HABITAT CONSERVATION PLAN
EDWARDS AQUIFER

Springflow Habitat Protection Work Group

May 20, 2020
2:00-4:00pm

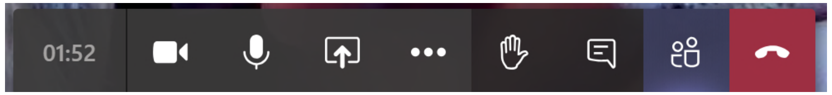
Agenda Overview

- Confirm attendance
- Meeting logistics
- Public comment
- 80 cfs pulse flow component overview
- EARIP water quality modeling effort presentation and discussion
- 2019 VISPO AMP low flow scenarios presentation and discussion
- Public comment
- Future meetings

Confirm attendance

Meeting logistics

- Virtual meeting logistics
  - Mute
  - Raise Hand
  - Chat / Asking questions
  - Meeting recording



- Meeting points of contact
  - Meeting access
    - Jared Morris (jmorris@...)
  - Technical questions
    - Jared Morris (jmorris@...)
    - Victor Hutchison (vhutchison@..)
  - Participant monitor
    - Kristy Kollaus (kkollaus@...)
  - Chat and Q&A monitors
    - Kristina Tolman (ktolman@...)
    - Damon Childs (dchilds@...)

Meeting logistics

- Work Group logistics
  - Members use Chat
  - Everyone can raise hands
  - Email public comments
- Meeting Minutes
  - April 22, 2020

Today’s Meeting

- **Clarify and refine the question**
- The Implementing Committee should ensure a technical evaluation is undertaken of water quality impacts of predicted extended periods of flow below 80 cfs in both spring systems, either using the Hardy water quality model, but calibrated and validated using data from recent low-flow periods, or using an alternate approach;

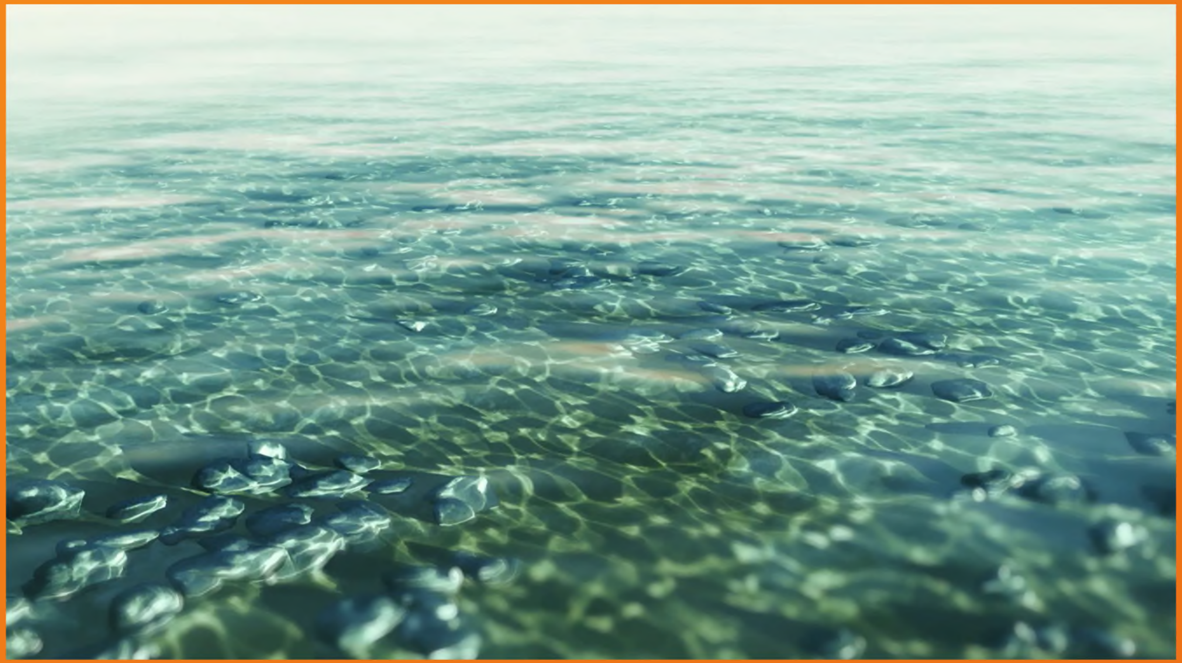
Public comment

HABITAT CONSERVATION PLAN
EDWARDS AQUIFER

80 cfs pulse flow

EAHCP QUALTEX MODELING

Dr. Thom Hardy
Texas State University



Foundations

Hardy, T.B.,N.R. Bartsch, D.K. Stevens, and P. Connor. 1998. Development and Application of an Instream Flow Assessment Framework for the Fountain Darter (*Etheostoma fonticola*) in Landa Lake and the Comal River System. Final Report Cooperative Agreement #1448-00002-92-0279.

1998

Hardy

- Technical Assessments in Support of the Edwards Aquifer Science Committee "J Charge" Flow Regime Evaluation for the Comal and San Marcos River Systems

2009

Hardy et al

- Evaluation of the Proposed Edwards Aquifer Recovery Implementation Program Drought of Record Minimum Flow Regimes in the Comal and San Marcos River Systems

2010

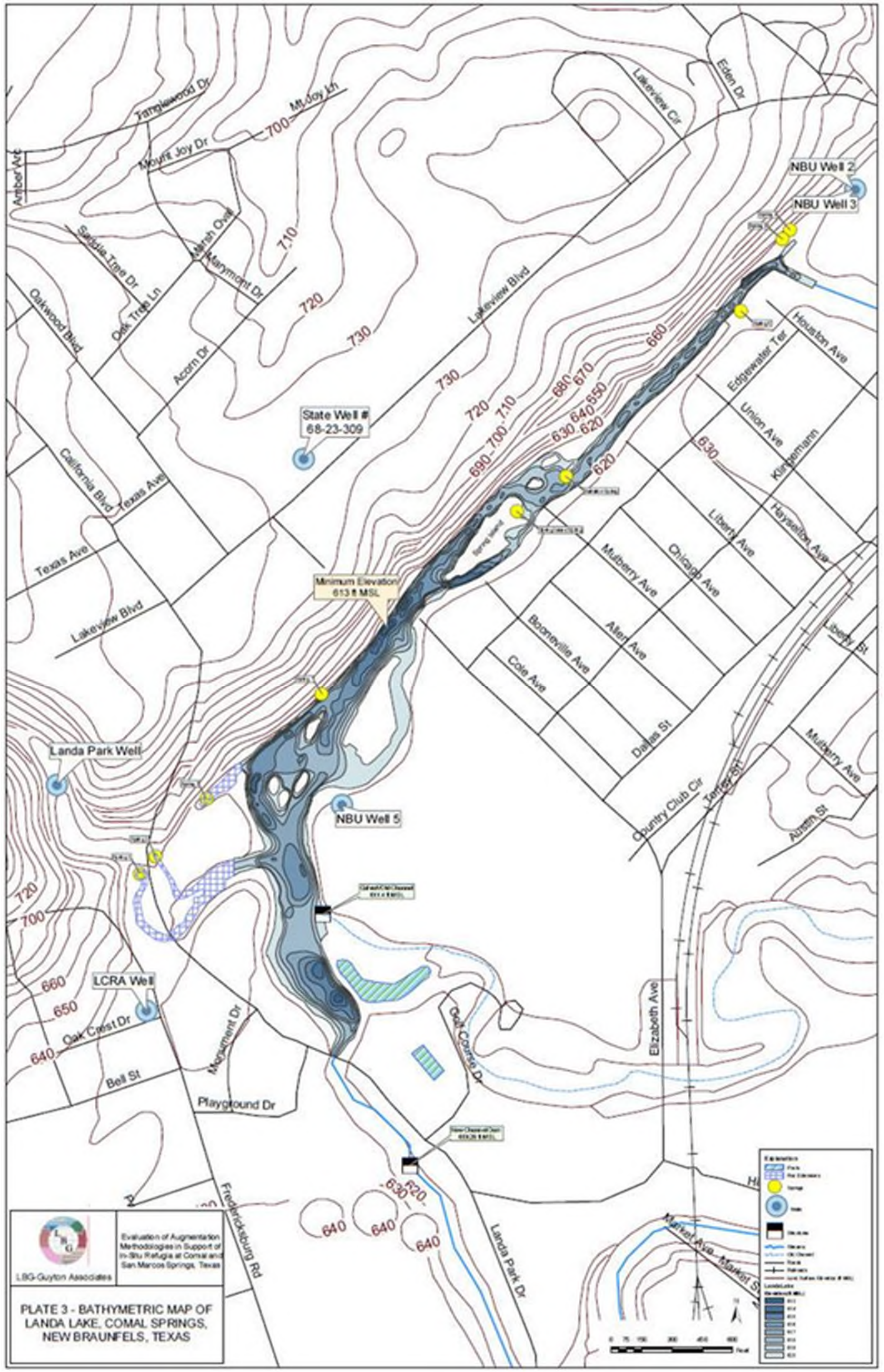
Hardy

- Water Quality and Temperature Simulation System (WQTSS)

2017

Temperature Simulations: Comal: What Matters

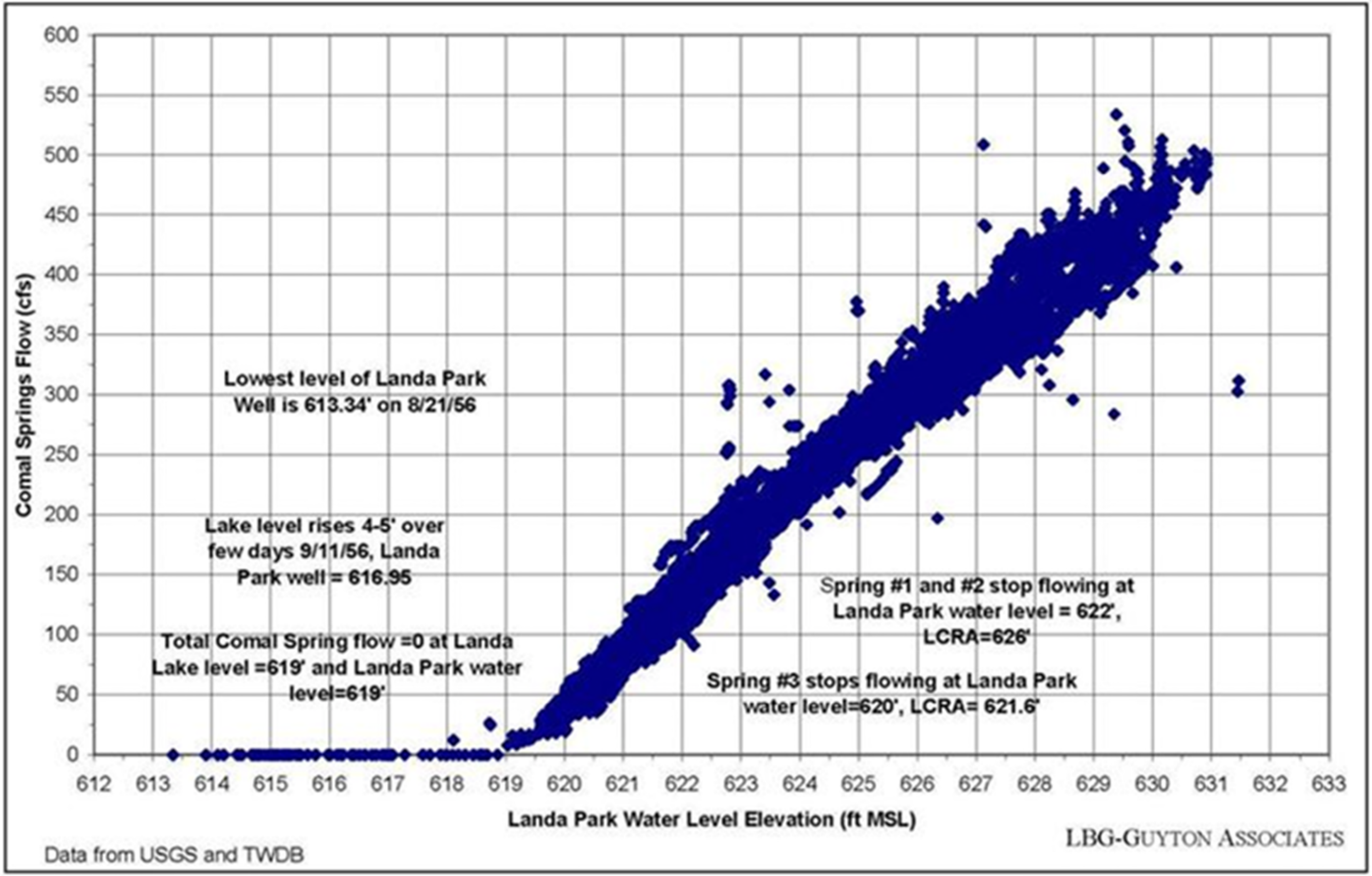
- Seven Defined Headwaters:
  - The NE Branch (Reach 1 – Bleeders Creek),
  - NW Branch (Reach 2),
  - Spring Run 1 (Reach 6),
  - Spring Run 2 (Reach 9),
  - Spring Run 3 (Reach 8),
  - Old Channel outlet (Reach 17) and,
  - The Spring Fed Pool outlet (Reach 16).
- 44 Point Loads (Springs in Landa Lake)
- Relative contributions of Headwaters and Point Loads assumed in Hardy (2010/2017) based on spot measurements for“8 years of measured flows” and Guyton Associates (2004).

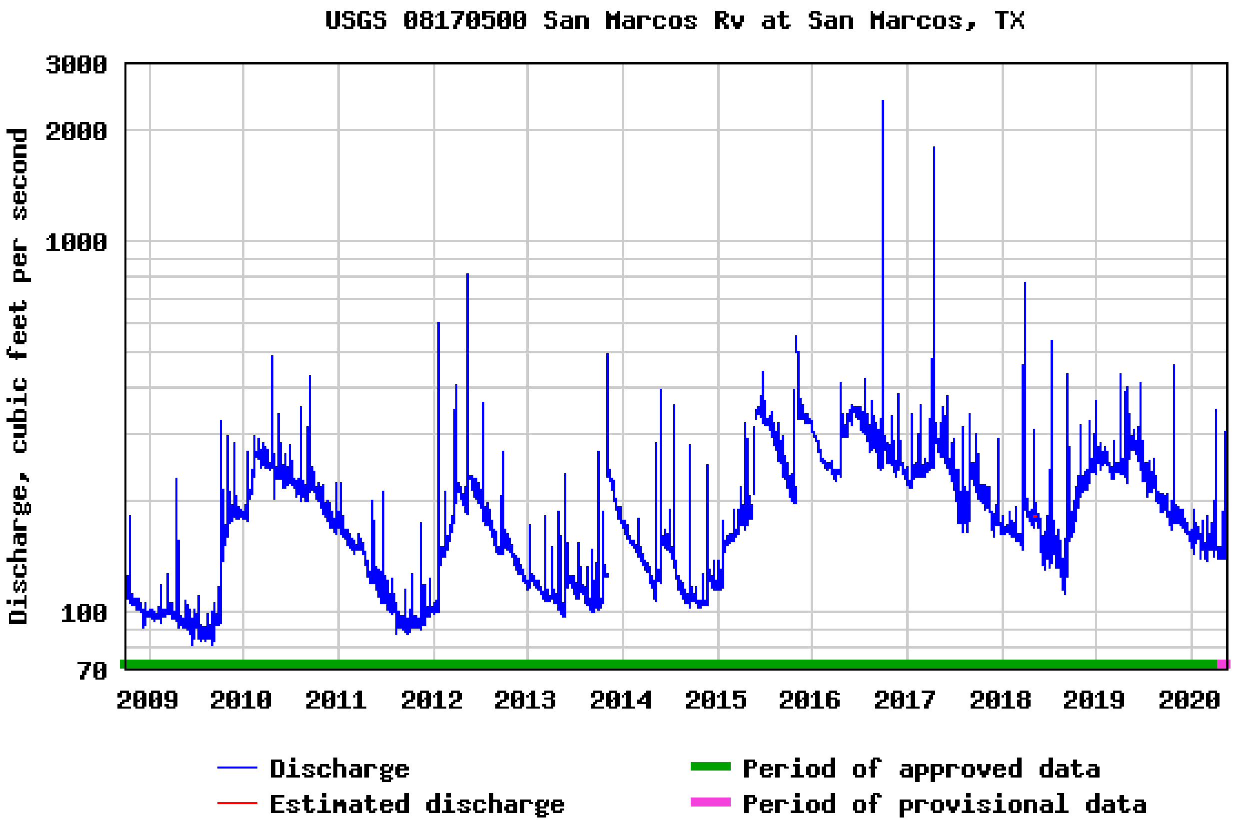


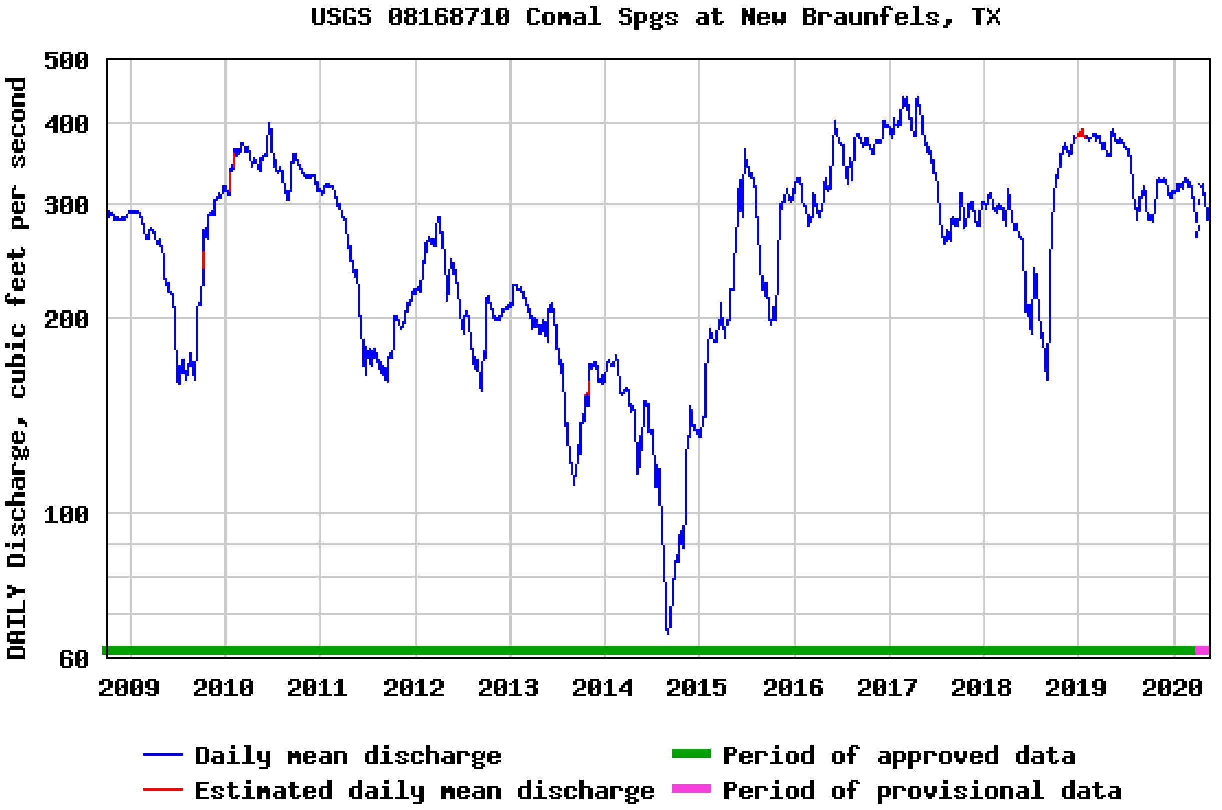
LBG-Guyton Associates
Evaluation of Augmentation Methodologies in Support of In-Situ Refugia at Comal and San Marcos Springs, Texas
PLATE 3 - BATHYMETRIC MAP OF LANDA LAKE, COMAL SPRINGS, NEW BRAUNFELS, TEXAS
NBU Well 2
NBU Well 3
State Well #
68-23-309
Minimum Elevation
613 ft MSL
Landa Park Well
NBU Well 5
LCRA Well
Tanglewood Dr
Mount Joy Dr
Mt Joy Ln
Lakeview Blvd
Lakeview Cir
Eden Dr
Oakwood Blvd
Acorn Dr
Marymont Dr
California Blvd
Texas Ave
Edgewater Ter
Houston Ave
Union Ave
Klingemann
Liberty Ave
Chicago Ave
Mulberry Ave
Allen Ave
Booneville Ave
Cole Ave
Dallas St
Country Club Cir
Elizabeth Ave
Oak Crest Dr
Bell St
Playground Dr
Fredericksburg Rd
Landa Park Dr
Market Ave
Austin St
Liberty St
730
720
710
700
690
680
670
660
650
640
630
620

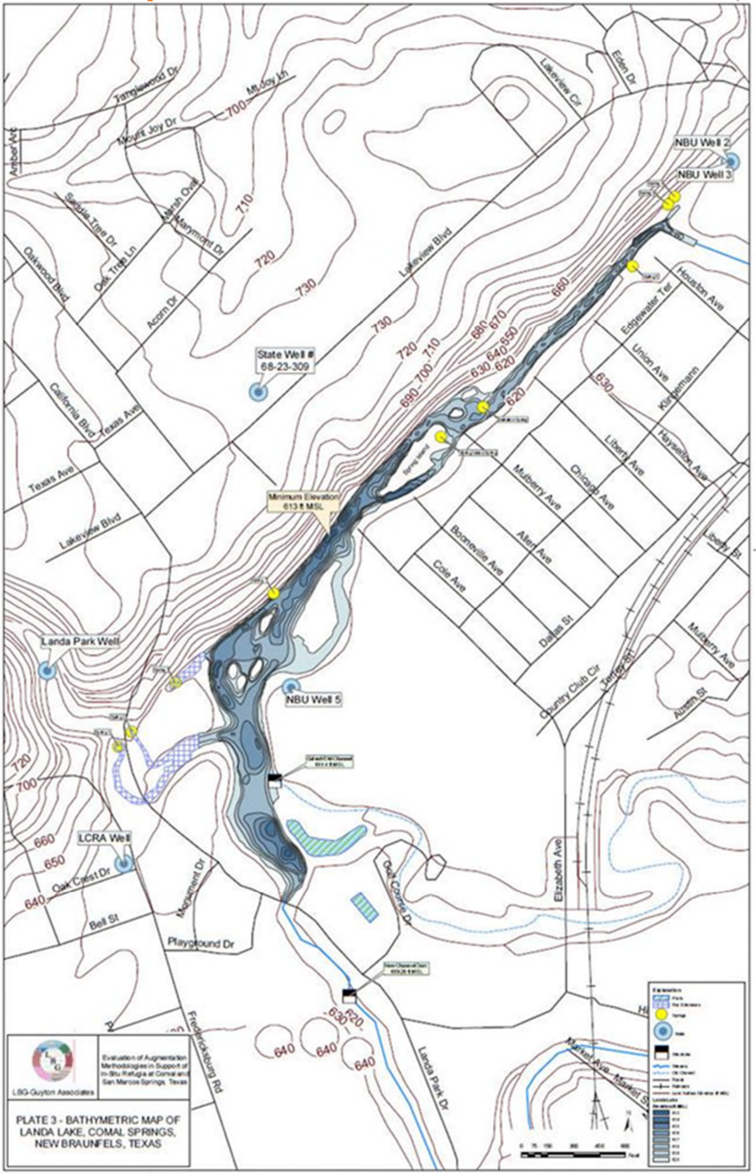
Total Comal Discharge (cfs)	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	105	110	115	120	125	130	135	140	145	150	155	160	165	170
HeadWaters Discharge (cfs)																														
NW_Branch	0.01	0.01	0.01	0.01	0.01	0.01	2.20	2.40	2.60	2.80	3.00	3.20	3.40	3.60	3.80	4.00	4.20	4.40	4.60	4.80	5.00	5.20	5.40	5.60	5.80	6.00	6.20	6.40	6.60	6.80
NE_Branch	0.01	0.01	0.01	0.01	0.01	0.01	0.06	0.06	0.07	0.07	0.08	0.08	0.09	0.09	0.10	0.10	0.11	0.11	0.12	0.12	0.13	0.13	0.14	0.14	0.15	0.15	0.16	0.16	0.17	0.17
Spring_Run_3	0.01	0.01	0.01	0.01	0.01	2.35	2.59	2.82	3.06	3.29	3.53	3.76	4.00	4.23	4.47	4.70	4.94	5.17	5.41	5.64	5.88	6.11	6.35	6.58	6.82	7.05	7.29	7.52	7.76	7.99
Spring_Run_1	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	1.25	1.30	1.34	1.39	1.44	1.49	1.54	1.58	1.63
Spring_Run_2	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	2.28	2.36	2.45	2.54	2.63	2.71	2.80	2.89	2.98
OC-Woods (culvert)	10.50	14.00	17.50	21.00	24.50	28.00	31.50	35.00	38.50	42.00	42.00	42.00	42.00	42.00	42.00	42.00	42.00	42.00	42.00	42.00	42.00	42.00	42.00	42.00	42.00	42.00	42.00	42.00	42.00	42.00
OC-SPring_fed_pool	4.50	6.00	7.50	9.00	10.50	12.00	13.50	15.00	16.50	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00

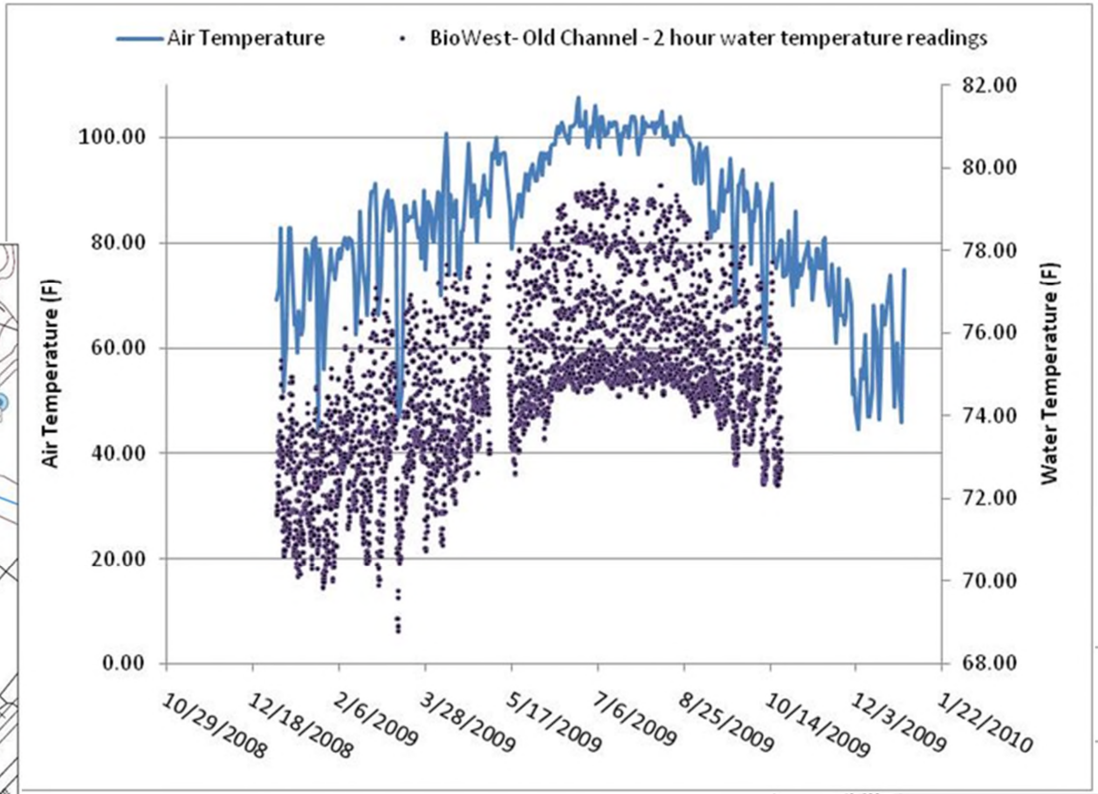
Total Comal Flow (cfs)	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	105	110	115	120	125	130	135	140	145	150	155	160	165	170
Point Load Flow (cfs)																														
1	0.00	0.00	0.00	0.00	0.00	0.00	1.79	1.95	2.12	2.28	2.44	2.61	2.77	2.94	3.10	3.26	3.43	3.59	3.75	3.92	4.08	3.96	4.11	4.26	4.41	4.57	4.72	4.87	5.02	5.18
2	0.00	0.00	0.00	0.00	0.00	0.00	1.24	1.35	1.47	1.58	1.70	1.81	1.92	2.04	2.15	2.27	2.38	2.49	2.61	2.72	2.83	2.66	2.76	2.86	2.97	3.07	3.17	3.28	3.38	3.48
3	0.00	0.00	0.00	0.00	0.00	0.00	1.24	1.35	1.47	1.58	1.70	1.81	1.92	2.04	2.15	2.27	2.38	2.49	2.61	2.72	2.83	2.66	2.76	2.86	2.97	3.07	3.17	3.28	3.38	3.48
4	0.00	0.00	0.00	0.00	0.00	0.00	0.63	0.69	0.75	0.81	0.87	0.93	0.98	1.04	1.10	1.16	1.22	1.28	1.34	1.40	1.45	1.21	1.25	1.30	1.35	1.40	1.44	1.49	1.54	1.58
5	0.23	0.28	0.33	0.37	0.42	0.26	1.24	1.35	1.47	1.58	1.70	1.81	1.92	2.04	2.15	2.27	2.38	2.49	2.61	2.72	2.83	2.66	2.76	2.86	2.97	3.07	3.17	3.28	3.38	3.48
6	0.23	0.28	0.33	0.37	0.42	0.26	1.24	1.35	1.47	1.58	1.70	1.81	1.92	2.04	2.15	2.27	2.38	2.49	2.61	2.72	2.83	2.66	2.76	2.86	2.97	3.07	3.17	3.28	3.38	3.48
7	0.23	0.28	0.33	0.37	0.42	0.26	1.24	1.35	1.47	1.58	1.70	1.81	1.92	2.04	2.15	2.27	2.38	2.49	2.61	2.72	2.83	2.66	2.76	2.86	2.97	3.07	3.17	3.28	3.38	3.48
8	0.23	0.28	0.33	0.37	0.42	0.26	1.24	1.35	1.47	1.58	1.70	1.81	1.92	2.04	2.15	2.27	2.38	2.49	2.61	2.72	2.83	2.66	2.76	2.86	2.97	3.07	3.17	3.28	3.38	3.48
9	0.23	0.28	0.33	0.37	0.42	0.26	1.24	1.35	1.47	1.58	1.70	1.81	1.92	2.04	2.15	2.27	2.38	2.49	2.61	2.72	2.83	2.66	2.76	2.86	2.97	3.07	3.17	3.28	3.38	3.48
10	0.23	0.28	0.33	0.37	0.42	0.26	1.24	1.35	1.47	1.58	1.70	1.81	1.92	2.04	2.15	2.27	2.38	2.49	2.61	2.72	2.83	2.66	2.76	2.86	2.97	3.07	3.17	3.28	3.38	3.48
11	0.23	0.28	0.33	0.37	0.42	0.26	1.24	1.35	1.47	1.58	1.70	1.81	1.92	2.04	2.15	2.27	2.38	2.49	2.61	2.72	2.83	2.66	2.76	2.86	2.97	3.07	3.17	3.28	3.38	3.48
12	0.23	0.28	0.33	0.37	0.42	0.26	1.24	1.35	1.47	1.58	1.70	1.81	1.92	2.04	2.15	2.27	2.38	2.49	2.61	2.72	2.83	2.66	2.76	2.86	2.97	3.07	3.17	3.28	3.38	3.48
13	0.23	0.28	0.33	0.37	0.42	0.26	1.24	1.35	1.47	1.58	1.70	1.81	1.92	2.04	2.15	2.27	2.38	2.49	2.61	2.72	2.83	2.66	2.76	2.86	2.97	3.07	3.17	3.28	3.38	3.48
14	0.23	0.28	0.33	0.37	0.42	0.26	1.24	1.35	1.47	1.58	1.70	1.81	1.92	2.04	2.15	2.27	2.38	2.49	2.61	2.72	2.83	2.66	2.76	2.86	2.97	3.07	3.17	3.28	3.38	3.48
15	0.23	0.28	0.33	0.37	0.42	0.26	1.24	1.35	1.47	1.58	1.70	1.81	1.92	2.04	2.15	2.27	2.38	2.49	2.61	2.72	2.83	2.66	2.76	2.86	2.97	3.07	3.17	3.28	3.38	3.48
16	0.23	0.28	0.33	0.37	0.42	0.26	1.24	1.35	1.47	1.58	1.70	1.81	1.92	2.04	2.15	2.27	2.38	2.49	2.61	2.72	2.83	2.66	2.76	2.86	2.97	3.07	3.17	3.28	3.38	3.48
17	0.23	0.28	0.33	0.37	0.42	0.26	1.24	1.35	1.47	1.58	1.70	1.81	1.92	2.04	2.15	2.27	2.38	2.49	2.61	2.72	2.83	2.66	2.76	2.86	2.97	3.07	3.17	3.28	3.38	3.48
18	1.48	1.77	2.07	2.36	2.66	2.75	0.47	0.51	0.56	0.60	0.64	0.69	0.73	0.78	0.82	0.86	0.91	0.95	0.99	1.04	1.08	0.84	0.87	0.90	0.93	0.97	1.00	1.03	1.06	1.10
19	1.48	1.77	2.07	2.36	2.66	2.75	0.47	0.51	0.56	0.60	0.64	0.69	0.73	0.78	0.82	0.86	0.91	0.95	0.99	1.04	1.08	0.84	0.87	0.90	0.93	0.97	1.00	1.03	1.06	1.10
20	0.35	0.42	0.49	0.56	0.64	0.50	0.81	0.85	0.89	0.93	0.97	1.01	1.05	1.09	1.12	1.16	1.20	1.24	1.28	1.32	1.36	1.11	1.13	1.16	1.19	1.22	1.24	1.27	1.30	1.33
21	1.48	1.77	2.07	2.36	2.66	2.75	0.47	0.51	0.56	0.60	0.64	0.69	0.73	0.78	0.82	0.86	0.91	0.95	0.99	1.04	1.08	0.84	0.87	0.90	0.93	0.97	1.00	1.03	1.06	1.10
22	1.48	1.77	2.07	2.36	2.66	2.75	0.47	0.51	0.56	0.60	0.64	0.69	0.73	0.78	0.82	0.86	0.91	0.95	0.99	1.04	1.08	0.84	0.87	0.90	0.93	0.97	1.00	1.03	1.06	1.10
23	1.48	1.77	2.07	2.36	2.66	2.75	0.47	0.51	0.56	0.60	0.64	0.69	0.73	0.78	0.82	0.86	0.91	0.95	0.99	1.04	1.08	0.84	0.87	0.90	0.93	0.97	1.00	1.03	1.06	1.10
24	1.48	1.77	2.07	2.36	2.66	2.75	1.33	1.45	1.57	1.70	1.82	1.94	2.06	2.19	2.31	2.43	2.55	2.67	2.80	2.92	3.04	2.87	2.98	3.10	3.21	3.32	3.43	3.54	3.65	3.76
25	1.48	1.77	2.07	2.36	2.66	2.75	1.33	1.45	1.57	1.70	1.82	1.94	2.06	2.19	2.31	2.43	2.55	2.67	2.80	2.92	3.04	2.87	2.98	3.10	3.21	3.32	3.43	3.54	3.65	3.76
26	0.91	1.09	1.27	1.46	1.64	1.62	1.33	1.45	1.57	1.70	1.82	1.94	2.06	2.19	2.31	2.43	2.55	2.67	2.80	2.92	3.04	2.87	2.98	3.10	3.21	3.32	3.43	3.54	3.65	3.76
27	0.91	1.09	1.27	1.46	1.64	1.62	1.33	1.45	1.57	1.70	1.82	1.94	2.06	2.19	2.31	2.43	2.55	2.67	2.80	2.92	3.04	2.87	2.98	3.10	3.21	3.32	3.43	3.54	3.65	3.76
28	0.91	1.09	1.27	1.46	1.64	1.62	1.33	1.45	1.57	1.70	1.82	1.94	2.06	2.19	2.31	2.43	2.55	2.67	2.80	2.92	3.04	2.87	2.98	3.10	3.21	3.32	3.43	3.54	3.65	3.76
29	0.91	1.09	1.27	1.46	1.64	1.62	1.33	1.45	1.57	1.70	1.82	1.94	2.06	2.19	2.31	2.43	2.55	2.67	2.80	2.92	3.04	2.87	2.98	3.10	3.21	3.32	3.43	3.54	3.65	3.76
30	0.91	1.09	1.27	1.46	1.64	1.62	1.33	1.45	1.57	1.70	1.82	1.94	2.06	2.19	2.31	2.43	2.55	2.67	2.80	2.92	3.04	2.87	2.98	3.10	3.21	3.32	3.43	3.54	3.65	3.76
31	0.91	1.09	1.27	1.46	1.64	1.62	1.33	1.45	1.57	1.70	1.82	1.94	2.06	2.19	2.31	2.43	2.55	2.67	2.80	2.92	3.04	2.87	2.98	3.10	3.21	3.32	3.43	3.54	3.65	3.76
32	0.91	1.09	1.27	1.46	1.64	1.62	1.33	1.45	1.57	1.70	1.82	1.94	2.06	2.19	2.31	2.43	2.55	2.67	2.80	2.92	3.04	2.87	2.98	3.10	3.21	3.32	3.43	3.54	3.65	3.76
33	0.91	1.09	1.27	1.46	1.64	1.62	1.33	1.45	1.57	1.70	1.82	1.94	2.06	2.19	2.31	2.43	2.55	2.67	2.80	2.92	3.04	2.87	2.98	3.10	3.21	3.32	3.43	3.54	3.65	3.76
34	0.91	1.09	1.27	1.46	1.64	1.62	1.33	1.45	1.57	1.70	1.82	1.94	2.06	2.19	2.31	2.43	2.55	2.67	2.80	2.92	3.04	2.87	2.98	3.10	3.21	3.32	3.43	3.54	3.65	3.76
35	0.91	1.09	1.27	1.46	1.64	1.62	1.33	1.45	1.57	1.70	1.82	1.94	2.06	2.19	2.31	2.43	2.55	2.67	2.80	2.92	3.04	2.87	2.98	3.10	3.21	3.32	3.43	3.54	3.65	3.76
36	0.91	1.09	1.27	1.46	1.64	1.62	1.33	1.45	1.57	1.70	1.82	1.94	2.06	2.19	2.31	2.43	2.55	2.67	2.80	2.92	3.04	2.87	2.98	3.10	3.21	3.32	3.43	3.54	3.65	3.76
37	0.01	0.01	0.01	0.01	0.01	2.23	2.45	2.67	2.89	3.12	3.34	3.56	3.78	4.01	4.23	4.45	4.67	4.90	5.12	5.34	5.56	5.79	6.01	6.23	6.45	6.68	6.90	7.12	7.34	7.57
38	0.01	0.01	0.01	0.01	0.01	2.23	2.45	2.67	2.89	3.12	3.34	3.56	3.78	4.01	4.23	4.45	4.67	4.90	5.12	5.34	5.56	5.79	6.01	6.23	6.45	6.68	6.90	7.12	7.34	7.57
39	0.93	1.12	1.31	1.49	1.68	1.87	3.30	3.60	3.90	4.20	4.50	4.80	5.10	5.40	5.70	6.00	6.30	6.60	6.90	7.20	7.50	7.80	8.10	8.40	8.70	9.00	9.30	9.60	9.90	10.20
40	0.23	0.28	0.33	0.37	0.42	0.26	0.42	0.46	0.50	0.54	0.58	0.62	0.66	0.70	0.73	0.77	0.81	0.85	0.89	0.93	0.97	2.98	3.10	3.21	3.33	3.44	3.56	3.67	3.79	3.90
41	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	1.25	1.30	1.34	1.39	1.44	1.49	1.54	1.58	1.63
42	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	1.25	1.30	1.34	1.39	1.44	1.49	1.54	1.58	1.63
43	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	1.25	1.30	1.34	1.39	1.44	1.49	1.54	1.58	1.63
44	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	1.25	1.30	1.34	1.39	1.44	1.49	1.54	1.58	1.63

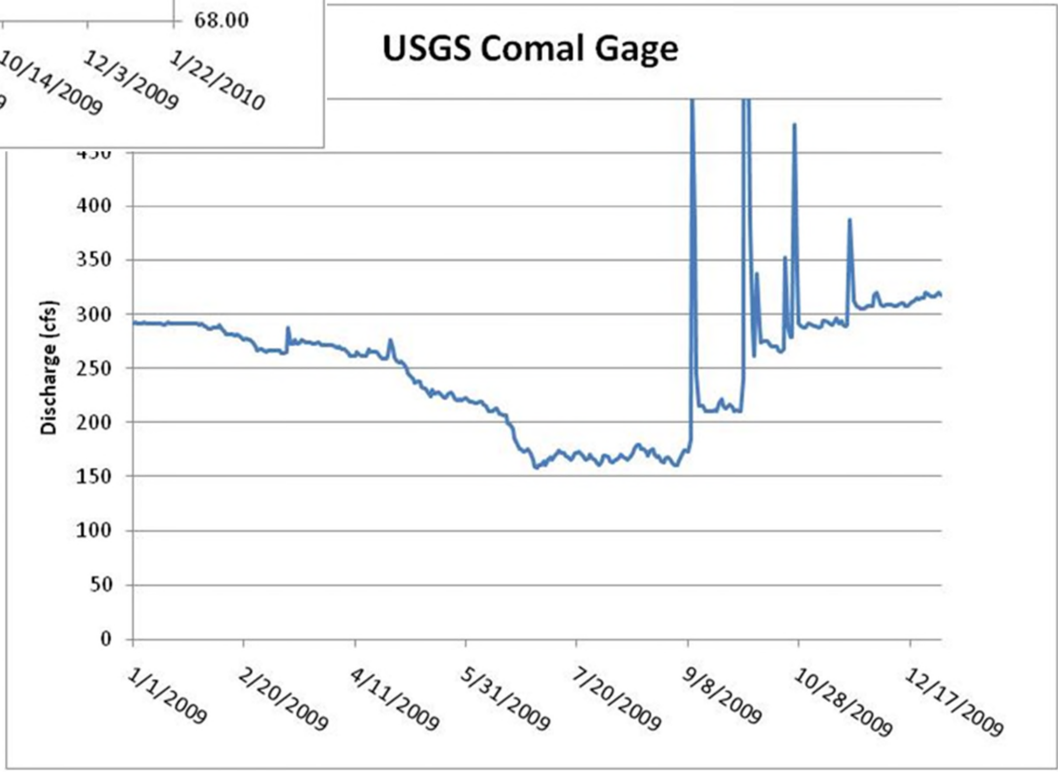

Comal Springs Flow (cfs)
600
550
500
450
400
350
300
250
200
150
100
50
0
612
613
614
615
616
617
618
619
620
621
622
623
624
625
626
627
628
629
630
631
632
633
Landa Park Water Level Elevation (ft MSL)
Lowest level of Landa Park Well is 613.34' on 8/21/56
Lake level rises 4-5' over few days 9/11/56, Landa Park well = 616.95
Total Comal Spring flow =0 at Landa Lake level =619' and Landa Park water level=619'
Spring #1 and #2 stop flowing at Landa Park water level = 622', LCRA=626'
Spring #3 stops flowing at Landa Park water level=620', LCRA= 621.6'
Data from USGS and TWDB
LBG-GUYTON ASSOCIATES

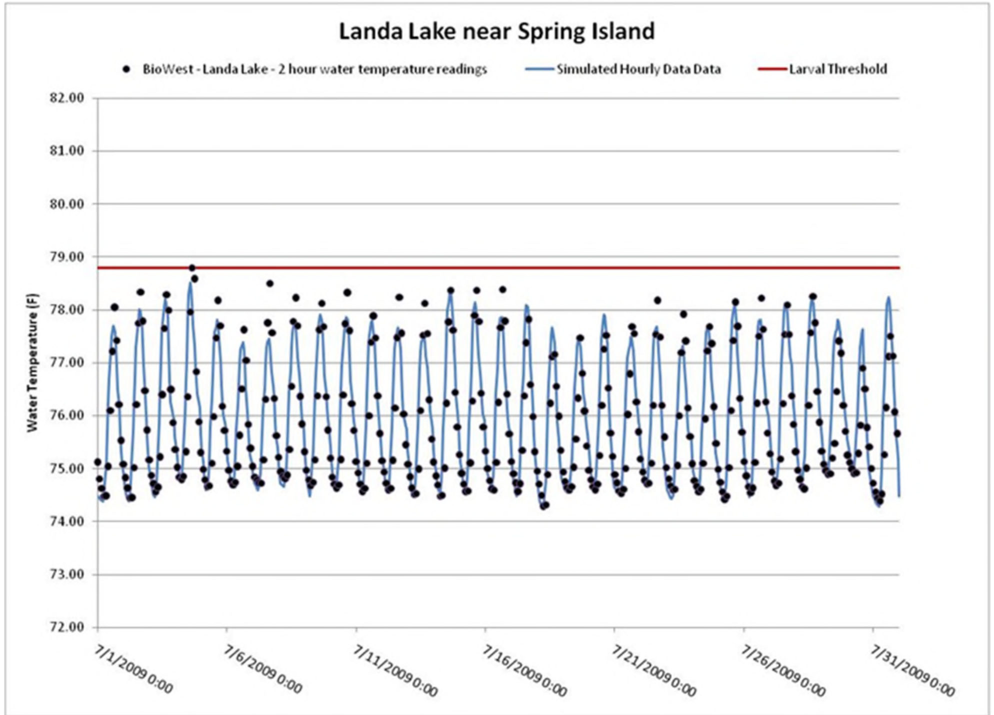

USGS 08170500 San Marcos Rv at San Marcos, TX
Discharge, cubic feet per second
3000
2000
1000
100
70
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
Discharge
Estimated discharge
Period of approved data
Period of provisional data

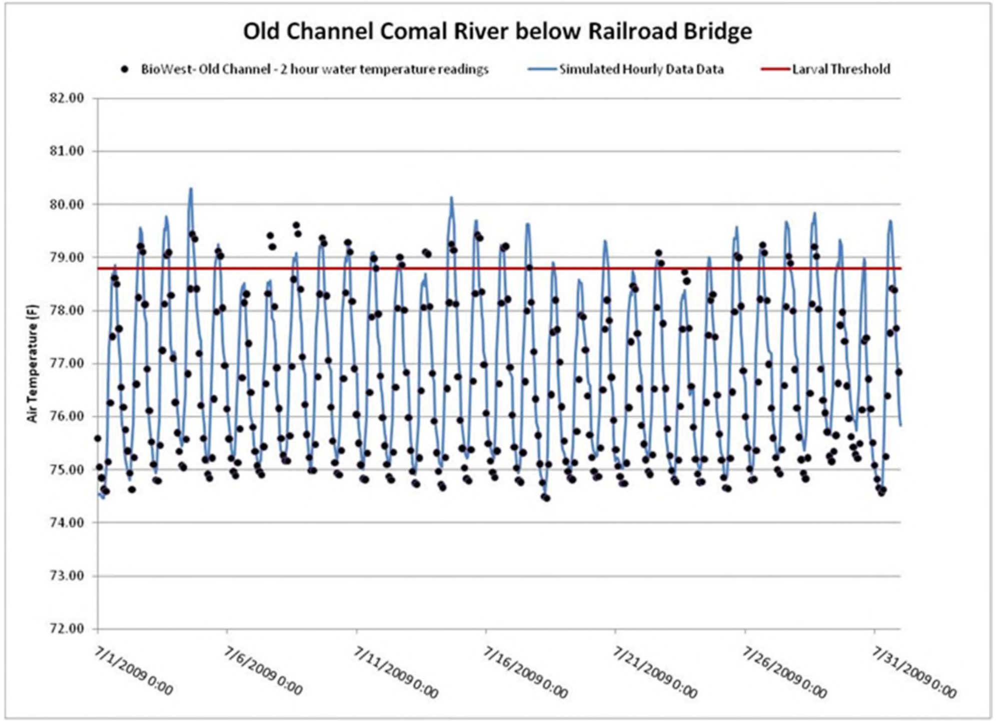

USGS 08168710 Comal Spgs at New Braunfels, TX
DAILY Discharge, cubic feet per second
500
400
300
200
100
60
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
Daily mean discharge
Estimated daily mean discharge
Period of approved data
Period of provisional data

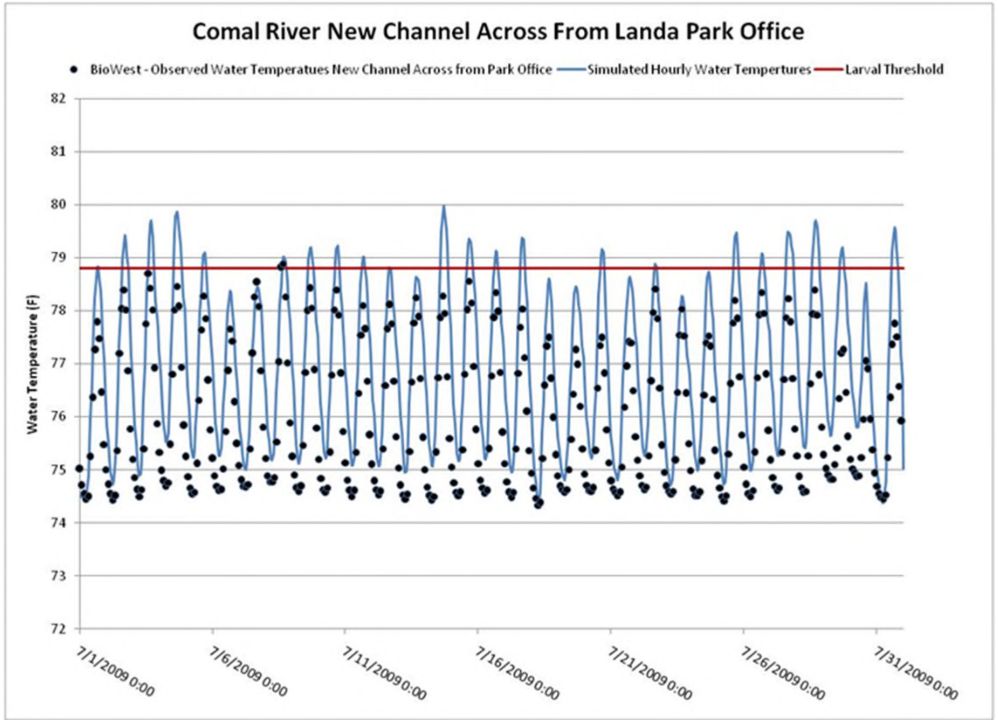

NBU Well 2
NBU Well 3
State Well # 68-23-309
Minimum Elevation 613 ft MSL
Landa Park Well
NBU Well 5
LCRA Well
Lakeview Blvd
Houston Ave
Union Ave
Liberty Ave
Chicago Ave
Mulberry Ave
Allen Ave
Cole Ave
Dallas St
Country Club Cir
Elizabeth Ave
Playground Dr
Bell St
Oak Crest Dr
Landa Park Dr
Texas Ave
California Blvd
Oakwood Blvd
Acorn Dr
Mount Joy Dr
LBG-Guyton Associates
Evaluation of Augmentation Methodologies in Support of In-Situ Refugia at Comal and San Marcos Springs, Texas
PLATE 3 - BATHYMETRIC MAP OF LANDA LAKE, COMAL SPRINGS, NEW BRAUNFELS, TEXAS


Air Temperature
BioWest- Old Channel - 2 hour water temperature readings
Air Temperature (F)
Water Temperature (F)
0.00
20.00
40.00
60.00
80.00
100.00
68.00
70.00
72.00
74.00
76.00
78.00
80.00
82.00
10/29/2008
12/18/2008
2/6/2009
3/28/2009
5/17/2009
7/6/2009
8/25/2009
10/14/2009
12/3/2009
1/22/2010


USGS Comal Gage
Discharge (cfs)
0
50
100
150
200
250
300
350
400
1/1/2009
2/20/2009
4/11/2009
5/31/2009
7/20/2009
9/8/2009
10/28/2009
12/17/2009



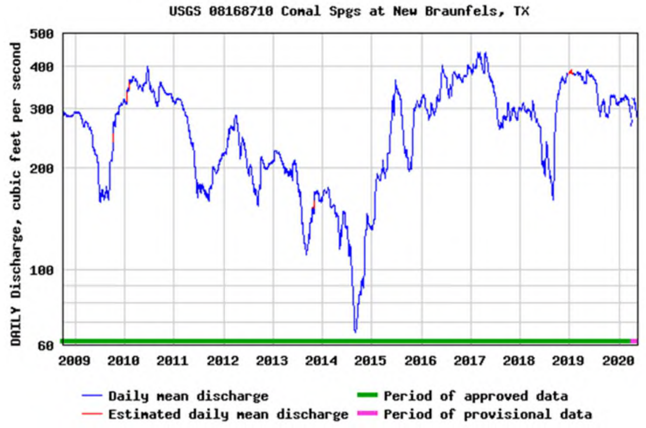




<u>2017 Ecosystem Model</u>:

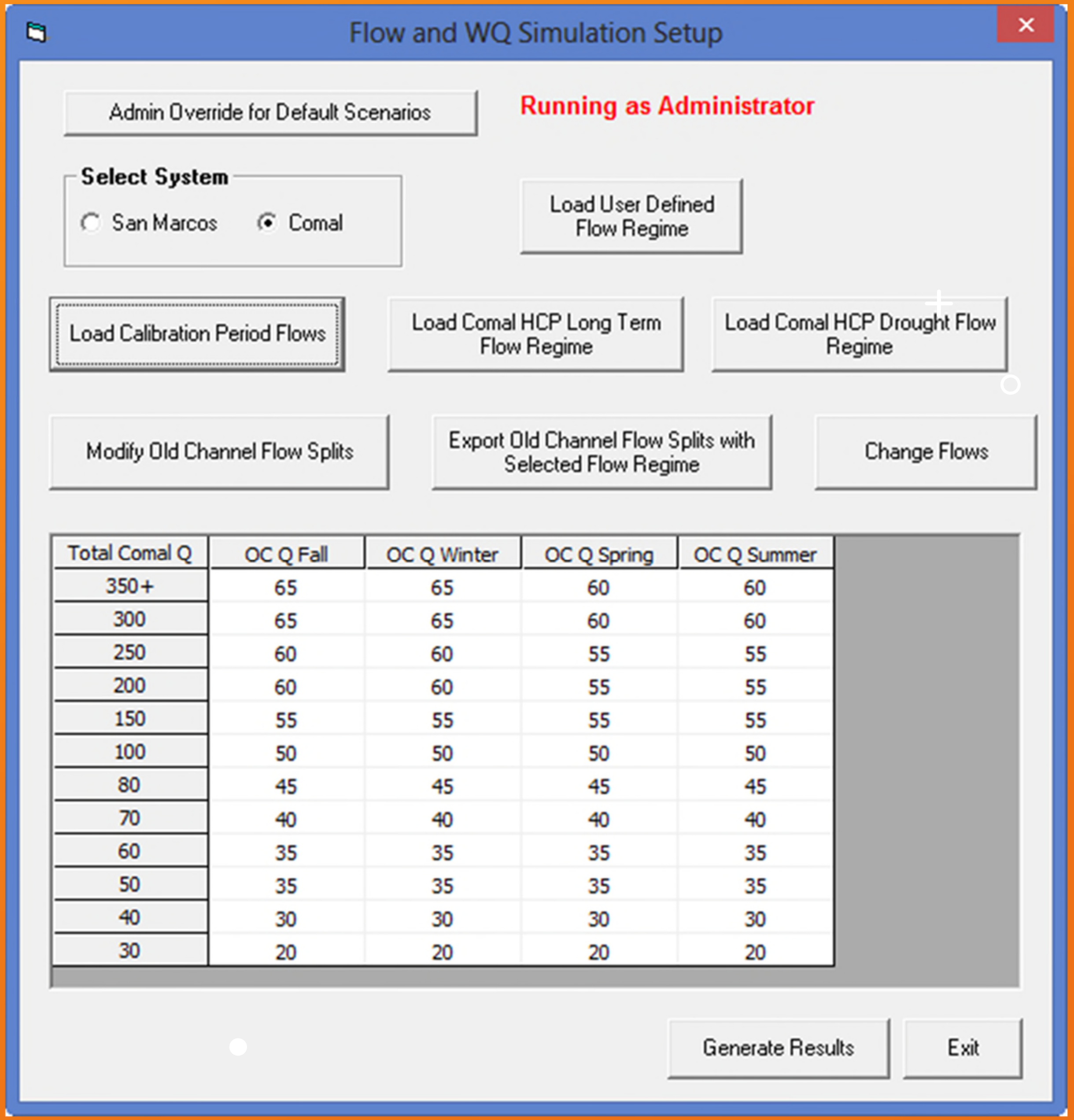
Updated Meteorological Data (2003 – 2013)

Used 2010 defined headwater/point load contributions for daily flows over this period



HARDY (2017)

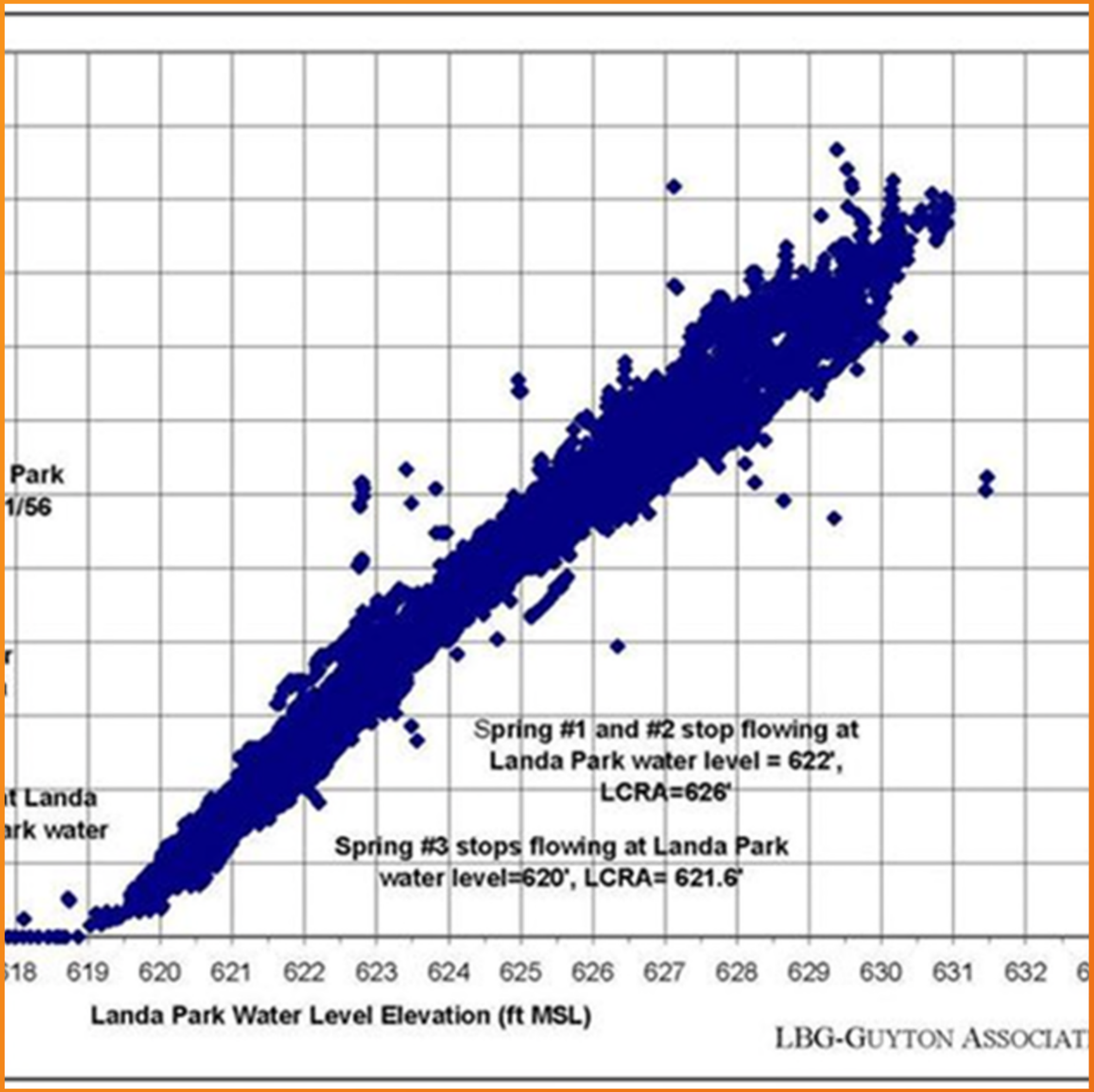
WATER QUALITY AND TEMPERATURE SIMULATION SYSTEM (WQTSS)



Total Comal Q	OC Q Fall	OC Q Winter	OC Q Spring	OC Q Summer
350+	65	65	60	60
300	65	65	60	60
250	60	60	55	55
200	60	60	55	55
150	55	55	55	55
100	50	50	50	50
80	45	45	45	45
70	40	40	40	40
60	35	35	35	35
50	35	35	35	35
40	30	30	30	30
30	20	20	20	20

Comal Temperatures: IMHO

- Fountain Darters
  - At the drought of record type flow regimes
    - The **only suitable areas** of darter habitat will be:
      - Landa Lake between the Spring Island area through Mid to Lower Landa Lake
      - Old Channel upstream of Schlitterbahn Park.
  - No additional calibration/simulations of temperature modeling is going to change this results for these areas of the Comal System.



Comal Temperatures: IMHO

- **Riffle Beetles (Headwater Springs or Point Loads)**
  - **There will be periods in which the phreatic surface results in surface or near surface flows and water temperature will 'rapidly' react with air temperatures. During 'summer periods' they will likely exceed the 26 C threshold established by Weston Nowlin's research.**
  - **Below this elevation when spring no longer provide surface or near surface flows there will be a phreatic surface where the capillary fringe of the hyporheic flows is at a depth in which it is no longer influenced by air temperatures. Temperatures of the hyporheic flows will be the same as the aquifer and below 26 C.**
  - **The physics of hydrostatic pressure of these hyporheic flows, will maintain some form of 'thermal refugia' at the temperature of the aquifer. Given estimated residence times of less than a day and the residual thermal mass of Landa Lake strongly suggest acceptable thermal regimes in riffle beetle areas.**
  - **Qual2E is not a ground water model nor is it a fully 3-dimensional hydrodynamic model of the lake that is coupled to temperature dynamics. Regardless, these 'advanced' class of models are not going to change the simple underlying physics of residual spring flows that are at aquifer temperatures.**

Temperature Simulations: San Marcos: What Matters

Four Defined Headwaters:

Spring Lake Headwater (Reach 1),

- Individual spring flows within Spring Lake were treated as a single incremental inflow within Reach 1. This approach within Qual2e assumes that the total discharge is distributed along the entire reach length which closely approximates the spatial distribution of springs (see next slide)

Spring Lake Slough Headwater (Reach 2),

Glover’s Ditch Headwater (Reach 10),

Mill Race Diversion Headwater (Reach 14),

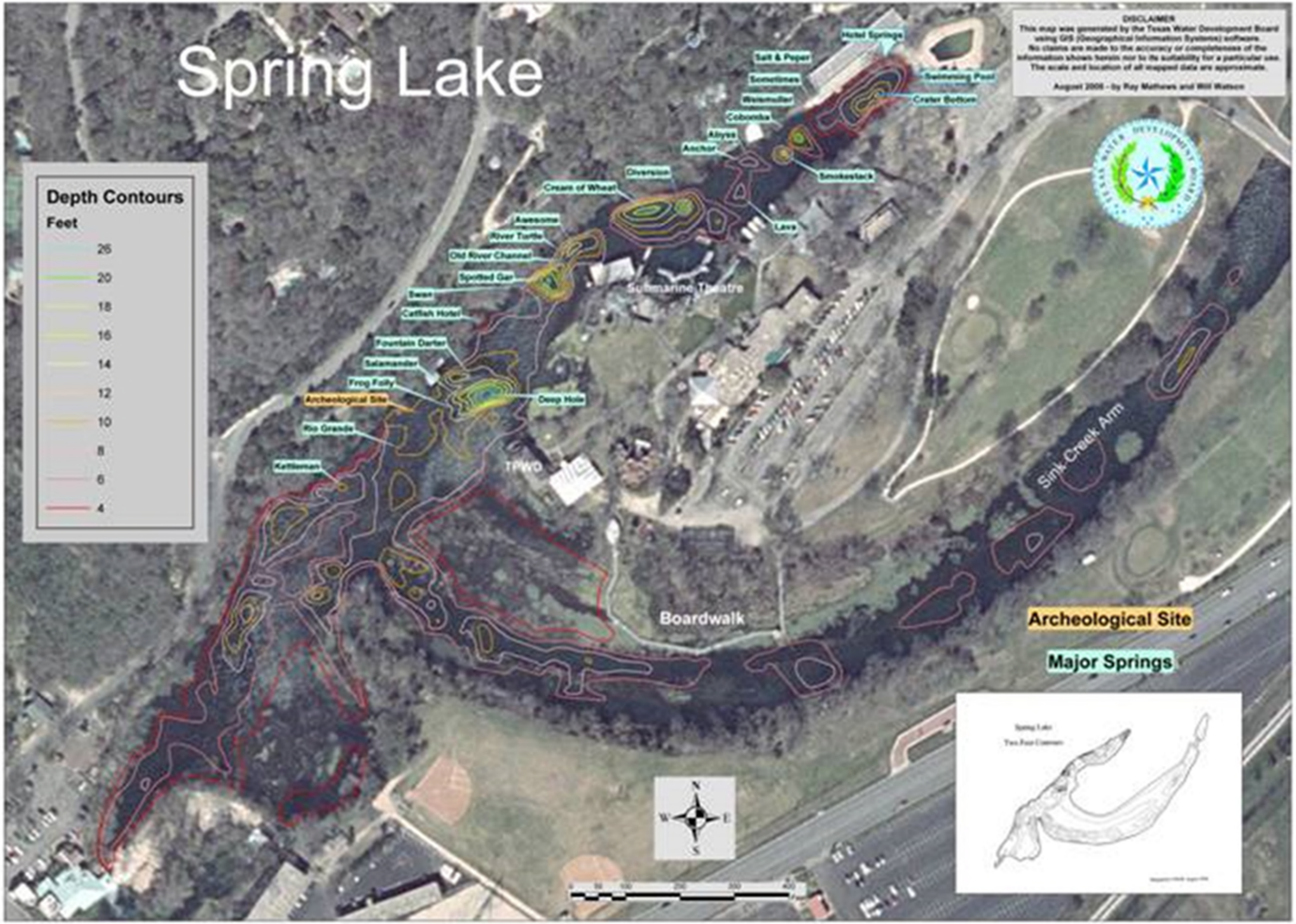
4 Point Loads

Sessoms Creek Point load,

Mill Race Discharge Point load,

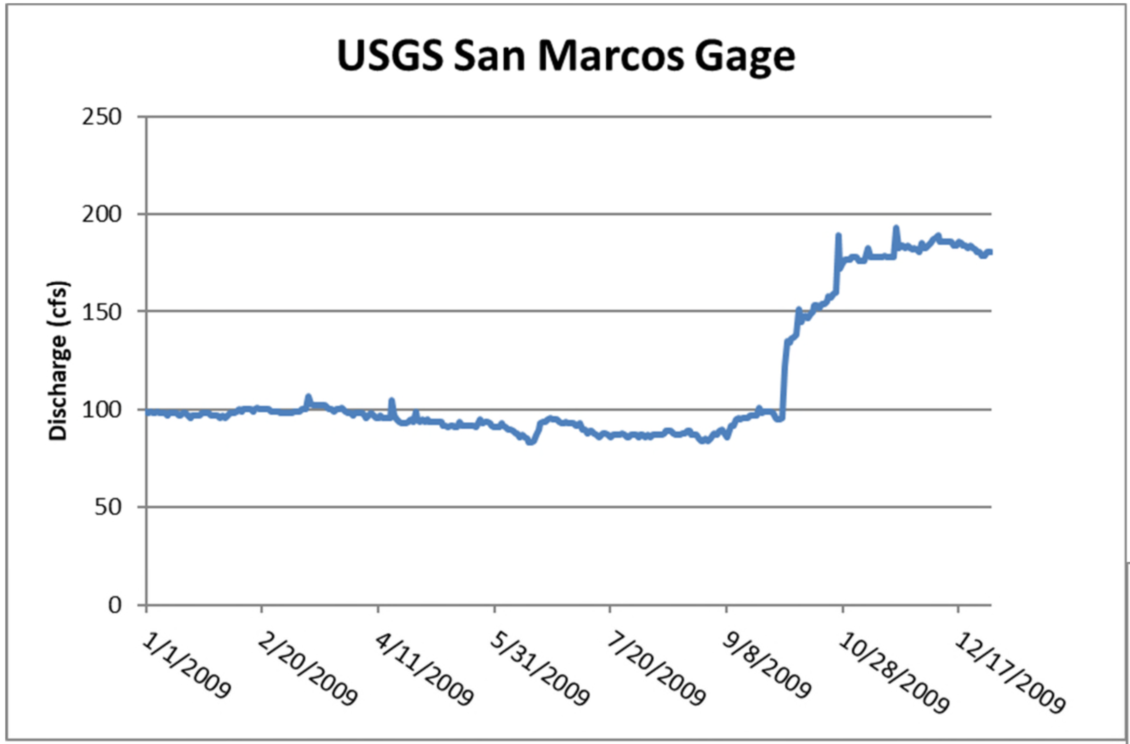
State Fish Hatchery Point load,

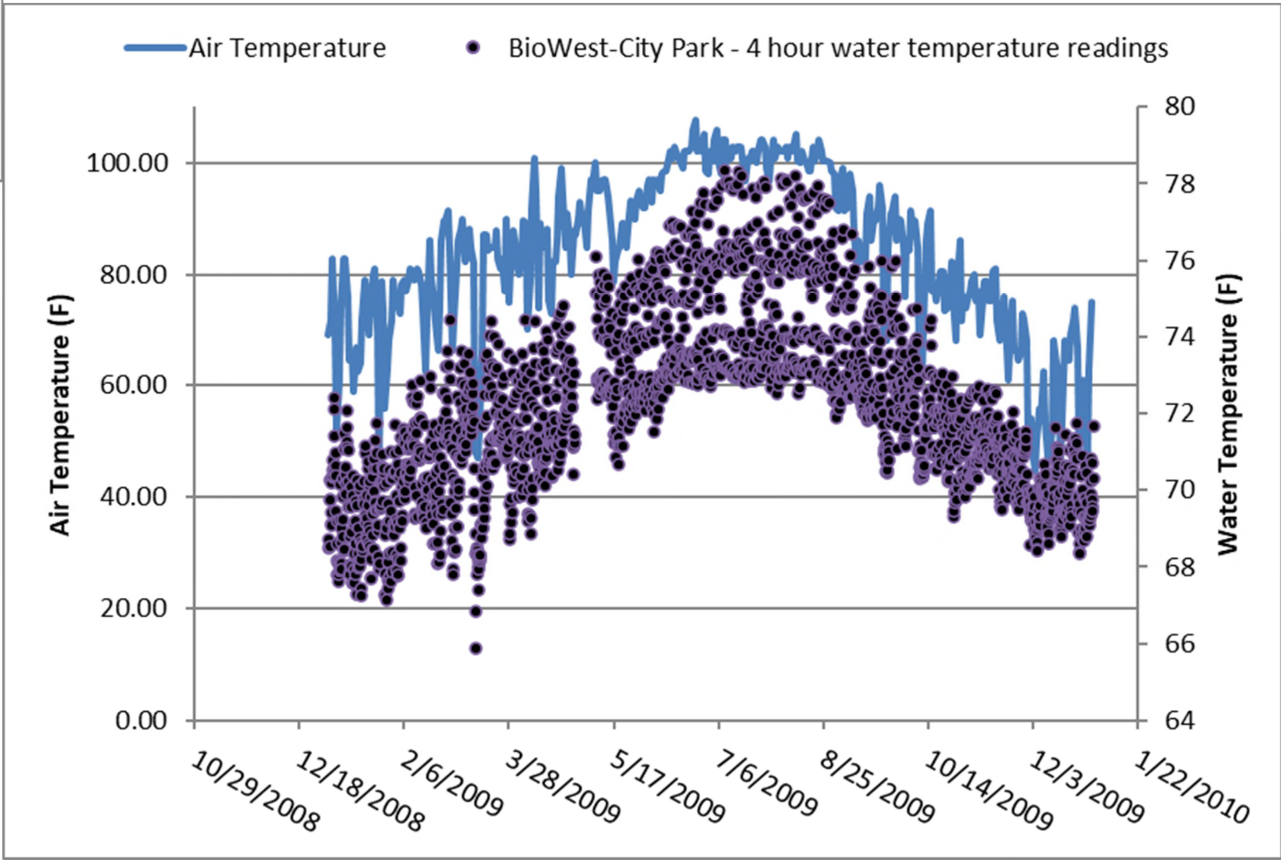
San Marcos Wastewater Treatment Plant Point load

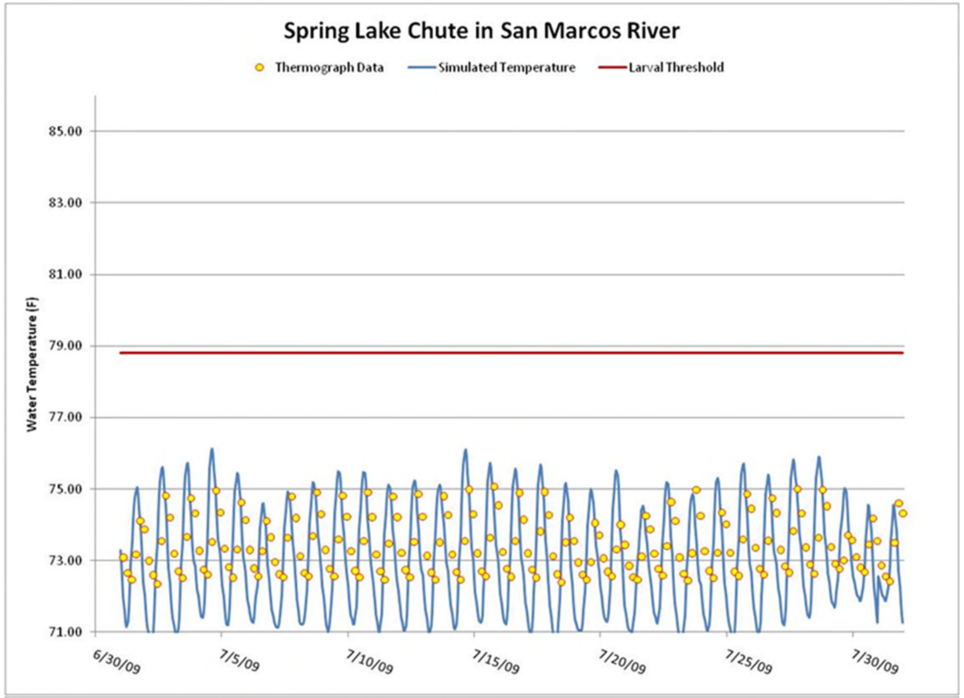


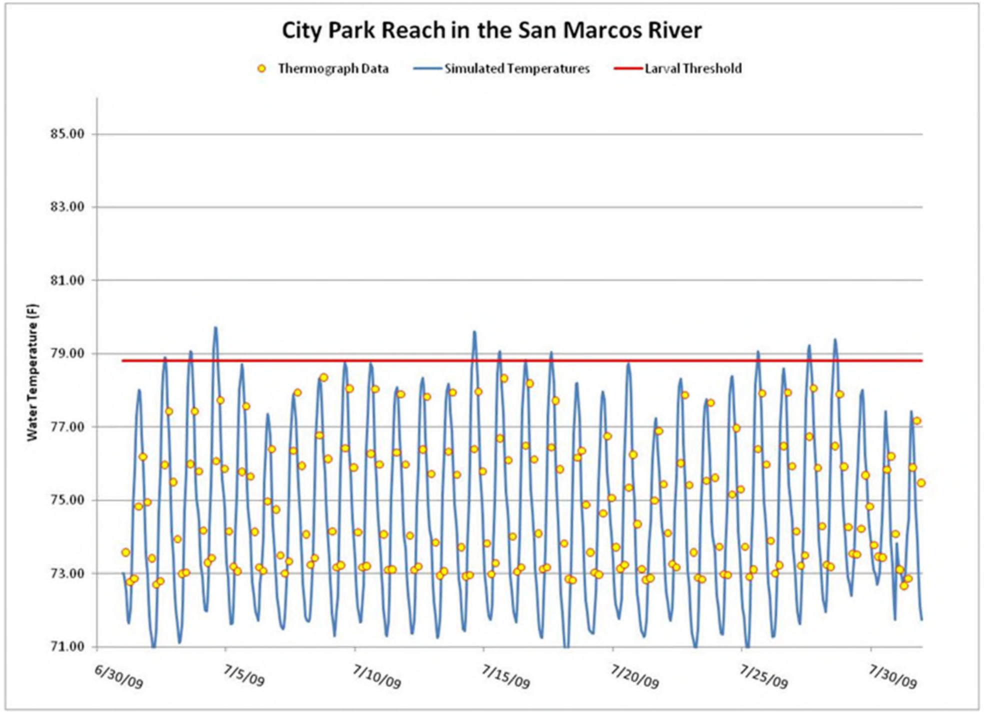
Spring Lake
Depth Contours
Feet
26
20
18
16
14
12
10
8
6
4
DISCLAIMER
This map was generated by the Texas Water Development Board using GIS (Geographical Information Systems) software.
No claims are made to the accuracy or completeness of the information shown herein nor to its suitability for a particular use.
The scale and location of all mapped data are approximate.
August 2006 - by Ray Mathews and Will Watson
Hotel Springs
Salt & Peper
Swimming Pool
Sometimes
Crater Bottom
Weismuller
Cobomba
Abyss
Anchor
Smokestack
Diversion
Cream of Wheat
Lava
Awesome
River Turtle
Old River Channel
Spotted Gar
Submarine Theatre
Swan
Catfish Hotel
Fountain Darter
Salamander
Frog Folly
Deep Hole
Archeological Site
Rio Grande
TPWD
Kettleman
Sink Creek Arm
Boardwalk
Archeological Site
Major Springs
N
W
E
S

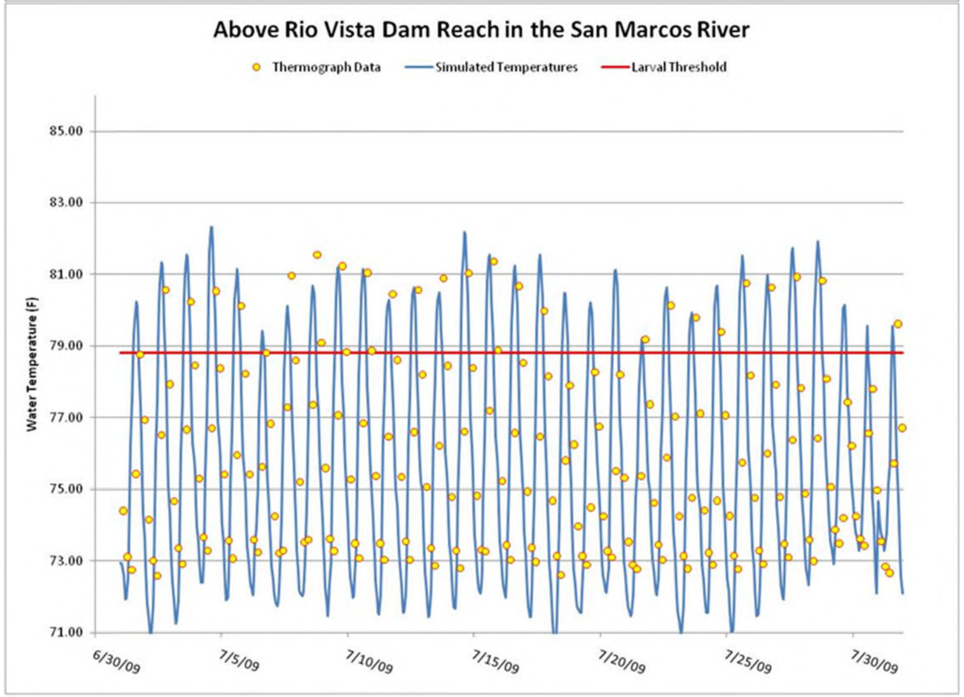
San Marcos Discharge (cfs)	45	50	55	60	65	70	75	80	85	90	100	110	120	130
Spring Lake Headwater	3.1	3.4	3.8	4.1	4.4	4.8	5.1	5.5	5.8	6.1	6.8	7.5	8.2	8.9
Incremental Inflow Reach 1	41.9	46.6	51.3	55.9	60.6	65.2	69.9	74.5	79.2	83.9	93.2	102.5	111.8	121.1
Spring Lake Slough	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Sessoms Creek	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
State Fish Hatchery	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0
Wastewater Plant	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6

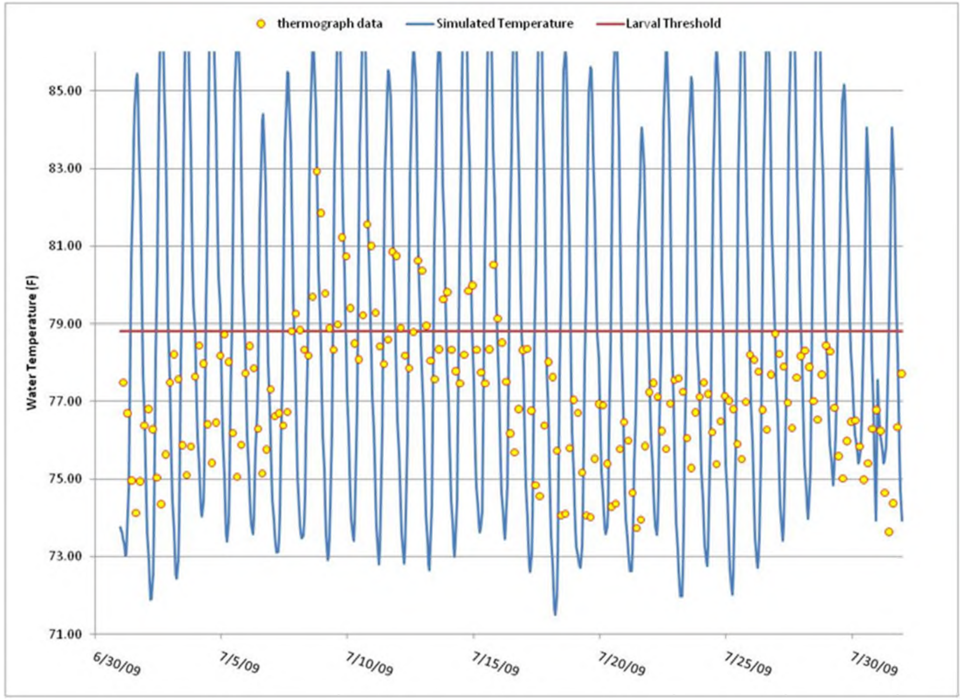

USGS San Marcos Gage
Discharge (cfs)
250
200
150
100
50
0
1/1/2009
2/20/2009
4/11/2009
5/31/2009
7/20/2009
9/8/2009
10/28/2009
12/17/2009

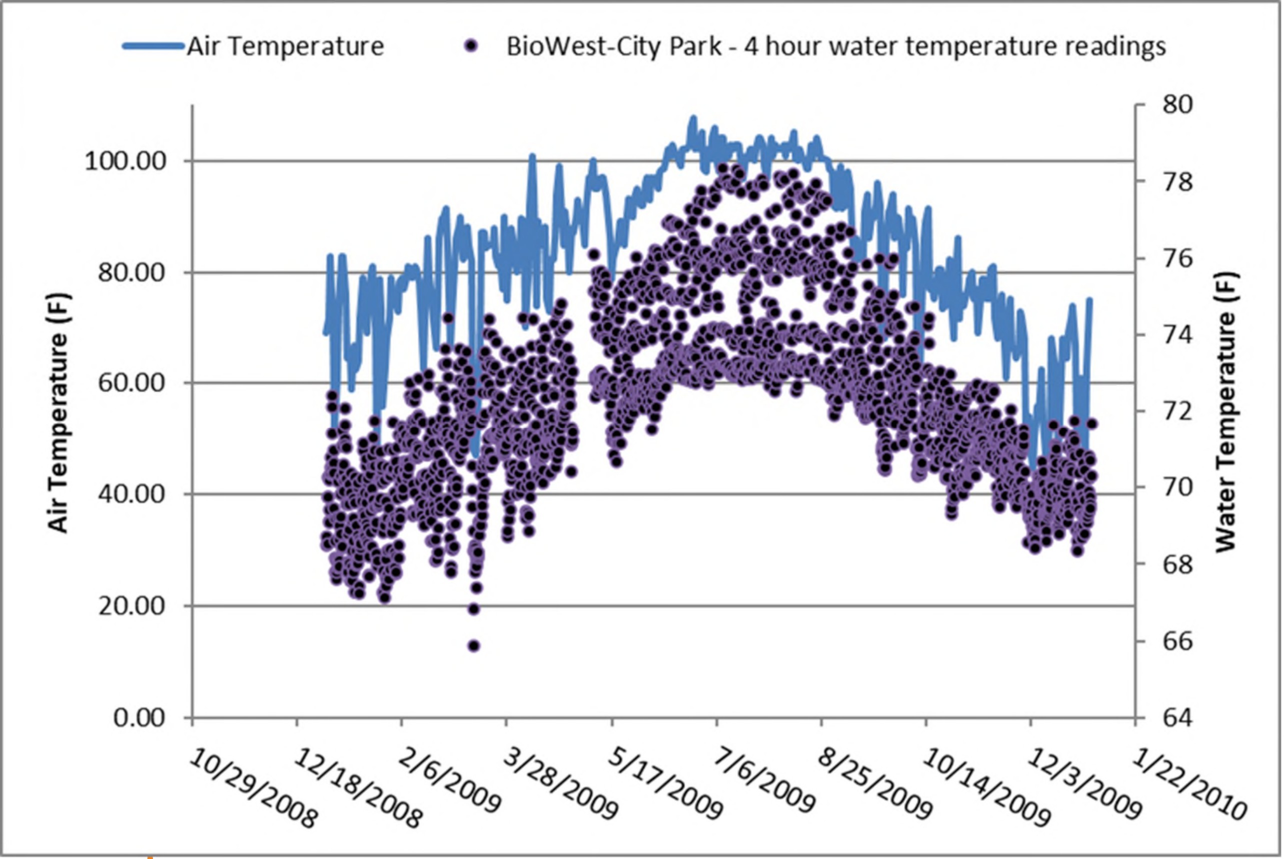

Air Temperature
BioWest-City Park - 4 hour water temperature readings
Air Temperature (F)
Water Temperature (F)
100.00
80.00
60.00
40.00
20.00
0.00
80
78
76
74
72
70
68
66
64
10/29/2008
12/18/2008
2/6/2009
3/28/2009
5/17/2009
7/6/2009
8/25/2009
10/14/2009
12/3/2009
1/22/2010


Spring Lake Chute in San Marcos River
Thermograph Data
Simulated Temperature
Larval Threshold
Water Temperature (F)
85.00
83.00
81.00
79.00
77.00
75.00
73.00
71.00
6/30/09
7/5/09
7/10/09
7/15/09
7/20/09
7/25/09
7/30/09

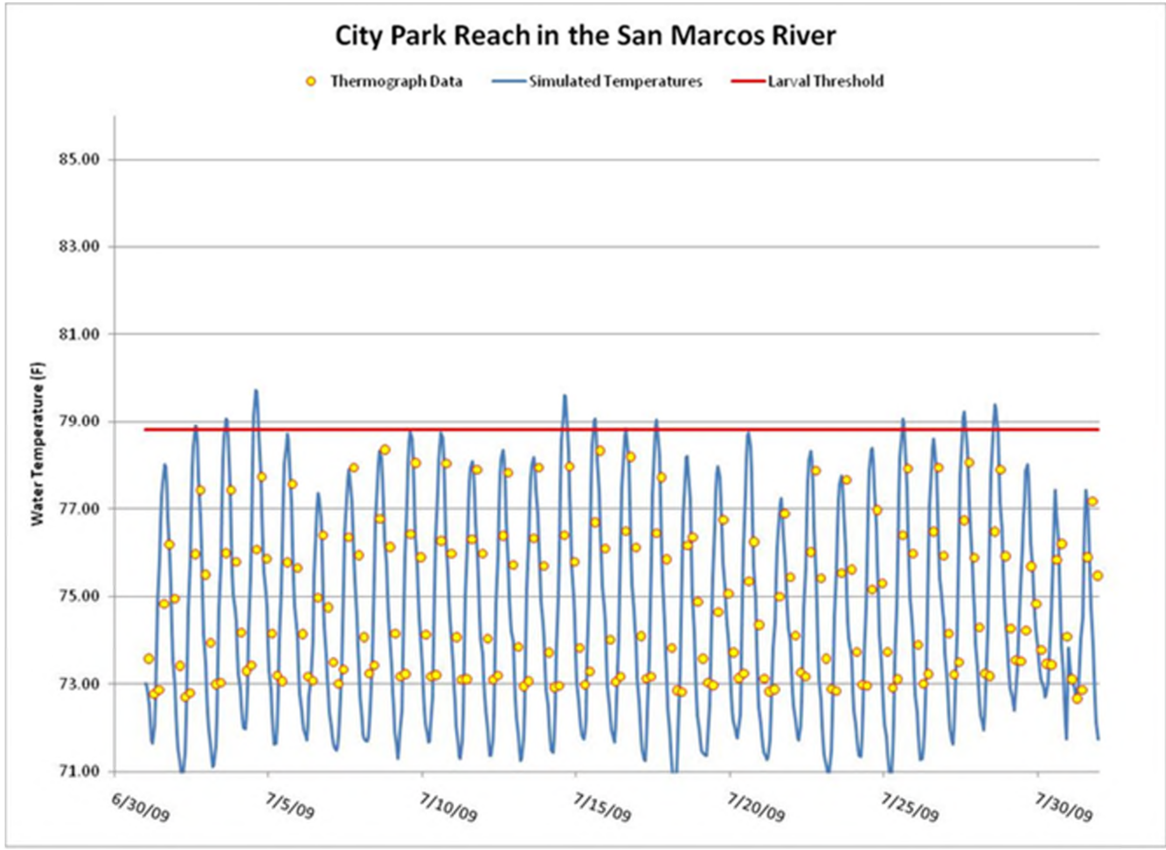

City Park Reach in the San Marcos River
Thermograph Data
Simulated Temperatures
Larval Threshold
Water Temperature (F)
85.00
83.00
81.00
79.00
77.00
75.00
73.00
71.00
6/30/09
7/5/09
7/10/09
7/15/09
7/20/09
7/25/09
7/30/09


Above Rio Vista Dam Reach in the San Marcos River
Thermograph Data
Simulated Temperatures
Larval Threshold
Water Temperature (F)
85.00
83.00
81.00
79.00
77.00
75.00
73.00
71.00
6/30/09
7/5/09
7/10/09
7/15/09
7/20/09
7/25/09
7/30/09


thermograph data
Simulated Temperature
Larval Threshold
Water Temperature (F)
85.00
83.00
81.00
79.00
77.00
75.00
73.00
71.00
6/30/09
7/5/09
7/10/09
7/15/09
7/20/09
7/25/09
7/30/09



Air Temperature
BioWest-City Park - 4 hour water temperature readings
Air Temperature (F)
Water Temperature (F)
0.00
20.00
40.00
60.00
80.00
100.00
64
66
68
70
72
74
76
78
80
10/29/2008
12/18/2008
2/6/2009
3/28/2009
5/17/2009
7/6/2009
8/25/2009
10/14/2009
12/3/2009
1/22/2010



City Park Reach in the San Marcos River
Thermograph Data
Simulated Temperatures
Larval Threshold
Water Temperature (F)
71.00
73.00
75.00
77.00
79.00
81.00
83.00
85.00
6/30/09
7/5/09
7/10/09
7/15/09
7/20/09
7/25/09
7/30/09

San Marcos Temperatures: IMHO

- At drought of record flows (i.e. 45 cfs)
  - Small headwater springs are likely to cease flowing
  - Major springs (Balcones Escarpment) are not expected to cease flowing based on historical records during the drought of record (45 cfs)
  - Major springs will continue to provide aquifer water temperatures (22-24 C depending on specific spring – Nowlin and Schwartz SMOS).
  - Residence time is much less than a day and the thermal mass of Spring Lake buffers responses to meteorological conditions.

Sam Marcos Temperatures: IMHO

- **Fountain darters**
  - **Spring Lake and the San Marcos River downstream to 'above' Rio Vista will maintain water temperatures within target ranges**
  - **Downstream of Rio Vista the Qual2e model has a wider range of uncertainty in predicted water temperatures but empirical data on water temperatures show it will infringe on acceptable thermal regimes**
  - **Additional water quality calibration/simulations will not substantially refine the residual longitudinal thermal zone acceptable to fountain darters**
- **The 'real issue' is the likely loss of aquatic vegetation below Spring Lake**
  - **Vegetation monitoring since 2009 I have conduced clearly shows seasonal loss of vegetation from recreation in all river reaches below Spring Lake Dam**
  - **An assessment of the State Scientific Area flow regime triggers suggests extensive vulnerability of TWR (all aquatic vegetation in reality) to disturbance at flows as high as 120 cfs that reflects the empirical observations**
  - **The effectiveness of restricted river access is unknown if 'closures' are warranted**
- **Temperature is not the limiting factor for fountain darters (or other aquatic organisms such as salamanders). It is protection of aquatic vegetation downstream of Spring Lake.**

Discharge (cfs)	Clear Springs	Saltgrass to Sewell Park	Sewell Park to Bicentennial Park	Bicentennial Park to Rio Vista Park	Cheatham to IH35
TWR % in reach with depth ≥ 1 m					
60	0	11	27	20	25
80	0	14	31	21	29
100	0	18	36	23	34
120	0	22	41	28	38
140	1	26	46	34	42
160	3	30	51	40	45
180	5	36	56	43	49
200	19	42	59	48	53
220	31	50	63	54	57
240	43	58	67	64	62
260	49	66	69	77	66
TWR total Area*	188	1652	2982	601	338

HABITAT CONSERVATION PLAN EDWARDS AQUIFER

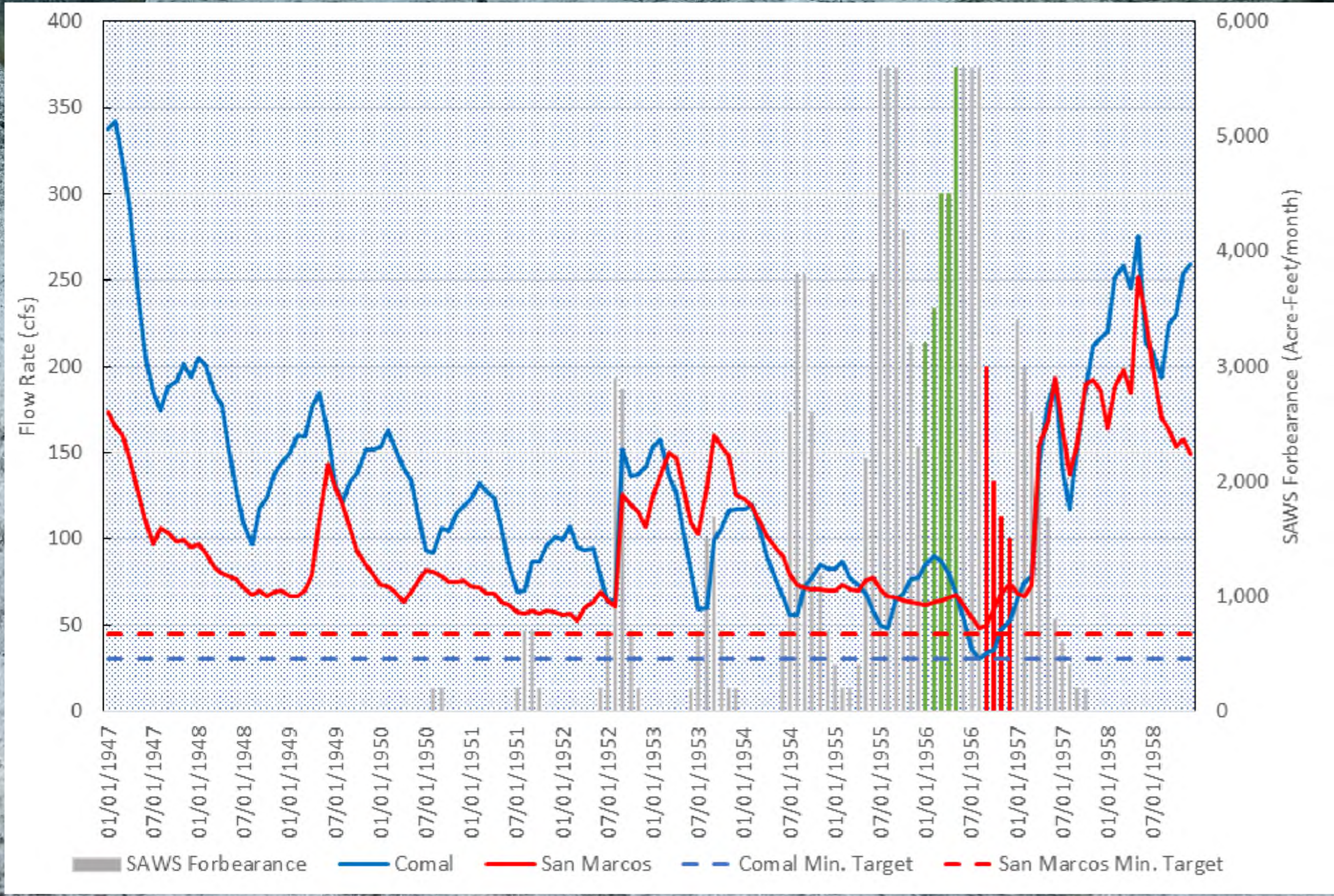
2019 VISPO AMP low-flow scenarios

EDWARDS AQUIFER AUTHORITY

Springflow Habitat Protection WG

- The VISPO AMP Scientific Evaluation Report contains the predicted Phase II flow regime through a repeat of the DOR (EAHCP 2019).

- Changes to springflow protection measures described in the EAHCP are an addition of 1,795 ac·ft yr^{-1} to the VISPO program.



Springflow Habitat Protection WG

Description	Total Comal Discharge (cfs)[a]	Time-step
Long-term average	225	Daily average
Minimum	$\boxed{30^b}$	Daily average

[a]Assumes a minimum of a 50-year modeling period that includes the drought of record
[b]Not to exceed six months in duration followed by 80 cfs (daily average) flows for 3 months

Table 3. Long-term average and minimum total San Marcos discharge management objectives (Table 4-13 of EAHCP)

Description	Total San Marcos Discharge (cfs)[a]	Time-step
Long-term average	140	Daily average
Minimum	$\boxed{45^b}$	Daily average

[a]Assumes a minimum of a 50-year modeling period that includes the drought of record
[b]Not to exceed six months in duration followed by 80 cfs (daily average) flows for 3 months

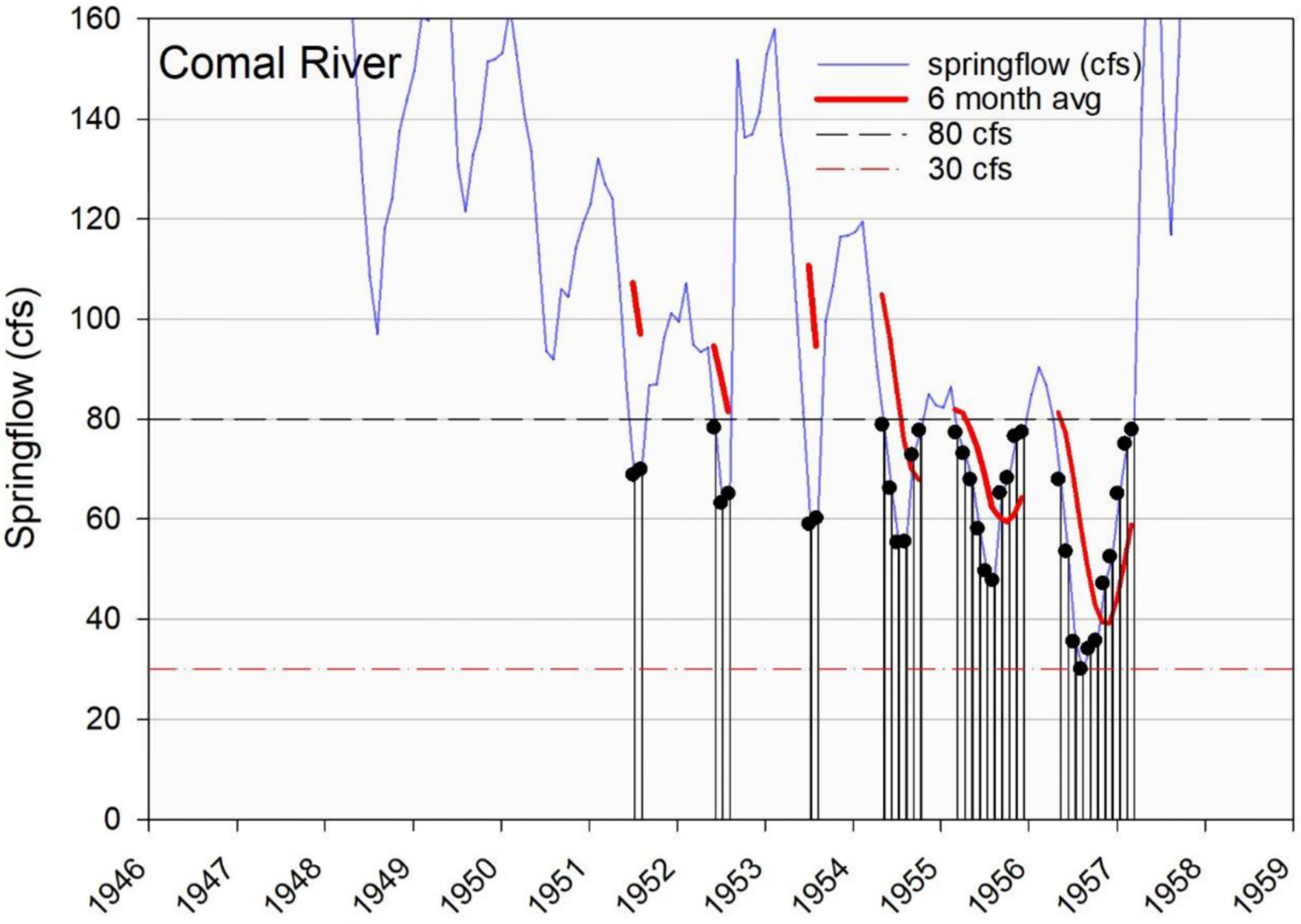


Figure 3. Comal Springs Drought of Record MODFLOW simulation shown in Figure 2 with periods of less than 80 cfs shown with bars. Other selected thresholds and statistics are shown.

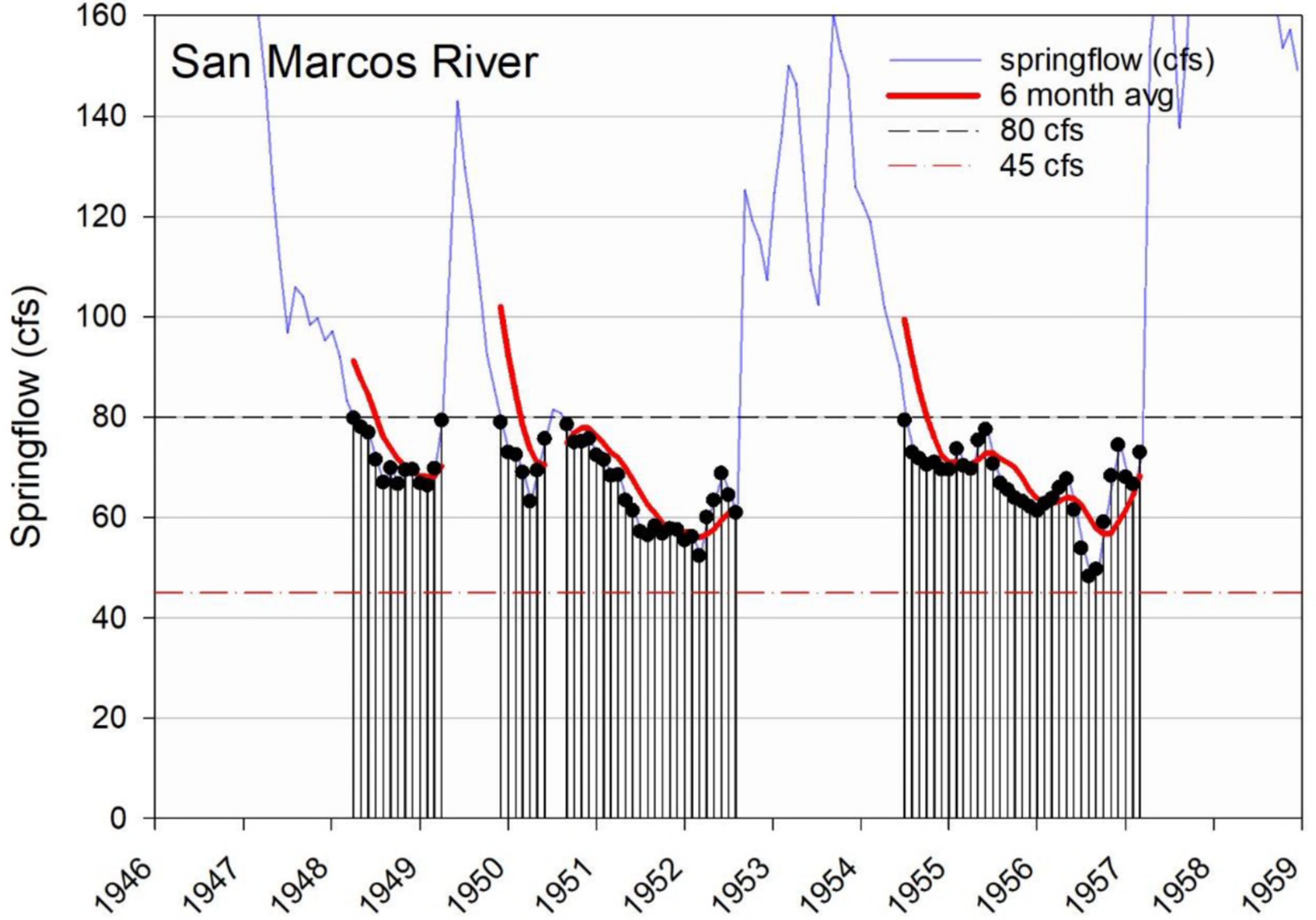


Figure 4. San Marcos Springs Drought of Record MODFLOW simulation shown in Figure 2 with periods of less than 80 cfs shown with bars. Other selected thresholds and statistics are shown.

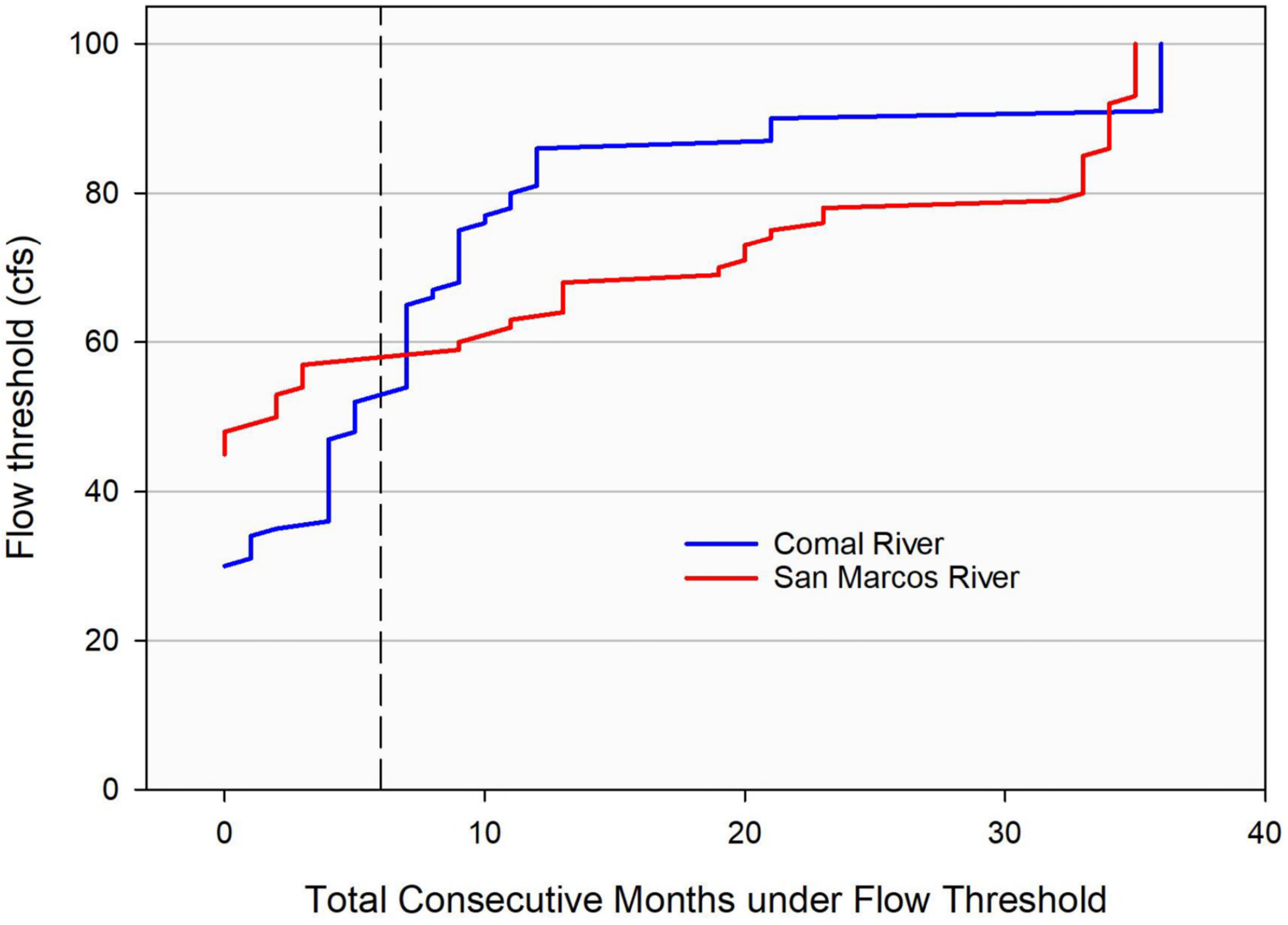


Figure 5. Frequency distributions displaying consecutive months less than flow thresholds. The vertical line is placed at 6 consecutive months.

Public comment

Future meetings

- Meeting 3 - Salamanders
  - Thursday, May 28
  - 9AM-11AM
- Meeting 4 – CS Riffle Beetles
  - Wednesday, June 3
  - 2PM-4PM
- Meeting 5 – TBD
  - TBD

HABITAT CONSERVATION PLAN
EDWARDS AQUIFER

Thank you!

eahcp@edwardsaquifer.org