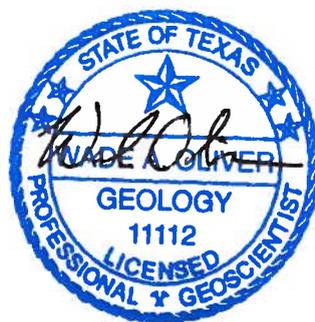


# GAM Run 11-005

by **Wade A. Oliver, P.G.**

Texas Water Development Board  
Groundwater Availability Modeling Section  
(512) 463-3132  
January 26, 2012



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## **EXECUTIVE SUMMARY:**

This report describes the methods and results for a series of four 50-year predictive simulations using the groundwater availability model for the northern portion of the Trinity Aquifer. These simulations were performed at the request of Central Texas Groundwater Conservation District in order to evaluate the average drawdown in the aquifer as a whole in the district. Among the scenarios pumping in the district ranged from approximately 3,600 to 32,000 acre-feet per year, producing average drawdowns between 12 and 28 feet.

## **REQUESTOR:**

Mr. Richard Bowers on behalf of Central Texas Groundwater Conservation District

## **DESCRIPTION OF REQUEST:**

Mr. Bowers requested that the Texas Water Development Board (TWDB) provide the average drawdown in Central Texas Groundwater Conservation District (that is, Burnet County) for four scenarios containing different levels of pumping within the district. The requested pumping included scenarios of 3,600, 10,000, 20,000, and 32,000 acre-feet per year within the district. Mr. Bowers also specified that the average drawdown be reported for the Trinity Aquifer as a whole as opposed to individual units of the aquifer.

## **METHODS:**

In order to determine the impact of the pumping for each of the scenarios requested for Central Texas Groundwater Conservation District above, the groundwater availability model for the northern portion of the Trinity Aquifer was used. The base pumping distribution used in the simulations was the same distribution used for development of the desired future conditions for Groundwater Management Area 8. This is documented in Oliver and Bradley (2010), Wade (2009), and Donnelly (2008).

Scenario 1, containing 3,600 acre-feet per year of pumping within the district, is the same pumping as in the base distribution described above. That is, it achieves drawdowns matching the current desired future conditions of the aquifer. Scenarios 2, 3, and 4 contain approximately 10,000, 20,000, and 32,000 acre-feet per year of pumping in Central Texas Groundwater Conservation District, respectively. When increasing the pumping in the district, the ratio of pumping in each model layer to the total amount of pumping in the Trinity Aquifer in the district was kept at the same level as in the base distribution. In addition, for each model layer, the amount of the increase in pumping was spread evenly among all cells in the layer in the district that contained pumping in the base distribution.

## **PARAMETERS AND ASSUMPTIONS:**

The parameters and assumptions for the model runs using the groundwater availability model for the northern portion of the Trinity Aquifer are described below:

- Version 1.01 of the groundwater availability model for the northern portion of the Trinity Aquifer was used for this analysis. See Bené and others (2004) for assumptions and limitations of the model.
- The model includes seven layers which generally correspond to the Woodbine Aquifer (Layer 1), the Washita and Fredericksburg Groups (Layer 2), the Paluxy Formation (Layer 3), the Glen Rose Formation (Layer 4), the Hensell Formation (Layer 5), the Pearsall/Cow Creek/Hammett/Sligo Members (Layer 6), and the Hosston Formation (Layer 7).
- The mean absolute error (a measure of the difference between simulated and measured water levels during model calibration) for the four main aquifers in the model (Woodbine, Paluxy, Hensell, and Hosston) for the calibration and verification time periods (1980 to 2000) ranged from approximately 38 to 75 feet. The root mean squared error was less than ten percent of the maximum change in water levels across the model (Bené and others, 2004).
- Average annual recharge conditions based on climate data from 1980 to 1999 were assumed for the first 47 years of the simulation. During the last three years of the simulation, drought-of-record recharge conditions were assumed. This is defined as the years 1954 to 1956.

## **RESULTS:**

Table 1 below shows the results of the four scenarios described above. The results include the pumping output from the groundwater availability model by year and the average drawdown in the Trinity Aquifer in the district over the 50-year simulation. With pumping increasing from approximately 3,600 to 32,000 acre-feet per year, the average drawdown in the aquifer in the district increases from 12 feet to 28 feet.

Notice in Table 1 that in each of the scenarios, the pumping output from the model decreases with time during the simulation. This is due to the presence of inactive (or “dry”) cells. A cell becomes inactive when the water level in the cells drops below the base of the aquifer. In this situation, pumping can no longer occur. In the scenarios below, the impact of dry cells increases as the amount of pumping increases.

It is also important to note that, even though pumping in areas outside of Central Texas Groundwater Conservation District was held at the same levels used during development of the existing desired future conditions, increases in pumping within the district can result in increases in drawdown in areas outside the district. Appendix A shows the drawdown for each unit of the Trinity Aquifer, and for the aquifer as a whole, for each county within Groundwater Management Area 8. Tables A-1 through A-4 correspond to scenarios 1 through 4, respectively. Note that there may be small differences between the drawdown results shown in Table A-1 and those shown in GAM Run 08-06 due to the methods used when calculating average drawdown (Donnelly, 2008). All results presented here are within 3 feet of the results shown in Donnelly (2008).

Appendix B contains the same information as Appendix A, but is organized by layer of the Trinity Aquifer to more clearly show the differences in drawdown among model scenarios. Tables B-1 through B-4 correspond to the Paluxy, Glenn Rose, Hensell, and Hosston units of the Trinity Aquifer, respectively. Table B-5 contains the average drawdown by county in the Trinity Aquifer as a whole.

**REFERENCES:**

Bené, J., Harden, B., O'Rourke, D., Donnelly, A., and Yelderman, J., 2004, Northern Trinity/Woodbine Groundwater Availability Model: contract report to the Texas Water Development Board by R.W. Harden and Associates, 391 p.

Donnelly, A., 2008, GAM Run 08-06, Texas Water Development Board GAM Run 08-06 Report, 44 p.

Oliver, W., and Bradley, R.G., 2010, Draft GAM Run 10-063 MAG, Texas Water Development Board GAM Run 10-063 MAG Draft Report, 25 p.

Wade, S., 2009, GAM Run 08-84mag, Texas Water Development Board GAM Run 08-84mag Report, 37 p.

Table 1. Pumping and average drawdown in the Trinity Aquifer in Central Texas Groundwater Conservation District (Burnet County) for each scenario.

		<b>Scenario 1</b>	<b>Scenario 2</b>	<b>Scenario 3</b>	<b>Scenario 4</b>
<b>Pumping (acre-feet per year)</b>	<b>Year 1</b>	3,591	9,992	19,977	31,933
	<b>Year 10</b>	3,587	9,968	19,773	31,449
	<b>Year 20</b>	3,584	9,902	19,620	31,139
	<b>Year 30</b>	3,559	9,845	19,529	30,573
	<b>Year 40</b>	3,556	9,802	19,320	29,861
	<b>Year 50</b>	3,545	9,783	19,143	28,830
<b>Average Drawdown (feet)</b>		12	18	24	28

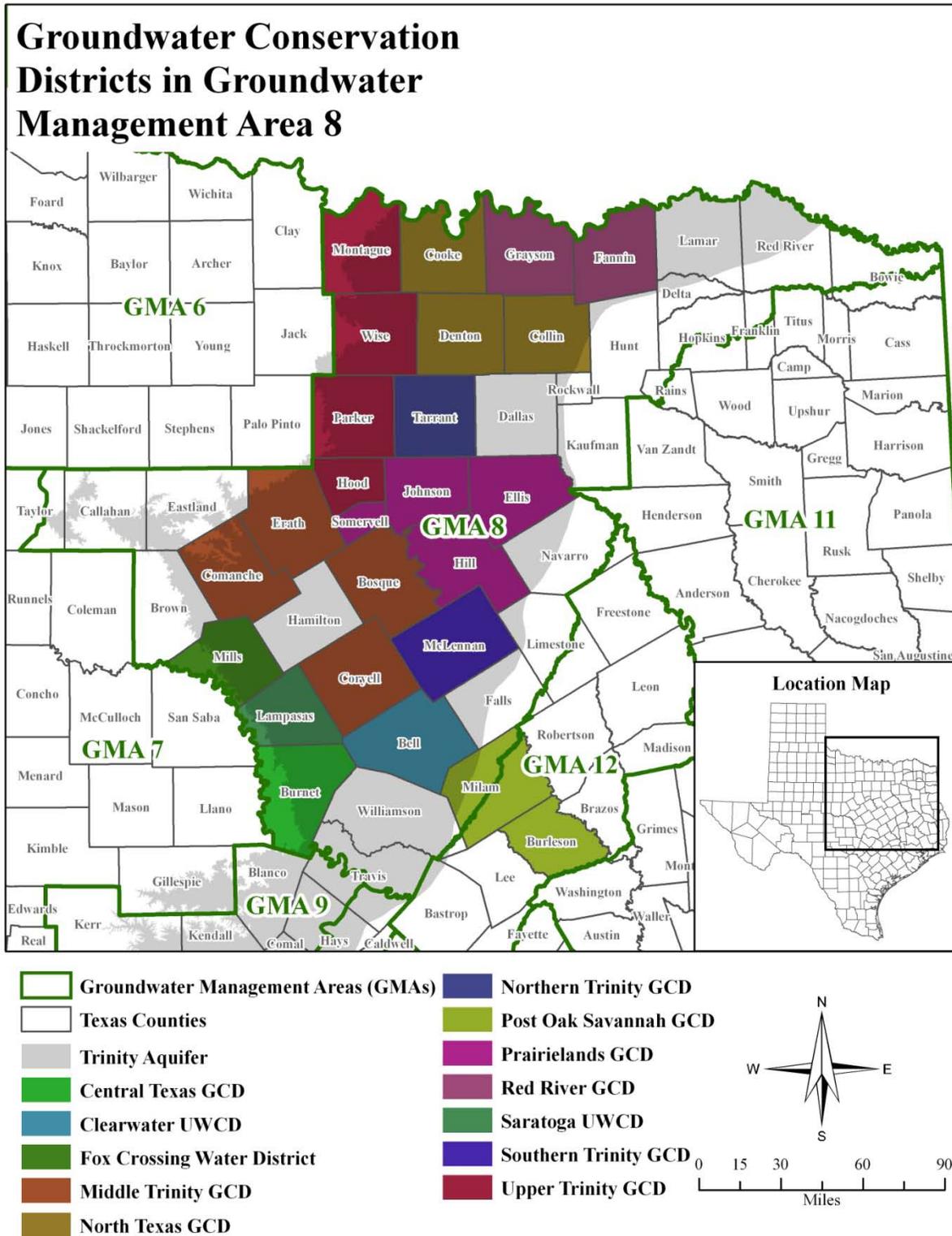


Figure 1. Counties and groundwater conservation districts (GCDs) within Groundwater Management Area 8. UWCD refers to Underground Water Conservation District.

# Appendix A

Average drawdown  
in the Trinity Aquifer by  
county for each scenario

Table A-1. Average drawdown in feet for Scenario 1 (3,600 acre-feet per year in Central Texas Groundwater Conservation District) in each county by unit of the Trinity Aquifer. The average drawdown in each county for the Trinity Aquifer as a whole is also shown.

<b>County</b>	<b>Layer 3 (Paluxy)</b>	<b>Layer 4 (Glen Rose)</b>	<b>Layer 5 (Hensell)</b>	<b>Layer 7 (Hosston)</b>	<b>Trinity Aquifer Average</b>
Bell	133	155	288	318	225
Bosque	26	33	201	220	120
Bowie	44	41	44	45	44
Brown	0	0	1	1	1
Burnet	1	1	11	29	12
Callahan	-	-	0	2	2
Collin	298	247	224	236	251
Comanche	0	0	2	10	5
Cooke	26	43	60	78	52
Coryell	15	15	159	179	97
Dallas	240	224	263	290	254
Delta	175	163	162	159	165
Denton	98	134	180	214	156
Eastland	0	0	0	0	0
Ellis	264	283	337	362	311
Erath	1	1	11	27	12
Falls	279	354	461	480	394
Fannin	212	197	182	181	193
Franklin	116	105	106	106	108
Grayson	175	161	160	165	165
Hamilton	0	2	40	51	25
Hill	209	252	382	406	312
Hood	1	2	16	56	23
Hopkins	153	139	142	140	143
Hunt	286	245	215	223	242
Johnson	37	83	208	234	141
Kaufman	303	286	295	312	299
Lamar	132	130	136	134	133
Lampasas	0	1	12	23	11
Limestone	328	392	476	492	422
McLennan	251	291	491	527	390
Milam	252	295	339	345	308
Mills	0	0	3	12	4
Montague	0	1	3	12	6
Navarro	344	353	400	413	377
Parker	5	6	16	40	18
Red River	82	77	78	78	79
Rockwall	346	272	248	265	283
Somervell	1	4	53	113	49
Tarrant	33	74	160	173	110
Taylor	-	-	-	3	3
Travis	124	61	99	116	98
Williamson	108	88	142	166	126
Wise	4	14	23	53	28

Table A-2. Average drawdown in feet for Scenario 2 (10,000 acre-feet per year in Central Texas Groundwater Conservation District) in each county by unit of the Trinity Aquifer. The average drawdown in each county for the Trinity Aquifer as a whole is also shown.

<b>County</b>	<b>Layer 3 (Paluxy)</b>	<b>Layer 4 (Glen Rose)</b>	<b>Layer 5 (Hensell)</b>	<b>Layer 7 (Hosston)</b>	<b>Trinity Aquifer Average</b>
Bell	134	156	294	326	229
Bosque	26	33	201	220	121
Bowie	44	41	44	45	44
Brown	0	0	1	1	1
Burnet	2	1	15	44	18
Callahan	-	-	0	2	2
Collin	298	247	224	236	251
Comanche	0	0	2	10	5
Cooke	26	43	60	78	52
Coryell	15	15	160	180	97
Dallas	240	224	263	290	254
Delta	175	163	162	159	165
Denton	98	134	180	214	157
Eastland	0	0	0	0	0
Ellis	265	283	337	362	312
Erath	1	1	11	27	12
Falls	280	355	464	483	395
Fannin	212	197	182	181	193
Franklin	116	105	106	106	108
Grayson	175	161	160	165	165
Hamilton	0	2	40	51	25
Hill	209	253	383	406	313
Hood	1	2	16	56	23
Hopkins	153	139	142	140	143
Hunt	286	245	215	223	242
Johnson	37	83	208	234	141
Kaufman	303	286	296	312	299
Lamar	132	130	136	134	133
Lampasas	0	2	12	24	12
Limestone	328	392	477	494	423
McLennan	251	292	493	529	391
Milam	253	297	343	349	311
Mills	0	0	3	12	4
Montague	0	1	3	12	6
Navarro	344	354	400	413	378
Parker	5	6	16	40	18
Red River	82	77	78	78	79
Rockwall	346	272	248	265	283
Somervell	1	4	53	113	49
Tarrant	33	74	160	173	110
Taylor	-	-	-	3	3
Travis	124	62	102	121	101
Williamson	109	89	149	176	131
Wise	4	14	23	53	28

Table A-3. Average drawdown in feet for Scenario 3 (20,000 acre-feet per year in Central Texas Groundwater Conservation District) in each county by unit of the Trinity Aquifer. The average drawdown in each county for the Trinity Aquifer as a whole is also shown.

<b>County</b>	<b>Layer 3 (Paluxy)</b>	<b>Layer 4 (Glen Rose)</b>	<b>Layer 5 (Hensell)</b>	<b>Layer 7 (Hosston)</b>	<b>Trinity Aquifer Average</b>
Bell	135	158	300	334	233
Bosque	26	33	201	221	121
Bowie	44	41	44	45	44
Brown	0	0	1	1	1
Burnet	2	2	18	58	24
Callahan	-	-	0	2	2
Collin	298	247	224	236	251
Comanche	0	0	2	10	5
Cooke	26	43	60	78	52
Coryell	15	15	161	182	98
Dallas	240	224	263	290	254
Delta	175	163	162	160	165
Denton	98	134	180	215	157
Eastland	0	0	0	0	0
Ellis	265	283	337	363	312
Erath	1	1	11	27	12
Falls	281	357	467	487	398
Fannin	212	197	182	181	193
Franklin	116	105	106	106	108
Grayson	175	161	161	165	165
Hamilton	0	2	40	51	25
Hill	209	253	383	407	313
Hood	1	2	16	56	23
Hopkins	153	139	142	140	143
Hunt	286	245	215	223	242
Johnson	37	83	209	234	141
Kaufman	303	286	296	313	299
Lamar	132	130	136	134	133
Lampasas	0	2	12	25	12
Limestone	329	393	479	495	424
McLennan	251	292	495	531	392
Milam	255	299	347	354	314
Mills	0	0	3	12	4
Montague	0	1	3	12	6
Navarro	344	354	401	414	378
Parker	5	6	16	40	18
Red River	82	77	78	78	79
Rockwall	346	272	248	265	283
Somervell	1	4	53	113	49
Tarrant	33	74	160	173	110
Taylor	-	-	-	3	3
Travis	125	63	105	126	103
Williamson	110	91	157	186	136
Wise	4	14	23	53	28

Table A-4. Average drawdown in feet for Scenario 4 (32,000 acre-feet per year in Central Texas Groundwater Conservation District) in each county by unit of the Trinity Aquifer. The average drawdown in each county for the Trinity Aquifer as a whole is also shown.

<b>County</b>	<b>Layer 3 (Paluxy)</b>	<b>Layer 4 (Glen Rose)</b>	<b>Layer 5 (Hensell)</b>	<b>Layer 7 (Hosston)</b>	<b>Trinity Aquifer Average</b>
Bell	136	159	305	340	236
Bosque	26	33	202	221	121
Bowie	44	41	44	45	44
Brown	0	0	1	1	1
Burnet	3	3	21	69	28
Callahan	-	-	0	2	2
Collin	298	247	224	236	251
Comanche	0	0	2	10	5
Cooke	26	43	60	78	52
Coryell	15	15	161	183	98
Dallas	240	224	263	290	254
Delta	175	163	162	160	165
Denton	98	134	180	215	157
Eastland	0	0	0	0	0
Ellis	265	283	338	363	312
Erath	1	1	11	27	12
Falls	281	358	469	489	399
Fannin	212	197	182	181	193
Franklin	116	105	106	106	108
Grayson	175	161	161	165	165
Hamilton	0	2	40	51	25
Hill	209	253	384	408	313
Hood	1	2	16	56	23
Hopkins	153	139	142	140	143
Hunt	286	245	215	223	242
Johnson	37	83	209	234	141
Kaufman	303	286	296	313	299
Lamar	132	130	136	134	133
Lampasas	0	2	12	26	12
Limestone	329	394	480	497	425
McLennan	251	293	496	532	393
Milam	256	301	350	358	316
Mills	0	0	3	12	4
Montague	0	1	3	12	6
Navarro	344	354	402	415	379
Parker	5	6	16	40	18
Red River	82	77	78	78	79
Rockwall	346	272	248	265	283
Somervell	1	4	53	113	49
Tarrant	33	74	160	173	110
Taylor	-	-	-	3	3
Travis	126	64	107	129	105
Williamson	111	92	162	193	140
Wise	4	14	23	53	28

# Appendix B

Average drawdown by  
county for each layer of  
the Trinity Aquifer

Table B-1. Average drawdown in feet for the Paluxy unit of the Trinity Aquifer (Layer 3) in each county by scenario. The pumping shown reflects the amount of pumping in Central Texas Groundwater Conservation District (Burnet County).

<b>County</b>	<b>Scenario 1: 3,600 acre-feet per year</b>	<b>Scenario 2: 10,000 acre-feet per year</b>	<b>Scenario 3: 20,000 acre-feet per year</b>	<b>Scenario 4: 32,000 acre-feet per year</b>
Bell	133	134	135	136
Bosque	26	26	26	26
Bowie	44	44	44	44
Brown	0	0	0	0
Burnet	1	2	2	3
Callahan	-	-	-	-
Collin	298	298	298	298
Comanche	0	0	0	0
Cooke	26	26	26	26
Coryell	15	15	15	15
Dallas	240	240	240	240
Delta	175	175	175	175
Denton	98	98	98	98
Eastland	0	0	0	0
Ellis	264	265	265	265
Erath	1	1	1	1
Falls	279	280	281	281
Fannin	212	212	212	212
Franklin	116	116	116	116
Grayson	175	175	175	175
Hamilton	0	0	0	0
Hill	209	209	209	209
Hood	1	1	1	1
Hopkins	153	153	153	153
Hunt	286	286	286	286
Johnson	37	37	37	37
Kaufman	303	303	303	303
Lamar	132	132	132	132
Lampasas	0	0	0	0
Limestone	328	328	329	329
McLennan	251	251	251	251
Milam	252	253	255	256
Mills	0	0	0	0
Montague	0	0	0	0
Navarro	344	344	344	344
Parker	5	5	5	5
Red River	82	82	82	82
Rockwall	346	346	346	346
Somervell	1	1	1	1
Tarrant	33	33	33	33
Taylor	-	-	-	-
Travis	124	124	125	126
Williamson	108	109	110	111
Wise	4	4	4	4

Table B-2. Average drawdown in feet for the Glen Rose unit of the Trinity Aquifer (Layer 4) in each county by scenario. The pumping shown reflects the amount of pumping in Central Texas Groundwater Conservation District (Burnet County).

<b>County</b>	<b>Scenario 1: 3,600 acre-feet per year</b>	<b>Scenario 2: 10,000 acre-feet per year</b>	<b>Scenario 3: 20,000 acre-feet per year</b>	<b>Scenario 4: 32,000 acre-feet per year</b>
Bell	155	156	158	159
Bosque	33	33	33	33
Bowie	41	41	41	41
Brown	0	0	0	0
Burnet	1	1	2	3
Callahan	-	-	-	-
Collin	247	247	247	247
Comanche	0	0	0	0
Cooke	43	43	43	43
Coryell	15	15	15	15
Dallas	224	224	224	224
Delta	163	163	163	163
Denton	134	134	134	134
Eastland	0	0	0	0
Ellis	283	283	283	283
Erath	1	1	1	1
Falls	354	355	357	358
Fannin	197	197	197	197
Franklin	105	105	105	105
Grayson	161	161	161	161
Hamilton	2	2	2	2
Hill	252	253	253	253
Hood	2	2	2	2
Hopkins	139	139	139	139
Hunt	245	245	245	245
Johnson	83	83	83	83
Kaufman	286	286	286	286
Lamar	130	130	130	130
Lampasas	1	2	2	2
Limestone	392	392	393	394
McLennan	291	292	292	293
Milam	295	297	299	301
Mills	0	0	0	0
Montague	1	1	1	1
Navarro	353	354	354	354
Parker	6	6	6	6
Red River	77	77	77	77
Rockwall	272	272	272	272
Somervell	4	4	4	4
Tarrant	74	74	74	74
Taylor	-	-	-	-
Travis	61	62	63	64
Williamson	88	89	91	92
Wise	14	14	14	14

Table B-3. Average drawdown in feet for the Hensell unit of the Trinity Aquifer (Layer 5) in each county by scenario. The pumping shown reflects the amount of pumping in Central Texas Groundwater Conservation District (Burnet County).

<b>County</b>	<b>Scenario 1: 3,600 acre-feet per year</b>	<b>Scenario 2: 10,000 acre-feet per year</b>	<b>Scenario 3: 20,000 acre-feet per year</b>	<b>Scenario 4: 32,000 acre-feet per year</b>
Bell	288	294	300	305
Bosque	201	201	201	202
Bowie	44	44	44	44
Brown	1	1	1	1
Burnet	11	15	18	21
Callahan	0	0	0	0
Collin	224	224	224	224
Comanche	2	2	2	2
Cooke	60	60	60	60
Coryell	159	160	161	161
Dallas	263	263	263	263
Delta	162	162	162	162
Denton	180	180	180	180
Eastland	0	0	0	0
Ellis	337	337	337	338
Erath	11	11	11	11
Falls	461	464	467	469
Fannin	182	182	182	182
Franklin	106	106	106	106
Grayson	160	160	161	161
Hamilton	40	40	40	40
Hill	382	383	383	384
Hood	16	16	16	16
Hopkins	142	142	142	142
Hunt	215	215	215	215
Johnson	208	208	209	209
Kaufman	295	296	296	296
Lamar	136	136	136	136
Lampasas	12	12	12	12
Limestone	476	477	479	480
McLennan	491	493	495	496
Milam	339	343	347	350
Mills	3	3	3	3
Montague	3	3	3	3
Navarro	400	400	401	402
Parker	16	16	16	16
Red River	78	78	78	78
Rockwall	248	248	248	248
Somervell	53	53	53	53
Tarrant	160	160	160	160
Taylor	-	-	-	-
Travis	99	102	105	107
Williamson	142	149	157	162
Wise	23	23	23	23

Table B-4. Average drawdown in feet for the Hosston unit of the Trinity Aquifer (Layer 7) in each county by scenario. The pumping shown reflects the amount of pumping in Central Texas Groundwater Conservation District (Burnet County).

<b>County</b>	<b>Scenario 1: 3,600 acre-feet per year</b>	<b>Scenario 2: 10,000 acre-feet per year</b>	<b>Scenario 3: 20,000 acre-feet per year</b>	<b>Scenario 4: 32,000 acre-feet per year</b>
Bell	318	326	334	340
Bosque	220	220	221	221
Bowie	45	45	45	45
Brown	1	1	1	1
Burnet	29	44	58	69
Callahan	2	2	2	2
Collin	236	236	236	236
Comanche	10	10	10	10
Cooke	78	78	78	78
Coryell	179	180	182	183
Dallas	290	290	290	290
Delta	159	159	160	160
Denton	214	214	215	215
Eastland	0	0	0	0
Ellis	362	362	363	363
Erath	27	27	27	27
Falls	480	483	487	489
Fannin	181	181	181	181
Franklin	106	106	106	106
Grayson	165	165	165	165
Hamilton	51	51	51	51
Hill	406	406	407	408
Hood	56	56	56	56
Hopkins	140	140	140	140
Hunt	223	223	223	223
Johnson	234	234	234	234
Kaufman	312	312	313	313
Lamar	134	134	134	134
Lampasas	23	24	25	26
Limestone	492	494	495	497
McLennan	527	529	531	532
Milam	345	349	354	358
Mills	12	12	12	12
Montague	12	12	12	12
Navarro	413	413	414	415
Parker	40	40	40	40
Red River	78	78	78	78
Rockwall	265	265	265	265
Somervell	113	113	113	113
Tarrant	173	173	173	173
Taylor	3	3	3	3
Travis	116	121	126	129
Williamson	166	176	186	193
Wise	53	53	53	53

Table B-5. Average drawdown in feet for the Trinity Aquifer (as a whole) in each county by scenario. The pumping shown reflects the amount of pumping in Central Texas Groundwater Conservation District (Burnet County).

<b>County</b>	<b>Scenario 1: 3,600 acre-feet per year</b>	<b>Scenario 2: 10,000 acre-feet per year</b>	<b>Scenario 3: 20,000 acre-feet per year</b>	<b>Scenario 4: 32,000 acre-feet per year</b>
Bell	225	229	233	236
Bosque	120	121	121	121
Bowie	44	44	44	44
Brown	1	1	1	1
Burnet	12	18	24	28
Callahan	2	2	2	2
Collin	251	251	251	251
Comanche	5	5	5	5
Cooke	52	52	52	52
Coryell	97	97	98	98
Dallas	254	254	254	254
Delta	165	165	165	165
Denton	156	157	157	157
Eastland	0	0	0	0
Ellis	311	312	312	312
Erath	12	12	12	12
Falls	394	395	398	399
Fannin	193	193	193	193
Franklin	108	108	108	108
Grayson	165	165	165	165
Hamilton	25	25	25	25
Hill	312	313	313	313
Hood	23	23	23	23
Hopkins	143	143	143	143
Hunt	242	242	242	242
Johnson	141	141	141	141
Kaufman	299	299	299	299
Lamar	133	133	133	133
Lampasas	11	12	12	12
Limestone	422	423	424	425
McLennan	390	391	392	393
Milam	308	311	314	316
Mills	4	4	4	4
Montague	6	6	6	6
Navarro	377	378	378	379
Parker	18	18	18	18
Red River	79	79	79	79
Rockwall	283	283	283	283
Somervell	49	49	49	49
Tarrant	110	110	110	110
Taylor	3	3	3	3
Travis	98	101	103	105
Williamson	126	131	136	140
Wise	28	28	28	28