APPENDIX D

ESTIMATED REGIONAL GROUNDWATER DRAWDOWN FOR THE CARRIZO, CALVERT BLUFF, AND SIMSBORO AQUIFERS

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APPENDIX D

Two numerical groundwater models were developed by R. W. Harden & Associates, Inc. that model groundwater flow in the Three Oaks Mine area (Three Oaks Life-of-Mine [LOM] model) and the lower basin area of the Brazos G Regional Water Planning Area (Region G model). These models differ in their design because each model was intended for a specific purpose. The Three Oaks LOM model was designed for modeling dewatering of the Calvert Bluff aquifer and depressurization of the underlying Simsboro aquifer during lignite coal mining by Alcoa in the Three Oaks Mine area. This model has six layers for the Calvert Bluff and one layer separating the Calvert Bluff and the Simsboro Formations to simulate the compact clay horizon between the lowest lignite zone in the Calvert Bluff and the Simsboro. The Region G model was designed solely to model water supply and water level changes in the Simsboro due to municipal pumpage in the Brazos G Water Planning Area. This model has only one layer for the Calvert Bluff. The Three Oaks LOM model is described in the Alcoa Railroad Commission of Texas (RRC) Permit Application (Alcoa 2000 [Volume 4]) and in a report prepared for the U.S. Geological Survey (USGS) and the U.S. Office of Surface Mining entitled: *Review of the Three Oaks Life-of–Mine Groundwater Flow Model for Groundwater Analyses in the Three Oaks Mine EIS* (ENSR and HydroGeo, Inc. 2002a). The Region G model is described in R. W. Harden & Associates, Inc. (2000). At the request of the USACE, the Region G model was modified by expanding the area in Bastrop County around and near the Colorado River to more accurately evaluate the cumulative effects to the Colorado River. The Modified Region G model is described in a report prepared for the USGS entitled: *Review of the Modified Region G Groundwater Flow Model for Groundwater Analyses in the Three Oaks Mine EIS* (ENSR and HydroGeo, Inc. 2002b).

The Three Oaks LOM and Modified Region G models were used for the Three Oaks Mine Environmental Impact Statement (EIS) to estimate groundwater impacts due to projected future pumpage between the years 2000 and 2050. The Three Oaks LOM model was used to project direct and indirect impacts related to the proposed mining by Alcoa at the Three Oaks Mine. This model showed that pumpage of groundwater in both the Calvert Bluff and Simsboro aquifers did not affect the Carrizo aquifer during the period between year 2000 and year 2030, the approximate projected end of mining at the Three Oaks Mine. Each of the seven layers used to model the Calvert Bluff aquifer in the Three Oaks LOM model had a low vertical hydraulic conductivity and a corresponding low vertical leakance (vertical hydraulic conductivity divided by the thickness of the layer), as the Calvert Bluff is mostly clay and silt with discontinuous sand layers. The vertical leakance in the Calvert Bluff ranged from a low value of approximately 1.0×10^{-7} to a high value of approximately 7.0×10^{-2} for the layers used to model the Calvert Bluff aquifer. The average vertical leakance for most layers in the vicinity of the Three Oaks Mine was in the range of 1.0×10^{-5} to 2.0×10^{-5}. For the transition layer separating the lowest lignite zone in the Calvert Bluff from the Simsboro, the vertical leakance was approximately 1.4×10^{-5} to 8.0×10^{-6}.

In the Three Oaks LOM model, layer thicknesses average approximately 100 feet each for the five main layers used for the lignite horizons, giving a total average thickness for these five layers of approximately 500 feet. The compact clay layer separating the lowest lignite zone from the Simsboro averaged approximately 60 feet in thickness, while the upper Calvert Bluff layer that lies above all of the lignite zones ranged in thickness from 100 to 1,160 feet and averaged approximately 300 to 500 feet in thickness in the vicinity of the Three Oaks Mine. Thus, approximately 1,000 feet of low conductivity clay and silt separate the

Simsboro aquifer from the Carrizo aquifer in the Three Oaks LOM model. This reflects the geology of the Three Oaks Mine area and the geology of Lee, Bastrop, and Milam Counties in the area of the proposed Three Oaks Mine and the existing Sandow Mine. Due to this thick layer of clay and silt that comprises the Calvert Bluff Formation, pumpage of the Simsboro aquifer is not projected to affect the Carrizo aquifer in the area of Lee, Bastrop, and Milam Counties.

The Modified Region G model has only one layer representing the Calvert Bluff aquifer. This model was originally designed to model groundwater availability and drawdown in the Simsboro aquifer due to regional municipal pumpage in the lower basin area of the Brazos G Regional Water Planning Area. The Calvert Bluff layer in the Modified Region G model ranges in thickness from 10 to 3,595 feet, with the thinner portions of the aquifer located in the area of Lee, Bastrop, and Milam Counties. Vertical leakance values assigned to the Calvert Bluff range from 6.3×10^{-9} to 2.3×10^{-1}, with the higher values located in and around Lee, Bastrop, and Milam Counties due to the generally lower thickness of the Calvert Bluff Formation in these areas. The average value for vertical leakance in the Lee, Bastrop, and Milam County areas was approximately 1.0×10^{-5} to 1.5×10^{-5}.

The Modified Region G model was used for modeling cumulative impacts of the Three Oaks Mine. **Figure D-2** is for the Three Oaks Mine at year 2030, with no San Antonio Water System (SAWS) pumpage. **Figure D-4** is for Three Oaks plus SAWS pumpage of 40,000 acre-feet per year at the Sandow Mine for years 2013 through 2030. The difference between the model runs is SAWS pumpage in the Sandow Mine area.

A comparison of the results of these two simulations shows the 20-foot drawdown contour in Lee County moving out (enlarging) by approximately 2 to 3 miles in **Figure D-4** compared to **Figure D-2** due to less than 0.5-foot of artesian pressure decline. Thus, SAWS pumpage in the Sandow Mine area for the years 2013 through 2030 appears to result in a very small increase in artesian drawdown in the Carrizo aquifer when compared to Three Oaks Mine pumpage without SAWS for the same time period. There is essentially no effect in the outcrop area of the Carrizo.

The text (Section 3.2) of this EIS states that pumpage in the Simsboro and Calvert Bluff aquifers is not projected to affect the Carrizo Formation. This is based on modeling of direct impacts with the Three Oaks LOM model and on the geology of the Calvert Bluff Formation. As stated above, approximately 1,000 feet of clay and silt comprise the Calvert Bluff Formation in Lee, Bastrop, and Milam Counties. This thickness of low conductivity sedimentary rock should effectively insulate the Carrizo aquifer from the Simsboro Formation. The Three Oaks LOM model, which reflects this complex geology of low conductivity rock in the Calvert Bluff Formation, supports this conclusion and shows that pumpage in the Simsboro and lower Calvert Bluff aquifers should not affect the Carrizo aquifer.

Therefore, **Figures D-2** and **D-4** of this appendix should not be taken as literal projections of what will actually happen when SAWS pumpage begins in the Sandow Mine area. The Sandow Mine is currently pumping groundwater from the Simsboro aquifer at approximately 35,000 acre-feet per year to depressurize the mine. There has been no noticeable impact to the Carrizo aquifer from this pumpage. The Modified Region G model is suitable for estimating approximate regional impacts to the Simsboro, Calvert Bluff, and Carrizo aquifers due to regional municipal pumpage. The Modified Region G model was used for this

purpose in projecting cumulative impacts for this EIS. The Modified Region G model was not designed for modeling interaquifer flow or for estimating aquifer/stream impacts; thus, this model should not be used for these purposes. The apparent potential effect on the Carrizo Formation in the Lee, Bastrop, and Milam County area is an artifact of the model design and pumpage in the Carrizo Formation.

Navarro County
Hill County
Anderson County
Cherokee County
Freestone County
260
Limestone County
McLennan County
300
Houston County
400
Leon County
340
Falls County
Trinity County
320
Robertson County
320
Bell County
Madison County
Milam County
340
Walker County
400
Brazos County
Grimes County
San Jacinto County
Three Oaks Permit Area
340
Burleson County
Williamson County
360
Montgomery County
Lee County
Washington County
Waller County
340
Bastrop County
360
Austin County
Harris County
Fayette County
420
380
Colorado County
Fort Bend County
Lavaca County
Gonzales County
Wharton County
Brazoria County
Dewitt County
Jackson County
Matagorda County

Approximate Groundwater Elevation (feet NGVD, 20-foot increments)
Drainages
Modified Region G Model Boundary
Carrizo Outcrop

N

0 10 20 Miles

Source: Water elevation modeled by ENSR 2002.

Three Oaks Mine

Figure D-1
Regional
Groundwater Levels in
Carrizo Aquifer
Year 2000

7/19/02

Navarro County
Hill County
Anderson County
Cherokee County
Freestone County
Limestone County
McLennan County
10
20
Houston County
Leon County
Falls County
Trinity County
Robertson County
Bell County
Madison County
Milam County
Walker County
Brazos County
Grimes County
San Jacinto County
Three Oaks Permit Area
Burleson County
Montgomery County
Lee County
Washington County
Waller County
20
Bastrop County
20
Austin County
Harris County
10
Fayette County
10
Colorado County
Fort Bend County
Lavaca County
Gonzales County
Wharton County
Brazoria County
Dewitt County
Jackson County
Matagorda County

Approximate Drawdown (10- and 20-foot intervals)
Drainages
Modified Region G Model Boundary
Carrizo Outcrop

N

Note: The Modified Region G Model was used to estimate the regional groundwater drawdown shown on this map.
This map reflects municipal pumpage for the lower basin area of Region G and adjacent counties of Regions H, I, and K.
Municipal pumpage was based on estimates through the year 2050 provided from "Water for Texas - 2002" (TWDB 2002).

0 10 20 Miles

Source: Water elevation modeled by ENSR 2002.

Three Oaks Mine

Figure D-2

Regional Drawdown in Carrizo Aquifer Three Oaks without SAWS Year 2030

7/19/02

Navarro County
Hill County
Anderson County
Cherokee County
Freestone County
Limestone County
McLennan County
Houston County
Leon County
Falls County
Trinity County
Robertson County
Bell County
Madison County
Milam County
10
Walker County
Brazos County
20
San Jacinto County
Grimes County
Three Oaks Permit Area
20
Burleson County
Lee County
Montgomery County
Washington County
Waller County
Bastrop County
Austin County
Harris County
10
Fayette County
20
10
Colorado County
Fort Bend County
Lavaca County
Gonzales County
Wharton County
Brazoria County
Dewitt County
Jackson County
Matagorda County

Approximate Drawdown (10- and 20-foot intervals)
Drainages
Modified Region G Model Boundary
Carrizo Outcrop

N

Note: The Modified Region G Model was used to estimate the regional groundwater drawdown shown on this map.
This map reflects municipal pumpage for the lower basin area of Region G and adjacent counties of Regions H, I, and K.
Municipal pumpage was based on estimates through the year 2050 provided from "Water for Texas - 2002" (TWDB 2002).

0 10 20 Miles

Source: Water elevation modeled by ENSR 2002.

Three Oaks Mine

Figure D-3
Regional Drawdown in Carrizo Aquifer
Three Oaks without SAWS
Year 2050

7/19/02

Navarro County
Hill County
Anderson County
Cherokee County
Freestone County
Limestone County
McLennan County
Houston County
Leon County
Falls County
Trinity County
20
10
Robertson County
Bell County
Madison County
Milam County
Walker County
Brazos County
San Jacinto County
Grimes County
Three Oaks Permit Area
Burleson County
Montgomery County
Lee County
Washington County
10
Waller County
20
Bastrop County
20
Austin County
Harris County
10
Fayette County
Colorado County
Fort Bend County
Lavaca County
Gonzales County
Wharton County
Brazoria County
Dewitt County
Jackson County
Matagorda County

Approximate Drawdown (10- and 20-foot intervals)
Modified Region G Model Boundary
Carrizo Outcrop

N

Note: The Modified Region G Model was used to estimate the regional groundwater drawdown shown on this map.
This map reflects municipal pumpage for the lower basin area of Region G and adjacent counties of Regions H, I, and K.
Municipal pumpage was based on estimates through the year 2050 provided from "Water for Texas - 2002" (TWDB 2002).

0 10 20 Miles

Source: Water elevation modeled by ENSR 2002.

Three Oaks Mine

Figure D-4
Regional Drawdown in Carrizo Aquifer
Three Oaks with SAWS
Year 2030

7/19/02

Navarro County
Hill County
Anderson County
Cherokee County
Freestone County
Limestone County
McLennan County
Houston County
Leon County
Falls County
Trinity County
Robertson County
Bell County
Madison County
10
Milam County
Walker County
20
Brazos County
Grimes County
San Jacinto County
Three Oaks Permit Area
Burleson County
20
Montgomery County
Lee County
Washington County
10
20
Waller County
Bastrop County
Austin County
Harris County
10
Fayette County
Colorado County
Fort Bend County
Lavaca County
Gonzales County
Wharton County
Brazoria County
Dewitt County
Jackson County
Matagorda County

Approximate Drawdown (10- and 20-foot intervals)
Drainages
Modified Region G Model Boundary
Carrizo Outcrop

N

Note: The Modified Region G Model was used to estimate the regional groundwater drawdown shown on this map.
This map reflects municipal pumpage for the lower basin area of Region G and adjacent counties of Regions H, I, and K.
Municipal pumpage was based on estimates through the year 2050 provided from "Water for Texas - 2002" (TWDB 2002).

0 10 20 Miles

Source: Water elevation modeled by ENSR 2002.

Three Oaks Mine

Figure D-5
Regional Drawdown in Carrizo Aquifer
Three Oaks with SAWS
Year 2050

7/19/02

Navarro County
Hill County
Anderson County
Cherokee County
Freestone County
Limestone County
McLennan County
Houston County
Leon County
Falls County
Trinity County
Robertson County
Bell County
Madison County
Milam County
Walker County
Brazos County
Grimes County
San Jacinto County
Three Oaks Permit Area
Burleson County
Montgomery County
Lee County
Washington County
Waller County
Bastrop County
Austin County
Harris County
Fayette County
Colorado County
Fort Bend County
Lavaca County
Gonzales County
Wharton County
Brazoria County
Dewitt County
Jackson County
Matagorda County
10
20

Approximate Drawdown (10- and 20-foot intervals)
Drainages
Modified Region G Model Boundary
Carrizo Outcrop

N

Note: The Modified Region G Model was used to estimate the regional groundwater drawdown shown on this map.
This map reflects municipal pumpage for the lower basin area of Region G and adjacent counties of Regions H, I, and K.
Municipal pumpage was based on estimates through the year 2050 provided from "Water for Texas - 2002" (TWDB 2002).

0 10 20 Miles

Source: Water elevation modeled by ENSR 2002.

Three Oaks Mine

Figure D-6
Regional Drawdown in Carrizo Aquifer SAWS without Three Oaks Year 2030

7/19/02

Navarro County
Hill County
Anderson County
Cherokee County
Freestone County
Limestone County
McLennan County
Houston County
Leon County
Falls County
Trinity County
Robertson County
Bell County
Madison County
10
Milam County
Walker County
20
Brazos County
Grimes County
San Jacinto County
Three Oaks Permit Area
Burleson County
Montgomery County
Lee County
20
Washington County
10
20
Waller County
Bastrop County
Austin County
Harris County
10
Fayette County
Colorado County
Fort Bend County
Lavaca County
Gonzales County
Wharton County
Brazoria County
Dewitt County
Jackson County
Matagorda County

Approximate Drawdown (10- and 20-foot intervals)
Drainages
Modified Region G Model Boundary
Carrizo Outcrop

N

Note: The Modified Region G Model was used to estimate the regional groundwater drawdown shown on this map.
This map reflects municipal pumpage for the lower basin area of Region G and adjacent counties of Regions H, I, and K.
Municipal pumpage was based on estimates through the year 2050 provided from "Water for Texas - 2002" (TWDB 2002).

0 10 20 Miles

Source: Water elevation modeled by ENSR 2002.

Three Oaks Mine

Figure D-7
Regional Drawdown in Carrizo Aquifer SAWS without Three Oaks Year 2050

7/19/02

Navarro County
Hill County
Anderson County
Cherokee County
Freestone County
Limestone County
McLennan County
Houston County
Leon County
Falls County
Trinity County
Robertson County
Bell County
Madison County
Milam County
Walker County
Brazos County
Grimes County
San Jacinto County
Three Oaks Permit Area
Williamson County
Burleson County
Montgomery County
Lee County
Washington County
Waller County
Bastrop County
Austin County
Harris County
Fayette County
Colorado County
Fort Bend County
Lavaca County
Gonzales County
Wharton County
Brazoria County
Dewitt County
Jackson County
Matagorda County

180
220
260
300
320
340
360
380
400
420
440
460
480

Approximate Groundwater Elevation (feet NGVD, 20-foot increments)
Drainages
Modified Region G Model Boundary
Calvert Bluff Outcrop

N

0 10 20 Miles

Source: Water elevation modeled by ENSR 2002.

Three Oaks Mine

Figure D-8
Regional Groundwater Levels in Calvert Bluff Aquifer Year 2000

7/19/02

Navarro County
Hill County
Anderson County
Cherokee County
Freestone County
Limestone County
McLennan County
Houston County
Leon County
Falls County
Trinity County
Robertson County
Bell County
Madison County
Milam County
10
Walker County
20
Brazos County
San Jacinto County
Grimes County
Three Oaks Permit Area
Burleson County
Montgomery County
Lee County
Washington County
Waller County
20
Bastrop County
Austin County
Harris County
Fayette County
Colorado County
Fort Bend County
Lavaca County
Gonzales County
Wharton County
Brazoria County
Dewitt County
Jackson County
Matagorda County

Approximate Drawdown (10- and 20-foot intervals)
Drainages
Modified Region G Model Boundary
Calvert Bluff Outcrop

N

0 10 20 Miles

Note: The Modified Region G Model was used to estimate the regional groundwater drawdown shown on this map.
This map reflects municipal pumpage for the lower basin area of Region G and adjacent counties of Regions H, I, and K.
Municipal pumpage was based on estimates through the year 2050 provided from "Water for Texas - 2002" (TWDB 2002).

Source: Drawdown modeled by ENSR 2002.

Three Oaks Mine

Figure D-9
Regional Drawdown in Calvert Bluff Aquifer
Three Oaks without SAWS
Year 2030

7/19/02

Navarro County
Hill County
Anderson County
Cherokee County
Freestone County
Limestone County
McLennan County
Houston County
Leon County
Falls County
Trinity County
Robertson County
Bell County
Madison County
Milam County
10
20
Walker County
Brazos County
San Jacinto County
Grimes County
Three Oaks Permit Area
Burleson County
Montgomery County
Lee County
Washington County
Waller County
Bastrop County
20
Austin County
Harris County
Fayette County
Colorado County
Fort Bend County
Lavaca County
Gonzales County
Wharton County
Brazoria County
Dewitt County
Jackson County
Matagorda County

Approximate Drawdown (10- and 20-foot intervals)
Drainages
Modified Region G Model Boundary
Calvert Bluff Outcrop

Note: The Modified Region G Model was used to estimate the regional groundwater drawdown shown on this map.
This map reflects municipal pumpage for the lower basin area of Region G and adjacent counties of Regions H, I, and K.
Municipal pumpage was based on estimates through the year 2050 provided from "Water for Texas - 2002" (TWDB 2002).

N

0 10 20 Miles

Source: Drawdown modeled by ENSR 2002.

Three Oaks Mine

Figure D-10

Regional Drawdown in Calvert Bluff Aquifer Three Oaks without SAWS Year 2050

7/19/02

Navarro County
Hill County
Anderson County
Cherokee County
Freestone County
Limestone County
McLennan County
Houston County
Leon County
Falls County
Trinity County
Robertson County
Bell County
Madison County
Milam County
10
20
Walker County
Brazos County
San Jacinto County
Grimes County
Three Oaks Permit Area
Burleson County
20
Montgomery County
Lee County
Washington County
Waller County
Bastrop County
20
Austin County
Harris County
Fayette County
Colorado County
Fort Bend County
Lavaca County
Gonzales County
Wharton County
Brazoria County
Dewitt County
Jackson County
Matagorda County

Approximate Drawdown (10- and 20-foot intervals)
Drainages
Modified Region G Model Boundary
Calvert Bluff Outcrop

N

0 10 20 Miles

Note: The Modified Region G Model was used to estimate the regional groundwater drawdown shown on this map.
This map reflects municipal pumpage for the lower basin area of Region G and adjacent counties of Regions H, I, and K.
Municipal pumpage was based on estimates through the year 2050 provided from "Water for Texas - 2002" (TWDB 2002).

Source: Drawdown modeled by ENSR 2002.

Three Oaks Mine

Figure D-11

Regional Drawdown in Calvert Bluff Aquifer Three Oaks with SAWS Year 2030

7/19/02

Navarro County
Hill County
Anderson County
Cherokee County
Freestone County
Limestone County
McLennan County
Houston County
Leon County
Falls County
Trinity County
Robertson County
Bell County
Madison County
Milam County
10
20
Walker County
Brazos County
San Jacinto County
Grimes County
Three Oaks Permit Area
Burleson County
Montgomery County
Lee County
Washington County
Waller County
Bastrop County
Austin County
Harris County
Fayette County
20
Colorado County
Fort Bend County
Lavaca County
Gonzales County
Wharton County
Brazoria County
Dewitt County
Jackson County
Matagorda County

Approximate Drawdown (10- and 20-foot intervals)
Drainages
Modified Region G Model Boundary
Calvert Bluff Outcrop

N

Note: The Modified Region G Model was used to estimate the regional groundwater drawdown shown on this map.
This map reflects municipal pumpage for the lower basin area of Region G and adjacent counties of Regions H, I, and K.
Municipal pumpage was based on estimates through the year 2050 provided from "Water for Texas - 2002" (TWDB 2002).

0 10 20 Miles

Source: Drawdown modeled by ENSR 2002.

Three Oaks Mine

Figure D-12

Regional Drawdown in Calvert Bluff Aquifer Three Oaks with SAWS Year 2050

7/19/02

Navarro County
Hill County
Anderson County
Cherokee County
Freestone County
Limestone County
McLennan County
Houston County
Leon County
Falls County
Trinity County
Robertson County
Bell County
Madison County
Milam County
10
20
Walker County
Brazos County
San Jacinto County
Grimes County
Three Oaks Permit Area
Burleson County
Montgomery County
Lee County
Washington County
Waller County
Bastrop County
20
Austin County
Harris County
Fayette County
Colorado County
Fort Bend County
Lavaca County
Gonzales County
Wharton County
Brazoria County
Dewitt County
Jackson County
Matagorda County

Approximate Drawdown (10- and 20-foot intervals)
Drainages
Modified Region G Model Boundary
Calvert Bluff Outcrop

Note: The Modified Region G Model was used to estimate the regional groundwater drawdown shown on this map.
This map reflects municipal pumpage for the lower basin area of Region G and adjacent counties of Regions H, I, and K.
Municipal pumpage was based on estimates through the year 2050 provided from "Water for Texas - 2002" (TWDB 2002).

N

0 10 20 Miles

Source: Drawdown modeled by ENSR 2002.

Three Oaks Mine

Figure D-13

Regional Drawdown in Calvert Bluff Aquifer SAWS without Three Oaks Year 2030

7/19/02

Navarro County
Hill County
Anderson County
Cherokee County
Freestone County
Limestone County
McLennan County
Houston County
Leon County
Falls County
Trinity County
Robertson County
Bell County
Madison County
Milam County
10
20
Walker County
Brazos County
Grimes County
San Jacinto County
Three Oaks Permit Area
Burleson County
Montgomery County
Lee County
Washington County
Waller County
Bastrop County
Austin County
Harris County
Fayette County
Colorado County
Fort Bend County
Lavaca County
Gonzales County
Wharton County
Brazoria County
Dewitt County
Jackson County
Matagorda County

Approximate Drawdown (10- and 20-foot intervals)
Drainages
Modified Region G Model Boundary
Calvert Bluff Outcrop

Note: The Modified Region G Model was used to estimate the regional groundwater drawdown shown on this map.
This map reflects municipal pumpage for the lower basin area of Region G and adjacent counties of Regions H, I, and K.
Municipal pumpage was based on estimates through the year 2050 provided from "Water for Texas - 2002" (TWDB 2002).

N

0 10 20 Miles

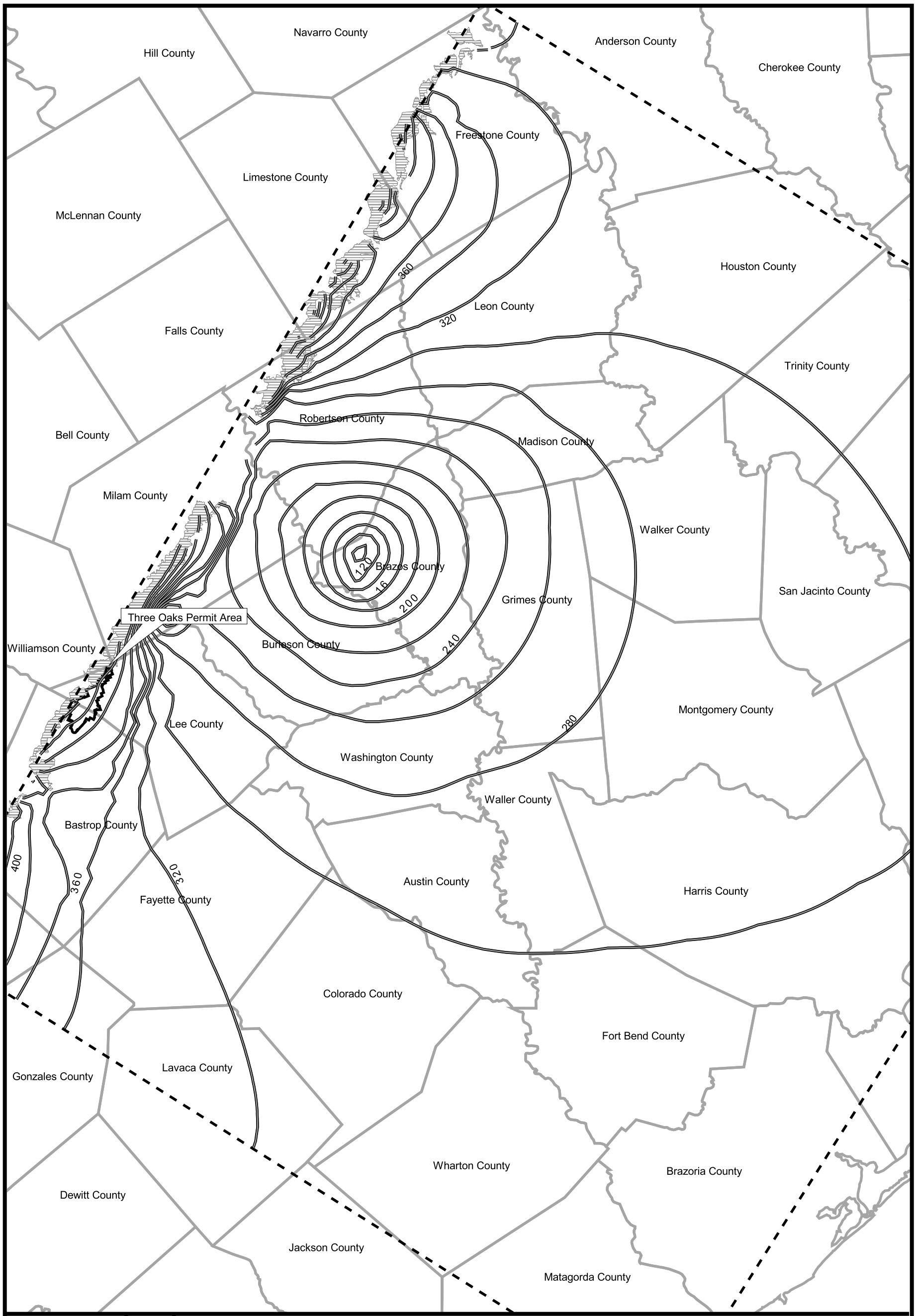
Source: Drawdown modeled by ENSR 2002.

Three Oaks Mine

Figure D-14

Regional Drawdown in Calvert Bluff Aquifer SAWS without Three Oaks Year 2050

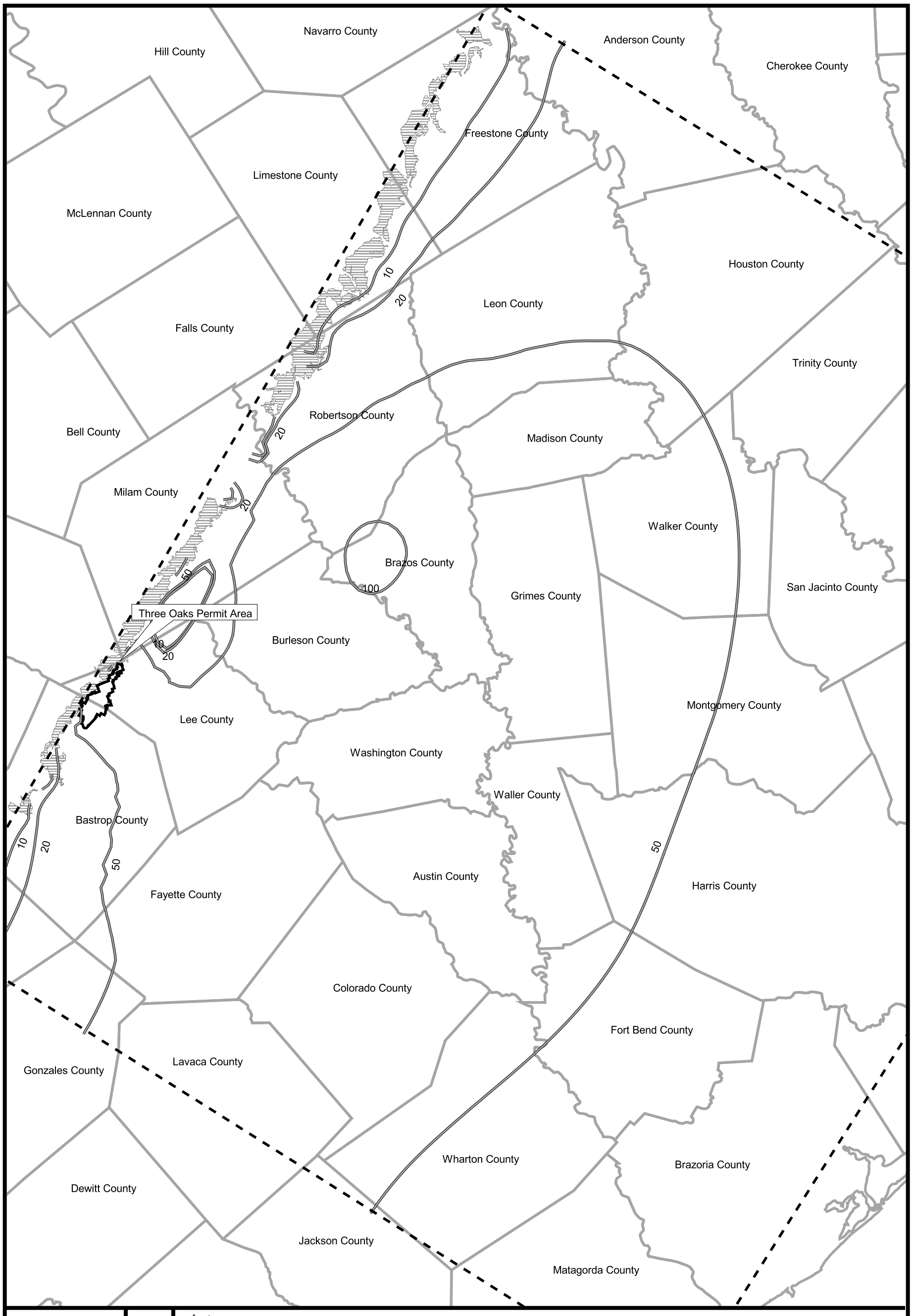
7/19/02



Three Oaks Mine

Figure D-15
Regional Groundwater Levels in Simsboro Aquifer Year 2000

7/19/02



Note: The Modified Region G Model was used to estimate the regional groundwater drawdown shown on this map.
This map reflects municipal pumpage for the lower basin area of Region G and adjacent counties of Regions H, I, and K.
Municipal pumpage was based on estimates through the year 2050 provided from "Water for Texas - 2002" (TWDB 2002).

Source: Drawdown modeled by ENSR 2002.

Three Oaks Mine

Figure D-16

Regional Drawdown in Simsboro Aquifer Three Oaks without SAWS Year 2030

7/19/02

Navarro County
Hill County
Anderson County
Cherokee County
Freestone County
Limestone County
McLennan County
Houston County
Leon County
Falls County
Trinity County
Robertson County
Bell County
Madison County
Milam County
Walker County
Brazos County
San Jacinto County
Grimes County
Three Oaks Permit Area
Burleson County
Montgomery County
Lee County
Washington County
Waller County
Bastrop County
Austin County
Harris County
Fayette County
Colorado County
Fort Bend County
Lavaca County
Gonzales County
Wharton County
Brazoria County
Dewitt County
Jackson County
Matagorda County
10
20
50
100

Approximate Drawdown (10-, 20-, 50-, and, 100-foot intervals)
Drainages
Modified Region G Model Boundary
Simsboro Outcrop

N

0 10 20 Miles

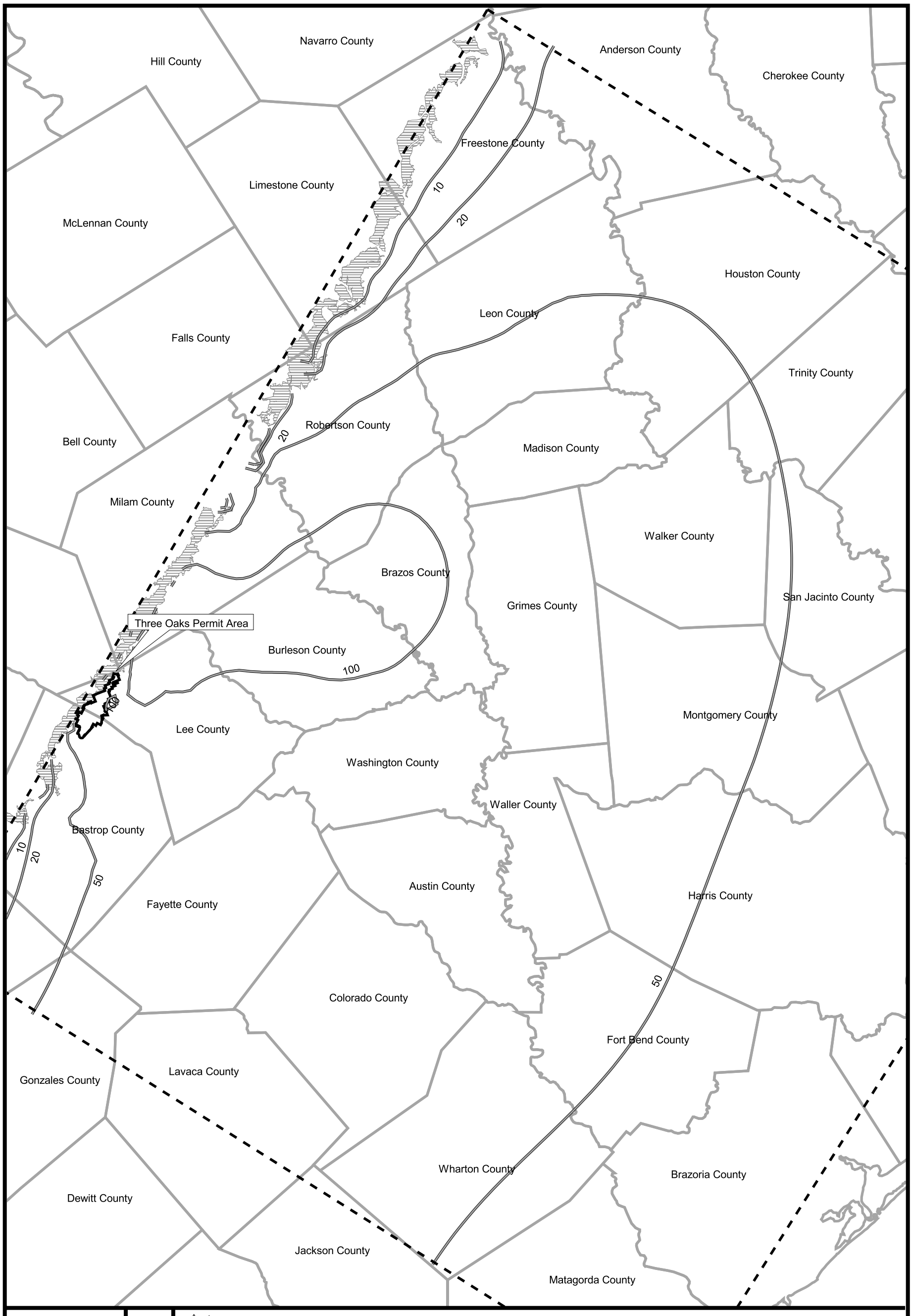
Note: The Modified Region G Model was used to estimate the regional groundwater drawdown shown on this map.
This map reflects municipal pumpage for the lower basin area of Region G and adjacent counties of Regions H, I, and K.
Municipal pumpage was based on estimates through the year 2050 provided from "Water for Texas - 2002" (TWDB 2002).

Source: Drawdown modeled by ENSR 2002.

Three Oaks Mine

Figure D-17
Regional Drawdown in Simsboro Aquifer Three Oaks without SAWS Year 2050

7/19/02



Three Oaks Mine

Figure D-18

Regional Drawdown in Simsboro Aquifer Three Oaks with SAWS Year 2030

Note: The Modified Region G Model was used to estimate the regional groundwater drawdown shown on this map. This map reflects municipal pumpage for the lower basin area of Region G and adjacent counties of Regions H, I, and K. Municipal pumpage was based on estimates through the year 2050 provided from "Water for Texas - 2002" (TWDB 2002).

Source: Drawdown modeled by ENSR 2002.

7/19/02

Navarro County
Hill County
Anderson County
Cherokee County
Freestone County
Limestone County
McLennan County
Houston County
Leon County
Falls County
Trinity County
Robertson County
Bell County
Madison County
Milam County
Walker County
Brazos County
San Jacinto County
Grimes County
Three Oaks Permit Area
Burleson County
Montgomery County
Lee County
Washington County
Waller County
Bastrop County
Austin County
Harris County
Fayette County
Colorado County
Fort Bend County
Lavaca County
Gonzales County
Wharton County
Brazoria County
Dewitt County
Jackson County
Matagorda County

10
20
50
200
200
20
50
100
50

Approximate Drawdown (10-, 20-, 50-, 100-, and 200-foot intervals)
Drainages
Modified Region G Model Boundary
Simsboro Outcrop

N

Note: The Modified Region G Model was used to estimate the regional groundwater drawdown shown on this map.
This map reflects municipal pumpage for the lower basin area of Region G and adjacent counties of Regions H, I, and K.
Municipal pumpage was based on estimates through the year 2050 provided from "Water for Texas - 2002" (TWDB 2002).

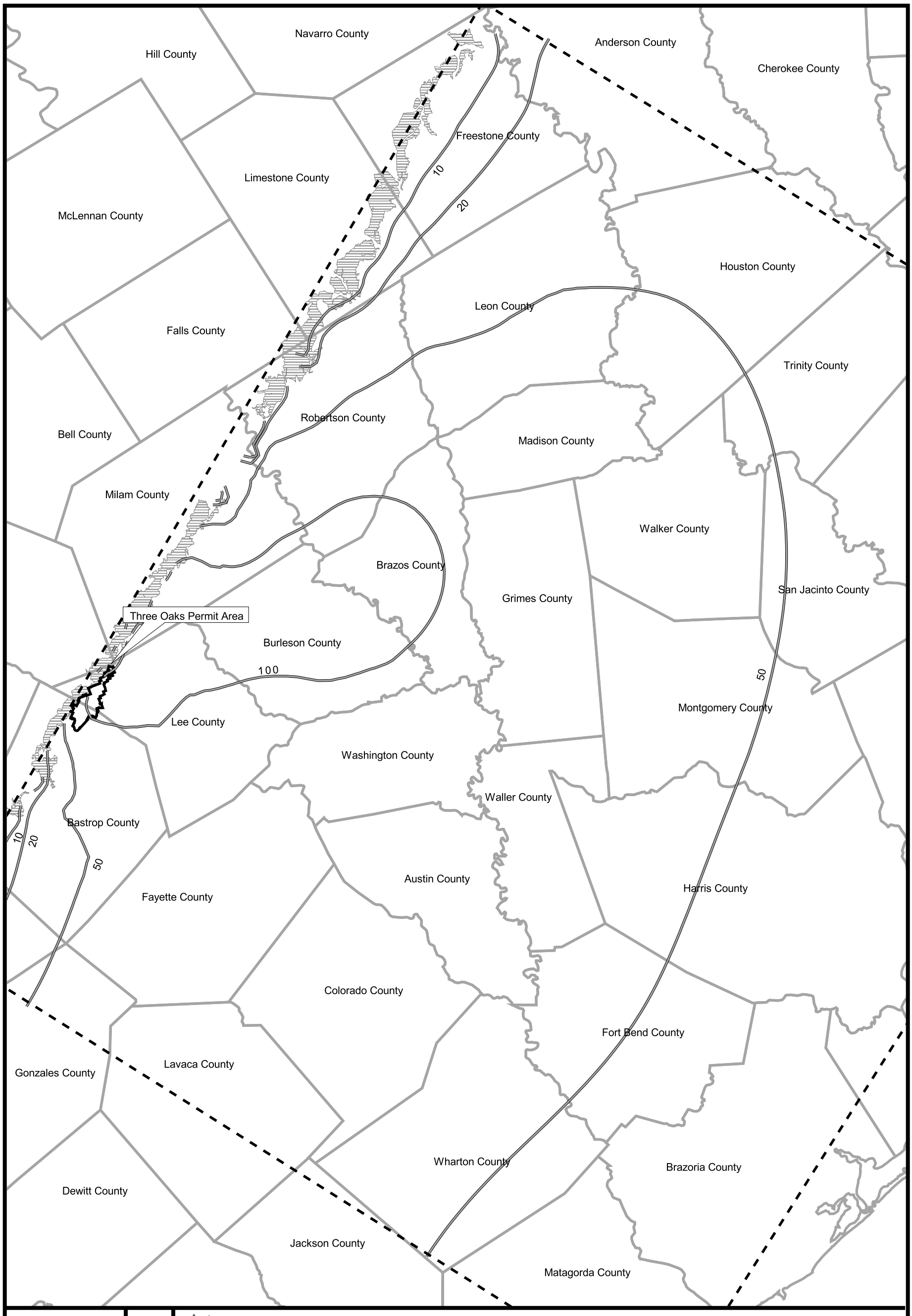
0 10 20 Miles

Source: Drawdown modeled by ENSR 2002.

Three Oaks Mine

Figure D-19
Regional Drawdown in Simsboro Aquifer
Three Oaks with SAWS
Year 2050

7/19/02



Note: The Modified Region G Model was used to estimate the regional groundwater drawdown shown on this map.
This map reflects municipal pumpage for the lower basin area of Region G and adjacent counties of Regions H, I, and K.
Municipal pumpage was based on estimates through the year 2050 provided from "Water for Texas - 2002" (TWDB 2002).

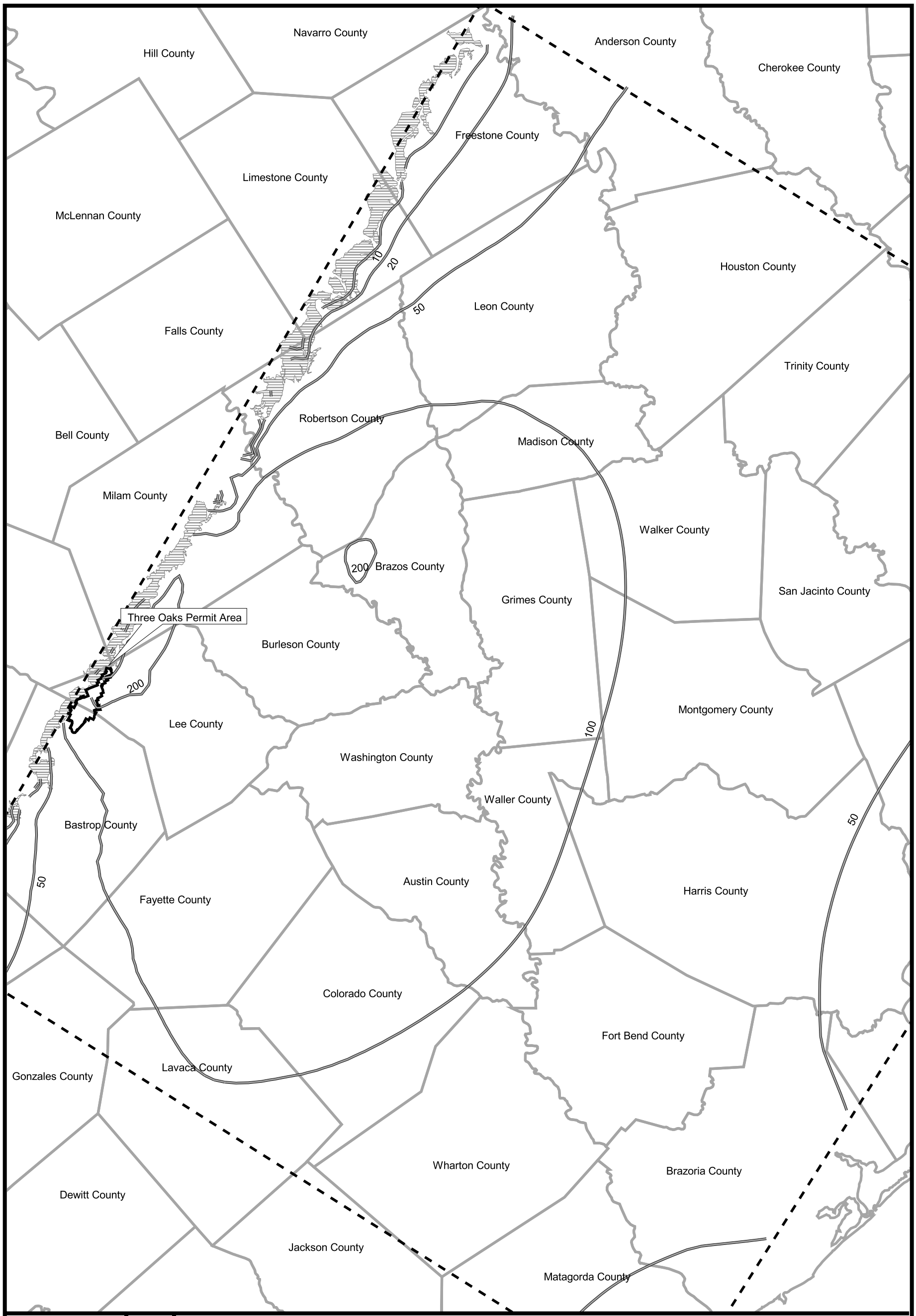
Source: Drawdown modeled by ENSR 2002.

Three Oaks Mine

Figure D-20

Regional Drawdown in Simsboro Aquifer SAWS without Three Oaks Year 2030

7/19/02



Approximate Drawdown (10-, 20-, 50-, 100-, and 200-foot intervals)
Drainages
Modified Region G Model Boundary
Simsboro Outcrop

Note: The Modified Region G Model was used to estimate the regional groundwater drawdown shown on this map.
This map reflects municipal pumpage for the lower basin area of Region G and adjacent counties of Regions H, I, and K.
Municipal pumpage was based on estimates through the year 2050 provided from "Water for Texas - 2002" (TWDB 2002).

N

0 10 20 Miles

Source: Drawdown modeled by ENSR 2002.

Three Oaks Mine

Figure D-21

Regional Drawdown in Simsboro Aquifer SAWS without Three Oaks Year 2050

7/19/02