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
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)

<table>
<thead>
<tr>
<th>MAGNITUDE</th>
<th>AVERAGE DISCHARGE</th>
<th>AVERAGE DISCHARGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>First</td>
<td>( \geq 100 \text{ ft}^3/\text{s} )</td>
<td>( \geq 2.83 \text{ m}^3/\text{s} )</td>
</tr>
<tr>
<td>Second</td>
<td>10 – 100 ( \text{ ft}^3/\text{s} )</td>
<td>0.283 – 2.83 ( \text{ m}^3/\text{s} )</td>
</tr>
<tr>
<td>Third</td>
<td>1 – 10 ( \text{ ft}^3/\text{s} )</td>
<td>0.0283 – 0.283 ( \text{ m}^3/\text{s} )</td>
</tr>
<tr>
<td>Fourth</td>
<td>100 gallons per minute (gpm) – 1 ( \text{ ft}^3/\text{s} )</td>
<td>0.006309 – 0.0283 ( \text{ m}^3/\text{s} )</td>
</tr>
<tr>
<td>Fifth</td>
<td>10 – 100 gpm</td>
<td>630.9 – 6309 ( \text{ cm}^3/\text{s} )</td>
</tr>
<tr>
<td>Sixth</td>
<td>1 – 10 gpm</td>
<td>63.1 – 630.9 ( \text{ cm}^3/\text{s} )</td>
</tr>
<tr>
<td>Seventh</td>
<td>1 pint per minute – 1 gpm</td>
<td>7.89 – 63.1 ( \text{ cm}^3/\text{s} )</td>
</tr>
<tr>
<td>Eighth</td>
<td>&lt; 1 pint per minute</td>
<td>&lt; 7.89 ( \text{ cm}^3/\text{s} )</td>
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</tbody>
</table>
History of Assessment in Texas

• Gunnar Brune (1975) – Major and Historical Springs of Texas (TWDB Report 189) – 281 springs
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
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

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
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
Phase I

08168710 - Comal Springs at New Braunfels, Texas
Phase I

08104300 - Salado Springs at Salado, Texas

Robertson Spring
Big Boiling Spring
Spring Groves Spring
Comal Springs and Goodenough Spring

Flow - Comal Springs and Goodenough Spring

Discharge (ft$^3$/s) - Comal Springs

Discharge (ft$^3$/s) - Goodenough Spring

Date

1928 1933 1938 1943 1948 1953 1958
Roaring Springs – Texas Panhandle

\[ \mu = 1.38 \text{ ft}^3/\text{s}; \sigma = 0.32 \text{ ft}^3/\text{s} \]

1960s – Flow becomes sensitive (local pumping?)
Hannah Springs – Lampasas

μ 1.44 ft³/s; σ 0.48 ft³/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

![Graph of Comal Springs with data points for annual precipitation in New Braunfels and Uvalde, and spring flow.]

- Mean ($\mu$) 287 ft$^3$/s; Standard Deviation ($\sigma$) 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

San Solomon Springs

μ 30 ft³/s; σ 6.4 ft³/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
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

EXPLANATION
Level III ecoregions 23 - 35
Median silica concentration in milligrams per liter

EXPLANATION
Level III ecoregions 23 - 35
Median sodium concentration in milligrams per liter

EXPLANATION
Level III ecoregions 23 - 35
Median bicarbonate concentration in milligrams per liter

EXPLANATION
Level III ecoregions 23 - 35
Median sulfate concentration in milligrams per liter

EXPLANATION
Level III ecoregions 23 - 35
Median chloride concentration in milligrams per liter

EXPLANATION
Level III ecoregions 23 - 35
Median pH
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
References