Kinney County GCD Rules Committee

Bill Hutchison

April 11, 2024

Topics

- LMSCA “Kinney County Critical Period Management Plan (Las Moras Springs)”
- Technical considerations for threshold selection
- Dye Trace study review

Topics

- LMSCA "Kinney County Critical Period Management Plan (Las Moras Springs)"
- Technical considerations for threshold selection
- Dye Trace study review

LMSCA "Kinney County Critical Period Management Plan (Las Moras Springs)"

- Includes a table of "Avg Spring Flow (Normal Conditions)" for each month
- Includes a table of monthly 4-stage flow thresholds/triggers
- Includes pumping reductions for each stage

March 11, 2024

Kinney County Critical Period Management Plan (Las Moras Springs)

Goals of Plan

- Protect the health of Las Moras Springs, Las Moras Creek, and its aquifer
- Avoid unnecessary losses to permit holders
- Give transparency to the public who has an interest in the health of the springs and creek
- Balance property rights of permit holders and property rights of landowners along the springs and creek
- Give notice and predictability to permit holders in order to help plan for potential drought or reservoir pressure depletion

Las Moras Springs Trigger

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Avg Spring Flow (Normal Conditions)	22	19	18	18	20	20	20	20	21	25	25	24
Stage 1	20	17	16	16	18	18	18	19	23	23	22	20
Stage 2	18	15	14	14	16	16	16	17	20	20	19	18
Stage 3	14	12	11	11	13	13	13	13	16	16	15	14
Stage 4	11	9	9	9	10	10	10	10	12	12	12	11

*Avg Spring Flow is calculated from monthly USGS data from 1966 – 2019
**Stage 1 is a 10% reduction in Avg Spring Flow
***Stage 2 is a 20% reduction in Avg Spring Flow
****Stage 3 is a 30% reduction in Avg Spring Flow
*****Stage 4 is a 40% reduction in Avg Spring Flow

March 11, 2024

Kinney County Critical Period Management Plan (Las Moras Springs)

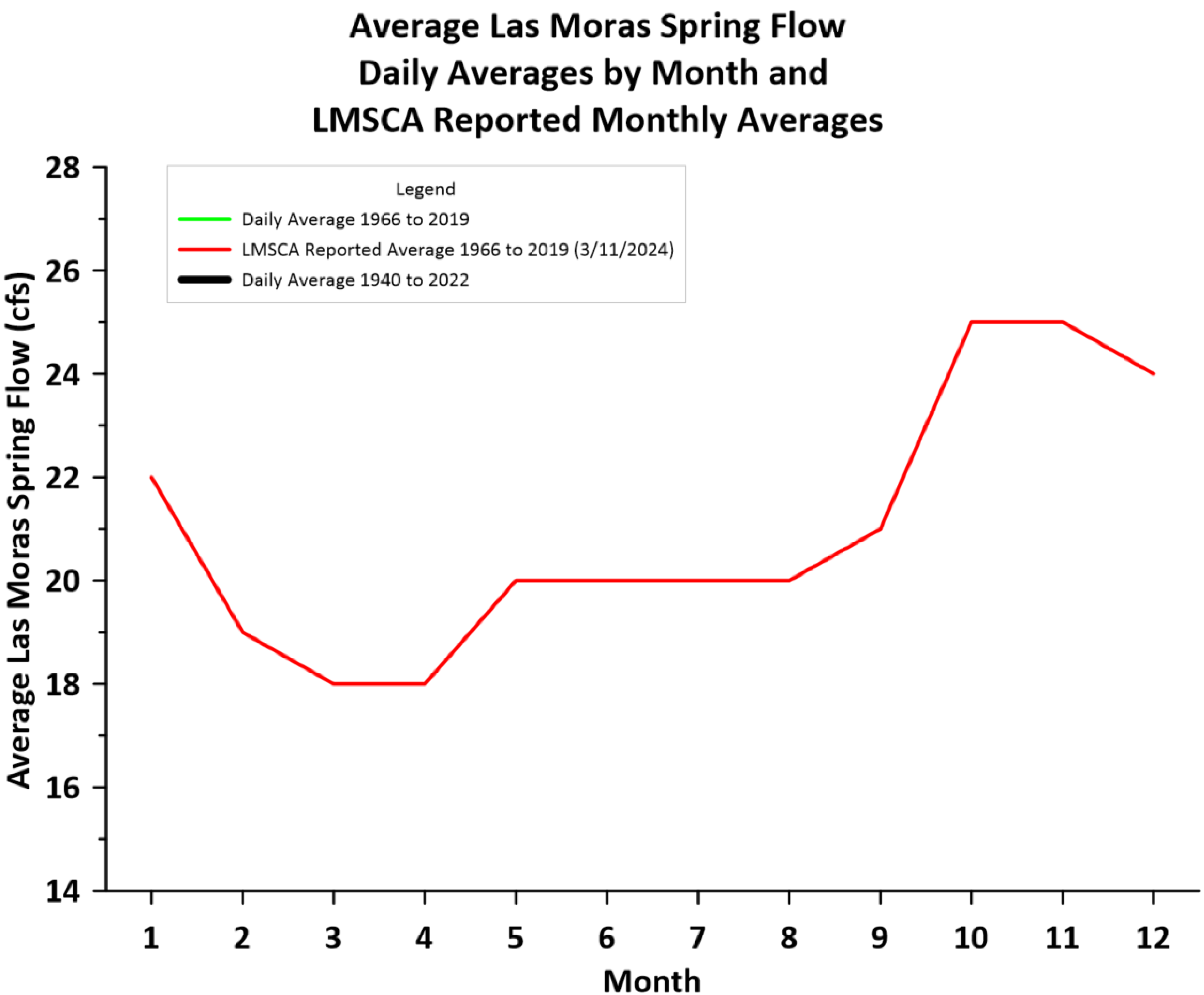
Goals of Plan

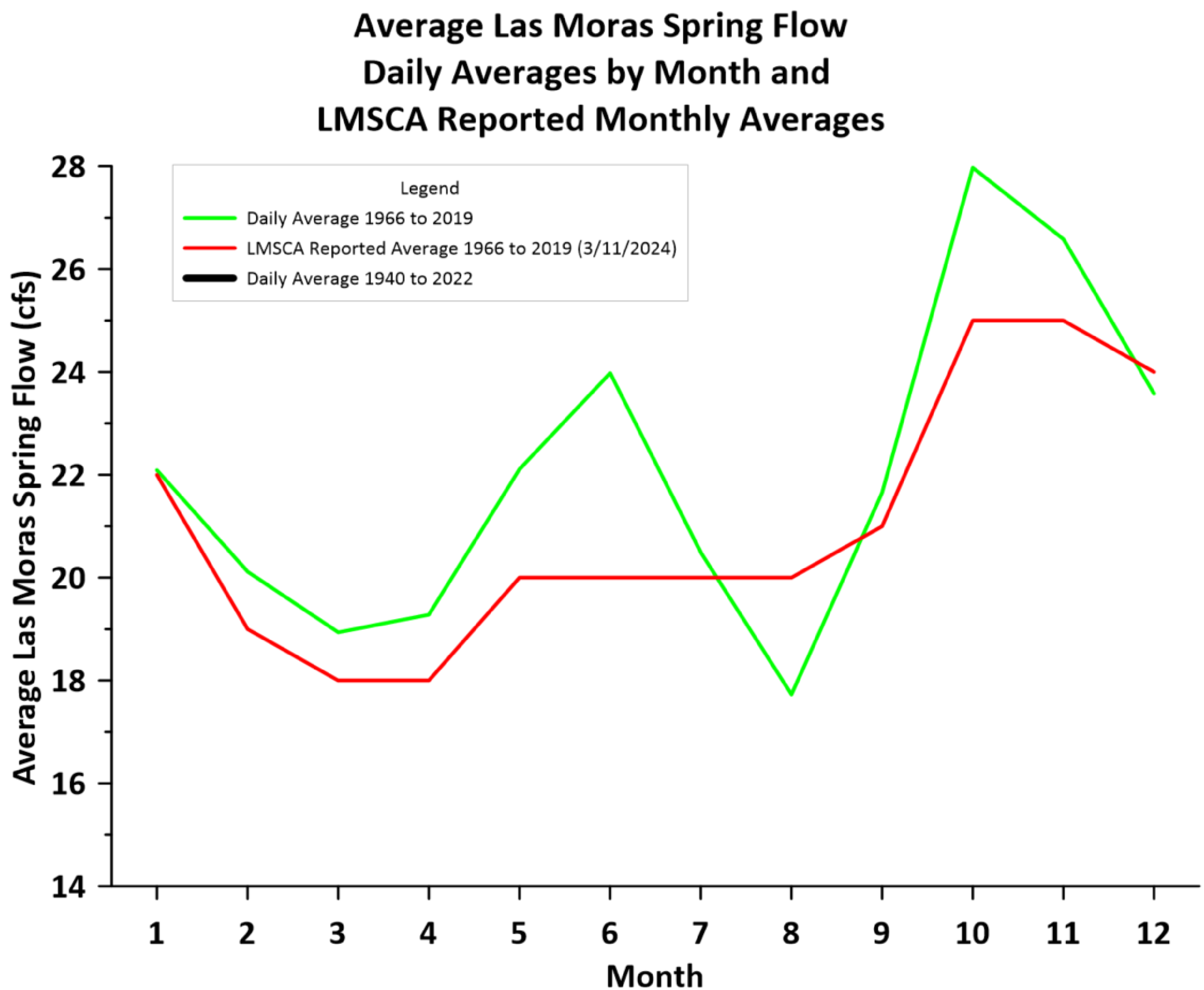
- Protect the health of Las Moras Springs, Las Moras Creek, and its aquifer
- Avoid unnecessary losses to permit holders
- Give transparency to the public who has an interest in the health of the springs and creek
- Balance property rights of permit holders and property rights of landowners along the springs and creek
- Give notice and predictability to permit holders in order to help plan for potential drought or reservoir pressure depletion

Las Moras Springs Trigger

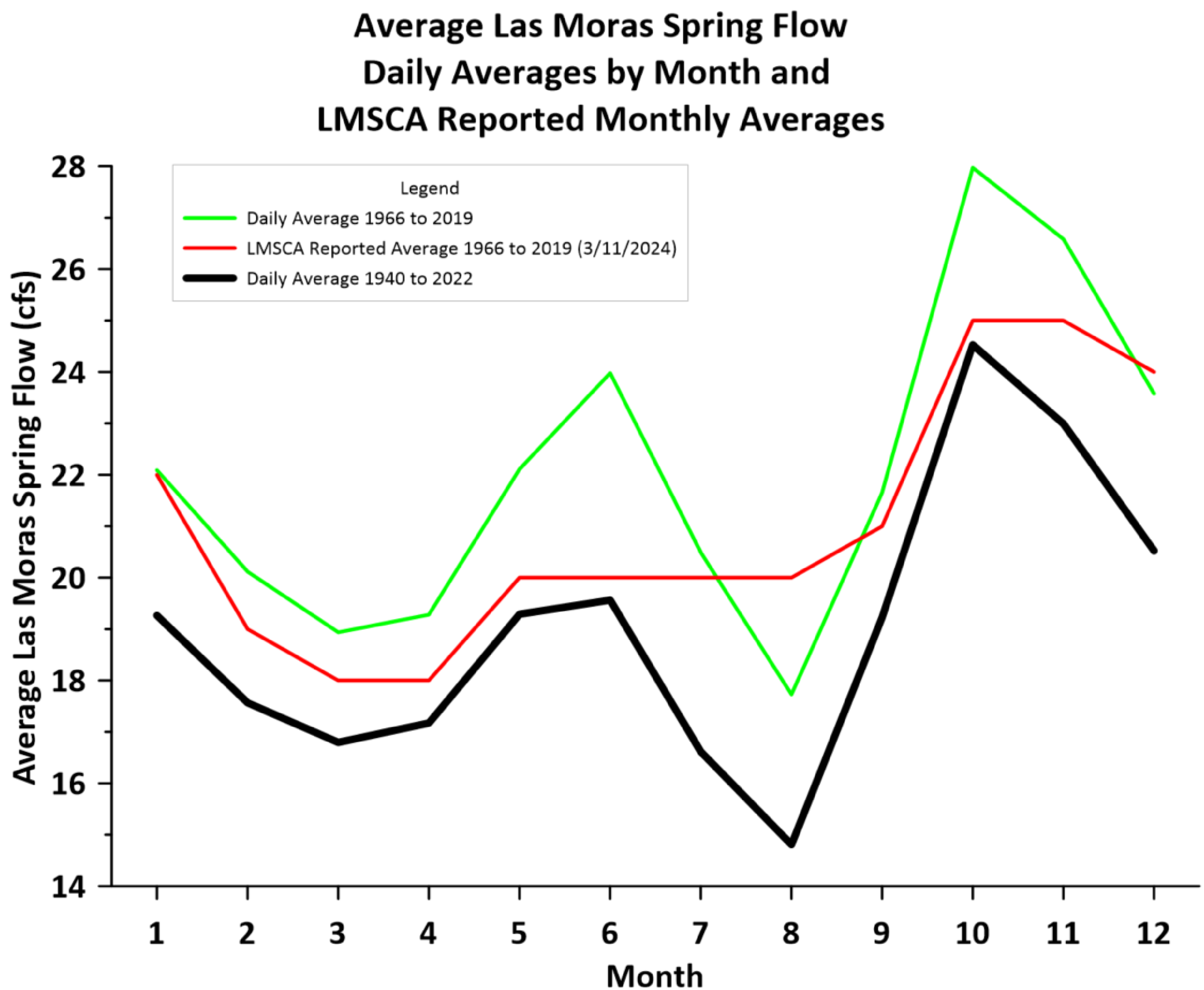
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Avg Spring Flow (Normal Conditions)	22	19	18	18	20	20	20	20	21	25	25	24
Stage 1	20	17	16	16	18	18	18	19	23	23	22	20
Stage 2	18	15	14	14	16	16	16	17	20	20	19	18
Stage 3	14	12	11	11	13	13	13	13	16	16	15	14
Stage 4	11	9	9	9	10	10	10	10	12	12	12	11

*Avg Spring Flow is calculated from monthly USGS data from 1966 – 2019
**Stage 1 is a 10% reduction in Avg Spring Flow
***Stage 2 is a 20% reduction in Avg Spring Flow
****Stage 3 is a 30% reduction in Avg Spring Flow
*****Stage 4 is a 40% reduction in Avg Spring Flow


Average Las Moras Spring Flow
Daily Averages by Month and
LMSCA Reported Monthly Averages
Legend
Daily Average 1966 to 2019
LMSCA Reported Average 1966 to 2019 (3/11/2024)
Daily Average 1940 to 2022
Average Las Moras Spring Flow (cfs)
28
26
24
22
20
18
16
14
1
2
3
4
5
6
7
8
9
10
11
12
Month



Average Las Moras Spring Flow
Daily Averages by Month and
LMSCA Reported Monthly Averages
Legend
Daily Average 1966 to 2019
LMSCA Reported Average 1966 to 2019 (3/11/2024)
Daily Average 1940 to 2022
Average Las Moras Spring Flow (cfs)
28
26
24
22
20
18
16
14
1
2
3
4
5
6
7
8
9
10
11
12
Month


Average Las Moras Spring Flow
Daily Averages by Month and
LMSCA Reported Monthly Averages
Legend
Daily Average 1966 to 2019
LMSCA Reported Average 1966 to 2019 (3/11/2024)
Daily Average 1940 to 2022
Average Las Moras Spring Flow (cfs)
28
26
24
22
20
18
16
14
1
2
3
4
5
6
7
8
9
10
11
12
Month

Las Moras Springs Trigger

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Avg Spring Flow (Normal Conditions)	22	19	18	18	20	20	20	20	21	25	25	24
Stage 1	20	17	16	16	18	18	18	19	23	23	22	20
Stage 2	18	15	14	14	16	16	16	17	20	20	19	18
Stage 3	14	12	11	11	13	13	13	13	16	16	15	14
Stage 4	11	9	9	9	10	10	10	10	12	12	12	11

*Avg Spring Flow is calculated from monthly USGS data from 1966 – 2019

**Stage 1 is a 10% reduction in Avg Spring Flow

***Stage 2 is a 20% reduction in Avg Spring Flow

****Stage 3 is a 30% reduction in Avg Spring Flow

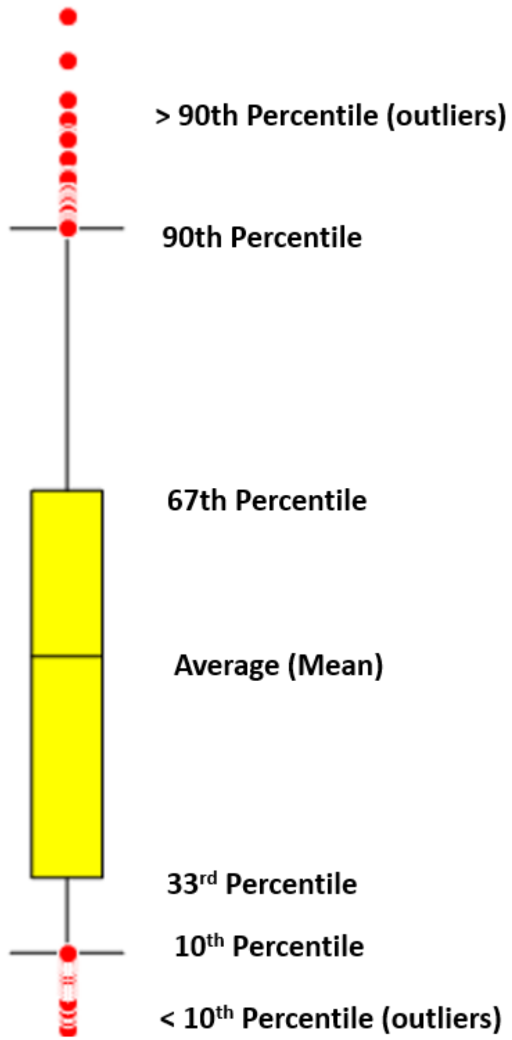
*****Stage 4 is a 40% reduction in Avg Spring Flow

Las Moras Spring Flow Analysis

- TM 23-16 (June 11, 2023)
  - Daily flow analysis organized by month

Month	Data Points
January	413
February	377
March	413
April	418
May	440
June	391
July	396
August	397
September	404
October	471
November	446
December	436
Total	**5,002**

Box and Whisker Plot Legend



Modified from Figure 1 of TM 23-16 (June 11, 2023)

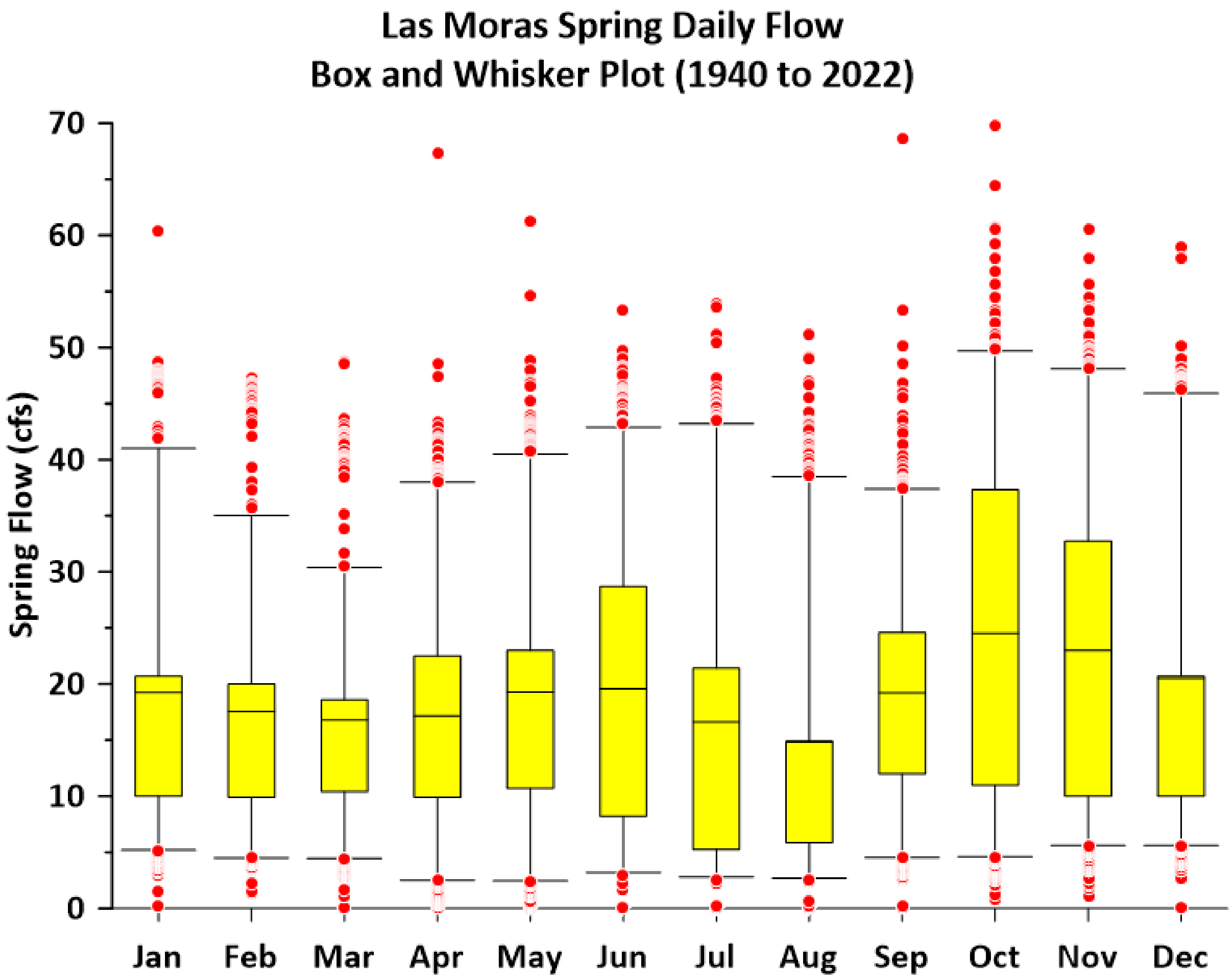


Figure 3 of TM 23-16 (June 11, 2023)

Statistical Summary of Las Moras Spring Flow (cfs): 1940 to 2022

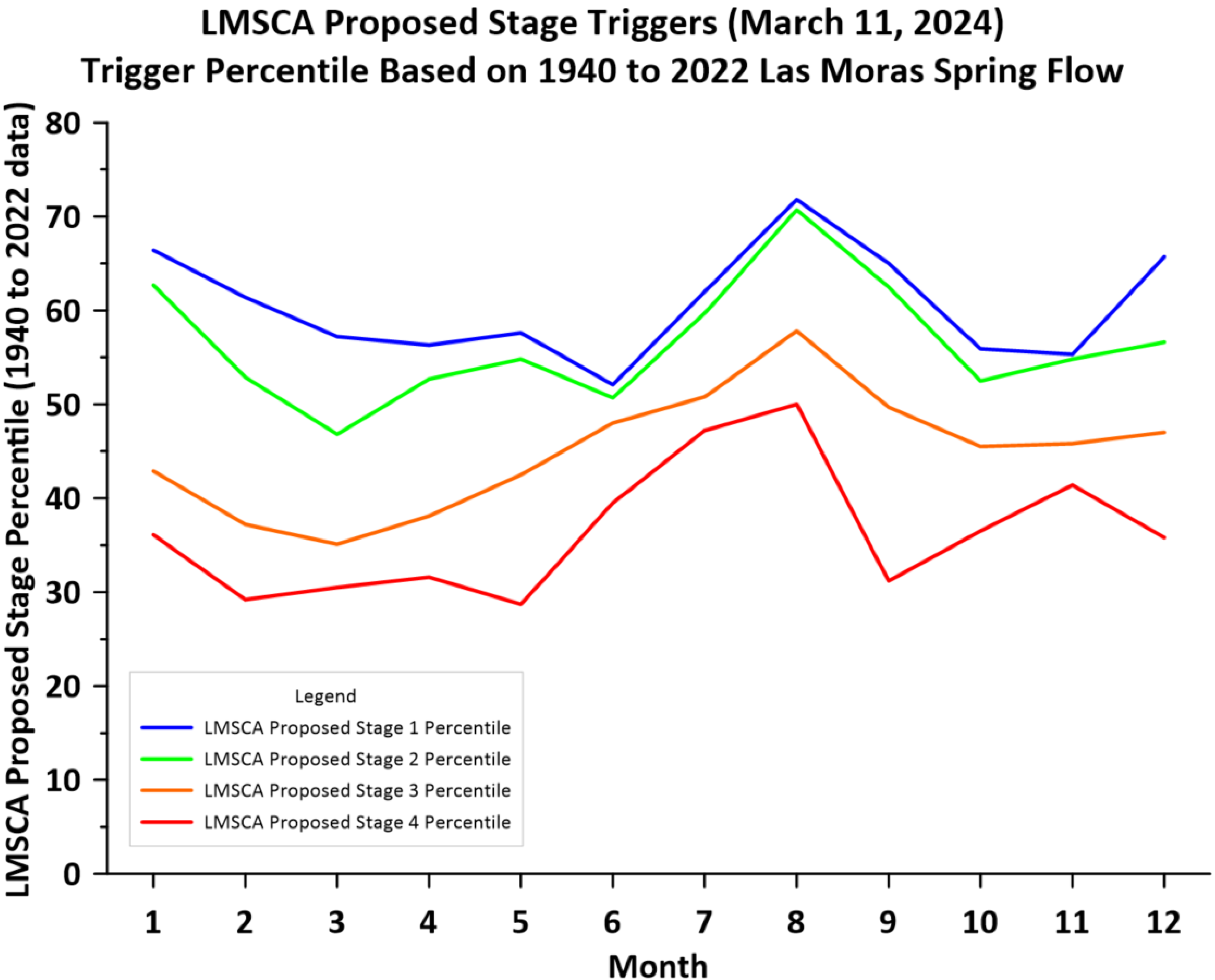
Month	10th Percentile	33rd Percentile	Median (50th Percentile)	Mean	67th Percentile	90th Percentile
January	5.20	10.00	15.00	19.27	20.71	41.00
February	4.50	9.90	14.00	17.57	19.98	34.58
March	4.46	10.39	14.00	16.80	18.61	30.32
April	2.75	9.90	13.00	17.17	22.44	37.86
May	2.45	10.70	14.50	19.29	23.03	40.32
June	3.20	8.22	14.71	19.56	28.70	42.45
July	2.80	5.27	12.65	16.61	21.26	43.20
August	2.70	5.85	10.00	14.81	14.93	38.50
September	4.52	12.00	16.20	19.23	24.60	37.40
October	4.60	11.00	18.60	24.53	37.26	49.70
November	5.59	10.00	17.00	22.99	32.78	48.10
December	5.60	10.00	15.00	20.52	20.65	45.45

Table 1 of TM 23-16 (June 11, 2023)

Statistical Summary of Las Moras Spring Flow (cfs): 1940 to 2022

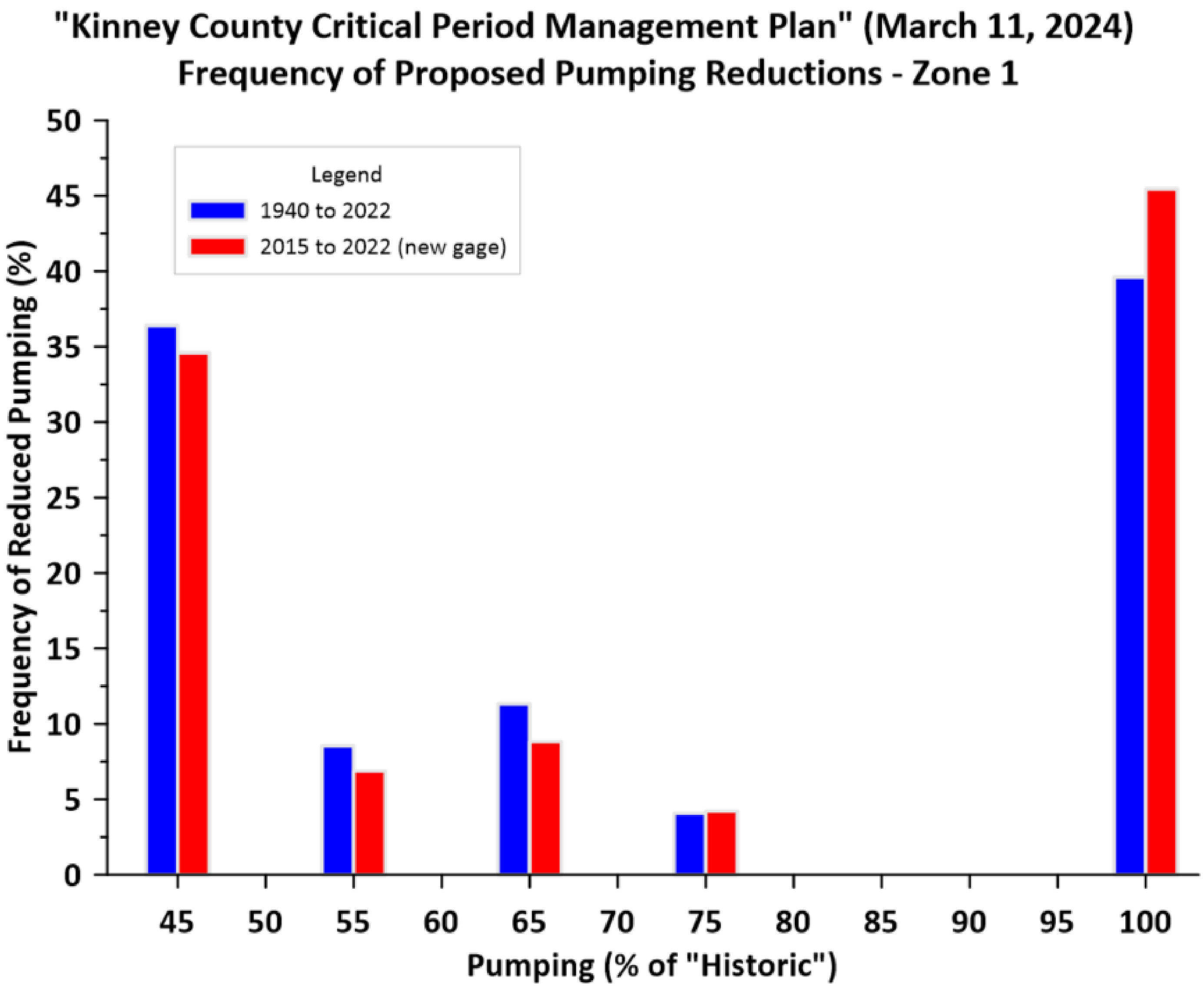
Month	10th Percentile	33rd Percentile	Median (50th Percentile)	Mean	67th Percentile	90th Percentile
January	5.20	10.00	15.00	19.27	20.71	41.00
February	4.50	9.90	14.00	17.57	19.98	34.58
March	4.46	10.39	14.00	16.80	18.61	30.32
April	2.75	9.90	13.00	17.17	22.44	37.86
May	2.45	10.70	14.50	19.29	23.03	40.32
June	3.20	8.22	14.71	19.56	28.70	42.45
July	2.80	5.27	12.65	16.61	21.26	43.20
August	2.70	5.85	10.00	14.81	14.93	38.50
September	4.52	12.00	16.20	19.23	24.60	37.40
October	4.60	11.00	18.60	24.53	37.26	49.70
November	5.59	10.00	17.00	22.99	32.78	48.10
December	5.60	10.00	15.00	20.52	20.65	45.45

Table 1 of TM 23-16 (June 11, 2023)


LMSCA Proposed Stage Triggers (March 11, 2024)
Trigger Percentile Based on 1940 to 2022 Las Moras Spring Flow
LMSCA Proposed Stage Percentile (1940 to 2022 data)
0
10
20
30
40
50
60
70
80
1
2
3
4
5
6
7
8
9
10
11
12
Month
Legend
LMSCA Proposed Stage 1 Percentile
LMSCA Proposed Stage 2 Percentile
LMSCA Proposed Stage 3 Percentile
LMSCA Proposed Stage 4 Percentile

“Critical Period” occurs 55 to 60% of the time

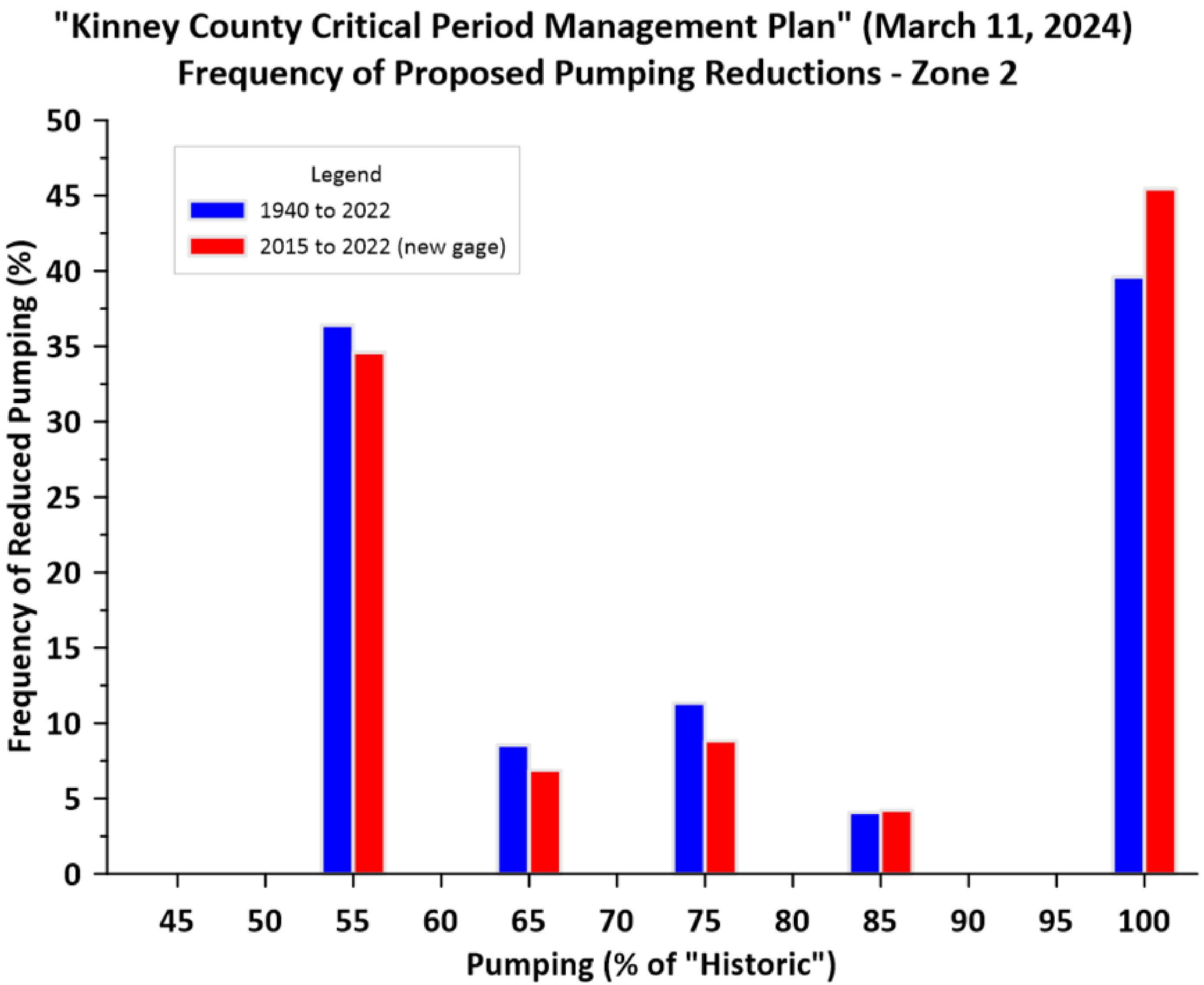
Average Zone 1 Pumping Reduction (1940 to 2022) = 29%



Notes: Does not include any assumed spring flow increase associated with pumping reductions
Does not include any non reductions associated with “crop protection” provisions

"Critical Period" occurs 55 to 60% of the time

Average Zone 2 Pumping Reduction (1940 to 2022) = 23%

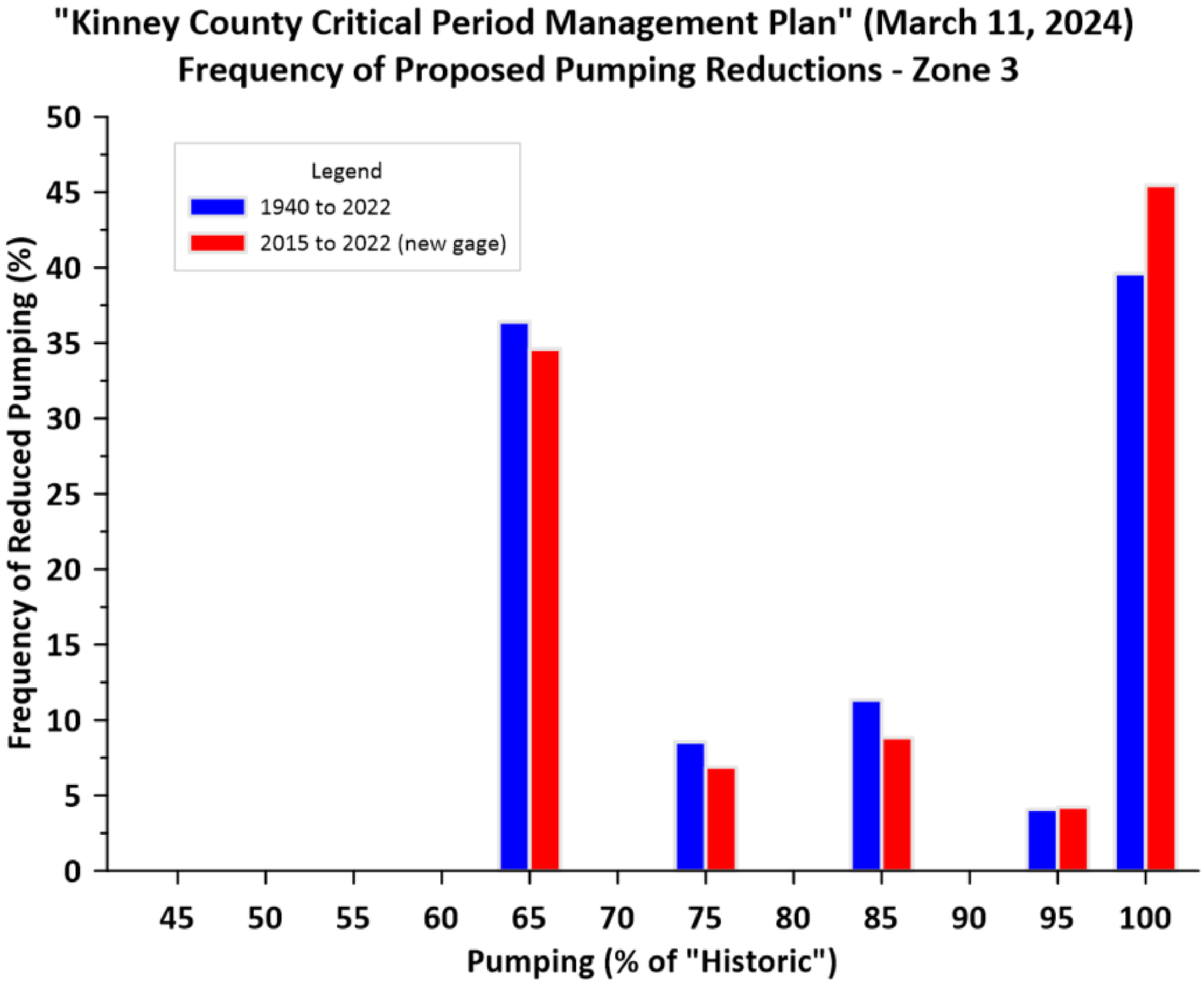


Notes: Does not include any assumed spring flow increase associated with pumping reductions

Does not include any non reductions associated with "crop protection" provisions

"Critical Period" occurs 55 to 60% of the time

Average Zone 3 Pumping Reduction (1940 to 2022) = 17%



Notes: Does not include any assumed spring flow increase associated with pumping reductions

Does not include any non reductions associated with "crop protection" provisions

Topics

- LMSCA “Kinney County Critical Period Management Plan (Las Moras Springs)”
- Technical considerations for threshold selection
- Dye Trace study review

Thresholds

- Should be based on a stated policy objective
  - Overall pumping reduction
  - Drought period management
  - Critical drought period management
- TM 23-16 included a discussion of simulating 10th percentile, 33rd percentile, and 50th percentile as thresholds
  - Estimate spring flow recovery
  - Estimate resulting pumping reductions

Statistical Summary of Las Moras Spring Flow (cfs): 1940 to 2022

Month	10th Percentile	33rd Percentile	Median (50th Percentile)	Mean	67th Percentile	90th Percentile
January	5.20	10.00	15.00	19.27	20.71	41.00
February	4.50	9.90	14.00	17.57	19.98	34.58
March	4.46	10.39	14.00	16.80	18.61	30.32
April	2.75	9.90	13.00	17.17	22.44	37.86
May	2.45	10.70	14.50	19.29	23.03	40.32
June	3.20	8.22	14.71	19.56	28.70	42.45
July	2.80	5.27	12.65	16.61	21.26	43.20
August	2.70	5.85	10.00	14.81	14.93	38.50
September	4.52	12.00	16.20	19.23	24.60	37.40
October	4.60	11.00	18.60	24.53	37.26	49.70
November	5.59	10.00	17.00	22.99	32.78	48.10
December	5.60	10.00	15.00	20.52	20.65	45.45

Table 1 of TM 23-16 (June 11, 2023)

Possible Simplified Thresholds

- 4 cfs (associated with 10th percentile)
  - “Critical Drought Period”
- 9 cfs (associated with 33rd percentile)
  - “Drought Period”
- 15 cfs (associated with 50th percentile)
  - “Pumping Reduction”

From TM 23-16 (June 11, 2023)

Topics

- LMSCA "Kinney County Critical Period Management Plan (Las Moras Springs)"
- Technical considerations for threshold selection
- Dye Trace study review

Dye Trace Study

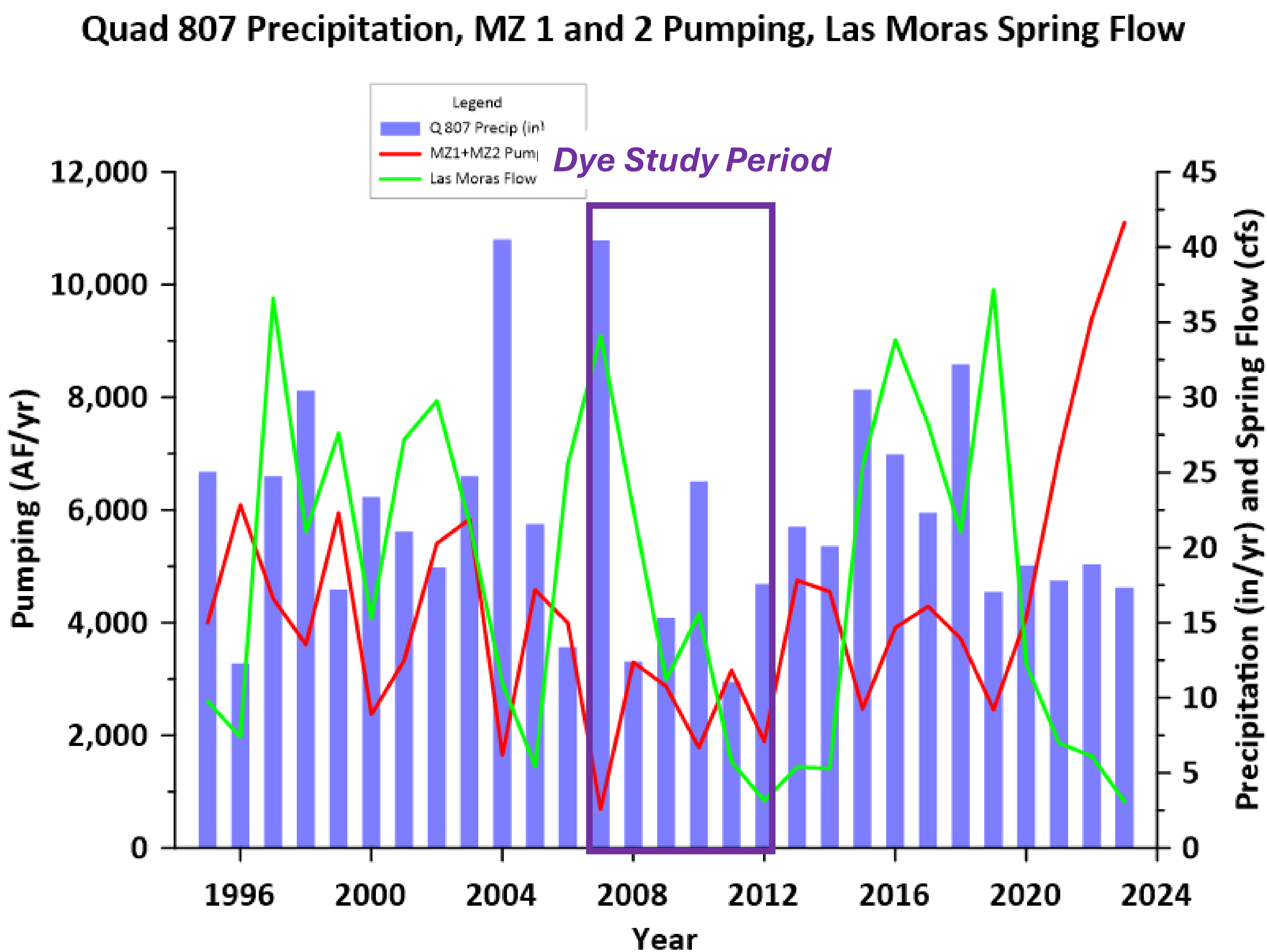
Period of Study: 2007 to 2012

Tracing Groundwater Flowpaths in Kinney County, Texas

Steve Johnson and Geary Schindel

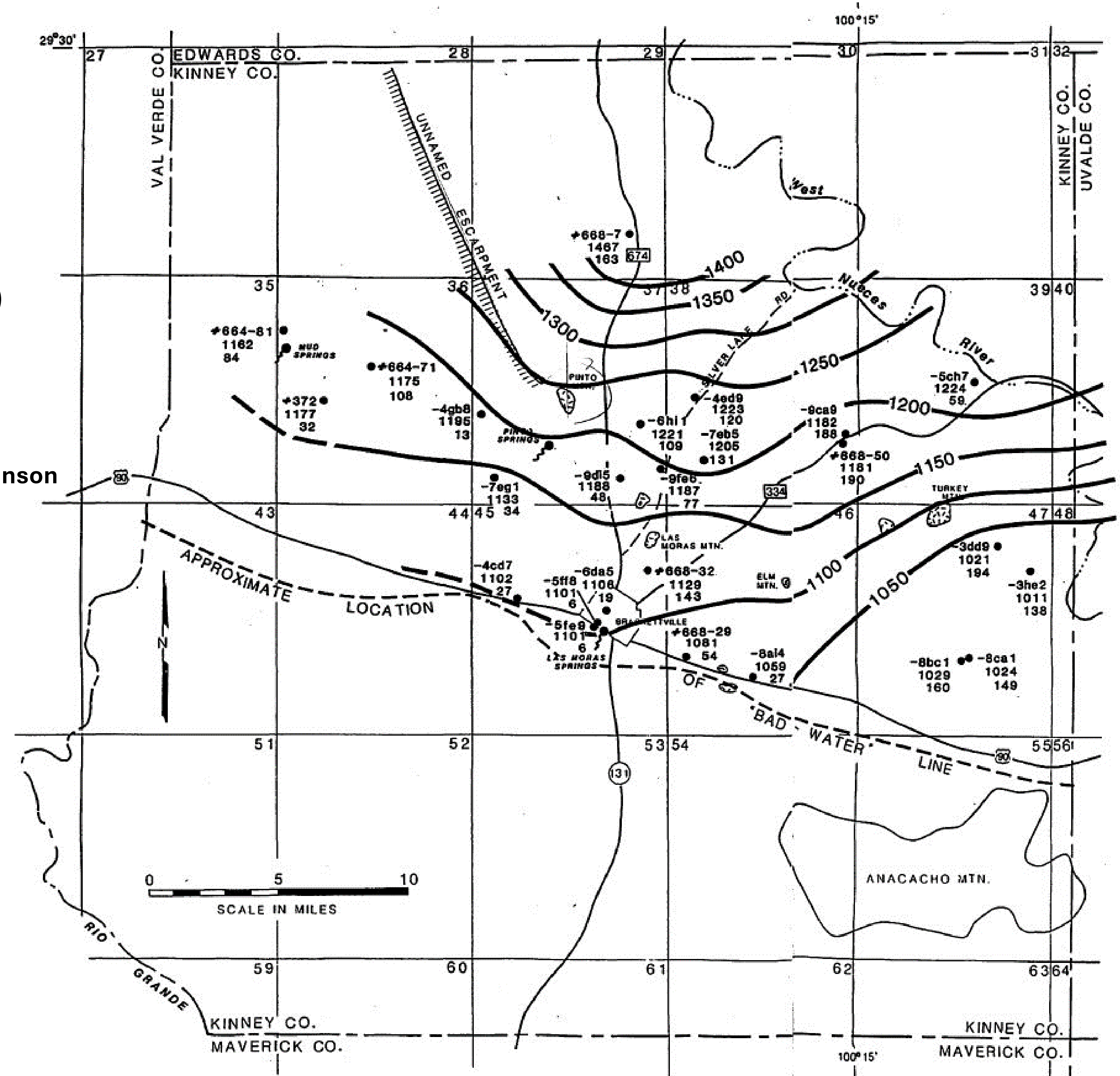
December 2015 / Report 15-02

Edwards Aquifer Authority
900 E. Quincy, San Antonio, Texas 78215


Quad 807 Precipitation, MZ 1 and 2 Pumping, Las Moras Spring Flow
Legend
Q 807 Precip (in)
MZ1+MZ2 Pump
Las Moras Flow
Dye Study Period
Pumping (AF/yr)
12,000
10,000
8,000
6,000
4,000
2,000
0
Precipitation (in/yr) and Spring Flow (cfs)
45
40
35
30
25
20
15
10
5
0
1996
2000
2004
2008
2012
2016
2020
2024
Year

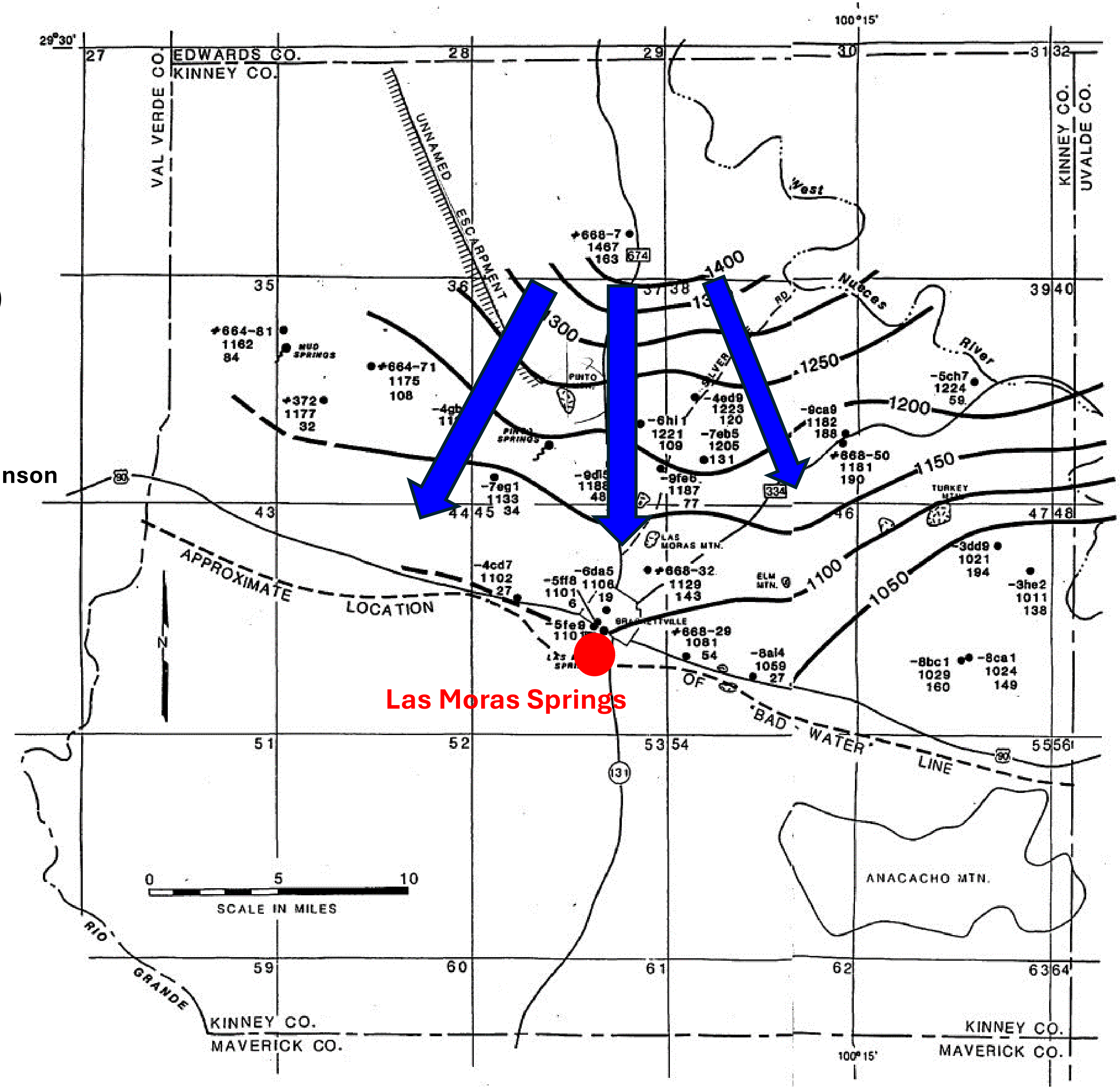
LBG Guyton (1996) Groundwater Elevation Contour Map

Note: Also presented in Johnson and Schindel (2015) "Dye Study"



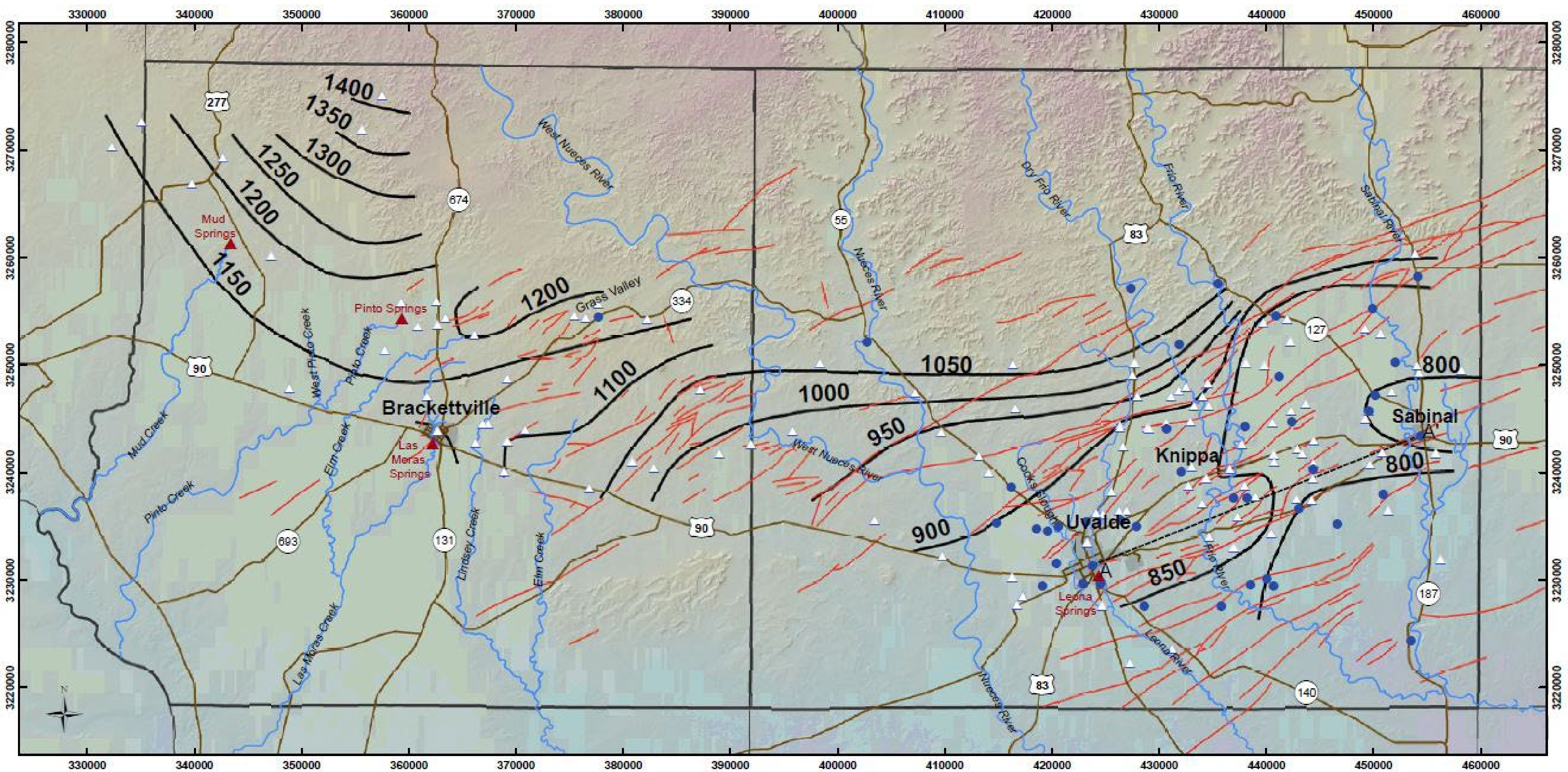
LBG Guyton (1996) Groundwater Elevation Contour Map

Note: Also presented in Johnson and Schindel (2015) "Dye Study"



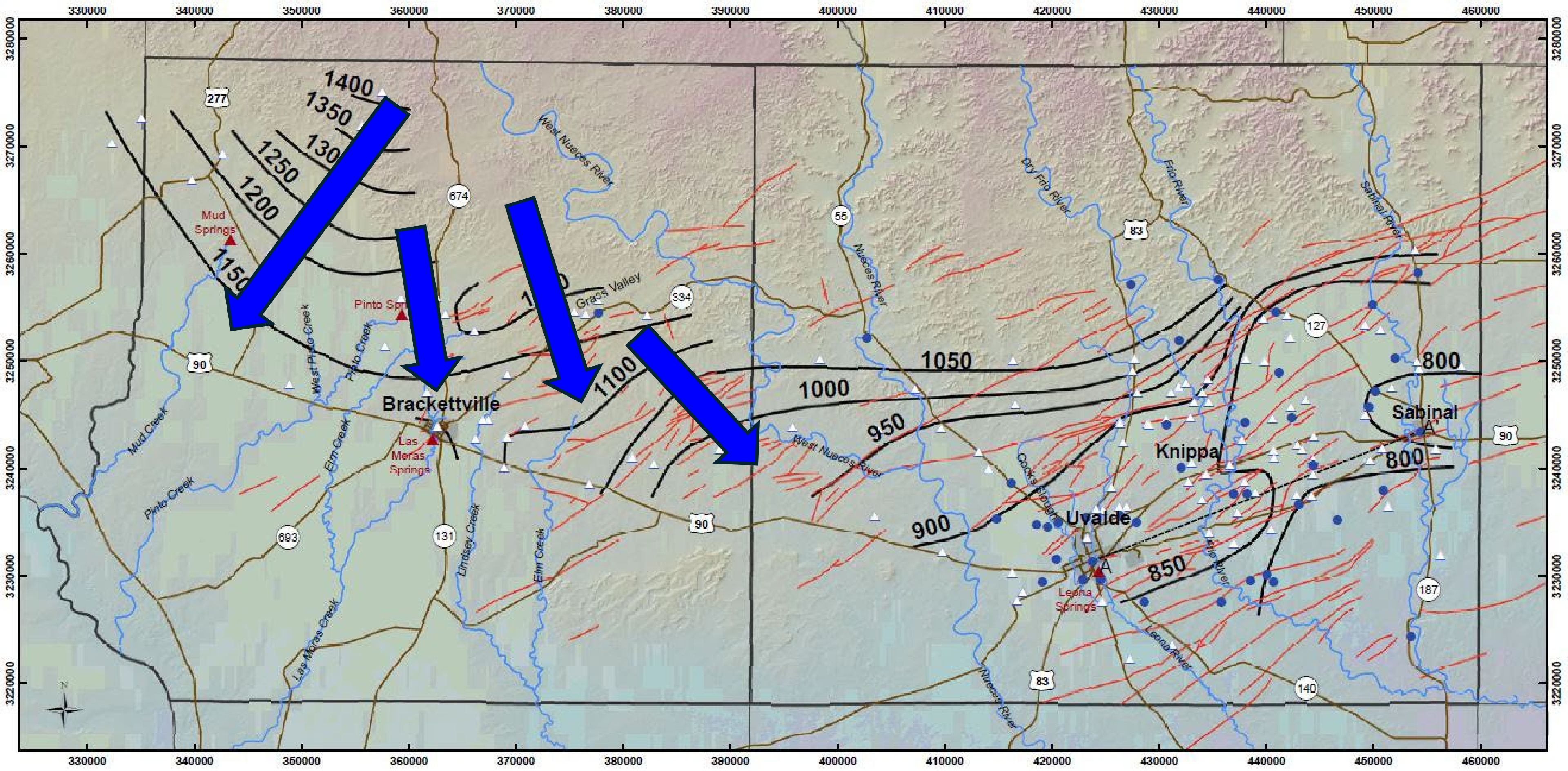
Green and others (2006) Groundwater Contour Map

Note: Also presented in Johnson and Schindel (2015) "Dye Study"



Green and others (2006) Groundwater Contour Map

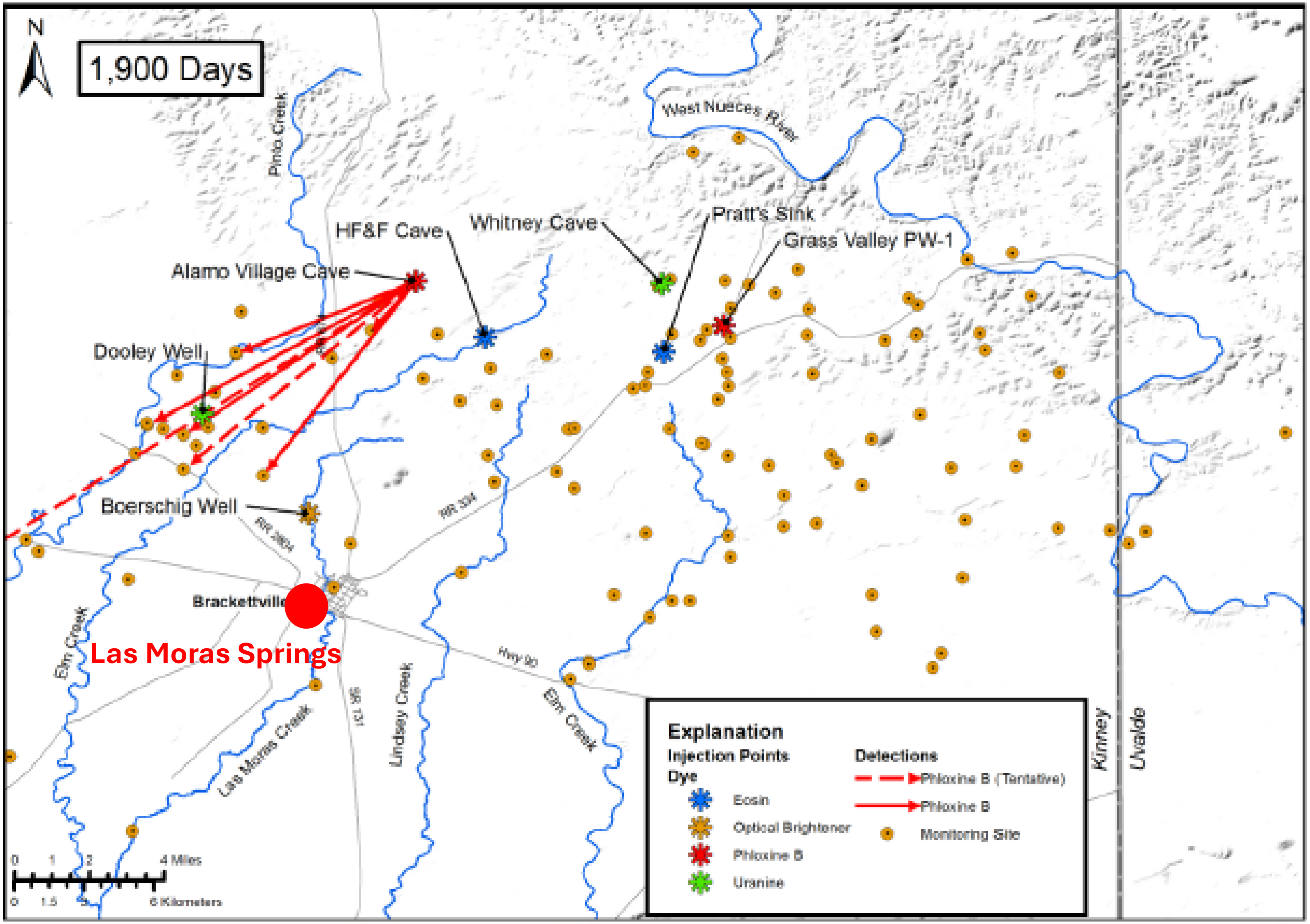
Note: Also presented in Johnson and Schindel (2015) "Dye Study"



Dye Trace Results

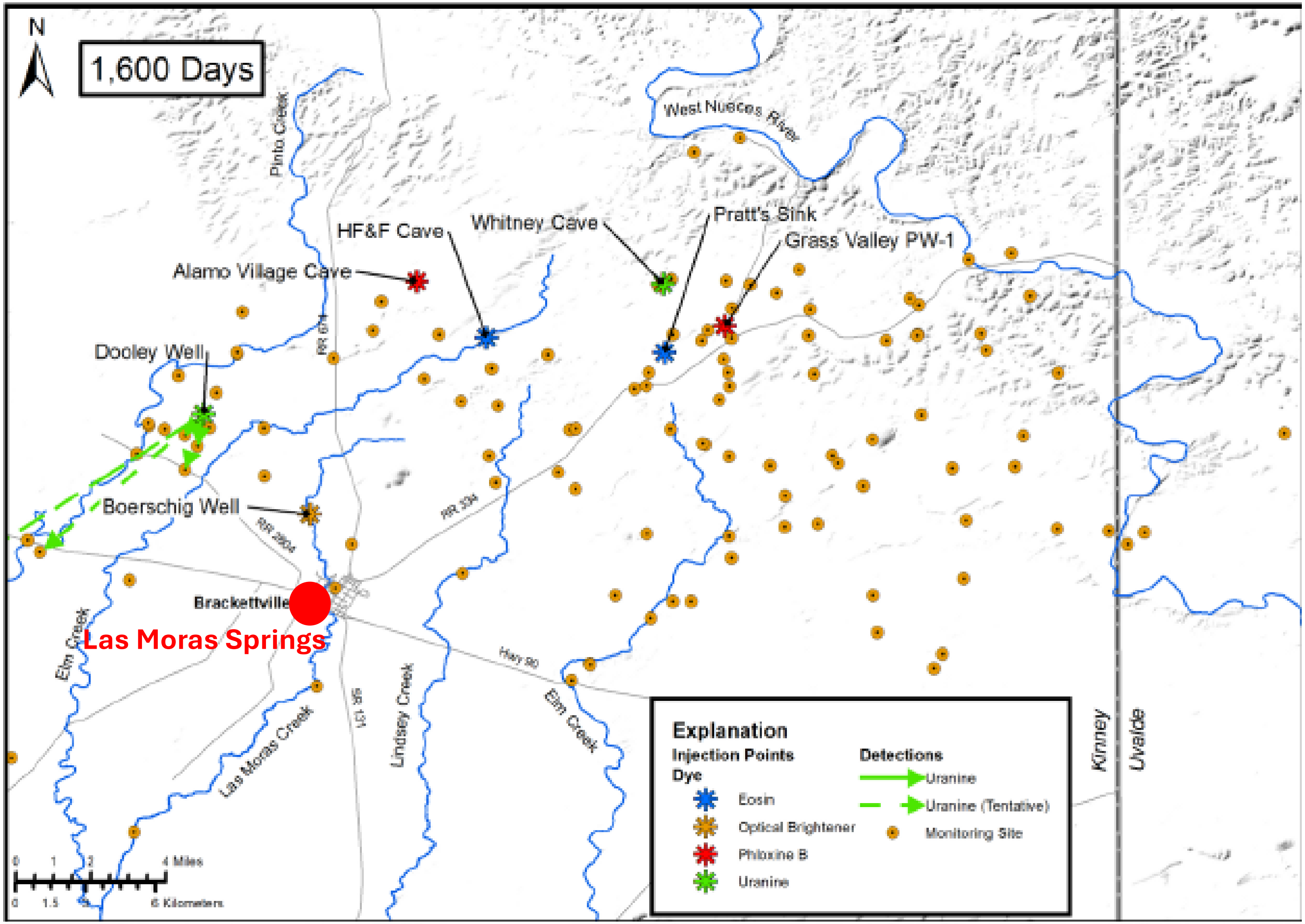
- Alamo Cave
- Dooley Well
- Boerschig Well
- Whitney Cave
- Pratt’s Sink
- Grass Valley Well

Alamo Cave – 1,900 Days



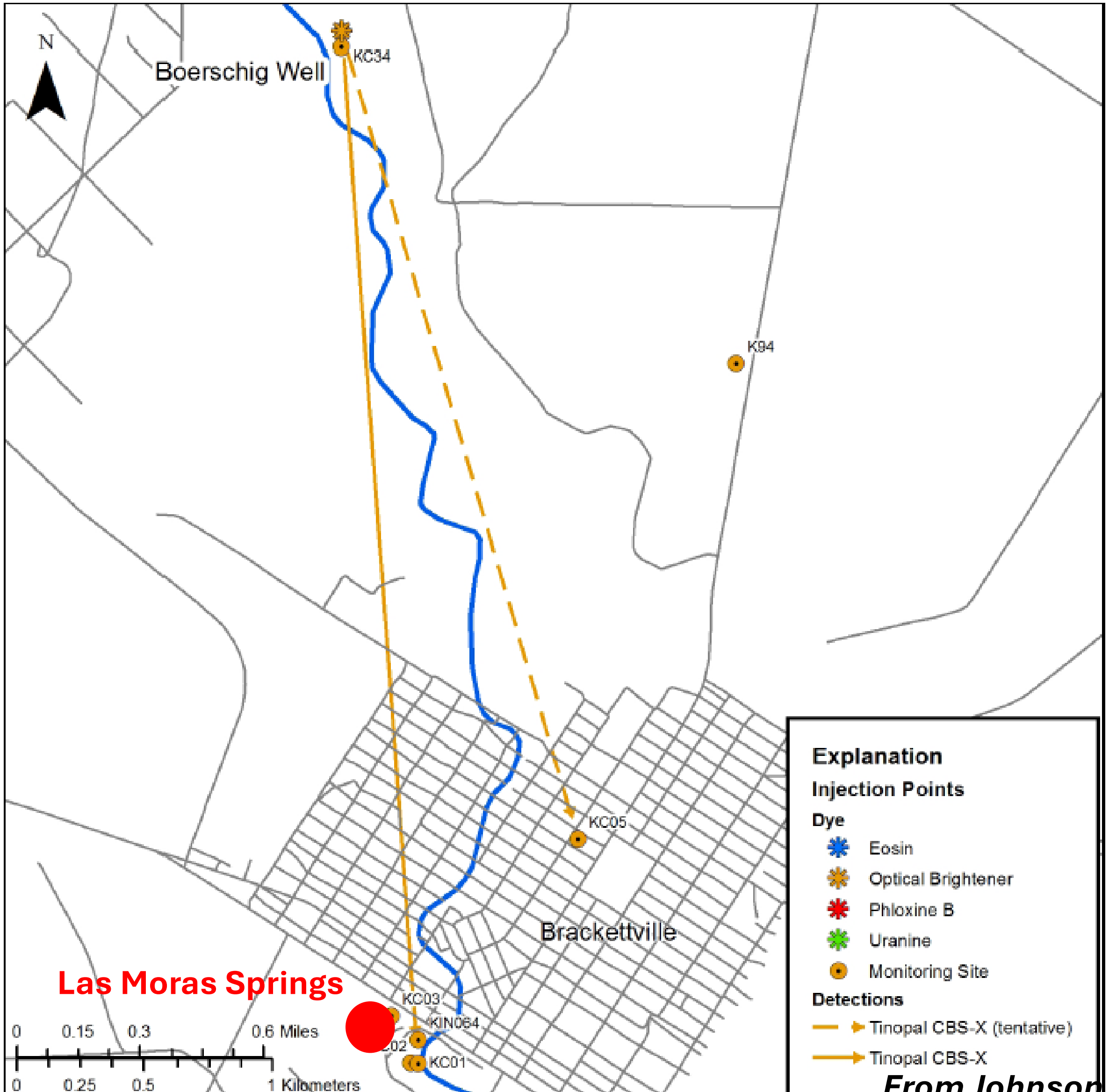
From Johnson and Schindel (2015)

Dooley Well – 1,600 Days



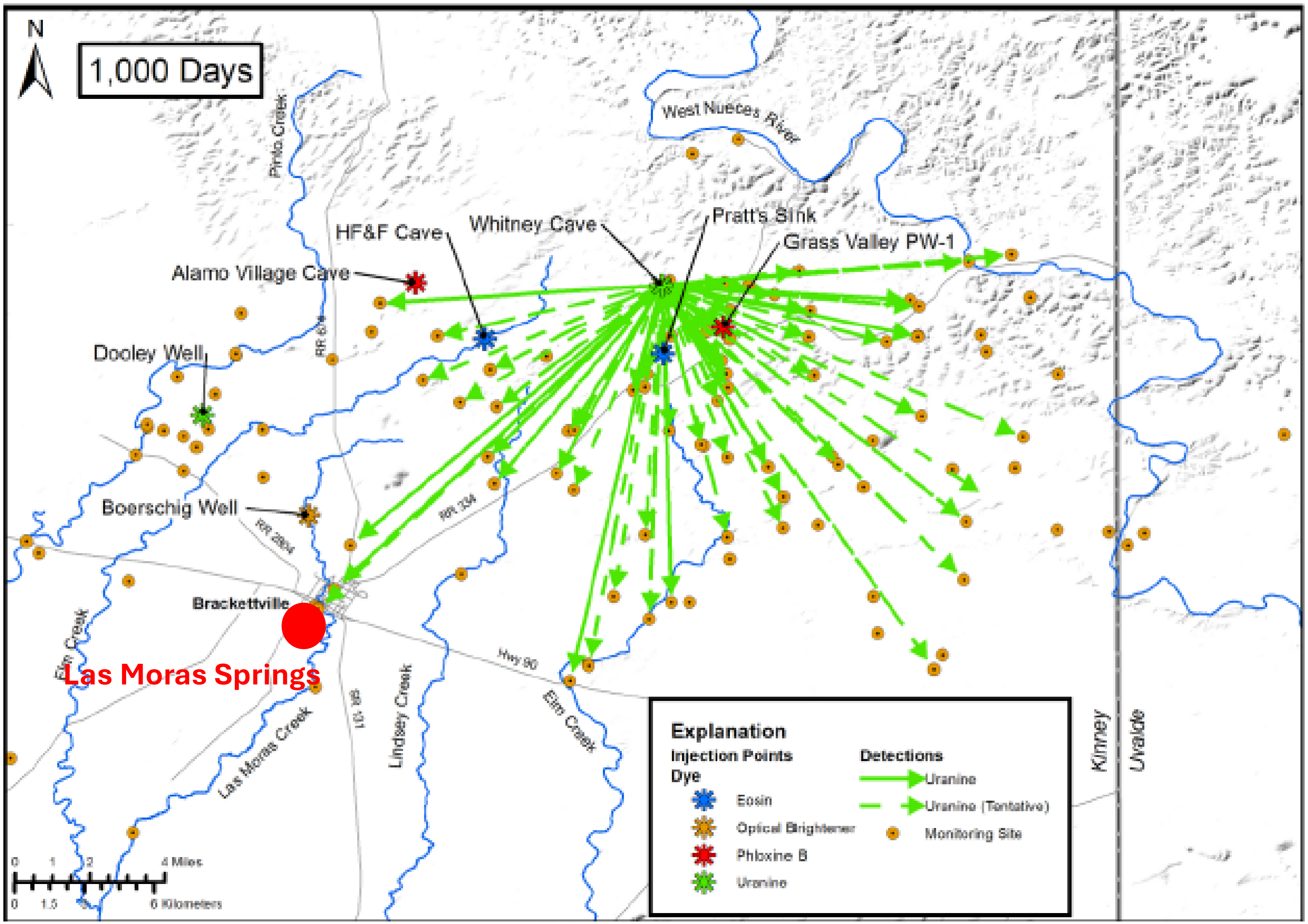
From Johnson and Schindel (2015)

Boerschig Well – 7 Days



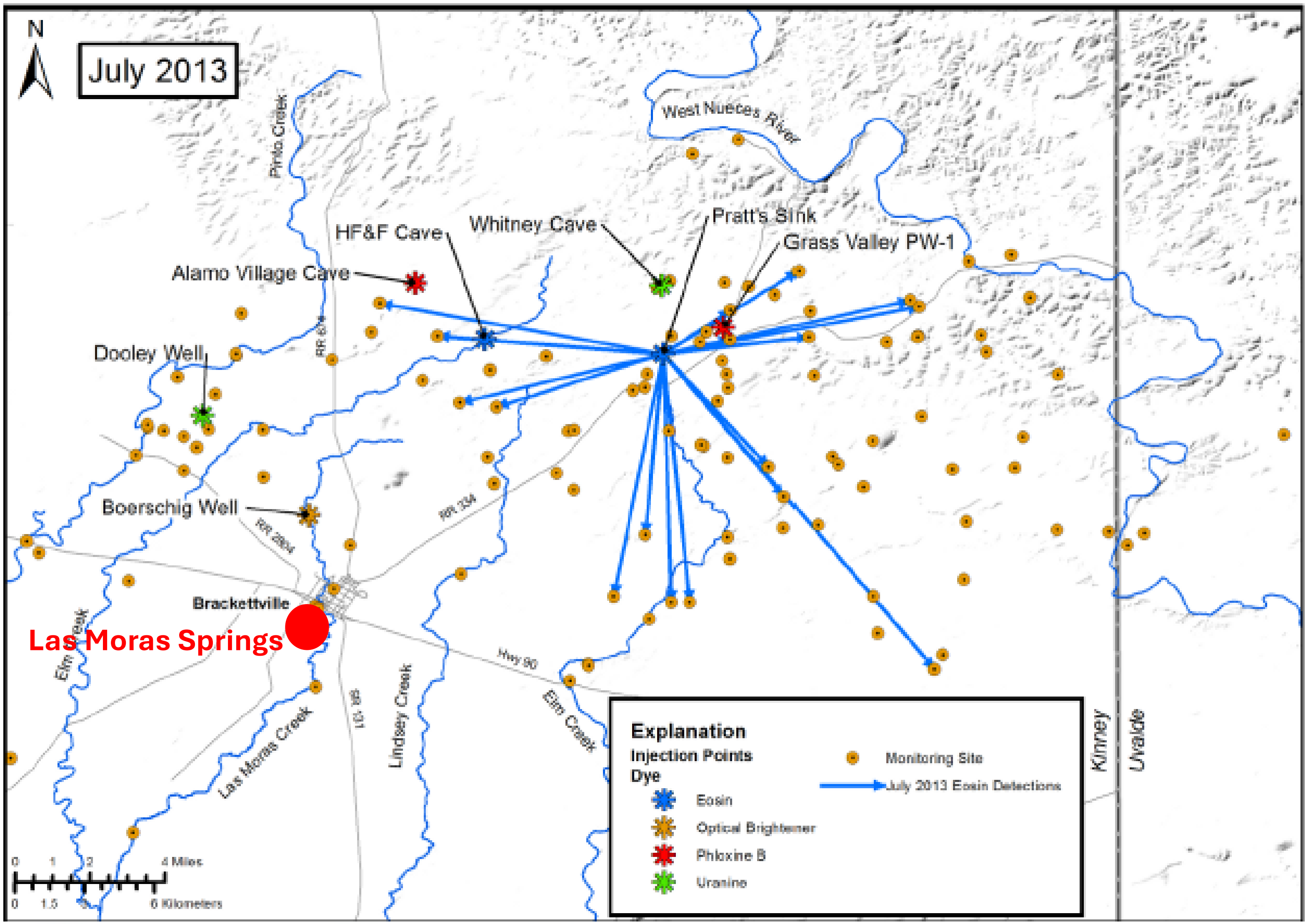
From Johnson and Schindel (2015)

Whitney Cave – 1,000 Days



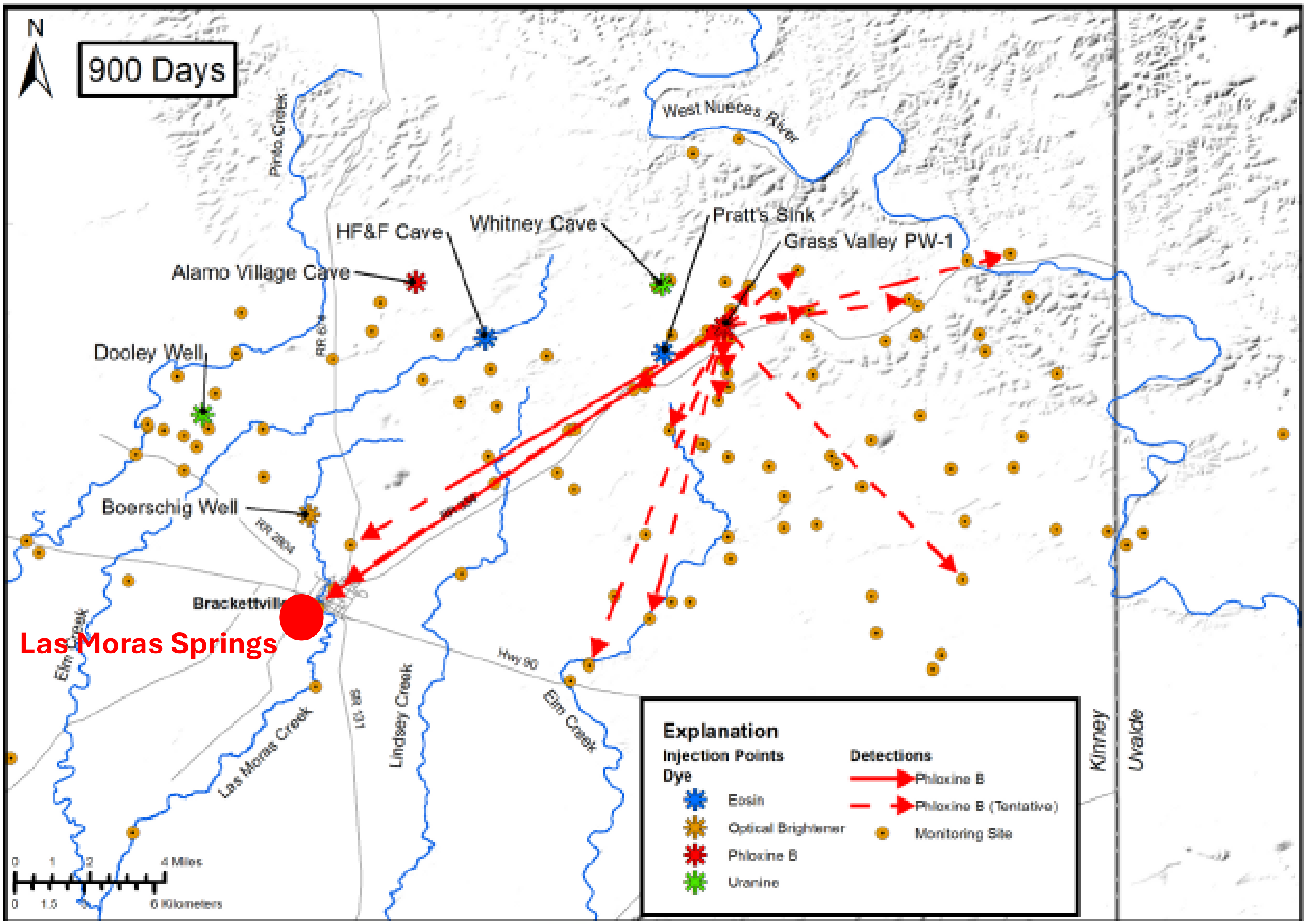
From Johnson and Schindel (2015)

Pratt's Sink – 900 Days



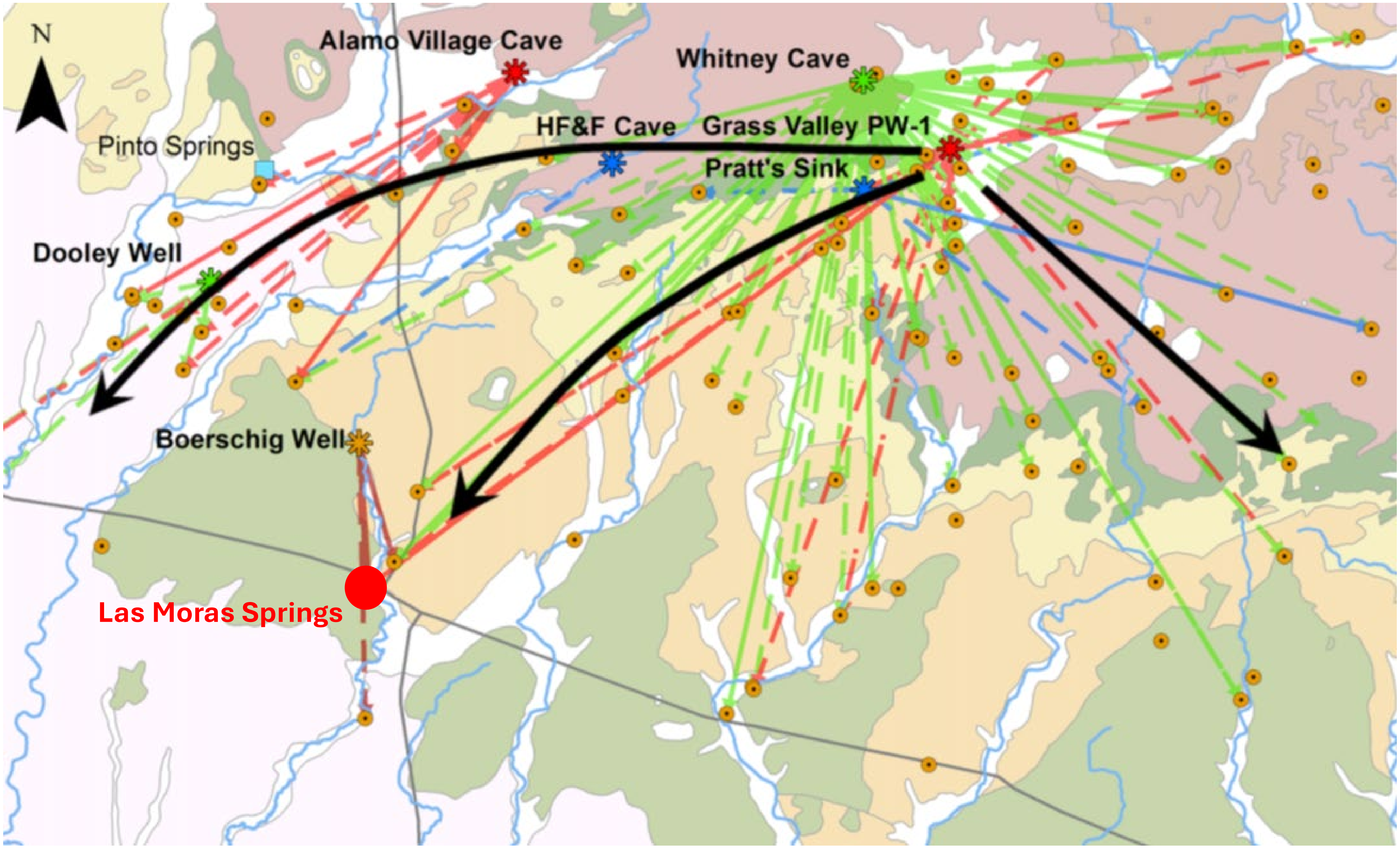
From Johnson and Schindel (2015)

Grass Valley Well – 900 Days



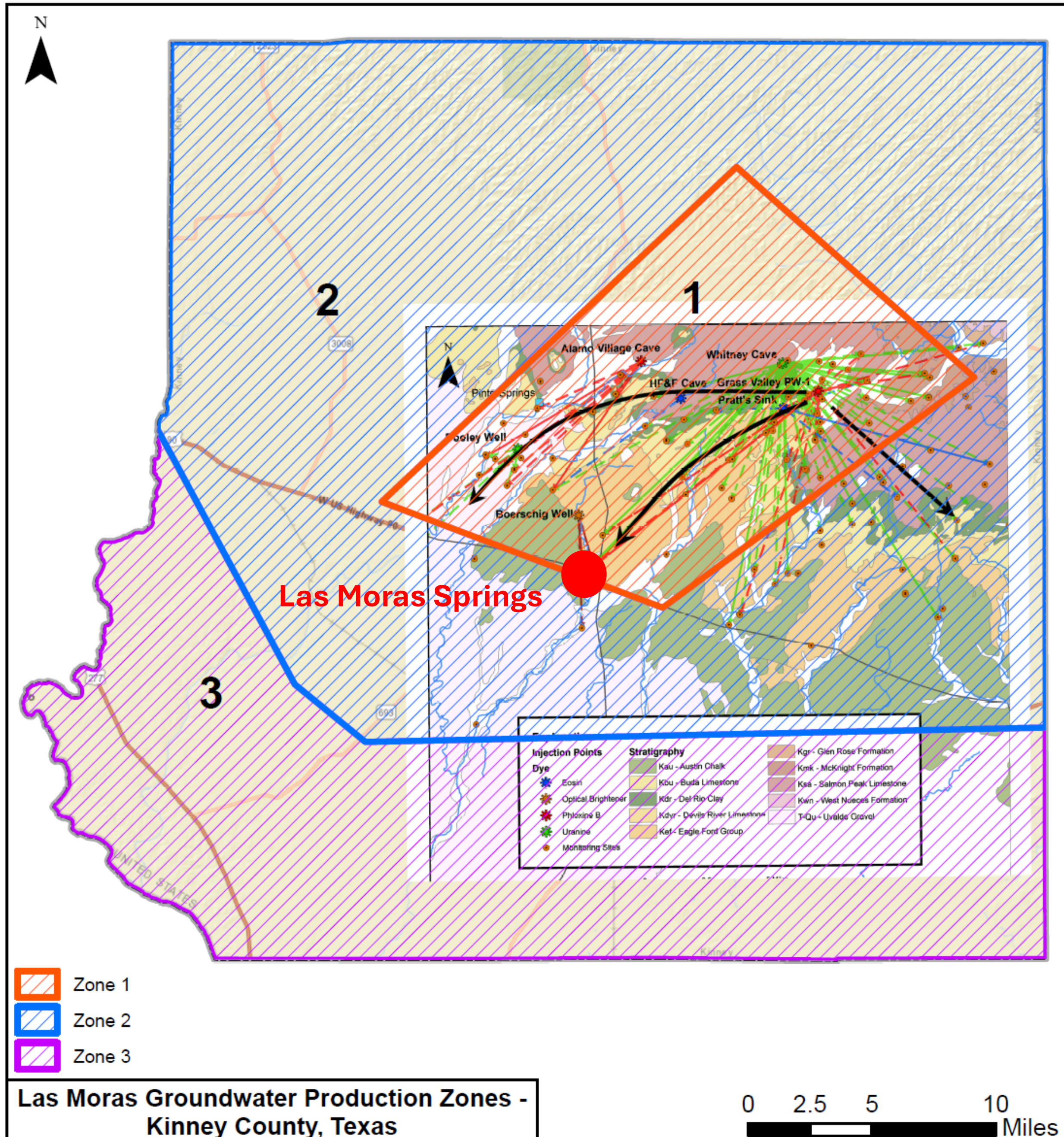
From Johnson and Schindel (2015)

Summary of All Dye Traces



From Johnson and Schindel (2015)

Summary of All Dye Traces Overlaid on Management Zone Map

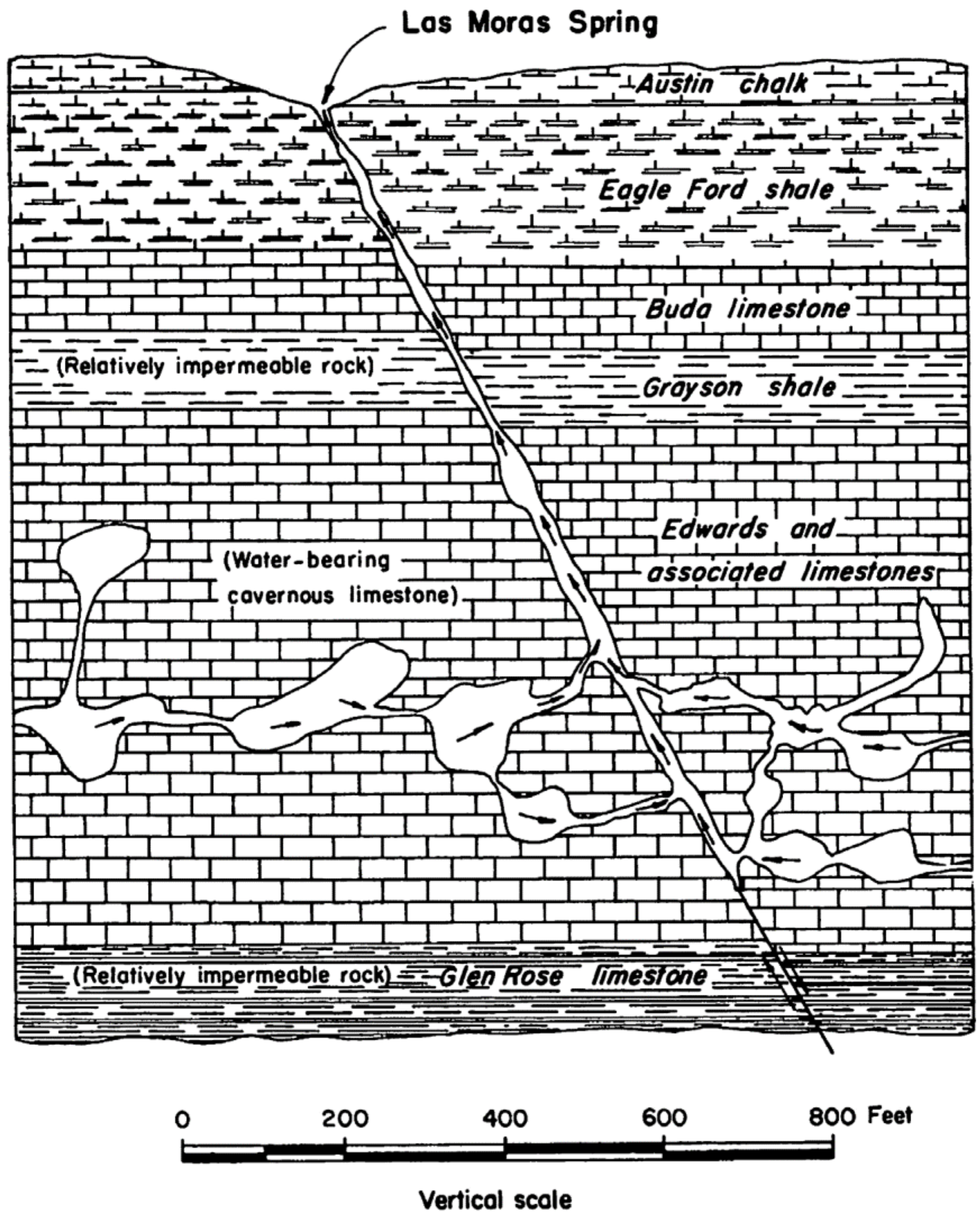


Takeaways

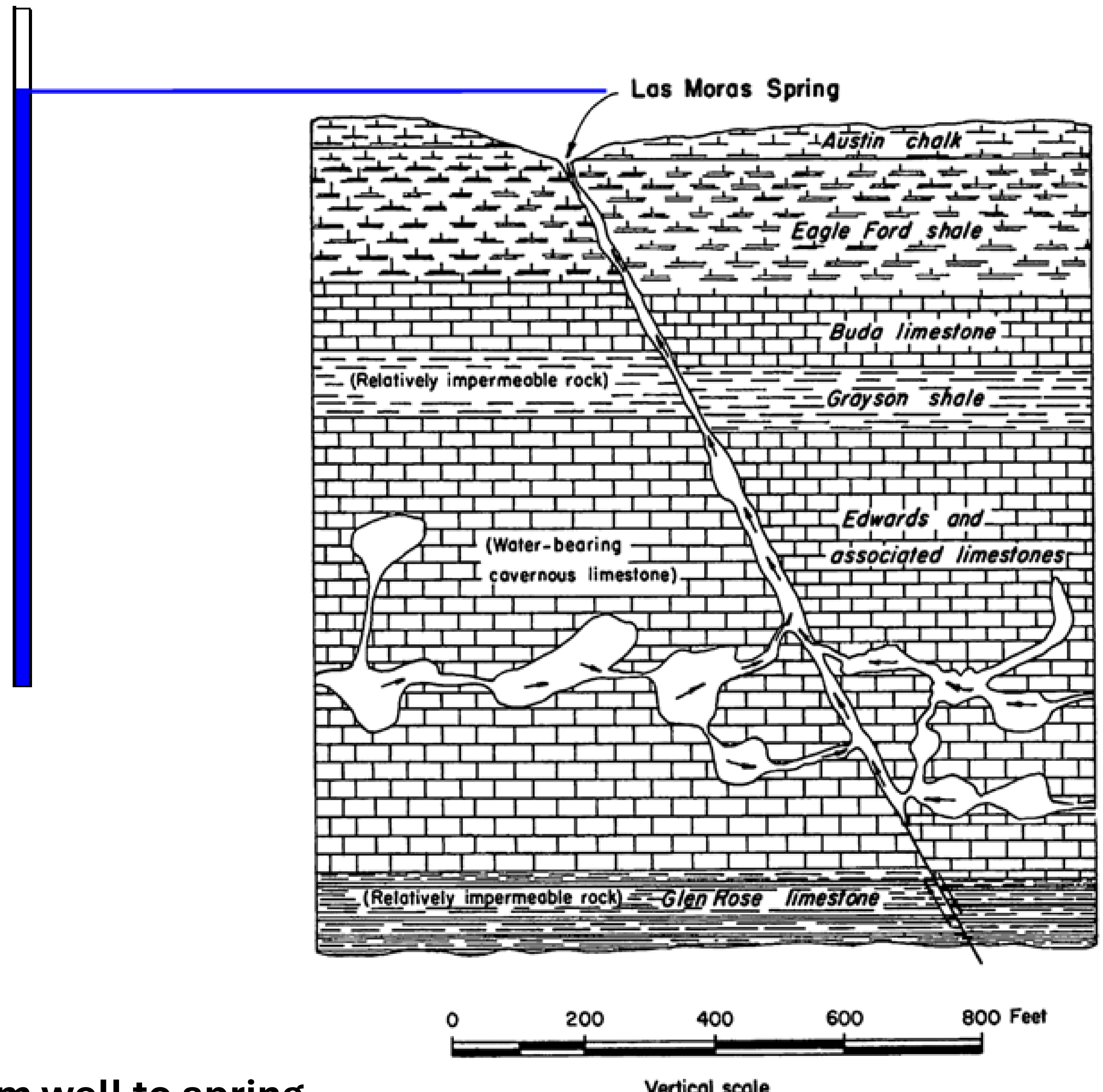
- Alamo Cave and Dooley Well results support conceptual model of preferential flow paths along drainages
  - Karst formation
  - Concept that is foundational to groundwater model in development
- Whitney Cave, Pratt's Sink, Grass Valley Well results demonstrate that groundwater flow can cross boundaries of watersheds
  - Hydraulic or pressure gradients control groundwater movement
- Dye traces track groundwater "transport"
- Dye traces cannot be used to infer "capture" caused by pumping (change in hydraulic or pressure gradients)

Bennett and Sayre (1962) Las Moras Springs Diagram

Note: Also presented in Johnson and Schindel (2015) "Dye Study"

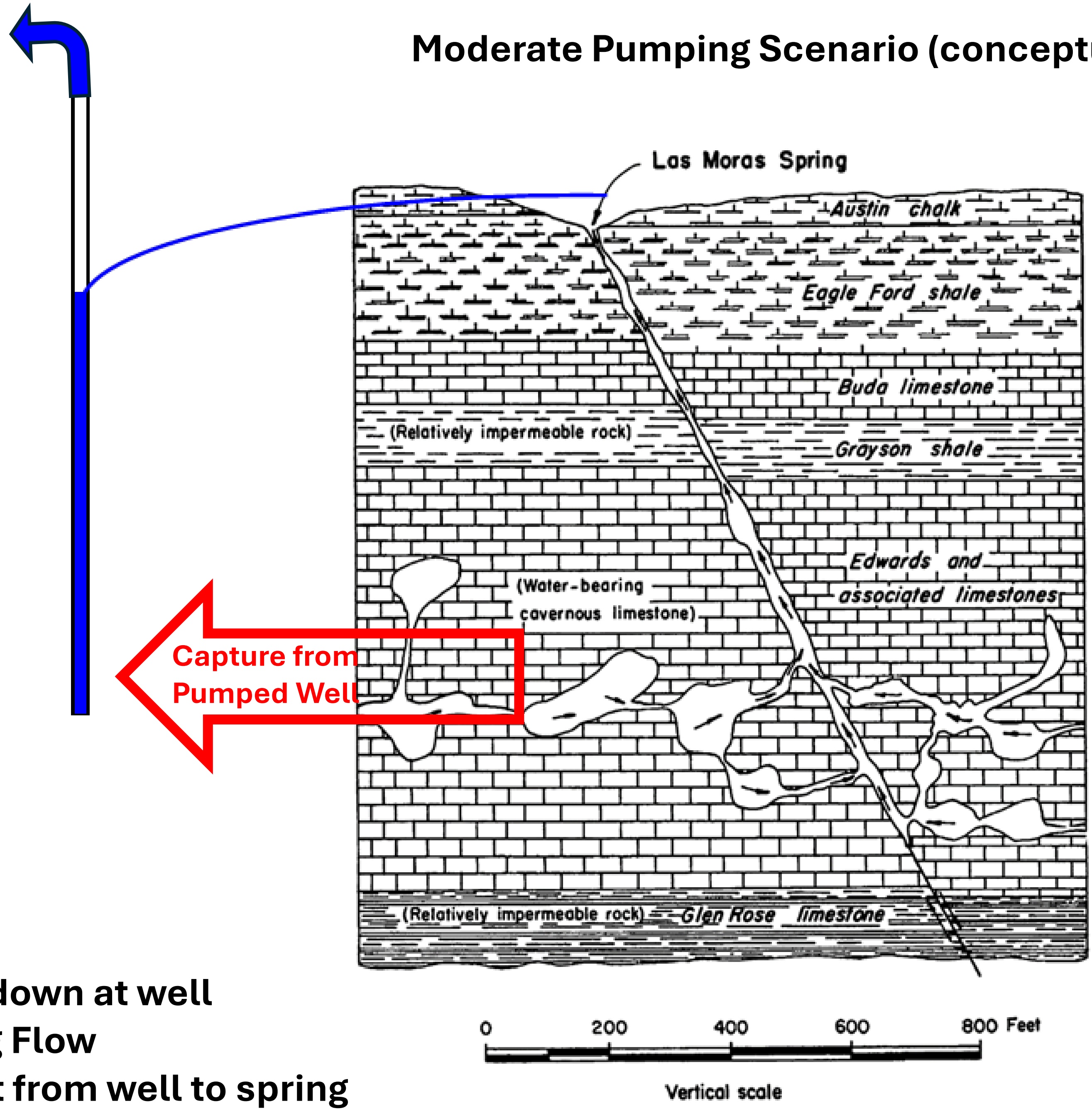


No Pumping Scenario (conceptual)



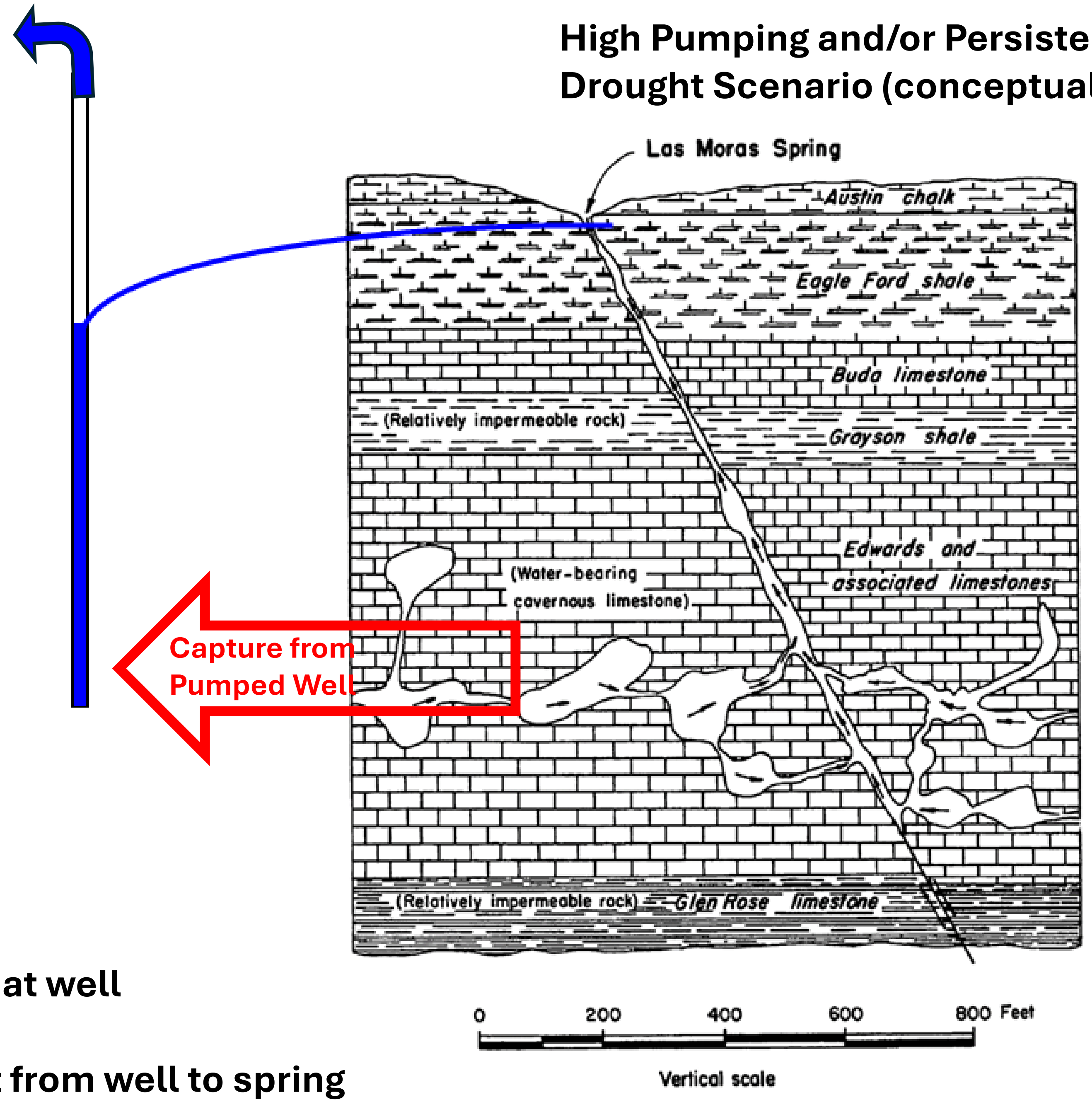
No drawdown at well
“Full” Spring Flow
No dye movement from well to spring

Moderate Pumping Scenario (conceptual)



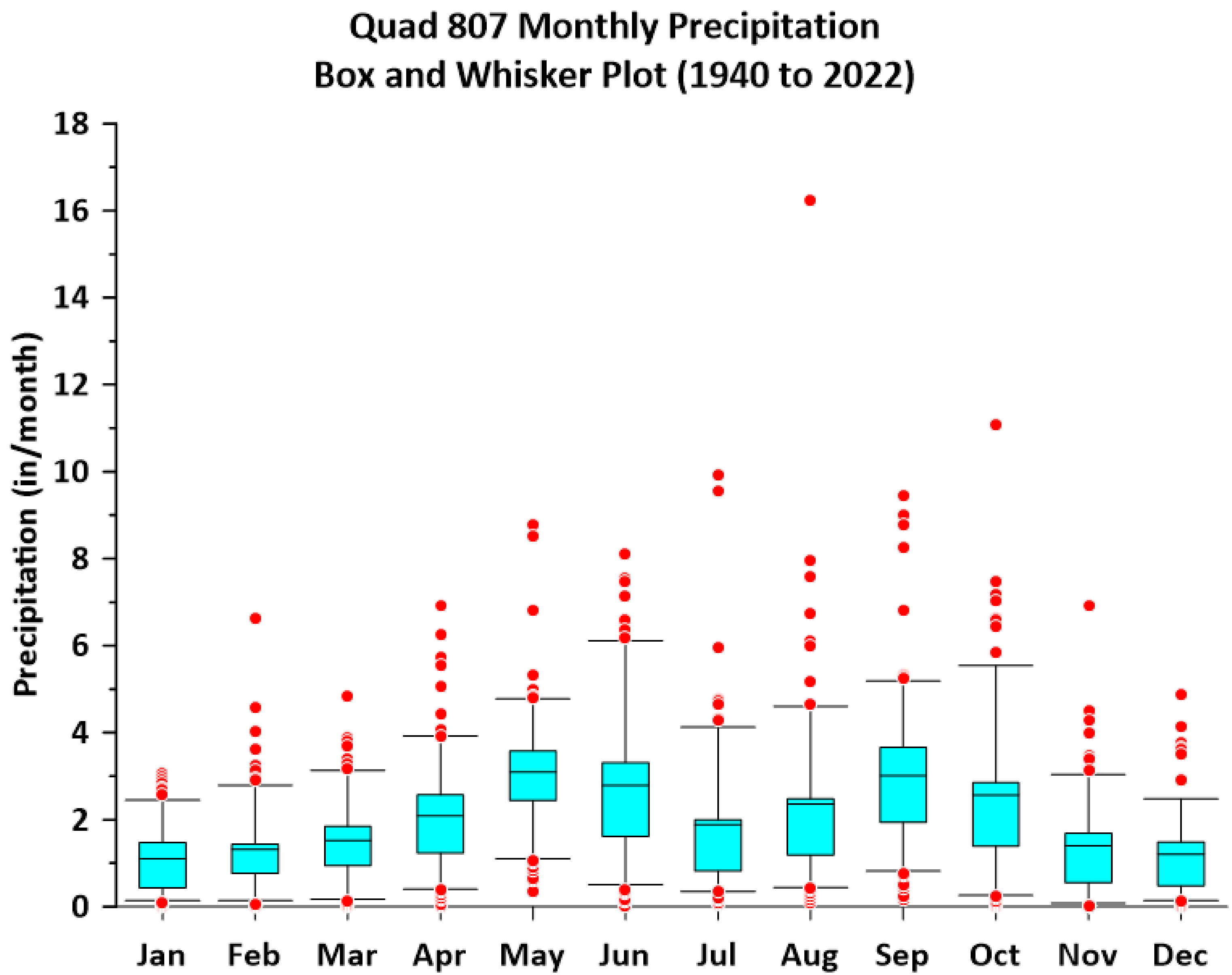
"Moderate" drawdown at well
"Reduced" Spring Flow
No dye movement from well to spring

High Pumping and/or Persistent Drought Scenario (conceptual)



"High" drawdown at well
No Spring Flow
No dye movement from well to spring

Rainfall Analysis (Monthly)



Quad 807 Monthly Precipitation
Box and Whisker Plot (1940 to 2022)
Precipitation (in/month)
0
2
4
6
8
10
12
14
16
18
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec