January 2007


Barton Springs/Edwards Aquifer Conservation District

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GROUNDWATER LEVELS IN THE BALCONES FAULT ZONE, HAYS AND TRAVIS COUNTIES, TEXAS, 1937-2005
Disclaimer
All of the information provided in this report is believed to be accurate and reliable; however, the Barton Springs/Edwards Aquifer Conservation District (District) assumes no responsibility for any errors or for the use of the information provided. While this report has attempted to provide a comprehensive database of water level data, there may be unintended omissions of data or wells.

Cover. Hydrograph of two wells; top hydrograph is from the Zumwald Well (58-50-417) and is highly influenced by conduit development within the aquifer; the lower hydrograph is from the Lovelady Well (58-50-301) and is highly influenced by diffuse flow within the aquifer.
GROUNDWATER LEVELS IN THE BALCONES FAULT ZONE, HAYS AND TRAVIS COUNTIES, TEXAS, 1937-2005

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Precinct 5

Chuck Murphy
Precinct 1

Gary Franklin
Precinct 2

BSEACD Data Series Report 2006-1025
October 2006

Barton Springs/Edwards Aquifer Conservation District
1124 Regal Row
Austin, Texas
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GROUNDWATER LEVELS IN THE BALCONES FAULT ZONE, HAYS AND TRAVIS COUNTIES, TEXAS, 1937-2005

Brian B. Hunt, P.G. and Brian A. Smith, Ph.D., P.G.

ABSTRACT

More than 50,000 water-level measurements from 1937 to 2005 in the Balcones Fault Zone of Central Texas were compiled from 49 wells, and one quarry. Data represent water levels from the Edwards, Trinity, and Austin Chalk Aquifers. A simple database was constructed to compile the water-level and well-construction data. The purpose of this report is to provide a foundation for future hydrogeologic investigations.

INTRODUCTION

Groundwater is an important resource for Texans and constituted nearly 60% of all water used by Texans in 1999 (TWDB, 2002). Aquifers along the Balcones Fault Zone in Central Texas provide an important groundwater resource for industrial, domestic, recreational, and ecological needs. The study area is located along the Balcones Fault Zone of Central Texas within portions of Travis and Hays counties (Figure 1). Water-level data within this report are primarily from wells completed within the Edwards, and to a lesser extent, the Trinity Aquifer. A relatively minor, locally water-bearing unit in the study area is the Austin Chalk.

This paper and accompanying database present a compilation of continuous water-level data from groundwater resources in the study area. Groundwater levels provide critical information about the hydrologic relationships of recharge and discharge to storage within an aquifer, and the direction of groundwater flow. Long-term, systematic measurements of water-level data are essential to develop groundwater models and to design, implement, and monitor the effectiveness of groundwater management programs (Taylor and Alley, 2001). This report includes data that numerous agencies have collected over the years: the United States Geological Survey (USGS), Texas Water Development Board (TWDB), Edwards Aquifer Authority (EAA), Hays-Trinity Groundwater Conservation District (HTGCD), San Antonio Water Systems (SAWS), and the Barton Springs/Edwards Aquifer Conservation District (BSEACD).

Purpose and Scope

This report compiles more than 50,000 water-level measurements made from 1937 to 2005 for 49 wells (and one quarry) completed in the Edwards, Trinity, and Austin Chalk Aquifers. A simple Microsoft® Excel-based database was constructed and accompanies this report. The database contains well-completion information and water-level data. The purpose of this report is to provide a foundation for future hydrogeologic investigations and evaluations of water resources in central Texas. The database presented in the report is currently the most comprehensive available for the study area.
Figure 1. General well location map showing aquifer hydrologic zones, District boundaries, rivers and creeks, roads, major cities/towns, springs, and other landmarks.
## WELL AND DATA INVENTORY

This report contains tabulation of wells and data summarized in Table 1. More information about the completion and construction of the wells can be found in the accompanying database or in the BSEACD Data Series Report 2006-0818.

### Table 1. Well and Data Inventory.

<table>
<thead>
<tr>
<th>SWN</th>
<th>Well Name</th>
<th>Well Owner</th>
<th>County</th>
<th>DD Lat</th>
<th>DD Long</th>
<th>Lat/long Source</th>
<th>LSD (ft)</th>
<th>LSD Source</th>
<th>M.P. (ft)</th>
<th>TD (ft)</th>
<th>Date Drilled</th>
<th>Aquifer Code</th>
<th>Period of record</th>
<th>Data Count</th>
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<tbody>
<tr>
<td>1</td>
<td>Greenbelt</td>
<td>City of Austin</td>
<td>Travis</td>
<td>30.26101000</td>
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<td>1999 to 2005</td>
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<td>530</td>
<td>1985</td>
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<td>1986 to 1987</td>
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**Note:**
- **SWN:** Statewide Unique Number
- **Well Name:** Name of the well
- **Well Owner:** Owner of the well
- **County:** County in which the well is located
- **DD Lat:** Decimalseconds latitude
- **DD Long:** Decimalseconds longitude
- **Lat/long Source:** Source of latitude and longitude data
- **LSD (ft):** Length of Screen (feet)
- **LSD Source:** Source of length of screen data
- **M.P. (ft):** Maximum Pressure (feet)
- **TD (ft):** Total Depth (feet)
- **Date Drilled:** Date well was drilled
- **Aquifer Code:** Aquifer code
- **Period of record:** Period of record
- **Data Count:** Count of data
<table>
<thead>
<tr>
<th>SWN</th>
<th>Well Name</th>
<th>Well Owner</th>
<th>County</th>
<th>DD Lat</th>
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<td>1994</td>
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</table>

1. Land Surface Datum (LSD) is the elevation in feet above mean seal level.
2. Measurement Point (MP), measured in feet above the LSD.
3. Total Depth (TD) of well in feet.

* Aquifer code of the Texas Water Development Board.
Figure 2a: Water Level Hydrographs

Elevation of Water Level (ft-msl)

08/04/35 08/01/45 07/30/55 07/27/65 07/25/75 07/22/85 07/20/95 07/17/05

57-56-9CB
58-49-406
58-49-706
58-50-216
58-50-301
58-50-601
58-57-201
58-57-301
58-58-9A
58-58-101
58-58-301
58-49-9QL
Figure 2b: Water Level Hydrographs
WATER-LEVEL DATA

Hydrographs of the data within this report are presented in Figures 2a-e. A simple database accompanying this report contains water-level and well-construction data (see Appendix). The period of record for this report includes continuous data through March 2005, however some wells have data through August 2006.

Data Collection Methods

Data within this report were collected by a variety of agencies including: TWDB, BSEACD, USGS, EAA, SAWS, and HTGCD. It should be noted that each of these agencies has their own protocols and methods for the collection of data, which in some cases have changed over time. Methods are only briefly discussed in this report and individuals interested in the details of those methods are encouraged to contact the corresponding agencies. Data collection methods employed by the BSEACD are described in Hunt et al. (2004).

Water-level data compiled in this report were collected with either manual measurements or with automated recorders. Manual measurements were often made with a steel tape or electric lines (eline). Automated instruments include chart recorders or pressure transducers with data loggers. Manual measurements are periodically made in conjunction with automated instruments for calibration and verification purposes. Manual measurements are generally accurate to within ±0.1 feet. These data are also contained in the report where available and provide quality control and assurance for the automated data.

Measurement Points and Datums

Water-level measurements are made in reference to a measurement point (MP) at the well head. Commonly the MP corresponds to the top of casing (TOC). The MP or TOC measurement is subtracted from the depth-to-water measurement to reflect a depth from the land surface datum (LSD). LSD is generally defined as the top of the concrete slab around the casing, or from ground level. Data obtained from the TWDB, USGS, EAA and HTGCD are reported as depth from LSD; however, some data may actually be from the TOC. Historic data from the BSEACD were originally reported as depth from TOC (both manual and transducer data), but have been adjusted in this report to reflect the depth from LSD. Depth to water below LSD is a positive value, negative values reflect a level above the LSD, such as flowing artesian wells (see 58-42-927, 58-42-929; 58-50-601).

Elevations for LSDs were obtained from USGS topographic maps (10-ft contours), City of Austin topographic maps (2-ft contours), or from surveys. Vertical datums from those maps are either North American Vertical Datum 1929 (NAVD29) or North American Vertical Datum 1988 (NAVD88). Many of the horizontal coordinates were collected with a Global Positioning System (GPS), or by locating on a USGS topographic map, or
by survey. Horizontal datums are in World Geodetic System 1984 (WGS84) or North American Datum 1983 (NAD83).

**Frequency of Water-Level Measurements**

All the data in this report are considered “continuous” because there is a significant density of data over a given period of time from a well allowing some inference as to the hydraulic stresses on the aquifer or well. However, a majority of the data are actually periodic in nature with data spanning weeks to years. Data prior to about 1980 consist of periodic manual measurements of this type. After the 1980’s, automated data collection systems (chart recorders and pressure transducers with data loggers) were used more frequently within the study area. These automated systems collect data continuously, like chart recorders, or at a high frequency (such as hourly to daily), such as pressure transducers with data loggers. These large datasets have been reduced to daily measurements by the various agencies and may represent an average value for the day, or as in the case of the BSEACD data, represent the maximum elevation (minimum depth) for that day. Accordingly, data from automated recorders do not generally have a time associated with the date. However, many manual measurements do have an associated time. Those with an unknown time are indicated by a 0:00 AM or 1:00 AM in the date column.

**Data Compilation and Quality Assurance**

The TWDB database was the source of most of the historical data before 1990. Only data listed as publishable were incorporated into the database. TWDB data are available on their website at:

http://www.twdb.state.tx.us/GwRD/waterwell/well_info.asp

Additionally, the USGS collected a significant amount of historical data, and those are available via their website or in published reports. After about 1990, agencies such as the EAA, SAWS, BSEACD, and the HTGCD began collecting data from more sites, and more frequently.

A systematic quality-assurance review was conducted for this report and database. Automated data from the BSEACD since about 1988 provided the greatest challenge for quality control and assurance. Manual measurements were compiled from field notebooks and were plotted with the automated data for quality control and assurance purposes.

All of the information provided is believed to be accurate and reliable; however, the BSEACD assumes no responsibility for any errors or for the use of the information provided. BSEACD makes no guarantees or warranties as to the accuracy, completeness, currency, or suitability of the data provided in this report. All data from agencies other than the BSEACD should be regarded as provisional.
SOURCES OF WATER LEVEL FLUCTUATIONS

The purpose of this report is to present data without significant interpretations. However, a brief discussion of the factors and hydrologic stresses on the groundwater resources is warranted.

Water-level fluctuations represent changes in storage within the aquifer and are caused by hydrologic stresses. Long-term fluctuations in water levels represent changes in storage due to recharge and discharge (Table 2). Fluctuations from drought-of-record conditions to high-flow conditions in the Edwards Aquifer are on the order of 75 and 100 feet in the unconfined and confined portion of the Edwards Aquifer, respectively. Although data from the Trinity Aquifer are more limited, Trinity wells appear to have a similar dynamic range in water-levels, although they vary within specific Trinity units.

Table 2. Source of water-level fluctuations in the Edwards Aquifer.

<table>
<thead>
<tr>
<th>Hydrologic Stress</th>
<th>Approximate magnitude of fluctuation</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Long-term Climatic (months to years)</td>
<td>up to 100 ft (confined) up to 70 ft (unconfined)</td>
<td></td>
</tr>
<tr>
<td>Pumping (daily)</td>
<td>up to 50 ft (confined)</td>
<td>Influenced by nearby large-capacity pumping wells</td>
</tr>
<tr>
<td>Recharge (daily)</td>
<td>up to 15 ft (confined) up to 10 ft (unconfined)</td>
<td></td>
</tr>
<tr>
<td>Barometric (daily)</td>
<td>up to 0.1 ft</td>
<td>Confined conditions only</td>
</tr>
<tr>
<td>Tidal (daily)</td>
<td>0.1-0.01 ft?</td>
<td>Needs further study</td>
</tr>
</tbody>
</table>

The dynamic nature of water levels in the Edwards Aquifer is a result of triple porosity of the aquifer, with diffuse, fracture, and conduit porosity (Hovorka et al., 1998). The Edwards and to a lesser extent, the Trinity Aquifer, are very heterogeneous and anisotropic aquifers. Accordingly, the response of water levels to the various hydrologic stresses can be markedly different for each well site. For example, many wells correlate very well with Barton Springs, such as the Porter Well (58-58-123), which indicates they are heavily influenced by conduit flow. However, the Lovelady well (58-50-301) appears to have a muted response to recharge and is dominated by diffuse flow to the well. Other wells appear to be dominated by conduit flow such as wells 58-50-411 and 58-50-417.

The Trinity Aquifer is dominated by diffuse flow; however there is some indication of dynamic water-level responses that could indicate fracture or conduit flow within certain limestone units (see well 58-49-706).

Proximity to a pumping well can also influence water levels within a well. Although most of the wells in the database are not located close to actively pumping wells, or are not significantly impacted by their “cones of influence,” there are some wells that are heavily influenced by pumping, and their water levels can be temporarily lowered by 50 feet from the static level. The Buda (58-58-101) and Dowell monitor wells (58-50-801) are two examples of wells heavily influenced by nearby pumping. Other wells, such as the
Porter (58-58-123) and Centex (58-58-4CT) wells also have relatively minor pumping influences, on the order 2 to 3 feet under average conditions. However, these fluctuations are generally discernable on hourly data. It is important to note that the BSEACD collects data hourly with pressure transducers and data loggers, but the daily measurement reported is the maximum elevation for a given day. This method appears to filter out most minor fluctuations due to local pumping effects.

**Barometric Effects**

Barometric pressure acts upon the aquifer rock matrix and water levels within a well. Water levels have an inverse relationship to barometric pressure changes and are most commonly observed in confined aquifers because of the hydraulic gradient between the well and the surrounding aquifer. Barometric responses are not commonly observed in wells completed within unconfined aquifers because the pressures are evenly distributed between water levels within a well and the water table (Domenico and Schwartz, 1990). The barometric efficiency of the Negley well (58-57-903) in the confined portion of the Barton Springs aquifer, and determined from a 2-day period, is 0.67, indicating a good relationship between water-level and barometric changes.

BSEACD water-level data after 2002 were collected with non-vented (absolute pressure-transducer) probes. Most data have been compensated for barometric fluctuations unless otherwise noted.

**WELL COMPLETION**

Well completion information was obtained from drillers logs, many of which are within the TWDB database. Most wells were drilled as water-supply wells that have been converted into monitoring sites. Most wells have an open borehole completion with diameters of at least 4 to 6 inches. Many wells within the Edwards Aquifer only partially penetrate the entire saturated thickness. Water levels from a partially penetrating well may not be representative of the aquifer as a whole. Wells reported as completed within the Trinity Aquifer are often hybrids of the upper and middle Trinity aquifers.

**ACKNOWLEDGEMENTS**

The TWDB, USGS, SAWS, EAA, and HTGCD provided much of the data within this report. Specifically, thanks go to Rob Esquelin (EAA) and Kenneth Davis (HTGCD) for supplying data. BSEACD staff that collected data and contributed to the District’s water-level program include: Stefani Campbell, Joe Beery, Nico Hauwert, Ron Fiesler, Beckie Morris, and Shu Liang.
REFERENCES


**Appendix.** Database of groundwater levels in the Balcones Fault Zone, Hays and Travis Counties, Texas, 1937-2005.

The compact disk contains a simple Microsoft® Excel-based database. It contains a summary worksheet titled: ‘Figure 1-Well & Data Summary’ with an internal hyperlink to each well and corresponding data set. Figure 2a-e hydrographs are also presented as worksheets in the database.