Texas Springs Inventory, Flow, and Water Quality

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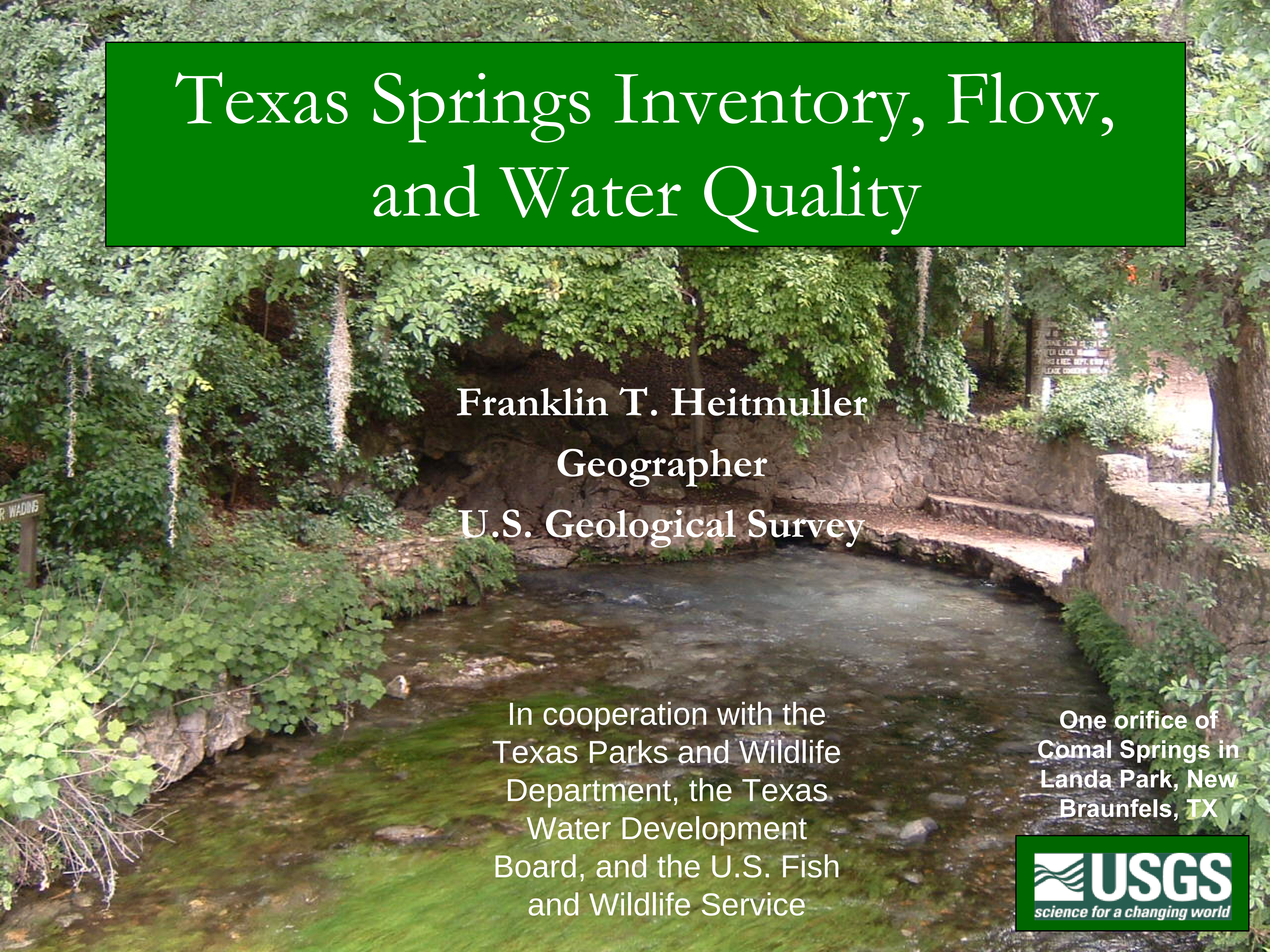
In cooperation with the Texas Parks and Wildlife Department, the Texas Water Development Board, and the U.S. Fish and Wildlife Service



One orifice of Comal Springs in Landa Park, New Braunfels, TX

USGS
science for a changing world

Outline

1. Importance of Springs
2. History of Assessment
3. Current Studies in Texas
4. Recent USGS Activity
5. Possible Future Work

Importance of Texas Springs

- Discrete connections between ground water and surface water; water budget studies
- Maintain baseflow for numerous perennial rivers in Texas
- Form unique habitats for a variety of species, including rare, threatened, and endangered species
- Recreation
- Historical or cultural significance
- Municipal or industrial water-supply
- Unique features in their own right; education

Hancock Springs at Lampasas, Texas

History of Assessment in Texas

- USGS monitoring began in 1894 – Barton Springs in Austin (Comal, San Felipe, and Las Moras followed in 1895)
- Meinzer (1927) – called attention to large springs in the U.S. and proposed a magnitude classification system
- Texas Board of Water Engineers (TBWE) and Texas Water Commission (TWC) county records of wells and springs – 1930s-60s
- Texas Water Development Board (TWDB)

Spring Magnitude

- Meinzer (1927)

MAGNITUDE	AVERAGE DISCHARGE	AVERAGE DISCHARGE
First	$\geq$100 ft^3/s	$\geq$ 2.83 m^3/s
Second	10 – 100 ft^3/s	0.283 – 2.83 m^3/s
Third	1 – 10 ft^3/s	0.0283 – 0.283 m^3/s
Fourth	100 gallons per minute (gpm) – 1 ft^3/s	0.006309 – 0.0283 m^3/s
Fifth	10 – 100 gpm	630.9 – 6309 cm^3/s
Sixth	1 – 10 gpm	63.1 – 630.9 cm^3/s
Seventh	1 pint per minute – 1 gpm	7.89 – 63.1 cm^3/s
Eighth	< 1 pint per minute	< 7.89 cm^3/s

History of Assessment in Texas

- Gunnar Brune (1975) – Major and Historical Springs of Texas (TWDB Report 189) – 281 springs
- Guyton & Associates (1979) – Geohydrology of Comal, San Marcos, and Hueco Springs (TWDB Report 234)
- Gunnar Brune (1981) – Springs of Texas: Vol. 1 (183 of 254 Texas counties)

Research Today

- Uliana and Sharp (2001) – Investigation of regional flow paths and localized contributions to spring flow in Trans-Pecos Texas
- Schuster (1997) – M.S. thesis on precipitation and springs in Trans-Pecos Texas
- Mahler and Lynch (1999) – Suspended sediment from Barton Springs
- Helen Besse – effort to publish Springs of Texas – Volume 2
- TPWD (Chad Norris) – Assessments of spring flow and water quality of springs in Central Texas
- USGS – Use of ADV to monitor flow in Barton Springs and Jacob's Well
- USGS – Aggregate information on springs, flow, and water-quality into a singular database (Heitmuller and Reece, 2003)

USGS-Monitored Springs

- **CONTINUOUSLY MONITORED**
  - 08155500 Barton Springs
  - 08168000 Hueco Springs
  - 08168710 Comal Springs
  - 08170000 San Marcos Springs
  - 08170990 Jacob's Well
  - 08427000 Giffin Springs
  - 08456300 Las Moras Springs
- **DISCRETE VISITS**
  - 08155395 Upper Barton Springs (QW only)
  - 08155501 Eliza Spring (QW only)
  - 08155503 Old Mill Spring (QW only)
  - 08129500 Dove Creek Spring
  - 08143900 Springs at Fort McKavett
  - 08146500 San Saba Springs
  - 08149500 Seven Hundred Springs
  - 08149395 Tanner Springs
  - 08177818 San Antonio Springs
  - 08178090 San Pedro Springs
  - 08425500 Phantom Lake Spring
  - 08427500 San Solomon Springs

San Antonio Spring; San Antonio, TX

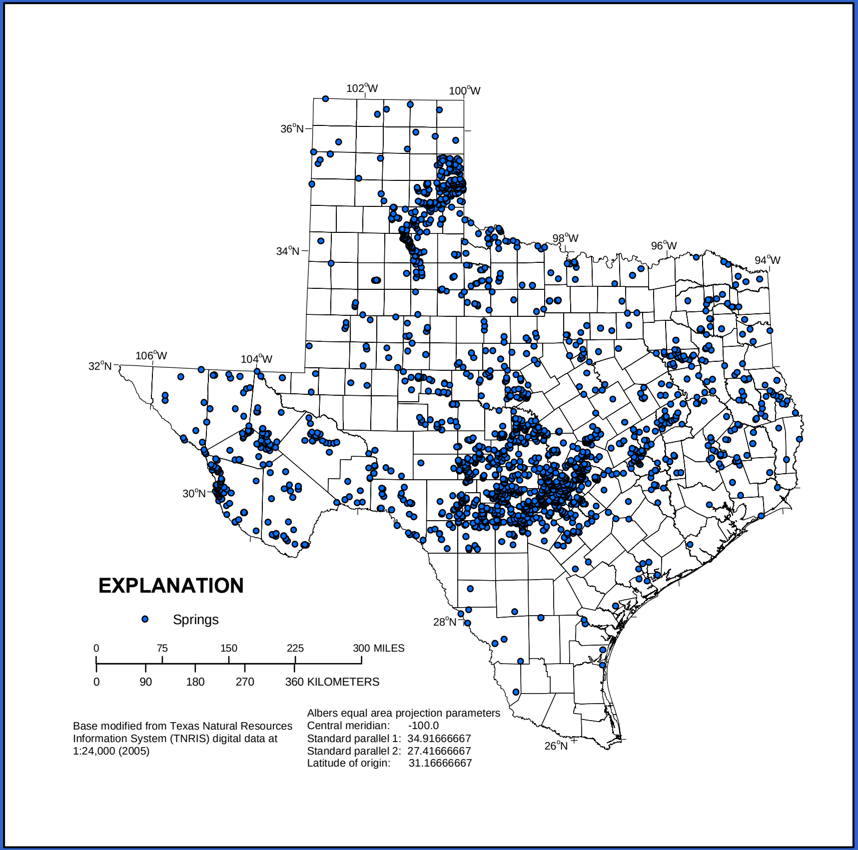
3-phase Texas springs project

1. DATABASE - Aggregation of known springs and spring flow measurements from selected sources into a singular database (Heitmuller and Reece, 2003) – **complete** http://water.usgs.gov/pubs/of/2003/ofr03-315
2. MAJOR SPRINGS - Identify large or significant springs; aggregate all known water quality and quantity data for these springs into a singular database; identify gaps in the data – **complete**
3. SAMPLING - Sample springs from Phase 2 to fill gaps in water quantity and quality data; status and trends analysis – **planned**

Small spring along fracture in Guadalupe / Canyon Lake spillway canyon

Phase I

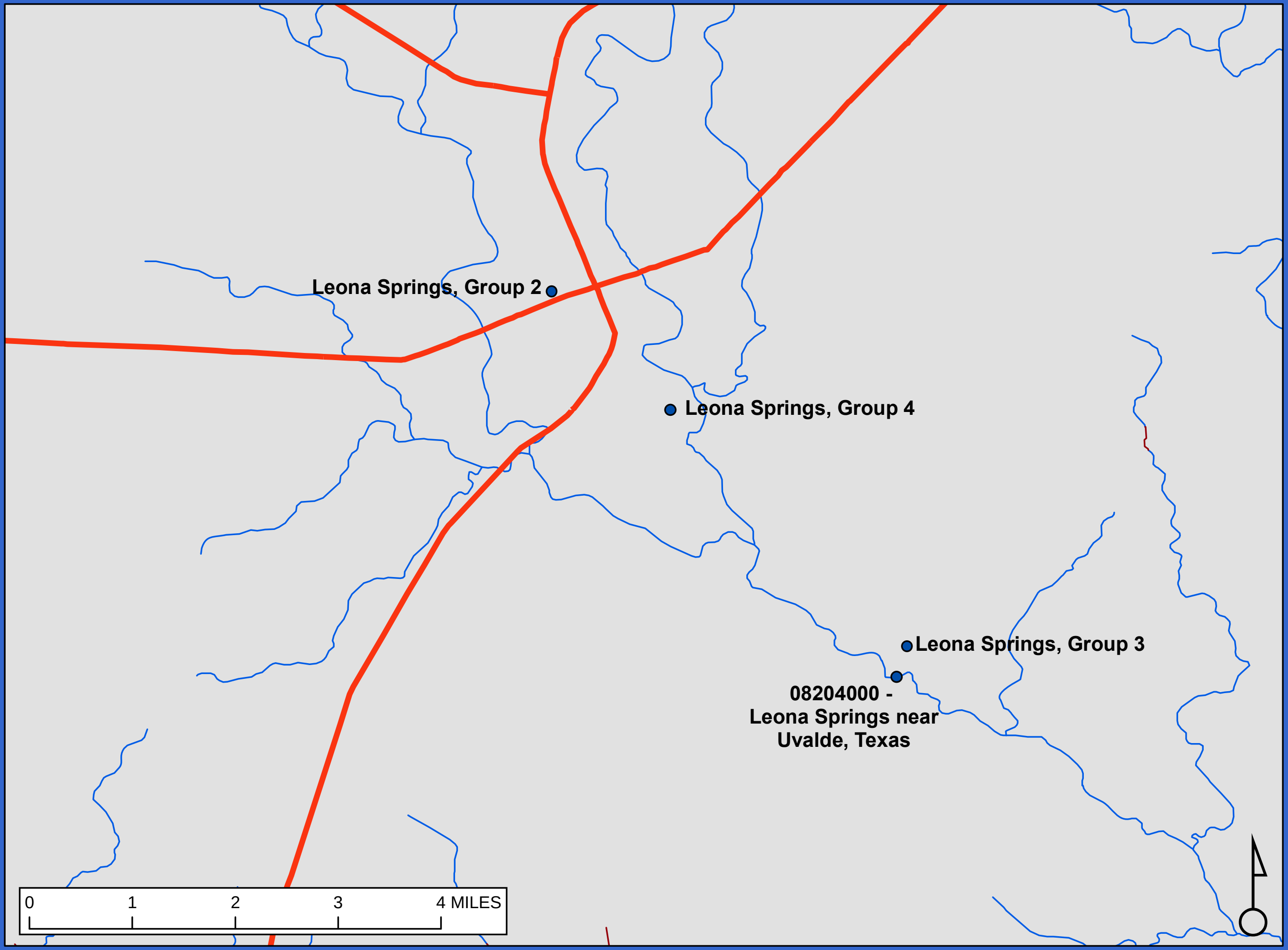
- Spring and spring flow database
- 2,061 springs
- Over 7,000 spring flow measurements, not including continuously monitored data
- http://water.usgs.gov/pubs/of/2003/ofr03-315



Phase I Issues

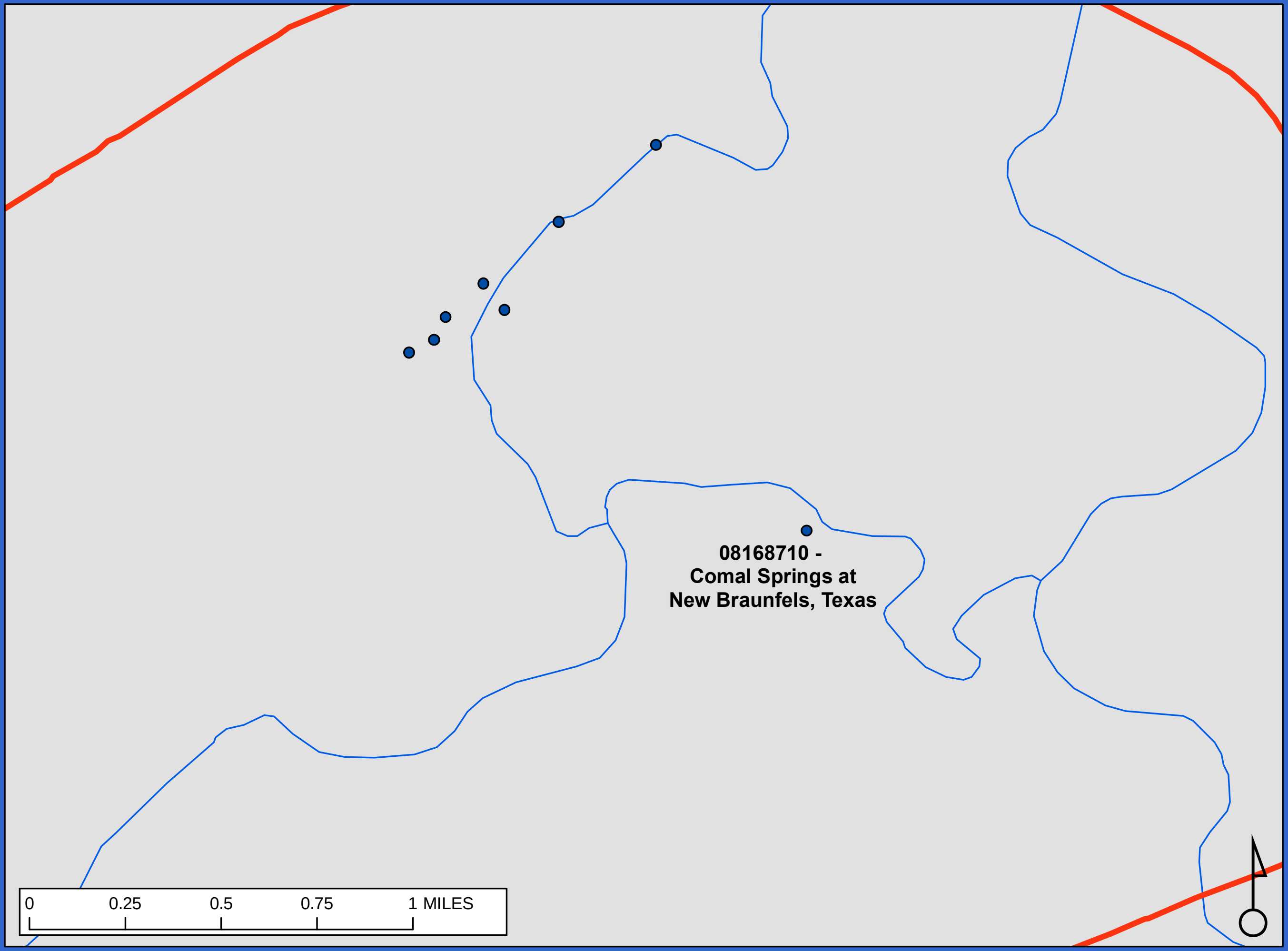
1. **Some accuracy issues derived from historical data source**
    - Location reported to minute accuracy
    - Some locations only from description (e.g., 13 miles NNW of Cameron)
    - Alternate names resulting in two points for one spring (e.g. Fort Stockton Springs, Comanche Springs)
2. **Data limited to selected sources**
    - Brune (1975) and Brune (1981) not digitized; although TWDB digital data contained many; many Brune springs w/o coordinate data
    - Anderson County – 3 springs in database; 23 springs when other data sources were searched (DRGs, very old USGS and miscellaneous reports)

Phase I

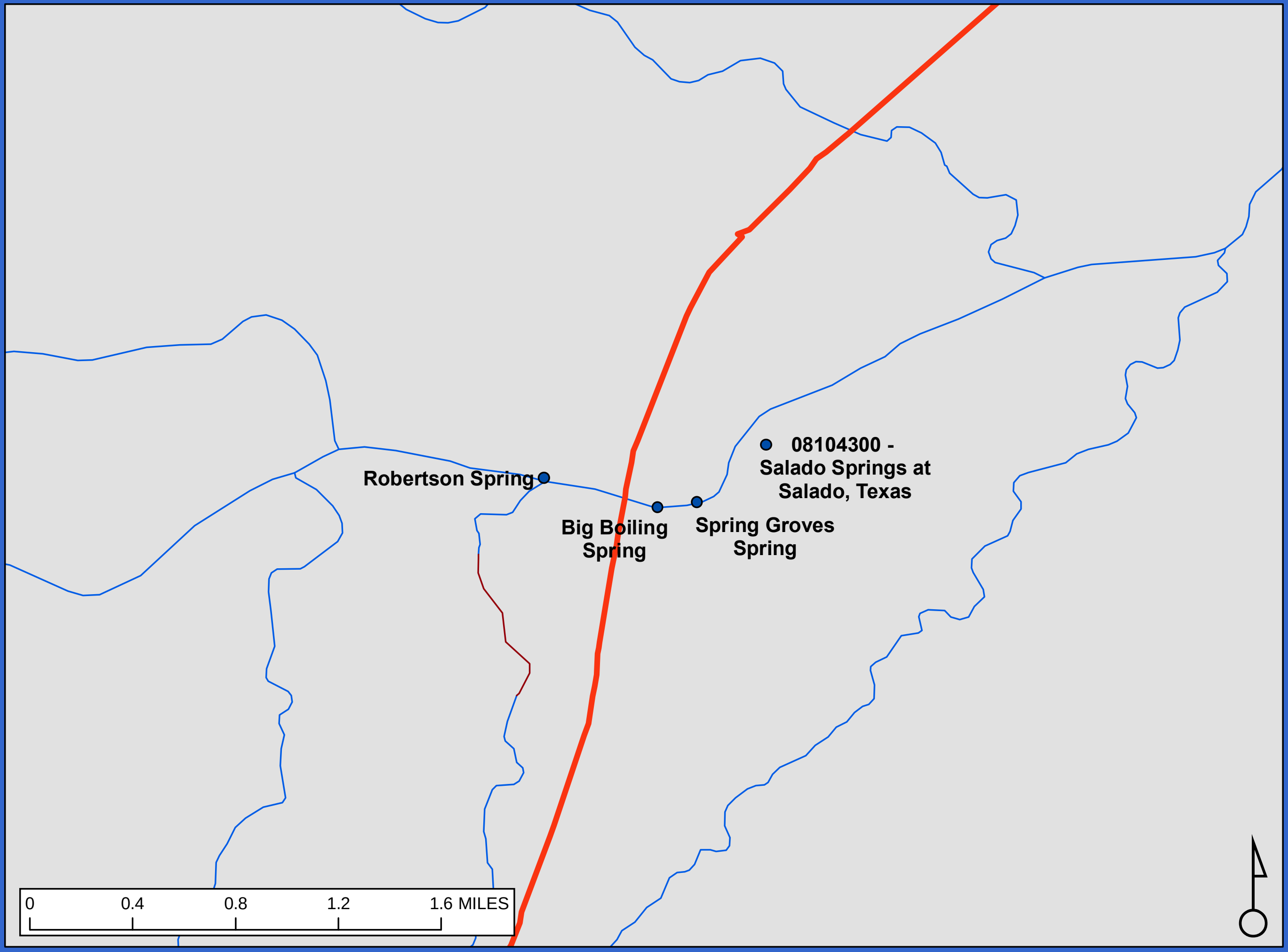


Leona Springs, Group 2
Leona Springs, Group 4
Leona Springs, Group 3
08204000 -
Leona Springs near
Uvalde, Texas
0
1
2
3
4 MILES

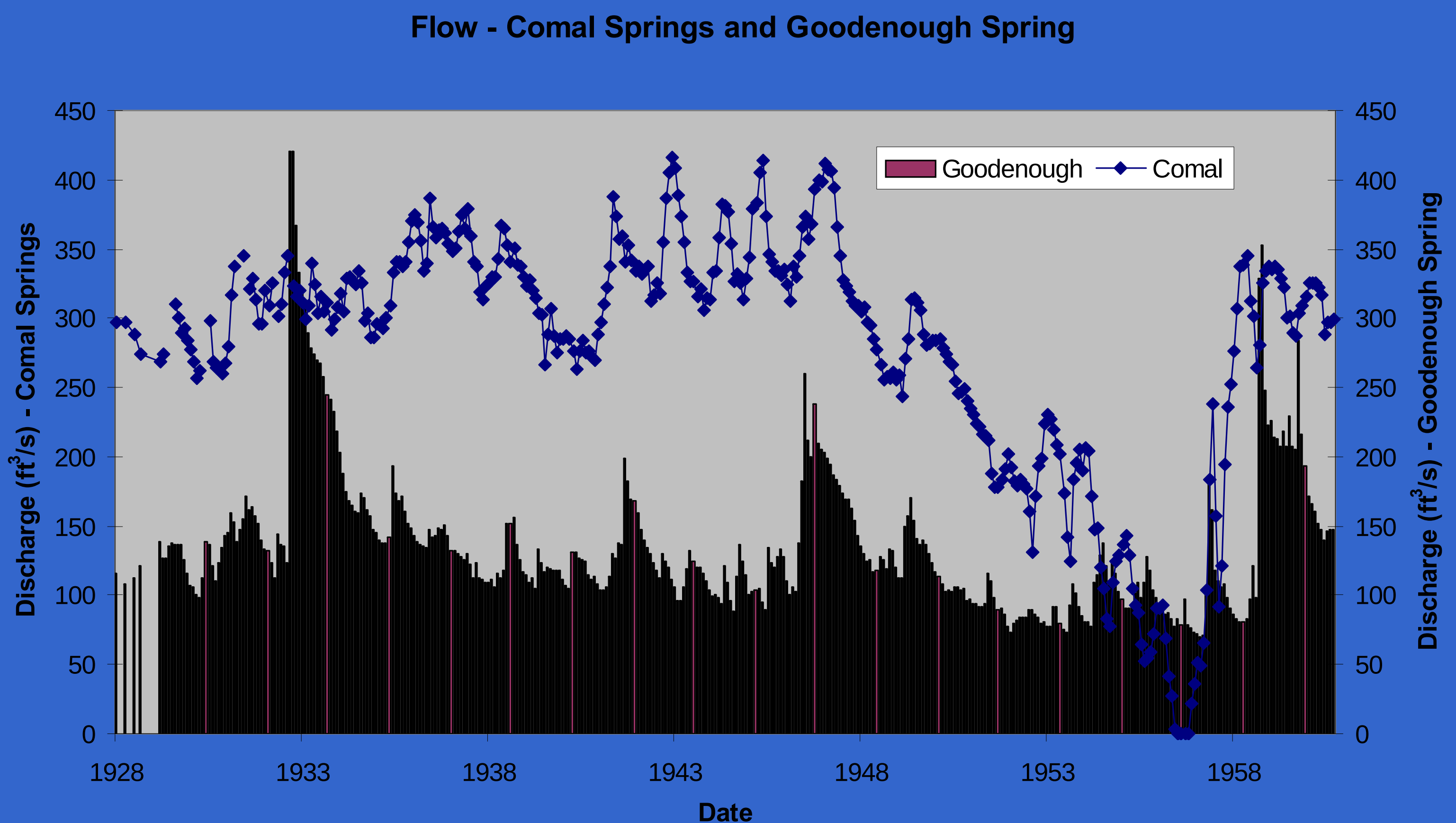
Phase I


08168710 -
Comal Springs at
New Braunfels, Texas
0
0.25
0.5
0.75
1 MILES

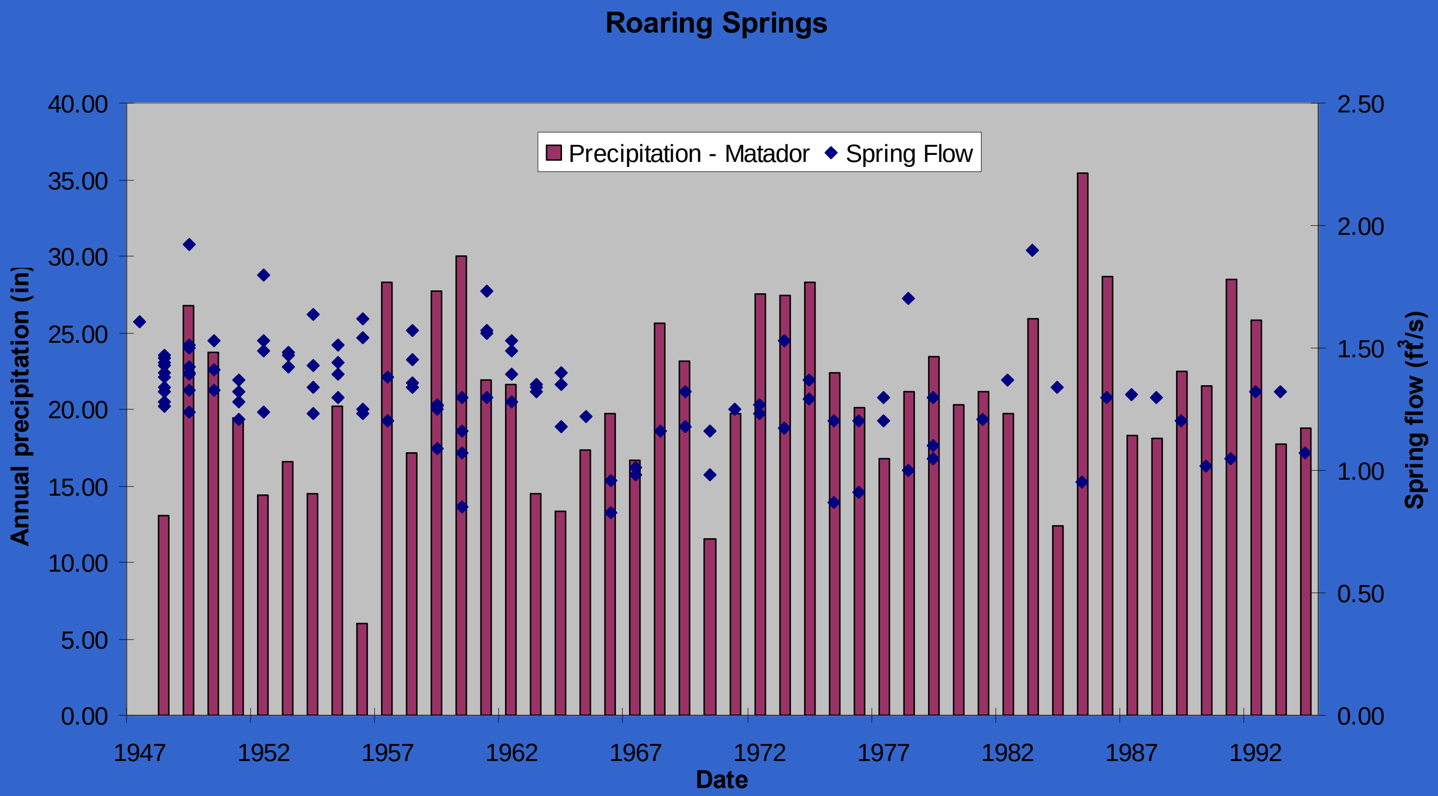
Phase I


08104300 -
Salado Springs at
Salado, Texas
Robertson Spring
Big Boiling
Spring
Spring Groves
Spring
0
0.4
0.8
1.2
1.6 MILES

Comal Springs and Goodenough Spring



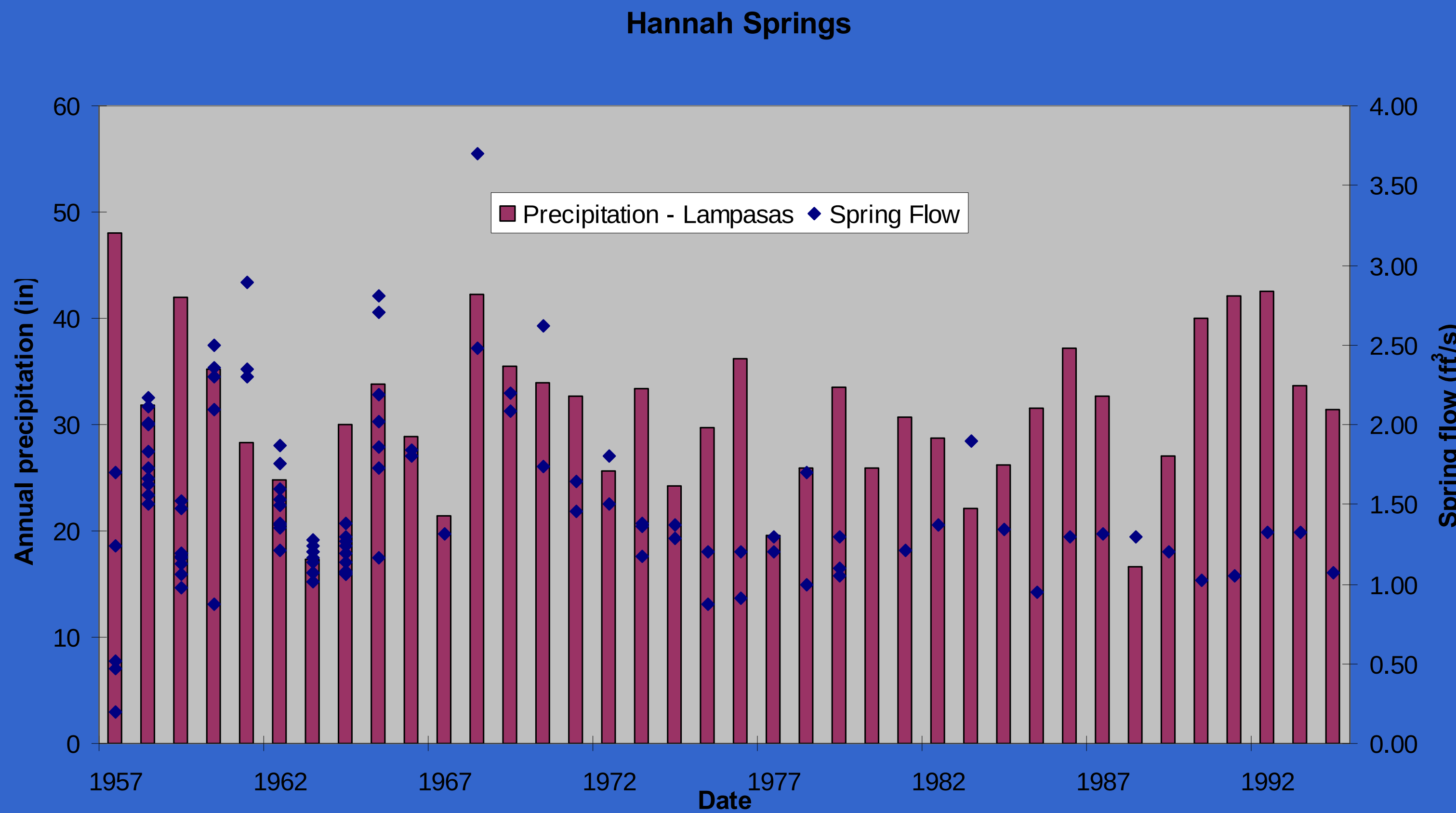
Roaring Springs – Texas Panhandle



μ 1.38 ft^3/s; σ 0.32 ft^3/s

1960s – Flow becomes sensitive (local pumping?)

Hannah Springs – Lampasas

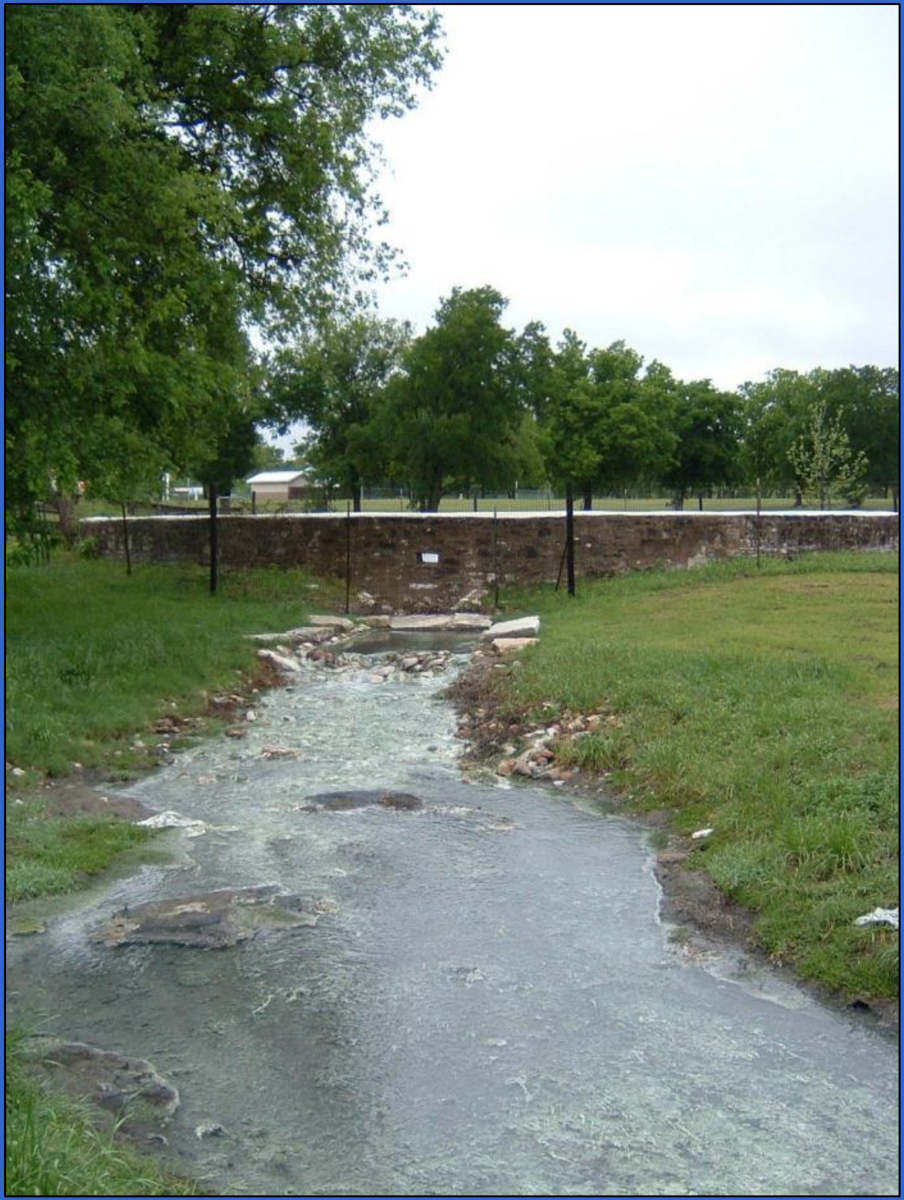


μ 1.44 ft^3/s; σ 0.48 ft^3/s

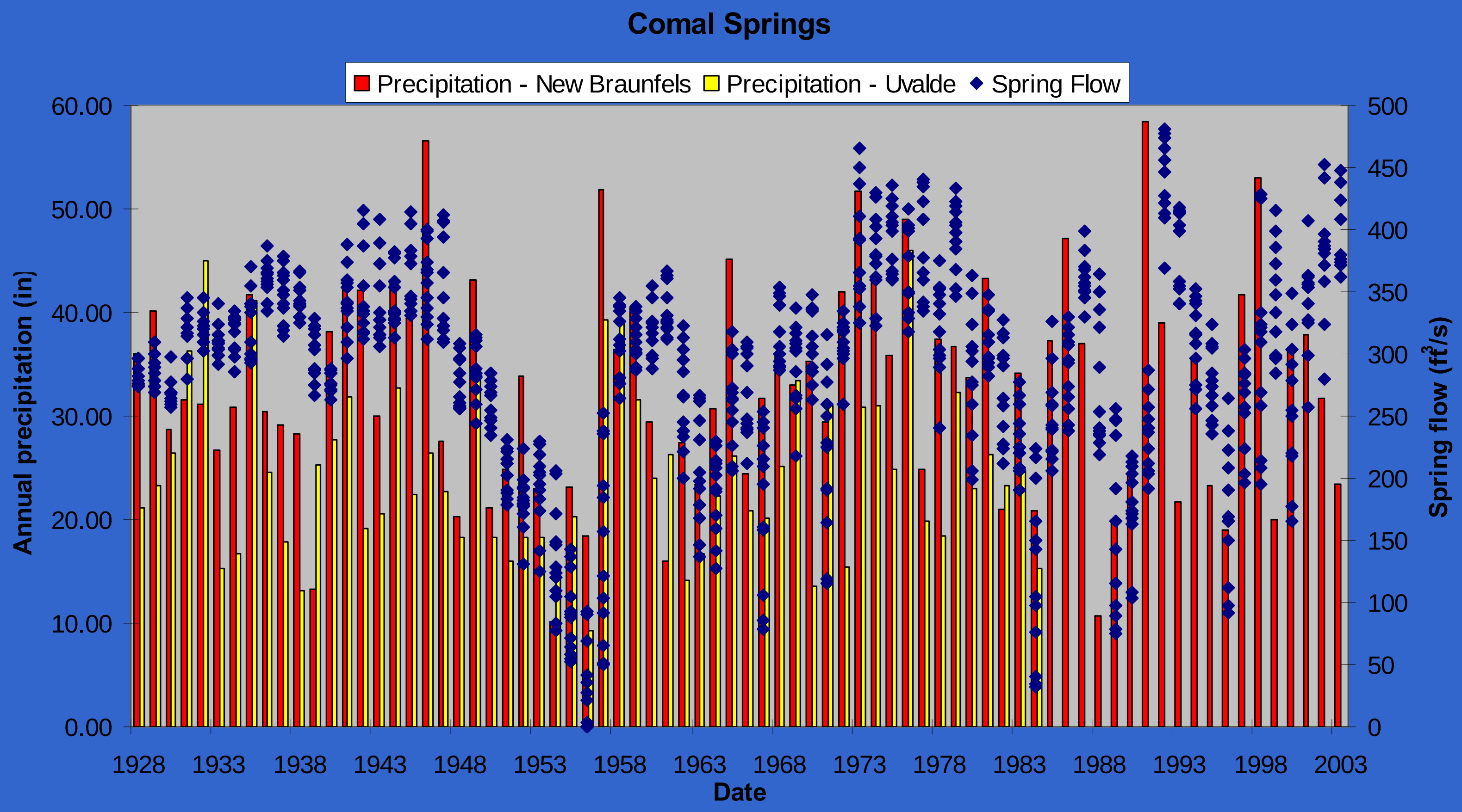
More rapid response to precipitation – small recharge area

Decline in flow – pumping or pool construction that applies a greater constant head

Hannah Springs in Lampasas, TX



Comal Springs – New Braunfels

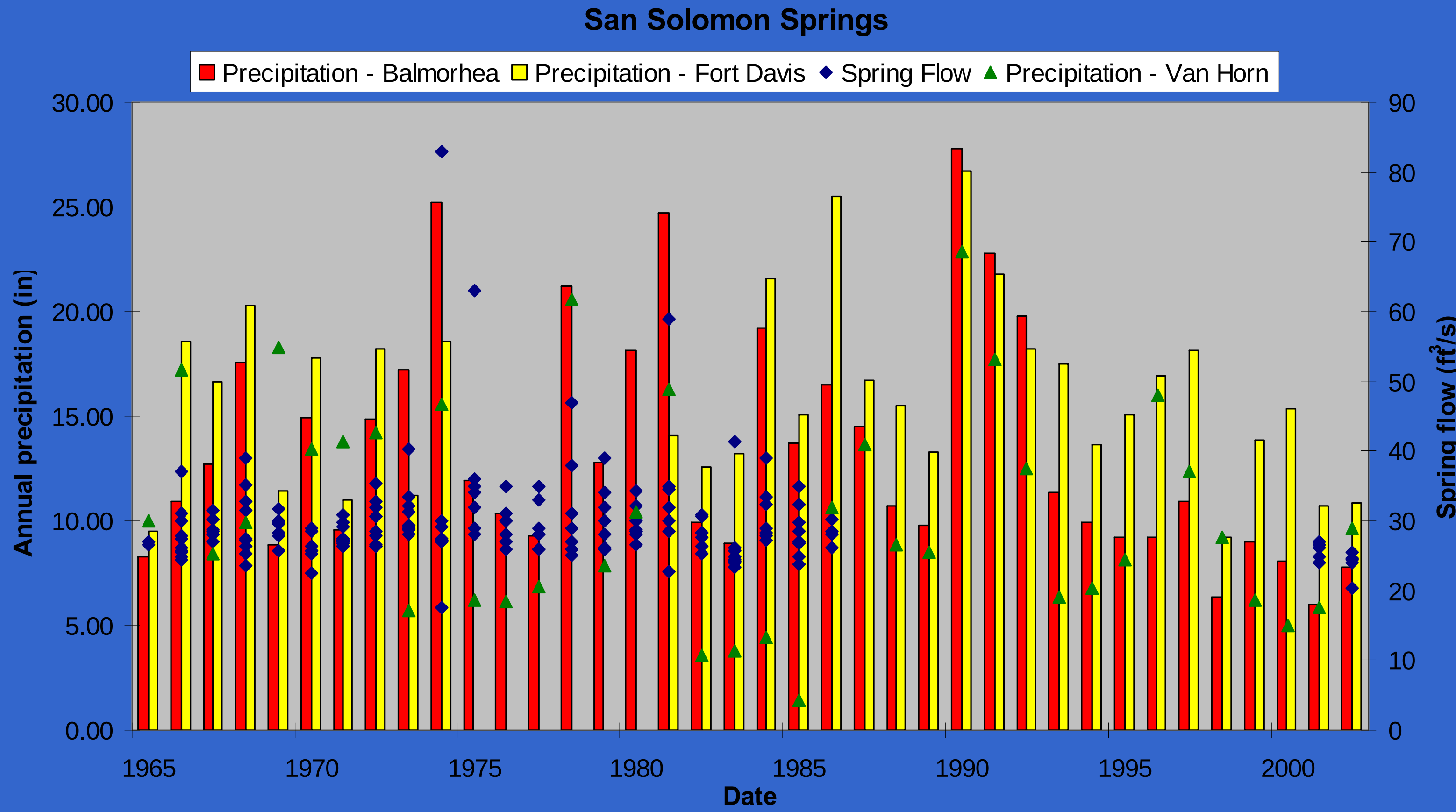


μ 287 ft^3/s; σ 86 ft^3/s

Lag period of ~ 1 year from peak rainfall to peak flow

High precipitation in Uvalde – lagged pulse in flow that remains for a few years

San Solomon Spring - Balmorhea

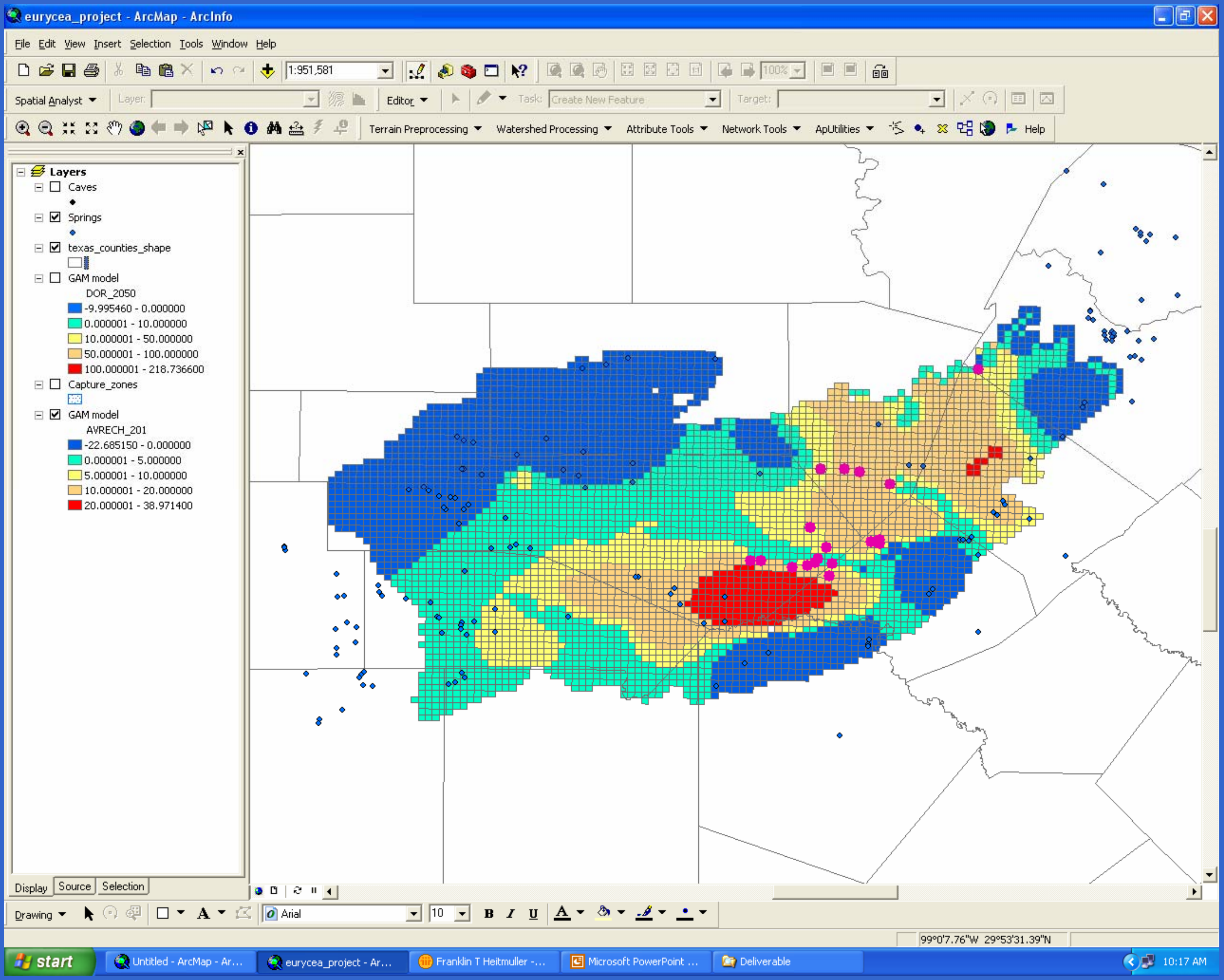


μ 30 ft^3/s; σ 6.4 ft^3/s

Very steady spring flow; highest discharge related to local precipitation events

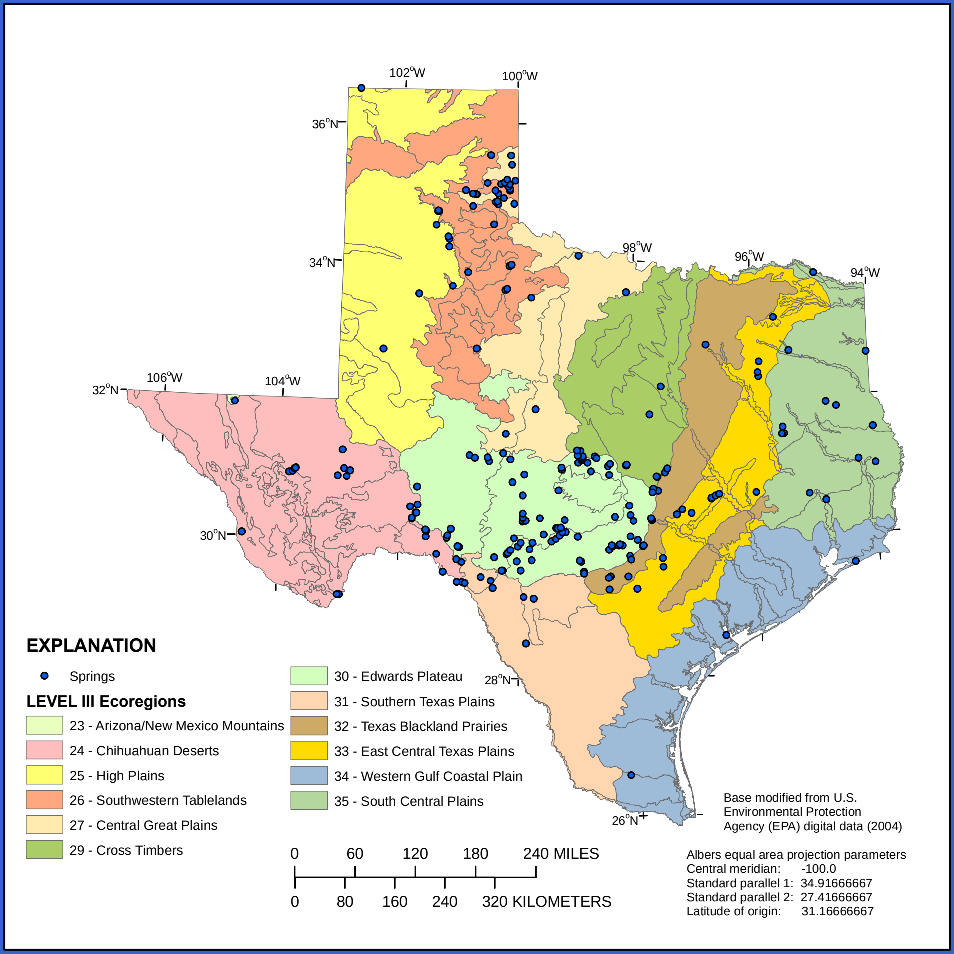
Large contributing zone

Eurycea habitat assessment

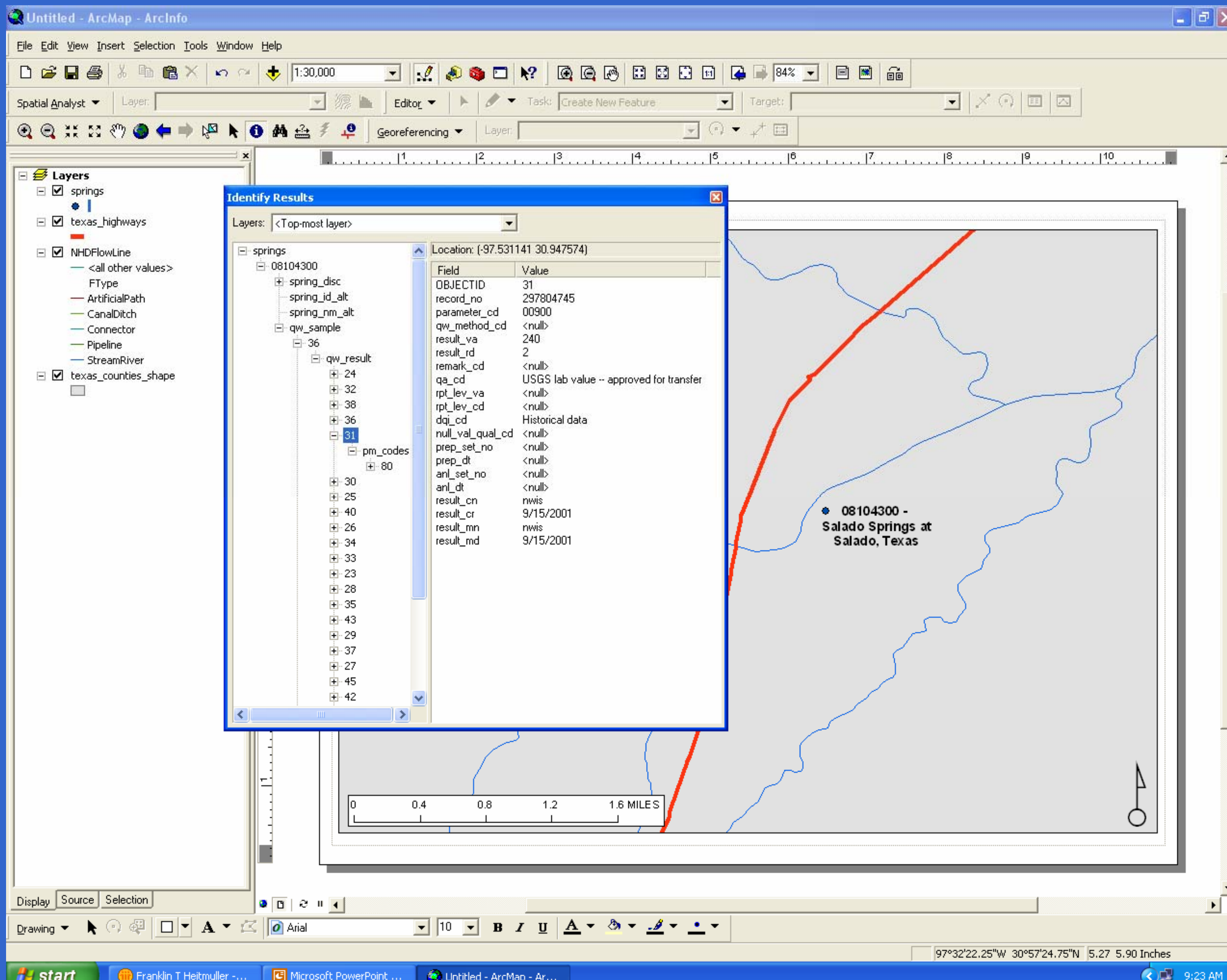


Phase II

- Aggregation of water-quality data
- Stakeholder meetings – 2004
- Select springs based on established criteria and mailed questionnaires
- 232 springs selected to represent all level III ecoregions



Phase II



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84%
Spatial Analyst
Layer:
Editor
Task: Create New Feature
Target:
Georeferencing
Layers
springs
texas_highways
NHDFlowLine
<all other values>
FType
ArtificialPath
CanalDitch
Connector
Pipeline
StreamRiver
texas_counties_shape
Display Source Selection
Identify Results
Layers: <Top-most layer>
springs
08104300
spring_disc
spring_id_alt
spring_nm_alt
qw_sample
36
qw_result
24
32
38
36
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pm_codes
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25
40
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34
33
23
28
35
43
29
37
27
45
42
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Field Value
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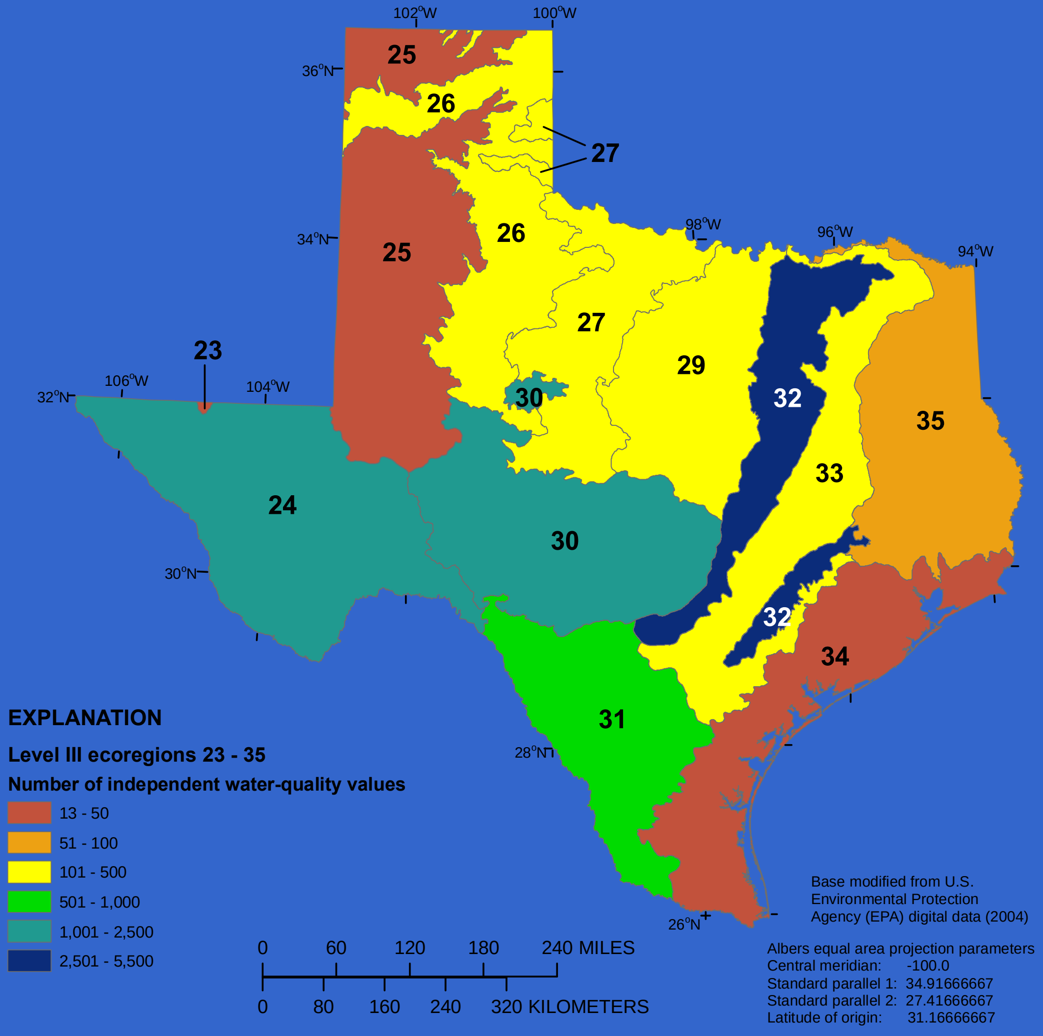
parameter_cd 00900
qw_method_cd <null>
result_va 240
result_rd 2
remark_cd <null>
qa_cd USGS lab value -- approved for transfer
rpt_lev_va <null>
rpt_lev_cd <null>
dqi_cd Historical data
null_val_qual_cd <null>
prep_set_no <null>
prep_dt <null>
anl_set_no <null>
anl_dt <null>
result_cn nwis
result_cr 9/15/2001
result_mn nwis
result_md 9/15/2001
08104300 -
Salado Springs at
Salado, Texas
0 0.4 0.8 1.2 1.6 MILES
Drawing
Arial
10
97°32'22.25"W 30°57'24.75"N 5.27 5.90 Inches
start
Franklin T Heitmuller -...
Microsoft PowerPoint ...
Untitled - ArcMap - Ar...
9:23 AM

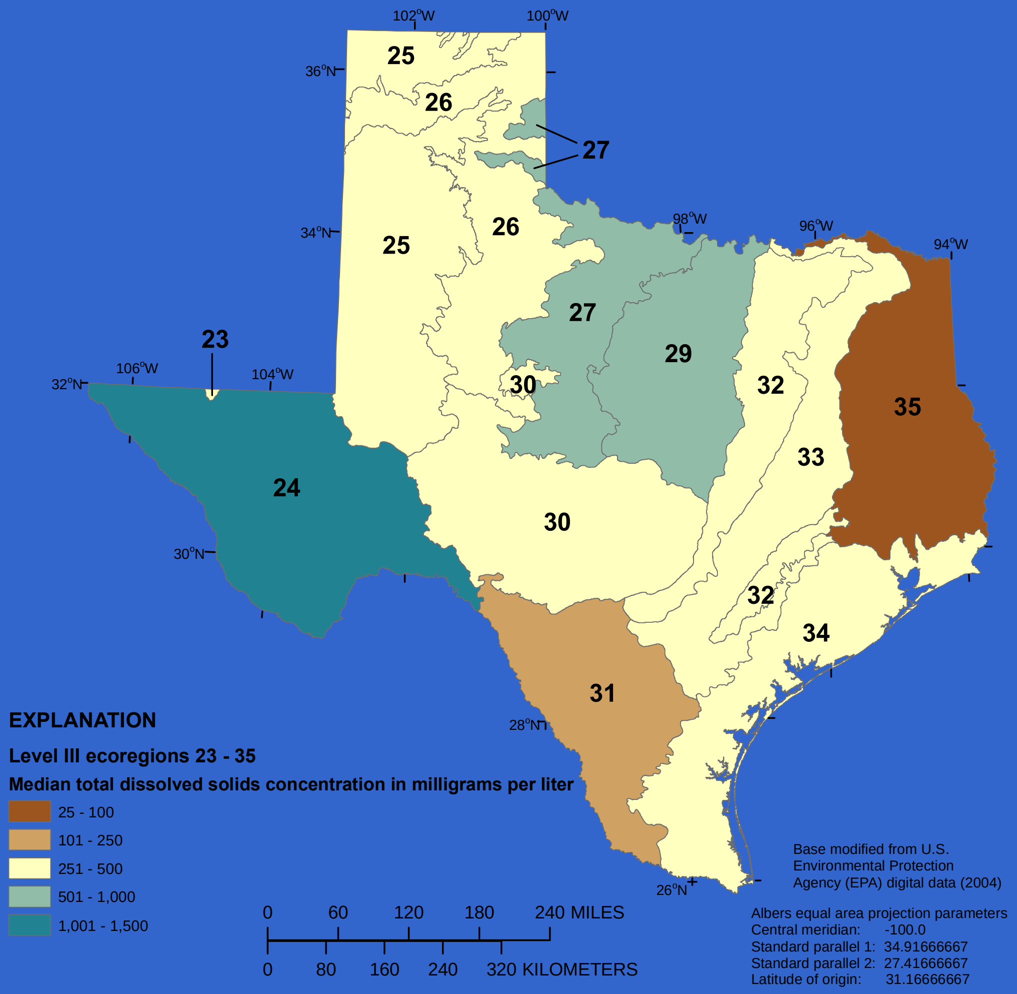
Phase II

- Few water-quality data for High Plains and Gulf Coastal Plain correspond with few springs
- Wide availability of water-quality data in Blackland Prairie because largest, most closely monitored springs issue from this ecoregion, although QW associated with Edwards Plateau

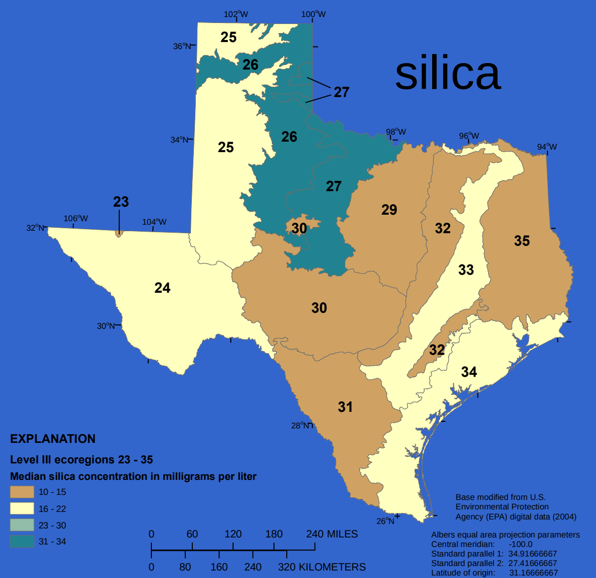


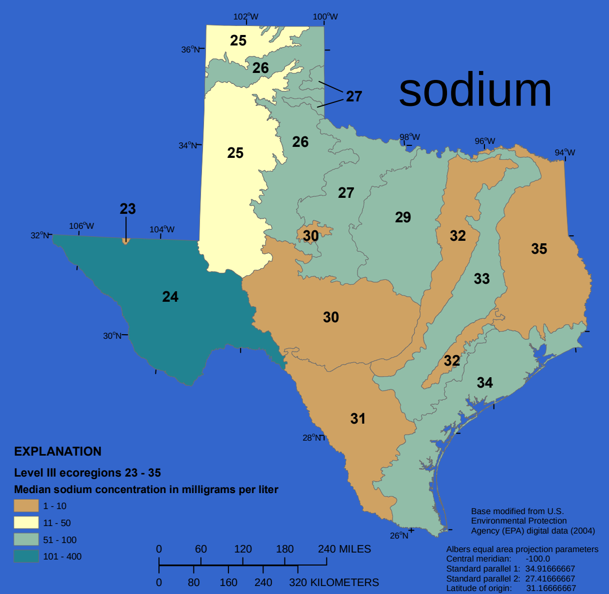
Phase II

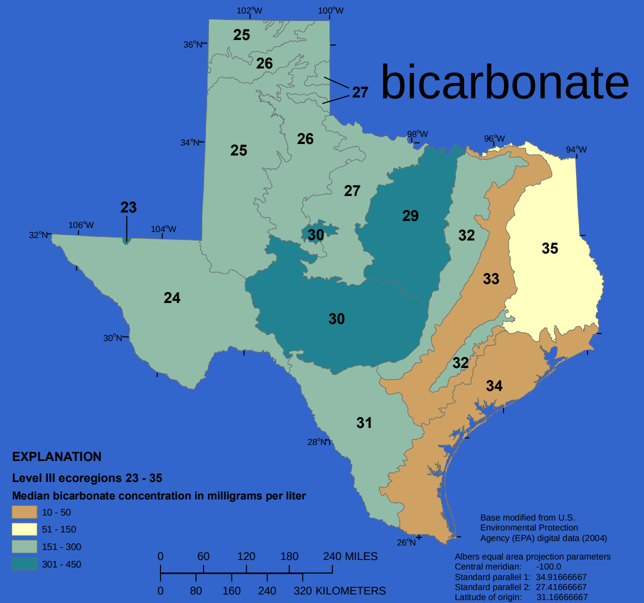
- Median total dissolved solids highest in Chihuahuan Desert springs; associated with long, deep flow paths and subsurface geology
- Median total dissolved solids lowest in South Central Plains; most bottling companies use these springs



Phase II


silica
EXPLANATION
Level III ecoregions 23 - 35
Median silica concentration in milligrams per liter
10 - 15
16 - 22
23 - 30
31 - 34
0 60 120 180 240 MILES
0 80 160 240 320 KILOMETERS
Base modified from U.S. Environmental Protection Agency (EPA) digital data (2004)
Albers equal area projection parameters
Central meridian: -100.0
Standard parallel 1: 34.91666667
Standard parallel 2: 27.41666667
Latitude of origin: 31.16666667


sodium
EXPLANATION
Level III ecoregions 23 - 35
Median sodium concentration in milligrams per liter
1 - 10
11 - 50
51 - 100
101 - 400
0 60 120 180 240 MILES
0 80 160 240 320 KILOMETERS
Base modified from U.S. Environmental Protection Agency (EPA) digital data (2004)
Albers equal area projection parameters
Central meridian: -100.0
Standard parallel 1: 34.91666667
Standard parallel 2: 27.41666667
Latitude of origin: 31.16666667


bicarbonate
EXPLANATION
Level III ecoregions 23 - 35
Median bicarbonate concentration in milligrams per liter
10 - 50
51 - 150
151 - 300
301 - 450
0 60 120 180 240 MILES
0 80 160 240 320 KILOMETERS
Base modified from U.S. Environmental Protection Agency (EPA) digital data (2004)
Albers equal area projection parameters
Central meridian: -100.0
Standard parallel 1: 34.91666667
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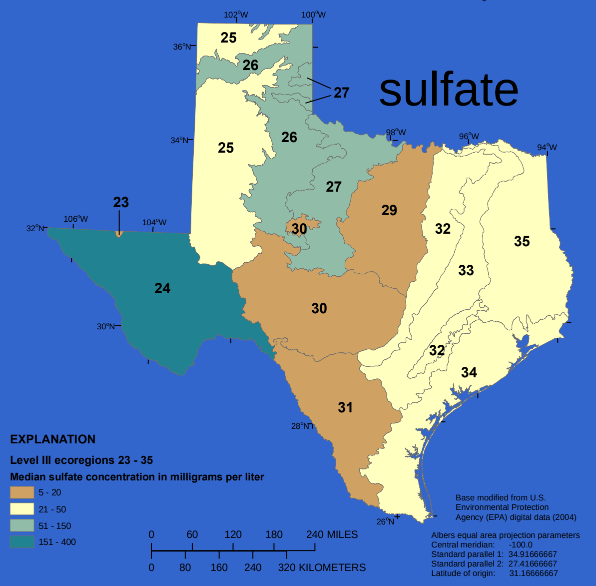
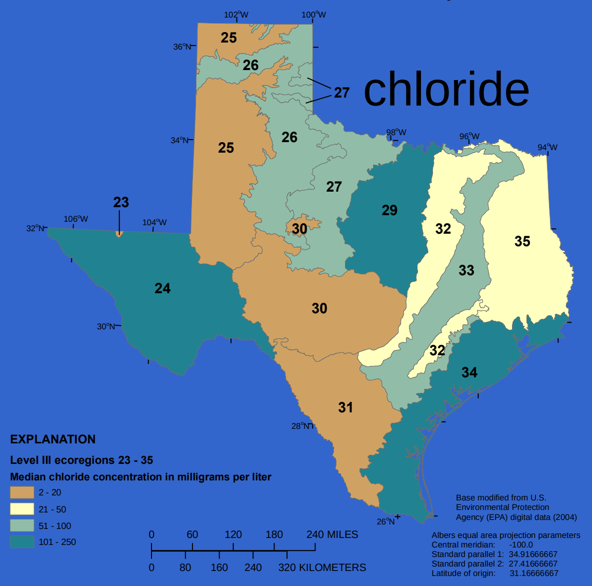
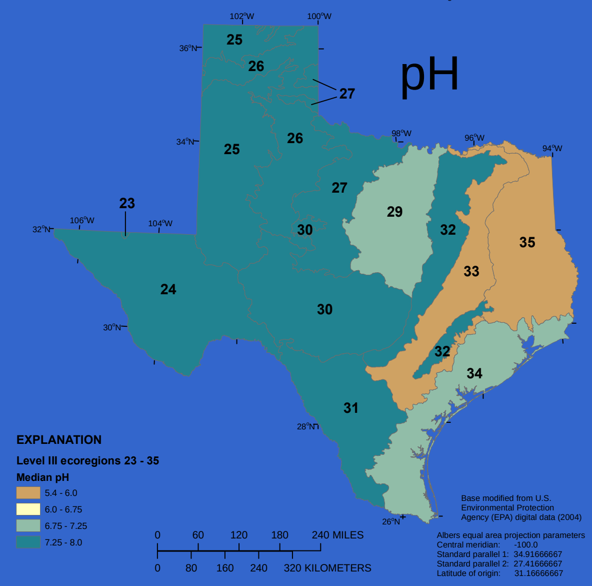
Latitude of origin: 31.16666667

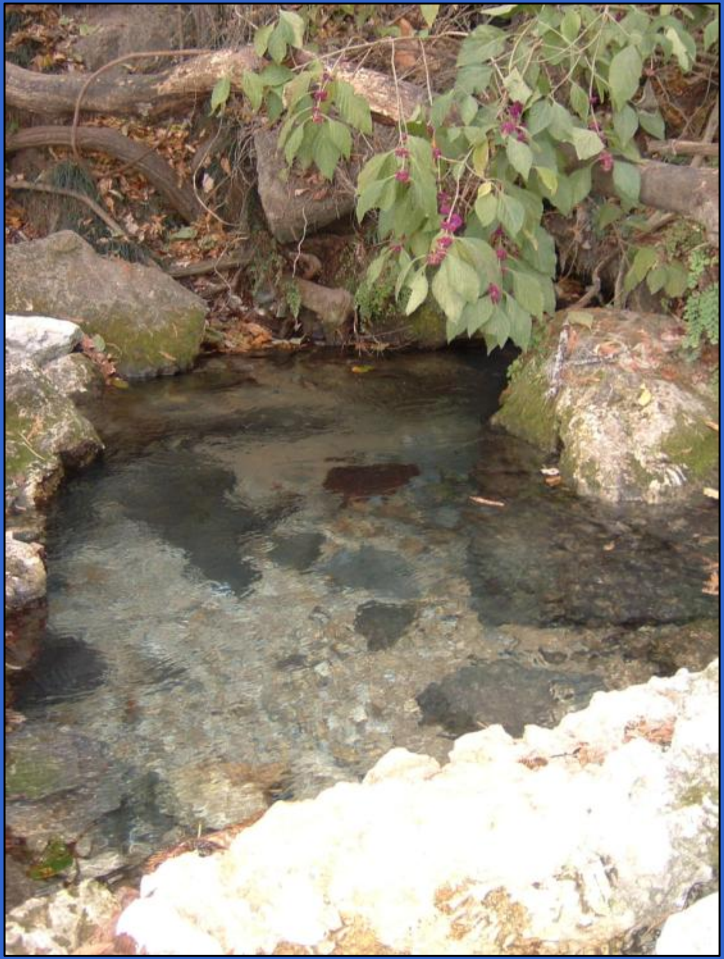

sulfate
EXPLANATION
Level III ecoregions 23 - 35
Median sulfate concentration in milligrams per liter
5 - 20
21 - 50
51 - 150
151 - 400
0 60 120 180 240 MILES
0 80 160 240 320 KILOMETERS
Base modified from U.S. Environmental Protection Agency (EPA) digital data (2004)
Albers equal area projection parameters
Central meridian: -100.0
Standard parallel 1: 34.91666667
Standard parallel 2: 27.41666667
Latitude of origin: 31.16666667


chloride
EXPLANATION
Level III ecoregions 23 - 35
Median chloride concentration in milligrams per liter
2 - 20
21 - 50
51 - 100
101 - 250
0 60 120 180 240 MILES
0 80 160 240 320 KILOMETERS
Base modified from U.S. Environmental Protection Agency (EPA) digital data (2004)
Albers equal area projection parameters
Central meridian: -100.0
Standard parallel 1: 34.91666667
Standard parallel 2: 27.41666667
Latitude of origin: 31.16666667


pH
EXPLANATION
Level III ecoregions 23 - 35
Median pH
5.4 - 6.0
6.0 - 6.75
6.75 - 7.25
7.25 - 8.0
0 60 120 180 240 MILES
0 80 160 240 320 KILOMETERS
Base modified from U.S. Environmental Protection Agency (EPA) digital data (2004)
Albers equal area projection parameters
Central meridian: -100.0
Standard parallel 1: 34.91666667
Standard parallel 2: 27.41666667
Latitude of origin: 31.16666667

Phase III

- Visit and measure 232 springs selected in Phase II
- Standardized spring flow measurement and water-quality sampling
- 2 purposes
  - Identify additional springs for long-term monitoring
  - Update existing data and identify status and trends of flow and water quality



Cold Spring along Town Lake in Austin, Texas

References

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