B. HUNT

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Ground-Water Availability Modeling of the Three Major Segments of the Edwards Aquifer, Central Texas

Brian A. Smith, Ph.D., P.G., BSEACD; Brian B. Hunt, P.G., BSEACD; Ian Jones, Ph.D., P.G., TWDB; Richard Lindgren, P.G., USGS; Geary Schindel, P.G., Edwards Aquifer Authority

Abstract

The Edwards Aquifer of central Texas is subdivided into the northern, Barton Springs, and San Antonio segments. These segments, which are based on ground-water divides and other hydrogeologic boundaries, have many similarities in geographic and hydrogeologic aspects, but also have important differences. Ground-water availability models have been completed for each segment and are being used for ground-water management.

General Characteristics

The entire Edwards Aquifer (Balcones Fault Zone) system covers an area of about 4,350 mi^2. The San Antonio segment is 3,600 mi^2, or 82% of the total area. The Barton Springs segment is 155 mi^2, or 4% of the total area, and the northern segment is about 600 mi^2, or 14% of the total area. The Edwards Aquifer is a sole-source of water for 1.7 million people in the San Antonio segment with pumping at about 436,600 acre-ft/yr. The Barton Springs segment provides water for about 50,000 people and currently has about 7,800 acre-ft/yr of pumping. The northern segment provides water for about 230,000 people with about 30,000 acre-ft/yr of pumping.

Hydrogeologic Setting

The Edwards Aquifer is a prolific karst aquifer system composed of Cretaceous-age limestone located along the Balcones Fault Zone. East- and northeast-trending normal faulting strongly influences groundwater flow in the San Antonio and Barton Springs segments, respectively. Faults appear to have less influence on groundwater flow in the northern segment. In the San Antonio and Barton Springs segments the majority of recharge occurs along major losing streams within the recharge zone. Recharge in the northern segment occurs in the uplands and minor streams, while major streams are often sites of spring discharge with total mean discharge of about 44,000 acre-ft/yr. Spring discharge in the San Antonio and Barton Springs segments occurs primarily at discrete locations. Comal and San Marcos Springs in the San Antonio segment have mean historical flows of 200,900 and 114,300 acre-ft/yr, respectively. Barton Springs has a mean historical flow of 38,400 acre-ft/yr.

Approaches to Ground-Water Availability Modeling

Ground-water availability models for each segment of the Edwards Aquifer are based on the U.S. Geological Survey's MODFLOW program. To simulate ground-water flow through conduits, the San Antonio model uses lines of contiguous cells with high values of hydraulic conductivity. The Barton Springs model uses zones of high hydraulic conductivity to simulate the effect of rapid ground-water flow through conduits. The northern model assigns uniform hydraulic conductivity values to all active model cells. All three models use drain cells to simulate spring discharge.

Determination of Ground-Water Availability

The amount of ground water available from an aquifer is not based entirely on water budgets, hydrogeologic data, and modeling, but is based, in part, on political, economic, and environmental factors. Results of ground-water modeling and an evaluation of historical hydrogeologic data indicate that pumping 7,240 acre-ft/yr of ground water during severe drought conditions will lead to drying of Barton Springs and will impact yields from many of the wells in the District. Because pumping from the northern segment is a relatively small portion of the water budget, no significant impacts to wells or spring discharge are expected to occur under severe drought conditions. The amount of ground water available in the San Antonio segment is considered to be less than the amount of ground water currently permitted to be pumped from the aquifer. The Edwards Aquifer Authority, management agency for the San Antonio segment, is required by state law to reduce pumping from 450,000 acre-ft/yr to 400,000 acre-ft/yr by 2008.

Biographical Sketches

Brian A. Smith received his B.A. from Rice University, and his Ph.D. from the University of Texas at Austin. Brian is the Assessment Program Manager and Senior Hydrogeologist at the Barton Springs/Edwards Aquifer Conservation District in Austin, Texas.

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Ian Jones received his B.S. from the University of Western Ontario, M.S. at the University of South Florida, and Ph.D. from the University of Texas at Austin. Ian is a Hydrologist at the Texas Water Development Board in Austin, Texas.

Richard Lindgren received his M.F. from the University of Minnesota. Richard is a Hydrologist at the U.S. Geological Survey in San Antonio, Texas.

Geary Schindel received his B.S. at West Virginia University and his M.S. at Western Kentucky University. Geary is the Chief Technical Officer at the Edwards Aquifer Authority in San Antonio, Texas.

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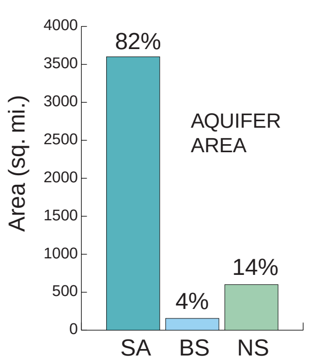
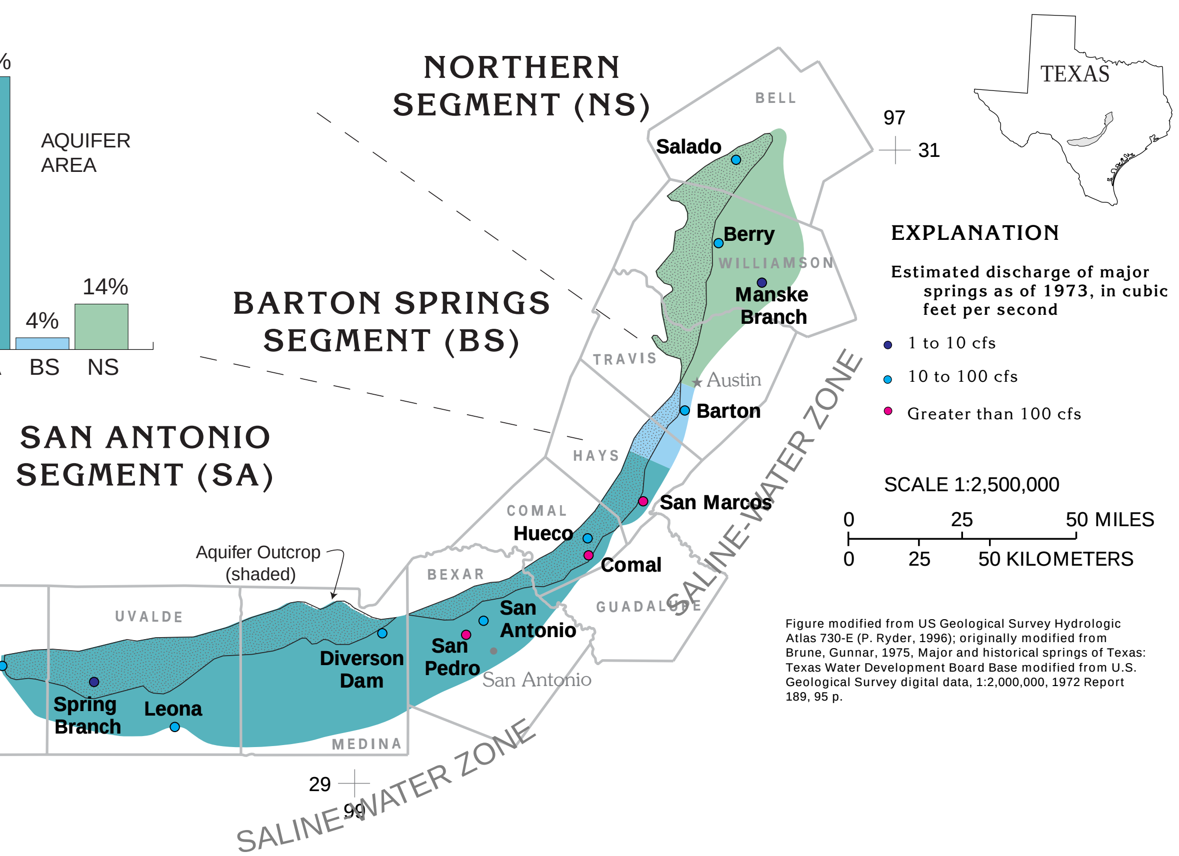
INTRODUCTION

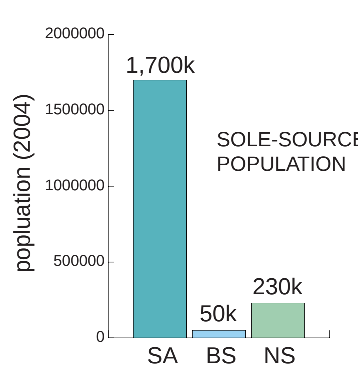
The Edwards Aquifer is a prolific karst aquifer system composed of Cretaceous-age limestone located along the Balcones Fault Zone. The Edwards Aquifer of central Texas is subdivided into the northern (NS), Barton Springs (BS), and San Antonio (SA) segments. These segments, which are based on ground-water divides and other hydrogeologic boundaries, have many geographic and hydrogeologic similarities, but also have important differences. Ground-water availability models (GAMs) have been completed for each segment and are being used for ground-water management. The purpose of this poster is to highlight some aspects of those studies to compare and contrast these resources and our understanding of those systems. The GAM models compared in this poster include:

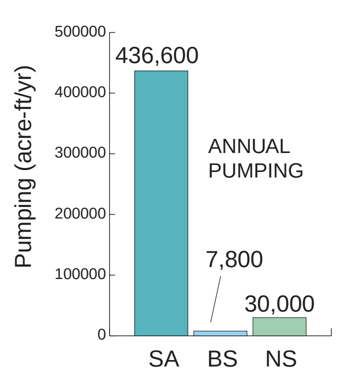
San Antonio Segment (SA):	Lindgren et al. (2004)
Barton Springs Segment (BS):	Scanlon et al., (2001); Smith and Hunt (2004)
Northern Segment (NS):	Jones, Ian (2004)

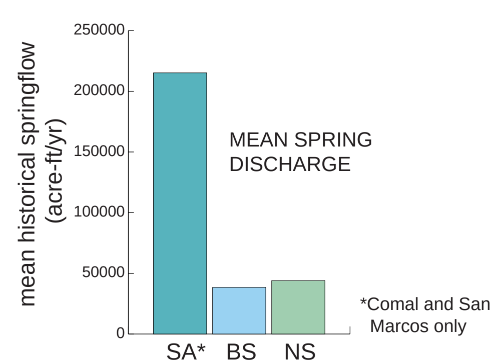
GENERAL SETTING





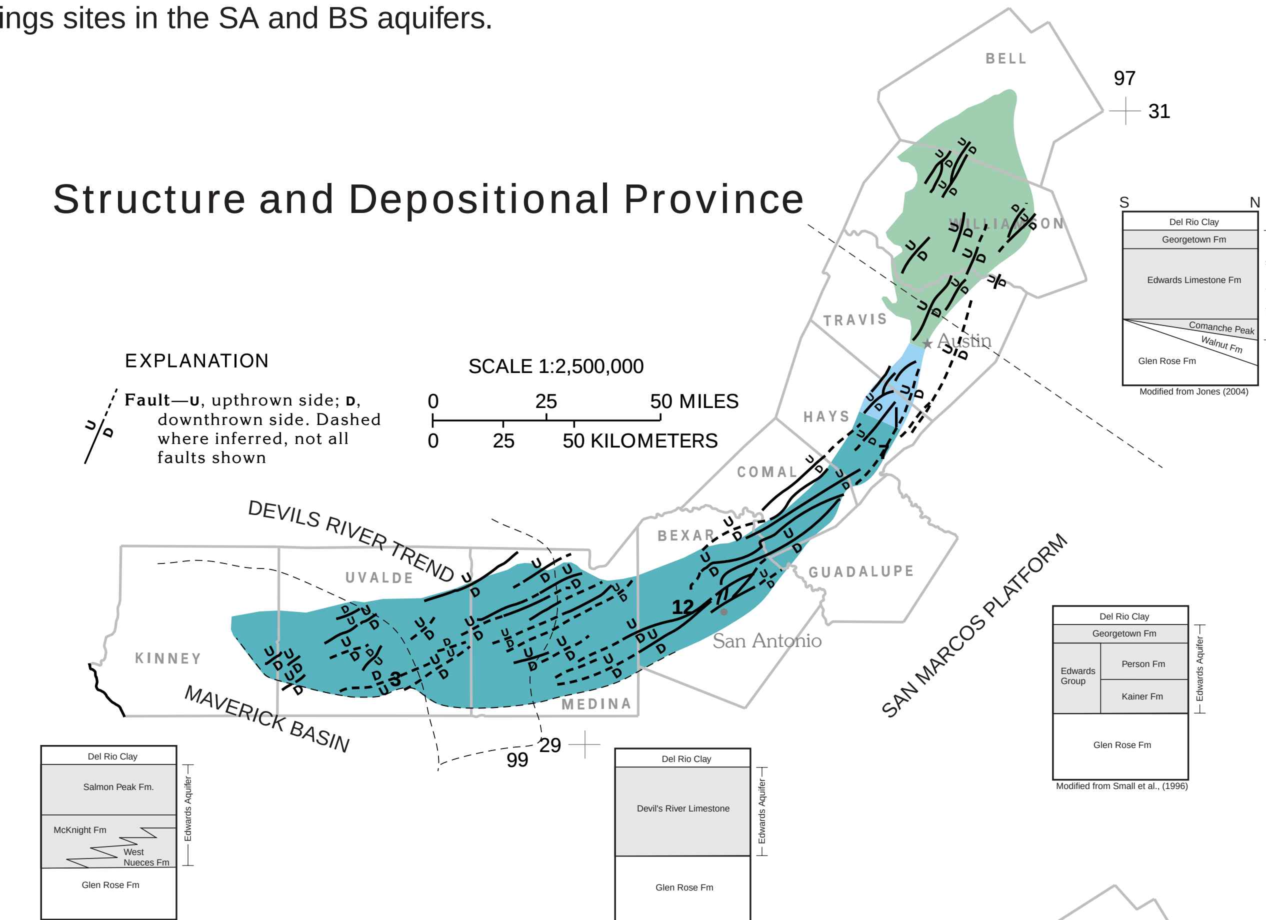


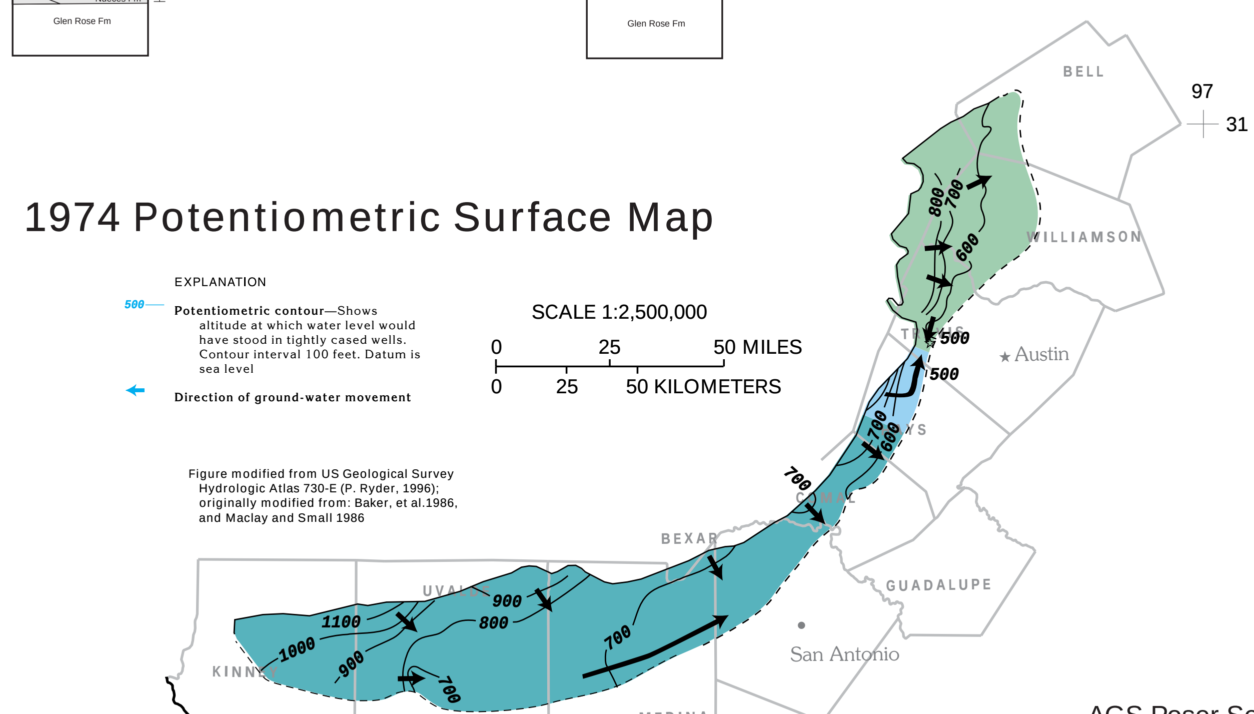




HYDROGEOLOGY

Hydrostratigraphy of the aquifer varies west to east according to depositional and structural provinces. East- and northeast-trending normal faulting strongly influences groundwater flow in the SA and BS segments. Faults appear to have less influence on groundwater flow in the NS. In the SA and BS segments the majority of recharge occurs along major losing streams within the recharge zone. Recharge in the NS occurs in the uplands and minor streams. Spring discharge generally occurs at discrete locations in the SA and BS, while major streams are often sites of spring discharge in the NS. Potentiometric surfaces contain broad "troughs" indicating zones of preferential flow toward springs sites in the SA and BS aquifers.





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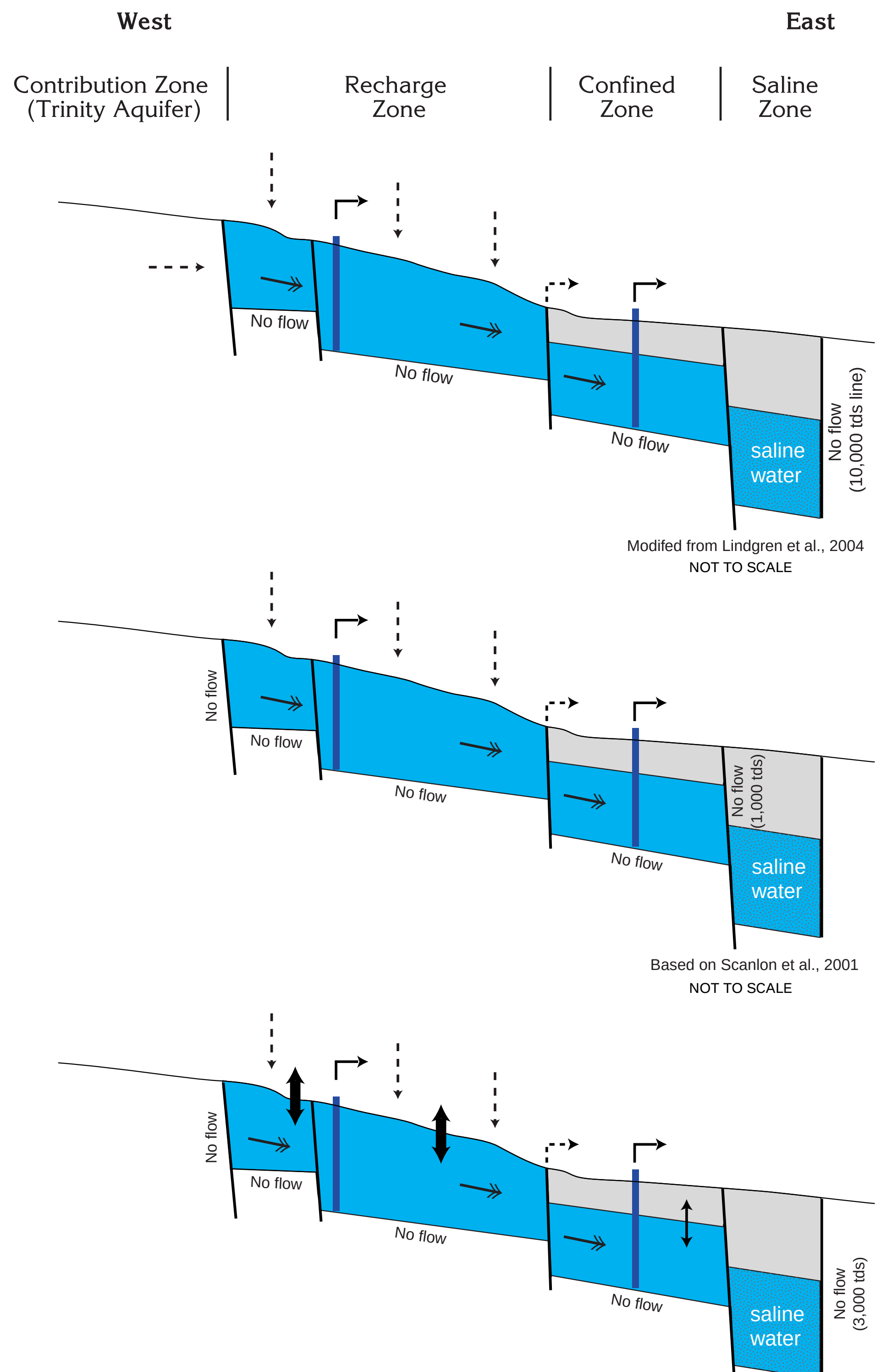
CONCEPTUAL MODELS

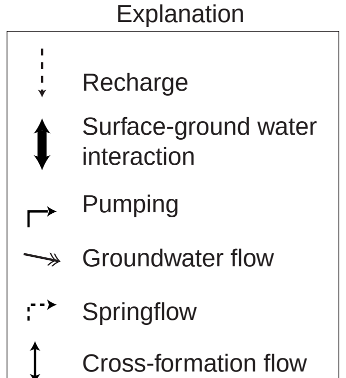


Modifed from Lindgren et al., 2004
NOT TO SCALE

Based on Scanlon et al., 2001
NOT TO SCALE

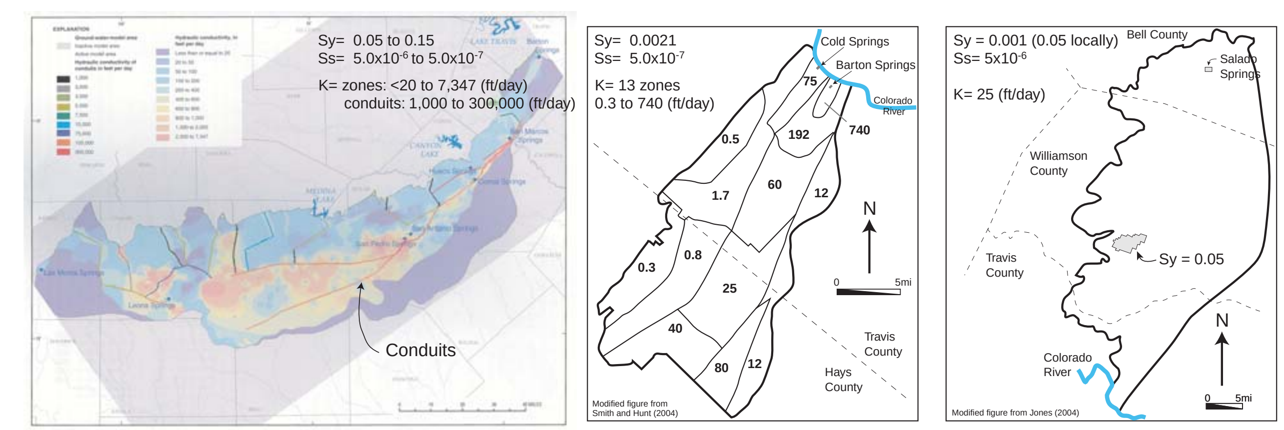
Modifed from Jones, 2004
NOT TO SCALE

Explanation



APPROACHES TO GROUND-WATER AVAILABILITY MODELING

Ground-water availability models for each segment of the Edwards Aquifer are based on the U.S. Geological Survey's MODFLOW program. To simulate ground-water flow through conduits, the SA model uses lines of contiguous cells with high values of hydraulic conductivity. The BS model uses zones of high hydraulic conductivity to simulate the effect of rapid ground-water flow through conduits. The NS model assigns uniform hydraulic conductivity values to all active model cells. The SA model assigns zones of specific yield and specific storage, while the BS and NS assign uniform values for each.



259,000 active cells (1,320 x 1,320 ft each)

7,043 active cells (1,000 x 500 ft each)

15,076 active cells (1,320 x 1,320 ft each)

GROUNDWATER AVAILABILITY

The amount of ground water available from an aquifer is not based entirely on water budgets, hydrogeologic data, and modeling, but is based, in part, on political, economic, and environmental factors. Results of ground-water modeling and an evaluation of historical hydrogeologic data indicate that pumping 7,240 acre-ft/yr of ground water during severe drought conditions will lead to drying of Barton Springs and will impact yields from many of the wells in the District. Because pumping from the northern segment is a relatively small portion of the water budget, no significant impacts to wells or spring discharge are expected to occur under severe drought conditions. However, recently the Clearwater Conservation Disctrict has determined the pumping limit for Bell County to be 7,500 acre-ft/yr to sustain springflow at 2,400 acre-ft/yr under drought conditions. The amount of ground water available in the San Antonio segment is considered to be less than the amount of ground water currently permitted to be pumped from the aquifer. The Edwards Aquifer Authority, management agency for the San Antonio segment, is required by state law to reduce pumping from 450,000 acre-ft/yr