aquifer and local supply (stock ponds)
- Projected demands will *not* exceed current supplies
- There are no projected shortages
- Currently, no strategies are recommended.

Manufacturing

- Current supply is water from the Ogallala aquifer
- Projected demands will exceed current supplies starting in 2010
- Shortage occurs in the Canadian River basin
- The recommended water management strategies to meet shortages is to purchase additional water from Cactus

Mining

- Current supply is water from the Ogallala aquifer
- Projected demands will *not* exceed current supplies by 2060
- There are no projected shortages
- Currently, no strategies are recommended

Steam Electric Power

- Current supply is water from the Ogallala aquifer
- Projected demands will exceed current supplies starting in 2010
- Shortage occurs in the Canadian River basin
- The recommended water management strategies to meet shortages include the installation of new wells in the Ogallala aquifer.

Sunray

- Current supply is water from the Ogallala aquifer
- Projected demands will exceed current supplies starting in 2030
- The recommended water management strategies to meet shortages include new wells in the Ogallala aquifer and implementation of conservation measures.
- The recommended alternate strategy is to participate in the Palo Duro Reservoir transmission project.

Moore County – Strategy Summary

Water User Group	Current Supplies	Shortage	Proposed Water Management Strategies
Cactus	Ogallala aquifer	Yes	New wells in Ogallala, Municipal conservation
Dumas	Ogallala aquifer	Yes	New wells in Ogallala, Municipal conservation
Sunray	Ogallala aquifer	Yes	New wells in Ogallala, Municipal conservation
County-Other	Ogallala aquifer	Yes	New wells in Ogallala, Municipal conservation
Irrigation	Ogallala and Dockum aquifers, Canadian River and reuse	Yes	Irrigation conservation
Livestock	Ogallala aquifer and local supply (stock ponds)	No	None
Manufacturing	Ogallala aquifer	Yes	Purchase from Cactus
Mining	Ogallala aquifer	No	None
Steam Electric	Ogallala aquifer	Yes	New wells

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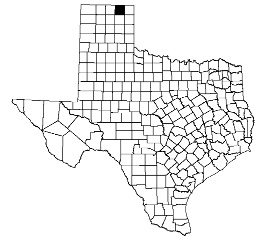
Panhandle Water Planning Group
Ochiltree County
Supply/Demand Summary



The following narrative describes the source/source(s) of current water supply for water user groups in Ochiltree County. All groundwater supplies are based on the PWPG adopted approach for the respective aquifer. Based on the findings of the updated Northern Ogallala GAM, Ochiltree County is shown to have more available groundwater countywide, but some areas within the county are shown to have less supply. Initial assessments indicate that with the updated GAM supplies, the City of Perryton will have a shortage.

<u>Perryton</u>

- Current supply is water from the Ogallala aquifer
- Projected demands will exceed current supplies by 2050
- The projected shortage is estimated at 1,140 acre-feet per year by 2060
- The recommended strategies are conservation and new wells in the Ogallala aquifer

<u>County-Other</u>

- Current supply is water from the Ogallala aquifer
- Projected demands will *not* exceed current supplies by 2060
- There are no projected shortages
- Currently, no strategies are recommended

<u>Irrigation</u>

- Current supply is water from the Ogallala aquifer
- Projected demands will *not* exceed current supplies by 2060
- There are no projected shortages
- While no shortages are identified, it is recommended that irrigation conservation be implemented

<u>Livestock</u>

- Current supply is water from the Ogallala aquifer and local supply (stock ponds)
- Projected demands will *not* exceed current supplies by 2060
- There are no projected shortages
- Currently, no strategies are recommended

<u>Manufacturing</u>

- There are no demands in this category

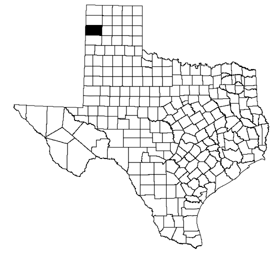
Mining

- Current supply is water from the Ogallala aquifer
- Projected demands will *not* exceed current supplies by 2060
- There are no projected shortages
- Currently, no strategies are recommended

Steam Electric Power

- There are no demands in this category

Water User Group	**Current Supplies**	**Shortage**	**Proposed Water Management Strategies**
Perryton	Ogallala aquifer	Yes	Conservation, New wells in Ogallala aquifer
County-Other	Ogallala aquifer	No	None
Irrigation	Ogallala aquifer	No	Irrigation conservation
Livestock	Ogallala aquifer and local supply (stock ponds)	No	None
Manufacturing	None	---	---
Mining	Ogallala aquifer	No	None
Steam Electric	None	---	---



Panhandle Water Planning Group
Oldham County
Supply/Demand Summary

The following narrative describes the source(s) of current water supply for water user groups in Oldham County. All groundwater supplies are based on the PWPG adopted approach for the respective aquifer. There are no projected shortages in Oldham County.

<u>Vega</u>

- Current supply is water from the Ogallala aquifer
- Projected demands will *not* exceed current supplies by 2060
- There are no projected shortages
- Currently, no strategies are recommended

<u>County-Other</u>

- Current supply is water from the Ogallala and Dockum aquifers
- Projected demands will *not* exceed current supplies by 2060
- There are no projected shortages
- Currently, no strategies are recommended

<u>Irrigation</u>

- Current supply is water from the Ogallala and Dockum aquifers
- Projected demands will *not* exceed current supplies by 2060
- There are no projected shortages
- While no shortages are identified, it is recommended that irrigation conservation be implemented

<u>Livestock</u>

- Current supply is water from the Ogallala and Dockum aquifers and local supply (stock ponds)
- Projected demands will *not* exceed current supplies by 2060
- There are no projected shortages
- Currently, no strategies are recommended

<u>Manufacturing</u>

- There are no demands in this category

Mining

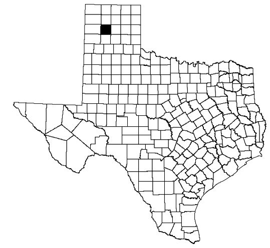
- Current supply is water from the Ogallala and Dockum aquifers
- Projected demands will *not* exceed current supplies by 2060
- There are no projected shortages
- Currently, no strategies are recommended

Steam Electric Power

- There are no demands in this category

Water User Group	Current Supplies	Shortage	Proposed Water Management Strategies
Vega	Ogallala aquifer	No	None
County-Other	Ogallala and Dockum aquifers	No	None
Irrigation	Ogallala and Dockum aquifers	No	Irrigation conservation
Livestock	Ogallala and Dockum aquifers and local supply (stock ponds)	No	None
Manufacturing	None	---	---
Mining	Ogallala and Dockum aquifers	No	None
Steam Electric	None	---	---

Panhandle Water Planning Group
Potter County
Strategy Summary



The following narrative describes the source(s) of current water supply and recommended water management strategies for water user groups in Potter County. All groundwater supplies are based on the PWPG adopted approach for the respective aquifer. Strategies have been identified for all water user groups that have a projected shortage. Based on the findings of the updated Northern Ogallala GAM, Potter County is shown to have less available groundwater. Further review of the available supplies with the updated GAM model is needed. Preliminary assessments indicate that there may be potential new shortages for irrigation needs.

<u>Amarillo</u>

- Current supply is water from the Ogallala aquifer and the CRMWA system
- Projected demands will exceed current supplies starting in 2030.
- Shortages occur in the Red and Canadian River basins.
- The recommended water management strategies to meet shortages include the installation of new wells in the Ogallala in Potter and Roberts counties with the associated transmission systems and implementation of conservation measures.

<u>County-Other</u>

- Current supply is water from the Ogallala aquifer
- Projected demands will exceed current supplies starting in 2020
- Shortages occur in the Canadian and Red River basins
- The recommended water management strategies to meet shortages include the installation of new wells in the Ogallala aquifer and municipal conservation.

<u>Irrigation</u>

- Current supply is water from the Ogallala aquifer, Canadian River irrigation water rights and reuse
- Projected demands will *not* exceed current supplies by 2060
- There are no projected shortages
- While no shortages are identified, it is recommended that irrigation conservation be implemented

<u>Livestock</u>

- Current supply is water from the Ogallala and Dockum aquifers and local supply (stock ponds)
- Projected demands will *not* exceed current supplies by 2060
- There are no projected shortages
- Currently, no strategies are recommended

Manufacturing

- Current supply is water from the Ogallala aquifer and the CRMWA system (through Amarillo)
- Projected demands will exceed current supplies starting in 2030
- Shortages occur in the Canadian and Red River basins
- The recommended water management strategies to meet shortages is to purchase additional water from Amarillo

Mining

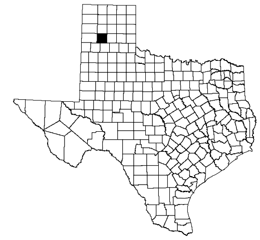
- Current supply is water from the Ogallala aquifer
- Projected demands will *not* exceed current supplies by 2060
- There are no projected shortages
- Currently, no strategies are recommended.

Steam Electric Power

- Current supply is water from the reuse from Amarillo and Ogallala aquifer
- Projected demands will *not* exceed current supplies by 2060
- There are no projected shortages
- Currently, no strategies are recommended.

Water User Group	**Current Supplies**	**Shortage**	**Proposed Water Management Strategies**
Amarillo	CRMWA system Ogallala aquifer	Yes	Potter and Roberts Counties well fields, Municipal conservation
County-Other	Ogallala and Dockum aquifers	Yes	New wells, Municipal conservation
Irrigation	Ogallala aquifer, local supply and reuse	No	Irrigation conservation
Livestock	Ogallala and Dockum aquifers and local supply (stock ponds)	No	None
Manufacturing	Ogallala aquifer & CRMWA system	Yes	Purchase from Amarillo
Mining	Ogallala aquifer	No	None
Steam Electric	Ogallala aquifer, CRMWA system and reuse	No	None

Panhandle Water Planning Group
Randall County
Strategy Summary



The following narrative describes the source(s) of current water supply and recommended water management strategies for water user groups in Randall County. All groundwater supplies are based on the PWPG adopted approach for the respective aquifer. Strategies have been identified for all water user groups that have a projected shortage.

<u>Amarillo</u>

- Current supply is water from the Ogallala aquifer and the CRMWA system
- Projected demands will exceed current supplies starting in 2030.
- Shortages occur in the Red River basin.
- The recommended water management strategies to meet shortages include the installation of new wells in the Ogallala in Potter and Roberts counties with the associated transmission systems and implementation of conservation measures.

<u>Canyon</u>

- Current supply is water from the Ogallala aquifer and CRMWA system
- Projected demands will exceed current supplies starting in 2020.
- Shortages occur in the Red River basin.
- The recommended water management strategies to meet shortages include drilling new wells in the Dockum aquifer and implementation of conservation measures.

<u>Lake Tanglewood</u>

- Current supply is water from the Ogallala aquifer
- Projected demands will *not* exceed current supplies by 2060
- There are no projected shortages
- Currently, no strategies are recommended

<u>County-Other</u>

- Current supply is water from the CRMWA system in the Canadian River basin and from the Ogallala and Dockum aquifers in the Red River basin
- Projected demands will exceed current supplies (greater than 10 ac-ft/yr) starting in 2020 in the Red River basin and no shortages (greater than 10 ac-ft/yr) in the Canadian Basin
- Shortages occur in the Red River basin
- The recommended water management strategies to meet shortages include new wells in the Ogallala and implementation of municipal conservation.
- The recommended alternate strategy is to purchase water from Amarillo.

Irrigation

- Current supply is water from the Ogallala aquifer, Red River irrigation water rights and reuse
- Projected demands will *not* exceed current supplies by 2060
- There are no projected shortages
- While no shortages are identified, it is recommended that irrigation conservation be implemented

Livestock

- Current supply is water from the Ogallala and Dockum aquifers and local supply (stock ponds)
- Projected demands will *not* exceed current supplies by 2060
- There are no projected shortages
- Currently, no strategies are recommended

Manufacturing

- Current supply is water from the Ogallala aquifer and the CRMWA system (through Amarillo)
- Projected demands will *not* exceed current supplies by 2060
- There are no projected shortages
- Currently, no strategies are recommended

Mining

- Current supply is water from the Ogallala aquifer
- Projected demands will *not* exceed current supplies by 2060
- There are no projected shortages
- Currently, no strategies are recommended

Steam Electric

- There are no demands in this category

Randall County – Strategy Summary

Water User Group	Current Supplies	Shortage	Proposed Water Management Strategies
Amarillo	Ogallala aquifer and CRMWA system	Yes	Potter and Roberts Counties well fields, Municipal conservation
Canyon	Ogallala aquifer and CRMWA system	Yes	New wells in Dockum, Municipal conservation
Lake Tanglewood	Ogallala aquifer	No	None
County-Other	Ogallala & Dockum aquifers and CRMWA system	Yes	New wells in Ogallala, Conservation
Irrigation	Ogallala aquifer, Red River and reuse	No	Irrigation conservation
Livestock	Ogallala & Dockum aquifers and local supply (stock ponds)	No	None
Manufacturing	Ogallala aquifer & CRMWA system	No	None
Mining	Ogallala aquifer	No	None
Steam Electric	None	---	---

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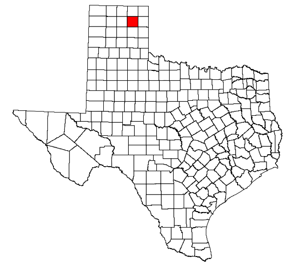
Panhandle Water Planning Group
Roberts County
Supply/Demand Summary



The following narrative describes the source(s) of current water supply for water user groups in Roberts County. All groundwater supplies are based on the PWPG adopted approach for the respective aquifer. The analysis of supplies includes CRMWA withdrawing water from Roberts County for use elsewhere in the region. There are no projected shortages in Roberts County.

Miami

- Current supply is water from the Ogallala aquifer
- Projected demands will *not* exceed current supplies by 2060
- There are no projected shortages
- Currently, no strategies are recommended

County-Other

- Current supply is water from the Ogallala aquifer
- Projected demands will *not* exceed current supplies by 2060
- There are no projected shortages
- Currently, no strategies are recommended

Irrigation

- Current supply is water from the Ogallala aquifer and reuse
- Projected demands will *not* exceed current supplies by 2060
- There are no projected shortages
- While no shortages are identified, it is recommended that irrigation conservation be implemented

Livestock

- Current supply is water from the Ogallala aquifer and local supply (stock ponds)
- Projected demands will *not* exceed current supplies by 2060
- There are no projected shortages
- Currently, no strategies are recommended

Manufacturing

- There are no demands in this category

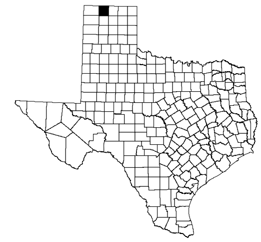
Mining

- Current supply is water from the Ogallala and aquifer
- Projected demands will *not* exceed current supplies by 2060
- There are no projected shortages
- Currently, no strategies are recommended

Steam Electric Power

- There are no demands in this category

Water User Group	Current Supplies	Shortage	Proposed Water Management Strategies
Miami	Ogallala aquifer	No	None
County-Other	Ogallala aquifer	No	None
Irrigation	Ogallala aquifer and reuse	No	Irrigation conservation
Livestock	Ogallala aquifer and local supply (stock ponds)	No	None
Manufacturing	None	---	---
Mining	Ogallala aquifer	No	None
Steam Electric	None	---	---



Panhandle Water Planning Group
Sherman County
Strategy Summary

The following narrative describes the source(s) of current water supply and recommended water management strategies for water user groups in Sherman County. All groundwater supplies are based on the PWPG adopted approach for the respective aquifer. Strategies have been identified for all water user groups that have a projected shortage.

<u>Stratford</u>

- Current supply is water from the Ogallala aquifer
- Projected demands will *not* exceed current supplies by 2060
- There are no projected shortages
- Currently, no strategies are recommended

<u>County-Other</u>

- Current supply is water from the Ogallala aquifer
- Projected demands will *not* exceed current supplies by 2060
- There are no projected shortages
- Currently, no strategies are recommended

<u>Irrigation</u>

- Current supply is water from the Ogallala aquifer and Canadian River irrigation water rights
- Projected demands will exceed current supplies starting in 2010
- Shortage occurs in the Canadian River basin
- The recommended water management strategies to meet shortages include NPET, improved irrigation equipment, change in crop types and/or varieties, conversion to dryland, conservation tillage, and biotechnologically developed drought resistant crops.

<u>Livestock</u>

- Current supply is water from the Ogallala aquifer and local supply (irrigation and stock ponds)
- Projected demands will *not* exceed current supplies by 2060
- There are no projected shortages
- Currently, no strategies are recommended

Manufacturing

- There are no demands in this category

Mining

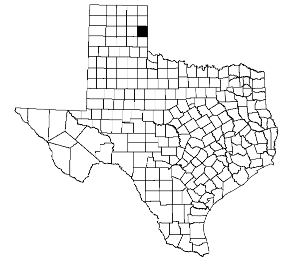
- Current supply is water from the Ogallala aquifer
- Projected demands will *not* exceed current supplies by 2060
- There are no projected shortages
- Currently, no strategies are recommended

Steam Electric

- There are no demands in this category

Water User Group	Current Supplies	Shortage	Proposed Water Management Strategies
Stratford	Ogallala aquifer	No	None
County-Other	Ogallala aquifer	No	None
Irrigation	Ogallala aquifer & local supply	Yes	Irrigation conservation
Livestock	Ogallala aquifer and local supply (irrigation and stock ponds)	No	None
Manufacturing	None	---	---
Mining	Ogallala aquifer	No	None
Steam Electric	None	---	---

Panhandle Water Planning Group
Wheeler County
Supply/Demand Summary



The following narrative describes the source(s) of current water supply for water user groups in Wheeler County. All groundwater supplies are based on the PWPG adopted approach for the respective aquifer. Based on the findings of the updated Northern Ogallala GAM, Wheeler County is shown to have more available groundwater countywide, but some areas within the county are shown to have less supply. Initial assessments indicate that with the updated GAM supplies, the City of Wheeler will have a shortage.

Shamrock

- Current supply is water from the Ogallala aquifer
- Projected demands will *not* exceed current supplies by 2060
- There are no projected shortages
- Currently, no strategies are recommended

Wheeler

- Current supply is water from the Ogallala aquifer
- Projected demands will exceed current supplies by 2050
- The shortages are estimated at 150 acre-feet per year
- The recommended strategies are conservation and new wells in the Ogallala aquifer

County-Other

- Current supply is water from the Ogallala, Blaine, Seymour and Other aquifers
- Projected demands will *not* exceed current supplies by 2060
- There are no projected shortages
- Currently, no strategies are recommended

Irrigation

- Current supply is water from the Ogallala, Blaine, Seymour, Other aquifers and reuse
- Projected demands will *not* exceed current supplies by 2060
- There are no projected shortages
- While no shortages are identified, it is recommended that irrigation conservation be implemented

Livestock

- Current supply is water from the Ogallala, Blaine, Seymour and Other aquifers and local supply (stock ponds)
- Projected demands will *not* exceed current supplies by 2060
- There are no projected shortages
- Currently, no strategies are recommended

Manufacturing

- There are no demands in this category

Mining

- Current supply is water from the Ogallala aquifer
- Projected demands will *not* exceed current supplies by 2060
- There are no projected shortages
- Currently, no strategies are recommended

Steam Electric Power

- There are no demands in this category

Water User Group	**Current Supplies**	**Shortage**	**Proposed Water Management Strategies**
Shamrock	Ogallala aquifer	No	None
Wheeler	Ogallala aquifer	Yes	Conservation, New wells in Ogallala aquifer
County-Other	Ogallala, Blaine, Seymour and Other aquifers	No	None
Irrigation	Ogallala, Blaine, Seymour, Other aquifers and reuse	No	Irrigation conservation
Livestock	Ogallala, Blaine, Seymour, Other aquifers and local supply (stock ponds)	No	None
Manufacturing	None	---	---
Mining	Ogallala aquifers	No	None
Steam Electric	None	---	---

APPENDIX C

2011 PANHANDLE REGIONAL WATER PLAN TASK 2 REPORT: AGRICULTURAL WATER DEMAND PROJECTIONS

2011 Panhandle Regional Water Plan
Task 2 Report:
Agricultural Water Demand Projections

A Water Planning Report
by

Thomas Marek, Steve Amosson,
Fran Bretz, Bridget Guerrero and Rick Kotara

Texas A&M University System
AgriLife Research and Extension Center
Amarillo, Texas

for

Freese and Nichols, Inc.
Fort Worth, Texas

April 24, 2009

2011 Panhandle Regional Water Plan Task 2 Report:
Agricultural Water Demand Projections

Executive Summary

In the Texas 2006 Regional Water Plan (2006RWP), over 92% of all water use in Region A occurred by the agricultural sector. Irrigated crop use accounted for almost 98%of the total agricultural water demand, while livestock production used just over two percent. The magnitude of agricultural water demand makes accurate water use assessment of this sector critical in future water planning efforts. Therefore, the overall objective of Task 2 of the regional water planning and management project under the Panhandle 2011 Regional Water Plan (2011RWP) was to update and refine water use estimates as they relate to changed conditions since the 2006RWP. Specific objectives of Task 2 included: 1) Review of prior agricultural water use estimates for eight major irrigated crop categories and the addition of new crop sectors that have emerged within the region; 2) Update acreages, irrigation application data by producers and compute the latest average ET demand data to update irrigation water use estimates; 3) Document the irrigation estimation model assumptions concerning updated producer adoption rates and aquifer water availability; 4) Collect recent data on livestock production, develop anticipated livestock trends and update livestock water use by species; and 5) Develop new agricultural demand estimates for Region A.

The amount of irrigated acreage significantly influences water use estimates. The 2006 – 2008 average irrigated acres by county and crop obtained from the Farm Service Agency (FSA) were used as the basis for making the 2011RWP water uses computations. In cases where significant acreage deviations has occurred from the previous 2006RWP values, comparison was made with another acreage source and analyzed to provide the most appropriate and representative crop acreage for use in calculation of the water use estimates. In counties with major changes in irrigated acreage comparisons with Texas Agricultural Statistics Service (TASS) acreages were reviewed to validate the changes. Differences are provided for each county per crop and represent acreage shifts and reductions within the region. The total crop acreage used in the 2006RWP for Region A was over 1.65 million and the acreage used in the 2011RWP approaches 1.44 million. This difference represents a total irrigated decline of 216,759 acres or 13.1%. The primary change in irrigated acreage occurred in wheat which showed a decrease of 177,103 acres. The change in irrigated wheat acreage accounted for 81.7% of the decrease in irrigated acreage from the 2006RWP to the 2011RWP. Most of the decrease in irrigated wheat acreage can be attributed to a data collection error that occurred in the 2006RWP development process. Several counties showed shifts in crop type, such as, in Carson, Collingsworth, Dallam, Hansford, and Hartley counties. Significant acreage shifts were noted in the counties of Hutchison, Moore, Ochiltree, Roberts and Sherman.

Under Task 2 of the 2011RWP, TAMA (Texas A&M–Amarillo) based water personnel were charged with updating the Region A irrigated water use projections. Using the TAMA model, water demand for irrigated agriculture was estimated utilizing compiled FSA acreage numbers. The total regional water demand estimates using the TAMA model indicates an overall reduction of irrigation demand as compared to the prior 2006RWP estimates. This was in part to regional based acreage changes, crop type shifts, reduced irrigation capacity and higher energy prices. Nonetheless, there are substantial differences in projected irrigation demand for several counties, such as Hartley, resulting from the area dairy demands. As before, Dallam, Hartley, Moore, and Sherman represent the largest irrigated water use counties in the region. The next largest county based irrigation users are Ochiltree, Hansford and Carson.

Using FSA acreages along with the addition of three crop categories, updated long-term, quadrangle based, average rainfall computations of irrigated water demands indicated that five counties were again responsible for majority of water use in Region A. Additional TAMA model modifications included the water use attributed to "hailed out" crop acreages within the region. Refinements to future year water demands were made by "resetting" the adoption and availability factors from year 2010 which in turn provided new estimates that again were lower as compared to those predicted in the 2006RWP. Available irrigation demand estimates are also presented considering deductions of water demand increases in livestock water use.

Current, livestock inventories were estimated, water use by species and future growth rates were modified, where warranted, under the guidance of three expert advisory committees. The resultant projected water use in the Region A livestock sector is predicted to increase 40% from 2000 to 2060 which represents approximately two to three percent of the total water use in the region. However, the 2011RWP total livestock water use estimates are significantly less (70%) than the 2006RWP projections due to the changes in swine projections and water use by species. The largest livestock water use group is projected to be the fed cattle industry with an annual usage of 25,973 ac-ft/year by 2060. The forecasted expansion of the dairy industry results in a water usage estimate by 2060 of 10,011 ac-ft/year. These two user groups account for 68% of projected livestock water use in 2060. The swine industry is the third largest water user group with a projected annual water use of 5,883 ac-ft/year in 2060.

The 2011RWP total agricultural water use demand was derived using the revised projected irrigation and livestock estimates. Increases in livestock water use past 2010 were designated to be derived from the irrigation sector and the increases were deducted from the 2020 and beyond values accordingly. Overall, agricultural water use projections declined an average of 17% as compared to the prior 2006RWP estimates for 2010 through 2060. Livestock increase reductions to the irrigation demand, however, only represent an average decrease of 2.51% from 2020 through 2060. The 2011RWP estimates indicate a total Region A agricultural water use demand of 1,469,667ac-ft as compared to the previous 2006RWP value of 1,713,466 ac-ft in 2010. The revised value represents a reduction of 14.23%.

2011 Panhandle Regional Water Plan Task 2 Report:
Agricultural Water Demand Projections

Thomas Marek, Steve Amosson, Fran Bretz, Bridget Guerrero and Rick Kotara[1]

Nomenclature regarding the assessment of agricultural demand estimates authorized by Texas Legislative Senate Bill 1 (TWDB, 2009a) and subsequent legislation are herein referred to as the 2001 Regional Water Plan (2001RWP), the 2006 Regional Water Plan (2006RWP) and the 2011 Regional Water Plan (2011RWP).

In the 2006RWP, it was calculated that over 92% of all water use in Region A occurred by the agricultural sector. Irrigated crop use accounted for almost 98% of the total agricultural water use, while livestock production used just over two percent. The magnitude of the water use in agriculture makes accurate water use assessment of this sector critical to future water planning within the region.

The objective of this project task is to update water use estimates for Region A agriculture. The specific objectives are:

1. Review prior agricultural water use estimates for eight major irrigated crop categories and add new crop sectors that have emerged within the region since the prior estimates,
2. Update acreages, irrigation application data by producers and compile the latest average ET demand data to update the irrigation water use estimates,
3. Document the estimation model assumptions concerning updated producer adoption rates and aquifer water availability,
4. Collect recent data on livestock production, develop anticipated livestock trends and update livestock water use by industry type, and
5. Revise and supply new agricultural demands for Region A.

1. Review prior agricultural water use estimates

The amount of irrigated acreage and appropriate crop categories dramatically impact the computation of the regional water use estimates. Accurate acreage values are crucial in water use predictions and high water use crop acreage variations are magnified when projecting water use over the next 50-year planning horizon.

<u>2011RWP Texas A&M–Amarillo Model Crop Categories</u>

Three new crop categories were compiled for the 2011RWP computations and added to the 2006RWP water use categories in the Texas A&M-Amarillo (TAMA) irrigation demand estimation model. The crop categories of alfalfa, forage sorghum and sunflowers were included based on either shifted regional or initiated production acreage trends since year 2000. Thus, the 2011RWP TAMA model resulted in a total of 11 total crop categories. In several counties,

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acreage shift out of a certain crop category resulted in an increase or establishment of a new production category. For example, shifted regional acreage (reduction) of corn to alfalfa, forage sorghum and wheat occurred particularly in response to the new cheese plant located in Dallam County. Area demand in Hartley and Sherman counties also increased forage production to meet the new dairy needs. Other county crop shifts were noted and examined accordingly. Generally, county based reductions in wheat production were identified and seen shifted into other categories from the 2000 to 2008 period, although in some counties an overall reduction was seen.

In addition to the three crop categories, another significant addition to the 2011RWP TAMA model included the amount of hailed out seasonal acreages and accompanying water use. In the TAMA model, it was assumed that 50% of the seasonal crop water was applied at the time of hail out events. These parameter values were selected based on the author(s)' field production experience and typically witnessed events amassed over time from within the region. Thus, the TAMA model now incorporates planted, hailed and harvested acreage data per crop per county.

2. Estimated Irrigated Acreages used in the TAMA Model Water Use Estimations

In the 2006RWP, it was determined that generally the most representative acreage values were derived with use of the Farm Service Agency (FSA) data. Thus, FSA acreage values were again utilized in the projections of Task 2 of the 2011RWP.

For the 2006RWP, estimates of irrigated acreages for the year 2000 were developed for each of eight crop categories by county. Crop categories included corn, cotton, sorghum, hay, pasture, peanuts, soybeans, and wheat. For the 2011RWP, irrigated acreage was determined using an average of FSA reported acreage from years 2006, 2007 and 2008. This average value was determined to provide the "best" representative acreage value(s), particularly as they have been recently influenced by shifts in corn and other alternative oilseed crop production due to recent energy demands and commodity price escalation. Subsequently, a comparison and review of the 2000 to the 2008 average values was computed and reviewed.

The planted irrigated acreages used in the 2006RWP, the 2011RWP and the associated change are presented in Table 2-1. A significant drop in the Region A planted irrigated acres has occurred (decrease of 216,759 acres) between the 2000 base used in the 2006RWP versus the 2006 – 2008 FSA average that was used in the 2011RWP effort. A portion of the decline in planted irrigated acreage was anticipated given rising energy costs and declining water tables leading to abandonment of some irrigated acreage and a reduction in double cropping practices. However, it is believed that a majority of the difference is due to errors in the 2000 planted acreage estimates which lead to an overestimate in the amount of irrigated acres in some counties. In the 2006RWP, FSA provided a summary of the data which had to be queried on a county-by-county basis. This procedure may have lead to errors in the data collection process, in particular, regarding irrigated wheat. In the 2011RWP, all county records were provided from a centralized database from which the A&M team was provided the raw data from each county. Data were assembled for each crop and calculations were spot checked manually to insure accuracy.

Table 2-1. 2006RWP and 2011RWP Region A irrigated acres by county.

County	2006RWP 2000, pia	2011RWP 2006-2008 Average, pia	County Difference, pia
Armstrong	12,233	4,813	-7,420
Carson	96,966	54,940	-42,026
Childress	9,640	8,392	-1,248
Collingsworth	21,459	36,252	14,793
Dallam	251,606	232,707	-18,899
Donley	18,268	21,766	3,498
Gray	29,409	21,901	-7,508
Hall	20,212	22,423	2,211
Hansford	127,128	122,447	-4,681
Hartley	216,022	210,890	-5,132
Hemphill	3,179	1,982	-1,197
Hutchinson	61,292	36,295	-24,997
Lipscomb	12,241	19,012	6,771
Moore	156,302	140,832	-15,470
Ochiltree	96,929	59,607	-37,322
Oldham	4,607	3,917	-690
Potter	5,616	2,859	-2,757
Randall	28,953	20,883	-8,070
Roberts	18,442	5,665	-12,777
Sherman	235,347	180,208	-55,139
Wheeler	9,572	10,873	1,301
Total regional acreage	**1,435,423**	**1,218,664**	**-216,759**

Notes: 1) A negative difference represents a decrease in acreage, and
2) Irrigated acreages are based on county crop planted irrigated acreage (pia).

The Region A planted irrigated acreages used by county by crop in the 2006RWP, the 2011RWP and the associated changes are presented in Table 2-2. It should be noted that three crops were added to the 2011RWP analysis; alfalfa, forage sorghum and sunflowers. These crops had no acreage assigned in the 2006RWP analysis and were “lumped” into other crop categories. Therefore, some slight distortion may occur in the acreages of the crop categories they were assigned in the 2006RWP comparative to the 2011RWP.

The primary change in irrigated acreage occurred in wheat which showed a decrease of 177,103 acres. The change in irrigated wheat acreage accounted for 81.7% of the decrease in irrigated acreage from the 2006RWP to the 2011RWP. Again, most of the decrease in irrigated wheat acreage can be attributed to a data collection error that occurred in the 2006RWP assessment effort.

Table 2-2. Comparison of the 2006RWP and the 2011RWP planted irrigated acreage by county and by crop 2000, 2006-2008 average and acreage difference.

County	2006RWP 2000, pia	2011RWP 2006-2008 Average, pia	Acreage difference, ac.
ARMSTRONG			
Alfalfa:	0	268	268
Corn:	732	718	-14
Cotton:	0	447	447
Hay:	0	0	0
Pasture and Other:	0	45	45
Peanuts:	0	0	0
Sorghum:	2,491	806	-1,685
Forage sorghum:	0	690	690
Soybeans:	1,404	58	-1,346
Sunflowers:	0	0	0
Wheat:	7,606	1,783	-5,823
CARSON			
Alfalfa:	0	800	800
Corn:	15,966	17,039	1,073
Cotton:	682	16,746	16,064
Hay:	926	0	-926
Pasture and Other:	3,660	645	-3,015
Peanuts:	0	0	0
Sorghum:	12,819	6,984	-5,835
Forage sorghum:	0	1,037	1,037
Soybeans:	11,402	695	-10,707
Sunflowers:	0	0	0
Wheat:	51,511	10,994	-40,517
CHILDRESS			
Alfalfa:	0	194	194
Corn:	0	132	132
Cotton:	5,687	5,534	-153
Hay:	87	0	-87
Pasture and Other:	232	219	-13
Peanuts:	1,411	621	-791
Sorghum:	33	117	84
Forage sorghum:	0	267	267
Soybeans:	0	0	0
Sunflowers:	0	0	0
Wheat:	2,190	1,309	-881

Table 2-2. Comparison of the 2006RWP and the 2011RWP planted irrigated acreage by county and by crop 2000, 2006-2008 average and acreage difference (continued).

County	2006RWP 2000, pia	2011RWP 2006-2008 Average, pia	Acreage difference, ac.
COLLINGSWORTH			
Alfalfa:	0	1,179	1,179
Corn:	30	78	48
Cotton:	5,508	16,645	11,137
Hay:	707	0	-707
Pasture and Other:	34	305	271
Peanuts:	14,114	9,463	-4,651
Sorghum:	245	3,245	3,000
Forage sorghum:	0	713	713
Soybeans:	0	0	0
Sunflowers:	0	0	0
Wheat:	821	4,625	3,804
DALLAM			
Alfalfa:	0	3,689	3,689
Corn:	166,949	124,076	-42,873
Cotton:	15	1,441	1,426
Hay:	299	0	-299
Pasture and Other:	3,515	4,770	1,255
Peanuts:	0	82	82
Sorghum:	5,482	7,382	1,900
Forage sorghum:	0	1,720	1,720
Soybeans:	784	545	-239
Sunflowers:	0	2,896	2,896
Wheat:	74,562	86,106	11,544
DONLEY			
Alfalfa:	0	2,378	2,378
Corn:	1,216	1,242	26
Cotton:	5,303	5,951	648
Hay:	2,149	0	-2,149
Pasture and Other:	1,716	3,075	1,359
Peanuts:	2,689	4,485	1,796
Sorghum:	187	601	414
Forage sorghum:	0	1,181	1,181
Soybeans:	323	35	-288
Sunflowers:	0	0	0
Wheat:	4,685	2,819	-1,866

Table 2-2. Comparison of the 2006RWP and the 2011RWP planted irrigated acreage by county and by crop 2000, 2006-2008 average and acreage difference (continued).

County	2006RWP 2000, pia	2011RWP 2006-2008 Average, pia	Acreage difference, ac.
GRAY			
Alfalfa:	0	510	510
Corn:	6,268	6,278	10
Cotton:	54	4,258	4,204
Hay:	572	0	-572
Pasture and Other:	1,564	2,027	463
Peanuts:	0	0	0
Sorghum:	1,210	1,858	648
Forage sorghum:	0	751	751
Soybeans:	3,226	81	-3,145
Sunflowers:	0	0	0
Wheat:	16,515	6,139	-10,376
HALL			
Alfalfa:	0	694	694
Corn:	0	0	0
Cotton:	11,349	17,785	6,436
Hay:	329	0	-329
Pasture and Other:	41	1,467	1,426
Peanuts:	6,379	931	-5,448
Sorghum:	23	292	269
Forage sorghum:	0	201	201
Soybeans:	0	0	0
Sunflowers:	0	45	45
Wheat:	2,091	1,007	-1,084
HANSFORD			
Alfalfa:	0	1,009	1,009
Corn:	31,668	42,829	11,161
Cotton:	0	3,572	3,572
Hay:	859	0	-859
Pasture and Other:	1,452	973	-479
Peanuts:	0	0	0
Sorghum:	6,563	1,378	-5,185
Forage sorghum:	0	2,163	2,163
Soybeans:	6,943	1,378	-5,565
Sunflowers:	0	1,069	1,069
Wheat:	79,643	68,076	-11,567

Table 2-2. Comparison of the 2006RWP and the 2011RWP planted irrigated acreage by county and by crop 2000, 2006-2008 average and acreage difference (continued).

County	2006RWP 2000, pia	2011RWP 2006-2008 Average, pia	Acreage difference, ac.
HARTLEY			
Alfalfa:	0	9,444	9,444
Corn:	131,041	113,581	-17,460
Cotton:	2,925	4,297	1,372
Hay:	1,809	0	-1,809
Pasture and Other:	9,128	1,860	-7,268
Peanuts:	0	0	0
Sorghum:	7,944	9,445	1,501
Forage sorghum:	0	1,994	1,994
Soybeans:	1,052	1,342	290
Sunflowers:	0	3,609	3,609
Wheat:	62,123	65,318	3,195
HEMPHILL			
Alfalfa:	0	90	90
Corn:	0	79	79
Cotton:	250	0	-250
Hay:	449	0	-449
Pasture and Other:	970	404	-566
Peanuts:	0	0	0
Sorghum:	1,180	94	-1,086
Forage sorghum:	0	105	105
Soybeans:	0	37	37
Sunflowers:	0	0	0
Wheat:	330	1,173	843
HUTCHINSON			
Alfalfa:	0	163	163
Corn:	14,401	13,458	-943
Cotton:	0	2,740	2,740
Hay:	198	0	-198
Pasture and Other:	1,644	3,804	2,160
Peanuts:	0	0	0
Sorghum:	4,052	1,496	-2,556
Forage sorghum:	0	359	359
Soybeans:	2,421	176	-2,245
Sunflowers:	0	47	47
Wheat:	38,576	14,052	-24,524

Table 2-2. Comparison of the 2006RWP and the 2011RWP planted irrigated acreage by county and by crop 2000, 2006-2008 average and acreage difference (continued).

County	2006RWP 2000, pia	2011RWP 2006-2008 Average, pia	Acreage difference, ac.
LIPSCOMB			
Alfalfa:	0	244	244
Corn:	4,956	3,608	-1,348
Cotton:	0	249	249
Hay:	175	0	-175
Pasture and Other:	2,390	2,429	39
Peanuts:	0	0	0
Sorghum:	385	919	534
Forage sorghum:	0	582	582
Soybeans:	0	243	243
Sunflowers:	0	827	827
Wheat:	4,335	9,911	5,576
MOORE			
Alfalfa:	0	2,098	2,098
Corn:	83,739	56,732	-27,007
Cotton:	0	16,000	16,000
Hay:	927	0	-927
Pasture and Other:	2,325	1,151	-1,174
Peanuts:	0	0	0
Sorghum:	15,666	21,450	5,784
Forage sorghum:	0	1,199	1,199
Soybeans:	7,556	628	-6,928
Sunflowers:	0	811	811
Wheat:	46,089	40,763	-5,326
OCHILTREE			
Alfalfa:	0	354	354
Corn:	15,626	18,344	2,718
Cotton:	0	3,483	3,483
Hay:	437	0	-437
Pasture and Other:	1,494	693	-801
Peanuts:	0	0	0
Sorghum:	9,367	7,863	-1,504
Forage sorghum:	0	1,668	1,668
Soybeans:	14,578	3,167	-11,411
Sunflowers:	0	577	577
Wheat:	55,427	23,457	-31,970

Table 2-2. Comparison of the 2006RWP and the 2011RWP planted irrigated acreage by county and by crop 2000, 2006-2008 average and acreage difference (continued).

County	2006RWP 2000, pia	2011RWP 2006-2008 Average, pia	Acreage difference, ac.
OLDHAM			
Alfalfa:	0	15	15
Corn:	0	188	188
Cotton:	30	0	-30
Hay:	0	0	0
Pasture and Other:	399	223	-176
Peanuts:	0	0	0
Sorghum:	1,140	1,588	448
Forage sorghum:	0	238	238
Soybeans:	0	0	0
Sunflowers:	0	0	0
Wheat:	3,038	1,666	-1,372
POTTER			
Alfalfa:	0	808	808
Corn:	347	7	-340
Cotton:	225	130	-95
Hay:	1,158	0	-1,158
Pasture and Other:	227	0	-227
Peanuts:	0	0	0
Sorghum:	724	55	-669
Forage sorghum:	0	206	206
Soybeans:	125	0	-125
Sunflowers:	0	64	64
Wheat:	2,810	1,589	-1,221
RANDALL			
Alfalfa:	0	727	727
Corn:	1,824	686	-1,138
Cotton:	2,472	1,169	-1,303
Hay:	697	0	-697
Pasture and Other:	0	1,086	1,086
Peanuts:	0	0	0
Sorghum:	6,804	5,634	-1,170
Forage sorghum:	0	474	474
Soybeans:	120	0	-120
Sunflowers:	0	81	81
Wheat:	17,036	11,026	-6,010

Table 2-2. Comparison of the 2006RWP and the 2011RWP planted irrigated acreage by county and by crop 2000, 2006-2008 average and acreage difference (continued).

County	2006RWP 2000, pia	2011RWP 2006-2008 Average, pia	Acreage difference, ac.
ROBERTS			
Alfalfa:	0	0	0
Corn:	1,971	2,129	158
Cotton:	0	682	682
Hay:	61	0	-61
Pasture and Other:	8,049	494	-7,555
Peanuts:	0	0	0
Sorghum:	921	311	-610
Forage sorghum:	0	374	374
Soybeans:	1,684	351	-1,334
Sunflowers:	0	0	0
Wheat:	5,756	1,325	-4,431
SHERMAN			
Alfalfa:	0	683	683
Corn:	91,741	76,444	-15,297
Cotton:	399	16,861	16,462
Hay:	878	0	-878
Pasture and Other:	1,016	3,028	2,012
Peanuts:	0	0	0
Sorghum:	15,028	12,328	-2,700
Forage sorghum:	0	2,410	2,410
Soybeans:	5,043	492	-4,551
Sunflowers:	0	1,624	1,624
Wheat:	121,242	66,339	-54,903
WHEELER			
Alfalfa:	0	616	616
Corn:	375	1,038	663
Cotton:	2,264	3,063	799
Hay:	123	0	-123
Pasture and Other:	339	207	-132
Peanuts:	692	1,404	712
Sorghum:	1,784	380	-1,404
Forage sorghum:	0	483	483
Soybeans:	120	0	-120
Sunflowers:	0	0	0
Wheat:	3,875	3,681	-194
Total regional crop acreage	1,435,423	1,218,664	-216,759

Note: A negative difference represents a decrease in acreage.

Counties with a change of more than more than 10,000 planted irrigated acres from the 2006RWP to the 2011RWP were flagged for additional scrutiny. These counties included Carson, Collingsworth, Dallam, Hutchinson, Moore, Ochiltree, Roberts and Sherman. In addition, Hartley was included due to the increased irrigation well drilling that has occurred in this county.

To check the validity of acreage estimates used in these selected counties, 2006 – 2007 average FSA acreage for the major irrigated crops (corn, cotton, sorghum, soybeans and wheat) were compared to TASS reported acreage for the same years and crops. A summary of the findings is presented in Table 2-3. The 2006 – 2007 data were used for comparison since the TASS 2008 data by county is not yet available.

Overall, there was very little variation in the total planted irrigated acreage for the major crops between the FSA and TASS data. TASS reported about 12,000 less acres than FSA for a difference of 1.37%. However, Roberts and Collingsworth had significant differences in planted irrigated acreage of 114.46% and 21.18%, respectively. It should be noted the relatively small planted irrigated acreages in these counties tends to distort the magnitude of percentage changes. Second and more importantly, TASS does not report planted acres for crops with relatively low acreages for disclosure reasons resulting in an artificially low irrigated planted acres in those counties. It can be concluded that the FSA acreages used in the 2011RWP effort are reasonably accurate.

Table 2-3. 2006 - 2007 average planted irrigated acres from TASS and FSA for the major crops in selected Region A counties.

Counties	2006-2007 TASS Average Acres	2006-2007 FSA Average Acres	Difference in Sources, acre	Percent Difference in Sources, %
Carson	51,150	51,336	-186	-0.36
Collingsworth	19,300	23,388	-4,088	-21.18
Dallam	220,900	219,539	1,361	0.62
Hartley	189,500	195,862	-6,362	-3.36
Hutchinson	28,200	28,507	-307	-1.09
Moore	130,800	133,347	-2,547	-1.95
Ochiltree	57,800	55,351	2,449	4.24
Roberts	2,250	4,825	-2,575	-114.46
Sherman	172,800	172,506	294	0.17
Totals	**872,700**	**884,661**	**-11,961**	**-1.37**

Note: The above counties had more than 10,000 acreage decrease from the 2006RWP to the 2011RWP.

Estimated Crop Evapotranspiration (ET)

Estimation of crop evapotranspiration (ET) can and does have a significant impact on water demand computations. All ET data in the water use estimates were based on ET data recorded and acquired from the North Plains ET network (NPET, 2009 - a part of the Texas High Plains ET network - TXHPET, 2009). Crop ET variations can and do occur per year due to differing climatic demands as shown in Figure 2-1; however, an averaged ET demand approach is typically more applicable and desirable for predictive water planning purposes. The variation in corn demand for Moore County using 2005 versus 2007 ET values shown in Figure 2-1 would result in corn water use seasonal fluctuation of over 15,200 ac-ft. Extrapolating such fluctuations accurately over a 50-year time period would be truly difficult and, thus, it appears not the best approach given available, representative data.

The respective crop ET values used in the 2011RWP TAMA model calculations from year 2000 to 2010 were determined using a proportional and weighted type computational approach. From year 2000 through 2008, the annual county crop ET was based on a proportional change per annum between the two values. The relationship could be either increasing or decreasing per crop between the two time periods and was observed to have occurred, as such, within the various crops of the counties. In computation of the projected 2010 value, the long-term average (LTA) ET value was added to the proportioned 2000 to 2008 values, thus, resulting in a “weighted type” decadal value for year 2010. This per crop value was then used as the ET value(s) for the decadal year computations of 2020 through 2060. A plot of the proportional ET trend for Moore County is illustrated in Figure 2-2 for years 2008 through 2010. (The vertical scale of the plot is kept the same as Figure 2-1 for comparative purposes.) A comparison of the irrigation demand between Figures 2-1 and 2-2 results in approximately the same total decadal value. Thus, for predictive purposes, the proportionally weighted crop ET values of 2010 were computed for each county and crop and used in computations for the decadal years of 2020 through 2060.

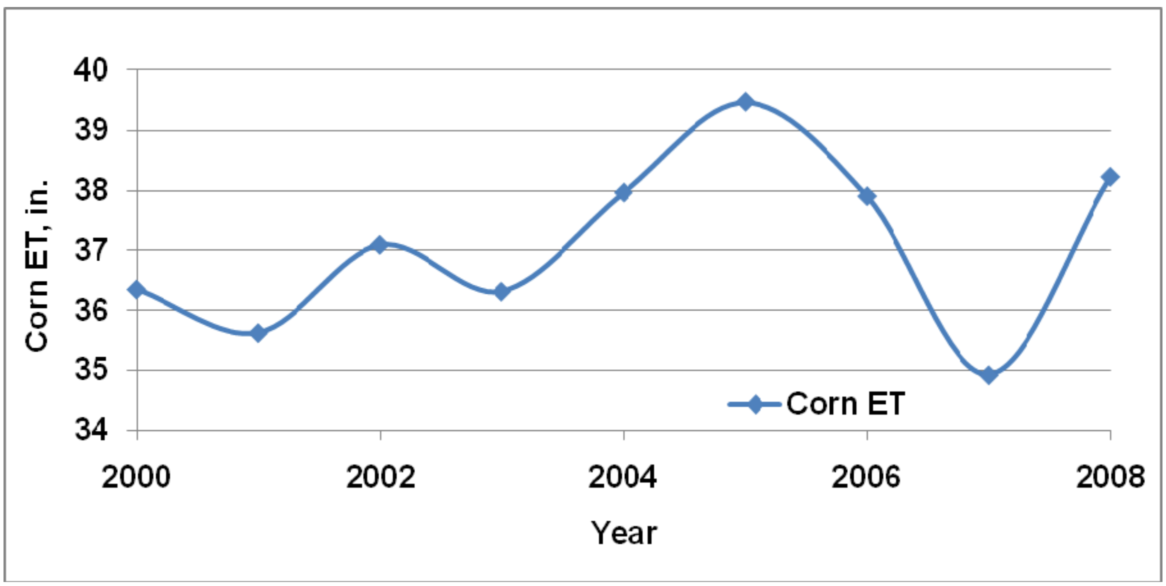

Figure 2-1. North Plains ET Network corn ET for years 2000 through 2008 for Moore County, Texas.

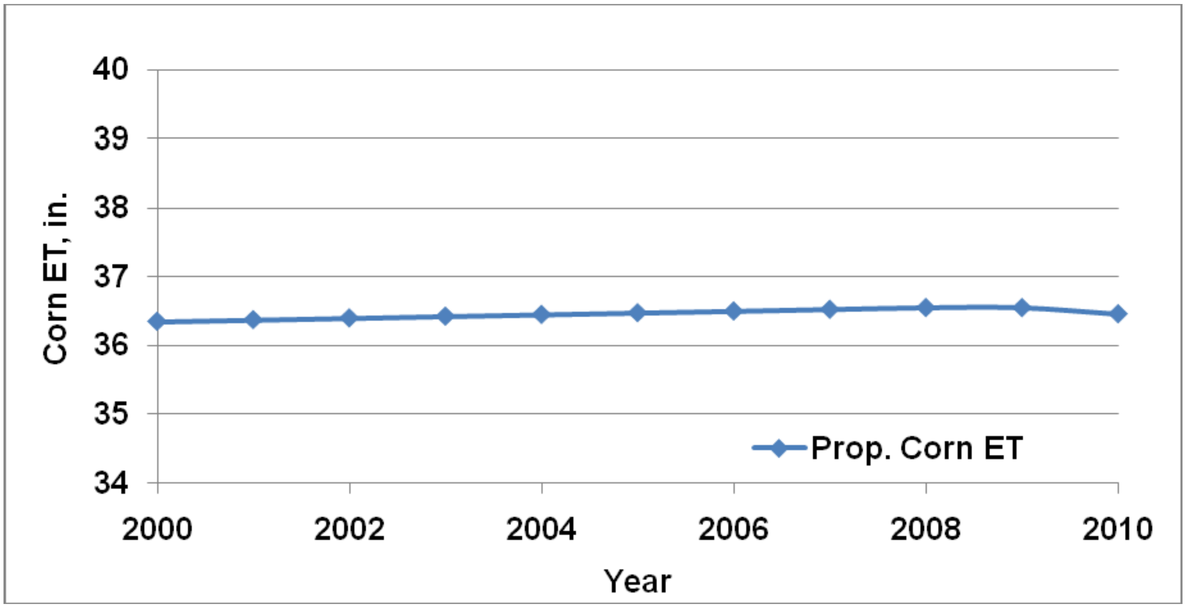

Figure 2-2. Proportional derived corn ET values used in the TAMA model for years 2000 through 2010 for Moore County, Texas.

Region A grower water application data were reviewed and remained at the same values as used in the 2006RWP computations. New producer application values were estimated for alfalfa based on increased hay values, for sunflowers based on cotton ET values and for sorghum forage on sorghum ET values.

3. TAMA Model assumptions

Methodology Review and Update

The Texas A&M-Amarillo (TAMA) model methodology utilizes a categorized crop, ET based, water use approach. As mentioned earlier, the number of crop categories was increased and previously defined to reflect regional crop production changes since the 2006RWP estimates. Inputs to the TAMA model include acreages provided through the Farm Service Agency (FSA) upon which producer payments are based. The TAMA model requires county-by-county input data regarding crop ET, a term referred to as a “grower factor” (which represents the amount of ET pumped and includes the percent of crop ET generally applied by producers using all irrigation system types and associated system application efficiencies), rainfall, soil water type and holding capacity, and seasonal soil profile moisture used per crop planted. The grower factor could be synonymously labeled as a “pumpage factor” within Region A; however, it may not be a representative term in other regions.

The TAMA model is based on the crop water use equation as follows:

$$ET_C * P_T = IRR_C + ER + SSM_D \qquad (1)$$

where:

ET_C = Crop evapotranspiration (or crop water use) for maximum production potential (in.),
P_T = Grower factor which represents a fraction of the crop evapotranspiration pumped on a crop's seasonal basis and includes all irrigation systems and associated efficiencies (can be more or less than 1.0 reference crop ET, ETc),
IRR_C = Irrigation applied on a seasonal basis to a crop (in.),
ER = Effective rainfall computed from seasonal rainfall occurring during the crop season (in.), and
SSM_D = Seasonal soil moisture depletion used in crop production which is extracted from the soil profile during the respective growing season (in.).

Rearranging and solving for IRR_C yields:

$$IRR_C = ET_C * P_T - ER - SSM_D \tag{2}$$

The summary equation for all categorized crops grown per county is:

$$IRR_{CTY} = \sum_{1}^{n} (IRR_C / 12 * A_C) \tag{3}$$

where:

n = Number of categorized crops of interest per county,
IRR_{CTY} = Total quantity of irrigation volume applied (or pumped) to the crops grown within a county in a given year or season, (ac-ft), and
A_C = Acreage of crop c in a given county.

Similarly, the summary equation for the counties within a region is:

$$IRR_{REG} = \sum_{1}^{n} IRR_{CTY} \tag{4}$$

where:

IRR_{REG} = Total quantity of irrigation volume applied (or pumped) to crops grown within a region in a given year or crop season, (ac-ft).

Crop ET data were utilized from the North Plains ET network (Howell, 1998; Marek et al., 1998) as it relates to Region A counties using a modified Penman-Monteith equation for calculation of potential evapotranspiration (PET) from the meteorological data. Upgrading of the network data sets was done using the ASCE Standardized Reference Evapotranspiration Equation for Agriculture Crops (ASCE-EWRI, 2005). The NPET network uses a well-watered grass reference for reference ET, but also now computes an alfalfa-based reference for comparative purposes with other ET data sets. Data are specifically available for eight of the 21 counties in Region A. The remainder of the counties was computed using a correlation matrix attributing each NPET meteorological station's respective percentage of influence due to elevation, longitude and latitude considering known cropping differences of particular counties. A portion of the correlation matrix indicating attribution used in the computations is presented in Table 2-4. Crop season and effective rainfall season periods used in Region A per crop are presented in Table 2-5.

Table 2-4. Selected meteorological station correlation (proportioning) matrix identifying station attribution used in computing county crop ET values in Region A.

NPET Meteorological Station	Dallam	Hartley	Hansford	Sherman
Dalhart	1.00	0.40	-	0.20
Dimmitt	-	-	-	-
Etter	-	0.40	-	0.60
JBF	-	0.20	-	-
Morse	-	-	0.50	0.20
Perryton	-	-	0.50	-
Wellington	-	-	-	-
White Deer	-	-	-	-

Another significant topic is effective rainfall and was left unchanged as to the computational equations used in the 2006RWP. The procedure is based upon the Natural Resource Conservation Service (NRCS) method (N.E.H., 1993) of computing effective rainfall. Long-term monthly quadrangle rainfall data obtained from the Texas Water Development Board (TWDB, 2009b) were utilized to update and calculate the respective seasonal crop rainfall. This was desired given the spatial representation error of single point rainfall sites. The quad based rainfall data were, thus, deemed more representative and applicable.

The next model variable required for the water use calculations was an estimation of the "grower factor" associated with each respective crop by producers within Region A. As in the previous 2006RWP estimates, data were obtained and analyzed from ancillary research/extension/producer projects that had been conducted within Region A and from comparative parts of Region O. This information was compiled from a 10-year effort from 548 specific crop irrigation and production field demonstrations with 448 cooperating growers on 71,000 acres (New, 2008). These irrigated fields were monitored in terms of water applied (pumped volume) per crop. The resulting irrigation application information is used in equation 2. In addition, over 21 producer's fields were monitored for irrigation applied and used from the production area surrounding the North Plains Research Field in Moore County.

Table 2-5. Seasonal periods and crop categories used in effective rainfall computations, Region A.

Crop	Growing Season Used in Crop ET Computations	Season Used in Effective Rainfall (ER) Computations	Number of Months Used in ER Calculations
Corn	April 15 - October 15	April 15- August 15	4
Cotton	May 15-October 15	May 15-October 15	5
Grain Sorghum	May 15-October 15	May 15-October 15	5
Hay	April 1-November 1	April 1-November 1	7
Pasture & Other	April 1-November 1	April 1-November 1	7
Peanuts	May 1-November 1	May 1-November 1	6
Soybeans	June 1-November 1	June 1-November 1	5
Wheat	October 1-July 1	October 1-July 1	9
Alfalfa	April 1-November 1	April 1-November 1	7
Forage Sorghum	May 15-September 15	May 15- September 15	4
Sunflowers	May 15-October 15	May 15-October 15	5

Differential soil profile moisture was assumed to be available to each crop at a level of 50% per respective crop within Region A. This is commonly referred as the Managed Available Depletion (MAD - Marek et al., 2009). The respective available soil profile water used in the 2011RWP calculations is included in Table 2-6.

Table 2-6. Average differential seasonal soil moisture, producer applied NPET network crop ET percentages and 2000 and 2010 acreage weighted crop water values of Region A.

Crop	Differential Seasonal Soil Moisture , (inches)	Percent of NPET Crop ET Applied by Producers	Irrigation Water Pumped, in./ac.	
			2000 Acreage Weighted Average	2010 Acreage Weighted Average
Corn	2.41	0.86	18.50	19.11
Cotton	4.22	0.91	10.67	6.70
Grain Sorghum	3.62	0.84	9.66	9.66
Hay	1.50	0.95	31.30	-
Pasture and Other	2.50	0.80	22.35	27.40
Peanuts	2.20	1.35	17.05	17.03
Soybeans	3.11	0.91	9.95	10.05
Wheat	3.84	0.79	10.35	7.73
Alfalfa	1.50	0.95	-	26.11
Forage Sorghum	3.62	0.84	-	9.70
Sunflowers	4.22	0.91	-	3.70

Water use by crop was multiplied by the harvested irrigated acreage (hia) in each respective county to attain the harvested crop irrigation demand estimates (in the 2011RWP, harvested irrigated acreage equals the planted irrigated acreage minus the hailed out irrigated acreage). In addition, the hailed out crop water use was added to the harvested irrigated crop water use to obtain the total water use per crop per county. Hailed out crop water use was estimated at 50% of the normal full season crop water use value. The 2000 versus 2010 water use per crop by county comparison is provided in Appendix A.

<u>Irrigation Demand Reduction Assumptions (Modification of Future Water Use Projections)</u>

Declines in the Ogallala aquifer supply availability are considered virtually inevitable, as they were projected within the 2006RWP. This availability constraint is considered due to the fact that the Ogallala aquifer has a very small or minimal rate of recharge within the planning region and for the time period of interest. In previous Region A analysis efforts, it was demonstrated that irrigated crop use per unit of water pumped had the lowest return as compared to other water use sectors. Therefore, any projected reduction in water use due to limited availability is expected to occur in the irrigation water sector. Furthermore, any anticipated increases in water use by other water use sectors are expected to come at the "expense" of irrigation sector.

In the 2006RWP, the estimated irrigation demand shape over time resembled that of a "curved" depletion scenario due to reduced aquifer availability, adoption of more advanced irrigation technologies and possible pumpage regulations were to be anticipated with future conditions. The reduction rate shape included a "mild" declination rate during the initial period of the forecasted horizon, steeper in the middle and then a reduced or "relaxed" rate near year 2060. The respective periods' "change rate" coincide with the philosophy and past experience that at first 1) Change, adoption or conformance takes time by clientele and occurs relatively slowly on a regional basis (whether to technology or to regulation), 2) Then in the mid-years, the decline rate steepens as technologies and compliance become fully adopted along with cultural practice changes and diminished economics, and 3) Finally, in the later years, with reduced water availability and altered production potentials, the decline resembles the declination rate reflective of the first stage. In this 2011RWP effort, the 2006RWP declination curve rates were reset to begin again starting at year 2010. The general shape and shift of the reduction curve is illustrated in Figure 2-3 for the 2006RWP and the 2011RWP.

The shape of the declination curve is also predicated on that producers are not likely to rapidly change current operational practices due to management and equipment changeover costs. Thus, a rapid decline in current irrigation demand is not foreseen from current or existing pumpage values. The principal altering variable that would have the most impact in this early stage would be energy costs, but economics dictate that high production be maintained to cover current fixed irrigation system costs. During the middle decades, it is anticipated that irrigation will fall sharply as systems wear out or are paid off allowing producers to either terminate irrigation or adjust to lower water use crops in response to reduced irrigation profitability. It is expected that by the final decade of the planning horizon that the decline in irrigation will moderate as adjustments in acreage and crop mix reach a sustainable and possibly even marginal "long-term equilibrium" state.

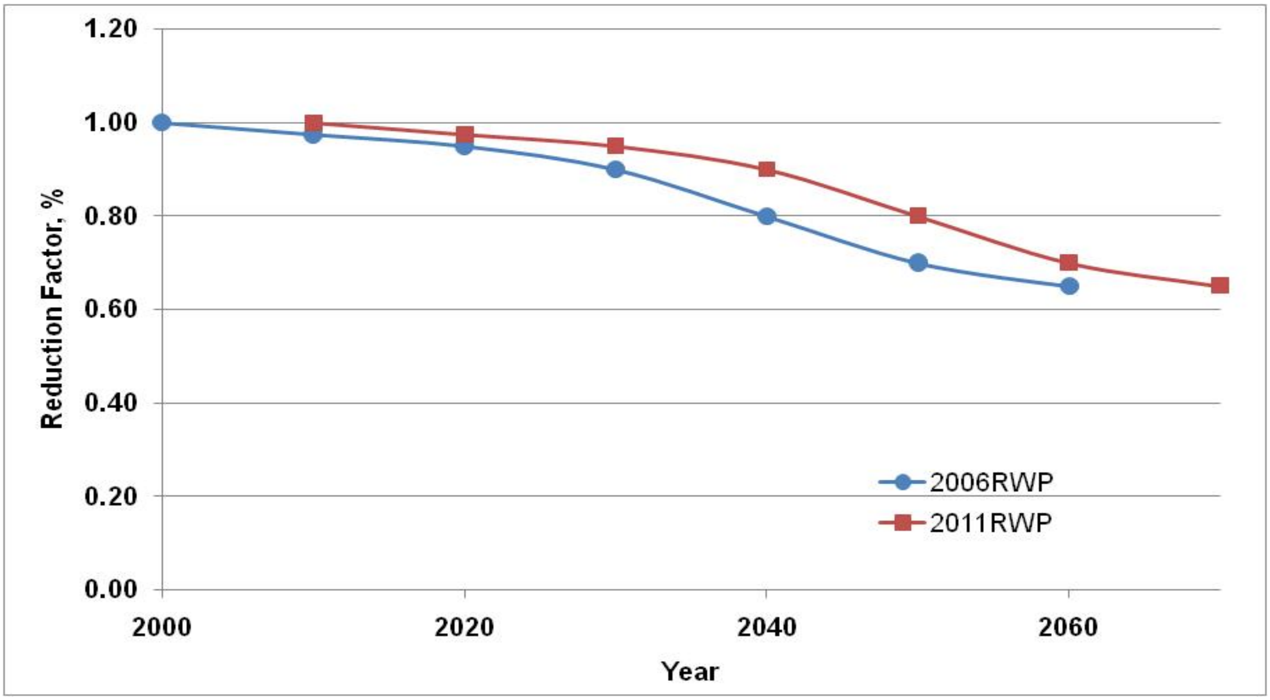

Figure 2-3. Declination shape of irrigation water demand curve with time based on technology adoption, aquifer availability and regulation parameters.

<u>2011RWP Irrigation Demand Estimates for Region A</u>

Using the TAMA model with input parameters as designated in previous sections, updated county based irrigation water demand calculations utilizing FSA based acreage numbers are presented in Table 2-7.

Table 2-7. 2011RWP Region A estimated irrigation water demand by county for selected years, acre-feet.

County	2000	2010	2020	2030	2040	2050	2060
Armstrong	10,544	5,118	4,688	4,544	4,305	3,827	3,349
Carson	97,345	58,775	49,230	47,982	45,457	36,368	35,355
Childress	10,304	7,418	5,519	5,350	5,068	4,505	3,942
Collingsworth	25,607	28,693	21,907	21,236	20,118	17,883	15,648
Dallam	320,475	292,031	283,315	274,642	260,187	231,278	202,368
Donley	21,019	32,000	29,676	28,771	27,257	24,228	21,200
Gray	25,499	22,705	20,410	19,785	18,744	16,661	14,578
Hall	20,789	16,719	10,731	10,403	9,855	8,760	7,665
Hansford	138,389	130,694	115,027	111,506	105,637	93,899	82,162
Hartley	289,008	294,932	281,648	273,026	258,657	229,917	201,177
Hemphill	3,779	1,825	1,705	1,653	1,566	1,392	1,218
Hutchinson	63,208	43,104	39,971	38,748	36,708	32,630	28,551
Lipscomb	14,789	16,956	15,546	15,070	14,277	12,690	11,104
Moore	180,594	147,471	135,001	130,869	123,981	110,205	96,430
Ochiltree	104,220	60,844	51,839	50,252	47,607	42,317	37,028
Oldham	5,223	4,235	3,914	3,794	3,594	3,195	2,795
Potter	8,009	6,226	5,697	5,525	5,234	4,652	4,071
Randall	30,302	22,477	19,900	19,291	18,275	16,245	14,214
Roberts	22,890	6,084	5,639	5,466	5,179	4,603	4,028
Sherman	294,703	220,372	200,521	194,437	182,913	163,736	143,269
Wheeler	8,335	11,311	9,488	9,198	8,713	7,745	6,777
Total	**1,695,031**	**1,429,989**	**1,311,372**	**1,271,546**	**1,203,332**	**1,066,738**	**936,929**

From the graphical data in Figure 2-4, it is obvious in 2011RWP for year 2000 that several Region A counties were responsible for the majority of water use with over a 150,000 acre-feet irrigation demand per year. These counties were Dallam, Hartley, Moore, and Sherman. The next three counties above or near 100,000 acre-feet irrigation demand level were Carson, Hansford and Ochiltree. For year 2010 in Figure 2-5, the same counties exhibit similar irrigation demand volumes but at a reduced level.

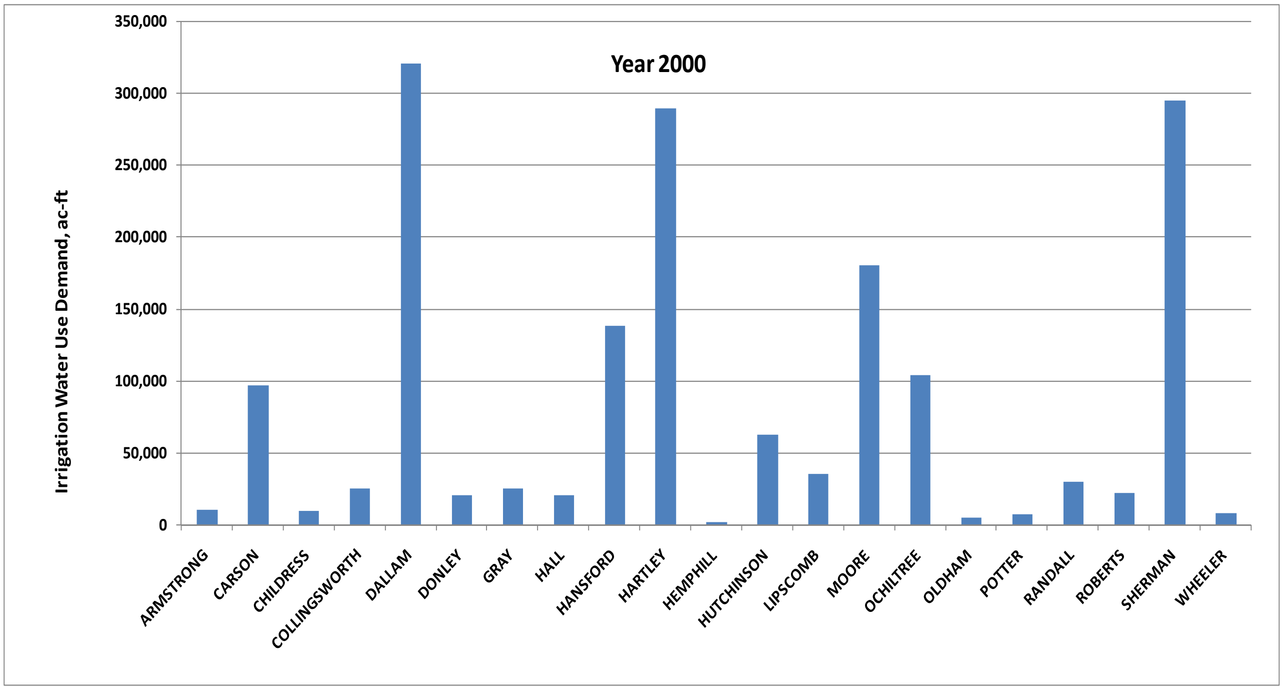

Figure 2-4. Region A total irrigated water use by county for year 2000.

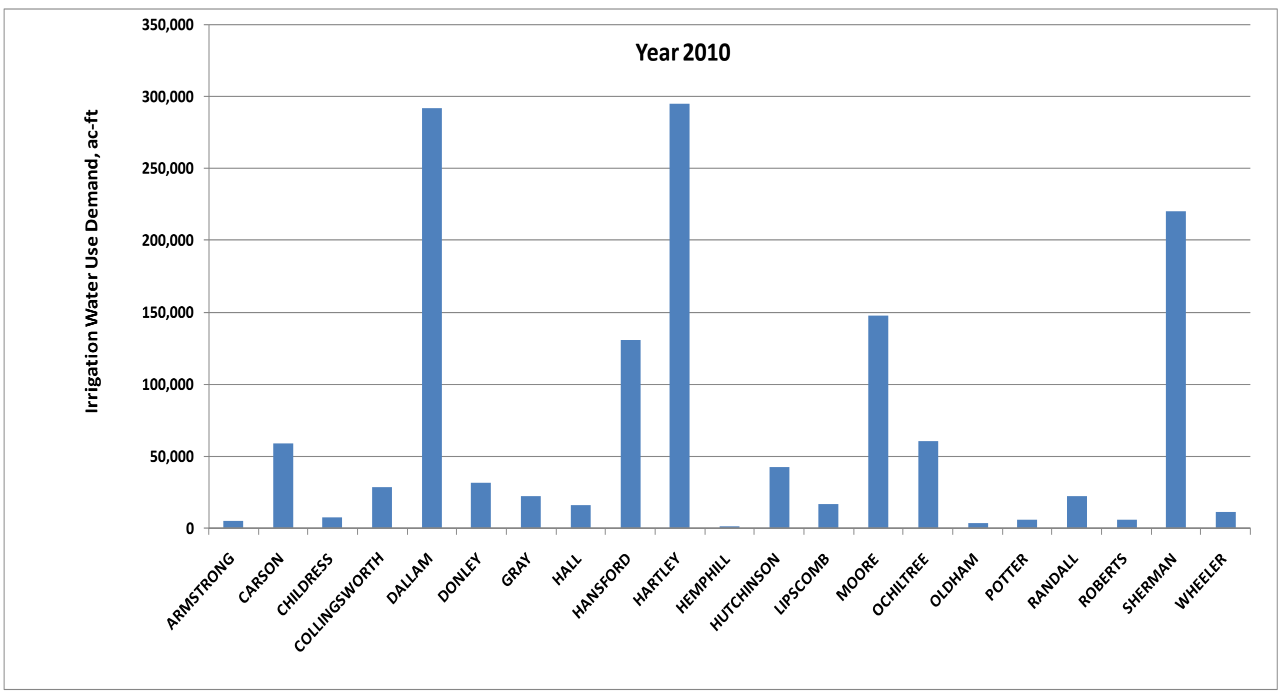

Figure 2-5. Region A total irrigated water use by county for year 2010.

A graphical breakdown of the crop category irrigation water demand use is presented in Figure 2-6. Generally, each major county has declines from year 2000 to 2010 with the exception of Hartley County. Counties, such as, Carson and Sherman experience significantly more decline than other counties. In Figure 2-7, the crop category irrigation demand per decade are illustrated, and it is apparent that corn has overwhelming the dominant crop water demand over the planning period. The next largest crop demand is for wheat.

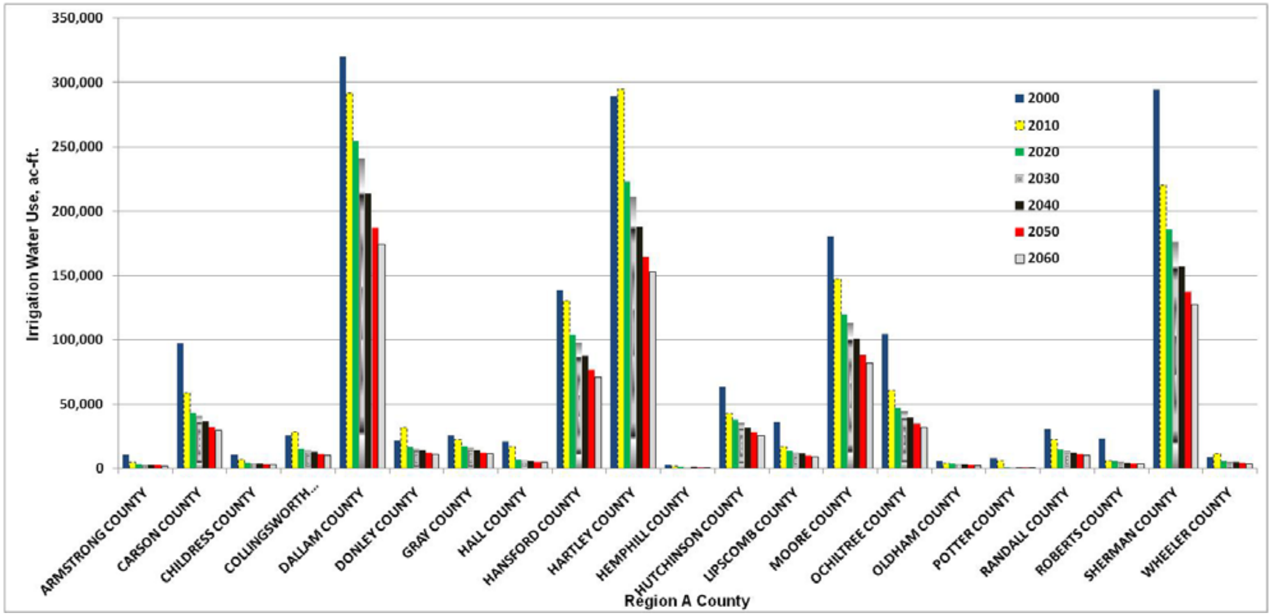

Figure 2-6. Region A total irrigated water use by county for selected years, 2000 – 2060.

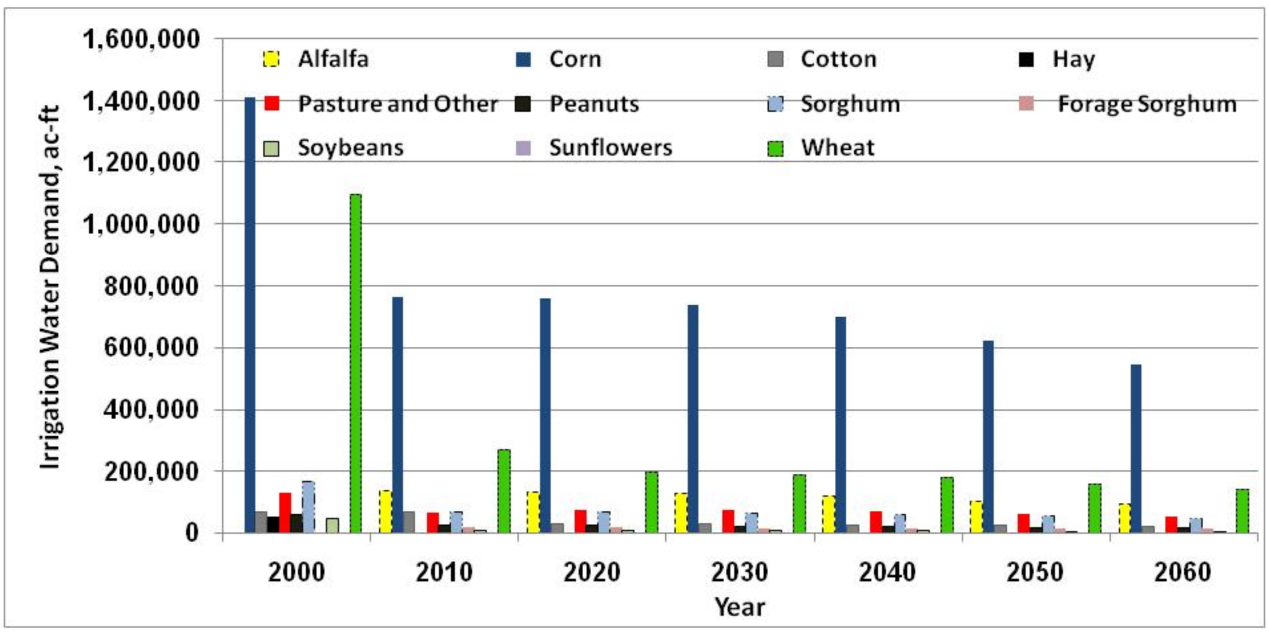

Figure 2-7. Region A total irrigated water use by crop for selected years, 2000 – 2060.

The total regional irrigation water demand estimates over the planning period as illustrated in Figure 2-8 indicate a reduction as compared to the previous 2006RWP forecasted demand values beginning from 2010. Not surprising, the four northwest counties still present the greatest demand and usage. The counties are Dallam, Moore, Hartley and Sherman. In these counties, the TAMA projected water use is to be reduced by 14.4% overall and 18.5%, 16.6%, 11.4%, 10.4% and 15.3% less for the decadal years of 2020 through 2060 as compared to the 2006RWP estimates, respectively. This does not indicate that the 2006RWP future estimates were in error, but rather that the forecasted irrigated demand conditions have changed and are now reflected with the changed 2011RWP estimates.

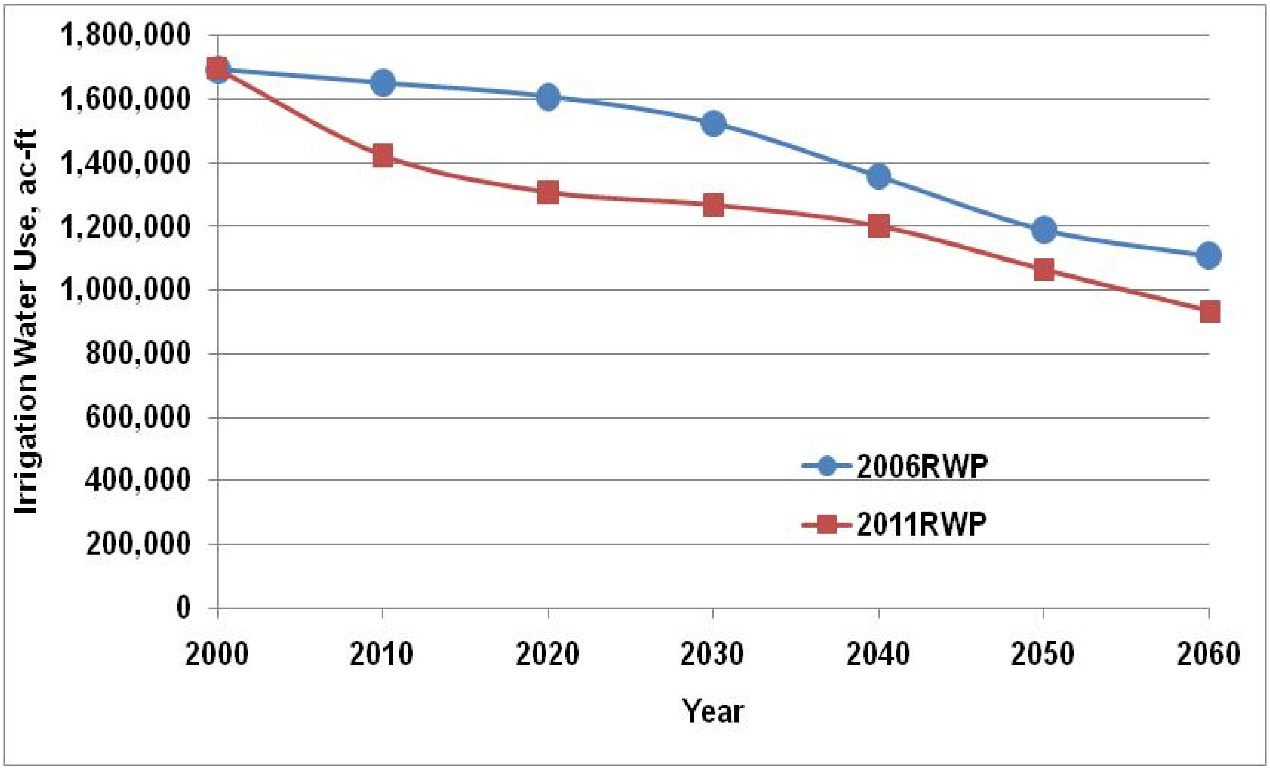

Figure 2-8. 2006RWP versus 2011RWP irrigation demands, 2000 - 2060.

4. Livestock Water Demand Estimates

It was estimated in the 2006RWP that livestock operations accounted for 2% - 3% of the water use in Region A. The anticipated rapid growth of the livestock industry makes on-going monitoring of this sector relevant. Given the importance of livestock to the region's economy, an objective of the 2011RWP is to review/revise/modify, where necessary, regional livestock water use projections. Specific objectives were to:

1. Refine livestock inventory projections for 2010 used in the 2006RWP given current inventories (Appendix B),
2. Review/revise, where necessary, future livestock growth projections though 2060, and
3. Review/revise, where necessary, water use estimates per species.

<u>2010 Livestock Inventory Estimates</u>

Livestock inventories by species were estimated for each county of Region A for 2000 in the 2006RWP effort. County determination of livestock numbers is vital to the accurate estimation of water use. The planning committee has identified eight livestock water use groups. They include beef cows, fed beef, summer stockers, winter stockers, dairy cattle, equine, swine and poultry. The procedure utilized to develop the 2000 county level estimates by species varied depending on the data sources available.

In the 2011RWP, updated inventory projections were estimated and utilized to replace 2010 inventory projections to improve the accuracy of the base for making future projections. Texas Agricultural Statistics Service (TASS, 2007) was used as the primary source of livestock inventory estimates. However, TASS does not provide county level livestock inventory estimates for all species. In some species, only crop reporting district or state level estimates are made. In these instances, other sources of information including the 2007 Census of Agriculture, Milk Market Administrator, Extension or Industry specialists, and advisory groups were used to refine/improve county level estimates.

Beef Cows

TASS inventory estimates of 2008 beef cow numbers by county were assumed to be equal to the 2010 inventories (TASS, 2007).

Fed Beef

TASS only estimates fed beef by inventories on a crop reporting district basis. In the 2006RWP, county level estimates were made by establishing the feedlot capacity in each county (SPS, 2000). Inventory estimates were calculated as 85% of the total permitted capacity. The 85% "occupancy rate" was determined from TASS data and feedlot turnover data provided by the Texas Cattle Feeders Association (TCFA), Amarillo, Texas. In the 2011RWP, TCFA personnel updated county level feedlot inventories via secondary data and personal communications with feedlot managers.

Summer Stockers

The procedure for estimating the number of summer stockers was revisited and refined. In the 2006RWP, the number of summer stockers in a county was adjusted depending on the change in beef cow inventory (TASS, 1997). If the beef inventory increased (from 1997 to 2000), it was assumed the number of summer stockers decreased because of less pasture being available. The change was calculated on the basis of 0.7 cow units being equivalent to 1 stocker unit. The basic assumption was pasture not being grazed by beef cows was being utilized for summer stocker production. For example, if County A had 20,000 acres of pasture, a 500 cow inventory with an estimated stocking rate of 25 acres per cow, then the estimated number of summer stockers would be 429 ((20,000 – 500 * 25)/(25 * .7)). In the 2011RWP, the projected 2010 summer stocker numbers were adjusted based on the TASS 2008 (TASS, 2007) beef cow inventory estimates. However, a second adjustment was added to the calculation. Previously, a stocking rate was estimated assuming permanent pasture/rangeland. The cropland used for the grazing purposes in this category was identified via the 2007 Census of Agriculture and stocking rate on that acreage was doubled to reflect its improved grazing capacity relative to typical pastureland (McCollum and Amosson, 2009).

Winter Stockers

A decrease in the number of stocker cattle grazing wheat have been observed over the last five years. A survey of Texas AgriLife County Extension Agents in the major wheat producing counties was conducted to ascertain changes in wheat pasture grazing. Based on the survey, the percentage of irrigated and dryland wheat assumed to be grazed, on average, was reduced to 60% and 20%, respectively. In addition, winter stocker numbers were adjusted to reflect the new wheat crop acreage base (2006 – 2008 average). These changes in winter stockers were reflected in the 2010 estimated inventory.

Dairy Cattle

The TASS 2000 dairy cow inventory numbers by county were used for Region A in 2006RWP. In the 2011RWP, 2010 projections were modified to reflect current inventories. Inventories for counties with three or more dairies were estimated based on the December 2008 milk production (Milk Market Administrator, 2008) assuming a cow produces 60 pounds of milk per day. In counties with less than three milking dairies, the number of cows was estimated using the latest inventory counts made by TCEQ (Tucker, 2008).

Equine

In the 2006RWP, the county level distribution provided by the 1997 Census was utilized and adjusted upward to reflect the 2000 inventory number reported by TASS. For example, if a county had 1,000 equine according to the 1997 Census data (Census of Ag., 1997), the 2000 inventory number was scaled up by multiplying the 2000 TASS state inventory (600,000) divided by the 1997 Census state total (241,000). TASS has since stopped making these estimates; therefore, the 2010 inventories were modified to reflect the estimates made in the 2007 Census of Agriculture.

Swine

TASS only estimates swine inventory numbers on a crop reporting district basis. The distribution of hog inventories by county determined in the 2001RWP was utilized (TASS, 1997). The one exception was Lipscomb County where the inventory estimate was reduced from 40,000 to 10,000. These estimates were "scaled up" in a similar manner as described above for dairy cattle. Each county inventory number was adjusted by multiplying it by 1.042 (780,000/748,236 or 2000 TASS inventory/1997 in the 2001RWP inventory) to arrive at the 2006RWP inventory estimates. These estimates by county were verified through TCEQ permits and validated by a focus group of swine producers from the region.

Currently, four companies control the commercial hog production in Region A. In the 2011Water Plan, these companies were surveyed directly in the winter of 2009 with the assistance of the Texas Pork Producers Association (Horton, 2009) to determine the actual inventories to use in the 2011RWP effort. The 2007 Census of Agriculture was utilized to estimate inventories in counties without commercial scale operations (Census of Ag, 2007).

Poultry

Virtually no poultry currently exists within Region A. In the 2006RWP, 2000 inventory numbers were arbitrarily set at 1,000 birds per county. The same assumption is being utilized in Water Plan 2011.

Livestock Growth Projections

An objective of this study was to review and revise, where warranted, projected growth assumptions in the livestock sector made in the 2006RWP for use in the 2011RWP cycle. Resulting from this review, no changes were recommended in the projected growth rates used in the 2001RWP for beef cows and equine. The expansion in the poultry industry has basically remained unchanged with the exception of the size of incoming operations was doubled (Table 2-8). Growth rates for fed beef and stockers were modified slightly while major changes were recommended for swine and dairy.

Table 2-8. Region A 2006RWP and 2011RWP projected livestock inventory growth by species, 2000 – 2060 and annual growth rate.

Species	2006RWP	2011RWP
(---------- Annual Growth Rates ----------)		
Beef Cows:		
2010 – 2060	0.00%	0.00%
Fed Beef:		
2000 – 2010	1.00%	2010 Inventory estimated by TCFA.
2010 – 2060	1.15% annual growth rate from 2010 – 2020, and 0.60% annual growth rate 2020 – 2060.	10% growth per decade in Dallam, Hansford, Hartley, Moore, Ochiltree, and Sherman Counties. No growth in other counties.
Summer Stockers:		
2010 - 2060	0.50%	0.00%
Winter Stockers:		
2010 - 2060	0.50%	0.25%
Dairy Cattle:		
2000 - 2010	In 2010, 28.75% of TCEQ current and pending permit capacity and add 4,000 cow units in Sherman and Oldham Counties.	
2010 - 2020	In 2020, 57.50% of TCEQ current and pending capacity.	In 2020, 60,000 cows allocated to Dallam, Hartley, Moore and Sherman Counties based on percentage of current TCEQ permits
2020 - 2060	0.00%	1.00% annual growth rate in all dairy counties.
Equine		
2010 - 2060	1.00%	1.00%
Poultry:		
2000 - 2060	In 2020, add 500,000 capacity operations in Childress, Collingsworth, Hemphill, Lipscomb, and Wheeler Counties. No other growth is assumed.	In 2020, add 1,000,000 capacity operations in Armstrong, Carson, Childress, Collingsworth, Gray, Oldham, and Wheeler Counties. No other growth is assumed.
Swine:		
2000 - 2010	57.50% of TCEQ total permit capacity and add 10,000 hog units to Hemphill County.	2010 inventories determined by a survey of swine producers.
2010 - 2020	100% of current TCEQ permit capacity.	0.00%
2020 - 2060	0.00%	0.00%

Fed Beef

The beef advisory committee (Sweeten, Casey, Amosson, and Weinheimer, 2009) decided to lower the growth projections that existed in the 2006RWP on the recommendation of Texas Cattle Feeders Association (TCFA) staff working in consultation with feedlot operators. The growth of the ethanol industry in the Midwest and the slowdown in the economy which already resulted in lower than expected projected 2010 inventories were the basis for this recommendation. In the 2011RWP, it is assumed Dallam, Hansford, Hartley, Moore, Ochiltree and Sherman counties would experience a 10% growth per decade for the 2010 – 2060 time periods. No growth was assumed in other Region A counties.

Summer and Winter Stockers

The annual projected growth rate in summer and winter stockers was reduced from a half percent used in the 2006RWP to a no-growth level and a 0.25% level, respectively, for the 2011RWP. In the 2006RWP, it was thought that the continued growth of the fed cattle industry, improved pastures exiting the Conservation Reserve Program (CRP), and an increase in dryland wheat production as irrigation declined would result in a half percent annual growth rate. While growth in the fed beef industry is still expected to occur, it will be at a slower rate than anticipated. Given the reauthorization of the CRP in the 2007 Farm Bill, it was decided to go with zero growth for summer stockers. With the realization that some of the growth in dryland winter wheat pasture would come at the expense of irrigated wheat pasture with higher stocking rates, it was decided to reduce the anticipated growth rate of winter stocker inventories by half.

Dairy Cattle

The building of the Hilmar Cheese Plant (Phase 1) in Dalhart, since the 2006RWP effort justified revising 2010 inventory numbers for the 2011RWP. Hilmar Cheese Plant's planned expansion (Phase 2) which should occur within the next five years will require an additional 80,000 cows suggests inventory projections need to be revised upward.

Of the 80,000 cows needed to meet the milk requirements of Hilmar's Phase 1 construction, 52.5% were located in the four northwest counties of Region A (Dallam, Hartley, Moore and Sherman) with the remaining milk required coming from outside the Region and primarily from Region O. These existing operations are permitted to handle an additional 100,000 cows. Therefore, in the 2011RWP, it is assumed that 75% (60,000 cows) of the Phase 2 expansion will occur in these counties in existing or new operations with the remainder being located outside Region A. The 60,000 cows were added to the appropriate counties' 2020 inventory based on their portion of current TCEQ permits. A one percent annual growth rate in all counties with dairy cow inventories was assumed for the 2020 - 2060 time period on the recommendation of the dairy advisory group (Cowan, 2009).

Swine

The most significant change in inventory projections between the 2006RWP and the 2011RWP was in the swine industry. In the 2006RWP, a dramatic increase in hog inventories was projected based on the speculation of another packing plant being built specifically in Region A. However, plans to build that packing plant have been dropped, and it is no longer even a consideration. Representatives of the four major swine operations have indicated that they expect no future growth in the industry.

Poultry

A few adjustments were made to the poultry projections. The advisory committee still believes that poultry operations are coming to Region A and will be located in the eastern counties of the Region or close to I-40 to have greater access to markets. The anticipated size of the operations was increased from 500,000 birds to a 1,000,000 birds based on industry trends. Poultry operations were projected to be opened in Armstrong, Carson, Childress, Collingsworth, Gray, Oldham, and Wheeler counties from 2010 – 2020. No further growth is anticipated from 2020 to 2060.

Inventory Projection Summary

A summary of the impacts of changes in livestock inventories and future projections utilized in the 2011RWP compared to the 2006RWP is given in Table 2-9. The livestock inventories for 2000 are the same for 2006RWP and 2011RWP. The 2010 inventories were changed in 2011RWP to reflect current inventories that were estimated based on 2007 – 2009 data. Projected growth rates were altered to account for changing industry conditions. The 2011RWP ending inventories (2060) of fed beef are expected to be almost 200,000 lower while dairy cow numbers are projected to be 70,000 cows higher than the 2006RWP estimates. The most significant change in inventory projections was in the swine industry where ending inventory was dropped more than 4,500,000 head. Again, this was due to the elimination of plans to build a much anticipated hog packing plant in the Region.

Table 2-9. Region A 2000, 2010 and 2060 inventories by species for 2006RWP and 2011RWP.

	2006RWP and 2011RWP	**2006RWP**	**2011RWP**	**2006RWP**	**2011RWP**
Species	**2000**	**2010**	**2010**	**2060**	**2060**
(---------- Number of Head ----------)					
Beef Cows	237,000	237,000	251,000	237,000	251,000
Fed Beef	1,182,241	1,414,145	1,312,739	2,052,513	1,854,972
Summer Stockers	372,053	391,080	368,921	501,844	368,921
Winter Stockers	646,946	680,031	467,971	872,633	530,198
Dairy Cattle	4,400	50,662	49,137	92,425	162,490
Equine	24,806	27,402	16,882	45,006	26,372
Poultry	21,000	21,000	21,000	2,516,000	7,014,000
Swine	779,999	3,449,057	1,182,371	5,611,617	1,093,971

Livestock Water Use by Species

Three advisory committees consisting of industry experts were formed to review 2006RWP water use estimates by species and recommend changes, as warranted. The dairy advisory committee consisted of Drs. Ellen Jordan and Todd Bilby (2009), Texas AgriLife Extension Dairy Specialists and John Cowan (2009), Executive Director of the Texas Association of Dairymen. The Swine advisory group was coordinated by Ken Horton (2009), Executive Vice President of the Texas Pork Producers Association and included representatives of the four major hog producing organizations in Region A. The Beef and other species committee included Drs. John Sweeten, Ken Casey and Steve Amosson (2009), all of the Texas A&M AgriLife Center in Amarillo, and Ben Weinheimer (2009), Vice President of the Texas Cattle Feeders Association. In addition, other experts were consulted to provide input into the committee process. All recommended changes in water use were implemented beginning with the 2010 time period.

The dairy focus group recommended that daily water use per animal by dairies be reduced from 65 gallons/day to 55 gallons/day (Table 2-10). This was based on improvements employed by West Texas dairies to more efficiently use operational wastewater which has led to most new dairies requesting TCEQ permits at the 50 gallon/day level. This usage level is consistent with what has recently been adopted in Region O planning effort.

Swine water use was changed from a regionally used 5 gallons/day in the 2006RWP (focus committee recommendation) to what estimated actual water use is by the hog operations specific to each county (Horton, 2009). Water use estimates varied from 2.5 gallons/day to 8.5 gallons/day. The primary reason for the variance in water use estimates was differences in the composition in operations (farrow, nursery or finish) within the county. A secondary reason was differences in the cleaning system (pull-plug vs. flush).

The Beef and other species committee decided to leave water use estimates for equine (Baker, Gibbs, and Pipkin, 2009) poultry and beef cows unchanged from the 2006RWP estimates (Sweeten, Casey, Amosson and Weinheimer, 2009). However, after reviewing recent research findings, water use estimates for fed beef, summer stockers and winter stockers were reduced. Fed beef, summer stockers and winter stockers were estimated to use 15, 12 and 12 gallons/day, respectively, in the 2006RWP and were reduced to 12.5, 10 and 8 gallons/day, respectively, in the 2011RWP.

Table 2-10. 2006RWP and 2011RWP livestock water use estimates per animal in Region A.

Species	2006RWP (gal/day)	2011RWP (gal/day)
Beef Cows	20	20
Fed Beef	15	12.5
Summer Stockers	12	10
Winter Stockers	12	8
Dairy Cattle	65[a)]	55
Equine	12	12
Poultry	0.09	0.09
Swine	5[a)b)]	2.5 – 8.5

[a)] Focus group of dairy and swine producers, permit specialist and industry experts.
[b)] In 2000, Dallam County swine water use was 8 gallons/head.

TAMA 2011RWP Livestock Projected Water Use

Region A annual livestock water use projections by species for selected years during the 2011RWP 50-year horizon are presented in Table 2-11 and is illustrated by county in Figure 2-9. Overall, water use in the Region A livestock sector is predicted to increase 40% from 38,176 ac-ft usage in 2000 to 53,287 ac-ft in 2060. While this increase is significant, it still will only represent approximately three to four percent of the total water use within the region.

The largest livestock water use group is projected to be the fed cattle industry with an annual usage of 25,973 ac-ft per year by 2060. The anticipated expansion of the dairy industry will make it the second largest user group by 2060 (10,011 ac-ft per year). These two user groups account for 68% of projected livestock water use in 2060.

The swine and beef cow sectors are forecasted to have zero growth, however, will still use more than 10% each of the livestock water with an estimated demand of 5,883 and 5,623 ac-ft per year, respectively. Summer and winter stockers follow in importance using an estimated 2,755 and 1,980 ac-ft per year, respectively. Poultry and equine accounted for less than two percent of the projected livestock water consumption in 2060.

Table 2-11. 2011RWP estimated annual livestock water use (acre-feet) by species in Region A for selected years.

Species	2000	2010	2020	2030	2040	2050	2060
(---------- acre-feet/year----------)							
Beef Cows	5,310	5,623	5,623	5,623	5,623	5,623	5,623
Fed Beef	19,864	18,381	19,625	20,992	22,497	24,152	25,973
Summer Stockers	3,334	2,755	2,755	2,755	2,755	2,755	2,755
Winter Stockers	3,623	1,747	1,792	1,837	1,883	1,931	1,980
Dairy Cattle	320	3,027	6,724	7,427	8,204	9,063	10,011
Equine	333	216	238	263	291	321	355
Poultry	2	2	707	707	707	707	707
Swine	5,390	5,917	5,883	5,883	5,883	5,883	5,883
Totals	**38,176**	**37,668**	**43,347**	**45,487**	**47,843**	**50,435**	**53,287**

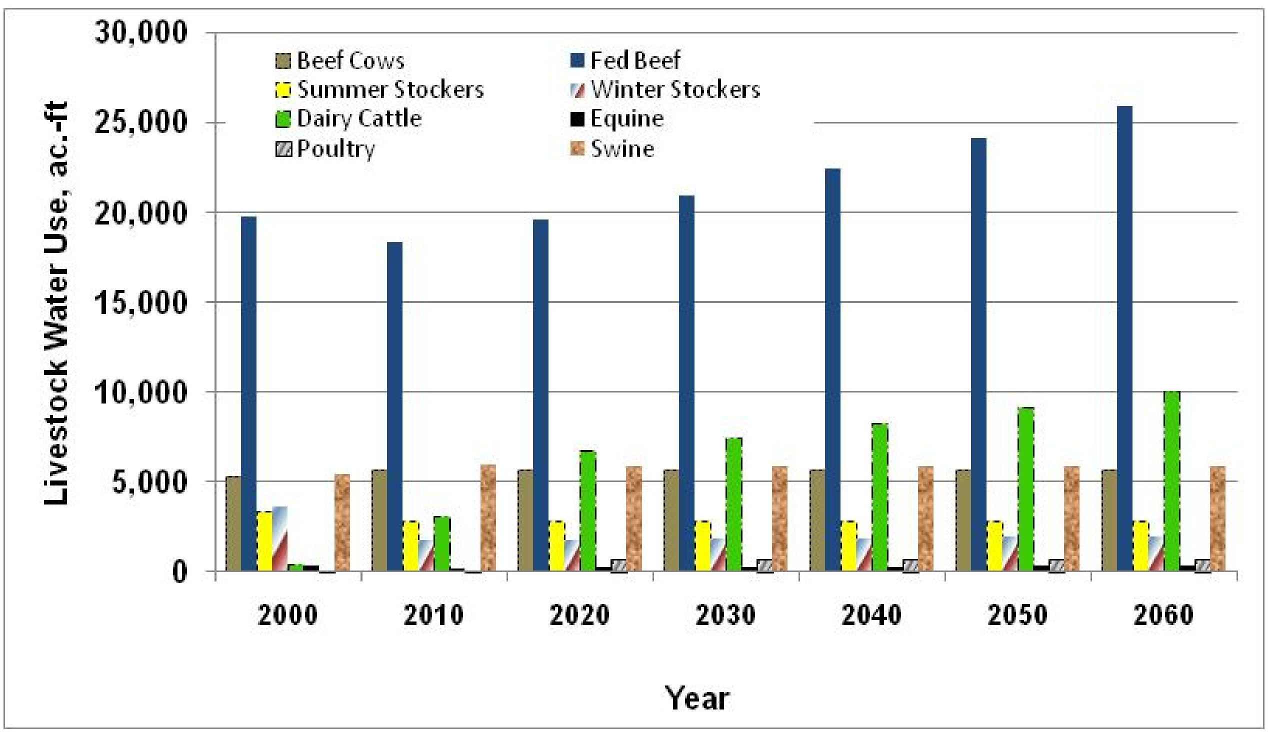

Figure 2-9. Estimated annual livestock water use (acre-feet) by species for selected years.

Estimated livestock water use by county for selected years is provided in Table 2-12. In 2000, the top five counties in livestock water use were Dallam, Ochiltree, Hansford, Hartley and Sherman using 5,689, 4,168, 4,088, 3,572 and 2,995 acre-feet, respectively. By 2060, Hartley County is expected to be the largest water use for livestock (10,024 acre-feet) due to anticipated expansion of the dairy and feedlot industries in the county. Other major users are expected to be Sherman, Dallam, Hansford and Moore pumping 7,019, 6,246, 5,346 and 5,120 acre-feet, respectively, on an annual basis.

Table 2-12. 2011RWP estimated annual livestock water use (acre-feet) by county in Region A for selected years.

County	2000	2010	2020	2030	2040	2050	2060
(----------acre/ft/year----------)							
Armstrong	573	566	670	673	677	681	685
Carson	945	607	711	716	720	725	730
Childress	288	368	470	472	473	475	477
Collingsworth	578	461	564	566	569	571	574
Dallam	5,689	3,509	4,654	4,996	5,373	5,788	6,246
Donley	1,100	1,267	1,268	1,270	1,271	1,273	1,275
Gray	1,706	1,348	1,451	1,474	1,499	1,527	1,557
Hall	297	329	330	331	332	334	335
Hansford	4,088	3,683	3,956	4,256	4,586	4,948	5,346
Hartley	3,572	5,106	7,103	7,731	8,422	9,184	10,024
Hemphill	1,408	1,276	1,281	1,285	1,290	1,296	1,301
Hutchinson	596	685	689	698	708	720	732
Lipscomb	589	1,005	1,007	1,028	1,051	1,076	1,104
Moore	2,684	2,831	3,605	3,931	4,290	4,685	5,120
Ochiltree	4,168	3,367	3,463	3,605	3,761	3,932	4,119
Oldham	1,635	1,154	1,257	1,259	1,262	1,265	1,267
Potter	478	502	504	505	507	509	511
Randall	2,751	2,732	2,741	2,756	2,772	2,789	2,808
Roberts	534	385	385	386	387	388	388
Sherman	2,995	4,933	5,579	5,889	6,230	6,606	7,019
Wheeler	1,504	1,554	1,657	1,660	1,662	1,664	1,667
Total*	**38,178**	**37,668**	**43,346**	**45,488**	**47,843**	**50,435**	**53,286**

*Year totals may not sum exactly due to rounding of species values.

2006RWP and 2011RWP Region A Livestock Water Use Comparison

Projected total livestock water use in the 2006RWP and the 2011RWP are presented graphically in Figure 2-10. The 2011RWP annual water use estimates by 2060 are estimated to be approximately 70% less than those made during the 2006RWP process. However, this still represents almost a 40% increase by 2060 relative to the 2000 estimated water use by the livestock sector. This dramatic drop in anticipated water use can be attributed basically to two factors. First and foremost, the revision downward in swine inventory projections due to the scrapping of plans to build a packing plant in the region. Second, the refinement downward in water use estimates for dairy cows, fed beef, summer stockers and winter stockers. A detailed breakdown of the 2011RWP county level livestock water use projections is presented in Appendix B**.**

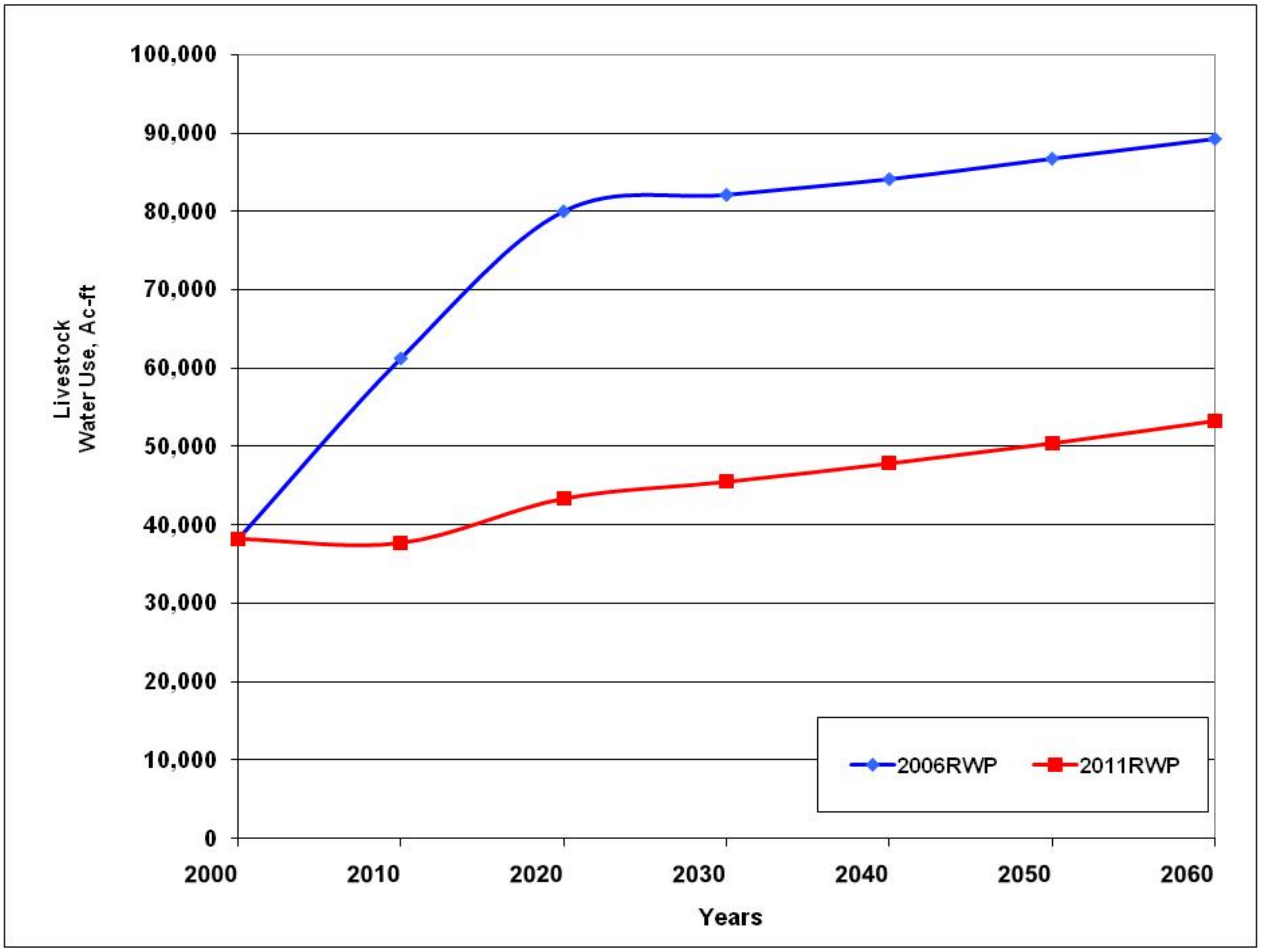

Figure 2-10. Comparison of livestock water use estimates (acre-feet) for the 2006RWP and the 2011RWP, 2000 - 2060.

Summary and Conclusions

The objectives of Task 2B were to: Refine livestock inventory projections for 2010 used in the 2006RWP given current inventories; Review/revise, where necessary, future livestock growth projections though 2060; and Review/revise, where necessary, water use estimates per species made in the 2006RWP for use in the 2011RWP cycle. Resulting from this review, inventory estimates for all species were updated with changes being implemented in the 2010 inventories.

No changes were recommended in the projected growth rates used in the 2006RWP for beef cows, equine and poultry. However, anticipated poultry operations were increased in size from 500,000 to one million birds in Armstrong, Carson, Childress, Collingsworth, Gray, Oldham, and Wheeler counties. Growth rates for fed beef and stockers were modified downward slightly reflecting the impacts of the ethanol industry and changes in the economy. Major changes in the future growth rate were recommended for swine and dairy. The failure to build a packing plant in the region lead the swine group to recommend a zero growth rate resulting in a projected 2060 inventory of 1.1 million versus 5.6 million in the 2006RWP. Conversely, the building and expected expansion of the Hilmar Cheese Plant in Dalhart resulted in a relative 70,000 increase in projected 2060 dairy cow numbers.

Advisory committees were set up to review and revise water use by species, as warranted. No changes were recommended for beef cows, equine or poultry. Swine water use was changed from a regionally used 5 gallons/day in the 2006RWP to what estimated actual water use is by the hog operations specific to each county. Daily water use per animal by dairies was reduced from 65 gallons/day to 55 gallons/day based on improvements employed by West Texas dairies to more efficiently use operational wastewater. After reviewing recent research findings, water use estimates for fed beef, summer stockers and winter stockers were reduced to 12.5, 10 and 8 gallons/day from 15, 12 and 12 gallons/day, respectively.

Overall, water use in the Region A livestock sector is predicted to increase 40% from 2000 to 2060 which represents approximately two to three percent of the total water use in the region. However, the 2011RWP total livestock water use estimates are significantly less (70%) than the 2006RWP projections due to the changes in swine projections and water use by species. The largest livestock water use group is projected to be the fed cattle industry with an annual usage of 25,973 ac-ft/year by 2060. The forecasted expansion of the dairy industry results in usage estimate by 2060 of 10,011 ac-ft/year. These two user groups account for 68% of projected livestock water use in 2060. The swine industry is the third largest water user group with a projected annual water use of 5,883 ac-ft/year in 2060.

5. 2011RWP Agricultural Water Use estimates

The total agricultural water use demand is derived from combining the irrigation and livestock use demands. However, recognizing that increases in future livestock growth and water use will be achieved through a reduction from irrigation, estimates of the irrigation water use considering (deducting) the increases in livestock water use, results in available water use per county and total values as presented in Table 2-13. These deductions begin in 2020 and were carried out through 2060. Graphically, the difference is illustrated in Figure 2-11. Although the projected increase in livestock water use appears dramatic, livestock water use is still minimal when compared to the irrigation demand.

Table 2-13. Annual agricultural water use projections (acre-feet) by county in Region A for selected years.

Region A County	2010 Ag. Water Use, ac-ft	2020 Ag. Water Use, ac-ft	2030 Ag. Water Use, ac-ft	2040 Ag. Water Use, ac-ft	2050 Ag. Water Use, ac-ft	2060 Ag. Water Use, ac-ft
Armstrong	5,683	5,150	5,003	4,760	4,278	3,795
Carson	59,381	49,732	48,480	45,950	36,857	35,839
Childress	7,786	5,784	5,614	5,331	4,766	4,201
Collingsworth	29,154	22,264	21,591	20,471	18,233	15,994
Dallam	295,541	285,680	276,665	261,833	232,508	203,141
Donley	33,267	30,941	30,034	28,518	25,488	22,458
Gray	24,053	21,654	21,007	19,941	17,831	15,718
Hall	17,048	11,060	10,730	10,181	9,085	7,989
Hansford	134,377	118,437	114,615	108,417	96,317	84,182
Hartley	300,038	284,757	275,507	260,446	230,944	201,365
Hemphill	3,102	2,978	2,921	2,829	2,649	2,469
Hutchinson	43,789	40,653	39,420	37,370	33,280	29,189
Lipscomb	17,961	16,549	16,052	15,236	13,624	12,010
Moore	150,302	137,058	132,600	125,353	111,183	96,972
Ochiltree	64,211	55,110	53,381	50,581	45,120	39,643
Oldham	5,389	4,965	4,843	4,640	4,238	3,836
Potter	6,728	6,198	6,023	5,731	5,147	4,564
Randall	25,209	22,622	21,998	20,967	18,919	16,870
Roberts	6,468	6,023	5,849	5,561	4,985	4,409
Sherman	225,305	204,808	198,414	186,548	166,997	146,116
Wheeler	12,866	10,940	10,647	10,161	9,190	8,219
Counties Total	**1,469,667**	**1,345,382**	**1,303,424**	**1,232,864**	**1,093,689**	**961,038**

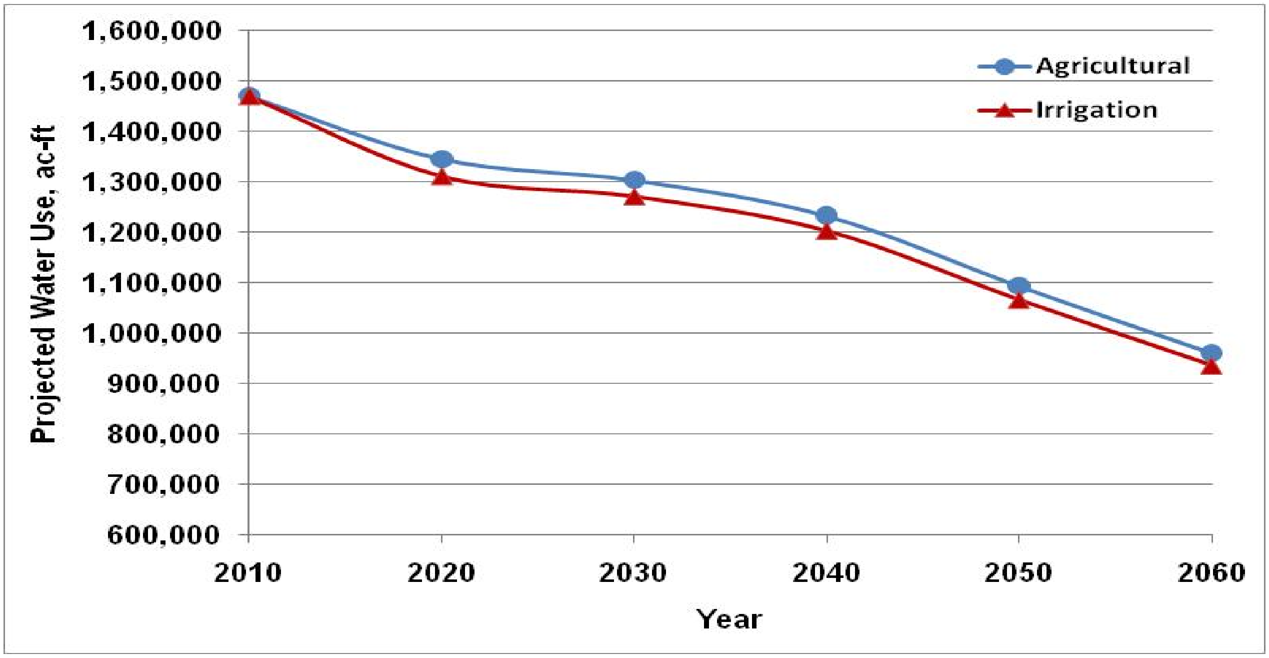

Figure 2-11. Region A projected irrigation and total agricultural water use, 2010 to 2060.

Summary and Conclusions

Under Task 2 of the 2011RWP, Texas A&M personnel are charged with updating the Region A irrigated water use demand estimates. This information is to be used to assist the Panhandle Regional Planning Committee (PRPC) through the Panhandle Water Planning Group (PWPG) in evaluating the proposed Texas Water Development Board (TWDB) irrigated water use estimates for the region. In addition, the updated Texas A&M–Amarillo (TAMA) model can be used to provide the planning group members a "first and possibly best representative look" at the effectiveness of any proposed water conservation strategy in subsequent analyses.

Refinements in the previously developed methodology for estimating irrigation water use demands for Region A in the Texas Panhandle were accomplished and include the addition of new crop categories and updated crop ET data, where available. Subsequently, updated water demand estimates were computed using the Texas A&M–Amarillo (TAMA) model utilizing Farm Service Agency (FSA) acreages with average based grower factors compiled from many years of field data, soil moisture values and long term quadrangle rainfall data. The updated water use values include hailed out crop acreage water use.

Declining water levels in the groundwater aquifers and the marginal profitability of irrigated crop production in the region suggest future reductions in irrigation capacity will occur. Revised computations indicate that an average 35 percent reduction in irrigation is assumed to occur over the next 50-year planning horizon. The irrigation decrease is anticipated to occur in a progressive, declination type pattern reflecting expected trends in cultural practice, well capacity, water conservation and efficiency technology transfers and adoption considerations along with pumpage reductions by potential regulation. Future water demand estimates should continue to improve in accuracy as compared to actual conditions as influenced by longer term records of crop ET, effective rainfall and complete county acreages from FSA.

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APPENDIX A

TEXAS A&M UNIVERSITY 2011 PANHANDLE REGIONAL WATER PLAN REGION A IRRIGATION WATER APPLIED PER ACRE BY CROP AND COUNTY, 2000, 2010 & AVERAGE

Table A-1. Irrigation water applied per acre by crop and county.

COUNTY	2000 Water Use per Crop (in./ac.)	2010 Water Use per Crop (in./ac.)	Average Water Use per Crop (in./ac.)
ARMSTRONG			
Alfalfa:	0.00	27.94	27.94
Corn:	19.71	19.70	19.70
Cotton:	12.60	7.69	10.15
Hay:	32.83	39.15	35.99
Pasture and Other:	24.04	29.24	26.64
Peanuts:	20.40	20.46	20.43
Sorghum:	9.79	9.88	9.84
Forage Sorghum:	0.00	9.87	9.87
Soybeans:	10.49	10.38	10.43
Sunflowers:	0.00	2.95	2.95
Wheat:	9.60	7.70	8.65
CARSON			
Alfalfa:	0.00	26.50	26.50
Corn:	18.70	18.83	18.76
Cotton:	12.11	7.99	10.05
Hay:	31.41	37.40	34.41
Pasture and Other:	22.87	27.80	25.34
Peanuts:	19.90	20.05	19.97
Sorghum:	9.65	9.83	9.74
Forage Sorghum:	0.00	9.90	9.90
Soybeans:	9.69	9.71	9.70
Sunflowers:	0.00	3.99	3.99
Wheat:	9.98	7.34	8.66
CHILDRESS			
Alfalfa:	0.00	25.90	25.90
Corn:	19.35	19.32	19.33
Cotton:	12.27	8.08	10.17
Hay:	30.89	36.80	33.84
Pasture and Other:	22.35	27.20	24.78
Peanuts:	19.71	19.80	19.76
Sorghum:	9.81	9.93	9.87
Forage Sorghum:	0.00	9.99	9.99
Soybeans:	9.50	9.45	9.48
Sunflowers:	0.00	4.08	4.08
Wheat:	8.15	5.50	6.82

Table A-1. Irrigation water applied per acre by crop and county (continued).

COUNTY	2000 Water Use per Crop (in./ac.)	2010 Water Use per Crop (in./ac.)	Average Water Use per Crop (in./ac.)
COLLINGSWORTH			
Alfalfa:	0.00	24.53	24.53
Corn:	16.83	16.74	16.79
Cotton:	8.72	4.06	6.39
Hay:	29.14	35.03	32.09
Pasture and Other:	20.85	25.68	23.26
Peanuts:	16.41	16.38	16.40
Sorghum:	6.93	6.87	6.90
Forage Sorghum:	0.00	6.73	6.73
Soybeans:	7.36	7.23	7.29
Sunflowers:	0.00	0.00	0.00
Wheat:	5.06	2.52	3.79
DALLAM			
Alfalfa:	0.00	25.66	25.66
Corn:	17.50	18.65	18.07
Cotton:	10.57	7.51	9.04
Hay:	29.24	35.32	32.28
Pasture and Other:	21.43	26.46	23.94
Peanuts:	19.05	19.87	19.46
Sorghum:	9.15	9.85	9.50
Forage Sorghum:	0.00	10.45	10.45
Soybeans:	9.39	9.99	9.69
Sunflowers:	0.00	4.64	4.64
Wheat:	10.50	8.31	9.40
DONLEY			
Alfalfa:	0.00	25.14	25.14
Corn:	17.58	17.50	17.54
Cotton:	9.69	4.96	7.32
Hay:	30.04	35.92	32.98
Pasture and Other:	21.59	26.41	24.00
Peanuts:	17.31	17.30	17.31
Sorghum:	7.63	7.59	7.61
Forage Sorghum:	0.00	7.49	7.49
Soybeans:	7.93	7.80	7.87
Sunflowers:	0.00	0.44	0.44
Wheat:	5.83	3.29	4.56

Table A-1. Irrigation water applied per acre by crop and county (continued).

COUNTY	2000 Water Use per Crop (in./ac.)	2010 Water Use per Crop (in./ac.)	Average Water Use per Crop (in./ac.)
GRAY			
Alfalfa:	0.00	25.09	25.09
Corn:	17.92	17.94	17.93
Cotton:	10.84	6.51	8.67
Hay:	29.58	35.78	32.68
Pasture and Other:	21.09	26.17	23.63
Peanuts:	18.23	18.33	18.28
Sorghum:	8.38	8.50	8.44
Forage Sorghum:	0.00	8.53	8.53
Soybeans:	8.18	8.17	8.17
Sunflowers:	0.00	2.31	2.31
Wheat:	6.46	3.76	5.11
HALL			
Alfalfa:	0.00	25.35	25.35
Corn:	17.97	17.79	17.88
Cotton:	9.97	5.19	7.58
Hay:	30.16	36.04	33.10
Pasture and Other:	21.76	26.58	24.17
Peanuts:	17.59	17.50	17.55
Sorghum:	7.89	7.79	7.84
Forage Sorghum:	0.00	7.65	7.65
Soybeans:	8.24	8.04	8.14
Sunflowers:	0.00	0.67	0.67
Wheat:	6.25	3.54	4.89
HANSFORD			
Alfalfa:	0.00	27.28	27.28
Corn:	20.13	20.02	20.07
Cotton:	12.93	7.82	10.37
Hay:	33.25	38.64	35.94
Pasture and Other:	24.57	29.01	26.79
Peanuts:	20.75	20.84	20.79
Sorghum:	10.17	10.23	10.20
Forage Sorghum:	0.00	10.28	10.28
Soybeans:	11.14	10.93	11.04
Sunflowers:	0.00	3.03	3.03
Wheat:	10.23	7.71	8.97

Table A-1. Irrigation water applied per acre by crop and county (continued).

COUNTY	2000 Water Use per Crop (in./ac.)	2010 Water Use per Crop (in./ac.)	Average Water Use per Crop (in./ac.)
HARTLEY			
Alfalfa:	0.00	26.42	26.42
Corn:	18.52	19.09	18.81
Cotton:	11.57	7.70	9.64
Hay:	30.82	36.78	33.80
Pasture and Other:	22.63	27.55	25.09
Peanuts:	19.66	20.12	19.89
Sorghum:	9.43	9.87	9.65
Forage Sorghum:	0.00	10.18	10.18
Soybeans:	9.87	10.14	10.01
Sunflowers:	0.00	4.00	4.00
Wheat:	10.63	8.36	9.50
HEMPHILL			
Alfalfa:	0.00	24.38	24.38
Corn:	16.80	16.82	16.81
Cotton:	9.12	4.65	6.88
Hay:	28.96	34.94	31.95
Pasture and Other:	20.60	25.50	23.05
Peanuts:	16.70	16.76	16.73
Sorghum:	7.11	7.17	7.14
Forage Sorghum:	0.00	7.09	7.09
Soybeans:	7.30	7.26	7.28
Sunflowers:	0.00	0.29	0.29
Wheat:	5.16	2.53	3.84
HUTCHINSON			
Alfalfa:	0.00	26.18	26.18
Corn:	19.21	19.32	19.27
Cotton:	12.08	7.22	9.65
Hay:	31.94	37.43	34.69
Pasture and Other:	23.31	27.83	25.57
Peanuts:	19.79	19.95	19.87
Sorghum:	9.44	9.55	9.49
Forage Sorghum:	0.00	9.54	9.54
Soybeans:	10.08	10.03	10.05
Sunflowers:	0.00	2.53	2.53
Wheat:	9.71	7.17	8.44

Table A-1. Irrigation water applied per acre by crop and county (continued).

COUNTY	2000 Water Use per Crop (in./ac.)	2010 Water Use per Crop (in./ac.)	Average Water Use per Crop (in./ac.)
LIPSCOMB			
Alfalfa:	0.00	25.83	25.83
Corn:	17.16	17.06	17.11
Cotton:	9.59	4.92	7.26
Hay:	30.41	36.36	33.39
Pasture and Other:	22.08	26.96	24.52
Peanuts:	17.45	17.39	17.42
Sorghum:	7.67	7.58	7.62
Forage Sorghum:	0.00	7.48	7.48
Soybeans:	8.23	8.06	8.14
Sunflowers:	0.00	0.53	0.53
Wheat:	7.24	4.62	5.93
MOORE			
Alfalfa:	0.00	24.81	24.81
Corn:	17.78	18.01	17.90
Cotton:	10.99	6.80	8.90
Hay:	29.59	35.20	32.39
Pasture and Other:	21.44	26.06	23.75
Peanuts:	18.47	18.66	18.56
Sorghum:	8.51	8.75	8.63
Forage Sorghum:	0.00	8.88	8.88
Soybeans:	8.98	9.02	9.00
Sunflowers:	0.00	2.77	2.77
Wheat:	8.67	6.64	7.65
OCHILTREE			
Alfalfa:	0.00	24.92	24.92
Corn:	19.26	19.25	19.25
Cotton:	12.15	7.18	9.66
Hay:	32.21	36.59	34.40
Pasture and Other:	23.56	27.15	25.35
Peanuts:	19.86	20.05	19.96
Sorghum:	9.46	9.62	9.54
Forage Sorghum:	0.00	9.74	9.74
Soybeans:	10.18	10.09	10.14
Sunflowers:	0.00	2.48	2.48
Wheat:	11.97	7.76	9.86

Table A-1. Irrigation water applied per acre by crop and county (continued).

COUNTY	2000 Water Use per Crop (in./ac.)	2010 Water Use per Crop (in./ac.)	Average Water Use per Crop (in./ac.)
OLDHAM			
Alfalfa:	0.00	30.19	30.19
Corn:	21.68	21.79	21.74
Cotton:	14.56	9.64	12.10
Hay:	35.65	41.92	38.78
Pasture and Other:	26.59	31.77	29.18
Peanuts:	22.61	22.79	22.70
Sorghum:	11.71	11.91	11.81
Forage Sorghum:	0.00	12.00	12.00
Soybeans:	11.92	11.92	11.92
Sunflowers:	0.00	4.95	4.95
Wheat:	12.60	9.82	11.21
POTTER			
Alfalfa:	0.00	28.70	28.70
Corn:	20.51	20.65	20.58
Cotton:	13.65	8.80	11.22
Hay:	34.27	40.43	37.35
Pasture and Other:	25.22	30.28	27.75
Peanuts:	21.63	21.82	21.73
Sorghum:	10.81	11.02	10.91
Forage Sorghum:	0.00	11.10	11.10
Soybeans:	10.90	10.90	10.90
Sunflowers:	0.00	4.10	4.10
Wheat:	11.15	8.37	9.76
RANDALL			
Alfalfa:	0.00	29.06	29.06
Corn:	21.20	21.27	21.24
Cotton:	13.99	9.09	11.54
Hay:	34.64	40.79	37.71
Pasture and Other:	25.58	30.64	28.11
Peanuts:	21.97	22.14	22.06
Sorghum:	11.15	11.33	11.24
Forage Sorghum:	0.00	11.41	11.41
Soybeans:	11.25	11.24	11.24
Sunflowers:	0.00	4.40	4.40
Wheat:	11.10	8.05	9.57

Table A-1. Irrigation water applied per acre by crop and county (continued).

COUNTY	2000 Water Use per Crop (in./ac.)	2010 Water Use per Crop (in./ac.)	Average Water Use per Crop (in./ac.)
ROBERTS			
Alfalfa:	0.00	25.13	25.13
Corn:	18.94	18.92	18.93
Cotton:	11.64	6.94	9.29
Hay:	30.42	36.23	33.32
Pasture and Other:	21.78	26.54	24.16
Peanuts:	19.09	19.23	19.16
Sorghum:	8.92	9.07	9.00
Forage Sorghum:	0.00	9.12	9.12
Soybeans:	9.24	9.13	9.19
Sunflowers:	0.00	2.37	2.37
Wheat:	6.33	3.93	5.13
SHERMAN			
Alfalfa:	0.00	28.51	28.51
Corn:	20.19	20.40	20.30
Cotton:	13.36	8.74	11.05
Hay:	33.71	39.73	36.72
Pasture and Other:	25.00	29.95	27.47
Peanuts:	21.35	21.59	21.47
Sorghum:	10.83	11.03	10.93
Forage Sorghum:	0.00	11.20	11.20
Soybeans:	11.06	11.10	11.08
Sunflowers:	0.00	4.41	4.41
Wheat:	11.59	8.96	10.27
WHEELER			
Alfalfa:	0.00	25.33	25.33
Corn:	18.28	18.28	18.28
Cotton:	11.38	7.08	9.23
Hay:	29.83	36.06	32.94
Pasture and Other:	21.31	26.40	23.85
Peanuts:	18.72	18.81	18.76
Sorghum:	8.79	8.92	8.85
Forage Sorghum:	0.00	8.97	8.97
Soybeans:	8.47	8.46	8.47
Sunflowers:	0.00	2.92	2.92
Wheat:	6.93	4.12	5.52

APPENDIX B

TEXAS A&M UNIVERSITY 2011 REGIONAL WATER PLAN
REGION A PROJECTED LIVESTOCK INVENTORY AND WATER USE
BY COUNTY AND REGION, 2000 – 2060

Table B-1. Projected Future Livestock Numbers and Water Use – Beef Cows, Range/Pasture Operations.

	Beef Cows									2000		
	Beef: Projected Inventory---->							Beef Cows	Water use	Water Use, Beef Cows-------->		
County	2000	2010*	2020	2030	2040	2050	2060	Head	gal/hd/day	gal/day	gal/hd/yr	ac-ft/yr
Armstrong	6,000	15,000	15,000	15,000	15,000	15,000	15,000	6,000	20	120,000	7,300	134.4
Carson	11,000	8,000	8,000	8,000	8,000	8,000	8,000	11,000	20	220,000	7,300	246.4
Childress	9,000	10,000	10,000	10,000	10,000	10,000	10,000	9,000	20	180,000	7,300	201.6
Collingsworth	15,000	10,000	10,000	10,000	10,000	10,000	10,000	15,000	20	300,000	7,300	336.0
Dallam	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	20	200,000	7,300	224.0
Donley	21,000	15,000	15,000	15,000	15,000	15,000	15,000	21,000	20	420,000	7,300	470.5
Gray	12,000	7,000	7,000	7,000	7,000	7,000	7,000	12,000	20	240,000	7,300	268.8
Hall	11,000	8,000	8,000	8,000	8,000	8,000	8,000	11,000	20	220,000	7,300	246.4
Hansford	6,000	8,000	8,000	8,000	8,000	8,000	8,000	6,000	20	120,000	7,300	134.4
Hartley	10,000	18,000	18,000	18,000	18,000	18,000	18,000	10,000	20	200,000	7,300	224.0
Hemphill	18,000	23,000	23,000	23,000	23,000	23,000	23,000	18,000	20	360,000	7,300	403.3
Hutchinson	6,000	7,000	7,000	7,000	7,000	7,000	7,000	6,000	20	120,000	7,300	134.4
Lipscomb	10,000	18,000	18,000	18,000	18,000	18,000	18,000	10,000	20	200,000	7,300	224.0
Moore	6,000	8,000	8,000	8,000	8,000	8,000	8,000	6,000	20	120,000	7,300	134.4
Ochiltree	9,000	9,000	9,000	9,000	9,000	9,000	9,000	9,000	20	180,000	7,300	201.6
Oldham	12,000	13,000	13,000	13,000	13,000	13,000	13,000	12,000	20	240,000	7,300	268.8
Potter	5,000	11,000	11,000	11,000	11,000	11,000	11,000	5,000	20	100,000	7,300	112.0
Randall	10,000	13,000	13,000	13,000	13,000	13,000	13,000	10,000	20	200,000	7,300	224.0
Roberts	8,000	9,000	9,000	9,000	9,000	9,000	9,000	8,000	20	160,000	7,300	179.2
Sherman	7,000	6,000	6,000	6,000	6,000	6,000	6,000	7,000	20	140,000	7,300	156.8
Wheeler	35,000	25,000	25,000	25,000	25,000	25,000	25,000	35,000	20	700,000	7,300	784.1
Total	237,000	251,000	251,000	251,000	251,000	251,000	251,000	237,000		4,740,000		5,309.5

Note: Assumes 0.0% growth factor from 2010 through 2060.
*Source: Updated January 1, 2008 inventory estimates from 2007 Texas Agricultural Statistics Service.

Table B-1. Projected Future Livestock Numbers and Water Use – Beef Cows, Range/Pasture Operations (continued).

	2010					2020				
	Beef Cows	Water use	Water Use, Beef Cows-------->			Beef Cows	Water use	Water Use, Beef Cows-------->		
County	Head	gal/hd/day	gal/day	gal/hd/yr	ac-ft/yr	Head	gal/hd/day	gal/day	gal/hd/yr	ac-ft/yr
Armstrong	15,000	20	300,000	7,300	336.0	15,000	20	300,000	7,300	336.0
Carson	8,000	20	160,000	7,300	179.2	8,000	20	160,000	7,300	179.2
Childress	10,000	20	200,000	7,300	224.0	10,000	20	200,000	7,300	224.0
Collingsworth	10,000	20	200,000	7,300	224.0	10,000	20	200,000	7,300	224.0
Dallam	10,000	20	200,000	7,300	224.0	10,000	20	200,000	7,300	224.0
Donley	15,000	20	300,000	7,300	336.0	15,000	20	300,000	7,300	336.0
Gray	7,000	20	140,000	7,300	156.8	7,000	20	140,000	7,300	156.8
Hall	8,000	20	160,000	7,300	179.2	8,000	20	160,000	7,300	179.2
Hansford	8,000	20	160,000	7,300	179.2	8,000	20	160,000	7,300	179.2
Hartley	18,000	20	360,000	7,300	403.3	18,000	20	360,000	7,300	403.3
Hemphill	23,000	20	460,000	7,300	515.3	23,000	20	460,000	7,300	515.3
Hutchinson	7,000	20	140,000	7,300	156.8	7,000	20	140,000	7,300	156.8
Lipscomb	18,000	20	360,000	7,300	403.3	18,000	20	360,000	7,300	403.3
Moore	8,000	20	160,000	7,300	179.2	8,000	20	160,000	7,300	179.2
Ochiltree	9,000	20	180,000	7,300	201.6	9,000	20	180,000	7,300	201.6
Oldham	13,000	20	260,000	7,300	291.2	13,000	20	260,000	7,300	291.2
Potter	11,000	20	220,000	7,300	246.4	11,000	20	220,000	7,300	246.4
Randall	13,000	20	260,000	7,300	291.2	13,000	20	260,000	7,300	291.2
Roberts	9,000	20	180,000	7,300	201.6	9,000	20	180,000	7,300	201.6
Sherman	6,000	20	120,000	7,300	134.4	6,000	20	120,000	7,300	134.4
Wheeler	25,000	20	500,000	7,300	560.1	25,000	20	500,000	7,300	560.1
Total	251,000		5,020,000		5,623.2	251,000		5,020,000		5,623.2

Table B-1. Projected Future Livestock Numbers and Water Use – Beef Cows, Range/Pasture Operations (continued).

	2030					2040				
	Beef Cows	Water use	Water Use, Beef Cows-------->			Beef Cows	Water use	Water Use, Beef Cows-------->		
County	Head	gal/hd/day	gal/day	gal/hd/yr	ac-ft/yr	Head	gal/hd/day	gal/day	gal/hd/yr	ac-ft/yr
Armstrong	15,000	20	300,000	7,300	336.0	15,000	20	300,000	7,300	336.0
Carson	8,000	20	160,000	7,300	179.2	8,000	20	160,000	7,300	179.2
Childress	10,000	20	200,000	7,300	224.0	10,000	20	200,000	7,300	224.0
Collingsworth	10,000	20	200,000	7,300	224.0	10,000	20	200,000	7,300	224.0
Dallam	10,000	20	200,000	7,300	224.0	10,000	20	200,000	7,300	224.0
Donley	15,000	20	300,000	7,300	336.0	15,000	20	300,000	7,300	336.0
Gray	7,000	20	140,000	7,300	156.8	7,000	20	140,000	7,300	156.8
Hall	8,000	20	160,000	7,300	179.2	8,000	20	160,000	7,300	179.2
Hansford	8,000	20	160,000	7,300	179.2	8,000	20	160,000	7,300	179.2
Hartley	18,000	20	360,000	7,300	403.3	18,000	20	360,000	7,300	403.3
Hemphill	23,000	20	460,000	7,300	515.3	23,000	20	460,000	7,300	515.3
Hutchinson	7,000	20	140,000	7,300	156.8	7,000	20	140,000	7,300	156.8
Lipscomb	18,000	20	360,000	7,300	403.3	18,000	20	360,000	7,300	403.3
Moore	8,000	20	160,000	7,300	179.2	8,000	20	160,000	7,300	179.2
Ochiltree	9,000	20	180,000	7,300	201.6	9,000	20	180,000	7,300	201.6
Oldham	13,000	20	260,000	7,300	291.2	13,000	20	260,000	7,300	291.2
Potter	11,000	20	220,000	7,300	246.4	11,000	20	220,000	7,300	246.4
Randall	13,000	20	260,000	7,300	291.2	13,000	20	260,000	7,300	291.2
Roberts	9,000	20	180,000	7,300	201.6	9,000	20	180,000	7,300	201.6
Sherman	6,000	20	120,000	7,300	134.4	6,000	20	120,000	7,300	134.4
Wheeler	25,000	20	500,000	7,300	560.1	25,000	20	500,000	7,300	560.1
Total	251,000		5,020,000		5,623.2	251,000		5,020,000		5,623.2

Table B-1. Projected Future Livestock Numbers and Water Use – Beef Cows, Range/Pasture Operations (continued).

	2050					2060				
	Beef cows	Water use	Water Use, Beef Cows-------->			Beef cows	Water use	Water Use, Beef Cows-------->		
County	Head	gal/hd/day	gal/day	gal/hd/yr	ac-ft/yr	Head	gal/hd/day	gal/day	gal/hd/yr	ac-ft/yr
Armstrong	15,000	20	300,000	7,300	336.0	15,000	20	120,000	7,300	336.0
Carson	8,000	20	160,000	7,300	179.2	8,000	20	220,000	7,300	179.2
Childress	10,000	20	200,000	7,300	224.0	10,000	20	180,000	7,300	224.0
Collingsworth	10,000	20	200,000	7,300	224.0	10,000	20	300,000	7,300	224.0
Dallam	10,000	20	200,000	7,300	224.0	10,000	20	200,000	7,300	224.0
Donley	15,000	20	300,000	7,300	336.0	15,000	20	420,000	7,300	336.0
Gray	7,000	20	140,000	7,300	156.8	7,000	20	240,000	7,300	156.8
Hall	8,000	20	160,000	7,300	179.2	8,000	20	220,000	7,300	179.2
Hansford	8,000	20	160,000	7,300	179.2	8,000	20	120,000	7,300	179.2
Hartley	18,000	20	360,000	7,300	403.3	18,000	20	200,000	7,300	403.3
Hemphill	23,000	20	460,000	7,300	515.3	23,000	20	360,000	7,300	515.3
Hutchinson	7,000	20	140,000	7,300	156.8	7,000	20	120,000	7,300	156.8
Lipscomb	18,000	20	360,000	7,300	403.3	18,000	20	200,000	7,300	403.3
Moore	8,000	20	160,000	7,300	179.2	8,000	20	120,000	7,300	179.2
Ochiltree	9,000	20	180,000	7,300	201.6	9,000	20	180,000	7,300	201.6
Oldham	13,000	20	260,000	7,300	291.2	13,000	20	240,000	7,300	291.2
Potter	11,000	20	220,000	7,300	246.4	11,000	20	100,000	7,300	246.4
Randall	13,000	20	260,000	7,300	291.2	13,000	20	200,000	7,300	291.2
Roberts	9,000	20	180,000	7,300	201.6	9,000	20	160,000	7,300	201.6
Sherman	6,000	20	120,000	7,300	134.4	6,000	20	140,000	7,300	134.4
Wheeler	25,000	20	500,000	7,300	560.1	25,000	20	700,000	7,300	560.1
Total	251,000		5,020,000		5,623.2	251,000		4,740,000		5,623.2

Table B-2. Projected Future Livestock Numbers and Water Use – Dairy Operations.

	Dairy Cows (Milkers & dry cows + heifers)									2000		
	Dairy: Projected Inventory---->							Dairy	Water use	Water Use, Dairy---------->		
County	2000	2010	2020	2030	2040	2050	2060	Head	gal/hd/day	gal/day	gal/hd/yr	ac-ft/yr
Armstrong	0	0	0	0	0	0	0	0	0	0	0	0.0
Carson	0	0	0	0	0	0	0	0	0	0	0	0.0
Childress	0	0	0	0	0	0	0	0	0	0	0	0.0
Collingsworth	0	0	0	0	0	0	0	0	0	0	0	0.0
Dallam	1,900	5,504	21,029	23,229	25,659	28,344	31,309	1,900	65	123,500	23,725	138.3
Donley	0	0	0	0	0	0	0	0	0	0	0	0.0
Gray	1,600	3,100	3,100	3,424	3,783	4,178	4,615	1,600	65	104,000	23,725	116.5
Hall	0	0	0	0	0	0	0	0	0	0	0	0.0
Hansford	0	0	0	0	0	0	0	0	0	0	0	0.0
Hartley	0	21,936	49,842	55,057	60,817	67,179	74,208	0	0	0	0	0.0
Hemphill	0	0	0	0	0	0	0	0	0	0	0	0.0
Hutchinson	0	865	865	955	1,055	1,166	1,288	0	0	0	0	0.0
Lipscomb	0	3,000	3,000	3,314	3,661	4,044	4,467	0	0	0	0	0.0
Moore	0	8,359	17,809	19,672	21,730	24,004	26,515	0	0	0	0	0.0
Ochiltree	0	0	0	0	0	0	0	0	0	0	0	0.0
Oldham	0	0	0	0	0	0	0	0	0	0	0	0.0
Potter	0	0	0	0	0	0	0	0	0	0	0	0.0
Randall	900	800	800	884	976	1,078	1,191	900	65	58,500	23,725	65.5
Roberts	0	0	0	0	0	0	0	0	0	0	0	0.0
Sherman	0	5,573	12,692	14,020	15,487	17,107	18,897	0	0	0	0	0.0
Wheeler	0	0	0	0	0	0	0	0	0	0	0	0.0
Total	4,400	49,137	109,137	120,555	133,168	147,100	162,490	4,400		286,000		320.4

Note: Assumes expansion in Region A will occur in the four counties in the northwest quadrant.
TCEQ inventory count data used for Sherman, Gray, Hutchinson, Lipscomb, and Randall Counties.
December 2008 Milk Market Administrator records were used to estimate 2010 inventories in Dallam, Hartley, and Moore Counties.
Assumes 75% of the Phase II expansion of Hilmar Cheese Plant (80,000 cows) occurs in the four counties of Region A with the remaining 25% "leakage" to Region O or out-of-state.
Assumes a growth rate of 1.00%/year from 2020 to 2060.
Water use per cow was reduced to 55 gallons per day effective 2010 on recommendations of the dairy advisory committee.

Table B-2. Projected Future Livestock Numbers and Water Use – Dairy Operations (continued).

	2010					2020				
	Dairy	Water use	Water Use, Dairy---------->			Dairy	Water use	Water Use, Dairy---------->		
County	Head	gal/hd/day	gal/day	gal/hd/yr	ac-ft/yr	Head	gal/hd/day	gal/day	gal/hd/yr	ac-ft/yr
Armstrong	0	0	0	0	0.0	0	0	0	0	0.0
Carson	0	0	0	0	0.0	0	0	0	0	0.0
Childress	0	0	0	0	0.0	0	0	0	0	0.0
Collingsworth	0	0	0	0	0.0	0	0	0	0	0.0
Dallam	5,504	55	302,720	20,075	339.1	21,029	55	1,156,595	20,075	1,295.6
Donley	0	0	0	0	0.0	0	0	0	0	0.0
Gray	3,100	55	170,500	20,075	191.0	3,100	55	170,500	20,075	191.0
Hall	0	0	0	0	0.0	0	0	0	0	0.0
Hansford	0	0	0	0	0.0	0	0	0	0	0.0
Hartley	21,936	55	1,206,480	20,075	1,351.4	49,842	55	2,741,310	20,075	3,070.7
Hemphill	0	0	0	0	0.0	0	0	0	0	0.0
Hutchinson	865	55	47,575	20,075	53.3	865	55	47,575	20,075	53.3
Lipscomb	3,000	55	165,000	20,075	184.8	3,000	55	165,000	20,075	184.8
Moore	8,359	55	459,745	20,075	515.0	17,809	55	979,495	20,075	1,097.2
Ochiltree	0	0	0	0	0.0	0	0	0	0	0.0
Oldham	0	0	0	0	0.0	0	0	0	0	0.0
Potter	0	0	0	0	0.0	0	0	0	0	0.0
Randall	800	55	44,000	20,075	49.3	800	55	44,000	20,075	49.3
Roberts	0	0	0	0	0.0	0	0	0	0	0.0
Sherman	5,573	55	306,515	20,075	343.3	12,692	55	698,060	20,075	781.9
Wheeler	0	0	0	0	0.0	0	0	0	0	0.0
Total	49,137		2,702,535		3,027.3	109,137		6,002,535		6,723.8

Table B-2. Projected Future Livestock Numbers and Water Use – Dairy Operations (continued).

	2030					2040				
	Dairy	Water use	Water Use, Dairy---------->			Dairy	Water use	Water Use, Dairy---------->		
County	Head	gal/hd/day	gal/day	gal/hd/yr	ac-ft/yr	Head	gal/hd/day	gal/day	gal/hd/yr	ac-ft/yr
Armstrong	0	0	0	0	0.0	0	0	0	0	0.0
Carson	0	0	0	0	0.0	0	0	0	0	0.0
Childress	0	0	0	0	0.0	0	0	0	0	0.0
Collingsworth	0	0	0	0	0.0	0	0	0	0	0.0
Dallam	23,229	55	1,277,600	20,075	1,431.1	25,659	55	1,411,266	20,075	1,580.8
Donley	0	0	0	0	0.0	0	0	0	0	0.0
Gray	3,424	55	188,338	20,075	211.0	3,783	55	208,042	20,075	233.0
Hall	0	0	0	0	0.0	0	0	0	0	0.0
Hansford	0	0	0	0	0.0	0	0	0	0	0.0
Hartley	55,057	55	3,028,112	20,075	3,392.0	60,817	55	3,344,919	20,075	3,746.8
Hemphill	0	0	0	0	0.0	0	0	0	0	0.0
Hutchinson	955	55	52,552	20,075	58.9	1,055	55	58,051	20,075	65.0
Lipscomb	3,314	55	182,263	20,075	204.2	3,661	55	201,331	20,075	225.5
Moore	19,672	55	1,081,972	20,075	1,212.0	21,730	55	1,195,170	20,075	1,338.8
Ochiltree	0	0	0	0	0.0	0	0	0	0	0.0
Oldham	0	0	0	0	0.0	0	0	0	0	0.0
Potter	0	0	0	0	0.0	0	0	0	0	0.0
Randall	884	55	48,603	20,075	54.4	976	55	53,688	20,075	60.1
Roberts	0	0	0	0	0.0	0	0	0	0	0.0
Sherman	14,020	55	771,093	20,075	863.7	15,487	55	851,766	20,075	954.1
Wheeler	0	0	0	0	0.0	0	0	0	0	0.0
Total	120,555		6,630,533		7,427.2	133,168		7,324,233		8,204.3

Table B-2. Projected Future Livestock Numbers and Water Use – Dairy Operations (continued).

	2050					2060				
	Dairy	Water use	Water Use, Dairy---------->			Dairy	Water use	Water Use, Dairy---------->		
County	Head	gal/hd/day	gal/day	gal/hd/yr	ac-ft/yr	Head	gal/hd/day	gal/day	gal/hd/yr	ac-ft/yr
Armstrong	0	0	0	0	0.0	0	0	0	0	0.0
Carson	0	0	0	0	0.0	0	0	0	0	0.0
Childress	0	0	0	0	0.0	0	0	0	0	0.0
Collingsworth	0	0	0	0	0.0	0	0	0	0	0.0
Dallam	28,344	55	1,558,915	20,075	1,746.2	31,309	55	1,722,012	20,075	1,928.9
Donley	0	0	0	0	0.0	0	0	0	0	0.0
Gray	4,178	55	229,808	20,075	257.4	4,615	55	253,851	20,075	284.4
Hall	0	0	0	0	0.0	0	0	0	0	0.0
Hansford	0	0	0	0	0.0	0	0	0	0	0.0
Hartley	67,179	55	3,694,872	20,075	4,138.8	74,208	55	4,081,437	20,075	4,571.8
Hemphill	0	0	0	0	0.0	0	0	0	0	0.0
Hutchinson	1,166	55	64,124	20,075	71.8	1,288	55	70,833	20,075	79.3
Lipscomb	4,044	55	222,395	20,075	249.1	4,467	55	245,663	20,075	275.2
Moore	24,004	55	1,320,211	20,075	1,478.8	26,515	55	1,458,335	20,075	1,633.6
Ochiltree	0	0	0	0	0.0	0	0	0	0	0.0
Oldham	0	0	0	0	0.0	0	0	0	0	0.0
Potter	0	0	0	0	0.0	0	0	0	0	0.0
Randall	1,078	55	59,305	20,075	66.4	1,191	55	65,510	20,075	73.4
Roberts	0	0	0	0	0.0	0	0	0	0	0.0
Sherman	17,107	55	940,879	20,075	1,053.9	18,897	55	1,039,316	20,075	1,164.2
Wheeler	0	0	0	0	0.0	0	0	0	0	0.0
Total	147,100		8,090,510		9,062.6	162,490		8,936,957		10,010.8

Table B-3. Projected Future Livestock Numbers and Water Use – Beef Cattle Feedlots.

	Beef Feedlots:Projected Inventory---->							2000 Feedlots	Water Use	Water Use, beef feedlots		
County	2000	2010	2020	2030	2040	2050	2060	Inventory	gal/hd/day	gal/day	gal/hd/yr	ac-ft/yr
Armstrong	5,722	4,250	4,250	4,250	4,250	4,250	4,250	5,722	15.0	85,833.0	5,475	96.1
Carson	12,572	12,750	12,750	12,750	12,750	12,750	12,750	12,572	15.0	188,572.5	5,475	211.2
Childress	0	0	0	0	0	0	0	0	0.0	0.0	0	0.0
Collingsworth	0	0	0	0	0	0	0	0	0.0	0.0	0	0.0
Dallam	132,651	132,600	145,860	160,446	176,491	194,140	213,554	132,651	15.0	1,989,765.0	5,475	2,228.8
Donley	26,010	52,700	52,700	52,700	52,700	52,700	52,700	26,010	15.0	390,150.0	5,475	437.0
Gray	60,690	43,350	43,350	43,350	43,350	43,350	43,350	60,690	15.0	910,350.0	5,475	1,019.7
Hall	0	0	0	0	0	0	0	0	0.0	0.0	0	0.0
Hansford	174,267	190,315	209,347	230,281	253,309	278,640	306,504	174,267	15.0	2,614,005.0	5,475	2,928.1
Hartley	170,799	197,200	216,920	238,612	262,473	288,721	317,593	170,799	15.0	2,561,985.0	5,475	2,869.8
Hemphill	44,217	42,500	42,500	42,500	42,500	42,500	42,500	44,217	15.0	663,255.0	5,475	742.9
Hutchinson	12,572	12,325	12,325	12,325	12,325	12,325	12,325	12,572	15.0	188,572.5	5,475	211.2
Lipscomb	694	12,750	12,750	12,750	12,750	12,750	12,750	694	15.0	10,404.0	5,475	11.7
Moore	123,201	134,300	147,730	162,503	178,753	196,629	216,291	123,201	15.0	1,848,010.5	5,475	2,070.1
Ochiltree	92,769	87,549	96,304	105,934	116,528	128,180	140,999	92,769	15.0	1,391,535.0	5,475	1,558.7
Oldham	42,483	39,950	39,950	39,950	39,950	39,950	39,950	42,483	15.0	637,245.0	5,475	713.8
Potter	2,254	5,950	5,950	5,950	5,950	5,950	5,950	2,254	15.0	33,813.0	5,475	37.9
Randall	117,045	142,800	142,800	142,800	142,800	142,800	142,800	117,045	15.0	1,755,675.0	5,475	1,966.6
Roberts	0	0	0	0	0	0	0	0	0.0	0.0	0	0.0
Sherman	127,883	146,200	160,820	176,902	194,592	214,051	235,457	127,883	15.0	1,918,237.5	5,475	2,148.7
Wheeler	36,414	55,250	55,250	55,250	55,250	55,250	55,250	36,414	15.0	546,210.0	5,475	611.8
Total	1,182,241	1,312,739	1,401,555	1,499,253	1,606,721	1,724,936	1,854,972	1,182,241		17,733,618.0		19,864.4

Note: County level inventory estimates made in early 2009 by TCFA were assumed to equal 2010 inventories.
Six counties include growth projections at a rate of 10% per decade from 2010 to 2060 including: Dallam, Hansford, Hartley, Moore, Ochiltree, and Sherman.
No growth was projected for the remaining counties from 2010-2060.
Water use per head was reduced from 15.0 gallon/hd/day to 12.5 gallons/hd/day starting in 2010 based on the advisory committee recommendations.

Table B-3. Projected Future Livestock Numbers and Water Use – Beef Cattle Feedlots (continued).

County	2010 Feedlots Inventory	2010 Water Use gal/hd/day	2010 Water Use, beef feedlots gal/day	2010 Water Use, beef feedlots gal/hd/yr	2010 Water Use, beef feedlots ac-ft/yr	2020 Feedlots Inventory	2020 Water Use gal/hd/day	2020 Water Use, beef feedlots gal/day	2020 Water Use, beef feedlots gal/hd/yr	2020 Water Use, beef feedlots ac-ft/yr
Armstrong	4,250	12.5	53,125.0	4,563	59.5	4,250	12.5	53,125.0	4,563	59.5
Carson	12,750	12.5	159,375.0	4,563	178.5	12,750	12.5	159,375.0	4,563	178.5
Childress	0	0.0	0.0	0	0.0	0	0.0	0.0	0	0.0
Collingsworth	0	0.0	0.0	0	0.0	0	0.0	0.0	0	0.0
Dallam	132,600	12.5	1,657,500.0	4,563	1,856.7	145,860	12.5	1,823,250.0	4,563	2,042.3
Donley	52,700	12.5	658,750.0	4,563	737.9	52,700	12.5	658,750.0	4,563	737.9
Gray	43,350	12.5	541,875.0	4,563	607.0	43,350	12.5	541,875.0	4,563	607.0
Hall	0	0.0	0.0	0	0.0	0	0.0	0.0	0	0.0
Hansford	190,315	12.5	2,378,937.5	4,563	2,664.8	209,347	12.5	2,616,831.3	4,563	2,931.3
Hartley	197,200	12.5	2,465,000.0	4,563	2,761.2	216,920	12.5	2,711,500.0	4,563	3,037.3
Hemphill	42,500	12.5	531,250.0	4,563	595.1	42,500	12.5	531,250.0	4,563	595.1
Hutchinson	12,325	12.5	154,062.5	4,563	172.6	12,325	12.5	154,062.5	4,563	172.6
Lipscomb	12,750	12.5	159,375.0	4,563	178.5	12,750	12.5	159,375.0	4,563	178.5
Moore	134,300	12.5	1,678,750.0	4,563	1,880.5	147,730	12.5	1,846,625.0	4,563	2,068.5
Ochiltree	87,549	12.5	1,094,362.5	4,563	1,225.9	96,304	12.5	1,203,798.8	4,563	1,348.4
Oldham	39,950	12.5	499,375.0	4,563	559.4	39,950	12.5	499,375.0	4,563	559.4
Potter	5,950	12.5	74,375.0	4,563	83.3	5,950	12.5	74,375.0	4,563	83.3
Randall	142,800	12.5	1,785,000.0	4,563	1,999.5	142,800	12.5	1,785,000.0	4,563	1,999.5
Roberts	0	0.0	0.0	0	0.0	0	0.0	0.0	0	0.0
Sherman	146,200	12.5	1,827,500.0	4,563	2,047.1	160,820	12.5	2,010,250.0	4,563	2,251.8
Wheeler	55,250	12.5	690,625.0	4,563	773.6	55,250	12.5	690,625.0	4,563	773.6
Total	1,312,739		16,409,237.5		18,380.9	1,401,555		17,519,442.5		19,624.5

Table B-3. Projected Future Livestock Numbers and Water Use – Beef Cattle Feedlots (continued).

County	2030 Feedlots Inventory	2030 Water Use gal/hd/day	2030 Water Use, beef feedlots gal/day	2030 Water Use, beef feedlots gal/hd/yr	2030 Water Use, beef feedlots ac-ft/yr	2040 Feedlots Inventory	2040 Water Use gal/hd/day	2040 Water Use, beef feedlots gal/day	2040 Water Use, beef feedlots gal/hd/yr	2040 Water Use, beef feedlots ac-ft/yr
Armstrong	4,250	12.5	53,125.0	4,563	59.5	4,250	12.5	53,125.0	4,563	59.5
Carson	12,750	12.5	159,375.0	4,563	178.5	12,750	12.5	159,375.0	4,563	178.5
Childress	0	0.0	0.0	0	0.0	0	0.0	0.0	0	0.0
Collingsworth	0	0.0	0.0	0	0.0	0	0.0	0.0	0	0.0
Dallam	160,446	12.5	2,005,575.0	4,563	2,246.6	176,491	12.5	2,206,132.5	4,563	2,471.2
Donley	52,700	12.5	658,750.0	4,563	737.9	52,700	12.5	658,750.0	4,563	737.9
Gray	43,350	12.5	541,875.0	4,563	607.0	43,350	12.5	541,875.0	4,563	607.0
Hall	0	0.0	0.0	0	0.0	0	0.0	0.0	0	0.0
Hansford	230,281	12.5	2,878,514.4	4,563	3,224.4	253,309	12.5	3,166,365.8	4,563	3,546.8
Hartley	238,612	12.5	2,982,650.0	4,563	3,341.0	262,473	12.5	3,280,915.0	4,563	3,675.1
Hemphill	42,500	12.5	531,250.0	4,563	595.1	42,500	12.5	531,250.0	4,563	595.1
Hutchinson	12,325	12.5	154,062.5	4,563	172.6	12,325	12.5	154,062.5	4,563	172.6
Lipscomb	12,750	12.5	159,375.0	4,563	178.5	12,750	12.5	159,375.0	4,563	178.5
Moore	162,503	12.5	2,031,287.5	4,563	2,275.4	178,753	12.5	2,234,416.3	4,563	2,502.9
Ochiltree	105,934	12.5	1,324,178.6	4,563	1,483.3	116,528	12.5	1,456,596.5	4,563	1,631.6
Oldham	39,950	12.5	499,375.0	4,563	559.4	39,950	12.5	499,375.0	4,563	559.4
Potter	5,950	12.5	74,375.0	4,563	83.3	5,950	12.5	74,375.0	4,563	83.3
Randall	142,800	12.5	1,785,000.0	4,563	1,999.5	142,800	12.5	1,785,000.0	4,563	1,999.5
Roberts	0	0.0	0.0	0	0.0	0	0.0	0.0	0	0.0
Sherman	176,902	12.5	2,211,275.0	4,563	2,477.0	194,592	12.5	2,432,402.5	4,563	2,724.7
Wheeler	55,250	12.5	690,625.0	4,563	773.6	55,250	12.5	690,625.0	4,563	773.6
Total	1,499,253		18,740,668.0		20,992.4	1,606,721		20,084,016.1		22,497.2

Table B-3. Projected Future Livestock Numbers and Water Use – Beef Cattle Feedlots (continued).

	2050					2060				
	Feedlots	Water Use	Water Use, beef feedlots			Feedlots	Water Use	Water Use, beef feedlots		
County	Inventory	gal/hd/day	gal/day	gal/hd/yr	ac-ft/yr	Inventory	gal/hd/day	gal/day	gal/hd/yr	ac-ft/yr
Armstrong	4,250	12.5	53,125.0	4,563	59.5	4,250	12.5	53,125.0	4,563	59.5
Carson	12,750	12.5	159,375.0	4,563	178.5	12,750	12.5	159,375.0	4,563	178.5
Childress	0	0.0	0.0	0	0.0	0	0.0	0.0	0	0.0
Collingsworth	0	0.0	0.0	0	0.0	0	0.0	0.0	0	0.0
Dallam	194,140	12.5	2,426,745.8	4,563	2,718.3	213,554	12.5	2,669,420.3	4,563	2,990.2
Donley	52,700	12.5	658,750.0	4,563	737.9	52,700	12.5	658,750.0	4,563	737.9
Gray	43,350	12.5	541,875.0	4,563	607.0	43,350	12.5	541,875.0	4,563	607.0
Hall	0	0.0	0.0	0	0.0	0	0.0	0.0	0	0.0
Hansford	278,640	12.5	3,483,002.4	4,563	3,901.5	306,504	12.5	3,831,302.6	4,563	4,291.6
Hartley	288,721	12.5	3,609,006.5	4,563	4,042.6	317,593	12.5	3,969,907.2	4,563	4,446.9
Hemphill	42,500	12.5	531,250.0	4,563	595.1	42,500	12.5	531,250.0	4,563	595.1
Hutchinson	12,325	12.5	154,062.5	4,563	172.6	12,325	12.5	154,062.5	4,563	172.6
Lipscomb	12,750	12.5	159,375.0	4,563	178.5	12,750	12.5	159,375.0	4,563	178.5
Moore	196,629	12.5	2,457,857.9	4,563	2,753.2	216,291	12.5	2,703,643.7	4,563	3,028.5
Ochiltree	128,180	12.5	1,602,256.1	4,563	1,794.8	140,999	12.5	1,762,481.7	4,563	1,974.3
Oldham	39,950	12.5	499,375.0	4,563	559.4	39,950	12.5	499,375.0	4,563	559.4
Potter	5,950	12.5	74,375.0	4,563	83.3	5,950	12.5	74,375.0	4,563	83.3
Randall	142,800	12.5	1,785,000.0	4,563	1,999.5	142,800	12.5	1,785,000.0	4,563	1,999.5
Roberts	0	0.0	0.0	0	0.0	0	0.0	0.0	0	0.0
Sherman	214,051	12.5	2,675,642.8	4,563	2,997.1	235,457	12.5	2,943,207.0	4,563	3,296.8
Wheeler	55,250	12.5	690,625.0	4,563	773.6	55,250	12.5	690,625.0	4,563	773.6
Total	1,724,936		21,561,698.9		24,152.4	1,854,972		23,187,150.0		25,973.2

Table B-4. Projected Future Livestock Numbers and Water Use – Equine Operations.

County	Equine: Projected Inventory--->							2000				
								Equine	Water use	Water Use, Equine--->		
	2000	2010	2020	2030	2040	2050	2060	Head	gal/hd/day	gal/day	gal/hd/yr	ac-ft/yr
Armstrong	769	688	760	839	927	1,024	1,132	769	12	9,231.4	4,380	10.3
Carson	483	559	617	682	753	832	919	483	12	5,795.8	4,380	6.5
Childress	697	361	399	440	487	537	594	697	12	8,365.1	4,380	9.4
Collingsworth	1,738	492	543	600	663	733	809	1,738	12	20,852.9	4,380	23.4
Dallam	1,110	555	613	677	748	826	913	1,110	12	13,324.3	4,380	14.9
Donley	1,845	655	724	799	883	975	1,077	1,845	12	22,137.5	4,380	24.8
Gray	1,648	742	820	905	1,000	1,105	1,220	1,648	12	19,777.4	4,380	22.2
Hall	326	312	345	381	421	465	513	326	12	3,913.7	4,380	4.4
Hansford	1,387	747	825	911	1,007	1,112	1,229	1,387	12	16,640.5	4,380	18.6
Hartley	1,056	394	435	481	531	587	648	1,056	12	12,667.1	4,380	14.2
Hemphill	1,646	2,601	2,873	3,174	3,506	3,873	4,278	1,646	12	19,747.5	4,380	22.1
Hutchinson	1,155	1,064	1,175	1,298	1,434	1,584	1,750	1,155	12	13,862.1	4,380	15.5
Lipscomb	742	506	559	617	682	753	832	742	12	8,902.8	4,380	10.0
Moore	685	448	495	547	604	667	737	685	12	8,215.7	4,380	9.2
Ochiltree	963	630	696	769	849	938	1,036	963	12	11,561.7	4,380	13.0
Oldham	1,168	557	615	680	751	829	916	1,168	12	14,011.5	4,380	15.7
Potter	1,080	813	898	992	1,096	1,210	1,337	1,080	12	12,965.8	4,380	14.5
Randall	3,286	2,624	2,899	3,202	3,537	3,907	4,316	3,286	12	39,435.3	4,380	44.2
Roberts	702	257	284	314	346	383	423	702	12	8,424.8	4,380	9.4
Sherman	588	522	577	637	704	777	858	588	12	7,050.5	4,380	7.9
Wheeler	1,733	508	561	620	685	756	835	1,733	12	20,793.1	4,380	23.3
Total	24,806	16,035	17,713	19,566	21,613	23,874	26,372	24,806		297,676.5		333.4

Notes: Assumes growth of 1.00% / year from 2010-2060.
Source: 2000 equine inventory obtained from Texas Agricultural Statistics Service for Senate Bill 2.
For Senate Bill 3, the equine inventory was obtained from the *2007 Census of Agriculture* and utilized for the future 2010 estimates.
Source: Water consumed by equine was validated of Dr. John Pipkin (WTAMU), Dr. Lance Baker (WTAMU), & Dr. Pete Gibbs (TAMU).

Table B-4. Projected Future Livestock Numbers and Water Use – Equine Operations (continued).

	2010					2020				
	Equine	Water use	Water Use, Equine--->			Equine	Water use	Water Use, Equine--->		
County	Head	gal/hd/day	gal/day	gal/hd/yr	ac-ft/yr	Head	gal/hd/day	gal/day	gal/hd/yr	ac-ft/yr
Armstrong	688	12	8,256.0	4,380	9.2	760	12	9,119.8	4,380	10.2
Carson	559	12	6,708.0	4,380	7.5	617	12	7,409.8	4,380	8.3
Childress	361	12	4,332.0	4,380	4.9	399	12	4,785.2	4,380	5.4
Collingsworth	492	12	5,904.0	4,380	6.6	543	12	6,521.7	4,380	7.3
Dallam	555	12	6,660.0	4,380	7.5	613	12	7,356.8	4,380	8.2
Donley	655	12	7,860.0	4,380	8.8	724	12	8,682.3	4,380	9.7
Gray	742	12	8,904.0	4,380	10.0	820	12	9,835.6	4,380	11.0
Hall	312	12	3,744.0	4,380	4.2	345	12	4,135.7	4,380	4.6
Hansford	747	12	8,964.0	4,380	10.0	825	12	9,901.8	4,380	11.1
Hartley	394	12	4,728.0	4,380	5.3	435	12	5,222.7	4,380	5.9
Hemphill	2,601	12	31,212.0	4,380	35.0	2,873	12	34,477.5	4,380	38.6
Hutchinson	1,064	12	12,768.0	4,380	14.3	1,175	12	14,103.8	4,380	15.8
Lipscomb	506	12	6,072.0	4,380	6.8	559	12	6,707.3	4,380	7.5
Moore	448	12	5,376.0	4,380	6.0	495	12	5,938.4	4,380	6.7
Ochiltree	630	12	7,560.0	4,380	8.5	696	12	8,350.9	4,380	9.4
Oldham	557	12	6,684.0	4,380	7.5	615	12	7,383.3	4,380	8.3
Potter	813	12	9,756.0	4,380	10.9	898	12	10,776.7	4,380	12.1
Randall	2,624	12	31,488.0	4,380	35.3	2,899	12	34,782.3	4,380	39.0
Roberts	257	12	3,084.0	4,380	3.5	284	12	3,406.7	4,380	3.8
Sherman	522	12	6,264.0	4,380	7.0	577	12	6,919.4	4,380	7.8
Wheeler	508	12	6,096.0	4,380	6.8	561	12	6,733.8	4,380	7.5
Total	16,035		192,420.0		215.5	17,713		212,551.4		238.1

Table B-4. Projected Future Livestock Numbers and Water Use – Equine Operations (continued).

	2030					2040				
	Equine	Water use	Water Use, Equine--->			Equine	Water use	Water Use, Equine--->		
County	Head	gal/hd/day	gal/day	gal/hd/yr	ac-ft/yr	Head	gal/hd/day	gal/day	gal/hd/yr	ac-ft/yr
Armstrong	839	12	10,073.9	4,380	11.3	927	12	338,471.8	4,380	12.5
Carson	682	12	8,185.0	4,380	9.2	753	12	275,008.4	4,380	10.1
Childress	440	12	5,285.9	4,380	5.9	487	12	177,599.3	4,380	6.5
Collingsworth	600	12	7,204.0	4,380	8.1	663	12	242,046.7	4,380	8.9
Dallam	677	12	8,126.5	4,380	9.1	748	12	273,040.5	4,380	10.1
Donley	799	12	9,590.7	4,380	10.7	883	12	322,237.0	4,380	11.9
Gray	905	12	10,864.6	4,380	12.2	1,000	12	365,037.9	4,380	13.4
Hall	381	12	4,568.4	4,380	5.1	421	12	153,493.0	4,380	5.7
Hansford	911	12	10,937.8	4,380	12.3	1,007	12	367,497.7	4,380	13.5
Hartley	481	12	5,769.1	4,380	6.5	531	12	193,834.2	4,380	7.1
Hemphill	3,174	12	38,084.6	4,380	42.7	3,506	12	1,279,600.6	4,380	47.1
Hutchinson	1,298	12	15,579.4	4,380	17.5	1,434	12	523,450.6	4,380	19.3
Lipscomb	617	12	7,409.0	4,380	8.3	682	12	248,934.2	4,380	9.2
Moore	547	12	6,559.7	4,380	7.3	604	12	220,400.3	4,380	8.1
Ochiltree	769	12	9,224.6	4,380	10.3	849	12	309,937.9	4,380	11.4
Oldham	680	12	8,155.8	4,380	9.1	751	12	274,024.4	4,380	10.1
Potter	992	12	11,904.2	4,380	13.3	1,096	12	399,967.4	4,380	14.7
Randall	3,202	12	38,421.3	4,380	43.0	3,537	12	1,290,915.8	4,380	47.5
Roberts	314	12	3,763.1	4,380	4.2	346	12	126,435.0	4,380	4.7
Sherman	637	12	7,643.3	4,380	8.6	704	12	256,805.7	4,380	9.5
Wheeler	620	12	7,438.3	4,380	8.3	685	12	249,918.1	4,380	9.2
Total	19,566		234,789.0		263.0	21,613		7,888,656.4		290.5

Table B-4. Projected Future Livestock Numbers and Water Use – Equine Operations (continued).

	2050					2060				
	Equine	Water use	Water Use, Equine--->			Equine	Water use	Water Use, Equine--->		
County	Head	gal/hd/day	gal/day	gal/hd/yr	ac-ft/yr	Head	gal/hd/day	gal/day	gal/hd/yr	ac-ft/yr
Armstrong	1,024	12	12,292.1	4,380	13.8	1,132	12	13,578.1	4,380	15.2
Carson	832	12	9,987.3	4,380	11.2	919	12	11,032.2	4,380	12.4
Childress	537	12	6,449.8	4,380	7.2	594	12	7,124.5	4,380	8.0
Collingsworth	733	12	8,790.3	4,380	9.8	809	12	9,709.9	4,380	10.9
Dallam	826	12	9,915.8	4,380	11.1	913	12	10,953.2	4,380	12.3
Donley	975	12	11,702.5	4,380	13.1	1,077	12	12,926.8	4,380	14.5
Gray	1,105	12	13,256.8	4,380	14.8	1,220	12	14,643.8	4,380	16.4
Hall	465	12	5,574.3	4,380	6.2	513	12	6,157.5	4,380	6.9
Hansford	1,112	12	13,346.2	4,380	14.9	1,229	12	14,742.5	4,380	16.5
Hartley	587	12	7,039.3	4,380	7.9	648	12	7,775.8	4,380	8.7
Hemphill	3,873	12	46,470.4	4,380	52.1	4,278	12	51,332.2	4,380	57.5
Hutchinson	1,584	12	19,009.8	4,380	21.3	1,750	12	20,998.7	4,380	23.5
Lipscomb	753	12	9,040.4	4,380	10.1	832	12	9,986.2	4,380	11.2
Moore	667	12	8,004.1	4,380	9.0	737	12	8,841.5	4,380	9.9
Ochiltree	938	12	11,255.8	4,380	12.6	1,036	12	12,433.4	4,380	13.9
Oldham	829	12	9,951.6	4,380	11.1	916	12	10,992.7	4,380	12.3
Potter	1,210	12	14,525.4	4,380	16.3	1,337	12	16,045.0	4,380	18.0
Randall	3,907	12	46,881.3	4,380	52.5	4,316	12	51,786.2	4,380	58.0
Roberts	383	12	4,591.7	4,380	5.1	423	12	5,072.0	4,380	5.7
Sherman	777	12	9,326.2	4,380	10.4	858	12	10,302.0	4,380	11.5
Wheeler	756	12	9,076.1	4,380	10.2	835	12	10,025.7	4,380	11.2
Total	23,874		286,487.2		320.9	26,372		316,460.1		354.5

Table B-5. Projected Future Livestock Numbers and Water Use – Poultry, Laying Hens or Broilers.

County	Poultry: Projected Inventory---->							2000				
								Poultry	Water use	Water Use, Poultry---->		
	2000	2010	2020	2030	2040	2050	2060	Head	gal/hd/day	gal/day	gal/hd/yr	ac-ft/yr
Armstrong	1,000	1,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000	0.09	90.0	32.85	0.1
Carson	1,000	1,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000	0.09	90.0	32.85	0.1
Childress	1,000	1,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000	0.09	90.0	32.85	0.1
Collingsworth	1,000	1,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000	0.09	90.0	32.85	0.1
Dallam	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	0.09	90.0	32.85	0.1
Donley	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	0.09	90.0	32.85	0.1
Gray	1,000	1,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000	0.09	90.0	32.85	0.1
Hall	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	0.09	90.0	32.85	0.1
Hansford	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	0.09	90.0	32.85	0.1
Hartley	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	0.09	90.0	32.85	0.1
Hemphill	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	0.09	90.0	32.85	0.1
Hutchinson	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	0.09	90.0	32.85	0.1
Lipscomb	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	0.09	90.0	32.85	0.1
Moore	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	0.09	90.0	32.85	0.1
Ochiltree	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	0.09	90.0	32.85	0.1
Oldham	1,000	1,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000	0.09	90.0	32.85	0.1
Potter	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	0.09	90.0	32.85	0.1
Randall	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	0.09	90.0	32.85	0.1
Roberts	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	0.09	90.0	32.85	0.1
Sherman	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	0.09	90.0	32.85	0.1
Wheeler	1,000	1,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000	0.09	90.0	32.85	0.1
Total	21,000	21,000	7,014,000	7,014,000	7,014,000	7,014,000	7,014,000	21,000		1,890.0		2.1

Note: Assumed growth in counties on the eastern side of the Panhandle, closest to urban markets or close to I-40 for transportation purposes.

Table B-5. Projected Future Livestock Numbers and Water Use – Poultry, Laying Hens or Broilers (continued).

	2010					2020				
	Poultry	Water use	Water Use, Poultry---->			Poultry	Water use	Water Use, Poultry---->		
County	Head	gal/hd/day	gal/day	gal/hd/yr	ac-ft/yr	Head	gal/hd/day	gal/day	gal/hd/yr	ac-ft/yr
Armstrong	1,000	0.09	90.0	32.85	0.1	1,000,000	0.09	90,000.0	32.85	100.8
Carson	1,000	0.09	90.0	32.85	0.1	1,000,000	0.09	90,000.0	32.85	100.8
Childress	1,000	0.09	90.0	32.85	0.1	1,000,000	0.09	90,000.0	32.85	100.8
Collingsworth	1,000	0.09	90.0	32.85	0.1	1,000,000	0.09	90,000.0	32.85	100.8
Dallam	1,000	0.09	90.0	32.85	0.1	1,000	0.09	90.0	32.85	0.1
Donley	1,000	0.09	90.0	32.85	0.1	1,000	0.09	90.0	32.85	0.1
Gray	1,000	0.09	90.0	32.85	0.1	1,000,000	0.09	90,000.0	32.85	100.8
Hall	1,000	0.09	90.0	32.85	0.1	1,000	0.09	90.0	32.85	0.1
Hansford	1,000	0.09	90.0	32.85	0.1	1,000	0.09	90.0	32.85	0.1
Hartley	1,000	0.09	90.0	32.85	0.1	1,000	0.09	90.0	32.85	0.1
Hemphill	1,000	0.09	90.0	32.85	0.1	1,000	0.09	90.0	32.85	0.1
Hutchinson	1,000	0.09	90.0	32.85	0.1	1,000	0.09	90.0	32.85	0.1
Lipscomb	1,000	0.09	90.0	32.85	0.1	1,000	0.09	90.0	32.85	0.1
Moore	1,000	0.09	90.0	32.85	0.1	1,000	0.09	90.0	32.85	0.1
Ochiltree	1,000	0.09	90.0	32.85	0.1	1,000	0.09	90.0	32.85	0.1
Oldham	1,000	0.09	90.0	32.85	0.1	1,000,000	0.09	90,000.0	32.85	100.8
Potter	1,000	0.09	90.0	32.85	0.1	1,000	0.09	90.0	32.85	0.1
Randall	1,000	0.09	90.0	32.85	0.1	1,000	0.09	90.0	32.85	0.1
Roberts	1,000	0.09	90.0	32.85	0.1	1,000	0.09	90.0	32.85	0.1
Sherman	1,000	0.09	90.0	32.85	0.1	1,000	0.09	90.0	32.85	0.1
Wheeler	1,000	0.09	90.0	32.85	0.1	1,000,000	0.09	90,000.0	32.85	100.8
					0.0					
Total	21,000		1,890.0		2.1	7,014,000		631,260.0		707.1

Table B-5. Projected Future Livestock Numbers and Water Use – Poultry, Laying Hens or Broilers (continued).

	2030					2040				
	Poultry	Water use	Water Use, Poultry---->			Poultry	Water use	Water Use, Poultry---->		
County	Head	gal/hd/day	gal/day	gal/hd/yr	ac-ft/yr	Head	gal/hd/day	gal/day	gal/hd/yr	ac-ft/yr
Armstrong	1,000,000	0.09	90,000.0	32.85	100.8	1,000,000	0.09	90,000.0	32.85	100.8
Carson	1,000,000	0.09	90,000.0	32.85	100.8	1,000,000	0.09	90,000.0	32.85	100.8
Childress	1,000,000	0.09	90,000.0	32.85	100.8	1,000,000	0.09	90,000.0	32.85	100.8
Collingsworth	1,000,000	0.09	90,000.0	32.85	100.8	1,000,000	0.09	90,000.0	32.85	100.8
Dallam	1,000	0.09	90.0	32.85	0.1	1,000	0.09	90.0	32.85	0.1
Donley	1,000	0.09	90.0	32.85	0.1	1,000	0.09	90.0	32.85	0.1
Gray	1,000,000	0.09	90,000.0	32.85	100.8	1,000,000	0.09	90,000.0	32.85	100.8
Hall	1,000	0.09	90.0	32.85	0.1	1,000	0.09	90.0	32.85	0.1
Hansford	1,000	0.09	90.0	32.85	0.1	1,000	0.09	90.0	32.85	0.1
Hartley	1,000	0.09	90.0	32.85	0.1	1,000	0.09	90.0	32.85	0.1
Hemphill	1,000	0.09	90.0	32.85	0.1	1,000	0.09	90.0	32.85	0.1
Hutchinson	1,000	0.09	90.0	32.85	0.1	1,000	0.09	90.0	32.85	0.1
Lipscomb	1,000	0.09	90.0	32.85	0.1	1,000	0.09	90.0	32.85	0.1
Moore	1,000	0.09	90.0	32.85	0.1	1,000	0.09	90.0	32.85	0.1
Ochiltree	1,000	0.09	90.0	32.85	0.1	1,000	0.09	90.0	32.85	0.1
Oldham	1,000,000	0.09	90,000.0	32.85	100.8	1,000,000	0.09	90,000.0	32.85	100.8
Potter	1,000	0.09	90.0	32.85	0.1	1,000	0.09	90.0	32.85	0.1
Randall	1,000	0.09	90.0	32.85	0.1	1,000	0.09	90.0	32.85	0.1
Roberts	1,000	0.09	90.0	32.85	0.1	1,000	0.09	90.0	32.85	0.1
Sherman	1,000	0.09	90.0	32.85	0.1	1,000	0.09	90.0	32.85	0.1
Wheeler	1,000,000	0.09	90,000.0	32.85	100.8	1,000,000	0.09	90,000.0	32.85	100.8
Total	7,014,000		631,260.0		707.1	7,014,000		631,260.0		707.1

Table B-5. Projected Future Livestock Numbers and Water Use – Poultry, Laying Hens or Broilers (continued).

	2050					2060				
	Poultry	Water use	Water Use, Poultry---->			Poultry	Water use	Water Use, Poultry---->		
County	Head	gal/hd/day	gal/day	gal/hd/yr	ac-ft/yr	Head	gal/hd/day	gal/day	gal/hd/yr	ac-ft/yr
Armstrong	1,000,000	0.09	90,000.0	32.85	100.8	1,000,000	0.09	90,000.0	32.85	100.8
Carson	1,000,000	0.09	90,000.0	32.85	100.8	1,000,000	0.09	90,000.0	32.85	100.8
Childress	1,000,000	0.09	90,000.0	32.85	100.8	1,000,000	0.09	90,000.0	32.85	100.8
Collingsworth	1,000,000	0.09	90,000.0	32.85	100.8	1,000,000	0.09	90,000.0	32.85	100.8
Dallam	1,000	0.09	90.0	32.85	0.1	1,000	0.09	90.0	32.85	0.1
Donley	1,000	0.09	90.0	32.85	0.1	1,000	0.09	90.0	32.85	0.1
Gray	1,000,000	0.09	90,000.0	32.85	100.8	1,000,000	0.09	90,000.0	32.85	100.8
Hall	1,000	0.09	90.0	32.85	0.1	1,000	0.09	90.0	32.85	0.1
Hansford	1,000	0.09	90.0	32.85	0.1	1,000	0.09	90.0	32.85	0.1
Hartley	1,000	0.09	90.0	32.85	0.1	1,000	0.09	90.0	32.85	0.1
Hemphill	1,000	0.09	90.0	32.85	0.1	1,000	0.09	90.0	32.85	0.1
Hutchinson	1,000	0.09	90.0	32.85	0.1	1,000	0.09	90.0	32.85	0.1
Lipscomb	1,000	0.09	90.0	32.85	0.1	1,000	0.00	0.0	0.00	0.0
Moore	1,000	0.09	90.0	32.85	0.1	1,000	0.09	90.0	32.85	0.1
Ochiltree	1,000	0.09	90.0	32.85	0.1	1,000	0.09	90.0	32.85	0.1
Oldham	1,000,000	0.09	90,000.0	32.85	100.8	1,000,000	0.09	90,000.0	32.85	100.8
Potter	1,000	0.09	90.0	32.85	0.1	1,000	0.09	90.0	32.85	0.1
Randall	1,000	0.09	90.0	32.85	0.1	1,000	0.09	90.0	32.85	0.1
Roberts	1,000	0.09	90.0	32.85	0.1	1,000	0.09	90.0	32.85	0.1
Sherman	1,000	0.09	90.0	32.85	0.1	1,000	0.09	90.0	32.85	0.1
Wheeler	1,000,000	0.09	90,000.0	32.85	100.8	1,000,000	0.09	90,000.0	32.85	100.8
Total	7,014,000		631,260.0		707.1	7,014,000		631,170.0		707.0

Table B-6. Projected Future Livestock Numbers and Water Use – Stocker Beef Cattle, Winter Pasture Operations (5 mo/yr).

	Stocker Cattle -- Winter Pasture -- Projected Inventory---->							Stockers	Water use	2000 Water Use, Stocker Cattle--->		
County	**2000**	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**Head**	**gal/hd/day**	**gal/day**	**gal/hd/yr**	**ac-ft/yr**
Armstrong	15,420	24,914	25,544	26,189	26,851	27,530	28,226	15,420	12	185,040.0	1,825	86.4
Carson	46,445	35,013	35,898	36,806	37,737	38,691	39,669	46,445	12	557,340.0	1,825	260.1
Childress	11,357	10,788	11,061	11,340	11,627	11,921	12,222	11,357	12	136,284.0	1,825	63.6
Collingsworth	18,567	17,916	18,368	18,833	19,309	19,797	20,298	18,567	12	222,804.0	1,825	104.0
Dallam	77,692	16,512	16,930	17,358	17,797	18,247	18,708	77,692	12	932,304.0	1,825	435.1
Donley	3,410	5,680	5,824	5,971	6,122	6,277	6,436	3,410	12	40,920.0	1,825	19.1
Gray	29,585	16,491	16,908	17,336	17,774	18,224	18,684	29,585	12	355,020.0	1,825	165.7
Hall	3,245	6,046	6,199	6,355	6,516	6,681	6,850	3,245	12	38,940.0	1,825	18.2
Hansford	105,594	59,796	61,308	62,858	64,447	66,077	67,748	105,594	12	1,267,128.0	1,825	591.4
Hartley	27,263	17,719	18,166	18,626	19,097	19,580	20,075	27,263	12	327,156.0	1,825	152.7
Hemphill	6,469	5,076	5,205	5,336	5,471	5,610	5,751	6,469	12	77,628.0	1,825	36.2
Hutchinson	17,107	23,435	24,027	24,635	25,258	25,896	26,551	17,107	12	205,284.0	1,825	95.8
Lipscomb	25,801	9,113	9,344	9,580	9,822	10,070	10,325	25,801	12	309,612.0	1,825	144.5
Moore	43,892	36,152	37,066	38,003	38,964	39,949	40,959	43,892	12	526,704.0	1,825	245.8
Ochiltree	51,464	63,861	65,476	67,131	68,829	70,569	72,353	51,464	12	617,568.0	1,825	288.2
Oldham	37,327	15,674	16,070	16,476	16,893	17,320	17,758	37,327	12	447,924.0	1,825	209.1
Potter	9,909	4,503	4,617	4,734	4,854	4,976	5,102	9,909	12	118,908.0	1,825	55.5
Randall	44,959	59,187	60,684	62,218	63,791	65,404	67,058	44,959	12	539,508.0	1,825	251.8
Roberts	7,240	3,256	3,338	3,423	3,509	3,598	3,689	7,240	12	86,880.0	1,825	40.5
Sherman	57,215	21,849	22,402	22,968	23,549	24,144	24,755	57,215	12	686,580.0	1,825	320.4
Wheeler	6,985	14,989	15,368	15,757	16,155	16,564	16,982	6,985	12	83,820.0	1,825	39.1
Total	646,946	467,971	479,803	491,934	504,372	517,124	530,198	646,946		7,763,352.0		3,623.4

Note: Assumes 0.25%/year growth in this beef cattle industry sector, 2010-2060.
Gal/hd/day (8 gal) resulted from focused group meeting between Dr. Steve Amosson, Dr. John Sweeten, Dr. Ken Casey, and Ben Weinheimer.
Inventories were re-estimated for 2010 based on planted wheat and grazing practices.

Table B-6. Projected Future Livestock Numbers and Water Use – Stocker Beef Cattle, Winter Pasture Operations (5 mo/yr) (continued).

	2010					2020				
	Stockers	Water use	Water Use, Stocker Cattle--->			Stockers	Water use	Water Use, Stocker Cattle--->		
County	Head	gal/hd/day	gal/day	gal/hd/yr	ac-ft/yr	Head	gal/hd/day	gal/day	gal/hd/yr	ac-ft/yr
Armstrong	24,914	8	199,308.8	1,217	93.0	25,544	8	204,348.0	1,217	95.4
Carson	35,013	8	280,104.6	1,217	130.7	35,898	8	287,186.5	1,217	134.0
Childress	10,788	8	86,303.1	1,217	40.3	11,061	8	88,485.1	1,217	41.3
Collingsworth	17,916	8	143,324.0	1,217	66.9	18,368	8	146,947.7	1,217	68.6
Dallam	16,512	8	132,099.7	1,217	61.7	16,930	8	135,439.6	1,217	63.2
Donley	5,680	8	45,441.7	1,217	21.2	5,824	8	46,590.6	1,217	21.7
Gray	16,491	8	131,931.2	1,217	61.6	16,908	8	135,266.9	1,217	63.1
Hall	6,046	8	48,366.8	1,217	22.6	6,199	8	49,589.7	1,217	23.1
Hansford	59,796	8	478,370.5	1,217	223.3	61,308	8	490,465.2	1,217	228.9
Hartley	17,719	8	141,748.0	1,217	66.2	18,166	8	145,331.9	1,217	67.8
Hemphill	5,076	8	40,611.7	1,217	19.0	5,205	8	41,638.5	1,217	19.4
Hutchinson	23,435	8	187,478.5	1,217	87.5	24,027	8	192,218.5	1,217	89.7
Lipscomb	9,113	8	72,904.9	1,217	34.0	9,344	8	74,748.2	1,217	34.9
Moore	36,152	8	289,212.6	1,217	135.0	37,066	8	296,524.8	1,217	138.4
Ochiltree	63,861	8	510,890.3	1,217	238.4	65,476	8	523,807.2	1,217	244.5
Oldham	15,674	8	125,389.2	1,217	58.5	16,070	8	128,559.4	1,217	60.0
Potter	4,503	8	36,027.1	1,217	16.8	4,617	8	36,938.0	1,217	17.2
Randall	59,187	8	473,500.0	1,217	221.0	60,684	8	485,471.6	1,217	226.6
Roberts	3,256	8	26,047.6	1,217	12.2	3,338	8	26,706.2	1,217	12.5
Sherman	21,849	8	174,794.8	1,217	81.6	22,402	8	179,214.2	1,217	83.6
Wheeler	14,989	8	119,914.7	1,217	56.0	15,368	8	122,946.5	1,217	57.4
Total	467,971		3,743,769.9		1,747.3	479,803		3,838,424.2		1,791.5

Table B-6. Projected Future Livestock Numbers and Water Use – Stocker Beef Cattle, Winter Pasture Operations (5 mo/yr) (continued).

	2030					2040				
	Stockers	Water use	Water Use, Stocker Cattle--->			Stockers	Water use	Water Use, Stocker Cattle--->		
County	Head	gal/hd/day	gal/day	gal/hd/yr	ac-ft/yr	Head	gal/hd/day	gal/day	gal/hd/yr	ac-ft/yr
Armstrong	26,189	8	209,514.6	1,217	97.8	26,851	8	214,811.7	1,217	100.3
Carson	36,806	8	294,447.5	1,217	137.4	37,737	8	301,892.0	1,217	140.9
Childress	11,340	8	90,722.3	1,217	42.3	11,627	8	93,016.1	1,217	43.4
Collingsworth	18,833	8	150,663.0	1,217	70.3	19,309	8	154,472.2	1,217	72.1
Dallam	17,358	8	138,863.9	1,217	64.8	17,797	8	142,374.8	1,217	66.5
Donley	5,971	8	47,768.5	1,217	22.3	6,122	8	48,976.3	1,217	22.9
Gray	17,336	8	138,686.8	1,217	64.7	17,774	8	142,193.3	1,217	66.4
Hall	6,355	8	50,843.5	1,217	23.7	6,516	8	52,129.0	1,217	24.3
Hansford	62,858	8	502,865.7	1,217	234.7	64,447	8	515,579.7	1,217	240.6
Hartley	18,626	8	149,006.3	1,217	69.5	19,097	8	152,773.6	1,217	71.3
Hemphill	5,336	8	42,691.3	1,217	19.9	5,471	8	43,770.7	1,217	20.4
Hutchinson	24,635	8	197,078.4	1,217	92.0	25,258	8	202,061.1	1,217	94.3
Lipscomb	9,580	8	76,638.0	1,217	35.8	9,822	8	78,575.7	1,217	36.7
Moore	38,003	8	304,021.9	1,217	141.9	38,964	8	311,708.5	1,217	145.5
Ochiltree	67,131	8	537,050.7	1,217	250.7	68,829	8	550,629.0	1,217	257.0
Oldham	16,476	8	131,809.8	1,217	61.5	16,893	8	135,142.4	1,217	63.1
Potter	4,734	8	37,871.9	1,217	17.7	4,854	8	38,829.4	1,217	18.1
Randall	62,218	8	497,745.8	1,217	232.3	63,791	8	510,330.4	1,217	238.2
Roberts	3,423	8	27,381.4	1,217	12.8	3,509	8	28,073.7	1,217	13.1
Sherman	22,968	8	183,745.3	1,217	85.8	23,549	8	188,390.9	1,217	87.9
Wheeler	15,757	8	126,055.0	1,217	58.8	16,155	8	129,242.0	1,217	60.3
Total	491,934		3,935,471.6		1,836.8	504,372		4,034,972.6		1,883.2

Table B-6. Projected Future Livestock Numbers and Water Use – Stocker Beef Cattle, Winter Pasture Operations (5 mo/yr) (continued).

	2050					2060				
	Stockers	Water use	Water Use, Stocker Cattle--->			Stockers	Water use,	Water Use, Stocker Cattle--->		
County	Head	gal/hd/day	gal/day	gal/hd/yr	ac-ft/yr	Head	gal/hd/day	gal/day	gal/hd/yr	ac-ft/yr
Armstrong	27,530	8	220,242.9	1,217	102.8	28,226	8	225,811.3	1,217	105.4
Carson	38,691	8	309,524.8	1,217	144.5	39,669	8	317,350.6	1,217	148.1
Childress	11,921	8	95,367.8	1,217	44.5	12,222	8	97,779.0	1,217	45.6
Collingsworth	19,797	8	158,377.8	1,217	73.9	20,298	8	162,382.1	1,217	75.8
Dallam	18,247	8	145,974.5	1,217	68.1	18,708	8	149,665.2	1,217	69.9
Donley	6,277	8	50,214.5	1,217	23.4	6,436	8	51,484.1	1,217	24.0
Gray	18,224	8	145,788.4	1,217	68.0	18,684	8	149,474.4	1,217	69.8
Hall	6,681	8	53,446.9	1,217	24.9	6,850	8	54,798.2	1,217	25.6
Hansford	66,077	8	528,615.2	1,217	246.7	67,748	8	541,980.2	1,217	253.0
Hartley	19,580	8	156,636.2	1,217	73.1	20,075	8	160,596.5	1,217	75.0
Hemphill	5,610	8	44,877.3	1,217	20.9	5,751	8	46,012.0	1,217	21.5
Hutchinson	25,896	8	207,169.9	1,217	96.7	26,551	8	212,407.8	1,217	99.1
Lipscomb	10,070	8	80,562.3	1,217	37.6	10,325	8	82,599.2	1,217	38.6
Moore	39,949	8	319,589.5	1,217	149.2	40,959	8	327,669.7	1,217	152.9
Ochiltree	70,569	8	564,550.6	1,217	263.5	72,353	8	578,824.3	1,217	270.2
Oldham	17,320	8	138,559.2	1,217	64.7	17,758	8	142,062.4	1,217	66.3
Potter	4,976	8	39,811.2	1,217	18.6	5,102	8	40,817.7	1,217	19.1
Randall	65,404	8	523,233.1	1,217	244.2	67,058	8	536,462.1	1,217	250.4
Roberts	3,598	8	28,783.5	1,217	13.4	3,689	8	29,511.2	1,217	13.8
Sherman	24,144	8	193,154.0	1,217	90.2	24,755	8	198,037.6	1,217	92.4
Wheeler	16,564	8	132,509.7	1,217	61.8	16,982	8	135,859.9	1,217	63.4
Total	517,124		4,136,989.4		1,930.9	530,198		4,241,585.4		1,979.7

Table B-7. Projected Future Livestock Numbers and Water Use – Stocker Beef Cattle, Summer Pasture Operations (8 mo/yr).

	Stocker Cattle --Summer Pasture --Projected Inventory---->							Stockers	Water use	2000 Water Use, Stocker Cattle--->		
County	**2000**	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**Head**	**gal/hd/day**	**gal/day**	**gal/hd/yr**	**ac-ft/yr**
Armstrong	27,300	9,037	9,037	9,037	9,037	9,037	9,037	27,300	12	327,600.0	2,920	244.6
Carson	24,286	14,288	14,288	14,288	14,288	14,288	14,288	24,286	12	291,432.0	2,920	217.6
Childress	1,429	13,160	13,160	13,160	13,160	13,160	13,160	1,429	12	17,148.0	2,920	12.8
Collingsworth	12,714	21,804	21,804	21,804	21,804	21,804	21,804	12,714	12	152,568.0	2,920	113.9
Dallam	18,557	22,179	22,179	22,179	22,179	22,179	22,179	18,557	12	222,684.0	2,920	166.3
Donley	16,429	21,738	21,738	21,738	21,738	21,738	21,738	16,429	12	197,148.0	2,920	147.2
Gray	12,143	25,203	25,203	25,203	25,203	25,203	25,203	12,143	12	145,716.0	2,920	108.8
Hall	2,771	16,318	16,318	16,318	16,318	16,318	16,318	2,771	12	33,252.0	2,920	24.8
Hansford	15,764	8,645	8,645	8,645	8,645	8,645	8,645	15,764	12	189,168.0	2,920	141.3
Hartley	34,557	9,937	9,937	9,937	9,937	9,937	9,937	34,557	12	414,684.0	2,920	309.7
Hemphill	22,071	15,005	15,005	15,005	15,005	15,005	15,005	22,071	12	264,852.0	2,920	197.8
Hutchinson	15,486	26,790	26,790	26,790	26,790	26,790	26,790	15,486	12	185,832.0	2,920	138.8
Lipscomb	15,611	14,616	14,616	14,616	14,616	14,616	14,616	15,611	12	187,332.0	2,920	139.9
Moore	13,336	15,435	15,435	15,435	15,435	15,435	15,435	13,336	12	160,032.0	2,920	119.5
Ochiltree	3,771	9,001	9,001	9,001	9,001	9,001	9,001	3,771	12	45,252.0	2,920	33.8
Oldham	47,586	31,761	31,761	31,761	31,761	31,761	31,761	47,586	12	571,032.0	2,920	426.4
Potter	28,371	18,819	18,819	18,819	18,819	18,819	18,819	28,371	12	340,452.0	2,920	254.2
Randall	15,714	18,018	18,018	18,018	18,018	18,018	18,018	15,714	12	188,568.0	2,920	140.8
Roberts	34,021	22,374	22,374	22,374	22,374	22,374	22,374	34,021	12	408,252.0	2,920	304.9
Sherman	5,136	13,679	13,679	13,679	13,679	13,679	13,679	5,136	12	61,632.0	2,920	46.0
Wheeler	5,000	21,114	21,114	21,114	21,114	21,114	21,114	5,000	12	60,000.0	2,920	44.8
Total	372,053	368,921	368,921	368,921	368,921	368,921	368,921	372,053		4,464,636.0		3,334.1

Note: In Senate Bill 2, water consumption was 12 gal/hd/day. In Senate Bill 3, a focused group of Dr. Steve Amosson, Dr. John Sweeten, Dr. Ken Casey and Ben Weinheimer determined water consumption at 10 gal/hd/day beginning in 2010.
2010 summer stocker inventories were adjusted based on the change in beef cows reported by TASS.

Table B-7. Projected Future Livestock Numbers and Water Use – Stocker Beef Cattle, Summer Pasture Operations (8 mo/yr) (continued).

	2010					2020				
	Stockers	Water use	se, Stocker Cattle--->			Stockers	Water use	se, Stocker Cattle--->		
County	Head	gal/hd/day	gal/day	gal/hd/yr	ac-ft/yr	Head	gal/hd/day	gal/day	gal/hd/yr	ac-ft/yr
Armstrong	9,037	10	90,371.7	2,433	67.5	9,037	10	90,371.7	2,433	67.5
Carson	14,288	10	142,879.1	2,433	106.7	14,288	10	142,879.1	2,433	106.7
Childress	13,160	10	131,600.3	2,433	98.3	13,160	10	131,600.3	2,433	98.3
Collingsworth	21,804	10	218,039.1	2,433	162.8	21,804	10	218,039.1	2,433	162.8
Dallam	22,179	10	221,793.6	2,433	165.6	22,179	10	221,793.6	2,433	165.6
Donley	21,738	10	217,380.6	2,433	162.3	21,738	10	217,380.6	2,433	162.3
Gray	25,203	10	252,025.5	2,433	188.2	25,203	10	252,025.5	2,433	188.2
Hall	16,318	10	163,184.1	2,433	121.9	16,318	10	163,184.1	2,433	121.9
Hansford	8,645	10	86,449.9	2,433	64.6	8,645	10	86,449.9	2,433	64.6
Hartley	9,937	10	99,365.6	2,433	74.2	9,937	10	99,365.6	2,433	74.2
Hemphill	15,005	10	150,054.7	2,433	112.1	15,005	10	150,054.7	2,433	112.1
Hutchinson	26,790	10	267,900.6	2,433	200.1	26,790	10	267,900.6	2,433	200.1
Lipscomb	14,616	10	146,156.2	2,433	109.1	14,616	10	146,156.2	2,433	109.1
Moore	15,435	10	154,352.2	2,433	115.3	15,435	10	154,352.2	2,433	115.3
Ochiltree	9,001	10	90,009.1	2,433	67.2	9,001	10	90,009.1	2,433	67.2
Oldham	31,761	10	317,609.8	2,433	237.2	31,761	10	317,609.8	2,433	237.2
Potter	18,819	10	188,190.6	2,433	140.5	18,819	10	188,190.6	2,433	140.5
Randall	18,018	10	180,183.2	2,433	134.6	18,018	10	180,183.2	2,433	134.6
Roberts	22,374	10	223,737.9	2,433	167.1	22,374	10	223,737.9	2,433	167.1
Sherman	13,679	10	136,790.6	2,433	102.2	13,679	10	136,790.6	2,433	102.2
Wheeler	21,114	10	211,139.0	2,433	157.7	21,114	10	211,139.0	2,433	157.7
Total	368,921		3,689,213.4		2,755.0	368,921		3,689,213.4		2,755.0

Table B-7. Projected Future Livestock Numbers and Water Use – Stocker Beef Cattle, Summer Pasture Operations (8 mo/yr) (continued).

	2030					2040				
	Stockers	Water use	Water Use, Stocker Cattle--->			Stockers	Water use	Water Use, Stocker Cattle--->		
County	Head	gal/hd/day	gal/day	gal/hd/yr	ac-ft/yr	Head	gal/hd/day	gal/day	gal/hd/yr	ac-ft/yr
Armstrong	9,037	10	90,371.7	2,433	67.5	9,037	10	90,371.7	2,433	67.5
Carson	14,288	10	142,879.1	2,433	106.7	14,288	10	142,879.1	2,433	106.7
Childress	13,160	10	131,600.3	2,433	98.3	13,160	10	131,600.3	2,433	98.3
Collingsworth	21,804	10	218,039.1	2,433	162.8	21,804	10	218,039.1	2,433	162.8
Dallam	22,179	10	221,793.6	2,433	165.6	22,179	10	221,793.6	2,433	165.6
Donley	21,738	10	217,380.6	2,433	162.3	21,738	10	217,380.6	2,433	162.3
Gray	25,203	10	252,025.5	2,433	188.2	25,203	10	252,025.5	2,433	188.2
Hall	16,318	10	163,184.1	2,433	121.9	16,318	10	163,184.1	2,433	121.9
Hansford	8,645	10	86,449.9	2,433	64.6	8,645	10	86,449.9	2,433	64.6
Hartley	9,937	10	99,365.6	2,433	74.2	9,937	10	99,365.6	2,433	74.2
Hemphill	15,005	10	150,054.7	2,433	112.1	15,005	10	150,054.7	2,433	112.1
Hutchinson	26,790	10	267,900.6	2,433	200.1	26,790	10	267,900.6	2,433	200.1
Lipscomb	14,616	10	146,156.2	2,433	109.1	14,616	10	146,156.2	2,433	109.1
Moore	15,435	10	154,352.2	2,433	115.3	15,435	10	154,352.2	2,433	115.3
Ochiltree	9,001	10	90,009.1	2,433	67.2	9,001	10	90,009.1	2,433	67.2
Oldham	31,761	10	317,609.8	2,433	237.2	31,761	10	317,609.8	2,433	237.2
Potter	18,819	10	188,190.6	2,433	140.5	18,819	10	188,190.6	2,433	140.5
Randall	18,018	10	180,183.2	2,433	134.6	18,018	10	180,183.2	2,433	134.6
Roberts	22,374	10	223,737.9	2,433	167.1	22,374	10	223,737.9	2,433	167.1
Sherman	13,679	10	136,790.6	2,433	102.2	13,679	10	136,790.6	2,433	102.2
Wheeler	21,114	10	211,139.0	2,433	157.7	21,114	10	211,139.0	2,433	157.7
Total	368,921		3,689,213.4		2,755.0	368,921		3,689,213.4		2,755.0

Table B-7. Projected Future Livestock Numbers and Water Use – Stocker Beef Cattle, Summer Pasture Operations (8 mo/yr) (continued).

	2050					2060				
	Stockers	Water use	Water Use, Stocker Cattle--->			Stockers	Water use	Water Use, Stocker Cattle--->		
County	Head	gal/hd/day	gal/day	gal/hd/yr	ac-ft/yr	Head	gal/hd/day	gal/day	gal/hd/yr	ac-ft/yr
Armstrong	9,037	10	90,371.7	2,433	67.5	9,037	10	90,371.7	2,433	67.5
Carson	14,288	10	142,879.1	2,433	106.7	14,288	10	142,879.1	2,433	106.7
Childress	13,160	10	131,600.3	2,433	98.3	13,160	10	131,600.3	2,433	98.3
Collingsworth	21,804	10	218,039.1	2,433	162.8	21,804	10	218,039.1	2,433	162.8
Dallam	22,179	10	221,793.6	2,433	165.6	22,179	10	221,793.6	2,433	165.6
Donley	21,738	10	217,380.6	2,433	162.3	21,738	10	217,380.6	2,433	162.3
Gray	25,203	10	252,025.5	2,433	188.2	25,203	10	252,025.5	2,433	188.2
Hall	16,318	10	163,184.1	2,433	121.9	16,318	10	163,184.1	2,433	121.9
Hansford	8,645	10	86,449.9	2,433	64.6	8,645	10	86,449.9	2,433	64.6
Hartley	9,937	10	99,365.6	2,433	74.2	9,937	10	99,365.6	2,433	74.2
Hemphill	15,005	10	150,054.7	2,433	112.1	15,005	10	150,054.7	2,433	112.1
Hutchinson	26,790	10	267,900.6	2,433	200.1	26,790	10	267,900.6	2,433	200.1
Lipscomb	14,616	10	146,156.2	2,433	109.1	14,616	10	146,156.2	2,433	109.1
Moore	15,435	10	154,352.2	2,433	115.3	15,435	10	154,352.2	2,433	115.3
Ochiltree	9,001	10	90,009.1	2,433	67.2	9,001	10	90,009.1	2,433	67.2
Oldham	31,761	10	317,609.8	2,433	237.2	31,761	10	317,609.8	2,433	237.2
Potter	18,819	10	188,190.6	2,433	140.5	18,819	10	188,190.6	2,433	140.5
Randall	18,018	10	180,183.2	2,433	134.6	18,018	10	180,183.2	2,433	134.6
Roberts	22,374	10	223,737.9	2,433	167.1	22,374	10	223,737.9	2,433	167.1
Sherman	13,679	10	136,790.6	2,433	102.2	13,679	10	136,790.6	2,433	102.2
Wheeler	21,114	10	211,139.0	2,433	157.7	21,114	10	211,139.0	2,433	157.7
Total	368,921		3,689,213.4		2,755.0	368,921		3,689,213.4		2,755.0

Table B-8. Projected Future Livestock Numbers and Water Use – Swine Operations.

	Swine Operations: Projected Inventory---->							2000				
								Swine	Water use	Water Use, Swine --->		
County	2000	2010	2020	2030	2040	2050	2060	Head	gal/hd/day	gal/day	gal/hd/yr	ac-ft/yr
Armstrong	154	35	35	35	35	35	35	154	5.00	771.4	1,825.0	0.86
Carson	508	685	685	685	685	685	685	508	5.00	2,538.4	1,825.0	2.84
Childress	0	62	62	62	62	62	62	0	0.00	0.0	0.0	0.00
Collingsworth	90	8	8	8	8	8	8	90	5.00	448.3	1,825.0	0.50
Dallam	260,613	171,868	171,868	171,868	171,868	171,868	171,868	260,613	8.50	2,215,206.3	3,102.5	2,481.37
Donley	167	31	31	31	31	31	31	167	5.00	834.0	1,825.0	0.93
Gray	794	45,125	45,125	45,125	45,125	45,125	45,125	794	5.00	3,971.7	1,825.0	4.45
Hall	529	224	224	224	224	224	224	529	5.00	2,642.6	1,825.0	2.96
Hansford	48,995	100,840	100,840	100,840	100,840	100,840	100,840	48,995	5.00	244,975.8	1,825.0	274.41
Hartley	208	107,479	107,479	107,479	107,479	107,479	107,479	208	5.00	1,042.5	1,825.0	1.17
Hemphill	1,042	0	0	0	0	0	0	1,042	5.00	5,212.3	1,825.0	5.84
Hutchinson	35	59	59	59	59	59	59	35	5.00	177.2	1,825.0	0.20
Lipscomb	10,425	31,600	31,600	31,600	31,600	31,600	31,600	10,425	5.00	52,122.5	1,825.0	58.39
Moore	18,764	25	25	25	25	25	25	18,764	5.00	93,820.5	1,825.0	105.09
Ochiltree	370,070	296,800	208,400	208,400	208,400	208,400	208,400	370,070	5.00	1,850,348.8	1,825.0	2,072.68
Oldham	104	25	25	25	25	25	25	104	5.00	521.2	1,825.0	0.58
Potter	632	713	713	713	713	713	713	632	5.00	3,158.6	1,825.0	3.54
Randall	10,425	124	124	124	124	124	124	10,425	5.00	52,122.5	1,825.0	58.39
Roberts	0	25	25	25	25	25	25	0	0.00	0.0	0.0	0.00
Sherman	56,292	426,600	426,600	426,600	426,600	426,600	426,600	56,292	5.00	281,461.5	1,825.0	315.28
Wheeler	152	43	43	43	43	43	43	152	5.00	761.0	1,825.0	0.85
Total	779,999	1,182,371	1,093,971	1,093,971	1,093,971	1,093,971	1,093,971	779,999		4,812,136.8		5,390.34

Note: In 2010, inventories reflect responses from a survey conducted of the major swine operations. 2007 census of agriculture was used to estimate inventories in in other counties. No growth is assumed from 2020 - 2060.

For 2000, water use for initial Dallam County inventory was 8.5 gallons/day. Water use for all other counties was to be 5 gallons/day.

In 2010, water use was changed per county based on survey responses in Dallam, Gray, Hansford, Hartley, Lipscomb, Ochiltree, and Sherman Counties.

Table B-8. Projected Future Livestock Numbers and Water Use – Swine Operations (continued).

	2010					2020				
	Swine	Water use	Water Use, Swine --->			Swine	Water use	Water Use, Swine --->		
County	Head	gal/hd/day	gal/day	gal/hd/yr	ac-ft/yr	Head	gal/hd/day	gal/day	gal/hd/yr	ac-ft/yr
Armstrong	35	5.00	175.0	1,825.0	0.20	35	5.00	175.0	1,825.0	0.20
Carson	685	5.00	3,425.0	1,825.0	3.84	685	5.00	3,425.0	1,825.0	3.84
Childress	62	5.00	310.0	1,825.0	0.35	62	5.00	310.0	1,825.0	0.35
Collingsworth	8	5.00	40.0	1,825.0	0.04	8	5.00	40.0	1,825.0	0.04
Dallam	171,868	4.44	763,093.9	1,620.6	854.78	171,868	4.44	763,093.9	1,620.6	854.78
Donley	31	5.00	155.0	1,825.0	0.17	31	5.00	155.0	1,825.0	0.17
Gray	45,125	2.64	119,130.0	963.6	133.44	45,125	2.64	119,130.0	963.6	133.44
Hall	224	5.00	1,120.0	1,825.0	1.25	224	5.00	1,120.0	1,825.0	1.25
Hansford	100,840	4.79	483,023.6	1,748.4	541.06	100,840	4.79	483,023.6	1,748.4	541.06
Hartley	107,479	3.69	396,597.5	1,346.9	444.25	107,479	3.69	396,597.5	1,346.9	444.25
Hemphill	0	0.00	0.0	0.0	0.00	0	0.00	0.0	0.0	0.00
Hutchinson	59	5.00	295.0	1,825.0	0.33	59	5.00	295.0	1,825.0	0.33
Lipscomb	31,600	2.50	79,000.0	912.5	88.49	31,600	2.50	79,000.0	912.5	88.49
Moore	25	5.00	125.0	1,825.0	0.14	25	5.00	125.0	1,825.0	0.14
Ochiltree	296,800	4.89	1,451,352.0	1,784.9	1,625.74	208,400	6.82	1,421,288.0	2,489.3	1,592.06
Oldham	25	5.00	125.0	1,825.0	0.14	25	5.00	125.0	1,825.0	0.14
Potter	713	5.00	3,565.0	1,825.0	3.99	713	5.00	3,565.0	1,825.0	3.99
Randall	124	5.00	620.0	1,825.0	0.69	124	5.00	620.0	1,825.0	0.69
Roberts	25	5.00	125.0	1,825.0	0.14	25	5.00	125.0	1,825.0	0.14
Sherman	426,600	4.64	1,979,424.0	1,693.6	2,217.26	426,600	4.64	1,979,424.0	1,693.6	2,217.26
Wheeler	43	5.00	215.0	1,825.0	0.24	43	5.00	215.0	1,825.0	0.24
Total	1,182,371		5,281,916.0		5,916.56	1,093,971		5,251,852.0		5,882.88

Table B-8. Projected Future Livestock Numbers and Water Use – Swine Operations (continued).

	2030					2040				
	Swine	Water use	Water Use, Swine --->			Swine	Water use	Water Use, Swine --->		
County	Head	gal/hd/day	gal/day	gal/hd/yr	ac-ft/yr	Head	gal/hd/day	gal/day	gal/hd/yr	ac-ft/yr
Armstrong	35	5.00	175.0	1,825.0	0.20	35	5.00	175.0	1,825.0	0.20
Carson	685	5.00	3,425.0	1,825.0	3.84	685	5.00	3,425.0	1,825.0	3.84
Childress	62	5.00	310.0	1,825.0	0.35	62	5.00	310.0	1,825.0	0.35
Collingsworth	8	5.00	40.0	1,825.0	0.04	8	5.00	40.0	1,825.0	0.04
Dallam	171,868	4.44	763,093.9	1,620.6	854.78	171,868	4.44	763,093.9	1,620.6	854.78
Donley	31	5.00	155.0	1,825.0	0.17	31	5.00	155.0	1,825.0	0.17
Gray	45,125	2.64	119,130.0	963.6	133.44	45,125	2.64	119,130.0	963.6	133.44
Hall	224	5.00	1,120.0	1,825.0	1.25	224	5.00	1,120.0	1,825.0	1.25
Hansford	100,840	4.79	483,023.6	1,748.4	541.06	100,840	4.79	483,023.6	1,748.4	541.06
Hartley	107,479	3.69	396,597.5	1,346.9	444.25	107,479	3.69	396,597.5	1,346.9	444.25
Hemphill	0	0.00	0.0	0.0	0.00	0	0.00	0.0	0.0	0.00
Hutchinson	59	5.00	295.0	1,825.0	0.33	59	5.00	295.0	1,825.0	0.33
Lipscomb	31,600	2.50	79,000.0	912.5	88.49	31,600	2.50	79,000.0	912.5	88.49
Moore	25	5.00	125.0	1,825.0	0.14	25	5.00	125.0	1,825.0	0.14
Ochiltree	208,400	6.82	1,421,288.0	2,489.3	1,592.06	208,400	6.82	1,421,288.0	2,489.3	1,592.06
Oldham	25	5.00	125.0	1,825.0	0.14	25	5.00	125.0	1,825.0	0.14
Potter	713	5.00	3,565.0	1,825.0	3.99	713	5.00	3,565.0	1,825.0	3.99
Randall	124	5.00	620.0	1,825.0	0.69	124	5.00	620.0	1,825.0	0.69
Roberts	25	5.00	125.0	1,825.0	0.14	25	5.00	125.0	1,825.0	0.14
Sherman	426,600	4.64	1,979,424.0	1,693.6	2,217.26	426,600	4.64	1,979,424.0	1,693.6	2,217.26
Wheeler	43	5.00	215.0	1,825.0	0.24	43	5.00	215.0	1,825.0	0.24
Total	1,093,971		5,251,852.0		5,882.88	1,093,971		5,251,852.0		5,882.88

Table B-8. Projected Future Livestock Numbers and Water Use – Swine Operations (continued).

	2050					2060				
	Swine	Water use	Water Use, Swine --->			Swine	Water use	Water Use, Swine --->		
County	Head	gal/hd/day	gal/day	gal/hd/yr	ac-ft/yr	Head	gal/hd/day	gal/day	gal/hd/yr	ac-ft/yr
Armstrong	35	5.00	175.0	1,825.0	0.20	35	5.00	175.0	1,825.0	0.20
Carson	685	5.00	3,425.0	1,825.0	3.84	685	5.00	3,425.0	1,825.0	3.84
Childress	62	5.00	310.0	1,825.0	0.35	62	5.00	310.0	1,825.0	0.35
Collingsworth	8	5.00	40.0	1,825.0	0.04	8	5.00	40.0	1,825.0	0.04
Dallam	171,868	4.44	763,093.9	1,620.6	854.78	171,868	4.44	763,093.9	1,620.6	854.78
Donley	31	5.00	155.0	1,825.0	0.17	31	5.00	155.0	1,825.0	0.17
Gray	45,125	2.64	119,130.0	963.6	133.44	45,125	2.64	119,130.0	963.6	133.44
Hall	224	5.00	1,120.0	1,825.0	1.25	224	5.00	1,120.0	1,825.0	1.25
Hansford	100,840	4.79	483,023.6	1,748.4	541.06	100,840	4.79	483,023.6	1,748.4	541.06
Hartley	107,479	3.69	396,597.5	1,346.9	444.25	107,479	3.69	396,597.5	1,346.9	444.25
Hemphill	0	0.00	0.0	0.0	0.00	0	0.00	0.0	0.0	0.00
Hutchinson	59	5.00	295.0	1,825.0	0.33	59	5.00	295.0	1,825.0	0.33
Lipscomb	31,600	2.50	79,000.0	912.5	88.49	31,600	2.50	79,000.0	912.5	88.49
Moore	25	5.00	125.0	1,825.0	0.14	25	5.00	125.0	1,825.0	0.14
Ochiltree	208,400	6.82	1,421,288.0	2,489.3	1,592.06	208,400	6.82	1,421,288.0	2,489.3	1,592.06
Oldham	25	5.00	125.0	1,825.0	0.14	25	5.00	125.0	1,825.0	0.14
Potter	713	5.00	3,565.0	1,825.0	3.99	713	5.00	3,565.0	1,825.0	3.99
Randall	124	5.00	620.0	1,825.0	0.69	124	5.00	620.0	1,825.0	0.69
Roberts	25	5.00	125.0	1,825.0	0.14	25	5.00	125.0	1,825.0	0.14
Sherman	426,600	4.64	1,979,424.0	1,693.6	2,217.26	426,600	4.64	1,979,424.0	1,693.6	2,217.26
Wheeler	43	5.00	215.0	1,825.0	0.24	43	5.00	215.0	1,825.0	0.24
Total	1,093,971		5,251,852.0		5,882.64	1,093,971		5,251,852.0		5,882.88

This article can be referenced as follows:
Marek, T., S. Amosson, F. Bretz, B. Guerrero and R. Kotara. 2009. 2011 Panhandle Regional Water Plan Task 2 Report: Agricultural Water Demand Projections. Technical Report for the Texas Water Development Board (Water Planning Division) and Region A Panhandle Regional Planning Group through Freese and Nichols, Inc. Texas A&M AgriLife – Amarillo. April 24. AREC 09-21. pp.83.

APPENDIX D

GROUNDWATER AVAILABILITY GAM ANALYSES

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M E M O R A N D U M

To: PWPG Modeling Committee

From: Van Kelley, INTERA
Dennis Fryar, INTERA
Neil Deeds, INTERA

Date: November 11, 2009

RE: Regional Availability and Available Supplies: Current GAM

In the planning group meeting held July 14th in Amarillo, it was determined that the draft groundwater planning numbers would be based upon the current GAM, with updated estimates being included in a later draft after the GAM is revised. In a modeling committee meeting held August 7th in Amarillo, the simulations desired by the planning group were defined. It was the intention of the group that each of these simulations be available using both the current Dutton (2004) GAM and the revised GAM being developed by INTERA. The three simulation types requested include; the Baseline Demand simulation (Baseline); the Regional Availability simulation, and the Available Supplies simulation. As defined by GMA 1, these are to be simulated using both the current GAM and the future revised GAM. Table 1 provides a summary of each of these three simulation types in terms of purpose, approach, and results. This memorandum documents the Regional Availability Simulation and the Available Supplies Simulation for the current GAM.

Table 1. Scope of simulations requested by the planning group.

Simulation	Purpose	Approach	Expected Results
Baseline (Includes updated demands)	Estimate groundwater availability with current pumping locations	Use current pumping locations and projected use	Capability to meet demands with current infrastructure – areas of concern
Regional Availability (MAG)	Determine available groundwater given regional management goals	Approach employed in GAM Run 09-001 except to correct pumping annually to meet goals	Theoretical availability assuming management at the one-square mile level
Available Supplies	Estimate groundwater available to each user groups	Refined approach to GAM Run 09-001 with management areas defined by dominant user groups	Available supplies to be used in the needs analysis and water management strategies analysis

Methods:

The Regional Availability run and the Available Supplies run are derived from the same simulation based upon the management criteria spelled out by GMA-1 for the MAG run (Draft Run 09-001). INTERA and Freese and Nichols met with the TWDB to discuss the approach used to perform the draft MAG Run developed by the TWDB (GAM Run 09-001). The Desired Future Condition (DFC) specified by GMA-1 was:

1. 40% volume in storage remaining after fifty (50) years for Dallam, Sherman, Hartley, and Moore counties;
2. 80% volume in storage remaining after fifty (50) years in Hemphill County;
3. 50% volume in storage remaining after fifty (50) years in Hansford, Ochiltree, Lipscomb, Hutchinson, Roberts, Oldham, Potter, Carson, Gray, Wheeler, Randall, Armstrong, and Donley counties.

The TWDB stated that the run was challenging to simulate and that they would like to develop an approach where pumping follows a decline curve to the target saturated thickness on a cell-by-cell basis. The TWDB stated that they had a significant number of dry cells in the MAG Run (GAM Run 09-001) and that it would be better to end up in a physical state where all cells meet the target saturated thickness.

As part of the work performed by INTERA to support Region A, we developed an algorithm that would calculate the flow rate in each model cell based upon a decline curve that would meet a specified target, expressed as a fraction of the initial saturated thickness. The Texas portion of the Northern Ogallala GAM was divided into three areas, each with different drawdown targets. Pumping for portions of the model in Oklahoma and New Mexico was provided by Alan Dutton.

The algorithm developed for calculating regional availability used an iterative process that included MODFLOW 96 and FORTRAN utility codes that read the MODFLOW head file and calculated pumping on a yearly basis. The Northern Ogallala GAM (Dutton, 2004) was run through stress period 55 (based on Richard Smith's GAM run 09-001 report) to provide initial water level conditions for the MAG run. Based on the stress period 55 water levels, an initial flow rate was calculated for each cell to meet the target over the 50-year horizon. These calculated flow rates were used for the first one-year MODFLOW simulation. The heads from the first one-year simulation were then used to estimate the next flow rate based upon a 49-year horizon. This process continued with one-year simulations through the 50-year timeframe. This approach, as originally contemplated, did not succeed in providing asymptotic saturated thickness declines. The reason was because of the significant hydraulic communication which could occur between model cells.

A second approach was developed to ensure that pumping was sustained at rates that would accomplish the predetermined drawdown (i.e., saturated thickness). As with the first approach, the Northern Ogallala GAM (Dutton, 2004) was run through stress period 55 to provide initial water level conditions. A constant decline rate was then calculated for each model cell based on the drawdown target (fraction of initial aquifer storage remaining in 2060) for the area of the model where that cell is located.

The calculated decline rate was used to determine a target head for each model cell on a yearly basis. This allowed for year-to-year adjustments of pumping to account for flow between cells and flow to or from boundaries. For each year, the model heads from the previous year were compared to the calculated target heads to determine the volume of water that could be removed from each cell during that year. These volumes were then combined with recharge for each cell to determine pumping rates.

Figure 1 provides a hypothetical model cell pumping and head time series. In this example, the initial flow rate is calculated a priori to model simulation. However, the lower part of Figure 1 shows that the theoretical drawdown curve at the end of the first year is not achieved. This occurs because the flow rates are calculated assuming no flow from, or to, adjoining model cells. The new algorithm uses the theoretical drawdown curve to estimate the pumping rate for the next year. Through this approach, we successfully developed a method that follows the theoretical drawdown curve for each model cell closely and meets the design saturated thickness with the generation of no new inactive (dry) model cells.

Results:

The results determined to date include the regional groundwater availability and the available supplies for municipal and irrigation water user groups (WUGs) subject to drawdown criteria over 50 years and a pre-determined decline curve function. Results at this time are limited to the use of the existing GAM (Dutton, 2004). The drawdown criteria applied are consistent with the draft desired future conditions defined by GMA-1. This simulation differs significantly from the draft DFC/MAG simulation currently under review at the TWDB (GAM Run 09-001). Specifically, this simulation implements a consistent methodology for all regions, counties, and grid cells. Secondly, this simulation invokes the drawdown criteria at each model grid cell which implies groundwater management at the scale of one square mile. As a result, this simulation results in preservation of saturated thickness in all model grid blocks. This simulation does not increase inactive (dry) grid cells in the predictive time period. These modeling results do not take the place of the current TWDB draft DFC/MAG simulation (GAM Run 09-001) but rather augment understanding of the potential management of the resource under defined management criteria.

Table 2 provides a summary of the annual regional groundwater availability by county as defined by the simulation described herein. Table 3 provides a summary of groundwater in place (storage) by county from the simulation described herein. This estimate of storage accounts for the variable specific yield implemented in the GAM. By dividing the 2060 groundwater in place by the 2010 groundwater in place and multiplying by 100 one should calculate the management criterion applied to that county minus round off.

For the available supplies by WUG we analyzed the two largest WUGs, irrigation and municipal. To perform these calculations required definition of WUG zones for both categories within the model area. This required assignment of specific grid cells of the model with pumping associated with these two WUGs. A single cell could not be assigned multiple WUGs. Figure 2 provides the coverage of the irrigation zones used and Figure 3 provides the coverage of the municipal zones used. Each irrigation WUG zone was tracked by WUG type, county, river basin, and groundwater conservation district. Each municipal WUG zones was tracked by WUG type, county, river basin, and municipality. This approach resulted in 26 unique irrigation zones and 35 unique municipal zones.

Table 4 provides the available irrigation supply by county and Table 5 provides the available municipal supply by county. One will note that in tables 4 and 5 the year 2011 has been added to the table in addition to the typical decadal reporting convention. The reason for this is that the initial pumping rate calculated for the year 2010 was typically an underestimate of the true rate required to attain the drawdown calculated for that one year time period. As a result, the algorithm developed corrected that rate in the next year of simulation to account for the communication between model cells. From that simulation year forward the flow rate was calculated specifically to attain a theoretical drawdown curve (see Figure 1). Generally after the year 2011 the flow rates were on a downward trend from 2012 through 2060.

References:

Dutton, A., 2004. Adjustments of Parameters to Improve the Calibration of the Og-n Model of the Ogallala Aquifer, Panhandle Water Planning Group, Prepared for Freese and Nichols, Inc. and the Panhandle Water Planning Group, June 2004.

Table 2. Annual regional groundwater availability - AFY.

County	2010	2020	2030	2040	2050	2060
Armstrong	48,916	40,834	36,089	31,978	28,462	25,383
Carson	198,232	178,545	160,493	144,656	129,882	116,336
Dallam	290,088	253,072	225,124	198,739	173,986	151,305
Donley	90,450	81,347	76,005	69,672	63,613	58,017
Gray	186,939	157,029	143,819	130,646	117,614	105,634
Hansford	279,085	258,780	238,529	217,640	195,835	174,892
Hartley	413,782	361,195	314,995	273,474	236,815	204,661
Hemphill	82,951	44,654	44,129	43,784	43,673	43,579
Hutchinson	153,829	129,548	119,798	108,985	98,239	87,979
Lipscomb	260,989	253,488	247,761	234,999	219,735	203,198
Moore	172,388	164,319	142,529	122,138	103,539	86,974
Ochiltree	257,903	236,618	215,489	195,506	176,566	159,017
Oldham	5,288	6,434	6,090	5,571	5,079	4,658
Potter	38,084	29,224	26,093	23,205	20,684	18,459
Randall	19,730	18,411	16,419	14,589	12,974	11,531
Roberts	375,334	339,518	322,909	301,420	277,509	251,933
Sherman	316,971	298,567	262,820	229,557	198,809	169,672
Wheeler	120,205	114,819	112,163	106,500	99,802	92,993
Sum	**3,311,163**	**2,966,401**	**2,711,253**	**2,453,060**	**2,202,815**	**1,966,221**

Table 3. Groundwater in place – AFY.

County	2010	2020	2030	2040	2050	2060
Armstrong	3,393,836	2,980,888	2,614,958	2,292,115	2,007,702	1,757,463
Carson	14,523,374	12,748,607	11,166,494	9,751,901	8,489,527	7,367,135
Dallam	15,651,329	13,171,909	11,022,071	9,172,190	7,596,070	6,270,784
Donley	5,822,805	5,121,980	4,498,266	3,944,520	3,453,986	3,021,052
Gray	13,000,446	11,420,486	10,008,063	8,744,601	7,618,601	6,621,642
Hansford	20,769,174	18,218,902	15,883,250	13,768,737	11,879,677	10,213,135
Hartley	23,097,231	19,495,348	16,428,918	13,820,010	11,603,668	9,725,660
Hemphill	15,407,023	14,834,800	14,206,672	13,569,550	12,947,908	12,352,238
Hutchinson	10,542,798	9,248,736	8,078,744	7,025,960	6,087,234	5,257,916
Lipscomb	18,394,426	16,186,671	14,214,079	12,448,522	10,873,857	9,477,201
Moore	9,608,708	8,053,014	6,694,926	5,528,205	4,540,089	3,714,338
Ochiltree	19,066,318	16,739,260	14,648,686	12,768,510	11,083,298	9,580,902
Oldham	238,603	210,149	184,496	161,908	141,974	124,384
Potter	2,632,774	2,311,941	2,026,885	1,774,128	1,550,482	1,353,520
Randall	1,455,665	1,283,475	1,131,174	996,195	876,866	771,861
Roberts	26,852,172	23,590,451	20,655,707	18,018,243	15,657,191	13,557,937
Sherman	18,035,001	15,203,063	12,766,854	10,667,622	8,860,604	7,320,539
Wheeler	7,340,143	6,468,071	5,684,345	4,987,318	4,369,708	3,824,747
Sum	**225,831,824**	**197,287,750**	**171,914,589**	**149,440,235**	**129,638,441**	**112,312,455**

Table 4. Available irrigation supplies by county (AFY).

County	2010	2011	2020	2030	2040	2050	2060
Armstrong	4,863	6,639	5,767	5,051	4,477	3,962	3,511
Carson	99,376	109,908	101,110	92,086	83,796	75,773	67,954
Dallam	122,148	151,907	135,104	118,797	103,857	90,356	77,787
Donley	28,483	32,927	30,629	28,611	26,626	24,638	22,617
Gray	39,434	46,544	43,347	40,598	37,676	34,463	31,290
Hansford	91,195	117,316	114,936	109,261	101,068	90,839	80,500
Hartley	102,548	113,191	101,126	89,569	78,674	68,550	59,098
Hemphill	1,983	2,222	2,492	2,843	3,000	2,997	3,032
Hutchinson	27,517	27,621	27,921	27,126	25,605	23,581	21,394
Lipscomb	27,284	32,719	34,005	33,214	31,947	30,360	28,479
Moore	65,363	80,586	72,212	64,505	56,716	48,993	41,407
Ochiltree	57,568	72,556	67,470	63,162	58,444	53,619	48,921
Potter	1,788	3,131	2,469	1,929	1,555	1,290	1,065
Randall	4,104	6,390	4,857	4,356	3,918	3,495	3,080
Roberts	21,838	30,043	27,084	24,314	21,889	19,460	17,005
Sherman	121,224	147,808	131,122	114,716	99,927	86,586	74,048
Wheeler	10,429	12,558	12,818	12,440	11,961	11,309	10,537

Table 5. Available municipal supplies by county (AFY).

County	2010	2011	2020	2030	2040	2050	2060
Armstrong	443	663	591	528	471	420	374
Carson	9,252	18,294	15,707	14,025	12,481	11,090	9,957
Dallam	1,841	2,068	2,321	2,483	2,477	2,357	2,182
Donley	255	248	239	214	194	176	161
Gray	2,040	2,361	1,562	1,152	768	624	541
Hansford	2,768	2,842	1,678	1,399	1,121	1,018	1,004
Hartley	2,066	3,033	2,550	2,045	1,606	1,231	965
Hemphill	238	377	354	356	372	386	399
Hutchinson	1,326	4,443	3,655	3,130	2,693	2,316	1,989
Lipscomb	2,710	3,277	3,749	4,056	4,125	4,047	3,885
Moore	2,253	2,898	2,155	1,693	1,306	1,007	737
Ochiltree	2,494	3,625	3,634	3,604	3,611	3,478	3,238
Potter	3,478	2,576	2,759	2,787	2,660	2,457	2,261
Randall	1,819	4,174	2,748	2,173	1,775	1,498	1,274
Roberts	16,531	31,742	29,155	27,733	26,200	24,283	22,274
Sherman	1,591	1,894	1,835	1,680	1,460	1,249	1,085
Wheeler	2,304	2,579	2,476	2,287	2,025	1,725	1,444

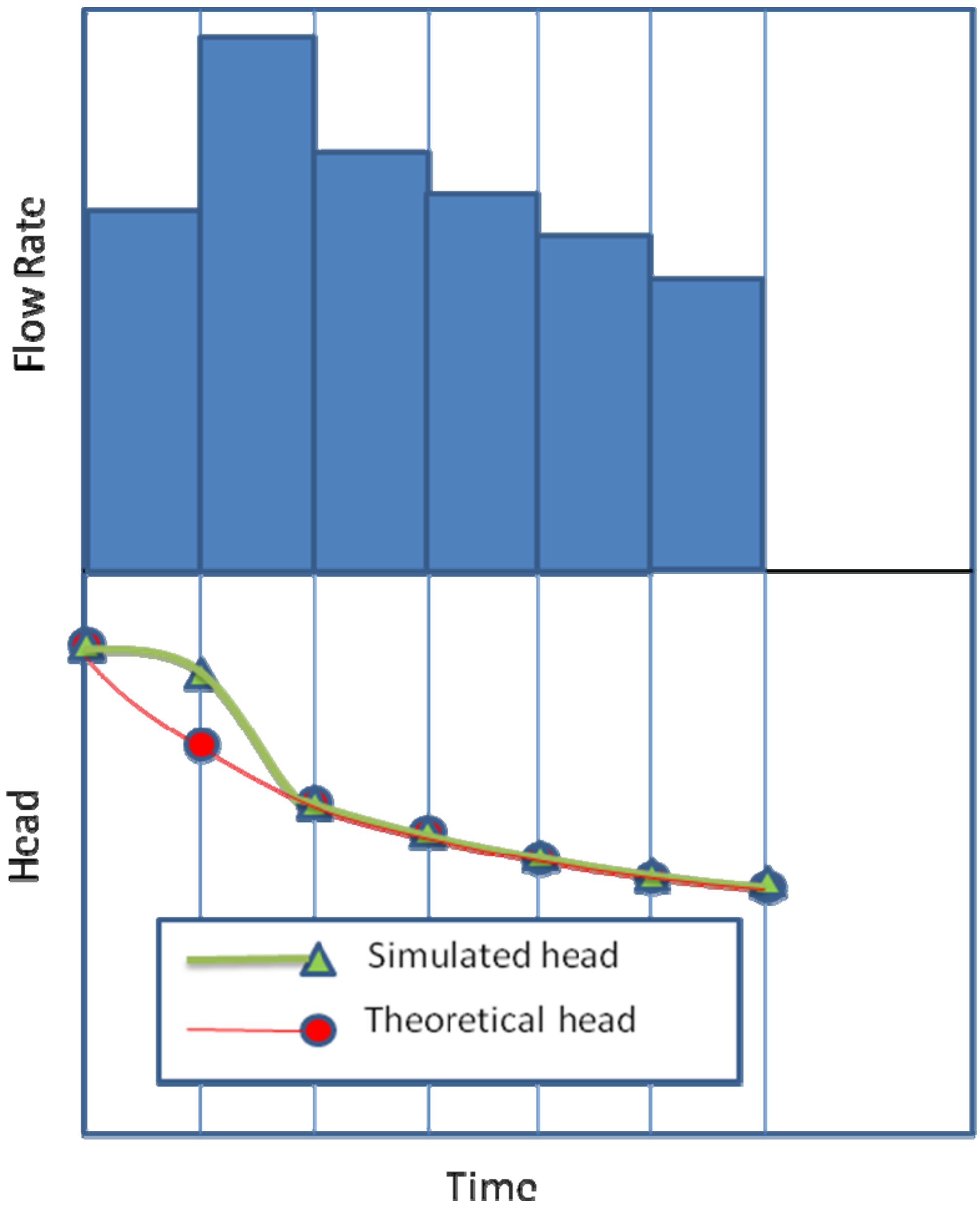

Figure 1. Approach to developing flow rates in the regional availability simulation.

Irrigation Zones

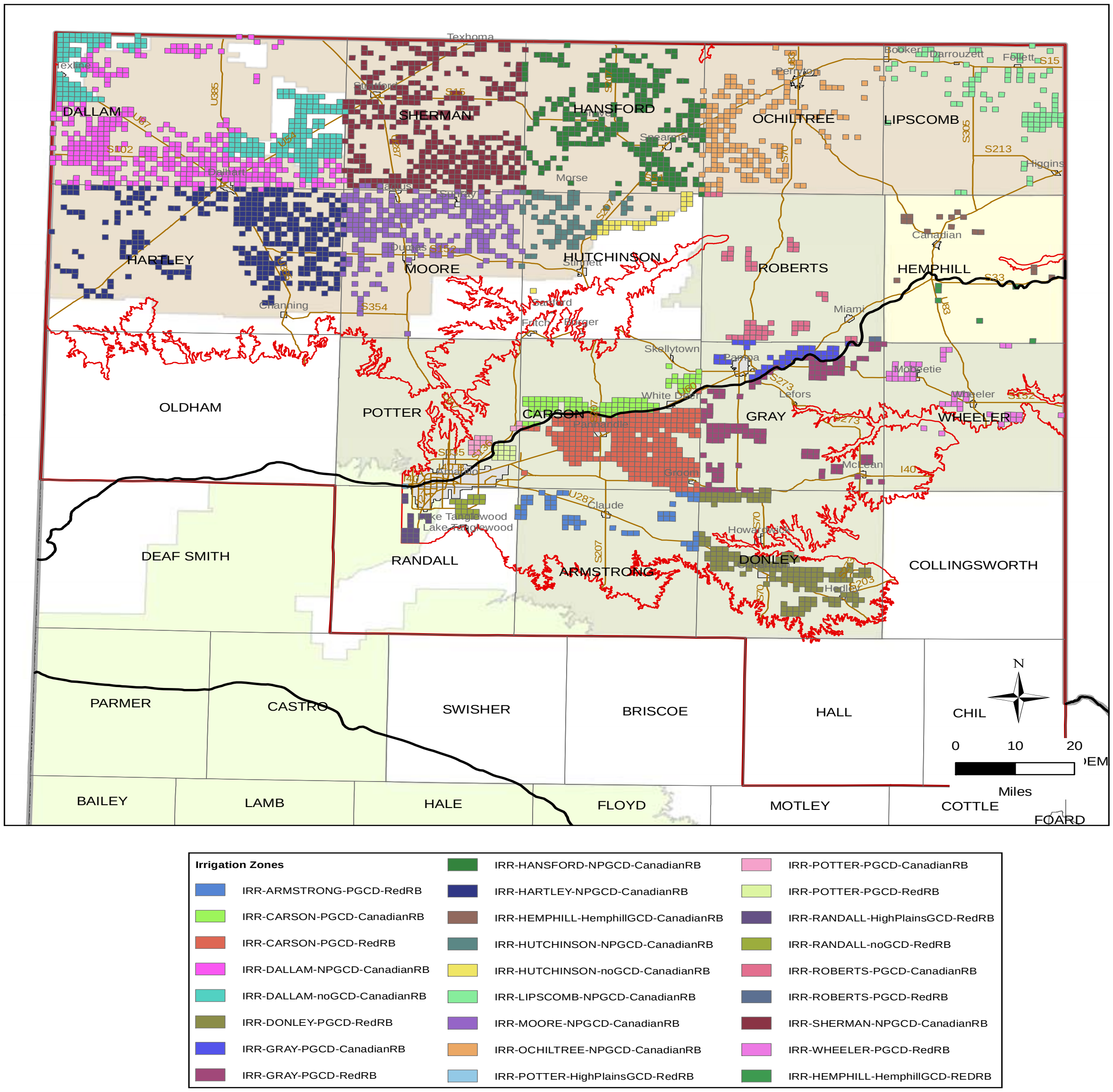

Figure 2. Irrigation zones for available supplies calculations.

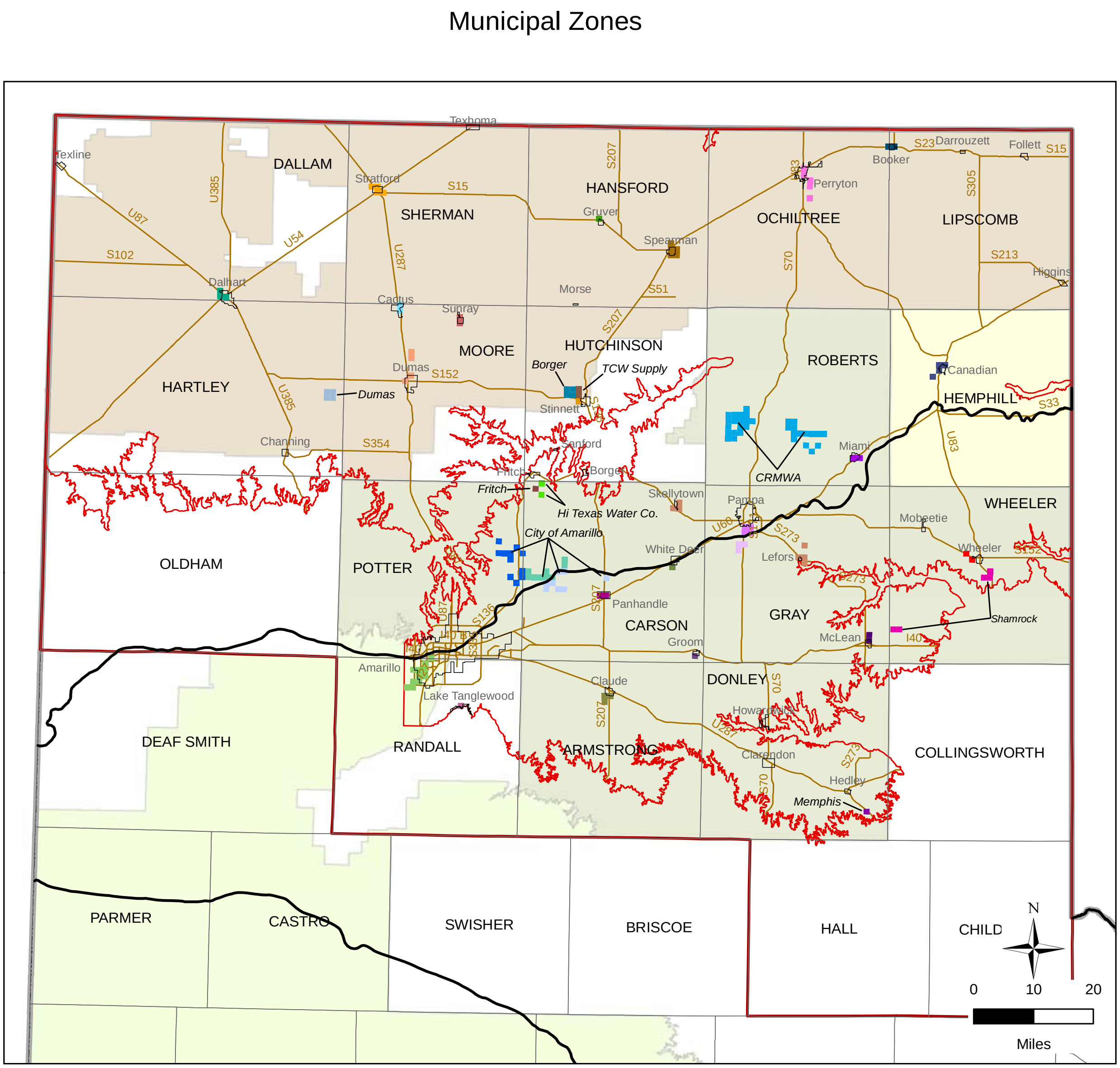

Figure 3. Municipal zones for available supplies calculations.

Northern Ogallala GAM Results
Groundwater Availability (Ac-Ft/Yr)

SP (YEAR)	ARMSTRONG	CARSON	CARSON_RED	CARSON_CAN	DALLAM	DONLEY	GRAY
2010	(48,916.1)	(198,231.8)	(101,938.2)	(96,293.6)	(290,088.3)	(90,449.5)	(186,938.9)
2011	(43,999.4)	(196,888.7)	(108,208.2)	(88,680.5)	(280,136.0)	(80,599.2)	(166,636.1)
2012	(43,968.1)	(194,525.2)	(106,794.2)	(87,731.0)	(276,002.8)	(81,659.2)	(166,330.2)
2013	(43,763.7)	(192,387.3)	(105,640.1)	(86,747.2)	(273,025.5)	(82,085.0)	(165,367.4)
2014	(43,482.2)	(190,303.8)	(104,540.6)	(85,763.2)	(269,970.3)	(82,311.6)	(164,363.1)
2015	(43,139.3)	(188,296.0)	(103,494.6)	(84,801.4)	(267,048.0)	(82,402.6)	(163,184.0)
2016	(42,745.2)	(186,293.1)	(102,421.9)	(83,871.2)	(264,234.6)	(82,330.6)	(161,974.5)
2017	(42,328.7)	(184,274.3)	(101,338.6)	(82,935.7)	(261,515.5)	(82,179.0)	(160,782.3)
2018	(41,844.6)	(182,313.3)	(100,255.3)	(82,058.0)	(258,728.0)	(81,943.6)	(159,618.5)
2019	(41,337.7)	(180,399.3)	(99,179.1)	(81,220.2)	(255,907.4)	(81,659.7)	(158,370.9)
2020	(40,833.9)	(178,545.0)	(98,152.9)	(80,392.1)	(253,071.8)	(81,347.4)	(157,029.1)
2021	(40,343.0)	(176,717.3)	(97,161.0)	(79,556.3)	(250,203.4)	(80,999.4)	(155,707.4)
2022	(39,851.5)	(174,857.9)	(96,166.8)	(78,691.1)	(247,365.0)	(80,604.2)	(154,464.3)
2023	(39,356.8)	(172,998.2)	(95,163.3)	(77,835.0)	(244,563.1)	(80,115.5)	(153,202.5)
2024	(38,867.9)	(171,159.2)	(94,158.7)	(77,000.6)	(241,755.2)	(79,575.1)	(151,854.3)
2025	(38,384.2)	(169,357.1)	(93,162.9)	(76,194.2)	(238,957.8)	(79,015.2)	(150,473.3)
2026	(37,904.7)	(167,537.7)	(92,179.1)	(75,358.6)	(236,171.0)	(78,456.6)	(149,128.9)
2027	(37,440.9)	(165,739.8)	(91,222.9)	(74,517.0)	(233,456.5)	(77,860.3)	(147,785.6)
2028	(36,986.6)	(163,960.5)	(90,276.6)	(73,683.9)	(230,719.8)	(77,251.5)	(146,448.5)
2029	(36,531.9)	(162,211.0)	(89,338.5)	(72,872.5)	(227,895.3)	(76,621.7)	(145,132.0)
2030	(36,089.5)	(160,493.4)	(88,409.1)	(72,084.4)	(225,123.8)	(76,005.1)	(143,818.6)
2031	(35,654.8)	(158,809.1)	(87,509.2)	(71,299.9)	(222,374.9)	(75,388.2)	(142,487.2)
2032	(35,224.6)	(157,194.7)	(86,629.7)	(70,565.0)	(219,674.6)	(74,749.5)	(141,164.9)
2033	(34,804.9)	(155,620.8)	(85,748.6)	(69,872.3)	(217,003.2)	(74,092.6)	(139,877.7)
2034	(34,379.2)	(154,028.0)	(84,856.4)	(69,171.6)	(214,405.3)	(73,441.8)	(138,569.5)
2035	(33,964.1)	(152,447.7)	(83,982.7)	(68,464.9)	(211,782.0)	(72,807.2)	(137,241.5)
2036	(33,555.3)	(150,860.8)	(83,117.6)	(67,743.1)	(209,167.4)	(72,178.9)	(135,918.0)
2037	(33,157.7)	(149,300.2)	(82,282.2)	(67,017.9)	(206,532.1)	(71,549.8)	(134,605.4)
2038	(32,760.5)	(147,739.5)	(81,452.6)	(66,286.9)	(203,878.8)	(70,927.5)	(133,296.5)
2039	(32,364.5)	(146,194.2)	(80,638.4)	(65,555.8)	(201,303.1)	(70,303.4)	(131,984.5)
2040	(31,977.7)	(144,656.4)	(79,835.7)	(64,820.7)	(198,738.9)	(69,672.3)	(130,646.2)
2041	(31,596.1)	(143,107.7)	(79,016.1)	(64,091.5)	(196,195.0)	(69,048.2)	(129,322.9)
2042	(31,224.2)	(141,577.1)	(78,215.5)	(63,361.6)	(193,664.0)	(68,423.8)	(127,988.3)
2043	(30,860.5)	(140,064.0)	(77,412.0)	(62,651.9)	(191,134.8)	(67,803.0)	(126,660.8)
2044	(30,505.7)	(138,593.0)	(76,622.1)	(61,970.9)	(188,656.4)	(67,185.7)	(125,339.6)
2045	(30,155.3)	(137,114.6)	(75,808.0)	(61,306.6)	(186,176.0)	(66,573.8)	(124,027.3)
2046	(29,815.1)	(135,635.2)	(74,984.6)	(60,650.5)	(183,688.4)	(65,970.6)	(122,726.0)

Northern Ogallala GAM Results
Groundwater Availability (Ac-Ft/Yr)

SP (YEAR)	ARMSTRONG	CARSON	CARSON_RED	CARSON_CAN	DALLAM	DONLEY	GRAY
2047	(29,466.1)	(134,166.9)	(74,169.4)	(59,997.5)	(181,233.6)	(65,371.6)	(121,444.8)
2048	(29,131.4)	(132,725.2)	(73,377.9)	(59,347.3)	(178,791.7)	(64,775.6)	(120,159.5)
2049	(28,795.4)	(131,285.9)	(72,588.7)	(58,697.1)	(176,389.5)	(64,192.1)	(118,882.7)
2050	(28,461.8)	(129,881.7)	(71,804.3)	(58,077.4)	(173,985.6)	(63,612.7)	(117,613.9)
2051	(28,133.4)	(128,488.6)	(71,033.8)	(57,454.8)	(171,599.4)	(63,038.8)	(116,352.9)
2052	(27,805.9)	(127,121.7)	(70,274.3)	(56,847.3)	(169,259.1)	(62,462.2)	(115,118.6)
2053	(27,491.9)	(125,742.9)	(69,517.8)	(56,225.1)	(166,954.7)	(61,891.8)	(113,894.5)
2054	(27,180.6)	(124,389.0)	(68,764.7)	(55,624.3)	(164,676.5)	(61,324.8)	(112,683.0)
2055	(26,868.9)	(123,028.7)	(68,003.9)	(55,024.8)	(162,399.4)	(60,761.2)	(111,494.4)
2056	(26,566.1)	(121,669.8)	(67,251.4)	(54,418.4)	(160,133.1)	(60,198.9)	(110,307.7)
2057	(26,260.7)	(120,321.3)	(66,497.9)	(53,823.3)	(157,873.6)	(59,651.4)	(109,126.4)
2058	(25,962.3)	(118,992.2)	(65,757.6)	(53,234.6)	(155,645.5)	(59,100.6)	(107,952.0)
2059	(25,670.9)	(117,662.2)	(65,001.9)	(52,660.3)	(153,454.4)	(58,559.0)	(106,793.0)
2060	(25,383.2)	(116,335.8)	(64,244.9)	(52,090.9)	(151,305.0)	(58,017.0)	(105,634.3)

Northern Ogallala GAM Results
Groundwater Availability (Ac-Ft/Yr)

SP (YEAR)	GRAY_CAN	GRAY_RED	HANSFORD	HARTLEY	HEMPHILL	HEMPHILL_RED	HEMPHILL_CAN
2010	(41,658.9)	(145,280.0)	(279,084.6)	(413,782.1)	(82,950.6)	(39,877.1)	(43,073.5)
2011	(38,826.8)	(127,809.3)	(276,276.5)	(398,799.5)	(49,909.1)	(22,778.8)	(27,130.4)
2012	(38,699.1)	(127,631.1)	(274,269.6)	(395,190.6)	(47,969.4)	(21,915.4)	(26,054.0)
2013	(38,448.8)	(126,918.6)	(271,849.1)	(391,482.1)	(46,707.5)	(21,427.9)	(25,279.6)
2014	(38,228.1)	(126,135.0)	(269,753.2)	(387,564.9)	(46,160.3)	(21,202.4)	(24,957.9)
2015	(37,994.2)	(125,189.9)	(267,765.9)	(383,434.0)	(45,714.0)	(20,905.6)	(24,808.4)
2016	(37,760.2)	(124,214.3)	(265,724.1)	(379,265.6)	(45,387.1)	(20,701.3)	(24,685.8)
2017	(37,565.7)	(123,216.5)	(263,890.5)	(374,996.2)	(45,139.3)	(20,611.0)	(24,528.3)
2018	(37,378.7)	(122,239.8)	(262,251.5)	(370,586.8)	(44,956.2)	(20,574.1)	(24,382.1)
2019	(37,188.3)	(121,182.6)	(260,522.7)	(365,960.4)	(44,789.5)	(20,546.0)	(24,243.5)
2020	(36,997.9)	(120,031.2)	(258,779.6)	(361,194.6)	(44,654.1)	(20,527.3)	(24,126.8)
2021	(36,810.6)	(118,896.8)	(257,223.5)	(356,416.3)	(44,546.7)	(20,508.4)	(24,038.3)
2022	(36,656.9)	(117,807.3)	(255,405.3)	(351,728.3)	(44,480.0)	(20,500.6)	(23,979.4)
2023	(36,514.1)	(116,688.4)	(253,388.6)	(346,982.8)	(44,456.6)	(20,514.5)	(23,942.1)
2024	(36,340.8)	(115,513.5)	(251,443.9)	(342,278.8)	(44,408.0)	(20,522.1)	(23,885.8)
2025	(36,143.3)	(114,330.0)	(249,413.5)	(337,636.6)	(44,331.6)	(20,506.3)	(23,825.3)
2026	(35,942.5)	(113,186.4)	(247,247.9)	(333,014.0)	(44,239.7)	(20,460.1)	(23,779.7)
2027	(35,728.0)	(112,057.6)	(245,018.0)	(328,433.9)	(44,154.6)	(20,409.7)	(23,744.9)
2028	(35,508.4)	(110,940.1)	(242,795.9)	(323,907.4)	(44,143.8)	(20,401.9)	(23,741.9)
2029	(35,279.2)	(109,852.8)	(240,652.9)	(319,423.7)	(44,139.8)	(20,402.5)	(23,737.3)
2030	(35,050.4)	(108,768.2)	(238,529.4)	(314,994.7)	(44,129.0)	(20,414.3)	(23,714.7)
2031	(34,806.7)	(107,680.5)	(236,486.0)	(310,584.3)	(44,112.8)	(20,417.0)	(23,695.9)
2032	(34,547.0)	(106,617.9)	(234,409.4)	(306,257.6)	(44,070.0)	(20,394.0)	(23,676.0)
2033	(34,283.2)	(105,594.5)	(232,376.1)	(301,962.2)	(44,036.4)	(20,373.1)	(23,663.3)
2034	(34,022.9)	(104,546.6)	(230,292.5)	(297,743.5)	(43,996.3)	(20,343.6)	(23,652.7)
2035	(33,765.2)	(103,476.3)	(228,186.3)	(293,561.4)	(43,948.8)	(20,304.7)	(23,644.1)
2036	(33,489.0)	(102,429.0)	(226,092.9)	(289,468.0)	(43,886.4)	(20,249.6)	(23,636.8)
2037	(33,225.1)	(101,380.3)	(224,004.1)	(285,391.2)	(43,831.0)	(20,202.7)	(23,628.3)
2038	(32,956.0)	(100,340.5)	(221,892.7)	(281,366.2)	(43,818.8)	(20,199.1)	(23,619.7)
2039	(32,676.5)	(99,308.0)	(219,763.6)	(277,395.0)	(43,802.0)	(20,194.7)	(23,607.4)
2040	(32,396.3)	(98,249.9)	(217,640.0)	(273,474.0)	(43,784.4)	(20,198.1)	(23,586.3)
2041	(32,121.6)	(97,201.3)	(215,495.7)	(269,584.0)	(43,763.0)	(20,201.3)	(23,561.7)
2042	(31,845.3)	(96,143.0)	(213,362.1)	(265,744.8)	(43,739.2)	(20,206.2)	(23,532.9)
2043	(31,568.0)	(95,092.8)	(211,226.6)	(261,959.8)	(43,722.9)	(20,205.5)	(23,517.4)
2044	(31,283.2)	(94,056.4)	(209,063.6)	(258,235.3)	(43,715.1)	(20,208.2)	(23,506.9)
2045	(30,989.3)	(93,038.0)	(206,868.0)	(254,543.4)	(43,702.1)	(20,208.3)	(23,493.8)
2046	(30,685.5)	(92,040.5)	(204,655.4)	(250,916.1)	(43,699.9)	(20,218.0)	(23,481.9)

Northern Ogallala GAM Results
Groundwater Availability (Ac-Ft/Yr)

SP (YEAR)	GRAY_CAN	GRAY_RED	HANSFORD	HARTLEY	HEMPHILL	HEMPHILL_RED	HEMPHILL_CAN
2047	(30,379.8)	(91,065.0)	(202,445.2)	(247,319.9)	(43,697.6)	(20,230.8)	(23,466.8)
2048	(30,075.7)	(90,083.7)	(200,231.4)	(243,783.9)	(43,696.4)	(20,245.1)	(23,451.3)
2049	(29,767.1)	(89,115.5)	(198,029.4)	(240,274.6)	(43,688.6)	(20,256.1)	(23,432.6)
2050	(29,456.6)	(88,157.4)	(195,835.4)	(236,815.0)	(43,672.7)	(20,255.8)	(23,416.9)
2051	(29,146.7)	(87,206.3)	(193,685.6)	(233,390.9)	(43,654.7)	(20,248.0)	(23,406.7)
2052	(28,844.6)	(86,274.0)	(191,553.5)	(230,014.3)	(43,641.1)	(20,241.2)	(23,399.9)
2053	(28,541.0)	(85,353.4)	(189,423.7)	(226,713.3)	(43,642.8)	(20,236.1)	(23,406.8)
2054	(28,239.6)	(84,443.4)	(187,325.9)	(223,446.8)	(43,636.4)	(20,227.5)	(23,408.8)
2055	(27,949.5)	(83,544.9)	(185,277.8)	(220,222.7)	(43,631.2)	(20,214.9)	(23,416.3)
2056	(27,654.0)	(82,653.8)	(183,193.2)	(217,030.5)	(43,620.8)	(20,198.3)	(23,422.5)
2057	(27,355.4)	(81,771.1)	(181,103.5)	(213,880.8)	(43,610.3)	(20,176.0)	(23,434.3)
2058	(27,060.7)	(80,891.3)	(179,004.5)	(210,780.2)	(43,600.5)	(20,158.3)	(23,442.1)
2059	(26,767.4)	(80,025.5)	(176,933.6)	(207,696.0)	(43,591.3)	(20,142.6)	(23,448.8)
2060	(26,479.9)	(79,154.3)	(174,892.3)	(204,660.9)	(43,578.7)	(20,132.2)	(23,446.5)

Northern Ogallala GAM Results
Groundwater Availability (Ac-Ft/Yr)

SP (YEAR)	HUTCHINSON	LIPSCOMB	MOORE	OCHILTREE	OLDHAM	POTTER	POTTER_CAN
2010	(153,829.2)	(260,988.7)	(172,388.3)	(257,903.5)	(5,288.2)	(38,083.6)	(30,284.0)
2011	(135,941.4)	(245,529.7)	(182,771.3)	(257,080.2)	(4,857.1)	(31,477.3)	(24,932.1)
2012	(135,189.0)	(247,846.3)	(180,386.7)	(254,476.8)	(5,218.6)	(31,484.5)	(25,022.3)
2013	(134,432.7)	(249,409.0)	(178,488.3)	(252,283.5)	(5,470.4)	(31,241.0)	(24,885.8)
2014	(133,866.8)	(250,695.2)	(176,627.0)	(250,023.9)	(5,704.7)	(30,999.9)	(24,747.0)
2015	(133,288.2)	(251,634.8)	(174,706.9)	(247,787.1)	(5,911.4)	(30,752.5)	(24,600.4)
2016	(132,671.6)	(252,350.4)	(172,720.2)	(245,491.8)	(6,105.5)	(30,460.9)	(24,406.8)
2017	(132,016.1)	(252,841.1)	(170,776.4)	(243,191.4)	(6,242.0)	(30,155.3)	(24,198.2)
2018	(131,308.6)	(253,185.4)	(168,707.6)	(240,999.0)	(6,349.5)	(29,846.7)	(23,983.4)
2019	(130,473.1)	(253,405.6)	(166,524.0)	(238,835.9)	(6,430.0)	(29,530.6)	(23,759.6)
2020	(129,548.1)	(253,487.6)	(164,318.8)	(236,618.5)	(6,433.6)	(29,223.7)	(23,543.3)
2021	(128,611.6)	(253,372.2)	(162,126.0)	(234,405.1)	(6,421.6)	(28,920.5)	(23,328.5)
2022	(127,645.8)	(253,108.0)	(159,904.7)	(232,222.3)	(6,404.7)	(28,616.2)	(23,111.5)
2023	(126,753.2)	(252,733.9)	(157,662.5)	(230,106.9)	(6,385.9)	(28,292.5)	(22,872.4)
2024	(125,897.1)	(252,238.1)	(155,458.0)	(228,009.1)	(6,363.9)	(27,964.6)	(22,627.5)
2025	(124,992.7)	(251,685.9)	(153,279.6)	(225,962.2)	(6,327.0)	(27,635.8)	(22,380.9)
2026	(124,003.7)	(251,061.0)	(151,077.4)	(223,891.8)	(6,280.4)	(27,319.4)	(22,142.0)
2027	(122,988.5)	(250,398.6)	(148,910.7)	(221,781.5)	(6,235.0)	(27,001.8)	(21,903.4)
2028	(121,942.6)	(249,666.6)	(146,789.2)	(219,691.7)	(6,187.9)	(26,690.3)	(21,667.9)
2029	(120,893.7)	(248,764.7)	(144,660.0)	(217,588.8)	(6,139.6)	(26,394.0)	(21,445.6)
2030	(119,797.9)	(247,761.1)	(142,528.7)	(215,489.0)	(6,090.0)	(26,093.4)	(21,215.8)
2031	(118,692.7)	(246,680.6)	(140,357.2)	(213,466.6)	(6,039.3)	(25,780.5)	(20,976.1)
2032	(117,584.6)	(245,531.7)	(138,245.1)	(211,483.5)	(5,988.1)	(25,473.1)	(20,738.1)
2033	(116,497.9)	(244,331.3)	(136,178.5)	(209,438.7)	(5,936.7)	(25,170.1)	(20,502.9)
2034	(115,431.3)	(243,073.4)	(134,131.2)	(207,402.5)	(5,884.9)	(24,873.0)	(20,272.6)
2035	(114,372.0)	(241,811.5)	(132,102.5)	(205,377.6)	(5,831.5)	(24,576.7)	(20,041.9)
2036	(113,301.0)	(240,514.0)	(130,065.1)	(203,350.1)	(5,778.7)	(24,296.3)	(19,827.0)
2037	(112,214.5)	(239,166.2)	(128,014.7)	(201,337.1)	(5,725.7)	(24,011.9)	(19,607.8)
2038	(111,136.3)	(237,810.5)	(126,004.0)	(199,361.8)	(5,672.2)	(23,738.7)	(19,397.1)
2039	(110,060.6)	(236,418.4)	(124,064.6)	(197,438.7)	(5,622.1)	(23,469.4)	(19,190.2)
2040	(108,985.5)	(234,998.7)	(122,137.5)	(195,505.7)	(5,571.0)	(23,204.6)	(18,985.7)
2041	(107,915.0)	(233,567.7)	(120,219.4)	(193,563.3)	(5,519.7)	(22,936.7)	(18,779.2)
2042	(106,838.2)	(232,107.2)	(118,281.6)	(191,633.7)	(5,469.3)	(22,675.8)	(18,576.6)
2043	(105,758.8)	(230,614.2)	(116,377.3)	(189,696.4)	(5,418.5)	(22,420.3)	(18,376.5)
2044	(104,691.8)	(229,104.1)	(114,485.3)	(187,767.6)	(5,368.1)	(22,161.3)	(18,175.9)
2045	(103,608.6)	(227,566.3)	(112,597.4)	(185,857.1)	(5,318.3)	(21,905.2)	(17,973.1)
2046	(102,501.3)	(226,034.4)	(110,809.4)	(183,951.7)	(5,268.7)	(21,659.6)	(17,779.7)

Northern Ogallala GAM Results
Groundwater Availability (Ac-Ft/Yr)

SP (YEAR)	HUTCHINSON	LIPSCOMB	MOORE	OCHILTREE	OLDHAM	POTTER	POTTER_CAN
2047	(101,403.7)	(224,492.7)	(108,962.9)	(182,062.8)	(5,220.4)	(21,412.1)	(17,583.7)
2048	(100,338.3)	(222,925.7)	(107,141.9)	(180,186.2)	(5,171.9)	(21,166.2)	(17,389.9)
2049	(99,286.6)	(221,333.7)	(105,332.2)	(178,356.1)	(5,124.2)	(20,926.8)	(17,200.4)
2050	(98,239.3)	(219,735.0)	(103,539.1)	(176,566.1)	(5,079.2)	(20,684.2)	(17,007.0)
2051	(97,187.4)	(218,120.4)	(101,773.1)	(174,784.8)	(5,033.5)	(20,449.0)	(16,820.0)
2052	(96,129.4)	(216,503.2)	(100,052.9)	(172,982.5)	(4,988.3)	(20,218.0)	(16,637.9)
2053	(95,064.0)	(214,865.9)	(98,334.2)	(171,171.2)	(4,944.3)	(19,994.6)	(16,460.5)
2054	(94,017.8)	(213,219.4)	(96,632.8)	(169,385.1)	(4,900.8)	(19,768.9)	(16,280.6)
2055	(92,990.5)	(211,549.1)	(94,956.9)	(167,615.1)	(4,859.1)	(19,542.4)	(16,099.7)
2056	(91,964.5)	(209,872.0)	(93,323.5)	(165,852.6)	(4,817.1)	(19,321.4)	(15,922.4)
2057	(90,956.8)	(208,206.3)	(91,700.1)	(164,107.4)	(4,775.7)	(19,103.4)	(15,749.0)
2058	(89,947.0)	(206,544.1)	(90,099.0)	(162,396.7)	(4,736.2)	(18,885.0)	(15,573.9)
2059	(88,961.1)	(204,871.8)	(88,523.5)	(160,707.6)	(4,696.5)	(18,668.9)	(15,399.9)
2060	(87,979.3)	(203,197.9)	(86,974.5)	(159,016.6)	(4,658.3)	(18,458.6)	(15,229.8)

Northern Ogallala GAM Results
Groundwater Availability (Ac-Ft/Yr)

SP (YEAR)	POTTER_RED	RANDALL	ROBERTS	ROBERTS_CAN	ROBERTS_RED	SHERMAN	WHEELER
2010	(7,799.7)	(19,729.9)	(375,334.2)	(361,045.1)	(14,289.1)	(316,970.6)	(120,205.2)
2011	(6,545.2)	(22,578.8)	(345,056.7)	(330,363.6)	(14,693.1)	(331,069.3)	(101,705.6)
2012	(6,462.2)	(21,500.4)	(344,853.7)	(329,698.6)	(15,155.1)	(326,912.4)	(105,614.5)
2013	(6,355.2)	(20,926.1)	(344,692.0)	(329,109.9)	(15,582.1)	(323,893.1)	(108,234.9)
2014	(6,252.9)	(20,422.7)	(344,526.9)	(328,593.9)	(15,933.0)	(320,414.5)	(110,356.2)
2015	(6,152.1)	(19,984.6)	(344,187.3)	(327,976.8)	(16,210.5)	(316,816.4)	(111,947.6)
2016	(6,054.1)	(19,579.6)	(343,805.7)	(327,363.3)	(16,442.4)	(313,160.2)	(113,035.0)
2017	(5,957.0)	(19,229.1)	(343,264.6)	(326,627.0)	(16,637.6)	(309,519.1)	(113,784.5)
2018	(5,863.3)	(18,918.2)	(342,180.8)	(325,407.4)	(16,773.4)	(305,909.3)	(114,309.0)
2019	(5,771.1)	(18,650.3)	(340,922.2)	(324,043.5)	(16,878.6)	(302,301.8)	(114,665.4)
2020	(5,680.4)	(18,411.1)	(339,517.7)	(322,555.7)	(16,962.0)	(298,567.5)	(114,819.0)
2021	(5,592.0)	(18,186.0)	(338,086.7)	(321,061.6)	(17,025.2)	(294,893.7)	(114,816.2)
2022	(5,504.7)	(17,970.4)	(336,630.9)	(319,557.5)	(17,073.4)	(291,269.6)	(114,675.5)
2023	(5,420.1)	(17,757.7)	(334,944.7)	(317,851.6)	(17,093.1)	(287,632.1)	(114,461.6)
2024	(5,337.1)	(17,564.4)	(333,236.5)	(316,148.9)	(17,087.5)	(284,041.3)	(114,218.9)
2025	(5,255.0)	(17,369.6)	(331,547.8)	(314,477.2)	(17,070.6)	(280,477.7)	(113,951.9)
2026	(5,177.4)	(17,179.5)	(329,929.1)	(312,885.4)	(17,043.7)	(276,951.9)	(113,655.4)
2027	(5,098.4)	(16,982.8)	(328,285.6)	(311,277.3)	(17,008.3)	(273,388.0)	(113,318.8)
2028	(5,022.4)	(16,789.9)	(326,589.3)	(309,624.6)	(16,964.7)	(269,865.6)	(112,939.7)
2029	(4,948.4)	(16,598.7)	(324,822.7)	(307,910.1)	(16,912.6)	(266,333.5)	(112,547.9)
2030	(4,877.6)	(16,418.6)	(322,908.8)	(306,054.1)	(16,854.8)	(262,819.5)	(112,162.6)
2031	(4,804.4)	(16,225.2)	(320,887.5)	(304,096.7)	(16,790.7)	(259,369.9)	(111,724.9)
2032	(4,735.0)	(16,038.8)	(318,768.2)	(302,047.9)	(16,720.3)	(255,945.2)	(111,225.1)
2033	(4,667.2)	(15,850.0)	(316,722.5)	(300,083.5)	(16,639.0)	(252,544.3)	(110,694.3)
2034	(4,600.4)	(15,661.9)	(314,666.3)	(298,115.6)	(16,550.7)	(249,142.1)	(110,145.1)
2035	(4,534.7)	(15,474.2)	(312,491.7)	(296,037.6)	(16,454.1)	(245,741.4)	(109,573.6)
2036	(4,469.3)	(15,291.1)	(310,258.0)	(293,907.1)	(16,350.9)	(242,408.3)	(108,997.5)
2037	(4,404.1)	(15,112.0)	(308,004.0)	(291,760.7)	(16,243.3)	(239,154.8)	(108,396.1)
2038	(4,341.6)	(14,935.5)	(305,778.4)	(289,648.6)	(16,129.7)	(235,939.8)	(107,778.6)
2039	(4,279.2)	(14,762.1)	(303,612.3)	(287,597.8)	(16,014.5)	(232,753.2)	(107,142.9)
2040	(4,218.9)	(14,589.1)	(301,420.3)	(285,524.7)	(15,895.6)	(229,557.3)	(106,500.1)
2041	(4,157.5)	(14,419.2)	(299,134.9)	(283,358.8)	(15,776.1)	(226,421.8)	(105,854.1)
2042	(4,099.2)	(14,248.7)	(296,813.8)	(281,159.4)	(15,654.4)	(223,312.3)	(105,210.7)
2043	(4,043.8)	(14,083.1)	(294,429.6)	(278,898.2)	(15,531.4)	(220,232.7)	(104,554.7)
2044	(3,985.4)	(13,923.0)	(292,043.0)	(276,635.3)	(15,407.8)	(217,136.4)	(103,888.5)
2045	(3,932.2)	(13,761.5)	(289,706.5)	(274,423.2)	(15,283.3)	(214,052.5)	(103,212.9)
2046	(3,879.9)	(13,603.5)	(287,350.5)	(272,191.5)	(15,159.0)	(210,965.5)	(102,532.8)

Northern Ogallala GAM Results
Groundwater Availability (Ac-Ft/Yr)

SP (YEAR)	POTTER_RED	RANDALL	ROBERTS	ROBERTS_CAN	ROBERTS_RED	SHERMAN	WHEELER
2047	(3,828.4)	(13,443.9)	(284,979.8)	(269,935.5)	(15,044.3)	(207,904.3)	(101,861.5)
2048	(3,776.3)	(13,288.1)	(282,520.8)	(267,594.9)	(14,925.9)	(204,872.0)	(101,171.9)
2049	(3,726.3)	(13,129.2)	(280,017.0)	(265,211.2)	(14,805.8)	(201,825.9)	(100,485.0)
2050	(3,677.1)	(12,973.9)	(277,508.6)	(262,824.7)	(14,683.9)	(198,809.3)	(99,801.5)
2051	(3,629.0)	(12,821.4)	(275,003.2)	(260,442.3)	(14,560.9)	(195,801.9)	(99,124.2)
2052	(3,580.2)	(12,664.8)	(272,468.6)	(258,031.7)	(14,436.9)	(192,823.1)	(98,444.3)
2053	(3,534.2)	(12,518.1)	(269,917.6)	(255,603.6)	(14,314.0)	(189,860.7)	(97,759.2)
2054	(3,488.3)	(12,369.9)	(267,377.5)	(253,187.4)	(14,190.1)	(186,896.7)	(97,081.7)
2055	(3,442.6)	(12,225.2)	(264,840.8)	(250,774.5)	(14,066.3)	(183,935.6)	(96,396.8)
2056	(3,399.0)	(12,085.6)	(262,302.4)	(248,360.0)	(13,942.4)	(181,011.6)	(95,713.1)
2057	(3,354.4)	(11,945.4)	(259,733.5)	(245,910.2)	(13,823.3)	(178,121.4)	(95,027.5)
2058	(3,311.1)	(11,806.3)	(257,132.7)	(243,424.0)	(13,708.7)	(175,261.9)	(94,346.9)
2059	(3,269.1)	(11,666.8)	(254,541.3)	(240,949.9)	(13,591.4)	(172,452.7)	(93,671.0)
2060	(3,228.8)	(11,530.9)	(251,932.7)	(238,459.1)	(13,473.6)	(169,671.7)	(92,993.3)

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Telephone: 512 425 2000
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MEMORANDUM

To: Simone Kiel, Freese and Nichols, Inc.

From: Van Kelley, INTERA
Dennis Fryar, INTERA

Date: July 29, 2010

RE: Baseline Simulation Results Using the Dutton (2004) GAM with Updated Pumping Demands

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The revised GAM (INTERA, 2010) documented in Appendix F of this plan was not completed in time to be completely incorporated into the Initially Prepared Plan. As a result, simulations to support the planning process were made using the 2004 Dutton GAM (Dutton, 2004) updated to include updated historical (1950-2008) pumping and an updated predictive demand distribution (2009-2060).

A baseline simulation was performed to determine the capability of the aquifer to meet projected demands through 2060 with current infrastructure. Table D-1 summarizes the groundwater in storage in the PWPA for the baseline simulation across the predictive simulation period from 2010 through 2060.

Figure D-1 shows the saturated thickness of the aquifer simulated by the GAM in the year 2010. One can see that in 2010 most of the Northern Ogallala in Texas is saturated with the largest number of inactive cells (representing dry aquifer conditions and white in the figure) in Dallam County. Figures D-2 and D-3 provide similar saturated thickness plots for the years 2030 and 2060, respectively. By 2060 one can see that significant portions of the aquifer in Dallam, Hartley, Moore and Sherman counties have become inactive. The baseline analysis shows that with projected pumping there will be significant areas of the aquifer with significant depletion. Many of these areas occur in heavily irrigated areas. As areas of the model region become over-pumped, the model cells become inactive which represents dry aquifer conditions. In reality, there will likely be a thin saturated thickness in these portions of the aquifer in the future because pumping efficiency will decrease to such a degree that desaturation of the aquifer will be uneconomical. When a model cell becomes inactive, the pumping that is assigned to that cell as a demand cannot be satisfied and these wells are effectively shut off.

Table D-2 provides a summary of the pumping demand requested of the model on a county basis by decade from 2010 through 2060. Table D-3 provides a summary of the pumping volume actually pumped from each county by decade from 2010 through 2060. In the period between 2010 and 2060 the annual average demand for the Ogallala is 1,303,482 acre-ft/year in Region A. However, the model predicts that users will only be able to pump an average annual amount of 969,212 acre-ft/year for the planning period. By the year 2060, the model predicts that pumping will be reduced by approximately 44.9 percent from the pumping demand.

References:

Dutton, A., 2004. Adjustments of Parameters to Improve the Calibration of the Og-n Model of the Ogallala Aquifer, Panhandle Water Planning Group, Prepared for Freese and Nichols, Inc. and the Panhandle Water Planning Group, June 2004.

INTERA, 2010. Northern Ogallala Update to Support 2011 State Water Plan, Submitted to the Panhandle Area Water Planning Group, February 2010, Included as Appendix F of this Regional Water Plan for the Panhandle Water Planning Area.

Table D-1 Groundwater in storage (acre-ft), baseline simulation(1).

County	2010	2020	2030	2040	2050	2060
Armstrong	3,422,773	3,386,035	3,350,603	3,316,695	3,285,329	3,257,389
Carson	14,071,052	13,519,741	13,005,845	12,514,858	12,085,200	11,713,447
Collingsworth	85,793	85,696	85,600	85,511	85,430	85,361
Dallam	14,420,421	12,504,805	10,931,542	9,783,757	8,991,767	8,462,420
Donley	5,733,509	5,496,388	5,295,354	5,121,490	4,977,372	4,866,096
Gray	13,126,321	12,852,731	12,601,443	12,363,648	12,150,490	11,961,188
Hansford	20,409,655	19,271,486	18,237,164	17,258,378	16,386,542	15,633,384
Hartley	21,747,772	19,377,289	17,700,362	16,616,557	15,941,982	15,484,458
Hemphill	15,473,075	15,429,244	15,391,305	15,359,662	15,334,260	15,314,243
Hutchinson	10,553,132	9,932,670	9,380,780	8,888,808	8,478,132	8,130,914
Lipscomb	18,458,532	18,264,312	18,094,708	17,943,872	17,818,846	17,722,298
Moore	9,073,330	7,800,781	6,654,934	5,647,404	4,918,946	4,434,168
Ochiltree	19,104,748	18,628,312	18,189,073	17,767,415	17,381,757	17,042,149
Oldham	348,291	347,997	347,638	347,183	346,613	345,929
Potter	2,679,448	2,541,100	2,441,898	2,354,113	2,278,140	2,230,359
Randall	1,644,728	1,639,999	1,631,057	1,622,772	1,616,472	1,609,374
Roberts	27,078,546	26,266,991	25,543,758	24,997,372	24,543,081	24,192,427
Sherman	17,294,485	15,442,185	13,754,762	12,197,899	10,880,317	9,830,743
Wheeler	7,415,354	7,351,351	7,298,190	7,252,283	7,215,583	7,188,348
Sum	**222,140,963**	**210,139,113**	**199,936,014**	**191,439,679**	**184,716,258**	**179,504,693**

(1) Simulations results using the 2004 Dutton GAM with 2011 Plan updated pumping demands

Table D-2 Groundwater pumping demand (acre-ft) – baseline simulation(1).

County	2010	2020	2030	2040	2050	2060
Armstrong	3,410	3,295	3,209	3,073	2,817	2,557
Carson	68,003	58,348	60,281	57,497	47,771	45,958
Collingsworth	0	0	0	0	0	0
Dallam	282,335	274,929	266,771	252,853	224,580	196,260
Donley	32,353	30,019	29,096	27,563	24,518	21,468
Gray	29,428	26,222	26,632	25,863	24,477	22,385
Hansford	131,074	115,976	112,902	107,564	96,482	85,421
Hartley	296,286	285,034	277,076	263,478	235,664	207,936
Hemphill	5,396	5,285	4,956	4,384	3,836	3,346
Hutchinson	65,137	63,632	63,754	62,948	59,852	57,541
Lipscomb	30,583	28,210	27,291	25,733	22,893	20,078
Moore	150,074	139,282	137,125	132,845	121,040	109,251
Ochiltree	61,419	53,254	51,910	49,459	44,554	39,689
Oldham	1	1	1	1	1	0
Potter	13,344	12,569	11,859	10,970	10,129	9,384
Randall	7,865	7,631	7,915	8,144	8,131	8,033
Roberts	57,377	76,004	75,690	75,152	74,369	67,190
Sherman	228,557	208,975	203,141	191,877	172,757	152,394
Wheeler	10,021	8,727	8,368	7,733	6,794	5,896
Sum	**1,472,661**	**1,397,393**	**1,367,975**	**1,307,136**	**1,180,663**	**1,054,789**

(1) Simulations results using the 2004 Dutton GAM with 2011 Plan updated pumping demands

Table D-3 Actual groundwater pumping (acre-ft) – baseline simulation(1).

County	2010	2020	2030	2040	2050	2060
Armstrong	2,575	2,530	2,468	2,370	2,193	2,011
Carson	68,003	58,348	60,281	57,497	47,771	45,365
Collingsworth	0	0	0	0	0	0
Dallam	227,098	189,908	150,979	112,347	80,176	59,718
Donley	32,353	27,249	25,838	23,160	20,260	17,250
Gray	26,622	23,866	23,418	22,179	19,772	17,741
Hansford	131,074	115,975	112,901	106,527	95,027	83,831
Hartley	274,329	213,607	146,551	96,754	64,542	50,626
Hemphill	5,396	5,285	4,956	4,384	3,836	3,346
Hutchinson	62,505	53,783	49,785	41,502	35,226	28,659
Lipscomb	30,583	28,210	27,290	25,733	22,893	20,078
Moore	145,288	127,205	114,947	95,252	65,509	41,390
Ochiltree	60,950	52,854	51,522	49,092	44,228	39,403
Oldham	1	1	1	1	1	0
Potter	13,344	9,201	8,787	8,252	6,504	4,528
Randall	6,941	6,821	6,945	6,756	6,604	6,642
Roberts	57,377	76,003	60,594	52,882	43,685	32,734
Sherman	228,556	206,130	194,352	176,793	147,465	121,598
Wheeler	10,021	8,727	8,368	7,733	6,794	5,896
Sum	**1,383,012**	**1,205,703**	**1,049,983**	**889,212**	**712,486**	**580,817**

(1) Simulations results using the 2004 Dutton GAM with 2011 Plan updated pumping demands

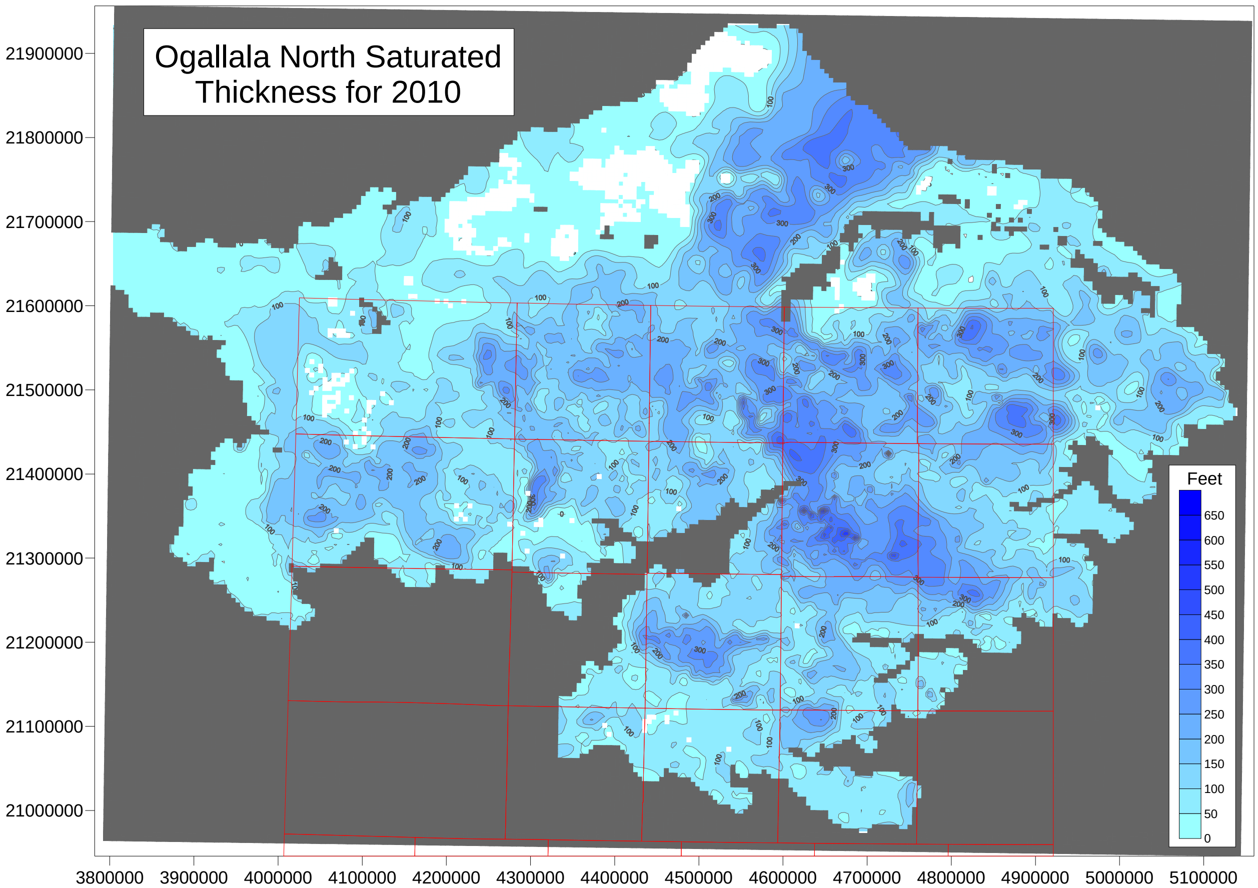


Figure D-1. **Saturated thickness in 2010 – baseline simulation; 2004 Dutton GAM with 2011 Plan updated pumping demands.**

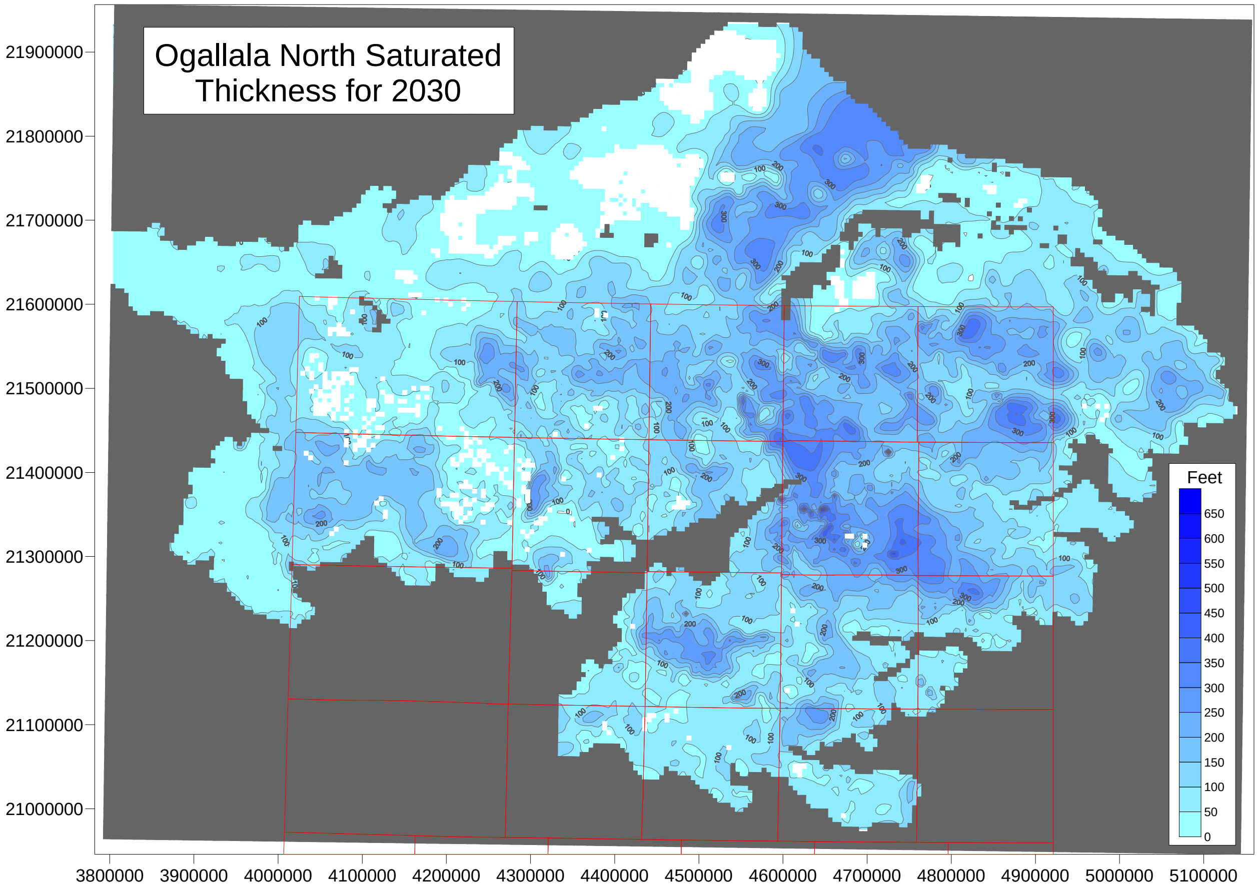


Figure D-2. Saturated thickness in 2030 – baseline simulation; 2004 Dutton GAM with 2011 Plan updated pumping demands.

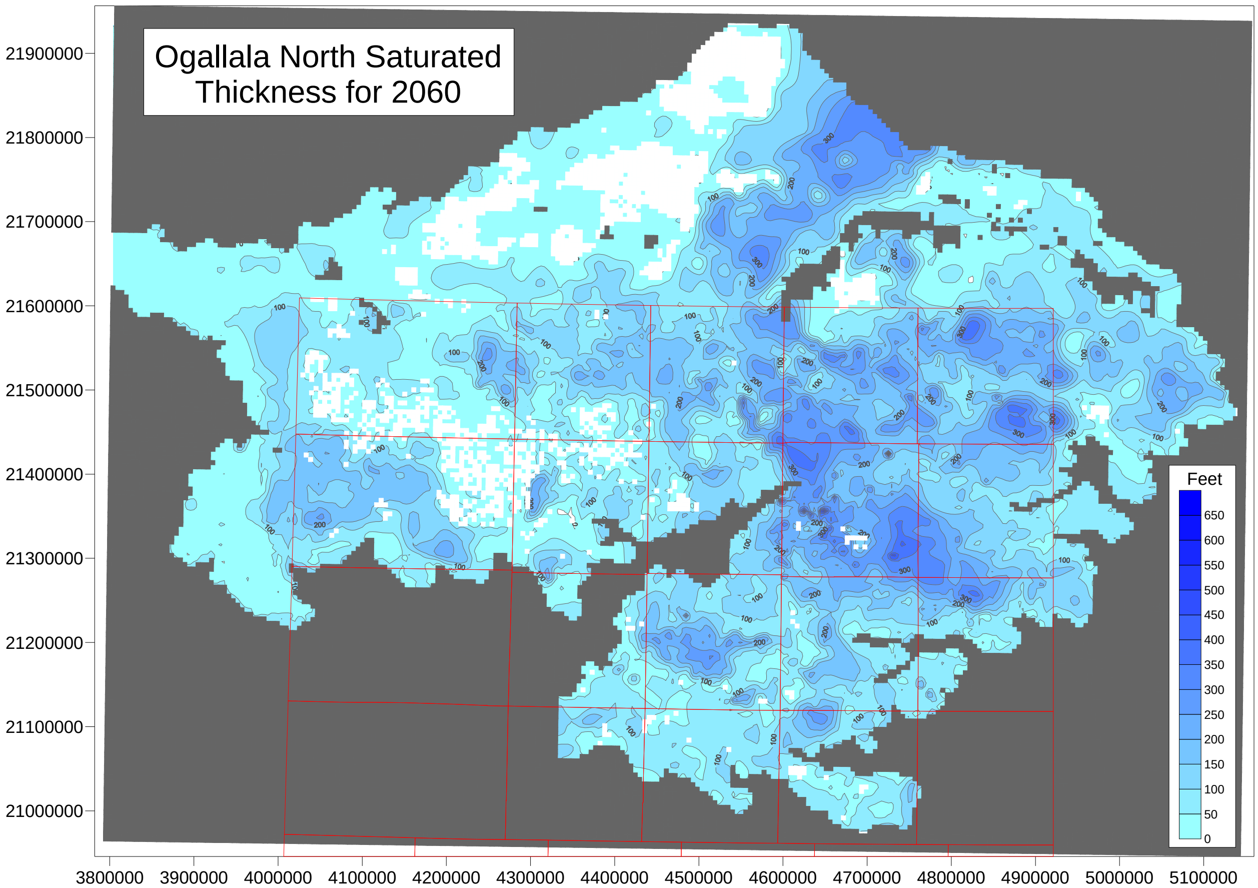


Figure D-3. Saturated thickness in 2060 – baseline simulation; 2004 Dutton GAM with 2011 Plan updated pumping demands.

GAM run 04-22

by Roberto Anaya, Scott Hamlin, and Shirley Wade
Texas Water Development Board
Groundwater Availability Modeling Section
(512) 936-2415
March 4, 2005

REQUESTOR:

Mr. Stefan Schuster with Freese and Nichols, Inc. on behalf of the Panhandle Regional Water Planning Group

DESCRIPTION OF REQUEST:

Determine the groundwater volume in storage for the Blaine aquifer in Childress, Collingsworth, Hall, and Wheeler counties and for the Seymour aquifer in Childress, Collingsworth, and Hall counties for the years 2000 to 2060 on a decadal basis using the Groundwater Availability Model (GAM) for the Seymour aquifer (Ewing, and others, 2004).

METHODS:

To address the request, we ran the GAM for the Seymour aquifer using average annual recharge for the period through 2060 and predictive pumpage based on new demands that the Panhandle Regional Water Planning Group plans to include in their 2006 regional water plan. We saved water-level values for the Blaine and the Seymour aquifers for the end of each decade and imported them into ArcView. Some water levels (less than 10 percent of the active cells) exceeded the land surface. We adjusted these water levels to land surface and calculated the saturated thicknesses of the aquifers. We then multiplied the saturated thickness by the appropriate area and specific yield to calculate groundwater volumes.

PARAMETERS AND ASSUMPTIONS:

- See Ewing and others (2004) for assumptions and limitations of the GAM. Root mean squared error for this model ranges from 9.7 feet to 27.5 feet for the Seymour aquifer and is 26.4 feet for the Blaine aquifer (Ewing and others, 2004). This error will have more of an effect on model results where the aquifer is thin.
- We used a specific yield of 0.05 for the Blaine aquifer and 0.15 for the Seymour aquifer.
- Recharge represents average conditions for the predictive period.

RESULTS:

The volume of groundwater from the Seymour and Blaine aquifers in the counties are listed in Table 1. Note that the GAM run may include less pumpage than initially assigned because, according to the GAM, the Seymour aquifer cannot support the pumpage and begins to go dry. In the GAM, once a part of the model goes dry, it stays dry, and the pumping is “shut off.” This can result in water levels rising in nearby areas once the pumping in the area is stopped (Table 1). This also results in less pumping in the model because the pumping has been stopped in these areas. In reality, the aquifer will probably not go dry because pumping will become uneconomical before the aquifer goes dry in any particular area. However, the GAM is suggesting that these areas may experience water supply problems sometime in the next 50 years.

REFERENCES:

Ewing, J. E., Jones, T. L., Pickens, J. F., Chastain-Howley, A., Dean, K. E., Spear, and A. A., 2004, Groundwater availability model for the Seymour aquifer: final report prepared for the Texas Water Development Board by INTERA Inc., 432 p.

Table 1. Volume of groundwater in the Blaine and Seymour aquifers for counties in the Panhandle Regional Water Planning Area based on the GAM for the Seymour aquifer.

Blaine aquifer **Groundwater volumes in acre-feet**

County	2000	2010	2020	2030	2040	2050	2060
Childress	4,900,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000
Collingsworth	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000
Hall	800,000	800,000	800,000	800,000	800,000	800,000	800,000
Wheeler	2,600,000	2,600,000	2,500,000	2,500,000	2,500,000	2,500,000	2,500,000

Seymour aquifer **Groundwater volumes in acre-feet**

County	2000	2010	2020	2030	2040	2050	2060
Childress	130,000	130,000	130,000	140,000	140,000	140,000	140,000
Collingsworth	520,000	480,000	460,000	450,000	450,000	460,000	470,000
Hall	210,000	200,000	180,000	180,000	180,000	190,000	190,000

- values are rounded to two significant figures

GAM run 05-11

by Richard Smith, PG
Texas Water Development Board
Groundwater Availability Modeling Section
(512) 936-0877
March 4, 2005

REQUESTOR:

Mr. Stefan Schuster with Freese and Nichols, Inc. on behalf of the Panhandle Regional Water Planning Group

DESCRIPTION OF REQUEST:

Mr. Schuster requested that we run the Groundwater Availability Model (GAM) for the southern part of the Ogallala aquifer for the period 2000 to 2050 for Randall and Oldham counties and (1) compute groundwater volumes for the same counties and (2) estimate groundwater volumes for 2060. He wanted this information for 2000, 2010, 2020, 2030, 2040, 2050, and 2060.

METHODS:

We used the GAM for the southern part of the Ogallala aquifer (Blandford and others, 2003) with average recharge and the 2000 to 2050 predictive scenario. We calculated saturated thickness by subtracting the bottom of the Ogallala aquifer, as included in the GAM, from the GAM calculated water levels. We then used ArcView to generate total volumes for each county based on the saturated thickness for each decade. On a cell-by-cell basis in the GAM, we multiplied the saturated thickness by the area of the cell and by a specific yield of 0.15. We used trend line projections, as calculated in Excel, to estimate aquifer volumes for 2060.

In addition, we adjusted the partial values listed in Table 1 of GAM run 05-10 (Smith and Mace, 2005) for Oldham and Randall counties to reflect the full aquifer volumes for these counties and included the results in this report.

PARAMETERS AND ASSUMPTIONS:

- See Blandford and others (2003) for assumptions and limitations of the GAM. Root mean squared error for this model is 44 ft. This error will have more of an effect on model results where the aquifer is thin.
- Recharge represents average conditions for the predictive period.
- Assumed a uniform specific yield of 0.15 across aquifer.
- Assumed the trend line analysis represents a reasonable projection based on 2000 to 2050 volumes.

RESULTS:

Table 1 shows the estimated aquifer volumes for the parts of Oldham and Randall counties that were modeled in the GAM of the southern part of the Ogallala aquifer. Note that the GAM run may include less pumpage than initially assigned because, according to the GAM, the aquifer cannot support the pumpage and begins to go dry in Randall County. In the GAM, once a part of the model goes dry, it stays dry, and the pumping is "shut off." This can result in water levels rising in nearby areas once the pumping in the area is stopped (Figure 1). This also results in less pumping in the model because the pumping has been stopped in these areas. In reality, the aquifer will probably not go dry because pumping will become uneconomical before the aquifer goes dry in any particular area. However, the GAM is suggesting that these areas may experience water supply problems sometime in the next 50 years.

The polynomial trend line and linear analysis to project the aquifer volume for 2060 for Randall and Oldham counties had a 98 percent R-squared value and a 90 percent R-squared value, respectively (see Figures 1 and 2).

Table 2 shows the adjusted groundwater volumes to reflect all of Oldham and Randall counties. The projected volumes are consistently higher than the 1.25% analysis from GAM run 04-13 (Smith, 2004). See GAM Run 05-10 (Smith and Mace, 2005) for an analysis of what these numbers mean.

REFERENCES:

Blandford, T. N., Blazer, D. J., Calhoun, K. C., Dutton, A. R., Naing, T., Reedy, R. C., and Scanlon, B. R., 2003, Groundwater Availability of the Southern Ogallala Aquifer in Texas and New Mexico; Numerical Simulations Through 2050: final report prepared for the Texas Water Development Board.

Smith, R., 2004, GAM Run 04-13: Texas Water Development Board, 7 p.

Smith, R., 2005, GAM Run 05-09: Texas Water Development Board, 14 p.

Smith, R. and Mace, R., 2005, GAM Run 05-10: Texas Water Development Board, 4 p.

Table 1. Estimates of groundwater volumes for the portions of Oldham and Randall counties located in the GAM of the southern part of the Ogallala aquifer.

County	GAM 2000 (acre-feet)	GAM 2010 (acre-feet)	GAM 2020 (acre-feet)	GAM 2030 (acre-feet)	GAM 2040 (acre-feet)	GAM 2050 (acre-feet)	*GAM 2060 (acre-feet)
Oldham	2,220,000	2,120,000	2,100,000	2,070,000	2,050,000	2,050,000	1,990,000
Randall	4,840,000	4,370,000	4,100,000	4,040,000	4,140,000	4,220,000	4,620,000

- Values are rounded to three significant figures.
* 2060 is not based on the GAM.

Table 2. Update to Table 1 in GAM run 05-10 for Oldham and Randall counties reflecting the combination of aquifer volumes from the northern and southern parts of the GAMs of the Ogallala aquifer.

County	1.25% 2000 (acre-feet)	GAM 2000 (acre-feet)	1.25% 2010 (acre-feet)	GAM 2010 (acre-feet)	1.25% 2020 (acre-feet)	GAM 2020 (acre-feet)	1.25% 2030 (acre-feet)	GAM 2030 (acre-feet)	1.25% 2040 (acre-feet)	GAM 2040 (acre-feet)
Oldham*	2,580,000	2,660,000	2,310,000	2,560,000	2,080,000	2,530,000	1,870,000	2,490,000	1,690,000	2,470,000
Randall*	6,230,000	6,400,000	5,730,000	5,820,000	5,290,000	5,460,000	4,900,000	5,320,000	4,560,000	5,360,000

County	1.25% 2050 (acre-feet)	GAM 2050 (acre-feet)	1.25% 2060 (acre-feet)	GAM 2060 (acre-feet)
Oldham*	1,530,000	2,460,000	1,390,000	2,400,000**
Randall*	4,250,000	5,390,000	3,990,000	5,750,000**

- Values are rounded to three significant figures.
* Additional information on the method and assumptions used to calculate the 1.25% reduction can be found in GAM run 04-13 (Smith, 2004) and the method and assumptions used to estimate the portion of the counties in the northern portion of the Ogallala aquifer GAM can be found in GAM run 05-09 (Smith, 2005).
** 2060 is not based on the GAM.

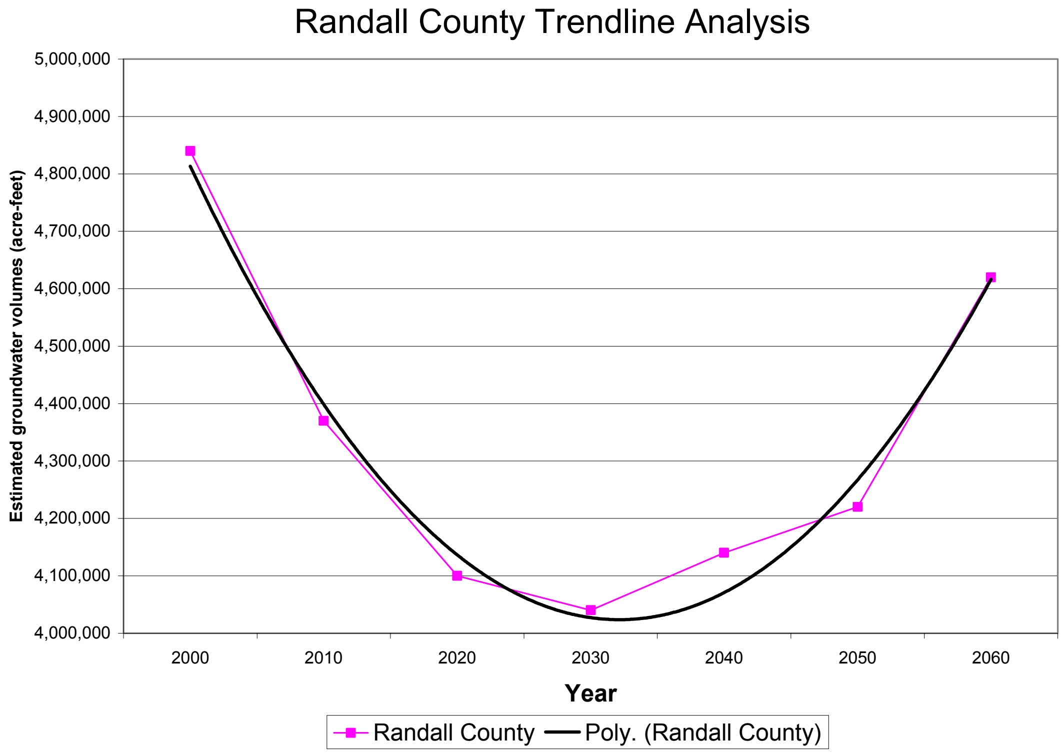


Figure 1. Polynomial best fit trend analysis for groundwater volume in Randall County (Equation is $y = 76{,}429x^2 - 644{,}286x + 5{,}380{,}000$; $R^2 = 0.9811$).

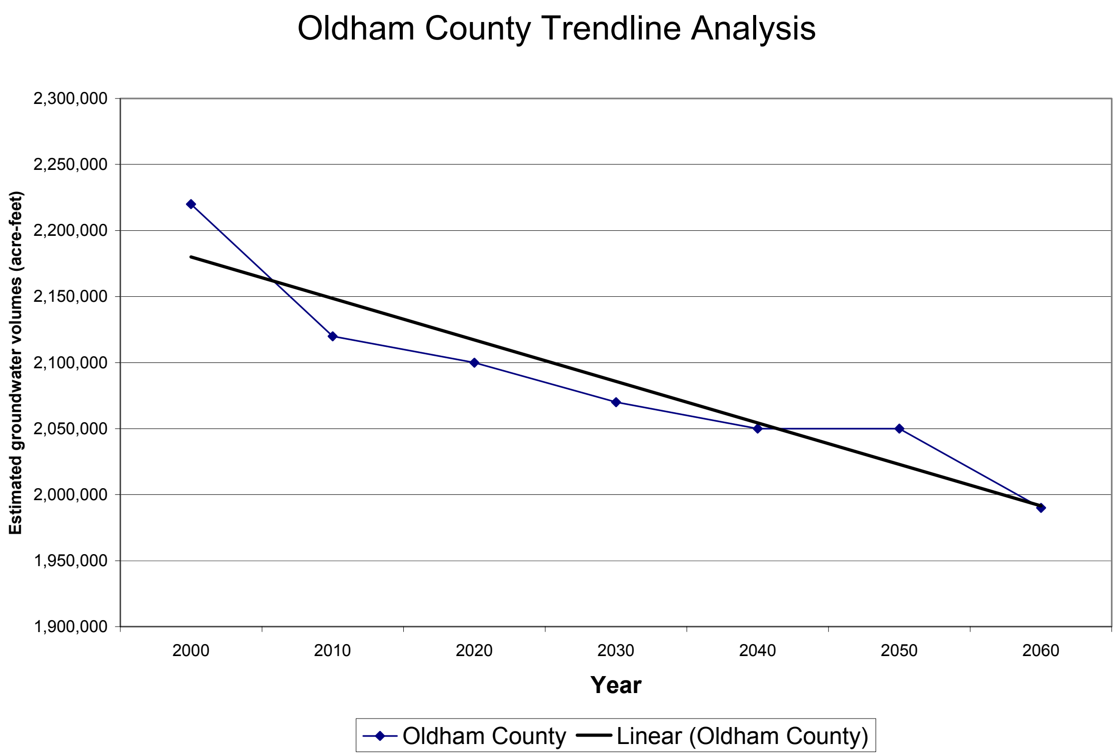


Figure 2 Linear trend analysis for groundwater volume in Oldham County (Equation is $y = -31{,}429x + 2{,}000{,}000$; $R^2 = 0.8816$).

GAM run 05-16

by Richard Smith, P.G.
Texas Water Development Board
Groundwater Availability Modeling Section
(512) 936-0877
June 12, 2005

REQUESTOR:

Mr. Stefan Schuster with Freese and Nichols, Inc. on behalf of the Panhandle Regional Water Planning Group

DESCRIPTION OF REQUEST:

Mr. Schuster requested that we run the Groundwater Availability Model (GAM) for the southern part of the Ogallala aquifer for the period 1950 to 2060 and provide maps of saturated thicknesses for 1950, 1960, 1970, 1980, 1990, 2000, 2010, 2020, 2030, 2040, 2050, and 2060 in Oldham, Potter, and Randall counties.

METHODS:

We used the Groundwater Availability Model (GAM) for the southern part of the Ogallala aquifer (Blandford and others, 2003). For the historical simulation (1950 to 1999), we used pumpage as included in the GAM. For the predictive simulation (2000 to 2060), we used the water demand projections for water user groups of the Llano Estacado Regional Water Planning Group, as approved by the Texas Water Development Board on September 17, 2003, for the period of record through 2060 (see GAM run 03-36). In GAM run 05-11, volumes in 2060 for Oldham and Randall counties were projected using polynomial trend line and linear analysis. This was done as a simplification and the resulting values are essentially the same as the GAM values for the same year using the pumpage from GAM run 03-36. Once we ran the GAM, we calculated saturated thickness by subtracting the bottom elevation of the Ogallala aquifer as included in the GAM from the GAM calculated water levels. We contoured the saturated thickness data on a cell-by-cell basis within PMWIN to create maps.

PARAMETERS AND ASSUMPTIONS:

- See Blandford and others (2003) for assumptions and limitations of the GAM. Root mean squared error for this model is 34 feet. This error will have more of an effect on model results where the aquifer is thin.
- Recharge represents average conditions for the predictive period.
- Assumed a uniform specific yield of 0.15 across the aquifer.

RESULTS:

We developed estimates for groundwater volumes for 2060 in GAM run 05-11 using polynomial trend line and linear analysis for Randall and Oldham counties. The estimates for 2060 are slightly different when the model was re-run to 2060 using the pumpage from GAM run 03-26 (Table 1). We have also included groundwater volumes for Potter County for the portion of Potter County located in the southern part of the Ogallala aquifer GAM. In addition, we have included the total groundwater volumes for Randall, Oldham, and Potter counties for the northern and southern part of the Ogallala aquifer GAMs combined (Table 2).

Figures 1 through 12 show GAM historic and predicted saturated thicknesses. Note that the white areas in these figures represent dry cells in the GAM. As the predictive run progresses, more white appears in the GAM. These white areas represent parts of the GAM that are going dry because the aquifer can not continue to support the pumping. In the GAM, once a part of the model goes dry, it stays dry, and the pumping is "shut off." This can result in water levels rising in nearby areas once the pumping in the area is stopped. This also results in less pumping in the model because the pumping has been stopped in these areas. In reality, the aquifer will probably not go dry because pumping will become uneconomical before the aquifer goes dry in any particular area. However, the GAM is suggesting that these areas may experience water supply problems sometime in the next 50 years.

REFERENCES:

Blandford, T. N., Blazer, D. J., Calhoun, K. C., Dutton, A. R., Naing, T., Reedy, R. C.,and Scanlon, B. R., 2003, Groundwater availability of the southern Ogallala aquifer in Texas and New Mexico: Numerical simulations through 2050: Final Report prepared by D. B. Stephens & Assoc, for the Texas Water Development Board.

Table 1. Estimates of groundwater volumes for the portions of Oldham, Randall, and Potter counties located in the GAM of the southern part of the Ogallala aquifer.

County	GAM 2000 (acre-feet)	GAM 2010 (acre-feet)	GAM 2020 (acre-feet)	GAM 2030 (acre-feet)	GAM 2040 (acre-feet)	GAM 2050 (acre-feet)	GAM 2060 (acre-feet)
Oldham	2,220,000	2,120,00 0	2,100,00 0	2,070,000	2,050,000	2,050,000	2,040,000
Randall	4,840,000	4,370,00 0	4,100,00 0	4,040,000	4,140,000	4,220,000	4,210,000
Potter	294,000	241,00 0	213,00 0	204,000	203,000	202,000	200,000

- Values are rounded to three significant figures.

Table 2. Update to Table 1 in GAM run 05-10 for Oldham, Randall, and Potter counties reflecting the combination of aquifer volumes from the northern and southern parts of the GAMs of the Ogallala aquifer.

County	1.25% 2000 (acre-feet)	GAM 2000 (acre-feet)	1.25% 2010 (acre-feet)	GAM 2010 (acre-feet)	1.25% 2020 (acre-feet)	GAM 2020 (acre-feet)	1.25% 2030 (acre-feet)	GAM 2030 (acre-feet)	1.25% 2040 (acre-feet)	GAM 2040 (acre-feet)
Oldham*	2,580,000	2,660,000	2,310,000	2,560,000	2,080,000	2,530,000	1,870,000	2,490,000	1,690,000	2,470,000
Randall*	6,230,000	6,400,000	5,730,000	5,820,000	5,290,000	5,460,000	4,900,000	5,320,000	4,560,000	5,360,000
Potter	2,790,000	3,084,000	2,490,000	2,921,000	2,230,000	2,743,000	2,000,000	2,614,000	1,800,000	2,543,000

County	1.25% 2050 (acre-feet)	GAM 2050 (acre-feet)	1.25% 2060 (acre-feet)	GAM 2060 (acre-feet)
Oldham*	1,530,000	2,460,000	1,390,000	2,450,000
Randall*	4,250,000	5,390,000	3,990,000	5,340,000
Potter	1,620,000	2,262,000	1,460,000	2,390,000

- Values are rounded to three significant figures.

* Additional information on the method and assumptions used to calculate the 1.25% reduction can be found in GAM run 04-13 (Smith, 2004) and the method and assumptions used to estimate the portion of the counties in the northern portion of the Ogallala aquifer GAM can be found in GAM run 05-09 (Smith, 2005).

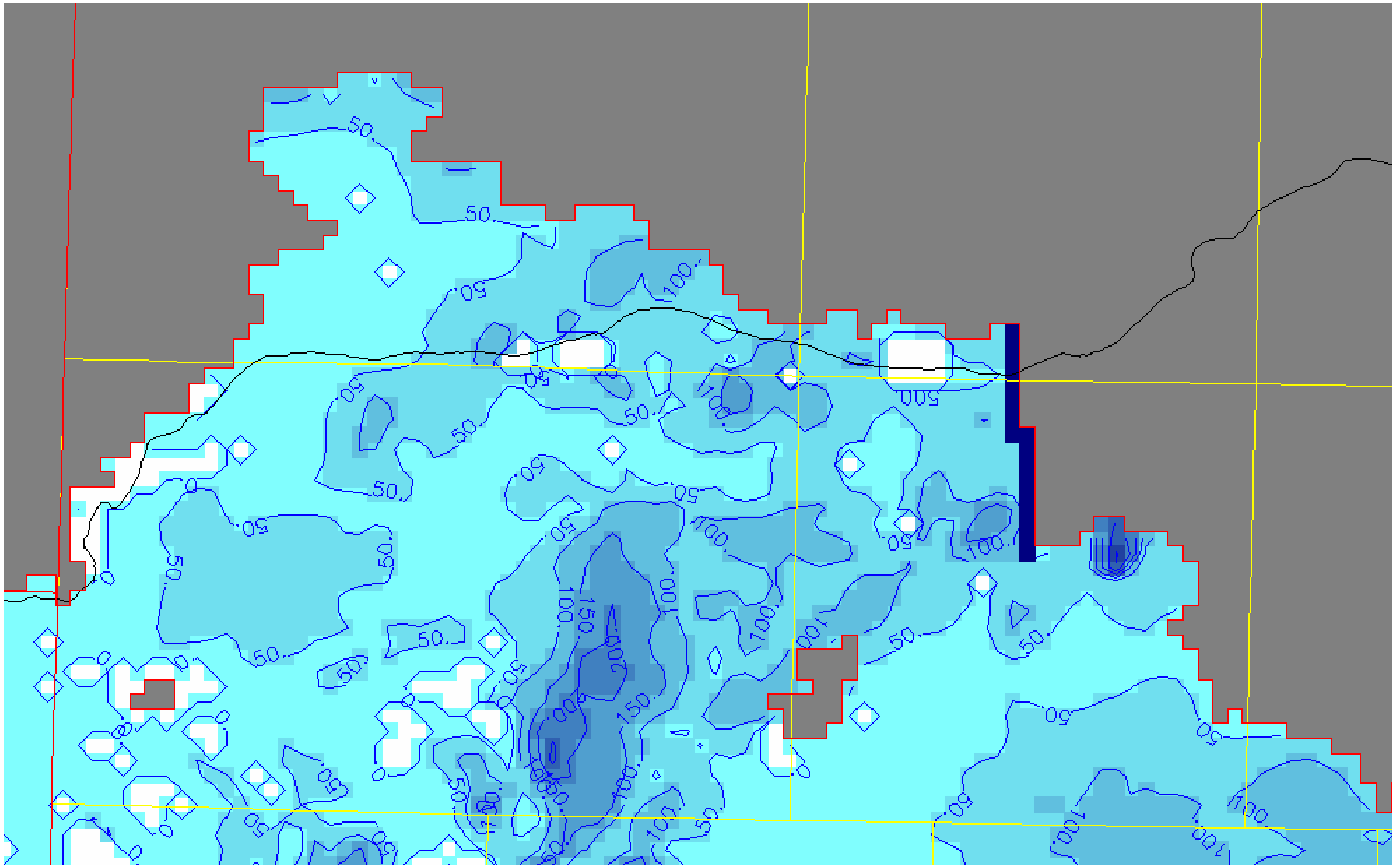


Figure 6: Simulated saturated thickness in feet of the Ogallala aquifer in Oldham, Potter, Deaf Smith, and Randall counties for 2000. North is at the top of the map, and county boundaries are shown in yellow. Inactive cells are in dark gray, and dry cells are white.

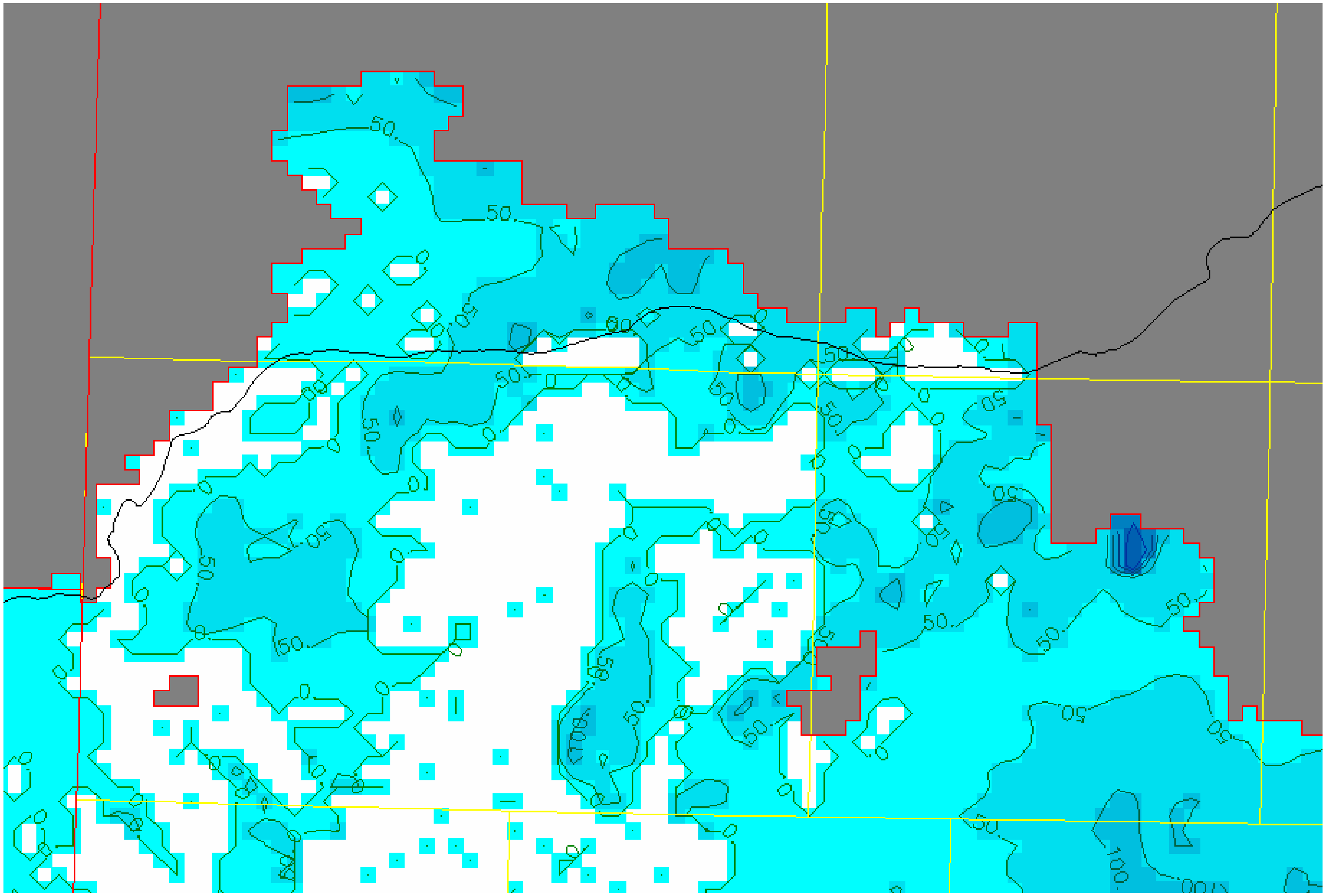


Figure 12: Simulated saturated thickness in feet of the Ogallala aquifer in Oldham, Potter, Deaf Smith, and Randall counties for 2060. North is at the top of the map, and county boundaries are shown in yellow. Inactive cells are in dark gray, and dry cells are white.

GAM run 05-17

by Richard Smith, P.G.
Texas Water Development Board
Groundwater Availability Modeling Section
(512) 936-0877
May 16, 2005

REQUESTOR:

Mr. Stefan Schuster with Freese and Nichols, Inc. on behalf of the Panhandle Regional Water Planning Group

DESCRIPTION OF REQUEST:

Mr. Schuster requested that we run the Groundwater Availability Model (GAM) for the Seymour and Blaine aquifers for the period 1975 to 2060 and provide maps of saturated thicknesses for 1980, 1990, 2000, 2010, 2020, 2030, 2040, 2050, and 2060 in Hall, Childress, Collingsworth and Wheeler counties for the Blaine aquifer and Hall, Childress, and Collingsworth counties for the Seymour aquifer.

METHODS:

We used the Groundwater Availability Model (GAM) for the Seymour aquifer (Ewing, and others, 2004). For the historical simulation (1975 to 1999), we used pumpage as included in the GAM with average annual recharge. We ran the GAM for the Seymour aquifer using average annual recharge for the period through 2060 and predictive pumpage based on new demands that the Panhandle Regional Water Planning Group plans to include in their 2006 regional water plan. Once we ran the GAM, we calculated saturated thickness by subtracting the bottom elevation of the Seymour aquifer as included in the GAM from the GAM calculated water levels. If the calculated water level exceeded the elevation of the top of the Seymour, the water level was changed to match the elevation value and then the difference between the top and bottom elevations was considered the saturated thickness. We used the same procedure to calculate the saturated thickness of the Blaine in Hall, Childress, Collingsworth, and Wheeler counties. We imported the saturated thickness data on a cell-by-cell basis into Surfer8© for the Blaine aquifer and we contoured the information to create maps. We calculated and contoured the saturated thickness of the Seymour aquifer in Hall, Childress, and Collingsworth counties using ArcView.

PARAMETERS AND ASSUMPTIONS:

- See Ewing and others (2004) for assumptions and limitations of the GAM.
- Root mean squared error for this model ranges from 9.7 feet to 27.5 feet for the Seymour aquifer and is 26.4 feet for the Blaine aquifer (Ewing and others, 2004). This error will have more of an effect on model results where the aquifer is thin

- Recharge represents average conditions for the predictive and historical period.

RESULTS:

Figures 1 through 9 show GAM historic and predicted saturated thicknesses for the Blaine aquifer. Figures 10 through 18 show GAM historic and predicted saturated thicknesses for the Seymour aquifer.

REFERENCES:

Ewing, J. E., Jones, T. L., Pickens, J. F., Chastain-Howley, A., Dean, K. E., Spear, and A. A., 2004, Groundwater availability model for the Seymour aquifer: final report prepared for the Texas Water Development Board by INTERA Inc., 432 p.

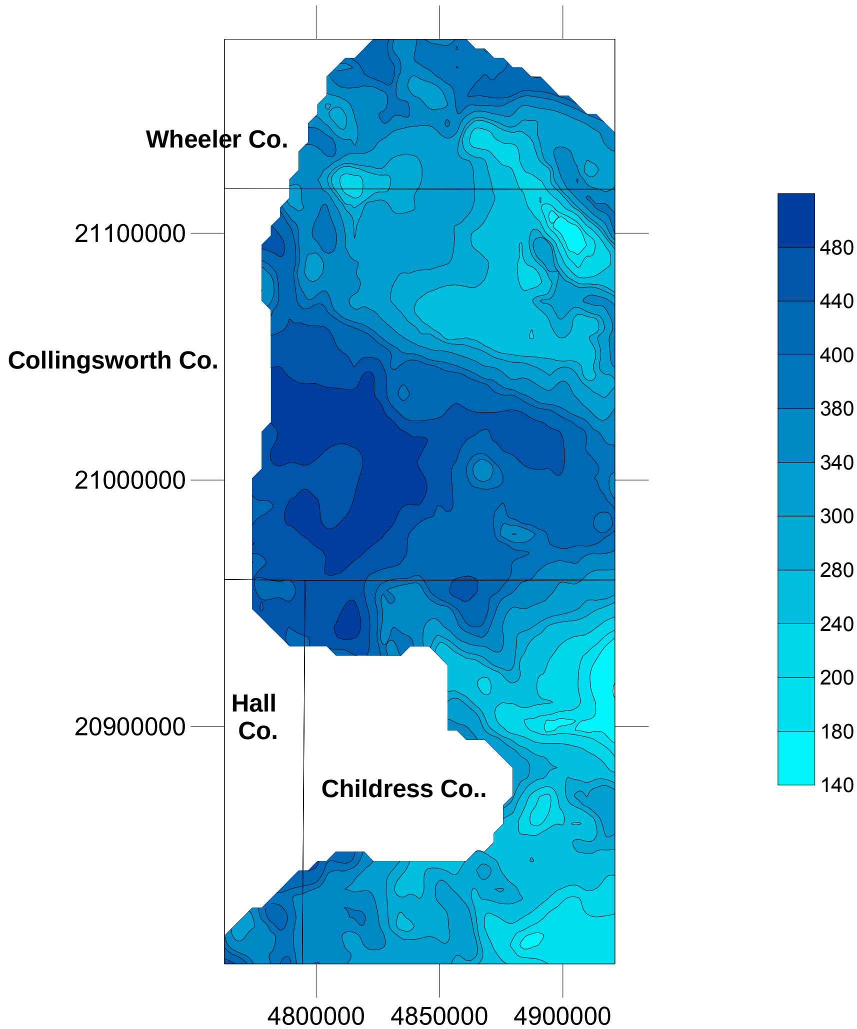


Figure 3: Saturated Thickness in feet of the Blaine aquifer in Childress, Collingsworth Hall and Wheeler counties in 2000. North is at the top of the figure and the maps units are in feet.

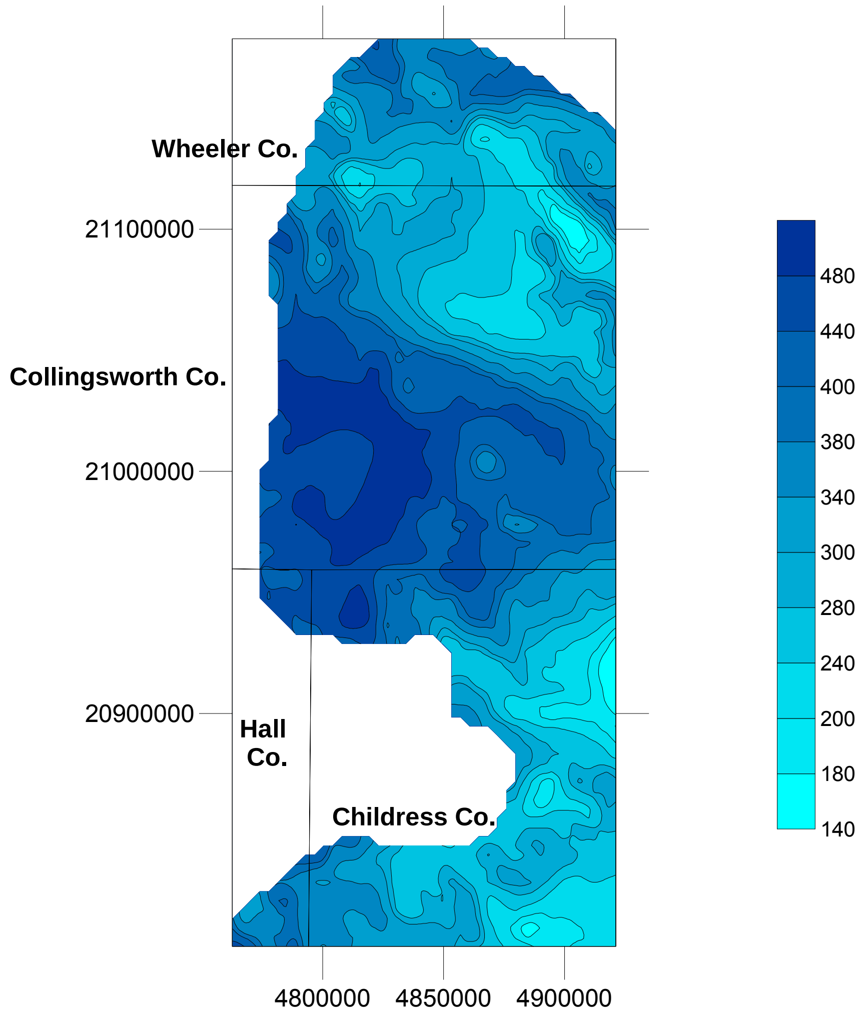


Figure 9: Saturated Thickness in feet of the Blaine aquifer in Childress, Collingsworth Hall and Wheeler counties in 2060. North is at the top of the figure and the maps units are in feet.

Saturated Thickness of the Seymour aquifer in 2000

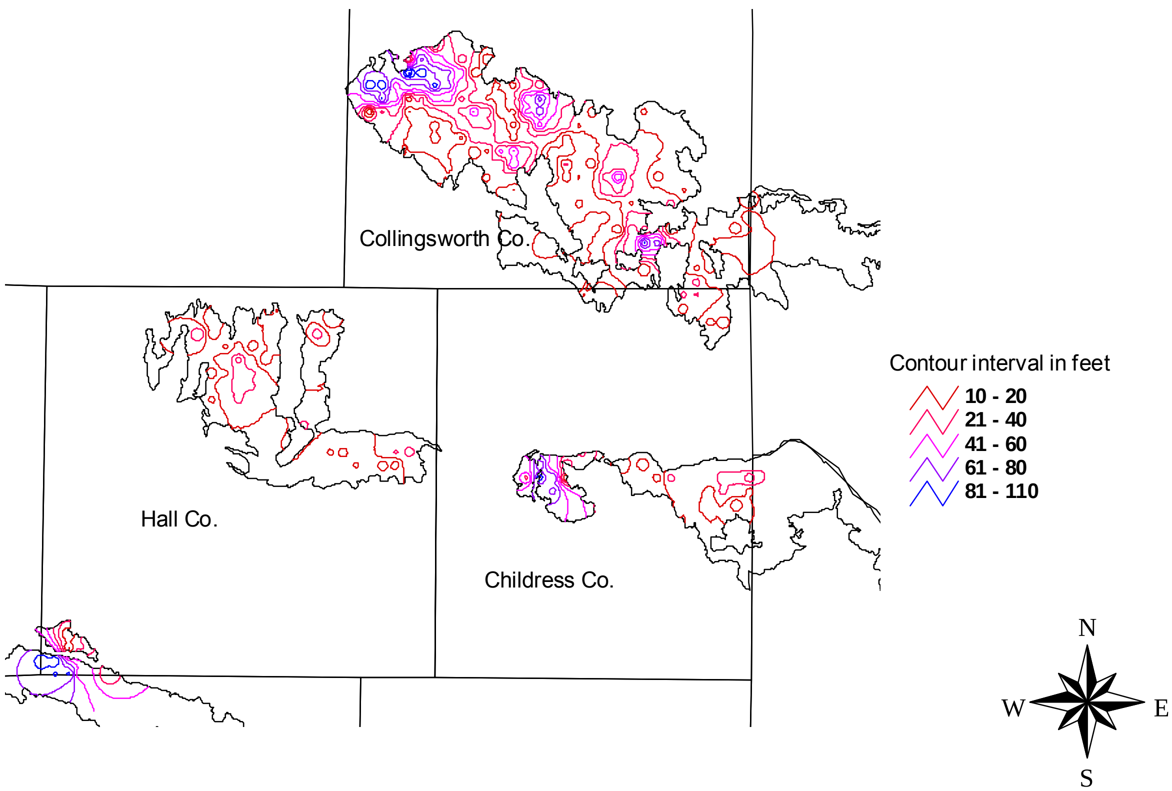


Figure 12: Saturated thickness of the Seymour aquifer in 2000.

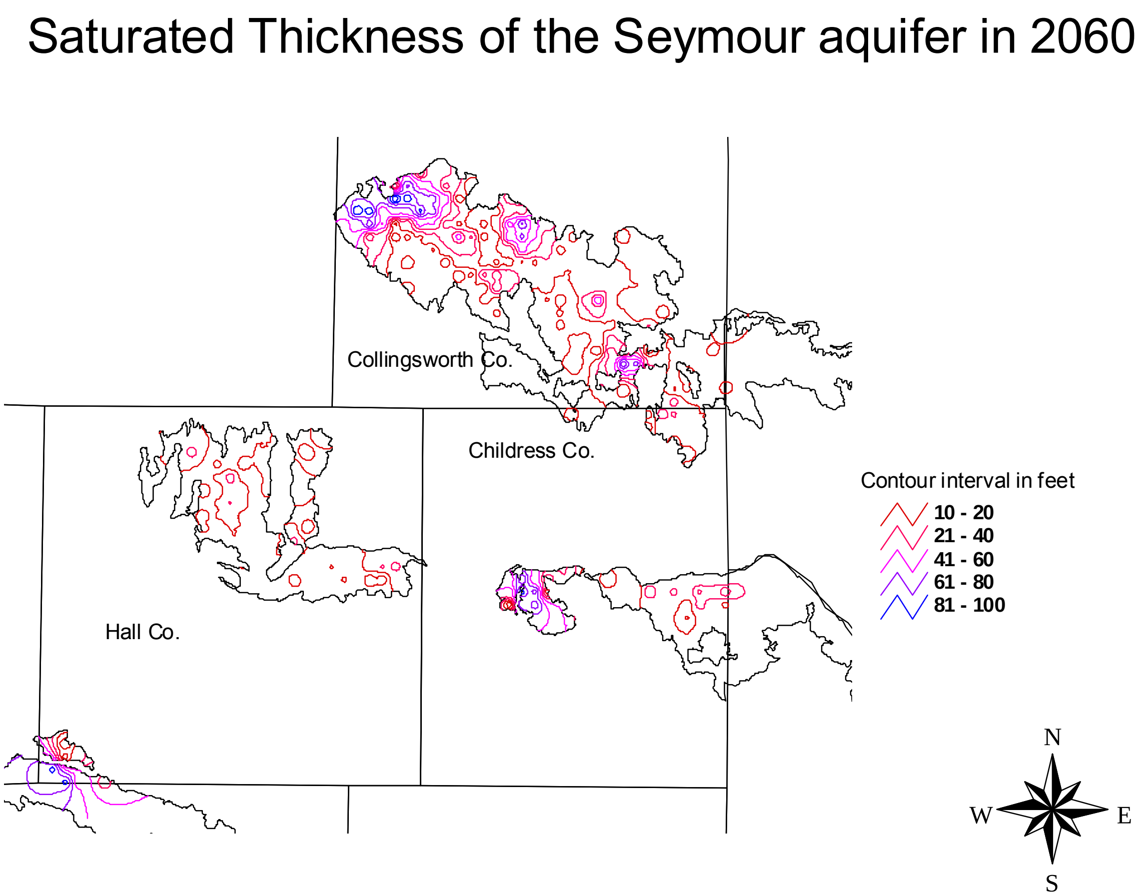


Figure 18: Saturated thickness of the Seymour aquifer in 2060.

APPENDIX E

SUMMARY OF SPECIAL STUDY

CONDUCTED FOR THE PWPA

Appendix E

Summary of Special Study Conducted for the PWPA

The Bureau of Economic Geology (BEG) conducted several studies to determine recharge rates for the Ogallala aquifer in Roberts and Hemphill counties. The report titled "Groundwater Recharge in the Central High Plains of Texas: Roberts and Hemphill Counties", was written in conjunction with the Panhandle Groundwater Conservation District and focuses on both Roberts and Hemphill Counties. This study report was adopted on July 14, 2009 and submitted to the TWDB on July 27, 2009. The findings of these studies were considered in the Update of the Northern Ogallala Groundwater Availability Model, which is included in Appendix F. Below is a brief synopsis of these studies.

Recharge Estimate for Roberts County based on Groundwater Chloride Data

The Roberts County study found a median recharge rate for the central portion of the county of 0.26 inches per year. The study found that little to no recharge occurs beneath rangeland vegetation. The highest recharge rates, which represent only about 2% of the study area, range from 0.7 to 0.9 inches per year. The higher recharge rates were found in drainage areas, which appear to function in a similar way to playa lakes in other regions. The density of playa lakes in Roberts County is very low, with all playa lakes located in the southeastern portion of the county.

This study confirmed previous estimates that there is little to no recharge beneath rangeland vegetation. The regional median recharge rate in the recent study, 0.26 inches per year, is similar to previous regional estimates for the central High Plains based on chloride data analyses.

Recharge in the Central High Plains based on Unsaturated Zones Field Studies

This study that focused on Roberts and Hemphill Counties study also found that little to no recharge occurs beneath vegetated rangeland. Six of nine test locations in a rangeland setting indicated essentially no recharge to the aquifer. Two of the nine test locations indicated recharge rates of 0.11 and 0.14 inches per year. Recharge rates were not estimated for the ninth location. The absence of recharge in most rangeland areas can be attributed to low permeability soils and evapotranspiration of the natural grasses and shrubs.

Where rangeland was converted to dryland agriculture, recharge did not increase in a test location in Roberts County but did increase in a Hemphill County test location to 0.41 inches per year. The test location in Roberts County has a low permeability clay loam soil.

The study found increased recharge under all irrigated locations. Two test locations in Robert County were found to have recharge rates of 1.9 and 2.2 inches per year, and a test location in Hemphill County had an estimated recharge rate of 1.3 inches per year.

Evaluation of one test location in a dry drainage channel in Roberts County indicated high recharge rates. It is estimated that a lower bound on the recharge rate may be 0.7 inches per year. The study also evaluated recharge beneath impoundments in Robert County and found the recharge rate to be between 0.6 and 1.4 inches per year.

General Observations from the Ogallala Aquifer Recharge Studies

The studies indicate that the regional recharge rates in Roberts and Hemphill counties are relatively low and similar to values estimated in previous studies. It is noted in both reports that different site conditions result in different recharge rates. The Roberts and Hemphill Counties study evaluated the following site conditions, in order of increasing recharge rates: vegetated rangeland, dryland agricultural areas, irrigated agricultural areas, drainage channels, and impoundments. The results from the studies are summarized in the following table.

Recharge Rates in Inches per Year in Roberts and Hemphill Counties

Description of Area	Roberts County	Hemphill County
Regional Recharge	0.26	N/A
Rangeland	0.0 – 0.2	0.0 – 0.2
Dryland Agriculture	0.0	0.4
Irrigated Agriculture	0.8 – 1.9	0.6
Drainage Channel	>0.7	N/A
Impoundment	0.6 – 1.4	N/A

APPENDIX F

NORTHERN OGALLALA GAM UPDATE TO SUPPORT 2011 WATER PLAN

Draft
Northern Ogallala Update to Support 2011 State Water Plan

Submitted to:

The Panhandle Area Water Planning Group

Prepared by:

INTERA Incorporated
1812 Centre Creek Drive, Suite 300
Austin, Texas 78754

and

Dr. Alan Dutton, P.G.

February 2010

Geoscientist and Engineering Seal

This report documents the work of the following Licensed Texas Geoscientists and Licensed Texas Professional Engineers:

Van A. Kelley, P.G.,

Mr. Kelley was the Project Manager for this work and was responsible for oversight on the project.

Van A. Kelley — 2/3/10

Signature — Date

STATE OF TEXAS
VAN ALAN KELLEY
GEOLOGY
No. 4923
LICENSED
PROFESSIONAL GEOSCIENTIST

Toya Jones [Dale], P.G.

Ms. Jones was responsible for pumping data integration and development and development of updated head targets.

Toya Jones Dale — 2/3/10

Signature — Date

STATE OF TEXAS
TOYA JONES DALE
GEOLOGY
No. 2497
LICENSED
PROFESSIONAL GEOSCIENTIST

Dennis Fryar, P.G.

Mr. Fryar was the technical lead responsible for model calibration and he also performed the predictive simulations

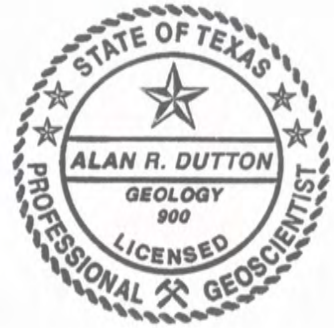
Dennis Fryar — 2/3/10

Signature — Date

STATE OF TEXAS
DENNIS FRYAR
GEOLOGY
No. 2190
LICENSED
PROFESSIONAL GEOSCIENTIST

Alan Dutton, P.G.

Dr. Dutton was responsible for developing the pumping datasets in coordination with Toya Jones. He also provided support in collecting necessary information regarding the 2004 GAM in terms files and details regarding implementation.



Alan R. Dutton

Signature

2/1/2010

Date

Neil Deeds, P.E.

Dr. Deeds supported model development focusing on the new base of aquifer surface.

Signature

2010/2/2

Date

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EXECUTIVE SUMMARY

The Panhandle Water Planning Group (RWPG), through the Panhandle Regional Planning Commission (PRPC) and Freese and Nichols, Inc. contracted with INTERA, Inc. to update the Northern Ogallala Groundwater Availability Model (GAM) (Dutton and others, 2001; Dutton 2004) to support planning activities in the 2011 planning cycle. These revisions were desired to reevaluate future aquifer conditions using updated projections of groundwater use in the region and to incorporate new hydrogeologic data relevant to the GAM. .

The specific revisions to the Northern Ogallala GAM proposed by the PRPC include the following:

- Revise and update pumping in the GAM to include historical estimates through the year 2008 and to include future demand estimates through the year 2060;

- Incorporate additional data available on aquifer properties including hydraulic conductivity, bedrock morphology (base of Ogallala aquifer or top of red beds), and specific yield;

- Review and incorporate recent research by the Bureau of Economic Geology (BEG) and the Panhandle Groundwater Conservation District (PGCD) on recharge rates within the region; and

- Estimate aquifer conditions under projected groundwater demand and perform simulations to support the estimation of groundwater availability within the Northern Ogallala in Texas.

Revisions and updates to the groundwater pumping data included extending the historical dataset from 1997 (Dutton and others, 2001; Dutton, 2004) through 2008 and developing projected groundwater demands from 2009 through 2060. The historical irrigation and livestock pumpage in Texas and all non-Texas pumping are identical to the Dutton and others (2001) and Dutton (2004) datasets for 1950 through 1997. For historical municipal pumping we used an improved historical dataset provided by the TWDB. We were successful in uniquely matching all municipal pumping to an owner and location. Other point pumping for manufacturing, mining, and power were also located and revised based upon the latest TWDB survey data. Rural-domestic pumping was allocated by 1980 census data.

AgriLife, under subcontract to Freese and Nichols, Inc. updated historic and projected irrigation and livestock pumping demands. Irrigation pumping was located to individual known metered irrigation well locations, where available, in the Panhandle and North Plains Groundwater Conservation Districts. In areas with no metered wells, the 2000 irrigated crop survey was used for spatial allocation. Livestock pumping was updated and centered around Confined Livestock Operations provided by AgriLife.

Twelve new point estimates of hydraulic conductivity from aquifer tests in Carson, Potter and Roberts counties were collected from the City of Amarillo, Mesa Water Inc. and their consultants, and Panhandle Groundwater Conservation District (PGCD). These estimates were evaluated for consistency with the model hydraulic conductivity field (Dutton, 2004) and neighboring support data. These new data were incorporated into the revised model prior to recalibration.

In addition to new hydraulic conductivity data, a large dataset of new picks of the base of the Ogallala aquifer were provided by North Plains Groundwater Conservation District (NPGCD), PGCD, Hemphill Groundwater Conservation District(HGCD), Canadian River Water Municipal Water Authority (CRMWA), the City of Amarillo, Mesa Water Inc. and Dr. Alan Dutton. Updates in the last Northern Ogallala GAM (Dutton, 2004) modified aquifer structure on a model cell-by-cell basis and only if the new pick increased saturated thickness. In this revision, the new structure picks for the base of the Ogallala were incorporated into the model using a consistent methodology that smoothly interpolated the aquifer base using all the available data. In this case, the aquifer thickness was allowed to increase and decrease.

The Bureau of Economic Geology, under funding from the Panhandle Regional Planning Commission (PRPC) and the Texas Water Development Board (TWDB), performed recharge studies in the region of the Northern Ogallala GAM. Many of their investigations are based upon the Chloride Mass Balance (CMB) recharge estimation method, which is based in part upon vadose zone or shallow saturated zone measurements of chloride. The studies provide a range of recharge estimates under a variety of land uses, many of which are not representative of predevelopment aquifer conditions. A review of the available data, including a draft recharge map based upon the CMB method applied to groundwater chloride data, provides a lower limit estimate of recharge for the region at approximately 0.22 in/year, which is considered by the investigators as being biased low. The Dutton (2004) calibrated model-wide average recharge rate is equal to 0.32 in/year. Given the uncertainty in a regional steady-state recharge rate, it is difficult to discriminate between these two recharge estimates. Because only the steady-state model is sensitive to natural recharge and because the model is calibrated with the Dutton and others, (2001) and Dutton (2004) hydraulic conductivity field, the Dutton (2004) recharge distribution was maintained in this revised model. Consistent with the 2004 GAM, return flow is not applied because it was found to be immaterial to model predictions, given vadose zone transit times consistent with field estimates (less than 0.5 ft/yr).

The model was calibrated to steady-state conditions (assumed to be prior to 1950) and to transient conditions from 1950 through 2008. The calibration was performed using a trial-and-error approach with the objective of decreasing residuals on a county-by-county basis. The primary parameter adjusted in calibration was hydraulic conductivity. However, it did not require significant modification from what is defined in Dutton (2004). The root mean square error (RMSE) of the steady-state model was reduced from 32 to 29 ft model wide. The RMSE was reduced in most counties with the most significant reduction of 20 ft occurring in Dallam County. The TWDB GAM standards stipulate that the model-wide RMSE divided by the range be less than or equal to 10 percent. The model-wide RMSE divided by the range was reduced from 1.4 percent to 1.2 percent. The model-wide mean-absolute error (MAE) was reduced from 23 ft to 21.8 ft.

The transient calibration was also improved in most counties. Comparing model error in 1998, the revised model reduced the RMSE from 53 ft to 46 ft, an improvement of 7 feet. The model-wide RMSE divided by observed head target range improved slightly from 2.2 percent to 2.0 percent. The revised model simulates through 2008. The calibration model-wide improved from 1998 to 2007 with a RMSE of 36 feet and a RMSE divided by observed head target range of 1.6 percent. The calibrated model was used in the forward mode to simulate predicted aquifer conditions from 2008 through 2060. The model was also used to assess availability based upon criteria defined by the planning group.

1.0 INTRODUCTION AND SCOPE

The Northern Ogallala Aquifer is the primary water resource for the Panhandle Water Planning Area (PWPA, or Region A). The current management strategy for the Northern Ogallala Aquifer is one of managed depletion as projected pumping demand far exceeds natural aquifer recharge in most of the PWPA. As a result, significant levels of drawdown have been observed in the Northern Ogallala Aquifer since the early 1950s.

To better manage the resource, a GAM was developed for the aquifer and was completely documented in Dutton and others (2001). This model covered the PWPA and portions of New Mexico, Oklahoma, and Colorado. The 2001 GAM model was calibrated to predevelopment conditions (prior to 1950) and to historical conditions from 1950 through 1998. In 2004 the GAM was revised to support regional planning (Dutton, 2004). The primary model revisions included; new base of aquifer elevations for selected model cells, a revised recharge model based upon greater definition of soil properties, and modification to aquifer boundary conditions implemented to better simulate groundwater flow and seepage at the edges of the aquifer.

In 2009, The Panhandle Regional Planning Commission (PRPC) in coordination with Freese and Nichols, Inc. contracted with INTERA, Inc. to make further revisions to the Northern Ogallala GAM (Dutton, 2004) to support regional water planning in the PWPA. The specific revisions to the Northern Ogallala GAM proposed by the PRPC include the following:

- Revise and update pumping in the GAM to include historical estimates through the year 2008 and to include future demand estimates through the year 2060;
- Incorporate additional data available on aquifer properties including hydraulic conductivity, bedrock morphology (base Ogallala and top red beds), and specific yield;
- Review and incorporate recent research by the Bureau of Economic Geology (BEG) and the Panhandle Groundwater Conservation District (PGCD) on recharge rates within the region; and

- Estimate aquifer conditions under projected groundwater demand and perform simulations to support the estimation of groundwater availability within the Northern Ogallala in Texas.

The conceptual model governing the Northern Ogallala GAM has not been revised as part of this study and remains consistent with Dutton and others (2001) and Dutton (2004). This report documents revisions to the 2004 GAM, as originally documented in Dutton and others (2001) and Dutton (2004). The principal revisions made to the Northern Ogallala GAM include a significantly revised aquifer base, an updated and improved historical and predictive pumping data set, and updates to hydraulic properties to incorporate new data and to improve model calibration in select counties.

These revisions were made with the significant help and new data supplied by the Groundwater Conservation Districts within the PWPA, Canadian River Municipal Water Authority, the City of Amarillo, Mesa Water Inc. and their consultants, and Dr. Alan Dutton (The University of Texas, San Antonio). The model revisions described herein were performed in a public process including three Regional Water Planning Group meetings, three PWPA Modeling Subcommittee Meetings, and two meetings with the Texas Water Development Board.

2.0 MODEL REVISIONS

The model revisions made to the 2004 GAM (Dutton, 2004) include revisions to the base of aquifer elevations, model hydraulic conductivity, model general head boundaries in Randall and southern Potter County, and historical and predictive pumping. Recent research on recharge performed by the Bureau of Economic Geology in the region was reviewed in the course of making these model revisions and all considered in calibration.

2.1 Base of Aquifer

Among several scope items identified in the model update supporting the 2011 State Water Plan is an update to the base of the Ogallala Aquifer, often referred to as the model structure or the top of the red beds. Along with pumping and specific yield, the base of the aquifer is one of the most important model input variables because it effects the amount of groundwater in storage under any assumed management strategy. Since the last model update in 2004 there has been a large number of new base aquifer picks that have come available which in part motivated the model revision. Also, in the 2004 model update, only base of aquifer picks that increased the thickness of the aquifer were implemented and in these cases only within the grid cell containing the new pick. In this revised GAM, the new surface incorporated all base aquifer picks and integrated them into the prior (Dutton, 2004) base aquifer surface through interpolation.

2.1.1 Data Sources

The base of the Ogallala Aquifer was revised using data received from the following sources. The NPGCD provided the elevation of the top of the "red bed" which corresponds to the top of the Permian-age sediments throughout the District. These data were obtained from individual well logs and from a historic contour map of the Permian-age surface. The Panhandle GCD provided elevations for the base of the Ogallala Formation throughout the District based on review of individual well logs. Mesa Water Inc. and their consultants provided elevations for the top of the red beds (Permian-age sediments) in Gray, Hemphill, Hutchinson, Libscomb, Ochiltree, and Roberts counties for individual wells. Daniel B Stephens and Associates on behalf of the Hemphill County GCD provided elevations of the base of the Ogallala Formation for test holes in Potter County. They also provided elevations for the top of the red beds (Permian-age sediments) in Hemphill County based on review of individual well logs. Structural interpretations were also obtained from Alan Dutton for Carson, Hutchinson, and Roberts counties. The structure maps were developed from several studies in 2004, 2005, and 2006 by the Canadian River Municipal Water Authority and various land owners to assess the local saturated thickness of the Ogallala Aquifer. Stratigraphic picks in these studies were taken from results of test holes including recorded drill cuttings logs and geophysical logs. Where new data were not available, the base of the Ogallala Aquifer from the 2004 GAM model was used. The location of the structure data are illustrated in Figure 2.1-1 by source.

2.1.2 New Base Aquifer

In revising the basal elevation of the Ogallala Aquifer, we had three types of data that were honored to varying degrees. The precedence of the data types was as follows:

1. Point elevation data from interpreted well logs
2. Basemap data provided by North Plains GCD
3. 2004 Northern Ogallala GAM base

The only locations where this precedence was occasionally reversed were at the outer boundary of the active model (corresponding to the aquifer lateral boundary). At the outer boundary we used the 2004 Northern Ogallala GAM base to set the elevation. This was to ensure that the lateral wet extent of the model was not affected during the revision, and that the connection with the drains and river would not be dramatically impacted by the structure change.

The point data, both those that had been used to derive the 2004 model base and the new point data that had been provided by various stakeholders and agencies, was combined into a single coverage. There were over 10,000 estimates of the elevation of the aquifer base in this combined dataset. A coverage was created containing a two-mile buffer around all of these point data locations. This buffer defined where the point data would be used exclusively to define the aquifer base. The basemap data from NPGCD was then intersected with this buffer coverage, creating a subset of the basemap data where the buffer areas were excluded. Thus, the basemap data would be allowed to define the base of the aquifer in those areas that were not covered by point data.

After the combination of the point data and the basemap data, nearly all of the Texas portion of the aquifer had data support. For those areas (mostly outside Texas), where there was no data coverage, the 2004 Northern Ogallala GAM base was used to estimate the elevation. Specifically, the combined point and basemap coverage was buffered and then intersected with the cell-centered 2004 GAM grid data, excluding from the 2004 GAM grid data those areas that had coverage from point or basemap data.

The final combined coverage of point data, basemap data, and 2004 GAM grid data formed a complete, non-overlapping point coverage of estimates of the base of aquifer. This point coverage was interpolated through kriging to create the final base of aquifer surface. This surface was then sampled at the new model grid centers to determine the base of aquifer for each grid cell. Note that where no point data or basemap data was available, the revised model base should be nearly identical to the 2004 GAM base.

Figure 2.1-2 shows the revised base of the Ogallala Aquifer on the model grid. This figure shows that the base of the aquifer increases in elevation from about 1,883 ft amsl in the east to about 5,892 ft amsl in the west. A low in the surface is observed along the Canadian River in Hemphill and Roberts counties.

A comparison between the Ogallala base used in the 2004 GAM and the updated Ogallala base is shown in Figure 2.1-3. On this figure, the areas in red are where the updated base is higher than the 2004 GAM base and areas in blue are where the updated base is lower than the 2004 GAM base. In Potter, Randall, Armstrong, Carson, and Donley counties, the areas where the updated base is higher than the 2004 GAM base correspond to areas where the Dockum Group lies between the Ogallala Formation and Permian-age sediments and wells are dual completed into both. Since the 2004 GAM used the bottom of the wells as the bottom of the Ogallala Aquifer, the structure in that model would have included the Dockum Group in these areas. This is consistent with the top surface of the Dockum Aquifer in the Dockum GAM (Ewing and others, 2008) being higher than the base of the Ogallala Aquifer in the 2004 Northern Ogallala GAM (Dutton , 2004) in these areas. In the northeastern portion of Dallam County, the areas where the updated base is higher than the 2004 GAM base appear to correspond to an area where the Ogallala Formation is thin and unsaturated and wells are completed into the Dockum Aquifer.

Again, since the 2004 GAM used the base of wells to define the base of the Ogallala, the Dockum Aquifer in this area was included in that model. The minor differences in surfaces in areas of the model outside of Texas are due to differences in the interpolation method used and are within 10 feet in most cases. These differences are an insignificant percentage of net saturated thickness.

Table 2.1-1 provides a summary and comparison of the average change in the base aquifer surface between the revised model and Dutton (2004). The table includes a count of the number of grid cells in the county, the average change in aquifer base in feet (negative equates to a reduction in storage) and the volumetric difference in acre feet assuming all cells are saturated in the area of elevation change difference and an average model specific yield. The net effect of the revised surface was an increase in aquifer volume of approximately 7 million acre feet. The most significant reduction was in Potter county where the PGCD have determined that Dockum is at surface over large portions of the county previously considered Ogallala. This is probably influenced by the Amarillo Uplift and could really be the area of separation between the Northern and Southern Ogallala Aquifers in Texas.

Table 2.1-1 Comparison of difference between new base aquifer as compared to base aquifer in the 2004 GAM (assumes a specific yield of 0.163).

County	Number of Grid Cells	Average Change in Surface (ft)	Volumetric Difference in Surfaces (acre-ft)
Armstrong	516	-19.03	(1,024,508)
Carson	933	-2.94	(286,521)
Dallam	1426	21.94	3,263,369
Donley	529	-16.35	(902,438)
Gray	896	-4.25	(396,847)
Hansford	881	0.84	77,128
Hartley	1381	8.05	1,159,214
Hemphill	917	-9.77	(934,853)
Hutchinson	657	2.87	196,963
Lipscomb	909	21.30	2,019,397
Moore	852	7.88	700,751
Ochiltree	898	7.03	658,761
Potter	356	-41.37	(1,536,517)
Randall	192	-1.96	(39,313)
Roberts	903	37.69	3,550,437
Sherman	930	4.27	414,482
Wheeler	527	4.07	223,666
Oldham	70	-1.02	(7,467)
Model	**13782**	**18.68**	**7,135,184**

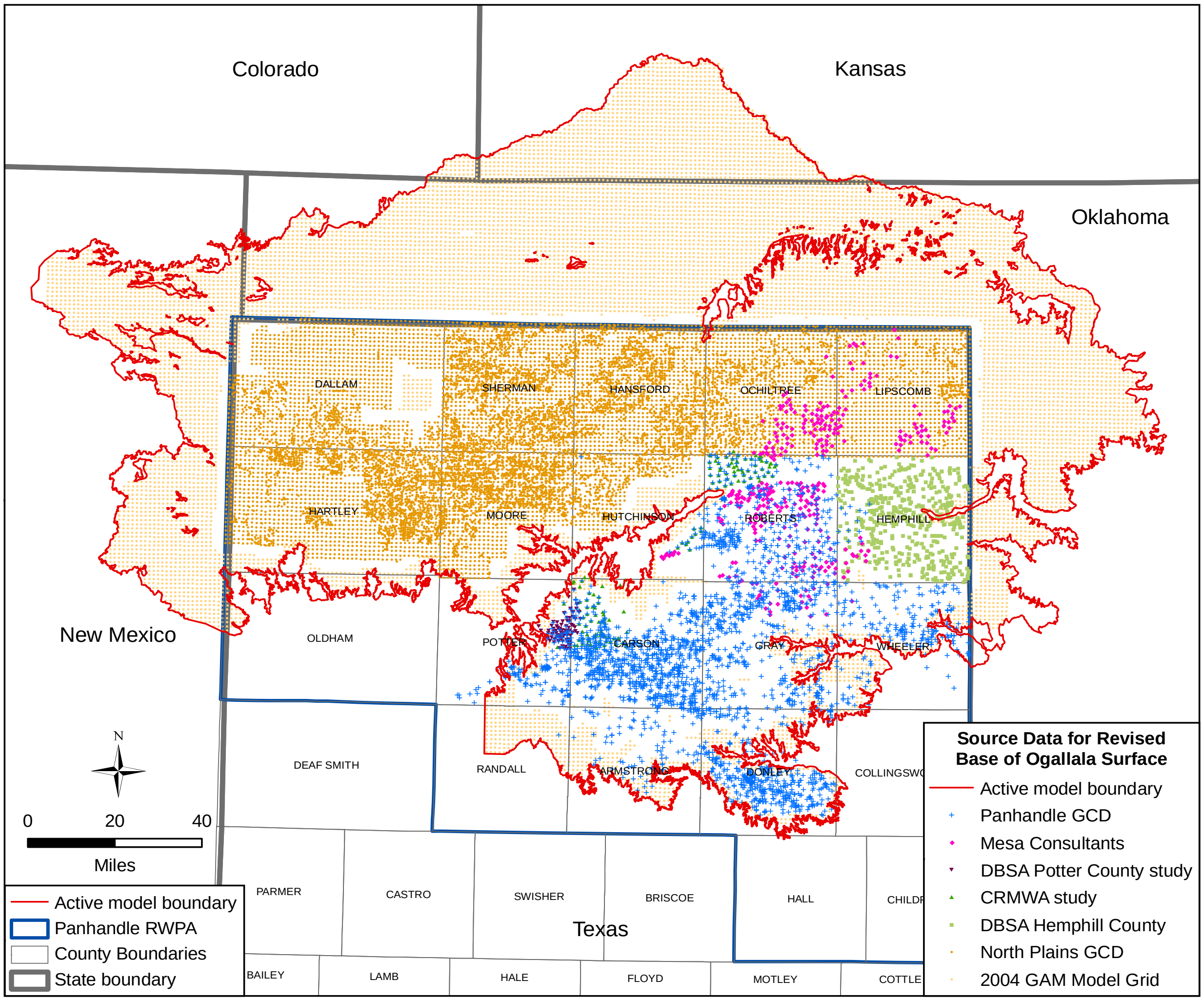

Figure 2.1-1 **Sources and locations of data for development of the revised base of Ogallala Aquifer.**

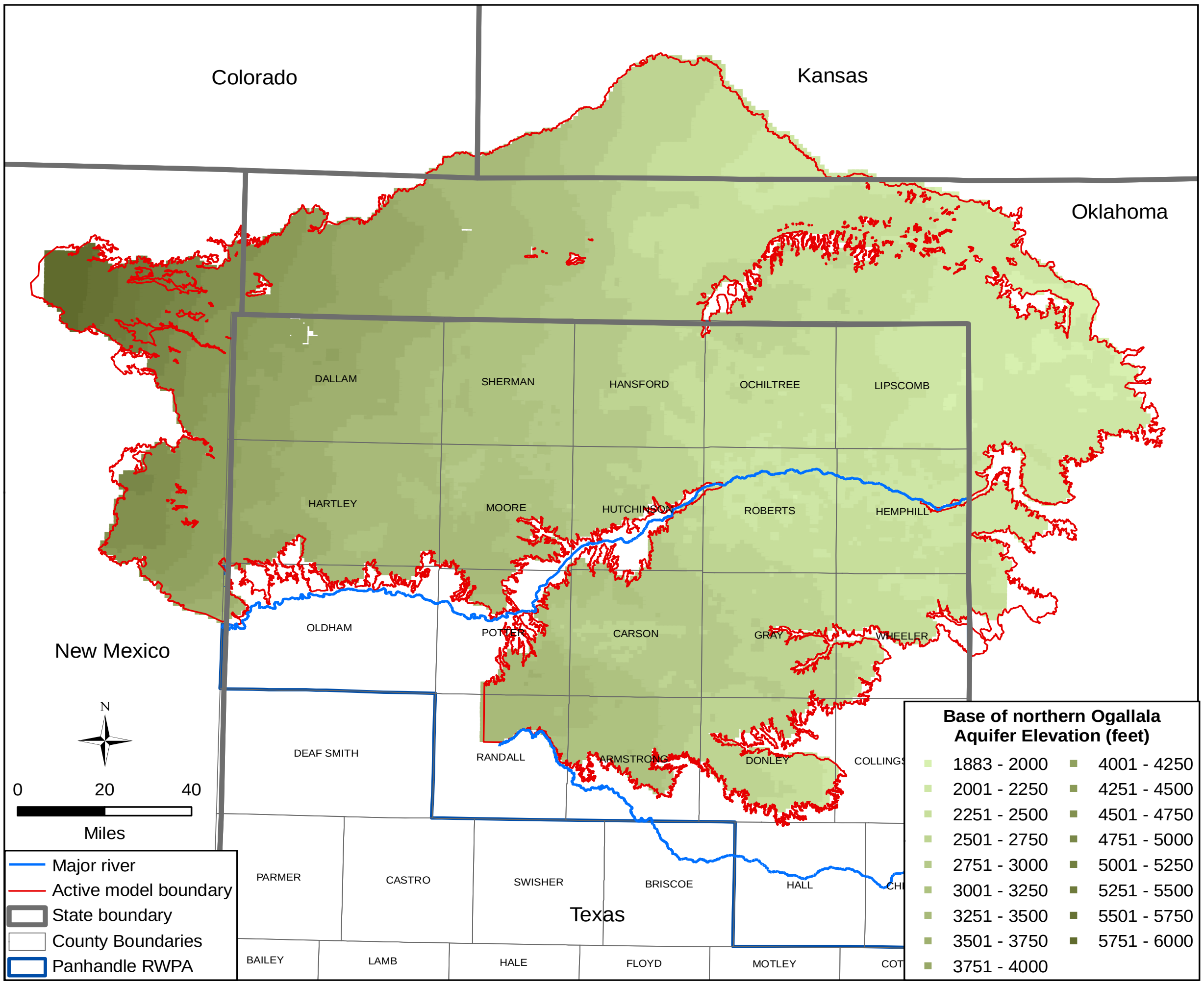

Figure 2.1-2 Revised base of Ogallala Aquifer.

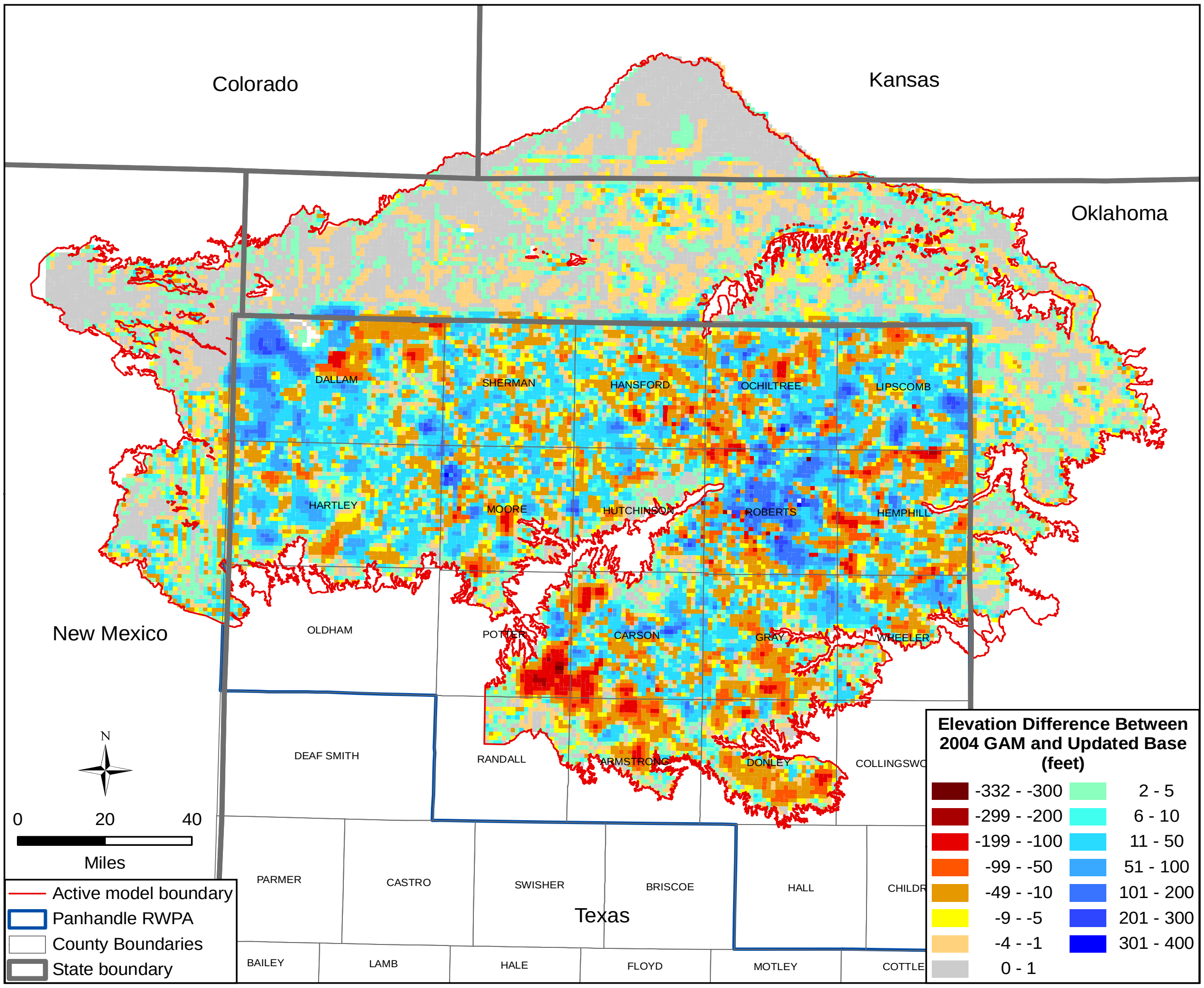

Figure 2.1-3 Difference in Ogallala Aquifer base between the 2004 GAM model and the updated model.

2.2 Hydraulic Conductivity

The hydraulic conductivity field developed for the original Northern Ogallala GAM (Dutton and others, 2001) included data from 70 high quality aquifer tests and 1,130 estimates of hydraulic conductivity from specific capacity tests taken from the TWDB groundwater database. In this round of planning stakeholders provided additional estimates of hydraulic conductivity which have been used in revision of the model.

2.2.1 New Data Sources

New point estimates of hydraulic conductivity from aquifer tests were collected from the City of Amarillo, Mesa Water Inc. and their consultants, and Panhandle Groundwater Conservation District resulting in twelve new estimates of hydraulic conductivity in Carson, Potter and Roberts counties. Table 2.2-1 provides a summary of the new hydraulic conductivity estimates included in the model.

The aquifer tests interpreted by INTERA were interpreted using the Cooper-Jacobs approximation. Drawdown during pumping was generally a small percent of the total saturated thickness making the approximation applicable. The range in hydraulic conductivity from these new values agrees very well with the original distribution range reported by Dutton and others (2001) of 5 to 44 ft/day.

We also received a gridded data set of hydraulic conductivity in Hemphill County from Daniel B. Stephens, Inc. from their draft county-scale groundwater model being developed for the Hemphill County Groundwater Conservation District. This data set was not supported with point estimates from aquifer tests and proved to have a significantly lower hydraulic conductivity distribution that that in Dutton (2004). As a result, we retained the original hydraulic conductivity distribution in Hemphill County to maintain consistency with the regional model.

2.2.2 Adjustments to Hydraulic Conductivity

The new hydraulic conductivity estimates were evaluated for consistency with the model hydraulic conductivity field (Dutton, 2004) and neighboring support data. These new data were incorporated into the revised model prior to recalibration. The new point estimates were posted along with the model hydraulic conductivity estimates plotted by grid cell. Hand contours of hydraulic conductivity were drawn around the point estimates to blend them into nearby model grid cell values. Model grid cell values were then updated to reflect the hand drawn contours near the new estimates. The impact was local in all cases, affecting an area of a few square miles near or between new point estimates. Other adjustments to hydraulic conductivity were made during model calibration and these will be discussed in Section 3.

Table 2.2-1 New hydraulic conductivity data included in the revised model.

Reported Well Name	County	Hydraulic Conductivity (ft/day)	Data Source	Notes
PWF-1	Potter	18	City of Amarillo	Potter County Well Field
PWF-2	Potter	15	City of Amarillo	Potter County Well Field
PWF-3	Potter	34	City of Amarillo	Potter County Well Field
PWF-4	Potter	7	City of Amarillo	Potter County Well Field
M07-238-PW	Roberts	26	Mesa Water Inc.	NA
M07-261-PW	Roberts	5	Mesa Water Inc.	NA
MV08-015-PW	Roberts	9	Mesa Water Inc.	NA
MV08-033-PW	Roberts	8	Mesa Water Inc.	NA
639708	Carson	25	PGCD	TWDB Interpreted
639712	Carson	31	PGCD	TWDB Interpreted
646418	Carson	19	PGCD	INTERA Interpreted
646412	Carson	20	PGCD	INTERA Interpreted

2.3 Recharge

The Bureau of Economic Geology, under funding from the Panhandle Regional Planning Commission (PRPC) and the Texas Water Development Board (TWDB), has performed recharge studies in the region of the Northern Ogallala GAM. Many of their investigations are based upon using the Chloride Mass Balance (CMB) recharge estimation method, which is based in part upon vadose zone or shallow saturated zone measurements of chloride. The studies have provided a range of recharge point estimates under a variety of land uses based upon unsaturated zone chloride data and more regional estimates based upon groundwater chloride data. The most recent study performed in support of the 2011 Regional Plan is documented as Reedy and others, (2009) and focused upon the determination of recharge rates in Roberts and Hemphill counties.

The recharge studies reported in Reedy and others, (2009) support the conclusion that recharge rates in Roberts and Hemphill counties are highly variable depending upon land use and or land form ranging from practically zero to greater than 1.5 in/year under irrigated agriculture and impoundments. The following Table 2.3-1 summarizes results from the most recent study (Reedy and others 2009). Important conclusions from this research include;

- A median recharge rate for Roberts County is approximately 0.26 in/year,
- Rangeland and dryland agriculture provide point estimate ranges of recharge from zero to 0.4 in/year,
- Vadose zone studies confirm prior conclusions that the volume of recent recharge has generally insignificantly added to current groundwater storage,
- An estimate of vadose zone velocity under irrigated agriculture in Roberts county of 0.52 ft/year is slow enough to provide little irrigation return flow to the groundwater over the current planning period (see Dutton and others, 2001)
- Dry stream channels and drainages appear to play a similar role as playas in providing areas of focused recharge.

Table 2.3-1 Recharge estimates in inches per year after Reedy and others, (2009).

Land Use/Form	Roberts County	Hemphill County
Regional Estimate	0.26	Not reported
Rangeland	0.0 – 0.2	0.0 – 0.2
Dryland Agriculture	0.0	0.4
Irrigated Agriculture	0.8 – 1.9	0.6
Drainage Channel	➢ 0.7	Not measured
Impoundment	0.6 – 1.4	Not measured

Point recharge estimates as those reported in Table 2.3-1 are not directly applicable to a regional model and require some rational method of scaling to regional average values. Previous investigators found that at the model scale, the location of recharge (i.e., playas) is not important as long as the volume of recharge remains the same. This will continue to be true even for planning as long as irrigation returns are not adding significant volumes of water to groundwater storage.

The Bureau of Economic Geology is currently using groundwater measurements of chloride to estimate regional average estimates of recharge within the study area. We reviewed the available data with principal investigator Bob Reedy which included a draft recharge map based upon the

CMB method. Regionally this method provided an average recharge estimate for the region of approximately 0.22 in/year. However, because of potential sources of chloride other than atmospheric deposition, the estimates were considered to be biased low in Gray, Hemphill, Roberts, Lipscomb, and Wheeler counties. As a result, the regional estimate of 0.22 in/year is biased low. Based upon this preliminary work, it seems reasonable to conclude that the steady-state recharge rate is greater than 0.22 in/year.

2.4 Boundary Conditions

The general head boundary (GHB) conditions in Randall and southern Potter counties were modified during calibration to simulated lower water levels near the boundary. Hydraulic head residuals indicated that the model was overestimating water levels near the boundary as a result of the specified heads. Heads in GHB cells with the highest values were lowered, improving model calibration near the boundary. River and drain boundary cells remain unchanged from the 2004 GAM (Dutton, 2004).

2.5 Pumping

Most groundwater discharge from the Ogallala Aquifer is by pumping. The Northern Ogallala Aquifer is very heavily pumped for irrigation throughout a large portion of the Panhandle RWPA. Pumping data were developed for the aquifer from 1955 through 2060 for use in the updated model. These data consist of the magnitude of pumping and the spatial distribution of pumping. The categories for pumpage from the northern Ogallala GAM model are irrigation, municipal, mining, manufacturing, livestock, and rural domestic. The following sections discuss the data sources for the pumping magnitude and the implementation of pumping (spatial distribution) for the different pumping categories.

2.5.1 Data Sources

Previous Northern Ogallala GAM models incorporated historical pumpage from 1950 through 1997 and predictive pumping from 1998 through 2050 (Dutton and others, 2001; Dutton, 2004). Since those models were developed, additional and/or revised pumping information has been obtained or determined by various entities for both the historical and predictive periods. In an effort to extend the historical model period through 2009, additional historical pumping data from 1998 through 2009 were collected and implemented in the updated model. In addition, revised historical pumping for several categories was obtained from the TWDB (TWDB, 2009a). The historical pumping used in the 2004 GAM was maintained for this updated model for irrigation, livestock, and rural domestic pumpage in Texas and all non-Texas pumping. Future demands on the Ogallala Aquifer have also been revised since 2004 and were incorporated into the updated model. The following sections describe the data sources for the magnitude of pumpage for the different categories. The total pumpage by category from the Ogallala Aquifer in the Panhandle RWPA assigned in the updated model is shown in Figure 2.5-1. Note that the y-axis on this figure is broken between the values of 120,000 and 250,000 acre-feet per year (ACRE-FT/YEAR). This was done because pumpage for irrigation purposes is substantially higher than for all other purposes, and pumpage for all non-irrigation purposes would not be distinguishable at the same axis scale. Figures 2.5-2 and 2.5-3 show the average yearly pumpage by county for the periods 1998 through 2009 and 2010 through 2060, respectively.

All changes in pumpage from the 2001 and 2004 GAMs to the updated model apply only to the Texas portion of the model. All historical and future water pumpage for the portion of the model located outside of Texas is the same in the updated model as was used in the 2001 and 2004 GAMs, which had been derived from digital files of Luckey and Becker (1999). The 2050 non-Texas pumpage in the 2001 and 2004 GAMs, which is the last year in those models, was used for the years 2051 through 2060 in the updated model.

2.5.1.1 Irrigation Pumpage

For most of the counties in the Panhandle RWPA, pumping for irrigation purposes dominates all other pumpage categories. Historical irrigation pumping in the 2004 GAM used irrigation pumpage estimates by the Texas Agricultural Experiment Station (TAES), who provided decadal estimates of irrigation withdrawal from 1950 to 1990 and an estimate for 1997 on the basis of rainfall and irrigation efficiencies, modified to reflect the amount supplied by the Ogallala Aquifer (Dutton and others, 2001). The modification consisted of subtracting irrigation water supplied by surface water sources or groundwater from sources other than the Ogallala Aquifer from the TAES estimates. The magnitude of historical irrigation pumping from the 2004 GAM model was used directly in the updated model for the historical period 1955 through 1997.

Decadal projections of irrigation demand by county for 2000 to 2060 were developed by the AgriLife Research and Extension Center (formerly the Texas Agricultural Experiment Station) of the Texas A&M University System for the 2011 Panhandle Regional Water Plan (Marek and others, 2009). These AgriLife projections were developed using the Texas A&M-Amarillo Water Model. Input for the model included irrigated acreage data, which were taken from Farm Service Agency data, and county-by-county data on crop evapotranspiration, which were developed from the North Plains evapotranspiration network as it relates to Region A counties using a modified Penman-Monteith equation for calculation of potential evapotranspiration from meteorological data (Marek and others, 2009). The AgriLife projections reflect estimated total irrigation demand from all sources (e.g., surface water and/or groundwater from the Ogallala Aquifer and other water-bearing units). Freese and Nichols (2009) developed future irrigation demand on the Ogallala Aquifer by estimating the amount of the total irrigation projected by AgriLife that will be supplied by the Ogallala Aquifer after subtracting out surface water sources and groundwater supplied from sources other than the Ogallala Aquifer. The future irrigation demands for the Ogallala Aquifer developed by Freese and Nichols (2009) were used in developing the irrigation pumpage for 1998 through 2060.

Irrigation pumpage data were also obtained from the NPGCD and PGCD, respectively. The NPGCD provided irrigation pumping volumes from their metering program for the years 2007 through 2008. These data consist of total irrigation pumpage by irrigating property. Since all irrigation wells within the District are metered, these metered data reflect all irrigation pumpage in the District (NPGCD, 2009a). The NPGCD also provided metered data for 2006. However, the metered program was not fully implemented at that time and those data did not reflect all irrigation pumpage in the District and, therefore, were not used. The PGCD provided irrigation pumping from their metering program for the years 1999 through 2008. The PGCD does not meter all irrigation wells; therefore, the metered data they provided do not reflect all irrigation pumpage in the District. The metered data received from the NPGCD and PGCD were used in conjunction with the Freese and Nichols (2009) future demand estimates in developing irrigation pumpage for 1998 through 2009.

2.5.1.2 Municipal, Manufacturing, Mining, and Power

Total historical (1955 through 2007) pumpage of groundwater for municipal, manufacturing, mining, and power use was provided by the TWDB (2009a). TWDB (2009a) enumerated annual water use by individual large and small surveyed entities. Only values indicated for self-supplied withdrawal from the Ogallala Aquifer were used. Information from TWDB (2009a) was supplemented or replaced as appropriate where more accurate data were available.

Total predicted (2010 through 2060) pumpage for municipal, manufacturing, mining, and power use was provided by Freese and Nichols (2009). These data consist of decadal water demand to be met by the Ogallala Aquifer by subtracting demand met by other sources from total water demand in the Panhandle RWPA.

2.5.1.3 Livestock and Rural Domestic

Pumpage for livestock and rural domestic purposes was combined in the 2004 GAM. That combined pumpage was used in the updated model for the historical period from 1955 through 1997. Predictive livestock and rural domestic pumpage every decade from 2010 through 2060 were provided by Freese and Nichols (2009). Freese and Nichols (2009) developed livestock pumpage estimates using total livestock demands reported by AgriLife (Marek and others, 2009) less supplies from sources other than the Ogallala Aquifer. A linear change in livestock and rural domestic pumpage was assumed between an estimated 1997 value based on the 2004 GAM and the predicted 2010 value from Freese and Nichols (2009). Since livestock and rural domestic pumpage were combined in the 2004 GAM, but were not combined in the project future demands, the combined 1997 value from the 2004 GAM could not be used directly in calculating the linear change between 1997 and 2010. The ratio of the 1997 value representing livestock and rural domestic pumpage was assumed to be the same as the ratio of livestock to rural domestic pumpage for the 2010 predicted future demand (Freese and Nichols, 2009). A linear change in livestock and rural domestic pumpage was also assumed between the predicted decadal estimates for 2010 through 2060 given in Freese and Nichols (2009).

2.5.2 Implementation of Pumping Demand

This section describes how pumping was implemented in the model. Implementation results in the assignment of a pumpage magnitude to each model grid cell in which pumping occurs. The availability of different types of data for irrigation pumpage required different methods of implementation for three time periods: the historical period from 1955 through 1997, the historical period from 1998 through 2009, and the predictive period from 2010 through 2060. Non-irrigation pumpage was implemented for two periods; the historical period from 1955 through 2009 and the predictive period from 2010 through 2060. The following sections discuss implementation of pumpage by category.

2.5.2.1 Implementation of Irrigation Pumpage

Historical Period from 1955 through 1997

The distribution of irrigation pumpage for the time period from 1955 through 1997 was taken from the 2004 GAM model (Dutton and others, 2001; Dutton, 2004). In that model, the decadal irrigation pumpage by county developed by the Texas Agricultural Experiment Station, modified to reflect pumpage from the Ogallala Aquifer, was used to assign an annual irrigation pumpage magnitude by county assuming a linear change during each decade. The yearly pumping was then distributed spatially within each county based on the 1994 irrigated cropland survey from the Texas Natural Resources Information System. Irrigation pumping was assigned only to grid blocks containing irrigated cropland as identified by the 1994 survey. This implementation assumes that the same pattern of irrigated acreage applies for the entire period from 1955 through 1997. In summary, the magnitude and spatial distribution of irrigation pumpage for the period 1955 through 1997 for the updated model was taken from the 2004 GAM.

Historical Period from 1998 through 2009

Several methods were used to implement irrigation pumpage for the time period 1998 through 2009 depending on the area. These methods differ in how the pumping magnitude was determined for each year and how the pumping was distributed spatially within counties. The use of different methods was required due to the fact that different data were available for the different areas. The three areas were (1) the NPGCD, (2) the PGCD, and (3) the Hemphill County GCD and areas not in a GCD. Each of these is discussed below. In general, the spatial distribution of irrigated pumpage was allocated based on meter locations where available and on the location of irrigated acreage as given by the 2000 irrigated acreage survey.

The 2000 survey of irrigated acreage contains both polygons of irrigated acres and irrigation point locations. Use of the 2000 survey to spatially distribute irrigation pumpage required calculation of the fraction of irrigated area within each grid cell of the model. Therefore, some area had to be assumed for the point irrigation indicated by the survey. For this modeling study, the point irrigation was assumed to reflect an irrigated area of 2 acres.

The irrigated acreage from the 2000 survey was modified in Donley County. A review of the 2000 survey by personnel at the PGCD indicated an underestimate of irrigated acreage in Donley County (PGCD, 2009a). Additional irrigated acreage was added to the 2000 survey in this county based on digitization of crop circles on areal photographs provided by the District. Figure 2.5-4 shows the GCDs, the modified 2000 irrigated acreage, meter locations, and the model grid cells in which irrigated acres are located for the Panhandle RWPA. The following paragraphs discuss the implementation of irrigation pumpage for the three areas.

NPGCD

The NPGCD includes all of Sherman, Hansford, Ochiltree, and Lipscomb counties and parts of Dallam, Hartley, Moore, and Hutchinson counties. All of the irrigated acreage in Hartley and Moore counties and 79.5 and 92.0 percent of the irrigated acreage in Dallam and Hutchinson counties, respectively, as identified by the modified 2000 survey, lies within the portion of the county included in the NPGCD.

The magnitude of irrigation pumpage in the NPGCD during the time period 1998 through 2009 is available for only 2007 and 2008. The source of that data is the District's meter program, which provides data for all irrigated properties in the District. AgriLife (Marek and others, 2009) provides an estimate of total irrigation pumpage for 2000, but they do not indicate how much of that pumpage is supplied by the Ogallala Aquifer. Freese and Nichols (2009) provide an estimate of supplies by sources other than the Ogallala Aquifer by decade from 2010 through 2060, but not for 2000. Irrigation pumpage supplied by the Ogallala Aquifer in 2000 was estimated here by subtracting supplies from other sources as estimated by Freese and Nichols (2009) for 2010 from the total irrigation pumpage for 2000 estimated by AgriLife. This calculation assumes that the volume of irrigation pumpage supplied by sources other than the Ogallala Aquifer is the same for 2000 and 2010.

In conclusion, data are available to estimate values for the magnitude of irrigation pumpage by county for the years 2000, 2007, and 2008. For the remaining years in the period from 1998 through 2009, pumping was assumed to change linearly. Table 2.5-1 summarizes the methods used to develop values of irrigation pumpage for the counties in the NPGCD from 1998 through 2009.

Once the magnitude of irrigation pumpage was determined for each year in each county, that pumpage was spatially distributed across the county. For the NPGCD, the distribution of irrigation pumpage for 1998 through 2009 was performed using the locations from the meter data. The meter data received from the NPGCD consisted of pumpage volume and location for irrigating properties within the District, with the location representing the centroid of the active irrigation wells located on the property (NPGCD, 2009b). The actual meter volumes and location were used to spatially distribute pumpage for 2007 and 2008, the two years for which actual meter data are available.

Irrigation pumping varies from property to property; so pumping could not be distributed evenly across all meter locations in the counties for the years with no actual meter data. Rather, the fraction of total county pumpage was calculated for each meter location for the two years with data (i.e., 2007 and 2008). This fraction was then used to spatially distribute pumping within the county for other years. The fractional pumping by meter location was not the same for the years 2007 and 2008. In spatially distributing irrigation pumping, the fraction of total pumping calculated for the 2007 meter data was assumed for the years 1998 through 2006 and the fraction of total pumping calculated for the 2008 meter data was assumed for the year 2009. Table 2.5-1 summarizes the sources used to spatially distribute irrigation pumpage in the NPGCD.

PGCD

The PGCD includes all of Roberts, Carson, Gray, Wheeler, and Donley counties, most of Potter and Armstrong counties, and a small portion of Hutchinson County. All of the irrigated acreage in Potter and Armstrong counties and none of the irrigated acreage in Hutchinson County, as identified by the modified 2000 survey, lies within the portion of the county included in the PGCD. Note that portions of Armstrong, Donley, and Wheeler counties lay outside of the active model boundary (see Figure 2.5-2).

The magnitude of total irrigation pumpage for the time period 1998 through 2009 is not available for any county within the District. Meter data are available for the years 1999 through 2008, but those data do not represent all irrigation pumpage in the counties. AgriLife (Marek and others, 2009) provides an estimate of total irrigation pumpage for 2000, but they do not indicate how much of that pumpage is supplied by the Ogallala Aquifer. Freese and Nichols (2009) provide an estimate of supplies by sources other than the Ogallala Aquifer by decade from 2010 through 2060, but not for 2000. The irrigation pumpage supplied by the Ogallala Aquifer in 2000 was estimated here by subtracting supplies from other sources as estimated by Freese and Nichols (2009) for 2010 from the total irrigation pumpage for 2000 estimated by AgriLife. This calculation assumes that the volume of irrigation pumpage supplied by sources other than the Ogallala Aquifer is the same for 2000 and 2010. This method was not used to estimate irrigation pumpage in 2000 for Roberts County. The 2000 estimate for Roberts County is a factor of 3.8 higher than the 2010 estimate by AgriLife (Marek and others, 2009). The PGCD indicated that the irrigated acres in Roberts County used by AgriLife to obtain the 2000 estimate was much higher than the actual irrigated acreage in the county for that year (PGCD, 2009b). Therefore, the 2000 estimated from AgriLife was not used for Roberts County.

The active model contains only portions of Armstrong, Donley, Potter, and Wheeler counties. The percentage of irrigated acreage located within the PGCD is 74, 82, 56, and 88 percent for Armstrong, Donley, Potter, and Wheeler counties, respectively. Assuming irrigation pumpage is consistent across the county, the predicted future demands received from Freese and Nichols (2009) were modified in these four counties to account for irrigation pumpage outside of the model boundary.

In conclusion, data are available to estimate values for the magnitude of irrigation pumpage by county for the year 2000, expect for Roberts County. For the remaining years in the period from 1998 through 2009 and all of the years for Roberts County, pumping was assumed to change linearly. For Roberts County, the magnitude of total irrigation pumpage for the county was estimated by assuming a linear change between the value for 1997 from the 2004 GAM and the predicted value for 2010 from Freese and Nichols (2009). For the remaining counties, the magnitude of total irrigation pumpage was estimated by assuming a linear change between the value for 1997 from the 2004 GAM and the estimated 2000 value and then again between the estimated 2000 value and the predicted value for 2010 from Freese and Nichols (2009). Table 2.5-2 summarizes the methods used to estimate irrigation pumpage in the PGCD from 1998 through 2009.

The spatial distribution of pumping in the counties within the District was developed using both meter locations from the available meter data and the modified 2000 irrigated acreage survey. For the two years for which meter data are not available (i.e., 1998 and 2009), the total irrigation pumpage in the counties was distributed based on the modified 2000 irrigated acreage. For the years with meter data (i.e., 1999 through 2008), several steps were used to distribute pumping. Note that the meter locations and pumping volumes differed from year to year. First, the model grid cells containing a meter were determined for each year with meter data. Second, it was determined whether model grid cells containing meters also contained irrigated acreage based on the modified 2000 survey. If they did, those grid cells were removed from the irrigated acreage coverage for that year. Third, the total volume of irrigation pumpage reflected by the meter data was subtracted from the total volume of irrigation pumpage for the county to yield a non-metered volume. Fourth, irrigation pumping was assigned to grid cells containing meters using the meter data. Fifth, the non-metered volume of irrigation pumpage for the county was distributed within the county based on the modified 2000 irrigated acreage survey less grid cells containing meter data. Table 2.5-2 summarizes the methods used to spatially distribute irrigation pumpage in the PGCD.

Hemphill County GCD and areas located outside of a GCD

This area of the model consists of Hemphill County, the portions of Dallam and Hutchinson counties not located in the NPGCD, and Randall County. Although portions of Harley and Moore counties are not located within the NPGCD, all of the irrigated acreage in those counties lies within the District and, thus, they are covered in the NPGCD discussion above. Note that portions of Randall County lay outside of the active model boundary.

For Hemphill County, total irrigation for 2000 was estimated from the estimated 2000 irrigation pumping by AgriLife (Marek and others, 2009) and the estimated sources other than Ogallala Aquifer for 2010 in Freese and Nichols (2009). For the remaining years, the magnitude of total irrigation pumpage was estimated by assuming a linear change between the value for 1997 from the 2004 GAM and the estimated 2000 value and then again from the estimated 2000 value to the predicted value for 2010 from Freese and Nichols (2009). Table 2.5-3 summarizes the methods used to estimate the magnitude of irrigation pumping for Hemphill County and to spatially distribute that pumpage in the county.

In Dallam County, 79.5 percent of the irrigated acreage is location within the NPGCD and 20.5 percent is located outside of the District. Assuming irrigation pumpage is the same across the county, the 2007 and 2008 meter data from the NPGCD for this county was assumed to account for 79.5 percent of the irrigation pumpage in the county. Based on this assumption, the amount of irrigation pumpage outside the District was calculated for 2007 and 2008 from the NPGCD meter data and for 2010 from the Freese and Nichols (2009) estimated Ogallala Aquifer demand. In addition, 20.5 percent of the total irrigation pumpage for the county in 2000, estimated as described under NPGCD above, was assigned to the portion of the county located outside of the District. Pumpage was assumed to change linearly from the 1997 value in the 2004 GAM to the estimated 2000 value, from the estimated 2000 value to the calculated 2007 value, and from the calculated 2008 to the predicted value for 2010 from Freese and Nichols (2009). The calculated pumpage was spatially distributed in the portion of the county not in the NPGCD based on the modified 2000 irrigated acreage survey. Table 2.5-3 summarizes the methods used to estimate the magnitude of irrigation pumping for the portion of Dallam County located outside of the NPGCD and to spatially distribute that pumpage in the county.

In Hutchinson County, 92 percent of the irrigated acreage is located within the NPGCD and 8 percent is located outside of the District. Assuming irrigation pumpage is the same across the county, the 2007 and 2008 meter data from the NPGCD for this county was assumed to account for 92 percent of the irrigation pumpage in the county. Based on this assumption, the amount of irrigation pumpage outside the District was calculated for 2007 and 2008 from the NPGCD meter data and for 2010 from the Freese and Nichols (2009) estimated Ogallala Aquifer demand. In addition, 8 percent of the total irrigation pumpage for the county in 2000, estimated as described under NPGCD above, was assigned to the portion of the county located outside of the District. Pumpage was assumed to change linearly from the 1997 value in the 2004 GAM to the estimated 2000 value, from the estimated 2000 value to the calculated 2007 value, and from the calculated 2008 to the predicted value for 2010 from Freese and Nichols (2009). The calculated pumpage was spatially distributed in the portion of the county not in the NPGCD based on the modified 2000 irrigated acreage survey. Table 2.5-3 summarizes the methods used to estimate the magnitude of irrigation pumping for Hutchinson County and to spatially distribute that pumpage in the county.

In Randall County, 28 percent of the irrigated acreage is located inside the active model boundary. Total irrigation in the county for 2000 was estimated from the estimated 2000 irrigation pumping by AgriLife (Marek and others, 2009) and the estimated sources other than Ogallala Aquifer for 2010 in Freese and Nichols (2009). Assuming irrigation pumpage is consistent across the county, 28 percent of this total pumpage was assumed for the portion of the county in the model area as was 28 percent of the estimated 2010 demand from Freese and Nichols (2009). Pumpage was assumed to change linearly from the 1997 value in the 2004 GAM to the estimated 2000 value and from the estimated 2000 value to the 2010 value from Freese and Nichols (2009). Irrigation pumpage was spatially distributed in the county based on the modified 2000 irrigated acreage survey. Table 2.5-3 summarizes the methods used to estimate the magnitude of irrigation pumping for Randall County and to spatially distribute that pumpage in the county.

<u>Predictive Period from 2010 through 2060</u>

The source of predictive irrigation pumpage is Freese and Nichols (2009), which provides values every decade from 2010 to 2060. For intervening years, pumping was assumed to change linearly. Total irrigation pumping in Dallam and Hutchinson counties was divided into 79.5 and 92 percent, respectively, in the NPGCD and 20.5 and 8 percent, respectively, outside of the District based on the ratio of irrigated acreage inside and outside of the District. For Armstrong, Donley, Potter, Randall, and Wheeler counties, 74, 82, 56, 28, and 88 percent, respectively, of total irrigation pumping in the county was assumed to occur within the active model boundary based on the ratio of irrigated acreage inside and outside the model boundary.

As discussed in Section 2.5.1, the predicted irrigation demands for counties in the Panhandle RWPA were developed by AgriLife (Marek and others, 2009) based on irrigated acreage data from Farm Service Agency data and county-by-county data on crop evapotranspiration. In Lipscomb County, the WHB Cattle Company has a large facility that does not participate in the

Farm Service Agency program (NPGCD, 2009c; 2009d). Therefore, the irrigated acres at that facility were not incorporated in the AgriLife calculations, resulting in under predictions of future irrigation demands for that county. Based on the 2007 and 2008 meter data from the NPGCD, which does include the WHB Cattle Company, irrigation at that facility accounts for about 59 percent of total irrigation in the county. Therefore, the future irrigation demands for Lipscomb County from Freese and Nichols (2009) were adjusted to reflect irrigation pumpage by the WHB Cattle Company. Tables 2.5-1 through 2.5-3 summarize the methods used to determine the magnitude of irrigation pumpage for the predictive period.

Two methods were used to spatially distribute irrigation pumping for the period 2010 through 2060. In the NPGCD, irrigation pumpage was distributed based on the 2008 meter locations and the fraction of total pumpage calculated for each meter for that year. This method assumes that the distribution of irrigation pumpage remains constant from 2008 through 2060. For all other areas, including all of the PGCD, irrigation pumpage was spatially distributed based on the modified 2000 irrigated acreage survey. Tables 2.5-1 through 2.5-3 summarize the methods used to determine the spatial distribution of irrigation pumpage for the predictive period. Figure 2.5-5 shows the average irrigation pumpage by model grid cell for the predictive period from 2010 through 2060 for the portion of the model located in Texas.

2.5.2.2 Implementation of Municipal Pumpage

Assigning pumping from the Ogallala Aquifer to model cells to represent municipal or public-water supplies primarily used the TWDB groundwater database (TWDB, 2009b). The main task involved matching surveyed entities in the municipal water user group (WUG), named in the municipal pumpage data received from the TWDB (TWDB, 2009a), to names of owners of public-water supply wells included in the TWDB groundwater database. Locations of 98 wells operated by the City of Amarillo in Carson, Potter, and Randall counties were taken from information used in the 2001 and 2004 GAM models and updated for this study. Municipal pumping by the Canadian River Municipal Water Authority (CRMWA) in Roberts County since 2001 was provided by Lee Wilson and Associates, Inc. (2009). Additional information for assigning pumping to model grid cells was obtained from the Texas Commission on Environmental Quality (TCEQ) online listing of public water suppliers (TCEQ, 2009). The TCEQ public-water supply list identified locations for assigning pumping for 23 surveyed entities including small water-supply corporations, mobile home parks, or camp grounds. Only four of these 23 surveyed entities were listed as still pumping in 2007 and none were included in the predicted municipal demand dataset (Freese and Nichols, 2009). Remaining historical municipal pumping from the Ogallala Aquifer estimated in the TWDB data (TWDB, 2009a) for unlocated municipal or public-water supply providers was assigned to model grid cells associated with communities where the water user group was assumed to have been present.

For the period of 1955 through 2007, once surveyed municipal entities in the TWDB (2009a) data were matched to specific wells or model grid cells, annual pumpage specified for each entity was prorated across the number of matched wells or grid cells. Annual pumpage was interpolated where pumping by a entity was not reported for two or more consecutive years.

The following approach was used to implement municipal pumping for the period of 2008 through 2060. Many cities and other major water-supply corporations in the predictive dataset were also included in the historical list of surveyed entities (TWDB, 2009a). Total Ogallala Aquifer pumpage by decade from 2010 through 2060 (Freese and Nichols, 2009) for each listed water user group in each county and basin was divided by the total number of matched wells (from the historical dataset) associated with that provider. Pumping allocated to wells for those decadal years was interpolated for the intervening nine years. Pumping for 2008 and 2009 was interpolated between municipal pumping for 2007 and 2010 for each well. Some reported pumping by major water providers had ended (no reported pumping) before or by 2007. If those major water providers were not included in the 2010 through 2060 predictive data set, no predictive pumping was assigned to those well locations.

Historical and/or predictive municipal pumpage was allocated to 441 wells or model grid cell locations. Average municipal pumpage for 2010 through 2060 by model grid cells is shown in Figure 2.5-6 for the Texas portion of the model.

2.5.2.3 Implementation of Manufacturing Pumpage

Of the 68 surveyed manufacturing entities listed in the historical pumpage received from the TWDB (TWDB, 2009a), 36 were matched to a total of 134 wells or model grid cell locations. Locations of 60 wells operated by Phillips Petroleum Company in the Herring-Pantex and Kay-Pantex Water Stations in Hutchinson County and the Plains-Pantex Water Station in Carson

County were taken from information used in the 2001 and 2004 GAM models. Of the 32 unmatched surveyed manufacturing entities, 20 have less than 5 years of pumpage record and 15 reported pumping of less than 10 acre-ft/year from the Ogallala Aquifer. Another 13 of the unmatched manufacturing entities, however, are listed as pumping since 2000, including several with over 30 years of reported pumpage (National Oil Well in Gray County, J. Lee Milligan, Inc. in Potter County, and Degussa Engineered Carbons in Hutchinson County). Not including pumpage for these and the other unmatched entities nonetheless was assumed to have a negligible effect on model calibration. Annual pumping reported for the 32 unmatched manufacturing entities totaled from ~40 to ~1500 acre-feet per year (acre-ft/year), which averages approximately 2 percent of total manufacturing pumpage and approximately 0.1 percent of total pumpage in the model. The 32 entities that could not be assigned to a well or grid cell location were kept in the GIS dataset but were assigned to a model grid cell in the inactive portion of the model.

An approach similar to that used for municipal pumping was followed for implementing predictive manufacturing pumpage. Total Ogallala Aquifer pumpage by decade for 2010 through 2060 for all manufacturing in each county and basin was divided by the total number of all matched wells (from the historical dataset) associated with manufacturing in that county and basin. Pumping allocated to wells for those decadal years was interpolated for the intervening nine years. Pumping for 2008 and 2009 was interpolated between manufacturing pumping for 2007 and 2010. In the case where a manufacturing well had no assigned pumping in 2007, predictive-period pumping was treated as if manufacturing pumping restarted in the model grid cell where there was previous manufacturing pumping. The average manufacturing pumpage for the predictive period 2010 through 2060 is shown by model grid cell in Figure 2.5-7 for the Texas portion of the model.

2.5.2.4 Implementation of Mining Pumpage

Groundwater from the Ogallala Aquifer used for mining purposes is mostly associated with sand and gravel operations or petroleum (oil and gas) production. Of the 45 surveyed mining entities in the TWDB (2009a) historical data, 14 were matched to a total of 41 wells or model grid cell locations. Another 32 historical mining entities in the TWDB (2009a) data, totaling 6 to 100 acre-ft/year, could not be associated with a specific well or location. The 32 entities that could not be assigned to a well or grid cell location were kept in the GIS dataset but were assigned to a model grid cell in the inactive portion of the model. Total pumping for mining decreased from an average of about 420 acre-ft/year before 1980 to an average of about50 acre-ft/year after 1985 (TWDB, 2009a), while the amount of non-assigned pumping decreased from an average 76 acre-ft/year before 1980 to an average 26 acre-ft/year after 1980. It is assumed that the range of 6 to 100 acre-ft/year for non-located mining-related pumping, which is less than 0.01 percent of irrigation pumping, would have a negligible effect on model calibration.

Predicted 2010 through 2060 withdrawal of groundwater from the Ogallala Aquifer for mining purposes was assigned to model cells on the basis of oil and gas fields in the Anadarko Basin. This groundwater production represents predicted use for drilling oil and gas wells and for so-called 'hydrofracing' of production zones in wells. The predicted pumping dataset designates production by county and basin. Oil and gas fields were digitized and overlapped with model grid cells using GIS tools. Predicted pumping by county and basin was prorated to model grid cells by the percent of total county area mapped as lying in oil and gas fields. The average mining pumpage for the predictive period 2010 through 2060 is shown by model grid cell in Figure 2.5-8 for the Texas portion of the model.

2.5.2.5 Implementation of Power Pumpage

Historical and predicted pumping from the Ogallala Aquifer for steam-electric and other power generation purposes was assigned to 21 wells. This includes pumping of groundwater from the Ogallala Aquifer for the Southwestern Public Service Company's Moore Company Plant in Moore County and East Plant (through 1975) in Potter County.

Predictive Ogallala Aquifer pumpage for steam-electric power generation for 2010 through 2060 was indicated for the Southwestern Public Service Company's Moore Company Plant in Moore County and the Hoescht Celanese Plant in Gray County. Historical use of groundwater for the wells at the Hoescht Celanese Plant is included under the surveyed manufacturing entities. Predictive pumping was implemented in the matched wells, as previously described, and interpolated for the nine intradecadal years. Pumping for 2008 and 2009 for the Southwestern Public Service Company's Moore Company Plant was interpolated between 2007 and 2010 over the five matched wells. Average power pumpage for the predictive period 2010 through 2060 is shown by model grid cell in Figure 2.6-9 for the Texas portion of the model.

2.5.2.6 Implementation of Livestock Pumpage

For the historical period from 1995 through 1997, the spatial distribution of livestock pumpage in the 2004 GAM was used. Recall that livestock and rural domestic pumpage were combined in the 2004 GAM.

Locations and livestock counts for confined livestock operations (CLOs) in the Panhandle RWPA were obtained from Texas AgriLife Extension Service (2009) based on TCEQ records for inspections in 2007, 2008, and 2009 and from the Texas Cattle Feeders Association (2009) based on their knowledge of feed lots in the Panhandle RWPA. Livestock pumpage for the period 1998 through 2060 was allocated to only these CLO locations.

Predictions of total water demand for livestock purposes were developed by AgriLife (Marek and others, 2009) using current livestock inventories and estimated future growth rates for the different livestock species based on the guidance of three expert advisory committees. Freese and Nichols (2009) estimated future livestock demands from the Ogallala Aquifer by decade for 2010 through 2060 as the total values from AgriLife less supplies from sources other than the Ogallala Aquifer. For intervening years, pumping was assumed to change linearly.

The distribution of future livestock pumpage at the CLO locations was based on the ratio of consumption at each CLO relative to the calculated consumption for all CLOs in the county. At each CLO, water consumption was calculated assuming water use of 12.5, 55, and 5 gallons of per head per day for beef cattle, dairy cattle, and hogs, respectively. Figure 2.5-10 shows the location and average livestock pumpage for the predictive period 2010 through 2060 for the Texas portion of the model.

2.5.2.7 Implementation of Rural Domestic Pumpage

For the historical period from 1995 through 1997, the spatial distribution of rural domestic pumpage in the 2004 GAM was used. Recall that livestock and rural domestic pumpage were combined in the 2004 GAM

Freese and Nichols (2009) estimated future rural domestic demands from the Ogallala Aquifer by decade for 2010 through 2060. For intervening years, pumping was assumed to change linearly. Future rural domestic pumpage was allocated in the model over the rural population based on the 1990 census block population density, which was provided as polygon feature class by the TWDB. Rural domestic pumpage was not assigned in urban areas with an identified municipal water supply source. Average rural domestic pumpage for the predictive period 2010 through 2060 is shown by model grid cell in Figure 2.5-11 for the Texas portion of the model.

Table 2.5-1 Methods for determining magnitude and spatial distribution of irrigation pumpage in the NPGCD.

Year	Methods for Determining the Magnitude of Irrigation Pumpage		Methods for Distribution of Irrigation Pumpage
	All Counties Except Lipscomb	Lipscomb County	All Counties
1998-1999	linear change between 1997 value from 2004 GAM and 2000 value		2007 meter data locations and fractions
2000	AgriLife 2000 value less the Freese and Nichols (2009) 2010 demand supplied by sources other than Ogallala[1]		2007 meter data locations and fractions
2001-2006	linear change between 2000 value and 2007 value		2007 meter data locations and fractions
2007	NPGCD meter data		2007 meter data
2008	NPGCD meter data		2008 meter data
2009	linear change between 2009 value and 2010 value		2008 meter data locations and fractions
2010	Freese and Nichols (2009)[1]	Freese and Nichols (2009) value adjusted to account for Braums Farms	2008 meter data locations and fractions
2011-2019	linear change between 2010 value and 2020 value		2008 meter data locations and fractions
2020	Freese and Nichols (2009) [1]	Freese and Nichols (2009) value adjusted to account for Braums Farms	2008 meter data locations and fractions
2021-2029	linear change between 2020 value and 2030 value		2008 meter data locations and fractions
2030	Freese and Nichols (2009) [1]	Freese and Nichols (2009) value adjusted to account for Braums Farms	2008 meter data locations and fractions
2031-2039	linear change between 2030 value and 2040 value		2008 meter data locations and fractions
2040	Freese and Nichols (2009) [1]	Freese and Nichols (2009) value adjusted to account for Braums Farms	2008 meter data locations and fractions
2041-2049	linear change between 2040 value and 2050 value		2008 meter data locations and fractions
2050	Freese and Nichols (2009) [1]	Freese and Nichols (2009) value adjusted to account for Braums Farms	2008 meter data locations and fractions
2051-2059	linear change between 2050 value and 2060 value		2008 meter data locations and fractions
2060	Freese and Nichols (2009) [1]	Freese and Nichols (2009) value adjusted to account for Braums Farms	2008 meter data locations and fractions

[1] value for Dallam and Hutchinson counties adjusted for the fraction of irrigated acreage in the county located outside of the NPGCD.

Table 2.5-2 Methods for determining magnitude and spatial distribution of irrigation pumpage in the PGCD.

Year	Method for Determining the Magnitude of Irrigation Pumpage			Methods for Distribution of Irrigation Pumpage
	Roberts, Carson, and Gray counties	Potter, Wheeler, Armstrong, and Donley counties	Roberts County	All Counties
1998	linear change between 1997 value from 2004 GAM and 2000 value		linear change between 1997 value from 2004 GAM and 2010 value	modified 2000 irrigated acreage survey
1999	linear change between 1997 value from 2004 GAM and 2000 value		linear change between 1997 value from 2004 GAM and 2010 value	meter locations and modified 2000 irrigated acreage survey
2000	AgriLife 2000 value less the Freese and Nichols (2009) 2010 demand supplied by sources other than Ogallala	AgriLife 2000 value less the Freese and Nichols (2009) 2010 demand supplied by sources other than Ogallala adjusted for fraction of irrigated acreage in the county located outside of the active model area[1]	linear change between 1997 value and 2010 value	meter locations and modified 2000 irrigated acreage survey
2001-2008	linear change between 2000 value and 2010 value		linear change between 1997 value and 2010 value	meter locations and modified 2000 irrigated acreage survey
2009	linear change between 2000 value and 2010 value		linear change between 1997 value and 2010 value	modified 2000 irrigated acreage survey
2010	Freese and Nichols (2009) value	Freese and Nichols (2009) value adjusted for fraction of irrigated acreage in the county located outside of the model area[1]	Freese and Nichols (2009) value	modified 2000 irrigated acreage survey
2011-2019	linear change between 2010 value and 2020 value			modified 2000 irrigated acreage survey
2020	Freese and Nichols (2009) value	Freese and Nichols (2009) value adjusted for fraction of irrigated acreage in the county located outside of the model area[1]	Freese and Nichols (2009) value	modified 2000 irrigated acreage survey
2021-2029	linear change between 2020 value and 2030 value			modified 2000 irrigated acreage survey
2030	Freese and Nichols (2009) value	Freese and Nichols (2009) value adjusted for fraction of irrigated acreage in the county located outside of the model area[1]	Freese and Nichols (2009) value	modified 2000 irrigated acreage survey
2031-2039	linear change between 2030 value and 2040 value			modified 2000 irrigated acreage survey
2040	Freese and Nichols (2009) value	Freese and Nichols (2009) value adjusted for fraction of irrigated acreage in the county located outside of the model area[1]	Freese and Nichols (2009) value	modified 2000 irrigated acreage survey
2041-2049	linear change between 2040 value and 2050 value			modified 2000 irrigated acreage survey

Table 2.5-2, continued

Year	Methods for Determining the Magnitude of Irrigation Pumpage			Methods for Distribution of Irrigation Pumpage
	Roberts, Carson, and Gray counties	Potter, Wheeler, Armstrong, and Donley counties	Roberts County	All Counties
2050	Freese and Nichols (2009) value	Freese and Nichols (2009) value adjusted for fraction of irrigated acreage in the county located outside of the model area[1]	Freese and Nichols (2009) value	modified 2000 irrigated acreage survey
2051-2059	linear change between 2050 value and 2060 value			modified 2000 irrigated acreage survey
2060	Freese and Nichols (2009) value	Freese and Nichols (2009) value adjusted for fraction of irrigated acreage in the county located outside of the model area[1]	Freese and Nichols (2009) value	modified 2000 irrigated acreage survey

[1] Percentage of irrigated acreage located outside of the active model boundary is 44 percent for Potter County, 12 percent for Wheeler County, 26 percent for Armstrong County, and 18 percent for Donley County.

Table 2.5-3 Methods for determining magnitude and spatial distribution of irrigation pumpage in the Hemphill GCD and areas located outside of a GCD.

Year	Methods for Determining the Magnitude of Irrigation Pumpage			Methods for Distribution of Irrigation Pumpage
	Hemphill County	Dallam and Hutchinson counties	Randall County	All Counties
1998-1999	linear change between 1997 value from 2004 GAM and 2000 value	linear change between 1997 value from 2004 GAM and 2000 value	linear change between 1997 value from 2004 GAM and 2000 value	modified 2000 irrigated acreage survey
2000	AgriLife) 2000 value less the Freese and Nichols (2009) 2010 demand supplied by sources other than Ogallala	AgriLife 2000 value less the Freese and Nichols (2009) 2010 demand supplied by sources other than Ogallala adjusted for fraction of irrigated acres in the NPGCD[1]	Freese and Nichols (2009) value less the Freese and Nichols (2009) 2010 demand supplied by sources other than Ogallala adjusted to account for the portion of irrigated acreage in the county located outside of the active model area[2]	modified 2000 irrigated acreage survey
2001-2006	linear change between 2000 value and 2010 value			modified 2000 irrigated acreage survey
2007-2008	linear change between 2000 value and 2010 value	county total (North Plains meter data divided by fraction of irrigated acreage in District) minus NPGCD meter data[1]	linear change between 2000 value and 2010 value	modified 2000 irrigated acreage survey
2009	linear change between 2000 value and 2010 value	linear change between 2008 value and 2010 value	linear change between 2000 value and 2010 value	modified 2000 irrigated acreage survey
2010	Freese and Nichols (2009)	Freese and Nichols (2009) adjusted for fraction of irrigated acreage in NPGCD[1]	Freese and Nichols (2009) value adjusted to account for the portion of irrigated acreage in the county located outside of the model area[2]	modified 2000 irrigated acreage survey
2011-2019	linear change between 2010 value and 2020 value			modified 2000 irrigated acreage survey
2020	Freese and Nichols (2009)	Freese and Nichols (2009) adjusted for fraction of irrigated acreage in NPGCD[1]	Freese and Nichols (2009) value adjusted to account for the portion of irrigated acreage in the county located outside of the model area[2]	modified 2000 irrigated acreage survey
2021-2029	linear change between 2020 value and 2030 value			modified 2000 irrigated acreage survey
2030	Freese and Nichols (2009)	Freese and Nichols (2009) adjusted for fraction of irrigated acreage in NPGCD[1]	Freese and Nichols (2009) value adjusted to account for the portion of irrigated acreage in the county located outside of the model area[2]	modified 2000 irrigated acreage survey
2031-2039	linear change between 2030 value and 2040 value			modified 2000 irrigated acreage survey
2040	Freese and Nichols (2009)	Freese and Nichols (2009) adjusted for fraction of irrigated acreage in NPGCD[1]	Freese and Nichols (2009) value adjusted to account for the portion of irrigated acreage in the county located outside of the model area[2]	modified 2000 irrigated acreage survey

Table 2.5-3, continued

Year	Methods for Determining the Magnitude of Irrigation Pumpage			Methods for Distribution of Irrigation Pumpage
	Hemphill County	Dallam and Hutchinson counties	Randall County	All Counties
2041-2049	linear change between 2040 value and 2050 value			modified 2000 irrigated acreage survey
2050	Freese and Nichols (2009)	Freese and Nichols (2009) adjusted for fraction of irrigated acreage in NPGCD[1]	Freese and Nichols (2009) value adjusted to account for the portion of irrigated acreage in the county located outside of the model area[2]	modified 2000 irrigated acreage survey
2051-2059	linear change between 2050 value and 2060 value			modified 2000 irrigated acreage survey
2060	Freese and Nichols (2009)	Freese and Nichols (2009) adjusted for fraction of irrigated acreage in NPGCD[1]	Freese and Nichols (2009) value adjusted to account for the portion of irrigated acreage in the county located outside of the model area[2]	modified 2000 irrigated acreage survey

[1] Percentage of irrigation acreage in Dallam and Hutchinson counties located inside the NPGCD is 79.5 and 92.0 percent, respectively.

[2] Percentage of irrigated acreage located outside of the active model boundary in Randall County is 72 percent.

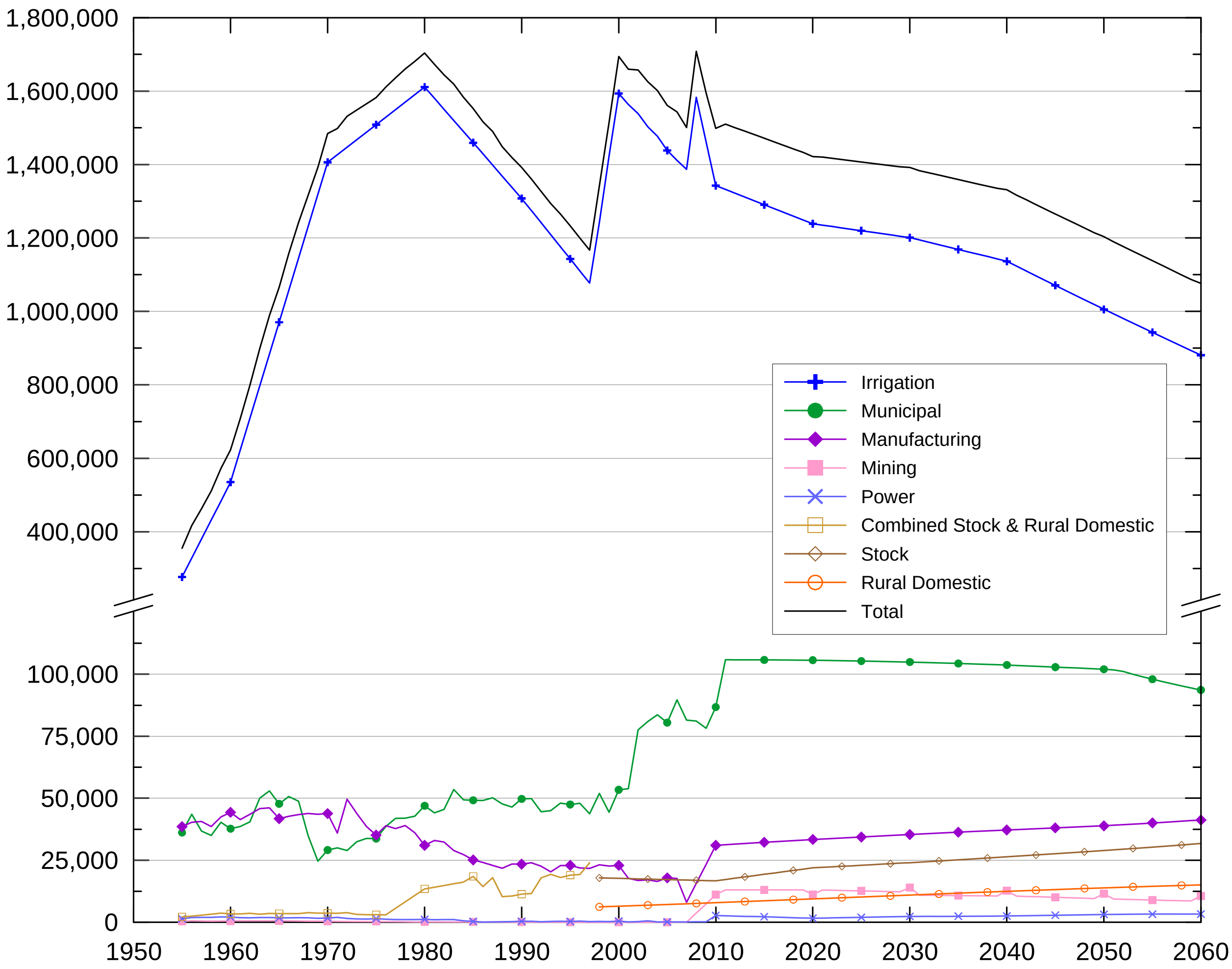

Figure 2.5-1 Estimated total pumpage by category from the Ogallala Aquifer.

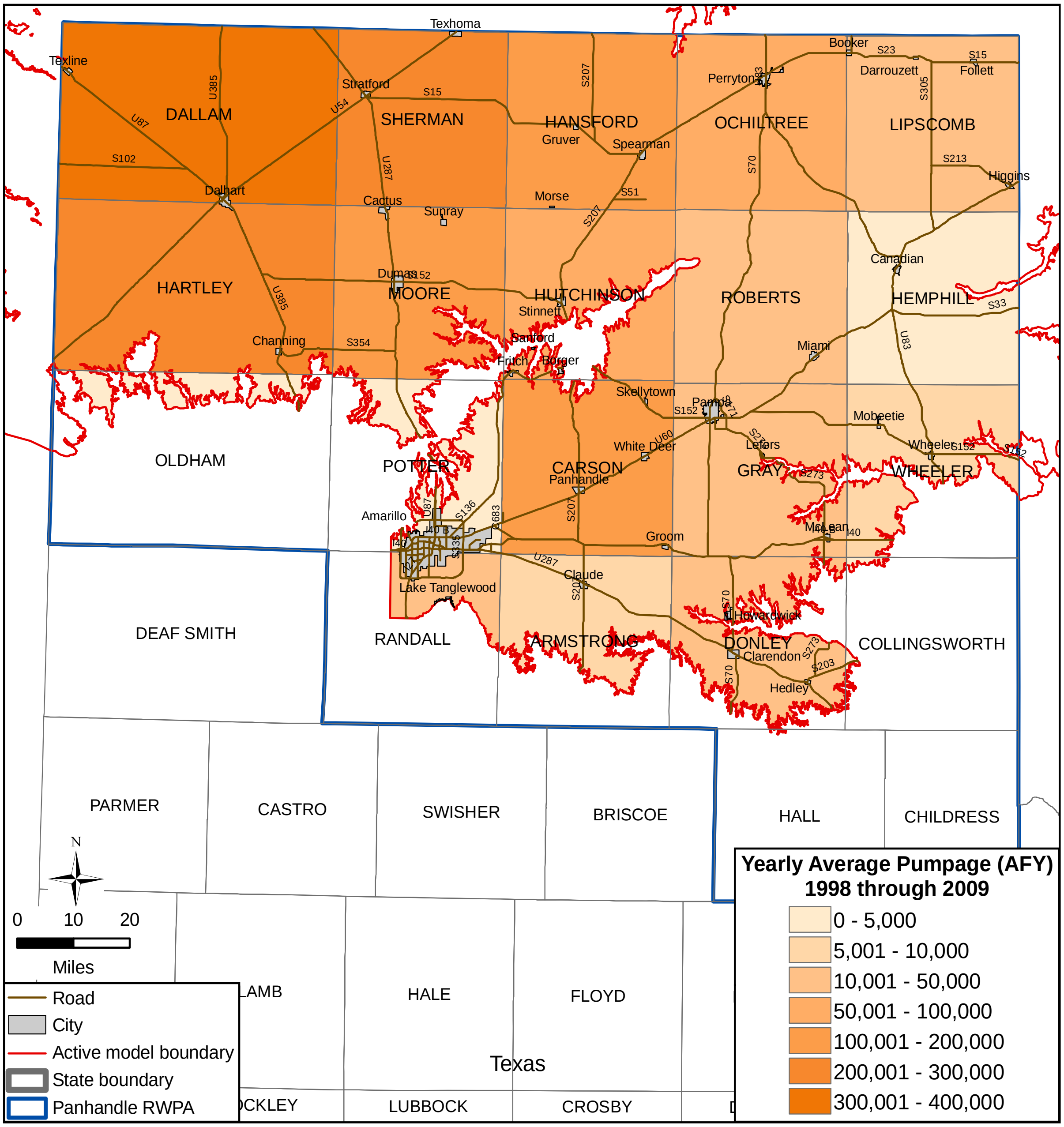

Figure 2.5-2 Yearly average pumping rate for the period 1998 through 2009 by county.

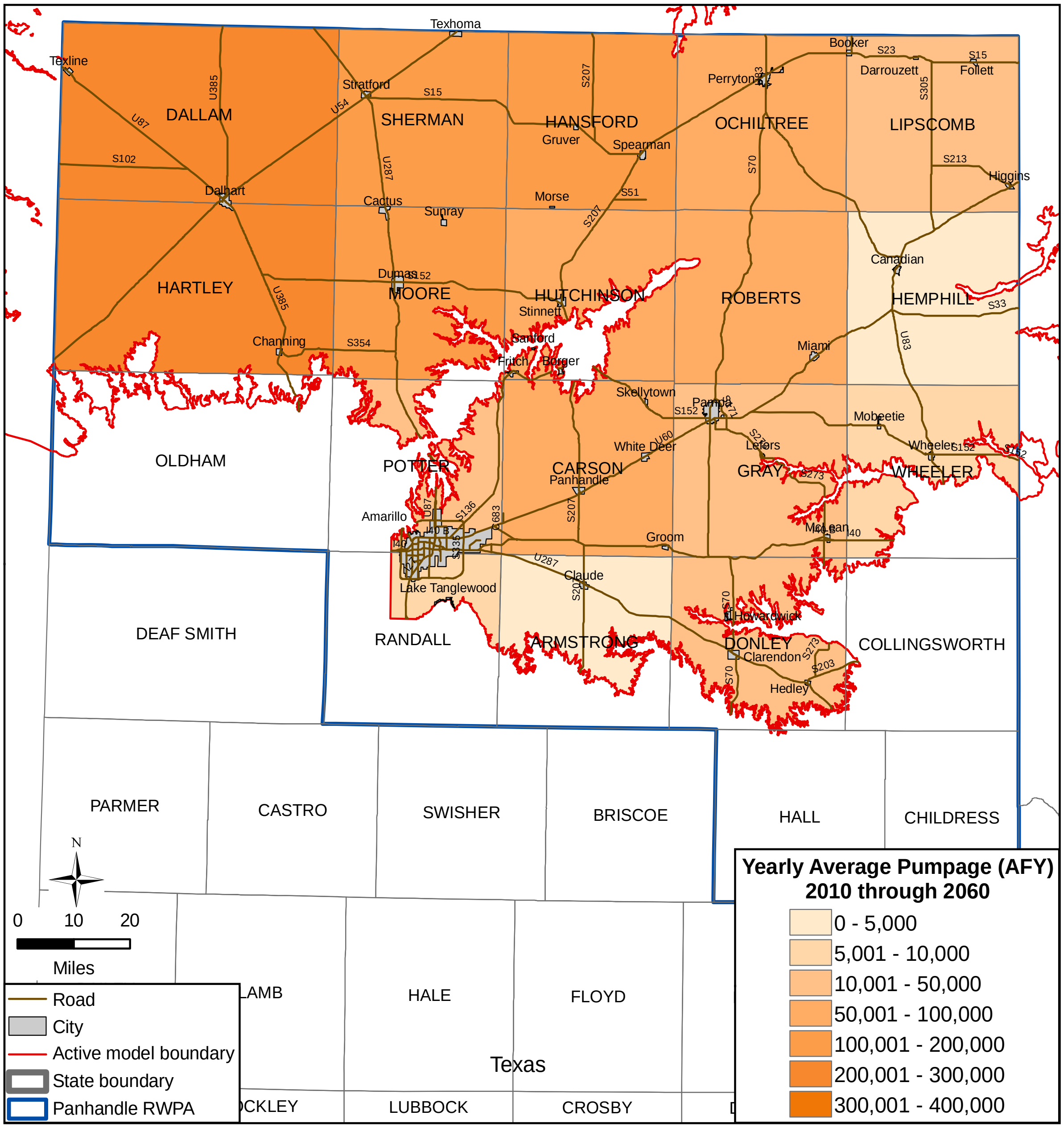

Figure 2.5-3 Yearly average pumping rate for the period 2010 through 2060 by county.

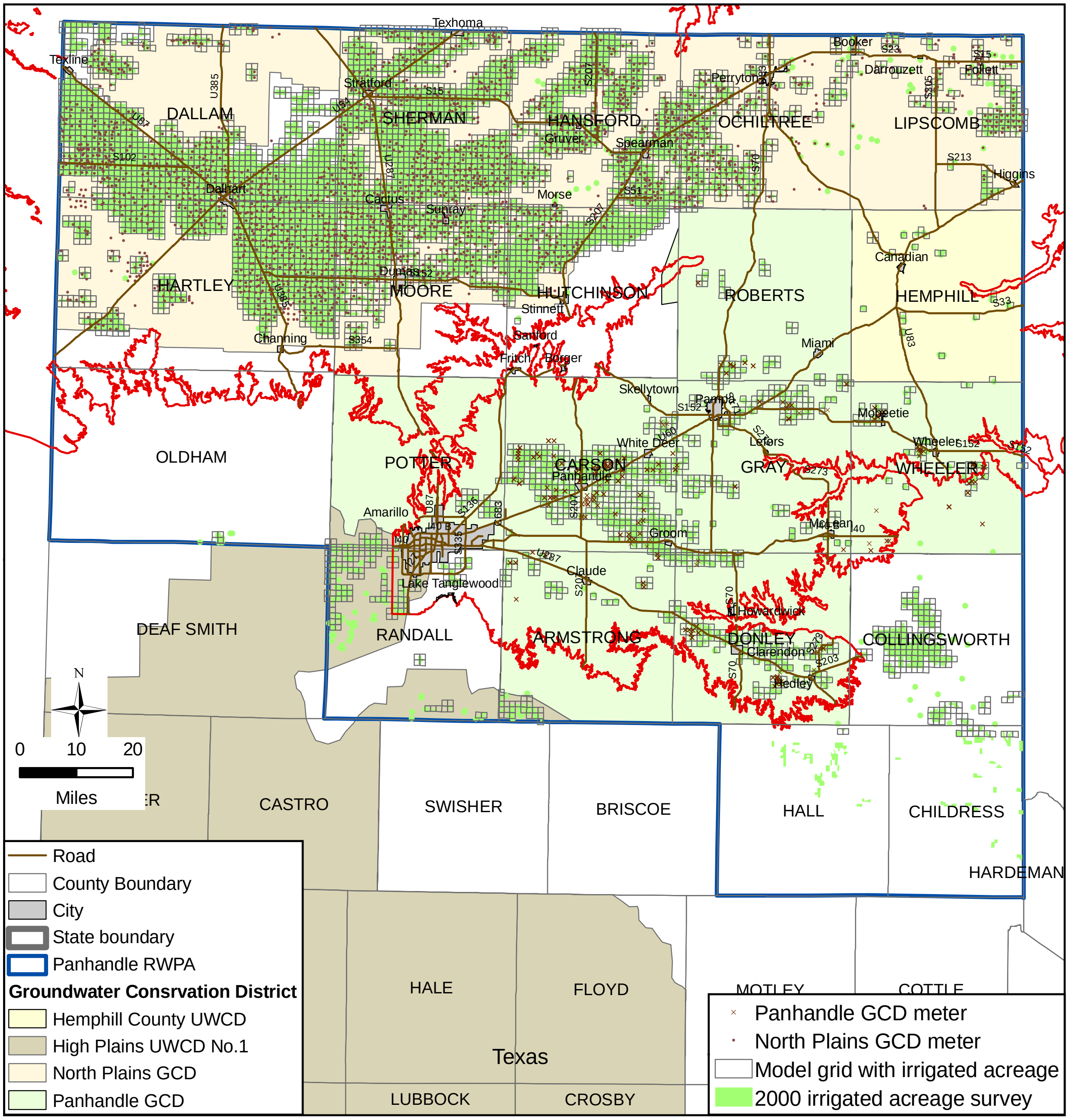

Figure 2.5-4 Modified 2000 irrigated acreage, meter locations, and model grid cells containing irrigated acreage.

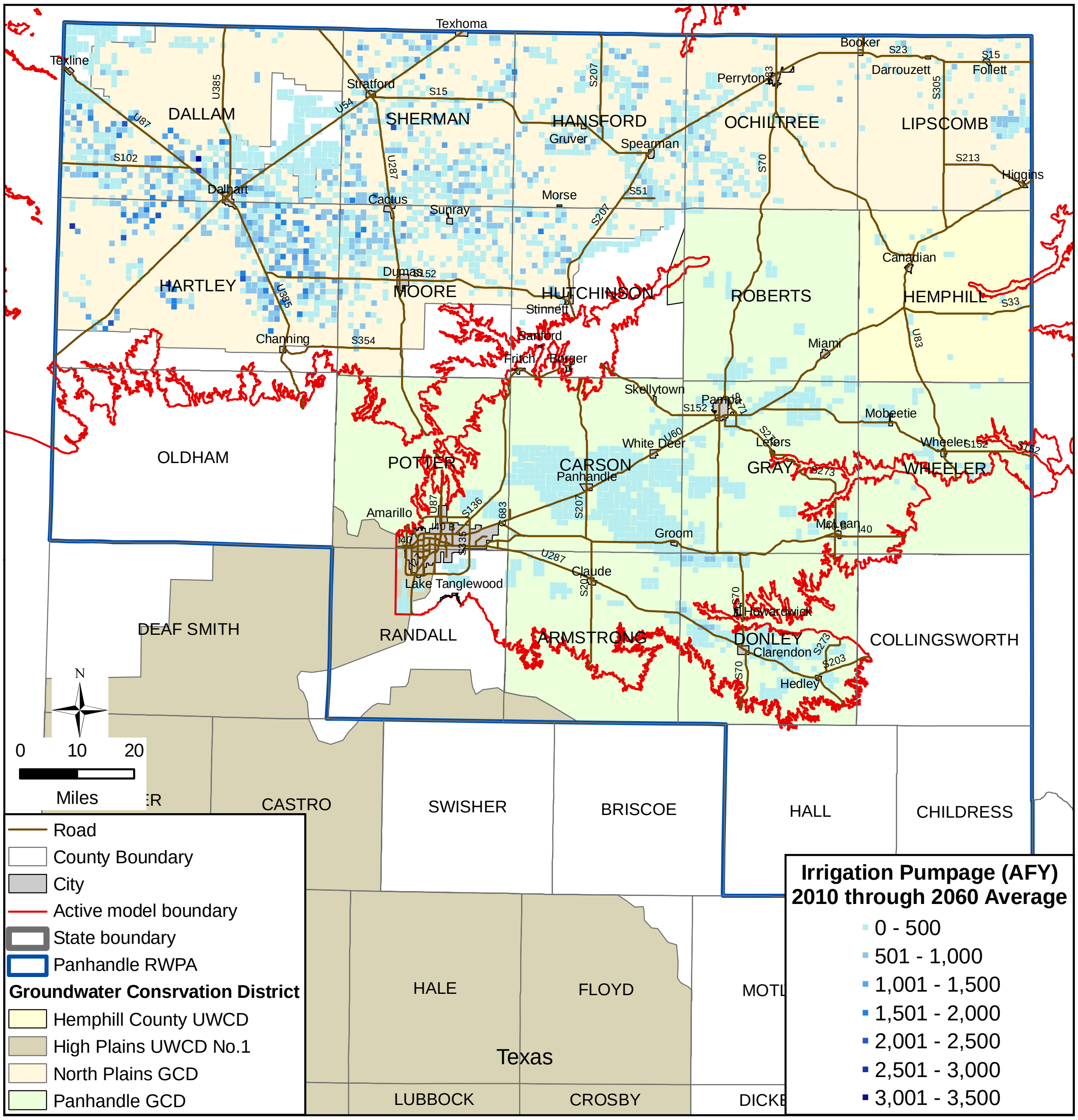

Figure 2.5-5 Average irrigation pumpage by model grid cell for the period 2010 through 2060 in the Texas portion of the model.

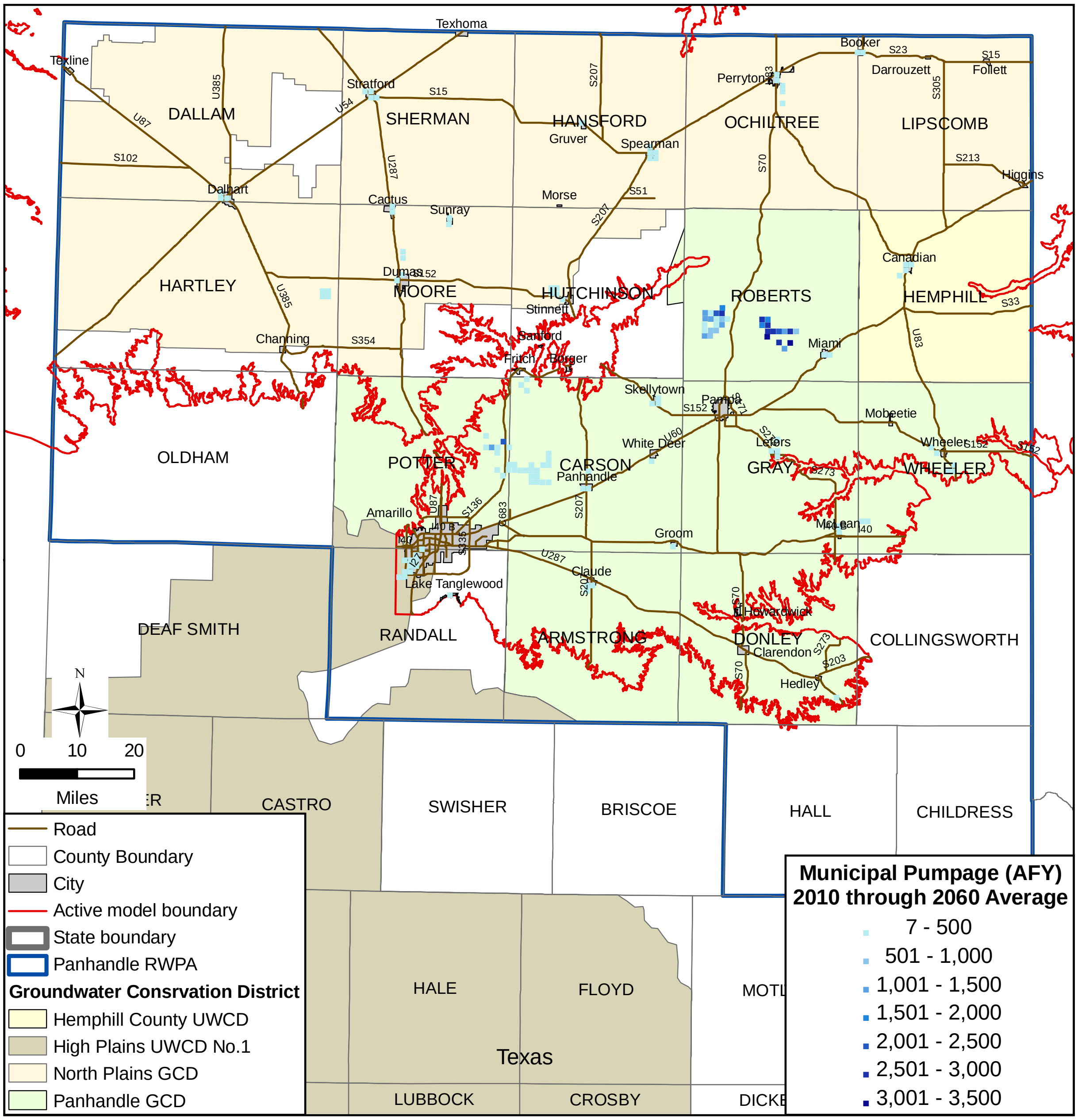

Figure 2.5-6 **Average municipal pumpage by model grid cell for the period 2010 through 2060 in the Texas portion of the model.**

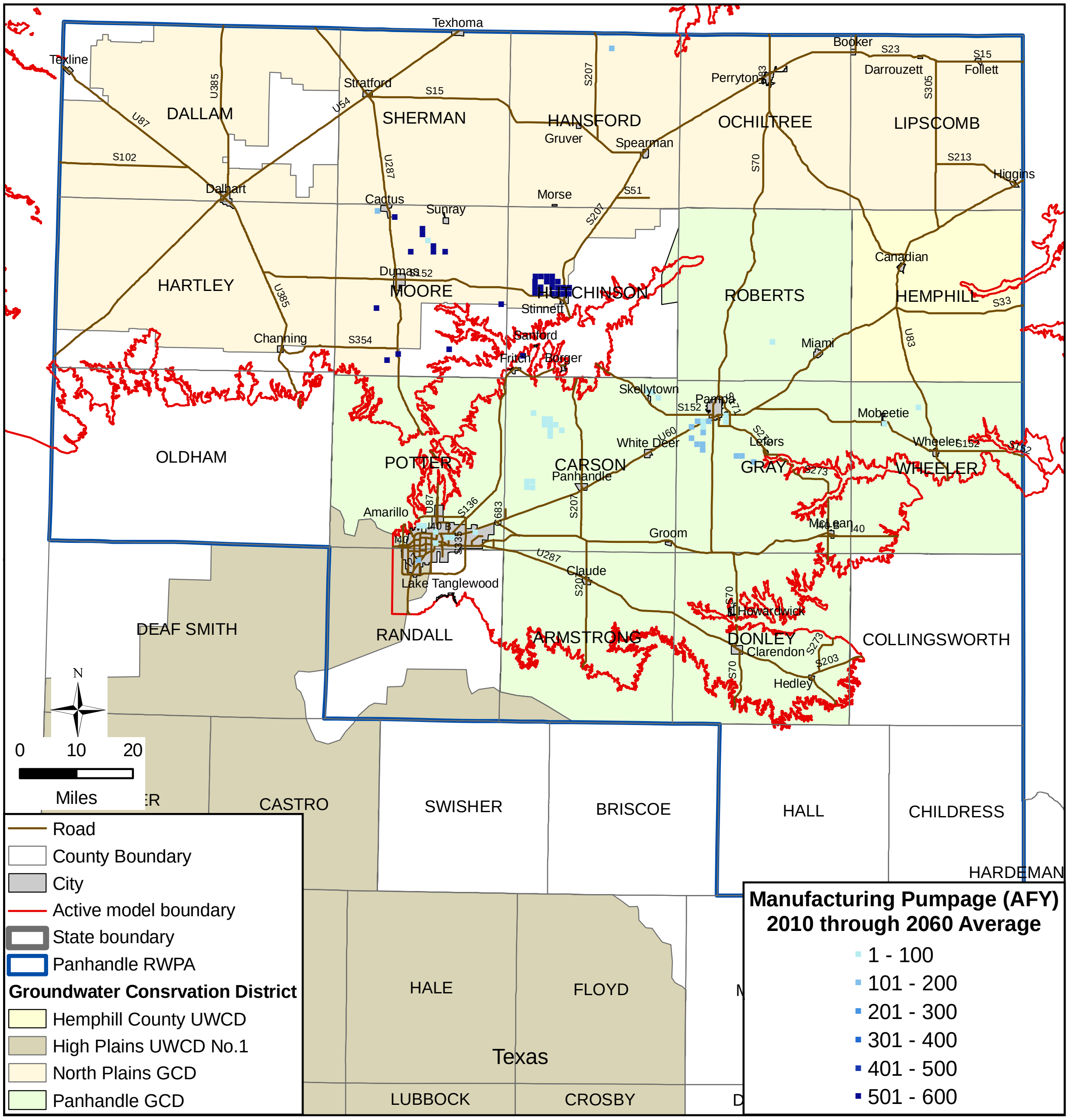

Figure 2.5-7 **Average manufacturing pumpage by model grid cell for the period 2010 through 2060 in the Texas portion of the model.**

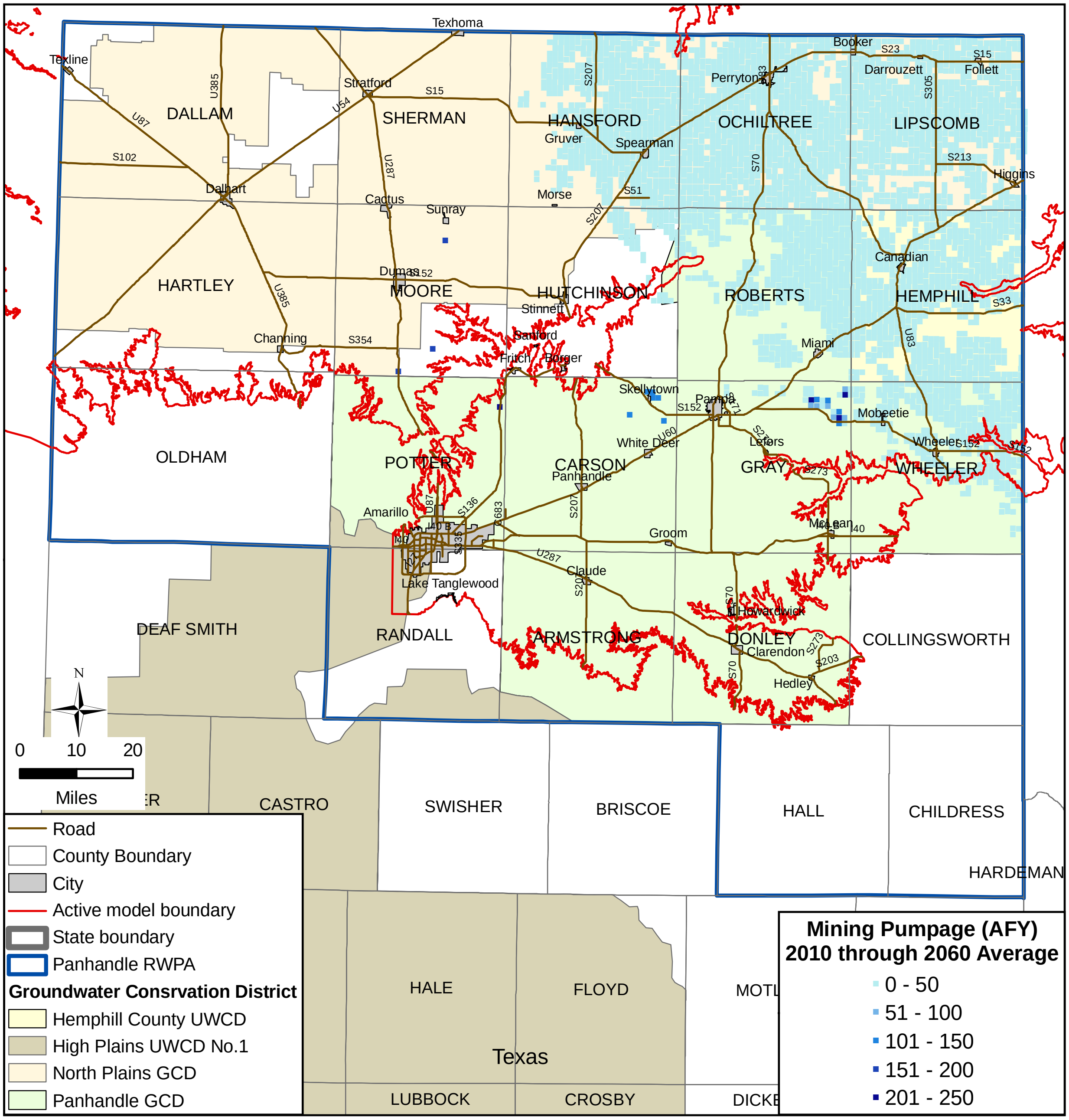

Figure 2.5-8 Average mining pumpage by model grid cell for the period 2010 through 2060 in the Texas portion of the model.

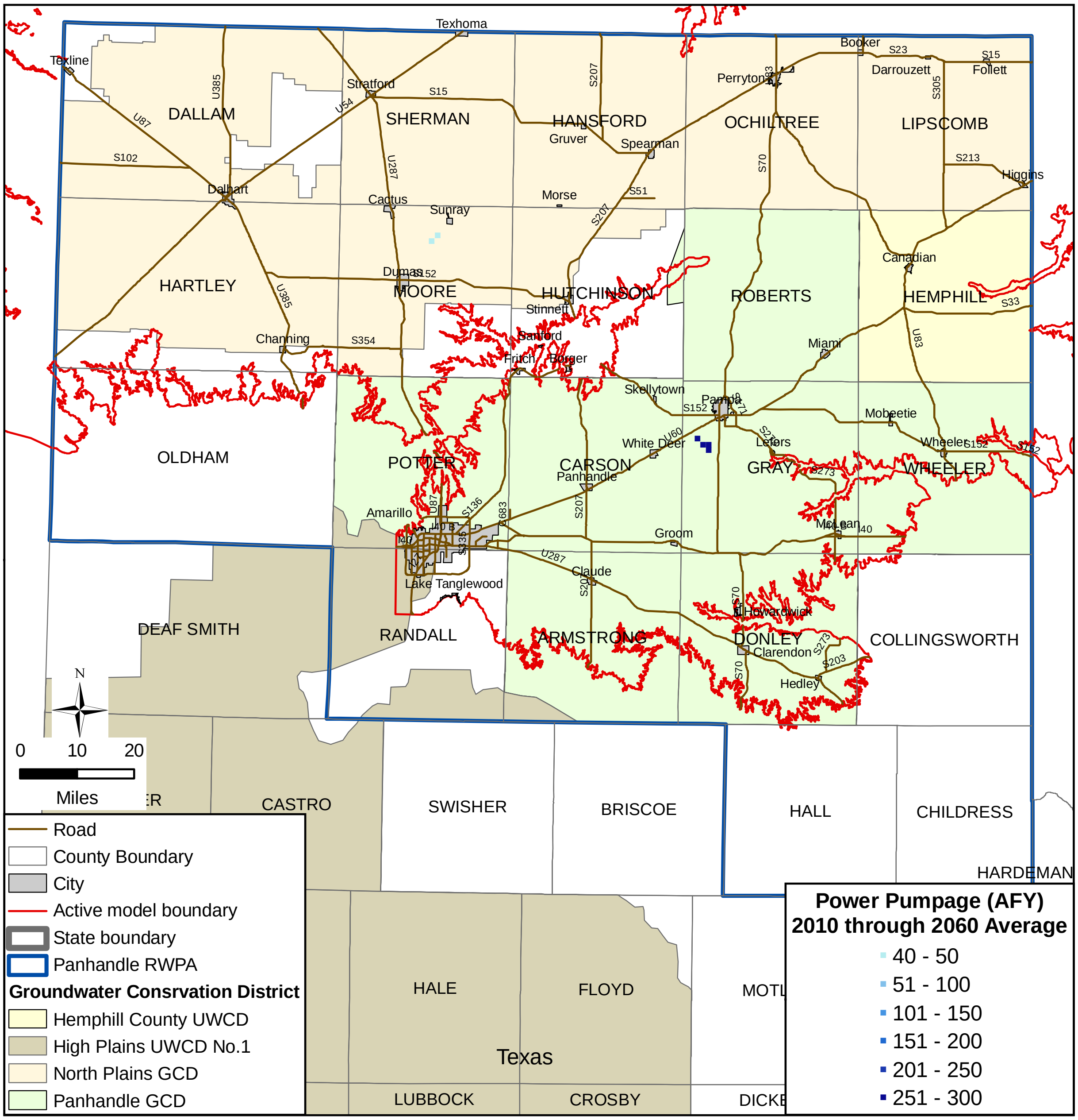

Figure 2.5-9 **Average power pumpage by model grid cell for the period 2010 through 2060 in the Texas portion of the model.**

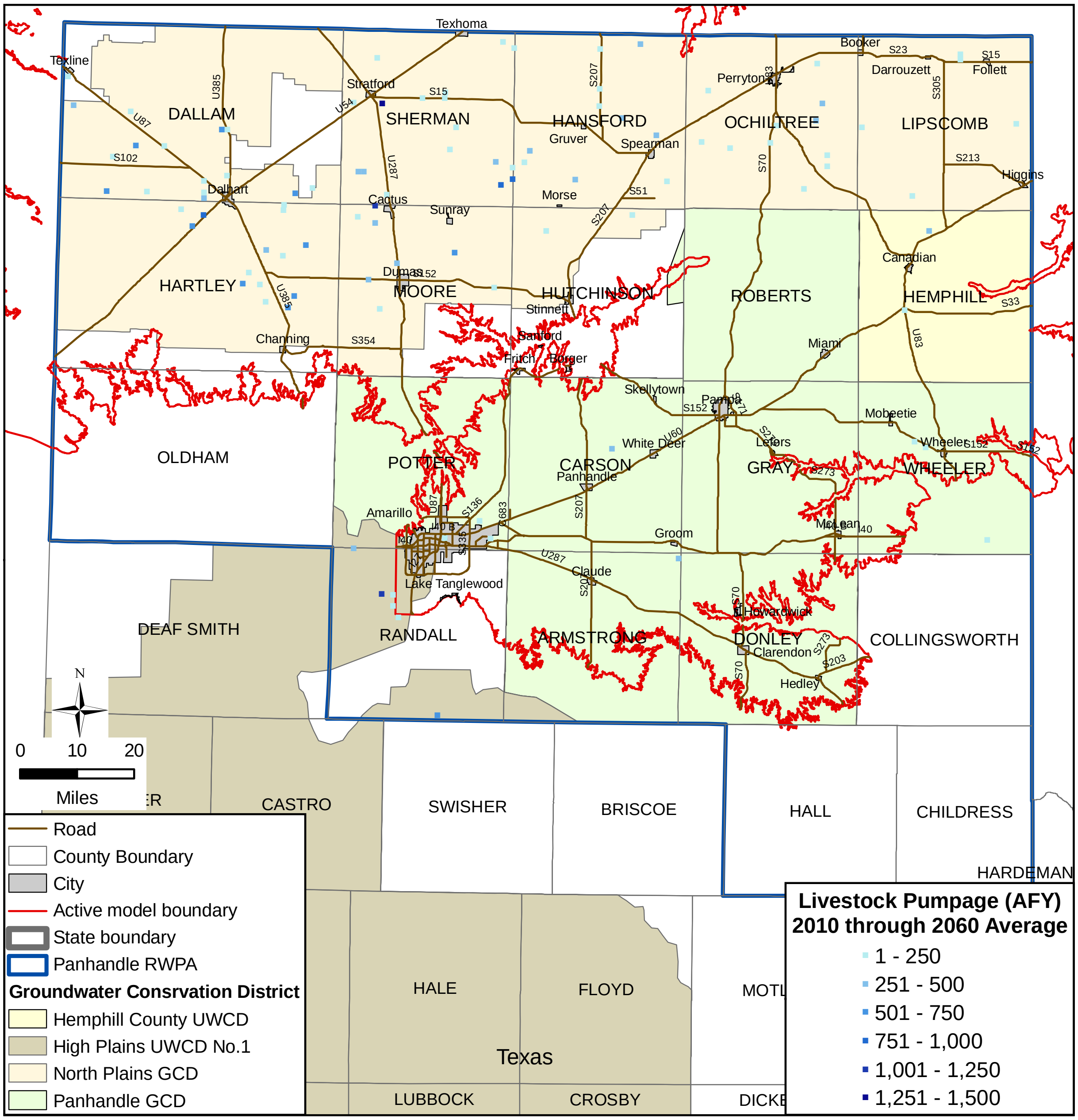

Figure 2.5-10 Average livestock pumpage by model grid cell for the period 2010 through 2060 in the Texas portion of the model.

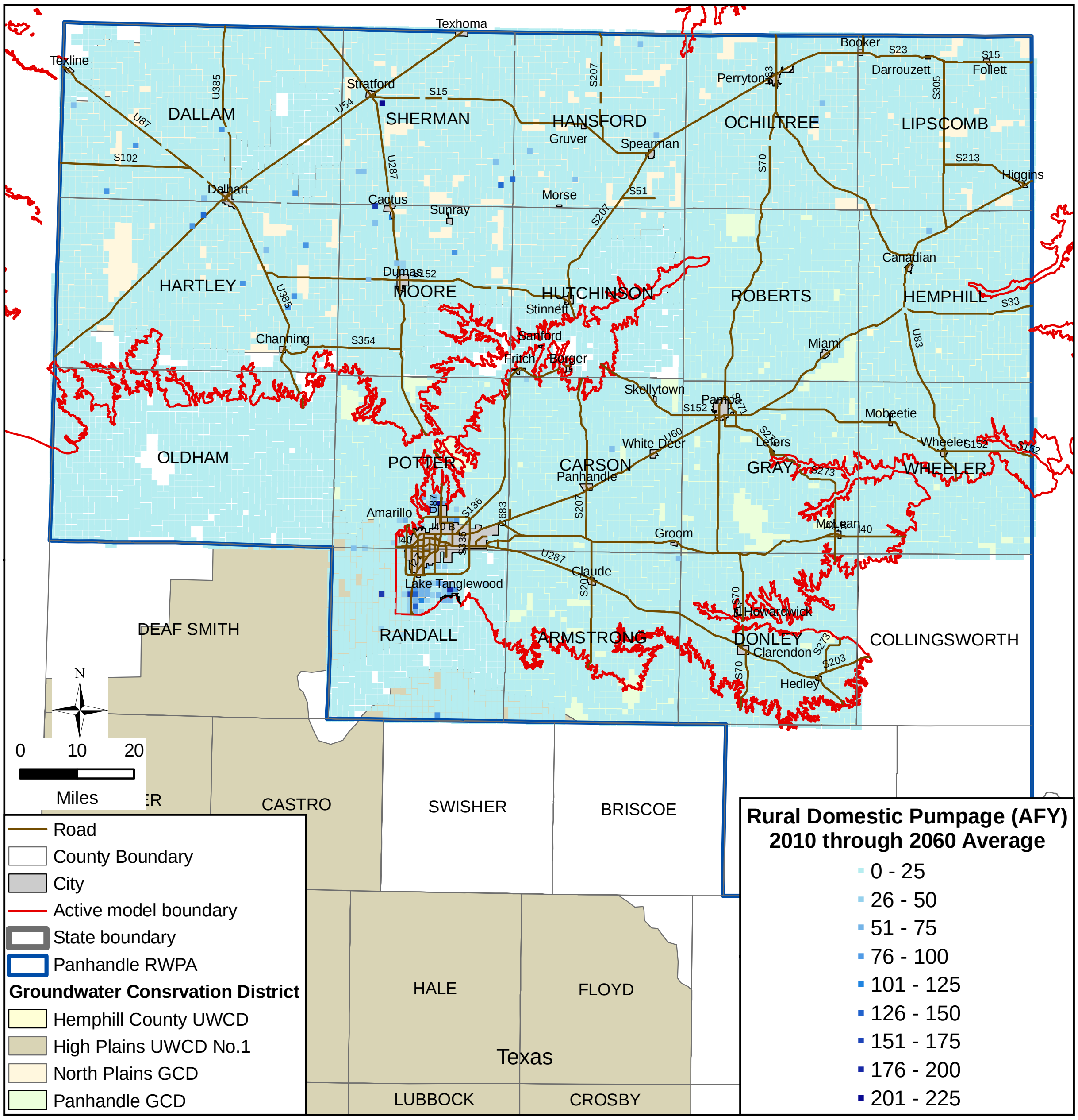

Figure 2.5-11 **Average rural domestic pumpage by model grid cell for the period 2010 through 2060 in the Texas portion of the model.**

3.0 RECALIBRATION RESULTS

The revised model was calibrated to steady-state conditions (pre-1950) and to transient conditions from 1955 through 2008. This extends the calibration period an additional 10 years beyond the last Northern Ogallala GAM which calibrated against the period 1950 through 1998. This section describes the revised model calibration starting with our approach, followed by the steady-state results and the transient calibration results.

3.1 Approach

The approach to calibration was focused on decreasing model residuals (observed head minus simulated head) on a model-wide basis through a county by county review. This process began with the steady-state model with the assumption that, as the simulated steady-state heads more closely matched measured heads, the transient model would improve because of improved initial conditions. Initially we focused on the modification of either recharge or hydraulic conductivity.

The idea behind potentially revising recharge was based upon the concept that on average recharge is thought to be approximately 0.25 in/year and the model currently has a model wide average recharge of 0.32 in/year. As Section 2.3 summarized, recharge in the High Plains has been shown to be highly variable and a function of land use, soils, and the presence of playas. Two initial considerations were at odds with significantly reducing recharge. First, the steady-state model as developed by Dutton (2004) and the current revised model tend to have a mean error biased low indicating that the model is drier than observed. Secondly, an obvious correlation between steady-state residuals and recharge was not prevalent (the transient model is relatively insensitive to recharge).

We did perform sensitivity simulations to investigate the effect of a lower average recharge. Given that the current model has approximately 0.32 in/year recharge in Texas, we first performed a simulation reducing recharge across the model by 22 percent which effectively results in an average recharge in Texas of 0.25 in/year. This simulation more than doubled the calibrated average residual mean and resulted in an even greater under prediction of steady-state targets. To bring the model back into calibration required a similar magnitude model-wide reduction in hydraulic conductivity owing to the direct correlation of these two variables. This model reproduced steady-state conditions nearly as well as our best calibrated simulation presented below. Without well defined flow targets at rivers, streams, seeps and springs in predevelopment time (which would equate to recharge), the model has limited ability to uniquely determine both recharge and hydraulic conductivity distributions. Given the uncertainty in recharge representative of the predevelopment aquifer condition, we felt it better to maintain consistency with the physical measurements of hydraulic conductivity under the assumption that they are static (i.e., do not change over time). Because recharge is a small percent of the transient flow balance on an annual basis (recharge is 14 percent of pumping in Texas in 2008) and the over estimation of recharge may be on the order of 22 percent, the potential error in water balance should be no more than about 3 percent of pumping in that same year. As a result, we did not focus on a model-wide reduction in hydraulic conductivity, believing that a structural model-wide revision to model hydraulic conductivity would require a complete review of all underlying data, depositional features and scaling concepts, not possible under the current scope.

Therefore we started calibration by performing focused edits to the hydraulic conductivity field by adjusting hydraulic conductivity down only in areas where we had significant increases in saturated thickness of the aquifer due to revisions in the base of the aquifer (as discussed in Section 2.1). At this point we reviewed residuals versus hydraulic conductivity from the underlying point data set reported by Dutton and others (2001) and a updated by Blandford and others (2003). If we found evidence that modification of hydraulic conductivity could improve residuals while remaining consistent with the source data, we made the modification and re-evaluated residuals. The hydraulic conductivity field changes were relatively minor and the model distribution was changed very little over the entire model (Figure 3.1-1).

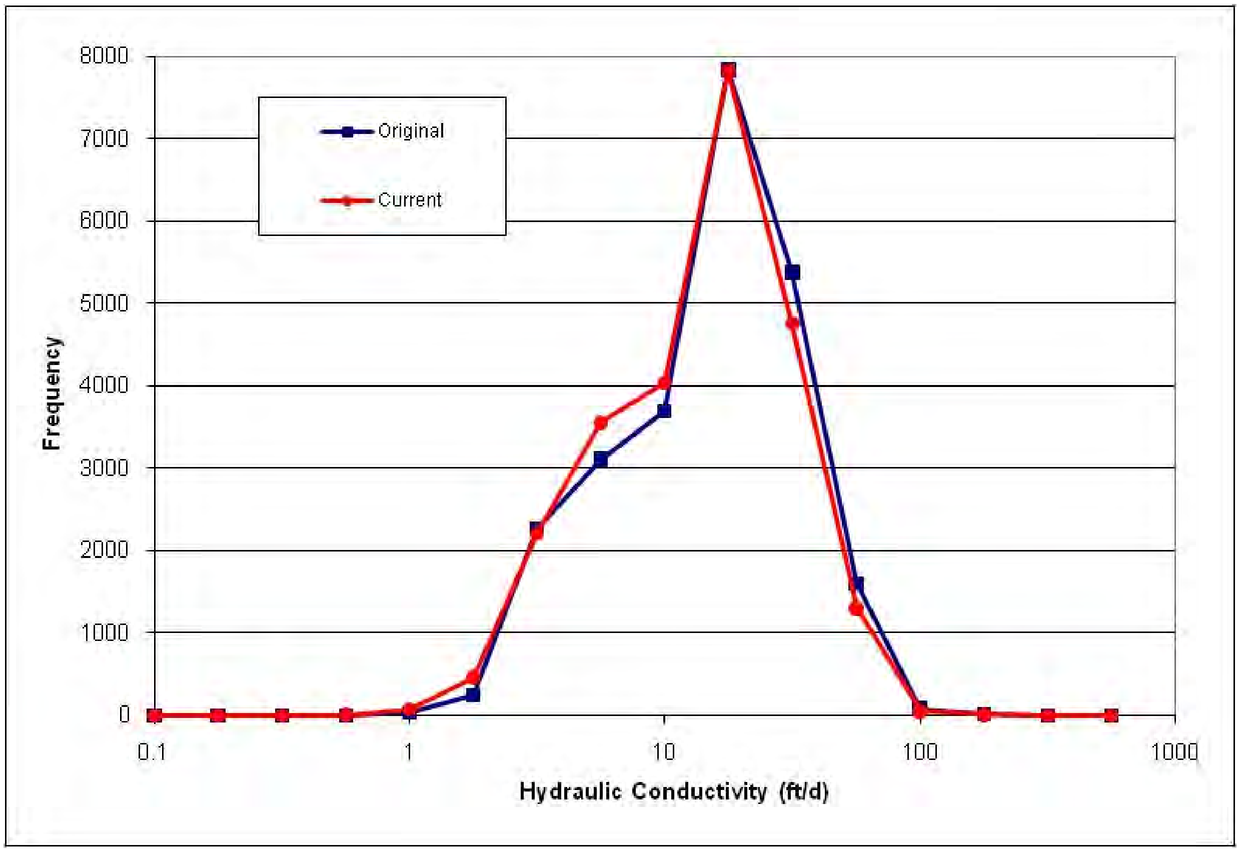

Figure 3.1.1 Comparison of model hydraulic conductivity.

3.2 Steady-State Calibration

The model was calibrated to steady-state conditions (assumed to be prior to 1950) and to transient conditions from 1950 through 2008. The steady-state model root mean square error (RMSE) was reduced from 32 ft for the 2004 GAM to 29 ft model wide. The RMSE was reduced in 11 of 18 Texas counties with the most significant reduction of 20 ft in Dallam County. The model-wide mean absolute error (MAE) divided by observed head target range improved one tenth of a percent to 0.9 percent. Table 3.2-1 summarizes the calibration statistics for the revised steady-state model. Table 3.2-2 provides a model-wide summary comparison between the revised GAM and the 2004 GAM (Dutton, 2004).

Figures 3.2-1 and Figure 3.2-2 show a scatter plot and residuals versus head target elevation plot for the revised steady-state model. Residuals are defined as the observed (measured) head target minus the model simulated head and have units of feet. Therefore, if the residual is positive, the model is simulating heads lower than observed at that observation point. This convention is reversed from the one used by Dutton (2004) which defined residual as the model simulated head minus the observed head target. For purposes of comparison in this report, we have converted residuals and associated statistics to our sign convention for ease of comparison. In a perfect fitting model, all residuals (points on the scatter plot) would align perfectly on the 45 degree line. One can see that the residuals are very evenly distributed about the perfect fit line, with the exception of a slight bias toward under estimation of head at elevations 4,200 ft above mean seal level (amsl).

Figure 3.2-3 posts residuals on the model area. One can see that for most areas of the model region residuals are both positive and negative showing no significant spatial bias. However, we do see a negative bias in western Sherman County, and we see a positive bias in far western Dallam County. Both of these areas were improved in the revised model.

Table 3.2-1 Steady-state calibration statistics.

County	Number of Targets	Residual Mean (ft)	MAE (ft)	RMSE (ft)	Observed Range (ft)	MAE/Range
Armstrong	10	1.1	19.3	26.4	425.2	4.5%
Carson	72	7.6	16.7	20.2	263.0	6.3%
Collingsworth	2	14.1	14.1	14.6	7.4	190.6%
Dallam	69	21.5	35.4	44.0	1037.3	3.4%
Donley	116	10.2	26.2	35.9	726.5	3.6%
Gray	110	4.1	16.1	21.0	457.8	3.5%
Hansford	89	7.5	14.4	19.9	492.8	2.9%
Hartley	53	-1.3	25.6	32.8	839.6	3.1%
Hemphill	88	9.0	21.1	30.3	374.7	5.6%
Hutchinson	55	14.7	19.4	24.4	468.6	4.1%
Lipscomb	45	3.4	20.3	27.2	369.0	5.5%
Moore	83	4.1	20.8	26.2	403.8	5.1%
Ochiltree	49	2.6	15.0	18.3	254.3	5.9%
Potter	3	14.0	14.0	15.0	249.6	5.6%
Randall	21	-11.1	13.2	17.4	188.9	7.0%
Roberts	45	-1.7	17.2	21.0	398.4	4.3%
Sherman	88	-10.2	23.5	26.7	364.9	6.4%
Wheeler	154	16.2	28.3	38.0	412.9	6.9%
Model	**1152**	**6.8**	**21.8**	**29.3**	**2349.7**	**0.9%**

Table 3.2-2 Model wide calibration statistics comparison between Dutton (2004) and the revised model.

Metric	Dutton (2004)	Revised Model
Number of Targets	1,280	1,152
Target Range (ft)	2,360	2,350
Mean Error (ft)	10.3	6.8
MAE (ft)	23	21.8
RMSE (ft)	32.2	29.3
MAE / Range (%)	1.0%	0.9%

Table 3.2-3 provides the steady-state water balance for the entire model. Table 3.2-3 also provides the water budget for the 2001 GAM (Dutton and others, 2001). The revised 2004 GAM did not report the water balance. From a review of Table 3.2-3, one can see that recharge has been slightly increased between the models based upon the 2004 updates to the recharge model. Drains represent ephemeral streams and springs, seeps, and evapotranspiration occurring at the aquifer boundaries. The lateral boundaries are isolated to general head boundaries located in Randall and southern Potter counties which connect the Southern and Northern Ogallala GAMs.

Table 3.2-3 Steady-state water balance - comparison between 2001 GAM and the revised model (net flow in acre-ft/year).

Flow Component	Dutton and others, 2001	Revised Model
Recharge	387,903	407,762
River	(149,073)	(157,345)
Lateral Boundaries	1,835	3,588
Drains	(241,510)	(254,852)
Storage	36	–
Balance Error	(809)	(847)

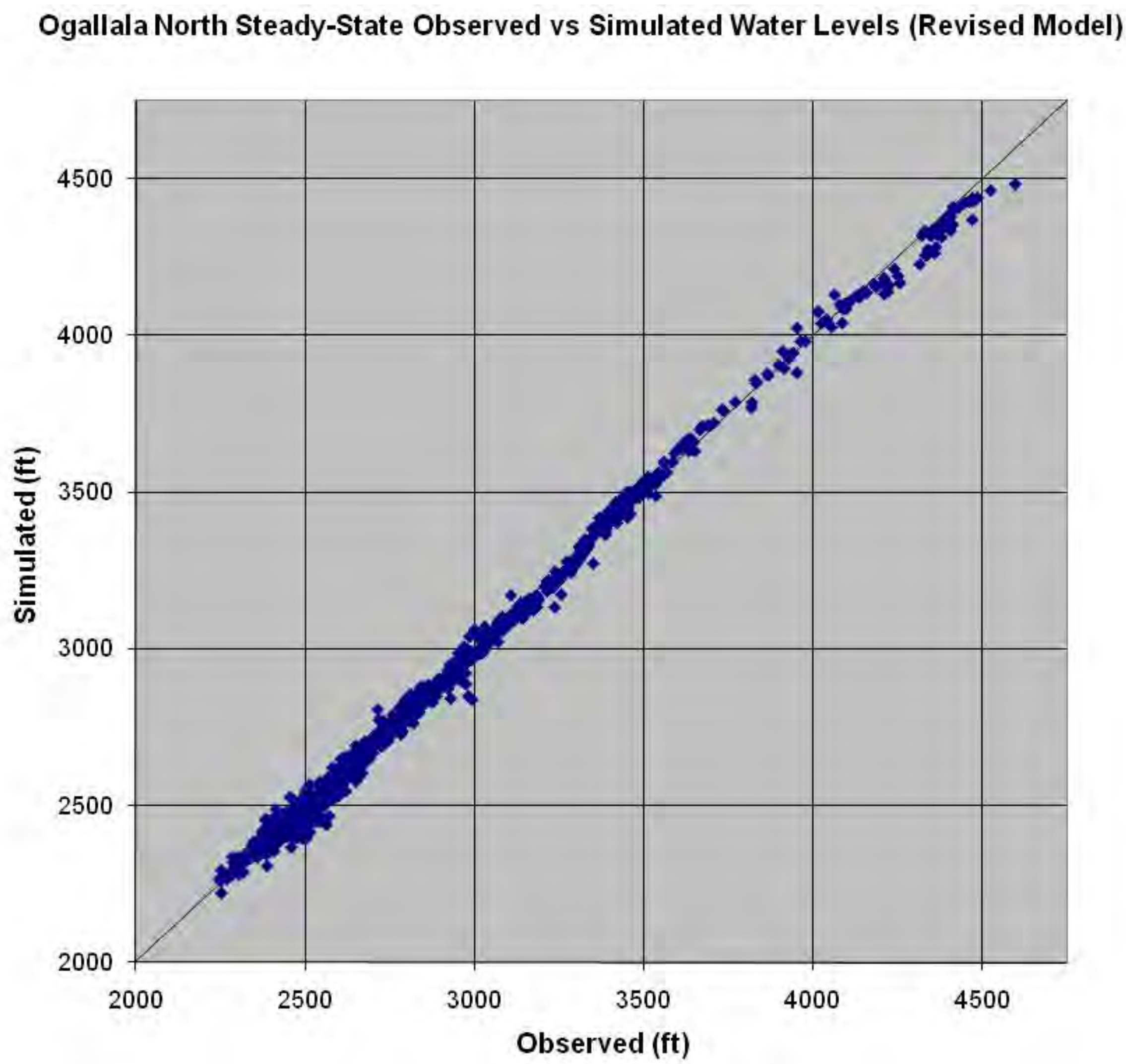

Figure 3.2-1 Scatter plot for the revised steady-state model.

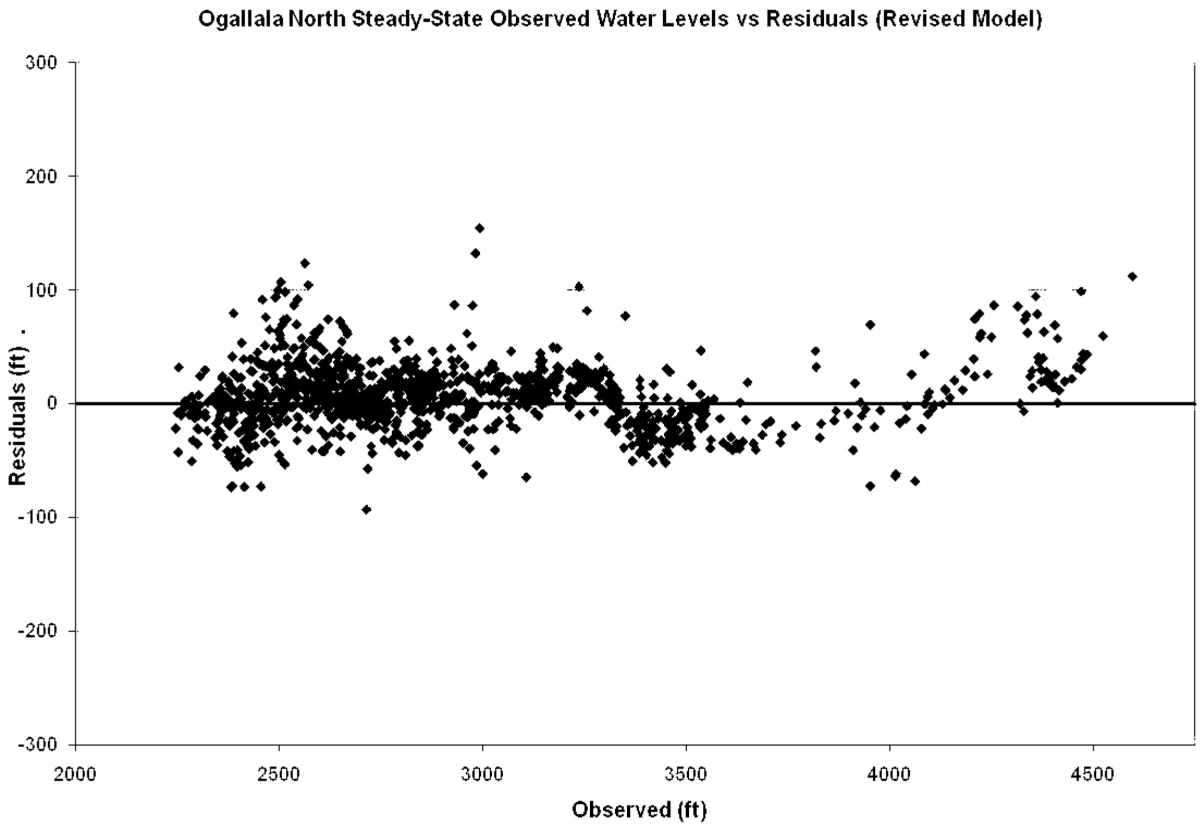

Figure 3.2-2 Residuals versus head for the revised steady-state model.

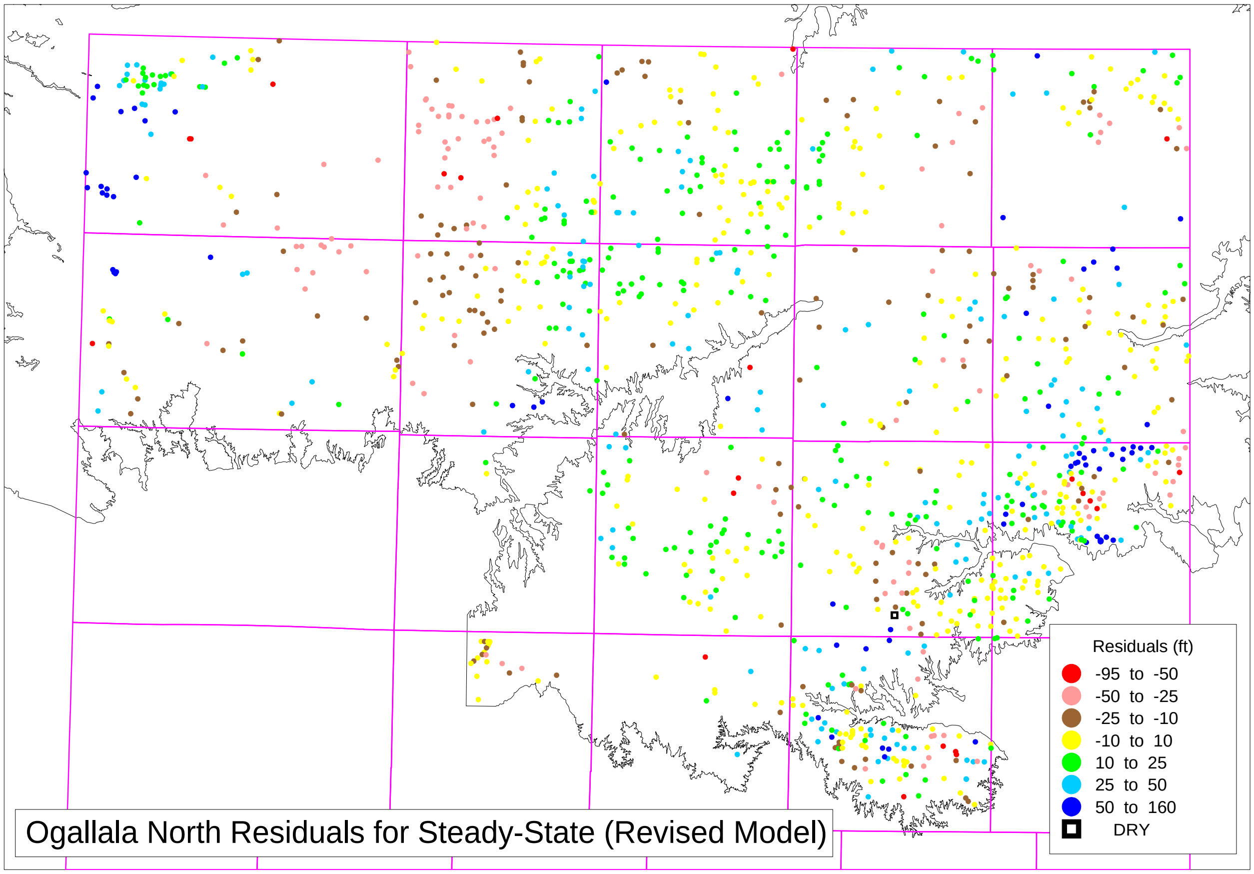

Figure 3.2-3 Post plot of residuals for the revised steady-state model.

3.3 Transient Calibration

Transient calibration was performed for the historical period from 1950 through 2008. Pumping was updated through 2008 but the last complete set of heads that could be used as targets represent the winter of 2007. The revised model extends calibration another decade from 1998 through 2008 (represented by winter 2007 targets).

The revised transient calibration also improved model wide and in most counties. Table 3.3-1 provides a summary of the calibration statistics for the transient model in 1998 on a county basis and model wide. The revised transient model improved calibration in 14 of 17 of the counties with targets with targets in Texas. Table 3.3-2 provides a model-wide summary comparison between the revised GAM and the 2004 GAM (Dutton, 2004). Comparing model error in 1998, the revised model reduced the RMSE from 52.8 ft to 45.7 ft, an improvement of 7 feet. The model-wide MAE divided by observed head target range improved slightly from 1.5 percent to 1.4 percent.

Table 3.3-1 Transient model calibration statistic, 1998.

County	Number of Targets	Residual Mean (ft)	MAE (ft)	RMSE (ft)	Observed Range (ft)	MAE/Range
Armstrong	22	9.5	25.1	37.2	399.8	6.3%
Carson	66	11.2	22.3	28.2	271.9	8.2%
Collingsworth	0	NA	NA	NA	NA	NA
Dallam	40	12.4	45.9	60.0	997.9	4.6%
Donley	53	37.1	43.1	53.1	700.7	6.2%
Gray	81	7.5	18.5	28.2	466.5	4.0%
Hansford	74	-2.6	47.6	66.4	578.0	8.2%
Hartley	16	10.3	24.9	32.9	566.5	4.4%
Hemphill	31	18.2	21.5	27.7	403.6	5.3%
Hutchinson	42	3.3	30.6	43.8	493.8	6.2%
Lipscomb	35	-11.5	55.4	72.8	423.2	13.1%
Moore	45	26.3	42.1	50.8	461.2	9.1%
Ochiltree	42	-15.3	48.0	67.0	350.8	13.7%
Potter	3	9.6	9.6	14.5	249.7	3.8%
Randall	15	-25.0	32.9	36.3	178.9	18.4%
Roberts	107	8.9	21.9	26.5	461.8	4.8%
Sherman	39	2.6	32.0	38.1	366.8	8.7%
Wheeler	51	19.7	26.6	35.0	424.6	6.3%
Model	**762**	**8.6**	**32.6**	**45.7**	**2249.3**	**1.4%**

Table 3.3-2 Model wide calibration statistics comparison between Dutton (2004) and the revised model – 1998.

Metric	Dutton (2004)	Revised Model
Number of Targets	851	762
Target Range (ft)	2327.9	2249.3
Mean Error (ft)	10.9	8.6
MAE (ft)	35.8	32.6
RMSE (ft)	52.8	45.7
MAE / Range (%)	1.5%	1.4%

Figures 3.3-1 and Figure 3.3-2 show a scatter plot and residuals versus head target elevation plot for the revised transient model at 1998. Again the fit is very good but one still sees the under prediction of heads at the highest groundwater elevations (northwestern portions of the model). Figure 3.3-3 is a post plot of residuals in 1998 for the revised model. By 1998, as compared to the predevelopment condition, we see an improvement in the regions which showed some spatial bias.

The revised model simulates through 2008. Tables 3.3-3 and 3.3-4 summarize the calibration statistics on a county basis and model wide with Table 3.3-4 comparing model-wide calibration from 1998 to 2007. The revised model-wide calibration improved from 1998 to 2007 with a RMSE of 35.6 feet and a RMSE divided by observed head target range of 1.6 percent. The MAE over head target range also reduced from 1.4 percent to 1.2 percent. The only three counties which saw a degradation in calibration from 1998 to 2007 were Carson, Hartley and Hemphill counties. The rest showed very good improvements with the exception of Gray County which degraded slightly.

Figures 3.3-4 and Figure 3.3-5 show a scatter plot and residuals versus head target elevation plot for the revised transient model at 2007. Again the fit is very good with trends similar to 1998. Figure 3.3-6 is a post plot of residuals in 2007 for the revised model. The 2007 calibrated condition also shows little spatial bias and provides a pretty good departure point for the predictive simulations.

Table 3.3-3 Transient model calibration statistic, 2007.

County	Number of Targets	Residual Mean (ft)	MAE (ft)	RMSE (ft)	Observed Range (ft)	MAE/Range
Armstrong	28	12.0	25.4	36.3	361.5	7.0%
Carson	121	13.5	24.2	30.6	262.5	9.2%
Collingsworth	0	NA	NA	NA	NA	NA
Dallam	46	6.3	39.5	53.1	1010.7	3.9%
Donley	74	35.7	42.0	51.3	719.6	5.8%
Gray	84	7.9	18.5	28.3	467.8	4.0%
Hansford	70	-11.9	26.5	32.9	473.8	5.6%
Hartley	51	13.3	33.4	50.7	947.1	3.5%
Hemphill	66	17.9	24.0	30.6	418.0	5.7%
Hutchinson	52	7.9	22.2	27.6	455.5	4.9%
Lipscomb	43	0.7	25.2	30.6	388.6	6.5%
Moore	41	23.0	37.2	42.6	386.3	9.6%
Ochiltree	47	-18.3	29.8	37.8	189.7	15.7%
Potter	4	4.6	8.6	11.9	269.0	3.2%
Randall	10	-26.6	30.1	33.5	150.3	20.1%
Roberts	108	6.4	20.7	25.8	461.8	4.5%
Sherman	53	6.1	21.0	26.5	472.3	4.5%
Wheeler	65	17.4	24.3	31.5	416.7	5.8%
Model	**963**	**9.4**	**26.7**	**35.6**	**2215.8**	**1.2%**

Table 3.3-4 Model wide calibration statistics comparison between 1998 and 2007 targets – revised model.

Metric	1998 Targets	2007 Targets
Number of Targets	762	963
Target Range (ft)	2,249.3	2,215.8
Mean Error (ft)	8.6	9.4
MAE (ft)	32.6	26.7
RMSE (ft)	45.9	35.6
MAE / Range (%)	1.4%	1.2%

Table 3.3-5 provides a summary table of the predevelopment (steady-state) and the 2008 transient net flow balances. One can see that by 2008 pumping is being almost entirely supplied by a reduction of aquifer storage which results in falling water levels. Because recharge and natural discharge are a fraction of total pumping in Texas, pumping will continue to be supplied dominantly by storage until depletion occurs or pumping abates.

Table 3.3-5 Steady-state and 2008 (transient) model flow balance (net flow in acre-ft/year).

Year	Well Pumping	Drains	Rivers	Head Dependent Boundaries	Recharge	Storage
Predevelopment	0	(254,852)	(157,345)	3,588	407,762	-
2008	(2,197,882)	(193,720)	(96,286)	8,144	402,524	2,076,498

The final metrics used to assess the transient calibration are transient hydrographs. There are over 800 long-term good quality hydrographs in the Northern Ogallala GAM region and all of these cannot be shown in this report. However, we developed and reviewed a spreadsheet with all hydrographs and found that in general the model does a very good job of reproducing trends in the region. Figure 3.3-7 shows the locations of hydrographs selected for this report with the location and well number. Figures 3.3-8 through 3.3-13 present representative hydrographs throughout the model region. One can generally find both good and bad hydrograph fits in most regions of the model but overall the fits tend to be very good. In areas where the pumping is not spatially distributed correctly, fits are worse. In some cases, such as Hydrograph 249901 in Dallam County (Figure 3.3-10), one can see that the trend is good but the initial head is low. Areas with this offset in initial head are areas for future calibration improvement.

With the calibration targets updated through 2008, a post audit could be performed on the 2004 GAM to provide a feeling for its accuracy over a decade of predictive simulation. The Dutton (2004) GAM was run with the old pumping dataset (updated in 2001) from 1998 through 2008 to see how the model did in predicting water levels in 2007. The model performed well over this time period with a MAE of 29.6 ft compared to the revised model of 26.7 ft. The MAE divided by the target range in the post audit simulation was 1.8% compared to 1.2% for the revised model. The results from the post audit indicates that the Northern Ogallala GAM, both the 2004 version and the revised version, provide a reasonable degree of confidence in predicting future conditions in the decade time frame.

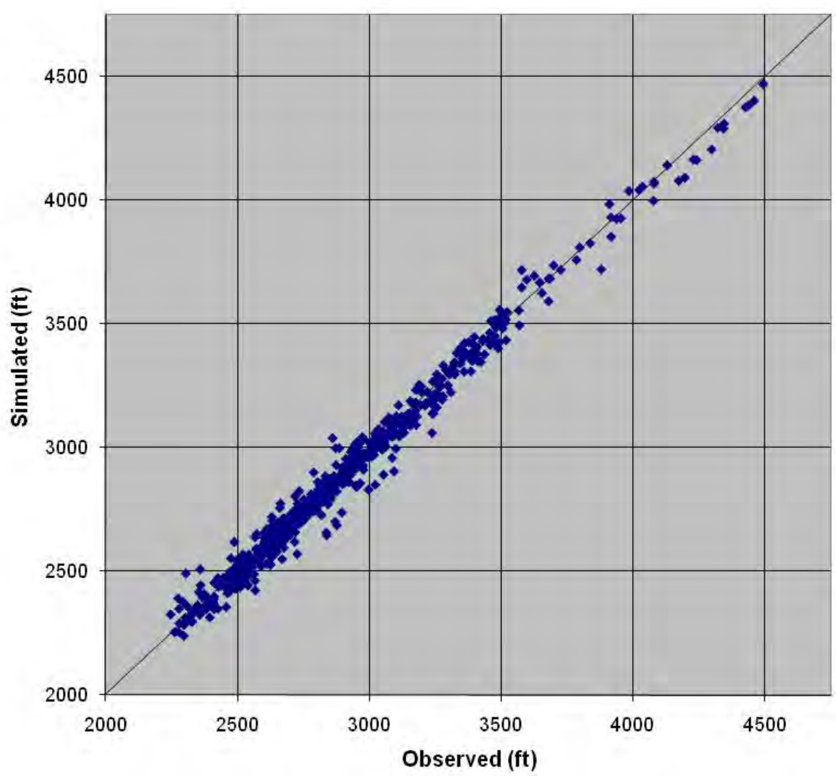

Figure 3.3-1 Scatter plot for the revised transient model – 1998.

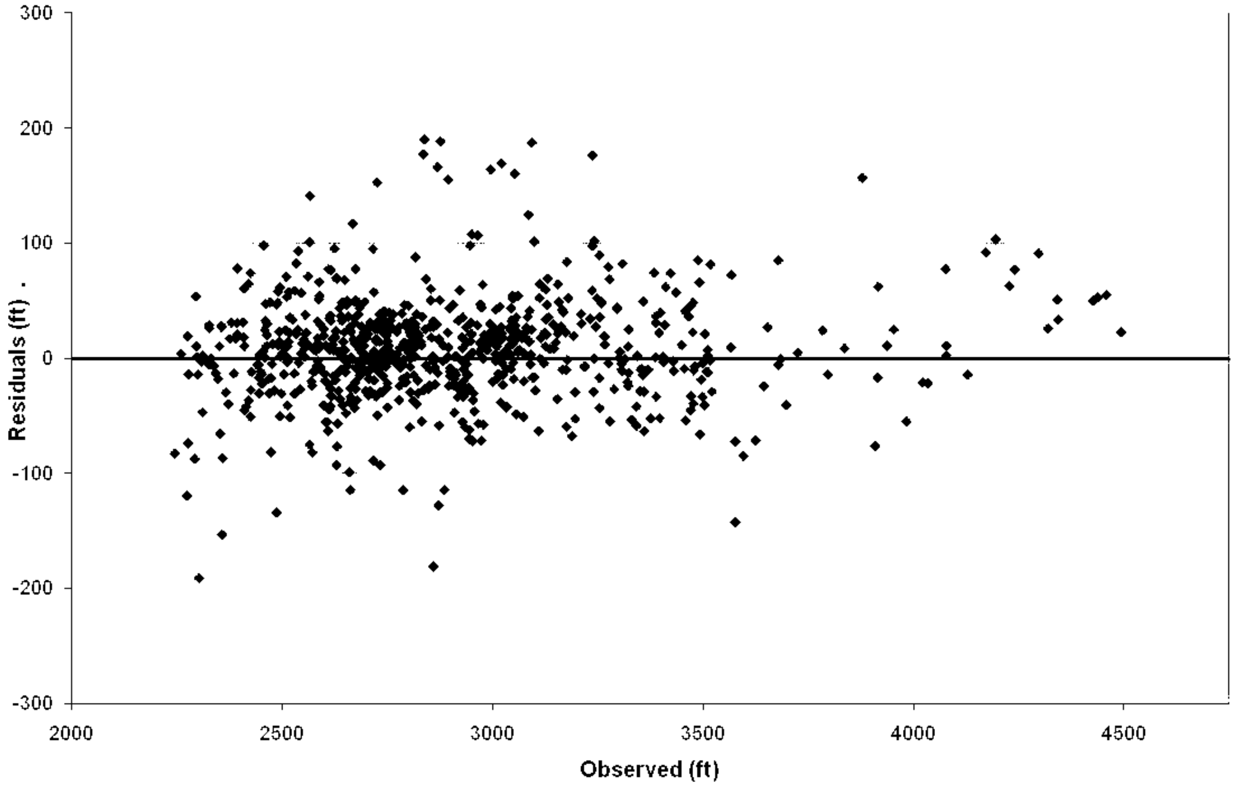

Figure 3.3-2 Residuals versus head for the revised transient model – 1998.

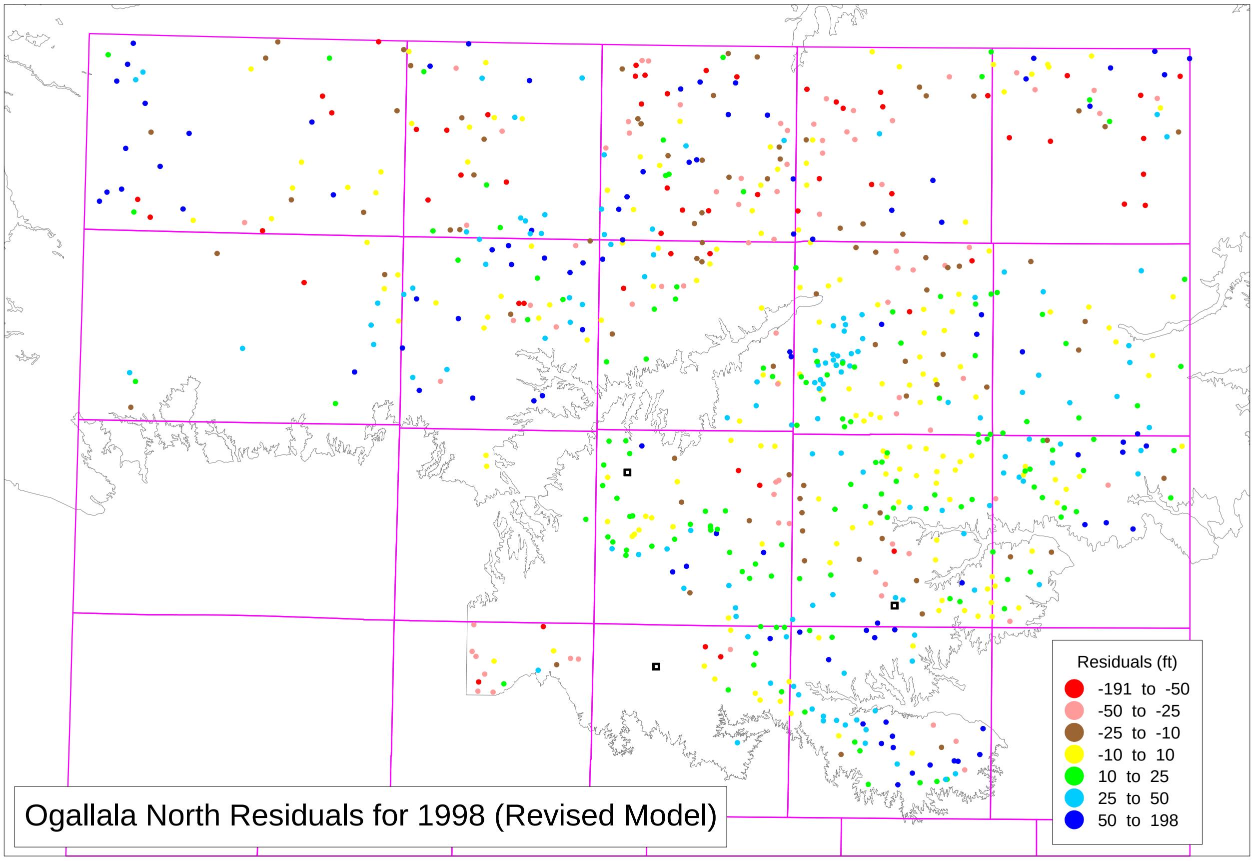

Figure 3.3-3 Post plot of residuals for the revised transient model – 1998.

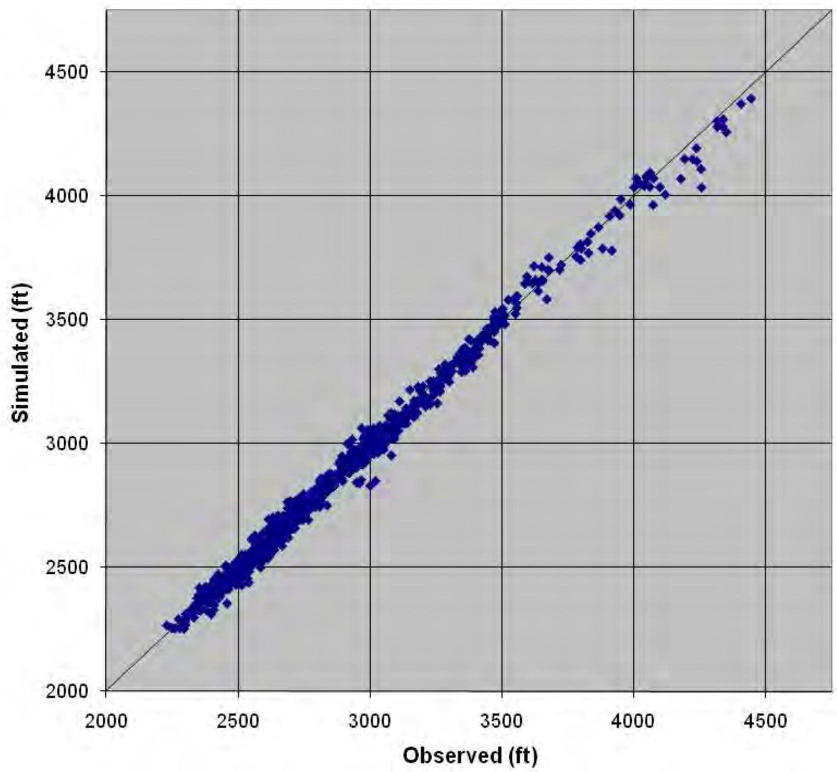

Figure 3.3-4 Scatter plot for the revised transient model – 2007.

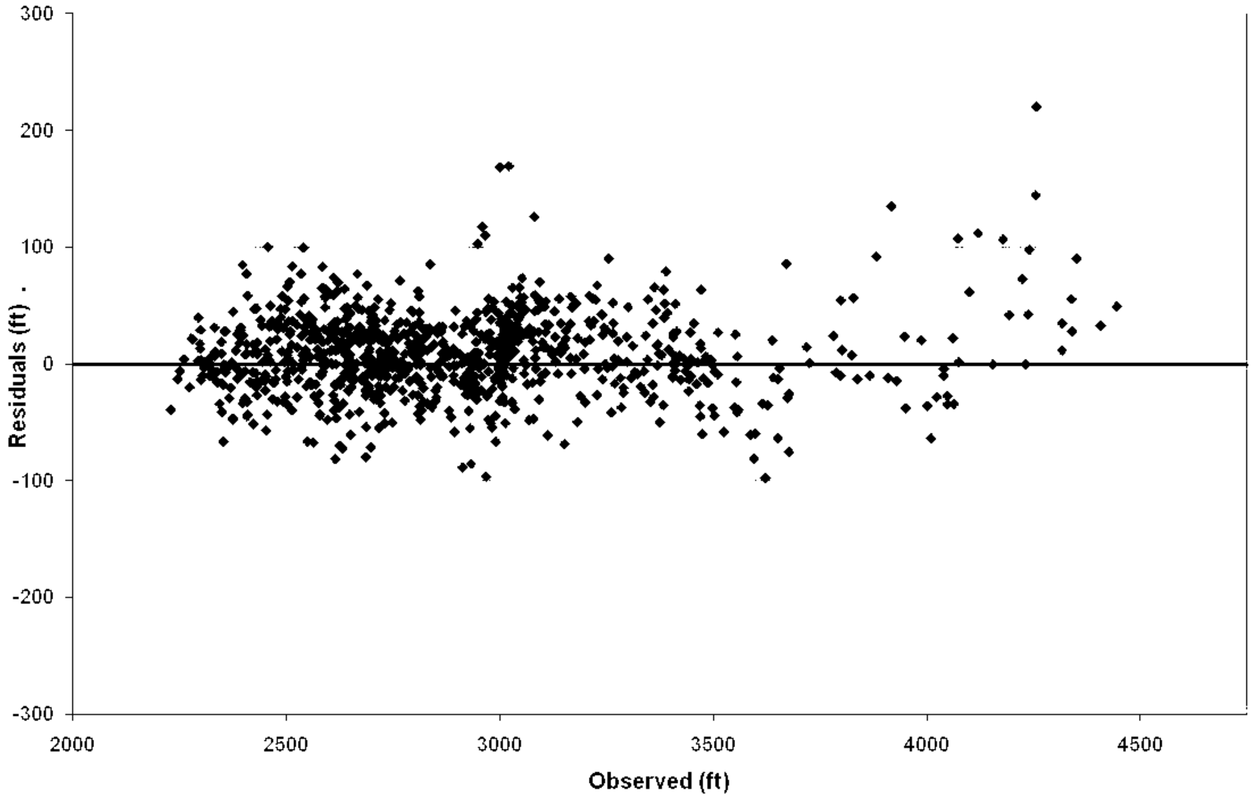

Figure 3.3-5 Residuals versus head for the revised transient model – 2007.

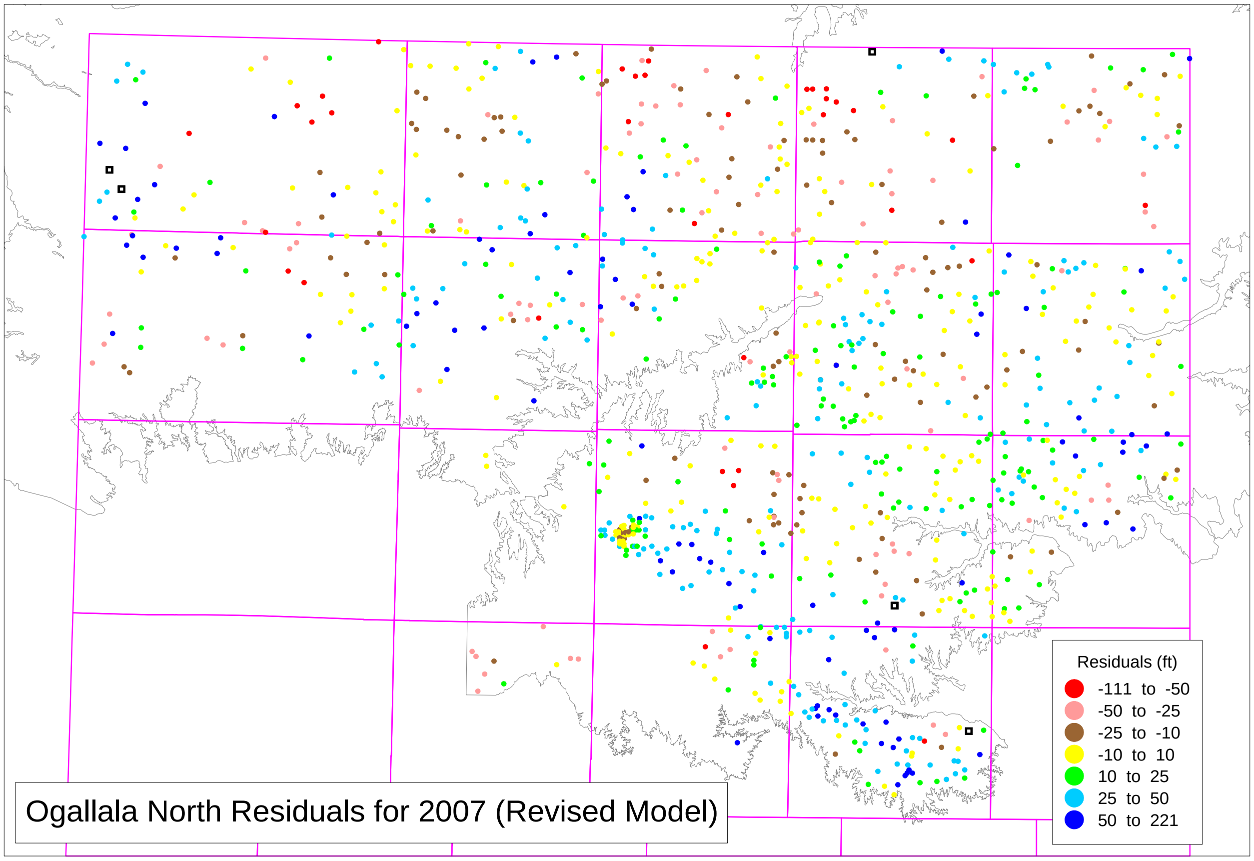

Figure 3.3-6 Post plot of residuals for the revised transient model – 2007.

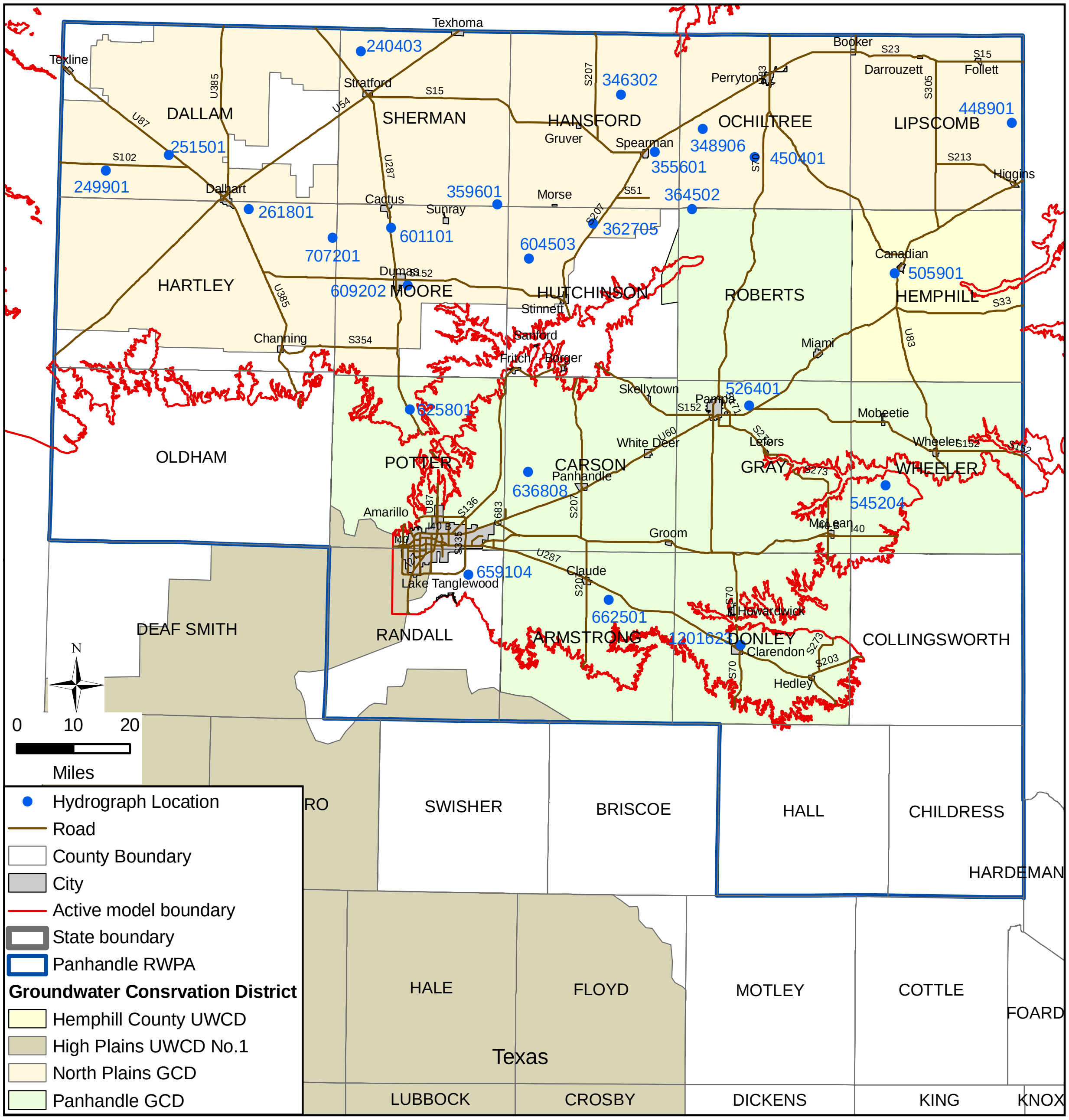

Figure 3.3-7 Location of select hydrographs.

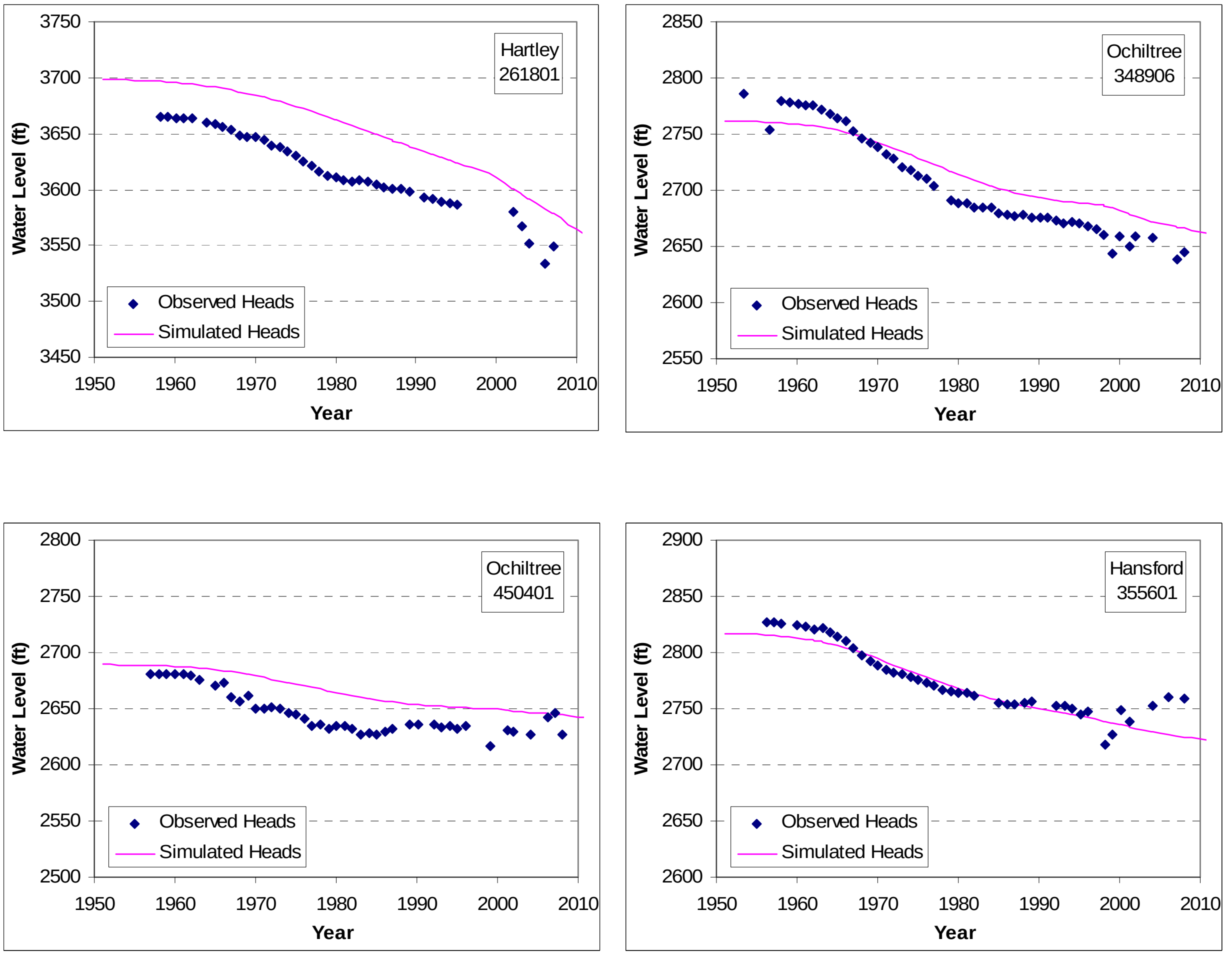

Figure 3.3-8 Select hydrographs showing simulated and observed heads (ft-amsl).

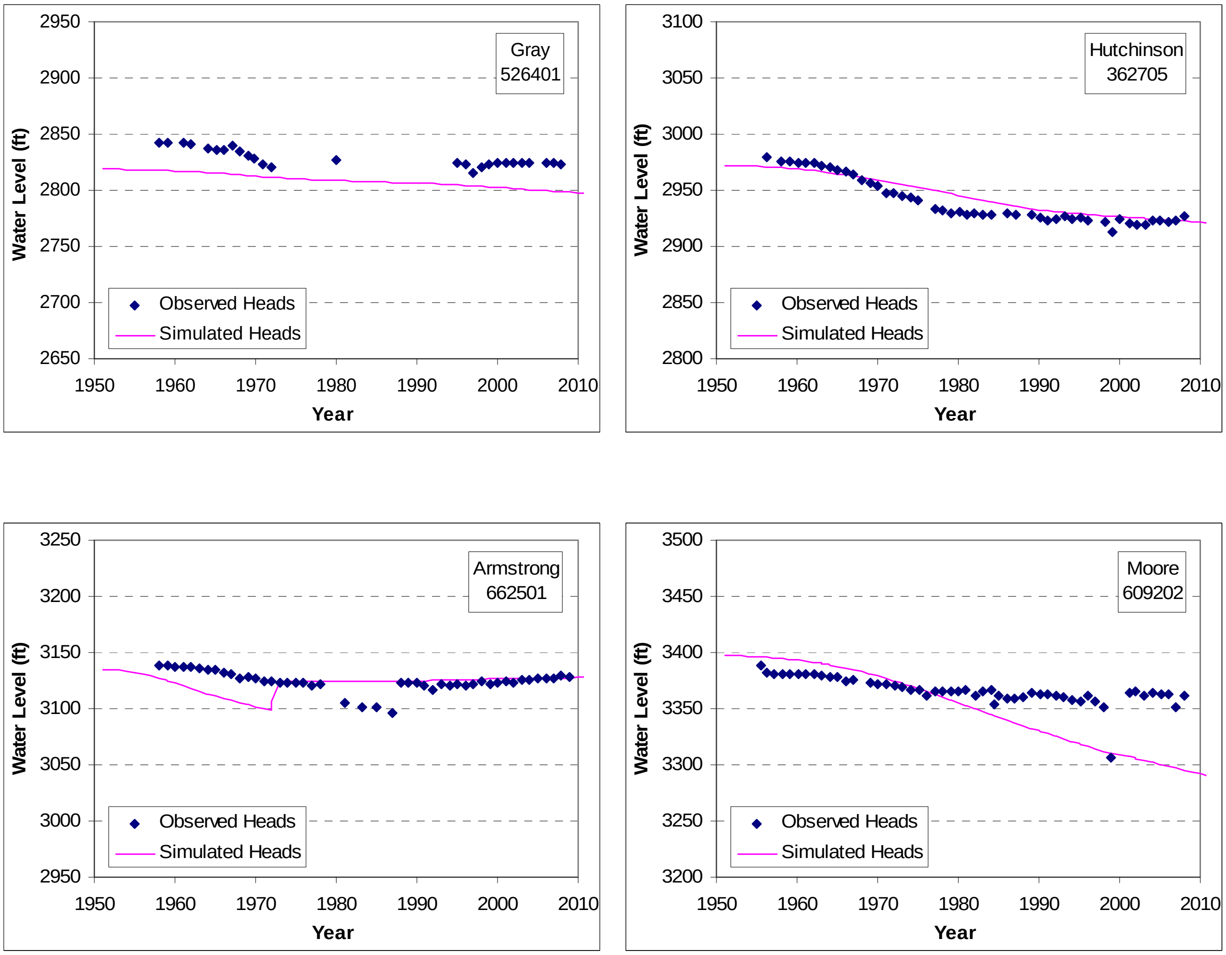

Figure 3.3-9 Select hydrographs showing simulated and observed heads (ft-amsl).

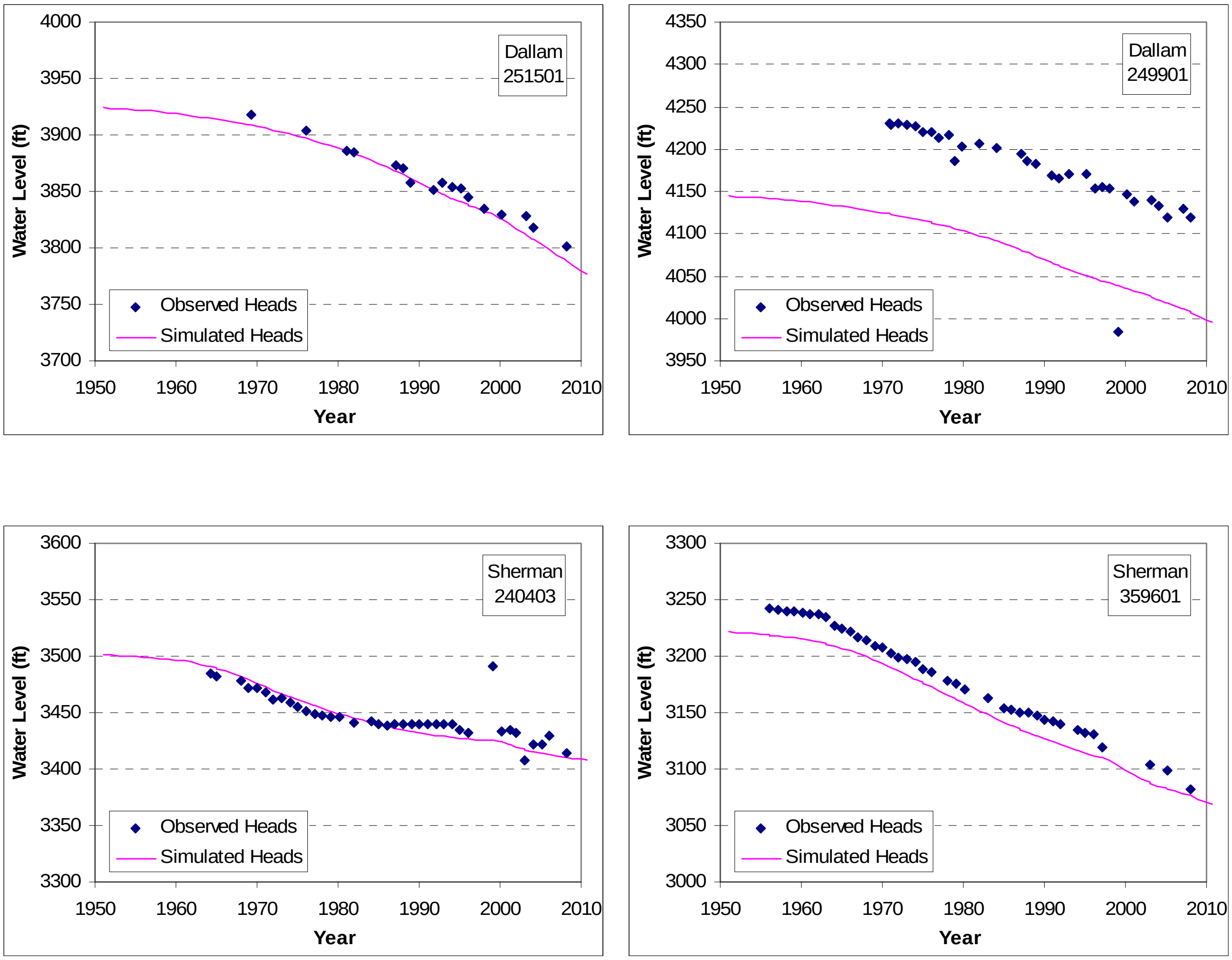

Figure 3.3-10 Select hydrographs showing simulated and observed heads (ft-amsl).

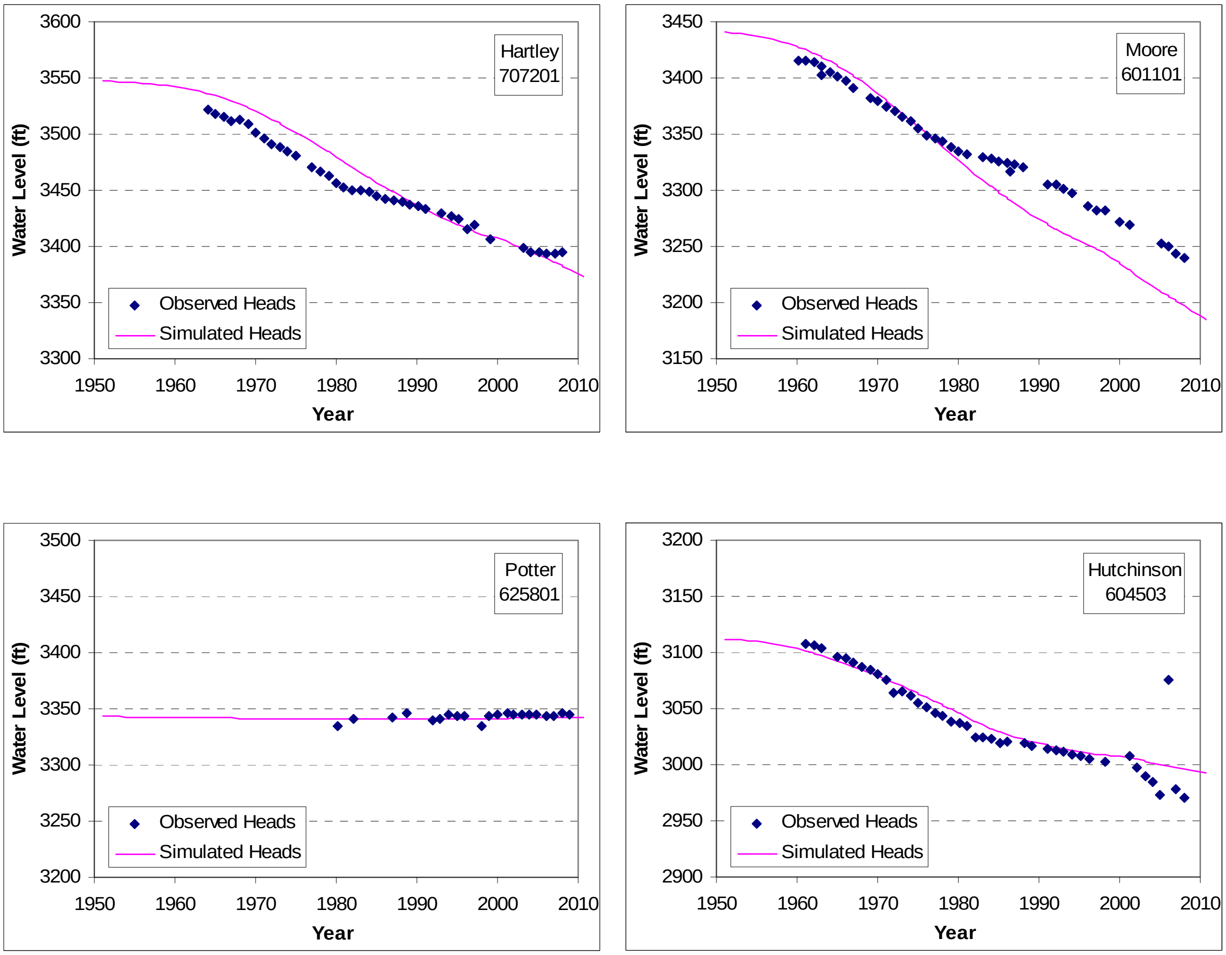

Figure 3.3-11 Select hydrographs showing simulated and observed heads (ft-amsl).

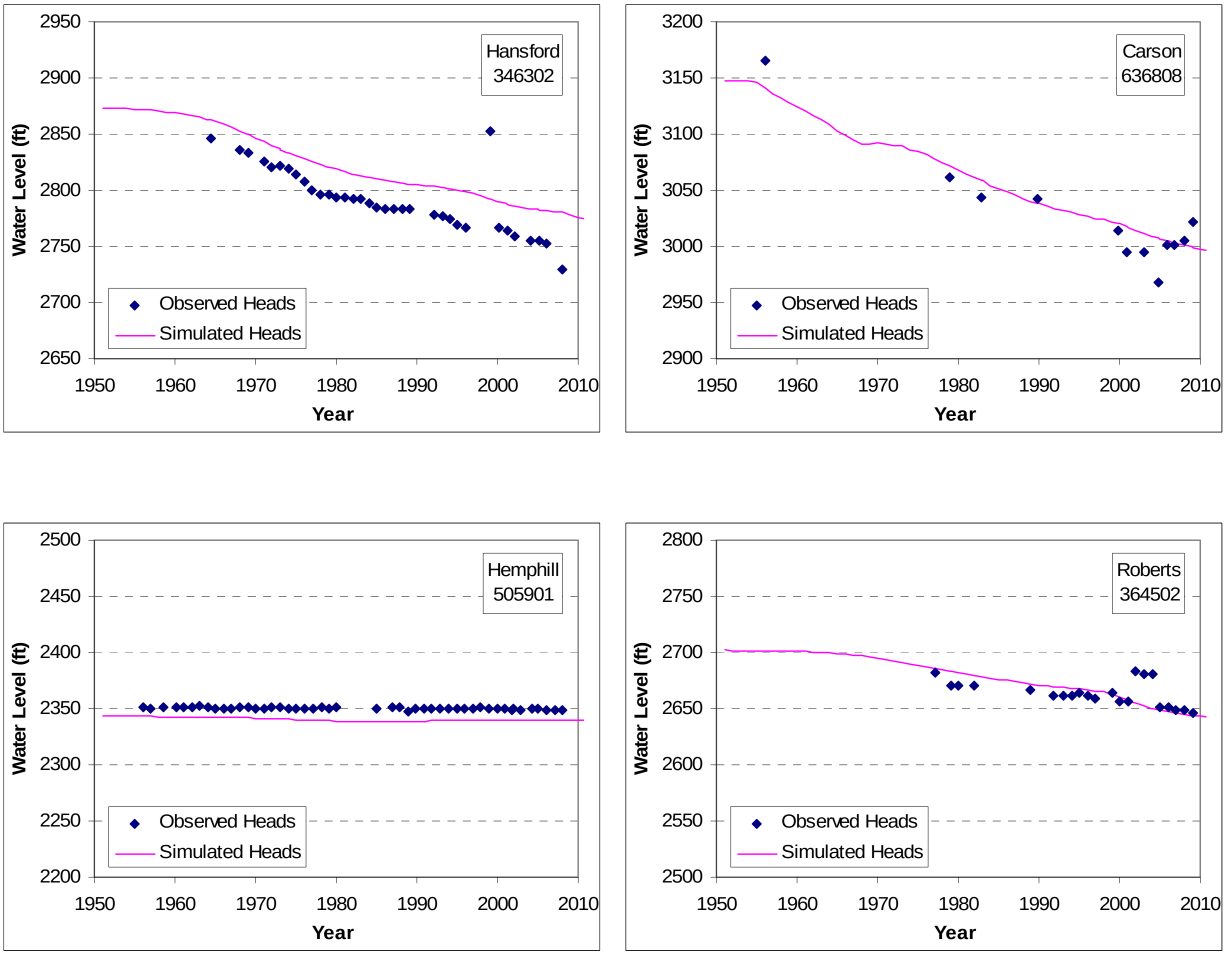

Figure 3.3-12 Select hydrographs showing simulated and observed heads (ft-amsl).

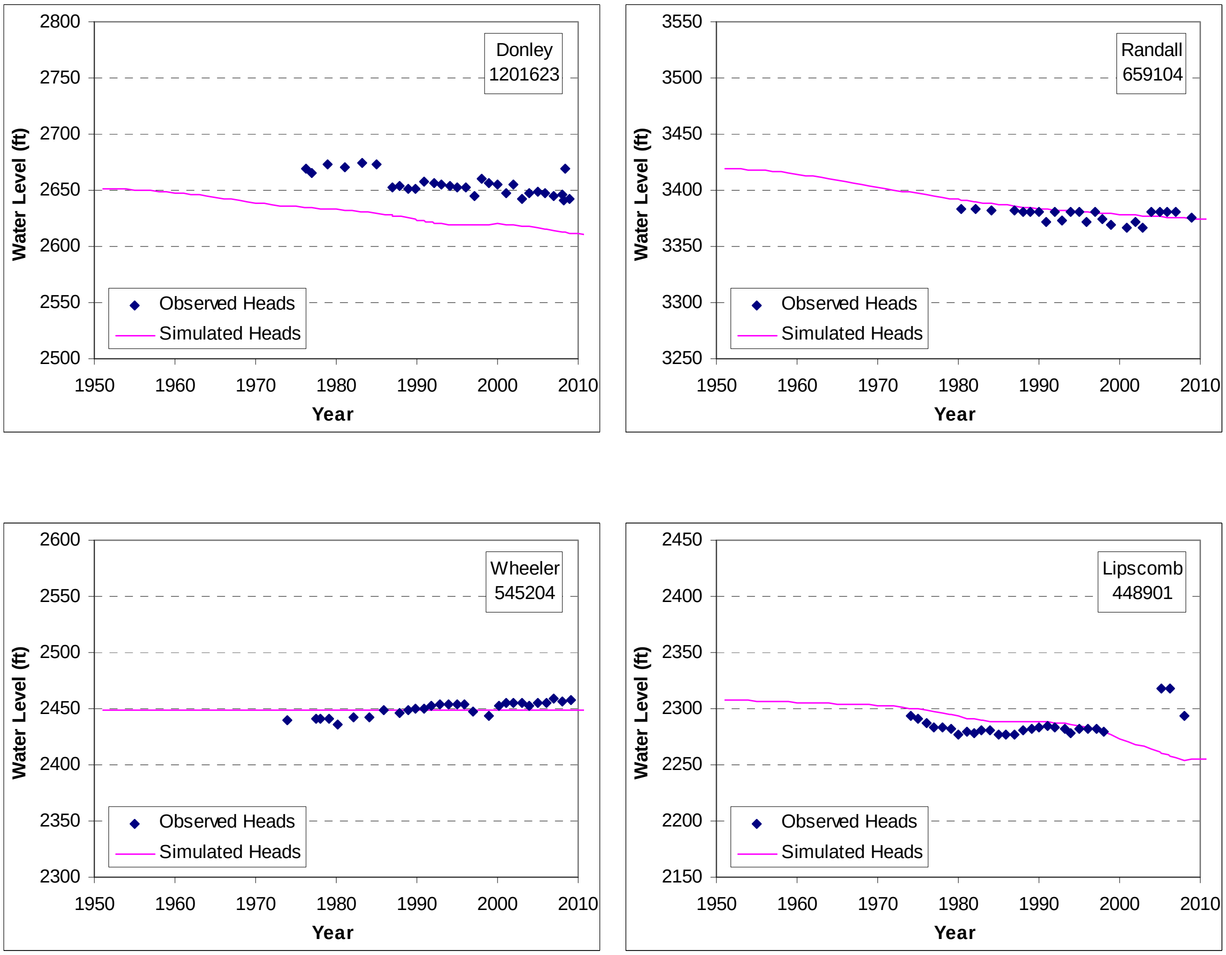

Figure 3.3-13 Select hydrographs showing simulated and observed heads (ft-amsl).

4.0 PREDICTIVE SIMULATIONS

In the modeling committee meeting held August 7th in Amarillo, the predictive simulations to be performed to support planning were defined. The three simulation types requested include; the Baseline Demand simulation (Baseline); the Regional Availability simulation, and the Available Supplies simulation. Table 4.0-1 provides a summary of the scope of these three simulations.

Table 4.0-1 Scope of simulations requested by the planning group.

Simulation	Purpose
Baseline (Includes updated demands)	Estimate groundwater availability with current pumping locations and updated pumping demand
Regional Availability	Determine available groundwater given availability criteria
Available Supplies	Estimate groundwater available to IRR and MUN water user groups

4.1 Baseline Simulation

To determine the capability of the aquifer to meet projected demands through 2060 with current infrastructure, a baseline analysis using the revised model was conducted. The baseline simulation uses the updated historical (1950-2008) pumping and the updated demand distribution (2009-2060). Figure 4.1-1 shows the saturated thickness of the aquifer simulated of the GAM in the year 2000. One can see that in 2000 most of the Northern Ogallala in Texas is saturated with the largest number of inactive cells (representing dry aquifer conditions and white in the figure) in Dallam County. Figures 4.1-2 and 4.1-3 provide similar saturated thickness plots for the years 2030 and 2060, respectively. By 2060 one can see that significant portions of the aquifer in Dallam, Hartley, Moore and Sherman counties have become inactive. As a MODFLOW grid cell dries out and becomes inactive, the pumping is turned off for that cell. In reality, there will likely be a thin saturated thickness in these portions of the aquifer in the future because pumping efficiency will decrease to such a degree that desaturation of the aquifer will be uneconomical. However, these regions would not support irrigation rates of pumping without significant modification to pumping strategies. In the period between 2010 and 2060 the annual average demand for the Ogallala is 1,303,482 acre-ft/year in Region A. However, the model predicts that users will only be able to pump an average annual amount of 1,062,075 acre-ft/year for the planning period. By the year 2060, the model predicts that pumping will be reduced by approximately 39 percent from the pumping demand. The relationship between the pumping demand versus the actual pumping allowed in the model for the baseline simulation is shown in Figure 4.1-4 for the planning period from 2010 through 2060. Table 4.1-1 summarizes the groundwater in storage in the PWPA for the baseline simulation.

The baseline analysis shows that with unrestrained pumping there will be significant areas of the aquifer with significant depletion. Many of these areas occur in heavily irrigated areas. Irrigation water users have limited options for new water sources and are constrained by geographical location.

Table 4.1-1 Groundwater in storage (acre-ft) – baseline simulation.

County	2010	2020	2030	2040	2050	2060
Armstrong	3,064,082	3,027,514	2,991,795	2,957,489	2,925,656	2,897,217
Carson	13,516,065	12,958,513	12,440,596	11,947,003	11,513,502	11,131,498
Collingsworth	82,710	82,646	82,570	82,495	82,433	82,384
Dallam	20,705,363	18,407,355	16,434,617	14,782,516	13,599,275	12,777,978
Donley	5,263,516	5,042,366	4,862,050	4,710,929	4,596,368	4,519,392
Gray	13,085,314	12,815,785	12,564,408	12,323,656	12,101,407	11,905,772
Hansford	20,595,423	19,458,840	18,425,369	17,445,545	16,559,236	15,797,444
Hartley	23,790,456	21,253,923	19,171,475	17,668,375	16,740,792	16,097,595
Hemphill	14,863,706	14,823,571	14,788,447	14,759,006	14,735,229	14,716,268
Hutchinson	10,897,784	10,292,071	9,781,923	9,300,024	8,862,730	8,531,276
Lipscomb	20,612,211	20,418,083	20,248,342	20,097,265	19,972,022	19,875,163
Moore	10,856,675	9,542,904	8,274,867	7,082,981	6,094,996	5,401,799
Ochiltree	19,706,391	19,224,931	18,780,991	18,354,572	17,964,426	17,620,672
Oldham	342,207	341,942	341,606	341,186	340,676	340,068
Potter	2,058,551	1,911,959	1,806,737	1,719,556	1,641,982	1,578,115
Randall	1,760,549	1,754,066	1,745,754	1,739,894	1,733,501	1,726,699
Roberts	31,229,005	30,420,566	29,663,915	28,979,771	28,412,811	28,002,937
Sherman	17,280,958	15,407,736	13,670,942	12,079,617	10,692,165	9,574,232
Wheeler	7,775,414	7,711,123	7,658,326	7,620,693	7,592,509	7,571,871
Sum	**237,486,382**	**224,895,893**	**213,734,729**	**203,992,573**	**196,161,717**	**190,148,383**

Table 4.1-2 provides a summary of the net flow balance of the model from predevelopment through 2060. One can see that as one moves into the transient historical portion of the model, most pumping is supplied by depleting aquifer storage, which results in the decrease in water levels seen through the region near pumping centers. In the predictive time period (2010-2060),

there is a significant reduction in drain flows and river boundary flows representing springs and seeps and stream base flows, respectively. This decrease in natural aquifer discharge is pumping capture. However, it is expected that it will take a very long time for all natural aquifer discharge to be captured because of the very large storage available in the aquifer.

Table 4.1-2 Steady-state and transient model flow balance (net flow in acre-ft/year).

Year/Period	Well Pumping	Drains	Rivers	Head Dependent Boundaries	Recharge	Storage
Predevelopment	**0**	**(254,852)**	**(157,345)**	**3,588**	**407,762**	**-**
1998	(1,812,495)	(202,969)	(109,200)	8,354	404,142	1,711,364
2010	(1,987,128)	(191,823)	(94,123)	7,983	402,131	1,862,187
2020	(1,821,796)	(183,220)	(84,194)	7,382	400,243	1,680,807
2030	(1,683,400)	(175,482)	(75,464)	7,068	398,168	1,528,314
2040	(1,513,002)	(168,980)	(68,018)	6,897	395,601	1,346,759
2050	(1,286,604)	(163,647)	(61,464)	6,761	392,943	1,111,250
2060	(1,117,111)	(158,997)	(55,714)	6,643	390,632	933,807

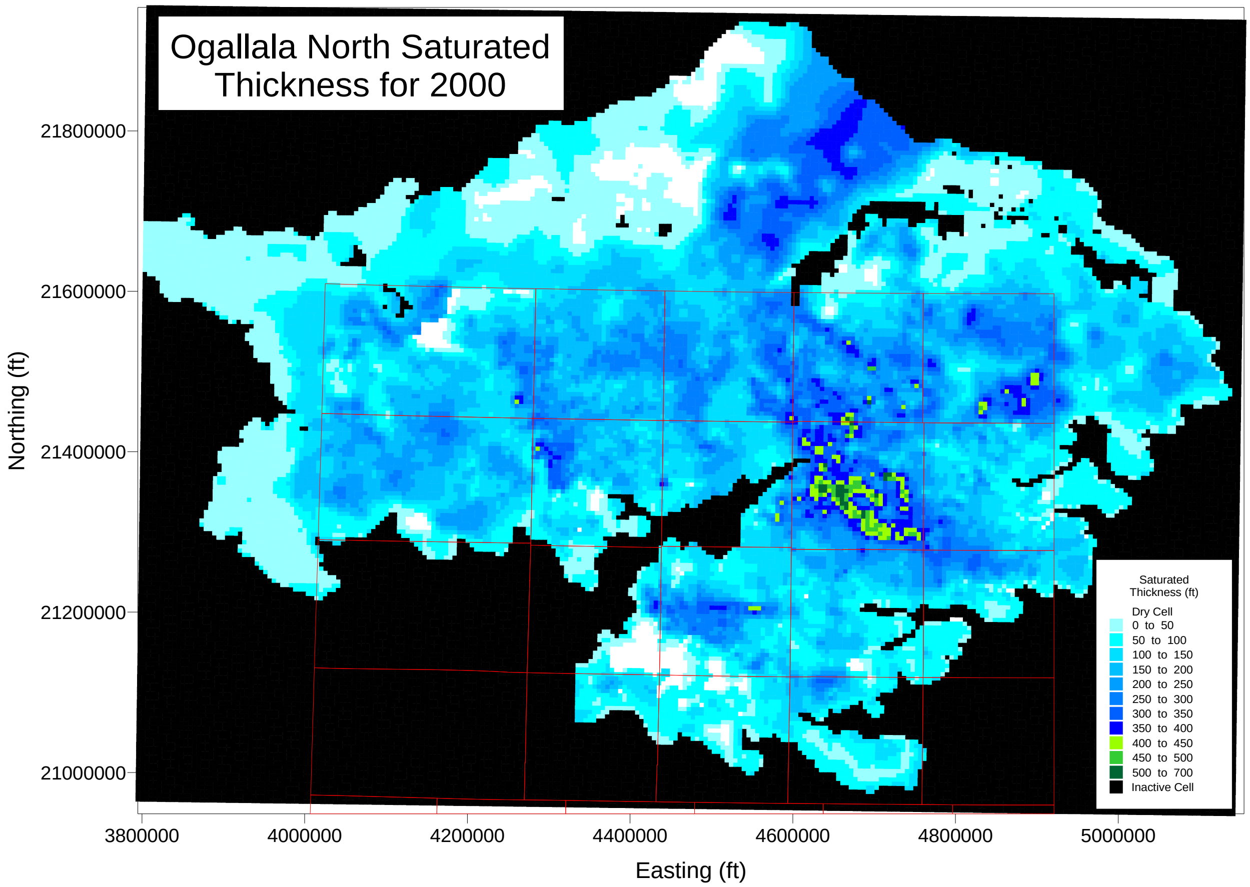

Figure 4.1-1 Saturated thickness in 2000 – baseline simulation.

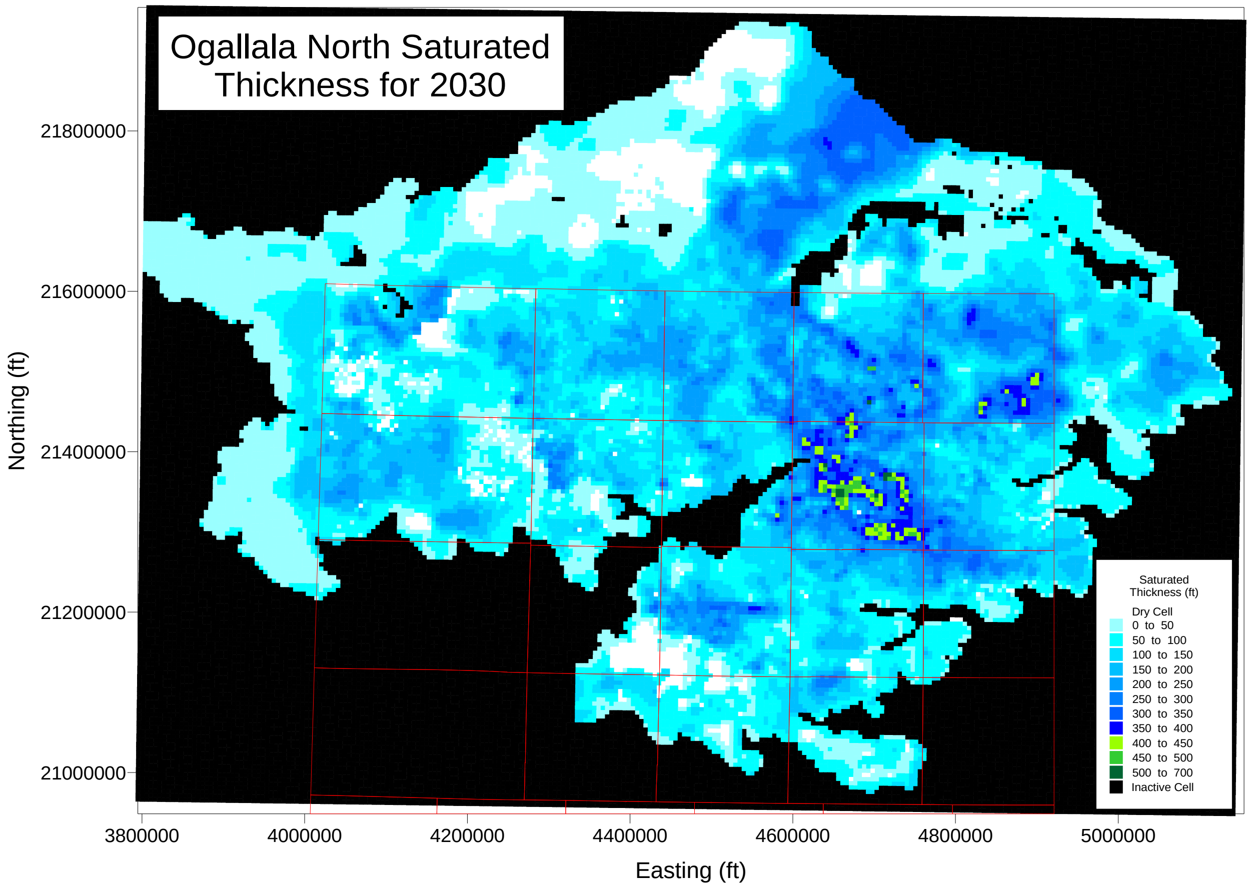

Figure 4.1-2 Saturated thickness in 2030 – baseline simulation.

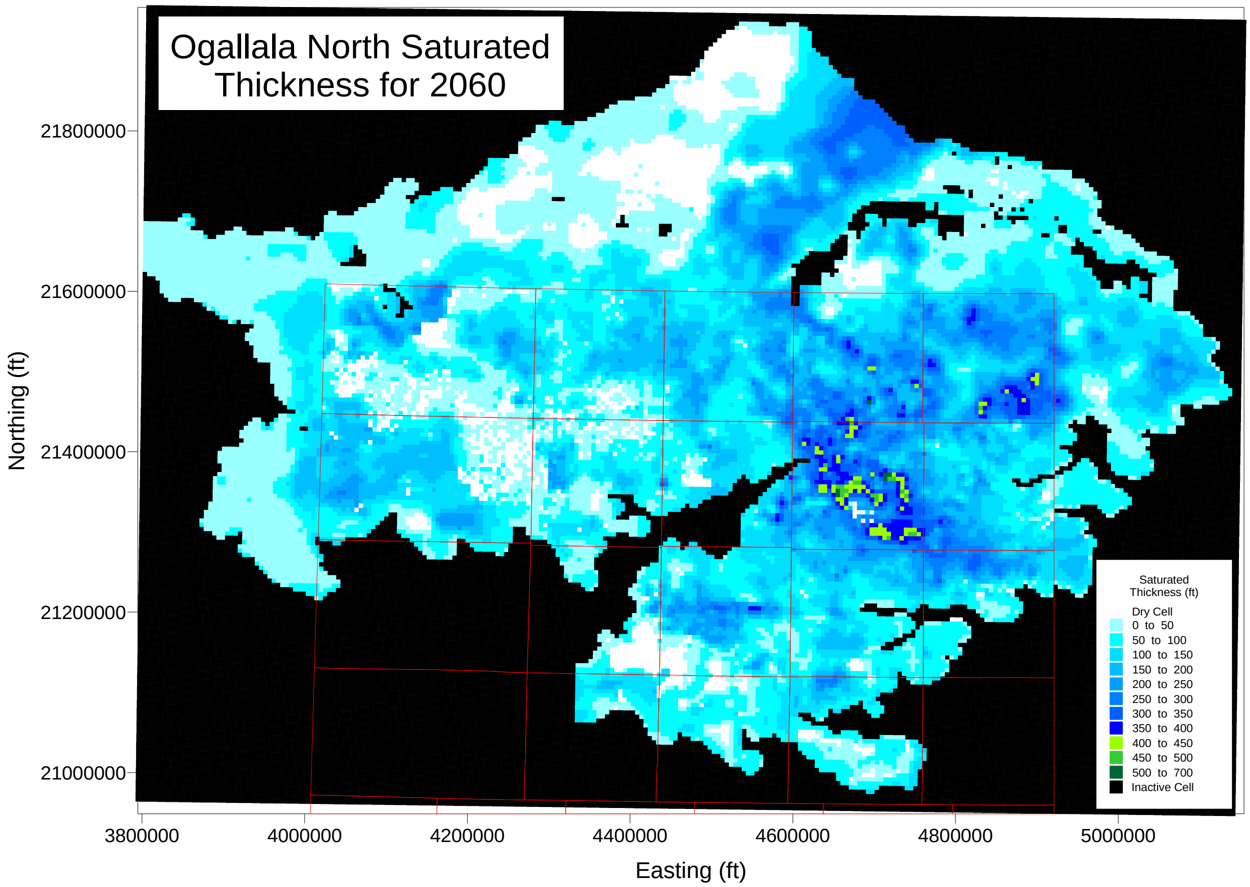

Figure 4.1-3 Saturated thickness in 2060 – baseline simulation.

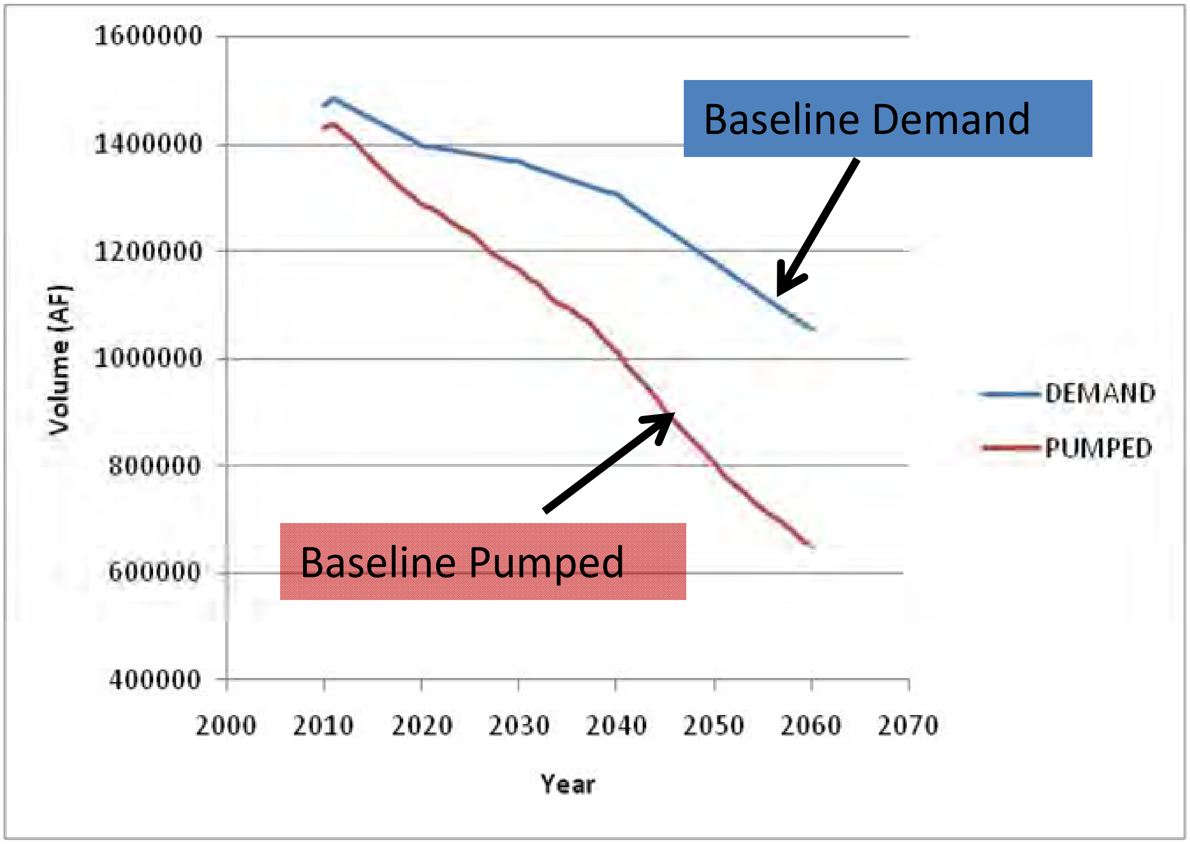

Figure 4.1-4 Pumping demand versus actual model pumping in Texas, baseline simulation.

4.2 Availability Simulation

The Regional Availability and Available Supplies simulations defined in Table 4.0-1 were performed to define a theoretical groundwater availability based upon predefined criteria developed by the PWPA.

4.2.1 Methodology

The method employed to look at Regional Availability and Available Supplies is similar in nature to that used by the TWDB in their support of GMA-1 (Draft Run 09-001). This does not imply that the results included in this report represent nor replace the managed available groundwater as it may be defined by the TWDB for GMA-1.

INTERA and Freese and Nichols met with the TWDB to discuss the approach used to perform the availability simulation. The aquifer management criteria defined by the PWPA Modeling Subcommittee were essentially the same as those specified by GMA-1:

1. 40 percent volume in storage remaining after fifty (50) years for Dallam, Sherman, Hartley, and Moore counties;

2. 80 percent volume in storage remaining after fifty (50) years in Hemphill County;

3. 50 percent volume in storage remaining after fifty (50) years in Hansford, Ochiltree, Lipscomb, Hutchinson, Roberts, Oldham, Potter, Carson, Gray, Wheeler, Randall, Armstrong, and Donley counties.

In our meeting, the TWDB stated that a model run to meet the criteria defined above is challenging. They suggested that an automated approach where pumping follows a decline curve to the target saturated thickness on a cell-by-cell basis would be a good advancement. It was anticipated that this approach would remedy the dry cell problems, resulting in each a final condition at 2060 where each model cell meets the target saturated thickness.

Based upon our discussions, we developed an algorithm that would calculate the flow rate in each model cell based upon a decline curve that would meet a specified target, expressed as a fraction of the initial saturated thickness. The Texas portion of the Northern Ogallala GAM was divided into the three areas detailed above, each with different drawdown targets. Pumping for portions of the model in Oklahoma and New Mexico were taken from the 2004 GAM (Dutton, 2004).

The algorithm developed for calculating Regional Availability used an iterative process that included MODFLOW and FORTRAN utility codes that read the MODFLOW head file and calculated pumping on a yearly basis. The GAM was run through stress period 55 (2004) to provide initial water level conditions for the regional availability run. The choice of stress period 55 is based upon a decision to be consistent with the TWDB calculations and to provide a common means of comparison between GAMs. In the TWDB's simulations to support the groundwater management area they chose stress period 55 because it best represented actual aquifer volumes as defined by NPGCD in the year 2006. This is understandable given that both the 2004 GAM and the revised GAM are biased slightly dry. Based on the stress period 55 water levels, an initial flow rate was calculated for each cell to meet the target over the 50-year planning period. These calculated flow rates were used for the first one-year MODFLOW simulation. The heads from the first one-year simulation were then used to estimate the next flow rate based upon a remaining 49-year period. This process continued with one-year simulations through the 50-year timeframe. This approach, as originally contemplated, did not succeed in providing asymptotic saturated thickness declines. The reason was because of the significant hydraulic communication which occurs between model cells.

A second approach was developed to ensure that pumping was sustained at rates that would accomplish the predetermined drawdown (i.e., remaining saturated thickness). As with the first approach, the revised model was run through stress period 55 to provide initial water level conditions. A constant decline rate was then calculated for each model cell based on the drawdown target (fraction of initial aquifer storage remaining in 2060) for the area of the model where that cell is located.

The calculated decline rate was used to determine a target head for each model cell on a yearly basis. This allowed for year-to-year adjustments of pumping to account for flow between cells and flow to or from boundaries. For each year, the model heads from the previous year were compared to the calculated target heads to determine the volume of water that could be removed from each cell during that year. These volumes were then combined with recharge for each cell to determine pumping rates.

Figure 4.2-1 shows a hypothetical time series of model cell pumping and head. In this example, the initial flow rate is calculated before model simulation. However, the lower part of Figure 4.2-1 shows that the theoretical drawdown curve at the end of the first year is not achieved. This occurs because the flow rates are calculated assuming no flow between adjoining model cells. The new algorithm uses the theoretical drawdown curve to estimate the pumping rate for the next year. Through this approach, we successfully developed a method that follows the theoretical drawdown curve for each model cell closely and meets the design saturated thickness with the generation of no new inactive (dry) model cells.

4.2.2 Availability Results

The results determined to date include regional groundwater availability and available supplies for municipal and irrigation water user groups (WUGs) subject to drawdown criteria over 50 years and a pre-determined decline curve function. This simulation differs significantly from the draft DFC/MAG simulation currently under review at the TWDB (GAM Run 09-001). Specifically, this simulation implements a consistent methodology for all regions, counties, and grid cells. Secondly, this simulation invokes a drawdown criteria at each model grid cell that implies groundwater management at the scale of one square mile. As a result, this simulation results in preservation of saturated thickness in all model grid blocks. This simulation does not increase inactive (dry) grid cells in the predictive time period.

Table 4.2-1 provides a summary of the annual regional groundwater availability by county as defined by the simulation described herein. Table 4.2-2 provides a summary of groundwater in place (storage) by county from the simulation described herein. This estimate of storage accounts for the spatially variable specific yield included in the GAM. By dividing the 2060 groundwater in place by the 2010 groundwater in place and multiplying by 100 one should calculate the management criterion applied to that county minus round off.

For the available supplies by water user group (WUG) we analyzed the two largest WUGs categories, irrigation and municipal. To perform these calculations required definition of WUG zones for both categories within the model area. This required assignment of specific grid cells of the model with pumping associated WUGs in these two categories. A single cell could only be assigned one unique WUG identification. Figure 4.2-2 provides the coverage of the irrigation zones used and Figure 4.2-3 provides the coverage of the municipal zones used. Each irrigation WUG zone was tracked by WUG type, county, river basin, and groundwater conservation district. Each municipal WUG zone was tracked by WUG type, county, river basin, and municipality. This approach resulted in 26 unique irrigation zones and 35 unique municipal zones.

Table 4.2-3 provides the available irrigation supply by county and Table 4.2.4 provides the available municipal supply by county. One will note that in Tables 4.2-3 and 4.2-4 the year 2011 has been added to the table in addition to the typical decadal reporting convention. The reason for this is that the initial pumping rate calculated for the year 2010 was typically an underestimate of the true rate required to attain the drawdown calculated for that one year time period. As a result, the algorithm developed corrected that rate in the next year of simulation to account for the communication between model cells. From that simulation year forward the flow rate was calculated specifically to attain a theoretical drawdown curve (see Figure 4.2-1). Generally, after the year 2011, the flow rates were on a downward trend from 2012 through 2060.

Table 4.2-1 Annual regional groundwater availability by county by decade - acre-ft/year.

County	2010	2020	2030	2040	2050	2060
Armstrong	44,517	37,021	32,753	29,104	25,919	23,142
Carson	189,998	171,143	154,066	137,853	122,989	109,410
Collingsworth	1,329	1,761	1,923	1,744	1,525	1,341
Dallam	404,285	352,123	308,825	270,154	234,731	203,478
Donley	84,639	76,515	72,094	66,137	60,322	54,999
Gray	189,188	158,698	144,142	130,769	118,180	106,432
Hansford	284,588	262,271	240,502	218,406	197,454	177,536
Hartley	452,460	389,548	337,001	291,093	250,966	216,099
Hemphill	45,171(1)	41,759	42,398	42,777	42,989	43,158
Hutchinson	162,022	136,433	124,573	112,149	100,575	90,438
Lipscomb	290,469	283,751	273,793	256,362	237,721	219,055
Moore	207,306	199,354	173,988	147,616	123,574	103,113
Ochiltree	269,463	246,475	224,578	203,704	183,227	164,265
Oldham	5,307	6,065	5,967	5,555	5,144	4,776
Potter	30,588	23,101	21,350	19,409	17,547	15,790
Randall	23,936	21,638	19,472	17,331	15,409	13,722
Roberts	434,959	390,901	368,617	339,245	307,512	277,039
Sherman	323,005	301,259	263,998	229,285	197,562	169,184
Wheeler	125,708	119,556	114,817	107,697	100,289	93,117
Sum	**3,568,937**	**3,219,371**	**2,924,857**	**2,626,389**	**2,343,633**	**2,086,094**

(1) Hemphill County 2010 availability is taken from simulation year 2011.

Table 4.2-2 Groundwater in storage – availability simulation (acre-feet).

County	2010	2020	2030	2040	2050	2060
Armstrong	3,045,005	2,672,141	2,342,846	2,053,437	1,799,125	1,575,917
Carson	13,781,335	12,077,463	10,554,483	9,193,654	7,983,451	6,911,938
Collingsworth	81,613	72,231	63,686	55,871	48,975	42,932
Dallam	22,152,496	18,633,112	15,624,664	13,044,324	10,845,091	8,982,576
Donley	5,334,284	4,686,452	4,109,554	3,598,921	3,148,926	2,753,514
Gray	13,063,030	11,461,859	10,041,052	8,779,258	7,659,235	6,667,997
Hansford	20,994,195	18,412,638	16,092,736	14,012,842	12,160,321	10,520,548
Hartley	25,138,232	21,151,832	17,767,582	14,905,686	12,489,463	10,449,202
Hemphill	14,805,111	14,275,736	13,681,825	13,073,355	12,477,965	11,907,585
Hutchinson	11,069,395	9,704,184	8,476,083	7,375,571	6,398,860	5,535,550
Lipscomb	20,463,052	17,985,744	15,790,263	13,843,395	12,120,433	10,597,034
Moore	11,548,667	9,671,568	8,017,612	6,603,322	5,417,787	4,442,166
Ochiltree	19,767,265	17,330,581	15,131,400	13,145,757	11,365,826	9,782,402
Oldham	244,180	214,781	188,402	165,191	144,857	127,042
Potter	2,074,081	1,815,387	1,582,546	1,373,939	1,189,059	1,026,631
Randall	1,749,823	1,522,369	1,330,890	1,163,291	1,016,197	886,717
Roberts	31,121,829	27,321,636	23,936,409	20,915,827	18,226,174	15,841,670
Sherman	18,231,075	15,355,045	12,895,979	10,795,165	9,004,302	7,483,290
Wheeler	7,702,560	6,778,855	5,952,448	5,223,920	4,583,097	4,019,417
Sum	**242,367,228**	**211,143,613**	**183,580,460**	**159,322,723**	**138,079,143**	**119,554,128**

Table 4.2-3 Available irrigation supplies by county - (acre-ft/year).

County	2010	2011	2020	2030	2040	2050	2060
Armstrong	5,057	6,454	5,663	4,952	4,419	3,922	3,474
Carson	98,581	112,879	102,663	93,537	84,650	76,032	67,735
Dallam	162,479	249,075	205,577	174,778	149,185	127,263	108,528
Donley	25,752	30,562	28,238	26,027	23,881	21,822	19,913
Gray	40,339	47,783	44,428	41,093	37,574	34,308	31,121
Hansford	89,809	144,200	129,710	119,296	108,005	97,147	87,155
Hartley	113,895	196,316	157,274	130,797	109,850	92,496	77,728
Hemphill	1,574	2,721	2,487	2,391	2,165	1,802	1,510
Hutchinson	27,554	44,001	37,599	33,442	29,114	25,237	21,910
Lipscomb	28,600	42,251	40,085	37,406	34,491	31,820	29,377
Moore	78,978	129,114	107,217	90,970	75,630	62,068	50,511
Ochiltree	57,132	86,706	75,606	67,757	60,736	54,056	48,206
Potter	787	572	423	333	296	264	238
Randall	4,955	7,097	5,487	4,931	4,424	3,958	3,544
Roberts	24,712	26,679	25,113	23,231	21,191	19,095	17,038
Sherman	118,864	208,951	170,352	143,961	121,217	102,180	85,934
Wheeler	10,507	12,776	11,865	10,468	9,258	8,220	7,389

Table 4.2-4 Available municipal supplies by county (acre-ft/year).

County	2010	2011	2020	2030	2040	2050	2060
Armstrong	348	529	463	405	354	311	273
Carson	8,680	16,166	13,849	11,995	10,411	9,153	8,160
Dallam	1,865	2,309	2,007	1,760	1,552	1,354	1,166
Donley	244	567	471	401	344	296	256
Gray	2,524	3,413	2,870	2,404	1,984	1,622	1,318
Hansford	2,705	3,962	2,908	2,019	1,603	1,321	1,063
Hartley	2,593	3,158	3,054	2,883	2,622	2,304	1,980
Hemphill	241	521	511	535	539	541	537
Hutchinson	1,000	5,084	3,996	3,184	2,543	2,034	1,635
Lipscomb	2,851	3,316	3,724	4,004	4,084	4,026	3,897
Moore	2,764	5,780	4,970	4,208	3,374	2,567	1,976
Ochiltree	1,862	4,041	3,209	2,807	2,411	2,074	1,737
Potter	3,201	2,419	1,595	1,333	1,163	1,031	875
Randall	2,056	4,549	3,175	2,584	2,129	1,769	1,495
Roberts	158,863	150,819	137,323	122,738	109,170	97,167	86,485
Sherman	1,511	1,849	1,791	1,643	1,406	1,123	920
Wheeler	2,077	2,416	2,244	2,032	1,832	1,636	1,464

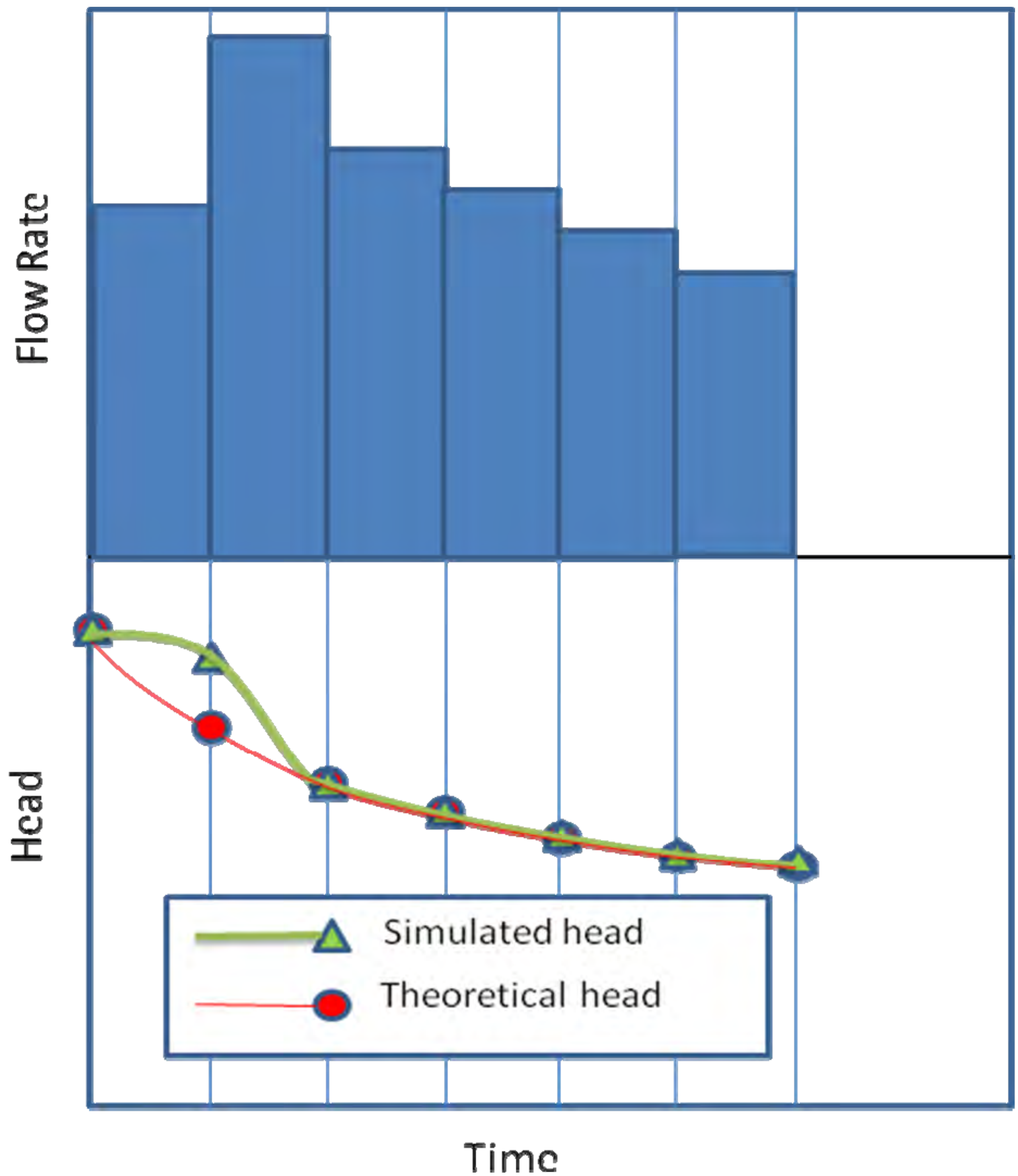

Figure 4.2-1 Approach to developing flow rates in the regional availability simulation.

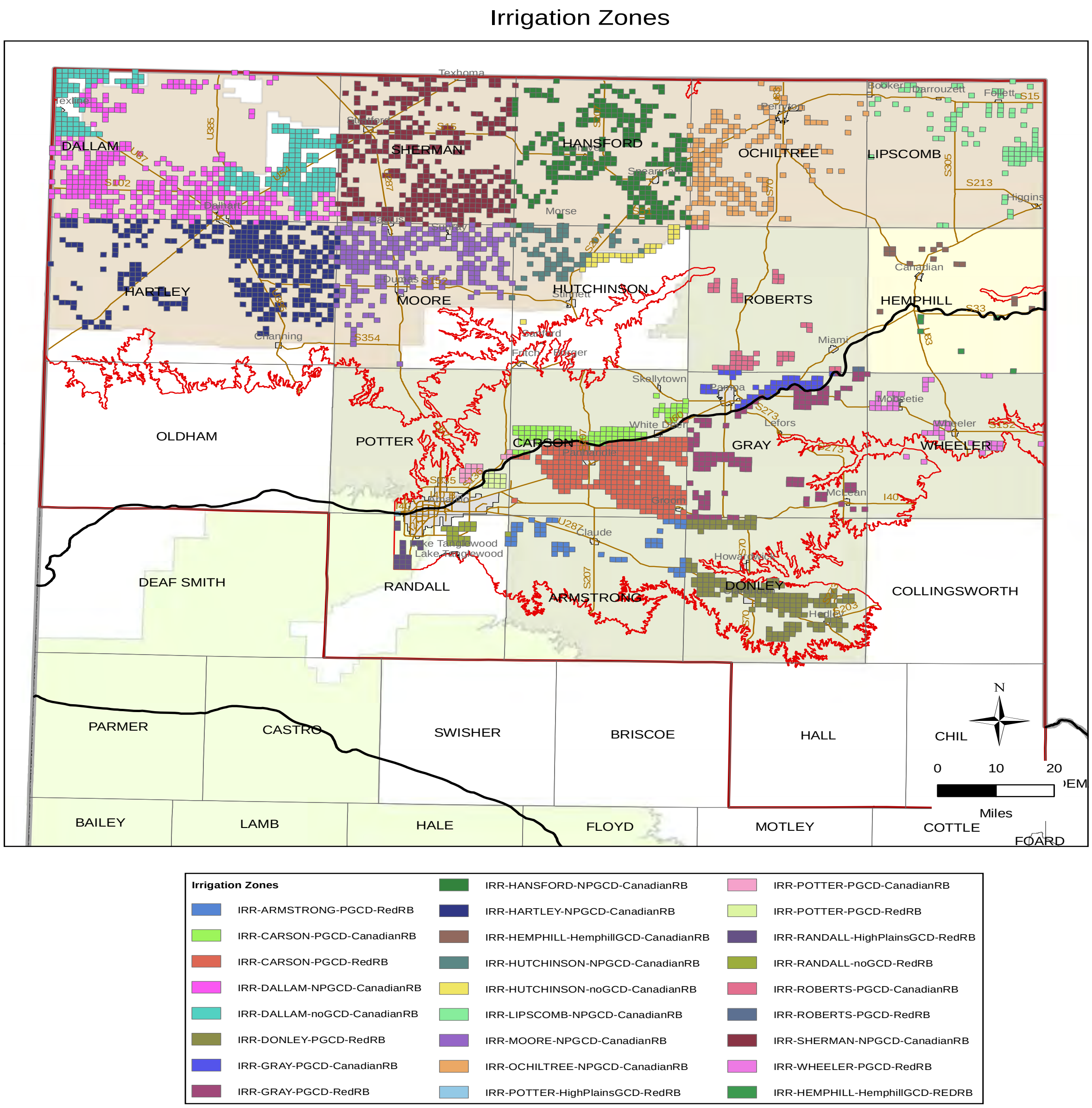

Figure 4.2-2 Irrigation zones for available supplies calculations.

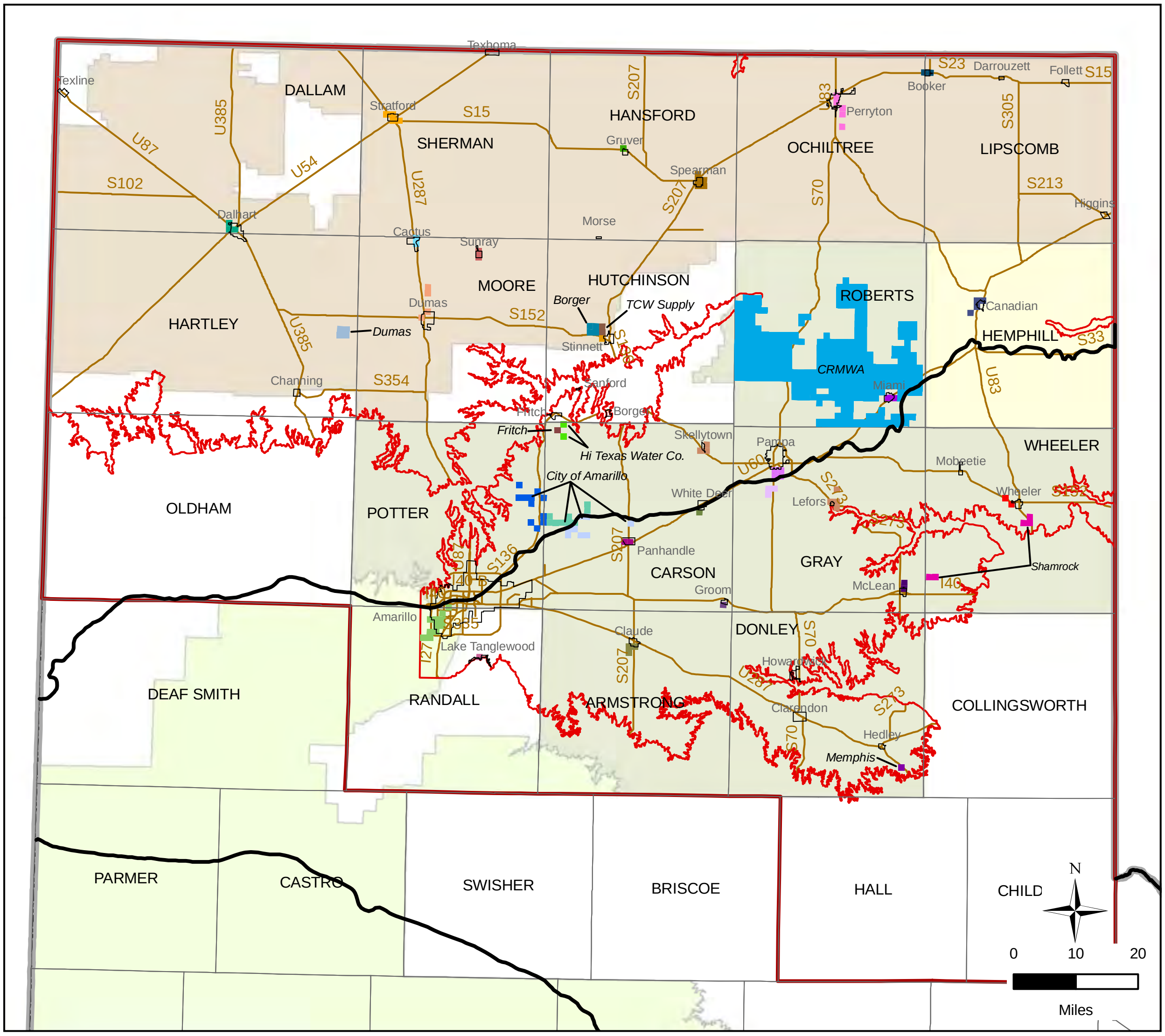

Figure 4.2-3 **Municipal zones for available supplies calculations.**

5.0 CONCLUSIONS AND RECOMMENDATIONS

The 2004 Northern Ogallala GAM (Dutton, 2004) was updated in support of the 2011 Panhandle Regional Water Planning Group Plan. INTERA was supported by subcontractors Dr. Alan Dutton (The University of Texas, San Antonio) and Dr. Bridget Scanlon (Bureau of Economic Geology). We were also supported by our prime, Freese and Nichols, Inc. and by the Texas AgriLife Extension Service.

Key revisions to this version of the Northern Ogallala GAM include:

- Updates to the historical pumping data set to extend it through 2008 with improved information supporting municipal, manufacturing, power and mining water user groups;
- Development of a new predictive dataset from 2009 through 2060. This included updated agricultural demands developed by AgriLife Extension Service;
- Revised aquifer base resulting in a net increase of over seven million acre feet of aquifer storage; and
- Updates to model hydraulic conductivity based upon new data provided by stakeholders within the region.

A post audit was performed on the 2004 GAM by assessing calibration at 2007. The 2004 GAM remained in calibration across this 10 year test period providing evidence of the Northern Ogallala GAM's accuracy as a predictive tool within a 10 year period.

The calibration of the revised GAM has been improved from the 2004 Northern Ogallala GAM in both the steady-state model and the transient model as analyzed at 1998. The RMSE of the steady-state model was reduced from 32 to 29 ft model wide. The RMSE was reduced in most counties with the most significant reduction of 20 ft occurring in Dallam County. The model-wide steady-state MAE was reduced from 23 ft to 21.8 ft. The transient calibration was also improved in most counties. Comparing model error in 1998, the revised model reduced the RMSE from 53 ft to 46 ft, an improvement of 7 feet. The revised model simulates through 2008. The model-wide calibration improved from 1998 to 2007 with a reduction of RMSE from 46 ft to 36 ft. The model does a good job fitting trends in water levels within the region and provides a valuable tool for planning purposes.

The revised GAM was used to perform three planning simulations. They were the Baseline Demand simulation (Baseline), the Regional Availability simulation, and the Available Supplies analysis. Consistent with previous predictive simulations, the Baseline Simulation from 2009 through 2060 predicted that several agricultural high use areas would not be able to meet demand because of limited aquifer productivity (i.e., low saturated thickness). The average annual groundwater demand from 2010 through 2060 is 1,303,482 acre-feet in Texas. However, in the baseline simulation, the aquifer can only provide 1,062,075 acre-feet of groundwater in Texas. If the aquifer could be optimally developed the aquifer could theoretically provide an average of 2,781,210 acre-feet per year from 2010-2060 while still meeting regional availability criteria.

There are several recommendations for improvement to the model from a future development calibration perspective and for use in water planning. Some of these ideas will be briefly provided below.

- The Northern Ogallala GAM has relatively few grid cells given modern computing capabilities. The model error could likely be reduced by reducing the horizontal grid size.

- There has been significant effort in this revision to better define the base of the Ogallala in the northwestern portion of Texas. This area has been a problem area for calibration since the original 2001 GAM. This is likely because of the complex hydrostratigraphy in the area of Dallam, Hartley, Sherman counties, eastern New Mexico, and the western end of Oklahoma Panhandle. Because of groundwater use, this is a very important area within the model. A detailed hydrostratigraphy study in that region would benefit the Northern Ogallala GAM and might provide the data needed to accurately include other aquifers in that area.

- The model would benefit from further studies in characterizing specific yield. The current distribution in Texas is based upon Knowles and others (1984). Several means could be used to further characterize this property. First, if one could find a correlation between hydraulic conductivity and specific yield we would have a much larger data set from which to introduce heterogeneity. Secondly, with metered wells becoming the standard within portions of the region, this data can be used with observation wells as large scale pump tests capable of providing specific storage estimates as well as transmissivity estimates.

- Recharge as a process in the Northern Ogallala Aquifer is reasonably well conceptualized and there are numerous point estimates of recharge available. It would be advantageous from a modeling perspective to develop a means of scaling these point estimates up to grid-scale recharge estimates. This would allow for a consistent method of varying recharge in calibration based upon factors considered to be important to the process. This work would have to discriminate between predevelopment and modern day. It would also be useful to develop an error analysis on the recharge estimates to support calibration.

- A region-wide textural model (stratigraphy) of the aquifer would be of benefit to the model improvement. Such information would provide a means to develop relationships between properties and aquifer texture that could be used in scaling properties to grid-scale, assigning properties where no measurements occur, and provide a calibration approach which could greatly reduce the number of unknowns being estimated.

- Once consistent approaches to varying key properties such as recharge, hydraulic conductivity, and specific yield are developed, it would be possible to use an inverse-automated calibration methodology to improve model fits while developing estimates of the uncertainty in model predictions. There are over 800 long-term hydrographs within the Northern Ogallala GAM model domain in Texas. This offers a unique ability to focus on calibration and make improvements in initialization and model performance.

- We would also recommend coordination with the High Plains Aquifer studies by the USGS as they continue to work within the Texas Northern Ogallala region and potentially revise their models. It is possible that they are developing a solid textural model of the aquifer in the Northern Ogallala Aquifer region, which would be invaluable to developing additional constraints on hydraulic properties and providing a framework for scale-up from point values (aquifer tests at wells) to grid block scale properties and for parameter estimation.

6.0 ACKNOWLEDGMENTS

We would like to acknowledge the support and valuable input provided by the PWPG chaired by Mr. C.E. Williams and the PWPG Modeling Subcommittee chaired by Mr. John Williams. The PWPG has been instrumental in our understanding of the aquifer and the region and this study has benefited greatly from their participation and recommendations. We would also like to thank the staff of NPGCD, PGCD, and the Hemphill County UWCD for their support in providing data to support this model revision. We would also like to acknowledge the support of the Canadian River Water Municipal Water Authority (CRMWA), the City of Amarillo, Mesa Water Inc. and Dr. Alan Dutton in providing new data to support this model revision. Finally we would like to acknowledge Ms. Simone Kiel of Freese and Nichols, Inc. for providing clear direction and support through the model revision process.

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APPENDIX G

HISTORICAL TRENDS IN KEY COMPONENTS OF THE HYDROLOGIC CYCLE FOR THE LAKE MERIDETH WATERSHED

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TO: File – PPC07480

FROM: Spencer Schnier and Andres Salazar

SUBJECT: Historical Trends in Key Components of the Hydrologic Cycle for the Lake Meredith Watershed

DATE: July 27, 2010

1.0. INTRODUCTION

Lake Meredith is located in the Texas Panhandle (Figure 1) and is a significant water supply for the Panhandle Water Planning Area (PWPA). Sanford Dam was constructed in 1965 impounding the Canadian River to form Lake Meredith. The reservoir had an intended capacity of nearly 864,400 ac-ft (as modeled in Run 3 of the Canadian WAM), but has only reached maximum of 60% full during a period in the 1970s (Figure 2). Precipitous declines in content have been observed since 2000. The streamflows that fill Lake Meredith have trended substantially downwards over the past 70 years, with flows from the last decade being especially low (Figure 3).

Currently, the lake is at a historic low content of 27,000 ac-ft (less than 4% of the original capacity). The reliable supply from Lake Meredith has decreased from over 70,000 acre-feet per year to about 30,000 acre-feet per year in 2008. The impact of the reduced supplies to the PWPA is great. Without renewable surface water, the region must rely on groundwater.

This study was conducted to better understand the current decline in Lake Meredith water supplies and assess whether this supply reduction is transient or a long-term trend. Other regional surface water sources, Lake Palo Duro and Lake Greenbelt, are also in drought conditions. The Lake Meredith study could have important implications for these reservoirs as well. The study evaluated several potential causes of reduced inflows, including hydrologic loss, groundwater-surface water interactions and changes in land use.

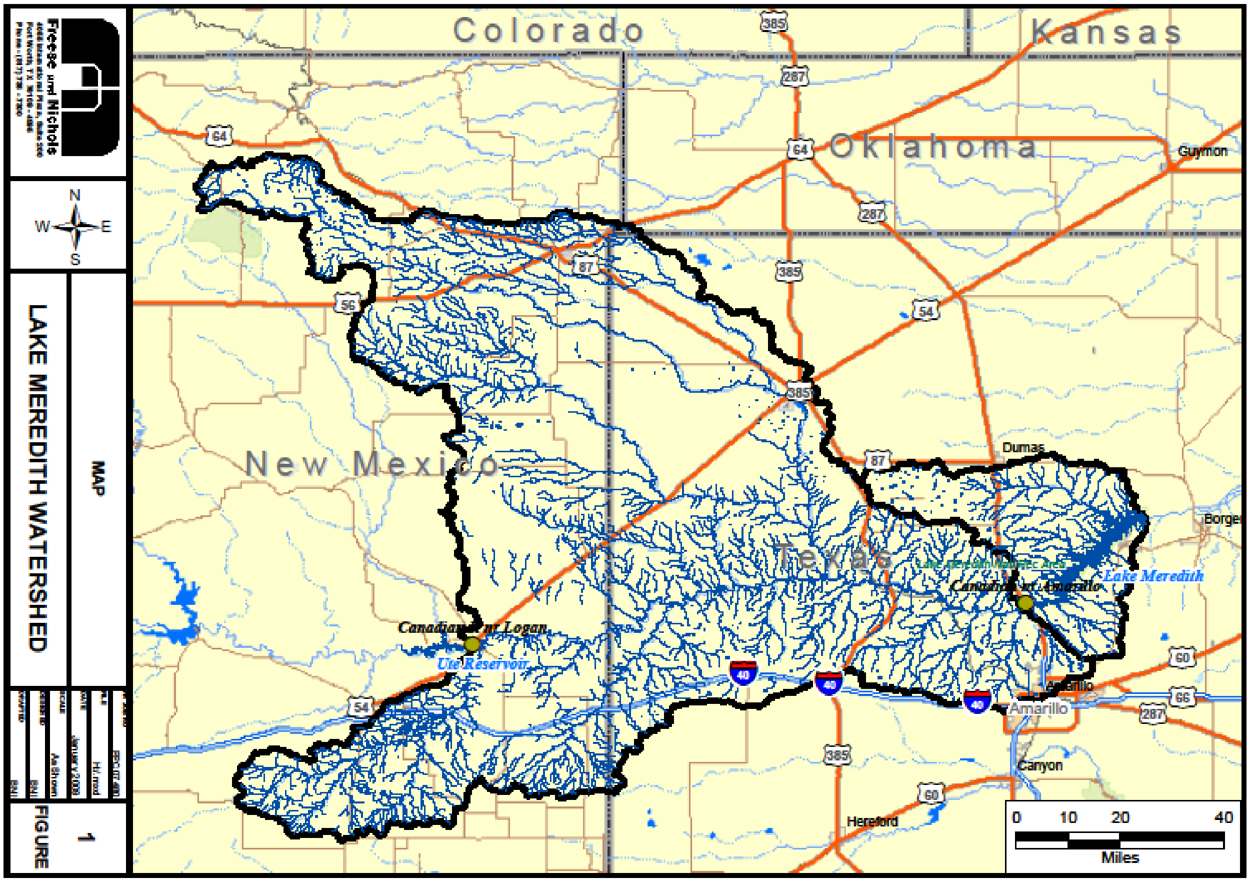

Figure 1. Map of the Lake Meredith Watershed

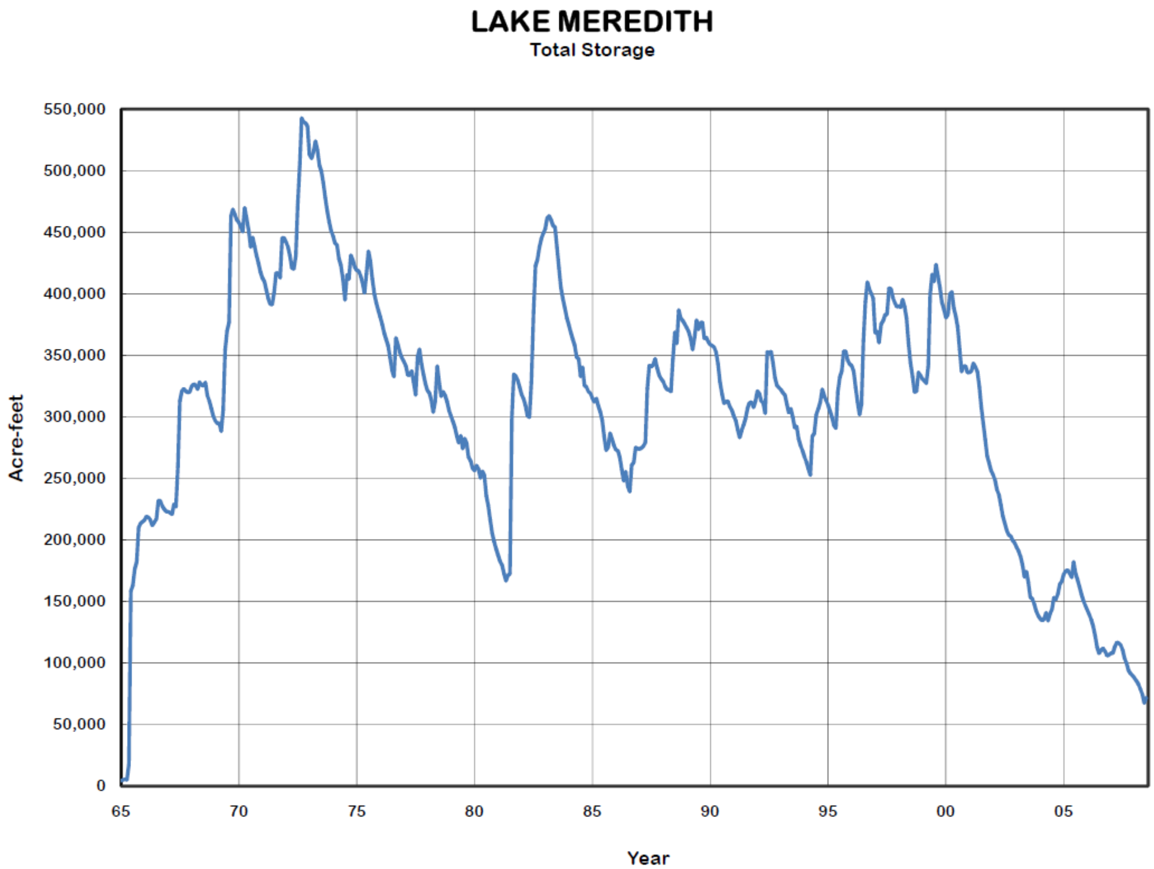

Figure 2. Historical Storage Levels in Lake Meredith

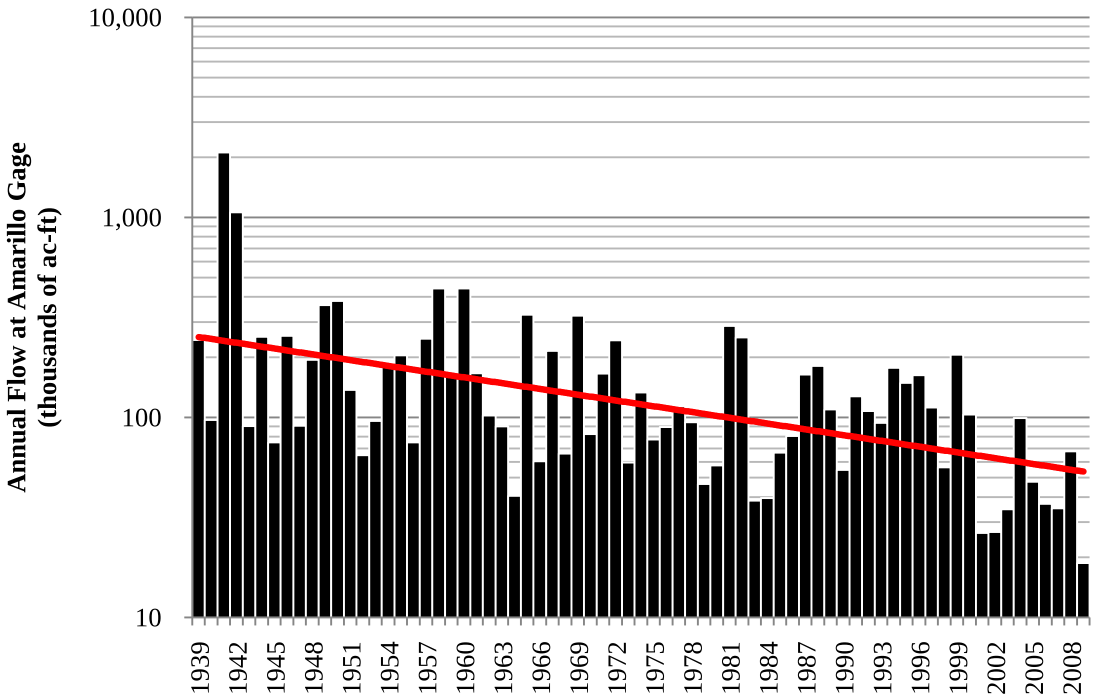

Figure 3. Historical Streamflows at the Amarillo Gage (07227500) near Lake Meredith

The Lake Meredith study is organized into six sections. The first section introduces the issue and provides background information describing the problem. Section 2 documents the calculation of hydrologic loss by decade and evaluates trends in the rainfall to runoff ratio. Section 3 analyzes trends in temperature and precipitation. Section 4 examines interactions between groundwater and surface water as a possible cause for declining lake levels. Section 5 investigates whether changing land use practices are reducing the watershed's ability to generate runoff. Finally, section 6 presents a summary of the findings and the conclusions of the research.

2.0. Hydrologic Loss

In this study, the *net hydrologic loss* is defined as the amount of precipitation that does not contribute to increased runoff at the outlet of the watershed. Historical changes to hydrologic loss were evaluated for the Canadian River watershed between Logan and Amarillo. Hydrologic loss can occur due to evaporation, transpiration, and/or infiltration. It is indicative of the watershed's ability to generate runoff from precipitation events.

Hydrologic loss may change because of a variety of factors. Some of these factors could include addition of water impoundments (which increase evaporation and prevent water from reaching the river), additional infiltration (due to changes in agricultural practices or ground cover), climatic variability, increased diversions of water or decreased return flows. The objective of this task is to analyze the change of the hydrologic loss over time.

The study area for this task is the watershed between the Canadian River at Logan (USGS gage 07227000) and the Canadian River near Amarillo (07227500). Delineating the watershed in this way eliminates activities above Ute as a possible explanation for changes in hydrologic loss. The watershed has a drainage area of 7,868 sq. miles, of which 2,900 sq. miles (36%) are non-contributing. The study area composes 90% of the incremental watershed of Lake Meredith below Ute Reservoir. Figure 1 shows the location of watershed.

2.1. Net Hydrologic Loss Using Mass Balance

Hydrologic loss can be calculated with a mass balance on the surface of the watershed. The mass balance relates inflows, outflows, and the water stored in a control volume and is mathematically expressed with the following equation:

$$I - O = \frac{\Delta S}{\Delta t} \tag{1}$$

where

I = water inputs to the watershed

O= water outputs from the watershed

ΔS= change in volume stored in the watershed

Δt = length of time to which the mass balance is applied

The watershed between Logan and Amarillo does not have large impoundments. (Lake Meredith is downstream from the Amarillo gage.) Therefore, for long periods of time, the change in storage ΔS can be assumed to be zero and the mass balance equation becomes:

$$I = O \tag{2}$$

The inflow is composed of precipitation (P), incoming surface water flowing at the Logan gage (Q_{in}), gain from groundwater in the form of base flow (G_w) and irrigation return flows (R_f). The outflow is composed of the surface water flowing at Amarillo gage (Q_{out}), surface evaporation (E), evapotranspiration (ET), and infiltration (F). Surface water diversions are very small and can be ignored. Thus, the mass balance equation can be rewritten as:

$$P + Q_{in} + G_w + R_f = Q_{out} + E + ET + F \tag{3}$$

or

$$E + ET + F - G_w - R_f = P - (Q_{out} - Q_{in}) \tag{4}$$

The net loss of precipitation (i.e., the precipitation that does not contribute to an increase of incremental flow between the inlet and the outlet) is the total volume of precipitation minus the incremental flow. Such amount is the net hydrologic loss. The net hydrologic loss can be calculated as:

$$\text{Net hydrologic loss} = P - (Q_{out} - Q_{in}) \tag{5}$$

The net hydrologic loss can be calculated with historical values of precipitation and streamflow records. By comparing equations (4) and (5), the net hydrologic loss is also calculated as:

$$\text{Net hydrologic loss} = E + ET + F - G_w - R_f \tag{6}$$

Equation (6) suggests that the hydrologic loss could be increased to due to increased evaporation, transpiration and infiltration, and could be affected by gains or losses from groundwater (base flow) and return flows.

This section evaluated hydrologic data over 10-year periods using equation (5) with historical precipitation and streamflow records from 1950 to 2006. The hydrologic loss is expressed as a percentage of the total precipitation. From equation (6), any historical increase in net hydrologic loss over time could possibly be explained by one or more of the following activities:

- Increase in evaporation due to additional surface water impoundment (examples include SCS structures and livestock ponds)
- Increase evapotranspiration due to additional crops or the presence of more vegetation that consumes water (for example, salt cedar)
- Reduction in groundwater inflow due to lower groundwater levels
- Reduction of return flows
- Increase of infiltration due to land leveling or other factors
- Increased surface water diversions
- Climatic variation which may include changes in precipitation, rainfall intensities, and temperature

2.2. Methodology

To obtain values of the hydrologic loss within the watershed, available data from various precipitation and streamflow gages were collected for the period of record 1940-2006[1]. Precipitation gages within the watershed area include 46 gages in Texas, 59 in New Mexico, 14 in Oklahoma, and 1 in Kansas. Not all of the gages have continuous records. Gages to be used in the analysis for a given decade were selected based on the availability of data; in most cases, gages with less than 60 days of missing precipitation records in a decade were selected. For instance, between 1997 and 2006, 6 gages were used in Texas, 7 in New Mexico, 1 in Oklahoma, and 1 in Kansas. For periods of missing data, nearby gages were analyzed to be sure a large storm did not occur in the area, which could affect precipitation totals. If a large storm did occur, precipitation data of nearby gages were averaged to fill in missing records.

For each of the 6 decades studied, chosen gages were loaded in the ArcMap application.

1 Precipitation gage data were obtained from the NOAA Cooperative Extension Network (COOP). Streamflow gage data was obtained from USGS.

The average annual precipitation for the entire watershed was estimated with the *Inverse Distance Weighted* (IDW) interpolation method. The IDW interpolation method calculates the precipitation at any point of the watershed as a weighted average of the precipitation gages around the point, where the weight of each gage is inversely proportional to the distance to the point. In this case, as the distance from a particular precipitation gage increases, it is reasonable to assume the precipitation estimate is less influenced by the gage and more weight is given to closer gages. The process produces a precipitation raster with resolution of 500 meters. (That is a grid with cells of size 500 m x 500 m where precipitation estimates are calculated for each cell). The average annual precipitation for the watershed is calculated as the average of all its raster cells. As an example, Figure 4 displays the average annual precipitation map for the 1950-1959 period. Maps of average annual precipitation for each decade from 1940 to 2006 are included in Attachment A.

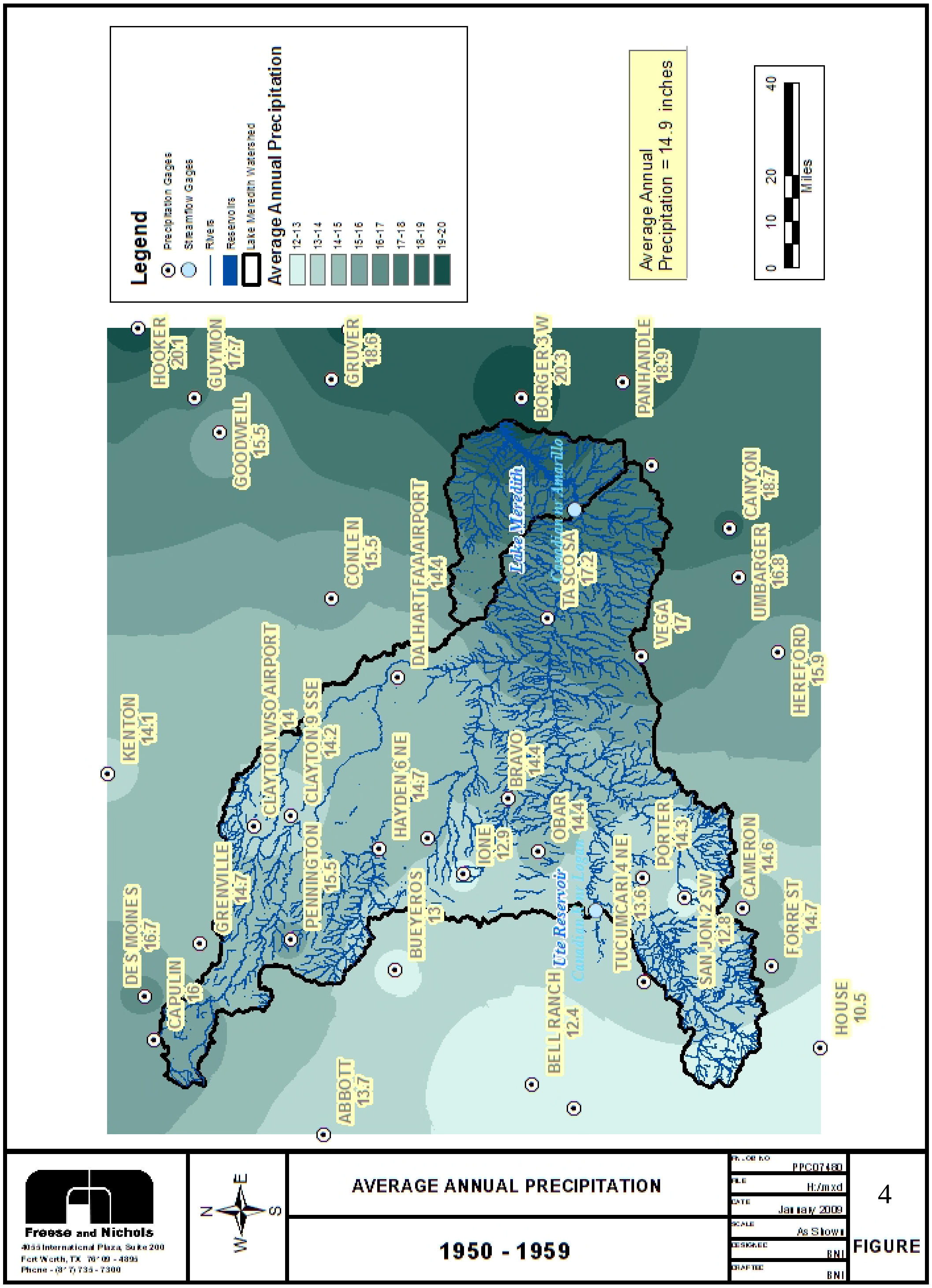

Figure 4. Average Annual Precipitation from 1950 to 1959

The mass balance method described in Section 2 was then used to calculate percent hydrologic loss. This calculation depends on the average annual precipitation calculations for each decade, and average annual flow into and out of the watershed based on data from the Logan and Amarillo Canadian River stream flow gages. The total volume of precipitation volume (P) for the decade is calculated as the annual average precipitation times the total drainage area. The hydrologic loss as a percentage of the precipitation volume is:

$$\%\text{ hydrologic loss} = \frac{P - (Q_{out} - Q_{in})}{P} \tag{7}$$

In Equation 7, precipitation is the volume over the total drainage area. Precipitation over non-contributing area flows to a closed basin and is accounted as a loss. The hydrologic loss could be calculated using only contributing area. This number based on contributing areas is smaller because the loss from closed basin is removed. However, as long as the calculation area is consistent throughout the decades, either method should reflect the same historical trend of loss.

2.3. Results

Figure 5 provides the basic trend in hydrologic loss for the Lake Meredith watershed for the 6 decades selected for this study.

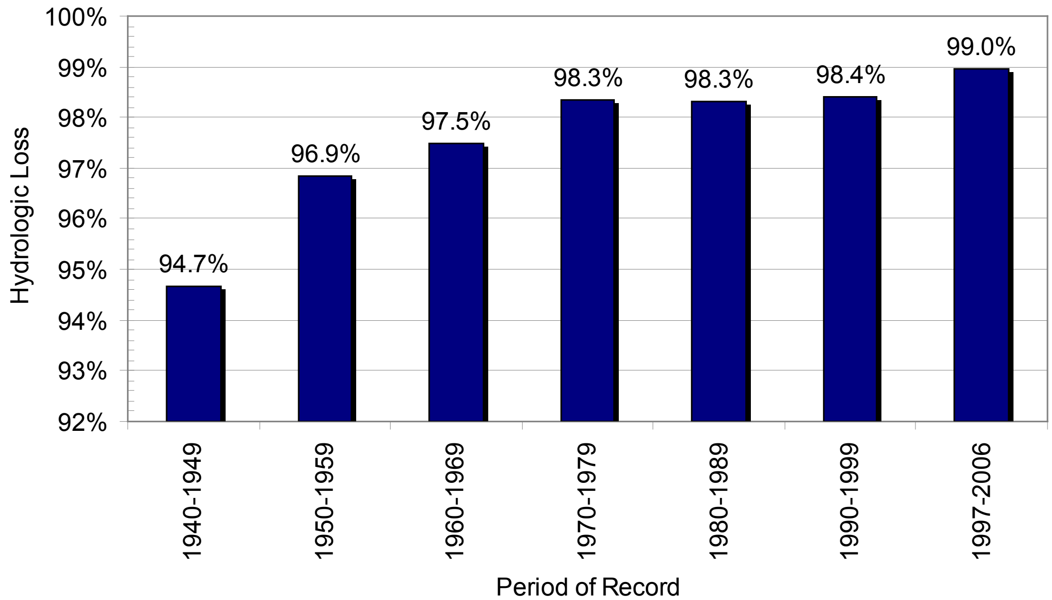

Figure 5. Hydrologic Loss per Decade

Between 1940 and 2006, hydrologic loss increased over time from 94.7% to 99.0%, resulting in less runoff (as a percent of precipitation) reaching Lake Meredith. These results can also be expressed as a percent rainfall/runoff. In the 1940-1949 decade, 5.3% of the precipitation reached the Amarillo gage. In the last decade, the ratio was reduced to 1%. For reference purposes, Lake Meredith and Ute Reservoir began impounding the Canadian River in 1965 and 1962, respectively.

Attachment A contains the maps of average annual precipitation for the six decades in this study. Annual average precipitation and percent hydrologic loss are labeled. While there is no trend in annual average precipitation over time, hydrologic loss has clearly increased. Between decades 1960-1969 and 1970-1979, hydrological loss increases by 9.42%, compared to a 0.18% increase between 1970-1979 and 1980-1989.

2.4. Conclusions

Hydrologic losses across the Lake Meredith watershed have increased over time. Preliminary trends of precipitation data show no corresponding decrease in annual precipitation amounts over the period of record. Losses have increase from 94.7% to 99% in 60 years. In other words, the portion of the precipitation on the watershed reaching the Amarillo gage has decreased from 5.3% to 1%. These findings imply that the watershed is losing its ability to generate runoff. Further analyses of changes in climatic variations, groundwater levels and land use over time may provide more information about the watersheds changing hydrology.

3.0. CLIMATIC VARIATION

Climate change is affecting temperatures and precipitation patterns worldwide. Climatic variation could be responsible for decreased flows in the Lake Meredith watershed. Evaporation is an important avenue of hydrologic loss. Air temperature is as an indicator of potential evapotranspiration (Hamon, 1961). Actual evaporative losses also consider surface area of impounded or retained water and wind. Increases in stored water in the basin are discussed under land use, Section 5. This section focuses on the potential for climatic factors to impact hydrologic loss. Annual and seasonal trends in maximum and minimum temperatures are investigated in Section 3.1. Precipitation trends are presented in Section 3.2.

3.1. Temperature Trends

Temperature records from 1949 to 1999 were examined for the Lake Meredith watershed. The objective of this analysis is to identify trends in average annual and seasonal temperature values and determine if correlations exist between historical trends in the ratio of rainfall to runoff and temperature. Trends in historical temperature variability were evaluated using modeled land surface temperatures from a study by Maurer et al. (2002). The temperature dataset was modeled at a 3-hr time step and subsequently aggregated to a monthly time step with a spatial resolution of 1/8 degree (approximately 12 sq. km). Temperatures for each time step were interpolated using an asymmetric spline through the daily maxima and minima. For more information on how the dataset was developed, please refer to the study by Maurer et al.

3.1.1. Trends in Annual Maxima and Minima

This study uses the dataset developed by Maurer et al (2002) described above to extract the 194 control points within or near (within 5 miles of) the Lake Meredith watershed. The annual average maximum and minimum temperatures were calculated for each gridded point in the Lake Meredith watershed. At each data point, trendlines were fit to the annual averages using linear least-squares regression (Stafford et al, 2000). The slopes of these 194 regression lines are mapped using the Inverse Distance Weighted (IDW) method of interpolation to assign weight to each station. Figures 6 and 7 show the change in maxima and minima temperatures in degrees Celsius over the 51 year period. A positive value indicates that temperatures have been increasing, while a negative value indicates that temperatures have been decreasing.

Figure 6 shows the annual maximum temperature has decreased throughout the entire watershed with the most rapid decreases occurring in the central-western portion. Figure 7 shows the annual minimum temperature has decreased in some parts of the watershed and increased in others. The increases in average annual minima are concentrated in the northwestern and southwestern portions of the watershed, while the deceases occur in the central and eastern portions of the watershed.

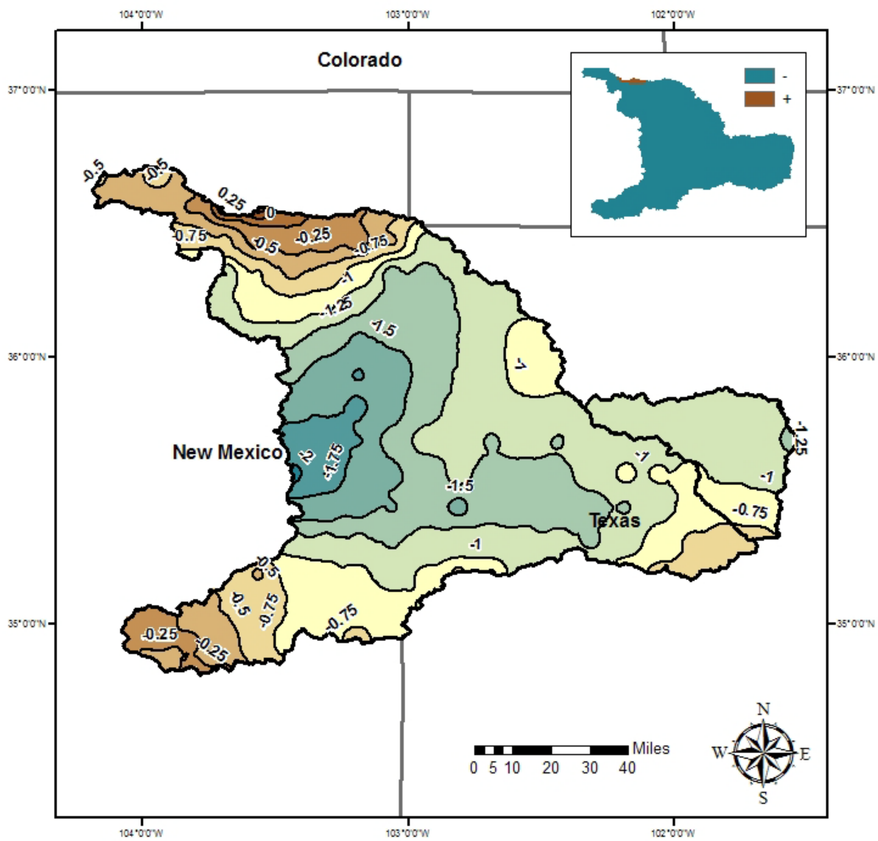

Figure 6. Change in Average Annual Maxima Temperature from 1949 to 1999 (in Celsius) using regression lines unique to each point

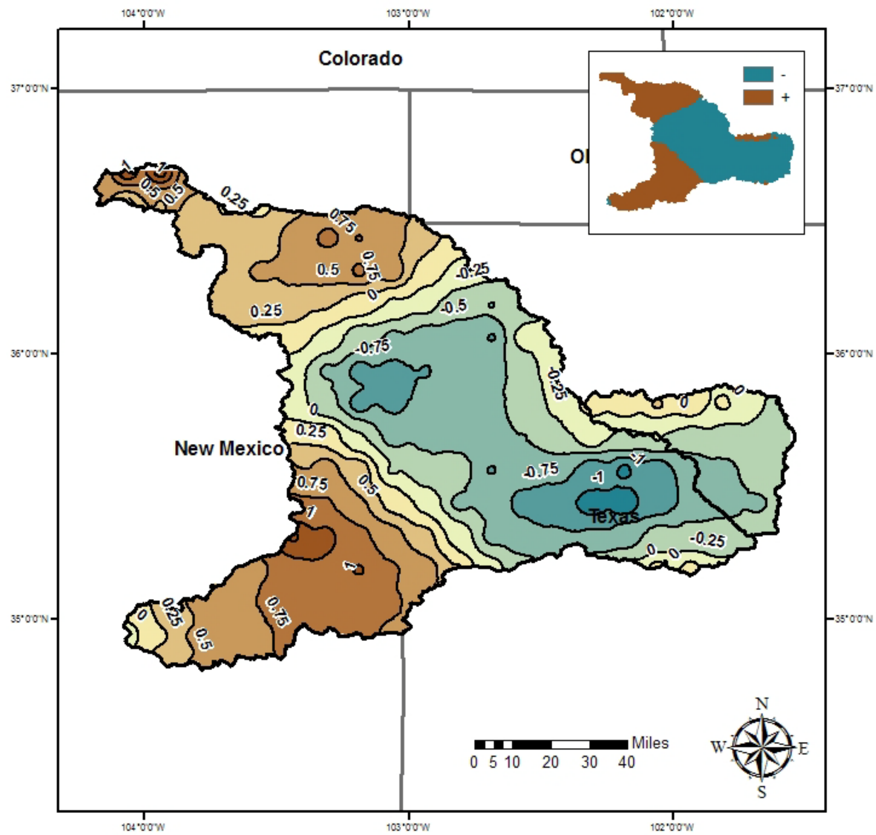

Figure 7. Change in Average Annual Minima Temperature from 1949 to 1999 (in Celsius) using regression lines unique to each point

Figure 8 is a plot of the average annual maxima and minima temperatures for the Lake Meredith watershed with linear least squares regression lines. The trends are generally linear over time with deviations due primarily to interannual variability. Very little change is observed in the minima, while the temperature decrease of the maxima is more pronounced. The lack of change in the average annual minima is likely the result of averaging, as temperature in some parts of the watershed increased while it decreased in other areas. The regression lines indicate that the temperature range between minima and maxima has decreased since 1949. The coefficient of determination (R^2) for these trends is relatively low. The statistical significance of the trend still needs to be evaluated.

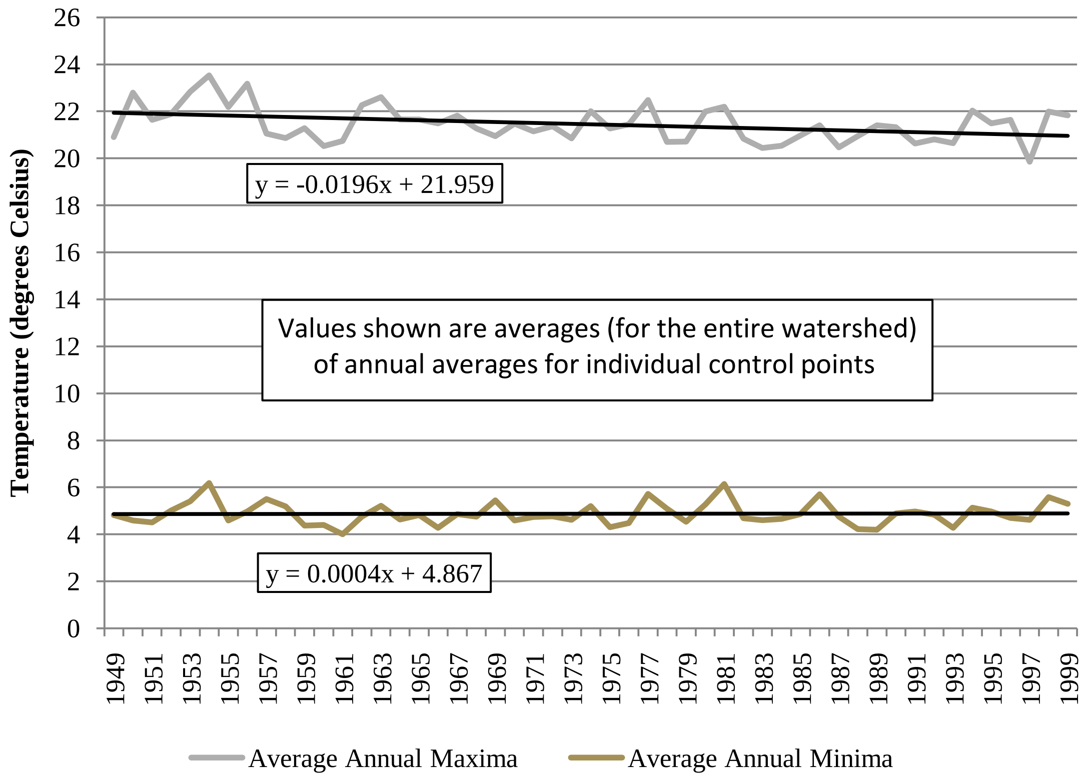

Figure 8. Average Annual Maxima and Minima Temperature for Lake Meredith Watershed

3.1.2. Seasonal Trends

The procedures outlined in Section 3.1.1. were applied to analyze trends in the seasonal minima and maxima temperatures. Seasonal temperature values are the averages of monthly values. Seasons were defined as closely to their naturally occurring dates as possible while preserving complete months (i.e. winter = Jan-Mar, spring = Apr-Jun, etc). This definition of seasons has the added benefit of having all seasons occur within the same year.

Time series graphs were plotted for each of the 194 centroids for the 51 year period-of-record. A linear least-squares regression line was then fitted to each time series. The change in temperatures from 1949 to 1999 was calculated from the end points of the regression line. The coefficient of determination (R^2) for these trends is relatively low. The statistical significance of the trend still needs to be evaluated.

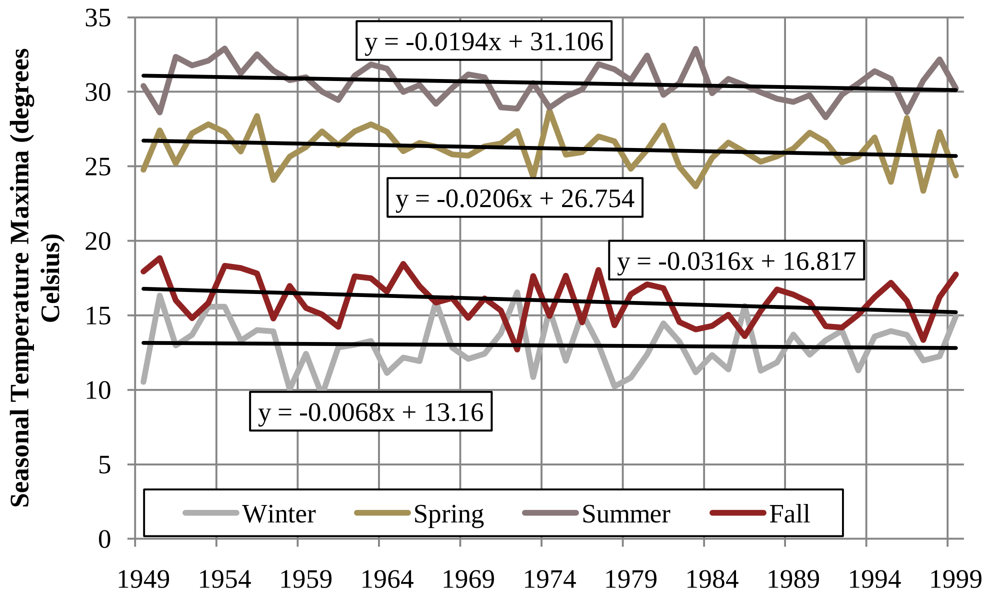

Figure 9. Average Seasonal Maxima Temperature for Lake Meredith Watershed

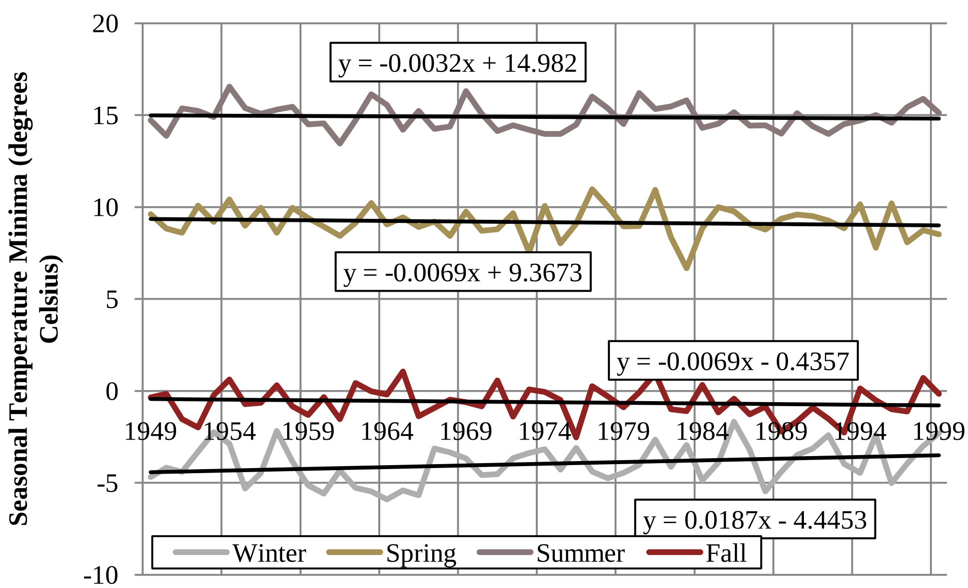

Figure 10. Average Seasonal Minima Temperature for Lake Meredith Watershed

Maps similar to Figures 6 and 7 were generated for average seasonal maxima and minima temperatures. These maps are included in Attachment B.

3.1.3. Range

Mean temperature ranges for each of the 51 years and 194 centroids were obtained by subtracting monthly minima from monthly maxima and averaging them annually and seasonally. Time series graphs were plotted for each of the centroids for the 51 year period-of-record. A linear least-squares regression line was then fitted to each time series of temperature ranges. The change in temperature ranges from 1949 to 1999 was calculated from the end points of the regression line. Basin-wide averages of annual and seasonal changes in temperature range are presented in Table 1.

Table 1. Change in Temperature Range from 1949 to 1999
Annual and Seasonal means for the Lake Meredith watershed

	Annual	Winter	Spring	Summer	Fall
Range	-1.0	-1.3	-0.7	-0.8	-1.2

As can be seen in Figures 6 through 8, both the maxima and the minima annual temperatures are decreasing over significant portions of the Lake Meredith watershed but the maximum temperature is decreasing more rapidly than the minimum. As a result, the annual mean temperature range is decreasing with time. While all seasons show decreases in temperature ranges, winter and fall show the most pronounced decreases.

3.1.4. Three and Five Year Moving Averages

Figure 11 shows the 3 and 5 year moving averages for annual maxima temperature.

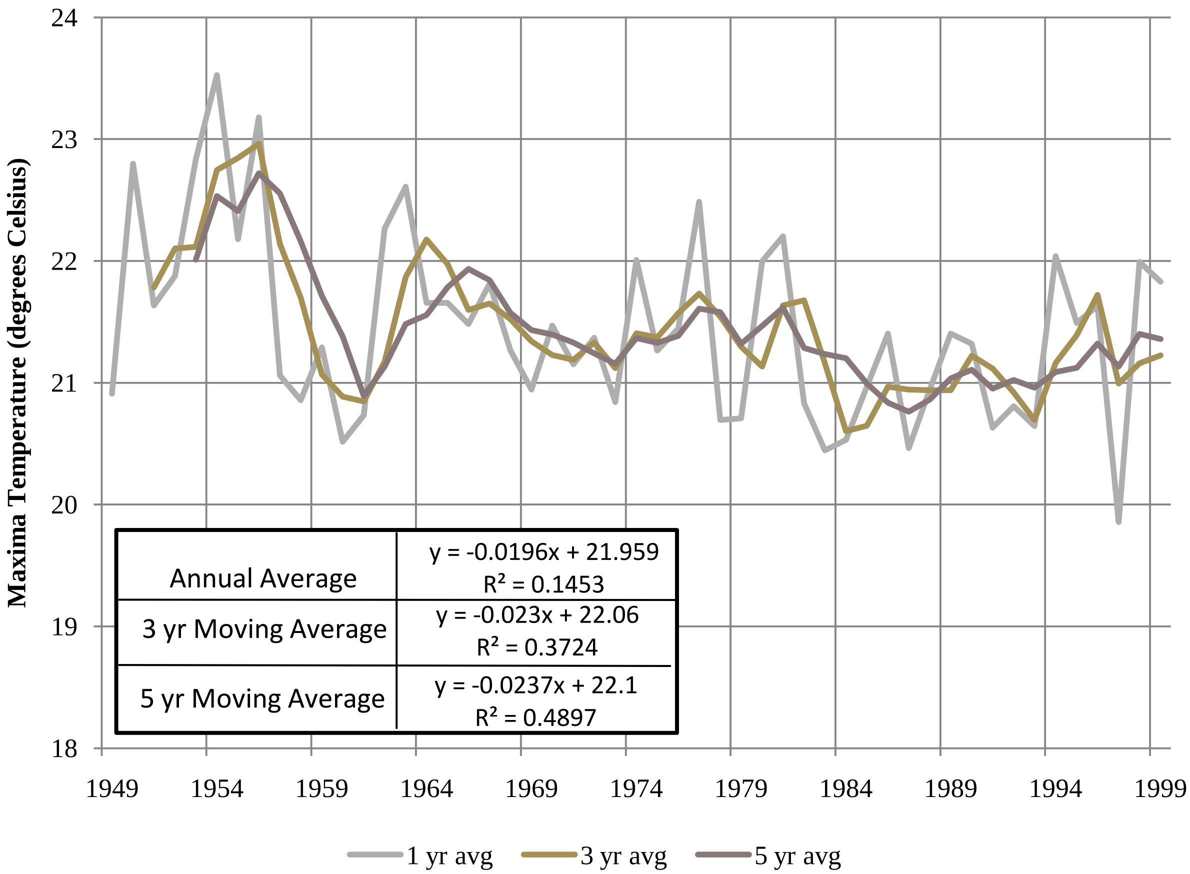

Figure 11. Three and Five Year Moving Averages for Maxima Annual Temperature

3.1.5. Temperature Trend Conclusions

The annual maxima temperature has decreased throughout the entire watershed with the most rapid decreases occurring in the central-western portion. The annual minima temperature has decreased in the northwestern and southwestern portions of the watershed and increased in the center and eastern portions of the watershed. On average, the average annual maxima have decreased around 1 degree Celsius in the Lake Meredith watershed while the average minima have changed very little.

Air temperature affects the rate of evaporation. Hamon (1961) derived an equation for calculating potential evapotranspiration that depends only on air temperature and hours of daylight. The Hamon Equation is expressed as

$$ET = 0.55D^2\left(\frac{4.95e^{(0.062T_a)}}{100}\right) \quad (8)$$

where ET is potential evapotranspiration (inch/day), D is the hours of daylight for a given day (in units of 12 hrs) and Ta is the daily mean air temperature (°C) (Xu and Singh, 2001). Daylight is a function of latitude and day of the year (Forsythe et al, 1995). The ratio on the right hand side is the saturated water vapor density term which is defined as a function daily mean air temperature (°C). As can be seen in the Hamon equation, with lower average temperatures we would expect lower rates of evaporation.

3.2. Precipitation Trends

This section presents a statistical analysis of the historical annual precipitation in the watershed of the Canadian River between Logan and Amarillo. The analysis was divided in three groups:

- Basic statistics
- Trend analysis
- Persistence analysis

Historical precipitation records were obtained from the Cooperative Extension Network operated by the National Oceanography and Atmospheric Administration (NOAA) for 191 gages around the study area. These gages are shown in Figure 12.

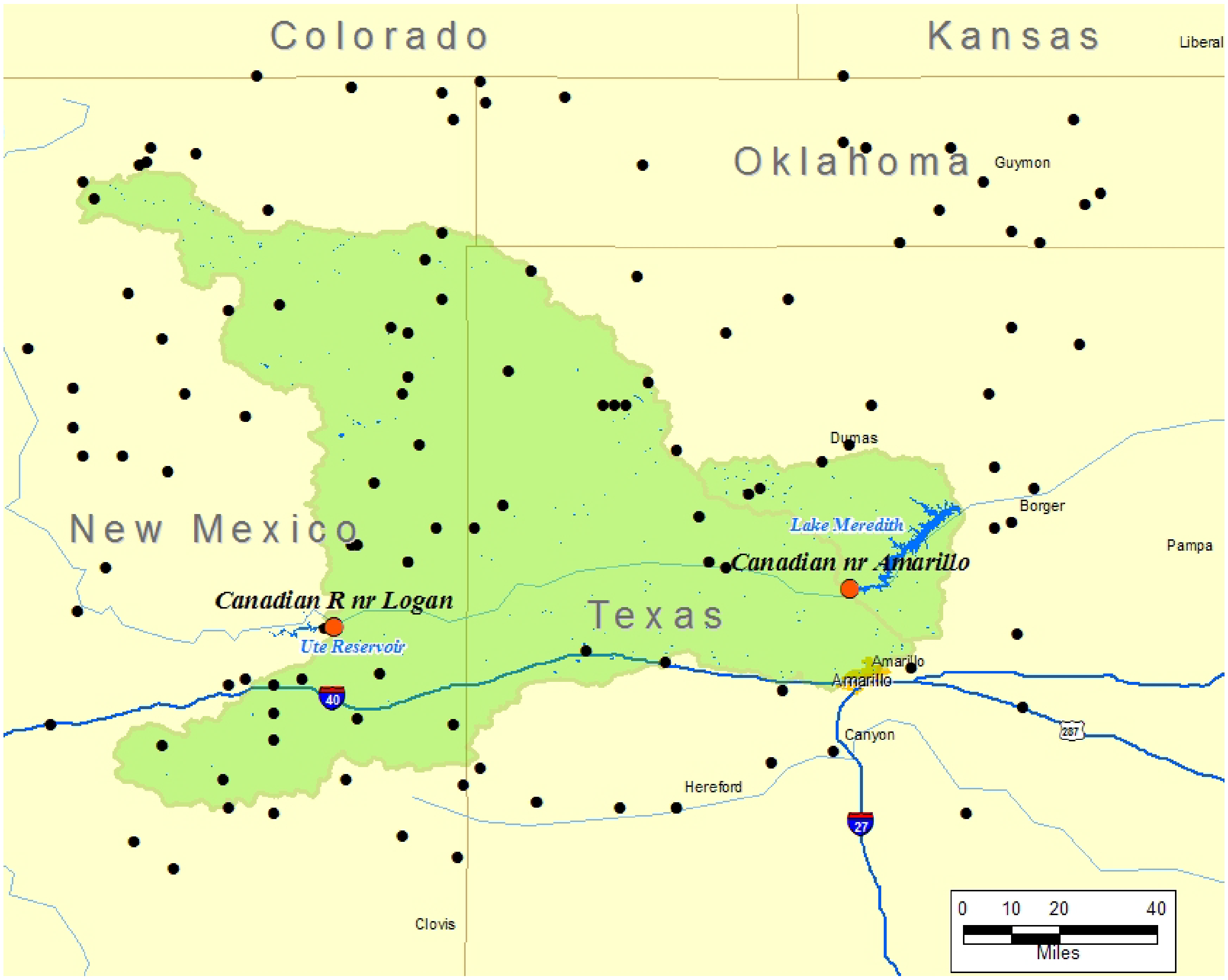

Figure 12. Location of 191 Stream Gages around the Study Area

Most of the gages have short period of record or have multiple missing periods. Only a few gages have multiple decades of continuous records. Two gages have records as early as 1904. For purposes of the development of the statistical analysis of precipitation, 21 gages with a period of record of 50 years or more were selected. Although the records are mostly complete, the selected 21 gages have a few missing days or months. Data for nearby gages were used to fill in missing values for the selected 21 gages.

3.2.1. General Description of Historical Precipitation

The methodology and results for the calculation of historical precipitation are discussed in the following sections.

3.2.1.1. Methodology

The area of study is the Canadian River watershed between Logan and Amarillo and the period of record is 1904-2006. Daily precipitation records were obtained for 122 gages from the National Oceanographic and Atmospheric Administration (NOAA). All of these gages are located within or near the watershed. Records for two gages go back to 1904.

The average annual precipitation was calculated for the geographic region located between latitude N34.75 and N37.00 and longitude W104.50 and W101.25. This region encompasses the entire watershed of interest. A grid was drawn over this region, with lines every 1/8 of a degree. Daily precipitation for the period 1904-2006 was estimated for the corners of the grid using the inverse distance weighted (IDW) average method. The method calculates a weighted average of precipitation using data from nearby gages, where closer gages have more weight than gages far away. After the daily precipitation records were calculated for each corner of the grid, the daily average for the region was calculated as the average of all the points.

The accuracy of the precipitation for each point depends on the number of gages. The number of gages with available records changes from 2 in 1904 to 84 in 1950. After the 1960 decade the number of gages decreases. In 2006, 40 gages were used.

3.2.1.2. Results

Historical annual precipitation in gages in the vicinity of the study area has ranged between 5.5 inches and 44.8 inches. The average annual precipitation in the watershed between Logan and Amarillo is 16.8 inches. This average is calculated based on estimated precipitation across the watershed using the inverse distance weight interpolation method. The average precipitation in the study area increases from west to east. The average precipitation in Conchas Dam, the most western gage, is 14.5 inches while the average precipitation in Spearman, the most eastern gage, is 20.9 inches. Two wet years occurred in 1923 and 1941. Precipitation was remarkably high in 1923 in the southeast corner of the study area when the Claude and

Panhandle gages had a precipitation of 45 and 43 inches respectively (or more than twice the normal rainfall). Precipitation in the western portion was not as high, but was still well above average. In 1941, rainfall had less spatial variability as the precipitation in the area was between 31 and 40 inches. Other wet periods are 1948-1950, 1957-1961, and 1984-1988.

The most severe droughts (in terms of precipitation) occurred during the periods 1933 – 1937 and 1951 – 1956. These periods have three or more consecutive years below normal rainfall. Other less severe droughts occurred between 1962 and 1964, 1973 and 1978, and 2000 and 2003.

Generally, hydrology in the region tends to switch between a period of drought followed by wet years. As is discussed below, a persistence test suggests that a fluctuation between drought and wet years occurs every 3 to 5 years.

3.2.2. Trends in Precipitation

Five gages with more 59 consecutive years of records were selected for a trend analysis. These gages are: Canyon, TX (1924-2006), Conchas Dam, NM (1948-2006), Elkhart, KS (1912-2006), Spearman, TX (1921-2002) and Tucumcari, NM (1905-2006). The existence (or non-existence) of a trend was verified with the following parameters:

- Moving average every 3, 5, 10 and 50 years.
- Correlation analysis with past values

Trends in time series can be identified using a lag-one differential. The lag-one differential obtains a new time series from the difference between two consecutive values. If the mean of this new series is different from zero, then it is likely that the original time series has a trend.

$$Y(t) = X(t+1) - X(t)$$

Detailed trend analyses, including the moving averages and correlation with past values, are shown in Attachment C. Analysis of moving average and correlation with past values do not identify any significant trend of precipitation over time for the gages at Canyon, Elkhart, Spearman, and Tucumcari. The annual precipitation at Conchas Dam exhibits an increasing trend of precipitation over time of 0.09 inches per year.

3.2.3. Persistence Analysis

Persistence of annual precipitation is the correlation of the precipitation at any given year with its immediate past values. If a precipitation series has persistence, the annual precipitation in the current year is somewhat dependent on the precipitation during one or more preceding years. For example, if a region is experiencing a drought, the probability that the next year will be dry is higher than the probability of having a wet year. In contrast, during a wet spell, the probability of a wet year is higher than the probability of a dry year. It is very common for hydrologic series to have persistence.

Hydrologic variables such as annual precipitation may have persistence, also known as autocorrelation. Persistence reflects the degree of dependency on previous values. For example, if a year is dry, a dry year has more probability to follow than a wet year, and a several consecutive years may follow until a wet year occurs. When a wet year occurs, there is some probability of a starting a series of consecutive wet years. As a result, the series may have a tendency to fluctuate between wet and dry periods.

Persistence is usually measured by autocorrelation. Autocorrelation is a standard correlation coefficient of the series with its own past values. A lag-time needs to be defined to calculate the autocorrelation. For example, a lag-one autocorrelation is the correlation of today with yesterday. A lag-two autocorrelation is the correlation of today with the values 2 days ago, and so on. One can plot the autocorrelation values of lag-n versus n. This graph is called the autocorrelogram. The autocorrelogram can be useful for determining cycles in time series. For example, in monthly data that reflect yearly seasonality, the lag-12 is higher, which indicates a cycle occurs every 12 months. In this example, this result is somewhat obvious. But if the length of the cycle is unknown, the length of the cycle in the autocorrelogram may provide a hint. The autocorrelogram was calculated for the annual average precipitation in the study area.

In this study, persistence was evaluated with two parameters:

- Correlation coefficients with past values (plotted in a graph called correlogram)
- Conditional frequency duration curves

The analyses were performed for the same 5 gages used in the trend analysis and are presented in Attachment C. This analysis did not identify any large persistence in the hydrologic series.

3.2.4. Trends in Rainfall Intensity

While rainfall totals have remained relatively constant, rainfall events in recent years may lack the intensity and duration needed to generate significant run-off. The purpose of this section is to verify whether such a trend can be observed in daily precipitation data from the region.

The analysis of rainfall intensities uses four of the gages used in the previous trend analyses: Tucumcari, NM (1905-2006), Canyon, TX (1924-2006), Spearman, TX (1921-2002) and Elkhart, KS (1912-2006). The analysis is performed by applying trend detection techniques to the average number of rainy days (precipitation > 0 in.) per year and the average rainfall intensity (in/day) per rain day. The techniques involve plotting a trendline using linear least-squares regression to determine the rate of change and average deviations from the trendline. The linear correlation coefficient (r) is used to detect correlations between rainfall intensity or number of days and the year. Statistical significance is determined using the nonparametric Mann-Kendall test.

The results of the analyses are shown in Tables 2 and 3. In Table 2, the rate of change (i.e. the slope of the trendline) for the number of rainy days per year is positive for all gages. The slope is less for the Elkhart gage. This implies an increasing trend. The average deviation from the trendline is consistently around 10 days, with the exception of the Elkhart gage (8.7 days). The Linear Correlation Coefficient shows positive correlations between the years and the number of days with rain, which means that as years advance, the number of days of rain per year increases. This increasing trend in the number of rainy days has a greater than 99% confidence level for Tucumcari, Spearman, and Elkhart.

In Table 3, the rate of change for rainfall intensity is negative for all gages. The slope is less for the Elkhart gage. This implies a decreasing trend in rainfall intensity. The average deviation from the trendline is consistently around 0.06 in/day. The Linear Correlation Coefficient shows negative correlations between the years and rainfall intensity, which means that as years advance, rainfall intensity decreases. This decreasing trend in rainfall intensity has a greater than 95% confidence level for Tucumcari, Canyon, and Spearman. No clear trend exists for the Elkhart gage.

Table 2. Trends in the Average Number of Rainy Days per Year

	Rate of Change (days/yr)	Average Deviation from Trendline (+/-)	Linear Correlation Coefficient (r)	Significance Level
Tucumcari	0.1853	9.7969	0.4104	99.998
Canyon	0.1213	10.1951	0.2217	94.800
Spearman	0.1684	9.8902	0.2964	99.609
Elkhart	0.0968	8.7000	0.2242	99.682

Table 3. Trends in the Average Annual Precipitation Intensity

	Rate of Change (in/day/yr)	Average Deviation from Trendline (+/-)	Linear Correlation Coefficient (r)	Significance Level
Tucumcari	-0.0011	0.0639	-0.3435	97.323
Canyon	-0.0011	0.0626	-0.3021	98.212
Spearman	-0.0012	0.0609	-0.3563	99.680
Elkhart	-0.0003	0.0593	-0.1133	47.330

The return interval for high intensity rain events (>2 in/day) was also considered. Preliminary results are based on an analysis of four gages: Amarillo WSO Airport, TX (1948-2006), Pasamonte, NM (1948-2006), Bravo, TX (1948-2006), and San Jon, NM (1948-2006). The analysis looked at the number of days between high intensity rain events. Amarillo, Pasamonte and Bravo gages show increasing trends in the number of days between heavy rain events. This pattern does not hold true for the San Jon gage. The statistical significance of these trends still needs to be evaluated.

3.2.5. Precipitation Trend Conclusions

Precipitation data was collected from five gaging stations near the Panhandle, with a maximum period-of-analysis from 1905-2006. During this period, the average number of rain days has shown a more significant positive trend than total precipitation. Consequently, rainfall intensity has a negative trend. There also appears to be an increasing interval between significant rain events (large storms).

4.0. GROUNDWATER – SURFACE WATER INTERACTIONS

The objective of this section is to analyze trends in groundwater levels and determine if correlations exist between historical trends in the rainfall to runoff ratio and groundwater. If changes in groundwater levels are affecting spring flows, they could be contributing to the decline in inflow to Lake Meredith. Trends in historical groundwater levels in the Northern Ogallala aquifer were evaluated using modeled potentiometric head surfaces developed by Dutton (2004). Changes in groundwater levels for the Dockum aquifer were estimated using well data and water levels reported to the TWDB.

4.1. Change in Groundwater levels in the Ogallala

The analysis of groundwater levels in the Northern Ogallala uses the dataset developed by Dutton (2004) to determine the extent to which groundwater levels have changed since 1950. For more information on how the dataset was developed, please refer to the study. The change in groundwater levels from 1950 to 1998 is presented in Figure 12. The map was generated by subtracting the potentiometric head surfaces in 1950 from the head surfaces in 1998. Where the value is positive, groundwater levels have risen since 1950. Where the value is negative, groundwater level have dropped by the amounts indicated in the legend. Moore County experienced the greatest decreases since 1950 (decreases of up to 200 ft). Sherman, Dallam, Carson, Hartley, Hutchinson, and Hansford Counties experienced draw-downs of up to 120 ft. The other counties of the PWPA experienced less significant drawdowns.

There are three named springs within the Lake Meredith watershed that overlie the Northern Ogallala aquifer: Bravo Springs, XIT Springs, and Alibates Springs. The flow in these and surrounding springs could be affected by decreases in groundwater levels in the Northern Ogallala.

The Bravo Springs are located in the northwest corner of Oldham County where draw-downs over the past 50 years have not exceeded 20 ft. For this reason, significant reductions in spring flow at this site due to decreased groundwater levels are unlikely. The flow in Bravo Springs was 1.1 liters per second (lps) on June 22, 1971 and 1.4 lps on May 4, 1977 (Brune, 1981). The XIT Springs are located in Hartley County, approximately 9 miles to the southwest of Hartley, Texas. While water levels have changed only slightly since 1950 underneath the spring itself, draw-downs of up to 120 feet have occurred around Hartley. The flow in this spring could be affected by pumping groundwater. Flow in the XIT Springs was probably larger and continuous in the 19th century. By 1981, however, flow in the springs ceased for three or four months out of the year due to irrigation pumping (Brune, 1981). Alibates Springs are located in the northwest corner of Potter County and may be affected by areas of increased draw-down within 10 miles to the southwest.

4.2. Changes in Groundwater Levels in the Dockum

Changes in historical water levels in the Dockum Aquifer could be contributing to declining lake levels in Lake Meredith. The Dockum aquifer lies beneath much of the Meredith watershed and is the only aquifer present beneath the Canadian River. The break in the Ogallala corresponds with a Dockum outcrop.

The following information was used to build a dataset of water levels in wells drawing from the Dockum Aquifer:

1) Text file containing well information from TWDB website
2) Text file containing historical water levels from TWDB website

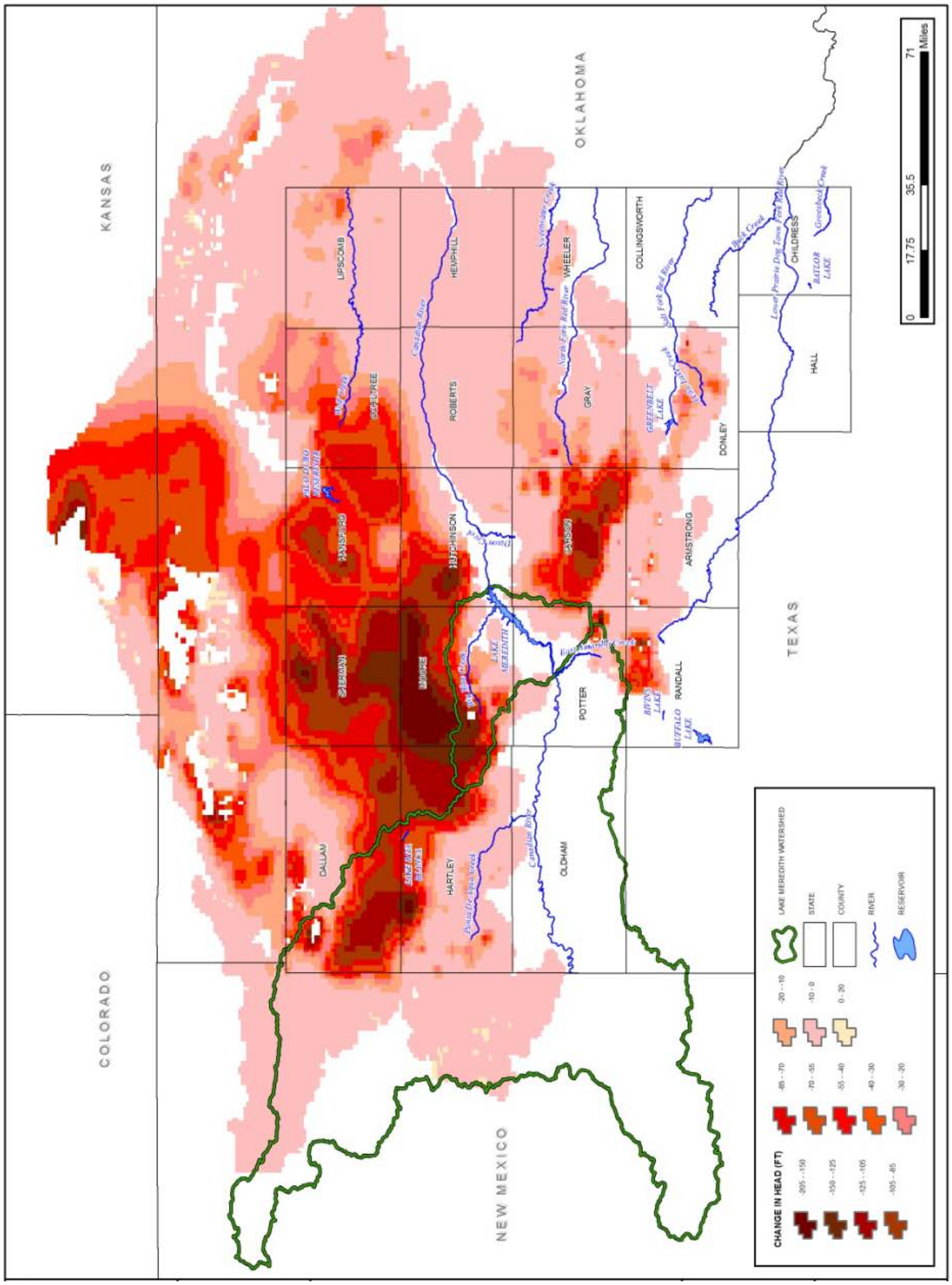

Figure 12. Change in Groundwater Levels in the Ogallala Aquifer from 1950 to 1998.

The text file containing well information includes data on latitude, longitude, and land surface elevations at each well. Historical water levels are reported as depth from land surface. Water levels were determined by subtracting the depth to water surface from the land surface elevation. Next, decadal averages were calculated for the water level in each well. The average water levels were appended to the well records and the wells were added to ArcMap using the XY coordinates.

The wells chosen for this study comply with the following criteria:

Identified by the TWDB as being drilled in one of the formations listed in Table 4.

… or ….

Located within the Ogallala break

… and …

Located within the Lake Meredith watershed or within 35 miles of its boundary.

Table 4. Dockum and Dockum Related Formations

CODE	**FORMATION**
100CPDG	CENOZOIC PECOS ALLUVIUM AND DOCKUM FORMATION
100CPDR	CENOZOIC PECOS ALLUVIUM, AND DOCKUM AND RUSTLER FORMATIONS
110AVDK	ALLUVIUM AND DOCKUM FORMATION
121OGDK	OGALLALA FORMATION AND DOCKUM FORMATION
218ASDG	ANTLERS SAND AND DOCKUM FORMATION
218EDAD	EDWARDS AND ASSOCIATED LIMESTONES, ANTLERS SAND, AND DOCKUM FORMATION
231DCKM	DOCKUM FORMATION
231DCKP	DOCKUM FORMATION AND PERMIAN ROCKS

Seven hundred twenty-one (721) wells with a total of 4,633 records meeting the criteria above were identified. These records span a period of time from pre-1950s to 2009. Table 5 shows the distribution of wells and well records by decade.

Table 5. Number of Wells and Well Records meeting the Criteria Above

Decade	Number of Wells	Number of Well Records
1950-1959	37	55
1960-1969	231	483
1970-1979	299	806
1980-1989	327	1079
1990-1999	145	862
2000-2009	186	1345

Potentiometric head surfaces were developed on a decade by decade basis using the Ordinary Kriging interpolation method with a spherical semivariogram model. Kriging is an advanced geostatistical technique that is used in hydrogeology to interpolate groundwater levels at any point of the area of analysis based on the available well data (Sun et al, 2009). For example, the head surface map for the 1960s was estimated using the kriging interpolation method based on the 483 well records between 1960 and 1969. For more information, please consult the extensive body of work on kriging as a method of interpolation in GIS (Heine, 1986; Oliver, 1990; McBratney and Webster, 1986).

In order to determine the change in head surfaces between decades, the head surface from the earlier decade is simply subtracted from the head surface of the later decade. Data from the 1950s was not used in this analysis because greater modeling uncertainties are introduced by the limited well data. The estimated change in head surfaces from 1960 to 2009 in the Dockum aquifer is shown in Figure 13. It can be seen in Figure 13 that the area of greatest drawdown occurs below Lake Meredith and the 30 miles of the Canadian River leading up to the reservoir. According to this analysis, groundwater levels have dropped by more than 250 ft in some areas of the watershed since the 1960s.

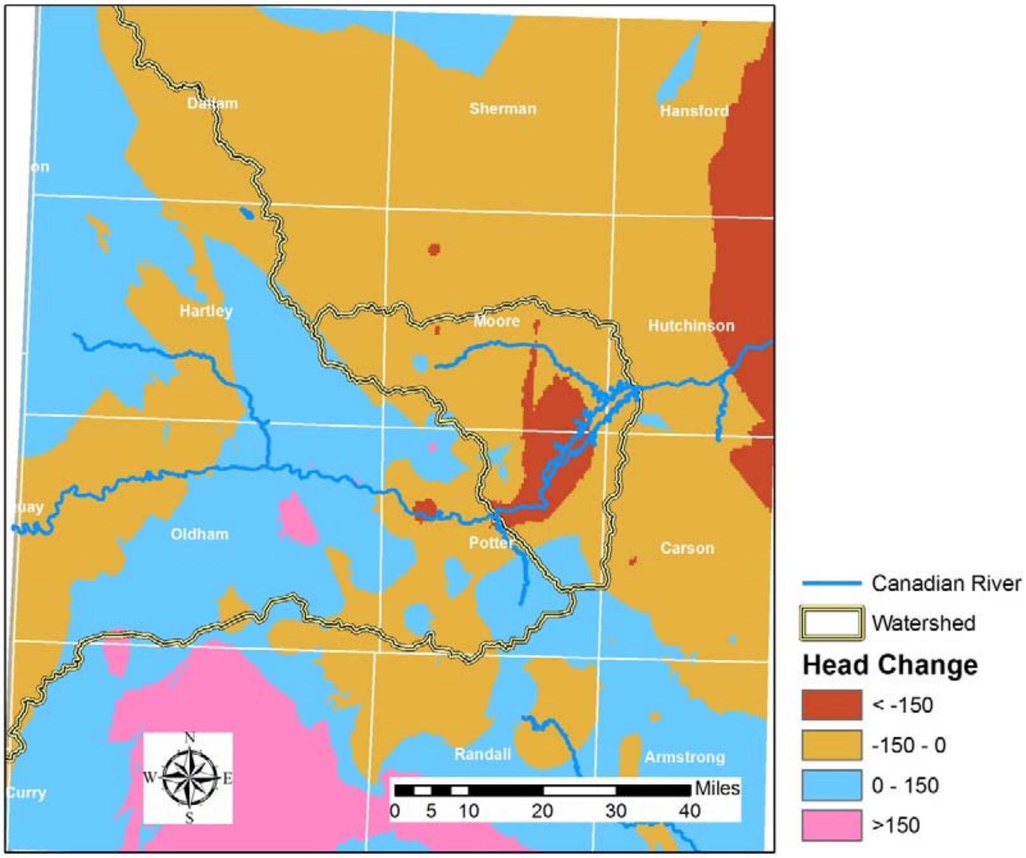

Figure 13. Estimated change in potentiometric head surfaces from the 1960s to the 2000s.

Differences in Dockum groundwater levels between successive decades were also considered. The metrics used to assess the change in groundwater levels are the Mean Absolute Relative Error/Difference (MARE), the Mean Relative Error (MRE), and the percent of the Canadian River (considering the 125 miles between the Texas border and Sanford Dam) that the previous decade water levels were higher than the later decade.

The mean absolute relative error (MARE) is calculated using Eq. 9 (Dawson et al., 2007).

$$MARE = \frac{100}{n}\sum_{i=1}^{n}\frac{\left|Q_i^o - Q_i^s\right|}{Q_i^o} \tag{9}$$

Where n is the number of data points, Q_i is the groundwater level at point *i* along the Canadian River, Q^o is the groundwater level in the earlier decade, and Q^s is the groundwater level in the later decade. MARE is a non-negative metric with no upper bound. In this study, the MARE is used to describe the change in groundwater levels between decades. A value of zero for MARE would mean there is no change in groundwater levels between decades. Because the metric uses the absolute difference between simulated and observed values, it is not as sensitive to large errors as the difference squared. The mean absolute error (MAE) may also be used for this type of assessment.

The MRE is formulated in a way similar to Eq. 9 except that the signed value of the difference between decades is taken instead of the absolute value. When MRE is positive, the earlier decade is greater than the later decade. When MRE is negative, the opposite is true. It is used in conjunction with the MARE because negative and positive errors will cancel each other out, so it is possible to approach zero even when successive decades are not similar.

Table 6 shows that the two successive decades with the greatest differences in groundwater levels are the 1960s and the 1970s. Differences between the 1990s and 2000s are also large in comparison to other decades. This suggests that the rate of drawdown has increased in recent years. A plot of historical storage contents in Lake Meredith is shown in Figure 2. Historical streamflow at the Amarillo gage is shown in Figure 3. It is possible to see in Figures 2 and 3 that while streamflows and storage levels may have been declining for the past few decades, it was not until around 2000 that a precipitous decline is observed. This could be related to the increasing draw down in Dockum water levels during the same period of time.

Table 6. Differences in Dockum Groundwater Levels between Successive Decades

Time Period	MARE	MRE	% of river with earlier decade higher than later decade
1960s - 1970s	3.217	2.601	85
1970s - 1980s	2.202	-1.629	38
1980s - 1990s	1.782	-0.916	41
1990s - 2000s	2.074	1.684	64

4.3. Base Flow Analysis

A preliminary analysis of base flows was also conducted. Base flows enter stream channels from groundwater. It is the portion of stream flow attributable to groundwater and not runoff. Base flow separation techniques use gaged stream flows to derive a base flow signature. Two commonly-used techniques are the recursive method and the local minima method.

The Local Minima Method compares the slope of the hydrograph and connects the points located at local minima (Lim et al., 2005). The recursive method separates base flow based on the assumption that the outflow from an aquifer is proportional to its storage (Eckhardt, 2005).

The results of applying these methods to stream flows at the Amarillo gage are presented in Figures 14 and 15. Implementation of these methods was facilitated using the Web-based Hydrograph Analysis Tool (WHAT) developed at Purdue University.

At least two observations can be made from Figures 14 and 15: 1) base flows contribute a considerable amount of water to stream flows in the Canadian River, and 2) base flows exhibit a decreasing trend (as total stream flows also do as shown on Figure 3).

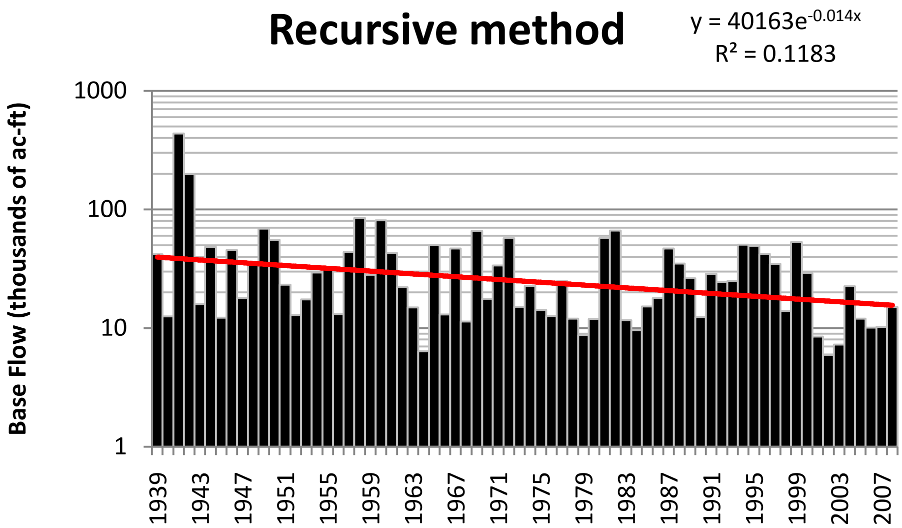

Figure 14. Base Flows as determined using the Recursive Method

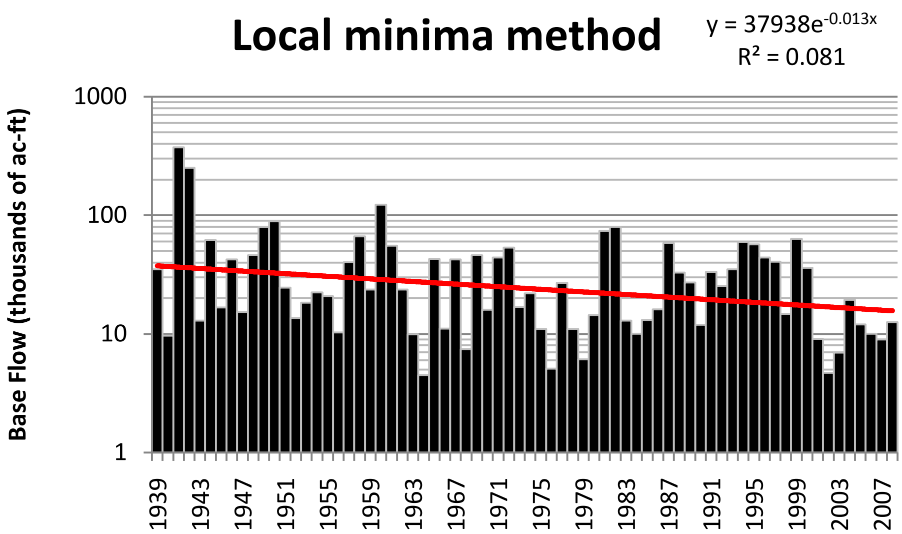

Figure 15. Base Flows as determined using the Local Minima Method

The tremendous variability in base flows seen in Figures 14 and 15 is likely an artifact of the separation techniques, which are based entirely on gaged flows. Other base flow separation methods should be investigated. Adjustments can be made to account for releases from Ute Reservoir, which may be mistakenly identified as base flow.

4.4. Groundwater Conclusions

There have been declining groundwater levels in the aquifers within the Lake Meredith watershed. Base flows are shown to be declining from approximately 40,000 acre-feet per year to less than 20,000 acre-feet per year. Spring flows likely have been affected by changes in groundwater levels, but in areas with known springs the groundwater draw downs have not been significant. Also, the areas with the largest draw downs in the Ogallala aquifer tend to coincide with the non-contributing portions of the watershed. Changes in historical water levels in the Dockum aquifer appear to be the greatest along the Canadian River near Lake Meredith. Groundwater levels have dropped by more than 250 ft in some areas of the watershed since the 1960s. The decline in inflows to Lake Meredith could be related to draw downs in Dockum water levels during same period of time. However, the reductions in groundwater base flow contributions are only a fraction of the observed decline in stream flows.

5.0. LAND USE

Changes in land use and land cover can have important implications for watershed hydrology. Additional crops or the expansion of brush lands can increase hydrologic losses due to transpiration and interception. Land cover can also affect the rate of infiltration. Increased surface water impoundments, changes in diversions and return flows, and consideration of non-contributing areas are also relevant.

5.1. Changes in Land Use through Time

Land use records from 1967 to 2001 were examined for the Lake Meredith watershed. The objective of this study is to analyze changes in land use to determine if correlations exist between historical trends in the rainfall to runoff ratio and land cover. Changes in historical land use were evaluated using land cover datasets developed for the following years: 1967 (Marschner and Anderson, 1967), 1970 to 1985 (Price et al., 2006), 1992 (Vogelmann et al., 2001), and 2001 (Homer et al., 2007). For more information on how each dataset was developed, please refer to the individual studies.

An important caveat of this analysis is that the datasets were developed at different scales and use distinct classification schemes which discourage comparisons. That said, generalized trends can be extracted from the data if each dataset is reclassified into more general land use categories (e.g. combining Commercial, Industrial and Residential uses into one Urban land use category). The 1967 dataset was developed at the smallest scale (i.e. 1:7,500,000) and uses the most general land use categories. Consequently, the 1967 dataset largely governs the scale and classification scheme of the analysis.

Land use maps for the four years are presented in Attachment D. Since 1967, four land use classes have occupied 99% of the land in the Lake Meredith watershed: Urban, Agriculture, Grassland, and Shrubland. On average, these land use classes occupy 1%, 13%, 69%, and 16% of the watershed, respectively. Graphs of how the percentage of total watershed area occupied by each class has changed through time are presented in Figures 16 through 19.

Several trends are apparent from Figures 16 through 19. The percent of total watershed area occupied by urban areas has increased roughly 1%. The area occupied by agricultural land has decreased by around 9%. Grasslands have decreased by around 17% and shrublands have increased roughly 24%. In Figure 16, the drop in Urban land class in 1992 (or conversely, the increase in 2001) is because the mapping technique used for the 2001 dataset resulted in the identification of more roads than could be identified in 1992 dataset.

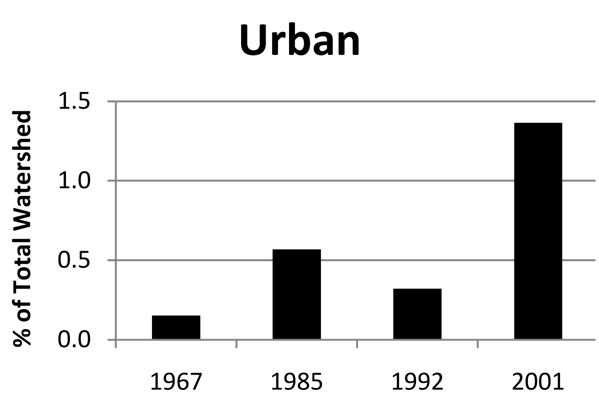

Figure 16. Percentage of watershed area designated as Urban

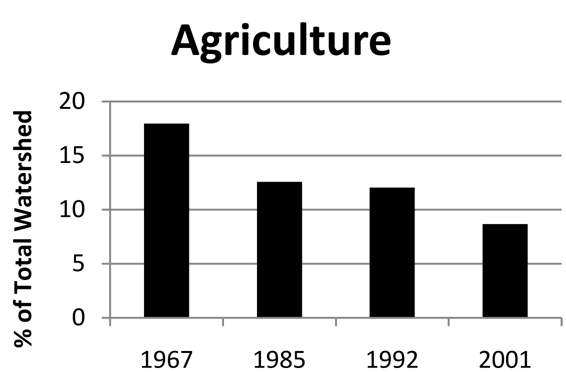

Figure 17. Percentage of watershed area designated as Agricultural

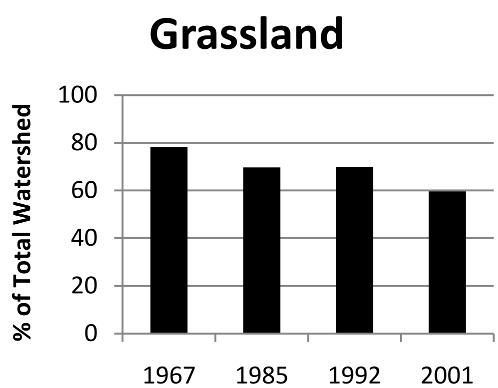

Figure 18. Percentage of watershed area designated as Grassland

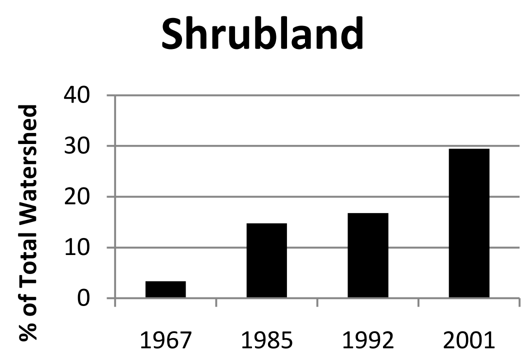

Figure 19. Percentage of watershed area designated as Shrubland

Figures 17 and 18 show that the percent of watershed area occupied by agricultural lands and grasslands has decreased since 1967. Figures 16 and 19 show that the area occupied by urban areas and shrublands has increased since 1967.

According to the reclassification used in this analysis, agricultural land was being lost to grasslands at a rate of 20 square miles per year up to 1992. Around 85% of the grasslands being lost are converted to shrublands. Much of this shrubland is associated with invasive species such as salt cedar. Roughly 90% of the new shrubland is replacing grasslands and mixed forest. Expanding urban areas are replacing grasslands and agricultural lands.

In short, agricultural lands have decreased by 9% and are generally being replaced by grasslands. Grasslands have decreased by 17% and are generally being replaced by shrublands. Shrublands have increased by around 24% and are generally replacing grasslands. Urban areas have increased by about 1% and are generally replacing both agricultural lands and grasslands. These trends appear to be consistent with natural succession.

The increase in shrublands (salt cedar) is occurring primarily in the southwestern portion of the watershed and along the Canadian River. This part of the watershed typically experiences less rainfall (between 14 and 17 inches per year) compared to other areas (see Section 3.2.). Brush management strategies are typically more effective in areas with greater rainfall (Hibbert, 1983). Significant expansion of shrubland has also occurred along the Canadian River and the watershed area draining directly to Lake Meredith as shown on Figure 20.

a. **b.**

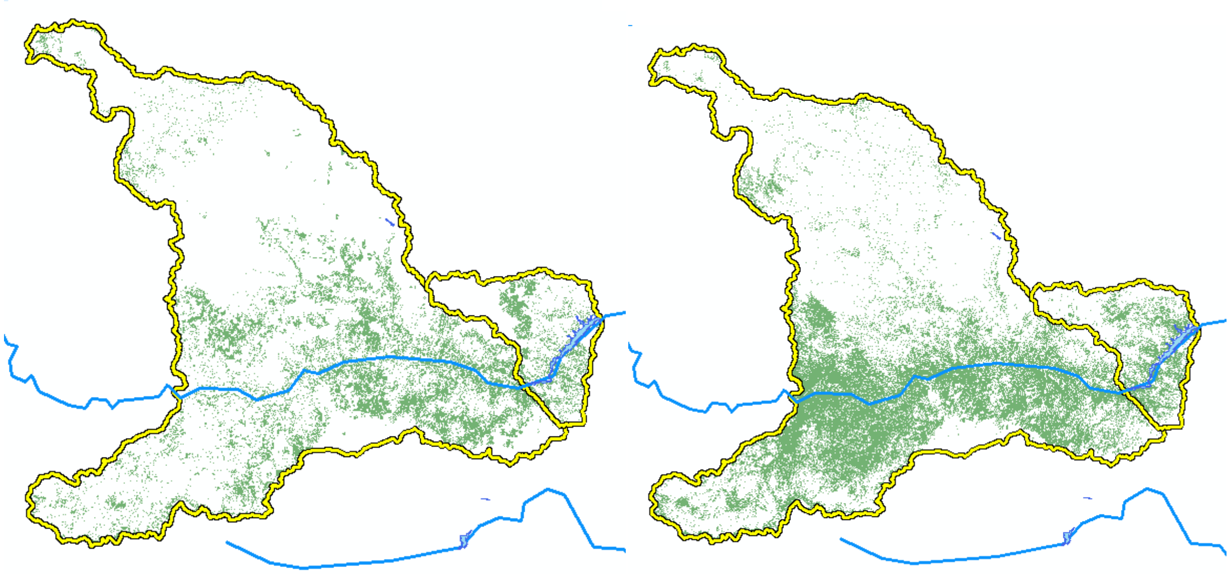

Figure 20. Comparison of the Extent of Shrubland between 1992 (a) and 2001 (b).

The analysis presented in Figure 18 for shrubland was rerun considering only contributing areas of the watershed. Figure 21 show that the results have changed. Since 1967, shrubland in the contributing areas of the watershed has increased from less than 5% to nearly 35%. If the same exercise were repeated for agricultural areas, the percentages displayed in Figure 17 would be considerably less.

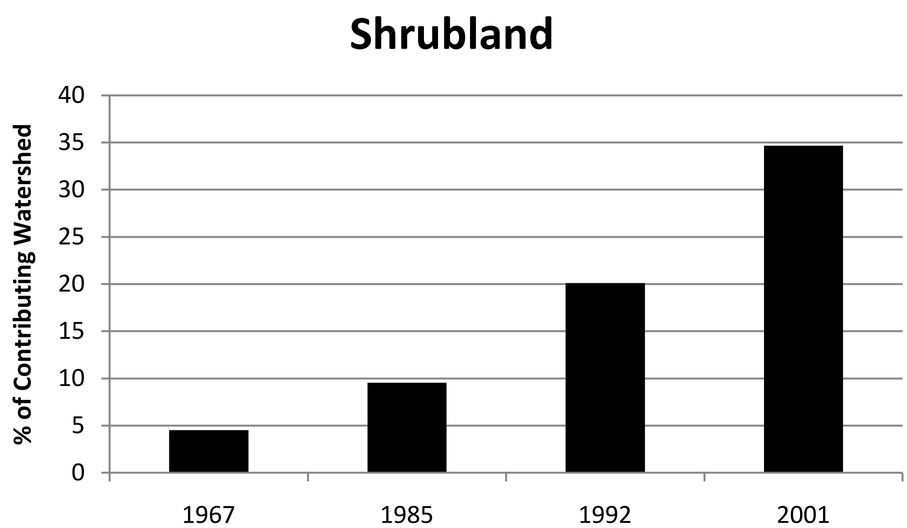

Figure 21. Percentage of Contributing Watershed Area designated as Shrubland

5.2. Surface Water Impoundments

This study also considered an increase in surface water impoundments as a possible explanation for declining lake levels. The national inventory of dams was used to generate Figures 22 and 23. Figure 22 shows the location of small dams within the watershed. Figure 23 shows the cumulative capacity of each dam and the year it was built. For example, if the first dam was built in 1940 and had a capacity of 100 ac-ft, the cumulative capacity in 1940 would be 100 ac-ft. If the second dam was built in 1941 and had a capacity of 150 ac-ft, the cumulative capacity in 1941 would be 250 ac-ft.

The total amount of water impounded by small dams since 1940 is around 10,000 ac-ft, which by itself is not sufficient to explain the losses in stream flow. Impoundment of surface water by small dams is likely playing a limited (but not negligible) role in declining stream flows.

This analysis considers impoundment by small dams listed in the national inventory. There were no historical and geographical data on development of small impoundments that are not listed in the national inventory (livestock ponds, some SCS structures and others). One indicator of the potential for development of livestock ponds is the historical livestock water demands available through the TWDB. These demands are developed based on the number of livestock and the need for water. Some of the water is met through groundwater sources and some through the development of small impoundments. The data show that there has been an increase in livestock demands in Hartley County from approximately 2,200 acre-feet per year demand in 1974 to a maximum demand of over 6,000 acre-feet per year in 1997. The other counties within the Lake Meredith watershed show only slight increases in demand. While small impoundments are likely increasing in the watershed, these changes probably are not causing the significant decreases in runoff observed today.

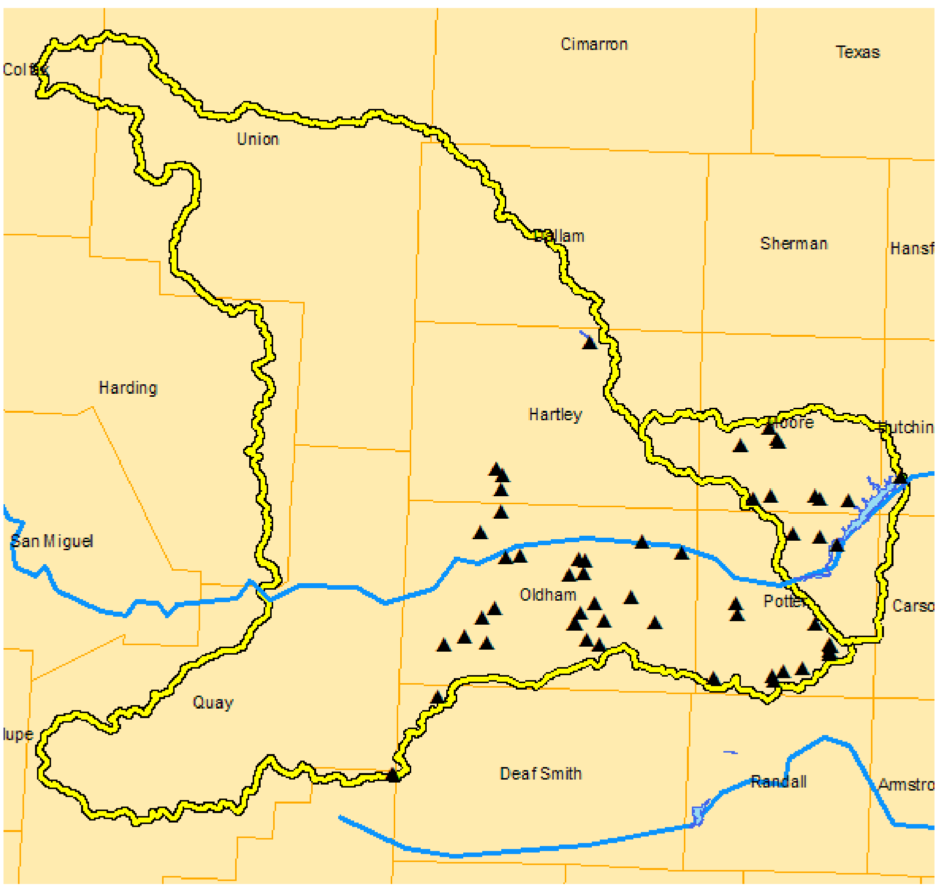

Figure 22. Location of Small Dams in Lake Meredith Watershed

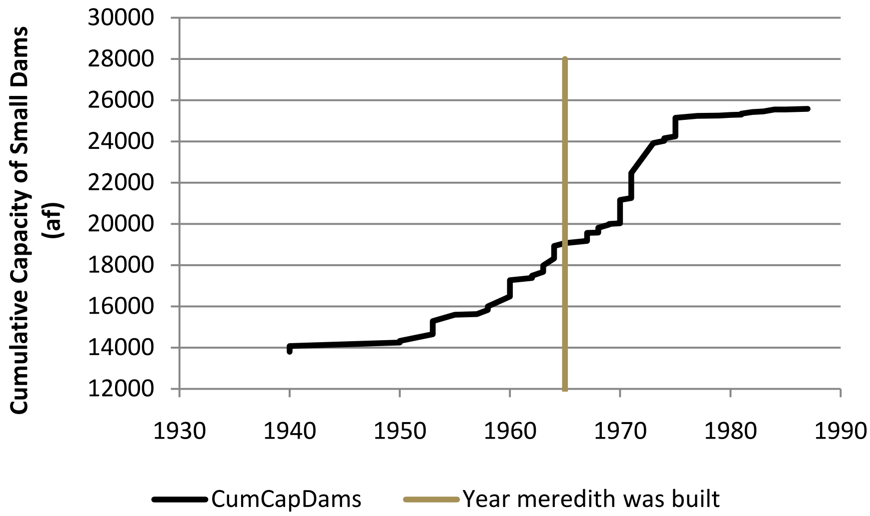

Figure 23. Cumulative Capacity of Small Dams in Lake Meredith Watershed

5.3. Changes in Diversions and Return Flows

Changes in water use, including diversions and return flows, were considered in this study. A review of the Canadian River WAM Run 8 (current conditions) reveals that water rights for diversions made at locations besides Lake Meredith total less than 2,000 ac-ft per year. Return flows made at locations other than Lake Meredith are less than 300 ac-ft per year. Because the magnitude of these water use patterns is so small, it was determined that no further investigation was required because any historical changes to the pattern would be unlikely to affect Lake Meredith.

5.4. Land-Use Conclusions

The major land use change in the Lake Meredith watershed appears to be an increase in shrubland (salt cedar), especially within the contributing areas of the watershed. Changes in agricultural lands and irrigation practices likely have minimal impacts to surface water runoff because most of these lands are located in the non-contributing areas of the watershed. Total impoundments have increased over time and will impact runoff. However, the storage volumes in these impoundments stabilized in the 1970s and are likely not a major contributing factor to the precipitous declines in runoff observed in the last decade.

6.0. SUMMARY AND CONCLUSIONS

The study confirmed that the Lake Meredith watershed is losing its ability to generate runoff and stream flow to the Canadian River. The greatest increase in hydrologic loss occurred in the 1950s with another major increase in the last decade (1997–2006). There appears to be no one factor or event causing the decline of inflows to Lake Meredith. Analyses of climatic factors show little to no change in annual precipitation and decreasing temperatures. Rainfall intensities are declining over time and significant rainfall events (>2 in/day) appear to be occurring less frequently. Groundwater levels are declining in both the Ogallala and Dockum aquifers. Base flows in the Canadian River also show declining trends. The decline in base flow is less than one tenth of the decrease in stream flow at the Amarillo gage since 1939. The largest declines in the Ogallala aquifer coincide with the non-contributing portions of the watershed, while the declines in the Dockum are beneath Lake Meredith and 30 miles upstream along the Canadian River.

Changes in land use include reductions in agricultural and pasture lands, increases in shrubland and increases in small impoundments. Of these changes, the increase in shrubland and decline in pasture land has the greatest potential to impact surface water runoff. The changes in agricultural lands (along with any changes to irrigation practices) are assumed to have minimal impacts to runoff because most of the agricultural lands are located in the non-contributing portions of the watershed. The increases in shrubland will increase evapotranspiration and intercept potential runoff due to increased vegetation.

In summary, annual precipitation, potential evaporation, and changes in irrigation practices do not appear to be contributing factors to the apparent hydrologic loss in the Lake Meredith watershed. Changing trends in the potential contributing factors occur over decades with no significant increase in this last decade. It is likely that the combination of factors, including reduced rainfall intensities, increasing shrubland and declining groundwater levels, have resulted in tipping the hydrologic balance of the watershed to the point that inflows to Lake Meredith (generated below Ute Reservoir) is now about 20 percent of inflows observed in the 1940s. While the activities in the watershed above the Logan gage cannot be ignored with respect to the total amount of inflow to Lake Meredith, this study confirms that changes in the watershed below Ute Reservoir have contributed to reduced stream flows.

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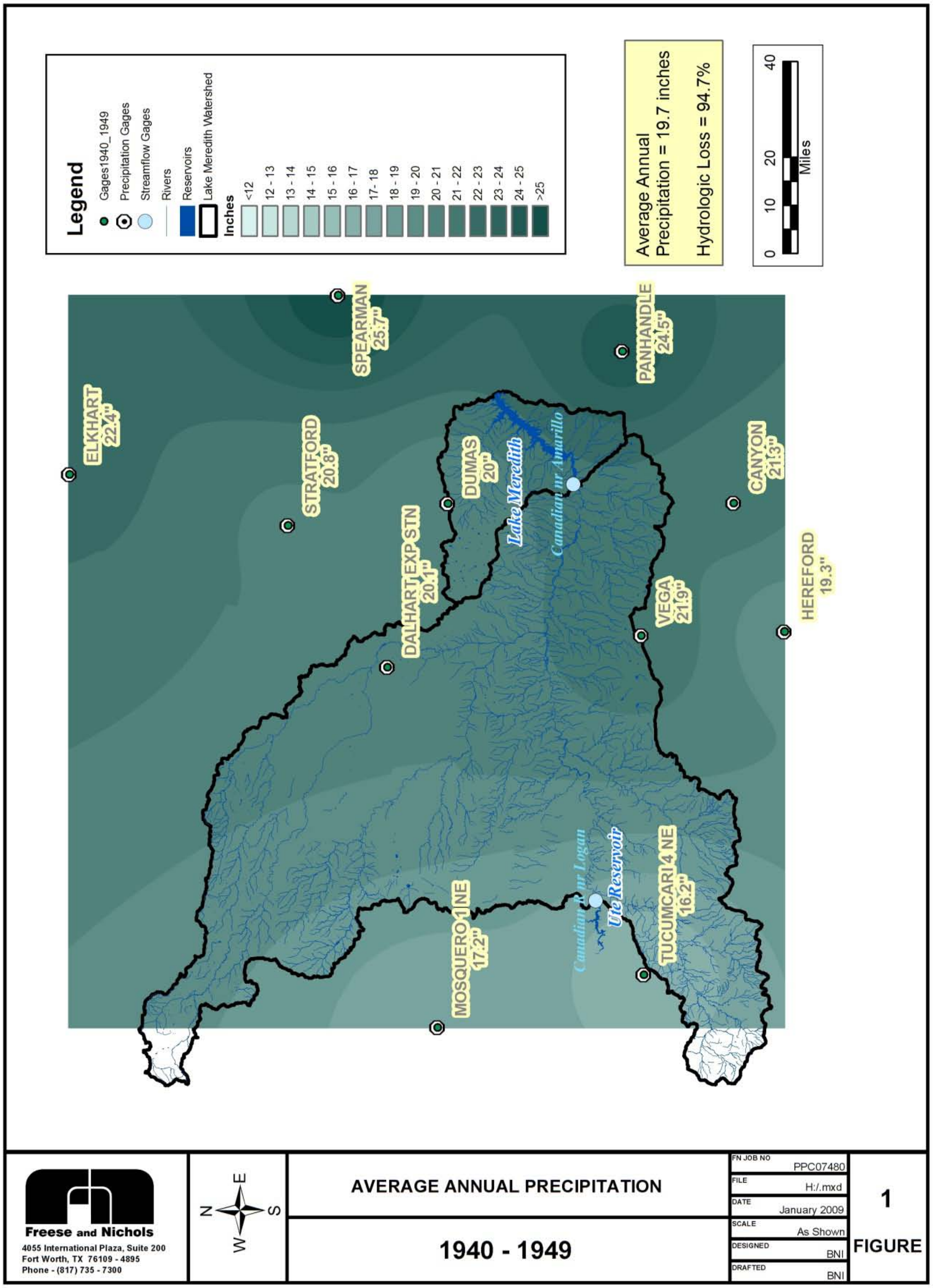
ATTACHMENT A

AVERAGE ANNUAL PRECIPITATION MAPS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Gages1940_1949
Precipitation Gages
Streamflow Gages
Rivers
Reservoirs
Lake Meredith Watershed
Inches
<12
12 - 13
13 - 14
14 - 15
15 - 16
16 - 17
17- 18
18 - 19
19 - 20
20 - 21
21 - 22
22 - 23
23 - 24
24 - 25
>25
Average Annual Precipitation = 19.7 inches
Hydrologic Loss = 94.7%
0 10 20 40
Miles
ELKHART 22.4"
SPEARMAN 25.7"
STRATFORD 20.8"
DUMAS 20"
PANHANDLE 24.5"
Lake Meredith
Canadian nr Amarillo
CANYON 21.3"
DALHART EXP STN 20.1"
VEGA 21.9"
HEREFORD 19.3"
Canadian nr Logan
Ute Reservoir
TUCUMCARI 4 NE 16.2"
MOSQUERO 1 NE 17.2"
Freese and Nichols
4055 International Plaza, Suite 200
Fort Worth, TX 76109 - 4895
Phone - (817) 735 - 7300
N E S W
AVERAGE ANNUAL PRECIPITATION
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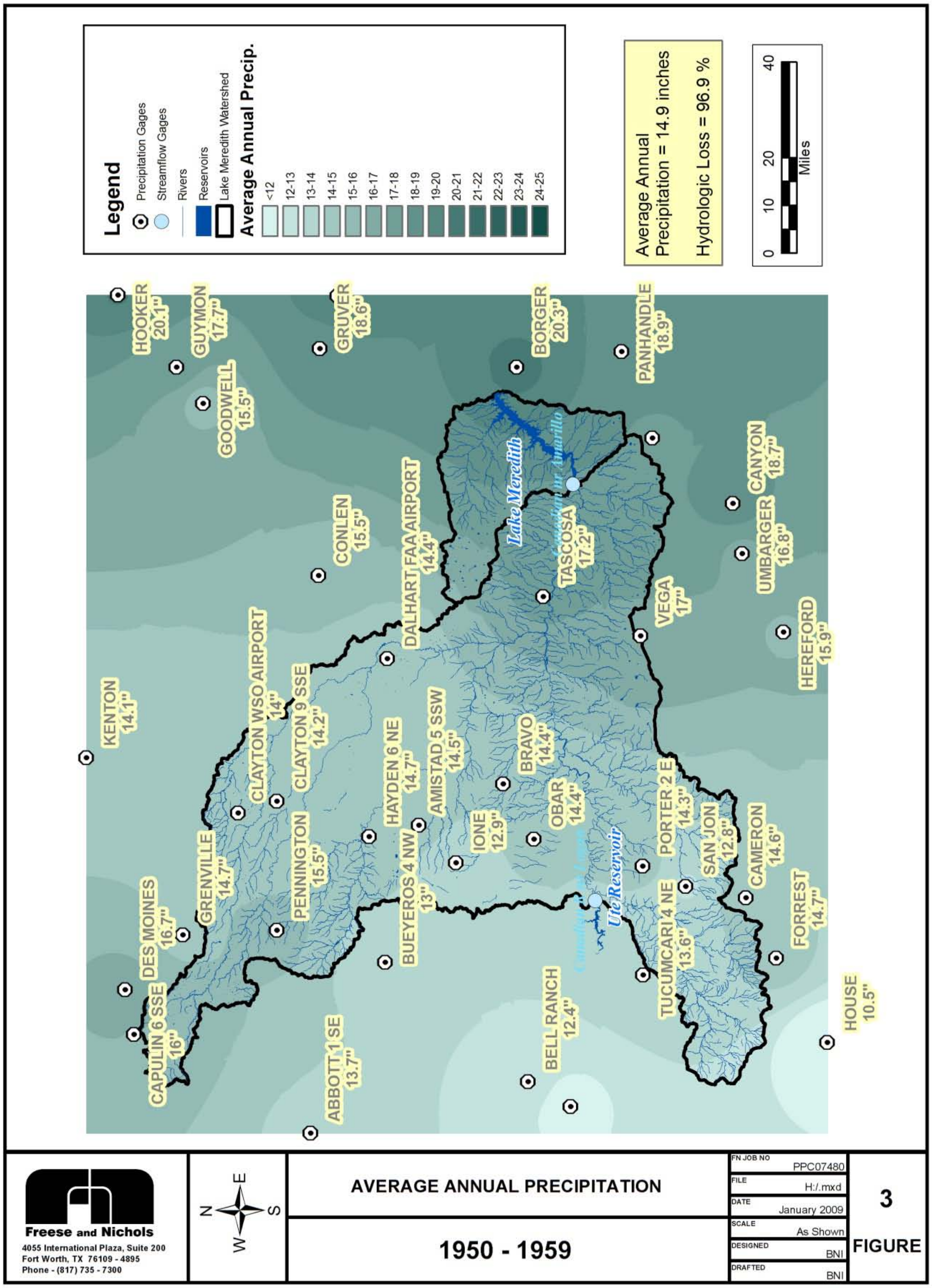
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Precipitation Gages
Streamflow Gages
Rivers
Reservoirs
Lake Meredith Watershed
Average Annual Precip.
<12
12-13
13-14
14-15
15-16
16-17
17-18
18-19
19-20
20-21
21-22
22-23
23-24
24-25
Average Annual Precipitation = 14.9 inches
Hydrologic Loss = 96.9 %
0 10 20 40
Miles
HOOKER 20.1"
GUYMON 17.7"
GOODWELL 15.5"
GRUVER 18.6"
BORGER 20.3"
PANHANDLE 18.9"
CANYON 18.7"
UMBARGER 16.8"
HEREFORD 15.9"
VEGA 17"
TASCOSA 17.2"
Lake Meredith
CONLEN 15.5"
DALHART FAA AIRPORT 14.4"
KENTON 14.1"
CLAYTON WSO AIRPORT 14"
CLAYTON 9 SSE 14.2"
HAYDEN 6 NE 14.7"
AMISTAD 5 SSW 14.5"
BRAVO 14.4"
OBAR 14.4"
PORTER 2 E 14.3"
SAN JON 12.8"
CAMERON 14.6"
FORREST 14.7"
IONE 12.9"
Ute Reservoir
GRENVILLE 14.7"
PENNINGTON 15.5"
BUEYEROS 4 NW 13"
DES MOINES 16.7"
CAPULIN 6 SSE 16"
ABBOTT 1 SE 13.7"
BELL RANCH 12.4"
TUCUMCARI 4 NE 13.6"
HOUSE 10.5"
Freese and Nichols
4055 International Plaza, Suite 200
Fort Worth, TX 76109 - 4895
Phone - (817) 735 - 7300
N E S W
AVERAGE ANNUAL PRECIPITATION
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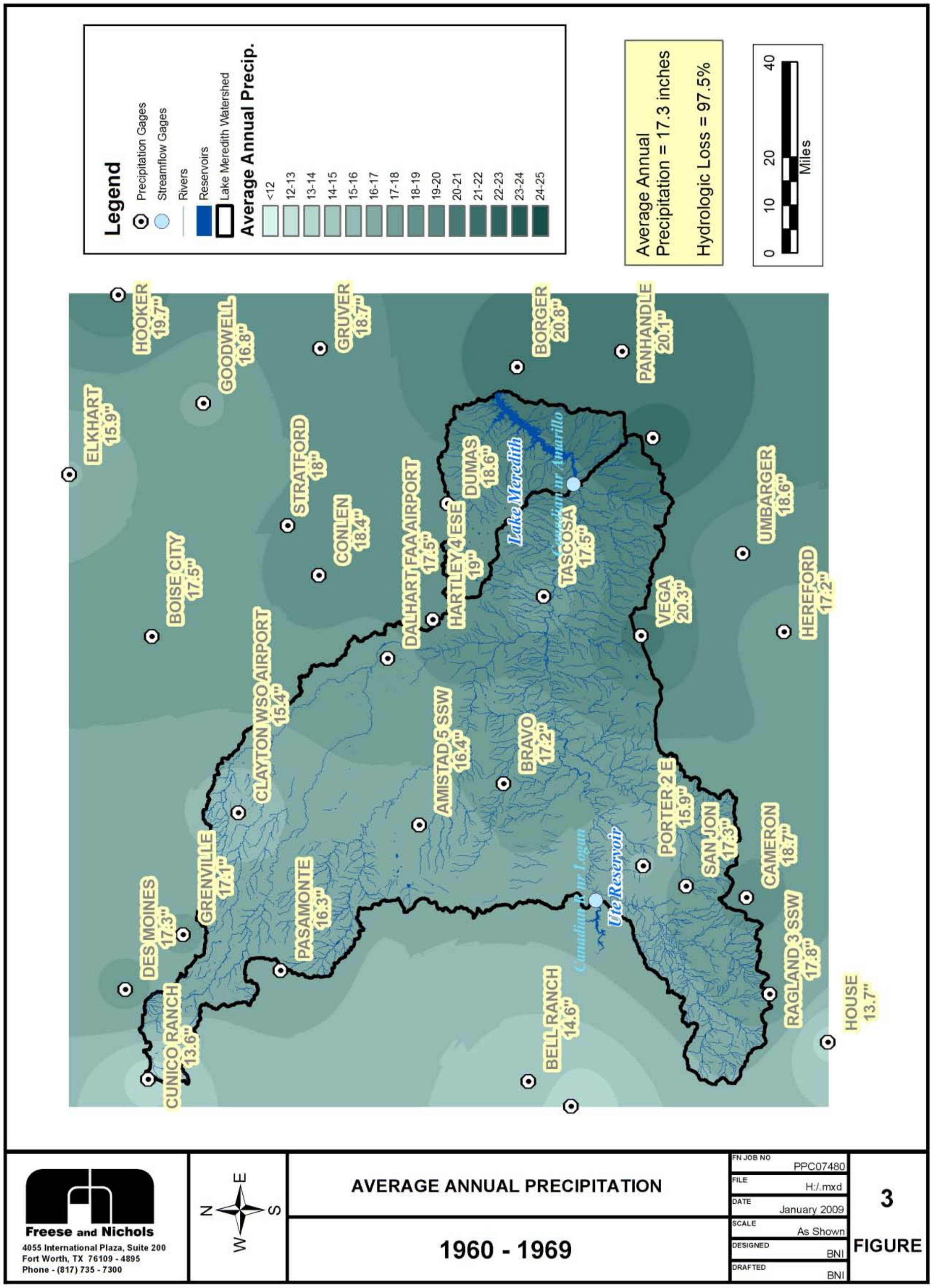
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Precipitation Gages
Streamflow Gages
Rivers
Reservoirs
Lake Meredith Watershed
Average Annual Precip.
<12
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13-14
14-15
15-16
16-17
17-18
18-19
19-20
20-21
21-22
22-23
23-24
24-25
Average Annual Precipitation = 17.3 inches
Hydrologic Loss = 97.5%
0 10 20 40
Miles
HOOKER 19.7"
GOODWELL 16.8"
GRUVER 18.7"
BORGER 20.8"
PANHANDLE 20.1"
ELKHART 15.9"
STRATFORD 18"
DUMAS 18.6"
Lake Meredith
Canadian nr Amarillo
CONLEN 18.4"
DALHART FAA AIRPORT 17.5"
HARTLEY 4 ESE 19"
TASCOSA 17.5"
UMBARGER 18.6"
BOISE CITY 17.5"
VEGA 20.3"
HEREFORD 17.2"
CLAYTON WSO AIRPORT 15.4"
AMISTAD 5 SSW 16.4"
BRAVO 17.2"
PORTER 2 E 15.9"
SAN JON 17.3"
CAMERON 18.7"
GRENVILLE 17.1"
PASAMONTE 16.3"
Ute Reservoir
Canadian nr Logan
DES MOINES 17.3"
RAGLAND 3 SSW 17.8"
CUNICO RANCH 13.6"
BELL RANCH 14.6"
HOUSE 13.7"
Freese and Nichols
4055 International Plaza, Suite 200
Fort Worth, TX 76109 - 4895
Phone - (817) 735 - 7300
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AVERAGE ANNUAL PRECIPITATION
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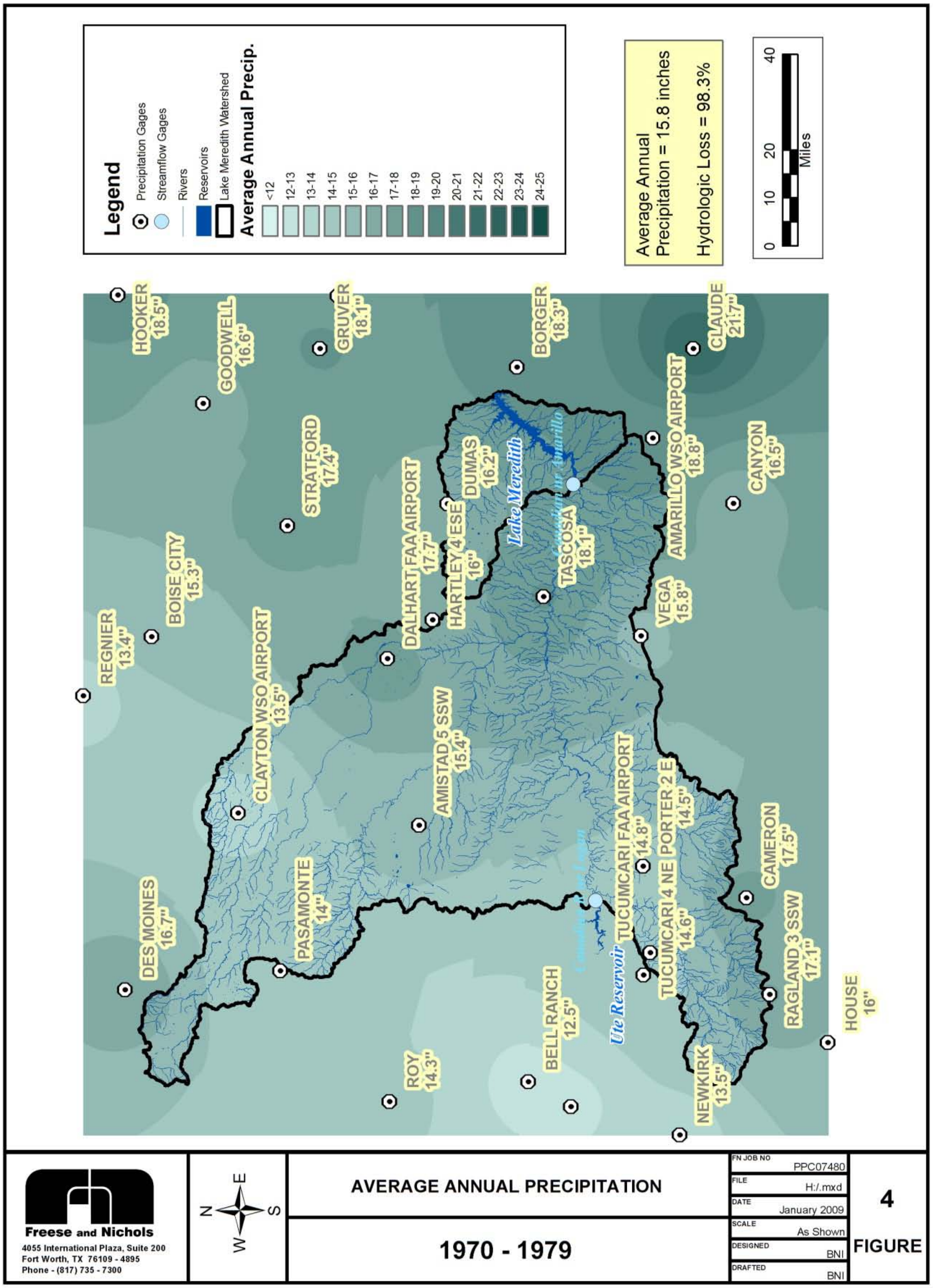
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Precipitation Gages
Streamflow Gages
Rivers
Reservoirs
Lake Meredith Watershed
Average Annual Precip.
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22-23
23-24
24-25
Average Annual Precipitation = 15.8 inches
Hydrologic Loss = 98.3%
0 10 20 40
Miles
HOOKER 18.5"
GOODWELL 16.6"
GRUVER 18.1"
BORGER 18.3"
CLAUDE 21.7"
AMARILLO WSO AIRPORT 18.8"
CANYON 16.5"
STRATFORD 17.4"
DALHART FAA AIRPORT 17.7"
HARTLEY 4 ESE 16"
DUMAS 16.2"
Lake Meredith
TASCOSA 18.1"
VEGA 15.8"
BOISE CITY 15.3"
REGNIER 13.4"
CLAYTON WSO AIRPORT 13.5"
AMISTAD 5 SSW 15.4"
TUCUMCARI FAA AIRPORT 14.8"
PORTER 2 E 14.5"
CAMERON 17.5"
DES MOINES 16.7"
PASAMONTE 14"
TUCUMCARI 4 NE 14.6"
RAGLAND 3 SSW 17.1"
HOUSE 16"
Ute Reservoir
BELL RANCH 12.5"
ROY 14.3"
NEWKIRK 13.5"
Freese and Nichols
4055 International Plaza, Suite 200
Fort Worth, TX 76109 - 4895
Phone - (817) 735 - 7300
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AVERAGE ANNUAL PRECIPITATION
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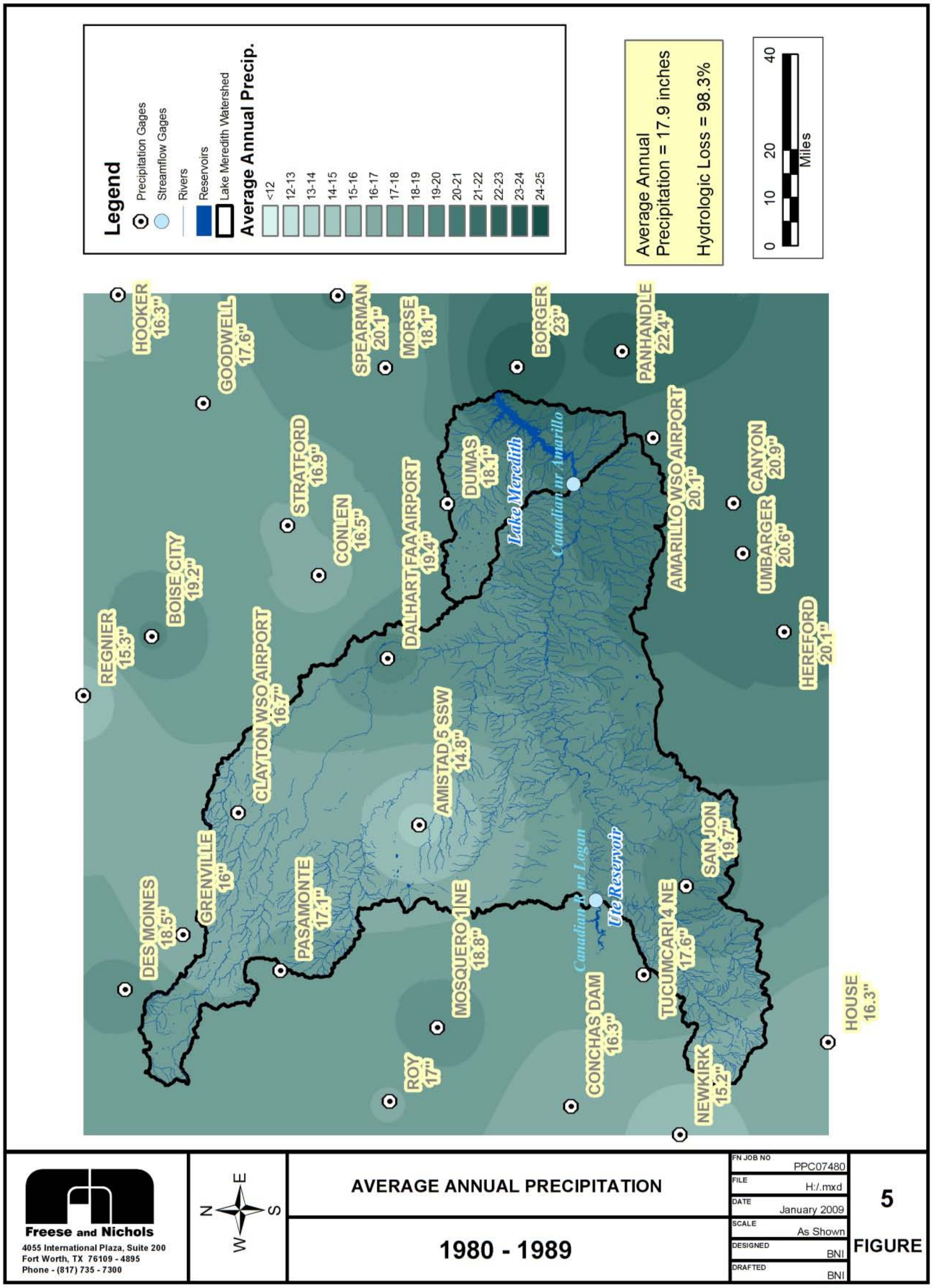
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Precipitation Gages
Streamflow Gages
Rivers
Reservoirs
Lake Meredith Watershed
Average Annual Precip.
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13-14
14-15
15-16
16-17
17-18
18-19
19-20
20-21
21-22
22-23
23-24
24-25
Average Annual Precipitation = 17.9 inches
Hydrologic Loss = 98.3%
0 10 20 40
Miles
HOOKER 16.3"
GOODWELL 17.6"
SPEARMAN 20.1"
MORSE 18.1"
BORGER 23"
PANHANDLE 22.4"
STRATFORD 16.9"
CONLEN 16.5"
DUMAS 18.1"
Lake Meredith
Canadian nr Amarillo
DALHART FAA AIRPORT 19.4"
AMARILLO WSO AIRPORT 20.1"
CANYON 20.9"
UMBARGER 20.6"
HEREFORD 20.1"
BOISE CITY 19.2"
REGNIER 15.3"
CLAYTON WSO AIRPORT 16.7"
AMISTAD 5 SSW 14.8"
GRENVILLE 16"
DES MOINES 18.5"
PASAMONTE 17.1"
MOSQUERO 1 NE 18.8"
Canadian R nr Logan
Ute Reservoir
SAN JON 19.7"
TUCUMCARI 4 NE 17.6"
CONCHAS DAM 16.3"
ROY 17"
NEWKIRK 15.2"
HOUSE 16.3"
Freese and Nichols
4055 International Plaza, Suite 200
Fort Worth, TX 76109 - 4895
Phone - (817) 735 - 7300
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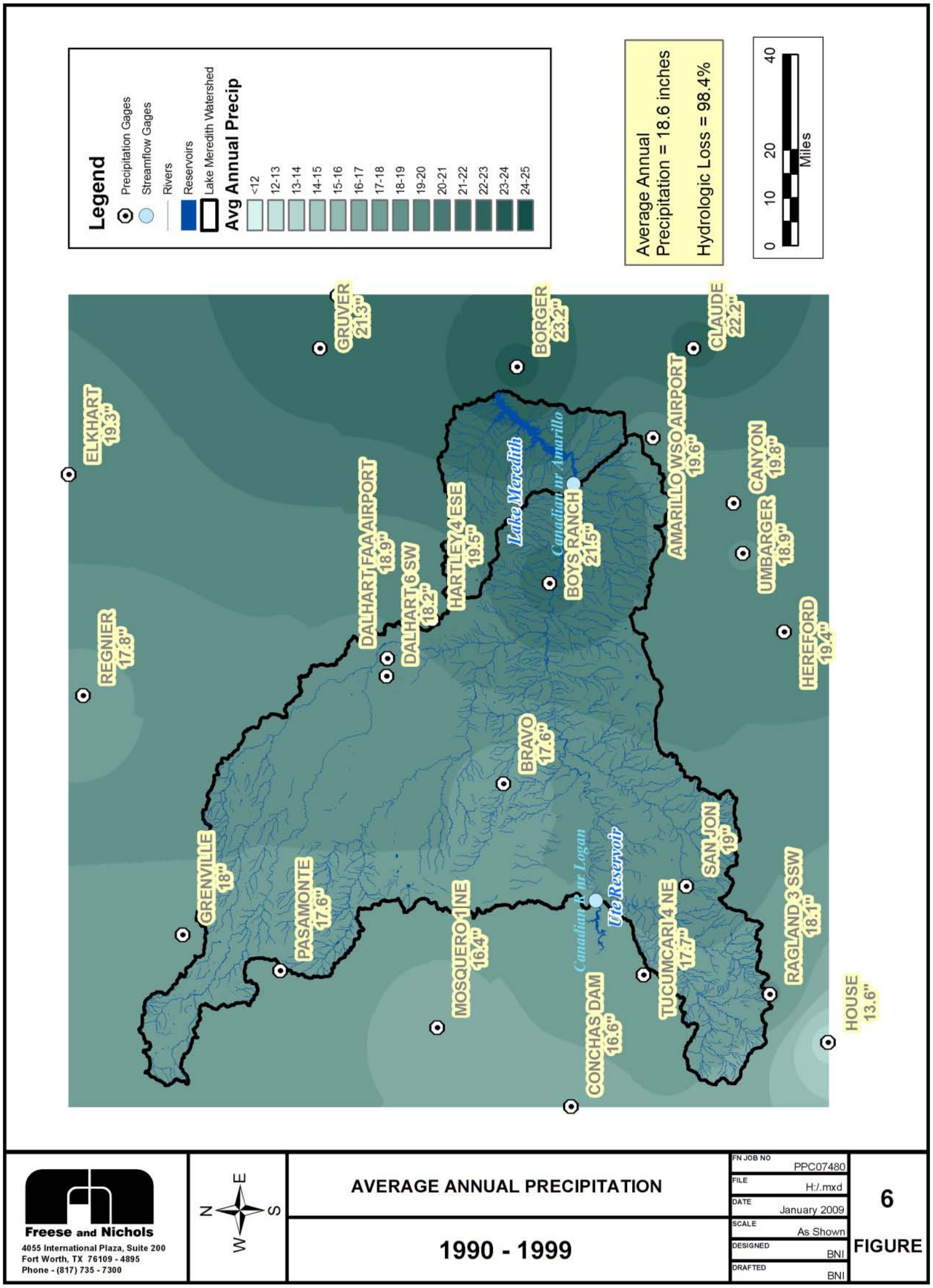
Legend
Precipitation Gages
Streamflow Gages
Rivers
Reservoirs
Lake Meredith Watershed
Avg Annual Precip
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16-17
17-18
18-19
19-20
20-21
21-22
22-23
23-24
24-25
Average Annual Precipitation = 18.6 inches
Hydrologic Loss = 98.4%
0 10 20 40
Miles
GRUVER 21.3"
BORGER 23.2"
CLAUDE 22.2"
ELKHART 19.3"
DALHART FAA AIRPORT 18.9"
DALHART 6 SW 18.2"
HARTLEY 4 ESE 19.5"
Lake Meredith
Canadian nr Amarillo
BOYS RANCH 21.5"
AMARILLO WSO AIRPORT 19.6"
CANYON 19.8"
UMBARGER 18.9"
HEREFORD 19.4"
REGNIER 17.8"
BRAVO 17.6"
GRENVILLE 18"
PASAMONTE 17.6"
MOSQUERO 1 NE 16.4"
Canadian R nr Logan
Ute Reservoir
SAN JON 19"
TUCUMCARI 4 NE 17.7"
RAGLAND 3 SSW 18.1"
CONCHAS DAM 16.6"
HOUSE 13.6"
Freese and Nichols
4055 International Plaza, Suite 200
Fort Worth, TX 76109 - 4895
Phone - (817) 735 - 7300
N E S W
AVERAGE ANNUAL PRECIPITATION
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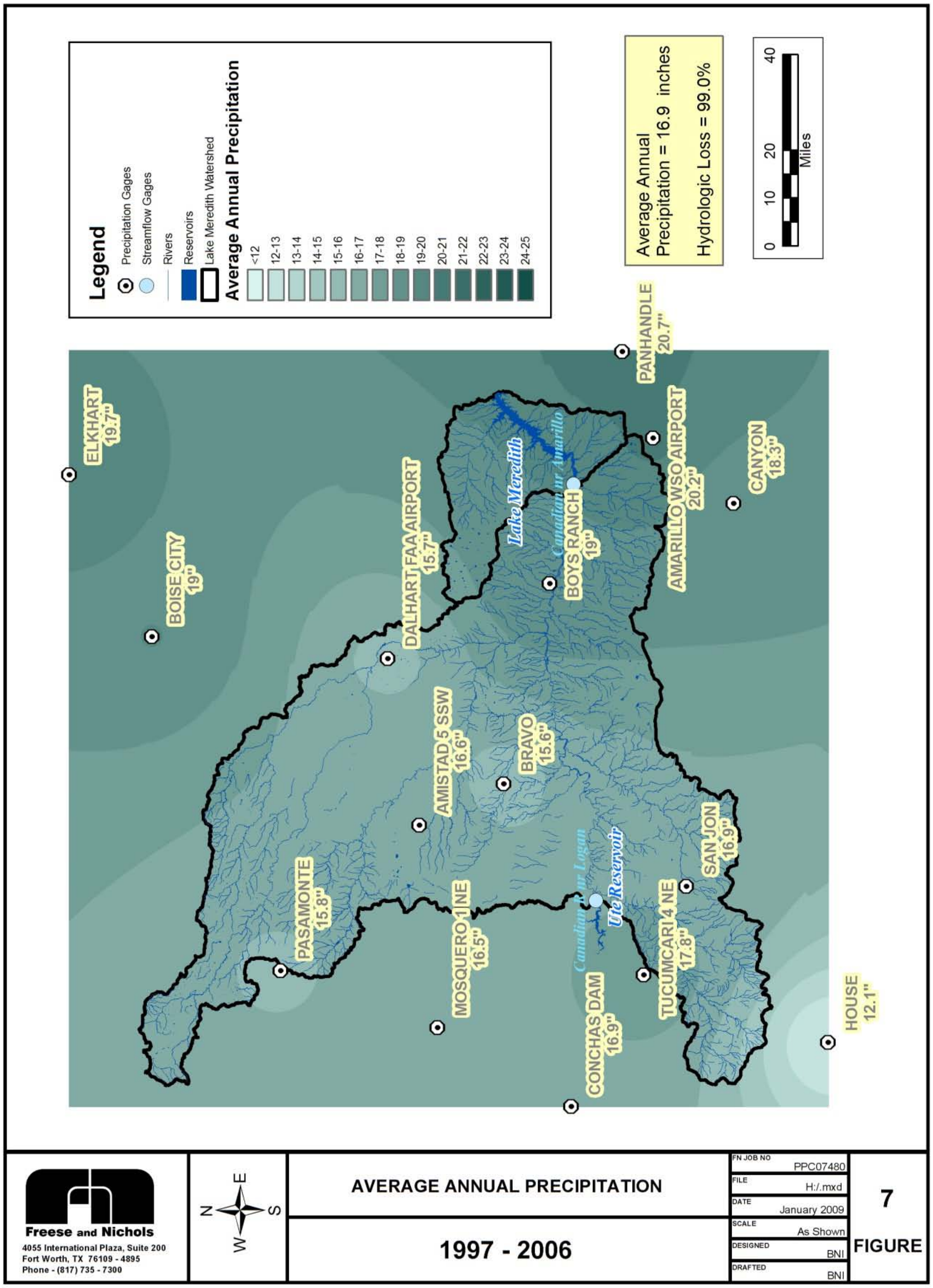
Legend
Precipitation Gages
Streamflow Gages
Rivers
Reservoirs
Lake Meredith Watershed
Average Annual Precipitation
<12
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15-16
16-17
17-18
18-19
19-20
20-21
21-22
22-23
23-24
24-25
Average Annual Precipitation = 16.9 inches
Hydrologic Loss = 99.0%
0
10
20
40
Miles
ELKHART 19.7"
BOISE CITY 19"
DALHART FAA AIRPORT 15.7"
PANHANDLE 20.7"
AMARILLO WSO AIRPORT 20.2"
CANYON 18.3"
BOYS RANCH 19"
Lake Meredith
Canadian nr Amarillo
AMISTAD 5 SSW 16.6"
BRAVO 15.6"
PASAMONTE 15.8"
MOSQUERO 1NE 16.5"
Canadian nr Logan
Ute Reservoir
SAN JON 16.9"
TUCUMCARI 4 NE 17.8"
CONCHAS DAM 16.9"
HOUSE 12.1"
Freese and Nichols
4055 International Plaza, Suite 200
Fort Worth, TX 76109 - 4895
Phone - (817) 735 - 7300
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AVERAGE ANNUAL PRECIPITATION
1997 - 2006
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7
FIGURE

ATTACHMENT B

SEASONAL TEMPERATURE MAPS

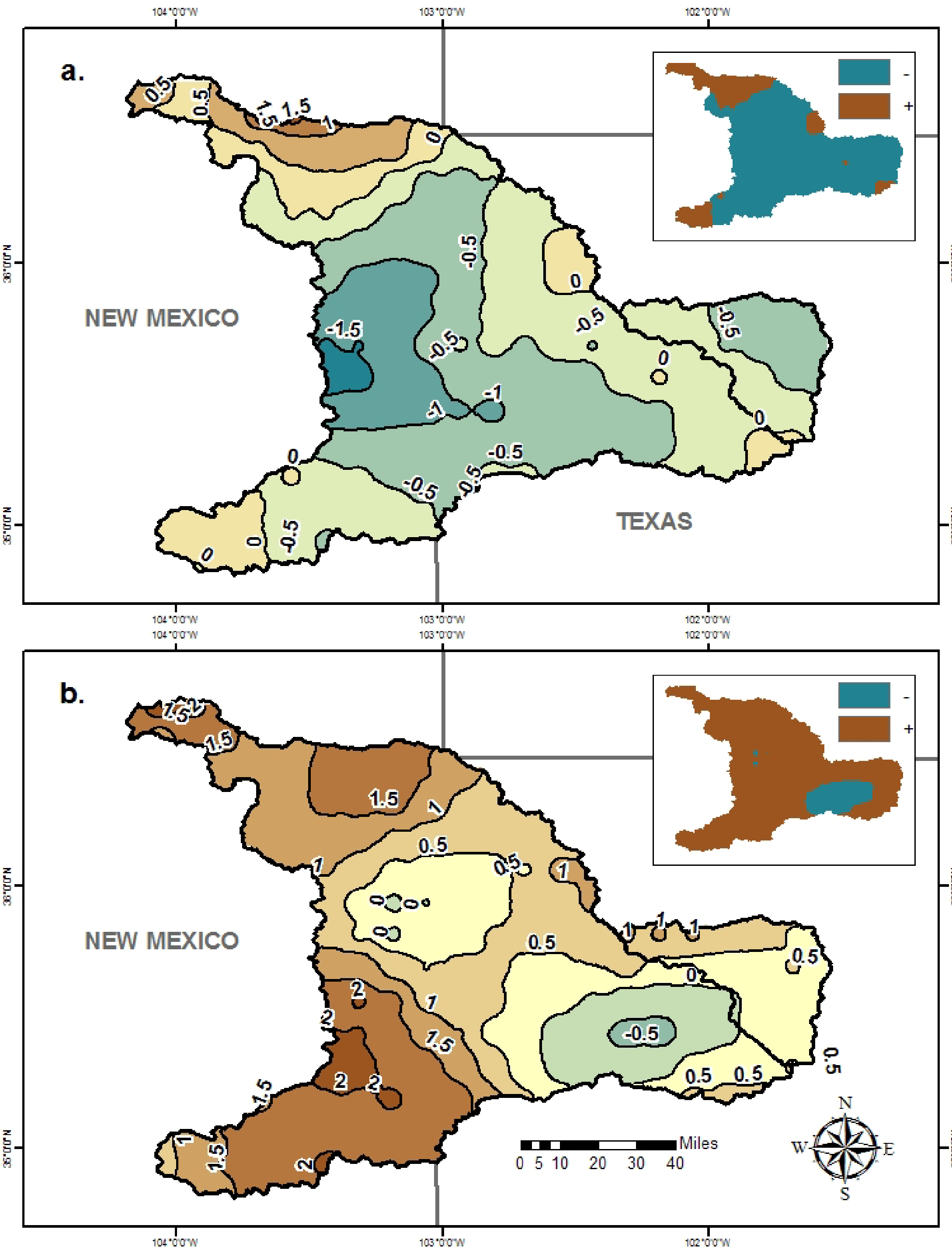


Figure B-1. Change in Average Winter Maxima (a) and Minima (b) Temperature from 1949 to 1999 (in Celsius) using regression lines unique to each point.

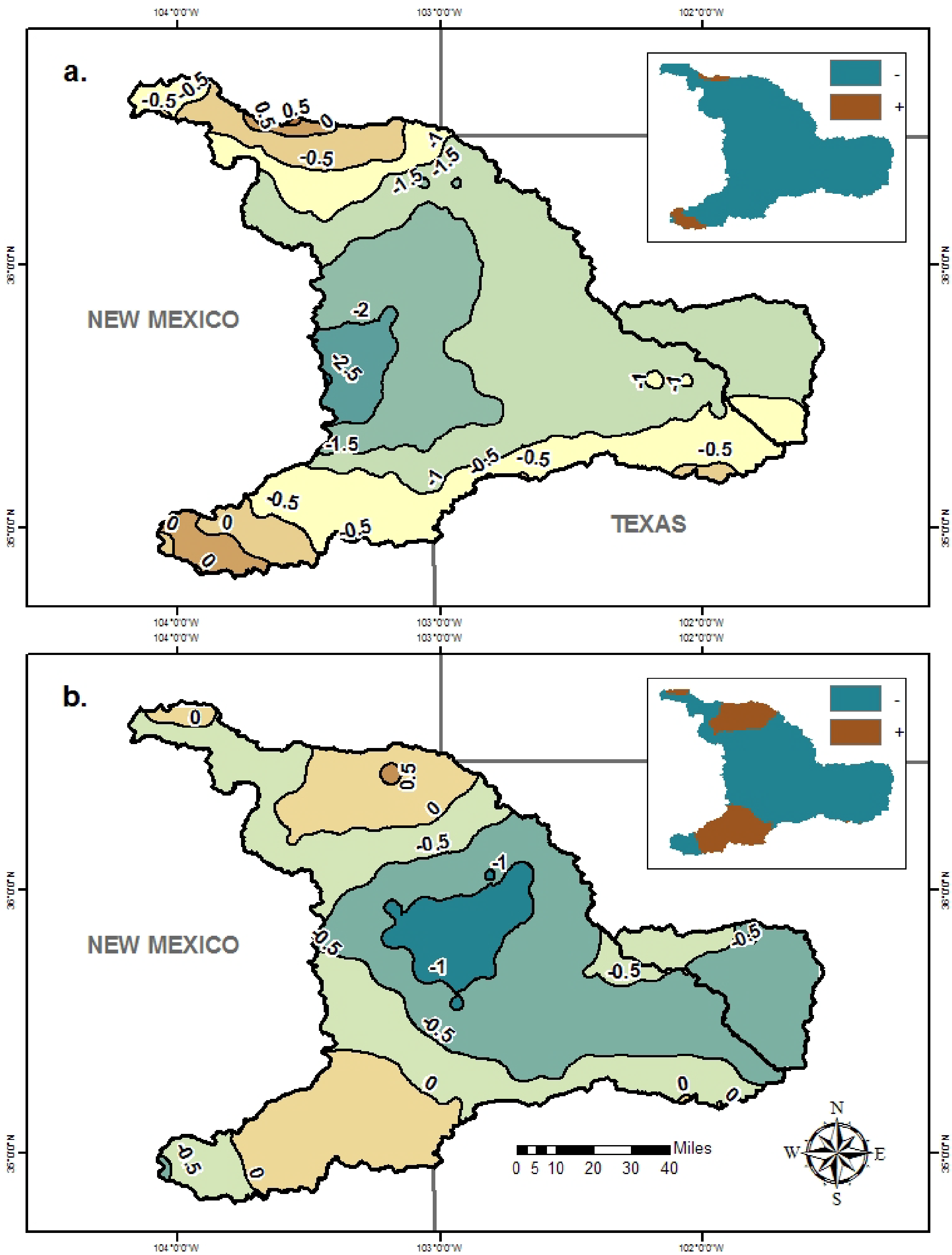


Figure B-2. Change in Average Spring Maxima (a) and Minima (b) Temperature from 1949 to 1999 (in Celsius) using regression lines unique to each point.

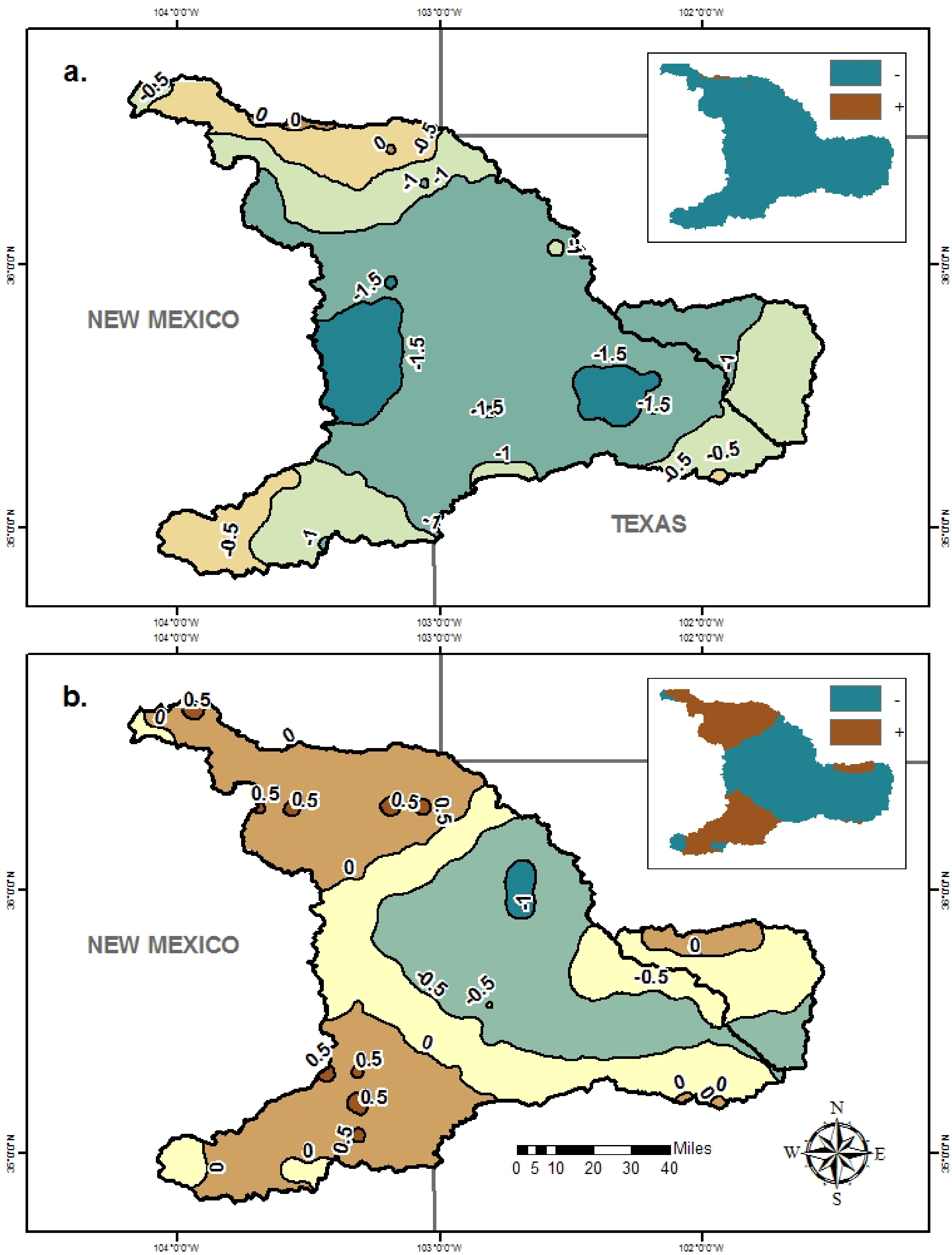


Figure B-3. Change in Average Summer Maxima (a) and Minima (b) Temperature from 1949 to 1999 (in Celsius) using regression lines unique to each point.

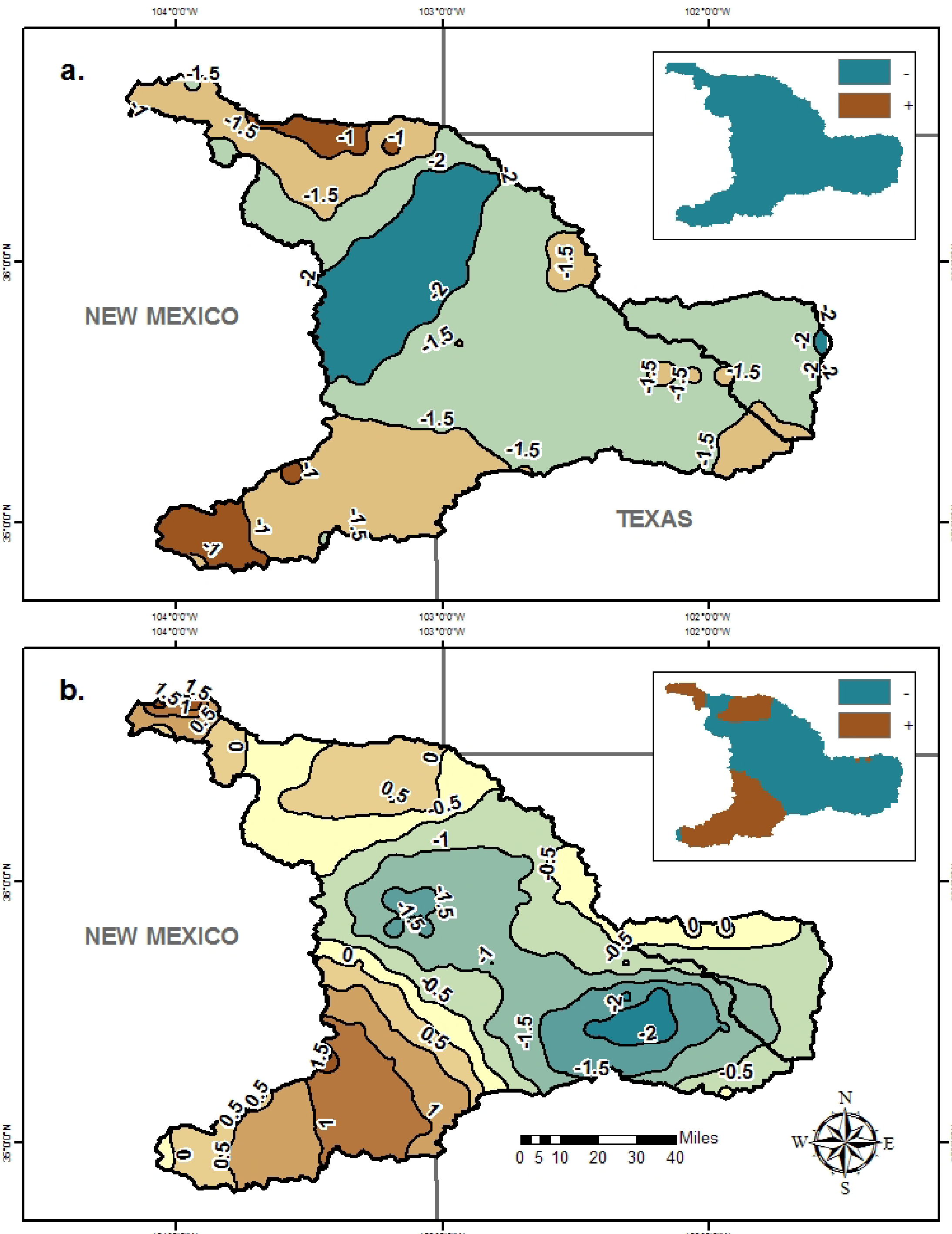


Figure B-4. Change in Average Fall Maxima (a) and Minima (b) Temperature from 1949 to 1999 (in Celsius) using regression lines unique to each point.

ATTACHMENT C

PRECIPITATION TREND ANALYSIS

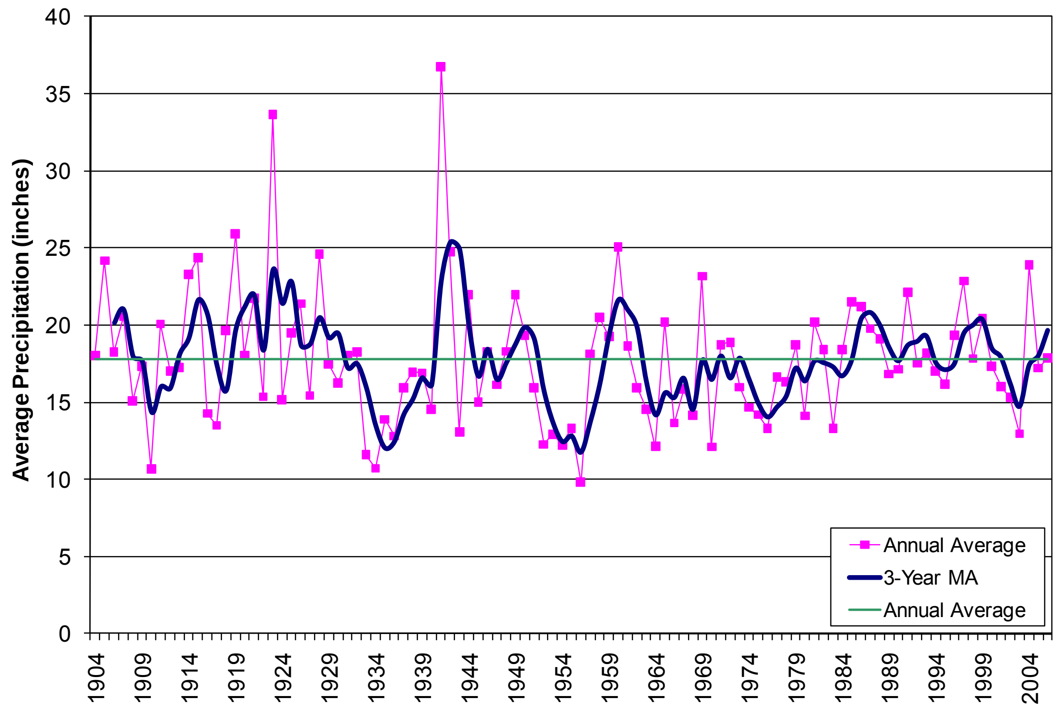


Figure C-1. 3 Year Moving Average

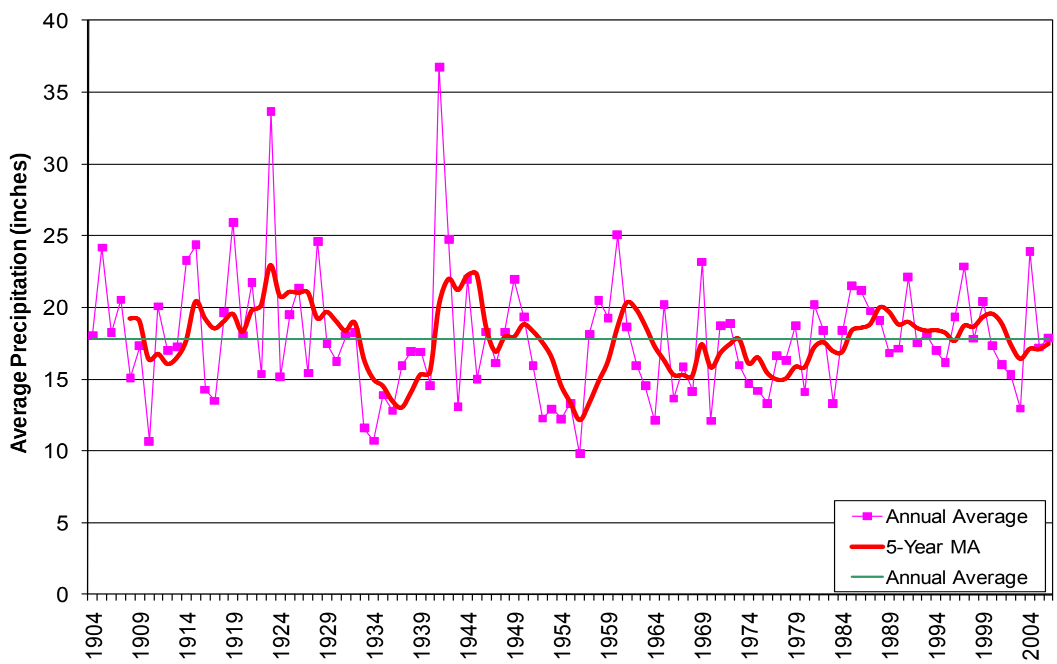


Figure C-2. 5 Year Moving Average

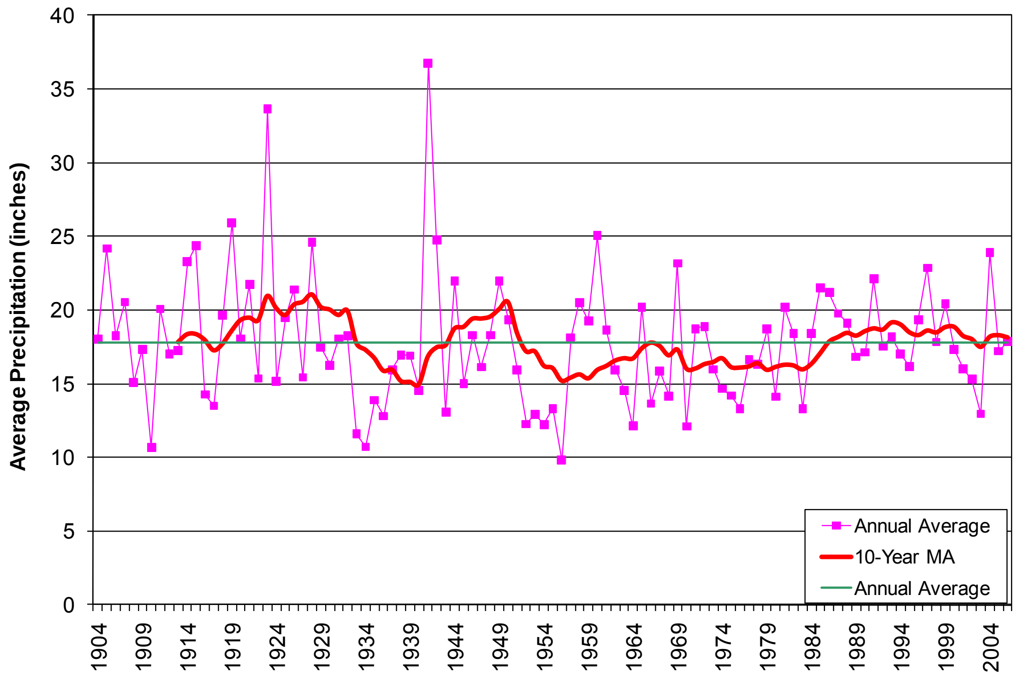


Figure C-3. 10 Year Moving Average

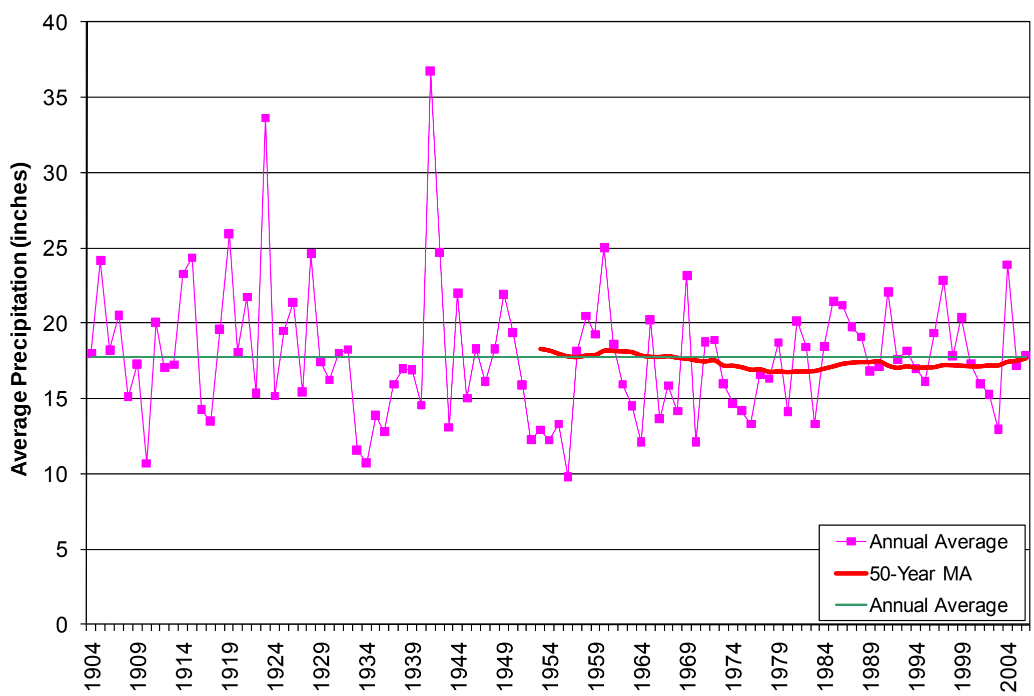


Figure C-4. 50 Year Moving Average

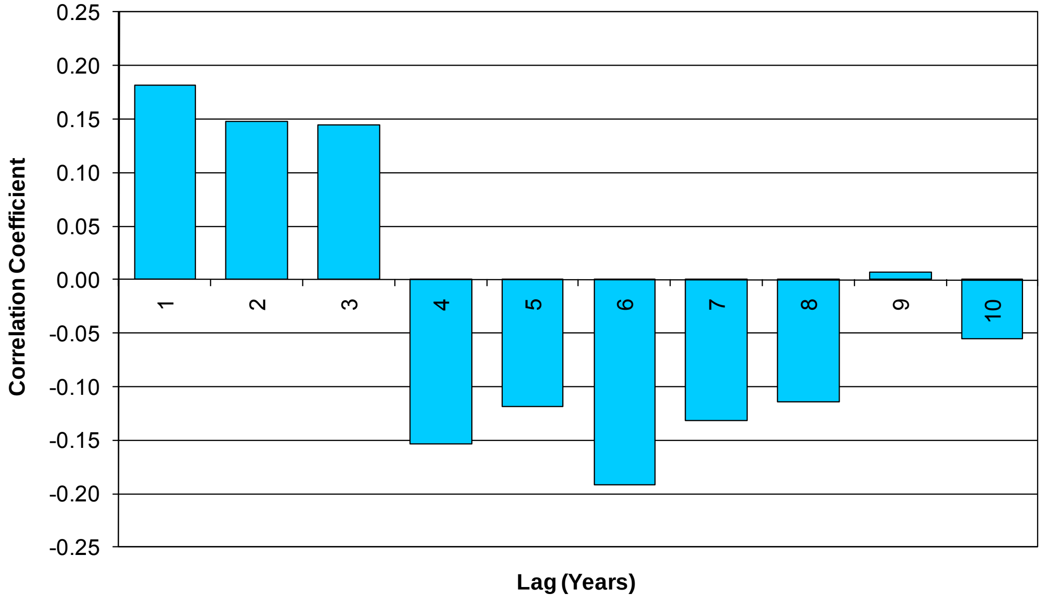


Figure C-5. Correlation of Average Precipitation with Past Values for the Watershed

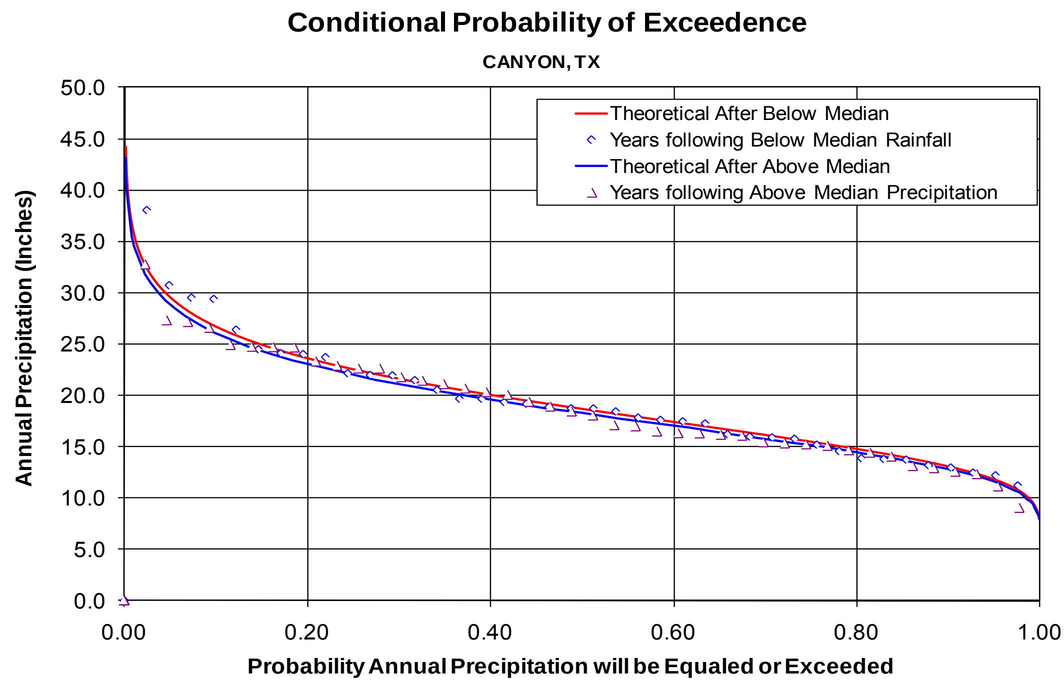


Figure C-6. Conditional Probability of Exceedance for Canyon, TX

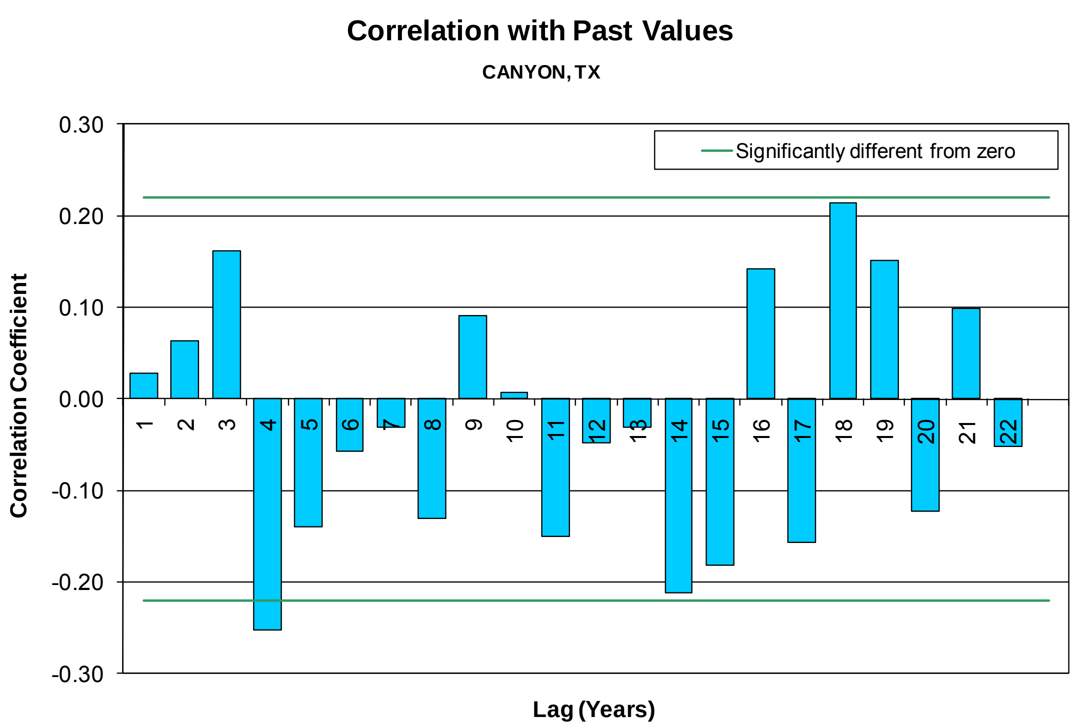


Figure C-7. Correlation with Past Values for Canyon, TX

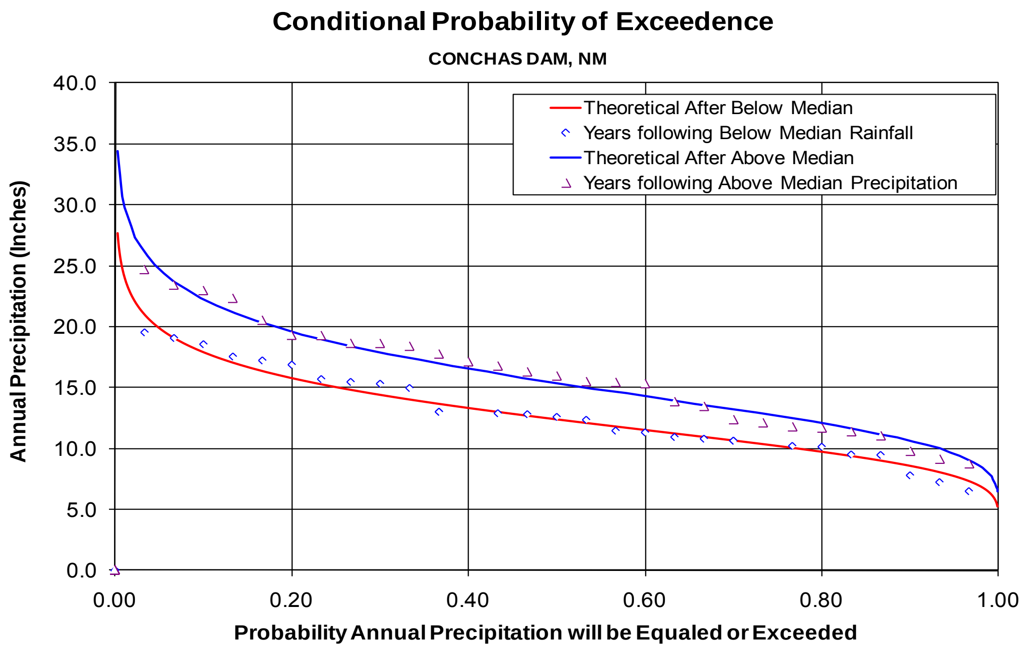


Figure C-8. Conditional Probability of Exceedance for Conchas, NM

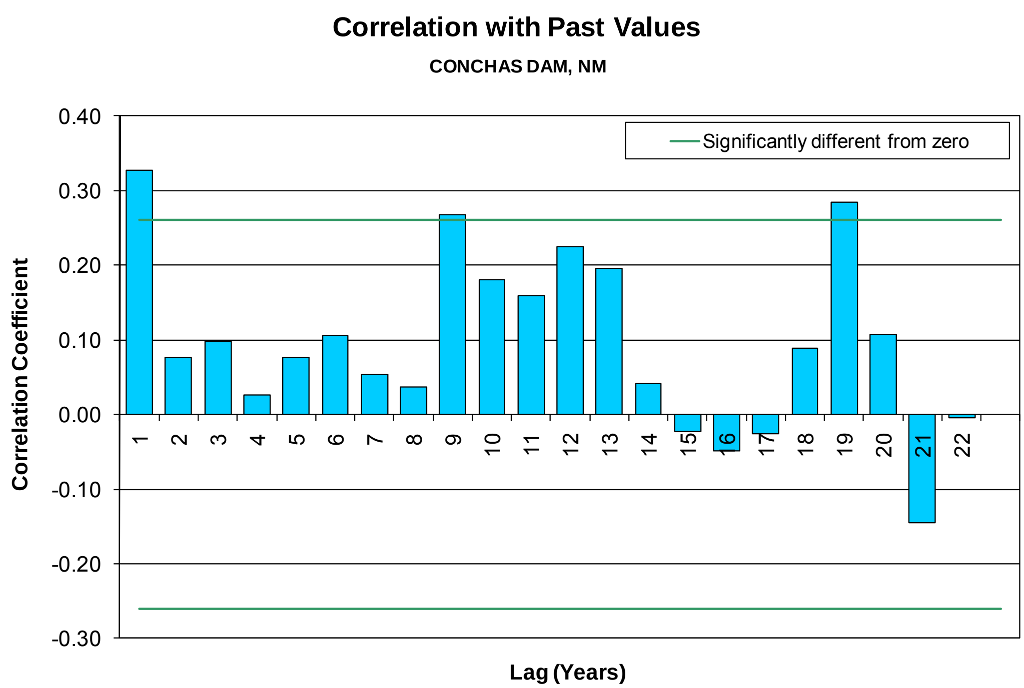


Figure C-9. Correlation with Past Values for Conchas, NM

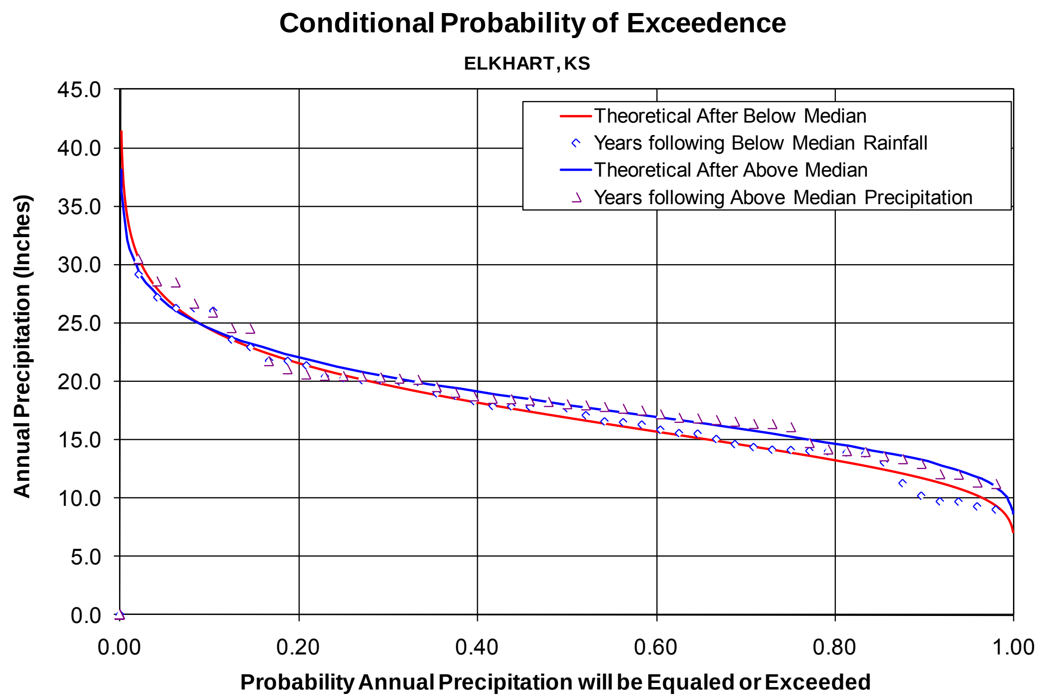


Figure C-10. Conditional Probability of Exceedance for Elkhart, KS

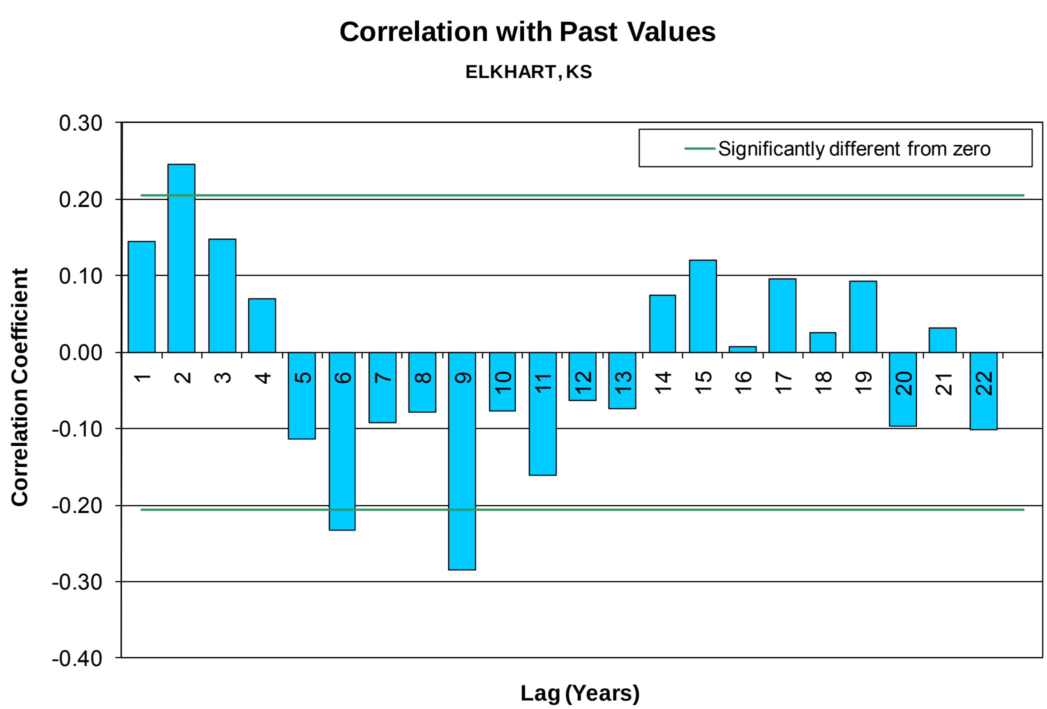


Figure C-11. Correlation with Past Values for Elkhart, KS

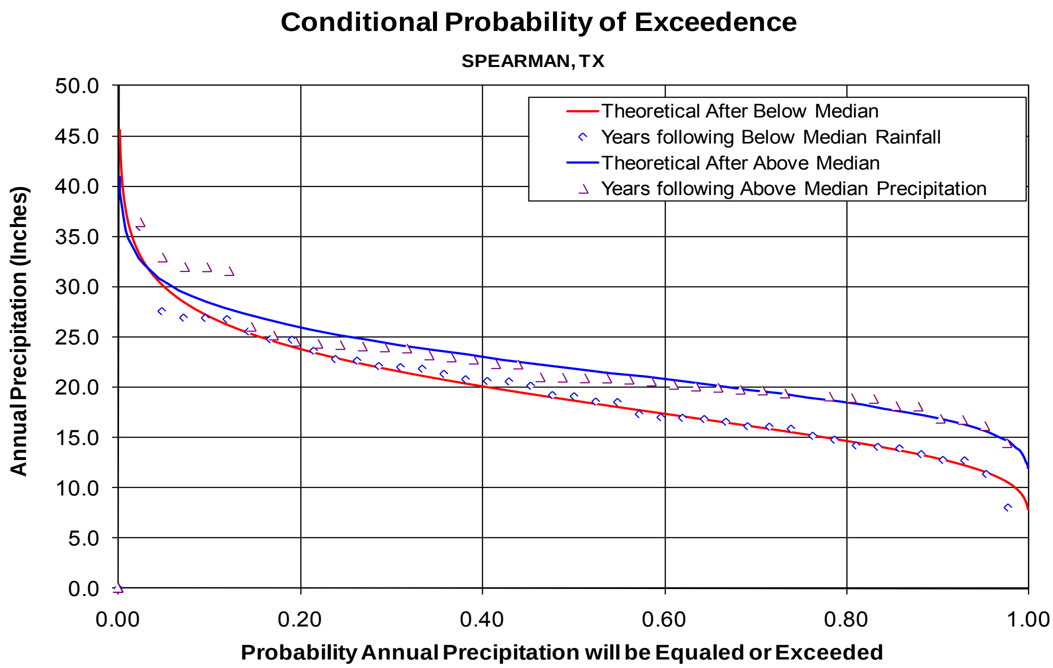


Figure C-12. Conditional Probability of Exceedance for Spearman, TX

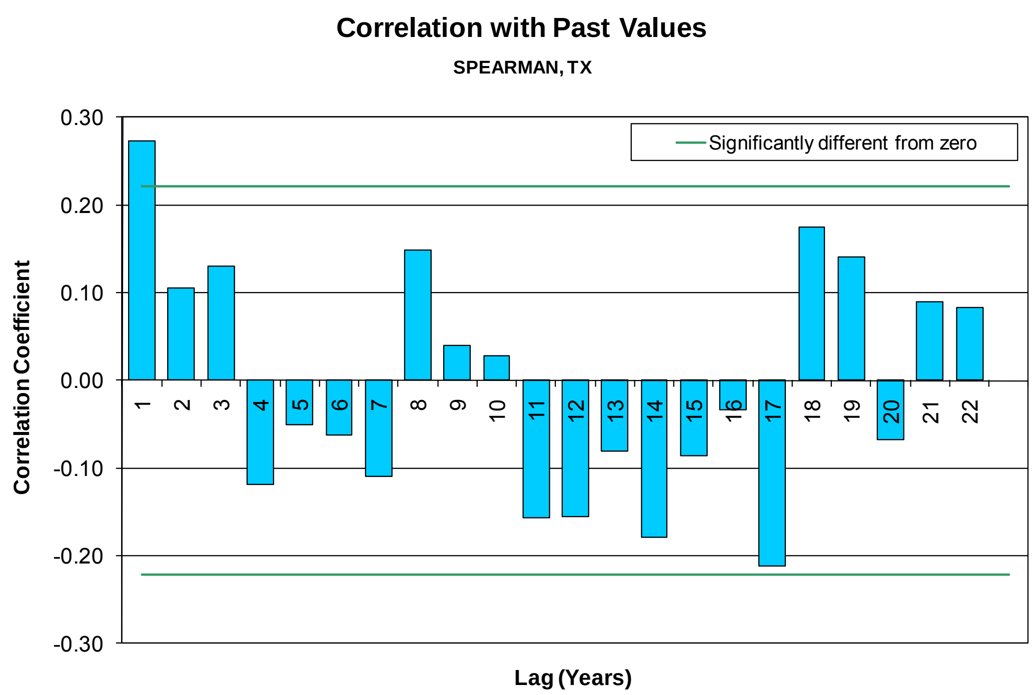


Figure C-13. Correlation with Past Values for Spearman, TX

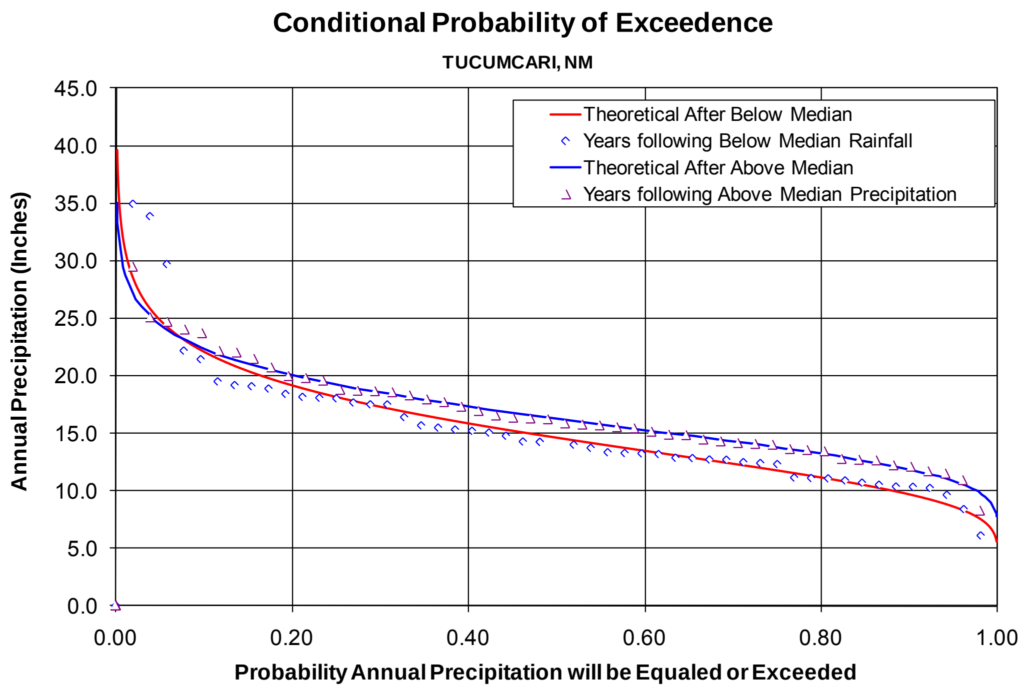


Figure C-14. Conditional Probability of Exceedance for Tucumcari, NM

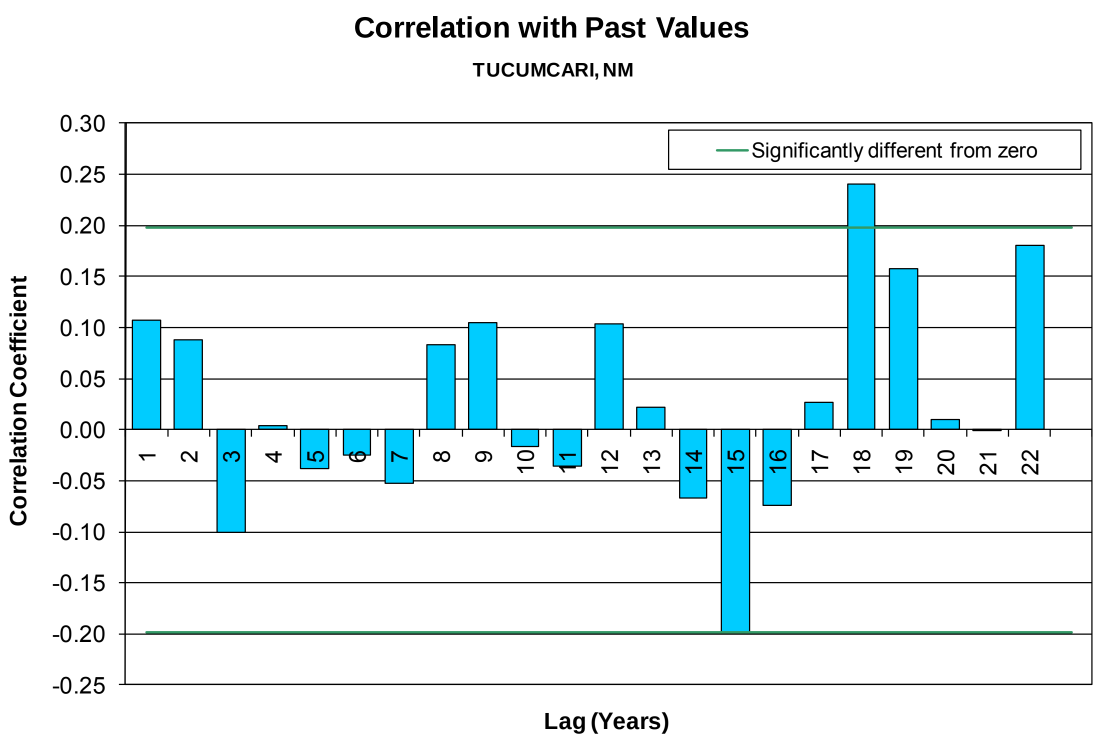


Figure C-15. Correlation with Past Values for Tucumcari, NM

ATTACHMENT D

RECLASSIFIED LAND USE MAPS

	Reclassification	1967		1970-1985		1992		2001	
Value	Description	LUC	Description	LUCODE	Description	No.	Description	No.	Description
1	Urban	16	Urban areas	10s (11-17)	Urban or built-up land	20s (21-23)	Developed	20s (21-24)	Developed
2	Agriculture	1	Mostly cropland	21	Cropland and Pasture	81	Pasture/Hay	81	Pasture/Hay
		2	Cropland with grazing land	22	Orchards	82	Row Crops	82	Cultivated Crops
		3	Cropland with pasture, woodland, and forest	23	Confined Animal Feeding Operations	83	Small Grains		
		4	Irrigated land	24	Other Agricultural Land	84	Fallow		
3	Grasslands	8	Subhumid grassland and semiarid grazing land	31	Herbaceous rangeland	71	grasslands/herbaceous	71	grasslands/herbaceous
4	Shrubland	9	Open woodland grazed (pinon, juniper, haparral and brush)	32	Shrub and brush rangeland	51	Shrubland	51	Dwarf Scrub
		10	Desert shrubland grazed					52	Shrub/Scrub
		11	Desert shrubland mostly ungrazed						
5	Forest	5	Woodland and forest with some cropland and pasture	41	deciduous forest land	41	Deciduous forest	41	Deciduous forest
		6	Forest and woodland mostly grazed	42	Evergreen forest land	42	Evergreen Forest	42	Evergreen Forest
		7	Forest and woodland mostly ungrazed	43	Mixed Forest	43	Mixed Forest	43	Mixed Forest
6	Wetlands	13	Swamp	61	Forested wetland	91	Woody wetlands	90-94	woody, forested, and scrub/shrub wetlands
		14	Marsh	62	Nonforested wetland	92	emergent herbaceous wetlands	95-99	emergent wetlands and aquatic bed
7	Open water	17	Open water	50s (51-54)	Water	11	Open water	11	open water
8	Barren land	12	Barren land	70s (71-77)	Barren land	30s (31-33)	Barren land	30s (31-32)	Barren Land

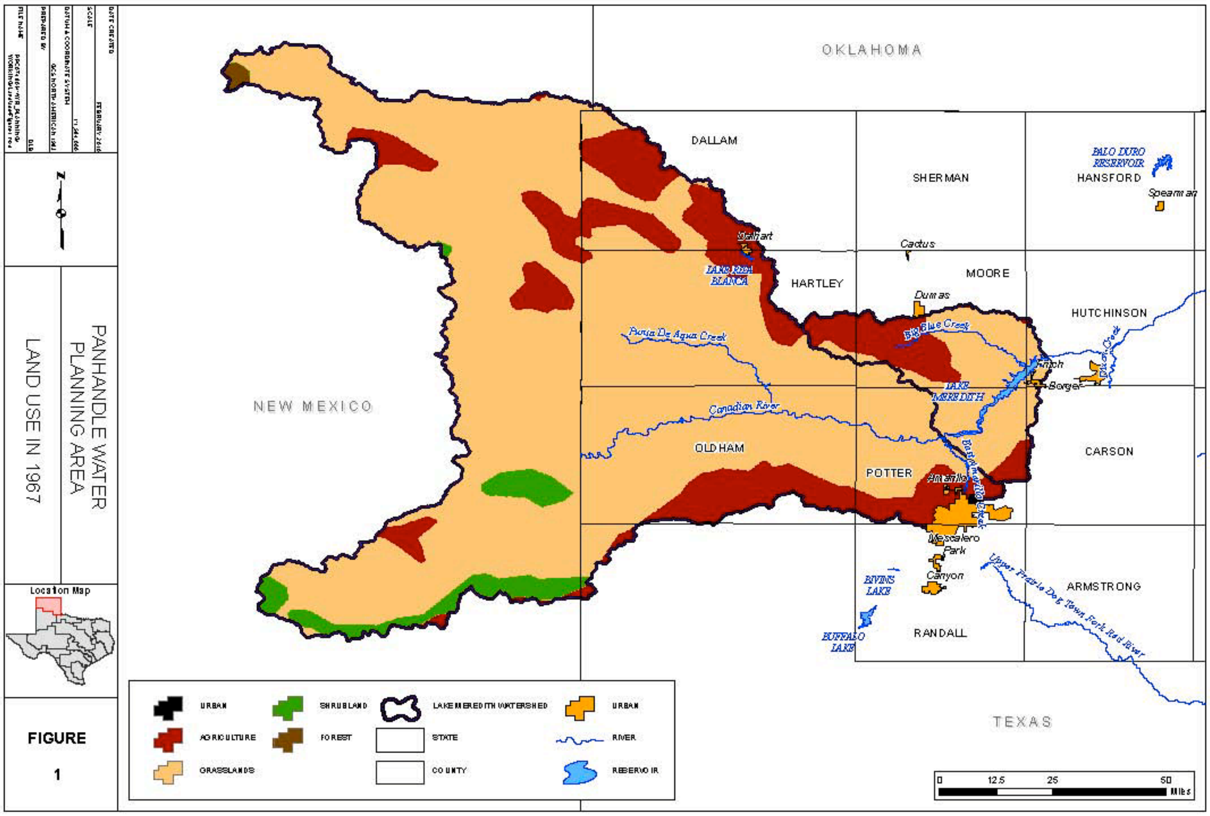


Figure D-1. Reclassified Land Use Map for 1967

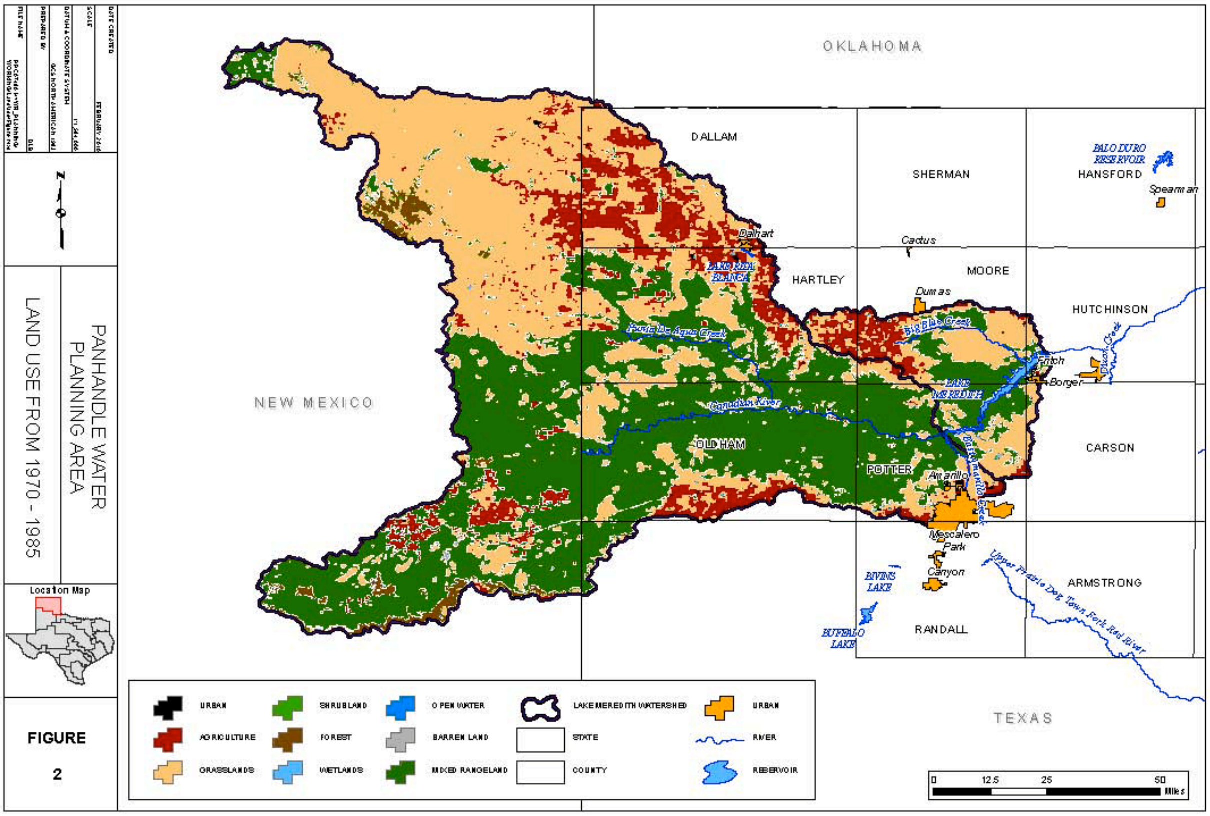


Figure D-2. Reclassified Land Use Map for 1970-1985

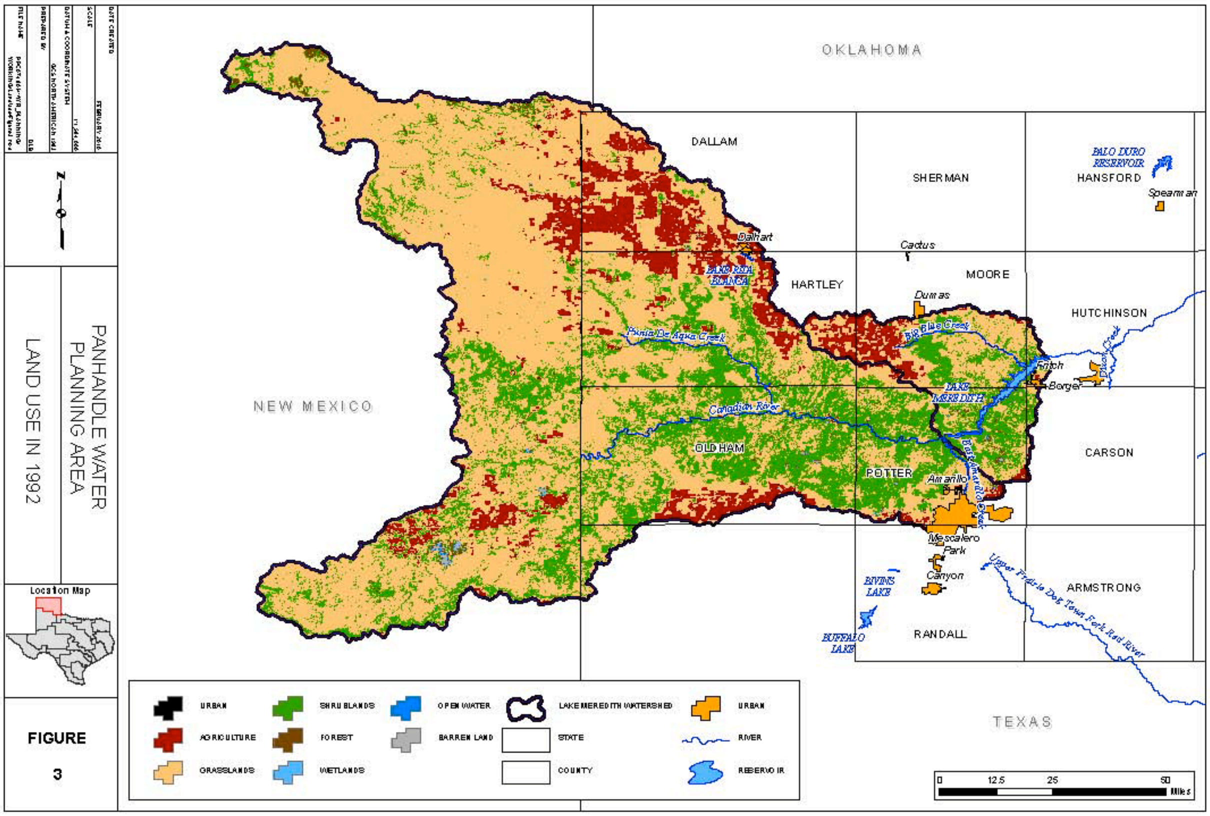


Figure D-3. Reclassified Land Use Map for 1992

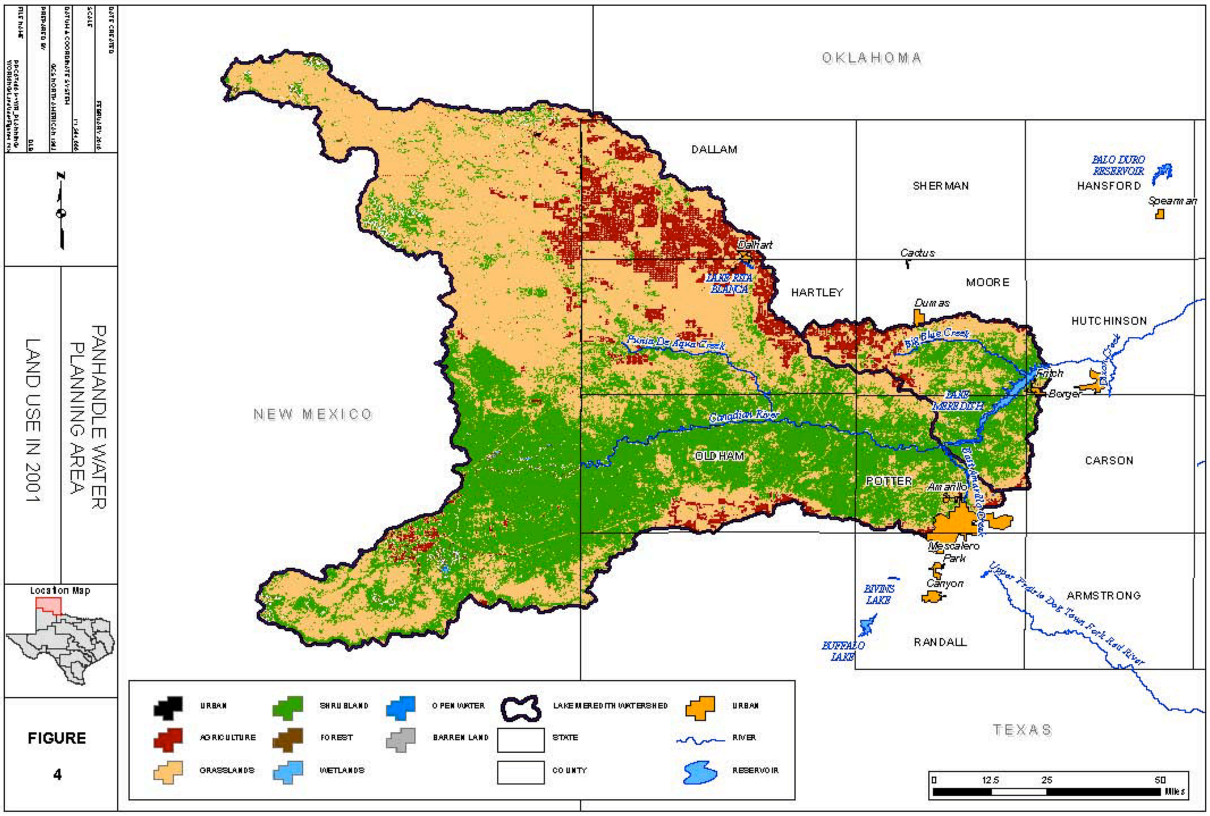


Figure D-4. Reclassified Land Use Map for 2001

APPENDIX H

COST ESTIMATES

Appendix H:

Panhandle Regional Water Planning Area Cost Estimates

As part of the 2006 PWPA Regional Water Plan, cost estimates were developed for each of the recommended water management strategies Region. As appropriate, these cost estimates have been updated for the 2011 regional water plan. In accordance with the Texas Water Development Board guidance the costs for water management strategies are to be updated from second quarter 2002 dollars to September 2008 dollars. The methodology used to develop the 2011 costs is described in the following sections. Where updated unit costs were not available, the Engineering News Record (ENR) Index for construction was used to increase the costs from second quarter 2002 (March) costs to September 2008 costs. An increase of 134% from March 2002 to September 2008 was determined using the ENR Index method. For strategies that do not rely heavily on construction costs were updated based on an annual inflation rate of 3 percent.

Introduction

1. The evaluation of water management strategies requires developing cost estimates. Guidance for cost estimates may be found in the TWDB's "General Guidelines for Regional Water Plan Development (2007-2012)", Section 4.1.2. Costs are to be reported in September 2008 dollars.
2. Standard unit costs for installed pipe, pump stations and standard treatment facilities were developed from actual bid data from similar projects throughout the State of Texas. These estimates were used for all SB1 projects, unless more detailed costing is available. All unit costs include the contractors' mobilization, overhead and profit. The unit costs generally do not include engineering, contingency, financial and legal services, costs for land and rights-of-way, permits, environmental and archeological studies, or mitigation. The costs for these items are determined separately in the cost tables.
3. The information presented in this section is intended to be 'rule-of-thumb' guidance. Specific situations may call for alteration of the procedures and costs. Note that the costs in this memorandum provide a planning level estimate for comparison purposes.
4. It is important that when comparing alternatives that the cost estimates be similar and include similar items. If an existing reliable cost estimate is available for a project it should be used where appropriate. All cost estimates must meet the requirements set forth in the TWDB's "General Guidelines for Regional Water Plan Development (2007-2012)".
5. The cost estimates have two components:
    - Initial capital costs, including engineering and construction costs, and
    - Average annual costs, including annual operation and maintenance costs and debt service.

    TWDB does not require the consultant to determine life cycle or present value analysis. For most situations annual costs are sufficient for comparison purposes and a life-cycle analysis is not required.

ASSUMPTIONS FOR CAPITAL COSTS:

Conveyance Systems

Standard pipeline costs used for these cost estimates are shown in Table 1. Pump station costs are based on required Horsepower capacity and are listed in Table 2. The power capacity is to be determined from the hydraulic analyses conducted from a planning level hydraulic grade line evaluation (or detailed analysis if available). Pipelines and pump stations are to be sized for peak pumping capacity.

- Pump efficiency is assumed to be 72 percent.
- Peaking factor of 2 times the average demand is to be used for strategies when the water is pumped directly to a water treatment plant. (or historical peaking factor, if available)
- Peaking factor of 1.2 to 1.5 is to be used if there are additional water sources and/or the water is transported to a terminal storage facility.
- Ground storage is to be provided at each booster pump station along the transmission line unless there is a more detailed design.
- Ground storage tanks should provide sufficient storage for 2.5 to 4 hours of pumping at peak capacity. Costs for ground storage are shown in Table 3. Covered storage tanks are used for all strategies transporting treated water.

Water Treatment Plants

Water treatment plants are to be sized for peak day capacity (assume peaking factor of 2 if no specific data is available). Costs estimated for new conventional surface water treatment facilities and expansions of existing facilities are listed in Table 4. Conventional treatment does not include advanced technologies, such as ozone or UV treatment. **All treatment plants are to be sized for finished water capacity**.

New Groundwater Wells

Cost estimates required for water management strategies that include additional wells or well fields can be roughly estimated from the relationships in Table 5. These cost relationships are “rule-of-thumb” in nature and are only appropriate in the broad context of the cost evaluations for the RWP process.

The cost relationships assume construction methods required for public water supply wells, including carbon steel surface casing and pipe-based, stainless steel, and wire-wrap screen.

The cost estimates assume that wells would be gravel-packed in the screen sections and the surface casing cemented to their total depth. Estimates include the cost of drilling, completion, well development, well testing, pump, motor, motor controls, column pipe, installation and mobilization. The cost relationships do not include engineering, contingency, financial and legal services, land costs, or permits. A more detailed cost analysis should be completed prior to developing a project.

The costs associated with conveyance systems for multi-well systems can vary widely based on the distance between wells, terrain characteristics, well production, and distance to the treatment facility. These costs should be estimated using standard engineering approaches and site-specific information. For planning purposes, these costs are estimated at $50,000 to $125,000 per well depending on the amount of additional water required and the size and complexity of the infrastructure already in place.

Other Costs

- Engineering, contingency, construction management, financial and legal costs are to be estimated at 30 percent of construction cost for pipelines and 35 percent of construction costs for pump stations, treatment facilities and reservoir projects. (This is in accordance with TWDB guidance.)
- Permitting and mitigation for transmission and treatment projects are to be estimated at 1 percent of the total construction costs. For reservoirs, mitigation and permitting costs are assumed equal to twice the land purchase cost, unless site specific data is available.
- Right-of-way (ROW) costs for transmission lines are estimated at $1,200 per acre of rural ROW. Urban ROW will be higher. If no data is available, assume $10,000 per acre. If a small pipeline follows existing right-of-ways (such as highways), no additional right-of-way cost may be assumed. Large pipelines will require ROW costs regardless of routing.

Interest during construction is the total of interest accrued at the end of the construction period using a 6 percent annual interest rate on total borrowed funds, less a 4 percent rate of return on investment of unspent funds. This is calculated assuming that the total estimated project cost (excluding interest during construction) would be drawn down at a constant rate per month during the construction period. Factors were determined for different lengths of time for project construction. These factors were used in cost estimating and are presented in Table 6.

ASSUMPTIONS FOR ANNUAL COSTS:

Annual costs are to be estimated using the following assumptions:

- Debt service for all transmission and treatment facilities is to be annualized over 20 years, but not longer than the life of the project. [Note: uniform amortization periods should be used when evaluating similar projects for an entity.]
- Annual interest rate for debt service is 6 percent.
- Water purchase costs are to be based on wholesale rates reported by the selling entity when possible. In lieu of known rates, a typical regional cost for treated water and raw water will be developed. For planning purposes, treated water costs are $2.50 per 1,000 gallons and raw water is $0.50 per 1,000 gallons. Actual costs are negotiated between the buyer and seller.
- Operation and Maintenance costs are to be calculated based on the construction cost of the capital improvement. Engineering, permitting, etc. should not be included as a basis for this calculation. However, a 20% allowance for construction contingencies should be included for all O&M calculations. Per the "General Guidelines for Regional Water Plan Development (2007-2012)", O&M should be calculated at:
    - 1 percent of the construction costs for pipelines
    - 1.5 percent for dams
    - 2.5 percent of the construction costs for pump stations, storage tanks, meters and SCADA systems
    - Assume O&M costs for treatment facilities are included in the treatment cost
- Surface water treatment costs are estimated at $0.70 per 1,000 gallons for conventional plants. Treatment for groundwater (assuming disinfection and labor only) is estimated at $0.30 per 1,000 gallons. These costs include chemicals, labor and electricity for treatment and should be applied to amount of finished water receiving the treatment. Electricity associated with moving raw water to the treatment facility is calculated separately (this includes electricity associated with groundwater well fields).
- Pumping costs are to be estimated using an electricity rate of $0.09 per Kilowatt Hour. If local data is available, this can be used.

Table 1

Pipeline Costs (does not include ROW)

Diameter	**Base Installed Cost**	**Rural Cost with Appurtenances**	**Urban Cost with Appurtenances**	**Assumed ROW Width**	**Assumed Temporary Easement Width**
(Inches)	($/Foot)	($/Foot)	($/Foot)	(Feet)	(Feet)
6	24	26	39	15	50
8	31	34	52	15	50
10	39	43	65	20	60
12	47	52	77	20	60
14	55	60	90	20	60
16	62	69	103	20	60
18	70	77	116	20	60
20	82	90	135	20	60
24	105	116	174	20	60
30	132	145	215	20	60
36	167	184	276	20	60
42	196	215	323	30	70
48	244	269	374	30	70
54	288	317	435	30	70
60	332	366	495	30	70
66	401	441	591	30	70
72	469	516	697	30	70
78	538	591	799	40	80
84	616	677	914	40	80
90	704	774	1,045	40	80
96	782	860	1,161	40	80
102	870	957	1,290	40	80
108	977	1,075	1,451	40	80
114	1,075	1,183	1,596	50	100
120	1,212	1,333	1,801	50	100
132	1,466	1,613	2,177	50	100
144	1,730	1,903	2,569	50	100

Notes:
a Costs are based on PVC class 150 pipe for the smaller long, rural pipelines.
b Appurtenances assumed to be 10% of installed pipe costs.
c For urban pipelines, costs were increased by 35% for cost with appurtenances. For pipes 42"and smaller, additional costs were added.
d Adjust costs for obstacles (rock, forested areas) and easy conditions (soft soil in flat country).

Table 2
Pump Station Costs for Transmission Systems

	Booster PS	Lake PS with Intake
Horsepower	Costs	Costs
5	$516,000	
10	$538,000	
20	$564,000	
25	$591,000	
50	$645,000	
100	$742,000	
200	$1,118,000	$1,484,000
300	$1,441,000	$1,914,000
400	$1,795,000	$2,387,000
500	$2,032,000	$2,698,000
600	$2,150,000	$2,860,000
700	$2,268,000	$3,021,000
800	$2,516,000	$3,343,000
900	$2,634,000	$3,505,000
1,000	$2,870,000	$3,817,000
2,000	$4,182,000	$5,562,000
3,000	$5,020,000	$6,677,000
4,000	$6,095,000	$8,107,000
5,000	$6,988,000	$9,293,000
6,000	$8,063,000	$10,723,000
7,000	$8,923,000	$11,867,000
8,000	$9,890,000	$13,154,000
9,000	$10,965,000	$14,583,000
10,000	$12,255,000	$16,299,000
20,000	$20,425,000	$27,165,000
30,000	$26,875,000	$35,744,000
40,000	$33,325,000	$44,322,000
50,000	$38,700,000	$51,471,000
60,000	$44,075,000	$58,620,000
70,000	$49,450,000	$65,769,000

Note:
1. Lake PS with intake costs include intake and pump station.
2. Adjust pump station costs upward if the pump station is designed to move large quantities of water at a low head (i.e. low horsepower).
3. Assumed multiple pump setup for all pump stations.

Table 3
Ground Storage Tanks

Size (MG)	With Roof	Without Roof
0.05	$125,000	$106,000
0.1	$183,000	$156,000
0.5	$438,000	$333,000
1	$634,000	$469,000
1.5	$796,000	$591,000
2	$957,000	$714,000
2.5	$1,086,000	$821,000
3	$1,215,000	$928,000
3.5	$1,355,000	$1,023,000
4	$1,505,000	$1,118,000
5	$1,720,000	$1,303,000
6	$2,075,000	$1,505,000
7	$2,446,000	$1,740,000
8	$2,822,000	$2,069,000
10	$3,746,000	$2,752,000
12	$4,671,000	$3,419,000
14	$5,595,000	$4,085,000

Note: Costs assume steel tanks smaller than 1 MG, concrete tanks 1 MG and larger.

Table 4
Conventional Water Treatment Plant Costs

Plant Capacity (MGD)	New Conventional Plants	Conventional Plant Expansions
1	$5,800,000	$2,900,000
3	$10,600,000	$7,400,000
7	$17,500,000	$12,900,000
10	$22,400,000	$16,000,000
15	$29,100,000	$20,900,000
20	$35,400,000	$26,100,000
30	$47,600,000	$35,700,000
40	$60,000,000	$45,500,000
50	$72,600,000	$54,400,000
60	$84,900,000	$63,500,000
70	$96,600,000	$72,200,000
80	$107,900,000	$81,400,000
90	$118,500,000	$90,500,000
100	$130,200,000	$100,200,000

Note: Plant is sized for finished peak day capacity.

Table 5

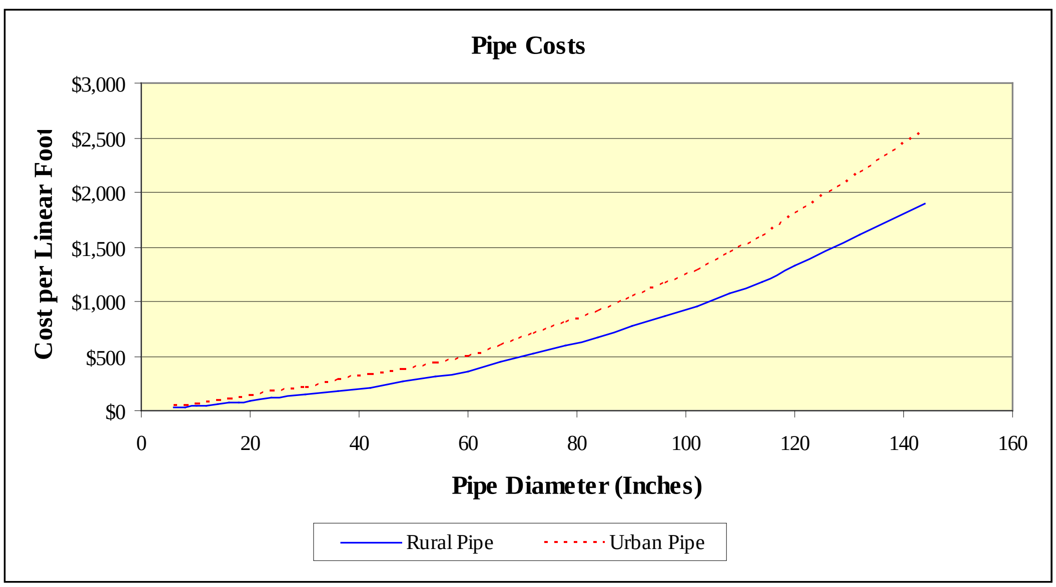
Table 5
Cost Elements for Water Wells

Well Use	Assumed Depth (ft)	Cost ($) per foot
Municipal	500-800	$325-$525
Manufacturing	500	$350
Livestock	500	$200
Mining	500	$200

Table 6
Factors for Interest During Construction

Construction Period	Factor
6 months	0.02167
12 months	0.04167
18 months	0.06167
24 months	0.08167
36 month construction	0.12167

Figure 1



Cost Methodologies for Irrigation Water Management Strategies

NPET: The cost of implementing this water conservation strategy is evaluated in terms of the purchase and maintenance of weather stations used throughout the NPET Network. It is assumed that the stations within the network incur maintenance expenses of $125,000 annually. Each weather station is estimated to have a 10-year life expectancy with a total of $133,000 being required each decade for replacements. Cost estimates were assumed to be the same as identified in the 2006 plan and were inflated to 2008 dollars utilizing the Farm Machinery Price index. The total estimated cost incurred by the NPET Network over the planning horizon is approximately $9.0 million.

Change in crop variety: The cost of water savings is calculated by comparing the regional economic impact with the water savings produced. When evaluated, the cost to the region of saving an acre-foot of water is calculated by dividing the total regional impact by the total water savings from 2020 to 2060.The regional economic impact of this strategy is measured by the change in gross receipts as acreages are shifted from long season to short season. Gross receipts are calculated by using five-year (2004-2008) average regional crop prices obtained from the Master Marketer website and five-year average high and average yields obtained from the Texas Agricultural Statistics Service (TASS). When determining the regional impact of shifting acreage from long season to short season, the high yield was used for long season varieties and the average yield was used for short season crops. These yields were then multiplied by the average prices and the change in acreages for each crop.

Irrigation equipment changes: The estimated cost of implementation for converting irrigation systems is composed of two factors, the initial investment and the replacement costs. The reinvestment costs consist of the 25-year useful life of each system and an eight-year useful life for sprinkler heads. The per-acre investment cost of each system and the replacement costs are derived from “Economics of Irrigation Systems”, (Amosson et al. 2001). Cost estimates were assumed to be the same as identified in the 2006 plan and were inflated to 2008 dollars utilizing the Farm Machinery Price index. The calculated 50-year total implementation cost is $233,592,372.

Change in crop type: The cost of implementing this water conservation strategy is evaluated in terms of reduced land values. It is assumed the reason land is being shifted away from corn production is to generate water savings. Texas Rural Land prices are determined through the Real Estate Center at Texas A&M University. This resource provides estimates of irrigated land with fair water for various Regions for 2008. These values are then compared to dryland values in the same regions to determine the loss in value. Land that has sufficient water available for irrigation is worth a premium compared to land with limited irrigation resources. The cost of water savings is evaluated by calculating the cost incurred by producers to generate an acre-foot of water savings. This measure is generated by dividing the total change in land values by the amount of water conserved.

Conservation tillage: An acre of conservation tillage incurs different levels of cost than an acre of conventional tillage does. It is assumed that the average conventionally tilled field will be disked once, chiseled once and cultivated three times during the year with tillage costs totaling $46/acre. There is one estimated herbicide application, which is estimated to cost $7.59/acre. Plowing and herbicide costs for conventional tillage total $53.36/acre. It is assumed that conservation tillage will incur two field cultivations and one chiseling which will total $27.13/acre. Also, there are expected to be four herbicide applications totaling $30.36. Total plowing and herbicide expenses are estimated at $57.49. This estimates additional costs for conservation tillage at $4.13 when compared to conventional tillage costs. The additional 1.75 inches of water applied per acre to conventional tillage is estimated to cost $16.10/acre. After this is taken into account, the total implementation costs per acre are $69.46 for conventional tillage and $57.49 for conservation tillage. The final implementation cost is determined by subtracting the total implementation cost of conventional tillage from conservation tillage. This produces an additional $11.97 in implementation costs for conservation tillage. This $11.97 is then multiplied by the affected acreage for the corresponding decade. The rates for various filed operations were obtained from Texas Custom Rates Statistics (2008).

Precipitation Enhancement: The implementation costs of the strategy include yearly operating costs and aircraft replacement cost every 20 years. Cost estimates were assumed to be the same as identified in the 2006 plan and were inflated to 2008 dollars utilizing the Farm Machinery Price index. The annual operating expenses incurred are 5.32 million approximately and the aircraft replacement cost incurred once in two decades is 0.80 million.

Converting irrigated crops to dryland: The cost of implementing this water conservation strategy is evaluated in terms of reduced land values. Texas Rural Land prices are determined through the Real Estate Center at Texas A&M University. This resource provides estimates of irrigated land with fair water for various regions for the year 2008. These values are then compared to dryland values in the same regions to determine the loss in value. Land that has sufficient water available for irrigation is worth a premium compared to land with limited irrigation resources. The cost of water savings is evaluated by calculating the cost incurred by producers to generate an acre-foot of water savings. This measure is generated by dividing the total change in land values by the amount of water conserved.

Biotechnology: The implementation cost of this strategy was assumed an additional cost of drought resistant seed which was estimated at a dollar for every one percent reduction in water use. Therefore it was assumed a 15 percent reduction in water use is assumed to cost $15/acre and a 30 percent reduction will cost $30/ acre. Cost estimates were made after consultation with Industry and researches working in the area. These costs are then multiplied with the annual total acreage for corn, cotton and soybeans, affected by incorporation of this strategy.

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Table H-1
City of Amarillo
Develop Potter County Well Field (Ogallala Aquifer)

Owner: City of Amarillo
Quantity: 11,182 AF/Y

Capital Costs	Size		Quantity	Unit	Unit Price	Cost
Wellfield and Treatment						
Wells	800	gpm	21	Ea.	$600,000	$12,600,000
Connection to Pump Station (includes utility corridor)			1	Ea.		$22,100,000
Engineering and Contingencies (provided by Amarillo)						$10,125,200
Subtotal for Wellfield and Treatment						**$44,825,200**
Transmission System						
Pipeline - Transmission Main	48	inch	1	LS		$24,529,400
Pump Station and Storage Tank			1	LS		$9,000,000
Engineering and Contingencies (provided by Amarillo)						$10,058,800
Subtotal for Transmission						**$43,588,200**
Amarillo Delivery Pipeline						
South Delivery Pipeline - Urban	36	inch	42,240	LF	$276	$11,658,200
Alt. North Delivery Pipeline - urban	36	inch	34,000	LF	$276	$9,384,000
Alt North Route Crossings			1	LS	$4,000,000	$4,000,000
Storage tank	2.5	MG	1	EA	$1,086,000	$1,086,000
Pump Station Improvements						$1,000,000
Engineering and Contingencies (30% for pipelines, 35% for other items)						$7,042,800
Subtotal for Amarillo Delivery Pipeline						**$34,171,000**
TOTAL CONSTRUCTION COST						**$122,584,400**
Interest During Construction				**(12 months)**		**$5,108,100**
Permitting and Mitigation						**$818,800**
Groundwater Rights/ Purchase						**$0**
TOTAL CAPITAL COST						**$128,511,300**
Annual Costs						
Debt Service (6 percent for 20 years)						$11,204,200
Electricity						$472,800
Water Treatment ($0.30 per 1,000 gal)						$1,093,100
Operation and Maintenance						$1,605,400
Total Annual Cost						**$14,375,500**
UNIT COSTS (Until Amortized)						
Water Cost ($ per ac-ft)						**$1,286**
Water Cost ($ per 1,000 gallons)						**$3.95**
UNIT COSTS (After Amortization)						
Water Cost ($ per ac-ft)						**$284**
Water Cost ($ per 1,000 gallons)						**$0.87**

Table H-2
City of Amarillo
Develop Roberts County Well Field (Ogallala Aquifer)

Owner: City of Amarillo
Quantity: 11,210 AF/Y Each Phase

Capital Costs	Size		Quantity	Unit	Unit Price	Cost
Wellfield and Treatment						
Wells	800	gpm	15	Ea.	$600,000	$9,000,000
Connection to Pump Station			15	Ea.	$500,000	$7,500,000
Engineering and Contingencies (35% for well field)						$5,775,000
Subtotal for Wellfield and Treatment						**$22,275,000**
Transmission System						
Pipeline - Transmission Main	36	inch	401,280	LF	$184	$73,835,500
Pump Station	3,500	HP	2	LS	$5,557,500	$11,115,000
Storage Tank	3	MG	2	Ea.	$1,215,000	$2,430,000
Easement - Rural	20	Feet	184	AC	$1,219	$225,000
Engineering and Contingencies (30% for pipelines, 35% for other items)						$26,891,400
Subtotal for Transmission						**$114,496,900**
TOTAL CONSTRUCTION COST						**$136,771,900**
Interest During Construction				**(12 months)**		**$5,699,300**
Permitting and Mitigation						**$1,217,400**
Groundwater Rights/ Purchase						**$0**
TOTAL CAPITAL COST						**$143,688,600**
Annual Costs						
Debt Service (6 percent for 20 years)						$12,527,400
Electricity						$949,500
Water Treatment ($0.30 per 1,000 gal)						$1,095,800
Operation and Maintenance						$1,652,400
Total Annual Cost						**$16,225,100**
UNIT COSTS (Until Amortized)						
Water Cost ($ per ac-ft)						**$1,447**
Water Cost ($ per 1,000 gallons)						**$4.44**
UNIT COSTS (After Amortization)						
Water Cost ($ per ac-ft)						**$330**
Water Cost ($ per 1,000 gallons)						**$1.01**

Table H-3
Canadian River Municipal Water Authority
Replace Capacity of Roberts County Well Field (Ogallala Aquifer) in 2030

Owner: Canadian River Municipal Water Authority
Quantity: 15,000 AF/Y

Capital Costs	**Cost**
Collection Pipeline(s)	$1,300,000
Well Field(s) and Wells	$13,161,000
Total Capital Cost	**$14,461,000**
Engineering, Legal Costs and Contingencies (30% for pipelines & 35% for all other)	$4,996,000
Interest During Construction (3 years @ 4 percent)	$2,367,000
Total Project Cost	**$21,824,000**
Annual Costs	
Debt Service (6 percent for 20 years)	$1,903,000
Pipeline and Well Operation and Maintenance	$342,000
Pumping Energy Costs ($0.09/kWh)	$1,341,000
Total Annual Cost	**$3,586,000**
Unit Cost	
Annual Cost of Water ($ per acft)	$239
Annual Cost of Water ($ per 1,000 gallons)	$0.73

Table H-4
City of Borger
New Well Field

Owner: City of Borger
Quantity: 2,000 AF/Y

Capital Costs	Size		Quantity	Unit	Unit Price	Cost
Wellfield and Treatment						
Wells	600	gpm	4	Ea.	$162,500	$650,000
Connection to Pump Station			4	Ea.	$125,000	$500,000
Storage Tank (Closed)	400,000	Gal	1	Ea.	$288,750	$288,800
Engineering and Contingencies (35% for well field)						$503,600
Subtotal for Wellfield and Treatment						**$1,942,400**
Transmission System						
Pipeline - Rural	20	inch	52,800	LF	$90	$4,752,000
Pump Station	80	HP	1	LS	$703,200	$703,200
Easement - Rural	20	Feet	24	AC	$1,219	$30,000
Engineering and Contingencies (30% for pipelines, 35% for other items)						$1,671,700
Subtotal for Transmission						**$7,156,900**
TOTAL CONSTRUCTION COST						**$9,099,300**
Interest During Construction				**(6 months)**		**$197,200**
Permitting and Mitigation						**$82,700**
Groundwater Rights/ Purchase						
TOTAL CAPITAL COST						**$9,379,200**
Annual Costs						
Debt Service (6 percent for 20 years)						$817,700
Electricity						$122,400
Water Treatment ($0.30 per 1,000 gal)						$195,500
Operation and Maintenance						$121,300
Total Annual Cost						**$1,256,900**
UNIT COSTS (Until Amortized)						
Water Cost ($ per ac-ft)						**$628**
Water Cost ($ per 1,000 gallons)						**$1.93**
UNIT COSTS (After Amortization)						
Water Cost ($ per ac-ft)						**$220**
Water Cost ($ per 1,000 gallons)						**$0.67**

Table H-5
City of Cactus
New Well Field

Owner: City of Cactus
Quantity: 1,500 AF/Y

Capital Costs	Size		Quantity	Unit	Unit Price	Cost
Wellfield and Treatment						
Wells	600	gpm	3	Ea.	$552,752	$1,658,300
Connection to Pump Station			3	Ea.	$125,000	$375,000
Storage Tank (Closed)	300,000	Gal	1	Ea.	$244,500	$244,500
Engineering and Contingencies (35% for well field)						$797,200
Subtotal for Wellfield and Treatment						**$3,075,000**
Transmission System						
Pipeline - Transmission Main	20	inch	7,920	LF	$90	$712,800
Pump Station	40	HP	1	LS	$623,400	$623,400
Easement - Rural	20	Feet	4	AC	$1,219	$5,000
Engineering and Contingencies (30% for pipelines, 35% for other items)						$432,000
Subtotal for Transmission						**$1,773,200**
TOTAL CONSTRUCTION COST						**$4,848,200**
Interest During Construction				**(6 months)**		**$105,100**
Permitting and Mitigation						**$43,400**
Groundwater Rights/ Purchase						**$450,000**
TOTAL CAPITAL COST						**$5,446,700**
Annual Costs						
Debt Service (6 percent for 20 years)						$474,900
Electricity						$88,500
Water Treatment ($0.30 per 1,000 gal)						$146,600
Operation and Maintenance						$95,600
Total Annual Cost						**$805,600**
UNIT COSTS (Until Amortized)						
Water Cost ($ per ac-ft)						**$537**
Water Cost ($ per 1,000 gallons)						**$1.65**
UNIT COSTS (After Amortization)						
Water Cost ($ per ac-ft)						**$220**
Water Cost ($ per 1,000 gallons)						**$0.68**

Table H-6
City of Canyon
Drill Eight Wells

Owner: City of Canyon
Quantity: 3,800 AF/Y

Capital Costs	**Size**	**Quantity**	**Unit**	**Unit Price**	**Cost**
Mobilization		1	LS	$300,000	$300,000
Wells	500	8	Ea.	$400,000	$3,200,000
Subtotal for Wellfield and Treatment					**$3,500,000**
Transmission System					
PVC C905 Pipe	24 inch	15,000	LF	$100	$1,500,000
PVC C900 Pipe	12 inch	21,300	LF	$50	$1,065,000
GV & B	24 inch	4	EA	$20,000	$80,000
GV & B	12 inch	10	EA	$5,000	$50,000
Bore Under Railroad	36 inch	340	LF	$350	$119,000
Casing thru Bore	36 inch	340	LF	$200	$68,000
Ground Stoarage Tank	1 MG	1	EA	$1,000,000	$1,000,000
Controls		1	EA	$50,000	$50,000
Fittings		20,000	LBS	$5	$100,000
Electrical Service		1	LS	$100,000	$100,000
Subtotal for Transmission					**$4,132,000**
TOTAL CONSTRUCTION COST					**$7,632,000**
Contingencies (10%)					**$763,200**
Engineering					**$839,600**
Enginnering Survey					**$84,000**
Testing					**$42,000**
Project Representation					**$168,000**
TOTAL CAPITAL COST					**$9,528,800**
Annual Costs					
Debt Service (6 percent for 20 years)					$830,800
Electricity					$178,200
Water Treatment ($0.30 per 1,000 gal)					$371,500
Operation and Maintenance					$166,000
Total Annual Cost					**$1,546,500**
UNIT COSTS (Until Amortized)					
Water Cost ($ per ac-ft)					**$407**
Water Cost ($ per 1,000 gallons)					**$1.25**
UNIT COSTS (After Amortization)					
Water Cost ($ per ac-ft)					**$188**
Water Cost ($ per 1,000 gallons)					**$0.58**

Table H-7
City of Dumas
Develop Ogallala Aquifer with New Wells

Owner: City of Dumas
Quantity: 2,500 AF/Y

Capital Costs	**Size**	**Quantity**	**Unit**	**Unit Price**	**Cost**
Wellfield and Treatment					
Wells	800 gpm	4	Ea.	$368,501	$1,474,000
Connection to Pump Station		4	Ea.	$75,000	$300,000
Storage Tank	500,000 Gal	1	Ea.	$333,000	$333,000
Engineering and Contingencies (35% for well field)					$737,500
Subtotal for Wellfield and Treatment					**$2,844,500**
Transmission System					
Pipeline - Rural	20 inch	26,400	LF	$90	$2,376,000
Pump Station	80 HP	1	LS	$703,200	$703,200
Easement - Rural	20 Feet	12	AC	$1,219	$15,000
Engineering and Contingencies (30% for pipelines, 35% for other items)					$958,900
Subtotal for Transmission					**$4,053,100**
TOTAL CONSTRUCTION COST					**$6,897,600**
Interest During Construction			**(12 months)**		**$287,400**
Permitting and Mitigation					**$62,200**
Groundwater Rights/ Purchase					**$750,000**
TOTAL CAPITAL COST					**$7,997,200**
Annual Costs					
Debt Service (6 percent for 20 years)					$697,200
Electricity					$142,100
Water Treatment ($0.30 per 1,000 gal)					$244,400
Operation and Maintenance					$112,800
Total Annual Cost					**$1,196,500**
UNIT COSTS (Until Amortized)					
Water Cost ($ per ac-ft)					**$479**
Water Cost ($ per 1,000 gallons)					**$1.47**
UNIT COSTS (After Amortization)					
Water Cost ($ per ac-ft)					**$200**
Water Cost ($ per 1,000 gallons)					**$0.61**

Table H-8
City of Fritch
System Purchase and Rehabilitate Existing Well in Carson County

Owner: City of Fritch
Quantity: 200 AF/Y

Capital Costs	**Size**	**Quantity**	**Unit**	**Unit Price**	**Cost**
Wellfield					
Rehabilitate Existing Wells		1	Ea.	$58,000	$58,000
Engineering and Contingencies (35% for well field)					$20,300
Subtotal for Wellfield and Treatment					**$78,300**
TOTAL CONSTRUCTION COST					**$78,300**
Interest During Construction			**(6 months)**		**$1,700**
Permitting and Mitigation					**$32,800**
Water Rights Purchase					**$60,000**
Infrastructure Purchase		**1**	**LS**	**$2,677,500**	**$2,677,500**
TOTAL CAPITAL COST					**$2,850,300**
Annual Costs					
Debt Service (6 percent for 20 years)					$248,500
Electricity (estimated)					$9,700
Water Treatment ($0.30 per 1,000 gal)					$19,600
Operation and Maintenance					$33,800
Total Annual Cost					**$311,600**
UNIT COSTS (Until Amortized)					
Water Cost ($ per ac-ft)					**$1,558**
Water Cost ($ per 1,000 gallons)					**$4.78**
UNIT COSTS (After Amortization)					
Water Cost ($ per ac-ft)					**$316**
Water Cost ($ per 1,000 gallons)					**$0.97**

Table H-9
City of Fritch
New Well in Hutchinson County

Owner: City of Fritch
Quantity: 200 AF/Y   Assume new well is in Hutchinson County. May be located in Carson.

Capital Costs	Size		Quantity	Unit	Unit Price	Cost
Wellfield and Treatment						
New Well	500	gpm	1	Ea.	$563,000	$563,000
Engineering and Contingencies (35% for well field)						$197,100
Subtotal for Wellfield and Treatment						**$760,100**
Transmission System						
Pipeline - Rural	8	inch	5,280	LF	$34	$179,500
Pump Station	5	HP	1	LS	$50,000	$50,000
Easement - Rural	20	Feet	2	AC	$1,219	$3,000
Engineering and Contingencies (30% for pipelines, 35% for other items)						$71,400
Subtotal for Transmission						**$303,900**
TOTAL CONSTRUCTION COST						**$1,064,000**
Interest During Construction				**(6 months)**		**$23,100**
Permitting and Mitigation						**$9,500**
Groundwater Rights/ Purchase						**$60,000**
TOTAL CAPITAL COST						**$1,156,600**
Annual Costs						
Debt Service (6 percent for 20 years)						$100,800
Electricity						$9,200
Water Treatment ($0.30 per 1,000 gal)						$19,600
Operation and Maintenance						$20,600
Total Annual Cost						**$150,200**
UNIT COSTS (Until Amortized)						
Water Cost ($ per ac-ft)						**$751**
Water Cost ($ per 1,000 gallons)						**$2.30**
UNIT COSTS (After Amortization)						
Water Cost ($ per ac-ft)						**$247**
Water Cost ($ per 1,000 gallons)						**$0.76**

Table H-10
City of Gruver
New Wellfield

Owner: City of Gruver
Quantity: 350 AF/Y

Capital Costs	Size		Quantity	Unit	Unit Price	Cost
Wellfield and Treatment						
Wells	400	gpm	1	Ea.	$162,500	$162,500
Connection to Pump Station			1	Ea.	$50,000	$50,000
Storage Tank (Closed)	70,000	Gal	1	Ea.	$126,000	$126,000
Engineering and Contingencies (35% for well field)						$118,500
Subtotal for Wellfield and Treatment						**$457,000**
Transmission System						
Pipeline - Rural	8	inch	15,840	LF	$34	$538,600
Pump Station	15	HP	1	LS	$551,000	$551,000
Easement - Rural	20	Feet	7	AC	$1,219	$9,000
Engineering and Contingencies (30% for pipelines, 35% for other items)						$354,400
Subtotal for Transmission						**$1,453,000**
TOTAL CONSTRUCTION COST						**$1,910,000**
Interest During Construction				**(6 months)**		**$41,400**
Permitting and Mitigation						**$17,100**
Groundwater Rights/ Purchase						**$0**
TOTAL CAPITAL COST						**$1,968,500**
Annual Costs						
Debt Service (6 percent for 20 years)						$171,600
Electricity						$17,000
Water Treatment ($0.30 per 1,000 gal)						$34,200
Operation and Maintenance						$33,200
Total Annual Cost						**$256,000**
UNIT COSTS (Until Amortized)						
Water Cost ($ per ac-ft)						**$731**
Water Cost ($ per 1,000 gallons)						**$2.24**
UNIT COSTS (After Amortization)						
Water Cost ($ per ac-ft)						**$241**
Water Cost ($ per 1,000 gallons)						**$0.74**

Table H-11
City of Lefors
New Wellfield

Owner: City of Lefors
Quantity: 100 AF/Y

Capital Costs	Size		Quantity	Unit	Unit Price	Cost
Wellfield and Treatment						
Wells	200	gpm	1	Ea.	$162,500	$162,500
Connection to Pump Station			1	Ea.	$50,000	$50,000
Storage Tank (Closed)	20,000	Gal	1	Ea.	$53,000	$53,000
Engineering and Contingencies (35% for well field)						$92,900
Subtotal for Wellfield and Treatment						**$358,400**
Transmission System						
Pipeline - Rural	6	inch	10,560	LF	$26	$274,600
Pump Station	2	HP	1	LS	$258,000	$258,000
Easement - Rural	20	Feet	5	AC	$1,219	$6,000
Engineering and Contingencies (30% for pipelines, 35% for other items)						$172,700
Subtotal for Transmission						**$711,300**
TOTAL CONSTRUCTION COST						**$1,069,700**
Interest During Construction				**(6 months)**		**$23,200**
Permitting and Mitigation						**$9,600**
Groundwater Rights/ Purchase						**$30,000**
TOTAL CAPITAL COST						**$1,132,500**
Annual Costs						
Debt Service (6 percent for 20 years)						$98,700
Electricity						$5,300
Water Treatment ($0.30 per 1,000 gal)						$9,800
Operation and Maintenance						$19,000
Total Annual Cost						**$132,800**
UNIT COSTS (Until Amortized)						
Water Cost ($ per ac-ft)						**$1,328**
Water Cost ($ per 1,000 gallons)						**$4.08**
UNIT COSTS (After Amortization)						
Water Cost ($ per ac-ft)						**$341**
Water Cost ($ per 1,000 gallons)						**$1.05**

Table H-12
City of Memphis
New Wellfield

Owner: City of Memphis
Quantity: 100 AF/Y

Capital Costs	Size		Quantity	Unit	Unit Price	Cost
Wellfield and Treatment						
Wells	150	gpm	1	Ea.	$97,500	$97,500
Connection to Pump Station			1	Ea.	$50,000	$50,000
Storage Tank (Closed)	20,000	Gal	1	Ea.	$53,000	$53,000
Engineering and Contingencies (35% for well field)						$70,200
Subtotal for Wellfield and Treatment						**$270,700**
Transmission System						
Pipeline - Rural	6	inch	10,560	LF	$26	$274,600
Pump Station	2	HP	1	LS	$258,000	$258,000
Easement - Rural	20	Feet	5	AC	$1,219	$6,000
Engineering and Contingencies (30% for pipelines, 35% for other items)						$172,700
Subtotal for Transmission						**$711,300**
TOTAL CONSTRUCTION COST						**$982,000**
Interest During Construction				**(6 months)**		**$21,300**
Permitting and Mitigation						**$8,800**
Groundwater Rights/ Purchase						**$30,000**
TOTAL CAPITAL COST						**$1,042,100**
Annual Costs						
Debt Service (6 percent for 20 years)						$90,900
Electricity						$3,400
Water Treatment ($0.30 per 1,000 gal)						$9,800
Operation and Maintenance						$17,100
Total Annual Cost						**$121,200**
UNIT COSTS (Until Amortized)						
Water Cost ($ per ac-ft)						**$1,212**
Water Cost ($ per 1,000 gallons)						**$3.72**
UNIT COSTS (After Amortization)						
Water Cost ($ per ac-ft)						**$303**
Water Cost ($ per 1,000 gallons)						**$0.93**

Table H-13
City of Pampa
Rehabilitate Existing Wells and New Well

Owner: City of Pampa
Quantity: 2,581 AF/Y Assume 1500 af with new well and remainder from rehabbed wells

Capital Costs	**Size**		**Quantity**	**Unit**	**Unit Price**	**Cost**
Wellfield and Treatment						
Rehabilitate Existing Wells			5	Ea.	$25,000	$125,000
New Well	750	gpm	1	Ea.	$162,500	$162,500
Engineering and Contingencies (35% for well field)						$100,600
Subtotal for Wellfield and Treatment						**$388,100**
Transmission System						
Pipeline - Rural	18	inch	5,280	LF	$77	$406,600
Pump Station	22	HP	1	LS	$564,000	$564,000
Easement - Rural	20	Feet	2	AC	$1,219	$3,000
Engineering and Contingencies (30% for pipelines, 35% for other items)						$319,400
Subtotal for Transmission						**$1,293,000**
TOTAL CONSTRUCTION COST						**$1,681,100**
Interest During Construction				**(6 months)**		**$36,400**
Permitting and Mitigation						**$13,600**
Groundwater Rights/ Purchase	**(Assume well located on City property)**					**$0**
TOTAL CAPITAL COST						**$1,731,100**
Annual Costs						
Debt Service (6 percent for 20 years)						$150,900
Electricity						$69,400
Water Treatment ($0.30 per 1,000 gal)						$252,300
Operation and Maintenance						$30,400
Total Annual Cost						**$503,000**
UNIT COSTS (Until Amortized)						
Water Cost ($ per ac-ft)						**$195**
Water Cost ($ per 1,000 gallons)						**$0.60**
UNIT COSTS (After Amortization)						
Water Cost ($ per ac-ft)						**$136**
Water Cost ($ per 1,000 gallons)						**$0.42**

Table H-14
City of Panhandle
New Groundwater Wells in Ogallala Aquifer

Owner: City of Panhandle
Quantity: 600 AF/Y

Capital Costs	Size		Quantity	Unit	Unit Price	Cost
Wellfield and Treatment						
Wells	350	gpm	2	Ea.	$213,862	$427,700
Connection to Pump Station			1	Ea.	$50,000	$50,000
Storage Tank (Closed)	100,000	Gal	1	Ea.	$183,000	$183,000
Engineering and Contingencies (35% for well field)						$231,200
Subtotal for Wellfield and Treatment						**$891,900**
Transmission System						
Pipeline - Rural	8	inch	26,400	LF	$34	$897,600
Pump Station	85	HP	1	LS	$712,900	$712,900
Easement - Rural	20	Feet	12	AC	$1,219	$15,000
Engineering and Contingencies (30% for pipelines, 35% for other items)						$518,800
Subtotal for Transmission						**$2,144,300**
TOTAL CONSTRUCTION COST						**$3,036,200**
Interest During Construction				**(6 months)**		**$65,800**
Permitting and Mitigation						**$27,300**
Groundwater Rights/ Purchase						**$180,000**
TOTAL CAPITAL COST						**$3,309,300**
Annual Costs						
Debt Service (6 percent for 20 years)						$288,500
Electricity						$42,200
Water Treatment ($0.30 per 1,000 gal)						$58,700
Operation and Maintenance						$52,000
Total Annual Cost						**$441,400**
UNIT COSTS (Until Amortized)						
Water Cost ($ per ac-ft)						**$736**
Water Cost ($ per 1,000 gallons)						**$2.26**
UNIT COSTS (After Amortization)						
Water Cost ($ per ac-ft)						**$255**
Water Cost ($ per 1,000 gallons)						**$0.78**

Table H-15
City of Perryton
New Groundwater Wells in Ogallala Aquifer

Owner: City of Perryton
Quantity: 1,200 AF/Y

Capital Costs	Size		Quantity	Unit	Unit Price	Cost
Wellfield and Treatment						
Wells	400	gpm	4	Ea.	$213,862	$855,400
Connection to Pump Station			4	Ea.	$50,000	$200,000
Storage Tank (Closed)	200,000	Gal	1	Ea.	$250,000	$250,000
Engineering and Contingencies (35% for well field)						$456,900
Subtotal for Wellfield and Treatment						**$1,762,300**
Transmission System						
Pipeline - Rural	14	inch	52,800	LF	$60	$3,168,000
Pump Station	86	HP	1	LS	$714,840	$714,800
Easement - Rural	20	Feet	24	AC	$1,219	$30,000
Engineering and Contingencies (30% for pipelines, 35% for other items)						$1,200,600
Subtotal for Transmission						**$5,113,400**
TOTAL CONSTRUCTION COST						**$6,875,700**
Interest During Construction				**(6 months)**		**$149,000**
Permitting and Mitigation						**$62,300**
Groundwater Rights/ Purchase						**$0**
TOTAL CAPITAL COST						**$7,087,000**
Annual Costs						
Debt Service (6 percent for 20 years)						$617,900
Electricity						$77,000
Water Treatment ($0.30 per 1,000 gal)						$117,300
Operation and Maintenance						$98,600
Total Annual Cost						**$910,800**
UNIT COSTS (Until Amortized)						
Water Cost ($ per ac-ft)						**$759**
Water Cost ($ per 1,000 gallons)						**$2.33**
UNIT COSTS (After Amortization)						
Water Cost ($ per ac-ft)						**$244**
Water Cost ($ per 1,000 gallons)						**$0.75**

Table H-16
City of Spearman
New Wellfield

Owner: City of Spearman
Quantity: 900 AF/Y

Capital Costs	Size		Quantity	Unit	Unit Price	Cost
Wellfield and Treatment						
Wells	500	gpm	2	Ea.	$162,500	$325,000
Connection to Pump Station			1	Ea.	$100,000	$100,000
Storage Tank (Closed)	175,000	Gal	1	Ea.	$189,188	$189,200
Engineering and Contingencies (35% for well field)						$215,000
Subtotal for Wellfield and Treatment						**$829,200**
Transmission System						
Pipeline - Rural	12	inch	26,400	LF	$52	$1,372,800
Pump Station	45	HP	1	LS	$634,200	$634,200
Easement - Rural	20	Feet	12	AC	$1,219	$15,000
Engineering and Contingencies (30% for pipelines, 35% for other items)						$633,800
Subtotal for Transmission						**$2,655,800**
TOTAL CONSTRUCTION COST						**$3,485,000**
Interest During Construction				**(6 months)**		**$75,500**
Permitting and Mitigation						**$31,500**
Groundwater Rights/ Purchase						**$270,000**
TOTAL CAPITAL COST						**$3,862,000**
Annual Costs						
Debt Service (6 percent for 20 years)						$336,700
Electricity						$55,900
Water Treatment ($0.30 per 1,000 gal)						$88,000
Operation and Maintenance						$54,000
Total Annual Cost						**$534,600**
UNIT COSTS (Until Amortized)						
Water Cost ($ per ac-ft)						**$594**
Water Cost ($ per 1,000 gallons)						**$1.82**
UNIT COSTS (After Amortization)						
Water Cost ($ per ac-ft)						**$220**
Water Cost ($ per 1,000 gallons)						**$0.67**

Table H-17
City of Sunray
New Groundwater Wells in Ogallala Aquifer

Owner: City of Sunray
Quantity: 800 AF/Y

Capital Costs	Size		Quantity	Unit	Unit Price	Cost
Wellfield and Treatment						
Wells	350	gpm	3	Ea.	$213,862	$641,600
Connection to Pump Station			3	Ea.	$50,000	$150,000
Storage Tank (Closed)	150,000	Gal	1	Ea.	$225,000	$225,000
Engineering and Contingencies (35% for well field)						$355,800
Subtotal for Wellfield and Treatment						**$1,372,400**
Transmission System						
Pipeline - Rural	10	inch	10,560	LF	$43	$454,100
Pump Station	35	HP	1	LS	$612,600	$612,600
Easement - Rural	20	Feet	5	AC	$1,219	$6,000
Engineering and Contingencies (30% for pipelines, 35% for other items)						$350,600
Subtotal for Transmission						**$1,423,300**
TOTAL CONSTRUCTION COST						**$2,795,700**
Interest During Construction				**(6 months)**		**$60,600**
Permitting and Mitigation						**$25,000**
Groundwater Rights/ Purchase						**$240,000**
TOTAL CAPITAL COST						**$3,121,300**
Annual Costs						
Debt Service (6 percent for 20 years)						$272,100
Electricity						$49,100
Water Treatment ($0.30 per 1,000 gal)						$78,200
Operation and Maintenance						$54,300
Total Annual Cost						**$453,700**
UNIT COSTS (Until Amortized)						
Water Cost ($ per ac-ft)						**$567**
Water Cost ($ per 1,000 gallons)						**$1.74**
UNIT COSTS (After Amortization)						
Water Cost ($ per ac-ft)						**$227**
Water Cost ($ per 1,000 gallons)						**$0.70**

Table H-17
City of Texline
New Groundwater Wells in Ogallala Aquifer

Owner: City of Texline
Quantity: 250 AF/Y

Capital Costs	Size		Quantity	Unit	Unit Price	Cost
Wellfield and Treatment						
Wells	350	gpm	1	Ea.	$213,862	$213,900
Connection to Pump Station			1	Ea.	$25,000	$25,000
Storage Tank (Closed)	50,000	Gal	1	Ea.	$100,000	$100,000
Engineering and Contingencies (35% for well field)						$118,600
Subtotal for Wellfield and Treatment						**$457,500**
Transmission System						
Pipeline - Rural	6	inch	26,400	LF	$26	$686,400
Pump Station	25	HP	1	LS	$591,000	$591,000
Easement - Rural	20	Feet	12	AC	$1,219	$15,000
Engineering and Contingencies (30% for pipelines, 35% for other items)						$412,800
Subtotal for Transmission						**$1,705,200**
TOTAL CONSTRUCTION COST						**$2,162,700**
Interest During Construction				**(6 months)**		**$46,900**
Permitting and Mitigation						**$19,400**
Groundwater Rights/ Purchase						**$75,000**
TOTAL CAPITAL COST						**$2,304,000**
Annual Costs						
Debt Service (6 percent for 20 years)						$200,900
Electricity						$16,900
Water Treatment ($0.30 per 1,000 gal)						$24,400
Operation and Maintenance						$36,100
Total Annual Cost						**$278,300**
UNIT COSTS (Until Amortized)						
Water Cost ($ per ac-ft)						**$1,113**
Water Cost ($ per 1,000 gallons)						**$3.42**
UNIT COSTS (After Amortization)						
Water Cost ($ per ac-ft)						**$310**
Water Cost ($ per 1,000 gallons)						**$0.95**

Table H-19
City of Wheeler
New Groundwater Wells in Ogallala Aquifer

Owner: City of Wheeler
Quantity: 200 AF/Y

Capital Costs	Size		Quantity	Unit	Unit Price	Cost
Wellfield and Treatment						
Wells	350	gpm	1	Ea.	$213,862	$213,900
Connection to Pump Station			1	Ea.	$25,000	$25,000
Storage Tank (Closed)	50,000	Gal	1	Ea.	$100,000	$100,000
Engineering and Contingencies (35% for well field)						$118,600
Subtotal for Wellfield and Treatment						**$457,500**
Transmission System						
Pipeline - Rural	6	inch	26,400	LF	$26	$686,400
Pump Station	15	HP	1	LS	$551,000	$551,000
Easement - Rural	20	Feet	12	AC	$1,219	$15,000
Engineering and Contingencies (30% for pipelines, 35% for other items)						$398,800
Subtotal for Transmission						**$1,651,200**
TOTAL CONSTRUCTION COST						**$2,108,700**
Interest During Construction				**(6 months)**		**$45,700**
Permitting and Mitigation						**$18,900**
Groundwater Rights/ Purchase						**$60,000**
TOTAL CAPITAL COST						**$2,233,300**
Annual Costs						
Debt Service (6 percent for 20 years)						$194,700
Electricity						$13,000
Water Treatment ($0.30 per 1,000 gal)						$19,600
Operation and Maintenance						$34,900
Total Annual Cost						**$262,200**
UNIT COSTS (Until Amortized)						
Water Cost ($ per ac-ft)						**$1,311**
Water Cost ($ per 1,000 gallons)						**$4.02**
UNIT COSTS (After Amortization)						
Water Cost ($ per ac-ft)						**$338**
Water Cost ($ per 1,000 gallons)						**$1.04**

Table H-20
Randall County-Other
Purchase Water from Amarillo

Owner: County-Other, Randall County
Quantity: 1,000 AF/Y

Capital Costs	Size		Quantity	Unit	Unit Price	Cost
Transmission System						
Pipeline - Rural	14	inch	26,400	LF	$60	$1,584,000
Pump Station	80	HP	1	LS	$703,200	$703,200
Easement - Rural	20	Feet	12	AC	$1,219	$15,000
Engineering and Contingencies (30% for pipelines, 35% for other items)						$721,300
Subtotal for Transmission						**$3,023,500**
TOTAL CONSTRUCTION COST						**$3,023,500**
Interest During Construction				**(6 months)**		**$65,500**
Permitting and Mitigation						**$27,400**
TOTAL CAPITAL COST						**$3,116,400**
Annual Costs						
Debt Service (6 percent for 20 years)						$271,700
Electricity (Transmission)						$16,000
Water Purchase ($2.50 per 1,000 gal.)						$814,600
Operation and Maintenance						$40,096
Total Annual Cost						**$1,142,396**
UNIT COSTS (Until Amortized)						
Water Cost ($ per ac-ft)						**$1,142**
Water Cost ($ per 1,000 gallons)						**$3.51**
UNIT COSTS (After Amortization)						
Water Cost ($ per ac-ft)						**$871**
Water Cost ($ per 1,000 gallons)						**$2.67**

Table H-21
County-Other WUGs with Needs less than 200 ac-ft/yr
Install New Groundwater Well

Owner: County-Other
Quantity: 200 AF/Y

Capital Costs	Size		Quantity	Unit	Unit Price	Cost
Wellfield and Treatment						
Wells	200	gpm	2	Ea.	$180,960	$361,900
Connection to Pump Station			2	Ea.	$50,000	$100,000
Storage Tank (Closed)	25,000	Gal	2	Ea.	$50,000	$100,000
Engineering and Contingencies (35% for well field)						$196,700
Subtotal for Wellfield and Treatment						**$758,600**
Transmission System						
Pipeline - Rural	6	inch	26,400	LF	$26	$686,400
Pump Station	10	HP	1	LS	$538,000	$538,000
Easement - Rural	15	Feet	9	AC	$1,219	$12,000
Engineering and Contingencies (30% for pipelines, 35% for other items)						$394,200
Subtotal for Transmission						**$1,630,600**
TOTAL CONSTRUCTION COST						**$2,389,200**
Interest During Construction				**(6 months)**		**$51,800**
Permitting and Mitigation						**$21,400**
Groundwater Rights/ Purchase						**$60,000**
TOTAL CAPITAL COST						**$2,522,400**
Annual Costs						
Debt Service (6 percent for 20 years)						$219,900
Electricity						$10,400
Water Treatment ($0.30 per 1,000 gal)						$19,600
Operation and Maintenance						$41,200
Total Annual Cost						**$291,100**
UNIT COSTS (Until Amortized)						
Water Cost ($ per ac-ft)						**$1,456**
Water Cost ($ per 1,000 gallons)						**$4.47**
UNIT COSTS (After Amortization)						
Water Cost ($ per ac-ft)						**$356**
Water Cost ($ per 1,000 gallons)						**$1.09**

Table H-22
County-Other WUGs with Needs around 600 ac-ft/yr
Install New Groundwater Wells

Owner: County-Other
Quantity: 600 AF/Y

Capital Costs	Size		Quantity	Unit	Unit Price	Cost
Wellfield and Treatment						
Wells	400	gpm	2	Ea.	$197,411	$394,800
Connection to Pump Station			2	Ea.	$100,000	$200,000
Storage Tank (Closed)	120,000	Gal	1	Ea.	$164,850	$164,900
Engineering and Contingencies (35% for well field)						$265,900
Subtotal for Wellfield and Treatment						**$1,025,600**
Transmission System						
Pipeline - Rural	10	inch	10,560	LF	$43	$454,100
Pump Station	25	HP	1	LS	$591,000	$591,000
Easement - Rural	20	Feet	5	AC	$1,219	$6,000
Engineering and Contingencies (30% for pipelines, 35% for other items)						$343,100
Subtotal for Transmission						**$1,394,200**
TOTAL CONSTRUCTION COST						**$2,419,800**
Interest During Construction				**(12 months)**		**$100,800**
Permitting and Mitigation						**$21,700**
Groundwater Rights/ Purchase						**$180,000**
TOTAL CAPITAL COST						**$2,722,300**
Annual Costs						
Debt Service (6 percent for 20 years)						$237,300
Electricity						$32,300
Water Treatment ($0.30 per 1,000 gal)						$58,700
Operation and Maintenance						$45,900
Total Annual Cost						**$374,200**
UNIT COSTS (Until Amortized)						
Water Cost ($ per ac-ft)						**$624**
Water Cost ($ per 1,000 gallons)						**$1.91**
UNIT COSTS (After Amortization)						
Water Cost ($ per ac-ft)						**$228**
Water Cost ($ per 1,000 gallons)						**$0.70**

Table H-23
County-Other WUGs with Needs around 1,000 ac-ft/yr
Install New Groundwater Wells

Owner: County-Other
Quantity: 1,000 AF/Y

Capital Costs	Size		Quantity	Unit	Unit Price	Cost
Wellfield and Treatment						
Wells	600	gpm	2	Ea.	$213,862	$427,700
Connection to Pump Station			2	Ea.	$100,000	$200,000
Storage Tank (Closed)	200,000	Gal	1	Ea.	$200,250	$200,300
Engineering and Contingencies (35% for well field)						$289,800
Subtotal for Wellfield and Treatment						**$1,117,800**
Transmission System						
Pipeline - Rural	12	inch	10,560	LF	$52	$549,100
Pump Station	40	HP	1	LS	$623,400	$623,400
Easement - Rural	20	Feet	5	AC	$1,219	$6,000
Engineering and Contingencies (30% for pipelines, 35% for other items)						$382,900
Subtotal for Transmission						**$1,561,400**
TOTAL CONSTRUCTION COST						**$2,679,200**
Interest During Construction				**(12 months)**		**$111,600**
Permitting and Mitigation						**$24,000**
Groundwater Rights/ Purchase						**$300,000**
TOTAL CAPITAL COST						**$3,114,800**
Annual Costs						
Debt Service (6 percent for 20 years)						$271,600
Electricity						$54,000
Water Treatment ($0.30 per 1,000 gal)						$97,800
Operation and Maintenance						$50,100
Total Annual Cost						**$473,500**
UNIT COSTS (Until Amortized)						
Water Cost ($ per ac-ft)						**$474**
Water Cost ($ per 1,000 gallons)						**$1.45**
UNIT COSTS (After Amortization)						
Water Cost ($ per ac-ft)						**$202**
Water Cost ($ per 1,000 gallons)						**$0.62**

Table H-24
County-Other WUGs with Needs around 2,000 ac-ft/yr
Install New Groundwater Wells

Owner: County-Other
Quantity: 2,000 AF/Y

Capital Costs	**Size**		**Quantity**	**Unit**	**Unit Price**	**Cost**
Wellfield and Treatment						
Wells	800	gpm	3	Ea.	$263,215	$789,600
Connection to Pump Station			3	Ea.	$100,000	$300,000
Storage Tank (Closed)	400,000	Gal	1	Ea.	$288,750	$288,800
Engineering and Contingencies (35% for well field)						$482,400
Subtotal for Wellfield and Treatment						**$1,860,800**
Transmission System						
Pipeline - Rural	16	inch	10,560	LF	$69	$728,600
Pump Station	80	HP	1	LS	$703,200	$703,200
Easement - Rural	20	Feet	5	AC	$1,219	$6,000
Engineering and Contingencies (30% for pipelines, 35% for other items)						$464,700
Subtotal for Transmission						**$1,902,500**
TOTAL CONSTRUCTION COST						**$3,763,300**
Interest During Construction				**(12 months)**		**$156,800**
Permitting and Mitigation						**$33,700**
Groundwater Rights/ Purchase						**$600,000**
TOTAL CAPITAL COST						**$4,553,800**
Annual Costs						
Debt Service (6 percent for 20 years)						$397,000
Electricity						$107,600
Water Treatment ($0.30 per 1,000 gal)						$195,500
Operation and Maintenance						$71,100
Total Annual Cost						**$771,200**
UNIT COSTS (Until Amortized)						
Water Cost ($ per ac-ft)						**$386**
Water Cost ($ per 1,000 gallons)						**$1.18**
UNIT COSTS (After Amortization)						
Water Cost ($ per ac-ft)						**$187**
Water Cost ($ per 1,000 gallons)						**$0.57**

Table H-25
Steam Electric Power WUGs with Needs less than 200 ac-ft/yr
Install New Groundwater Well

Owner: Steam Electric Power
Quantity: 200 AF/Y

Capital Costs	Size		Quantity	Unit	Unit Price	Cost
Wellfield and Treatment						
Wells	300	gpm	1	Ea.	$180,960	$181,000
Connection to Pump Station			1	Ea.	$131,608	$131,600
Storage Tank (Closed)	50,000	Gal	1	Ea.	$106,000	$106,000
Engineering and Contingencies (35% for well field)						$146,500
Subtotal for Wellfield and Treatment						**$565,100**
Transmission System						
Pipeline - Rural	8	inch	10,560	LF	$34	$359,000
Pump Station	6	HP	1	LS	$520,400	$520,400
Easement - Rural	15	Feet	4	AC	$1,219	$5,000
Engineering and Contingencies (30% for pipelines, 35% for other items)						$289,800
Subtotal for Transmission						**$1,174,200**
TOTAL CONSTRUCTION COST						**$1,739,300**
Interest During Construction				**(6 months)**		**$37,700**
Permitting and Mitigation						**$15,600**
Groundwater Rights/ Purchase						**$60,000**
TOTAL CAPITAL COST						**$1,852,600**
Annual Costs						
Debt Service (6 percent for 20 years)						$161,500
Electricity (Transmission)						$9,300
Operation and Maintenance						$32,500
Total Annual Cost						**$203,300**
UNIT COSTS (Until Amortized)						
Water Cost ($ per ac-ft)						**$1,017**
Water Cost ($ per 1,000 gallons)						**$3.12**
UNIT COSTS (After Amortization)						
Water Cost ($ per ac-ft)						**$209**
Water Cost ($ per 1,000 gallons)						**$0.64**

Table H-26
Connecting to Palo Duro Reservoir

Owner:	Palo Duro River Authority		Percentage
Quantity:	Cactus	1,744	45.0%
	Dumas	1,356	35.0%
	Sunray	271	7.0%
	Gruver	116	3.0%
	Spearman	271	7.0%
	Stinnet	116	3.0%
	Total	3,875	

		Quantity	Units	Unit Price	Cost
Water Treatment Plant					
9 MGD Conventional Treatment Plant		1	LS	$20,766,667	$20,766,700
Engineering and Contingencies (35%)					$7,268,300
Subtotal for Water Treatment Plant					**$28,035,000**

	Construction	Capital
Cactus	$9,345,000	$12,615,800
Dumas	$7,268,300	$9,812,300
Sunray	$1,453,700	$1,962,500
Gruver	$623,000	$841,100
Spearman	$1,453,700	$1,962,500
Stinnet	$623,000	$841,100
check total	$20,766,700	$28,035,300

		Quantity	Units	Unit Price	Cost
Pipeline System Components					
24" line from Res. to WTP		9,000	LF	$116	$1,044,000
24" line from WTP to Spearman		51,000	LF	$116	$5,916,000
Crossings		1	LS		$116,200
Connection to Spearman		1	LS		$15,500
ROW	20	23	AC	$1,219	$28,000
Engineering and Contingencies (30%)					$2,127,500
Pipeline Subtotal at Spearman					**$9,247,200**

	Construction	Capital	Electricity ($)
Cactus	$3,132,000	$4,161,200	$9,100
Dumas	$2,436,000	$3,236,500	$7,100
Sunray	$487,200	$647,300	$1,400
Gruver	$208,800	$277,400	$600
Spearman	$487,200	$647,300	$1,400
Stinnet	$208,800	$277,400	$600
check total	$6,960,000	$9,247,100	$20,200

Table H-26, Continued

		Quantity	Units	Unit Price	Cost
8" line from Spearman to Gruver		71,300	LF	$34	$2,424,200
Crossings		1	LS		$100,700
Connection to Gruver		1	LS		$15,500
ROW	15	25	AC	$1,219	$30,500
Engineering and Contingencies (30%)					$762,100
Pipeline Subtotal at Gruver					**$3,333,000**

	Construction	Capital	Electricity ($)
Cactus	$0	$0	$0
Dumas	$0	$0	$0
Sunray	$0	$0	$0
Gruver	$2,424,200	$3,333,000	$300
Spearman	$0	$0	$0
Stinnet	$0	$0	$0
check total	$2,424,200	$3,333,000	$300

		Quantity	Units	Unit Price	Cost
24" line from Spearman to Stinnet		133,500	LF	$116	$15,486,000
Crossings		1	LS		$193,600
ROW	20	61	AC	$1,219	$74,300
Engineering and Contingencies (30%)					$4,703,900
Pipeline Subtotal at Stinnet					**$20,457,800**

	Construction	Capital	Electricity ($)
Cactus	$7,743,000	$10,228,900	$14,700
Dumas	$6,022,300	$7,955,800	$11,400
Sunray	$1,204,500	$1,591,200	$2,300
Gruver	$0	$0	$0
Spearman	$0	$0	$0
Stinnet	$516,200	$681,900	$1,000
check total	$15,486,000	$20,457,800	$29,400

		Quantity	Units	Unit Price	Cost
8" line Stinnet Spur		83,350	LF	$34	$2,833,900
Crossings		1	LS		$309,800
Connection to Stinnet		1	LS		$15,500
ROW	20	38	AC	$1,219	$46,300
Engineering and Contingencies (30%)					$947,800
Pipeline Subtotal at Stinnet					**$4,153,300**

	Construction	Capital	Electricity ($)
Cactus	$0	$0	$0
Dumas	$0	$0	$0
Sunray	$0	$0	$0
Gruver	$0	$0	$0
Spearman	$0	$0	$0
Stinnet	$2,833,900	$4,153,300	$400
check total	$2,833,900	$4,153,300	$400

Table H-26, Continued

		Quantity	Units	Unit Price	Cost
24" line from Stinnet Spur to Dumas		122,800	LF	$116	$14,244,800
Crossings		1	LS		$178,100
Connection to Dumas		1	LS		$15,500
ROW	20	56	AC	$1,219	$68,300
Engineering and Contingencies (30%)					$4,331,500
Pipeline Subtotal at Dumas					**$18,838,200**

	Construction	Capital	Electricity ($)
Cactus	$7,368,000	$9,743,900	$12,900
Dumas	$5,730,700	$7,578,600	$10,000
Sunray	$1,146,100	$1,515,700	$2,000
Gruver	$0	$0	$0
Spearman	$0	$0	$0
Stinnet	$0	$0	$0
check total	$14,244,800	$18,838,200	$24,900

		Quantity	Units	Unit Price	Cost
8" line Sunray Spur		28,000	LF	$34	$952,000
Crossings		1	LS		$99,700
Pressure Reducing Valve		1	EA		$23,500
Connection to Sunray		1	LS		$11,700
ROW	15	10	AC	$1,219	$12,200
Engineering and Contingencies (30%)					$326,100
Pipeline Subtotal at Sunray					**$473,200**

	Construction	Capital	Electricity ($)
Cactus	0	$0	$0
Dumas	0	$0	$0
Sunray	$952,000	$473,200	$1,100
Gruver	0	$0	$0
Spearman	0	$0	$0
Stinnet	0	$0	$0
check total	$952,000	$473,200	$1,100

		Quantity	Units	Unit Price	Cost
18" line from Dumas to Cactus		67,150	LF	$77	$5,170,600
Crossings		1	LS		$193,600
Connection to Cactus		1	LS		$11,700
ROW	20	31	AC	$1,219	$37,800
Engineering and Contingencies (30%)					$1,612,800
Pipeline Subtotal at Sunray					**$7,026,500**

Table H-26, Continued

	Construction	Capital	Electricity ($)
Cactus	$5,170,600	$7,026,500	$9,400
Dumas	0	$0	$0
Sunray	0	$0	$0
Gruver	0	$0	$0
Spearman	0	$0	$0
Stinnet	0	$0	$0
check total	$5,170,600	$7,026,500	$9,400

Pump Station Components	**Quantity**	**Units**	**Unit Price**	**Cost**
9 MGD PS at intake	250	HP		$1,279,500
9 MGD PS at WTP	250	HP		$1,279,500
9 MGD PS at Spearman	400	HP		$1,795,000
8.12 MGD at Stinnet Spur	400	HP		$1,795,000
4.04 MGD at Dumas	100	HP		$742,000
Engineering and Contingencies (35%)				$2,411,900
Pump Station Subtotal				**$9,302,900**

Construction Costs	9 MGD PS at intake	9 MGD PS at WTP	9 MGD PS at Spearman	8.12 MGD at Stinnet Spur	4.04 MGD at Dumas
Cactus	$575,800	$575,800	$807,800	$897,500	$417,400
Dumas	$447,800	$447,800	$628,300	$698,100	$324,600
Sunray	$89,600	$89,600	$125,700	$139,600	$0
Gruver	$38,400	$38,400	$53,900	$0	$0
Spearman	$89,600	$89,600	$125,700	$0	$0
Stinnet	$38,400	$38,400	$53,900	$59,800	$0
check total	$1,279,600	$1,279,600	$1,795,300	$1,795,000	$742,000

Capital Costs	9 MGD PS at intake	9 MGD PS at WTP	9 MGD PS at Spearman	8.12 MGD at Stinnet Spur	4.04 MGD at Dumas
Cactus	$777,300	$777,300	$1,090,500	$1,211,600	$563,500
Dumas	$604,600	$604,600	$848,100	$942,400	$438,200
Sunray	$120,900	$120,900	$169,600	$188,500	$0
Gruver	$51,800	$51,800	$72,700	$0	$0
Spearman	$120,900	$120,900	$169,600	$0	$0
Stinnet	$51,800	$51,800	$72,700	$80,800	$0
check total	$1,727,300	$1,727,300	$2,423,200	$2,423,300	$1,001,700

Ground Storage Tanks	**Quantity**	**Units**	**Unit Price**	**Cost**
3 MG at WTP	1	LS	$928,000	$928,000
3 MG at Spearman	1	LS	$928,000	$928,000
2.5 MG at Stinnet Spur	1	LS	$821,000	$821,000
1.5 MG at Dumas	1	LS	$591,000	$591,000
Engineering and Contingencies (35%)				$1,143,800
Pump Station Subtotal				**$4,411,800**

Table H-26, Continued

Construction Costs	3 MG at WTP	3 MG at Spearman	2.5 MG at Stinnet Spur	1.5 MG at Dumas	
Cactus	$417,600	$417,600	$410,500	$332,400	
Dumas	$324,800	$324,800	$319,300	$258,600	
Sunray	$65,000	$65,000	$63,900	$0	
Gruver	$27,800	$27,800	$0	$0	
Spearman	$65,000	$65,000	$0	$0	
Stinnet	$27,800	$27,800	$27,400	$0	
check total	$928,000	$928,000	$821,100	$591,000	$3,268,100

Capital Costs	3 MG at WTP	3 MG at Spearman	2.5 MG at Stinnet Spur	1.5 MG at Dumas	
Cactus	$563,800	$563,800	$554,200	$448,800	
Dumas	$438,500	$438,500	$431,000	$349,100	
Sunray	$87,700	$87,700	$86,200	$0	
Gruver	$37,600	$37,600	$0	$0	
Spearman	$87,700	$87,700	$0	$0	
Stinnet	$37,600	$37,600	$36,900	$0	
check total	$1,252,900	$1,252,900	$1,108,300	$797,900	$4,412,000

TOTAL CONSTRUCTION COST

Cactus	$50,327,100
Dumas	$33,678,200
Sunray	$7,051,400
Gruver	$4,703,000
Spearman	$3,196,600
Stinnet	$6,322,900
check total	$105,279,200

Interest During Construction
(24 month)

Cactus	$4,110,200
Dumas	$2,750,500
Sunray	$575,900
Gruver	$384,100
Spearman	$261,100
Stinnet	$516,400
check total	$8,598,200

Permitting and Mitigation

Cactus	$405,000
Dumas	$266,800
Sunray	$64,800
Gruver	$39,900
Spearman	$25,100
Stinnet	$51,000
check total	$852,600

Table H-26, Continued

TOTAL CAPITAL COST	
Cactus	$54,842,300
Dumas	$36,695,500
Sunray	$7,692,100
Gruver	$5,127,000
Spearman	$3,482,800
Stinnet	$6,890,300
check total	$114,730,000

Annual Costs - Cactus	**Cost**
Debt Service (6 percent for 20 years)	$4,781,400
Electricity	$46,100
Price to Purchase Water ($0.15 per 1,000 gal)	$85,200
Operation and Maintenance	$589,100
Total Annual Cost	$5,501,800
UNIT COSTS (Until Amortized)	
Water Cost ($ per ac-ft)	$3,155
Water Cost ($ per 1,000 gallons)	$9.68
UNIT COSTS (After Amortization)	
Water Cost ($ per ac-ft)	$413
Water Cost ($ per 1,000 gallons)	$1.27

Annual Costs - Dumas	**Cost**
Debt Service (6 percent for 20 years)	$3,199,300
Electricity	$28,500
Price to Purchase Water ($0.15 per 1,000 gal)	$66,300
Operation and Maintenance	$418,000
Total Annual Cost	$3,712,100
UNIT COSTS (Until Amortized)	
Water Cost ($ per ac-ft)	$2,737
Water Cost ($ per 1,000 gallons)	$8.40
UNIT COSTS (After Amortization)	
Water Cost ($ per ac-ft)	$378
Water Cost ($ per 1,000 gallons)	$1.16

Table H-26, Continued

Annual Costs - Sunray	**Cost**
Debt Service (6 percent for 20 years)	$670,600
Electricity	$6,800
Price to Purchase Water ($0.15 per 1,000 gal)	$13,300
Operation and Maintenance	$90,200
Total Annual Cost	$780,900
UNIT COSTS (Until Amortized)	
Water Cost ($ per ac-ft)	$2,879
Water Cost ($ per 1,000 gallons)	$8.84
UNIT COSTS (After Amortization)	
Water Cost ($ per ac-ft)	$407
Water Cost ($ per 1,000 gallons)	$1.25

Annual Costs - Gruver	**Cost**
Debt Service (6 percent for 20 years)	$447,000
Electricity	$900
Price to Purchase Water ($0.15 per 1,000 gal)	$5,700
Operation and Maintenance	$46,600
Total Annual Cost	$500,200
UNIT COSTS (Until Amortized)	
Water Cost ($ per ac-ft)	$4,303
Water Cost ($ per 1,000 gallons)	$13.20
UNIT COSTS (After Amortization)	
Water Cost ($ per ac-ft)	$458
Water Cost ($ per 1,000 gallons)	$1.40

Annual Costs - Spearman	**Cost**
Debt Service (6 percent for 20 years)	$303,600
Electricity	$1,400
Price to Purchase Water ($0.15 per 1,000 gal)	$13,300
Operation and Maintenance	$52,100
Total Annual Cost	$370,400
UNIT COSTS (Until Amortized)	
Water Cost ($ per ac-ft)	$1,366
Water Cost ($ per 1,000 gallons)	$4.19
UNIT COSTS (After Amortization)	
Water Cost ($ per ac-ft)	$246
Water Cost ($ per 1,000 gallons)	$0.76

Table H-26, Continued

Annual Costs - Stinnet	Cost
Debt Service (6 percent for 20 years)	$600,700
Electricity	$2,000
Price to Purchase Water ($0.15 per 1,000 gal)	$5,700
Operation and Maintenance	$58,000
Total Annual Cost	$666,400
UNIT COSTS (Until Amortized)	
Water Cost ($ per ac-ft)	$5,732
Water Cost ($ per 1,000 gallons)	$17.59
UNIT COSTS (After Amortization)	
Water Cost ($ per ac-ft)	$565
Water Cost ($ per 1,000 gallons)	$1.73

Table H-27
Greenbelt M&IWA
Install New Groundwater Well to Supplement Greenbelt Reservoir

Owner: Greenbelt M&IWA
Quantity: 800 AF/Y

Capital Costs	Size		Quantity	Unit	Unit Price	Cost
Wellfield						
Wells	1500	gpm	1	Ea.	$175,000	$175,000
Connection to Pump Station			1	Ea.	$50,000	$50,000
Engineering and Contingencies (35% for well field)						$78,800
Subtotal for Wellfield and Treatment						**$303,800**
Transmission System						
Pipeline - Rural	10	inch	7,920	LF	$43	$340,600
Pump Station	35	HP	1	LS	$612,600	$612,600
Easement - Rural	15	Feet	3	AC	$1,219	$4,000
Engineering and Contingencies (30% for pipelines, 35% for other items)						$316,600
Subtotal for Transmission						**$1,273,800**
TOTAL CONSTRUCTION COST						**$1,577,600**
Interest During Construction				**(6 months)**		**$34,200**
Permitting and Mitigation						**$14,100**
Groundwater Rights/ Purchase						**$240,000**
TOTAL CAPITAL COST						**$1,865,900**
Annual Costs						
Debt Service (6 percent for 20 years)						$162,700
Electricity						$38,300
Water Treatment ($0.30 per 1,000 gal)						$0
Operation and Maintenance						$29,200
Total Annual Cost						**$230,200**
UNIT COSTS (Until Amortized)						
Water Cost ($ per ac-ft)						**$288**
Water Cost ($ per 1,000 gallons)						**$0.88**
UNIT COSTS (After Amortization)						
Water Cost ($ per ac-ft)						**$84**
Water Cost ($ per 1,000 gallons)						**$0.26**

Table H-28
Irrigation Strategy Costs

Armstrong

Strategy	Annual Costs					
	2010	**2020**	**2030**	**2040**	**2050**	**2060**
Change Crop Type		$ 1,556	$ 1,556	$ 1,556	$ 1,556	$ 1,556
Change Crop Variety		-	-	-	-	-
Conservation Tillage		$ (1,418)	$ (1,702)	$ (1,986)	$ (2,269)	$ (2,553)
Convert to Dry		$ 13,083	$ 13,083	$ 13,083	$ 13,083	$ 13,083
Irrigation Equipment		$ 33,297	$ 34,516	$ 36,954	$ 38,174	$ 39,393
PET Network		$ 1,483	$ 1,483	$ 1,483	$ 1,483	$ 1,483
Precipitation Enhancement		$ 4,718	$ 4,718	$ 4,718	$ 4,718	$ 4,718
Biotechnology		$ 3,013	$ 10,848	$ 12,053	$ 12,053	$ 12,053
Total		$ 55,732	$ 64,502	$ 67,862	$ 68,798	$ 69,733
Total - Precip. Enhance.		$51,013.20	$59,783.41	$63,143.55	$64,079.11	$65,014.66

Carson

Strategy	Annual Costs					
	2010	**2020**	**2030**	**2040**	**2050**	**2060**
Change Crop Type		$ 33,937	$ 33,937	$ 33,937	$ 33,937	$ 33,937
Change Crop Variety		-	-	-	-	-
Conservation Tillage		$ (11,243)	$ (13,492)	$ (15,741)	$ (17,989)	$ (20,238)
Convert to Dry		$ 84,208	$ 84,208	$ 84,208	$ 84,208	$ 84,208
Irrigation Equipment		$ 263,843	$ 273,504	$ 292,827	$ 302,488	$ 312,150
PET Network		$ 11,748	$ 11,748	$ 11,748	$ 11,748	$ 11,748
Precipitation Enhancement		$ 37,389	$ 37,389	$ 37,389	$ 37,389	$ 37,389
Biotechnology		$ 23,994	$ 86,379	$ 95,977	$ 95,977	$ 95,977
Total		$ 443,876	$ 513,674	$ 540,345	$ 547,758	$ 555,171
Total - Precip. Enhance.		$ 406,487	$ 476,285	$ 502,956	$ 510,369	$ 517,782

Childress

Strategy	Annual Costs					
	2010	**2020**	**2030**	**2040**	**2050**	**2060**
Change Crop Type		$ -	$ -	$ -	$ -	$ -
Change Crop Variety		-	-	-	-	-
Conservation Tillage		$ (1,118)	$ (1,341)	$ (1,565)	$ (1,788)	$ (2,012)
Convert to Dry		$ 10,270	$ 10,270	$ 10,270	$ 10,270	$ 10,270
Irrigation Equipment		$ 26,292	$ 27,255	$ 29,180	$ 30,143	$ 31,106
PET Network		$ 1,171	$ 1,171	$ 1,171	$ 1,171	$ 1,171
Precipitation Enhancement		$ 3,726	$ 3,726	$ 3,726	$ 3,726	$ 3,726
Biotechnology		$ 2,309	$ 8,314	$ 9,237	$ 9,237	$ 9,237
Total		$ 42,650	$ 49,394	$ 52,019	$ 52,759	$ 53,498
Total - Precip. Enhance.		$ 38,924	$ 45,668	$ 48,293	$ 49,033	$ 49,772

Table H-28 Continued

Collingsworth

Strategy	Annual Costs					
	2010	**2020**	**2030**	**2040**	**2050**	**2060**
Change Crop Type		$ 65	$ 65	$ 65	$ 65	$ 65
Change Crop Variety		-	-	-	-	-
Conservation Tillage		$ (2,488)	$ (2,986)	$ (3,483)	$ (3,981)	$ (4,479)
Convert to Dry		$ 8,639	$ 8,639	$ 8,639	$ 8,639	$ 8,639
Irrigation Equipment		$ 59,238	$ 61,407	$ 65,746	$ 67,915	$ 70,084
PET Network		$ 2,638	$ 2,638	$ 2,638	$ 2,638	$ 2,638
Precipitation Enhancement		$ 8,395	$ 8,395	$ 8,395	$ 8,395	$ 8,395
Biotechnology		$ 4,419	$ 15,909	$ 17,677	$ 17,677	$ 17,677
Total		$ 80,905	$ 94,067	$ 99,675	$ 101,346	$ 103,018
Total - Precip. Enhance.		$ 72,511	$ 85,672	$ 91,280	$ 92,952	$ 94,623

Dallam

Strategy	Annual Costs					
	2010	**2020**	**2030**	**2040**	**2050**	**2060**
Change Crop Type		$ 595,529	$ 595,529	$ 595,529	$ 595,529	$ 595,529
Change Crop Variety		-	-	-	-	-
Conservation Tillage		$ (26,865)	$ (26,865)	$ (26,865)	$ (26,865)	$ (26,865)
Convert to Dry		$ 126,592	$ 253,183	$ 253,183	$ 253,183	$ 253,183
Irrigation Equipment		$ 322,154	$ 644,358	$ 966,536	$ 966,536	$ 966,536
PET Network		$ 12,418	$ 24,837	$ 37,255	$ 49,674	$ 49,674
Precipitation Enhancement		$ 111,938	$ 111,938	$ 111,938	$ 111,938	$ 111,938
Biotechnology		$ 103,328	$ 371,980	$ 413,311	$ 413,311	$ 413,311
Total		$ 1,245,094	$ 1,974,960	$ 2,350,888	$ 2,363,306	$ 2,363,306
Total - Precip. Enhance.		$1,133,156	$1,863,021	$2,238,950	$2,251,368	$2,251,368

Donley

Strategy	Annual Costs					
	2010	**2020**	**2030**	**2040**	**2050**	**2060**
Change Crop Type		$ 2,599	$ 2,599	$ 2,599	$ 2,599	$ 2,599
Change Crop Variety		-	-	-	-	-
Conservation Tillage		$ (2,118)	$ (2,542)	$ (2,965)	$ (3,389)	$ (3,813)
Convert to Dry		$ 13,254	$ 13,254	$ 13,254	$ 13,254	$ 13,254
Irrigation Equipment		$ 49,987	$ 51,818	$ 55,478	$ 57,309	$ 59,139
PET Network		$ 2,226	$ 2,226	$ 2,226	$ 2,226	$ 2,226
Precipitation Enhancement		$ 7,084	$ 7,084	$ 7,084	$ 7,084	$ 7,084
Biotechnology		$ 4,191	$ 15,088	$ 16,764	$ 16,764	$ 16,764
Total		$ 77,223	$ 89,526	$ 94,440	$ 95,847	$ 97,253
Total - Precip. Enhance.		$ 70,139	$ 82,443	$ 87,356	$ 88,763	$ 90,170

Table H-28 Continued

Gray

Strategy	Annual Costs					
	2010	2020	2030	2040	2050	2060
Change Crop Type		$ 13,320	$ 13,320	$ 13,320	$ 13,320	$ 13,320
Change Crop Variety		-	-	-	-	-
Conservation Tillage		$ (3,410)	$ (4,092)	$ (4,774)	$ (5,456)	$ (6,138)
Convert to Dry		$ 23,023	$ 23,023	$ 23,023	$ 23,023	$ 23,023
Irrigation Equipment		$ 80,001	$ 82,930	$ 88,789	$ 91,719	$ 94,648
PET Network		$ 3,562	$ 3,562	$ 3,562	$ 3,562	$ 3,562
Precipitation Enhancement		$ 11,337	$ 11,337	$ 11,337	$ 11,337	$ 11,337
Biotechnology		$ 7,304	$ 26,293	$ 29,214	$ 29,214	$ 29,214
Total		$ 135,136	$ 156,373	$ 164,471	$ 166,718	$ 168,966
Total - Precip. Enhance.		$ 123,799	$ 145,036	$ 153,134	$ 155,381	$ 157,629

Hall

Strategy	Annual Costs					
	2010	2020	2030	2040	2050	2060
Change Crop Type		$ -	$ -	$ -	$ -	$ -
Change Crop Variety		-	-	-	-	-
Conservation Tillage		$ (2,344)	$ (2,812)	$ (3,281)	$ (3,750)	$ (4,218)
Convert to Dry		$ 17,537	$ 17,537	$ 17,537	$ 17,537	$ 17,537
Irrigation Equipment		$ 55,307	$ 57,332	$ 61,382	$ 63,408	$ 65,433
PET Network		$ 2,463	$ 2,463	$ 2,463	$ 2,463	$ 2,463
Precipitation Enhancement		$ 7,838	$ 7,838	$ 7,838	$ 7,838	$ 7,838
Biotechnology		$ 4,637	$ 16,693	$ 18,548	$ 18,548	$ 18,548
Total		$ 85,437	$ 99,049	$ 104,486	$ 106,042	$ 107,599
Total - Precip. Enhance.		$ 77,599	$ 91,212	$ 96,648	$ 98,205	$ 99,761

Hansford

Strategy	Annual Costs					
	2010	2020	2030	2040	2050	2060
Change Crop Type		$ 205,567	$ 205,567	$ 205,567	$ 205,567	$ 205,567
Change Crop Variety		-	-	-	-	-
Conservation Tillage		$ (14,152)	$ (14,152)	$ (14,152)	$ (14,152)	$ (14,152)
Convert to Dry		$ 97,383	$ 194,766	$ 194,766	$ 194,766	$ 194,766
Irrigation Equipment		$ 169,698	$ 339,406	$ 509,109	$ 509,109	$ 509,109
PET Network		$ 6,542	$ 13,083	$ 19,625	$ 26,166	$ 26,166
Precipitation Enhancement		$ 58,965	$ 58,965	$ 58,965	$ 58,965	$ 58,965
Biotechnology		$ 37,659	$ 135,573	$ 150,637	$ 150,637	$ 150,637
Total		$ 561,662	$ 933,209	$ 1,124,517	$ 1,131,059	$ 1,131,059
Total - Precip. Enhance.		$502,697	$874,244	$1,065,552	$1,072,094	$1,072,094

Table H-28 Continued

Hartley

Strategy	Annual Costs					
	2010	2020	2030	2040	2050	2060
Change Crop Type		$ 545,156	$ 545,156	$ 545,156	$ 545,156	$ 545,156
Change Crop Variety		-	-	-	-	-
Conservation Tillage		$ (23,446)	$ (23,446)	$ (23,446)	$ (23,446)	$ (23,446)
Convert to Dry		$ 105,430	$ 210,859	$ 210,859	$ 210,859	$ 210,859
Irrigation Equipment		$ 281,155	$ 562,323	$ 843,484	$ 843,484	$ 843,484
PET Network		$ 10,838	$ 21,676	$ 32,514	$ 43,352	$ 43,352
Precipitation Enhancement		$ 97,692	$ 97,692	$ 97,692	$ 97,692	$ 97,692
Biotechnology		$ 96,380	$ 346,968	$ 385,521	$ 385,521	$ 385,521
Total		$ 1,113,205	$ 1,761,229	$ 2,091,780	$ 2,102,618	$ 2,102,618
Total - Precip. Enhance.		$1,015,512	$1,663,536	$1,994,087	$2,004,925	$2,004,925

Hemphill

Strategy	Annual Costs					
	2010	2020	2030	2040	2050	2060
Change Crop Type		$ -	$ -	$ -	$ -	$ -
Change Crop Variety		-	-	-	-	-
Conservation Tillage		$ (148)	$ (177)	$ (207)	$ (236)	$ (266)
Convert to Dry		$ 1,570	$ 1,570	$ 1,570	$ 1,570	$ 1,570
Irrigation Equipment		$ 3,463	$ 3,590	$ 3,843	$ 3,970	$ 4,097
PET Network		$ 154	$ 154	$ 154	$ 154	$ 154
Precipitation Enhancement		$ 491	$ 491	$ 491	$ 491	$ 491
Biotechnology		$ 316	$ 1,137	$ 1,264	$ 1,264	$ 1,264
Total		$ 5,846	$ 6,765	$ 7,115	$ 7,212	$ 7,310
Total - Precip. Enhance.		$ 5,355	$ 6,274	$ 6,624	$ 6,722	$ 6,819

Hutchinson

Strategy	Annual Costs					
	2010	2020	2030	2040	2050	2060
Change Crop Type		$ 64,595	$ 64,595	$ 64,595	$ 64,595	$ 64,595
Change Crop Variety		-	-	-	-	-
Conservation Tillage		$ (4,277)	$ (4,277)	$ (4,277)	$ (4,277)	$ (4,277)
Convert to Dry		$ 24,388	$ 48,776	$ 48,776	$ 48,776	$ 48,776
Irrigation Equipment		$ 51,289	$ 102,598	$ 153,898	$ 153,898	$ 153,898
PET Network		$ 1,977	$ 3,954	$ 5,931	$ 7,908	$ 7,908
Precipitation Enhancement		$ 17,821	$ 17,821	$ 17,821	$ 17,821	$ 17,821
Biotechnology		$ 12,490	$ 44,965	$ 49,961	$ 49,961	$ 49,961
Total		$ 168,282	$ 278,431	$ 336,704	$ 338,681	$ 338,681
Total - Precip. Enhance.		$150,461	$260,610	$318,882	$320,860	$320,860

Table H-28 Continued

Lipscomb

Strategy	Annual Costs					
	2010	2020	2030	2040	2050	2060
Change Crop Type		$ 10,513	$ 10,513	$ 10,513	$ 10,513	$ 10,513
Change Crop Variety		-	-	-	-	-
Conservation Tillage		$ (1,419)	$ (1,703)	$ (1,987)	$ (2,271)	$ (2,555)
Convert to Dry		$ 6,101	$ 6,101	$ 6,101	$ 6,101	$ 6,101
Irrigation Equipment		$ 33,240	$ 34,458	$ 36,892	$ 38,109	$ 39,326
PET Network		$ 1,480	$ 1,480	$ 1,480	$ 1,480	$ 1,480
Precipitation Enhancement		$ 4,710	$ 4,710	$ 4,710	$ 4,710	$ 4,710
Biotechnology		$ 3,117	$ 11,221	$ 12,468	$ 12,468	$ 12,468
Total		$ 57,743	$ 66,780	$ 70,178	$ 71,111	$ 72,044
Total - Precip. Enhance.		$ 53,033	$ 62,070	$ 65,467	$ 66,400	$ 67,334

Moore

Strategy	Annual Costs					
	2010	2020	2030	2040	2050	2060
Change Crop Type		$ 272,297	$ 272,297	$ 272,297	$ 272,297	$ 272,297
Change Crop Variety		-	-	-	-	-
Conservation Tillage		$ (16,369)	$ (16,369)	$ (16,369)	$ (16,369)	$ (16,369)
Convert to Dry		$ 104,300	$ 208,600	$ 208,600	$ 208,600	$ 208,600
Irrigation Equipment		$ 196,283	$ 392,565	$ 588,847	$ 588,847	$ 588,847
PET Network		$ 7,566	$ 15,133	$ 22,699	$ 30,265	$ 30,265
Precipitation Enhancement		$ 68,202	$ 68,202	$ 68,202	$ 68,202	$ 68,202
Biotechnology		$ 54,721	$ 196,996	$ 218,885	$ 218,885	$ 218,885
Total		$ 687,001	$ 1,137,425	$ 1,363,162	$ 1,370,728	$ 1,370,728
Total - Precip. Enhance.		$618,799	$1,069,223	$1,294,960	$1,302,526	$1,302,526

Ochiltree

Strategy	Annual Costs					
	2010	2020	2030	2040	2050	2060
Change Crop Type		$ 33,219	$ 33,219	$ 33,219	$ 33,219	$ 33,219
Change Crop Variety		-	-	-	-	-
Conservation Tillage		$ (11,239)	$ (13,487)	$ (15,735)	$ (17,982)	$ (20,230)
Convert to Dry		$ 83,938	$ 83,938	$ 83,938	$ 83,938	$ 83,938
Irrigation Equipment		$ 263,781	$ 273,440	$ 292,758	$ 302,417	$ 312,076
PET Network		$ 11,746	$ 11,746	$ 11,746	$ 11,746	$ 11,746
Precipitation Enhancement		$ 37,380	$ 37,380	$ 37,380	$ 37,380	$ 37,380
Biotechnology		$ 23,936	$ 86,171	$ 95,745	$ 95,745	$ 95,745
Total		$ 442,761	$ 512,407	$ 539,051	$ 546,463	$ 553,874
Total - Precip. Enhance.		$ 405,381	$ 475,026	$ 501,671	$ 509,082	$ 516,494

Table H-28 Continued

Oldham

Strategy	Annual Costs 2010	2020	2030	2040	2050	2060
Change Crop Type		$ -	$ -	$ -	$ -	$ -
Change Crop Variety		-	-	-	-	-
Conservation Tillage		$ (534)	$ (641)	$ (748)	$ (855)	$ (962)
Convert to Dry		$ 5,453	$ 5,453	$ 5,453	$ 5,453	$ 5,453
Irrigation Equipment		$ 12,542	$ 13,001	$ 13,920	$ 14,379	$ 14,838
PET Network		$ 558	$ 558	$ 558	$ 558	$ 558
Precipitation Enhancement		$ 1,777	$ 1,777	$ 1,777	$ 1,777	$ 1,777
Biotechnology		$ 1,132	$ 4,074	$ 4,527	$ 4,527	$ 4,527
Total		$ 20,929	$ 24,224	$ 25,488	$ 25,841	$ 26,193
Total - Precip. Enhance.		$ 19,151	$ 22,446	$ 23,711	$ 24,063	$ 24,416

Potter

Strategy	Annual Costs 2010	2020	2030	2040	2050	2060
Change Crop Type		$ 740	$ 740	$ 740	$ 740	$ 740
Change Crop Variety		-	-	-	-	-
Conservation Tillage		$ (651)	$ (781)	$ (912)	$ (1,042)	$ (1,172)
Convert to Dry		$ 4,885	$ 4,885	$ 4,885	$ 4,885	$ 4,885
Irrigation Equipment		$ 15,333	$ 15,894	$ 17,017	$ 17,579	$ 18,140
PET Network		$ 683	$ 683	$ 683	$ 683	$ 683
Precipitation Enhancement		$ 2,173	$ 2,173	$ 2,173	$ 2,173	$ 2,173
Biotechnology		$ 1,327	$ 4,777	$ 5,308	$ 5,308	$ 5,308
Total		$ 24,490	$ 28,371	$ 29,894	$ 30,326	$ 30,757
Total - Precip. Enhance.		$ 22,317	$ 26,198	$ 27,722	$ 28,153	$ 28,584

Randall

Strategy	Annual Costs 2010	2020	2030	2040	2050	2060
Change Crop Type		$ 9,768	$ 9,768	$ 9,768	$ 9,768	$ 9,768
Change Crop Variety		-	-	-	-	-
Conservation Tillage		$ (11,316)	$ (13,580)	$ (15,843)	$ (18,106)	$ (20,369)
Convert to Dry		$ 120,020	$ 120,020	$ 120,020	$ 120,020	$ 120,020
Irrigation Equipment		$ 265,122	$ 274,831	$ 294,247	$ 303,955	$ 313,663
PET Network		$ 11,805	$ 11,805	$ 11,805	$ 11,805	$ 11,805
Precipitation Enhancement		$ 37,570	$ 37,570	$ 37,570	$ 37,570	$ 37,570
Biotechnology		$ 24,712	$ 88,964	$ 98,849	$ 98,849	$ 98,849
Total		$ 457,682	$ 529,378	$ 556,416	$ 563,861	$ 571,306
Total - Precip. Enhance.		$ 420,111	$ 491,808	$ 518,846	$ 526,291	$ 533,736

Table H-28 Continued

Roberts

Strategy	Annual Costs					
	2010	2020	2030	2040	2050	2060
Change Crop Type		$ 4,226	$ 4,226	$ 4,226	$ 4,226	$ 4,226
Change Crop Variety		-	-	-	-	-
Conservation Tillage		$ (2,138)	$ (2,566)	$ (2,994)	$ (3,421)	$ (3,849)
Convert to Dry		$ 8,723	$ 8,723	$ 8,723	$ 8,723	$ 8,723
Irrigation Equipment		$ 50,613	$ 52,466	$ 56,173	$ 58,026	$ 59,879
PET Network		$ 2,254	$ 2,254	$ 2,254	$ 2,254	$ 2,254
Precipitation Enhancement		$ 7,172	$ 7,172	$ 7,172	$ 7,172	$ 7,172
Biotechnology		$ 4,075	$ 14,670	$ 16,300	$ 16,300	$ 16,300
Total		$ 74,924	$ 86,945	$ 91,854	$ 93,279	$ 94,705
Total - Precip. Enhance.		$ 67,752	$ 79,772	$ 84,681	$ 86,107	$ 87,533

Sherman

Strategy	Annual Costs					
	2010	2020	2030	2040	2050	2060
Change Crop Type		$ 366,909	$ 366,909	$ 366,909	$ 366,909	$ 366,909
Change Crop Variety		-	-	-	-	-
Conservation Tillage		$ (21,010)	$ (21,010)	$ (21,010)	$ (21,010)	$ (21,010)
Convert to Dry		$ 127,390	$ 254,781	$ 254,781	$ 254,781	$ 254,781
Irrigation Equipment		$ 251,939	$ 503,914	$ 755,870	$ 755,870	$ 755,870
PET Network		$ 9,712	$ 19,424	$ 29,135	$ 38,847	$ 38,847
Precipitation Enhancement		$ 87,541	$ 87,541	$ 87,541	$ 87,541	$ 87,541
Biotechnology		$ 71,339	$ 256,822	$ 285,357	$ 285,357	$ 285,357
Total		$ 893,820	$ 1,468,380	$ 1,758,584	$ 1,768,296	$ 1,768,296
Total - Precip. Enhance.		$806,279	$1,380,839	$1,671,043	$1,680,755	$1,680,755

Wheeler

Strategy	Annual Costs					
	2010	2020	2030	2040	2050	2060
Change Crop Type		$ 798	$ 798	$ 798	$ 798	$ 798
Change Crop Variety		-	-	-	-	-
Conservation Tillage		$ (1,110)	$ (1,332)	$ (1,554)	$ (1,776)	$ (1,998)
Convert to Dry		$ 10,272	$ 10,272	$ 10,272	$ 10,272	$ 10,272
Irrigation Equipment		$ 26,070	$ 27,024	$ 28,933	$ 29,888	$ 30,843
PET Network		$ 1,161	$ 1,161	$ 1,161	$ 1,161	$ 1,161
Precipitation Enhancement		$ 3,694	$ 3,694	$ 3,694	$ 3,694	$ 3,694
Biotechnology		$ 2,338	$ 8,417	$ 9,352	$ 9,352	$ 9,352
Total		$ 43,223	$ 50,034	$ 52,657	$ 53,389	$ 54,122
Total - Precip. Enhance.		$ 39,528	$ 46,340	$ 48,962	$ 49,695	$ 50,428

Regional Totals

Strategy	Annual Costs					
	2010	2020	2030	2040	2050	2060
Change Crop Type		$ 2,160,793	$ 2,160,793	$ 2,160,793	$ 2,160,793	$ 2,160,793
Change Crop Variety		-	-	-	-	-
Conservation Tillage		$ (158,814)	$ (169,354)	$ (179,893)	$ (190,432)	$ (200,971)
Convert to Dry		$ 996,457	$ 1,581,940	$ 1,581,940	$ 1,581,940	$ 1,581,940
Irrigation Equipment		$ 2,510,646	$ 3,828,630	$ 5,191,886	$ 5,237,223	$ 5,282,561
PET Network		$ 104,185	$ 153,238	$ 202,291	$ 251,344	$ 251,344
Precipitation Enhancement		$ 617,614	$ 617,614	$ 617,614	$ 617,614	$ 617,614
Biotechnology		$ 486,739	$ 1,752,259	$ 1,946,954	$ 1,946,954	$ 1,946,954
Total		$ 6,717,619	$ 9,925,120	$ 11,521,586	$ 11,605,438	$ 11,640,236
Total - Precip. Enhance.		$ 6,100,005	$ 9,307,506	$ 10,903,972	$ 10,987,823	$ 11,022,622

APPENDIX I

REGION A SOCIOECONOMIC IMPACT REPORT

Socioeconomic Impacts of Projected Water Shortages for the Panhandle (Region A) Regional Water Planning Area

Prepared in Support of the 2011 Panhandle Regional Water Plan

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April 2010

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Introduction

Water shortages during drought would likely curtail or eliminate economic activity in business and industries reliant on water. For example, without water farmers cannot irrigate; refineries cannot produce gasoline, and paper mills cannot make paper. Unreliable water supplies would not only have an immediate and real impact on existing businesses and industry, but they could also adversely affect economic development in Texas. From a social perspective, water supply reliability is critical as well. Shortages would disrupt activity in homes, schools and government and could adversely affect public health and safety. For all of the above reasons, it is important to analyze and understand how restricted water supplies during drought could affect communities throughout the state.

Administrative rules require that regional water planning groups evaluate the impacts of not meeting water needs as part of the regional water planning process, and rules direct TWDB staff to provide technical assistance: "*The executive administrator shall provide available technical assistance to the regional water planning groups, upon request, on water supply and demand analysis, including methods to evaluate the social and economic impacts of not meeting needs*" [(§357.7 (4)(A)]. Staff of the TWDB's Water Resources Planning Division designed and conducted this report in support of the Panhandle Regional Water Planning Group (Region A).

This document summarizes the results of our analysis and discusses the methodology used to generate the results. Section 1 outlines the overall methodology and discusses approaches and assumptions specific to each water use category (i.e., irrigation, livestock, mining, steam-electric, municipal and manufacturing). Section 2 presents the results for each category where shortages are reported at the regional planning area level and river basin level. Results for individual water user groups are not presented, but are available upon request.

1. Methodology

Section 1 provides a general overview of how economic and social impacts were measured. In addition, it summarizes important clarifications, assumptions and limitations of the study.

1.1 Economic Impacts of Water Shortages

1.1.1 General Approach

Economic analysis as it relates to water resources planning generally falls into two broad areas. Supply side analysis focuses on costs and alternatives of developing new water supplies or implementing programs that provide additional water from current supplies. Demand side analysis concentrates on impacts or benefits of providing water to people, businesses and the environment. Analysis in this report focuses strictly on demand side impacts. When analyzing the economic impacts of water shortages as defined in Texas water planning, three potential scenarios are possible:

1) Scenario 1 involves situations where there are physical shortages of raw surface or groundwater due to drought of record conditions. For example, City A relies on a reservoir with average conservation storage of 500 acre-feet per year and a firm yield of 100 acre feet. In 2010, the city uses about 50 acre-feet per year, but by 2030 their demands are expected to increase to 200 acre-feet. Thus, in 2030 the reservoir would not have enough water to meet the city's demands, and people would experience a shortage of 100 acre-feet assuming drought of record conditions.

Under normal or average climatic conditions, the reservoir would likely be able to provide reliable water supplies well beyond 2030.

2) Scenario 2 is a situation where despite drought of record conditions, water supply sources can meet existing use requirements; however, limitations in water infrastructure would preclude future water user groups from accessing these water supplies. For example, City B relies on a river that can provide 500 acre-feet per year during drought of record conditions and other constraints as dictated by planning assumptions. In 2010, the city is expected to use an estimated 100 acre-feet per year and by 2060 it would require no more than 400 acre-feet. But the intake and pipeline that currently transfers water from the river to the city's treatment plant has a capacity of only 200 acre-feet of water per year. Thus, the city's water supplies are adequate even under the most restrictive planning assumptions, but their conveyance system is too small. This implies that at some point – perhaps around 2030 - infrastructure limitations would constrain future population growth and any associated economic activity or impacts.

3) Scenario 3 involves water user groups that rely primarily on aquifers that are being depleted. In this scenario, projected and in some cases existing demands may be unsustainable as groundwater levels decline. Areas that rely on the Ogallala aquifer are a good example. In some communities in the Panhandle region, irrigated agriculture forms a major base of the regional economy. With less irrigation water from the Ogallala, population and economic activity in the region could decline significantly assuming there are no offsetting developments.

Assessing the social and economic effects of each of the above scenarios requires various levels and methods of analysis and would generate substantially different results for a number of reasons; the most important of which has to do with the time frame of each scenario. Scenario 1 falls into the general category of static analysis. This means that models would measure impacts for a small interval of time such as a drought. Scenarios 2 and 3, on the other hand imply a dynamic analysis meaning that models are concerned with changes over a much longer time period.

Since administrative rules specify that planning analysis be evaluated under drought of record conditions (a static and random event), socioeconomic impact analysis developed by the TWDB for the state water plan is based on assumptions of Scenario 1. Estimated impacts under scenario 1 are point estimates for years in which needs are reported (2010, 2020, 2030, 2040, 2050 and 2060). They are independent and distinct "what if" scenarios for a particular year and shortages are assumed to be temporary events resulting from drought of record conditions. Estimated impacts measure what would happen if water user groups experience water shortages for a period of one year.

The TWDB recognize that dynamic models may be more appropriate for some water user groups; however, combining approaches on a statewide basis poses several problems. For one, it would require a complex array of analyses and models, and might require developing supply and demand forecasts under "normal" climatic conditions as opposed to drought of record conditions. Equally important is the notion that combining the approaches would produce inconsistent results across regions resulting in a so-called "apples to oranges" comparison.

A variety tools are available to estimate economic impacts, but by far, the most widely used today are input-output models (IO models) combined with social accounting matrices (SAMs). Referred to as IO/SAM models, these tools formed the basis for estimating economic impacts for agriculture (irrigation and livestock water uses) and industry (manufacturing, mining, steam-electric and commercial business activity for municipal water uses).

Since the planning horizon extends through 2060, economic variables in the baseline are adjusted in accordance with projected changes in demographic and economic activity. Growth rates for municipal water use sectors (i.e., commercial, residential and institutional) are based on TWDB population forecasts. Future values for manufacturing, agriculture, and mining and steam-electric activity are based on the same underlying economic forecasts used to estimate future water use for each category.

The following steps outline the overall process.

Step 1*: Generate IO/SAM Models and Develop Economic Baseline*

IO/SAM models were estimated using propriety software known as IMPLAN PRO™ (Impact for Planning Analysis). IMPLAN is a modeling system originally developed by the U.S. Forestry Service in the late 1970s. Today, the Minnesota IMPLAN Group (MIG Inc.) owns the copyright and distributes data and software. It is probably the most widely used economic impact model in existence. IMPLAN comes with databases containing the most recently available economic data from a variety of sources.[1] Using IMPLAN software and data, transaction tables conceptually similar to the one discussed previously were estimated for each county in the region and for the region as a whole. Each transaction table contains 528 economic sectors and allows one to estimate a variety of economic statistics including:

- **total sales -** total production measured by sales revenues;
- **intermediate sales -** sales to other businesses and industries within a given region;
- **final sales –** sales to end users in a region and exports out of a region**;**
- **employment -** number of full and part-time jobs (annual average) required by a given industry including self-employment;
- **regional income -** total payroll costs (wages and salaries plus benefits) paid by industries, corporate income, rental income and interest payments; and
- **business taxes -** sales, excise, fees, licenses and other taxes paid during normal operation of an industry (does not include income taxes).

TWDB analysts developed an economic baseline containing each of the above variables using year 2000 data. Since the planning horizon extends through 2060, economic variables in the baseline were allowed to change in accordance with projected changes in demographic and economic activity. Growth rates for municipal water use sectors (i.e., commercial, residential and institutional) are based on TWDB population forecasts. Projections for manufacturing, agriculture, and mining and steam-electric activity are based on the same underlying economic forecasts used to estimate future water use for each category. Monetary impacts in future years are reported in constant year 2006 dollars.

It is important to stress that employment, income and business taxes are the most useful variables when comparing the relative contribution of an economic sector to a regional economy. Total sales as reported in IO/SAM models are less desirable and can be misleading because they include sales to other industries in the region for use in the production of other goods. For example, if a mill buys grain from local farmers and uses it to produce feed, sales of both the processed feed and raw corn are counted as "output" in an IO model. Thus, total sales double-count or overstate the true economic value of goods

[1]The IMPLAN database consists of national level technology matrices based on benchmark input-output accounts generated by the U.S. Bureau of Economic Analysis and estimates of final demand, final payments, industry output and employment for various economic sectors. IMPLAN regional data (i.e. states, a counties or groups of counties within a state) are divided into two basic categories: 1) data on an industry basis including value-added, output and employment, and 2) data on a commodity basis including final demands and institutional sales. State-level data are balanced to national totals using a matrix ratio allocation system and county data are balanced to state totals.

and services produced in an economy. They are not consistent with commonly used measures of output such as Gross National Product (GNP), which counts only final sales.

Another important distinction relates to terminology. Throughout this report, the term *sector* refers to economic subdivisions used in the IMPLAN database and resultant input-output models (528 individual sectors based on Standard Industrial Classification Codes). In contrast, the phrase *water use category* refers to water user groups employed in state and regional water planning including irrigation, livestock, mining, municipal, manufacturing and steam electric. Each IMPLAN sector was assigned to a specific water use category.

Step 2: *Estimate Direct and Indirect Economic Impacts of Water Needs*

Direct impacts are reductions in output by sectors experiencing water shortages. For example, without adequate cooling and process water a refinery would have to curtail or cease operation, car washes may close, or farmers may not be able to irrigate and sales revenues fall. Indirect impacts involve changes in inter-industry transactions as supplying industries respond to decreased demands for their services, and how seemingly non-related businesses are affected by decreased incomes and spending due to direct impacts. For example, if a farmer ceases operations due to a lack of irrigation water, they would likely reduce expenditures on supplies such as fertilizer, labor and equipment, and businesses that provide these goods would suffer as well.

Direct impacts accrue to immediate businesses and industries that rely on water and without water industrial processes could suffer. However, output responses may vary depending upon the severity of shortages. A small shortage relative to total water use would likely have a minimal impact, but large shortages could be critical. For example, farmers facing small shortages might fallow marginally productive acreage to save water for more valuable crops. Livestock producers might employ emergency culling strategies, or they may consider hauling water by truck to fill stock tanks. In the case of manufacturing, a good example occurred in the summer of 1999 when Toyota Motor Manufacturing experienced water shortages at a facility near Georgetown, Kentucky.[2] As water levels in the Kentucky River fell to historic lows due to drought, plant managers sought ways to curtail water use such as reducing rinse operations to a bare minimum and recycling water by funneling it from paint shops to boilers. They even considered trucking in water at a cost of 10 times what they were paying. Fortunately, rains at the end of the summer restored river levels, and Toyota managed to implement cutbacks without affecting production, but it was a close call. If rains had not replenished the river, shortages could have severely reduced output.[3]

To account for uncertainty regarding the relative magnitude of impacts to farm and business operations, the following analysis employs the concept of elasticity. Elasticity is a number that shows how a change in one variable will affect another. In this case, it measures the relationship between a percentage reduction in water availability and a percentage reduction in output. For example, an elasticity of 1.0 indicates that a 1.0 percent reduction in water availability would result in a 1.0 percent reduction in economic output. An elasticity of 0.50 would indicate that for every 1.0 percent of unavailable water, output is reduced by 0.50 percent and so on. Output elasticities used in this study are:[4]

[2] Royal, W. "*High And Dry - Industrial Centers Face Water Shortages*." in Industry Week, Sept, 2000.

[3] The efforts described above are not planned programmatic or long-term operational changes. They are emergency measures that individuals might pursue to alleviate what they consider a temporary condition. Thus, they are not characteristic of long-term management strategies designed to ensure more dependable water supplies such as capital investments in conservation technology or development of new water supplies.

[4] Elasticities are based on one of the few empirical studies that analyze potential relationships between economic output and water shortages in the United States. The study, conducted in California, showed that a significant number of industries would suffer reduced output during water shortages. Using a survey based approach researchers posed two scenarios to different industries. In

- if water needs are 0 to 5 percent of total water demand, no corresponding reduction in output is assumed;

- if water needs are 5 to 30 percent of total water demand, for each additional one percent of water need that is not met, there is a corresponding 0.50 percent reduction in output;

- if water needs are 30 to 50 percent of total water demand, for each additional one percent of water need that is not met, there is a corresponding 0.75 percent reduction in output; and

- if water needs are greater than 50 percent of total water demand, for each additional one percent of water need that is not met, there is a corresponding 1.0 percent (i.e., a proportional reduction).

In some cases, elasticities are adjusted depending upon conditions specific to a given water user group.

Once output responses to water shortages were estimated, direct impacts to total sales, employment, regional income and business taxes were derived using regional level economic multipliers estimating using IO/SAM models. The formula for a given IMPLAN sector is:

$D_{i,t} = Q_{i,t} *_{,} S_{i,t} * E_Q * RFD_i * DM_{i(Q,\, L,\, I,\, T\,)}$

where:

$D_{i,t}$ = direct economic impact to sector *i* in period *t*

$Q_{i,t}$ = total sales for sector *i* in period *t* in an affected county

$RFD_{i,}$ = ratio of final demand to total sales for sector *i* for a given region

$S_{i,t}$ = water shortage as percentage of total water use in period *t*

E_Q = elasticity of output and water use

$DM_{i(L,\, I,\, T\,)}$ = direct output multiplier coefficients for labor (L), income (I) and taxes (T) for sector *i*.

Secondary impacts were derived using the same formula used to estimate direct impacts; however, indirect multiplier coefficients are used. Methods and assumptions specific to each water use sector are discussed in Sections 1.1.2 through 1.1.4.

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the first scenario, they asked how a 15 percent cutback in water supply lasting one year would affect operations. In the second scenario, they asked how a 30 percent reduction lasting one year would affect plant operations. In the case of a 15 percent shortage, reported output elasticities ranged from 0.00 to 0.76 with an average value of 0.25. For a 30 percent shortage, elasticities ranged from 0.00 to 1.39 with average of 0.47. For further information, see, California Urban Water Agencies, "*Cost of Industrial Water Shortages,*" Spectrum Economics, Inc. November, 1991.

General Assumptions and Clarification of the Methodology

As with any attempt to measure and quantify human activities at a societal level, assumptions are necessary and every model has limitations. Assumptions are needed to maintain a level of generality and simplicity such that models can be applied on several geographic levels and across different economic sectors. In terms of the general approach used here several clarifications and cautions are warranted:

1. Shortages as reported by regional planning groups are the starting point for socioeconomic analyses.

2. Estimated impacts are point estimates for years in which needs are reported (i.e., 2010, 2020, 2030, 2040, 2050 and 2060).They are independent and distinct "what if" scenarios for each particular year and water shortages are assumed to be temporary events resulting from severe drought conditions combined with infrastructure limitations. In other words, growth occurs and future shocks are imposed on an economy at 10-year intervals and resultant impacts are measured. Given, that reported figures are not cumulative in nature, it is inappropriate to sum impacts over the entire planning horizon. Doing so, would imply that the analysis predicts that drought of record conditions will occur every ten years in the future, which is not the case. Similarly, authors of this report recognize that in many communities needs are driven by population growth, and in the future total population will exceed the amount of water available due to infrastructure limitations, regardless of whether or not there is a drought. This implies that infrastructure limitations would constrain economic growth. However, since needs as defined by planning rules are based upon water supply and demand under the assumption of drought of record conditions, it improper to conduct economic analysis that focuses on growth related impacts over the planning horizon. Figures generated from such an analysis would presume a 50-year drought of record, which is unrealistic. Estimating lost economic activity related to constraints on population and commercial growth due to lack of water would require developing water supply and demand forecasts under "normal" or "most likely" future climatic conditions.

3. While useful for planning purposes, this study is not a benefit-cost analysis. Benefit cost analysis is a tool widely used to evaluate the economic feasibility of specific policies or projects as opposed to estimating economic impacts of unmet water needs. Nevertheless, one could include some impacts measured in this study as part of a benefit cost study if done so properly. Since this is not a benefit cost analysis, future impacts are not weighted differently. In other words, estimates are not discounted. If used as a measure of economic benefits, one should incorporate a measure of uncertainty into the analysis. In this type of analysis, a typical method of discounting future values is to assign probabilities of the drought of record recurring again in a given year, and weight monetary impacts accordingly. This analysis assumes a probability of one.

4. IO multipliers measure the strength of backward linkages to supporting industries (i.e., those who sell inputs to an affected sector). However, multipliers say nothing about forward linkages consisting of businesses that purchase goods from an affected sector for further processing. For example, ranchers in many areas sell most of their animals to local meat packers who process animals into a form that consumers ultimately see in grocery stores and restaurants. Multipliers do not capture forward linkages to meat packers, and since meat packers sell livestock purchased from ranchers as "final sales," multipliers for the ranching sector do fully account for all losses to a region's economy. Thus, as mentioned previously, in some cases closely linked sectors were moved from one water use category to another.

5. Cautions regarding interpretations of direct and secondary impacts are warranted. IO/SAM multipliers are based on "fixed-proportion production functions," which basically means that input use - including labor - moves in lockstep fashion with changes in levels of output. In a

scenario where output (i.e., sales) declines, losses in the immediate sector or supporting sectors could be much less than predicted by an IO/SAM model for several reasons. For one, businesses will likely expect to continue operating so they might maintain spending on inputs for future use; or they may be under contractual obligations to purchase inputs for an extended period regardless of external conditions. Also, employers may not lay-off workers given that experienced labor is sometimes scarce and skilled personnel may not be readily available when water shortages subside. Lastly people who lose jobs might find other employment in the region. As a result, direct losses for employment and secondary losses in sales and employment should be considered an upper bound. Similarly, since projected population losses are based on reduced employment in the region, they should be considered an upper bound as well.

6. IO models are static. Models and resultant multipliers are based upon the structure of the U.S. and regional economies in 2006. In contrast, water shortages are projected to occur well into the future. Thus, the analysis assumes that the general structure of the economy remains the same over the planning horizon, and the farther out into the future we go, this assumption becomes less reliable.

7. Impacts are annual estimates. If one were to assume that conditions persisted for more than one year, figures should be adjusted to reflect the extended duration. The drought of record in most regions of Texas lasted several years.

8. Monetary figures are reported in constant year 2006 dollars.

1.1.2 Impacts to Agriculture

Irrigated Crop Production

The first step in estimating impacts to irrigation required calculating gross sales for IMPLAN crop sectors. Default IMPLAN data do not distinguish irrigated production from dry-land production. Once gross sales were known other statistics such as employment and income were derived using IMPLAN direct multiplier coefficients. Gross sales for a given crop are based on two data sources:

1) county-level statistics collected and maintained by the TWDB and the USDA Farm Services Agency (FSA) including the number of irrigated acres by crop type and water application per acre, and

2) regional-level data published by the Texas Agricultural Statistics Service (TASS) including prices received for crops (marketing year averages), crop yields and crop acreages.

Crop categories used by the TWDB differ from those used in IMPLAN datasets. To maintain consistency, sales and other statistics are reported using IMPLAN crop classifications. Table 1 shows the TWDB crops included in corresponding IMPLAN sectors, and Table 2 summarizes acreage and estimated annual water use for each crop classification (five-year average from 2003-2007). Table 3 displays average (2003-2007) gross revenues per acre for IMPLAN crop categories.

Table 1: Crop Classifications Used in TWDB Water Use Survey and Corresponding IMPLAN Crop Sectors

IMPLAN Category	TWDB Category
Oilseeds	Soybeans and other oil crops
Grains	Grain sorghum, corn, wheat and other grain crops
Vegetable and melons	Vegetables and potatoes
Tree nuts	Pecans
Fruits	Citrus, vineyard and other orchard
Cotton	Cotton
Sugarcane and sugar beets	Sugarcane and sugar beets
All other crops	Forage crops, peanuts, alfalfa, hay and pasture, rice and all other crops

Table 2: Summary of Irrigated Crop Acreage and Water Demand for the Panhandle Regional Water Planning Area (average 2003-2007)

Sector	Acres (1000s)	Distribution of Acres	Water Use (1000s of AF)	Distribution of Water Use
Oilseeds	35	3%	47	2%
Grains	1,082	81%	1,588	83%
Vegetable and melons	8	<1%	13	<1%
Fruits	1	<1%	1	<1%
Cotton	107	8%	130	7%
All other crops	98	7%	146	8%
Total	1,331	100%	1,923	100%

Source: Water demand figures are a 5- year average (2003-2007) of the TWDB's annual Irrigation Water Use Estimates. Statistics for irrigated crop acreage are based upon annual survey data collected by the TWDB and the Farm Service Agency. Values do not include acreage or water use for the TWDB categories classified by the Farm Services Agency as "failed acres," "golf course" or "waste water."

Table 3: Average Gross Sales Revenues per Acre for Irrigated Crops for the Panhandle Regional Water Planning Area (2003-2007)		
IMPLAN Sector	**Gross revenues per acre**	**Crops included in estimates**
Oilseeds	$222	Based on five-year (2003-2007) average weighted by acreage for "irrigated soybeans" and "irrigated other oil crops."
Grains	$363	Based on five-year (2003-2007) average weighted by acreage for "irrigated grain sorghum," "irrigated corn," "irrigated wheat" and "irrigated 'other' grain crops."
Vegetable and melons	$4,976	Based on five-year (2003-2007) average weighted by acreage for "irrigated shallow and deep root vegetables," "irrigated Irish potatoes" and "irrigated melons."
Tree nuts	$290	Based on five-year (2003-2007) average weighted by acreage for "irrigated pecans."
Fruits	$5,390	Based on five-year (2003-2007) average weighted by acreage for "irrigated citrus", "irrigated vineyards" and "irrigated 'other' orchard."
Cotton	$494	Based on five-year (2003-2007) average weighted by acreage for "irrigated cotton."
All other crops	$407	Irrigated figure is based on five-year (2003-2007) average weighted by acreage for "irrigated 'forage' crops", "irrigated peanuts", "irrigated alfalfa", "irrigated 'hay' and pasture" and "irrigated 'all other' crops."

*Figures are rounded. Source: Based on data from the Texas Agricultural Statistics Service, Texas Water Development Board, and Texas A&M University.

An important consideration when estimating impacts to irrigation was determining which crops are affected by water shortages. One approach is the so-called rationing model, which assumes that farmers respond to water supply cutbacks by fallowing the lowest value crops in the region first and the highest valued crops last until the amount of water saved equals the shortage.[5] For example, if farmer A grows vegetables (higher value) and farmer B grows wheat (lower value) and they both face a proportionate cutback in irrigation water, then farmer B will sell water to farmer A. Farmer B will fallow her irrigated acreage before farmer A fallows anything. Of course, this assumes that farmers can and do transfer enough water to allow this to happen. A different approach involves constructing farm-level profit maximization models that conform to widely-accepted economic theory that farmers make decisions based on marginal net returns. Such models have good predictive capability, but data requirements and complexity are high. Given that a detailed analysis for each region would require a substantial amount of farm-level data and analysis, the following investigation assumes that projected shortages are distributed equally across predominant crops in the region. Predominant in this case are crops that comprise at least one percent of total acreage in the region.

The following steps outline the overall process used to estimate direct impacts to irrigated agriculture:

1. *Distribute shortages across predominant crop types in the region*. Again, unmet water needs were distributed equally across crop sectors that constitute one percent or more of irrigated acreage.

2. *Estimate associated reductions in output for affected crop sectors*. Output reductions are based on elasticities discussed previously and on estimated values per acre for different crops. Values per acre stem from the same data used to estimate output for the year 2006 baseline. Using multipliers, we then generate estimates of forgone income, jobs, and tax revenues based on reductions in gross sales and final demand.

Livestock

The approach used for the livestock sector is basically the same as that used for crop production. As is the case with crops, livestock categorizations used by the TWDB differ from those used in IMPLAN datasets, and TWDB groupings were assigned to a given IMPLAN sector (Table 4). Then we:

1) *Distribute projected water needs equally among predominant livestock sectors and estimate lost output*: As is the case with irrigation, shortages are assumed to affect all livestock sectors equally; however, the category of “other” is not included given its small size. If water needs were small relative to total demands, we assume that producers would haul in water by truck to fill stock tanks. The cost per acre-foot ($24,000) is based on 2008 rates charged by various water haulers in Texas, and assumes that the average truck load is 6,500 gallons at a hauling distance of 60 miles.

3) *Estimate reduced output in forward processors for livestock sectors*. Reductions in output for livestock sectors are assumed to have a proportional impact on forward processors in the region such as meat packers. In other words, if the cows were gone, meat-packing plants or fluid milk

[5] The rationing model was initially proposed by researchers at the University of California at Berkeley, and was then modified for use in a study conducted by the U.S. Environmental Protection Agency that evaluated how proposed water supply cutbacks recommended to protect water quality in the Bay/Delta complex in California would affect farmers in the Central Valley. See, Zilberman, D., Howitt, R. and Sunding, D. “*Economic Impacts of Water Quality Regulations in the San Francisco Bay and Delt*a.” Western Consortium for Public Health. May 1993.

manufacturers) would likely have little to process. This is not an unreasonable premise. Since the 1950s, there has been a major trend towards specialized cattle feedlots, which in turn has decentralized cattle purchasing from livestock terminal markets to direct sales between producers and slaughterhouses. Today, the meat packing industry often operates large processing facilities near high concentrations of feedlots to increase capacity utilization.[6] As a result, packers are heavily dependent upon nearby feedlots. For example, a recent study by the USDA shows that on average meat packers obtain 64 percent of cattle from within 75 miles of their plant, 82 percent from within 150 miles and 92 percent from within 250 miles.[7]

Table 4: Description of Livestock Sectors

IMPLAN Category	TWDB Category
Cattle ranching and farming	Cattle, cow calf, feedlots and dairies
Poultry and egg production	Poultry production.
Other livestock	Livestock other than cattle and poultry (i.e., horses, goats, sheep, hogs)
Milk manufacturing	Fluid milk manufacturing, cheese manufacturing, ice cream manufacturing etc.
Meat packing	Meat processing present in the region from slaughter to final processing

1.1.3 Impacts to Municipal Water User Groups

Disaggregation of Municipal Water Demands

Estimating the economic impacts for the municipal water user groups is complicated for a number of reasons. For one, municipal use comprises a range of consumers including commercial businesses, institutions such as schools and government and households. However, reported water needs are not distributed among different municipal water users. In other words, how much of a municipal need is commercial and how much is residential (domestic)?

The amount of commercial water use as a percentage of total municipal demand was estimated based on “GED” coefficients (gallons per employee per day) published in secondary sources.[8] For example, if year 2006 baseline data for a given economic sector (e.g., amusement and recreation services)

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[6] Ferreira, W.N. “*Analysis of the Meat Processing Industry in the United States*.” Clemson University Extension Economics Report ER211, January 2003.

[7] Ward, C.E. “*Summary of Results from USDA’s Meatpacking Concentration Study*.” Oklahoma Cooperative Extension Service, OSU Extension Facts WF-562.

[8] Sources for GED coefficients include: Gleick, P.H., Haasz, D., Henges-Jeck, C., Srinivasan, V., Wolff, G. Cushing, K.K., and Mann, A. "*Waste Not, Want Not*: *The Potential for Urban Water Conservation in California*." Pacific Institute. November 2003. U.S. Bureau of the Census. 1982 Census of Manufacturers: Water Use in Manufacturing. USGPO, Washington D.C. See also: “*U.S. Army Engineer Institute for Water Resources, IWR Report 88-R-6.*,” Fort Belvoir, VA. See also, Joseph, E. S., 1982, "*Municipal and Industrial Water Demands of the Western United States*." Journal of the Water Resources Planning and Management Division, Proceedings of the American Society of Civil Engineers, v. 108, no. WR2, p. 204-216. See also, Baumann, D. D., Boland, J. J., and Sims, J. H., 1981, “*Evaluation of Water Conservation for Municipal and Industrial Water Supply*.” U.S. Army Corps of Engineers, Institute for Water Resources, Contract no. 82-C1.

shows employment at 30 jobs and the GED coefficient is 200, then average daily water use by that sector is (30 x 200 = 6,000 gallons) or 6.7 acre-feet per year. Water not attributed to commercial use is considered domestic, which includes single and multi-family residential consumption, institutional uses and all use designated as “county-other.” Based on our analysis, commercial water use is about 5 to 35 percent of municipal demand. Less populated rural counties occupy the lower end of the spectrum, while larger metropolitan counties are at the higher end.

After determining the distribution of domestic versus commercial water use, we developed methods for estimating impacts to the two groups.

Domestic Water Uses

Input output models are not well suited for measuring impacts of shortages for domestic water uses, which make up the majority of the municipal water use category. To estimate impacts associated with domestic water uses, municipal water demand and needs are subdivided into residential, and commercial and institutional use. Shortages associated with residential water uses are valued by estimating proxy demand functions for different water user groups allowing us to estimate the marginal value of water, which would vary depending upon the level of water shortages. The more severe the water shortage, the more costly it becomes. For instance, a 2 acre-foot shortage for a group of households that use 10 acre-feet per year would not be as severe as a shortage that amounted to 8 acre-feet. In the case of a 2 acre-foot shortage, households would probably have to eliminate some or all outdoor water use, which could have implicit and explicit economic costs including losses to the horticultural and landscaping industry. In the case of an 8 acre-foot shortage, people would have to forgo all outdoor water use and most indoor water consumption. Economic impacts would be much higher in the latter case because people, and would be forced to find emergency alternatives assuming alternatives were available.

To estimate the value of domestic water uses, TWDB staff developed marginal loss functions based on constant elasticity demand curves. This is a standard and well-established method used by economists to value resources such as water that have an explicit monetary cost.

A constant price elasticity of demand is estimated using a standard equation:

$$w = kc^{(-\varepsilon)}$$

where:

- w is equal to average monthly residential water use for a given water user group measured in thousands of gallons;
- k is a constant intercept;
- c is the average cost of water per 1,000 gallons; and
- ε is the price elasticity of demand.

Price elasticities (-0.30 for indoor water use and -0.50 for outdoor use) are based on a study by Bell et al.[9] that surveyed 1,400 water utilities in Texas that serve at least 1,000 people to estimate demand elasticity for several variables including price, income, weather etc. Costs of water and average

[9] Bell, D.R. and Griffin, R.C. “*Community Water Demand in Texas as a Century is Turned*.” Research contract report prepared for the Texas Water Development Board. May 2006.

use per month per household are based on data from the Texas Municipal League's annual water and wastewater rate surveys - specifically average monthly household expenditures on water and wastewater in different communities across the state. After examining variance in costs and usage, three different categories of water user groups based on population (population less than 5,000, cities with populations ranging from 5,000 to 99,999 and cities with populations exceeding 100,000) were selected to serve as proxy values for municipal water groups that meet the criteria (Table 5).[10]

Table 5: Water Use and Costs Parameters Used to Estimate Water Demand Functions (average monthly costs per acre-foot for delivered water and average monthly use per household)

Community Population	Water	Wastewater	Total Monthly Cost	Avg. Monthly Use (gallons)
Less than or equal to 5,000	$1,335	$1,228	$2,563	6,204
5,000 to 100,000	$1,047	$1,162	$2,209	7,950
Great than or equal to 100,000	$718	$457	$1,190	8,409

Source: Based on annual water and wastewater rate surveys published by the Texas Municipal League.

As an example, Table 6 shows the economic impact per acre-foot of domestic water needs for municipal water user groups with population exceeding 100,000 people. There are several important assumptions incorporated in the calculations:

1) Reported values are net of the variable costs of treatment and distribution such as expenses for chemicals and electricity since using less water involves some savings to consumers and utilities alike; and for outdoor uses we do not include any value for wastewater.

2) Outdoor and "non-essential" water uses would be eliminated before indoor water consumption was affected, which is logical because most water utilities in Texas have drought contingency plans that generally specify curtailment or elimination of outdoor water use during droughts.[11] Determining how much water is used for outdoor purposes is based on several secondary sources. The first is a major study sponsored by the American Water Works Association, which surveyed cities in states including Colorado, Oregon, Washington, California, Florida and Arizona. On average across all cities surveyed 58 percent of single family residential water use was for outdoor activities. In cities with climates comparable to large metropolitan areas of Texas, the average was 40 percent.[12] Earlier findings of the U.S. Water Resources Council showed a national

[10] Ideally, one would want to estimate demand functions for each individual utility in the state. However, this would require an enormous amount of time and resources. For planning purposes, we believe the values generated from aggregate data are more than sufficient.

[11] In Texas, state law requires retail and wholesale water providers to prepare and submit plans to the Texas Commission on Environmental Quality (TCEQ). Plans must specify demand management measures for use during drought including curtailment of "non-essential water uses." Non-essential uses include, but are not limited to, landscape irrigation and water for swimming pools or fountains. For further information see the Texas Environmental Quality Code §288.20.

[12] See, Mayer, P.W., DeOreo, W.B., Opitz, E.M., Kiefer, J.C., Davis, W., Dziegielewski, D., Nelson, J.O. "*Residential End Uses of Water*." Research sponsored by the American Water Works Association and completed by Aquacraft, Inc. and Planning and Management Consultants, Ltd. (PMCL@CDM).

average of 33 percent. Similarly, the United States Environmental Protection Agency (USEPA) estimated that landscape watering accounts for 32 percent of total residential and commercial water use on annual basis.[13] A study conducted for the California Urban Water Agencies (CUWA) calculated average annual values ranging from 25 to 35 percent.[14] Unfortunately, there does not appear to be any comprehensive research that has estimated non-agricultural outdoor water use in Texas. As an approximation, an average annual value of 30 percent based on the above references was selected to serve as a rough estimate in this study.

3) As shortages approach 100 percent values become immense and theoretically infinite at 100 percent because at that point death would result, and willingness to pay for water is immeasurable. Thus, as shortages approach 80 percent of monthly consumption, we assume that households and non-water intensive commercial businesses (those that use water only for drinking and sanitation would have water delivered by tanker truck or commercial water delivery companies. Based on reports from water companies throughout the state, we estimate that the cost of trucking in water is around $21,000 to $27,000 per acre-feet assuming a hauling distance of between 20 to 60 miles. This is not an unreasonable assumption. The practice was widespread during the 1950s drought and recently during droughts in this decade. For example, in 2000 at the heels of three consecutive drought years Electra - a small town in North Texas - was down to its last 45 days worth of reservoir water when rain replenished the lake, and the city was able to refurbish old wells to provide supplemental groundwater. At the time, residents were forced to limit water use to 1,000 gallons per person per month - less than half of what most people use - and many were having water delivered to their homes by private contractors.[15] In 2003 citizens of Ballinger, Texas, were also faced with a dwindling water supply due to prolonged drought. After three years of drought, Lake Ballinger, which supplies water to more than 4,300 residents in Ballinger and to 600 residents in nearby Rowena, was almost dry. Each day, people lined up to get water from a well in nearby City Park. Trucks hauling trailers outfitted with large plastic and metal tanks hauled water to and from City Park to Ballinger.[16]

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[13] U.S. Environmental Protection Agency. *"Cleaner Water through Conservation*." USEPA Report no. 841-B-95-002. April, 1995.

[14] Planning and Management Consultants, Ltd. "*Evaluating Urban Water Conservation Programs: A Procedures Manual*." Prepared for the California Urban Water Agencies. February 1992.

[15] Zewe, C. "*Tap Threatens to Run Dry in Texas Town*." July 11, 2000. CNN Cable News Network.

[16] Associated Press, "*Ballinger Scrambles to Finish Pipeline before Lake Dries Up*." May 19, 2003.

Table 6: Economic Losses Associated with Domestic Water Shortages in Communities with Populations Exceeding 100,000 people						
Water shortages as a percentage of total monthly household demands	**No. of gallons remaining per household per day**	**No of gallons remaining per person per day**	**Economic loss (per acre-foot)**		**Economic loss (per gallon)**	
1%	278	93	$748		$0.00005	
5%	266	89	$812		$0.0002	
10%	252	84	$900		$0.0005	
15%	238	79	$999		$0.0008	
20%	224	75	$1,110		$0.0012	
25%	210	70	$1,235		$0.0015	
30%[a]	196	65	$1,699		$0.0020	
35%	182	61	$3,825		$0.0085	
40%	168	56	$4,181		$0.0096	
45%	154	51	$4,603		$0.011	
50%	140	47	$5,109		$0.012	
55%	126	42	$5,727		$0.014	
60%	112	37	$6,500		$0.017	
65%	98	33	$7,493		$0.02	
70%	84	28	$8,818		$0.02	
75%	70	23	$10,672		$0.03	
80%	56	19	$13,454		$0.04	
85%	42	14	$18,091	($24,000)[b]	$0.05	($0.07)[b]
90%	28	9	$27,363	($24,000)	$0.08	($0.07)
95%	14	5	$55,182	($24,000)	$0.17	($0.07)
99%	3	0.9	$277,728	($24,000)	$0.85	($0.07)
99.9%	1	0.5	$2,781,377	($24,000)	$8.53	($0.07)
100%	0	0	Infinite	($24,000)	Infinite	($0.07)

[a] The first 30 percent of needs are assumed to be restrictions of outdoor water use; when needs reach 30 percent of total demands all outdoor water uses would be restricted. Needs greater than 30 percent include indoor use

[b] As shortages approach 100 percent the value approaches infinity assuming there are not alternatives available; however, we assume that communities would begin to have water delivered by tanker truck at an estimated cost of $24,000 per acre-foot when shortages breached 85 percent.

Commercial Businesses

Effects of water shortages on commercial sectors were estimated in a fashion similar to other business sectors meaning that water shortages would affect the ability of these businesses to operate. This is particularly true for “water intensive” commercial sectors that are need large amounts of water (in addition to potable and sanitary water) to provide their services. These include:

- car-washes,
- laundry and cleaning facilities,
- sports and recreation clubs and facilities including race tracks,
- amusement and recreation services,
- hospitals and medical facilities,
- hotels and lodging places, and
- eating and drinking establishments.

A key assumption is that commercial operations would not be affected until water shortages were at least 50 percent of total municipal demand. In other words, we assume that residential water consumers would reduce water use including all non-essential uses before businesses were affected.

An example will illustrate the breakdown of municipal water needs and the overall approach to estimating impacts of municipal needs. Assume City A experiences an unexpected shortage of 50 acre-feet per year when their demands are 200 acre-feet per year. Thus, shortages are only 25 percent of total municipal use and residents of City A could eliminate needs by restricting landscape irrigation. City B, on the other hand, has a deficit of 150 acre-feet in 2020 and a projected demand of 200 acre-feet. Thus, total shortages are 75 percent of total demand. Emergency outdoor and some indoor conservation measures could eliminate 50 acre-feet of projected needs, yet 50 acre-feet would still remain. To eliminate” the remaining 50 acre-feet water intensive commercial businesses would have to curtail operations or shut down completely.

Three other areas were considered when analyzing municipal water shortages: 1) lost revenues to water utilities, 2) losses to the horticultural and landscaping industries stemming for reduction in water available for landscape irrigation, and 3) lost revenues and related economic impacts associated with reduced water related recreation.

Water Utility Revenues

Estimating lost water utility revenues was straightforward. We relied on annual data from the “*Water and Wastewater Rate Survey*” published annually by the Texas Municipal League to calculate an average value per acre-foot for water and sewer. For water revenues, average retail water and sewer rates multiplied by total water needs served as a proxy. For lost wastewater, total unmet needs were adjusted for return flow factor of 0.60 and multiplied by average sewer rates for the region. Needs reported as “county-other” were excluded under the presumption that these consist primarily of self-supplied water uses. In addition, 15 percent of water demand and needs are considered non-billed or “unaccountable” water that comprises things such as leakages and water for municipal government functions (e.g., fire departments). Lost tax receipts are based on current rates for the “miscellaneous gross receipts tax, “which the state collects from utilities located in most incorporated cities or towns in Texas. We do not include lost water utility revenues when aggregating impacts of municipal water shortages to regional and state levels to prevent double counting.

Horticultural and Landscaping Industry

The horticultural and landscaping industry, also referred to as the "green Industry," consists of businesses that produce, distribute and provide services associated with ornamental plants, landscape and garden supplies and equipment. Horticultural industries often face big losses during drought. For example, the recent drought in the Southeast affecting the Carolinas and Georgia horticultural and landscaping businesses had a harsh year. Plant sales were down, plant mortality increased, and watering costs increased. Many businesses were forced to close locations, lay off employees, and even file for bankruptcy. University of Georgia economists put statewide losses for the industry at around $3.2 billion during the 3-year drought that ended in 2008.[17] Municipal restrictions on outdoor watering play a significant role. During drought, water restrictions coupled with persistent heat has a psychological effect on homeowners that reduces demands for landscaping products and services. Simply put, people were afraid to spend any money on new plants and landscaping.

In Texas, there do not appear to be readily available studies that analyze the economic effects of water shortages on the industry. However, authors of this report believe negative impacts do and would result in restricting landscape irrigation to municipal water consumers. The difficulty in measuring them is two-fold. First, as noted above, data and research for these types of impacts that focus on Texas are limited; and second, economic data provided by IMPLAN do not disaggregate different sectors of the green industry to a level that would allow for meaningful and defensible analysis.[18]

Recreational Impacts

Recreational businesses often suffer when water levels and flows in rivers, springs and reservoirs fall significantly during drought. During droughts, many boat docks and lake beaches are forced to close, leading to big losses for lakeside business owners and local communities. Communities adjacent to popular river and stream destinations such as Comal Springs and the Guadalupe River also see their business plummet when springs and rivers dry up. Although there are many examples of businesses that have suffered due to drought, dollar figures for drought-related losses to the recreation and tourism industry are not readily available, and very difficult to measure without extensive local surveys. Thus, while they are important, economic impacts are not measured in this study.

Table 7 summarizes impacts of municipal water shortages at differing levels of magnitude, and shows the ranges of economic costs or losses per acre-foot of shortage for each level.

[17] Williams, D. *"Georgia landscapers eye rebound from Southeast drought."* Atlanta Business Chronicle, Friday, June 19, 2009

[18] Economic impact analyses prepared by the TWDB for 2006 regional water plans did include estimates for the horticultural industry. However, year 2000 and prior IMPLAN data were disaggregated to a finer level. In the current dataset (2006), the sector previously listed as "Landscaping and Horticultural Services" (IMPLAN Sector 27) is aggregated into "Services to Buildings and Dwellings" (IMPLAN Sector 458).

Table 7: Impacts of Municipal Water Shortages at Different Magnitudes of Shortages		
Water shortages as percent of total municipal demands	Impacts	Economic costs per acre-foot*
0-30%	✓ Lost water utility revenues ✓ Restricted landscape irrigation and non-essential water uses	$730 - $2,040
30-50%	✓ Lost water utility revenues ✓ Elimination of landscape irrigation and non-essential water uses ✓ Rationing of indoor use	$730 - $10,970
>50%	✓ Lost water utility revenues ✓ Elimination of landscape irrigation and non-essential water uses ✓ Rationing of indoor use ✓ Restriction or elimination of commercial water use ✓ Importing water by tanker truck	$10,970 - varies
*Figures are rounded		

1.1.4 Industrial Water User Groups

Manufacturing

Impacts to manufacturing were estimated by distributing water shortages among industrial sectors at the county level. For example, if a planning group estimates that during a drought of record water supplies in County A would only meet 50 percent of total annual demands for manufactures in the county, we reduced output for each sector by 50 percent. Since projected manufacturing demands are based on TWDB Water Uses Survey data for each county, we only include IMPLAN sectors represented in the TWBD survey database. Some sectors in IMPLAN databases are not part of the TWDB database given that they use relatively small amounts of water - primarily for on-site sanitation and potable purposes. To maintain consistency between IMPLAN and TWDB databases, Standard Industrial Classification (SIC) codes both databases were cross referenced in county with shortages. Non-matches were excluded when calculating direct impacts.

Mining

The process of mining is very similar to that of manufacturing. We assume that within a given county, shortages would apply equally to relevant mining sectors, and IMPLAN sectors are cross referenced with TWDB data to ensure consistency.

In Texas, oil and gas extraction and sand and gravel (aggregates) operations are the primary mining industries that rely on large volumes of water. For sand and gravel, estimated output reductions are straightforward; however, oil and gas is more complicated for a number of reasons. IMPLAN does not necessarily report the physical extraction of minerals by geographic local, but rather the sales revenues reported by a particular corporation.

For example, at the state level revenues for IMPLAN sector 19 (oil and gas extraction) and sector 27 (drilling oil and gas wells) totals $257 billion. Of this, nearly $85 billion is attributed to Harris County. However, only a very small fraction (less than one percent) of actual production takes place in the county. To measure actual potential losses in well head capacity due to water shortages, we relied on county level production data from the Texas Railroad Commission (TRC) and average well-head market prices for crude and gas to estimate lost revenues in a given county. After which, we used to IMPLAN ratios to estimate resultant losses in income and employment.

Other considerations with respect to mining include:

1) Petroleum and gas extraction industry only uses water in significant amounts for secondary recovery. Known in the industry as enhanced or water flood extraction, secondary recovery involves pumping water down injection wells to increase underground pressure thereby pushing oil or gas into other wells. IMPLAN output numbers do not distinguish between secondary and non-secondary recovery. To account for the discrepancy, county-level TRC data that show the proportion of barrels produced using secondary methods were used to adjust IMPLAN data to reflect only the portion of sales attributed to secondary recovery.

2) A substantial portion of output from mining operations goes directly to businesses that are classified as manufacturing in our schema. Thus, multipliers measuring backward linkages for a given manufacturer might include impacts to a supplying mining operation. Care was taken not to double count in such situations if both a mining operation and a manufacturer were reported as having water shortages.

Steam-electric

At minimum without adequate cooling water, power plants cannot safely operate. As water availability falls below projected demands, water levels in lakes and rivers that provide cooling water would also decline. Low water levels could affect raw water intakes and outfalls at electrical generating units in several ways. For one, power plants are regulated by thermal emission guidelines that specify the maximum amount of heat that can go back into a river or lake via discharged cooling water. Low water levels could result in permit compliance issues due to reduced dilution and dispersion of heat and subsequent impacts on aquatic biota near outfalls.[19] However, the primary concern would be a loss of head (i.e., pressure) over intake structures that would decrease flows through intake tunnels. This would affect safety related pumps, increase operating costs and/or result in sustained shut-downs. Assuming plants did shutdown, they would not be able to generate electricity.

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[19] Section 316 (b) of the Clean Water Act requires that thermal wastewater discharges do not harm fish and other wildlife.

Among all water use categories steam-electric is unique and cautions are needed when applying methods used in this study. Measured changes to an economy using input-output models stem directly from changes in sales revenues. In the case of water shortages, one assumes that businesses will suffer lost output if process water is in short supply. For power generation facilities this is true as well. However, the electric services sector in IMPLAN represents a corporate entity that may own and operate several electrical generating units in a given region. If one unit became inoperable due to water shortages, plants in other areas or generation facilities that do not rely heavily on water such as gas powered turbines might be able to compensate for lost generating capacity. Utilities could also offset lost production via purchases on the spot market.[20] Thus, depending upon the severity of the shortages and conditions at a given electrical generating unit, energy supplies for local and regional communities could be maintained. But in general, without enough cooling water, utilities would have to throttle back plant operations, forcing them to buy or generate more costly power to meet customer demands.

Measuring impacts end users of electricity is not part of this study as it would require extensive local and regional level analysis of energy production and demand. To maintain consistency with other water user groups, impacts of steam-electric water shortages are measured in terms of lost revenues (and hence income) and jobs associated with shutting down electrical generating units.

1.2 Social Impacts of Water Shortages

As the name implies, the effects of water shortages can be social or economic. Distinctions between the two are both semantic and analytical in nature – more so analytic in the sense that social impacts are harder to quantify. Nevertheless, social effects associated with drought and water shortages are closely tied to economic impacts. For example, they might include:

- demographic effects such as changes in population,
- disruptions in institutional settings including activity in schools and government,
- conflicts between water users such as farmers and urban consumers,
- health-related low-flow problems (e.g., cross-connection contamination, diminished sewage flows, increased pollutant concentrations),
- mental and physical stress (e.g., anxiety, depression, domestic violence),
- public safety issues from forest and range fires and reduced fire fighting capability,
- increased disease caused by wildlife concentrations,
- loss of aesthetic and property values, and
- reduced recreational opportunities.[21]

[20] Today, most utilities participate in large interstate "power pools" and can buy or sell electricity "on the grid" from other utilities or power marketers. Thus, assuming power was available to buy, and assuming that no contractual or physical limitations were in place such as transmission constraints; utilities could offset lost power that resulted from waters shortages with purchases via the power grid.

[21] Based on information from the website of the National Drought Mitigation Center at the University of Nebraska Lincoln. Available online at: http://www.drought.unl.edu/risk/impacts.htm. See also, Vanclay, F. "*Social Impact Assessment*." in Petts, J. (ed) International Handbook of Environmental Impact Assessment. 1999.

Social impacts measured in this study focus strictly on demographic effects including changes in population and school enrollment. Methods are based on demographic projection models developed by the Texas State Data Center and used by the TWDB for state and regional water planning. Basically, the social impact model uses results from the economic component of the study and assesses how changes in labor demand would affect migration patterns in a region. Declines in labor demand as measured using adjusted IMPLAN data are assumed to affect net economic migration in a given regional water planning area. Employment losses are adjusted to reflect the notion that some people would not relocate but would seek employment in the region and/or public assistance and wait for conditions to improve. Changes in school enrollment are simply the proportion of lost population between the ages of 5 and 17.

2.0 Results

Section 2 presents the results of the analysis at the regional level. Included are baseline economic data for each water use category, and estimated economic impacts of water shortages for water user groups with reported deficits. Appendix A-2 shows results by water user group. According to the 2011*Panhandle Regional Water Plan*, during severe drought irrigation, municipal, manufacturing, mining and steam-electric water user groups would experience water shortages in the absence of new water management strategies.

2.1 Overview of Regional Economy

The Panhandle regional economy generates slightly more than $14 billion in gross state product for Texas ($13 billion in income and $1 billion in business taxes), and supports almost 215,860 jobs (Table 8). Generating about $4 billion in income per year, mining, agriculture and manufacturing (particularly petroleum refining, copper smelting and automotive parts), are the primary base economic sectors in the region.[22] Municipal sectors also generate substantial amounts of income – about $9 billion per year – and are major employers in the region. While municipal sectors are the largest employer and source of wealth, many businesses that make up the municipal category such as restaurants and retail stores are non-basic industries meaning they exist to provide services to people who work would in base industries such as manufacturing, agriculture and mining. In other words, without base industries such as agriculture, many municipal jobs in the region would not exist.

[22] Base industries are those that supply markets outside of the region. These industries are crucial to the local economy and are called the economic base of a region. Appendix A shows how IMPLAN's 529 sectors were allocated to water use category, and shows economic data for each sector.

Table 8: The Panhandle Regional Economy by Water User Group ($millions)*						
Water Use Category	**Total Sales**	**Intermediate Sales**	**Final Sales**	**Jobs**	**Income**	**Business Taxes**
Irrigation	$537.73	$117.07	$420.66	6,833	$178.77	$8.95
Livestock	$4,311.56	$1,641.03	$2,670.54	15,846	$496.79	$45.14
Manufacturing	$12,109.93	$2,921.19	$9,188.74	22,131	$1,710.41	$63.95
Mining	$2,557.61	$1,379.99	$1,177.62	6,685	$1,529.14	$131.10
Steam-electric	$360.40	$101.39	$259.01	713	$250.42	$42.55
Municipal	$15,318.03	$4,535.93	$10,782.10	163,649	$8,706.95	$846.11
Regional total	$35,195.26	$10,696.60	$24,498.67	215,857	$12,872.49	$1,137.80

*Appendix 1 displays data by individual sectors for each water use category. Based on data from the Texas Water Development Board, and year 2006 data from the Minnesota IMPLAN Group, Inc.

2.2 Impacts of Agricultural Water Shortages

According to the 2011 *Panhandle Regional Water Plan*, during severe drought most counties in the region would experiences shortages of irrigation water. In 2010, shortages range from roughly 30 to 70 percent of annual irrigation water demands. In total, farmers would be short nearly 381,950 acre-feet in 2010 and about 311,850 acre-feet in 2060. Shortages of these magnitudes would result in estimated incomes losses of $181 million in 2010 and $151 million in 2060 (Table 9). Estimated jobs losses total 2,958 in 2010 and 2,445 in 2060.

Table 9: Economic Impacts of Water Shortages for Irrigation Water User Groups ($millions)			
Decade	**Lost income from reduced crop production** [a]	**Lost state and local tax revenues from reduced crop production**	**Lost jobs from reduced crop production**
2010	$181.64	$10.93	2,959
2020	$182.84	$11.76	2,984
2030	$190.90	$12.36	3,107
2040	$191.09	$12.41	3,107
2050	$171.46	$11.16	2,783
2060	$150.84	$9.84	2,446

[a] Changes to Income and business taxes are collectively equivalent to a decrease in gross state product, which is analogous to gross domestic product measured at the state rather than national level.

2.3 Impacts of Municipal Water Shortages

In Region A, water shortages are projected to occur for several municipal water user groups. The estimated costs of domestic water shortages range from nearly $2 million in 2020 to $182 million in 2060 (Table 10). Curtailed commercial business activity in communities with substantial shortages would reduce gross state product (income plus taxes) by nearly $14 million in 2040 and $56 million in 2060.

Table 10: Economic Impacts of Water Shortages for Municipal Water User Groups ($millions)

Decade	Monetary value of domestic water shortages	Lost income from reduced commercial business activity*	Lost state and local taxes from reduced commercial business activity	Lost jobs from reduced commercial business activity	Lost water utility revenues
2010	$0.00	$0.00	$0.00	0	$0.00
2020	$1.53	$0.00	$0.00	0	$1.72
2030	$40.71	$0.00	$0.00	0	$12.30
2040	$69.06	$12.47	$1.29	311	$23.03
2050	$124.29	$37.18	$3.70	899	$33.39
2060	$181.60	$50.69	$5.05	1,228	$41.24

* Changes to Income and business taxes are collectively equivalent to a decrease in gross state product, which is analogous to gross domestic product measured at the state rather than national level.

2.4 Impacts of Manufacturing Water Shortages

Manufacturing water shortages in the region are projected to occur in Hutchinson, Moore and Potter counties. In total, manufacturers in these counties would be short about 170 acre-feet in 2010 and roughly 7,050 acre-feet in 2060. In 2010, manufacturing water deficits would reduce gross state product by about $6 million threatening 106 jobs. By 2060, losses grow to nearly $161 million with about 2,000 jobs at stake (Table 11).

Table 11: Economic Impacts of Water Shortages for Manufacturing Water User Groups ($millions)			
Decade	**Lost income due to reduced manufacturing output**	**Lost state and local business tax revenues due to reduced manufacturing output**	**Lost jobs due to reduced manufacturing output**
2010	$5.17	$0.80	106
2020	$23.92	$3.71	492
2030	$43.95	$6.55	752
2040	$75.60	$10.85	1,168
2050	$106.06	$14.93	1,559
2060	$141.21	$19.66	2,002

[a] Changes to income and business taxes are collectively equivalent to a decrease in gross state product, which is analogous to gross domestic product measured at the state rather than national level.

2.5 Impacts of Steam-electric Water Shortages

Steam-electric water shortages are reported for Moore County in 2020 and would reduce gross state product by $1 million in 2010 and $4 million in 2060 (Table 12).

Table 12: Economic Impacts of Water Shortages for Steam-electric Water User Groups ($millions)			
Decade	**Lost income due to reduced steam-electric output***	**Lost state and local business tax revenues due to reduced steam-electric output**	**Lost jobs due to reduced steam-electric output**
2010	$0.83	$0.18	6
2020	$1.09	$0.23	8
2030	$2.59	$0.55	18
2040	$2.83	$0.60	20
2050	$3.00	$0.64	21
2060	$3.40	$0.73	24

*Changes to Income and business taxes are collectively equivalent to a decrease in gross state product, which is analogous to gross domestic product measured at the state rather than national level.

2.6 Social Impacts of Water Shortages

As discussed previously, estimated social impacts focus on changes in population and school enrollment. In 2010, estimated population losses total 3,693 with corresponding reductions in school enrollment of 1,042 students (Table 13). In 2060 population in the region would decline by 6,846 people and school enrollment would fall by 1,270 students.

Table 13: Social Impacts of Water Shortages (2010-2060)

Year	Population losses	Declines in school enrollment
2010	3,693	1,042
2020	4,234	1,201
2030	4,670	1,237
2040	5,548	1,025
2050	6,338	1,171
2060	6,864	1,270

2.7 Distribution of Impacts by Major River Basin

Administrative rules require that impacts are presented by both planning region and major river basin. To meet rule requirements, impacts were allocated among basins based on the distribution of water shortages in relevant basins. For example, if 50 percent of water shortages in River Basin A and 50 percent occur in River Basin B, then impacts were split equally among the two basins. Table 14 displays the results.

Table 14: Distribution of Impacts by Major River Basin (2010-2060)						
Water Use	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**
Irrigation						
Canadian	100%	100%	100%	100%	100%	100%
Red	0%	0%	0%	0%	0%	0%
Manufacturing						
Canadian	100%	100%	90%	75%	68%	65%
Red	0%	0%	10%	25%	32%	35%
Municipal						
Canadian	0%	43%	42%	41%	41%	39%
Red	0%	57%	58%	59%	59%	61%
Steam-electric						
Canadian	100%	100%	100%	100%	100%	100%
Red	0%	0%	0%	0%	0%	0%

Appendix 1: Economic Data for Individual IMPLAN Sectors for the Panhandle Regional Water Planning Area

Economic Data for Agricultural Water User Groups ($millions)

Water Use Category	IMPLAN Sector	IMPLAN Code	Total Sales	Intermediate Sales	Final Sales	Jobs	Income	Business Taxes
Irrigation	Grain Farming	1	$393.28	75.06	318.22	5259	$122.64	$0.00
Irrigation	Cotton Farming	2	$52.71	1.10	51.61	921	$13.36	$0.00
Irrigation	Vegetable and Melon Farming	3	$41.61	2.54	39.07	248	$25.15	$0.00
Irrigation	All "Other" Crop Farming	4	$39.94	36.73	3.21	292	$13.80	$0.00
Irrigation	Oilseed Farming	5	$7.72	1.08	6.64	75	$2.66	$0.00
Irrigation	Fruit Farming	6	$2.47	0.57	1.90	39	$1.16	$0.00
Livestock	Animal- except poultry- slaughtering	67	$2,988.41	$799.02	$2,189.39	7,626	$376.43	$20.69
Livestock	Cattle ranching and farming	11	$1,070.92	$742.57	$328.35	7,180	$84.60	$22.51
Livestock	Meat processed from carcasses	68	$85.14	$25.12	$60.02	193	$9.83	$0.50
Livestock	Rendering and meat byproduct processing	69	$53.76	$29.83	$23.93	93	$15.28	$0.44
Livestock	Animal production- except cattle and poultry	13	$38.90	$32.98	$5.92	655	$3.78	$0.60
Livestock	Dog and cat food manufacturing	46	$33.26	$3.21	$30.05	34	$2.81	$0.15
Livestock	Other animal food manufacturing	47	$22.17	$2.67	$19.49	31	$1.66	$0.13
Livestock	Fluid milk manufacturing	62	$17.09	$4.11	$12.98	29	$1.75	$0.10
Livestock	Poultry and egg production	12	$1.92	$1.51	$0.42	5	$0.65	$0.01
Total Agriculture			$4,849.29	$1,758.10	$3,091.19	22,679	$675.56	$45.14

Based on year 2006 data from the Minnesota IMPLAN Group, Inc.

Economic Data for Mining and Steam-electric Water User Groups ($millions)

Water Use Category	IMPLAN Sector	IMPLAN Code	Total Sales	Intermediate Sales	Final Sales	Jobs	Income	Business Taxes
Mining	Oil and gas extraction	19	$1,335.11	$1,239.90	$95.21	2,369	$768.72	$80.21
Mining	Support activities for oil and gas operations	28	$669.80	$93.03	$576.77	3,246	$607.12	$27.67
Mining	Drilling oil and gas wells	27	$419.74	$2.10	$417.64	698	$115.58	$15.25
Mining	Natural gas distribution	31	$104.73	$41.98	$62.76	231	$20.95	$7.20
Mining	Sand- gravel- clay- and refractory mining	25	$28.23	$2.98	$25.25	141	$16.78	$0.78
Total Mining			$2,557.61	$1,379.99	$1,177.62	6,685	$1,529.14	$131.10
Steam-electric	Power generation and supply	30	$360.40	$101.39	$259.01	713	$250.42	$42.55

Based on year 2006 data from the Minnesota IMPLAN Group, Inc.

Economic Data for Manufacturing Water User Groups ($millions)								
Water Use Category	**IMPLAN Sector**	**IMPLAN Code**	**Total Sales**	**Intermediate Sales**	**Final Sales**	**Jobs**	**Income**	**Business Taxes**
Manufacturing	Petroleum refineries	142	$5,919.94	$2,200.44	$3,719.49	711	$252.05	$10.77
Manufacturing	Primary smelting and refining of copper	214	$2,791.62	$249.62	$2,542.00	820	$166.74	$24.70
Manufacturing	New residential 1-unit structures- all	33	$545.93	$0.00	$545.93	3,700	$179.06	$2.82
Manufacturing	Commercial and institutional buildings	38	$305.99	$0.00	$305.99	3,222	$153.54	$1.89
Manufacturing	Ammunition manufacturing	256	$285.16	$1.13	$284.03	883	$133.87	$8.66
Manufacturing	Other basic inorganic chemical manufacturing	150	$206.08	$45.40	$160.68	364	$68.91	$0.78
Manufacturing	Glass and glass products - except glass containers	190	$187.05	$117.25	$69.80	710	$87.52	$1.92
Manufacturing	Oil and gas field machinery and equipment	261	$187.05	$6.97	$180.08	512	$47.89	$0.97
Manufacturing	Other new construction	41	$133.36	$0.00	$133.36	1,479	$71.18	$0.56
Manufacturing	Agriculture and forestry support activities	18	$91.23	$51.86	$39.37	2,486	$67.81	$0.80
Manufacturing	Machine shops	243	$86.47	$20.87	$65.60	657	$38.63	$0.62
Manufacturing	Construction machinery manufacturing	259	$84.04	$11.47	$72.57	119	$14.74	$0.44
Manufacturing	Other oilseed processing	53	$80.20	$2.61	$77.59	39	$2.43	$0.31
Manufacturing	New residential additions and alterations-all	35	$77.40	$0.00	$77.40	438	$28.35	$0.40
Manufacturing	Ready-mix concrete manufacturing	192	$67.64	$0.33	$67.31	244	$22.05	$0.54
Manufacturing	Highway- street- bridge- and tunnel construct	39	$65.74	$0.00	$65.74	624	$32.88	$0.42
Manufacturing	New multifamily housing structures- all	34	$59.29	$0.00	$59.29	540	$27.59	$0.16
Manufacturing	Sporting and athletic goods manufacturing	381	$56.36	$0.26	$56.11	289	$15.69	$0.55
Manufacturing	Water- sewer- and pipeline construction	40	$47.87	$0.00	$47.87	408	$21.06	$0.30
Manufacturing	Polish and other sanitation good manufacturing	164	$46.64	$16.29	$30.35	54	$9.80	$0.19
Manufacturing	Footwear manufacturing	110	$44.33	$0.37	$43.96	314	$17.85	$0.41
Manufacturing	Paperboard container manufacturing	126	$40.24	$0.43	$39.82	134	$9.26	$0.36
Manufacturing	Other ordnance and accessories manufacturing	251	$38.23	-$0.01	$38.24	210	$21.50	$0.20
Manufacturing	Speed changers and mechanical power transmissions	287	$32.89	$17.12	$15.78	160	$12.63	$0.13
Manufacturing	Plastics plumbing fixtures and all other plastics	177	$31.70	$22.97	$8.74	142	$13.59	$0.23
Manufacturing	Hunting and trapping	17	$30.36	$2.48	$27.88	241	$4.74	$1.31
Manufacturing	All other manufacturing sectors	various	$567.12	$153.35	$413.76	$2,631.00	$189.08	$3.54
Manufacturing	Total manufacturing		$12,677.05	$3,074.55	$9,602.50	24,762	$1,899.50	$67.49
Based on year 2006 data from the Minnesota IMPLAN Group, Inc.								

Economic Data for Municipal Water User Groups ($millions)								
Water Use Category	**IMPLAN Sector**	**IMPLAN Code**	**Total Sales**	**Intermediate Sales**	**Final Sales**	**Jobs**	**Income**	**Business Taxes**
Municipal	Wholesale trade	390	$1,231.19	$589.45	$641.74	8,549	$648.33	$181.97
Municipal	Owner-occupied dwellings	509	$1,066.17	$0.00	$1,066.17	0	$825.93	$126.07
Municipal	Insurance carriers	427	$948.03	$276.44	$671.59	4,159	$304.42	$37.38
Municipal	Real estate	431	$794.74	$314.60	$480.14	4,873	$459.53	$98.20
Municipal	State & local education	503	$760.59	$0.00	$760.58	19,045	$760.59	$0.00
Municipal	Offices of physicians- dentists- and other he	465	$567.00	$0.00	$567.00	4,903	$401.65	$3.52
Municipal	Food services and drinking places	481	$555.74	$70.97	$484.77	12,146	$218.95	$25.57
Municipal	Hospitals	467	$522.23	$0.00	$522.23	4,423	$283.67	$3.62
Municipal	Monetary authorities and depository credit in	430	$510.44	$168.12	$342.33	2,527	$358.44	$6.53
Municipal	State & local non-education	504	$398.55	$0.00	$398.55	7,848	$398.55	$0.00
Municipal	Telecommunications	422	$353.59	$121.45	$232.14	717	$160.52	$27.01
Municipal	Accounting and bookkeeping services	438	$342.78	$278.37	$64.41	3,350	$185.81	$1.52
Municipal	Rail transportation	392	$338.45	$163.64	$174.81	1,007	$205.53	$6.51
Municipal	Truck transportation	394	$332.03	$179.78	$152.24	2,596	$149.39	$3.39
Municipal	Securities- commodity contracts- investments	426	$310.14	$205.96	$104.18	3,060	$81.61	$2.45
Municipal	Motor vehicle and parts dealers	401	$303.04	$32.95	$270.09	2,873	$156.09	$44.19
Municipal	Pipeline transportation	396	$272.75	$119.28	$153.47	150	$119.16	$25.79
Municipal	General merchandise stores	410	$234.46	$24.71	$209.75	4,416	$104.45	$33.28
Municipal	Other State and local government enterprises	499	$230.31	$75.00	$155.32	1,169	$77.52	$0.02
Municipal	Gasoline stations	407	$197.41	$29.98	$167.43	2,382	$106.37	$28.72
Municipal	Legal services	437	$182.87	$116.06	$66.81	1,532	$114.10	$3.59
Municipal	Automotive repair and maintenance- except car	483	$180.63	$42.91	$137.72	2,454	$66.32	$13.17
Municipal	Food and beverage stores	405	$170.85	$22.84	$148.01	3,395	$84.18	$18.44
Municipal	Federal Non-Military	506	$168.66	$0.00	$168.66	1,227	$168.65	$0.00
Municipal	Hotels and motels- including casino hotels	479	$167.85	$86.47	$81.38	2,040	$91.97	$15.78
Municipal	All other municipal sectors	various	$15,318.03	$4,535.93	$10,782.10	163,649	$8,706.95	$846.11
Municipal	Total municipal		$15,318.03	$4,535.93	$10,782.10	163,649	$8,706.95	$846.11
Based on year 2006 data from the Minnesota IMPLAN Group, Inc.								

Appendix 2: Impacts by County and Water User Group

Dallam County ($millions)						
	2010	**2020**	**2030**	**2040**	**2050**	**2060**
Irrigation						
Reduced income from reduced crop production	$64.06	$67.96	$71.65	$71.89	$64.47	$56.59
Reduced business taxes from reduced crop production	$3.84	$4.08	$4.30	$4.31	$3.87	$3.40
Reduced jobs from reduced crop production	1,112	1,180	1,244	1,248	1,119	982

Gray County ($millions)						
	2010	**2020**	**2030**	**2040**	**2050**	**2060**
City of Lefors						
Monetary value of domestic water shortages	$0.00	$0.00	$0.00	$0.24	$0.38	$0.37
Lost income from reduced commercial business activity	$0.00	$0.00	$0.00	$0.00	$0.00	$0.02
Lost state and local taxes from reduced commercial business activity	$0.00	$0.00	$0.00	$0.00	$0.00	$0.01
Lost jobs due to reduced commercial business activity	0	0	0	0	0	1
Lost utility revenues	$0.00	$0.00	$0.00	$0.05	$0.06	$0.06

Hall County ($millions)						
	2010	**2020**	**2030**	**2040**	**2050**	**2060**
City of Memphis						
Monetary value of domestic water shortages	$0.00	$0.13	$1.16	$1.16	$1.16	$1.17
Reduced utility revenues	$0.00	$0.14	$0.25	$0.25	$0.25	$0.25

Hansford County ($millions)						
	2010	2020	2030	2040	2050	2060
City of Gruver						
Monetary value of domestic water shortages	$0.00	$0.14	$3.69	$6.14	$7.35	$7.37
Lost income from reduced commercial business activity	$0.00	$0.00	$0.00	$0.43	$0.57	$0.57
Lost state and local taxes from reduced commercial business activity	$0.00	$0.00	$0.00	$0.08	$0.10	$0.10
Lost jobs due to reduced commercial business activity	0	0	0	19	25	25
Lost utility revenues	$0.00	$0.14	$0.41	$0.50	$0.59	$0.59
City of Spearman						
Monetary value of domestic water shortages	$0.00	$0.00	$2.49	$12.41	$18.35	$18.75
Lost income from reduced commercial business activity	$0.00	$0.00	$0.00	$0.82	$1.42	$1.45
Lost state and local taxes from reduced commercial business activity	$0.00	$0.00	$0.00	$0.15	$0.26	$0.26
Lost jobs due to reduced commercial business activity	0	0	0	36	63	64
Lost utility revenues	$0.00	$0.00	$0.49	$1.09	$1.48	$1.51
Irrigation						
Reduced income from reduced crop production	$0.03	$0.20	$0.29	$0.90	$0.61	$0.32
Reduced business taxes from reduced crop production	$0.00	$0.01	$0.02	$0.05	$0.04	$0.02
Reduced jobs from reduced crop production	1	4	5	16	11	6

Hartley County ($millions)						
	2010	2020	2030	2040	2050	2060
Irrigation						
Reduced income from reduced crop production	$87.66	$87.08	$88.49	$86.82	$77.84	$68.53
Reduced business taxes from reduced crop production	$5.27	$5.23	$5.32	$5.22	$4.68	$4.12
Reduced jobs from reduced crop production	1,437	1,427	1,450	1,423	1,276	1,123

Hutchinson County ($millions)						
	2010	2020	2030	2040	2050	2060
City of Borger						
Monetary value of domestic water shortages	$0.00	$0.00	$0.23	$0.52	$0.73	$1.07
Lost utility revenues	$0.00	$0.00	$0.37	$0.74	$0.92	$1.04
Irrigation						
Reduced income from reduced crop production	$3.33	$2.70	$2.59	$2.36	$1.67	$1.21
Reduced business taxes from reduced crop production	$0.20	$0.17	$0.16	$0.14	$0.10	$0.07
Reduced jobs from reduced crop production	62	50	48	44	31	22
Manufacturing						
Reduced income from reduced manufacturing output	$0.00	$0.00	$6.96	$13.04	$18.37	$25.69
Reduced business taxes from reduced manufacturing output	$0.00	$0.00	$1.06	$1.98	$2.79	$3.90
Reduced jobs from reduced manufacturing output	0	0	58	109	153	214

Moore County ($millions)						
	2010	2020	2030	2040	2050	2060
City of Cactus						
Monetary value of domestic water shortages	$0.00	$0.00	$1.84	$2.87	$3.27	$4.15
Lost income from reduced commercial business activity	$0.00	$0.00	$0.00	$0.00	$0.43	$1.16
Lost state and local taxes from reduced commercial business activity	$0.00	$0.00	$0.00	$0.00	$0.05	$0.12
Lost jobs due to reduced commercial business activity	0	0	0	0	11	31
Lost utility revenues	$0.00	$0.00	$0.36	$0.47	$0.55	$0.63
County-other						
Monetary value of domestic water shortages	$0.00	$0.00	$0.42	$4.17	$5.87	$7.34
City of Dumas						
Monetary value of domestic water shortages	$0.00	$0.54	$11.51	$12.39	$24.34	$32.52
Lost income from reduced commercial business activity	$0.00	$0.00	$0.00	$0.68	$3.39	$8.67
Lost state and local taxes from reduced commercial business activity	$0.00	$0.00	$0.00	$0.07	$0.36	$0.92
Lost jobs due to reduced commercial business activity	0	0	0	18	89	228
Lost utility revenues	$0.00	$0.69	$2.07	$2.98	$3.95	$4.41
City of Sunray						
Monetary value of domestic water shortages	$0.00	$0.00	$0.00	$0.03	$0.15	$0.18
Lost utility revenues	$0.00	$0.00	$0.00	$0.05	$0.19	$0.23
Irrigation						
Reduced income from reduced crop production	$13.48	$12.39	$13.51	$14.17	$12.97	$11.70
Reduced business taxes from reduced crop production	$0.81	$0.75	$0.82	$0.86	$0.78	$0.71
Reduced jobs from reduced crop production	229	210	229	241	220	199
Manufacturing						
Reduced income from reduced manufacturing output	$5.17	$23.92	$30.89	$41.74	$51.37	$61.81
Reduced business taxes from reduced manufacturing output	$0.80	$3.71	$4.79	$6.48	$7.97	$9.59
Reduced jobs from reduced manufacturing output	106	492	636	859	1,057	1,272
Steam-electric						
Lost income due to reduced electrical generation	$0.83	$1.09	$2.59	$2.83	$3.00	$3.40
Lost state and local business tax revenues due to reduced electrical generation	$0.18	$0.23	$0.55	$0.60	$0.64	$0.73
Lost jobs due to reduced electrical generation	6	8	18	20	21	24

Potter County ($millions)						
	2010	2020	2030	2040	2050	2060
City of Amarillo						
Monetary value of domestic water shortages	$0.00	$0.00	$1.45	$4.41	$7.68	$11.23
Lost utility revenues	$0.00	$0.00	$6.13	$13.52	$21.03	$27.42
County-other						
Monetary value of domestic water shortages	$0.00	$0.11	$0.40	$1.59	$14.18	$21.17
Manufacturing						
Reduced income from reduced manufacturing output	$0.00	$0.00	$6.10	$20.82	$36.32	$53.72
Reduced business taxes from reduced manufacturing output	$0.00	$0.00	$0.70	$2.39	$4.18	$6.18
Reduced jobs from reduced manufacturing output	0	0	59	200	349	516

Randall County ($millions)						
	2010	2020	2030	2040	2050	2060
City of Amarillo						
Monetary value of domestic water shortages	$0.00	$0.00	$1.88	$5.63	$9.69	$14.05
Lost utility revenues	$0.00	$0.00	$0.72	$1.58	$2.44	$3.17
City of Canyon						
Monetary value of domestic water shortages	$0.00	$0.61	$15.08	$15.75	$27.53	$40.61
Lost income from reduced commercial business activity	$0.00	$0.00	$0.005	$10.54	$31.36	$38.82
Lost state and local taxes from reduced commercial business activity	$0.00	$0.00	$0.00	$0.99	$2.94	$3.63
Lost jobs due to reduced commercial business activity	0	0	0	239	710	879
Lost utility revenues	$0.00	$0.75	$2.22	$3.39	$4.36	$5.09
County-other						
Monetary value of domestic water shortages	$0.00	$0.00	$0.57	$1.77	$3.60	$21.62

Sherman County ($millions)						
	2010	**2020**	**2030**	**2040**	**2050**	**2060**
Irrigation						
Reduced income from reduced crop production	$13.08	$12.51	$14.37	$14.96	$13.90	$12.47
Reduced business taxes from reduced crop production	$0.80	$1.53	$1.75	$1.83	$1.70	$1.52
Reduced jobs from reduced crop production	119	113	130	136	126	113

APPENDIX J

MODEL WATER CONSERVATION

AND

DROUGHT CONTINGENCY PLANS

TEXAS ADMINISTRATIVE CODE

WATER CONSERVATION PLANS, DROUGHT CONTINGENCY PLANS, GUIDELINES AND REQUIREMENTS

Amended to be effective January 10, 2008

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CHAPTER 288	WATER CONSERVATION PLANS, DROUGHT CONTINGENCY PLANS, GUIDELINES AND REQUIREMENTS
SUBCHAPTER A	WATER CONSERVATION PLANS
RULE §288.1	**Definitions**

The following words and terms, when used in this chapter, shall have the following meanings, unless the context clearly indicates otherwise.

(1) Agricultural or Agriculture--Any of the following activities:

(A) cultivating the soil to produce crops for human food, animal feed, or planting seed or for the production of fibers;

(B) the practice of floriculture, viticulture, silviculture, and horticulture, including the cultivation of plants in containers or non-soil media by a nursery grower;

(C) raising, feeding, or keeping animals for breeding purposes or for the production of food or fiber, leather, pelts, or other tangible products having a commercial value;

(D) raising or keeping equine animals;

(E) wildlife management; and

(F) planting cover crops, including cover crops cultivated for transplantation, or leaving land idle for the purpose of participating in any governmental program or normal crop or livestock rotation procedure.

(2) Agricultural use--Any use or activity involving agriculture, including irrigation.

(3) Best management practices--Voluntary efficiency measures that save a quantifiable amount of water, either directly or indirectly, and that can be implemented within a specific time frame.

(4) Conservation--Those practices, techniques, and technologies that reduce the consumption of water, reduce the loss or waste of water, improve the efficiency in the use of water, or increase the recycling and reuse of water so that a water supply is made available for future or alternative uses.

(5) Drought contingency plan--A strategy or combination of strategies for temporary supply and demand management responses to temporary and potentially recurring water supply shortages and other water supply emergencies. A drought contingency plan may be a separate document identified as such or may be contained within another water management document(s).

(6) Industrial use--The use of water in processes designed to convert materials of a lower order of value into forms having greater usability and commercial value, commercial fish production, and the development of power by means other than hydroelectric, but does not include agricultural use.

(7) Irrigation--The agricultural use of water for the irrigation of crops, trees, and

pastureland, including, but not limited to, golf courses and parks which do not receive water through a municipal distribution system.

(8) Irrigation water use efficiency--The percentage of that amount of irrigation water which is beneficially used by agriculture crops or other vegetation relative to the amount of water diverted from the source(s) of supply. Beneficial uses of water for irrigation purposes include, but are not limited to, evapotranspiration needs for vegetative maintenance and growth, salinity management, and leaching requirements associated with irrigation.

(9) Mining use--The use of water for mining processes including hydraulic use, drilling, washing sand and gravel, and oil field repressuring.

(10) Municipal per capita water use--The sum total of water diverted into a water supply system for residential, commercial, and public and institutional uses divided by actual population served.

(11) Municipal use--The use of potable water within or outside a municipality and its environs whether supplied by a person, privately owned utility, political subdivision, or other entity as well as the use of sewage effluent for certain purposes, including the use of treated water for domestic purposes, fighting fires, sprinkling streets, flushing sewers and drains, watering parks and parkways, and recreational purposes, including public and private swimming pools, the use of potable water in industrial and commercial enterprises supplied by a municipal distribution system without special construction to meet its demands, and for the watering of lawns and family gardens.

(12) Municipal use in gallons per capita per day--The total average daily amount of water diverted or pumped for treatment for potable use by a public water supply system. The calculation is made by dividing the water diverted or pumped for treatment for potable use by population served. Indirect reuse volumes shall be credited against total diversion volumes for the purpose of calculating gallons per capita per day for targets and goals.

(13) Nursery grower--A person engaged in the practice of floriculture, viticulture, silviculture, and horticulture, including the cultivation of plants in containers or nonsoil media, who grows more than 50% of the products that the person either sells or leases, regardless of the variety sold, leased, or grown. For the purpose of this definition, grow means the actual cultivation or propagation of the product beyond the mere holding or maintaining of the item prior to sale or lease, and typically includes activities associated with the production or multiplying of stock such as the development of new plants from cuttings, grafts, plugs, or seedlings.

(14) Pollution--The alteration of the physical, thermal, chemical, or biological quality of, or the contamination of, any water in the state that renders the water harmful, detrimental, or injurious to humans, animal life, vegetation, or property, or to the public health, safety, or welfare, or impairs the usefulness or the public enjoyment of the water for any lawful or reasonable purpose.

(15) Public water supplier--An individual or entity that supplies water to the public for human consumption.

(16) Regional water planning group--A group established by the Texas Water Development Board to prepare a regional water plan under Texas Water Code, §16.053.

(17) Retail public water supplier--An individual or entity that for compensation supplies water to the public for human consumption. The term does not include an individual or

entity that supplies water to itself or its employees or tenants when that water is not resold to or used by others.

(18) Reuse--The authorized use for one or more beneficial purposes of use of water that remains unconsumed after the water is used for the original purpose of use and before that water is either disposed of or discharged or otherwise allowed to flow into a watercourse, lake, or other body of state-owned water.

(19) Water conservation plan--A strategy or combination of strategies for reducing the volume of water withdrawn from a water supply source, for reducing the loss or waste of water, for maintaining or improving the efficiency in the use of water, for increasing the recycling and reuse of water, and for preventing the pollution of water. A water conservation plan may be a separate document identified as such or may be contained within another water management document(s).

(20) Wholesale public water supplier--An individual or entity that for compensation supplies water to another for resale to the public for human consumption. The term does not include an individual or entity that supplies water to itself or its employees or tenants as an incident of that employee service or tenancy when that water is not resold to or used by others, or an individual or entity that conveys water to another individual or entity, but does not own the right to the water which is conveyed, whether or not for a delivery fee.

Source Note: The provisions of this §288.1 adopted to be effective May 3, 1993, 18 TexReg 2558; amended to be effective February 21, 1999, 24 TexReg 949; amended to be effective April 27, 2000, 25 TexReg 3544; amended to be effective August 15, 2002, 27 TexReg 7146; amended to be effective October 7, 2004, 29 TexReg 9384; amended to be effective January 10, 2008, 33 TexReg 193

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SUBCHAPTER A	WATER CONSERVATION PLANS
RULE §288.2	**Water Conservation Plans for Municipal Uses by Public Water Suppliers**

(a) A water conservation plan for municipal water use by public water suppliers must provide information in response to the following. If the plan does not provide information for each requirement, the public water supplier shall include in the plan an explanation of why the requirement is not applicable.

(1) Minimum requirements. All water conservation plans for municipal uses by public drinking water suppliers must include the following elements:

(A) a utility profile including, but not limited to, information regarding population and customer data, water use data, water supply system data, and wastewater system data;

(B) until May 1, 2005, specification of conservation goals including, but not limited to, municipal per capita water use goals, the basis for the development of such goals, and a time frame for achieving the specified goals;

(C) beginning May 1, 2005, specific, quantified five-year and ten-year targets for water savings to include goals for water loss programs and goals for municipal use, in gallons per capita per day. The goals established by a public water supplier under this subparagraph are not enforceable;

(D) metering device(s), within an accuracy of plus or minus 5.0% in order to measure and account for the amount of water diverted from the source of supply;

(E) a program for universal metering of both customer and public uses of water, for meter testing and repair, and for periodic meter replacement;

(F) measures to determine and control unaccounted-for uses of water (for example, periodic visual inspections along distribution lines; annual or monthly audit of the water system to determine illegal connections; abandoned services; etc.);

(G) a program of continuing public education and information regarding water conservation;

(H) a water rate structure which is not "promotional," i.e., a rate structure which is cost-based and which does not encourage the excessive use of water;

(I) a reservoir systems operations plan, if applicable, providing for the coordinated operation of reservoirs owned by the applicant within a common watershed or river basin in order to optimize available water supplies; and

(J) a means of implementation and enforcement which shall be evidenced by:

(i) a copy of the ordinance, resolution, or tariff indicating official adoption of the water conservation plan by the water supplier; and

(ii) a description of the authority by which the water supplier will implement and enforce the conservation plan; and

(K) documentation of coordination with the regional water planning groups for the service area of the public water supplier in order to ensure consistency with the appropriate approved regional water plans.

(2) Additional content requirements. Water conservation plans for municipal uses by public drinking water suppliers serving a current population of 5,000 or more and/or a projected population of 5,000 or more within the next ten years subsequent to the effective date of the plan must include the following elements:

(A) a program of leak detection, repair, and water loss accounting for the water transmission, delivery, and distribution system in order to control unaccounted-for uses of water;

(B) a record management system to record water pumped, water deliveries, water sales, and water losses which allows for the desegregation of water sales and uses into the following user classes:

(i) residential;

(ii) commercial;

(iii) public and institutional; and

(iv) industrial;

(C) a requirement in every wholesale water supply contract entered into or renewed after official adoption of the plan (by either ordinance, resolution, or tariff), and including any contract extension, that each successive wholesale customer develop and implement a water conservation plan or water conservation measures using the applicable elements in this chapter. If the customer intends to resell the water, the contract between the initial supplier and customer must provide that the contract for the resale of the water must have water conservation requirements so that each successive customer in the resale of the water will be required to implement water conservation measures in accordance with the provisions of this chapter.

(3) Additional conservation strategies. Any combination of the following strategies shall be selected by the water supplier, in addition to the minimum requirements in paragraphs (1) and (2) of this subsection, if they are necessary to achieve the stated water conservation goals of the plan. The commission may require that any of the following strategies be implemented by the water supplier if the commission determines that the strategy is necessary to achieve the goals of the water conservation plan:

(A) conservation-oriented water rates and water rate structures such as uniform or increasing block rate schedules, and/or seasonal rates, but not flat rate or decreasing block rates;

(B) adoption of ordinances, plumbing codes, and/or rules requiring water-conserving plumbing fixtures to be installed in new structures and existing structures undergoing substantial modification or addition;

(C) a program for the replacement or retrofit of water-conserving plumbing fixtures in existing structures;

(D) reuse and/or recycling of wastewater and/or graywater;

(E) a program for pressure control and/or reduction in the distribution system and/or for customer connections;

(F) a program and/or ordinance(s) for landscape water management;
(G) a method for monitoring the effectiveness and efficiency of the water conservation plan; and
(H) any other water conservation practice, method, or technique which the water supplier shows to be appropriate for achieving the stated goal or goals of the water conservation plan.

(b) A water conservation plan prepared in accordance with 31 TAC §363.15 (relating to Required Water Conservation Plan) of the Texas Water Development Board and substantially meeting the requirements of this section and other applicable commission rules may be submitted to meet application requirements in accordance with a memorandum of understanding between the commission and the Texas Water Development Board.

(c) Beginning May 1, 2005, a public water supplier for municipal use shall review and update its water conservation plan, as appropriate, based on an assessment of previous five-year and ten-year targets and any other new or updated information. The public water supplier for municipal use shall review and update the next revision of its water conservation plan not later than May 1, 2009, and every five years after that date to coincide with the regional water planning group.

Source Note: The provisions of this §288.2 adopted to be effective May 3, 1993, 18 TexReg 2558; amended to be effective February 21, 1999, 24 TexReg 949; amended to be effective April 27, 2000, 25 TexReg 3544; amended to be effective October 7, 2004, 29 TexReg 9384

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SUBCHAPTER A	WATER CONSERVATION PLANS
RULE §288.3	**Water Conservation Plans for Industrial or Mining Use**

(a) A water conservation plan for industrial or mining uses of water must provide information in response to each of the following elements. If the plan does not provide information for each requirement, the industrial or mining water user shall include in the plan an explanation of why the requirement is not applicable.

(1) a description of the use of the water in the production process, including how the water is diverted and transported from the source(s) of supply, how the water is utilized in the production process, and the estimated quantity of water consumed in the production process and therefore unavailable for reuse, discharge, or other means of disposal;

(2) until May 1, 2005, specification of conservation goals, the basis for the development of such goals, and a time frame for achieving the specified goals;

(3) beginning May 1, 2005, specific, quantified five-year and ten-year targets for water savings and the basis for the development of such goals. The goals established by industrial or mining water users under this paragraph are not enforceable;

(4) a description of the device(s) and/or method(s) within an accuracy of plus or minus 5.0% to be used in order to measure and account for the amount of water diverted from the source of supply;

(5) leak-detection, repair, and accounting for water loss in the water distribution system;

(6) application of state-of-the-art equipment and/or process modifications to improve water use efficiency; and

(7) any other water conservation practice, method, or technique which the user shows to be appropriate for achieving the stated goal or goals of the water conservation plan.

(b) Beginning May 1, 2005, an industrial or mining water user shall review and update its water conservation plan, as appropriate, based on an assessment of previous five-year and ten-year targets and any other new or updated information. The industrial or mining water user shall review and update the next revision of its water conservation plan not later than May 1, 2009, and every five years after that date to coincide with the regional water planning group.

Source Note: The provisions of this §288.3 adopted to be effective May 3, 1993, 18 TexReg 2558; amended to be effective April 27, 2000, 25 TexReg 3544; amended to be effective October 7, 2004, 29 TexReg 9384

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SUBCHAPTER A	WATER CONSERVATION PLANS
RULE §288.4	**Water Conservation Plans for Agricultural Use**

(a) A water conservation plan for agricultural use of water must provide information in response to the following subsections. If the plan does not provide information for each requirement, the agricultural water user must include in the plan an explanation of why the requirement is not applicable.

(1) For an individual agricultural user other than irrigation:

(A) a description of the use of the water in the production process, including how the water is diverted and transported from the source(s) of supply, how the water is utilized in the production process, and the estimated quantity of water consumed in the production process and therefore unavailable for reuse, discharge, or other means of disposal;

(B) until May 1, 2005, specification of conservation goals, the basis for the development of such goals, and a time frame for achieving the specified goals;

(C) beginning May 1, 2005, specific, quantified five-year and ten-year targets for water savings and the basis for the development of such goals. The goals established by agricultural water users under this subparagraph are not enforceable;

(D) a description of the device(s) and/or method(s) within an accuracy of plus or minus 5.0% to be used in order to measure and account for the amount of water diverted from the source of supply;

(E) leak-detection, repair, and accounting for water loss in the water distribution system;

(F) application of state-of-the-art equipment and/or process modifications to improve water use efficiency; and

(G) any other water conservation practice, method, or technique which the user shows to be appropriate for achieving the stated goal or goals of the water conservation plan.

(2) For an individual irrigation user:

(A) a description of the irrigation production process which shall include, but is not limited to, the type of crops and acreage of each crop to be irrigated, monthly irrigation diversions, any seasonal or annual crop rotation, and soil types of the land to be irrigated;

(B) a description of the irrigation method or system and equipment including pumps, flow rates, plans, and/or sketches of the system layout;

(C) a description of the device(s) and/or methods within an accuracy of plus or minus 5.0%, to be used in order to measure and account for the amount of water diverted from the source of supply;

(D) until May 1, 2005, specification of conservation goals including, where appropriate, quantitative goals for irrigation water use efficiency and a pollution abatement and prevention plan;

(E) beginning May 1, 2005, specific, quantified five-year and ten-year targets for water savings including, where appropriate, quantitative goals for irrigation water use efficiency and a pollution abatement and prevention plan. The goals established by an individual irrigation water user under this subparagraph are not enforceable;

(F) water-conserving irrigation equipment and application system or method including, but not limited to, surge irrigation, low pressure sprinkler, drip irrigation, and nonleaking pipe;

(G) leak-detection, repair, and water-loss control;

(H) scheduling the timing and/or measuring the amount of water applied (for example, soil moisture monitoring);

(I) land improvements for retaining or reducing runoff, and increasing the infiltration of rain and irrigation water including, but not limited to, land leveling, furrow diking, terracing, and weed control;

(J) tailwater recovery and reuse; and

(K) any other water conservation practice, method, or technique which the user shows to be appropriate for preventing waste and achieving conservation.

(3) For a system providing agricultural water to more than one user:

(A) a system inventory for the supplier's:

(i) structural facilities including the supplier's water storage, conveyance, and delivery structures;

(ii) management practices, including the supplier's operating rules and regulations, water pricing policy, and a description of practices and/or devices used to account for water deliveries; and

(iii) a user profile including square miles of the service area, the number of customers taking delivery of water by the system, the types of crops, the types of irrigation systems, the types of drainage systems, and total acreage under irrigation, both historical and projected;

(B) until May 1, 2005, specification of water conservation goals, including maximum allowable losses for the storage and distribution system;

(C) beginning May 1, 2005, specific, quantified five-year and ten-year targets for water savings including maximum allowable losses for the storage and distribution system. The goals established by a system providing agricultural water to more than one user under this subparagraph are not enforceable;

(D) a description of the practice(s) and/or device(s) which will be utilized to measure and account for the amount of water diverted from the source(s) of supply;

(E) a monitoring and record management program of water deliveries, sales, and losses;

(F) a leak-detection, repair, and water loss control program;

(G) a program to assist customers in the development of on-farm water conservation and pollution prevention plans and/or measures;

(H) a requirement in every wholesale water supply contract entered into or renewed after official adoption of the plan (by either ordinance, resolution, or tariff), and including any contract extension, that each successive wholesale customer develop and implement a water conservation plan or water conservation measures using the applicable elements in this chapter. If the customer intends to resell the water, the contract between the initial supplier and customer must provide that the contract for the resale of the water must have water conservation requirements so that each successive customer in the resale of the water will be required to implement water conservation measures in accordance with applicable provisions of this chapter;

(I) official adoption of the water conservation plan and goals, by ordinance, rule, resolution, or tariff, indicating that the plan reflects official policy of the supplier;

(J) any other water conservation practice, method, or technique which the supplier shows to be appropriate for achieving conservation; and

(K) documentation of coordination with the regional water planning groups in order to ensure consistency with appropriate approved regional water plans.

(b) A water conservation plan prepared in accordance with the rules of the United States Department of Agriculture Natural Resource Conservation Service, the Texas State Soil and Water Conservation Board, or other federal or state agency and substantially meeting the requirements of this section and other applicable commission rules may be submitted to meet application requirements in accordance with a memorandum of understanding between the commission and that agency.

(c) Beginning May 1, 2005, an agricultural water user shall review and update its water conservation plan, as appropriate, based on an assessment of previous five-year and ten-year targets and any other new or updated information. An agricultural water user shall review and update the next revision of its water conservation plan not later than May 1, 2009, and every five years after that date to coincide with the regional water planning group.

Source Note: The provisions of this §288.4 adopted to be effective May 3, 1993, 18 TexReg 2558; amended to be effective February 21, 1999, 24 TexReg 949; amended to be effective April 27, 2000, 25 TexReg 3544; amended to be effective August 15, 2002, 27 TexReg 7146; amended to be effective October 7, 2004, 29 TexReg 9384

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SUBCHAPTER A	WATER CONSERVATION PLANS
RULE §288.5	**Water Conservation Plans for Wholesale Water Suppliers**

A water conservation plan for a wholesale water supplier must provide information in response to each of the following paragraphs. If the plan does not provide information for each requirement, the wholesale water supplier shall include in the plan an explanation of why the requirement is not applicable.

(1) Minimum requirements. All water conservation plans for wholesale water suppliers must include the following elements:

(A) a description of the wholesaler's service area, including population and customer data, water use data, water supply system data, and wastewater data;

(B) until May 1, 2005, specification of conservation goals including, where appropriate, target per capita water use goals for the wholesaler's service area, maximum acceptable unaccounted-for water, the basis for the development of these goals, and a time frame for achieving these goals;

(C) beginning May 1, 2005, specific, quantified five-year and ten-year targets for water savings including, where appropriate, target goals for municipal use in gallons per capita per day for the wholesaler's service area, maximum acceptable unaccounted-for water, and the basis for the development of these goals. The goals established by wholesale water suppliers under this subparagraph are not enforceable;

(D) a description as to which practice(s) and/or device(s) will be utilized to measure and account for the amount of water diverted from the source(s) of supply;

(E) a monitoring and record management program for determining water deliveries, sales, and losses;

(F) a program of metering and leak detection and repair for the wholesaler's water storage, delivery, and distribution system;

(G) a requirement in every water supply contract entered into or renewed after official adoption of the water conservation plan, and including any contract extension, that each successive wholesale customer develop and implement a water conservation plan or water conservation measures using the applicable elements of this chapter. If the customer intends to resell the water, then the contract between the initial supplier and customer must provide that the contract for the resale of the water must have water conservation requirements so that each successive customer in the resale of the water will be required to implement water conservation measures in accordance with applicable provisions of this chapter;

(H) a reservoir systems operations plan, if applicable, providing for the coordinated operation of reservoirs owned by the applicant within a common watershed or river basin. The reservoir systems operations plans shall include optimization of water supplies as one of the significant goals of the plan;

(I) a means for implementation and enforcement, which shall be evidenced by a copy of the ordinance, rule, resolution, or tariff, indicating official adoption of the water conservation plan by the water supplier; and a description of the authority by which the water supplier will implement and enforce the conservation plan; and

(J) documentation of coordination with the regional water planning groups for the service area of the wholesale water supplier in order to ensure consistency with the appropriate approved regional water plans.

(2) Additional conservation strategies. Any combination of the following strategies shall be selected by the water wholesaler, in addition to the minimum requirements of paragraph (1) of this section, if they are necessary in order to achieve the stated water conservation goals of the plan. The commission may require by commission order that any of the following strategies be implemented by the water supplier if the commission determines that the strategies are necessary in order for the conservation plan to be achieved:

(A) conservation-oriented water rates and water rate structures such as uniform or increasing block rate schedules, and/or seasonal rates, but not flat rate or decreasing block rates;

(B) a program to assist agricultural customers in the development of conservation pollution prevention and abatement plans;

(C) a program for reuse and/or recycling of wastewater and/or graywater; and

(D) any other water conservation practice, method, or technique which the wholesaler shows to be appropriate for achieving the stated goal or goals of the water conservation plan.

(3) Review and update requirements. Beginning May 1, 2005, the wholesale water supplier shall review and update its water conservation plan, as appropriate, based on an assessment of previous five-year and ten-year targets and any other new or updated information. A wholesale water supplier shall review and update the next revision of its water conservation plan not later than May 1, 2009, and every five years after that date to coincide with the regional water planning group.

Source Note: The provisions of this §288.5 adopted to be effective May 3, 1993, 18 TexReg 2558; amended to be effective February 21, 1999, 24 TexReg 949; amended to be effective April 27, 2000, 25 TexReg 3544; amended to be effective October 7, 2004, 29 TexReg 9384

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SUBCHAPTER A	WATER CONSERVATION PLANS
RULE §288.6	**Water Conservation Plans for Any Other Purpose or Use**

A water conservation plan for any other purpose or use not covered in this subchapter shall provide information where applicable about those practices, techniques, and technologies that will be used to reduce the consumption of water, prevent or reduce the loss or waste of water, maintain or improve the efficiency in the use of water, increase the recycling and reuse of water, or prevent the pollution of water.

Source Note: The provisions of this §288.6 adopted to be effective May 3, 1993, 18 TexReg 2558; amended to be effective April 27, 2000, 25 TexReg 3544

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SUBCHAPTER A	WATER CONSERVATION PLANS
RULE §288.7	**Plans Submitted with a Water Right Application for New or Additional State Water**

(a) A water conservation plan submitted with an application for a new or additional appropriation of water must include data and information which:

(1) supports the applicant's proposed use of water with consideration of the water conservation goals of the water conservation plan;

(2) evaluates conservation as an alternative to the proposed appropriation; and

(3) evaluates any other feasible alternative to new water development including, but not limited to, waste prevention, recycling and reuse, water transfer and marketing, regionalization, and optimum water management practices and procedures.

(b) It shall be the burden of proof of the applicant to demonstrate that no feasible alternative to the proposed appropriation exists and that the requested amount of appropriation is necessary and reasonable for the proposed use.

Source Note: The provisions of this §288.7 adopted to be effective May 3, 1993, 18 TexReg 2558.

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SUBCHAPTER B	DROUGHT CONTINGENCY PLANS
RULE §288.20	**Drought Contingency Plans for Municipal Uses by Public Water Suppliers**

(a) A drought contingency plan for a retail public water supplier, where applicable, must include the following minimum elements.

(1) Minimum requirements. Drought contingency plans must include the following minimum elements.

(A) Preparation of the plan shall include provisions to actively inform the public and affirmatively provide opportunity for public input. Such acts may include, but are not limited to, having a public meeting at a time and location convenient to the public and providing written notice to the public concerning the proposed plan and meeting.

(B) Provisions shall be made for a program of continuing public education and information regarding the drought contingency plan.

(C) The drought contingency plan must document coordination with the regional water planning groups for the service area of the retail public water supplier to ensure consistency with the appropriate approved regional water plans.

(D) The drought contingency plan must include a description of the information to be monitored by the water supplier, and specific criteria for the initiation and termination of drought response stages, accompanied by an explanation of the rationale or basis for such triggering criteria.

(E) The drought contingency plan must include drought or emergency response stages providing for the implementation of measures in response to at least the following situations:

(i) reduction in available water supply up to a repeat of the drought of record;

(ii) water production or distribution system limitations;

(iii) supply source contamination; or

(iv) system outage due to the failure or damage of major water system components (e.g., pumps).

(F) The drought contingency plan must include specific, quantified targets for water use reductions to be achieved during periods of water shortage and drought. The entity preparing the plan shall establish the targets. The goals established by the entity under this subparagraph are not enforceable.

(G) The drought contingency plan must include the specific water supply or water demand management measures to be implemented during each stage of the plan including, but not limited to, the following:

(i) curtailment of non-essential water uses; and

(ii) utilization of alternative water sources and/or alternative delivery mechanisms with the prior approval of the executive director as appropriate (e.g., interconnection with another water system, temporary use of a non-municipal water supply, use of reclaimed water for non-potable purposes, etc.).

(H) The drought contingency plan must include the procedures to be followed for the initiation or termination of each drought response stage, including procedures for notification of the public.

(I) The drought contingency plan must include procedures for granting variances to the plan.

(J) The drought contingency plan must include procedures for the enforcement of mandatory water use restrictions, including specification of penalties (e.g., fines, water rate surcharges, discontinuation of service) for violations of such restrictions.

(2) Privately-owned water utilities. Privately-owned water utilities shall prepare a drought contingency plan in accordance with this section and incorporate such plan into their tariff.

(3) Wholesale water customers. Any water supplier that receives all or a portion of its water supply from another water supplier shall consult with that supplier and shall include in the drought contingency plan appropriate provisions for responding to reductions in that water supply.

(b) A wholesale or retail water supplier shall notify the executive director within five business days of the implementation of any mandatory provisions of the drought contingency plan.

(c) The retail public water supplier shall review and update, as appropriate, the drought contingency plan, at least every five years, based on new or updated information, such as the adoption or revision of the regional water plan.

Source Note: The provisions of this §288.20 adopted to be effective February 21, 1999, 24 TexReg 949; amended to be effective April 27, 2000, 25 TexReg 3544; amended to be effective October 7, 2004, 29 TexReg 9384

Texas Administrative Code

TITLE 30	ENVIRONMENTAL QUALITY
PART 1	TEXAS COMMISSION ON ENVIRONMENTAL QUALITY
CHAPTER 288	WATER CONSERVATION PLANS, DROUGHT CONTINGENCY PLANS, GUIDELINES AND REQUIREMENTS
SUBCHAPTER B	DROUGHT CONTINGENCY PLANS
RULE §288.21	**Drought Contingency Plans for Irrigation Use**

(a) A drought contingency plan for an irrigation use, where applicable, must include the following minimum elements.

(1) Minimum requirements. Drought contingency plans for irrigation water suppliers must include policies and procedures for the equitable and efficient allocation of water on a pro rata basis during times of shortage in accordance with Texas Water Code, §11.039. Such plans shall include the following elements as a minimum.

(A) Preparation of the plan shall include provisions to actively inform and to affirmatively provide opportunity for users of water from the irrigation system to provide input into the preparation of the plan and to remain informed of the plan. Such acts may include, but are not limited to, having a public meeting at a time and location convenient to the water users and providing written notice to the water users concerning the proposed plan and meeting.

(B) The drought contingency plan must document coordination with the regional water planning groups to ensure consistency with the appropriate approved regional water plans.

(C) The drought contingency plan must include water supply criteria and other considerations for determining when to initiate or terminate water allocation procedures, accompanied by an explanation of the rationale or basis for such triggering criteria.

(D) The drought contingency plan must include specific, quantified targets for water use reductions to be achieved during periods of water shortage and drought. The entity preparing the plan shall establish the targets. The goals established by the entity under this subparagraph are not enforceable.

(E) The drought contingency plan must include methods for determining the allocation of irrigation supplies to individual users.

(F) The drought contingency plan must include a description of the information to be monitored by the water supplier and the procedures to be followed for the initiation or termination of water allocation policies.

(G) The drought contingency plan must include procedures for use accounting during the implementation of water allocation policies.

(H) The drought contingency plan must include policies and procedures, if any, for the transfer of water allocations among individual users within the water supply system or to users outside the water supply system.

(I) The drought contingency plan must include procedures for the enforcement of water allocation policies, including specification of penalties for violations of such policies and for wasteful or excessive use of water.

(2) Wholesale water customers. Any irrigation water supplier that receives all or a portion of its water supply from another water supplier shall consult with that supplier and shall include in the drought contingency plan, appropriate provisions for responding to reductions in that water supply.

(3) Protection of public water supplies. Any irrigation water supplier that also provides or delivers water to a public water supplier(s) shall consult with that public water supplier(s) and shall include in the plan, mutually agreeable and appropriate provisions to ensure an uninterrupted supply of water necessary for essential uses relating to public health and safety. Nothing in this provision shall be construed as requiring the irrigation water supplier to transfer irrigation water supplies to non-irrigation use on a compulsory basis or without just compensation.

(b) Irrigation water users shall review and update, as appropriate, the drought contingency plan, at least every five years, based on new or updated information, such as adoption or revision of the regional water plan.

Source Note: The provisions of this §288.21 adopted to be effective February 21, 1999, 24 TexReg 949; amended to be effective April 27, 2000, 25 TexReg 3544; amended to be effective October 7, 2004, 29 TexReg 9384

Texas Administrative Code

TITLE 30	ENVIRONMENTAL QUALITY
PART 1	TEXAS COMMISSION ON ENVIRONMENTAL QUALITY
CHAPTER 288	WATER CONSERVATION PLANS, DROUGHT CONTINGENCY PLANS, GUIDELINES AND REQUIREMENTS
SUBCHAPTER B	DROUGHT CONTINGENCY PLANS
RULE §288.22	**Drought Contingency Plans for Wholesale Water Suppliers**

(a) A drought contingency plan for a wholesale water supplier must include the following minimum elements.

(1) Preparation of the plan shall include provisions to actively inform the public and to affirmatively provide opportunity for user input in the preparation of the plan and for informing wholesale customers about the plan. Such acts may include, but are not limited to, having a public meeting at a time and location convenient to the public and providing written notice to the public concerning the proposed plan and meeting.

(2) The drought contingency plan must document coordination with the regional water planning groups for the service area of the wholesale public water supplier to ensure consistency with the appropriate approved regional water plans.

(3) The drought contingency plan must include a description of the information to be monitored by the water supplier and specific criteria for the initiation and termination of drought response stages, accompanied by an explanation of the rationale or basis for such triggering criteria.

(4) The drought contingency plan must include a minimum of three drought or emergency response stages providing for the implementation of measures in response to water supply conditions during a repeat of the drought-of-record.

(5) The drought contingency plan must include the procedures to be followed for the initiation or termination of drought response stages, including procedures for notification of wholesale customers regarding the initiation or termination of drought response stages.

(6) The drought contingency plan must include specific, quantified targets for water use reductions to be achieved during periods of water shortage and drought. The entity preparing the plan shall establish the targets. The goals established by the entity under this paragraph are not enforceable.

(7) The drought contingency plan must include the specific water supply or water demand management measures to be implemented during each stage of the plan including, but not limited to, the following:

(A) pro rata curtailment of water deliveries to or diversions by wholesale water customers as provided in Texas Water Code, §11.039; and

(B) utilization of alternative water sources with the prior approval of the executive director as appropriate (e.g., interconnection with another water system, temporary use of a non-municipal water supply, use of reclaimed water for non-potable purposes, etc.).

(8) The drought contingency plan must include a provision in every wholesale water contract entered into or renewed after adoption of the plan, including contract extensions, that in case of a shortage of water resulting from drought, the water to be distributed shall be divided in accordance with Texas Water Code, §11.039.

(9) The drought contingency plan must include procedures for granting variances to the plan.

(10) The drought contingency plan must include procedures for the enforcement of any mandatory water use restrictions including specification of penalties (e.g., liquidated damages, water rate surcharges, discontinuation of service) for violations of such restrictions.

(b) The wholesale public water supplier shall notify the executive director within five business days of the implementation of any mandatory provisions of the drought contingency plan.

(c) The wholesale public water supplier shall review and update, as appropriate, the drought contingency plan, at least every five years, based on new or updated information, such as adoption or revision of the regional water plan.

Source Note: The provisions of this §288.22 adopted to be effective February 21, 1999, 24 TexReg 949; amended to be effective April 27, 2000, 25 TexReg 3544; amended to be effective October 7, 2004, 29 TexReg 9384

Texas Administrative Code

TITLE 30	ENVIRONMENTAL QUALITY
PART 1	TEXAS COMMISSION ON ENVIRONMENTAL QUALITY
CHAPTER 288	WATER CONSERVATION PLANS, DROUGHT CONTINGENCY PLANS, GUIDELINES AND REQUIREMENTS
SUBCHAPTER C	REQUIRED SUBMITTALS
RULE §288.30	**Required Submittals**

In addition to the water conservation and drought contingency plans required to be submitted with an application under §295.9 of this title (relating to Water Conservation and Drought Contingency Plans), water conservation and drought contingency plans are required as follows.

(1) Water conservation plans for municipal, industrial, and other non-irrigation uses. The holder of an existing permit, certified filing, or certificate of adjudication for the appropriation of surface water in the amount of 1,000 acre-feet a year or more for municipal, industrial, and other non-irrigation uses shall develop, submit, and implement a water conservation plan meeting the requirements of Subchapter A of this chapter (relating to Water Conservation Plans). The water conservation plan must be submitted to the executive director not later than May 1, 2005. Thereafter, the next revision of the water conservation plan for municipal, industrial, and other non-irrigation uses must be submitted not later than May 1, 2009, and every five years after that date to coincide with the regional water planning group. Any revised plans must be submitted to the executive director within 90 days of adoption. The revised plans must include implementation reports. The requirement for a water conservation plan under this section must not result in the need for an amendment to an existing permit, certified filing, or certificate of adjudication.

(2) Implementation report for municipal, industrial, and other non-irrigation uses. The implementation report must include:

(A) the list of dates and descriptions of the conservation measures implemented;

(B) data about whether or not targets in the plans are being met;

(C) the actual amount of water saved; and

(D) if the targets are not being met, an explanation as to why any of the targets are not being met, including any progress on that particular target.

(3) Water conservation plans for irrigation uses. The holder of an existing permit, certified filing, or certificate of adjudication for the appropriation of surface water in the amount of 10,000 acre-feet a year or more for irrigation uses shall develop, submit, and implement a water conservation plan meeting the requirements of Subchapter A of this chapter. The water conservation plan must be submitted to the executive director not later than May 1, 2005. Thereafter, the next revision of the water conservation plan for

irrigation uses must be submitted not later than May 1, 2009, and every five years after that date to coincide with the regional water planning group. Any revised plans must be submitted to the executive director within 90 days of adoption. The revised plans must include implementation reports. The requirement for a water conservation plan under this section must not result in the need for an amendment to an existing permit, certified filing, or certificate of adjudication.

(4) Implementation report for irrigation uses. The implementation report must include:

(A) the list of dates and descriptions of the conservation measures implemented;

(B) data about whether or not targets in the plans are being met;

(C) the actual amount of water saved; and

(D) if the targets are not being met, an explanation as to why any of the targets are not being met, including any progress on that particular target.

(5) Drought contingency plans for retail public water suppliers. Retail public water suppliers shall submit a drought contingency plan meeting the requirements of Subchapter B of this chapter (relating to Drought Contingency Plans) to the executive director after adoption by its governing body. The retail public water system shall provide a copy of the plan to the regional water planning group for each region within which the water system operates. These drought contingency plans must be submitted as follows.

(A) For retail public water suppliers providing water service to 3,300 or more connections, the drought contingency plan must be submitted to the executive director not later than May 1, 2005. Thereafter, the retail public water suppliers providing water service to 3,300 or more connections shall submit the next revision of the plan not later than May 1, 2009, and every five years after that date to coincide with the regional water planning group. Any revised plans must be submitted to the executive director within 90 days of adoption by the community water system. Any new retail public water suppliers providing water service to 3,300 or more connections shall prepare and adopt a drought contingency plan within 180 days of commencement of operation, and submit the plan to the executive director within 90 days of adoption.

(B) For all the retail public water suppliers, the drought contingency plan must be prepared and adopted not later than May 1, 2005 and must be available for inspection by the executive director upon request. Thereafter, the retail public water suppliers shall prepare and adopt the next revision of the plan not later than May 1, 2009, and every five years after that date to coincide with the regional water planning group. Any new retail public water supplier providing water service to less than 3,300 connections shall prepare and adopt a drought contingency plan within 180 days of commencement of operation, and shall make the plan available for inspection by the executive director upon request.

(6) Drought contingency plans for wholesale public water suppliers. Wholesale public water suppliers shall submit a drought contingency plan meeting the requirements of Subchapter B of this chapter to the executive director not later than May 1, 2005, after adoption of the drought contingency plan by the governing body of the water supplier. Thereafter, the wholesale public water suppliers shall submit the next revision of the plan not later than May 1, 2009, and every five years after that date to coincide with the regional water planning group. Any new or revised plans must be submitted to the executive director within 90 days of adoption by the governing body of the wholesale public water supplier. Wholesale public water suppliers shall also provide a copy of the drought contingency plan to the regional water planning group for each region within

which the wholesale water supplier operates.

(7) Drought contingency plans for irrigation districts. Irrigation districts shall submit a drought contingency plan meeting the requirements of Subchapter B of this chapter to the executive director not later than May 1, 2005, after adoption by the governing body of the irrigation district. Thereafter, the irrigation districts shall submit the next revision of the plan not later than May 1, 2009, and every five years after that date to coincide with the regional water planning group. Any new or revised plans must be submitted to the executive director within 90 days of adoption by the governing body of the irrigation district. Irrigation districts shall also provide a copy of the plan to the regional water planning group for each region within which the irrigation district operates.

(8) Additional submissions with a water right application for state water. A water conservation plan or drought contingency plan required to be submitted with an application in accordance with §295.9 of this title must also be subject to review and approval by the commission.

(9) Existing permits. The holder of an existing permit, certified filing, or certificate of adjudication shall not be subject to enforcement actions nor shall the permit, certified filing, or certificate of adjudication be subject to cancellation, either in part or in whole, based on the nonattainment of goals contained within a water conservation plan submitted with an application in accordance with §295.9 of this title or by the holder of an existing permit, certified filing, or certificate of adjudication in accordance with the requirements of this section.

(10) Submissions to the executive administrator of the Texas Water Development Board.

(A) Water conservation plans for retail public water suppliers. For retail public water suppliers providing water service to 3,300 or more connections, a water conservation plan meeting the minimum requirements of Subchapter A of this chapter and using appropriate best management practices must be developed, implemented, and submitted to the executive administrator of the Texas Water Development Board not later than May 1, 2009, and every five years after that date to coincide with the regional water planning group. Any revised plans must be submitted to the executive administrator within 90 days of adoption by the community water system. Any new retail public water suppliers providing water service to 3,300 or more connections shall prepare and adopt a water conservation plan within 180 days of commencement of operation, and submit the plan to the executive administrator of the Texas Water Development Board within 90 days of adoption.

(B) Water conservation plans. Each entity that is required to submit a water conservation plan to the commission shall submit a copy of the plan to the executive administrator of the Texas Water Development Board not later than May 1, 2009, and every five years after that date to coincide with the regional water planning group.

(C) Annual reports. Each entity that is required to submit a water conservation plan to the Texas Water Development Board or the commission, shall file a report not later than May 1, 2010, and annually thereafter to the executive administrator of the Texas Water Development Board on the entity's progress in implementing the plan.

(D) Violations of the Texas Water Development Board's rules. The water conservation plans and annual reports shall comply with the minimum requirements established in the Texas Water Development Board's rules. The Texas Water Development Board shall notify the commission if the Texas Water Development Board determines that an entity has not complied with the Texas Water Development Board rules relating to the minimum requirements for water conservation plans or submission of plans or annual reports. The commission shall take appropriate enforcement action upon receipt of notice from the Texas Water Development Board.

Source Note: The provisions of this §288.30 adopted to be effective February 21, 1999, 24 TexReg 949; amended to be effective April 27, 2000, 25 TexReg 3544; amended to be effective October 7, 2004, 29 TexReg 9384; amended to be effective January 10, 2008, 33 TexReg 193

MODEL WATER CONSERVATION PLANS

Water Conservation Plan for [Entity]

Date

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APPENDICES

Water Conservation Plan for [Entity]

1. OBJECTIVES

Recognizing the need for efficient use of existing water supplies, the Texas Commission on Environmental Quality (TCEQ) has developed guidelines and requirements governing the development of water conservation plans for public water suppliers.

The objectives of this water conservation plan are as follows:

- To reduce water consumption from the levels that would prevail without conservation efforts.
- To reduce the loss and waste of water.
- To improve efficiency in the use of water.
- To document the level of recycling and reuse in the water supply.
- To extend the life of current water supplies by reducing the rate of growth in demand.

The water conservation plan presented in this document is a model water conservation plan intended for adoption by wholesale or retail public water suppliers in Region I. This model plan includes all of the elements required by TCEQ. In order to adopt this plan, each water supplier will need to do the following:

- Complete the water utility profile.
- Set specific and quantifiable five- and ten-year goals for per capita water use.
- Adopt ordinance(s) or regulation(s) approving the model plan.

2 TEXAS COMMISSION ON ENVIRONMENTAL QUALITY RULES

2.1 Conservation Plans

The TCEQ rules governing development of water conservation plans for public water suppliers are contained in Title 30, Part 1, Chapter 288, Subchapter A, Rule 288.2 of the Texas Administrative Code, which is included in Appendix B. For the purpose of these rules, a water conservation plan is defined as "A strategy or combination of strategies for reducing the volume of water withdrawn from a water supply source, for reducing the loss or waste of water, for maintaining or improving the efficiency in the use of water, for increasing the recycling and reuse of water, and for preventing the pollution of water[1]." The

[1] Title 30 of the Texas Administrative Code, Part 1, Chapter 288, Subchapter A, Rules 288.1 and 288.2, and Subchapter B, Rule 288.20, downloaded from http://info.sos.state.tx.us/pls/pub/readtac$ext.viewtac, January 2010.

elements in the TCEQ water conservation rules covered in this conservation plan are listed below.

Minimum Conservation Plan Requirements

The minimum requirements in the Texas Administrative Code for Water Conservation Plans for Public Water Suppliers are covered in this report as follows:

- 288.2(a)(1)(A) – Utility Profile – Section 3 and Appendix C
- 288.2(a)(1)(B) – Specification of Goals – Section 4
- 288.2(a)(1)(C) – Specification of Goals for water loss and municipal use – Section 4
- 288.2(a)(1)(D) – Accurate Metering – Section 5.1
- 288.2(a)(1)(E) – Universal Metering – Section 5.1
- 288.2(a)(1)(F) – Determination and Control of Unaccounted Water – Section 5.3
- 288.2(a)(1)(G) – Public Education and Information Program – Section 6
- 288.2(a)(1)(H) – Non-Promotional Water Rate Structure – Section 7
- 288.2(a)(1)(I) – Reservoir System Operation Plan – Section 8.2
- 288.2(a)(1)(J) – Means of Implementation and Enforcement – Section 9
- 288.2(a)(1)(K) – Coordination with Regional Water Planning Group – Section 8.5

Conservation Additional Requirements (Population over 5,000)

The Texas Administrative Code includes additional requirements for water conservation plans for cities with a population over 5,000:

- 288.2(a)(2)(A) – Leak Detection, Repair, and Water Loss Accounting – Sections 5.3, 5.4, and 5.5
- 288.2(a)(2)(B) – Record Management System – Section 5.2
- 288.2(a)(2)(C) – Requirement for Water Conservation Plans by Wholesale Customers – Section 8.4

Additional Conservation Strategies

TCEQ rules also list additional optional but not required conservation strategies, which may be adopted by suppliers. The following optional strategies are included in this plan:

- 288.2(a)(3)(A) – Conservation Oriented Water Rates – Section 7
- 288.2(a)(3)(B) – Ordinances, Plumbing Codes or Rules on Water-Conserving Fixtures – Section 8.1
- 288.2(a)(3)(F) – Considerations for Landscape Water Management Regulations – Section 8.3
- 288.2(a)(3)(G) – Monitoring Method – Section 5.5

3. WATER UTILITY PROFILE

Appendix C to this water conservation plan is a sample water utility profile based on the format recommended by the TCEQ.

[Water supplier is to complete the utility profile and provide information on the public water supply system and customers if appropriate for this section.]

4. SPECIFICATION OF WATER CONSERVATION GOALS

[Current TCEQ rules require the adoption of specific water conservation goals for a water conservation plan. As part of plan adoption, each water supplier will develop 5-year and 10-year goals for per capita municipal use, following TCEQ procedures described in the water utility profile (Appendix C).]

The goals for this water conservation plan include the following:

- Strive to attain the per capita municipal water use below the specified amount in gallons per capita per day shown on the completed Table C-1 using a 5-year rolling average calculation. (See 5-year and 10-year goals in Appendix C)
- Conduct water audits as required by the TCEQ and maintain unaccounted for water to *[insert amount]* percent of the total water used through existing and new maintenance programs.
- Raise public awareness of water conservation and encourage responsible public behavior by a public education and information program, as discussed in Section 6.

5. METERING, WATER USE RECORDS, CONTROL OF UNACCOUNTED WATER, AND LEAK DETECTION AND REPAIR

One of the key elements in water conservation is careful tracking of water use and control of losses through illegal diversions and leaks. Careful metering of water deliveries and water use, detection and repair of leaks in the distribution system and regular monitoring of unaccounted water are important in controlling losses. *[Water suppliers serving a population of 5,000 people or more or a having a projected population of greater than 5,000 people or more within the next ten years must include the following elements in their water conservation plans:]*

5.1 Metering of Customer and Public Uses and Meter Testing, Repair, and Replacement

All customers of wholesale or retail public water suppliers, including public and governmental users, should be metered. In many cases, water suppliers already meter all of their water users. For those water suppliers who do not currently meter all of their water uses, these entities will implement a program to meter all water uses within the next five years.

Most water suppliers test and replace their customer meters on a regular basis. All customer meters should be replaced on a 15-year cycle. Those who do not currently have a meter testing and replacement program will implement such a program over the next five years.

5.2 Record Management System

As required by TAC Title 30, Part 1, Chapter 288, Subchapter A, Rule 288.2(a)(2)(B), the record management system allows for the separation of water sales and uses into residential, commercial, public/institutional, and industrial categories. This information will be included in an annual water conservation report, as described in Section 5.5 below.

For those entities whose record management systems do not currently allow for the separation of water sales as described above, they will move to implement such a system within the next five years.

5.3 Determination and Control of Unaccounted Water

Unaccounted water is the difference between water delivered to customers and metered deliveries to customers plus authorized but unmetered uses. (Authorized but unmetered uses would include use for fire fighting, releases for flushing of lines, and uses associated with new construction.) Unaccounted water can include several categories:

- Inaccuracies in customer meters. (Customer meters tend to run more slowly as they age and under-report actual use.)
- Accounts which are being used but have not yet been added to the billing system.
- Losses due to water main breaks and leaks in the water distribution system.
- Losses due to illegal connections and theft. (Included in Appendix H.)
- Other.

Measures to control unaccounted water are part of the routine operations of water suppliers. Water audits are useful methods of accounting for water usage within a system. Water audits will be conducted by water suppliers in order to decrease water loss. Maintenance crews and personnel will look for and report evidence of leaks in the water distribution system. The leak detection and repair program is described in Section 5.5 below. Meter readers are asked to watch for and report signs of illegal connections, so they can be addressed quickly. Unaccounted water calculated as part of the utility profile and is included in Appendix C.

5.4 Leak Detection and Repair

City crews and personnel will look for and report evidence of leaks in the water distribution system. Areas of the water distribution system in which numerous leaks and line breaks occur are targeted for replacement as funds are available.

5.5 Monitoring of Effectiveness and Efficiency - Annual Water Conservation Report

[Appendix D is a sample form that can be used in the development of an annual water conservation report for water suppliers.]

An annual conservation report will be completed by *[insert date]* of the following year and will be used to monitor the effectiveness and efficiency of the water conservation program and to plan conservation-related activities for the next year. This report records the water use by category, per capita municipal use, and unaccounted water for the current year and compares them to historical values.

6. CONTINUING PUBLIC EDUCATION AND INFORMATION CAMPAIGN

The continuing public education and information campaign on water conservation includes the following elements: *[Water provider is to select the appropriate measures for its system.]*

- Insert water conservation information with water bills. Inserts will include material developed by the [water supplier] staff and material obtained from the TWDB, the TCEQ, and other sources.
- Encourage local media coverage of water conservation issues and the importance of water conservation.
- Make the *Texas Smartscape CD*, water conservation brochures, and other water conservation materials available to the public.
- Make information on water conservation available on its website (if any) and include links to the *Texas Smartscape* website and to information on water conservation on the TWDB and TCEQ web sites.
- Provide water conservation materials to schools and utilize existing age-appropriate education programs available through the TCEQ and TWDB.
- Support the State-initiated Water Conservation Awareness and Education Campaign.

7. WATER RATE STRUCTURE

[If a water supplier has a decreasing block rate structure, it is recommended that a flat rate or increasing rate structure be adopted.]

An increasing block rate water structure that is intended to encourage water conservation and discourage excessive use and waste of water will be adopted upon completion of the next rate study or within five years. An example water rate structure is as follows:

Residential Rates

1. Monthly minimum charge. This can (but does not have to) include up to 2,000 gallons water use with no additional charge.
2. Base charge per 1,000 gallons up to the approximate average residential use.
3. 2^{nd} tier (from the average to 2 times the approximate average) at 1.25 to 2.0 times the base charge.
4. 3^{rd} tier (above 2 times the approximate average) at 1.25 to 2.0 times the 2^{nd} tier.
5. The residential rate can also include a lower tier for basic household use up to 4,000 gallons per month or so.

Commercial/Industrial Rates

Commercial/industrial rates should include at least 2 tiers, with rates for the 2^{nd} tier at 1.25 to 2.0 times the first tier.

[If a water supplier has an increasing rate structure, state the current rate structure as follows.]

The [water supplier] has adopted an increasing block rate water structure that is intended to encourage water conservation and discourage excessive use and waste of water. The water rate structure adopted on *[insert date]* is as follows:

Residential Rates

[To be completed by the supplier]

Commercial/Industrial Rates

[To be completed by the supplier]

8. OTHER WATER CONSERVATION MEASURES

8.1 Ordinances, Plumbing Codes, or Rules on Water-Conserving Fixtures

The State of Texas has required water-conserving fixtures in new construction and renovations since 1992. The state standards call for flows of no more than 2.5 gallons per minute (gpm) for faucets, 3.0 gpm for showerheads, and 1.6 gallons per flush for toilets. Similar standards are now required nationally under federal law. These state and federal standards assure that all new construction and renovations will use water-conserving fixtures. In addition, federal standards governing clothes washing machines will require all washers produced by 2007 to meet higher efficiency standards, which may include lower water use machines. The potential savings from these fixtures can be significant, but historically have been difficult to measure independently from other factors.

8.2 Reservoir System Operation Plan

[Insert description of reservoir system operation plan if public supplier has such a plan.]

or

The [water supplier] purchases water from [name] and does not have surface water supplies for which to implement a reservoir system operation plan.

8.3 Considerations for Landscape Water Management Regulations (Optional)

[The water supplier may choose to adopt landscape water management regulations as part of the development of this water conservation plan. These regulations are intended to minimize waste in landscape irrigation. The proposed regulations might include the following elements:

- *Require that all new irrigation systems be in compliance with state design and installation regulations (TAC Title 30, Part 1, Chapter 344).*
- *Prohibit irrigation systems that spray directly onto impervious surfaces or onto other non-irrigated areas. (Wind driven water drift will be taken into consideration.)*
- *Prohibit use of poorly maintained sprinkler systems that waste water.*
- *Prohibit outdoor watering during any form of precipitation.*
- *Enforce the regulations by a system of warnings followed by fines for continued or repeat violations.*
- *Implement other measures to encourage off-peak water use.]*

8.4 Requirement for Water Conservation Plans by Wholesale Customers

[Required for cities with populations over 5,000.]

Every contract for the wholesale sale of water by customers that is entered into, renewed, or extended after the adoption of this water conservation and drought contingency plan will include a requirement that the wholesale customer and any wholesale customers of that wholesale customer develop and implement a water conservation plan meeting the requirements of Title 30, Part 1, Chapter 288, Subchapter A, Rule 288.2 of the Texas Administrative Code. The requirement will also extend to each successive wholesale customer in the resale of the water.

8.5 Coordination with Regional Water Planning Group

In accordance with TCEQ regulations, a copy of this adopted water conservation plan will be sent to the Panhandle water planning group.

9. IMPLEMENTATION AND ENFORCEMENT OF THE WATER CONSERVATION PLAN

A copy of [an ordinance, order, or resolution] adopted by the [City Council or governing board] regarding this water conservation plan is attached to and made part of this plan. The [ordinance, order, or resolution] designates responsible officials to implement and enforce the water conservation plan.

Water Conservation Plan for [Industrial Entity]

Date

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Water Conservation Plan for [Industrial Entity]

1. Objectives

The Texas Commission on Environmental Quality has developed guidelines and requirements governing the development of water conservation plans for industrial or mining use. The purpose of this water conservation plan is to:

- To reduce water consumption from the levels that would exist without conservation efforts.
- To reduce the loss and waste of water.
- To encourage improvement of processes that inefficiently consume water.
- To extend the life of current supplies by reducing the rate of growth in demand.
- To document the level of recycling and reuse in the water supply.

This water conservation plan is intended to serve as a guide to [entity]. The following plan includes all conservation measures required by TCEQ.

2. Description of Water Use

The TCEQ requires that each mining or industrial water user must document how water is used in the production process.

- *[Entity provides information including:]*
  - *How water flows to and through their systems*
  - *What purpose water serves in the production process*
  - *How much water is consumed in the production process and not available for reuse*
  - *Means of discharging water used in industrial processes]*

3. Specification of Water Conservation Goals

The TCEQ regulations require that each industrial and mining user adopt quantifiable water conservation goals in their water conservation plan. *[Entity]* has specified a five-year and ten-year target for water savings. *[Include quantifiable water savings targets and the details of the basis for the development of these goals.]*

The goals for this water conservation plan include the following:

- *[Name goals.] Potential goals are:*
  - *Meter water use to decrease water loss through leaks*
  - *Regularly inspect systems for leaks and promptly repair in order to control unaccounted water*
  - *Improve, modify, or audit processes in order to increase efficient water use*

4. Metering of Industrial and Mining Water Users

[Entity]'s water use is metered at [description of location]. Submetering is a good strategy for some industrial water users. Processes or equipment that consume large quantities of water could be usefully submetered. Submetering is an effective way to account for all water use by process, subprocess, or piece of equipment in a facility. *[Identify processes and/or equipment that are currently submetered.]*

5. Control of Unaccounted Water and Leak Detection and Repair

Careful metering of water use, detection, and repair of leaks in the distribution system and regular monitoring of unaccounted water are important in controlling losses.

Unaccounted water is the difference between water delivered to a system and water delivered to a system plus authorized but unmetered uses. Authorized but unmetered uses includes water for fire fighting, releases for flushing of lines, and water used during new construction. Unaccounted water can be attributed to several things including:

- Inaccuracies in meters. Older meters tend to run slowly and therefore under-report actual use.
- Loss due to leaks and main breaks in the system.
- Illegal connections to a system.
- [Other].

In order to control unaccounted water, persons in industry are asked to watch for and report water main breaks and leaks. Broken and leaking lines should be replaced or repaired in a timely manner. Meter readers are asked to report signs of illegal connections so they can be quickly assessed.

[Entity] will implement and maintain a water loss program. This program will serve to reduce losses due to leakage. The measures of the water loss program include *[select applicable measure]*:

- Conducting regular inspections of water main fittings and connections.
- Installing leak noise detectors and loggers.
- Using a leakage modeling program.
- Metering individual pressure zones
- Controlling pressure just above the minimum standard-of-service level
- Limiting surges in pressure.
- [Other]

6. Improving, Modifying, and Auditing Processes and Equipment

[Entity] can increase water efficiency by improving, modifying, and auditing facility processes and equipment. Water can be conserved through the following measures *[select appropriate measure]*:

- Implementing a Water Waste Reduction Program
- Optimizing the water-use efficiency of cooling systems (other than cooling towers)
- Reducing water loss in cooling towers

Water Waste Reduction Programs cause [Entity] personnel to be more aware of wasteful activities. Measures resulting from a Water Waste Reduction Program include:

- Install water saving devices on equipment.
- Replace current equipment with more water-efficient equipment.
- Recycle water within a process.
- Change to waterless equipment or process.

7. Implementation and Modifications to Water Conservation Plan

Upon implementation of this water conservation plan, [Entity] is required by the TCEQ to update the plan at least every five years. New goals will be based on previous five-year and ten-year goals and any new information.

An implementation report will be prepared by the [date] of each year following the adoption of this plan. A sample report is included in Appendix C. This report includes:

- The list of dates and descriptions of conservation measures implemented
- Amount of water saved
- Data about whether or not targets in the plan are met
- If targets are not met, an explanation as to why the target was not met and a discussion of the progress to meet the target.

APPENDIX A

List of References

Title 30 of the Texas Administrative Code, Part 1, Chapter 288, Subchapter B, Rule 288.3, downloaded from http://info.sos.state.tx.us/pls/pub/readtac$ext.viewtac, January 2010.

Appendix B
Texas Commission on Environmental Quality Rules

Texas Administrative Code

TITLE 30 ENVIRONMENTAL QUALITY
PART 1 TEXAS COMMISSION ON ENVIRONMENTAL QUALITY
CHAPTER 288 WATER CONSERVATION PLANS, DROUGHT CONTINGENCY PLANS, GUIDELINES AND REQUIREMENTS
SUBCHAPTER A WATER CONSERVATION PLANS
RULE §288.3 Water Conservation Plans for Industrial or Mining Use

(a) A water conservation plan for industrial or mining uses of water must provide information in response to each of the following elements. If the plan does not provide information for each requirement, the industrial or mining water user shall include in the plan an explanation of why the requirement is not applicable.

(1) a description of the use of the water in the production process, including how the water is diverted and transported from the source(s) of supply, how the water is utilized in the production process, and the estimated quantity of water consumed in the production process and therefore unavailable for reuse, discharge, or other means of disposal;

(2) until May 1, 2005, specification of conservation goals, the basis for the development of such goals, and a time frame for achieving the specified goals;

(3) beginning May 1, 2005, specific, quantified five-year and ten-year targets for water savings and the basis for the development of such goals. The goals established by industrial or mining water users under this paragraph are not enforceable;

(4) a description of the device(s) and/or method(s) within an accuracy of plus or minus 5.0% to be used in order to measure and account for the amount of water diverted from the source of supply;

(5) leak-detection, repair, and accounting for water loss in the water distribution system;

(6) application of state-of-the-art equipment and/or process modifications to improve water use efficiency; and

(7) any other water conservation practice, method, or technique which the user shows to be appropriate for achieving the stated goal or goals of the water conservation plan.

(b) Beginning May 1, 2005, an industrial or mining water user shall review and update its water conservation plan, as appropriate, based on an assessment of previous five-year and ten-year targets and any other new or updated information. The industrial or mining water user shall review and update the next revision of its water conservation plan not later than May 1, 2009, and every five years after that date to coincide with the regional water planning group.

Source Note: The provisions of this §288.3 adopted to be effective May 3, 1993, 18 TexReg 2558; amended to be effective April 27, 2000, 25 TexReg 3544; amended to be effective October 7, 2004, 29 TexReg 9384

APPENDIX C
INDUSTRIAL USER WATER CONSERVATION REPORT
Due: {Date} of every year

Entity Reporting: ______________________________

Filled Out By: ______________________________

Date Completed: ______________________________

Year Covered: ______________________________

Industry ______________________________

Recorded Supplies and Process Uses by Month (in Acre-feet):

Month	Self-Supplied Water	Other Supplies	Industrial Processes Water Use						
			Process A	Process B	Process C	Process D	Process E		Total
January									
February									
March									
April									
May									
June									
July									
August									
September									
October									
November									
December									

TOTAL									

Unaccounted Water (Acre-feet):	
Self Supplies (total)	above
Other Supplies (total)	above
Total Supplies	above
Total Water use	above
Difference in Supplies and Water use	
% Unaccounted Water	
Goal for % Unaccounted Water	

Water Efficiency (Percent)

Process	**Design Use**	**Actual Use**	**Efficiency**
Process A			
Process B			
Process C			
Process D			

CONSERVATION MEASURES IMPLEMENTED

Measure	**Date Implemented**

AMOUNT OF WATER SAVED (per Industrial Process)								

Year	Total Water Supplied	Efficiency (%)	Efficiency Improvement (%)	Water saved (acre-feet)	Unaccounted water (%)	Reduction in Unaccounted water (%)	Water saved (acre-feet)	Total Saved (acre-feet)
2000								
2001								
2002								
2003								
2004								
2005								
2006								

Unusual Circumstances (use additional sheets if necessary):

Progress in Implementation of Conservation Plan (use additional sheets if necessary):

Conservation measures planned for next year (use additional sheets if necessary):

Other (use additional sheets if necessary):

Water Conservation Plan for [Irrigation District]

Date

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APPENDICES

Water Conservation Plan for [Irrigation District]

1. Objectives

The Texas Commission on Environmental Quality has developed guidelines and requirements governing the development of water conservation plans for irrigation use. The purpose of this water conservation plan is to:

- To reduce water consumption from the levels that would exist without conservation efforts.
- To reduce the loss and waste of water.
- To encourage improvement of processes that inefficiently consume water.
- To extend the life of current supplies by reducing the rate of growth in demand.

This water conservation plan is intended to serve as a guide to [irrigation district]. The following plan includes all conservation measures required by TCEQ.

2. Description of Water Use

[The TCEQ requires that each irrigation user must document how water is used in the irrigation production process.

- *Irrigation users will provide information including:*
    - *Type of crops.*
    - *Acreage of each crop to be irrigated.*
    - *Monthly irrigation diversions.*
    - *Details of seasonal or annual crop rotation.*
    - *Soil types of the land to be irrigated.*
    - *Description of the irrigation method including flow rates, plans, and sketches of the system layout.*
    - *Details of equipment used in the process within an accuracy of +/- 5 %.]*

3. Specification of Water Conservation Goals

[The Irrigation District must specify a five-year and ten-year target for water savings and detail the basis for the development of these goals. These goals will include targets for water use efficiency and a pollution abatement and prevention plan.]

The TCEQ regulations require that each irrigation user adopt quantifiable water conservation goals in their water conservation plan. The *[Irrigation District]* has adopted goals related to improving water efficiency of its delivery system. The *[Irrigation District]* will strive to increase water efficiency per irrigated acre by *[insert amount]* percent within 5 years and *[insert amount]* percent within 10 years.

[Alternate goal] The *[Irrigation District]* will maintain the water efficiency per irrigated acre of *[insert amount]* percent within 5 years and *[insert amount]* percent within 10 years.

The goals for this water conservation plan will be achieved through the following: *[select applicable measures and/or include additional measures.]*

- Regular inspections of systems for controllable operation losses or leaks
- Coordination of irrigation deliveries with customers
- Schedule the timing or measure the amount of water applied.
- Improve or modify irrigation processes in order to increase efficient water use.
- Employ water-conserving irrigation equipment or improve existing equipment.
- Implement methods of land improvement that reduce runoff and increase rain infiltration to the soil.
- Establish a tailwater recovery and reuse program.

4. Control of Unaccounted Water and Leak Detection and Repair

Detection and repair of leaks in an irrigation system is important in controlling losses. Unaccounted water is the difference between water delivered to a system and water delivered to a system plus authorized but unmetered uses. Unaccounted water in the irrigation system can be attributed to several things including:

- Inaccuracies in meters.
- Loss due to leaks in the conveyance system.
- Operational losses
- Illegal connections to a system.
- Other.

To help control unaccounted water, *[irrigation district]* will monitor supply deliveries, conduct water audits and adjust operations to minimize losses if applicable. Broken water lines will be replaced or repaired in a timely manner.

5. Irrigation Scheduling and Volumetric Measuring of Irrigation Water Use

Volumetric Measuring

Measuring the volume of water being used to irrigate a crop is useful because it provides [irrigation district] with information needed to evaluate the efficiency of an irrigation system. With this information, [irrigation district] and customers can better manage their crops. Irrigation water users will employ a method of measuring how much irrigation water is used in their system.

The following methods may be used to directly measure amounts of irrigation water being used *[select appropriate methods]*:

- Propeller meters
- Orifice, venture or differential pressure meters

- Ultrasonic
- Stage Discharge Rating Tables
- Area/Point Velocity Measurements

Indirect methods that may be used to measure irrigation water quantities include:

- Measurement of time of irrigation and size of irrigation delivery system
- Measurement of end-pressure in a sprinkler irrigation system
- Measurement of energy used by a pump supplying water to an irrigation system
- Change in the elevation of groundwater supply wells

Irrigation Scheduling

Coordination of irrigation schedules of customers can reduce losses associated with conveying irrigation water. The *[irrigation district]* will implement an irrigation schedule for deliveries to customers to best meet the customers' water needs and minimize conveyance losses.

6. Methods of Land Improvement

To reduce the amount of water required for irrigation, the following land improvement practices are encouraged for customers of the *[irrigation district]*:

- Creation of furrow dikes
- Crop residue management and conservation tillage
- Land leveling
- Contour farming

7. Improvements to Irrigation Equipment

The *[irrigation district]* encourages customers to utilize efficient irrigation equipment, including:

- Installation of a drip/micro-irrigation system
- Installation of gated and flexible pipe for field water distribution systems
- Replacement of on-farm irrigation ditches with pipelines
- Lining of on-farm irrigation ditches
- Installation of low pressure center pivot sprinkler irrigation systems

8. Implementation of Water Conservation Plan

Upon implementation of this water conservation plan, *[irrigation district]* is required by the TCEQ to update the plan at least every five years. Goals for irrigation use will be re-evaluated based on previous five-year and ten-year goals and any new information.

An implementation report will be prepared by the [date] of each year following the adoption of this plan. A sample report is included in Appendix C. This report includes:

- The list of dates and descriptions of conservation measures implemented
- Amount of water saved
- Data about whether or not targets in the plan are met
- If targets are not met, an explanation as to why the target was not met and a discussion of the progress to meet the target.

Appendix A
List of References

Title 30 of the Texas Administrative Code, Part 1, Chapter 3, Subchapter A, Rules 3.2 and Chapter 288, Subchapter A, Rule 288.4, downloaded from http://info.sos.state.tx.us/pls/pub/readtac$ext.viewtac, January 2010.

Water Conservation Implementation Task Force, *Draft Best Management Practices*, April 19,2004.

Texas Administrative Code

TITLE 30 ENVIRONMENTAL QUALITY
PART 1 TEXAS COMMISSION ON ENVIRONMENTAL QUALITY
CHAPTER 288 WATER CONSERVATION PLANS, DROUGHT CONTINGENCY PLANS, GUIDELINES AND REQUIREMENTS
SUBCHAPTER A WATER CONSERVATION PLANS
RULE §288.4 Water Conservation Plans for Agricultural Use

(a) A water conservation plan for agricultural use of water shall provide information, where applicable, in response to the following subsections.

(1) For an individual agricultural user other than irrigation:

(A) a description of the use of the water in the production process, including how the water is diverted and transported from the source(s) of supply, how the water is utilized in the production process, and the estimated quantity of water consumed in the production process and therefore unavailable for reuse, discharge, or other means of disposal;

(B) specification of conservation goals, the basis for the development of such goals, and a time frame for achieving the specified goals;

(C) a description of the device(s) and/or method(s) within an accuracy of plus or minus 5.0% to be used in order to measure and account for the amount of water diverted from the source of supply;

(D) leak-detection, repair, and accounting for water loss in the water distribution system;

(E) application of state-of-the-art equipment and/or process modifications to improve water use efficiency; and

(F) any other water conservation practice, method, or technique which the user shows to be appropriate for achieving the stated goal or goals of the water conservation plan.

(2) For an individual irrigation user:

(A) a description of the irrigation production process which shall include, but is not limited to, the type of crops and acreage of each crop to be irrigated, monthly irrigation diversions, any seasonal or annual crop rotation, and soil types of the land to be irrigated;

(B) a description of the irrigation method or system and equipment including pumps, flow rates, plans, and/or sketches of the system layout;

(C) a description of the device(s) and/or methods within an accuracy of plus or minus 5.0%, to be used in order to measure and account for the amount of water diverted from the source of supply;

(D) specification of conservation goals including, where appropriate, quantitative goals for irrigation water use efficiency and a pollution abatement and prevention plan;

(E) water-conserving irrigation equipment and application system or method including, but not limited to, surge irrigation, low pressure sprinkler, drip irrigation, and nonleaking pipe;

(F) leak-detection, repair, and water-loss control;

(G) scheduling the timing and/or measuring the amount of water applied (for example, soil moisture monitoring);

(H) land improvements for retaining or reducing runoff, and increasing the infiltration of rain and irrigation water including, but not limited to, land leveling, furrow diking, terracing, and weed control;

(I) tailwater recovery and reuse; and

(J) any other water conservation practice, method, or technique which the user shows to be appropriate for preventing waste and achieving conservation.

(3) For a system providing agricultural water to more than one user:

(A) a system inventory for the supplier's:

(i) structural facilities including the supplier's water storage, conveyance, and delivery structures;

(ii) management practices, including the supplier's operating rules and regulations, water pricing policy, and a description of practices and/or devices used to account for water deliveries; and

(iii) a user profile including square miles of the service area, the number of customers taking delivery of water by the system, the types of crops, the types of irrigation systems, the types of drainage systems, and total acreage under irrigation, both historical and projected;

(B) specification of water conservation goals, including maximum allowable losses for the storage and distribution system;

(C) a description of the practice(s) and/or device(s) which will be utilized to measure and account for the amount of water diverted from the source(s) of supply;

(D) a monitoring and record management program of water deliveries, sales, and losses;

(E) a leak-detection, repair, and water loss control program;

(F) a program to assist customers in the development of on-farm water conservation and pollution prevention plans and/or measures;

(G) a requirement in every wholesale water supply contract entered into or renewed after official adoption of the plan (by either ordinance, resolution, or tariff), and including any contract extension, that each successive wholesale customer develop and implement a water conservation plan or water conservation measures using the applicable elements in this chapter; if the customer intends to resell the water, then the contract between the initial supplier and customer must provide that the contract for the resale of the water must have water conservation requirements so that each successive customer in the resale of the water will be required to implement water conservation measures in accordance with applicable provisions of this chapter;

(H) official adoption of the water conservation plan and goals, by ordinance, rule, resolution, or tariff, indicating that the plan reflects official policy of the supplier;

(I) any other water conservation practice, method, or technique which the supplier shows to be appropriate for achieving conservation; and

(J) documentation of coordination with the Regional Water Planning Groups in order to insure consistency with the appropriate approved regional water plans.

(b) A water conservation plan prepared in accordance with the rules of the United States Department of Agriculture Natural Resource Conservation Service, the State Soil and Water Conservation Board, or other federal or state agency and substantially meeting the requirements of this section and other applicable commission rules may be submitted to meet application requirements pursuant to a memorandum of understanding between the commission and that agency.

Source Note: The provisions of this §288.4 adopted to be effective May 3, 1993, 18 TexReg 2558; amended to be effective February 21, 1999, 24 TexReg 949; amended to be effective April 27, 2000, 25 TexReg 3544; amended to be effective August 15, 2002, 27 TexReg 7146

APPENDIX C
IRRIGATION DISTRICT WATER CONSERVATION REPORT
Due: {Date} of every year

Entity Reporting: ______________________________
Filled Out By: ______________________________
Date Completed: ______________________________
Year Covered: ______________________________
# of Acres Irrigated ______________________________

Recorded Supplies and Sales by Month (in Acre-feet):

Month	Self-Supplied Water	Other Supplies	Deliveries by Crop Type						
			Crop A	Crop B	Crop C	Crop D	Crop E		Total
January									
February									
March									
April									
May									
June									
July									
August									
September									
October									
November									
December									
TOTAL									

Water Efficiency (Acre-feet):	
Self Supplies (total)	above
Other Supplies (total)	above
Total Supplies	above
Total Deliveries	above
Difference in Supplies and Deliveries	
% Efficient	
Goal for % Efficient	

CONSERVATION MEASURES IMPLEMENTED	
Measure	**Date Implemented**

AMOUNT OF WATER SAVED								
Year	Total Deliveries	Efficiency	Efficiency Improveme nt	Water saved (acre-feet)				
2000								
2001								

2002								
2003								
2004								
2005								
2006								

Unusual Circumstances (use additional sheets if necessary):

Progress in Implementation of Conservation Plan (use additional sheets if necessary):

Conservation measures planned for next year (use additional sheets if necessary):

Other (use additional sheets if necessary):

MODEL DROUGHT CONTINGENCY PLANS

Drought Contingency Plan for [Public Water Supplier]

Date

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APPENDICES

Drought Contingency Plan for [Public Water Supplier]

1. Objectives

This drought contingency plan (the Plan) is intended for use by [municipal water supplier]. The plan includes all current TCEQ requirements for a drought contingency plan.

This drought contingency plan serves to:

- Conserve available water supplies during times of drought and emergency.
- Minimize adverse impacts of water supply shortages.
- Minimize the adverse impacts of emergency water supply conditions.
- Preserve public health, welfare, and safety.

2. Texas Commission on Environmental Quality Rules

The TCEQ rules governing development of drought contingency plans for public water suppliers are contained in Title 30, Part 1, Chapter 288, Subchapter B, Rule 288.20 of the Texas Administrative Code.

3. Provisions to Inform the Public and Opportunity for Public Input

[Public water supplier] will give customers the opportunity to provide public input into the preparation of the plan by one of the following methods:

- Holding a public meeting.
- Providing written notice of the proposed plan and the opportunity to comment on the plan by newspaper or posted notice.

4. Public Education

[Public water supplier] will notify the public about the drought contingency plan, including changes in Stage and drought measures to be implemented, by one or more of the following methods:

- Prepare a description of the Plan and make it available to customers at appropriate locations.
- Include utility bill inserts that detail the Plan
- Provide radio announcements that inform customers of stages to be initiated or terminated and drought measures to be taken
- Include an ad in a newspaper of general circulation to inform customers of stages to be initiated or terminated and drought measures to be taken

5. Coordination with the Panhandle Water Planning Group

This drought contingency plan will be sent to the Chair of the Panhandle Water Planning Group in order to ensure consistency with the Panhandle Regional Water Plan. If any changes are made to the drought contingency plan, a copy of the newly adopted plan will be sent to the Regional Water Planning Group.

6. Initiation and Termination of Drought Response Stages

The designated official will order the implementation of a drought response stage when one or more of the trigger conditions for that stage exist. Official designees may also order the termination of a drought response stage when the termination criteria are met or at their own discretion.

If any mandatory provisions have been implemented or terminated, the water supplier is required to notify the Executive Director of the TCEQ within 5 business days.

7. Goals for Reduction in Water Use

TCEQ requires that each public water supplier develop quantifiable goals for water use reduction for each stage of the drought contingency plan. These goals are outlined below.

[To be developed by each supplier. An example is provided.]

- Stage 1, Mild
  - 0 to 2 percent reduction in use that would have occurred in the absence of drought contingency measures.
- Stage 2, Moderate
  - 2 to 6 percent reduction in use that would have occurred in the absence of drought contingency measures
- Stage 3, Severe
  - 6 to 10 percent reduction in use that would have occurred in the absence of drought contingency measures
- Stage 4, Emergency
  - 10 to 14 percent reduction in use that would have occurred in the absence of drought contingency measures

8. Drought and Emergency Response Stages

Stage 1, Mild

Trigger Conditions for Stage 1, Mild

- A wholesale water supplier that provides all or part of [public water supplier]'s supply has initiated Stage 1, Mild
- [To be otherwise completed by public water supplier]

- Potential triggers are:
  - When [public water supplier]'s available water supply is equal or less than [amount in ac-ft, percent of storage, etc.].
  - When total daily demand equals [number] million gallons for [number] consecutive days or [number] million gallons on a single day.
  - When the water level in [public water supplier]'s well(s) is equal or less than [number] feet above/below mean sea level.
  - When flows in the [name of river or stream segment] are equal to or less than [number] cubic feet per second.

Stage 1 will end when the circumstances that caused the initiation of Stage 1 no longer exist.

Goals for Use Reduction and Actions Available Under Stage 1, Mild
[Public water supplier] will reduce water use by [goal]. [Public water supplier] may order the implementation of any of the strategies listed below in order to decrease water use:

- Request voluntary reductions in water use.
- Review the problems that caused the initiation of Stage 1.
- Intensify leak detection and repair efforts

Stage 2, Moderate

Trigger Conditions for Stage 2, Moderate

- A wholesale water supplier that provides all or part of [public water supplier]'s supply has initiated Stage 2, Moderate
- [To be otherwise completed by public water supplier]
  - Potential triggers are:
    - When [public water supplier]'s available water supply is equal or less than [amount in ac-ft, percent of storage, etc.].
    - When total daily demand equals [number] million gallons for [number] consecutive days or [number] million gallons on a single day.
    - When the water level in [public water supplier]'s well(s) is equal or less than [number] feet above/below mean sea level.
    - When flows in the [name of river or stream segment] are equal to or less than [number] cubic feet per second.

Stage 2 will end when the circumstances that caused the initiation of Stage 2 no longer exist.

Goals for Use Reduction and Actions Available Under Stage 2, Moderate
[Public water supplier] will reduce water use by [goal]. [Public water supplier] may order the implementation of any of the strategies listed below in order to decrease water use:

- Request voluntary reductions in water use.
- Halt non-essential city government use
- Review the problems that caused the initiation of Stage 2.
- Intensify leak detection and repair efforts
- Implement mandatory restrictions on time of day outdoor water use in the summer.

Stage 3, Severe

Trigger Conditions for Stage 3, Severe

- A wholesale water supplier that provides all or part of [public water supplier]'s supply has initiated Stage 3, Severe
- [To be otherwise completed by public water supplier]
    - Potential triggers are:
        - When [public water supplier]'s available water supply is equal or less than [amount in ac-ft, percent of storage, etc.].
        - When total daily demand equals [number] million gallons for [number] consecutive days or [number] million gallons on a single day.
        - When the water level in [public water supplier]'s well(s) is equal or less than [number] feet above/below mean sea level.
        - When flows in the [name of river or stream segment] are equal to or less than [number] cubic feet per second.

Stage 3 will end when the circumstances that caused the initiation of Stage 3 no longer exist.

Goals for Use Reduction and Actions Available Under Stage 3, Severe
[Public water supplier] will reduce water use by [goal]. [Public water supplier] may order the implementation of any of the strategies listed below in order to decrease water use:

- Request voluntary reductions in water use.
- Require mandatory reductions in water use
- Halt non-essential city government use
- Review the problems that caused the initiation of Stage 3.
- Intensify leak detection and repair efforts
- Implement mandatory restrictions on time of day outdoor water use in the summer.
- Limit outdoor watering to specific weekdays.
- Create and implement a landscape ordinance.

Stage 4, Emergency

Trigger Conditions for Stage 4, Emergency

- A wholesale water supplier that provides all or part of [public water supplier]'s supply has initiated Stage 4, Emergency
- [To be otherwise completed by public water supplier]
  - Potential triggers are:
    - When [public water supplier]'s demand exceeds the amount that can be delivered to customers.
    - When [public water supplier]'s source becomes contaminated
    - [Public water supplier]'s system is unable to deliver water due to the failure or damage of major water system components.

Stage 4 will end when the circumstances that caused the initiation of Stage 4 no longer exist.

Goals for Use Reduction and Actions Available Under Stage 4, Emergency
[Public water supplier] will reduce water use by [goal]. [Public water supplier] may order the implementation of any of the strategies listed below in order to decrease water use:

- Require mandatory reductions in water use
- Halt non-essential city government use
- Review the problems that caused the initiation of Stage 4.
- Intensify leak detection and repair efforts
- Implement mandatory restrictions on time of day outdoor water use in the summer.
- Limit outdoor watering to specific weekdays.
- Create and implement a landscape ordinance.
- Prohibit washing of vehicles except as necessary for health, sanitation, or safety reasons.
- Prohibit commercial and residential landscape watering
- Prohibit golf course watering except for greens and tee boxes
- Prohibit filling of private pools.
- Initiate a rate surcharge for all water use over [amount in gallons per month].

9. Penalty for Violation of Water Use Restriction
Mandatory restrictions are required by TCEQ regulation to have a penalty. These restrictions will be strictly enforced with the following penalties:

- Potential penalties
  - Written warning that they have violated the mandatory water use restriction.
  - Issue a citation. Minimum and maximum fines are established by ordinance.
  - Discontinue water service to the user.

10. Review and Update of Drought Contingency Plan

This drought contingency plan will be updated at least every 5 years as required by TCEQ regulations.

APPENDIX A

List of References

Title 30 of the Texas Administrative Code, Part 1, Chapter 288, Subchapter B, Rule 288.20, downloaded from http://info.sos.state.tx.us/pls/pub/readtac$ext.viewtac, January 10, 2010.

APPENDIX B
Texas Commission on Environmental Quality Rules on Drought Contingency Plans

Texas Administrative Code

TITLE 30 ENVIRONMENTAL QUALITY
PART 1 TEXAS COMMISSION ON ENVIRONMENTAL QUALITY
CHAPTER 288 WATER CONSERVATION PLANS, DROUGHT CONTINGENCY PLANS, GUIDELINES AND REQUIREMENTS
SUBCHAPTER B DROUGHT CONTINGENCY PLANS
RULE §288.20 Drought Contingency Plans for Municipal Uses by Public Water Suppliers

(a) A drought contingency plan for a retail public water supplier, where applicable, shall provide information in response to each of the following.

(1) Minimum requirements. Drought contingency plans shall include the following minimum elements.

(A) Preparation of the plan shall include provisions to actively inform the public and affirmatively provide opportunity for public input. Such acts may include, but are not limited to, having a public meeting at a time and location convenient to the public and providing written notice to the public concerning the proposed plan and meeting.

(B) Provisions shall be made for a program of continuing public education and information regarding the drought contingency plan.

(C) The drought contingency plan must document coordination with the Regional Water Planning Groups for the service area of the retail public water supplier to insure consistency with the appropriate approved regional water plans.

(D) The drought contingency plan shall include a description of the information to be monitored by the water supplier, and specific criteria for the initiation and termination of drought response stages, accompanied by an explanation of the rationale or basis for such triggering criteria.

(E) The drought contingency plan must include drought or emergency response stages providing for the implementation of measures in response to at least the following situations:

(i) reduction in available water supply up to a repeat of the drought of record;

(ii) water production or distribution system limitations;

(iii) supply source contamination; or

(iv) system outage due to the failure or damage of major water system components (e.g., pumps).

(F) The drought contingency plan must include the specific water supply or water demand management measures to be implemented during each stage of the plan including, but not limited to, the following:

(i) curtailment of non-essential water uses; and

(ii) utilization of alternative water sources and/or alternative delivery mechanisms with the prior approval of the executive director as appropriate (e.g., interconnection with another water system, temporary use of a non-municipal water supply, use of reclaimed water for non-potable purposes, etc.).

(G) The drought contingency plan must include the procedures to be followed for the initiation or termination of each drought response stage, including procedures for notification of the public.

(H) The drought contingency plan must include the procedures to be followed for the initiation or termination of each drought response stage, including procedures for notification of the public.

(I) The drought contingency plan must include procedures for granting variances to the plan.

(J) The drought contingency plan must include procedures for the enforcement of any mandatory water use restrictions, including specification of penalties (e.g., fines, water rate surcharges, discontinuation of service) for violations of such restrictions.

(2) Privately-owned water utilities. Privately-owned water utilities shall prepare a drought contingency plan in accordance with this section and shall incorporate such plan into their tariff.

(3) Wholesale water customers. Any water supplier that receives all or a portion of its water supply from another water supplier shall consult with that supplier and shall include in the drought contingency plan appropriate provisions for responding to reductions in that water supply.

(b) A wholesale or retail water supplier shall notify the executive director within five business days of the implementation of any mandatory provisions of the drought contingency plan.

(c) The retail public water supplier shall review and update, as appropriate, the drought contingency plan, at least every five years, based on new or updated information, such as the adoption or revision of the regional water plan.

Model Drought Contingency Plan for [Irrigation District]

Date

TABLE OF CONTENTS

Drought Contingency Plan for [Irrigation District]

1. Objectives

This drought contingency plan is intended for use by [irrigation district]. The plan includes all current TCEQ requirements for a drought contingency plan.

This drought contingency plan serves to:

- Conserve available water supplies during times of drought and emergency.
- Minimize adverse impacts of water supply shortages.
- Minimize the adverse impacts of emergency water supply conditions.

2. Texas Commission on Environmental Quality Rules

The TCEQ rules governing development of drought contingency plans for irrigation districts are contained in Title 30, Part 1, Chapter 288, Subchapter B, Rule 288.21 of the Texas Administrative Code.

3. Provisions to Inform the Public and Opportunity for Public Input

[Irrigation district] will give customers the opportunity to provide public input into the preparation of the plan by one of the following methods:

- Holding a public meeting.
- Providing written notice of the proposed plan and the opportunity to comment on the plan by newspaper or posted notice.

4. Coordination with the Panhandle Water Planning Group

This drought contingency plan will be sent to the Chair of the Panhandle Water Planning Group in order to ensure consistency with the Panhandle Regional Water Plan.

5. Initiation and Termination of Drought Response Stages

Official designees order the implementation of a drought response stage when one or more of the trigger conditions for that stage are met. Official designees may also order the termination of a drought response stage when the termination criteria are met or at their own discretion. The official designee for the [irrigation district] is:

Name
Title
Contact Information

If any mandatory provisions have been implemented or terminated, [irrigation district] is required to notify the Executive Director of the TCEQ within 5 business days.

6. Goals for Reduction in Water Use

TCEQ requires that each irrigation water user develop goals for water use reduction for each stage of the drought contingency plan. [Entity]'s goals are independently developed and given below.

7. Drought and Emergency Response Stages

Stage 1, Mild

Trigger Conditions for Stage 1, Mild

- A wholesale water supplier that provides all or part of an irrigation user's supply has initiated Stage 1, Mild
- *[Select appropriate other triggers]*
  - When [irrigation district]'s available water supply is equal or less than [amount in ac-ft, percent of storage, etc.].
  - When total daily demand equals [number] million gallons for [number] consecutive days or [number] million gallons on a single day.
  - When the water level in [irrigation district]'s well(s) is equal or less than [number] feet above/below mean sea level.
  - When flows in the [name of river or stream segment] are equal to or less than [number] cubic feet per second.

Goals for Use Reduction and Actions Available Under Stage 1, Mild
[Entity]'s will reduce water use by [goal]. Irrigation water suppliers may order the implementation of any of the strategies listed below in order to reduce water use:

- Request voluntary reductions in water use.
- Review the problems that caused the initiation of Stage 1.

Stage 1 is intended to raise awareness of potential drought problems. Stage 1 will end when the circumstances that caused the initiation of Stage 1 no longer exist.

Stage 2, Moderate

Trigger Conditions for Stage 2, Moderate

- A wholesale water supplier that provides all or part of an irrigation user's supply has initiated Stage 2, Moderate
- *[Select appropriate other triggers]*
  - When [irrigation district]'s available water supply is equal or less than [amount in ac-ft, percent of storage, etc.].
  - When total daily demand equals [number] million gallons for [number] consecutive days or [number] million gallons on a single day.
  - When the water level in [irrigation district]'s well(s) is equal or less than [number] feet above/below mean sea level.

    - When flows in the [name of river or stream segment] are equal to or less than [number] cubic feet per second.

Goals for Use Reduction and Actions Available Under Stage 2, Moderate
[Entity]'s will reduce water use by [goal]. Irrigation water suppliers may order the implementation of any of the strategies listed below in order to reduce water use:

- Request voluntary reductions in water use.
- Review the problems that caused the initiation of Stage 2.
- Intensify leak detection and repair efforts.
- Other.

Stage 2 will end when the circumstances that caused the initiation of Stage 2 no longer exist.

Stage 3, Severe

Trigger Conditions for Stage 3, Severe

- A wholesale water supplier that provides all or part of an irrigation user's supply has initiated Stage 3, Severe
- *[Select appropriate other triggers]*
    - When [irrigation district]'s available water supply is equal or less than [amount in ac-ft, percent of storage, etc.].
    - When total daily demand equals [number] million gallons for [number] consecutive days or [number] million gallons on a single day.
    - When the water level in [irrigation district]'s well(s) is equal or less than [number] feet above/below mean sea level.
    - When flows in the [name of river or stream segment] are equal to or less than [number] cubic feet per second.

Goals for Use Reduction and Actions Available Under Stage 3, Severe
[Entity]'s will reduce water use by [goal]. Irrigation water suppliers may order the implementation of any of the strategies listed below in order to reduce water use:

- Request voluntary reductions in water use.
- Review the problems that caused the initiation of Stage 3.
- Intensify leak detection and repair efforts.
- Implement mandatory watering days and/or times.
- Other.

Stage 3 will end when the circumstances that caused the initiation of Stage 3 no longer exist.

Stage 4, Emergency

Trigger Conditions for Stage 4, Emergency

- A wholesale water supplier that provides all or part of an irrigation user's supply has initiated Stage 4, Emergency
- *[Select appropriate other triggers]*
    - When [irrigation district]'s available water supply is equal or less than [amount in ac-ft, percent of storage, etc.].
    - When total daily demand equals [number] million gallons for [number] consecutive days or [number] million gallons on a single day.
    - When the water level in [irrigation district]'s well(s) is equal or less than [number] feet above/below mean sea level.
    - When flows in the [name of river or stream segment] are equal to or less than [number] cubic feet per second.

Goals for Use Reduction and Actions Available Under Stage 4, Emergency
[Entity]'s will reduce water use by [goal]. Irrigation water suppliers may order the implementation of any of the strategies listed below in order to reduce water use:

- Review the problems that caused the initiation of Stage 4.
- Intensify leak detection and repair efforts.
- Implement mandatory watering days and/or times.
- Implement mandatory reductions in water deliveries.
- Other.

Stage 4 will end when the circumstances that caused the initiation of Stage 4 no longer exist.

8. Penalty for Violation of Water Use Restriction

Mandatory water use restrictions are implemented in Stages [1, 2, 3, or 4]. These restrictions will be strictly enforced with the following penalties:

- Potential penalties include:
    - Written warning that they have violated the mandatory water use restriction.
    - Issue a citation. Minimum and maximum fines are established by ordinance or other order.
    - Discontinue water service to the user.

9. Review and Update of Drought Contingency Plan

This drought contingency plan will be updated at least every 5 years as required by TCEQ regulations.

APPENDIX K

INFRASTRUCTURE FINANCING REPORT SURVEYS

Infrastructure Financing Survey Report

2: AMARILLO

As part of the regional and state water planning process, regional water planning groups recommend water supply projects for each of their respective regions. The purpose of this survey is gather information from your organization regarding how you plan to finance water supply projects recommended for the 2012 state water plan, and determine whether you intend to use financial assistance programs offered by the State of Texas and administered by the Texas Water Development Board (TWDB).

The TWDB has several funding programs for water projects identified in the 2012 state water plan. Funds are targeted toward: 1) construction of water supply projects, 2) planning and design and permitting for projects that have long development time frames meaning that construction would require 5-10 years of planning, design and permitting, and 3) projects that would be built with excess capacity intended to meet future water needs. These programs offer various attractive financing options such as subsidized interest rates, deferral of principal and interest during planning, design and permitting phase, partial deferral of interest and principal for those portions of the project which are optimally sized for future needs. Additionally, grant funding is available for those service areas which qualify as rural or economically disadvantaged. More information on these financial assistance programs (i.e., the Water Infrastructure Fund, the State Participation Fund, and the Economically Disadvantaged Areas Program) can be found at the TWDB website at:

http://www.twdb.state.tx.us/assistance/financial/financial_main.asp

Your cooperation and responses to these questions are crucial in helping the state in ensuring that our communities and our citizens have adequate water supplies. If you have any questions related to the financial programs offered by the TWDB or about the survey questions, please contact Kyle Ingham by phone at (806)372-3381 or by email at kingham@theprpc.org. If you have any computer or technology related problems with the survey, please contact Wendy Barron by phone at (512) 936-0886 or by email at wendy.barron@twdb.state.tx.us.

Section 1: Project Financing Information

For project(s) identified in the State Water Plan, the TWDB has funding available for different aspects of a project. The different programs available are:

- WIF-Deferred offers subsidized interest and deferral of principal and interest for up to 10 years for planning, design and permitting costs.

- WIF-Construction offers subsidized interest for all construction costs, including planning, acquisition, design, and construction.

- State Participation funding offers partial interest and principal deferral for the incremental cost of project elements which are designed and built to serve needs beyond 10 years.

- Rural areas funding offers grants and 0% interest loans for service areas which are not in a Metropolitan Statistical Area (MSA) and in which the population does not exceed 5,000. The service area must also meet the EDAP eligibility criteria.

- Economically Distressed Areas Program (EDAP) offers funding through grants and loans for service areas within a project which meet the EDAP eligibility criteria. Eligibility for the TWDB's EDAP requires that the median household income of the area to be served by the proposed project be less than 75 percent of the Texas median household income ($39,927), as shown in the 2000 Census. EDAP eligibility also requires adoption of Model Subdivision rules by the appropriate planning entities.

- State Participation funding offers partial interest and principal deferral for the incremental cost of project elements which are designed and built to serve needs beyond 10 years.

interested in receiving funds from the above programs, please complete the remainder of the survey.

Infrastructure Financing Survey Report

Please enter only the amounts you wish to receive from TWDB program in the Project Costs fields and do not enter a specific project cost more than once.

Section 2: Projects

For each of the project(s) listed below, please enter only the amounts you wish to receive from TWDB programs in the 'Cost' field and the earliest date you wish to receive these amounts. In addition, the total amount entered into all five categories cannot exceed the total cost of the project. Each of the five categories corresponds to a funding program available at the TWDB. Each of the funding programs and categories are described below.

- Planning, design, permitting: Enter costs into the 'Planning, design, permitting' category if you want to participate in the WIF-Deferred program. The WIF-Deferred program offers subsidized interest and deferral of principal and interest for up to 10 years for planning, design and permitting costs.

- Acquisition and construction: Enter costs into the 'Acquisition and construction' category if you want to participate in the WIF-Construction program. The WIF-Construction program offers subsidized interest for all construction costs, including planning, acquisition, design, and construction.

- Excess Capacity: Enter costs into the 'Excess capacity' category if you want to participate in the State Participation program. State Participating funding offers partial interest and principal deferral for the incremental cost of project elements which are designed and built to serve needs beyond 10 years.

- Rural: Enter costs into the 'Rural' category if you want to participate in the Rural areas funding program. Rural areas funding offers grants and 0% interest loans for service areas which are not in a Metropolitan Statistical Area (MSA) and in which the population does not exceed 5,000. The service area must also meet the EDAP eligibility criteria.

- Disadvantaged: Enter costs into the 'Disadvantaged' category if you want to participate in the Economically Distressed Areas Program (EDAP). EDAP offers funding through grants and loans for service areas within a project which meet the EDAP eligibility criteria. Eligibility for the TWDB's EDAP requires that the median household income of the area to be served by the proposed project be less than 75 percent of the Texas median household income ($39,927), as shown in the 2000 Census. EDAP eligibility also requires adoption of Model Subdivision rules by the appropriate planning entities.

630 - ROBERTS COUNTY WELL FIELD - AMARILLO **$125,751,700.00**

Planning, design, permitting	Cost:	36,536,000	Year:	2040
Acquisition and contruction	Cost:	250,841,000	Year:	2040
Excess Capacity	Cost:		Year:	
Rural	Cost:		Year:	
Disadvantaged	Cost:		Year:	
	Total:			

Infrastructure Financing Survey Report

814 - POTTER COUNTY WELL FIELD **$76,464,600.00**

Planning, design, permitting	Cost:	13,742,000	Year:	2010
Acquisition and contruction	Cost:	114,769,300	Year:	2011
Excess Capacity	Cost:		Year:	
Rural	Cost:		Year:	
Disadvantaged	Cost:		Year:	
	Total:			

Section 3: Contact Information

1. Name: Emmett Autrey
2. Phone Number: 806 378-4266
3. Email: emmett.autrey@amarillo.org
4. Comments: See revisions from original survey form

3/11/2010 3:16:20 PM

Infrastructure Financing Survey Report

13: BORGER

As part of the regional and state water planning process, regional water planning groups recommend water supply projects for each of their respective regions. The purpose of this survey is gather information from your organization regarding how you plan to finance water supply projects recommended for the 2012 state water plan, and determine whether you intend to use financial assistance programs offered by the State of Texas and administered by the Texas Water Development Board (TWDB).

The TWDB has several funding programs for water projects identified in the 2012 state water plan. Funds are targeted toward: 1) construction of water supply projects, 2) planning and design and permitting for projects that have long development time frames meaning that construction would require 5-10 years of planning, design and permitting, and 3) projects that would be built with excess capacity intended to meet future water needs. These programs offer various attractive financing options such as subsidized interest rates, deferral of principal and interest during planning, design and permitting phase, partial deferral of interest and principal for those portions of the project which are optimally sized for future needs. Additionally, grant funding is available for those service areas which qualify as rural or economically disadvantaged. More information on these financial assistance programs (i.e., the Water Infrastructure Fund, the State Participation Fund, and the Economically Disadvantaged Areas Program) can be found at the TWDB website at:

http://www.twdb.state.tx.us/assistance/financial/financial_main.asp

Your cooperation and responses to these questions are crucial in helping the state in ensuring that our communities and our citizens have adequate water supplies. If you have any questions related to the financial programs offered by the TWDB or about the survey questions, please contact Kyle Ingham by phone at (806)372-3381 or by email at kingham@theprpc.org. If you have any computer or technology related problems with the survey, please contact Wendy Barron by phone at (512) 936-0886 or by email at wendy.barron@twdb.state.tx.us.

Section 1: Project Financing Information

For project(s) identified in the State Water Plan, the TWDB has funding available for different aspects of a project. The different programs available are:

•WIF-Deferred offers subsidized interest and deferral of principal and interest for up to 10 years for planning, design and permitting costs.

•WIF-Construction offers subsidized interest for all construction costs, including planning, acquisition, design, and construction.

•State Participation funding offers partial interest and principal deferral for the incremental cost of project elements which are designed and built to serve needs beyond 10 years.

•Rural areas funding offers grants and 0% interest loans for service areas which are not in a Metropolitan Statistical Area (MSA) and in which the population does not exceed 5,000. The service area must also meet the EDAP eligibility criteria.

•Economically Distressed Areas Program (EDAP) offers funding through grants and loans for service areas within a project which meet the EDAP eligibility criteria. Eligibility for the TWDB's EDAP requires that the median household income of the area to be served by the proposed project be less than 75 percent of the Texas median household income ($39,927), as shown in the 2000 Census. EDAP eligibility also requires adoption of Model Subdivision rules by the appropriate planning entities.

•State Participation funding offers partial interest and principal deferral for the incremental cost of project elements which are designed and built to serve needs beyond 10 years.

If you are interested in receiving funds from the above programs, please complete the remainder of the survey.

Infrastructure Financing Survey Report

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Section 2: Projects

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- Planning, design, permitting: Enter costs into the 'Planning, design, permitting' category if you want to participate in the WIF-Deferred program. The WIF-Deferred program offers subsidized interest and deferral of principal and interest for up to 10 years for planning, design and permitting costs.

- Acquisition and construction: Enter costs into the 'Acquisition and construction' category if you want to participate in the WIF-Construction program. The WIF-Construction program offers subsidized interest for all construction costs, including planning, acquisition, design, and construction.

- Excess Capacity: Enter costs into the 'Excess capacity' category if you want to participate in the State Participation program. State Participating funding offers partial interest and principal deferral for the incremental cost of project elements which are designed and built to serve needs beyond 10 years.

- Rural: Enter costs into the 'Rural' category if you want to participate in the Rural areas funding program. Rural areas funding offers grants and 0% interest loans for service areas which are not in a Metropolitan Statistical Area (MSA) and in which the population does not exceed 5,000. The service area must also meet the EDAP eligibility criteria.

- Disadvantaged: Enter costs into the 'Disadvantaged' category if you want to participate in the Economically Distressed Areas Program (EDAP). EDAP offers funding through grants and loans for service areas within a project which meet the EDAP eligibility criteria. Eligibility for the TWDB's EDAP requires that the median household income of the area to be served by the proposed project be less than 75 percent of the Texas median household income ($39,927), as shown in the 2000 Census. EDAP eligibility also requires adoption of Model Subdivision rules by the appropriate planning entities.

192 - VOLUNTARY TRANSFER FROM OTHER USERS **$4,399,400.00**

Planning, design, permitting	Cost:		Year:	
Acquisition and contruction	Cost:		Year:	
Excess Capacity	Cost:		Year:	
Rural	Cost:		Year:	
Disadvantaged	Cost:		Year:	
	Total:			

Infrastructure Financing Survey Report

194 - DRILL ADDITIONAL GROUNDWATER WELL **$9,379,200.00**

	Cost:		Year:	
Planning, design, permitting	Cost:		Year:	
Acquisition and contruction	Cost:		Year:	
Excess Capacity	Cost:	$850,000.00	Year:	2012
Rural	Cost:		Year:	
Disadvantaged	Cost:		Year:	
	Total:			

Section 3: Contact Information

1. Name: James Harder
2. Phone Number: (806) 273-0906
3. Email: jharder@ci.borger.tx.us
4. Comments

Infrastructure Financing Survey Report

18: CACTUS

As part of the regional and state water planning process, regional water planning groups recommend water supply projects for each of their respective regions. The purpose of this survey is gather information from your organization regarding how you plan to finance water supply projects recommended for the 2012 state water plan, and determine whether you intend to use financial assistance programs offered by the State of Texas and administered by the Texas Water Development Board (TWDB).

The TWDB has several funding programs for water projects identified in the 2012 state water plan. Funds are targeted toward: 1) construction of water supply projects, 2) planning and design and permitting for projects that have long development time frames meaning that construction would require 5-10 years of planning, design and permitting, and 3) projects that would be built with excess capacity intended to meet future water needs. These programs offer various attractive financing options such as subsidized interest rates, deferral of principal and interest during planning, design and permitting phase, partial deferral of interest and principal for those portions of the project which are optimally sized for future needs. Additionally, grant funding is available for those service areas which qualify as rural or economically disadvantaged. More information on these financial assistance programs (i.e., the Water Infrastructure Fund, the State Participation Fund, and the Economically Disadvantaged Areas Program) can be found at the TWDB website at:

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Section 1: Project Financing Information

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•State Participation funding offers partial interest and principal deferral for the incremental cost of project elements which are designed and built to serve needs beyond 10 years.

•Rural areas funding offers grants and 0% interest loans for service areas which are not in a Metropolitan Statistical Area (MSA) and in which the population does not exceed 5,000. The service area must also meet the EDAP eligibility criteria.

•Economically Distressed Areas Program (EDAP) offers funding through grants and loans for service areas within a project which meet the EDAP eligibility criteria. Eligibility for the TWDB's EDAP requires that the median household income of the area to be served by the proposed project be less than 75 percent of the Texas median household income ($39,927), as shown in the 2000 Census. EDAP eligibility also requires adoption of Model Subdivision rules by the appropriate planning entities.

•State Participation funding offers partial interest and principal deferral for the incremental cost of project elements which are designed and built to serve needs beyond 10 years.

If you are interested in receiving funds from the above programs, please complete the remainder of the survey.

Infrastructure Financing Survey Report

•State Participation funding offers partial interest and principal deferral for the incremental cost of project elements which are designed and built to serve needs beyond 10 years.

If you are interested in receiving funds from the above programs, please complete the remainder of the survey.

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Section 2: Projects

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•Planning, design, permitting: Enter costs into the 'Planning, design, permitting' category if you want to participate in the WIF-Deferred program. The WIF-Deferred program offers subsidized interest and deferral of principal and interest for up to 10 years for planning, design and permitting costs.

•Acquisition and construction: Enter costs into the 'Acquisition and construction' category if you want to participate in the WIF-Construction program. The WIF-Construction program offers subsidized interest for all construction costs, including planning, acquisition, design, and construction.

•Excess Capacity: Enter costs into the 'Excess capacity' category if you want to participate in the State Participation program. State Participating funding offers partial interest and principal deferral for the incremental cost of project elements which are designed and built to serve needs beyond 10 years.

•Rural: Enter costs into the 'Rural' category if you want to participate in the Rural areas funding program. Rural areas funding offers grants and 0% interest loans for service areas which are not in a Metropolitan Statistical Area (MSA) and in which the population does not exceed 5,000. The service area must also meet the EDAP eligibility criteria.

•Disadvantaged: Enter costs into the 'Disadvantaged' category if you want to participate in the Economically Distressed Areas Program (EDAP). EDAP offers funding through grants and loans for service areas within a project which meet the EDAP eligibility criteria. Eligibility for the TWDB's EDAP requires that the median household income of the area to be served by the proposed project be less than 75 percent of the Texas median household income ($39,927), as shown in the 2000 Census. EDAP eligibility also requires adoption of Model Subdivision rules by the appropriate planning entities.

194 - DRILL ADDITIONAL GROUNDWATER WELL **$10,893,400.00**

Planning, design, permitting	Cost: 2,178,680.00	Year: 2011
Acquisition and contruction	Cost: 8,714,720.00	Year: 2011
Excess Capacity	Cost: 0	Year:

Infrastructure Financing Survey Report

Rural	Cost: 0	Year:	
Disadvantaged	Cost: 0	Year:	
	Total: 10,893,400.00		

Section 3: Contact Information

1. Name: Steve Schmidt-Witcher
2. Phone Number: 806-966-5458
3. Email: citymanager@amaonline.com
4. Comments

Infrastructure Financing Survey Report

20: CANADIAN RIVER MUNICIPAL WATER AUTHORITY

As part of the regional and state water planning process, regional water planning groups recommend water supply projects for each of their respective regions. The purpose of this survey is gather information from your organization regarding how you plan to finance water supply projects recommended for the 2012 state water plan, and determine whether you intend to use financial assistance programs offered by the State of Texas and administered by the Texas Water Development Board (TWDB).

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Section 1: Project Financing Information

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•State Participation funding offers partial interest and principal deferral for the incremental cost of project elements which are designed and built to serve needs beyond 10 years.

•Rural areas funding offers grants and 0% interest loans for service areas which are not in a Metropolitan Statistical Area (MSA) and in which the population does not exceed 5,000. The service area must also meet the EDAP eligibility criteria.

•Economically Distressed Areas Program (EDAP) offers funding through grants and loans for service areas within a project which meet the EDAP eligibility criteria. Eligibility for the TWDB's EDAP requires that the median household income of the area to be served by the proposed project be less than 75 percent of the Texas median household income ($39,927), as shown in the 2000 Census. EDAP eligibility also requires adoption of Model Subdivision rules by the appropriate planning entities.

•State Participation funding offers partial interest and principal deferral for the incremental cost of project elements which are designed and built to serve needs beyond 10 years.

If you are interested in receiving funds from the above programs, please complete the remainder of the survey.

Infrastructure Financing Survey Report

•State Participation funding offers partial interest and principal deferral for the incremental cost of project elements which are designed and built to serve needs beyond 10 years.

If you are interested in receiving funds from the above programs, please complete the remainder of the survey.

Please enter only the amounts you wish to receive from TWDB program in the Project Costs fields and do not enter a specific project cost more than once.

Section 2: Projects

For each of the project(s) listed below, please enter only the amounts you wish to receive from TWDB programs in the 'Cost' field and the earliest date you wish to receive these amounts. In addition, the total amount entered into all five categories cannot exceed the total cost of the project. Each of the five categories corresponds to a funding program available at the TWDB. Each of the funding programs and categories are described below.

•Planning, design, permitting: Enter costs into the 'Planning, design, permitting' category if you want to participate in the WIF-Deferred program. The WIF-Deferred program offers subsidized interest and deferral of principal and interest for up to 10 years for planning, design and permitting costs.

•Acquisition and construction: Enter costs into the 'Acquisition and construction' category if you want to participate in the WIF-Construction program. The WIF-Construction program offers subsidized interest for all construction costs, including planning, acquisition, design, and construction.

•Excess Capacity: Enter costs into the 'Excess capacity' category if you want to participate in the State Participation program. State Participating funding offers partial interest and principal deferral for the incremental cost of project elements which are designed and built to serve needs beyond 10 years.

•Rural: Enter costs into the 'Rural' category if you want to participate in the Rural areas funding program. Rural areas funding offers grants and 0% interest loans for service areas which are not in a Metropolitan Statistical Area (MSA) and in which the population does not exceed 5,000. The service area must also meet the EDAP eligibility criteria.

•Disadvantaged: Enter costs into the 'Disadvantaged' category if you want to participate in the Economically Distressed Areas Program (EDAP). EDAP offers funding through grants and loans for service areas within a project which meet the EDAP eligibility criteria. Eligibility for the TWDB's EDAP requires that the median household income of the area to be served by the proposed project be less than 75 percent of the Texas median household income ($39,927), as shown in the 2000 Census. EDAP eligibility also requires adoption of Model Subdivision rules by the appropriate planning entities.

816 - CRMWA ROBERTS COUNTY WELL FIELD **$21,824,000.00**

Planning, design, permitting	Cost:	2,182,000	Year:	2009-2010
Acquisition and contruction	Cost:	19,641,600	Year:	2009-2010
Excess Capacity	Cost:		Year:	

Infrastructure Financing Survey Report

Rural	Cost:		Year:	
Disadvantaged	Cost:		Year:	
	Total:			

Section 3: Contact Information

1. Name: Canadian River Municipal Water Authority
2. Phone Number: 806-865-3325
3. Email: ksatterwhite@crmwa.com
4. Comments

Funding for the project listed has been obtained through private bonds. CRMWA's future needs are water rights acquisition. CRMWA is interested in the purchase of 211,832 acres of water rights in Roberts County and the surrounding counties at a purchase cost of $84,000,000. Planning, design, and permitting could be another 5%, which would bring the total need to $88,200,000.

Infrastructure Financing Survey Report

329: CANYON

As part of the regional and state water planning process, regional water planning groups recommend water supply projects for each of their respective regions. The purpose of this survey is gather information from your organization regarding how you plan to finance water supply projects recommended for the 2012 state water plan, and determine whether you intend to use financial assistance programs offered by the State of Texas and administered by the Texas Water Development Board (TWDB).

The TWDB has several funding programs for water projects identified in the 2012 state water plan. Funds are targeted toward: 1) construction of water supply projects, 2) planning and design and permitting for projects that have long development time frames meaning that construction would require 5-10 years of planning, design and permitting, and 3) projects that would be built with excess capacity intended to meet future water needs. These programs offer various attractive financing options such as subsidized interest rates, deferral of principal and interest during planning, design and permitting phase, partial deferral of interest and principal for those portions of the project which are optimally sized for future needs. Additionally, grant funding is available for those service areas which qualify as rural or economically disadvantaged. More information on these financial assistance programs (i.e., the Water Infrastructure Fund, the State Participation Fund, and the Economically Disadvantaged Areas Program) can be found at the TWDB website at:

http://www.twdb.state.tx.us/assistance/financial/financial_main.asp

Your cooperation and responses to these questions are crucial in helping the state in ensuring that our communities and our citizens have adequate water supplies. If you have any questions related to the financial programs offered by the TWDB or about the survey questions, please contact Kyle Ingham by phone at (806)372-3381 or by email at kingham@theprpc.org. If you have any computer or technology related problems with the survey, please contact Wendy Barron by phone at (512) 936-0886 or by email at wendy.barron@twdb.state.tx.us.

Section 1: Project Financing Information

For project(s) identified in the State Water Plan, the TWDB has funding available for different aspects of a project. The different programs available are:

•WIF-Deferred offers subsidized interest and deferral of principal and interest for up to 10 years for planning, design and permitting costs.

•WIF-Construction offers subsidized interest for all construction costs, including planning, acquisition, design, and construction.

•State Participation funding offers partial interest and principal deferral for the incremental cost of project elements which are designed and built to serve needs beyond 10 years.

•Rural areas funding offers grants and 0% interest loans for service areas which are not in a Metropolitan Statistical Area (MSA) and in which the population does not exceed 5,000. The service area must also meet the EDAP eligibility criteria.

•Economically Distressed Areas Program (EDAP) offers funding through grants and loans for service areas within a project which meet the EDAP eligibility criteria. Eligibility for the TWDB's EDAP requires that the median household income of the area to be served by the proposed project be less than 75 percent of the Texas median household income ($39,927), as shown in the 2000 Census. EDAP eligibility also requires adoption of Model Subdivision rules by the appropriate planning entities.

•State Participation funding offers partial interest and principal deferral for the incremental cost of project elements which are designed and built to serve needs beyond 10 years.

If you are interested in receiving funds from the above programs, please complete the remainder of the survey.

cture Financing Survey Report

se enter only the amounts you wish to receive from TWDB program in the Project Costs fields and do not nter a specific project cost more than once.

Section 2: Projects

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- Planning, design, permitting: Enter costs into the 'Planning, design, permitting' category if you want to participate in the WIF-Deferred program. The WIF-Deferred program offers subsidized interest and deferral of principal and interest for up to 10 years for planning, design and permitting costs.
- Acquisition and construction: Enter costs into the 'Acquisition and construction' category if you want to participate in the WIF-Construction program. The WIF-Construction program offers subsidized interest for all construction costs, including planning, acquisition, design, and construction.
- Excess Capacity: Enter costs into the 'Excess capacity' category if you want to participate in the State Participation program. State Participating funding offers partial interest and principal deferral for the incremental cost of project elements which are designed and built to serve needs beyond 10 years.
- Rural: Enter costs into the 'Rural' category if you want to participate in the Rural areas funding program. Rural areas funding offers grants and 0% interest loans for service areas which are not in a Metropolitan Statistical Area (MSA) and in which the population does not exceed 5,000. The service area must also meet the EDAP eligibility criteria.
- Disadvantaged: Enter costs into the 'Disadvantaged' category if you want to participate in the Economically Distressed Areas Program (EDAP). EDAP offers funding through grants and loans for service areas within a project which meet the EDAP eligibility criteria. Eligibility for the TWDB's EDAP requires that the median household income of the area to be served by the proposed project be less than 75 percent of the Texas median household income ($39,927), as shown in the 2000 Census. EDAP eligibility also requires adoption of Model Subdivision rules by the appropriate planning entities.

194 - DRILL ADDITIONAL GROUNDWATER WELL

~~$8,218,000.00~~ $9,528,800.00

Planning, design, permitting	Cost: $1,905,760	Year: 2013
Acquisition and contruction	Cost: $7,623,040	Year: 2015
Excess Capacity	Cost:	Year:
Rural	Cost:	Year:
Disadvantaged	Cost:	Year:
	Total:	

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Infrastructure Financing Survey Report

Section 3: Contact Information

1.	Name:	DAN E. REESE, DIRECTOR OF PUBLIC WORKS
2.	Phone Number:	(806) 655-5011
3.	Email:	dreese@canyontx.com
4.	Comments	

Infrastructure Financing Survey Report

43: DUMAS

As part of the regional and state water planning process, regional water planning groups recommend water supply projects for each of their respective regions. The purpose of this survey is gather information from your organization regarding how you plan to finance water supply projects recommended for the 2012 state water plan, and determine whether you intend to use financial assistance programs offered by the State of Texas and administered by the Texas Water Development Board (TWDB).

The TWDB has several funding programs for water projects identified in the 2012 state water plan. Funds are targeted toward: 1) construction of water supply projects, 2) planning and design and permitting for projects that have long development time frames meaning that construction would require 5-10 years of planning, design and permitting, and 3) projects that would be built with excess capacity intended to meet future water needs. These programs offer various attractive financing options such as subsidized interest rates, deferral of principal and interest during planning, design and permitting phase, partial deferral of interest and principal for those portions of the project which are optimally sized for future needs. Additionally, grant funding is available for those service areas which qualify as rural or economically disadvantaged. More information on these financial assistance programs (i.e., the Water Infrastructure Fund, the State Participation Fund, and the Economically Disadvantaged Areas Program) can be found at the TWDB website at:

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Section 1: Project Financing Information

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- •WIF-Construction offers subsidized interest for all construction costs, including planning, acquisition, design, and construction.

- •State Participation funding offers partial interest and principal deferral for the incremental cost of project elements which are designed and built to serve needs beyond 10 years.

- •Rural areas funding offers grants and 0% interest loans for service areas which are not in a Metropolitan Statistical Area (MSA) and in which the population does not exceed 5,000. The service area must also meet the EDAP eligibility criteria.

- •Economically Distressed Areas Program (EDAP) offers funding through grants and loans for service areas within a project which meet the EDAP eligibility criteria. Eligibility for the TWDB's EDAP requires that the median household income of the area to be served by the proposed project be less than 75 percent of the Texas median household income ($39,927), as shown in the 2000 Census. EDAP eligibility also requires adoption of Model Subdivision rules by the appropriate planning entities.

- •State Participation funding offers partial interest and principal deferral for the incremental cost of project elements which are designed and built to serve needs beyond 10 years.

If you are interested in receiving funds from the above programs, please complete the remainder of the survey.

Infrastructure Financing Survey Report

- •State Participation funding offers partial interest and principal deferral for the incremental cost of project elements which are designed and built to serve needs beyond 10 years.

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•Planning, design, permitting: Enter costs into the 'Planning, design, permitting' category if you want to participate in the WIF-Deferred program. The WIF-Deferred program offers subsidized interest and deferral of principal and interest for up to 10 years for planning, design and permitting costs.

•Acquisition and construction: Enter costs into the 'Acquisition and construction' category if you want to participate in the WIF-Construction program. The WIF-Construction program offers subsidized interest for all construction costs, including planning, acquisition, design, and construction.

•Excess Capacity: Enter costs into the 'Excess capacity' category if you want to participate in the State Participation program. State Participating funding offers partial interest and principal deferral for the incremental cost of project elements which are designed and built to serve needs beyond 10 years.

•Rural: Enter costs into the 'Rural' category if you want to participate in the Rural areas funding program. Rural areas funding offers grants and 0% interest loans for service areas which are not in a Metropolitan Statistical Area (MSA) and in which the population does not exceed 5,000. The service area must also meet the EDAP eligibility criteria.

•Disadvantaged: Enter costs into the 'Disadvantaged' category if you want to participate in the Economically Distressed Areas Program (EDAP). EDAP offers funding through grants and loans for service areas within a project which meet the EDAP eligibility criteria. Eligibility for the TWDB's EDAP requires that the median household income of the area to be served by the proposed project be less than 75 percent of the Texas median household income ($39,927), as shown in the 2000 Census. EDAP eligibility also requires adoption of Model Subdivision rules by the appropriate planning entities.

194 - DRILL ADDITIONAL GROUNDWATER WELL **$7,997,200.00**

Planning, design, permitting	Cost:	1,599,440	Year:	2015
Acquisition and contruction	Cost:	6,397,760	Year:	2015
Excess Capacity	Cost:		Year:	

Infrastructure Financing Survey Report

Rural	Cost:		Year:	
Disadvantaged	Cost:		Year:	
	Total:			

Section 3: Contact Information

1. Name: Vince DiPiazza
2. Phone Number: 806-935-4101
3. Email: vdipiazza@ci.dumas.tx.us
4. Comments

Infrastructure Financing Survey Report

820: FRITCH

As part of the regional and state water planning process, regional water planning groups recommend water supply projects for each of their respective regions. The purpose of this survey is gather information from your organization regarding how you plan to finance water supply projects recommended for the 2012 state water plan, and determine whether you intend to use financial assistance programs offered by the State of Texas and administered by the Texas Water Development Board (TWDB).

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Section 1: Project Financing Information

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•State Participation funding offers partial interest and principal deferral for the incremental cost of project elements which are designed and built to serve needs beyond 10 years.

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Infrastructure Financing Survey Report

•State Participation funding offers partial interest and principal deferral for the incremental cost of project elements which are designed and built to serve needs beyond 10 years.

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Please enter only the amounts you wish to receive from TWDB program in the Project Costs fields and do not enter a specific project cost more than once.

Section 2: Projects

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•Excess Capacity: Enter costs into the 'Excess capacity' category if you want to participate in the State Participation program. State Participating funding offers partial interest and principal deferral for the incremental cost of project elements which are designed and built to serve needs beyond 10 years.

•Rural: Enter costs into the 'Rural' category if you want to participate in the Rural areas funding program. Rural areas funding offers grants and 0% interest loans for service areas which are not in a Metropolitan Statistical Area (MSA) and in which the population does not exceed 5,000. The service area must also meet the EDAP eligibility criteria.

•Disadvantaged: Enter costs into the 'Disadvantaged' category if you want to participate in the Economically Distressed Areas Program (EDAP). EDAP offers funding through grants and loans for service areas within a project which meet the EDAP eligibility criteria. Eligibility for the TWDB's EDAP requires that the median household income of the area to be served by the proposed project be less than 75 percent of the Texas median household income ($39,927), as shown in the 2000 Census. EDAP eligibility also requires adoption of Model Subdivision rules by the appropriate planning entities.

4006,900.00

194 - DRILL ADDITIONAL GROUNDWATER WELL ~~**$4,006,900.00**~~ ~~4,800,000.00~~

3,205,520

Planning, design, permitting	Cost:	~~$ [illegible]~~	Year:	2010
Acquisition and contruction	Cost:	801,380	Year:	2010
Excess Capacity	Cost:		Year:	

Infrastructure Financing Survey Report

Rural	Cost:		Year:	
Disadvantaged	Cost:		Year:	
	Total:			

Section 3: Contact Information

1. Name: Bobby Lamb
2. Phone Number: 806-857-3143
3. Email: blamb@fritchcityhall.com
4. Comments

Infrastructure Financing Survey Report

63: GREENBELT MUNICIPAL & INDUSTRIAL WATER AUTHORITY

As part of the regional and state water planning process, regional water planning groups recommend water supply projects for each of their respective regions. The purpose of this survey is gather information from your organization regarding how you plan to finance water supply projects recommended for the 2012 state water plan, and determine whether you intend to use financial assistance programs offered by the State of Texas and administered by the Texas Water Development Board (TWDB).

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Section 1: Project Financing Information

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•State Participation funding offers partial interest and principal deferral for the incremental cost of project elements which are designed and built to serve needs beyond 10 years.

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•State Participation funding offers partial interest and principal deferral for the incremental cost of project elements which are designed and built to serve needs beyond 10 years.

If you are interested in receiving funds from the above programs, please complete the remainder of the survey.

Infrastructure Financing Survey Report

- •State Participation funding offers partial interest and principal deferral for the incremental cost of project elements which are designed and built to serve needs beyond 10 years.

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Section 2: Projects

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•Acquisition and construction: Enter costs into the 'Acquisition and construction' category if you want to participate in the WIF-Construction program. The WIF-Construction program offers subsidized interest for all construction costs, including planning, acquisition, design, and construction.

•Excess Capacity: Enter costs into the 'Excess capacity' category if you want to participate in the State Participation program. State Participating funding offers partial interest and principal deferral for the incremental cost of project elements which are designed and built to serve needs beyond 10 years.

•Rural: Enter costs into the 'Rural' category if you want to participate in the Rural areas funding program. Rural areas funding offers grants and 0% interest loans for service areas which are not in a Metropolitan Statistical Area (MSA) and in which the population does not exceed 5,000. The service area must also meet the EDAP eligibility criteria.

•Disadvantaged: Enter costs into the 'Disadvantaged' category if you want to participate in the Economically Distressed Areas Program (EDAP). EDAP offers funding through grants and loans for service areas within a project which meet the EDAP eligibility criteria. Eligibility for the TWDB's EDAP requires that the median household income of the area to be served by the proposed project be less than 75 percent of the Texas median household income ($39,927), as shown in the 2000 Census. EDAP eligibility also requires adoption of Model Subdivision rules by the appropriate planning entities.

194 - DRILL ADDITIONAL GROUNDWATER WELL **$1,865,900.00**

Planning, design, permitting	Cost: 186,590	Year: 2012
Acquisition and contruction	Cost: 1,679,310	Year: 2012
Excess Capacity	Cost:	Year:

Infrastructure Financing Survey Report

Rural	Cost:		Year:
Disadvantaged	Cost:		Year:
	Total:		

Section 3: Contact Information

1. Name: Bobby Kid
2. Phone Number: 806-874-3650
3. Email: greenbelt wader@ valornet.com
4. Comments

5/26/2010 10:23:59 AM

Infrastructure Financing Survey Report

867: GRUVER

As part of the regional and state water planning process, regional water planning groups recommend water supply projects for each of their respective regions. The purpose of this survey is gather information from your organization regarding how you plan to finance water supply projects recommended for the 2012 state water plan, and determine whether you intend to use financial assistance programs offered by the State of Texas and administered by the Texas Water Development Board (TWDB).

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- State Participation funding offers partial interest and principal deferral for the incremental cost of project elements which are designed and built to serve needs beyond 10 years.

- Rural areas funding offers grants and 0% interest loans for service areas which are not in a Metropolitan Statistical Area (MSA) and in which the population does not exceed 5,000. The service area must also meet the EDAP eligibility criteria.

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If you are interested in receiving funds from the above programs, please complete the remainder of the survey.

Infrastructure Financing Survey Report

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•Excess Capacity: Enter costs into the 'Excess capacity' category if you want to participate in the State Participation program. State Participating funding offers partial interest and principal deferral for the incremental cost of project elements which are designed and built to serve needs beyond 10 years.

•Rural: Enter costs into the 'Rural' category if you want to participate in the Rural areas funding program. Rural areas funding offers grants and 0% interest loans for service areas which are not in a Metropolitan Statistical Area (MSA) and in which the population does not exceed 5,000. The service area must also meet the EDAP eligibility criteria.

•Disadvantaged: Enter costs into the 'Disadvantaged' category if you want to participate in the Economically Distressed Areas Program (EDAP). EDAP offers funding through grants and loans for service areas within a project which meet the EDAP eligibility criteria. Eligibility for the TWDB's EDAP requires that the median household income of the area to be served by the proposed project be less than 75 percent of the Texas median household income ($39,927), as shown in the 2000 Census. EDAP eligibility also requires adoption of Model Subdivision rules by the appropriate planning entities.

194 - DRILL ADDITIONAL GROUNDWATER WELL **$1,968,500.00**

Planning, design, permitting	Cost:	393700.00	Year:	2020
Acquisition and contruction	Cost:	1574800.00	Year:	2020
Excess Capacity	Cost:		Year:	

Infrastructure Financing Survey Report

Rural	Cost:		Year:
Disadvantaged	Cost:		Year:
	Total:		

Section 3: Contact Information

1. Name: Steve McKay
2. Phone Number: 806-733-2424
3. Email: ~~gruvercity1@yahoo.com~~ gruvercity1@yahoo.com
4. Comments

5/26/2010 10:23:59 AM

Infrastructure Financing Survey Report

1313: LEFORS

As part of the regional and state water planning process, regional water planning groups recommend water supply projects for each of their respective regions. The purpose of this survey is gather information from your organization regarding how you plan to finance water supply projects recommended for the 2012 state water plan, and determine whether you intend to use financial assistance programs offered by the State of Texas and administered by the Texas Water Development Board (TWDB).

The TWDB has several funding programs for water projects identified in the 2012 state water plan. Funds are targeted toward: 1) construction of water supply projects, 2) planning and design and permitting for projects that have long development time frames meaning that construction would require 5-10 years of planning, design and permitting, and 3) projects that would be built with excess capacity intended to meet future water needs. These programs offer various attractive financing options such as subsidized interest rates, deferral of principal and interest during planning, design and permitting phase, partial deferral of interest and principal for those portions of the project which are optimally sized for future needs. Additionally, grant funding is available for those service areas which qualify as rural or economically disadvantaged. More information on these financial assistance programs (i.e., the Water Infrastructure Fund, the State Participation Fund, and the Economically Disadvantaged Areas Program) can be found at the TWDB website at:

http://www.twdb.state.tx.us/assistance/financial/financial_main.asp

Your cooperation and responses to these questions are crucial in helping the state in ensuring that our communities and our citizens have adequate water supplies. If you have any questions related to the financial programs offered by the TWDB or about the survey questions, please contact Kyle Ingham by phone at (806)372-3381 or by email at kingham@theprpc.org. If you have any computer or technology related problems with the survey, please contact Wendy Barron by phone at (512) 936-0886 or by email at wendy.barron@twdb.state.tx.us.

Section 1: Project Financing Information

For project(s) identified in the State Water Plan, the TWDB has funding available for different aspects of a project. The different programs available are:

•WIF-Deferred offers subsidized interest and deferral of principal and interest for up to 10 years for planning, design and permitting costs.

•WIF-Construction offers subsidized interest for all construction costs, including planning, acquisition, design, and construction.

•State Participation funding offers partial interest and principal deferral for the incremental cost of project elements which are designed and built to serve needs beyond 10 years.

•Rural areas funding offers grants and 0% interest loans for service areas which are not in a Metropolitan Statistical Area (MSA) and in which the population does not exceed 5,000. The service area must also meet the EDAP eligibility criteria.

•Economically Distressed Areas Program (EDAP) offers funding through grants and loans for service areas within a project which meet the EDAP eligibility criteria. Eligibility for the TWDB's EDAP requires that the median household income of the area to be served by the proposed project be less than 75 percent of the Texas median household income ($39,927), as shown in the 2000 Census. EDAP eligibility also requires adoption of Model Subdivision rules by the appropriate planning entities.

•State Participation funding offers partial interest and principal deferral for the incremental cost of project elements which are designed and built to serve needs beyond 10 years.

If you are interested in receiving funds from the above programs, please complete the remainder of the survey.

Infrastructure Financing Survey Report

Please enter only the amounts you wish to receive from TWDB program in the Project Costs fields and do not enter a specific project cost more than once.

Section 2: Projects

For each of the project(s) listed below, please enter only the amounts you wish to receive from TWDB programs in the 'Cost' field and the earliest date you wish to receive these amounts. In addition, the total amount entered into all five categories cannot exceed the total cost of the project. Each of the five categories corresponds to a funding program available at the TWDB. Each of the funding programs and categories are described below.

- •Planning, design, permitting: Enter costs into the 'Planning, design, permitting' category if you want to participate in the WIF-Deferred program. The WIF-Deferred program offers subsidized interest and deferral of principal and interest for up to 10 years for planning, design and permitting costs.

- •Acquisition and construction: Enter costs into the 'Acquisition and construction' category if you want to participate in the WIF-Construction program. The WIF-Construction program offers subsidized interest for all construction costs, including planning, acquisition, design, and construction.

- •Excess Capacity: Enter costs into the 'Excess capacity' category if you want to participate in the State Participation program. State Participating funding offers partial interest and principal deferral for the incremental cost of project elements which are designed and built to serve needs beyond 10 years.

- •Rural: Enter costs into the 'Rural' category if you want to participate in the Rural areas funding program. Rural areas funding offers grants and 0% interest loans for service areas which are not in a Metropolitan Statistical Area (MSA) and in which the population does not exceed 5,000. The service area must also meet the EDAP eligibility criteria.

- •Disadvantaged: Enter costs into the 'Disadvantaged' category if you want to participate in the Economically Distressed Areas Program (EDAP). EDAP offers funding through grants and loans for service areas within a project which meet the EDAP eligibility criteria. Eligibility for the TWDB's EDAP requires that the median household income of the area to be served by the proposed project be less than 75 percent of the Texas median household income ($39,927), as shown in the 2000 Census. EDAP eligibility also requires adoption of Model Subdivision rules by the appropriate planning entities.

194 - DRILL ADDITIONAL GROUNDWATER WELL **$1,132,500.00**

Planning, design, permitting	Cost: 113,250	Year: 5
Acquisition and contruction	Cost: 1019,250	Year: 5
Excess Capacity	Cost:	Year:
Rural	Cost:	Year:
Disadvantaged	Cost:	Year:
	Total: 1,132,500	

Infrastructure Financing Survey Report

Section 3: Contact Information

1. Name: Lindy Forsyth
2. Phone Number: 806-835-2200
3. Email: Cityofleforsesbcglobal.net
4. Comments

Infrastructure Financing Survey Report

1825: MEMPHIS

As part of the regional and state water planning process, regional water planning groups recommend water supply projects for each of their respective regions. The purpose of this survey is gather information from your organization regarding how you plan to finance water supply projects recommended for the 2012 state water plan, and determine whether you intend to use financial assistance programs offered by the State of Texas and administered by the Texas Water Development Board (TWDB).

The TWDB has several funding programs for water projects identified in the 2012 state water plan. Funds are targeted toward: 1) construction of water supply projects, 2) planning and design and permitting for projects that have long development time frames meaning that construction would require 5-10 years of planning, design and permitting, and 3) projects that would be built with excess capacity intended to meet future water needs. These programs offer various attractive financing options such as subsidized interest rates, deferral of principal and interest during planning, design and permitting phase, partial deferral of interest and principal for those portions of the project which are optimally sized for future needs. Additionally, grant funding is available for those service areas which qualify as rural or economically disadvantaged. More information on these financial assistance programs (i.e., the Water Infrastructure Fund, the State Participation Fund, and the Economically Disadvantaged Areas Program) can be found at the TWDB website at:

http://www.twdb.state.tx.us/assistance/financial/financial_main.asp

Your cooperation and responses to these questions are crucial in helping the state in ensuring that our communities and our citizens have adequate water supplies. If you have any questions related to the financial programs offered by the TWDB or about the survey questions, please contact Kyle Ingham by phone at (806)372-3381 or by email at kingham@theprpc.org. If you have any computer or technology related problems with the survey, please contact Wendy Barron by phone at (512) 936-0886 or by email at wendy.barron@twdb.state.tx.us.

Section 1: Project Financing Information

For project(s) identified in the State Water Plan, the TWDB has funding available for different aspects of a project. The different programs available are:

- •WIF-Deferred offers subsidized interest and deferral of principal and interest for up to 10 years for planning, design and permitting costs.

- •WIF-Construction offers subsidized interest for all construction costs, including planning, acquisition, design, and construction.

- •State Participation funding offers partial interest and principal deferral for the incremental cost of project elements which are designed and built to serve needs beyond 10 years.

- •Rural areas funding offers grants and 0% interest loans for service areas which are not in a Metropolitan Statistical Area (MSA) and in which the population does not exceed 5,000. The service area must also meet the EDAP eligibility criteria.

- •Economically Distressed Areas Program (EDAP) offers funding through grants and loans for service areas within a project which meet the EDAP eligibility criteria. Eligibility for the TWDB's EDAP requires that the median household income of the area to be served by the proposed project be less than 75 percent of the Texas median household income ($39,927), as shown in the 2000 Census. EDAP eligibility also requires adoption of Model Subdivision rules by the appropriate planning entities.

Infrastructure Financing Survey Report

•State Participation funding offers partial interest and principal deferral for the incremental cost of project elements which are designed and built to serve needs beyond 10 years.

If you are interested in receiving funds from the above programs, please complete the remainder of the survey.

Please enter only the amounts you wish to receive from TWDB program in the Project Costs fields and do not enter a specific project cost more than once.

Section 2: Projects

For each of the project(s) listed below, please enter only the amounts you wish to receive from TWDB programs in the 'Cost' field and the earliest date you wish to receive these amounts. In addition, the total amount entered into all five categories cannot exceed the total cost of the project. Each of the five categories corresponds to a funding program available at the TWDB. Each of the funding programs and categories are described below.

•Planning, design, permitting: Enter costs into the 'Planning, design, permitting' category if you want to participate in the WIF-Deferred program. The WIF-Deferred program offers subsidized interest and deferral of principal and interest for up to 10 years for planning, design and permitting costs.

•Acquisition and construction: Enter costs into the 'Acquisition and construction' category if you want to participate in the WIF-Construction program. The WIF-Construction program offers subsidized interest for all construction costs, including planning, acquisition, design, and construction.

•Excess Capacity: Enter costs into the 'Excess capacity' category if you want to participate in the State Participation program. State Participating funding offers partial interest and principal deferral for the incremental cost of project elements which are designed and built to serve needs beyond 10 years.

•Rural: Enter costs into the 'Rural' category if you want to participate in the Rural areas funding program. Rural areas funding offers grants and 0% interest loans for service areas which are not in a Metropolitan Statistical Area (MSA) and in which the population does not exceed 5,000. The service area must also meet the EDAP eligibility criteria.

•Disadvantaged: Enter costs into the 'Disadvantaged' category if you want to participate in the Economically Distressed Areas Program (EDAP). EDAP offers funding through grants and loans for service areas within a project which meet the EDAP eligibility criteria. Eligibility for the TWDB's EDAP requires that the median household income of the area to be served by the proposed project be less than 75 percent of the Texas median household income ($39,927), as shown in the 2000 Census. EDAP eligibility also requires adoption of Model Subdivision rules by the appropriate planning entities.

194 - DRILL ADDITIONAL GROUNDWATER WELL **$1,042,100.00**

Planning, design, permitting	Cost: 208,420.000	Year: ~~2015~~ 2013
Acquisition and contruction	Cost: 833,680.00	Year: ~~2015~~ 2013
Excess Capacity	Cost:	Year:

Infrastructure Financing Survey Report

Rural	Cost:		Year:
Disadvantaged	Cost:		Year:
	Total:		

Section 3: Contact Information

1.	Name:	Kirby Gardenhire
2.	Phone Number:	940-537-1279
3.	Email:	pwdmemphistx@~~amo~~amaonline.com
4.	Comments	

Infrastructure Financing Survey Report

112: PALO DURO RIVER AUTHORITY

As part of the regional and state water planning process, regional water planning groups recommend water supply projects for each of their respective regions. The purpose of this survey is gather information from your organization regarding how you plan to finance water supply projects recommended for the 2012 state water plan, and determine whether you intend to use financial assistance programs offered by the State of Texas and administered by the Texas Water Development Board (TWDB).

The TWDB has several funding programs for water projects identified in the 2012 state water plan. Funds are targeted toward: 1) construction of water supply projects, 2) planning and design and permitting for projects that have long development time frames meaning that construction would require 5-10 years of planning, design and permitting, and 3) projects that would be built with excess capacity intended to meet future water needs. These programs offer various attractive financing options such as subsidized interest rates, deferral of principal and interest during planning, design and permitting phase, partial deferral of interest and principal for those portions of the project which are optimally sized for future needs. Additionally, grant funding is available for those service areas which qualify as rural or economically disadvantaged. More information on these financial assistance programs (i.e., the Water Infrastructure Fund, the State Participation Fund, and the Economically Disadvantaged Areas Program) can be found at the TWDB website at:

http://www.twdb.state.tx.us/assistance/financial/financial_main.asp

Your cooperation and responses to these questions are crucial in helping the state in ensuring that our communities and our citizens have adequate water supplies. If you have any questions related to the financial programs offered by the TWDB or about the survey questions, please contact Kyle Ingham by phone at (806)372-3381 or by email at kingham@theprpc.org. If you have any computer or technology related problems with the survey, please contact Wendy Barron by phone at (512) 936-0886 or by email at wendy.barron@twdb.state.tx.us.

Section 1: Project Financing Information

For project(s) identified in the State Water Plan, the TWDB has funding available for different aspects of a project. The different programs available are:

- WIF-Deferred offers subsidized interest and deferral of principal and interest for up to 10 years for planning, design and permitting costs.

- WIF-Construction offers subsidized interest for all construction costs, including planning, acquisition, design, and construction.

- State Participation funding offers partial interest and principal deferral for the incremental cost of project elements which are designed and built to serve needs beyond 10 years.

- Rural areas funding offers grants and 0% interest loans for service areas which are not in a Metropolitan Statistical Area (MSA) and in which the population does not exceed 5,000. The service area must also meet the EDAP eligibility criteria.

- Economically Distressed Areas Program (EDAP) offers funding through grants and loans for service areas within a project which meet the EDAP eligibility criteria. Eligibility for the TWDB's EDAP requires that the median household income of the area to be served by the proposed project be less than 75 percent of the Texas median household income ($39,927), as shown in the 2000 Census. EDAP eligibility also requires adoption of Model Subdivision rules by the appropriate planning entities.

- State Participation funding offers partial interest and principal deferral for the incremental cost of project elements which are designed and built to serve needs beyond 10 years.

If you are interested in receiving funds from the above programs, please complete the remainder of the survey.

Infrastructure Financing Survey Report

Please enter only the amounts you wish to receive from TWDB program in the Project Costs fields and do not enter a specific project cost more than once.

Section 2: Projects

For each of the project(s) listed below, please enter only the amounts you wish to receive from TWDB programs in the 'Cost' field and the earliest date you wish to receive these amounts. In addition, the total amount entered into all five categories cannot exceed the total cost of the project. Each of the five categories corresponds to a funding program available at the TWDB. Each of the funding programs and categories are described below.

•Planning, design, permitting: Enter costs into the 'Planning, design, permitting' category if you want to participate in the WIF-Deferred program. The WIF-Deferred program offers subsidized interest and deferral of principal and interest for up to 10 years for planning, design and permitting costs.

•Acquisition and construction: Enter costs into the 'Acquisition and construction' category if you want to participate in the WIF-Construction program. The WIF-Construction program offers subsidized interest for all construction costs, including planning, acquisition, design, and construction.

•Excess Capacity: Enter costs into the 'Excess capacity' category if you want to participate in the State Participation program. State Participating funding offers partial interest and principal deferral for the incremental cost of project elements which are designed and built to serve needs beyond 10 years.

•Rural: Enter costs into the 'Rural' category if you want to participate in the Rural areas funding program. Rural areas funding offers grants and 0% interest loans for service areas which are not in a Metropolitan Statistical Area (MSA) and in which the population does not exceed 5,000. The service area must also meet the EDAP eligibility criteria.

•Disadvantaged: Enter costs into the 'Disadvantaged' category if you want to participate in the Economically Distressed Areas Program (EDAP). EDAP offers funding through grants and loans for service areas within a project which meet the EDAP eligibility criteria. Eligibility for the TWDB's EDAP requires that the median household income of the area to be served by the proposed project be less than 75 percent of the Texas median household income ($39,927), as shown in the 2000 Census. EDAP eligibility also requires adoption of Model Subdivision rules by the appropriate planning entities.

195 - PALO DURO RESERVOIR **$114,730,000.00**

Water Treatment and Transmission System

Planning, design, permitting	Cost:	22,946,000.00	Year:	2030
Acquisition and contruction	Cost:	91,784,000.00	Year:	2030
Excess Capacity	Cost:		Year:	
Rural	Cost:		Year:	
Disadvantaged	Cost:		Year:	
	Total:			

Infrastructure Financing Survey Report

Section 3: Contact Information

1. Name: James Derington
2. Phone Number: 806-882-4401
3. Email: pdra@dishmail.net
4. Comments: Lake is at record low today (1%)

This seems premature, but to keep our project in mind, I am sending this in.

3/11/2010 3:16:20 PM

Infrastructure Financing Survey Report

2175: PAMPA

As part of the regional and state water planning process, regional water planning groups recommend water supply projects for each of their respective regions. The purpose of this survey is gather information from your organization regarding how you plan to finance water supply projects recommended for the 2012 state water plan, and determine whether you intend to use financial assistance programs offered by the State of Texas and administered by the Texas Water Development Board (TWDB).

The TWDB has several funding programs for water projects identified in the 2012 state water plan. Funds are targeted toward: 1) construction of water supply projects, 2) planning and design and permitting for projects that have long development time frames meaning that construction would require 5-10 years of planning, design and permitting, and 3) projects that would be built with excess capacity intended to meet future water needs. These programs offer various attractive financing options such as subsidized interest rates, deferral of principal and interest during planning, design and permitting phase, partial deferral of interest and principal for those portions of the project which are optimally sized for future needs. Additionally, grant funding is available for those service areas which qualify as rural or economically disadvantaged. More information on these financial assistance programs (i.e., the Water Infrastructure Fund, the State Participation Fund, and the Economically Disadvantaged Areas Program) can be found at the TWDB website at:

http://www.twdb.state.tx.us/assistance/financial/financial_main.asp

Your cooperation and responses to these questions are crucial in helping the state in ensuring that our communities and our citizens have adequate water supplies. If you have any questions related to the financial programs offered by the TWDB or about the survey questions, please contact Kyle Ingham by phone at (806)372-3381 or by email at kingham@theprpc.org. If you have any computer or technology related problems with the survey, please contact Wendy Barron by phone at (512) 936-0886 or by email at wendy.barron@twdb.state.tx.us.

Section 1: Project Financing Information

For project(s) identified in the State Water Plan, the TWDB has funding available for different aspects of a project. The different programs available are:

•WIF-Deferred offers subsidized interest and deferral of principal and interest for up to 10 years for planning, design and permitting costs.

•WIF-Construction offers subsidized interest for all construction costs, including planning, acquisition, design, and construction.

•State Participation funding offers partial interest and principal deferral for the incremental cost of project elements which are designed and built to serve needs beyond 10 years.

•Rural areas funding offers grants and 0% interest loans for service areas which are not in a Metropolitan Statistical Area (MSA) and in which the population does not exceed 5,000. The service area must also meet the EDAP eligibility criteria.

•Economically Distressed Areas Program (EDAP) offers funding through grants and loans for service areas within a project which meet the EDAP eligibility criteria. Eligibility for the TWDB's EDAP requires that the median household income of the area to be served by the proposed project be less than 75 percent of the Texas median household income ($39,927), as shown in the 2000 Census. EDAP eligibility also requires adoption of Model Subdivision rules by the appropriate planning entities.

Infrastructure Financing Survey Report

•State Participation funding offers partial interest and principal deferral for the incremental cost of project elements which are designed and built to serve needs beyond 10 years.

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Section 2: Projects

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•Planning, design, permitting: Enter costs into the 'Planning, design, permitting' category if you want to participate in the WIF-Deferred program. The WIF-Deferred program offers subsidized interest and deferral of principal and interest for up to 10 years for planning, design and permitting costs.

•Acquisition and construction: Enter costs into the 'Acquisition and construction' category if you want to participate in the WIF-Construction program. The WIF-Construction program offers subsidized interest for all construction costs, including planning, acquisition, design, and construction.

•Excess Capacity: Enter costs into the 'Excess capacity' category if you want to participate in the State Participation program. State Participating funding offers partial interest and principal deferral for the incremental cost of project elements which are designed and built to serve needs beyond 10 years.

•Rural: Enter costs into the 'Rural' category if you want to participate in the Rural areas funding program. Rural areas funding offers grants and 0% interest loans for service areas which are not in a Metropolitan Statistical Area (MSA) and in which the population does not exceed 5,000. The service area must also meet the EDAP eligibility criteria.

•Disadvantaged: Enter costs into the 'Disadvantaged' category if you want to participate in the Economically Distressed Areas Program (EDAP). EDAP offers funding through grants and loans for service areas within a project which meet the EDAP eligibility criteria. Eligibility for the TWDB's EDAP requires that the median household income of the area to be served by the proposed project be less than 75 percent of the Texas median household income ($39,927), as shown in the 2000 Census. EDAP eligibility also requires adoption of Model Subdivision rules by the appropriate planning entities.

194 - DRILL ADDITIONAL GROUNDWATER WELL **$1,731,100.00**

Planning, design, permitting	Cost:	346220	Year:	2012
Acquisition and contruction	Cost:	1384880	Year:	2012
Excess Capacity	Cost:		Year:	

Infrastructure Financing Survey Report

Rural	Cost:		Year:
Disadvantaged	Cost:		Year:
	Total:		

Section 3: Contact Information

1. Name: Donny Hooper
2. Phone Number: 806-669-5750
3. Email: dhooper@cityofpampa.org
4. Comments

Infrastructure Financing Survey Report

2176: PANHANDLE

As part of the regional and state water planning process, regional water planning groups recommend water supply projects for each of their respective regions. The purpose of this survey is gather information from your organization regarding how you plan to finance water supply projects recommended for the 2012 state water plan, and determine whether you intend to use financial assistance programs offered by the State of Texas and administered by the Texas Water Development Board (TWDB).

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Section 1: Project Financing Information

For project(s) identified in the State Water Plan, the TWDB has funding available for different aspects of a project. The different programs available are:

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•State Participation funding offers partial interest and principal deferral for the incremental cost of project elements which are designed and built to serve needs beyond 10 years.

•Rural areas funding offers grants and 0% interest loans for service areas which are not in a Metropolitan Statistical Area (MSA) and in which the population does not exceed 5,000. The service area must also meet the EDAP eligibility criteria.

•Economically Distressed Areas Program (EDAP) offers funding through grants and loans for service areas within a project which meet the EDAP eligibility criteria. Eligibility for the TWDB's EDAP requires that the median household income of the area to be served by the proposed project be less than 75 percent of the Texas median household income ($39,927), as shown in the 2000 Census. EDAP eligibility also requires adoption of Model Subdivision rules by the appropriate planning entities.

•State Participation funding offers partial interest and principal deferral for the incremental cost of project elements which are designed and built to serve needs beyond 10 years.

If you are interested in receiving funds from the above programs, please complete the remainder of the survey.

Infrastructure Financing Survey Report

- State Participation funding offers partial interest and principal deferral for the incremental cost of project elements which are designed and built to serve needs beyond 10 years.

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Please enter only the amounts you wish to receive from TWDB program in the Project Costs fields and do not enter a specific project cost more than once.

Section 2: Projects

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- Planning, design, permitting: Enter costs into the 'Planning, design, permitting' category if you want to participate in the WIF-Deferred program. The WIF-Deferred program offers subsidized interest and deferral of principal and interest for up to 10 years for planning, design and permitting costs.

- Acquisition and construction: Enter costs into the 'Acquisition and construction' category if you want to participate in the WIF-Construction program. The WIF-Construction program offers subsidized interest for all construction costs, including planning, acquisition, design, and construction.

- Excess Capacity: Enter costs into the 'Excess capacity' category if you want to participate in the State Participation program. State Participating funding offers partial interest and principal deferral for the incremental cost of project elements which are designed and built to serve needs beyond 10 years.

- Rural: Enter costs into the 'Rural' category if you want to participate in the Rural areas funding program. Rural areas funding offers grants and 0% interest loans for service areas which are not in a Metropolitan Statistical Area (MSA) and in which the population does not exceed 5,000. The service area must also meet the EDAP eligibility criteria.

- Disadvantaged: Enter costs into the 'Disadvantaged' category if you want to participate in the Economically Distressed Areas Program (EDAP). EDAP offers funding through grants and loans for service areas within a project which meet the EDAP eligibility criteria. Eligibility for the TWDB's EDAP requires that the median household income of the area to be served by the proposed project be less than 75 percent of the Texas median household income ($39,927), as shown in the 2000 Census. EDAP eligibility also requires adoption of Model Subdivision rules by the appropriate planning entities.

194 - DRILL ADDITIONAL GROUNDWATER WELL **$3,309,300.00**

Planning, design, permitting	Cost:	661,860	Year:	2020
Acquisition and contruction	Cost:	2,647,440	Year:	2020
Excess Capacity	Cost:		Year:	

Infrastructure Financing Survey Report

Rural	Cost:		Year:
Disadvantaged	Cost:		Year:
	Total:		

Section 3: Contact Information

1. Name: Rob Roach
2. Phone Number: 806-537-3517
3. Email: manager@cableone.net
4. Comments

Infrastructure Financing Survey Report

2193: PERRYTON

As part of the regional and state water planning process, regional water planning groups recommend water supply projects for each of their respective regions. The purpose of this survey is gather information from your organization regarding how you plan to finance water supply projects recommended for the 2012 state water plan, and determine whether you intend to use financial assistance programs offered by the State of Texas and administered by the Texas Water Development Board (TWDB).

The TWDB has several funding programs for water projects identified in the 2012 state water plan. Funds are targeted toward: 1) construction of water supply projects, 2) planning and design and permitting for projects that have long development time frames meaning that construction would require 5-10 years of planning, design and permitting, and 3) projects that would be built with excess capacity intended to meet future water needs. These programs offer various attractive financing options such as subsidized interest rates, deferral of principal and interest during planning, design and permitting phase, partial deferral of interest and principal for those portions of the project which are optimally sized for future needs. Additionally, grant funding is available for those service areas which qualify as rural or economically disadvantaged. More information on these financial assistance programs (i.e., the Water Infrastructure Fund, the State Participation Fund, and the Economically Disadvantaged Areas Program) can be found at the TWDB website at:

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Your cooperation and responses to these questions are crucial in helping the state in ensuring that our communities and our citizens have adequate water supplies. If you have any questions related to the financial programs offered by the TWDB or about the survey questions, please contact Kyle Ingham by phone at (806)372-3381 or by email at kingham@theprpc.org. If you have any computer or technology related problems with the survey, please contact Wendy Barron by phone at (512) 936-0886 or by email at wendy.barron@twdb.state.tx.us.

Section 1: Project Financing Information

For project(s) identified in the State Water Plan, the TWDB has funding available for different aspects of a project. The different programs available are:

•WIF-Deferred offers subsidized interest and deferral of principal and interest for up to 10 years for planning, design and permitting costs.

•WIF-Construction offers subsidized interest for all construction costs, including planning, acquisition, design, and construction.

•State Participation funding offers partial interest and principal deferral for the incremental cost of project elements which are designed and built to serve needs beyond 10 years.

•Rural areas funding offers grants and 0% interest loans for service areas which are not in a Metropolitan Statistical Area (MSA) and in which the population does not exceed 5,000. The service area must also meet the EDAP eligibility criteria.

•Economically Distressed Areas Program (EDAP) offers funding through grants and loans for service areas within a project which meet the EDAP eligibility criteria. Eligibility for the TWDB's EDAP requires that the median household income of the area to be served by the proposed project be less than 75 percent of the Texas median household income ($39,927), as shown in the 2000 Census. EDAP eligibility also requires adoption of Model Subdivision rules by the appropriate planning entities.

•State Participation funding offers partial interest and principal deferral for the incremental cost of project elements which are designed and built to serve needs beyond 10 years.

If you are interested in receiving funds from the above programs, please complete the remainder of the survey.

Infrastructure Financing Survey Report

- State Participation funding offers partial interest and principal deferral for the incremental cost of project elements which are designed and built to serve needs beyond 10 years.

If you are interested in receiving funds from the above programs, please complete the remainder of the survey.

Please enter only the amounts you wish to receive from TWDB program in the Project Costs fields and do not enter a specific project cost more than once.

Section 2: Projects

For each of the project(s) listed below, please enter only the amounts you wish to receive from TWDB programs in the 'Cost' field and the earliest date you wish to receive these amounts. In addition, the total amount entered into all five categories cannot exceed the total cost of the project. Each of the five categories corresponds to a funding program available at the TWDB. Each of the funding programs and categories are described below.

- Planning, design, permitting: Enter costs into the 'Planning, design, permitting' category if you want to participate in the WIF-Deferred program. The WIF-Deferred program offers subsidized interest and deferral of principal and interest for up to 10 years for planning, design and permitting costs.

- Acquisition and construction: Enter costs into the 'Acquisition and construction' category if you want to participate in the WIF-Construction program. The WIF-Construction program offers subsidized interest for all construction costs, including planning, acquisition, design, and construction.

- Excess Capacity: Enter costs into the 'Excess capacity' category if you want to participate in the State Participation program. State Participating funding offers partial interest and principal deferral for the incremental cost of project elements which are designed and built to serve needs beyond 10 years.

- Rural: Enter costs into the 'Rural' category if you want to participate in the Rural areas funding program. Rural areas funding offers grants and 0% interest loans for service areas which are not in a Metropolitan Statistical Area (MSA) and in which the population does not exceed 5,000. The service area must also meet the EDAP eligibility criteria.

- Disadvantaged: Enter costs into the 'Disadvantaged' category if you want to participate in the Economically Distressed Areas Program (EDAP). EDAP offers funding through grants and loans for service areas within a project which meet the EDAP eligibility criteria. Eligibility for the TWDB's EDAP requires that the median household income of the area to be served by the proposed project be less than 75 percent of the Texas median household income ($39,927), as shown in the 2000 Census. EDAP eligibility also requires adoption of Model Subdivision rules by the appropriate planning entities.

194 - DRILL ADDITIONAL GROUNDWATER WELL **$7,087,000.00**

Planning, design, permitting	Cost:	1,417,400.00	Year:	2012
Acquisition and contruction	Cost:	5,669,600.00	Year:	2012
Excess Capacity	Cost:		Year:	

Infrastructure Financing Survey Report

Rural	Cost:		Year:	
Disadvantaged	Cost:		Year:	
	Total:			

Section 3: Contact Information

1. Name: Jim Powell
2. Phone Number: 806-435-4014
3. Email: Jpowell@perryton.net
4. Comments

Infrastructure Financing Survey Report

2389: SPEARMAN

As part of the regional and state water planning process, regional water planning groups recommend water supply projects for each of their respective regions. The purpose of this survey is gather information from your organization regarding how you plan to finance water supply projects recommended for the 2012 state water plan, and determine whether you intend to use financial assistance programs offered by the State of Texas and administered by the Texas Water Development Board (TWDB).

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Section 1: Project Financing Information

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•WIF-Construction offers subsidized interest for all construction costs, including planning, acquisition, design, and construction.

•State Participation funding offers partial interest and principal deferral for the incremental cost of project elements which are designed and built to serve needs beyond 10 years.

•Rural areas funding offers grants and 0% interest loans for service areas which are not in a Metropolitan Statistical Area (MSA) and in which the population does not exceed 5,000. The service area must also meet the EDAP eligibility criteria.

•Economically Distressed Areas Program (EDAP) offers funding through grants and loans for service areas within a project which meet the EDAP eligibility criteria. Eligibility for the TWDB's EDAP requires that the median household income of the area to be served by the proposed project be less than 75 percent of the Texas median household income ($39,927), as shown in the 2000 Census. EDAP eligibility also requires adoption of Model Subdivision rules by the appropriate planning entities.

•State Participation funding offers partial interest and principal deferral for the incremental cost of project elements which are designed and built to serve needs beyond 10 years.

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Infrastructure Financing Survey Report

- State Participation funding offers partial interest and principal deferral for the incremental cost of project elements which are designed and built to serve needs beyond 10 years.

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Please enter only the amounts you wish to receive from TWDB program in the Project Costs fields and do not enter a specific project cost more than once.

Section 2: Projects

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- Planning, design, permitting: Enter costs into the 'Planning, design, permitting' category if you want to participate in the WIF-Deferred program. The WIF-Deferred program offers subsidized interest and deferral of principal and interest for up to 10 years for planning, design and permitting costs.

- Acquisition and construction: Enter costs into the 'Acquisition and construction' category if you want to participate in the WIF-Construction program. The WIF-Construction program offers subsidized interest for all construction costs, including planning, acquisition, design, and construction.

- Excess Capacity: Enter costs into the 'Excess capacity' category if you want to participate in the State Participation program. State Participating funding offers partial interest and principal deferral for the incremental cost of project elements which are designed and built to serve needs beyond 10 years.

- Rural: Enter costs into the 'Rural' category if you want to participate in the Rural areas funding program. Rural areas funding offers grants and 0% interest loans for service areas which are not in a Metropolitan Statistical Area (MSA) and in which the population does not exceed 5,000. The service area must also meet the EDAP eligibility criteria.

- Disadvantaged: Enter costs into the 'Disadvantaged' category if you want to participate in the Economically Distressed Areas Program (EDAP). EDAP offers funding through grants and loans for service areas within a project which meet the EDAP eligibility criteria. Eligibility for the TWDB's EDAP requires that the median household income of the area to be served by the proposed project be less than 75 percent of the Texas median household income ($39,927), as shown in the 2000 Census. EDAP eligibility also requires adoption of Model Subdivision rules by the appropriate planning entities.

194 - DRILL ADDITIONAL GROUNDWATER WELL **$3,862,000.00**

Planning, design, permitting	Cost:	772,400	Year:	2020
Acquisition and contruction	Cost:	3,089,600	Year:	2020
Excess Capacity	Cost:		Year:	

Infrastructure Financing Survey Report

Rural	Cost:		Year:
Disadvantaged	Cost:		Year:
	Total:		

Section 3: Contact Information

1. Name: Ed Hansen
2. Phone Number: 806-659-2524
3. Email: cm@antden.com
4. Comments

5/26/2010 10:24:00 AM

Infrastructure Financing Survey Report

2499: SUNRAY

As part of the regional and state water planning process, regional water planning groups recommend water supply projects for each of their respective regions. The purpose of this survey is gather information from your organization regarding how you plan to finance water supply projects recommended for the 2012 state water plan, and determine whether you intend to use financial assistance programs offered by the State of Texas and administered by the Texas Water Development Board (TWDB).

The TWDB has several funding programs for water projects identified in the 2012 state water plan. Funds are targeted toward: 1) construction of water supply projects, 2) planning and design and permitting for projects that have long development time frames meaning that construction would require 5-10 years of planning, design and permitting, and 3) projects that would be built with excess capacity intended to meet future water needs. These programs offer various attractive financing options such as subsidized interest rates, deferral of principal and interest during planning, design and permitting phase, partial deferral of interest and principal for those portions of the project which are optimally sized for future needs. Additionally, grant funding is available for those service areas which qualify as rural or economically disadvantaged. More information on these financial assistance programs (i.e., the Water Infrastructure Fund, the State Participation Fund, and the Economically Disadvantaged Areas Program) can be found at the TWDB website at:

http://www.twdb.state.tx.us/assistance/financial/financial_main.asp

Your cooperation and responses to these questions are crucial in helping the state in ensuring that our communities and our citizens have adequate water supplies. If you have any questions related to the financial programs offered by the TWDB or about the survey questions, please contact Kyle Ingham by phone at (806)372-3381 or by email at kingham@theprpc.org. If you have any computer or technology related problems with the survey, please contact Wendy Barron by phone at (512) 936-0886 or by email at wendy.barron@twdb.state.tx.us.

Section 1: Project Financing Information

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•WIF-Construction offers subsidized interest for all construction costs, including planning, acquisition, design, and construction.

•State Participation funding offers partial interest and principal deferral for the incremental cost of project elements which are designed and built to serve needs beyond 10 years.

•Rural areas funding offers grants and 0% interest loans for service areas which are not in a Metropolitan Statistical Area (MSA) and in which the population does not exceed 5,000. The service area must also meet the EDAP eligibility criteria.

•Economically Distressed Areas Program (EDAP) offers funding through grants and loans for service areas within a project which meet the EDAP eligibility criteria. Eligibility for the TWDB's EDAP requires that the median household income of the area to be served by the proposed project be less than 75 percent of the Texas median household income ($39,927), as shown in the 2000 Census. EDAP eligibility also requires adoption of Model Subdivision rules by the appropriate planning entities.

•State Participation funding offers partial interest and principal deferral for the incremental cost of project elements which are designed and built to serve needs beyond 10 years.

If you are interested in receiving funds from the above programs, please complete the remainder of the survey.

Infrastructure Financing Survey Report

•State Participation funding offers partial interest and principal deferral for the incremental cost of project elements which are designed and built to serve needs beyond 10 years.

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•Planning, design, permitting: Enter costs into the 'Planning, design, permitting' category if you want to participate in the WIF-Deferred program. The WIF-Deferred program offers subsidized interest and deferral of principal and interest for up to 10 years for planning, design and permitting costs.

•Acquisition and construction: Enter costs into the 'Acquisition and construction' category if you want to participate in the WIF-Construction program. The WIF-Construction program offers subsidized interest for all construction costs, including planning, acquisition, design, and construction.

•Excess Capacity: Enter costs into the 'Excess capacity' category if you want to participate in the State Participation program. State Participating funding offers partial interest and principal deferral for the incremental cost of project elements which are designed and built to serve needs beyond 10 years.

•Rural: Enter costs into the 'Rural' category if you want to participate in the Rural areas funding program. Rural areas funding offers grants and 0% interest loans for service areas which are not in a Metropolitan Statistical Area (MSA) and in which the population does not exceed 5,000. The service area must also meet the EDAP eligibility criteria.

•Disadvantaged: Enter costs into the 'Disadvantaged' category if you want to participate in the Economically Distressed Areas Program (EDAP). EDAP offers funding through grants and loans for service areas within a project which meet the EDAP eligibility criteria. Eligibility for the TWDB's EDAP requires that the median household income of the area to be served by the proposed project be less than 75 percent of the Texas median household income ($39,927), as shown in the 2000 Census. EDAP eligibility also requires adoption of Model Subdivision rules by the appropriate planning entities.

194 - DRILL ADDITIONAL GROUNDWATER WELL/ Ground storage & Booster station **$3,121,300.00**

Planning, design, permitting	Cost: 624,260	Year: 2015
Acquisition and contruction	Cost: 2,497,040	Year: 2015
Excess Capacity	Cost:	Year:

Infrastructure Financing Survey Report

Rural	Cost:		Year:	
Disadvantaged	Cost:		Year:	
	Total:			

Section 3: Contact Information

1. Name: Greg Smith
2. Phone Number: 806-948-4111
3. Email: greg.smith@cityofsurray.com
4. Comments

5/26/2010 10:24:00 AM

Infrastructure Financing Survey Report

2517: TEXLINE

As part of the regional and state water planning process, regional water planning groups recommend water supply projects for each of their respective regions. The purpose of this survey is gather information from your organization regarding how you plan to finance water supply projects recommended for the 2012 state water plan, and determine whether you intend to use financial assistance programs offered by the State of Texas and administered by the Texas Water Development Board (TWDB).

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Section 1: Project Financing Information

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Infrastructure Financing Survey Report

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Section 2: Projects

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•Planning, design, permitting: Enter costs into the 'Planning, design, permitting' category if you want to participate in the WIF-Deferred program. The WIF-Deferred program offers subsidized interest and deferral of principal and interest for up to 10 years for planning, design and permitting costs.

•Acquisition and construction: Enter costs into the 'Acquisition and construction' category if you want to participate in the WIF-Construction program. The WIF-Construction program offers subsidized interest for all construction costs, including planning, acquisition, design, and construction.

•Excess Capacity: Enter costs into the 'Excess capacity' category if you want to participate in the State Participation program. State Participating funding offers partial interest and principal deferral for the incremental cost of project elements which are designed and built to serve needs beyond 10 years.

•Rural: Enter costs into the 'Rural' category if you want to participate in the Rural areas funding program. Rural areas funding offers grants and 0% interest loans for service areas which are not in a Metropolitan Statistical Area (MSA) and in which the population does not exceed 5,000. The service area must also meet the EDAP eligibility criteria.

•Disadvantaged: Enter costs into the 'Disadvantaged' category if you want to participate in the Economically Distressed Areas Program (EDAP). EDAP offers funding through grants and loans for service areas within a project which meet the EDAP eligibility criteria. Eligibility for the TWDB's EDAP requires that the median household income of the area to be served by the proposed project be less than 75 percent of the Texas median household income ($39,927), as shown in the 2000 Census. EDAP eligibility also requires adoption of Model Subdivision rules by the appropriate planning entities.

194 - DRILL ADDITIONAL GROUNDWATER WELL **$2,304,000.00**

Planning, design, permitting	Cost: $ 175,000.00	Year:	2018/2050
Acquisition and contruction	Cost: $ 954,000.00	Year:	2020/2055
Excess Capacity	Cost: $ 175,000.00	Year:	2018/2050
Rural	Cost: $ 500,000.00	Year:	2020/2050
Disadvantaged	Cost: $ 500,000.00	Year:	2020/2050
	Total: $ 2,304,000.00		

Infrastructure Financing Survey Report

Section 3: Contact Information

1. Name: George A. Poling, Jr.
2. Phone Number: 806-362-4849
3. Email: texlinetoo@xit.net
4. Comments Hope I approached this correctly

Infrastructure Financing Survey Report

2611: WHEELER

As part of the regional and state water planning process, regional water planning groups recommend water supply projects for each of their respective regions. The purpose of this survey is gather information from your organization regarding how you plan to finance water supply projects recommended for the 2012 state water plan, and determine whether you intend to use financial assistance programs offered by the State of Texas and administered by the Texas Water Development Board (TWDB).

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Infrastructure Financing Survey Report

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•Acquisition and construction: Enter costs into the 'Acquisition and construction' category if you want to participate in the WIF-Construction program. The WIF-Construction program offers subsidized interest for all construction costs, including planning, acquisition, design, and construction.

•Excess Capacity: Enter costs into the 'Excess capacity' category if you want to participate in the State Participation program. State Participating funding offers partial interest and principal deferral for the incremental cost of project elements which are designed and built to serve needs beyond 10 years.

•Rural: Enter costs into the 'Rural' category if you want to participate in the Rural areas funding program. Rural areas funding offers grants and 0% interest loans for service areas which are not in a Metropolitan Statistical Area (MSA) and in which the population does not exceed 5,000. The service area must also meet the EDAP eligibility criteria.

•Disadvantaged: Enter costs into the 'Disadvantaged' category if you want to participate in the Economically Distressed Areas Program (EDAP). EDAP offers funding through grants and loans for service areas within a project which meet the EDAP eligibility criteria. Eligibility for the TWDB's EDAP requires that the median household income of the area to be served by the proposed project be less than 75 percent of the Texas median household income ($39,927), as shown in the 2000 Census. EDAP eligibility also requires adoption of Model Subdivision rules by the appropriate planning entities.

194 - DRILL ADDITIONAL GROUNDWATER WELL **$2,108,700.00**

Planning, design, permitting	Cost: $421,740.00	Year: 2020
Acquisition and contruction	Cost: $1,686,910.00	Year: 2020
Excess Capacity	Cost:	Year:

Infrastructure Financing Survey Report

Rural	Cost:		Year:
Disadvantaged	Cost:		Year:
	Total:		

Section 3: Contact Information

1. Name: Paul Arganbright
2. Phone Number: 806-669-4182
3. Email: ptarganbright@hotmail.com
4. Comments

APPENDIX L

PANHANDLE WATER PLANNING GROUPS

MEETINGS AND COMMITTEE MEETINGS

Panhandle Water Planning Groups Meetings and Committee Meetings

DATE	TIME	TYPE OF MEETING	LOCATION
3/24/06	1:30 pm	Water Planning Group	PRPC
6/20/06	1:00 pm	PWPG & LERWPG	Wayland U. Howeling Complex,
7/7/06	10:00 am	Joint Recharge Committee	Unger Library, Plainview
7/7/06	-	Interregional Coord Comm.	Unger Library, Plainview
8/11/06	10:30 am	Joint Recharge Committee	Chase Tower
8/18/06	1:30 pm	Water Planning Group	PRPC
5/30/07	1:30 pm	Water Planning Group	PRPC
8/22/07	1:30 pm	Water Planning Group	PRPC
4/16/08	10:00 am	Water Planning Group	PRPC
10/15/08	1:30 pm	Water Planning Group	PRPC
12/15/08	10:00 am	Water Planning Group	PRPC
1/6/09	1:30 pm	Modeling Committee	PRPC
1/16/09	1:00 pm	Modeling Committee	PRPC
4/20/09	-	Ag Committee	PRPC
5/13/09	10:00 am	Water Planning Group	PRPC
7/14/09	10:30 am	Water Planning Group	PRPC
8/7/09	10:30 am	Modeling Committee	PRPC
9/22/09	1:30 pm	Executive Committee	PRPC
11/9/09	1:30 pm	Ag Committee	PRPC
11/19/09	10:00 am	Modeling Committee	PRPC
11/19/09	1:30 pm	Water Planning Group	PRPC
12/7/09	10:30 am	Legislative Committee	PRPC
1/19/10	10:00 am	Modeling Committee	PRPC
1/19/10	1:30 pm	Water Planning Group	PRPC
2/22/10	1:30 pm	Water Planning Group	PRPC

Panhandle Water Planning Group Meetings	12
Committee Meetings	13
Total meetings	25

APPENDIX M

PWPG MILEAGE / EXPENSE TRACKING

Panhandle Water Planning Group

TOTALS	32734.0	$ 16,367.00	1,202.00

Date of Meeting	Attendee	Origin	Mileage	Mileage Expense	Time Expended(hrs)
6/20/2006	Ben Weinheimer	Amarillo	152	$ 76.00	5
8/18/2006	Ben Weinheimer	Amarillo	0	$ -	2
5/30/2007	Ben Weinheimer	Amarillo	0	$ -	2
7/7/2006	Ben Weinheimer	Amarillo	152	$ 76.00	7
8/22/2007	Ben Weinheimer	Amarillo	0	$ -	1.5
4/16/2008	Ben Weinheimer	Amarillo	0	$ -	1
10/15/2008	Ben Weinheimer	Amarillo	0	$ -	2
12/15/2008	Ben Weinheimer	Amarillo	0	$ -	1.5
1/6/2009	Ben Weinheimer	Amarillo	0	$ -	2
1/16/2009	Ben Weinheimer	Amarillo	0	$ -	2
4/20/2009	Ben Weinheimer	Amarillo	0	$ -	2
7/14/2009	Ben Weinheimer	Amarillo	0	$ -	3
8/7/2009	Ben Weinheimer	Amarillo	0	$ -	5.5
11/9/2009	Ben Weinheimer	Amarillo	0	$ -	1.5
11/19/2009	Ben Weinheimer	Amarillo	0	$ -	5
1/19/2010	Ben Weinheimer	Amarillo	0	$ -	2.5
2/22/2010	Ben Weinheimer	Amarillo	0	$ -	2.5
4/28/2010	Ben Weinheimer	Amarillo	0	$ -	1
5/30/2007	Bill Hallerberg	Amarillo	0	$ -	2
4/16/2008	Bill Hallerberg	Amarillo	0	$ -	1
12/15/2008	Bill Hallerberg	Amarillo	0	$ -	1.5
5/15/2009	Bill Hallerberg	Amarillo	0	$ -	2
7/14/2009	Bill Hallerberg	Amarillo	0	$ -	3
11/19/2009	Bill Hallerberg	Amarillo	0	$ -	2.5
12/7/2009	Bill Hallerberg	Amarillo	0	$ -	2
1/19/2010	Bill Hallerberg	Amarillo	0	$ -	2.5
2/22/2010	Bill Hallerberg	Amarillo	0	$ -	2.5
4/28/2010	Bill Hallerberg	Amarillo	0	$ -	1
3/24/2006	C.E. Williams	White Deer	80.2	$ 40.10	3.5
6/20/2006	C.E. Williams	White Deer	232.2	$ 116.10	7
8/18/2006	C.E. Williams	White Deer	80.2	$ 40.10	4
5/30/2007	C.E. Williams	White Deer	80.2	$ 40.10	4
7/7/2006	C.E. Williams	White Deer	232.2	$ 116.10	7
8/22/2007	C.E. Williams	White Deer	80.2	$ 40.10	3.5
4/16/2008	C.E. Williams	White Deer	80.2	$ 40.10	3
10/15/2008	C.E. Williams	White Deer	80.2	$ 40.10	4
12/15/2008	C.E. Williams	White Deer	80.2	$ 40.10	3.5
1/6/2009	C.E. Williams	White Deer	80.2	$ 40.10	4
1/16/2009	C.E. Williams	White Deer	80.2	$ 40.10	4
4/20/2009	C.E. Williams	White Deer	80.2	$ 40.10	4
5/15/2009	C.E. Williams	White Deer	80.2	$ 40.10	4
7/14/2009	C.E. Williams	White Deer	80.2	$ 40.10	5
8/7/2009	C.E. Williams	White Deer	80.2	$ 40.10	7.5

Panhandle Water Planning Group

TOTALS	32734.0	$ 16,367.00	1,202.00

Date of Meeting	Attendee	Origin	Mileage	Mileage Expense	Time Expended(hrs)
9/22/2009	C.E. Williams	White Deer	80.2	$ 40.10	2.5
11/9/2009	C.E. Williams	White Deer	80.2	$ 40.10	3.5
11/19/2009	C.E. Williams	White Deer	80.2	$ 40.10	6.5
12/7/2009	C.E. Williams	White Deer	80.2	$ 40.10	4
1/19/2010	C.E. Williams	White Deer	80.2	$ 40.10	6.5
2/22/2010	C.E. Williams	White Deer	80.2	$ 40.10	4.5
4/28/2010	C.E. Williams	White Deer	80.2	$ 40.10	3.5
3/24/06	Charles Cooke	Borger	97	$ 48.50	3.5
6/20/2006	Charles Cooke	Borger	249	$ 124.50	7
8/18/2006	Charles Cooke	Borger	97	$ 48.50	4
5/30/2007	Charles Cooke	Borger	97	$ 48.50	4
8/22/2007	Charles Cooke	Borger	97	$ 48.50	3.5
4/16/2008	Charles Cooke	Borger	97	$ 48.50	3
12/15/2008	Charles Cooke	Borger	97	$ 48.50	3.5
1/6/2009	Charles Cooke	Borger	97	$ 48.50	4
1/16/2009	Charles Cooke	Borger	97	$ 48.50	4
4/20/2009	Charles Cooke	Borger	97	$ 48.50	4
5/15/2009	Charles Cooke	Borger	97	$ 48.50	4
7/14/2009	Charles Cooke	Borger	97	$ 48.50	5
8/7/2009	Charles Cooke	Borger	97	$ 48.50	7.5
11/9/2009	Charles Cooke	Borger	97	$ 48.50	3.5
11/19/2009	Charles Cooke	Borger	97	$ 48.50	7
2/22/2010	Charles Cooke	Borger	97	$ 48.50	4.5
3/24/2006	Charles Munger	Canyon	37.4	$ 18.70	1.5
6/20/2006	Charles Munger	Canyon	114.6	$ 57.30	5
8/18/2006	Charles Munger	Canyon	37.4	$ 18.70	2
4/16/2008	Charles Munger	Canyon	37.4	$ 18.70	1
12/15/2008	Charles Munger	Canyon	37.4	$ 18.70	1.5
2/22/2010	Charles Munger	Canyon	37.4	$ 18.70	2.5
11/19/2009	Cole Camp	Amarillo	0	$ -	2.5
12/7/2009	Cole Camp	Amarillo	0	$ -	2
1/19/2010	Cole Camp	Amarillo	0	$ -	2.5
2/22/2010	Cole Camp	Amarillo	0	$ -	2.5
2/23/2010	Cole Camp	Amarillo	0	$ -	1
2/22/2010	Cleon Namken	Lubbock	248	$ 124.00	6.5
7/7/2006	Dale Hallmark	Dumas	246	$ 123.00	5
1/6/2009	Dale Hallmark	Dumas	94.2	$ 47.10	3.5
1/16/2009	Dale Hallmark	Dumas	94.2	$ 47.10	3.5
1/19/2010	Dale Hallmark	Dumas	94.2	$ 47.10	3.5
6/20/2006	Dan Coffey	Amarillo	152	$ 76.00	5
5/30/2007	Dan Coffey	Amarillo	0	$ -	2
3/24/2006	David Landis	Perryton	229.4	$ 114.70	5.5
8/18/2006	David Landis	Perryton	229.4	$ 114.70	6

Panhandle Water Planning Group

TOTALS	32734.0	$ 16,367.00	1,202.00

Date of Meeting	Attendee	Origin	Mileage	Mileage Expense	Time Expended(hrs)
5/30/2007	David Landis	Perryton	229.4	$ 114.70	6
8/22/2007	David Landis	Perryton	229.4	$ 114.70	5.5
12/15/2008	David Landis	Perryton	229.4	$ 114.70	5.5
5/15/2009	David Landis	Perryton	229.4	$ 114.70	6
7/14/2009	David Landis	Perryton	229.4	$ 114.70	7
9/22/2009	David Landis	Perryton	229.4	$ 114.70	4.5
11/19/2009	David Landis	Perryton	229.4	$ 114.70	6.5
1/19/2010	David Landis	Perryton	229.4	$ 114.70	6.5
2/22/2010	David Landis	Perryton	229.4	$ 114.70	6.5
4/28/2010	David Landis	Perryton	229.4	$ 114.70	4
3/24/06	Denise Jett	Borger	97	$ 48.50	3.5
8/18/2006	Denise Jett	Borger	97	$ 48.50	4
5/30/2007	Denise Jett	Borger	97	$ 48.50	4
8/22/2007	Denise Jett	Borger	97	$ 48.50	3.5
7/14/2009	Denise Jett	Borger	97	$ 48.50	5
1/19/2010	Denise Jett	Borger	97	$ 48.50	4.5
6/20/2006	Dr. R. Nolan Clark	Bushland	181	$ 90.50	6
8/18/2006	Dr. R. Nolan Clark	Bushland	29	$ 14.50	3
5/30/2007	Dr. R. Nolan Clark	Bushland	29	$ 14.50	3
4/16/2008	Dr. R. Nolan Clark	Bushland	29	$ 14.50	2
10/15/2008	Dr. R. Nolan Clark	Bushland	29	$ 14.50	3
12/15/2008	Dr. R. Nolan Clark	Bushland	29	$ 14.50	2.5
1/6/2009	Dr. R. Nolan Clark	Bushland	29	$ 14.50	3
1/16/2009	Dr. R. Nolan Clark	Bushland	29	$ 14.50	3
5/15/2009	Dr. R. Nolan Clark	Bushland	29	$ 14.50	3
11/19/2009	Dr. R. Nolan Clark	Bushland	29	$ 14.50	6
12/7/2009	Dr. R. Nolan Clark	Bushland	29	$ 14.50	3
1/19/2010	Dr. R. Nolan Clark	Bushland	29	$ 14.50	3.5
2/22/2010	Dr. R. Nolan Clark	Bushland	29	$ 14.50	3.5
4/28/2010	Dr. R. Nolan Clark	Bushland	29	$ 14.50	1.5
4/16/2008	Emmett Autrey	Amarillo	0	$ -	1
10/15/2008	Emmett Autrey	Amarillo	0	$ -	2
1/6/2009	Emmett Autrey	Amarillo	0	$ -	2
1/16/2009	Emmett Autrey	Amarillo	0	$ -	2
4/20/2009	Emmett Autrey	Amarillo	0	$ -	2
5/15/2009	Emmett Autrey	Amarillo	0	$ -	2
8/7/2009	Emmett Autrey	Amarillo	0	$ -	5.5
11/9/2009	Emmett Autrey	Amarillo	0	$ -	1.5
11/19/2009	Emmett Autrey	Amarillo	0	$ -	2.5
1/19/2010	Emmett Autrey	Amarillo	0	$ -	4.5
4/28/2010	Emmett Autrey	Amarillo	0	$ -	1
3/24/06	Gale Henslee	Amarillo	0	$ -	1.5
6/20/2006	Gale Henslee	Amarillo	152	$ 76.00	5

Panhandle Water Planning Group

TOTALS	32734.0	$ 16,367.00	1,202.00

Date of Meeting	Attendee	Origin	Mileage	Mileage Expense	Time Expended(hrs)
8/18/2006	Gale Henslee	Amarillo	0	$ -	2
5/30/2007	Gale Henslee	Amarillo	0	$ -	2
7/7/2006	Gale Henslee	Amarillo	152	$ 76.00	7
8/22/2007	Gale Henslee	Amarillo	0	$ -	1.5
4/16/2008	Gale Henslee	Amarillo	0	$ -	1
1/6/2009	Gale Henslee	Amarillo	0	$ -	2
1/16/2009	Gale Henslee	Amarillo	0	$ -	2
4/20/2009	Gale Henslee	Amarillo	0	$ -	2
5/15/2009	Gale Henslee	Amarillo	0	$ -	2
7/14/2009	Gale Henslee	Amarillo	0	$ -	3
8/7/2009	Gale Henslee	Amarillo	0	$ -	5.5
11/9/2009	Gale Henslee	Amarillo	0	$ -	1.5
11/19/2009	Gale Henslee	Amarillo	0	$ -	5
1/19/2010	Gale Henslee	Amarillo	0	$ -	4.5
2/22/2010	Gale Henslee	Amarillo	0	$ -	2.5
4/28/2010	Gale Henslee	Amarillo	0	$ -	1
3/24/2006	Grady Skaggs	Vega	70	$ 35.00	3.5
6/20/2006	Grady Skaggs	Vega	222	$ 111.00	7
8/18/2006	Grady Skaggs	Vega	70	$ 35.00	4
5/30/2007	Grady Skaggs	Vega	70	$ 35.00	4
8/22/2007	Grady Skaggs	Vega	70	$ 35.00	3.5
4/16/2008	Grady Skaggs	Vega	70	$ 35.00	3
10/15/2008	Grady Skaggs	Vega	70	$ 35.00	4
12/15/2008	Grady Skaggs	Vega	70	$ 35.00	3.5
1/6/2009	Grady Skaggs	Vega	70	$ 35.00	4
1/16/2009	Grady Skaggs	Vega	70	$ 35.00	4
4/20/2009	Grady Skaggs	Vega	70	$ 35.00	4
7/14/2009	Grady Skaggs	Vega	70	$ 35.00	5
8/7/2009	Grady Skaggs	Vega	70	$ 35.00	7.5
11/9/2009	Grady Skaggs	Vega	70	$ 35.00	3.5
11/19/2009	Grady Skaggs	Vega	70	$ 35.00	7
1/19/2010	Grady Skaggs	Vega	70	$ 35.00	6.5
11/19/2009	Greg Stanton	Vega	70	$ 35.00	4.5
8/22/2007	Jenny Pluhar	Canyon	37	$ 18.50	2.5
3/24/06	Janet Guthrie	Canadian	198	$ 99.00	5.5
6/20/2006	Janet Guthrie	Canadian	350	$ 175.00	9
8/18/2006	Janet Guthrie	Canadian	198	$ 99.00	6
5/30/2007	Janet Guthrie	Canadian	198	$ 99.00	6
7/7/2006	Janet Guthrie	Canadian	350	$ 175.00	11
8/22/2007	Janet Guthrie	Canadian	198	$ 99.00	5.5
4/16/2008	Janet Guthrie	Canadian	198	$ 99.00	5
12/15/2008	Janet Guthrie	Canadian	198	$ 99.00	5.5
1/6/2009	Janet Guthrie	Canadian	198	$ 99.00	6

Panhandle Water Planning Group

TOTALS	32734.0	$ 16,367.00	1,202.00

Date of Meeting	Attendee	Origin	Mileage	Mileage Expense	Time Expended(hrs)
1/16/2009	Janet Guthrie	Canadian	198	$ 99.00	6
4/20/2009	Janet Guthrie	Canadian	198	$ 99.00	6
5/15/2009	Janet Guthrie	Canadian	198	$ 99.00	6
7/14/2009	Janet Guthrie	Canadian	198	$ 99.00	7
8/7/2009	Janet Guthrie	Canadian	198	$ 99.00	9.5
11/9/2009	Janet Guthrie	Canadian	198	$ 99.00	5.5
11/19/2009	Janet Guthrie	Canadian	198	$ 99.00	9
1/19/2010	Janet Guthrie	Canadian	198	$ 99.00	6.5
8/18/2006	Janet Tregellas	Booker	260	$ 130.00	7
5/30/2007	Janet Tregellas	Booker	260	$ 130.00	7
8/22/2007	Janet Tregellas	Booker	260	$ 130.00	6.5
4/16/2008	Janet Tregellas	Booker	260	$ 130.00	6
10/15/2008	Janet Tregellas	Booker	260	$ 130.00	7
12/15/2008	Janet Tregellas	Booker	260	$ 130.00	6.5
1/19/2010	Janet Tregellas	Booker	260	$ 130.00	7.5
5/30/2007	Joe Baumgardner	Wellington	202.2	$ 101.10	4
10/15/2008	Joe Baumgardner	Wellington	202.2	$ 101.10	4
12/15/2008	Joe Baumgardner	Wellington	202.2	$ 101.10	3.5
5/15/2009	Joe Baumgardner	Wellington	202.2	$ 101.10	4
7/14/2009	Joe Baumgardner	Wellington	202.2	$ 101.10	5
1/19/2010	Joe Baumgardner	Wellington	202.2	$ 101.10	5.5
4/28/2010	Joe Baumgardner	Wellington	202.2	$ 101.10	4
3/24/06	Jim Derington	Spearman	178	$ 89.00	3.5
6/20/2006	Jim Derington	Spearman	330	$ 165.00	7
8/18/2006	Jim Derington	Spearman	178	$ 89.00	4
5/30/2007	Jim Derington	Spearman	178	$ 89.00	4
8/22/2007	Jim Derington	Spearman	178	$ 89.00	3.5
4/16/2008	Jim Derington	Spearman	178	$ 89.00	3
12/15/2008	Jim Derington	Spearman	178	$ 89.00	3.5
5/15/2009	Jim Derington	Spearman	178	$ 89.00	4
11/19/2009	Jim Derington	Spearman	178	$ 89.00	4.5
1/19/2010	Jim Derington	Spearman	178	$ 89.00	4.5
2/22/2010	Jim Derington	Spearman	84.8	$ 42.40	4.5
5/30/2007	John Schmucker	Dumas	94.2	$ 47.10	3.5
6/20/2006	John Sweeten	Amarillo	152	$ 76.00	5
5/30/2007	John Sweeten	Amarillo	0	$ -	2
10/15/2008	John Sweeten	Amarillo	0	$ -	2
1/19/2010	John Sweeten	Amarillo	0	$ -	2.5
2/22/2010	John Sweeten	Amarillo	0	$ -	2.5
4/28/2010	John Sweeten	Amarillo	0	$ -	1
3/24/2006	John Williams	Sanford	87.6	$ 43.80	2.5
8/18/2006	John Williams	Sanford	87.6	$ 43.80	3
7/7/2006	John Williams	Sanford	87.6	$ 43.80	8

Panhandle Water Planning Group

TOTALS	32734.0	$ 16,367.00	1,202.00

Date of Meeting	Attendee	Origin	Mileage	Mileage Expense	Time Expended(hrs)
8/22/2007	John Williams	Sanford	87.6	$ 43.80	2.5
4/16/2008	John Williams	Sanford	87.6	$ 43.80	2
10/15/2008	John Williams	Sanford	87.6	$ 43.80	3
12/15/2008	John Williams	Sanford	87.6	$ 43.80	2.5
1/6/2009	John Williams	Sanford	87.6	$ 43.80	3
1/16/2009	John Williams	Sanford	87.6	$ 43.80	3
4/20/2009	John Williams	Sanford	22.6	$ 11.30	3
5/15/2009	John Williams	Sanford	87.6	$ 43.80	3
7/14/2009	John Williams	Sanford	87.6	$ 43.80	4
8/7/2009	John Williams	Sanford	87.6	$ 43.80	6.5
9/22/2009	John Williams	Sanford	87.6	$ 43.80	1.5
11/9/2009	John Williams	Sanford	87.6	$ 43.80	2.5
11/19/2009	John Williams	Sanford	87.6	$ 43.80	6
1/19/2010	John Williams	Sanford	87.6	$ 43.80	5.5
2/22/2010	John Williams	Sanford	87.6	$ 43.80	3.5
4/28/2010	John Williams	Sanford	87.6	$ 43.80	2.5
11/19/2009	Kendall Harris	Wellington	202.2	$ 101.10	4.5
2/22/2010	Kendall Harris	Wellington	202.2	$ 101.10	4.5
8/18/2006	Mickey Black	Lubbock	541.2	$ 270.60	7
5/30/2007	Mickey Black	Lubbock	541.2	$ 270.60	7
8/22/2007	Mickey Black	Lubbock	541.2	$ 270.60	6.5
4/16/2008	Mickey Black	Lubbock	541.2	$ 270.60	6
10/15/2008	Mickey Black	Lubbock	541.2	$ 270.60	7
12/15/2008	Mickey Black	Lubbock	541.2	$ 270.60	6.5
1/6/2009	Ray Brady	White Deer	80.2	$ 40.10	3
1/16/2009	Ray Brady	White Deer	80.2	$ 40.10	3
4/20/2009	Ray Brady	White Deer	80.2	$ 40.10	3
8/7/2009	Ray Brady	White Deer	80.2	$ 40.10	6.5
11/9/2009	Ray Brady	White Deer	80.2	$ 40.10	2.5
1/19/2010	Ray Brady	White Deer	80.2	$ 40.10	3
2/22/2010	Ray Brady	White Deer	80.2	$ 40.10	3.5
4/28/2010	Ray Brady	White Deer	80.2	$ 40.10	3.5
6/20/2006	Richard Bowers	Dumas	246.2	$ 123.10	6
8/18/2006	Richard Bowers	Dumas	94.2	$ 47.10	3
6/20/2006	Rudie Tate	Wellington	354.2	$ 177.10	8
8/18/2006	Rudie Tate	Wellington	202.2	$ 101.10	4
6/20/2006	Rusty Gilmore	Dalhart	314	$ 157.00	7.5
8/18/2006	Rusty Gilmore	Dalhart	162	$ 81.00	4.5
5/30/2007	Rusty Gilmore	Dalhart	162	$ 81.00	4.5
4/16/2008	Rusty Gilmore	Dalhart	162	$ 81.00	3.5
11/19/2009	Rusty Gilmore	Dalhart	162	$ 81.00	5
1/19/2010	Rusty Gilmore	Dalhart	162	$ 81.00	5
3/24/06	Steve Jones	Amarillo	0	$ -	1.5

Panhandle Water Planning Group

TOTALS	32734.0	$ 16,367.00	1,202.00

Date of Meeting	Attendee	Origin	Mileage	Mileage Expense	Time Expended(hrs)
6/20/2006	Steve Jones	Amarillo	152	$ 76.00	5
5/30/2007	Steve Jones	Amarillo	0	$ -	2
12/15/2008	Steve Jones	Amarillo	0	$ -	1.5
7/14/2009	Steve Jones	Amarillo	0	$ -	3
2/22/2010	Steve Jones	Amarillo	0	$ -	2.5
2/22/2010	Steve Miller	Lubbock	541.2	$ 270.60	6.5
5/30/2007	Steve Walthour	Dumas	94.2	$ 47.10	3.5
8/22/2007	Steve Walthour	Dumas	94.2	$ 47.10	3
4/16/2008	Steve Walthour	Dumas	94.2	$ 47.10	2.5
10/15/2008	Steve Walthour	Dumas	94.2	$ 47.10	3.5
12/15/2008	Steve Walthour	Dumas	94.2	$ 47.10	3
1/6/2009	Steve Walthour	Dumas	94.2	$ 47.10	3.5
1/16/2009	Steve Walthour	Dumas	94.2	$ 47.10	3.5
7/14/2009	Steve Walthour	Dumas	94.2	$ 47.10	4.5
9/22/2009	Steve Walthour	Dumas	94.2	$ 47.10	2
11/19/2009	Steve Walthour	Dumas	94.2	$ 47.10	6.5
12/7/2009	Steve Walthour	Dumas	94.2	$ 47.10	3.5
1/19/2010	Steve Walthour	Dumas	94.2	$ 47.10	6
2/22/2010	Steve Walthour	Dumas	94.2	$ 47.10	4
11/19/2009	Tomas Marek	Amarillo	0	$ -	2.5
5/30/2007	Tom Baliff	Childress	230.2	$ 115.10	6
8/22/2007	Tom Baliff	Childress	230.2	$ 115.10	5.5
7/14/2009	Tom Baliff	Childress	230.2	$ 115.10	7
2/22/2010	Tom Baliff	Childress	230.2	$ 115.10	6.5
6/20/2006	Vernon Cook	Miami	152.4	$ 76.20	7.5
8/18/2006	Vernon Cook	Miami	152.4	$ 76.20	4.5
5/30/2007	Vernon Cook	Miami	152.4	$ 76.20	4.5
8/22/2007	Vernon Cook	Miami	152.4	$ 76.20	4
4/16/2008	Vernon Cook	Miami	152.4	$ 76.20	3.5
10/15/2008	Vernon Cook	Miami	152.4	$ 76.20	4.5
12/15/2008	Vernon Cook	Miami	152.4	$ 76.20	4
5/15/2009	Vernon Cook	Miami	152.4	$ 76.20	4.5
7/14/2009	Vernon Cook	Miami	152.4	$ 76.20	5.5
9/22/2009	Vernon Cook	Miami	152.4	$ 76.20	3
11/19/2009	Vernon Cook	Miami	102.4	$ 51.20	5
12/7/2009	Vernon Cook	Miami	152.4	$ 76.20	4.5
1/19/2010	Vernon Cook	Miami	152.4	$ 76.20	5

Panhandle Water Planning Group

Summary of Expense of Time and Mileage

Hours invested by Board Members	Approximate Value of Hours Invested	Miles Traveled	Mileage Cost	Total non-reimbursed Cost by Members
1202	$ 60,100.00	32734	$ 16,367.00	$ 76,467.00

		TOTALS	**1513.6**	**$ 756.80**	**54.00**
4/28/2010	Curtis Campbell	Wichita Fall	550	$ 275.00	9
3/24/2006	Kent Satterwhite	Sanford	87.6	$ 43.80	3
6/20/2006	Kent Satterwhite	Sanford	87.6	$ 43.80	6.5
8/18/2006	Kent Satterwhite	Sanford	87.6	$ 43.80	3.5
5/30/2007	Kent Satterwhite	Sanford	87.6	$ 43.80	3.5
5/30/2007	Kent Satterwhite	Sanford	87.6	$ 43.80	3.5
7/7/2006	Kent Satterwhite	Sanford	87.6	$ 43.80	8.5
8/22/2007	Kent Satterwhite	Sanford	87.6	$ 43.80	3
4/16/2008	Kent Satterwhite	Sanford	87.6	$ 43.80	2.5
########	Kent Satterwhite	Sanford	87.6	$ 43.80	3
1/19/2010	Kent Satterwhite	Sanford	87.6	$ 43.80	4
2/22/2010	Kent Satterwhite	Sanford	87.6	$ 43.80	4

		TOTALS	**38371.2**	**$ 19,185.60**	**972.00**
1/12/2006	PGCD General Manager	White Deer	80.2	$ 40.10	4.5
2/24/2006	PGCD General Manager	White Deer	80.2	$ 40.10	6.5
5/2/2006	PGCD General Manager	White Deer	80.2	$ 40.10	6
11/13/2006	PGCD General Manager	White Deer	80.2	$ 40.10	7.5
1/23/2007	PGCD General Manager	White Deer	80.2	$ 40.10	4.5
3/26/2007	PGCD General Manager	White Deer	80.2	$ 40.10	5.5
8/22/2007	PGCD General Manager	White Deer	80.2	$ 40.10	5
10/17/2007	PGCD General Manager	White Deer	80.2	$ 40.10	5
11/14/2007	PGCD General Manager	White Deer	80.2	$ 40.10	4
1/21/2008	PGCD General Manager	White Deer	80.2	$ 40.10	4
5/6/2008	PGCD General Manager	White Deer	80.2	$ 40.10	4
6/18/2008	PGCD General Manager	White Deer	80.2	$ 40.10	4
11/6/2008	PGCD General Manager	White Deer	80.2	$ 40.10	5.5
12/15/2008	PGCD General Manager	White Deer	80.2	$ 40.10	4.5
2/20/2009	PGCD General Manager	White Deer	80.2	$ 40.10	4
3/13/2009	PGCD General Manager	White Deer	80.2	$ 40.10	4
5/13/2009	PGCD General Manager	White Deer	80.2	$ 40.10	3.5
7/7/2009	PGCD General Manager	White Deer	80.2	$ 40.10	2.5
7/7/2009	PGCD General Manager	White Deer	80.2	$ 40.10	2.5
9/22/2009	PGCD General Manager	White Deer	80.2	$ 40.10	7
11/11/2009	PGCD General Manager	White Deer	80.2	$ 40.10	6.5
1/12/2006	PGCD Voting Member	White Deer	80.2	$ 40.10	4.5
2/24/2006	PGCD Voting Member	White Deer	80.2	$ 40.10	6.5
5/2/2006	PGCD Voting Member	White Deer	80.2	$ 40.10	6
11/13/2006	PGCD Voting Member	White Deer	80.2	$ 40.10	7.5
1/23/2007	PGCD Voting Member	White Deer	80.2	$ 40.10	4.5
3/26/2007	PGCD Voting Member	White Deer	80.2	$ 40.10	5.5
8/22/2007	PGCD Voting Member	White Deer	80.2	$ 40.10	5
10/17/2007	PGCD Voting Member	White Deer	80.2	$ 40.10	5
11/14/2007	PGCD Voting Member	White Deer	80.2	$ 40.10	4
1/21/2008	PGCD Voting Member	White Deer	80.2	$ 40.10	4
5/6/2008	PGCD Voting Member	White Deer	80.2	$ 40.10	4
6/18/2008	PGCD Voting Member	White Deer	80.2	$ 40.10	4
11/6/2008	PGCD Voting Member	White Deer	80.2	$ 40.10	5.5
12/15/2008	PGCD Voting Member	White Deer	80.2	$ 40.10	4.5
2/20/2009	PGCD Voting Member	White Deer	80.2	$ 40.10	4
3/13/2009	PGCD Voting Member	White Deer	80.2	$ 40.10	4

5/13/2009	PGCD Voting Member	White Deer	80.2	$	40.10	3.5
7/7/2009	PGCD Voting Member	White Deer	80.2	$	40.10	2.5
7/7/2009	PGCD Voting Member	White Deer	80.2	$	40.10	2.5
9/22/2009	PGCD Voting Member	White Deer	80.2	$	40.10	7
11/11/2009	PGCD Voting Member	White Deer	80.2	$	40.10	6.5
1/12/2006	HCUWCD General Manger	Canadian	198	$	99.00	6.5
2/24/2006	HCUWCD General Manger	Canadian	198	$	99.00	8.5
5/2/2006	HCUWCD General Manger	Canadian	198	$	99.00	8
11/13/2006	HCUWCD General Manger	Canadian	198	$	99.00	9.5
1/23/2007	HCUWCD General Manger	Canadian	198	$	99.00	6.5
3/26/2007	HCUWCD General Manger	Canadian	198	$	99.00	7.5
8/22/2007	HCUWCD General Manger	Canadian	198	$	99.00	7
10/17/2007	HCUWCD General Manger	Canadian	198	$	99.00	7
11/14/2007	HCUWCD General Manger	Canadian	198	$	99.00	6
1/21/2008	HCUWCD General Manger	Canadian	198	$	99.00	6
5/6/2008	HCUWCD General Manger	Canadian	198	$	99.00	6
6/18/2008	HCUWCD General Manger	Canadian	198	$	99.00	6
11/6/2008	HCUWCD General Manger	Canadian	198	$	99.00	7.5
12/15/2008	HCUWCD General Manger	Canadian	198	$	99.00	6.5
2/20/2009	HCUWCD General Manger	Canadian	198	$	99.00	6
3/13/2009	HCUWCD General Manger	Canadian	198	$	99.00	6
5/13/2009	HCUWCD General Manger	Canadian	198	$	99.00	5.5
7/7/2009	HCUWCD General Manger	Canadian	198	$	99.00	4.5
7/7/2009	HCUWCD General Manger	Canadian	198	$	99.00	4.5
9/22/2009	HCUWCD General Manger	Canadian	198	$	99.00	9
11/11/2009	HCUWCD General Manger	Canadian	198	$	99.00	8.5
1/12/2006	HCUWCD Voting Member	Canadian	198	$	99.00	6.5
2/24/2006	HCUWCD Voting Member	Canadian	198	$	99.00	8.5
5/2/2006	HCUWCD Voting Member	Canadian	198	$	99.00	8
11/13/2006	HCUWCD Voting Member	Canadian	198	$	99.00	9.5
1/23/2007	HCUWCD Voting Member	Canadian	198	$	99.00	6.5
3/26/2007	HCUWCD Voting Member	Canadian	198	$	99.00	7.5
8/22/2007	HCUWCD Voting Member	Canadian	198	$	99.00	7
10/17/2007	HCUWCD Voting Member	Canadian	198	$	99.00	7
11/14/2007	HCUWCD Voting Member	Canadian	198	$	99.00	6
1/21/2008	HCUWCD Voting Member	Canadian	198	$	99.00	6
5/6/2008	HCUWCD Voting Member	Canadian	198	$	99.00	6
6/18/2008	HCUWCD Voting Member	Canadian	198	$	99.00	6
11/6/2008	HCUWCD Voting Member	Canadian	198	$	99.00	7.5
12/15/2008	HCUWCD Voting Member	Canadian	198	$	99.00	6.5
2/20/2009	HCUWCD Voting Member	Canadian	198	$	99.00	6

3/13/2009	HCUWCD Voting Member	Canadian	198	$	99.00	6
5/13/2009	HCUWCD Voting Member	Canadian	198	$	99.00	5.5
7/7/2009	HCUWCD Voting Member	Canadian	198	$	99.00	4.5
7/7/2009	HCUWCD Voting Member	Canadian	198	$	99.00	4.5
9/22/2009	HCUWCD Voting Member	Canadian	198	$	99.00	9
11/11/2009	HCUWCD Voting Member	Canadian	198	$	99.00	8.5
1/12/2006	NPGCD General Manger	Dumas	94.2	$	47.10	4.5
2/24/2006	NPGCD General Manger	Dumas	94.2	$	47.10	6.5
5/2/2006	NPGCD General Manger	Dumas	94.2	$	47.10	6
11/13/2006	NPGCD General Manger	Dumas	94.2	$	47.10	7.5
1/23/2007	NPGCD General Manger	Dumas	94.2	$	47.10	4.5
3/26/2007	NPGCD General Manger	Dumas	94.2	$	47.10	5.5
8/22/2007	NPGCD General Manger	Dumas	94.2	$	47.10	5
10/17/2007	NPGCD General Manger	Dumas	94.2	$	47.10	5
11/14/2007	NPGCD General Manger	Dumas	94.2	$	47.10	4
1/21/2008	NPGCD General Manger	Dumas	94.2	$	47.10	4
5/6/2008	NPGCD General Manger	Dumas	94.2	$	47.10	4
6/18/2008	NPGCD General Manger	Dumas	94.2	$	47.10	4
11/6/2008	NPGCD General Manger	Dumas	94.2	$	47.10	5.5
12/15/2008	NPGCD General Manger	Dumas	94.2	$	47.10	4.5
2/20/2009	NPGCD General Manger	Dumas	94.2	$	47.10	4
3/13/2009	NPGCD General Manger	Dumas	94.2	$	47.10	4
5/13/2009	NPGCD General Manger	Dumas	94.2	$	47.10	3.5
7/7/2009	NPGCD General Manger	Dumas	94.2	$	47.10	2.5
7/7/2009	NPGCD General Manger	Dumas	94.2	$	47.10	2.5
9/22/2009	NPGCD General Manger	Dumas	94.2	$	47.10	7
11/11/2009	NPGCD General Manger	Dumas	94.2	$	47.10	6.5
1/12/2006	NPGCD Voting Member	Dumas	94.2	$	47.10	4.5
2/24/2006	NPGCD Voting Member	Dumas	94.2	$	47.10	6.5
5/2/2006	NPGCD Voting Member	Dumas	94.2	$	47.10	6
11/13/2006	NPGCD Voting Member	Dumas	94.2	$	47.10	7.5
1/23/2007	NPGCD Voting Member	Dumas	94.2	$	47.10	4.5
3/26/2007	NPGCD Voting Member	Dumas	94.2	$	47.10	5.5
8/22/2007	NPGCD Voting Member	Dumas	94.2	$	47.10	5
10/17/2007	NPGCD Voting Member	Dumas	94.2	$	47.10	5
11/14/2007	NPGCD Voting Member	Dumas	94.2	$	47.10	4
1/21/2008	NPGCD Voting Member	Dumas	94.2	$	47.10	4
5/6/2008	NPGCD Voting Member	Dumas	94.2	$	47.10	4
6/18/2008	NPGCD Voting Member	Dumas	94.2	$	47.10	4
11/6/2008	NPGCD Voting Member	Dumas	94.2	$	47.10	5.5
12/15/2008	NPGCD Voting Member	Dumas	94.2	$	47.10	4.5

2/20/2009	NPGCD Voting Member	Dumas	94.2	$ 47.10	4
3/13/2009	NPGCD Voting Member	Dumas	94.2	$ 47.10	4
5/13/2009	NPGCD Voting Member	Dumas	94.2	$ 47.10	3.5
7/7/2009	NPGCD Voting Member	Dumas	94.2	$ 47.10	2.5
7/7/2009	NPGCD Voting Member	Dumas	94.2	$ 47.10	2.5
9/22/2009	NPGCD Voting Member	Dumas	94.2	$ 47.10	7
11/11/2009	NPGCD Voting Member	Dumas	94.2	$ 47.10	6.5
1/12/2006	HPUWCD General Manager	Lubbock	541.2	$ 270.60	6.5
2/24/2006	HPUWCD General Manager	Lubbock	541.2	$ 270.60	8.5
5/2/2006	HPUWCD General Manager	Lubbock	541.2	$ 270.60	8
11/13/2006	HPUWCD General Manager	Lubbock	541.2	$ 270.60	9.5
1/23/2007	HPUWCD General Manager	Lubbock	541.2	$ 270.60	6.5
3/26/2007	HPUWCD General Manager	Lubbock	541.2	$ 270.60	7.5
8/22/2007	HPUWCD General Manager	Lubbock	541.2	$ 270.60	7
10/17/2007	HPUWCD General Manager	Lubbock	541.2	$ 270.60	7
11/14/2007	HPUWCD General Manager	Lubbock	541.2	$ 270.60	6
1/21/2008	HPUWCD General Manager	Lubbock	541.2	$ 270.60	6
5/6/2008	HPUWCD General Manager	Lubbock	541.2	$ 270.60	6
6/18/2008	HPUWCD General Manager	Lubbock	541.2	$ 270.60	6
11/6/2008	HPUWCD General Manager	Lubbock	541.2	$ 270.60	7.5
12/15/2008	HPUWCD General Manager	Lubbock	541.2	$ 270.60	6.5
2/20/2009	HPUWCD General Manager	Lubbock	541.2	$ 270.60	6
3/13/2009	HPUWCD General Manager	Lubbock	541.2	$ 270.60	6
5/13/2009	HPUWCD General Manager	Lubbock	541.2	$ 270.60	5.5
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7/7/2009	HPUWCD General Manager	Lubbock	541.2	$ 270.60	4.5
9/22/2009	HPUWCD General Manager	Lubbock	541.2	$ 270.60	9
11/11/2009	HPUWCD General Manager	Lubbock	541.2	$ 270.60	8.5
1/12/2006	HPUWCD Voting member	Lubbock	541.2	$ 270.60	6.5
2/24/2006	HPUWCD Voting member	Lubbock	541.2	$ 270.60	8.5
5/2/2006	HPUWCD Voting member	Lubbock	541.2	$ 270.60	8
11/13/2006	HPUWCD Voting member	Lubbock	541.2	$ 270.60	9.5
1/23/2007	HPUWCD Voting member	Lubbock	541.2	$ 270.60	6.5
3/26/2007	HPUWCD Voting member	Lubbock	541.2	$ 270.60	7.5
8/22/2007	HPUWCD Voting member	Lubbock	541.2	$ 270.60	7
10/17/2007	HPUWCD Voting member	Lubbock	541.2	$ 270.60	7
11/14/2007	HPUWCD Voting member	Lubbock	541.2	$ 270.60	6
1/21/2008	HPUWCD Voting member	Lubbock	541.2	$ 270.60	6
5/6/2008	HPUWCD Voting member	Lubbock	541.2	$ 270.60	6
6/18/2008	HPUWCD Voting member	Lubbock	541.2	$ 270.60	6
11/6/2008	HPUWCD Voting member	Lubbock	541.2	$ 270.60	7.5

12/15/2008	HPUWCD Voting member	Lubbock	541.2	$	270.60	6.5
2/20/2009	HPUWCD Voting member	Lubbock	541.2	$	270.60	6
3/13/2009	HPUWCD Voting member	Lubbock	541.2	$	270.60	6
5/13/2009	HPUWCD Voting member	Lubbock	541.2	$	270.60	5.5
7/7/2009	HPUWCD Voting member	Lubbock	541.2	$	270.60	4.5
7/7/2009	HPUWCD Voting member	Lubbock	541.2	$	270.60	4.5
9/22/2009	HPUWCD Voting member	Lubbock	541.2	$	270.60	9
11/11/2009	HPUWCD Voting member	Lubbock	541.2	$	270.60	8.5

APPENDIX N

COMMITTEE LISTING

Modeling Committee

Member	Interest Group
John Williams - Chair	Water Districts
Charles Cooke	Water Utilities
Rusty Gilmore	Small Business
Gale Henslee	Electrical Generating Utility
Ben Weinheimer	Agricultural
Denise Jett	Industrial
Janet Guthrie/Dale Hallmark	Water Districts
David Landis	Municipalities
C.E. Williams/Ray Brady	Water Districts
Grady Skaggs	Environmental
Steve Walthour	Industrial
Emmett Autrey	Municipalities

Demands and Projections - Agricultural

Member	Interest Group
Nolan Clark - Chair	Environmental
John M. Sweeten	Higher Education
Rusty Gilmore	Small Business
Mickey Black/Cleon Namken	USDA/NRCS
Ben Weinheimer	Agricultural
Steve Walthour	Water Districts
Joe Baumgardner	Agricultural
C.E. Williams	Water Districts
Janet Tregallas	Agriculture
Rudi Tate	
Kendall Harris	Agriculture
Steve Amosson	Consultant
Simone Kiel	Ex-Officio
Virginia Sabia	Ex-Officio
Kyle Ingham	Ex-Officio

Demands and Projections - Municipal and Industrial

Member	Interest Group
David Landis - Chair	Municipalities
John Williams	Water Districts
David Landis	Municipalities
Gale Henslee	Electrical Generating Utility
Tom Baliff	Water Districts

Legislative

Member	Interest Group
Steve Walthour - Chair	Industrial
Cole Camp	Environmental
Bill Hallerberg	Industrial
Vernon Cook	Counties
C.E. Williams	Water Districts
Nolan Clark	Environmental

APPENDIX O

WATER PLANNING LOCAL CONTRIBUTIONS

TOTAL CONTRIBUTION RECEIVED

Year	**2006**	**2007**	**2008**	**2009**	**2010**
Groundwater Districts	$27,665	$28,101	$28,398	$28,762	$28,426
City	$15,670	$15,196	$16,512	$15,197	$16,910
County	$3,600	$3,400	$3,895	$3,895	$3,685
Surface Water Districts	$12,600	$12,600	$12,942	$12,942	$12,360
Water Utilities	$1,004	$1,009	$1,045	$1,021	$1,061
E.D.C. Juristiction	$3,014	$4,110	$4,278	$4,004	$3,696
Solicited Contributions	$2,500	$3,100	$3,100	$2,500	$2,500
Total	$66,053	$67,516	$70,170	$68,321	$68,638
Total over 5 years	$340,698				

APPENDIX P

COMMENTS RECEIVED ON INITIALLY PREPARED PLAN AND RESPONSES

June 28, 2010

Mr. C.E. Williams
Chairman, Panhandle Water Planning Group
c/o Panhandle Groundwater
Conservation District
P.O. Box 637
White Deer, Texas 79097

Mr. Gary Pitner
Panhandle Regional Planning Commission
415 West 8th Street
Amarillo, Texas 79101

Re: Texas Water Development Board Comments for the Panhandle Water Planning Group (Region A) Initially Prepared Plan, Contract No. 0904830860

Dear Mr. Williams and Mr. Pitner:

Texas Water Development Board (TWDB) staff completed a review of the Initially Prepared Plan (IPP) submitted by March 1, 2010 on behalf of the Region A Regional Water Planning Group. The attached comments (Attachments A and B) follow this format:

- Level 1: Comments, questions, and online planning database revisions that must be satisfactorily addressed in order to meet statutory, agency rule, and/or contract requirements; and
- Level 2: Comments and suggestions for consideration that may improve the readability and overall understanding of the regional plan.

Based on the information provided to date by regional water planning groups, TWDB has identified potential interregional conflicts that are summarized in Attachment C. The TWDB's statutory requirement for review of potential interregional conflicts under Title 31, Texas Administrative Code (TAC) §357.14 will not be completed until submittal and review of adopted regional water plans.

Title 31, TAC §357.11(b) requires the regional water planning group to consider timely agency and public comment. Section 357.10(a)(3) of the TAC requires the final adopted plan include summaries of all timely written and oral comments received, along with a response explaining any resulting revisions or why changes are not warranted.

Copies of TWDB's Level 1 and 2 written comments and the region's responses must be included in the final, adopted regional water plan.

If you have any questions, please do not hesitate to contact Virginia Sabia at (512) 936-9363.

Sincerely,

Carolyn L. Brittin
Deputy Executive Administrator
Water Resources Planning and Information

Attachments (3)

c w/att: Ms. Simone Kiel, Freese & Nichols, Inc.

ATTACHMENT A

TWDB Comments on Initially Prepared 2011 Region A Regional Water Plan

LEVEL 1. Comments and questions must be satisfactorily addressed in order to meet statutory, agency rule, and/or contract requirements.

General Comment

1. Some electronic files submitted with the plan included track changes and comments. Please ensure that all final electronic documents submitted are print-ready. *[Contract Exhibit "D" Section 2.1]*

2. Please include base map source references (e.g. Figure 3-9 and 3-10). *[Contract Exhibit "D" Section 2.3]*

3. The plan does not appear to contain a list of potentially feasible water management strategies that were selected for evaluation by the planning group. Please include a list of potentailly feasible water management strategies. *[Contract Exhibit "C" Section 11.1]*

Executive Summary

4. Pages 4-5: The plan discusses both firm and safe yields for reservoir supplies. Please state in plan when firm or safe yields were used. *[Title 31 Texas Administrative Code (TAC) §357.7(a)(1)(L)]*

Chapter 1

5. Page 1-49, Section 1.8: Please describe any threats to agricultural and natural resources due to water quantity or water quality problems related to water supply. *[31 TAC §357.7(a)(1)(L)]*

Chapter 2

6. Page 2-3, Table 2-1: The plan does not present population and categories of water use by counties and river basins. Please present population and water demands by counties and river basin. *[31 TAC §357.7(a)(2)(A)(iv))]*

7. Pages 2-18 through 2-22, Section 2.3: Wholesale water provider water use is not presented by category and delineated by counties and river basins. Please present water use by category and delineate by counties and river basins. *[31 TAC §357.7(a)(2)(A)(iv) and (a)(2)(B)]*

Chapter 3

8. The Dallam County priority groundwater management area (PGMA) is not referred to in the plan. Please describe how water availability requirements or limitations associated with the (PGMA), if any, were considered in developing the regional water plan. *[31 TAC §357.5(k)(1)(G)]*

9. Groundwater and surface water supplies are not presented for wholesale water providers. Please present water supplies for wholesaler water providers. *[Title 31 TAC §357.7(a)(3)]*

10. Please explain whether plan includes all ongoing water development projects for which TCEQ has issued a permit. *[31 TAC §358.3(b)(21)]*

11. Page 3-19: The plan refers to "reliable yield" for Lake Meredith, instead of reservoir firm yield. Please define the term "reliable yield" and clarify whether it was used in plan and, if so, whether its use was approved by TWDB. Also explain how the "long-term reliable yield" of 50,000 ac-ft/y for Lake Meredith was obtained. *[31 TAC §357.7(a)(3)(B)]*

12. Page 3-42 through 3-44, Tables 3-24 and 3-26: The 2030 total supply (1,201,217 acft/yr) in Table 3-24 does not match the Grand Total supply (1,029,080 acft/yr) in Table 3-26. Please revise as appropriate throughout the plan.

13. Pages 3-42 through 3-45, Tables 3-25, 3-26, and 3-27: It appears that total county surplus/shortages were calculated incorrectly by subtracting total [county-wide] supply from total [county-wide] demand. Please revise to reflect total county water needs as the sum of the individual needs of each water user group in the county; needs that are calculated based on each water user group's own demands and supplies. *[31 Texas Administrative Code (TAC) §357.7(a)(4)(A)]*

<u>Chapter 4</u>

14. The plan does not appear to contain a table of alternative water management strategies. If applicable, please include a table of alternative water management strategies that include water supply volumes from water management strategy, by decade, and capital costs. *[Contract Exhibit "C" Sections 4.3, 11.1]*

15. Page 4-9, Table 4-2 and page 4-9, second paragraph: The plan assumes the cost for municipal conservation to be $1.50 per thousand gallons ($490 per acre-foot). Please include a description of how conservation unit costs were calculated.

16. Pages 4-10 to 4-41: The plan does not include information for strategies that were evaluated but not recommended. Please include documentation of all information on all potentially feasible strategies that were evaluated. *[31 TAC §357.7(a)(8)]*

17. Page 4-31 and 4-32: The capital cost of $2.1 million for the City of Wheeler water management strategy "New Wells in Ogallala" on page 4-31 and in table on page 4-31 ($2,108,700) do not match the "Total Capital Cost" of $2,233,300 shown in Appendix H, page 28 for the same strategy. Please reconcile the cost as appropriate. *[Contract Exhibit "D" Section 4.1.2]*

18. Page 4-54, Section 4.9: Water needs for wholesale water providers are not presented by county and basin river basins. Please present wholesale water providers water needs by county and basin, if appropraite. *[31 TAC §357.7(a)(4)(B)]*

19. Page 4-63: The cost presented for "City of Cactus New Well Field" ($8.6 Million) does not match the value presented in Appendix H, page 17, Table H-6 ($5,446,700.) Please revise as appropriate. *[Contract Exhibit "D" Section 4.1.2]*

Chapter 6

20. The differences between conservation strategies and drought management plans are unclear as presented in the plan. Please clarify differences. *[Contract Exhibit "D" Section 6]*

21. *(Attachment B)* Comments on the online planning database (i.e. DB12) are herein being provided in spreadsheet format. These Level 1 comments are based on a direct comparison of the online planning database against the Initially Prepared Regional Water Plan document as submitted. The table only includes numbers that do not reconcile between the plan (left side of spreadsheet) and online database (right side of spreadsheet). An electronic version of this spreadsheet will be provided upon request.

22. *(Attachment C)* Based on the information provided to date by the regional water planning groups, TWDB has also attached a summary, in spreadsheet format, of potential interregional conflicts, and apparent water source over allocations that were identified during the review of the online planning database and Initially Prepared Regional Water Plan. *[Additional TWDB comments regarding the general conformance of the online planning database (DB12) format and content to the Guidelines for Regional Water Planning Data Deliverables (Contract Exhibit D) are being provided by TWDB staff under separate cover as 'Exception Reports']*

LEVEL 2. Comments and suggestions that might be considered to clarify or enhance the plan.

Chapter 3

1. Some tables (e.g. Tables 3-3 and 3-4) show water supply totals for each water source while other tables (e.g. Table 3-6) do not present the total volumes for sources. Please consider including totals for all tables where appropriate.

2. Tables 3-8, and 3-22: The plan presents developed water supplies for the Dockum Aquifer in Table 3-22 (from 24,420 acft/yr in 2010 to 19,220 acft/yr in 2060). Table 3-8 is based on the assumption that available annual supplies are 1.25% of available storage (338,000 acft/yr in 2010.) In May 2010, the Texas Water Development Board released Groundwater Availability Model –Run Report 09-014 which estimates pumping for the Dockum Aquifer in GMA 1 to be 21,226 acft/yr for all decades from 2010 through 2060. Please consider referencing the new report as appropriate in the plan. *[Contract Exhibit "D" Section 3.0-3.1]*

Chapter 7

3. Page 7-6: The unnumbered and untitled table references where the plan considered regulatory requirements met. Please consider adding a title and number to the table.

REGION A

Non-matching numbers

		IPP document reference:		IPP document number							Online Planning Database (DB12) number						
Region IPP	Item	Page number	Table number	non-decadal number	2010	2020	2030	2040	2050	2060	non-decadal number	2010	2020	2030	2040	2050	2060
A	Dallam County water use	ES-2			358,177							297,251					
A	Available Water Supplies, Local Supply	ES-5	ES-1		21,022	21,022	21,022	21,022	21,022	21,022		21	21	21	21	21	21
A	Available Water Supplies, Other Aquifer	ES-5	ES-1		676	676	673	671	671	671		636	636	636	636	636	636
A	Water Conservation Strategies Total Volume	ES-8				219,653			·	462,965			315,253				573,887
A	Hansford County Summary, available supplies	ES-27	Hansford		137,130	120,292	116,158	107,259	97,160	87,286		136,980	120,143	116,011	107,113	97,016	87,142
A	Potter County Summary, available supplies	ES-43	Potter		65,126	70,261	70,342	70,764	71,420	73,155		64,799	69,995	70,017	70,440	71,098	72,833
A	Randall County Summary, available supplies	ES-45	Randall		51,534	50,372	48,646	46,993	44,454	42,008		50,814	49,657	47,937	46,289	43,753	41,307
A	Wheeler Co., Seymour Aquifer availability	3-9	3-4		na	na	na	na	na	na		88	88	88	88	88	88
A	Oldham County, Dockum Aquifer availability	3-11	3-8		74,400	65,400	57,600	50,800	44,800	39,500		74,000	64,800	56,700	49,600	43,400	38,000
A	Potter County, Dockum Aquifer availability	3-11	3-8		33,700	29,500	25,900	22,700	19,900	17,400		33,600	29,400	25,800	22,500	19,700	17,300
A	Colingsworth County, Red Basin, run-of-river supply	3-24	3-13		867	867	867	867	867	867		798	798	798	798	798	798
A	Hansford County, Canadian Basin, run-of-river supply	3-24	3-13		172	172	172	172	172	172		22	22	22	22	22	22
A	Potter Canadiand combined-run-of-river supply	3-24	3-13		322	322	322	322	322	322		na	na	na	na	na	na
A	Randall Co, Canadian Basin, combined-run-of-river-irrigation supply	3-24	3-13		215	215	215	215	215	215		175	175	175	175	175	175
A	Wheeler County, Canadian Basin, combined-run-of-river-irrigation supply	3-24	3-13		603	603	603	603	603	603		580	580	580	580	580	580
A	Direct reuse supply Carson Co	3-29	3-16		67	64	62	61	56	50		71	67	65	64	59	53
A	Direct reuse supply Collingsworth Co	3-29	3-16		50	50	50	50	50	50		300	300	300	300	300	300
A	Direct reuse supply Grey Co	3-29	3-16		na	na	na	na	na	na		1,902	1,879	1,615	1,568	1,525	1,525
A	Direct reuse supply Hall Co	3-29	3-16		na	na	na	na	na	na		7	6	6	6	5	5
A	Direct reuse supply Hutchinson Co	3-29	3-16		1,045	1,045	1,045	1,045	1,045	1,045		1,332	1,270	1,198	1,112	1,073	1,073
A	Direct reuse supply Lipscomb Co	3-29	3-16		na	na	na	na	na	na		34	34	34	34	34	34
A	livestock local supply Childress Co	3-30	3-17		100	100	100	100	100	100		300	300	300	300	300	300
A	Grand total supply	3-31	3-18		3,996,033	3,753,024	3,461,626	3,167,983	2,897,305	2,639,165		3,957,672	3,734,378	3,442,347	3,148,172	2,877,215	2,619,071
A	Carson County, Red Basin supply	3-42	3-24				39,842							40,142			
A	Childress County, Red Basin supply	3-42	3-24				7,735							7,835			
A	Collingsworth County, Red Basin supply	3-42	3-24		31,754							31,254					
A	Dallam County, Canadian Basin supply	3-42	3-24				139,942							132,949			
A	Donley County, Red Basin supply	3-42	3-24		34,751							34,530					
A	Gray County, Canadian Basin supply	3-42	3-24				17,469							17,032			
A	Gray County, Red Basin supply	3-42	3-24				20,777							20,354			
A	Hall County, Red Basin supply	3-42	3-24				11,863							11,558			
A	Hansford County, Canadian Basin supply	3-42	3-24		137,130		119,152			87,286		136,980		116,011			87,142
A	Hartley County, Canadian Basin supply	3-42	3-24				221,007							98,576			
A	Hemphill County, Canadian Basin supply	3-42	3-24				6,120							4,131			
A	Hutchinson County, Canadian Basin supply	3-42	3-24				73,180							58,921			
A	Lipscomb County, Canadian Basin supply	3-42	3-24				19,371							18,224			
A	Moore County, Canadian Basin supply	3-42	3-24				86,685							95,062			
A	Ochiltree County, Canadian Basin supply	3-42	3-24				59,113							58,445			
A	Potter County, Canadian Basin supply	3-42	3-24		44,524		48,615			54,434		44,197		48,826			54,112
A	Potter County, Red Basin supply	3-42	3-24				22,492							21,191			
A	Randall County, Canadian Basin supply	3-42	3-24		73		72			64		27		25			19
A	Randall County, Red Basin supply	3-42	3-24		51,461		51,440			41,944		50,787		47,912			41,288
A	Roberts County, Canadian Basin supply	3-42	3-24				6,521							7,601			
A	Roberts County, Red Basin supply	3-42	3-24				1,396							316			
A	Sherman County, Canadian Basin supply	3-42	3-24				147,487							121,895			
A	Wheeler County, Red Basin supply	3-42	3-24				15,921							15,876			
A	Supply amounts for Grand Total	3-42	3-24		1,198,474		1,201,217			798,357		1,196,564		1,027,899			797,190
A	Donley County 2010 Supply	na	3-25		34,751							34,530					
A	2010 Supply amounts for GRAY Co.	na	3-25		40,736							40,744					
A	2010 Supply amounts for HANSFORD Co.	na	3-25		137,130							136,980					
A	2010 Supply amounts for POTTER Co.	na	3-25		65,126							64,799					
A	2010 Supply amounts for RANDALL Co.	na	3-25		51,534							50,814					
A	2010 Supply amounts for Grand Total Co.	na	3-25		1,198,474							1,196,564					
A	2030 Supply amounts for POTTER Co.	na	3-26				70,342							70,017			
A	2030 Supply amounts for RANDALL Co.	na	3-26				48,646							47,937			
A	2030 Supply amounts for Grand Total Co.	na	3-26				1,029,080							1,027,899			
A	2060 Supply amounts for HANSFORD Co.	na	3-27							87,286							87,142
A	2060 Supply amounts for POTTER Co.	na	3-27							73,155							72,833
A	2060 Supply amounts for RANDALL Co.	na	3-27							42,008							41,307

REGION A

Non-matching numbers

		IPP document reference:		IPP document number							Online Planning Database (DB12) number						
Region IPP	Item	Page number	Table number	non-decadal number	2010	2020	2030	2040	2050	2060	non-decadal number	2010	2020	2030	2040	2050	2060
A	2060 Supply amounts for Grand Total Co.	na	3-27							798,357							797,190
A	Hartley Irrigation Conservation WMS Volume	4-6	4-2				98,786	110,553	111,772	111,772				98,787	110,554	111,773	111,773
A	Hutchinson Co Irrigation Cons. WMS Volume	4-6	4-2			7,514			16,128	16,128			7,513			16,127	16,127
A	Mfg -Huchinson Co. - Conservation WMS volume	4-6	4-2		na							0	500	1,000	1,000	1,000	1,000
A	Mfg-Huchinson Co. - Purchase from Borger WMS Volume	4-6	4-2						1,752							2,252	
A	Moore C-O Voluntary Transfer from Other Users WMS volume	4-6	4-2		na	na	na	na	na	na		0	0	50	100	100	100
A	Dumas - Moore New Wells WMS Volume	4-6	4-2							2,478							2,500
A	Irrigation - Moore - Conservation WMS Volume	4-6	4-2				59,485							58,995			
A	Manufacturing - Moore - Conservation WMS volume	4-6	4-2		na	na	na	na	na	na		0	254	446	469	489	522
A	Manufacturing - Moore - Purchase water from Cactus WMS Volume	4-6	4-2		173		1,033	1,396	1,718	2,067		200		1,100	1,400	1,800	2,100
A	Sunray - New Wells Ogallala WMS Volume	4-6	4-2				800	800	800	800				500	500	500	500
A	Sunray - New Wells WMS volume	4-6	4-2			600	600	600	1,200	1,200		na	na	na	na	na	na
A	C-O Potter Canadian basin - New Wells WMS Volume	4-6	4-2			0							1,000				
A	C-O Potter Red Basin - New Wells WMS Volume	4-6	4-2		na	na	na	na	na	na		0	600	600	600	1,200	1,200
A	Manufacturing-Potter-Canadian Purchase from Amarillo WMS Volume	4-6	4-2				33	57	35	43				200	328	313	225
A	Manufacturing-Potter-Red Conservation WMS volume	4-6	4-2		na	na	na	na	na	na		0	120	150	150	150	150
A	Mfg-Potter-Red Purchase from Amarillo WMS volume	4-6	4-2				0	602	1,333	2,155				444	1,087	1,846	2,638
A	C-O Randall - Voluntary Transfer from Other Users WMS volume	4-6	4-2		na	na	na	na	na	na		0	0	3	4	7	9
A	Irrigation - Sherman Conservation WMS volume	4-6	4-2			41,128							41,127				
A	Amarillo Conservation WMS volume	4-6	4-2				2,454	2,640	2,842	3,009				2,453	2,639	2,841	3,012
A	Amarillo Potter Well Field WMS volume	4-6	4-2			10,667	11,495	12,387	13,348	14,384			9,467	10,292	11,182	11,141	10,831
A	Borger - Conservation WMS compared to WWP table	4-6	4-2		0	72	118	114	107	102		na	na	na	na	na	na
A	Palo Duro River Authority - Transmission system WMS volume	4-6	4-2				3,875	3,833	3,792					3,758	3,758	3,758	
A	Sunray - New Wells Ogallala WMS Volume	4-27	WMS Table				800	800	800	800				500	500	500	500
A	Moore C-O Voluntary Transfer from Other Users WMS volume	4-31 & 4-32	WMS Table		na	na	na	na	na	na		0	0	50	100	100	100
A	Co. Other - Moore -new Ogallala Capital Cost	4-32		$ 3,114,800.00							$ 8,218,000						
A	Randall C-O Voluntary Transfer From Other Users WMS volume	4-35 & 4-36	WMS Table		na	na	na	na	na	na		0	0	3	4	7	9
A	Hall C-O New Wells Ogallala - Briscoe Co & Donley Co WMS Volume	4-37 & 4-38	WMS Table		150	600	200	200	200	200		50	50	50	100	100	100
A	Dallam County Irrigation Total WMS volume	4-48	4.8			77,900	127,101	140,186	141,582	141,582			59,275	108,476	121,561	122,958	122,958
A	Hansford County Irrigation Total WMS volume	4-49	4-9			33,246	55,074	61,026	61,762	61,762			24,436	45,264	51,215	51,951	51,951
A	Hartly County Irrigation Total WMS volume	4-50	4.10			70,010	115,042	126,809	128,028	128,028			53,755	98,787	110,554	111,773	111,773
A	Moor County Irrigation Total WMS volume	4-51	4.12			42,950	70,343	78,343	79,194	79,194			31,602	58,995	66,995	67,846	67,846
A	Sherman County Irrigation Total WMS volume	4-52	4.13			55,693	91,668	101,369	102,462	102,462			41,127	77,102	86,803	87,896	87,896
A	CRMWA Robert County Well Field WMS supply	4-55	4-15									0	0	15,000	15,000	15,000	15,000
A	Amarillo - Roberts County Well Field WMS Volume	4-58	4-16			10,667	11,495	12,387	13,348	14,384			9,467	10,292	11,182	11,141	10,831
A	Borger - Conservation WMS volume	4-60	4-17		0	24	71	71	71	71		na	na	na	na	na	na
A	Hutchinson County Irrigation Cons. WMS volume	4-72	4-21			7,514			16,128	16,128			7,513			16,127	16,127
A	Hartley Irrigation Conservation WMS volume	4-72	4-21				98,786	110,553	111,772	111,772				98,787	110,554	111,773	111,773
A	Irrigation - Precipitation Enhancement WMS	4-43	4-5	Alternative							Recommended						
A	Carson Co., Agriculture Conservation Savings	6-6	6.3		23,537	24,179	25,333	25,975	26,616				23,554	24,207	25,361	26,000	26,639
A	Gray Co., Agriculture Conservation Savings	6-6	6.3		7,166	7,361	7,711	7,905	8,100				7,168	7,365	7,715	7,909	8,104
A	Hutchinson Co., Ag. Conservation Savings	6-6	6.3		10,478	17,009	18,870	19,092	19,092				11,002	18,080	19,941	20,163	20,163
A	Potter Co., Agriculture Conservation Savings	6-6	6.3		1,298	1,335	1,402	1,439	1,476				2,266	3,011	3,206	3,382	3,536
A	Roberts Co., Agriculture Conservation Savings	6-6	6.3		3,965	4,087	4,307	4,429	4,551				3,966	4,087	4,308	4,430	4,551
A	Wheeler Co., Agriculture Conservation Savings	6-6	6.3		2,291	2,355	2,469	2,532	2,595				2,300	2,370	2,484	2,547	2,610
A	New GW (Ogallala Aquifer)- Dumas WMS	Appendix A	WMS Summary							2,478							2,500
A	New GW (Ogallala Aquifer)- Sunray WMS	Appendix A	WMS Summary				800	800	800	800				500	500	500	500
A	New GW (Ogallala Aquifer)- County-Other Randall	Appendix A	WMS Summary						2,600	2,600						1,800	2,400
A	New GW (Ogallala Aquifer)- County-Other Porter-Canadian	Appendix A	WMS Summary				600	600	1,200	1,200				1,600	1,600	2,200	2,200
A	New GW (Ogallala Aquifer)- C-O Hall - Red is listed twice in the table.	Appendix A	WMS Summary	$ 2,522,400.00	100	100	100	100	100	100							

REGION A

		IPP document reference:		Non-matching numbers													
				IPP document number							Online Planning Database (DB12) number						
Region IPP	Item	Page number	Table number	non-decadal number	2010	2020	2030	2040	2050	2060	non-decadal number	2010	2020	2030	2040	2050	2060
A	New GW (Ogallala Aquifer) C-O Moor - Capital Cost	Appendix A	WMS Summary	$ 3,114,800.00							$ 8,218,000.00						
A	New GW (Ogallala Aquifer) - Cactus Capital Cost	Appendix A	WMS Summary	$ 5,446,700.00							$ 10,893,400						
A	New GW (Ogallala Aquifer) - C-O Potter (Canadian) WMS Volume	Appendix A	WMS Summary				0							1,000			
A	New GW (Ogallala Aquifer) - C-O Randall Capital Cost & WMS Volume	Appendix A	WMS Summary	$ 7,276,100.00					2,600	2,600	$ 10,888,220					1,800	2,400
A	New GW (Ogallala Aq)-Amarillo (Potter Co. Well Field) Supply	Appendix A	WMS Summary			10,667	11,495	12,387	13,348	14,384			9,467	10,292	11,182	11,141	10,831
A	Municipal Conservation - Amarillo WMS Volume	Appendix A	WMS Summary				2,454	2,640	2,842	3,009				2,453	2,639	2,841	3,012
A	Municipal Conservation - Borger WMS Volume	Appendix A	WMS Summary			72	118	114	107	102			24	71	71	71	71
A	Municipal Conservation - Canyon WMS Volume	Appendix A	WMS Summary			81	146	159	174	186			80	176	191	208	227
A	Municipal Conservation - Amarillo WMS Volume	Appendix A	WMS Summary														
A	Municipal Conservation total Supply	Appendix A	WMS Summary			1,996	3,593	3,881	4,179	4,419			2,061	3,771	4,069	4,374	4,624
A	Voluntary Transfer - Hutchinson Co Mfg. WMS Volume	Appendix A	WMS Summary						1,752							2,252	
A	Voluntary Transfer - Moor Co Mfg. WMS Volume	Appendix A	WMS Summary		173	800	1,033	1,396	1,718	2,067		0	0	50	100	100	100
A	Voluntary Transfer - Borger (Capital Cost & WMS Volume	Appendix A	WMS Summary	$ 4,399,400.00			1,000	1,000	1,000	1,000	$ -			0	0	500	50
A	Voluntary Transfer - Potter Co. Mfg. (Canadian) WMS Volume	Appendix A	WMS Summary				33	57	35	43				200	328	313	225
A	Voluntary Transfer - Potter Co. Mfg. (Red) WMS Volume	Appendix A	WMS Summary				0	602	1,333	2,155				444	1,087	1,846	2,638
A	Municipal conservation strategies volume	AppA, p1-2	app 4A			1,996	3,593	3,881	4,179	4,419			2,061	3,771	4,069	4,374	4,624
A	Amarillo, new groundwater volume	AppA, p1-2	app 4A			10,667	11,495	12,387	13,348	14,384			9,467	10,292	11,182	11,141	10,831
A	New groundwater volume and capital cost	AppA, p1-2	app 4A	$308,730,400	1,550	16,404	38,108	43,459	60,477	63,372	$ 298,547,020	1,450	15,104	22,505	27,854	42,070	44,241
A	Irrigation conservation strategies volume	AppA, p1-2	app 4A			217,709	403,157	453,032	458,551	458,551			297,112	485,081	540,862	549,383	552,385
A	Municipal conservation strategies volume	AppA, p1-2	app 4A			1,996	3,593	3,881	4,179	4,419			2,061	3,771	4,069	4,374	4,624
A	Voluntary transfer strategies volume	AppA, p1-2	app 4A		173	800	2,830	4,399	5,938	7,815		200	800	2,561	4,263	6,918	7,672
A	Palo Duro Transmission system supply volume	AppA, p1-2	app 4A				3,875	3,833	3,792	3,750				3,758	3,758	3,758	3,750
A	Dallam C-O Municipal WMS volume	A-3	WUG Table		0	0	0	0	0	0			6	10	10	10	10
A	Dallam C-O WMS Total volume	A-3	WUG Table		0	0	0	0	0	0			6	10	10	10	10
A	Hall C-O New Ogallala Wells in Briscoe Co. volume	A-3	WUG Table		100	100	100	100	100	100		na	na	na	na	na	na
A	Hall C-O WMS Total volume	A-3	WUG Table		150	150	150	200	200	200		50	50	50	100	100	100
A	Hartley C-O Municipal Conservation WMS volume	A-3	WUG Table		na	na	na	na	na	na		0	16	28	28	27	26
A	Hartley C-O WMS Total volume	A-3	WUG Table		0	0	0	0	0	0		0	16	28	28	27	26
A	Moore C-O Voluntary Transfer From Other Users volume	A-4	WUG Table		na	na	na	na	na	na		0	0	50	100	100	100
A	Moore C-O WMS Total volume	A-4	WUG Table				563	575	1,083	1,087				613	675	1,183	1,187
A	Porter C-O New Wells WMS volume	A-5	WUG Table				600							1,600			
A	Porter C-O Total WMS volume	A-5	WUG Table				743							1,743			
A	Randall C-O New Wells WMS volume	A-5	WUG Table						2,600	2,600						1,800	2,400
A	Randall C-O Voluntary Transfer From Other Users volume	A-5	WUG Table		na	na	na	na	na	na		0	0	3	4	7	9
A	Randall C-O WMS Total volume	A-5	WUG Table				797	1,431	2,868	2,899				800	1,435	2,075	2,708
A	Sherman C-O Municipal Conservation WMS volume	A-5	WUG Table		na	na	na	na	na	na		0	7	12	13	13	13
A	Sherman C-O WMS Total volume	A-5	WUG Table		0	0	0	0	0	0		0	7	12	13	13	13
A	Dalhart WMS Total volume	A-6	WUG Table		0	0	0	0	0	0		0	64	110	111	110	104
A	Stratford WMS (Municipal Conservation) volume	A-10	WUG Table		0	0	0	0	0	0			20	35	36	37	38
A	Sunray - New Wells WMS volume	A-10	WUG Table				800	800	800	800				500	500	500	500
A	Sunray - WMS Total volume	A-10	WUG Table				834	836	838	839				534	536	538	539
A	Texline WMS Total volume	A-10	WUG Table			7	12	12	12	11			257	262	262	262	261
A	Wheeler WMS Total volume	A-11	WUG Table						15	15						215	215
A	City of Cactus -new well filed capital cost	H-17	H-6	$ 5,446,700.00							$ -						
A	City of Wheeler - new Ogallala wells capital cost	H-28	H-17	$ 2,233,300.00							$ 2,108,700						
A	Co Other WUGS - new wells capital cost; Co-Other not specified, matches DBProjectID 194 Source: Ogalalla/Donley/Red County-Other Hall	H-30	H-19	$ 2,522,400.00							na						
A	Co Other WUGS - new wells capital cost	H-31	H-20	$ 2,722,300.00							na						
A	Co Other WUGS - new wells capital cost; Co-Other not specified, matches DBProjectID 194 Source: Ogalalla/Potter/Canadian County-Other Potter	H-32	H-21	$ 3,114,800.00							na						

REGION A

POTENTIALLY OVER ALLOCATED SOURCES

Source Name	Source Region	Source County	Source Basin	Comments	Over allocated by WUG or WWP?	Interregional?
MEREDITH LAKE/RESERVOIR	A	RESERVOIR	CANADIAN	This source is over allocated by 1,339 acre feet in 2010.	WUG	Yes - A/O

June 24, 2010

Mr. Kyle Ingham, Director
Local Government Services
Panhandle Regional Planning Commission
P.O. Box 9257
Amarillo, TX 79105

Re: 2010 Panhandle Region A Initially Prepared Plan

Dear Mr. Ingham:

Thank you for the opportunity to review and comment on the 2010 Initially Prepared Regional Water Plan (IPP) Panhandle Region A Water Planning Area. Texas Parks and Wildlife (TPW) acknowledges the time, money and effort required to produce the regional water plan as mandated by Senate Bill 1 of the 75th Legislature. A number of positive steps have been taken since the first planning cycle to advance the issue of environmental protection. For example, the regional water planning groups are required by TAC §357.7(a)(8)(A), to perform a "quantitative reporting of environmental factors including effects on environmental water needs, wildlife habitat, cultural resources, and effect of upstream development on bays, estuaries, and arms of the Gulf of Mexico" when evaluating water management strategies (WMS). Quantification of environmental impacts is a critical step in planning for our state's future water needs while also protecting environmental resources.

TPW staff has reviewed the IPP with a focus on the following questions:

- Does the plan include a quantitative reporting of environmental factors including the effects on environmental water needs, and habitat?
- Does the plan include a description of natural resources and threats to natural resources due to water quantity or quality problems?
- Does the plan discuss how these threats will be addressed?
- Does the plan describe how it is consistent with long-term protection of natural resources?
- Does the plan include water conservation as a water management strategy? Reuse?
- Does the plan recommend any stream segments be nominated as ecologically unique?
- If the plan includes strategies identified in the 2006 regional water plan, does it address concerns raised by TPW at that time?

According to the Region A IPP, regional population is expected to grow but water demands are expected to decrease, primarily due to expected decreases in irrigation demand. Recommended water management strategies in the Panhandle Region A IPP include municipal and agricultural conservation, development of new groundwater well fields in the Ogallala, Dockum and Seymour aquifers and purchase of water from wholesale providers.

Brief discussions of wetlands, playa basins, springs, aquatic resources, endangered/threatened species, and ecologically unique resources are included in the Region A IPP. A good discussion of the importance of playa basins is included in the IPP. In addition to their biological importance as wetlands, playas also provide local recharge to the Ogallala aquifer. The IPP states that environmental impacts and the protection of the region's resources were a priority in the water management strategies selection process, and potential impacts to sensitive environmental factors were considered for each strategy.

The IPP does not include a quantitative reporting of environmental factors since minimal impacts to fish and wildlife are expected. Where additional groundwater pumping is proposed detailed evaluations were not provided because specific locations for groundwater rights were not available. Potential impacts to spring flows, spring ecosystems and playa lakes should be identified where additional groundwater development was identified as a water management strategy. Emphases should be placed on protecting springs and playa basins that support fish and wildlife.

Municipal and agricultural conservation are the principle strategies for meeting future water needs. The planning group has proposed municipal water conservation strategies that can potentially reduce per capita water use in the region by 5% by 2060. TPW supports the planning group's consideration of brush control/management as an additional means of conserving water if done in a manner that can also benefit wildlife habitat. The IPP also includes reuse of treated effluent as a water source for meeting future industrial and mining needs.

TPW notes that the plan does not recommend nomination of any stream segments as ecologically unique. The Regional Planning Group decided the unknown consequences of designation were outweighed by potential benefits. TPW has identified several stream segments in the region that meet at least one of the criteria for classification as ecologically unique should the regional planning group decide to pursue nomination of an ecologically significant stream in the future.

Thank you for your consideration of these comments. TPW looks forward to continuing to work with the planning group to develop water supply strategies that not only meet the future water supply needs of the region but also preserve the ecological health of the region's aquatic resources. Please contact Cindy Loeffler at (512) 389-8715 if you have any questions or comments.

Sincerely,

Ross Melinchuk,
Deputy Executive Director, Natural Resources

RM:CL:ch

SUBMISSION OF WRITTEN COMMENTS

Panhandle Water Planning Group
Panhandle Water Planning Area - Region A

Written Comments for Suggestions and Recommendations as to Issues to be Addressed or Provisions to be Included in the Regional Water Plan will be accepted through Monday, June 28, 2010 at 5:00 p.m. Comments may be mailed, delivered, or faxed to:

Kyle Ingham, Local Government Services Director
Panhandle Regional Planning Commission
415 West Eighth Avenue
Amarillo, TX 79101
Fax Number: (806) 373-3268
E-Mail: kingham@theprpc.org

COMMENTS (Name and Address Must be Completed - Please See Reverse Side)
I need to know who would rule on the following: I have a surface water right No: 5236 & NO 5235 (Type 6). The water District that I am a member of, issued a permit to a landowner adjacent to me. When we leased this section, we stopped the spring from running. Now this old well has not produced for over 10 yrs. & Now they are re-drilling it. I just wonder who would have precedence My surface water rights were granted in the 1950's. - Thankyou

COMMENTS (CONTINUED)

All comments will be considered by the PWPG. To ensure your comments are appropriately addressed, please complete the information below:

Name: Larry Henard

Address: 16300 FM 3446

City/State/Zip: Wellington, Tx. 79095

Telephone (optional): 806/290/4116 E-Mail Address (optional): Saltforkhunts@wildblue.net

Gary Pitner

13 May 2010
LONGRANGE PLAN STEERING COM. FOR WHOM THIS COVER LETTER WAS WRITTEN. BUT WE WANTED YOU TO HAVE A COPY.

Dear Steering Committee Member:

Alan

The enclosed document is a compilation of what the League of Women Voters of Amarillo learned during our two-year water study which commenced in May 2008 and ended in April of 2010. Because of your interest in the welfare of our area, we are sharing it with you.

Our study consisted of a series of book discussions, film viewings, public forums, small group meetings, and field trips. Managers of the groundwater districts, Bridget Scanlon and other experts met with the Environment Committee. Early on we established a partnership with the Amarillo Public Library. Our forums and book discussions provided an opportunity for city dwellers and farmers to share their concerns, creating a deeper understanding of each other's points of view.

Speakers at our public forums included:

State Senator Kel Seliger, "Whose Water Is It?"
Jarrett Atkinson, Assistant Amarillo City Manager, "Every Drop Counts"
Laura Marbry, Texas Living Waters Project, "Environmental Flow"
Darryl Birkenfeld, Ogallala Commons, "The Ethics of Water Use"
Janet Guthrie, Manager Hemphill Underground Water Conservation District, "HUWCD Groundwater Model "
James Herring, Chair Texas Water Development Board, "The Influence of Groundwater on Texas Water Planning and Policy"

Book Discussions on Saturday afternoons at the library covered the following:
The Worst Hard Times, by Tim Egan
Ogallala Blue, by William Ashworth
Blue Gold, by Maude Barlow & Tony Clarke
Pillar of Sand: Can the Irrigation Miracle Last? By Sandra Postel

There is no question that some day the Panhandle will run out of water. The good news is that a lot of people have started talking about the problem, and many of them are trying to do something to slow down the process. We think you, too, will be encouraged by the final section of the report.

Sincerely yours,

Tonya Kleuskens
Chair, Environment Committee LWV

Joyce Hinsley
President, Amarillo LWV

April 28, 2010

Dear Kyle,

The Amarillo League of Women Voters has finished its Water Study report. We want to thank you for your presentations, your time, information and support. This Water Study was only possible because you spent time with us and answered all of our questions. We sincerely hope that this study will continue to grow in purpose and intent, serving as an additional avenue for conservation education.

Sincerely,

Tonya

Tonya Kleuskens
Amarillo League of Women Voters, Environment Committee

SUBMISSION OF WRITTEN COMMENTS

Panhandle Water Planning Group
Panhandle Water Planning Area - Region A

Written Comments for Suggestions and Recommendations as to Issues to be Addressed or Provisions to be Included in the Regional Water Plan will be accepted through Monday, June 28, 2010 at 5:00 p.m. Comments may be mailed, delivered, or faxed to:

Kyle Ingham, Local Government Services Director
Panhandle Regional Planning Commission
415 West Eighth Avenue
Amarillo, TX 79101
Fax Number: (806) 373-3268
E-Mail: kingham@theprpc.org

COMMENTS
(Name and Address Must be Completed - Please See Reverse Side)

PLEASE NOTE CHANGES NEEDED FOR CITY OF PAMPA - ATTACHED.

* 3.1.7
TABLE 3-16

* NO DATA WAS SHOWN FOR PAMPA IN CHAPTER 4 - EVALUATION OF WATER MANAGEMENT STRATEGIES. PLEASE REVISE.
WE CAN PROVIDE COPY OF MICROSOFT WORD FILE.

COMMENTS (CONTINUED)

All comments will be considered by the PWPG. To ensure your comments are appropriately addressed, please complete the information below:

Name: DONNY HOOPER - DIR. OF PUBLIC WORKS - CITY OF PAMPA

Address: P.O. BOX 2499

City/State/Zip: PAMPA, TX. 79065

Telephone (optional): 806-669-5750 E-Mail Address (optional): ____________

A number of other small reservoirs are currently used for private storage and diversion purposes. In order to use any of the minor reservoirs for water supply purposes, water rights for diverting the water for a specific use may be needed. Other issues may be associated with diverting water from playa lakes. Therefore, these surface water sources have not been included as sources of available water supplies.

3.1.7 Reuse Supplies

Direct reuse is used in the PWPA for irrigation and industrial water uses. Currently, the largest producer of treated effluent for reuse is the city of Amarillo. Most of the city's wastewater is sold to Xcel Energy for steam electric power use. The city of Borger also sells a portion of its wastewater effluent for manufacturing and industrial use. Most of the other reuse in the PWPA is used for irrigation. A summary of the estimated direct reuse in the PWPA is shown in Table 3-16.

Table 3-16 Direct Reuse in the PWPA
(Values are in ac-ft /yr)

County	2010	2020	2030	2040	2050	2060
Carson	67	64	62	61	56	50
Childress	146	148	150	151	151	147
Collingsworth	50	50	50	50	50	50
Dallam	430	421	409	391	379	379
Gray	246 ~~0~~	246 ~~0~~	246 ~~0~~	246 ~~0~~	246 ~~0~~	246 ~~0~~
Hall	0	0	0	0	0	0
Hemphill	0	0	0	0	0	0
Hutchinson	1,045	1,045	1,045	1,045	1,045	1,045
Lipscomb	0	0	0	0	0	0
Moore	547	592	633	664	684	696
Potter	21,803	25,567	27,230	29,125	31,192	34,169
Randall	700	700	700	700	700	700
Roberts	0	0	0	0	0	0
Wheeler	95	95	95	95	95	95
Total	**24,883**	**28,682**	**30,374**	**32,282**	**34,352**	**37,331**

3.1.8 Local Supplies

Local supplies are those surface water supplies that cannot be quantified from the WAM models. These include water sources that do not require a State water right permit, such as local stock ponds for livestock use and self contained storage facilities (old gravel pits, etc.) for mining. The amounts of available supplies for these uses are based on data collected by the TWDB on historical water use. A summary of the local supplies by county is shown in Table 3-17.

4.?.? City of Pampa

The City of Pampa provides water to customers in Gray County, including TDCJ, and Titan Specialties and other manufactories. The City receives blended water from CRMWA and operates wells for groundwater from the Ogallala aquifer. The City also reuses treated wastewater to supply irrigation water to its municipal golf course. Table 4-? Lists the projected demands and supplies for the City of Pampa and its customers. Pampa has sufficient supplies to meet its current demands.

Table 4-?: Summary of Demands and Supplies for the City of Pampa

	Demands (AF/Y)					
Customer	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**
Residential	2,759	2,751	2,742	2,734	2,726	2,718
Commercial	655	655	655	655	655	655
TDCJ	257	257	257	257	257	257
Total Demand	**3,671**	**3,663**	**3,655**	**3,648**	**3,640**	**3,633**
	Current Water Supply (AF/Y)					
Sources	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**
Ogallala – Gray County	1,351	1,351	1,325	1,288	1,250	1,219
Reuse	246	246	246	246	246	246
TDCJ	484	484	484	484	484	484
Lake Meredith (CRMWA)	1,791	1,791	1,791	1,791	1,791	1,791
Ogallala – Roberts Co. (CRMWA)	1,980	1,980	1,980	1,980	1,980	1,980
Total Current Supply	**5,852**	**5,852**	**5,826**	**5,789**	**5,751**	**5,720**
Surplus or Shortage	**2,181**	**2,189**	**2,171**	**2,140**	**2,111**	**2,087**
Recommended Strategies:	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**
Conservation	0	15	65	65	65	65
Purchase additional water from CRMWA	0	0	0	0	1,000	1,000
Additional Ogallala – Gray Co.	968	2,581	0	0	0	0
Total from Strategies	**968**	**2,596**	**65**	**65**	**1,065**	**1,065**

<u>Recommended Strategies</u>

- Implement conservation strategies
- Purchase additional water form CRMWA
- Develop additional groundwater (Ogallala aquifer) and rehab existing wells
- Rehab of infrastructure

IPP Chapter 4
Evaluation of Water Management Strategies

Recommended Conservation Strategies

- Implementation of water conservation plan
- Water conservation pricing
- System water audit

Strategy Descriptions

The recommended strategies include implementing conservation measures, purchasing additional water from CRMWA and developing additional groundwater from the Ogallala in Gray County. Table 4-? Shows the amount of water supply associated with each of the recommended strategies. The yield of the City of Pampa well field is expected to decline over time. It is anticipated that Pampa will continue to operate groundwater system at levels similar to current pump age. To do this, the City will need to install additional wells and rehab existing wells. To provide for additional commercial demands, the City of Pampa can purchase additional water from CRMWA. For planning purposes, it is assumed that additional infrastructure will be needed and rehabbed; however, pending the additional purchase amount, there may be sufficient capacity in the existing infrastructure.

Time intended to complete

Water conservation strategies are in place with water savings being noticed in 2020. The Gray County well field rehab is beginning in 2010. Additional expansion of the well field will be developed as needed. Additional supply from CRMWA will be developed as needed.

Quality, Reliability and Cost

The quantity of water should be sufficient. The reliability of conservation is considered moderate because much of the conservation plan must be implemented by the consumers. The conservation measures do not have any capital costs associated with them.

Environmental Issues

The environmental impacts from conservation and groundwater development are expected to be low. Once the specific locations of additional wells and alignment associated with the infrastructure are identified, a detailed evaluation to determine environmental impacts, if any, will need to be performed.

Impact on Water Resources and Other Management Strategies

Water conservation may impact the amount of water returned to the system that might be available for reuse. The increased demands on the Ogallala will continue to deplete the storage in the aquifer. There are other users that may compete for groundwater supplies, but there is sufficient water in Gray County to support these demands.

Impact on Agriculture and Natural Resources

Water conservation and the possible development of the future well fields are expected to have minimal impact on the agriculture and other natural resources.

Other Relevant Factors

There are no other identified relevant factors.

Interbasin Transfer

The recommended strategies do not require interbasin transfer permits.

May 12, 2010

Kyle Ingham
Panhandle Regional Planning Commission
P.O. Box 9257
415 W. Eighth Ave.
Amarillo, TX 79105

Re: Regional Water Plan – Infrastructure Financing Report - City of Canyon

Dear Kyle:

As we discussed on the phone earlier this week, we have discovered a discrepancy in our submission to the regional water plan for 2011. In the preparation of the cost estimate for the project, the amount for the 1 MG ground storage tank was inadvertently omitted. Including the tank increases the project estimate to $9,528,800. We changed the number on the IFR, inserted 20% of the cost for planning, design and permitting and 80% of the total for acquisition and construction. We have estimated the timeframe for each phase of the project as well.

I have attached a copy of the revised estimate and a sketch of the overall project.

If you have any questions, or need anything else, please call me at 655-5011.

Sincerely,

Dan E. Reese

Dan E. Reese
Director of Public Works

cc: file

Department of Public Works ☆ 301 16th Street ☆ Canyon, Texas 79015 ☆ phone 806.655.5011 ☆ fax 806.655.5044

Comments on the Initially Prepared Regional Water Plan

For the Panhandle Water Planning Area

As submitted March 1, 2010

Prepared by John C. Williams

Primary Comments: Water supply availability

A. **For Surface Water, notably from Lake Meredith:** In Section 3.1.3, at pp 3-18 and 3-19, the document discusses the yield studies for Lake Meredith and correctly states that CRMWA believes the long-term reliable yield of Lake Meredith may be only approximately 50,000 AF/yr, and that for purposes of this Plan, the yield is estimated at 30,000 AF for 2010 and 50,000 AF/yr for the following decades (based on the assumption that the Lake will at least partially recover soon). These numbers are used in Table 3-10 and to calculate the supplies to WUG's as shown in Table 3-22. However, Table 3-18 on page 3-31, and the text of the Executive Summary on pages ES-4 and ES-5, as well as Table ES-1, still refer to the Firm Yield as determined previously from the WAM and need revision.

Also, the information in Table 1-8 on page 1-25 should be footnoted to show that the firm yield as given is questionable and subject to re-evaluation at the end of the current drought.

For Groundwater, notably from the Ogallala Aquifer: The Plan documentation is inconsistent and confusing about what version of the GAM was used to develop and illustrate water availability and shortages. Section 3.1.2, beginning on page 3-12, describes the refinement of the Northern Ogallala GAM as described more fully in Appendix F. In this section, on page 3-14, in the third paragraph, the Plan states that "The updated model was also used to assess groundwater availability based upon the criteria defined by the planning group. " However, the updated model was *not* used to calculate the Total Water in Storage shown in Table 3-1 on page 3-6 nor the Available Water Supplies shown in Tables 3-2 on page 3-7. As indicated somewhat obliquely by the footnote at Table 3-1, these data were derived with the 2004 version of the GAM, as run by Intera in October 2009, presumably with the demands derived for the 2011 Plan. The Plan text is also confusing because the last paragraph on page 3-3 says the "current TWDB Northern Ogallala GAM " in Appendix D was used to determine the availability of water from the Ogallala/Rita Blanca aquifer. It is unclear which version is the "current " version. Appendix D contains output from one run of the 2004 GAM by Interra, but only the county availability data are shown, not the totals for the entire region nor the demands which were input. The data from that run is used in Table 3-2, but Table 3-1 cannot be easily correlated to the GAM run in Appendix D. If I understand correctly, the only data reflected in the Plan (other than Appendix F) which is based on the fully revised "new" GAM is the illustration shown in Figures 3-9 and 3-10, reflecting the effect of unrestricted pumpage at current demand levels. The Plan text is not at all clear which version of the GAM has been used in most cases. The source of the data in Tables 3-24, 3-25, 3-26, 3-27, and in the DB-12 tables is not noted so far as I can see. The information in Table 1-6 on page 1-21 for 2010 is likewise not well identified, but is probably from the same source as Table 3-1. It does not appear that use of data from the updated GAM would substantially revise any county or user shortage (in fact the shortages would probably be less), but the document should make clear what source was used for each step in the process.

Other General comments, mostly editorial: Other comments are as follows:

1. On page ES-8, under "Long-term Protection...." The draft states that the plan recommends using not more than 1.25% of annual saturated thickness. This appears to be a carryover from the 2006 Plan and needs to be updated to comply with the management goals actually adopted for the 2011 Plan.
2. In the County Summaries which are in the ES, the legends are not clear. Meaning of the cross-hatching is not noted. Stippled areas presumably show various aquifers, but the small size of the legends make it difficult to discern which one is stippled. The graphical display of Supplies and Demands or Shortages is not the same for all counties. For Dallam, Hall, Hansford, Hartley, Hutchinson, Moore, Potter, Randall, and Sherman the bar graphs just show percentages of supply and shortages, while the quantities of each are tabulated below the graph. All of the other counties graph the quantities of Supplies and Demands for each WUG in the bar graphs as well as the pie charts . On the map for Roberts County, the Basin Boundary between the Canadian and Red crosses several drainages.
3. In Chapter 1, page 1-2, the Plan states there are 11 interest groups, where it should say 12 as reflected in Table 1-1.
4. On Page 1-11, Par. 1.3.2, and in Table 1-3, the data seems far outdated.
5. In Par.1.5.1. page 1-15, the Plan should mention the requirements of HB 1763, passed by the 79th Tx Legislature in 2005, requiring the GMA's to establish a Desired Future Condition and that each GWD in the GMA adopt goals and objectives consistent with achieving the DFC. Also, the last sentence of this section should state that the GWD's can regulate production as well as the other criteria enumerated.
6. In the second paragraph on Page 1-20, increased cost of power should be included in the list of factors reducing the rate of water level declination.
7. On page 1-39, par. 1.7.2, the document should note that CRMWA, partnered with the Texas State Soil and Water Conservation Board and NRCS (now Agri-Life) have conducted a salt-cedar control program in the Canadian Basin above Lake Meredith which has effectively treated over 10,000 acres of the infestation, at a cost of over $3 million.
8. Table 4-16 shows the Demands, Supplies, and Strategies for Amarillo. The current supplies from CRMWA Lake Meredith shown do not quite conform to the contractual allocations from CRMWA. Amarillo is entitled to receive 37.058% of CRMWA's Lake Meredith supply and 40.621% of the groundwater supply from CRMWA. If CRMWA's available supplies are

as shown in Table 4-15, Amarillo would have about 4000 AF more groundwater available from CRMWA in the 2020-2060 period. Other variations are smaller.

9. On page 5-12 and the top of page 5-13, the draft discusses a study done by BEG for the 2006 Water Plan. Apparently this section was not revised from the 2006 language. It should be made clear that this is not a new study done for the 2011 Plan. In addition, questions recently raised about this study may make it advisable to simply state that the study supports the probability of decreases in water quality with increased pumping, but that projections of the study are not entirely borne out by actual observations. References to Appendix X (of the 2006 Plan?) should be so noted, or deleted.
10. Section 6.4,page 6-9 does not mention the requirement for setting a Desired Future Condition or that the GCD's will have to regulate or manage groundwater so as to achieve the DFC, or to keep pumpage within the MAG.
11. Section 7.4.2, page 7-4 does not mention either the Lake Meredith National Recreation Area (it is not clear whether the 103,000 acres mentioned include the 45,000 acres in LMNRA) or the Alibates Flint Quarries National Monument (the only National Monument in Texas).
12. Paragraph 7-5 on page 7-4 contains a quotation concerning the Arkansas River shiner and the designation of critical habitat for the species, but no source is given for the statement quoted.
13. The City of Fritch has recently been approved for some financing from the TWDB to support purchase of water rights held by Hi Texas Water Supply Corp. Although this loan ($1,160,000) has already been approved and therefore may not need to be supported in the Plan, it may be judicious to include some mention of this as a strategy for the City of Fritch. Their plan includes acquisition of the High Texas Water System, including the water rights, rehab of those wells and drilling at least one new well, and installation of a connecting line. Other financing will also be needed (source presently unknown). The present draft of the Plan does not show any shortage or strategy for Hi Texas or Fritch.

    The information prepared by the staff for the TWDB's consideration stated that "the project is consistent with the 2007 State Water Plan and the 2006 Region A Water Plan, since it is using the water supply source identified in the Regional and State Water Plans." I presume the TCEQ will agree when Fritch seeks a CCN for the new service area, but it could be wise to have some provision in the new Plan.

Kyle Ingham

From: John Williams [jwilliams@crmwa.com]
Sent: Thursday, March 25, 2010 3:22 PM
To: simone.kiel@freese.com
Cc: Kyle Ingham; Chad Pernell; Kent Satterwhite
Subject: IPP Strategies for Borger and Amarillo

In looking at the IPP which was submitted 3/1, I notice some circumstances regarding the supply from CRMWA to Borger and the strategies shown for them to meet their needs. I'm not sure if the information for Borger was supplied by the city in response to PWPG questionnaires, but the strategies shown appear to need some tweaking.

Table 4-17 shows that the municipal demand for Borger will decrease somewhat over the planning period, but demand for their industrial customers will increase, resulting in an overall demand increase for them as a WWP. Table 4-2 shows that they will meet this increased demand first by installing new wells (presumably in their existing wellfield west of Stinnett) and later (2050-2060) by purchasing additional water from CRMWA.

There are two factors which will affect these strategies:

First, Borger is not shown to use all of the water they have the right to take from CRMWA. Based on the available supply which CRMWA is shown to have in Table 4-15 (30 KAF lake and 60KAF groundwater in 2010, increasing to 50KAF lake and 69 KAF ground in 2020 thru 2060), with Borger contractually entitled to 5.549% of each, Borger would have available supply from CRMWA of 2,774 AF lakewater and 3,849 AF wellwater (total 6,603 AF/Y) for the decades 2020 through the end of the planning period. Table 4-17 only shows that they will be using 1,681 AF from Lake Meredith and 2,319 AF from our Roberts County supply (total 4000 AF/Yr). So they could draw up to 2,603 AF/yr additional from CRMWA.

Second, however, their usage will probably be affected by the needs of their industrial customers. With one exception, I think the industrial users currently will not accept lake water. Since the demand growth is all on the industrial side, they may not be able to meet it with the surface supply. They could take an additional 1,530 AF/yr of Roberts County water from CRMWA, which is more than the 1000 AF/yr additional supply they are shown to purchase in Table 4-2. Their ability to supply our Roberts County water to industries will depend on installation of a new supply line from our Roberts County transmission line, or some modification of their own distribution system.

At any rate, the need for Borger to "purchase" additional water from CRMWA does not seem an appropriate strategy. They already have the right to use more than the additional purchase which is proposed. These comments ignore any possible need for contractual modifications.

A somewhat similar but less critical situation exists with the strategies shown for Amarillo. Like Borger, Amarillo could use slightly more water from CRMWA under the existing contracts than is shown in Table 4-16 late in the planning period. They are entitled to 37.058% of our lake water and 40.621% of our Roberts County supply. They could use about 3,000 AF/yr more groundwater from our Roberts County supply than is shown in Table 4-16, but that might not be enough to avoid the need to develop their own Roberts County supply. Furthermore, there could be some delivery problems related to getting that water into Amarillo, so I would not advocate modifying the strategies shown for Amarillo.

August 20, 2010

Response to Comments on the 2010 Initially Prepared Regional Water Plan for the Panhandle Regional Planning Area

Agency Comments

Comments received from Carolyn Brittin, TWDB, June 28, 2010

General comments:

1. All documents for the final plan will be submitted in final format.
2. Sources for all base maps were from the TWDB in accordance with Contract Exhibit D. The source for the maps shown on Figures 3-9 and 3-10 is the TWDB Northern Ogallala GAM (2004 Dutton GAM). This source was added to these figures.
3. A list of potentially feasible water management strategies is included in an attachment following Chapter 4.

Executive Summary:

4. The TWDB requires the regions to report firm yields for all surface water sources. Safe yield or reliable supply is the amount of water that is considered available for use by water user groups. This distinction is clarified in the Executive Summary.

Chapter 1:

5. A new subsection was added to describe the threats to agriculture and natural resources.

Chapter 2:

6. The population and water demands tables by county and river basin are included in the DB12 Data Tables in Appendix A in the final plan.
7. The water demands on wholesale water providers by county and river basin are included in the DB12 Data Tables in Appendix A in the final plan.

Chapter 3:

8. The identification of the Dallam County PGMA was added to the discussion in Chapter 1, Section 1.5.1, Groundwater Regulation. Groundwater availability is discussed in Section 3.1.1. The availability approach for the Ogallala Aquifer followed the recommendations of the Groundwater Management Area #1, which includes the Dallam County PGMA. There are no known water availability limitations set forth by the Dallam County Commissioners within the designated PGMA.

9. Wholesale water providers are discussed in Chapter 4, including the sources of water supplies. Details of the supply sources for wholesale water providers are included in the DB12 Data Tables in Appendix A in the final plan.
10. To our knowledge the plan includes all ongoing surface water development projects. The PWPA regional water plan evaluated surface water using the latest TCEQ-approved water availability models. These models include all water supply projects that TCEQ has issued a permit. Also, there has not been a consumptive surface water right issued by TCEQ in Region A since 1991, and the source of the water for this right is groundwater.
11. The discussion of reliable yield is included on Page 3-19. The values are based on studies conducted by CRMWA and provided to the PWPG by CRMWA staff. The 30,000 acre-feet per year value reported in 2010 is the allocation amount adopted by the CRMWA Board of Directors for supply distribution to its customers. The 50,000 acre-feet per year estimate for subsequent decades assumes that Lake Meredith will recover storage from the current drought. A reference was added to Chapter 3.
12. This was corrected.
13. These tables reflect a supply and demand comparison by county. The projected shortages by water user group are shown in Tables 3-29 through 3-31. The projected surplus or shortage for each water user group by county and river basin is included in the DB12 tables in Appendix A. A footnote was added to Tables 3-25 through 3-27 noting that the sum of individual shortages may differ from the surplus or shortage shown in this table. A reference to the tables with WUG shortages was added.

Chapter 4:

14. A table of alternative strategies is included in an attachment following Chapter 4.
15. A description of the cost assumption for conservation was added on Page 4-9.
16. The plan does include information for all strategies evaluated.
17. Capital costs were corrected.
18. The projected needs for each wholesale water provider by county and river basin are included in the DB12 tables in Appendix A.
19. Capital costs were corrected.

Chapter 6:

20. Conservation strategies are recommended or alternative strategies that conserve water over the long-term. Drought management plans are plans developed by a political subdivision to address short-term responses to drought conditions. Synopses of drought contingency plans that were submitted to the PWPG are included in Chapter 6.

21. Attachment B, online database comments: Data was reconciled. See tables at the end of the responses.
22. Attachment C, inter-regional conflicts: The overallocation of Lake Meredith is the result of inconsistencies with the data entered for Region O customers of CRMWA. The TWDB is working with Region O to resolve this issue. As of August 18, this has been resolved.

Level 2 Comments from the TWDB:

Chapter 3:

1. Totals were added to all tables where appropriate.
2. The Dockum GAM run report 09-014 was completed after the IPP was published and this information was not used for water availability or distribution of supplies. At this time it has not been adopted by the GMA 1. No changes are made.

Chapter 7:

3. Added title and table number to the regulatory table in Chapter 7.

Comments received from Ross Melinchuk, TPWD, June 24, 2010

The PWPG appreciates the TPWD comments on the 2010 Initially Prepared Plan and support of the recommended conservation strategies. The PWPG agrees that protection of the region's natural resources, including springs and playa lakes, is important to the region. The regional water plan generally provides for flexibility in developing water management strategies such that environmental sensitive areas can be avoided if possible. It is assumed that during the development of a project, more detailed assessments of potential impacts will be conducted.

Public Comments

Oral Comments received at the Public Hearing on April 28, 2010:

Mr. Marty Jones, representing George Arrington, Mesa Water and other land owners:

Mr. Jones questioned the adoption of the GMA #1 DFCs for the Ogallala aquifer in lieu of the 1.25% decline approach that was used for the 2006 Regional Water Plan, and he requested that the PWPG adopt a 50/50 standard for all aquifers in the Panhandle region. **Response:** The PWPG carefully considered all options in determining the approach to water availability in light of on-going activities with the GMAs and local GCDs. The PWPG concluded that following the approach adopted by the GMA #1 for the Ogallala was consistent with the intent of HB 1763. No changes were made to the plan.

Ms. Joyce Hinsley, Amarillo League of Women Voters:

Ms. Hinsley iterated support for the 2010 Panhandle Regional Water Plan. The PWPG appreciates the support provided by the Amarillo League of Women Voters.

Mr. Al Alford:

Mr. Alford asked several questions during the public hearing, which were generally answered at that time and recorded in the minutes of the meeting. In response to the question about conservation achievement dates, Mr. Alford provided a spreadsheet and subsequently spoke to Simone Kiel of Freese and Nichols. It was determined that Mr. Alford's assumptions and those used for planning were different. No changes were made to the plan.

Mr. Robert Eakles:

Mr. Eakles discussed the possibility of pumping seawater to meet future water needs. The PWPG appreciates Mr. Eakles input. No changes were made to the plan.

Written Comments received during the Public Comment Period:

Mr. Larry Henard, water rights holder, Wellington, TX:

The Mesquite Groundwater Conservation District regulates the issuance of groundwater permits, including well spacing and pumpage. The Texas Commission on Environmental Quality regulates surface water. The PWPG has no authority in this matter. You may wish to contact your local groundwater conservation district or the TCEQ.

Women League of Voters, Amarillo, TX, May 13, 2010:

The PWPG appreciates your comments and the copy of the Water Study report. No changes made to the plan.

Donny Hooper, City of Pampa, June 16, 2010:

The PWPG appreciates your input to the 2010 Regional Water Plan. The reuse water that your city is providing to the golf course was added to the existing supplies. The PWPG cannot change water demands at this time, but your input will be considered for the 2015 Regional Water

Plan. The City of Pampa currently does not show a need for water over the planning period. We understand the need to rehabilitate and replace lost capacity of existing wells. The supplies shown for water from the Ogallala in Gray County are based on the methodology used for regional water planning. This methodology limits the amount of annual withdrawal based on having 50% of the storage remaining in 50 years. As a result, the supplies from the City's existing well field are limited to 1,000 acre-feet per year in 2010 and reducing to 238 acre-feet per year by 2060. With the updated 2010 Intera GAM model there appears to be some additional supply associated with the current well field. To provide the full request of 2,581 acre-feet per year in 2020, the City will likely need to expand its existing well field. The regional water plan was updated to include the City's requested water management strategies. No changes were made to the City's demands or existing supplies.

Dan Reese, City of Canyon, May 12, 2010:

Mr. Reese provided an updated cost estimate for the recommended new groundwater strategy. The costs were updated in the regional water plan.

Written Comments received from the PWPG during the Public Comment Period:

John Williams Comments, March 1, 2010

Primary Comments:

A. Surface water supplies are clarified in Tables ES-1 and Table 3-18 to show the reliable supply for Lake Meredith and safe yield for Greenbelt Reservoir. These values are used for representing total available supply from these sources for regional water planning.

   To clarify which version of the Northern Ogallala GAM was used for different purposes, the models are now distinguished as the 2004 Dutton GAM and the 2010 Intera GAM. The 2004 Dutton GAM refers to the GAM model that is currently used and maintained by the TWDB. The 2010 Intera GAM is the model version that was updated by Intera as part of this regional water plan. Both models were updated in different ways. For the discussion in Section 3.2.1, the 2004 Dutton GAM was updated with new projected pumping amounts based on the revised agricultural demands developed by Texas AgriLife. The updates for the 2010 Intera GAM are documented in Appendix F and include updates to the aquifer structure and calibration. Changes were made to the plan to clarify these distinctions and better document the data sources.

Availability calculations shown in Appendix D were determined using the 2004 Dutton GAM. These calculations are not based on the projected demands, but rather the criteria set forth by the PWPG. The pumping amounts were initially set and adjusted for each grid cell in the model to meet the 40/50/80 criteria. The results reported in Appendix D represent these pumping values (i.e. demands = availability). The storage output from the 2004 Dutton GAM that was the basis for determine availability was added to Appendix D. These storage values are reported in Table 3-1, along with storage values estimated from the Southern Ogallala GAM. The interaction of flow between grid cells in the GAM model does not provide for a simple arithmetic calculation between Tables 3-1 and 3-2.

The updated pumping demands used for the discussion in Section 3.2.1 and used for the predictive runs in Appendix F were added to Appendix D.

To better document the data sources for tables showing supplies and demands, footnotes were added as appropriate.

Other General comments:

1. The sentence on Page ES-8 states that if no desired future conditions have been adopted, then the plan recommends using 1.25% of the saturated thickness. This is correct. Desired future conditions have been adopted for the Ogallala and Rita Blanca aquifers. These DFCs were used for groundwater availability. Sentence was re-worded to clarify this distinction for the Northern Ogallala GAM.
2. County maps were revised. Graphical displays for surplus/shortages by county are different based on PWPG input for the 2006 plan. The counties with different graphical displays are those counties with shortages.
3. The text is correct. The TWDB requires 11 interest groups. The PWPG elected to add another, making 12 interest groups in total.
4. Updated data with personal income for 1998 and 2008. Some economic data is older because the 2007 Economic Census had not been released at the time of publication.
5. Comments 5 through 7, 9, 10 and 12 were incorporated in the final plan.
6. Comment 8: The supply to Amarillo is limited to 42,987 acre-feet per year due to infrastructure constraints. The split between surface water and groundwater is based on the percentage of supply from each source rather than the contracted percentages. The 42,987 ac-ft/yr limit is less than the contracted percentages.
7. Comment 11: Both the Lake Meredith National recreation Area and Alibates Flint Quarries National Monument are included in Section 7.4.2, on page 7-4.
8. Comment 13: A strategy will be added for Fritch.

John Williams Comments, March 25, 2010 (email to Simone Kiel)

1. Comment regarding the city of Borger's contracted amounts with CRMWA and the need for a water management strategy for additional water from CRMWA. **Response:** Freese and Nichols contacted the city of Borger and confirmed that the city is using its full allotment of groundwater from Roberts County. The currently available supplies to Borger will be changed and the recommended strategy to purchase additional supplies from CRMWA will be removed. The City will continue to have a need, which will be met through developing additional groundwater.
2. Comment regarding the city of Amarillo's contracted amount with CRMWA. **Response:** The supplies to Amarillo are limited by infrastructure, not contractual amounts. No changes will be made to Amarillo's supplies from CRMWA.

REGION A

		IPP document reference:		Non-matching numbers														
				IPP document number							Online Planning Database (DB12) number							
Region IPP	Item	Page number	Table number	non-decadal number	2010	2020	2030	2040	2050	2060	non-decadal number	2010	2020	2030	2040	2050	2060	Response to Comments
A	Dallam County water use	ES-2			358,177							297,251						Text was changed.
A	Available Water Supplies, Local Supply	ES-5	ES-1		21,022	21,022	21,022	21,022	21,022	21,022		21	21	21	21	21	21	ES table includes livestock local supplies. DB12 is only showing local supplies.
A	Available Water Supplies, Other Aquifer	ES-5	ES-1		676	676	673	671	671	671		636	636	636	636	636	636	
A	Water Conservation Strategies Total Volume	ES-8				219,653				462,965			315,253				573,887	
A	Hansford County Summary, available supplies	ES-27	Hansford		137,130	120,292	116,158	107,259	97,160	87,286		136,980	120,143	116,011	107,113	97,016	87,142	DB12 and text are reconciled.
A	Potter County Summary, available supplies	ES-43	Potter		65,126	70,261	70,342	70,764	71,420	73,155		64,799	69,995	70,017	70,440	71,098	72,833	
A	Randall County Summary, available supplies	ES-45	Randall		51,534	50,372	48,646	46,993	44,454	42,008		50,814	49,657	47,937	46,289	43,753	41,307	
A	Wheeler Co., Seymour Aquifer availability	3-9	3-4		na	na	na	na	na	na		88	88	88	88	88	88	changed db12
A	Oldham County, Dockum Aquifer availability	3-11	3-8		74,400	65,400	57,600	50,800	44,800	39,500		74,000	64,800	56,700	49,600	43,400	38,000	changed db12
A	Potter County, Dockum Aquifer availability	3-11	3-8		33,700	29,500	25,900	22,700	19,900	17,400		33,600	29,400	25,800	22,500	19,700	17,300	changed db12
A	Colingsworth County, Red Basin, run-of-river supply	3-24	3-13		867	867	867	867	867	867		798	798	798	798	798	798	corrected DB12
A	Hansford County, Canadian Basin, run-of-river supply	3-24	3-13		172	172	172	172	172	172		22	22	22	22	22	22	corrected table
A	Potter Canadiand combined-run-of-river supply	3-24	3-13		322	322	322	322	322	322		na	na	na	na	na	na	Corrected table
A	Randall Co, Canadian Basin, combined-run-of-river-irrigation supply	3-24	3-13		215	215	215	215	215	215		175	175	175	175	175	175	corrected DB12
A	Wheeler County, Canadian Basin, combined-run-of-river-irrigation supply	3-24	3-13		603	603	603	603	603	603		580	580	580	580	580	580	corrected DB12
A	Direct reuse supply Carson Co	3-29	3-16		67	64	62	61	56	50		71	67	65	64	59	53	corrected DB12
A	Direct reuse supply Collingsworth Co	3-29	3-16		50	50	50	50	50	50		300	300	300	300	300	300	corrected DB12
A	Direct reuse supply Grey Co	3-29	3-16		na	na	na	na	na	na		1,902	1,879	1,615	1,568	1,525	1,525	corrected DB12
A	Direct reuse supply Hall Co	3-29	3-16		na	na	na	na	na	na		7	6	6	6	5	5	corrected DB12
A	Direct reuse supply Hutchinson Co	3-29	3-16		1,045	1,045	1,045	1,045	1,045	1,045		1,332	1,270	1,198	1,112	1,073	1,073	corrected DB12
A	Direct reuse supply Lipscomb Co	3-29	3-16		na	na	na	na	na	na		34	34	34	34	34	34	deleted from db12
A	livestock local supply Childress Co	3-30	3-17		100	100	100	100	100	100		300	300	300	300	300	300	correct table.
A	Grand total supply	3-31	3-18		3,996,033	3,753,024	3,461,626	3,167,983	2,897,305	2,639,165		3,957,672	3,734,378	3,442,347	3,148,172	2,877,215	2,619,071	corrected table and db12
A	Carson County, Red Basin supply	3-42	3-24				39,842							40,142				
A	Childress County, Red Basin supply	3-42	3-24				7,735							7,835				
A	Collingsworth County, Red Basin supply	3-42	3-24		31,754							31,254						
A	Dallam County, Canadian Basin supply	3-42	3-24				139,942							132,949				
A	Donley County, Red Basin supply	3-42	3-24		34,751							34,530						
A	Gray County, Canadian Basin supply	3-42	3-24				17,469							17,032				
A	Gray County, Red Basin supply	3-42	3-24				20,777							20,354				
A	Hall County, Red Basin supply	3-42	3-24				11,863							11,558				
A	Hansford County, Canadian Basin supply	3-42	3-24		137,130		119,152			87,286		136,980		116,011			87,142	
A	Hartley County, Canadian Basin supply	3-42	3-24				221,007							98,576				
A	Hemphill County, Canadian Basin supply	3-42	3-24				6,120							4,131				
A	Hutchinson County, Canadian Basin supply	3-42	3-24				73,180							58,921				
A	Lipscomb County, Canadian Basin supply	3-42	3-24				19,371							18,224				
A	Moore County, Canadian Basin supply	3-42	3-24				86,685							95,062				
A	Ochiltree County, Canadian Basin supply	3-42	3-24				59,113							58,445				
A	Potter County, Canadian Basin supply	3-42	3-24		44,524		48,615			54,434		44,197		48,826			54,112	
A	Potter County, Red Basin supply	3-42	3-24				22,492							21,191				
A	Randall County, Canadian Basin supply	3-42	3-24		73		72			64		27		25			19	
A	Randall County, Red Basin supply	3-42	3-24		51,461		51,440			41,944		50,787		47,912			41,288	DB12 and text are reconciled.
A	Roberts County, Canadian Basin supply	3-42	3-24				6,521							7,601				
A	Roberts County, Red Basin supply	3-42	3-24				1,396							316				
A	Sherman County, Canadian Basin supply	3-42	3-24				147,487							121,895				
A	Wheeler County, Red Basin supply	3-42	3-24				15,921							15,876				
A	Supply amounts for Grand Total	3-42	3-24		1,198,474		1,201,217			798,357		1,196,564		1,027,899			797,190	
A	Donley County 2010 Supply	na	3-25		34,751							34,530						
A	2010 Supply amounts for GRAY Co.	na	3-25		40,736							40,744						
A	2010 Supply amounts for HANSFORD Co.	na	3-25		137,130							136,980						
A	2010 Supply amounts for POTTER Co.	na	3-25		65,126							64,799						
A	2010 Supply amounts for RANDALL Co.	na	3-25		51,534							50,814						
A	2010 Supply amounts for Grand Total Co.	na	3-25		1,198,474							1,196,564						
A	2030 Supply amounts for POTTER Co.	na	3-26				70,342							70,017				
A	2030 Supply amounts for RANDALL Co.	na	3-26				48,646							47,937				
A	2030 Supply amounts for Grand Total Co.	na	3-26				1,029,080							1,027,899				
A	2060 Supply amounts for HANSFORD Co.	na	3-27							87,286							87,142	
A	2060 Supply amounts for POTTER Co.	na	3-27							73,155							72,833	
A	2060 Supply amounts for RANDALL Co.	na	3-27							42,008							41,307	
A	2060 Supply amounts for Grand Total Co.	na	3-27							798,357							797,190	
A	Hartley Irrigation Conservation WMS Volume	4-6	4-2				98,786	110,553	111,772	111,772				98,787	110,554	111,773	111,773	corrected DB12
A	Hutchinson Co Irrigation Cons. WMS Volume	4-6	4-2			7,514			16,128	16,128			7,513			16,127	16,127	corrected DB12
A	Mfg -Huchinson Co. - Conservation WMS volume	4-6	4-2		na							0	500	1,000	1,000	1,000	1,000	Deleted from DB12
A	Mfg-Huchinson Co. - Purchase from Borger WMS Volume	4-6	4-2						1,752							2,252		DB12 correct with 1752.
A	Moore C-O Voluntary Transfer from Other Users WMS volume	4-6	4-2		na	na	na	na	na	na		0	0	50	100	100	100	added to Table 4-2
A	Dumas - Moore New Wells WMS Volume	4-6	4-2							2,478							2,500	Corrected table
A	Irrigation - Moore - Conservation WMS Volume	4-6	4-2				59,485							58,995				Corrected Table 4-2
A	Manufacturing - Moore - Conservation WMS volume	4-6	4-2		na	na	na	na	na	na		0	254	446	469	489	522	Deleted from DB12
A	Manufacturing - Moore - Purchase water from Cactus WMS Volume	4-6	4-2		173		1,033	1,396	1,718	2,067		200		1,100	1,400	1,800	2,100	Corrected table 4-1
A	Sunray - New Wells Ogallala WMS Volume	4-6	4-2				800	800	800	800				500	500	500	500	corrected DB12
A	Sunray - New Wells WMS volume	4-6	4-2			600	600	600	1,200	1,200		na	na	na	na	na	na	Corrected table

REGION A

		IPP document reference:		*Non-matching numbers*														
				IPP document number							Online Planning Database (DB12) number							
Region IPP	Item	Page number	Table number	non-decadal number	2010	2020	2030	2040	2050	2060	non-decadal number	2010	2020	2030	2040	2050	2060	Response to Comments
A	C-O Potter Canadian basin - New Wells WMS Volume	4-6	4-2			0							1,000					Corrected table
A	C-O Potter Red Basin - New Wells WMS Volume	4-6	4-2		na	na	na	na	na	na		0	600	600	600	1,200	1,200	Corrected table
A	Manufacturing-Potter-Canadian Purchase from Amarillo WMS Volume	4-6	4-2				33	57	35	43				200	328	313	225	Corrected table
A	Manufacturing-Potter-Red Conservation WMS volume	4-6	4-2		na	na	na	na	na	na		0	120	150	150	150	150	deleted from DB12
A	Mfg-Potter-Red Purchase from Amarillo WMS volume	4-6	4-2				0	602	1,333	2,155				444	1,087	1,846	2,638	Corrected table
A	C-O Randall - Voluntary Transfer from Other Users WMS volume	4-6	4-2		na	na	na	na	na	na		0	0	3	4	7	9	Corrected DB12
A	Irrigation - Sherman Conservation WMS volume	4-6	4-2			41,128							41,127					Corrected DB13
A	Amarillo Conservation WMS volume	4-6	4-2				2,454	2,640	2,842	3,009				2,453	2,639	2,841	3,012	Corrected table
A	Amarillo Potter Well Field WMS volume	4-6	4-2			10,667	11,495	12,387	13,348	14,384			9,467	10,292	11,182	11,141	10,831	Corrected table
A	Borger - Conservation WMS compared to WWP table	4-6	4-2		0	72	118	114	107	102		na	na	na	na	na	na	This supply is shown on the WUG, not WWP. Added to WWP.
A	Palo Duro River Authority - Transmission system WMS volume	4-6	4-2				3,875	3,833	3,792					3,758	3,758	3,758		Corrected table
A	Sunray - New Wells Ogallala WMS Volume	4-27	WMS Table				800	800	800	800				500	500	500	500	Corrected DB12
A	Moore C-O Voluntary Transfer from Other Users WMS volume	4-31 & 4-32	WMS Table		na	na	na	na	na	na		0	0	50	100	100	100	Deleted in DB12
A	Co. Other - Moore -new Ogallala Capital Cost	4-32		$ 3,114,800.00							$ 8,218,000							Corrected DB12
A	Randall C-O Voluntary Transfer From Other Users WMS volume	4-35 & 4-36	WMS Table		na	na	na	na	na	na		0	0	3	4	7	9	Corrected DB12
A	Hall C-O New Wells Ogallala - Briscoe Co & Donley Co WMS Volume	4-37 & 4-38	WMS Table		150	600	200	200	200	200		50	50	50	100	100	100	Added Turkey in DB12 and corrected table.
A	Dallam County Irrigation Total WMS volume	4-48	4.8			77,900	127,101	140,186	141,582	141,582			59,275	108,476	121,561	122,958	122,958	
A	Hansford County Irrigation Total WMS volume	4-49	4-9			33,246	55,074	61,026	61,762	61,762			24,436	45,264	51,215	51,951	51,951	DB12 shows only recommended. Tables in plan
A	Hartly County Irrigation Total WMS volume	4-50	4.10			70,010	115,042	126,809	128,028	128,028			53,755	98,787	110,554	111,773	111,773	show all potential strategies (including
A	Moor County Irrigation Total WMS volume	4-51	4.12			42,950	70,343	78,343	79,194	79,194			31,602	58,995	66,995	67,846	67,846	precipitation enhancement)
A	Sherman County Irrigation Total WMS volume	4-52	4.13			55,693	91,668	101,369	102,462	102,462			41,127	77,102	86,803	87,896	87,896	
A	CRMWA Robert County Well Field WMS supply	4-55	4-15									0	0	15,000	15,000	15,000	15,000	added to Table 4-15
A	Amarillo - Roberts County Well Field WMS Volume	4-58	4-16			10,667	11,495	12,387	13,348	14,384			9,467	10,292	11,182	11,141	10,831	Corrected table
A	Borger - Conservation WMS volume	4-60	4-17		0	24	71	71	71	71		na	na	na	na	na	na	This supply is shown on the WUG, not WWP. Added to WWP.
A	Hutchinson County Irrigation Cons. WMS volume	4-72	4-21			7,514			16,128	16,128			7,513			16,127	16,127	Corrected DB12.
A	Hartley Irrigation Conservation WMS volume	4-72	4-21				98,786	110,553	111,772	111,772				98,787	110,554	111,773	111,773	Corrected DB12.
A	Irrigation - Precipitation Enhancement WMS	4-43	4-5	Alternative							Recommended							It is both.
A	Carson Co., Agriculture Conservation Savings	6-6	6.3		23,537	24,179	25,333	25,975	26,616				23,554	24,207	25,361	26,000	26,639	DB12 is correct.
A	Gray Co., Agriculture Conservation Savings	6-6	6.3		7,166	7,361	7,711	7,905	8,100				7,168	7,365	7,715	7,909	8,104	Corrected table as needed.
A	Hutchinson Co., Ag. Conservation Savings	6-6	6.3		10,478	17,009	18,870	19,092	19,092				11,002	18,080	19,941	20,163	20,163	Corrected table as needed.
A	Potter Co., Agriculture Conservation Savings	6-6	6.3		1,298	1,335	1,402	1,439	1,476				2,266	3,011	3,206	3,382	3,536	Corrected table as needed.
A	Roberts Co., Agriculture Conservation Savings	6-6	6.3		3,965	4,087	4,307	4,429	4,551				3,966	4,087	4,308	4,430	4,551	Corrected table as needed.
A	Wheeler Co., Agriculture Conservation Savings	6-6	6.3		2,291	2,355	2,469	2,532	2,595				2,300	2,370	2,484	2,547	2,610	Corrected table as needed.
A	New GW (Ogallala Aquifer)- Dumas WMS	Appendix A	WMS Summary							2,478							2,500	Corrected table as needed.
A	New GW (Ogallala Aquifer)- Sunray WMS	Appendix A	WMS Summary				800	800	800	800				500	500	500	500	Corrected DB12
A	New GW (Ogallala Aquifer)- County-Other Randall	Appendix A	WMS Summary						2,600	2,600						1,800	2,400	
A	New GW (Ogallala Aquifer)- County-Other Porter-Canadian	Appendix A	WMS Summary				600	600	1,200	1,200				1,600	1,600	2,200	2,200	Corrected Appendix to match DB12
A	New GW (Ogallala Aquifer)- C-O Hall - Red is listed twice in the table.	Appendix A	WMS Summary	$ 2,522,400.00	100	100	100	100	100	100								
A	New GW (Ogallala Aquifer) C-O Moor - Capital Cost	Appendix A	WMS Summary	$ 3,114,800.00							$ 8,218,000.00							Corrected DB12.
A	New GW (Ogallala Aquifer) - Cactus Capital Cost	Appendix A	WMS Summary	$ 5,446,700.00							$ 10,893,400							
A	New GW (Ogallala Aquifer) - C-O Potter (Canadian) WMS Volume	Appendix A	WMS Summary				0							1,000				
A	New GW (Ogallala Aquifer) - C-O Randall Capital Cost & WMS Volume	Appendix A	WMS Summary	$ 7,276,100.00					2,600	2,600	$ 10,888,220					1,800	2,400	
A	New GW (Ogallala Aq)-Amarillo (Potter Co. Well Field) Supply	Appendix A	WMS Summary			10,667	11,495	12,387	13,348	14,384			9,467	10,292	11,182	11,141	10,831	
A	Municipal Conservation - Amarillo WMS Volume	Appendix A	WMS Summary				2,454	2,640	2,842	3,009				2,453	2,639	2,841	3,012	
A	Municipal Conservation - Borger WMS Volume	Appendix A	WMS Summary			72	118	114	107	102			24	71	71	71	71	
A	Municipal Conservation - Canyon WMS Volume	Appendix A	WMS Summary			81	146	159	174	186			80	176	191	208	227	
A	Municipal Conservation - Amarillo WMS Volume	Appendix A	WMS Summary															
A	Municipal Conservation total Supply	Appendix A	WMS Summary			1,996	3,593	3,881	4,179	4,419			2,061	3,771	4,069	4,374	4,624	
A	Voluntary Transfer - Hutchinson Co Mfg. WMS Volume	Appendix A	WMS Summary						1,752							2,252		
A	Voluntary Transfer - Moor Co Mfg. WMS Volume	Appendix A	WMS Summary		173	800	1,033	1,396	1,718	2,067		0	0	50	100	100	100	
A	Voluntary Transfer - Borger (Capital Cost & WMS Volume	Appendix A	WMS Summary	$ 4,399,400.00			1,000	1,000	1,000	1,000	$ -			0	0	500	50	
A	Voluntary Transfer - Potter Co. Mfg. (Canadian) WMS Volume	Appendix A	WMS Summary				33	57	35	43				200	328	313	225	
A	Voluntary Transfer - Potter Co. Mfg. (Red) WMS Volume	Appendix A	WMS Summary				0	602	1,333	2,155				444	1,087	1,846	2,638	
A	Municipal conservation strategies volume	AppA, p1-2	app 4A			1,996	3,593	3,881	4,179	4,419			2,061	3,771	4,069	4,374	4,624	
A	Amarillo, new groundwater volume	AppA, p1-2	app 4A			10,667	11,495	12,387	13,348	14,384			9,467	10,292	11,182	11,141	10,831	
A	New groundwater volume and capital cost	AppA, p1-2	app 4A	$308,730,400	1,550	16,404	38,108	43,459	60,477	63,372	$ 298,547,020	1,450	15,104	22,505	27,854	42,070	44,241	Corrected Appendix to match DB12
A	Irrigation conservation strategies volume	AppA, p1-2	app 4A			217,709	403,157	453,032	458,551	458,551			297,112	485,081	540,862	549,383	552,385	
A	Municipal conservation strategies volume	AppA, p1-2	app 4A			1,996	3,593	3,881	4,179	4,419			2,061	3,771	4,069	4,374	4,624	
A	Voluntary transfer strategies volume	AppA, p1-2	app 4A		173	800	2,830	4,399	5,938	7,815		200	800	2,561	4,263	6,918	7,672	
A	Palo Duro Transmission system supply volume	AppA, p1-2	app 4A				3,875	3,833	3,792	3,750				3,758	3,758	3,758	3,750	

REGION A

		IPP document reference:		*Non-matching numbers*															
				IPP document number							Online Planning Database (DB12) number								
Region IPP	Item	Page number	Table number	non-decadal number	2010	2020	2030	2040	2050	2060	non-decadal number	2010	2020	2030	2040	2050	2060	Response to Comments
A	Dallam C-O Municipal WMS volume	A-3	WUG Table		0	0	0	0	0	0			6	10	10	10	10	
A	Dallam C-O WMS Total volume	A-3	WUG Table		0	0	0	0	0	0			6	10	10	10	10	
A	Hall C-O New Ogallala Wells in Briscoe Co. volume	A-3	WUG Table		100	100	100	100	100	100		na	na	na	na	na	na	
A	Hall C-O WMS Total volume	A-3	WUG Table		150	150	150	200	200	200		50	50	50	100	100	100	
A	Hartley C-O Municipal Conservation WMS volume	A-3	WUG Table		na	na	na	na	na	na		0	16	28	28	27	26	
A	Hartley C-O WMS Total volume	A-3	WUG Table		0	0	0	0	0	0		0	16	28	28	27	26	
A	Moore C-O Voluntary Transfer From Other Users volume	A-4	WUG Table		na	na	na	na	na	na		0	0	50	100	100	100	
A	Moore C-O WMS Total volume	A-4	WUG Table				563	575	1,083	1,087				613	675	1,183	1,187	
A	Porter C-O New Wells WMS volume	A-5	WUG Table				600							1,600				
A	Porter C-O Total WMS volume	A-5	WUG Table				743							1,743				
A	Randall C-O New Wells WMS volume	A-5	WUG Table						2,600	2,600						1,800	2,400	
A	Randall C-O Voluntary Transfer From Other Users volume	A-5	WUG Table		na	na	na	na	na	na		0	0	3	4	7	9	
A	Randall C-O WMS Total volume	A-5	WUG Table				797	1,431	2,868	2,899				800	1,435	2,075	2,708	
A	Sherman C-O Municipal Conservation WMS volume	A-5	WUG Table		na	na	na	na	na	na		0	7	12	13	13	13	
A	Sherman C-O WMS Total volume	A-5	WUG Table		0	0	0	0	0	0		0	7	12	13	13	13	
A	Dalhart WMS Total volume	A-6	WUG Table		0	0	0	0	0	0		0	64	110	111	110	104	
A	Stratford WMS (Municipal Conservation) volume	A-10	WUG Table		0	0	0	0	0	0			20	35	36	37	38	
A	Sunray - New Wells WMS volume	A-10	WUG Table				800	800	800	800				500	500	500	500	Corrected DB12
A	Sunray - WMS Total volume	A-10	WUG Table				834	836	838	839				534	536	538	539	Corrected DB12
A	Texline WMS Total volume	A-10	WUG Table			7	12	12	12	11			257	262	262	262	261	Corrected Appendix to match DB12
A	Wheeler WMS Total volume	A-11	WUG Table						15	15						215	215	Corrected Appendix to match DB12
A	City of Cactus -new well filed capital cost	H-17	H-6	$ 5,446,700.00							$ -							Capital costs shown on WWP
A	City of Wheeler - new Ogallala wells capital cost	H-28	H-17	$ 2,233,300.00							$ 2,108,700							Corrected DB12
A	Co Other WUGS - new wells capital cost; Co-Other not specified, matches DBProjectID 194 Source: Ogalalla/Donley/Red County-Other Hall	H-30	H-19	$ 2,522,400.00							na							Generic cost estimates were developed for County-Other. As needed, costs were adjusted for total quantities
A	Co Other WUGS - new wells capital cost	H-31	H-20	$ 2,722,300.00							na							
A	Co Other WUGS - new wells capital cost; Co-Other not specified, matches DBProjectID 194 Source: Ogalalla/Potter/Canadian County-Other Potter	H-32	H-21	$ 3,114,800.00							na							

TOTAL CONTRIBUTION RECEIVED

Year	**2006**	**2007**	**2008**	**2009**	**2010**
Groundwater Districts	$27,665	$28,101	$28,398	$28,762	$28,426
City	$15,670	$15,196	$16,512	$15,197	$16,910
County	$3,600	$3,400	$3,895	$3,895	$3,685
Surface Water Districts	$12,600	$12,600	$12,942	$12,942	$12,360
Water Utilities	$1,004	$1,009	$1,045	$1,021	$1,061
E.D.C. Juristiction	$3,014	$4,110	$4,278	$4,004	$3,696
Solicited Contributions	$2,500	$3,100	$3,100	$2,500	$2,500
Total	$66,053	$67,516	$70,170	$68,321	$68,638
Total over 5 years	$340,698				