GAM Run 07-21

by Roberto Anaya, P.G.
Texas Water Development Board
Groundwater Availability Modeling Section
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October 30, 2007

EXECUTIVE SUMMARY:

We ran the groundwater availability model for the model for the northern segment of the Edwards (Balcones Fault Zone) Aquifer to simulate natural discharge from Salado Creek in Bell County and aggregated springs and streams in Williamson and Travis counties. Distributed pumpage and recharge rates were developed by staff at Turner, Collie and Braden, Incorporated and we uniformly increased pumpage rates for Williamson County by a factor of 1.1659. The results show a period of below-average discharge from about 2014 to 2016 followed by above-average discharge from about 2017 to 2020 relative to the period from 2001 to 2010.

REQUESTOR:

Ms. Cheryl Maxwell of the Clearwater Underground Water Conservation District acting on behalf of Groundwater Management Area 8.

DESCRIPTION OF REQUEST:

Ms. Cheryl Maxwell requested we use the groundwater availability model for the northern segment of the Edwards (Balcones Fault Zone) Aquifer to determine projected discharge from model drain cells representing Salado Creek in Bell County and drain cells representing aggregated springs and streams in Williamson and Travis counties for a simulation period beginning 2001 through 2020. Ms. Cheryl Maxwell asked that we use pumpage and recharge model input files developed by staff at Turner, Collie and Braden, Incorporated.

METHODS:

To address the request, we:

- used pumpage (uniformly adjusted by a factor of 1.1659) and recharge distributions provided to us by staff at Turner, Collie and Braden, Incorporated;

- ran the model for 141 years, starting with a 100-year initial stress period (pre-1980) followed by 21 years of monthly stress periods (1980 to 2000), then 10 years of annual stress periods (2001 to 2010), and ending with 10 years of monthly stress periods (2011 to 2020);

- extracted projected discharge for each stress period for drain cells representing Salado Creek in Bell County, and drain cells representing aggregated springs and streams in Williamson and Travis counties;

- generated a table of discharge from drain cells representing Salado Creek in Bell County and drain cells representing aggregated springs and streams in Williamson and Travis counties for stress periods 254 through 383 (2001 to 2020); and

- generated hydrographs of discharge from drain cells representing Salado Creek in Bell County, and drain cells representing aggregated springs and streams in Williamson and Travis counties for stress periods 254 through 383 (2001 to 2020).

PARAMETERS AND ASSUMPTIONS:

- We used version 1.01 of the groundwater availability model for the northern segment of the Edwards (Balcones Fault Zone) Aquifer.

- See Jones (2003) for a more detailed discussion of assumptions and limitations of the groundwater availability model for the northern segment of the Edwards (Balcones Fault Zone) Aquifer.

- The model consists of one layer representing the northern segment of the Edwards (Balcones Fault Zone) Aquifer and assumes no hydraulic communication with the underlying Trinity Aquifer.

- The model utilizes the Drain package of MODFLOW to simulate discharge from springs and perennial streams with the assumption that the perennial streams are always gaining water from the aquifer.

- The root mean square error (a measure of the difference between simulated and actual water levels during model calibration) in the groundwater availability model is 32 feet for the steady-state calibration period (Jones, 2003).

- Distributed recharge rates were provided to us by staff at Turner, Collie and Braden, Incorporated and were not verified or analyzed for integrity or quality assurance. For more detailed information regarding distributed recharge rates for this model run, contact Randy Williams at Turner, Collie and Braden, Incorporated at 512-472-4519 or email at randy.williams@tcb.aecom.com.

- We developed the distributed pumpage rates by uniformly multiplying pumpage rates only for Williamson County provided to us by staff at Turner, Collie and Braden, Incorporated (GAM run report 07-15) by a factor of 1.1659 for the stress periods from 2001 to 2020. The annual county pumpage rates for this model run totaled: (1) 7,509 acre-feet per year for Bell County; (2) 21,372 acre-feet per year

for Williamson County; and (3) 4,870 acre-feet per year for Travis County for the period from 2001 to 2010.

RESULTS:

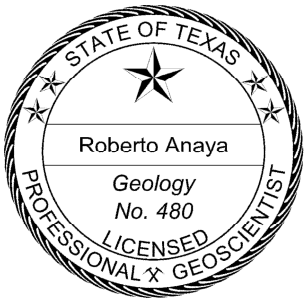
Discharge from the model drain cells representing Salado Creek in Bell County and aggregated natural springs and streams in Williamson and Travis counties (Figure 1) is listed in Table 1 for each annual stress period beginning with stress period number 254 to 263 (2001 to 2010) and for each monthly stress period beginning with stress period number 264 to 383 (2011 to 2020). The hydrographs (Figures 2, 3, and 4) show a period of below-average discharge from about 2014 to 2016 followed by above-average discharge from about 2017 to 2020 relative to the period from 2001 to 2010.

The difference between this run and the previously requested GAM run 07-15 is insignificant and cannot be discerned from the regional scale model or from the hydrographs due to the resolution of the ordinate (y-axis) scale for discharge. The small differences can only be observed by comparing Table 1 from each of the GAM run reports (Anaya, 2007).

REFERENCES:

Jones, I. C., 2003, Groundwater availability modeling: Northern Segment of the Edwards Aquifer: Texas Water Development Board, Report 358, 75 p.

Anaya, R., 2007, GAM run 07-15: Texas Water Development Board, GAM Run 07-15 Report, 11 p.



The seal appearing on this document was authorized by Roberto Anaya, P.G. on October 30, 2007.

Table 1. Discharge from model drain cells representing Salado Creek in Bell County and aggregated natural springs and streams in Williamson and Travis counties.

Time period	Stress period number	Salado Creek discharge (acre-feet per year)	Williamson County discharge (acre-feet per year)	Travis County discharge (acre-feet per year)
2001	254	23,718	36,894	2,290
2002	255	19,667	29,658	1,771
2003	256	22,104	34,864	2,180
2004	257	22,286	35,224	2,219
2005	258	17,880	26,254	1,530
2006	259	23,529	37,764	2,450
2007	260	11,734	13,966	1,222
2008	261	7,852	6,651	,979
2009	262	16,329	22,264	1,168
2010	263	11,064	12,159	1,082
JAN2011	264	3,873	806	1,023
FEB2011	265	11,230	11,321	1,000
MAR2011	266	13,997	16,941	1,000
APR2011	267	7,812	6,291	987
MAY2011	268	17,083	23,427	1,020
JUN2011	269	16,754	23,148	1,098
JUL2011	270	6,641	4,668	1,044
AUG2011	271	3,747	678	986
SEP2011	272	22,083	32,394	1,017
OCT2011	273	7,788	5,710	987
NOV2011	274	6,271	2,619	950
DEC2011	275	3,154	48	887
JAN2012	276	1,591	0	811
FEB2012	277	7,718	2,698	772
MAR2012	278	9,345	7,293	760
APR2012	279	26,663	42,295	1,643
MAY2012	280	28,155	46,074	2,859
JUN2012	281	15,282	17,781	1,083
JUL2012	282	11,067	11,646	1,106
AUG2012	283	4,019	918	1,049
SEP2012	284	8,992	6,629	997
OCT2012	285	1,733	0	897
NOV2012	286	21,769	28,298	913
DEC2012	287	21,514	30,675	1,397
JAN2013	288	8,600	6,439	984
FEB2013	289	10,934	9,967	993
MAR2013	290	8,975	7,708	987
APR2013	291	17,773	24,389	1,021
MAY2013	292	17,982	25,074	1,183
JUN2013	293	8,952	8,137	1,072
JUL2013	294	8,025	6,270	1,051
AUG2013	295	14,458	18,663	1,047
SEP2013	296	15,100	19,547	1,050
OCT2013	297	34,820	64,004	3,973

Time period	Stress period number	Salado Creek discharge (acre-feet per year)	Williamson County discharge (acre-feet per year)	Travis County discharge (acre-feet per year)
NOV2013	298	14,804	15,307	1,199
DEC2013	299	25,673	39,518	2,164
JAN2014	300	11,228	10,439	1,248
FEB2014	301	5,565	2,028	1,189
MAR2014	302	2,435	8	1,091
APR2014	303	6,534	2,358	1,011
MAY2014	304	8,693	6,719	952
JUN2014	305	3,579	383	883
JUL2014	306	3,886	554	820
AUG2014	307	3,545	289	757
SEP2014	308	4,649	901	705
OCT2014	309	5,124	1,524	664
NOV2014	310	5,602	2,015	639
DEC2014	311	2,422	0	605
JAN2015	312	7,113	2,543	602
FEB2015	313	19,211	24,805	672
MAR2015	314	8,623	6,644	722
APR2015	315	9,275	8,318	751
MAY2015	316	24,247	37,470	1,535
JUN2015	317	22,725	34,245	1,892
JUL2015	318	11,814	12,614	1,042
AUG2015	319	15,593	20,649	1,079
SEP2015	320	9,239	8,515	1,065
OCT2015	321	4,109	823	1,001
NOV2015	322	4,098	541	928
DEC2015	323	4,416	591	857
JAN2016	324	6,017	1,728	801
FEB2016	325	8,468	5,569	774
MAR2016	326	2,552	0	730
APR2016	327	1,313	0	681
MAY2016	328	5,889	966	654
JUN2016	329	4,259	696	632
JUL2016	330	3,247	55	606
AUG2016	331	4,581	876	585
SEP2016	332	1,216	0	540
OCT2016	333	2,215	0	514
NOV2016	334	6,008	1,277	502
DEC2016	335	8,054	4,543	517
JAN2017	336	4,773	1,080	532
FEB2017	337	9,060	6,955	568
MAR2017	338	16,107	19,958	654
APR2017	339	50,238	106,083	6,175
MAY2017	340	34,994	57,951	3,635
JUN2017	341	33,387	55,265	3,556
JUL2017	342	13,217	11,830	1,287
AUG2017	343	8,971	6,450	1,220
SEP2017	344	30,574	50,622	2,505
OCT2017	345	47,184	97,679	6,322

Time period	Stress period number	Salado Creek discharge (acre-feet per year)	Williamson County discharge (acre-feet per year)	Travis County discharge (acre-feet per year)
NOV2017	346	31,986	50,286	3,338
DEC2017	347	17,540	19,379	1,465
JAN2018	348	17,325	21,694	1,428
FEB2018	349	33,546	60,068	3,756
MAR2018	350	19,479	26,030	1,555
APR2018	351	18,095	25,016	1,479
MAY2018	352	18,246	26,164	1,485
JUN2018	353	26,385	44,650	2,931
JUL2018	354	15,919	21,711	1,440
AUG2018	355	13,417	17,356	1,395
SEP2018	356	40,429	81,351	5,214
OCT2018	357	29,114	46,860	3,211
NOV2018	358	16,051	18,473	1,488
DEC2018	359	12,188	13,013	1,419
JAN2019	360	5,838	2,918	1,305
FEB2019	361	14,599	18,050	1,248
MAR2019	362	4,183	1,495	1,148
APR2019	363	21,018	31,554	1,152
MAY2019	364	16,409	22,674	1,170
JUN2019	365	21,142	33,198	1,718
JUL2019	366	16,483	23,585	1,282
AUG2019	367	30,981	56,814	3,705
SEP2019	368	21,992	32,456	1,907
OCT2019	369	39,768	78,390	5,276
NOV2019	370	21,926	29,426	1,752
DEC2019	371	22,745	33,271	1,904
JAN2020	372	16,643	21,766	1,480
FEB2020	373	18,813	27,328	1,510
MAR2020	374	11,379	13,080	1,401
APR2020	375	18,306	27,606	1,395
MAY2020	376	9,020	9,258	1,319
JUN2020	377	23,677	39,561	1,946
JUL2020	378	13,940	18,771	1,321
AUG2020	379	14,605	20,479	1,307
SEP2020	380	10,463	11,870	1,259
OCT2020	381	54,944	124,558	7,304
NOV2020	382	31,290	49,173	3,122
DEC2020	383	35,339	62,430	4,126

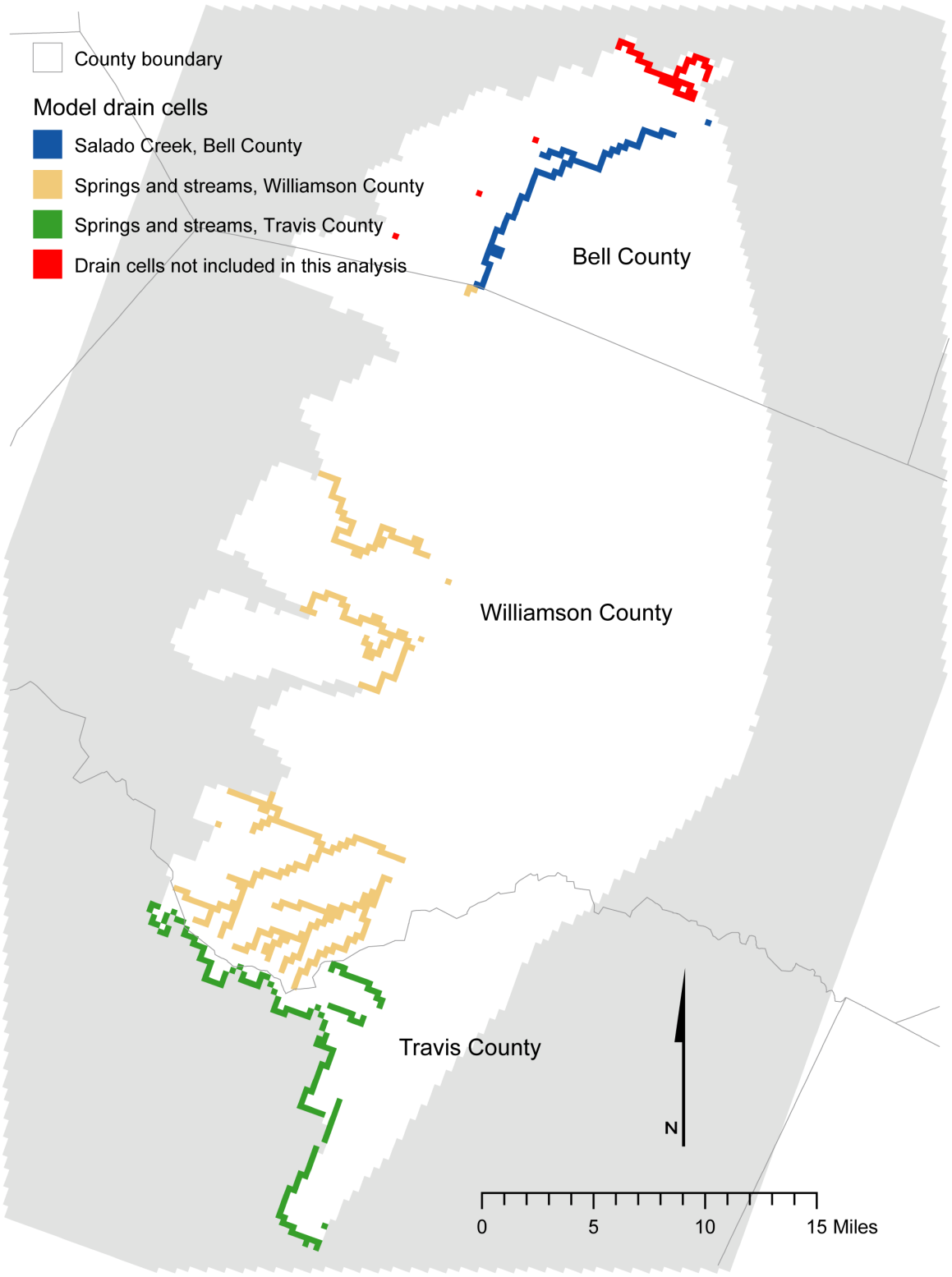


Figure 1: Model drain cells representing Salado Creek discharge in Bell County and natural spring-stream discharge in Williamson and Travis counties

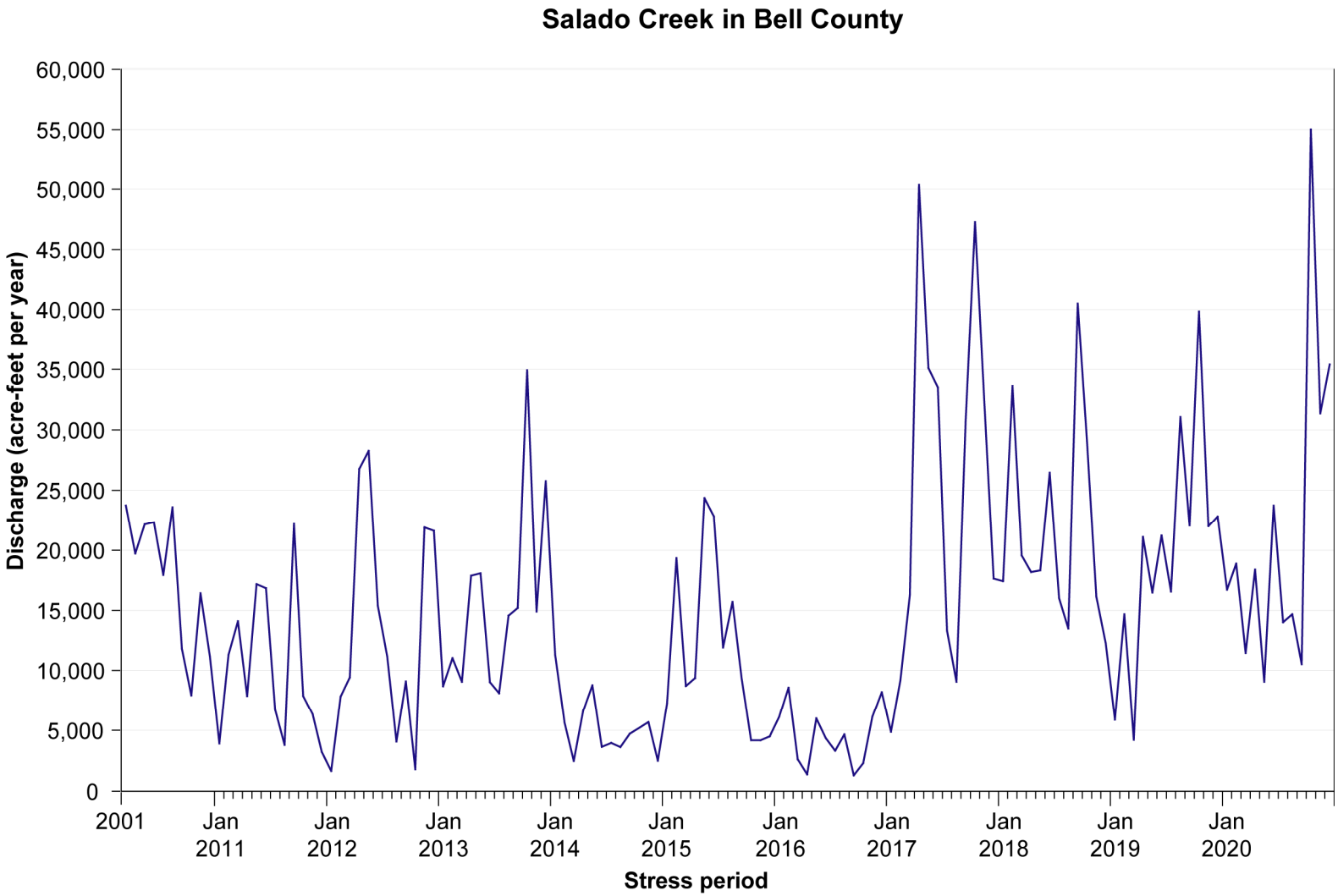


Figure 2: Hydrograph of simulated (2001 to 2020) discharge for Salado Creek in Bell County.

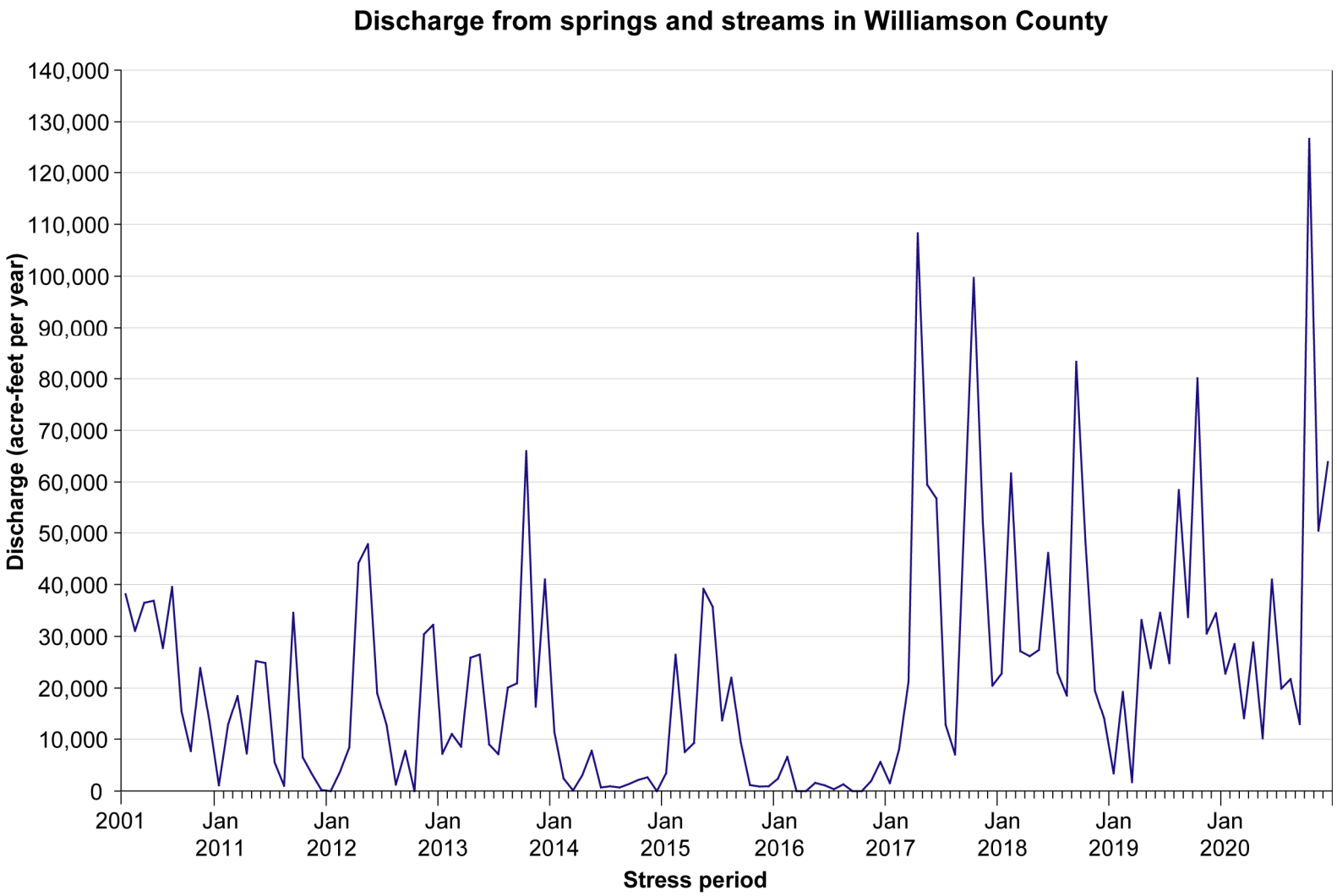


Figure 3: Hydrograph of simulated (2001 to 2020) aggregated natural spring-stream discharge in Williamson County.

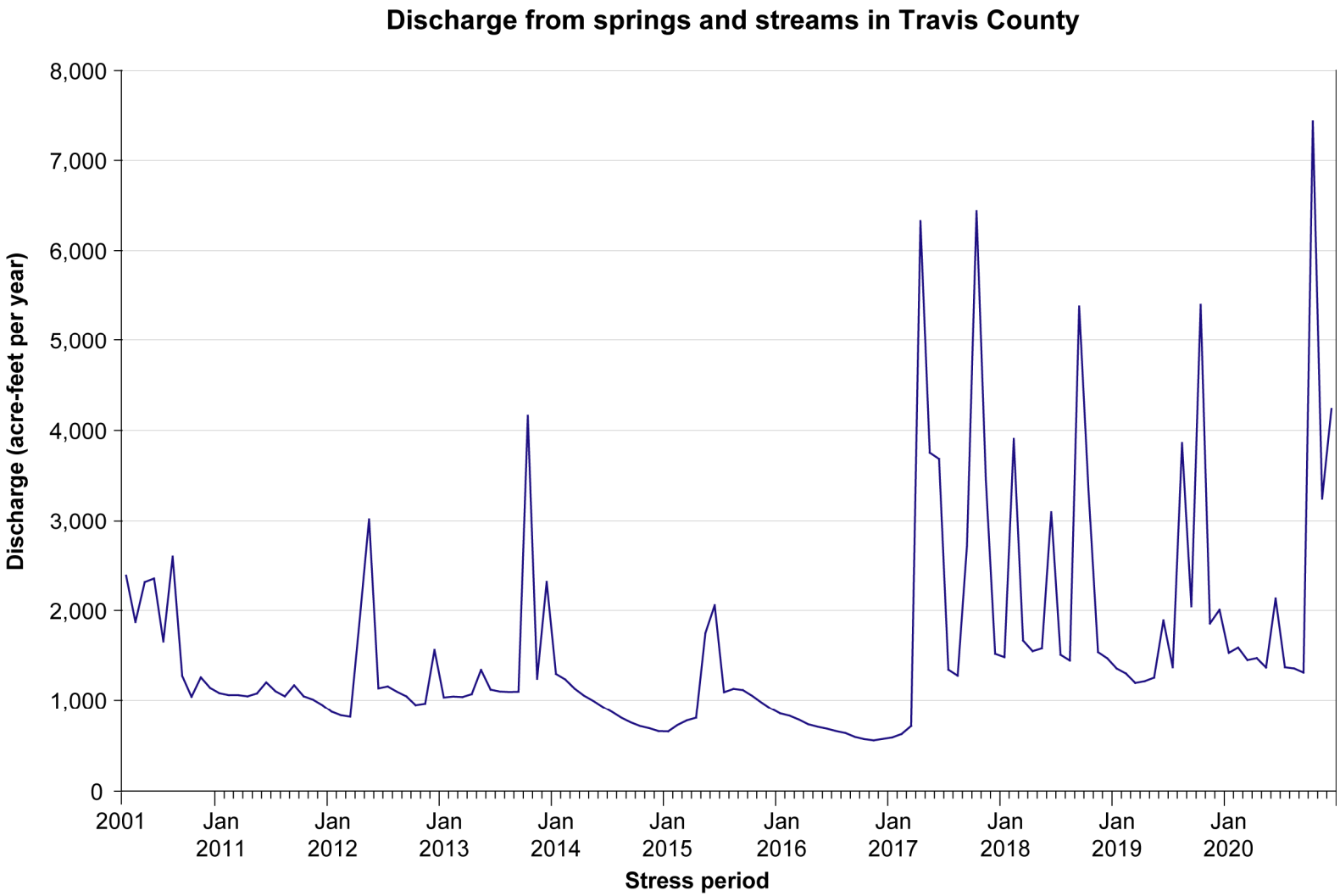


Figure 4: Hydrograph of simulated (2001 to 2020) aggregated natural spring-stream discharge in Travis County.

Appendix A

Groundwater Management Area 8 Second Simulation Request Specifications for the Northern Segment of the Edwards (Balcones Fault Zone) Aquifer Groundwater Availability Model

May 18, 2007

Clearwater Underground Water Conservation District (UWCD) acting on behalf of GMA-8 requests Texas Water Development Board (TWDB) to perform a projected pumping simulation of the N. Edwards aquifer Groundwater Availability Model (GAM). The N. Edwards aquifer GAM consists of one layer representing both the recharge and artesian zones of the aquifer. In the GAM, the recharge zone of the aquifer is represented as being unconfined (or un-pressurized) and the artesian zone is represented as being confined (or pressurized). The GAM represents streams with Drain Cells. These cells discharge water from the aquifer when the simulated aquifer water-level elevation is higher than the cell elevation. Springs are not represented directly in the GAM; however the aggregated discharge from Drain Cells from a particular creek may be used to represent the discharge from springs located along the same creek. Clearwater UWCD requests the GAM simulation be performed with the following specifications:

1. The simulation period should be for 20 years.
2. The simulation should use monthly time steps (supplied).
3. The simulated climatic conditions should use the supplied historic monthly average precipitation record for the model area for the time period 1940 through 1960 that includes the actual historic drought of record conditions.
4. The simulation should maintain the existing model spatial pumping distribution for Williamson and Travis Counties, but use the supplied spatial pumping distribution for Bell County.
5. The simulation should use the supplied monthly temporal distribution of pumping.
6. Annual pumping should be held constant for each area for which a pumping amount is specified (*i.e.* by County total for the Edwards aquifer).
7. The simulation should incorporate the supplied managed reductions in pumping for Bell County during periods of climatic stress. Climatic stress periods are defined as beginning when a running 2-month average of monthly precipitation values fall below 2.74 inches (the average monthly precipitation) and ending when the 2-month running average is equal to or greater than 2.74 inches.
8. The annual projected pumping to be applied to the Edwards aquifer by County should be as follows (note the projected pumping values for Travis and Williamson Counties are based on Regional Water Plan (RWP) groundwater availability values and TWDB water use survey data):
    a. Bell – 7,500 ac-ft per year
    b. Williamson – 21,000 ac-ft per year
    c. Travis – 5,600 ac-ft per year
9. The results of the GAM simulation should be presented as follows:
    a. The projected discharge of drain cells should be aggregated to simulate the monthly totals spring discharge in;
        i. Salado Creek of Bell County;
        ii. Aggregated as a monthly sum by County for;
            1. Williamson County and ;
            2. Travis County.

b. Hydrographs of the monthly simulated spring discharges for each of the requested representations of spring discharge over the simulation period should be prepared.
c. Additional presentations of GAM simulation results may be requested.