Sandy Land Underground Water Conservation District

Management Plan

2014-2019

Effective June 2014

Sandy Land Underground Water Conservation District

Groundwater Management Plan

Adopted 1998
Amended 2003
Amended 2009
Amended 2014

Sandy Land UWCD Management Plan
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Sandy Land Underground Water Conservation District Groundwater Management Plan

District Mission

Sandy Land Underground Water Conservation District will provide technical assistance and develop, promote and implement management strategies to provide for the conservation, preservation, protection, recharging and prevention of waste of the groundwater reservoir, thereby extending the quantity and quality of the Ogallala and the Edwards-Trinity (High Plains) aquifers in Yoakum County.

Time Period of This Plan

This plan will become effective upon adoption by the Sandy Land Underground Water Conservation District Board of Directors and once approved as administratively complete by the Texas Water Development Board. The plan will remain in effect for five years from the date of approval (on or around June 2019) or until a revised plan is adopted and approved.

Statement of Guiding Principles

Sandy Land Underground Water Conservation District recognizes that the groundwater resources of the region are of vital importance to the continued vitality of the citizens, economy and environment within the District. The preservation of the groundwater resources can be managed in the most prudent and cost effective manner through the regulation of production as effected by the District's production limits, well permitting, and well spacing rules. This management plan is intended as a tool to focus the thoughts and actions of those individuals charged with the responsibility for the execution of District activities.

General Description

Sandy Land Underground Water Conservation District (The District) was created in November, 1989 by authority of SB 1777 of the 71st Texas Legislature. The District has the same areal extent as Yoakum County, Texas and contains 510,540 upland acres. The District is bounded on the west by the State of New Mexico and by Cochran, Terry and Gaines Counties on the north, east and south, respectively. *(Figure 1)*

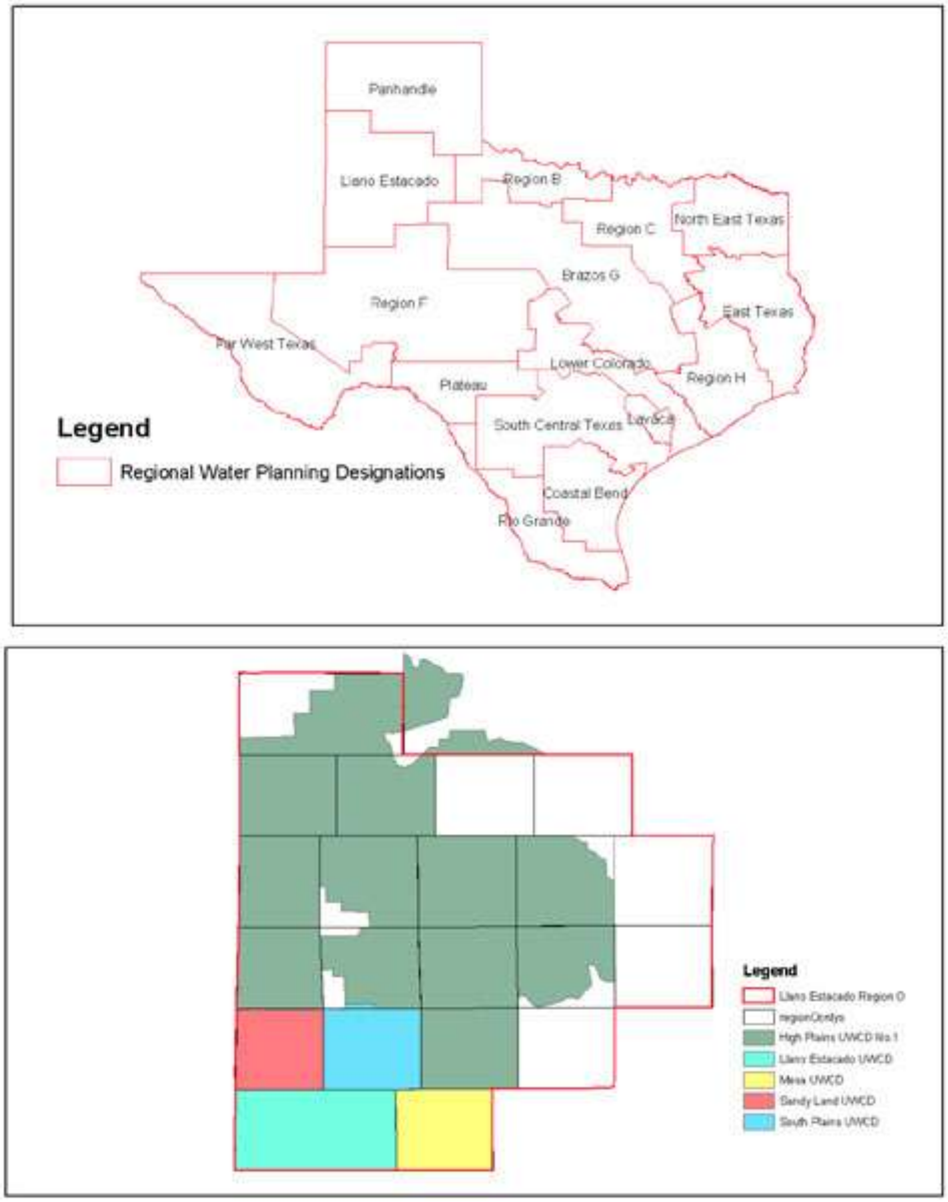

Figure 1. Location of Sandy Land Underground Water Conservation District

The economy of Yoakum County is primarily driven by two different industries; oil production and agriculture. The dominant crops produced in the District are irrigated cotton and peanuts. Additionally, grapes, watermelons, grain sorghum, sunflowers, soybeans, corn and hay are all grown both on irrigated and dry land acres.

Groundwater Resources

The District has jurisdictional authority over all groundwater that lies within the District's boundaries.

The Ogallala aquifer is the primary source of water for Yoakum County, *(Figure 2).* The Ogallala aquifer yields water from interfingered sands, gravels and silts of the Ogallala Formation which is of Pliocene age. These sediments represent deposits eroded from the ancestral Rocky Mountains to the west. Within the District, groundwater in the Ogallala aquifer is under water table or unconfined conditions. In this portion of the Southern High Plains, the Ogallala Formation is predominantly covered by dune sands of Quaternary age. Underlying the Ogallala aquifer are sandstones and limestones of the Edwards-Trinity aquifer. These sediments were deposited during Cretaceous time upon an eroded surface and were in turn eroded before being covered by deposition of Ogallala Formation. The result is that the Edwards-Trinity aquifer within the District is highly variable in thickness and depth of occurrence and represents a minor source of groundwater in the District.

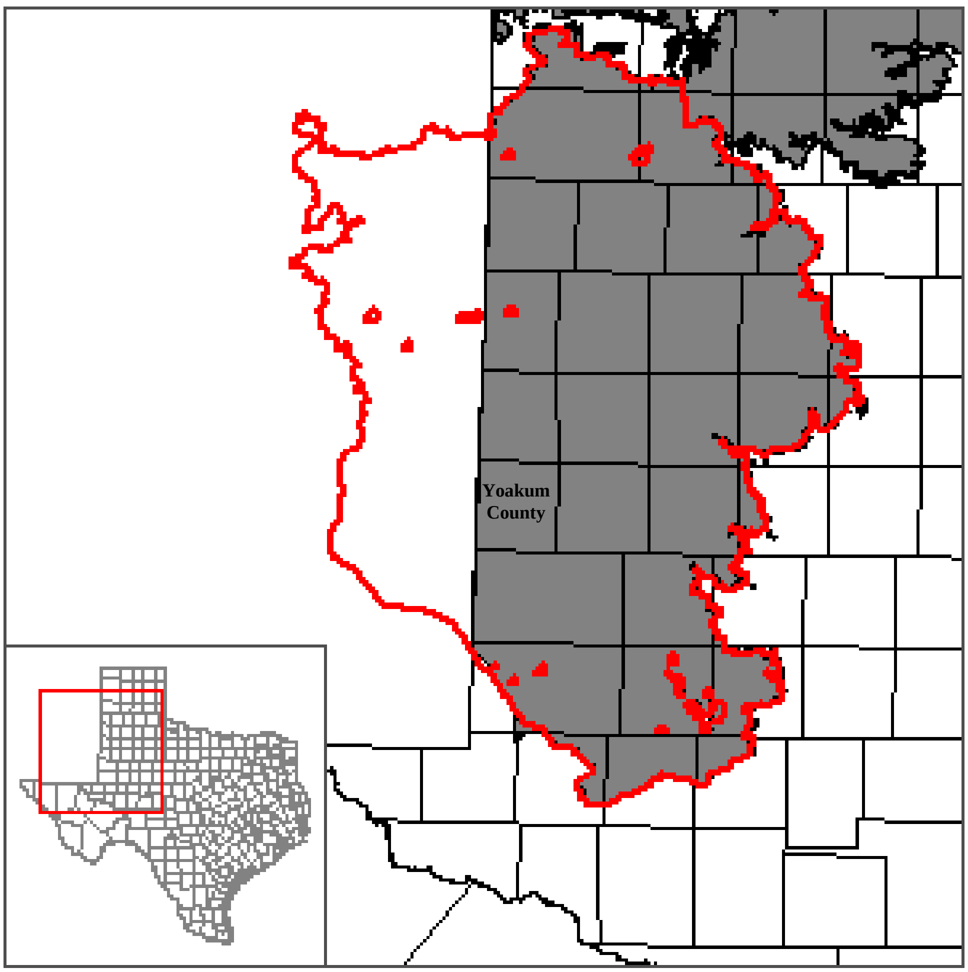

Figure 2. Map of Ogallala Aquifer

Natural recharge in the District is mostly through direct infiltration of precipitation into the coarse wind-blown sandy and silty surficial sediments. This is different from the more northern portions of the Southern High Plains where natural recharge is focused through the floors of the thousands of playas.

In order to increase the amount of recharge, which occurs within the District each year, the District has been a part of a regional weather modification program since 1997 to increase the amount of annual precipitation. In the fall of 2001, Sandy Land Underground Water Conservation District withdrew from that regional program and created a weather modification program with two other counties: Terry and Gaines. The TWDB has determined that recharge from rainfall is over 40,000 acre-feet per year, which is one third of the estimated irrigation demand for 2020. The benefits of even a slight increase in precipitation can be two-fold. First, with any increase in precipitation during the growing season, one can reasonably expect a corresponding decrease in pumping or mining of the aquifer. Second, due to the coarse nature of surficial sediments in the District, the infiltration of precipitation below the effective zone of evapotranspiration may be significant. Initial estimates by outside analysis indicate an increase of .12 inches of rainfall per seeded cloud. Clouds available for seeding are highly variable from year to year, but based on years 2002 and 2003, which were extremely dry with below average rainfall, an increase of .30 inch attributed to precipitation enhancement over the county equates to 14,400 acre feet of water on the ground. One final activity that, while not technically meeting the definition of natural or enhanced recharge, which may significantly impact the overall supply of groundwater in the District is that of circulating irrigation water. Clearly not all irrigation water applied in the District is lost to evapotranspiration; rather some as yet unquantified volume of groundwater produced actually infiltrates back to the Ogallala aquifer and is thus available for pumping again.

Estimates of Modeled Available Groundwater

The District adopted Desired Future Conditions for relevant aquifers in August 2010. The relevant aquifers are the Ogallala and Edwards-Trinity (High Plains) Aquifers. The Board decided that the Dockum Aquifer is not a relevant aquifer for Sandy Land UWCD at this time.

During the joint planning process, this District and five other GCDs along the southern end of GMA#2 adopted DFCs for the Ogallala and Edwards-Trinity (High Plains) based on an allowable amount of drawdown. The allowable drawdown is based on the average change during the 10-year period 1998-2007. For Sandy Land UWCD, that number is -1.10 ft/year. Based on the 50 year planning horizon, GAM Task 10-023 Model Run Report, Scenario 3, predicts the cumulative drawdown to be 18 feet for the District. For Estimated Pumping Values for Sandy Land UWCD, refer to *GAM Run 10-030 MAG, Table 7, Appendix C.*

Estimated Historical Annual Groundwater Usage

The estimated Historical Water Use from the TWDB Estimated Historical Water Use Survey (WUS) is estimation of the historical quantity of groundwater used in the area served by the District. It will be used as a guide to estimate future demands on the resource in the District. It should be emphasized that the quantities shown are estimates.

Refer to Estimated Historical Groundwater Use and 2012 State Water Plan Data Sets, Appendix B.

Estimates of Annual Groundwater Recharge from Precipitation

Refer to GAM Run 13-022, Appendix A

Estimates of Annual Groundwater Discharge to Springs/Surface Water Bodies

Refer to GAM Run 13-022, Appendix A

Estimates of Annual Groundwater Flow Into/Out of the District for the Ogallala; Estimates of Annual Groundwater Flow between Aquifers in the District

Refer to GAM Run 13-022, Appendix A

Estimates of Projected Surface Water Supplies

The District has no surface water available. As stated in GAM Run 13-022, the model does not include any major springs, lakes, streams, or rivers within the District; therefore, the estimated annual volume of water that discharges from the Ogallala Aquifer and the Edwards, Comanche Peak and the Antlers Sand Formations of the Edwards Trinity (High Plains) Aquifer to springs and any surface water body including lakes, streams, and rivers is reported as zero acre-feet.

Refer to GAM Run 13-022, Appendix A; and Estimated Historical Groundwater Use and 2012 State Water Plan Data Sets, Appendix B.

Estimates of Projected Total Demand for Water in the District

Projecting water demand is a laborious process. In order to make such projections, one must predict the trends of groundwater use. Assumptions must be made regarding population changes, economic development patterns and future weather patterns. Of particular difficulty is that of projecting the demand of irrigation water; rainfall, commodity prices, water level changes and federal farm policy are a few of the factors that complicate this matter.

Refer to Estimated Historical Groundwater Use and 2012 State Water Plan Data Sets, Appendix B.

Water Supply Needs

Refer to Estimated Historical Groundwater Use and 2012 State Water Plan Data Sets, Appendix B.

Water Management Strategies

Refer to Estimated Historical Groundwater Use and 2012 State Water Plan Data Sets, Appendix B.

Management of Groundwater Resources

The District will manage the supply of groundwater within the District in order to conserve the resource while seeking to maintain the economic viability of all resource user groups, public and private. In consideration of the economic and cultural activities occurring within the District, the District will identify and engage in such activities and practices that, if implemented, would result in a reduction of groundwater use. A monitor well observation network shall be established and maintained in order to evaluate changing conditions of groundwater supplies (water in storage) within the District. The District will make a regular assessment of water supply and groundwater storage conditions and will report those conditions to the Board and to the public.

Actions, Procedures, Performance and Avoidance for Plan Implementation

The District will implement the provisions of this plan and will utilize the provisions of this plan as a guidepost for determining the direction or priority for all District activities. All operations of the District, all agreements entered into by the District and any additional planning efforts in which the District may participate will be consistent with the provisions of this plan.

The District will adopt rules relating to the permitting of wells and the production of groundwater. The rules adopted by the District shall be pursuant to TWC Chapter 36 and the provisions of this plan. A copy of the District's rules is available on the District web site: http://www.sandylandwater.com/documents.html

The District will seek the cooperation in the implementation of this plan and the management of groundwater supplies within the District. All activities of the District will be undertaken in cooperation and coordinated with the appropriate state, regional or local water management entity.

Drought Contingency Plan

There essentially can be no drought contingency plan for Sandy Land Underground Water Conservation District (Yoakum County) because under any standards drought is a constant. Rainfall averages for the year may seem somewhat adequate, but the need, during the growing season, is only a fraction of the total yearly rainfall. Irrigation wells cannot be turned off, or the amount of water pumped by them reduced, because of the crops that are growing.

What we have seen in many cases are half circles being irrigated instead of full circles. Those that pump the most, agricultural users have been educated by the aquifer itself and the regulation it bestows on all users.

It is our belief that we will not make anymore groundwater. We have no surface water available to those located in Yoakum County and therefore our reliance on rainfall becomes even greater in the years ahead. Our most significant drought contingency plan is focused on increased rainfall through weather modification. The Texas Water Development Board has provided data that 40,447 acre-feet per year of recharge was supplied into the Ogallala Aquifer, in Yoakum County, from rainfall.

Refer to GAM Run 13-022; Appendix A.

For more information on drought in Texas, visit the Texas Water Development Board drought page at: www.twdb.state.tx.us/data/drought .

<u>Methodology for Tracking the District's Progress in Achieving Management Goals</u>

The District manager will prepare and present an annual report to the Board of Directors on District performance in regards to achieving management goals and objectives. The report will be prepared in a format that will be reflective of the performance standards listed following each management objective. The report will be presented to the Board of Directors within 60 days of the end of each fiscal year. The Board will maintain the report on file, for public inspection at the District's offices upon adoption. This methodology will apply to all management goals contained within this plan.

The District will actively enforce all rules and regulations necessary for conserving, preserving, protecting, recharging and prevention of waste of water from the Ogallala aquifer in Yoakum County. To accomplish this goal, the District will continue to develop and enforce rules and regulations, and modify as necessary, to carry out the duties as provided by Chapter 36 of the Texas Water code to effectively manage the Ogallala aquifer.

Goals, Management Objectives and Performance Standards

Goal
1.0 Provide for the most efficient use of groundwater within the District.

Management Objective
(a) Annually conduct irrigation well efficiency tests for 100 percent of requests within 10 days of the property owner request.

Performance Standard
(a1) Percentage of irrigation well efficiency test requests conducted annually within 10 days of request.

Management Objective
(b) There are currently 90 water wells in the District's water level monitoring network. The objective is to annually measure water levels in 80 percent of the District's monitor well network.

Performance Standard
(b1) Percentage of monitor wells in monitor well network in which water levels were measured.

Management Objective
(c) By January 1 of each year, prepare a map for the Internal Revenue Service documenting changes in water table elevations (the District Depletion Map) in the Ogallala aquifer within the District.

Performance Standard
(c1) A map submitted to the Internal Revenue Service by January 1 of each year.

Goal
2.0 Control and prevent waste of groundwater within the District.

Management Objective
(a) Each year, the District will sample the water quality in at least one selected well(s) in order to monitor water quality trends and prevent the waste of groundwater by contamination. The District will also sample for water quality analysis on 100 percent of other wells which the owner requests to be sampled each year.

Performance Standard
(a1) Number of wells sampled for water quality analysis by the District to monitor water quality trends each year.

Performance Standard
(a2) Percent of wells sampled for water quality analysis by the District upon request each year.

Management Objective
(b) Each year, the District will enforce District spacing and production limitation rules requiring the permitting of all new wells to prevent the waste of groundwater. The District will issue temporary permits for 100 percent of the application requests that meet the District's rigorous rules for spacing within 30 days of the receipt of the application.

Performance Standard
(b1) Number of temporary permits issued by the District for new wells in compliance with spacing and production limits each year.

(b2) Percent of temporary permits issued to applications that meet the District's rigorous rules for spacing within 30 days of receipt of application.

Management Objective
(c) The District will publish articles on the district's activities and water conservation to encourage a reduction of water use. This information may be made available by direct mail, website or local newspaper.

Performance Standard
(c1) Number of articles on water conservation presented by the District each year.

Goal
3.0 Conservation of Groundwater within the District.

Management Objective
(a) Each year the District will participate in the TWDB Agricultural Conservation Loan program as a lender district and make loans available to all qualified applicants for the purchase of water conserving irrigation apparatus, up to the maximum amount of the loan commitment made to the District by TWDB.

Performance Standard
(a1) Number of Agricultural Conservation loan applications received by the District from qualified applicants each year.

(a2) Number of Agricultural Conservation loans made by the District to qualified applicants each year.

Management Objective

(b) Each year, the District will award scholarships to at least four (4) high school students graduating from a high school within the District to facilitate study of water conservation topics.

Performance Standard
(b1) Number of scholarships awarded to students graduating high school within the District to facilitate study of water conservation topics, each year.

Management Objective
(c) Each year, the District will make available a water conservation video to each elementary level school within the District.

Performance Standard
(c1) Number of water conservation videos made available to elementary level schools within the District, each year.

Goal
4.0 Precipitation Enhancement.

Management Objective
(a) The District will conduct at least one weather modification activity during five months (April, May, June, July and August) of each year to increase rainfall.

Performance Standard
(a1) Number of months that weather modification activities took place.

Goal
5.0 Addressing in a Quantitative Manner Desired Future the Conditions.
The District adopted Desired Future Conditions for relevant aquifers in August 2010. The relevant aquifers are the Ogallala and Edwards-Trinity (High Plains) Aquifers. The Board decided that the Dockum Aquifer is not a relevant aquifer for Sandy Land UWCD at this time.

During the joint planning process, this District and five other gcds along the southern end of GMA#2 adopted DFCs for the Ogallala and Edwards-Trinity (High Plains) based on an allowable amount of drawdown. The allowable drawdown is based on the average change during the 10-year period 1998-2007. For Sandy Land UWCD, that number is -1.10 ft/year. Based on the 50 year planning horizon, GAM Task 10-023 Model Run Report, Scenario 3, predicts the cumulative drawdown to be 18 feet for the District. However, for the purposes of this management plan, the District proposes to evaluate the cumulative drawdown in 5 year increments, which will gage our attainment of the DFC in shorter increments, and allow us to make changes accordingly.

It is our belief that no additional rule changes are needed at this time in order to meet the adopted DFC. Our proposal may be altered if, at the end of the current 5 year period, our cumulative annual drawdown differs significantly from what is calculated to keep us on track for DFC attainment.

Management Objective

(a) The District will calculate the average annual drawdown using the results of annual water level measurements each winter.

Performance Standard

(a1) Present the average drawdown results to the Board of Directors each year.

(a2) The average drawdown results will be made available to the public each year.

Management Objective

(a) The District will calculate the average annual drawdown beginning with the year 2012. The District will calculate the remaining allowable drawdown (based on the DFC) for the remaining years of the 2012-2017 period.

Performance Standard

(a1) Present the cumulative average drawdown results to the Board of Directors each year.

(a2) The cumulative average drawdown results will be made available to the public each year.

Goal

6.0 Drought Conditions.

The District is under a constant state of drought; therefore this goal is not applicable.

Goal

7.0 Recharge Enhancement.

A review of past work conducted by others indicates this goal is not appropriate at present; therefore this goal is not applicable.

Goal

8.0 Rainwater Harvesting.

A review of past work conducted by others indicates this goal is not appropriate at present; therefore this goal is not applicable.

Goal

9.0 Brush Control.

Existing programs administered by the USDA-NRCS are sufficient for addressing this goal. The Board does not believe that this activity is cost-effective and applicable for the District at this time; therefore this goal is not applicable.

Goals identified in Chapter 36, Texas Water Code, not applicable to the District

The following goals referenced in Chapter 36, Texas Water Code, have been determined not applicable to the District.

§36.1071(a)(3)	The goal of controlling and preventing subsidence is not applicable to the District.
§36.1071(a)(4)	The goal for addressing conjunctive surface water management issues is not applicable to the District due to the absence of any surface water features and hence, any surface water management issues.
§36.1071(a)(5)	The goal for addressing natural resource issues that impact the use and availability of groundwater or are impacted by the use of groundwater within the District is not applicable.

Sandy Land UWCD

Groundwater Management Plan

Appendix A

GAM Run 13-022: Sandy Land Underground Water Conservation District Management Plan

by William Kohlrenken
Texas Water Development Board
Groundwater Resources Division
Groundwater Availability Modeling Section
(512) 463-8279

August 28, 2013

Cynthia K. Ridgeway is the Manager of the Groundwater Availability Modeling Section and is responsible for oversight of work performed by William Kohlrenken under her direct supervision. The seal appearing on this document was authorized by Cynthia K. Ridgeway, P.G. 471 on August 28, 2013.

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GAM RUN 13-022: SANDY LAND UNDERGROUND WATER CONSERVATION DISTRICT MANAGEMENT PLAN

by William Kohlrenken
Texas Water Development Board
Groundwater Resources Division
Groundwater Availability Modeling Section
(512) 463-8279
August 28, 2013

EXECUTIVE SUMMARY:

Texas State Water Code, Section 36.1071, Subsection (h), states that, in developing its groundwater management plan, a groundwater conservation district shall use groundwater availability modeling information provided by the executive administrator of the Texas Water Development Board (TWDB) in conjunction with any available site-specific information provided by the district for review and comment to the executive administrator. Information derived from groundwater availability models that shall be included in the groundwater management plan includes:

- the annual amount of recharge from precipitation to the groundwater resources within the district, if any;
- for each aquifer within the district, the annual volume of water that discharges from the aquifer to springs and any surface water bodies, including lakes, streams, and rivers; and
- the annual volume of flow into and out of the district within each aquifer and between aquifers in the district.

This report—Part 2 of a two-part package of information from the TWDB to Sandy Land Underground Water Conservation District—fulfills the requirements noted above. Part 1 of the two-part package is the Historical Water Use/State Water Plan data report. The District should have received, or will receive, this data report from the TWDB Groundwater Technical Assistance Section. Questions about the data report can be directed to Mr. Stephen Allen, stephen.allen@twdb.texas.gov, (512) 463-7317.

The groundwater management plan for Sandy Land Underground Water Conservation District should be adopted by the district on or before April 14, 2014 and submitted to the executive administrator of the TWDB on or before May 14, 2014. The current management plan for Sandy Land Underground Water Conservation District expires on July 13, 2014.

This report discusses the methods, assumptions, and results from model runs using the groundwater availability model for the Ogallala and Edwards-Trinity (High Plains), aquifers. This model run replaces the results of GAM Run 09-05 (Oliver, 2009). GAM Run 13-022 meets current standards set after the release of GAM Run 09-05 including use of the extent of the official aquifer boundaries within the district rather than the entire active area of the model within the district. Tables 1 and 2 summarize the groundwater availability model data required by the statute, and Figures 1 and 2 show the area of the model from which the values in the tables were extracted. If after review of the figures, Sandy Land Underground Water Conservation District determines that the district boundaries used in the assessment do not reflect current conditions, please notify the Texas Water Development Board immediately.

METHODS:

In accordance with the provisions of the Texas State Water Code, Section 36.1071, Subsection (h), the groundwater availability model for the southern portion of the Ogallala and the Edwards-Trinity (High Plains) aquifers was run for this analysis. Sandy Land Underground Water Conservation District water budgets were extracted for the historical model period (1980-2000) using ZONEBUDGET Version 3.01 (Harbaugh, 2009). The average annual water budget values for recharge, surface water outflow, inflow to the district, outflow from the district, net inter-aquifer flow (upper), and net inter-aquifer flow (lower) for the portion of the aquifer located within the district is summarized in this report.

PARAMETERS AND ASSUMPTIONS:

Southern portion of the Ogallala Aquifer and Edwards-Trinity (High Plains) Aquifer

- Version 2.01 of the groundwater availability model for the southern portion of the Ogallala Aquifer and the Edwards-Trinity (High Plains) Aquifer was used for this analysis. This model is an expansion on and update to the previously developed southern portion of the Ogallala Aquifer described in Blandford and others (2003). See Blandford and others (2008) and Blandford and others (2003) for assumptions and limitations of the model.
- The model includes four layers representing the southern portion of the Ogallala Aquifer and the Edwards-Trinity (High Plains) Aquifer. The units comprising the Edwards-Trinity (High Plains) Aquifer (primarily Edwards, Comanche Peak, and Antlers Sand formations) are separated from the overlying Ogallala Aquifer by a layer of Cretaceous shale, where present. Water budgets for the district have been determined for the Ogallala Aquifer (Layer 1), as well as the Edwards-Trinity (High Plains) Aquifer (Layer 2 through Layer 4, collectively).
- The model was run with MODFLOW-2000 (Harbaugh and others, 2000).

RESULTS:

A groundwater budget summarizes the amount of water entering and leaving the aquifer according to the groundwater availability model. Selected groundwater budget components listed below were extracted from the model results for the aquifers located within the district and averaged over the duration of the calibration and verification portion of the model run in the district, as shown in Table 1 and 2.

- Precipitation recharge—The areally distributed recharge sourced from precipitation falling on the outcrop areas of the aquifers (where the aquifer is exposed at land surface) within the district.
- Surface water outflow—The total water discharging from the aquifer (outflow) to surface water features such as streams, reservoirs, and drains (springs).
- Flow into and out of district—The lateral flow within the aquifer between the district and adjacent counties.

- Flow between aquifers—The net vertical flow between aquifers or confining units. This flow is controlled by the relative water levels in each aquifer or confining unit and aquifer properties of each aquifer or confining unit that define the amount of leakage that occurs. “Inflow” to an aquifer from an overlying or underlying aquifer will always equal the “Outflow” from the other aquifer.

The information needed for the District’s management plan is summarized in Tables 1 and 2. It is important to note that sub-regional water budgets are not exact. This is due to the size of the model cells and the approach used to extract data from the model. To avoid double accounting, a model cell that straddles a political boundary, such as a district or county boundary, is assigned to one side of the boundary based on the location of the centroid of the model cell. For example, if a cell contains two counties, the cell is assigned to the county where the centroid of the cell is located (Figures 1 and 2).

TABLE 1: SUMMARIZED INFORMATION FOR THE OGALLALA AQUIFER THAT IS NEEDED FOR SANDY LAND UNDERGROUND WATER CONSERVATION DISTRICT'S GROUNDWATER MANAGEMENT PLAN. ALL VALUES ARE REPORTED IN ACRE-FEET PER YEAR AND ROUNDED TO THE NEAREST 1 ACRE-FOOT.

Management Plan requirement	*Aquifer or confining unit*	*Results*
Estimated annual amount of recharge from precipitation to the district	Ogallala Aquifer	40,447
Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers	Ogallala Aquifer	0
Estimated annual volume of flow into the district within each aquifer in the district	Ogallala Aquifer	1,417
Estimated annual volume of flow out of the district within each aquifer in the district	Ogallala Aquifer	1,856
Estimated net annual volume of flow between each aquifer in the district	Net flow from the Ogallala Aquifer to the Edwards-Trinity (High Plains) Aquifer, Duck Creek Formation, and the Kiamichi Formation.	808

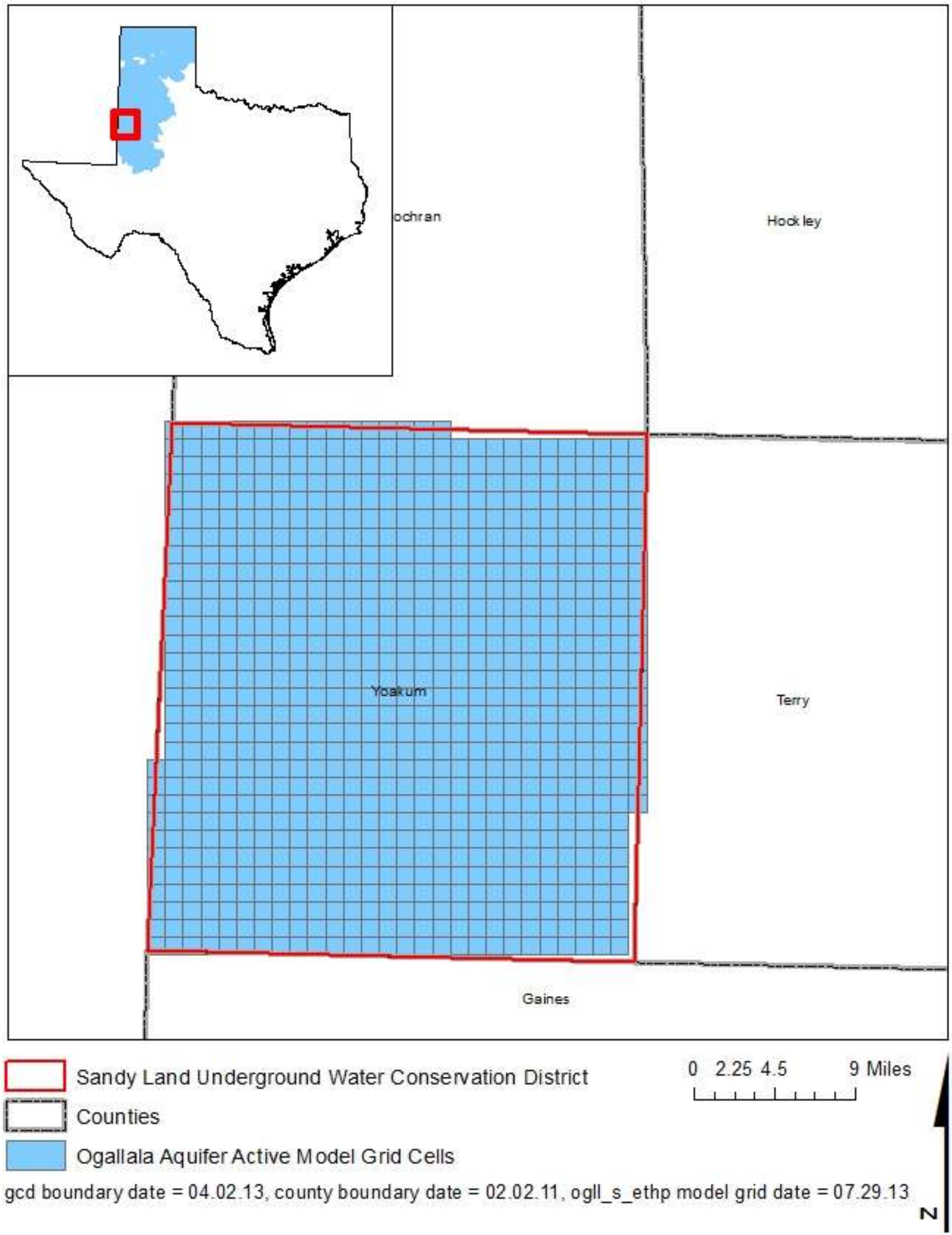

FIGURE 1: AREA OF THE GROUNDWATER AVAILABILITY MODEL FOR THE OGALLALA AQUIFER FROM WHICH THE INFORMATION IN TABLE 1 WAS EXTRACTED (THE OGALLALA AQUIFER EXTENT WITHIN THE DISTRICT BOUNDARY).

TABLE 2: SUMMARIZED INFORMATION FOR THE EDWARDS-TRINITY (HIGH PLAINS) AQUIFER THAT IS NEEDED FOR SANDY LAND UNDERGROUND WATER CONSERVATION DISTRICT'S GROUNDWATER MANAGEMENT PLAN. ALL VALUES ARE REPORTED IN ACRE-FEET PER YEAR AND ROUNDED TO THE NEAREST 1 ACRE-FOOT.

Management Plan requirement	*Aquifer or confining unit*	*Results*
Estimated annual amount of recharge from precipitation to the district	Edwards-Trinity (High Plains) Aquifer	0
Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers	Edwards-Trinity (High Plains) Aquifer	0
Estimated annual volume of flow into the district within each aquifer in the district	Edwards-Trinity (High Plains) Aquifer	1,331
Estimated annual volume of flow out of the district within each aquifer in the district	Edwards-Trinity (High Plains) Aquifer	224
Estimated net annual volume of flow between each aquifer in the district	Net flow from the Ogallala Aquifer, Duck Creek Formation, and Kiamichi Formation into the Edwards-Trinity (High Plains) Aquifer	58
	Net lateral flow from the Edwards-Trinity (High Plains) Aquifer to the Duck Creek and Kiamichi Formations.	188

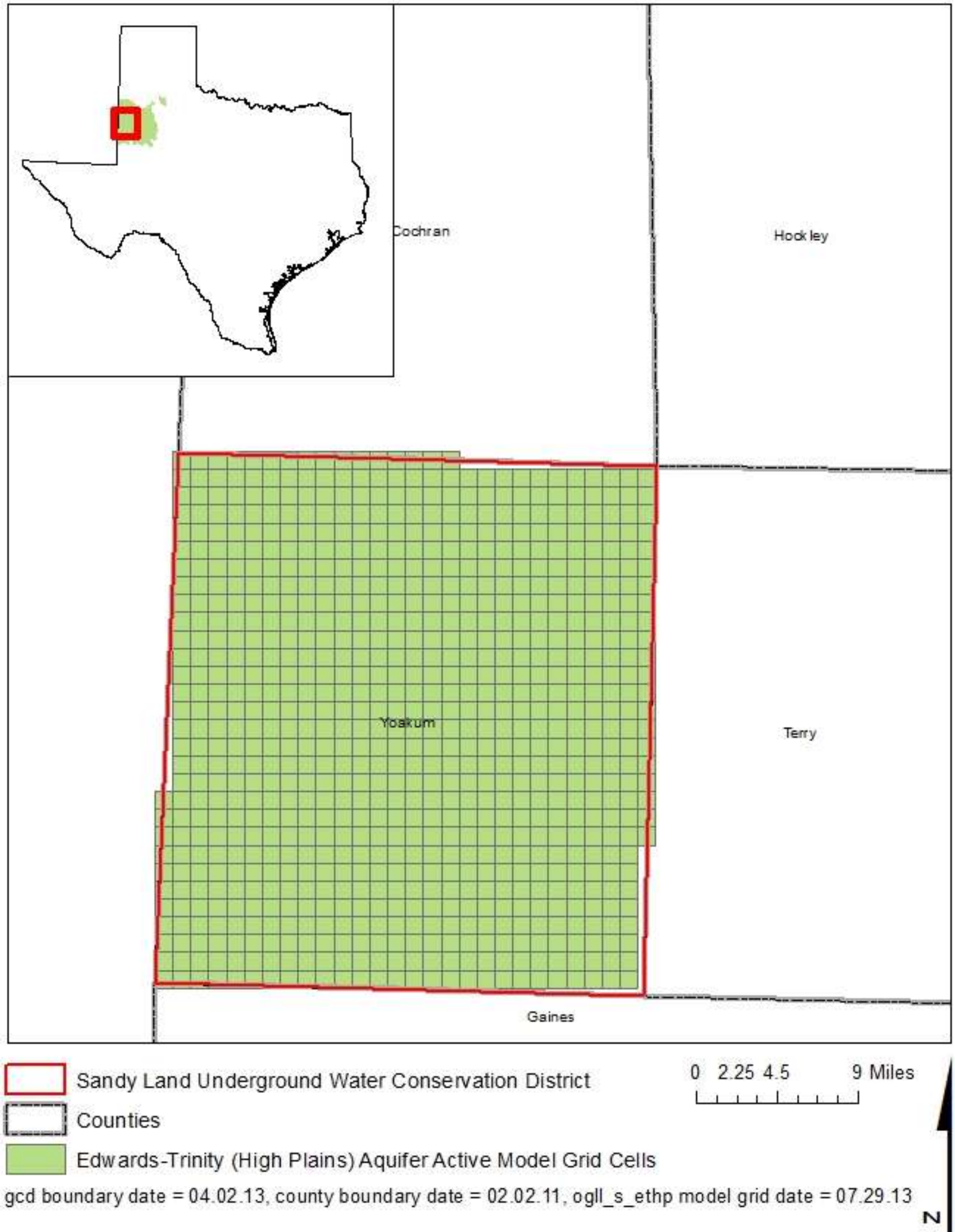

FIGURE 2: AREA OF THE GROUNDWATER AVAILABILITY MODEL FOR THE EDWARDS-TRINITY (HIGH PLAINS) AQUIFER FROM WHICH THE INFORMATION IN TABLE 2 WAS EXTRACTED (THE EDWARDS-TRINTIY (HIGH PLAINS) AQUIFER EXTENT WITHIN THE DISTRICT BOUNDARY).

LIMITATIONS:

The groundwater model(s) used in completing this analysis is the best available scientific tool that can be used to meet the stated objective(s). To the extent that this analysis will be used for planning purposes and/or regulatory purposes related to pumping in the past and into the future, it is important to recognize the assumptions and limitations associated with the use of the results. In reviewing the use of models in environmental regulatory decision making, the National Research Council (2007) noted:

> *"Models will always be constrained by computational limitations, assumptions, and knowledge gaps. They can best be viewed as tools to help inform decisions rather than as machines to generate truth or make decisions. Scientific advances will never make it possible to build a perfect model that accounts for every aspect of reality or to prove that a given model is correct in all respects for a particular regulatory application. These characteristics make evaluation of a regulatory model more complex than solely a comparison of measurement data with model results."*

A key aspect of using the groundwater model to evaluate historic groundwater flow conditions includes the assumptions about the location in the aquifer where historic pumping was placed. Understanding the amount and location of historic pumping is as important as evaluating the volume of groundwater flow into and out of the district, between aquifers within the district (as applicable), interactions with surface water (as applicable), recharge to the aquifer system (as applicable), and other metrics that describe the impacts of that pumping. In addition, assumptions regarding precipitation, recharge, and interaction with streams are specific to particular historic time periods.

Because the application of the groundwater models was designed to address regional scale questions, the results are most effective on a regional scale. The TWDB makes no warranties or representations related to the actual conditions of any aquifer at a particular location or at a particular time.

It is important for groundwater conservation districts to monitor groundwater pumping and overall conditions of the aquifer. Because of the limitations of the groundwater model and the assumptions in this analysis, it is important that the groundwater conservation districts work with the TWDB to refine this analysis in the future given the reality of how the aquifer responds to the actual amount and location of pumping now and in the future. Historic precipitation patterns also need to be placed in context as future climatic conditions, such as dry and wet year precipitation patterns, may differ and affect groundwater flow conditions.

REFERENCES:

Blandford, T.N., Blazer, D.J., Calhoun, K.C., Dutton, A.R., Naing, T., Reedy, R.C., and Scanlon, B.R., 2003, Groundwater availability of the southern Ogallala aquifer in Texas and New Mexico—Numerical simulations through 2050: Final report prepared for the Texas Water Development Board by Daniel B. Stephens & Associates, Inc., 158 p., http://www.twdb.texas.gov/groundwater/models/gam/ogll_s/OGLL_S_Full_Report.pdf.

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National Research Council, 2007, Models in Environmental Regulatory Decision Making Committee on Models in the Regulatory Decision Process, National Academies Press, Washington D.C., 287 p., http://www.nap.edu/catalog.php?record_id=11972.

Oliver, Wade, 2009, GAM Run 09-05: Texas Water Development Board, GAM Run 09-05 Report, 6 p., http://www.twdb.texas.gov/groundwater/docs/GAMruns/GR09-05.pdf.

Sandy Land UWCD

Groundwater Management Plan

Appendix B

Estimated Historical Water Use And
2012 State Water Plan Datasets:

Sandy Land Underground Water Conservation District

b
y Stephen Allen Texas
Water Development
Board Groundwater
Resources Division
Groundwater Technical
Assistance Section
stephen.allen@twdb.texa
s.gov
(512) 463-7317
February 13, 2014

GROUNDWATER MANAGEMENT PLAN DATA:

This package of water data reports (part 1 of a 2-part package of information) is being provided to groundwater conservation districts to help them meet the requirements for approval of their five- year groundwater management plan. Each report in the package addresses a specific numbered requirement in the Texas Water Development Board's groundwater management plan checklist. The checklist can be viewed and downloaded from this web address:

http://www.twdb.texas.gov/groundwater/docs/GCD/GMPChecklist0113.pdf

The five reports included in part 1 are:

1. Estimated Historical Water Use (checklist Item 2)

   from the TWDB Historical Water Use Survey (WUS)

2. Projected Surface Water Supplies (checklist Item 6)
3. Projected Water Demands (checklist Item 7)
4. Projected Water Supply Needs (checklist Item 8)
5. Projected Water Management Strategies (checklist Item 9)

   reports 2-5 are from the 2012 Texas State Water Plan (SWP)

Part 2 of the 2-part package is the groundwater availability model (GAM) report. The District should have received, or will receive, this report from the Groundwater Availability Modeling Section. Questions about the GAM can be directed to Dr. Shirley Wade, shirley.wade@twdb.texas.gov, (512) 936-0883.

DISCLAIMER:

The data presented in this report represents the most up-to-date WUS and 2012 SWP data available as of 2/13/2014. Although it does not happen frequently, neither of these datasets are static so they are subject to change pending the availability of more accurate WUS data or an amendment to the 2012 SWP. District personnel must review these datasets and correct any discrepancies in order to ensure approval of their groundwater management plan.

The WUS dataset can be verified at this web address:

http://www.twdb.texas.gov/waterplanning/waterusesurvey/estimates/

The 2012 SWP dataset can be verified by contacting Sabrina Anderson (sabrina.anderson@twdb.texas.gov or 512-936-0886).

For additional questions regarding this data, please contact Stephen Allen (stephen.allen@twdb.texas.gov or 512-463-7317) or Rima Petrossian (rima.petrossian@twdb.texas.gov or 512-936-2420).

Estimated Historical Water Use
TWDB Historical Water Use Survey (WUS) Data

Groundwater and surface water historical use estimates are currently unavailable for calendar year 2012. TWDB staff anticipates the calculation and posting of these estimates at a later date.

YOAKUM COUNTY

All values are in acre-fee/year

Year	Source	Municipal	Manufacturing	Mining	Steam Electric	Irrigation	Livestock	Total
2011	GW	2,003	0	525	0	157,147	168	159,843
	SW	0	0	124	0	0	9	133
2010	GW	1,680	0	253	0	199,437	165	201,535
	SW	0	0	60	0	0	9	69
2009	GW	1,556	0	509	0	186,461	174	188,700
	SW	0	0	121	0	0	9	130
2008	GW	1,474	0	764	0	172,445	191	174,874
	SW	0	0	182	0	0	10	192
2007	GW	1,330	0	0	0	155,776	143	157,249
	SW	0	0	0	0	0	7	7
2006	GW	1,558	0	0	0	123,394	302	125,254
	SW	0	0	0	0	0	16	16
2005	GW	1,402	0	0	0	127,747	254	129,403
	SW	0	0	0	0	0	13	13
2004	GW	1,371	0	0	0	126,533	195	128,099
	SW	0	0	0	0	0	48	48
2003	GW	1,594	0	0	0	132,391	209	134,194
	SW	0	0	0	0	0	52	52
2002	GW	1,400	0	0	0	144,251	208	145,859
	SW	0	0	0	0	0	52	52
2001	GW	1,504	0	0	0	118,305	123	119,932
	SW	0	0	0	0	0	31	31
2000	GW	1,494	0	0	0	127,059	123	128,676
	SW	0	0	0	0	0	31	31

Projected Surface Water Supplies
TWDB 2012 State Water Plan Data

YOAKUM COUNTY

All values are in acre-feet/year

RWPG	WUG	WUG Basin	Source Name	2010	2020	2030	2040	2050	2060
O	LIVESTOCK	COLORADO	LIVESTOCK LOCAL SUPPLY	218	273	278	282	288	293
	Sum of Projected Surface Water Supplies (acre-feet/year)			**218**	**273**	**278**	**282**	**288**	**293**

Projected Water Demands
TWDB 2012 State Water Plan Data

Please note that the demand numbers presented here include the plumbing code savings found in the Regional and State Water Plans.

YOAKUM COUNTY

All values are in acre-feet/year

RWPG	WUG	WUG Basin	2010	2020	2030	2040	2050	2060
O	LIVESTOCK	COLORADO	218	273	278	282	288	293
O	MINING	COLORADO	2,416	1,524	706	204	56	0
O	IRRIGATION	COLORADO	120,979	115,187	109,674	104,426	99,427	94,668
O	PLAINS	COLORADO	416	448	468	488	473	457
O	STEAM ELECTRIC POWER	COLORADO	2,597	3,718	4,346	5,113	6,047	7,186
O	DENVER CITY	COLORADO	1,043	1,126	1,172	1,220	1,181	1,141
O	COUNTY-OTHER	COLORADO	286	305	314	323	312	302
	Sum of Projected Water Demands (acre-feet/year)		**127,955**	**122,581**	**116,958**	**112,056**	**107,784**	**104,047**

Projected Water Supply Needs
TWDB 2012 State Water Plan Data

Negative values (in red) reflect a projected water supply need, positive values a surplus.

YOAKUM COUNTY

All values are in acre-feet/year

RWPG	WUG	WUG Basin	2010	2020	2030	2040	2050	2060
O	COUNTY-OTHER	COLORADO	0	0	0	0	0	0
O	DENVER CITY	COLORADO	0	0	-979	-1,046	-1,024	-1,000
O	IRRIGATION	COLORADO	-23,779	-22,744	-21,868	-20,553	-19,576	-18,502
O	LIVESTOCK	COLORADO	0	0	0	0	0	0
O	MINING	COLORADO	0	0	0	0	0	0
O	PLAINS	COLORADO	0	-448	-468	-488	-473	-457
O	STEAM ELECTRIC POWER	COLORADO	0	0	0	0	0	0
	Sum of Projected Water Supply Needs (acre-feet/year)		**-23,779**	**-23,192**	**-23,315**	**-22,087**	**-21,073**	**-19,959**

Projected Water Management Strategies
TWDB 2012 State Water Plan Data

YOAKUM COUNTY

WUG, Basin (RWPG)

All values are in acre-feet/year

WUG, Basin (RWPG)	Water Management Strategy	Source Name [Origin]	2010	2020	2030	2040	2050	2060
DENVER CITY, COLORADO (O)								
	LOCAL GROUNDWATER DEVELOPMENT	OGALLALA AQUIFER [YOAKUM]	0	0	1,283	1,154	1,039	935
	MUNICIPAL WATER CONSERVATION	CONSERVATION [YOAKUM]	77	169	179	171	160	155
IRRIGATION, COLORADO (O)								
	IRRIGATION WATER CONSERVATION	CONSERVATION [YOAKUM]	10,407	9,366	8,429	7,587	6,828	6,145

PLAINS, COLORADO (O)

LOCAL GROUNDWATER DEVELOPMENT	OGALLALA AQUIFER [YOAKUM]	0	618	556	501	600	539
MUNICIPAL WATER CONSERVATION	CONSERVATION [YOAKUM]	33	68	106	107	102	98
Sum of Projected Water Management Strategies (acre-feet/year)		**10,517**	**10,221**	**10,553**	**9,520**	**8,729**	**7,872**

Sandy Land UWCD

Groundwater Management Plan

Appendix C

GAM Run 10-030 MAG

by Mr. Wade Oliver

Texas Water Development Board
Groundwater Availability Modeling Section
(512) 463-3132
June 22, 2011

Cynthia K. Ridgeway is the Manager of the Groundwater Availability Modeling Section and is responsible for oversight of work performed by employees under her direct supervision. The seal appearing on this document was authorized by Cynthia K. Ridgeway, P.G. 471 on June 22, 2011.

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EXECUTIVE SUMMARY:

The estimated total pumping from the Ogallala Aquifer that achieves the desired future conditions adopted by the members of Groundwater Management Area 2 declines from approximately 2,367,000 acre-feet per year to 1,307,000 acre-feet per year between 2010 and 2060. This is summarized by county, regional water planning area, and river basin as shown in Table 2. The corresponding total pumping from the Edwards-Trinity (High Plains) Aquifer declines from approximately 96,000 acre-feet per year to 23,000 acre-feet per year over the same time period (Table 3). The estimated managed available groundwater, the amount available for permitting, for the groundwater conservation districts within Groundwater Management Area 2 for the Ogallala and Edwards-Trinity (High Plains) aquifers declines from approximately 2,368,000 acre-feet per year to 1,266,000 acre-feet per year between 2010 and 2060 (Table 9). The pumping estimates were extracted from Groundwater Availability Modeling Task 10-023, Scenario 3, which Groundwater Management Area 2 used as the basis for developing their desired future conditions.

REQUESTOR:

Mr. Jason Coleman of South Plains Underground Water Conservation District on behalf of Groundwater Management Area 2

DESCRIPTION OF REQUEST:

In a letter dated August 10, 2010 and received August 13, 2010, Mr. Jason Coleman provided the Texas Water Development Board (TWDB) with the desired future conditions of the Ogallala and Edwards-Trinity (High Plains) aquifers adopted by the members of Groundwater Management Area 2. Below are the desired future conditions for the Ogallala and Edwards-Trinity (High Plains) aquifers in the northern portion of the management area as described in Resolution No. 2010-01 and adopted August 5, 2010:

> [T]he *members of* [Groundwater Management Area] *#2 adopt the desired future condition of 50 percent of the saturated thickness remaining after 50 years for the Northern Portion of* [Groundwater Management Area] *#2, based on GAM Run 10-023, Scenario 3…*

As described in Resolution No. 2010-01, the northern portion of Groundwater Management Area 2 consists of Bailey, Briscoe, Castro, Cochran, Crosby, Deaf Smith, Floyd, Hale, Hockley, Lamb, Lubbock, Lynn, Parmer, and Swisher counties.

For the southern portion of Groundwater Management Area 2, desired future conditions for the Ogallala and Edwards-Trinity (High Plains) aquifers were stated as average water-level declines (drawdowns) over the same time period. The average drawdowns specified as desired future conditions for the southern portion of Groundwater Management Area 2 are: Andrews–6 feet, Bordon–3 feet, Dawson–74 feet, Gaines–70 feet, Garza–40 feet, Howard–1 foot, Martin–8 feet, Terry–42 feet, and Yoakum–18 feet.

In response to receiving the adopted desired future conditions, the Texas Water Development Board has estimated the managed available groundwater for each of the groundwater conservation districts within Groundwater Management Area 2 for the Ogallala and Edwards-Trinity (High Plains) aquifers.

Although not explicitly stated in the adopted desired future conditions statement, drawdown estimates for the Edwards-Trinity (High Plains) Aquifer associated with Scenario 3 of GAM Task 10-023 are shown in Table 1 below.

Table 1. Average drawdown in feet in the Edwards-Trinity (High Plains) Aquifer by county in Scenario 3 of GAM Task 10-023.

County	Average drawdown (feet)					
	2010	2020	2030	2040	2050	2060
Bailey	0	1	2	4	4	5
Borden	0	1	1	2	3	4
Cochran	-1	0	3	6	9	11
Dawson	3	21	37	50	60	67
Floyd	3	16	29	41	52	61
Gaines	6	28	42	53	61	67
Garza	2	10	18	26	33	40
Hale	1	8	15	22	29	36
Hockley	1	7	13	19	24	28
Lamb	0	1	1	2	3	3
Lubbock	1	8	14	20	25	29
Lynn	0	7	14	21	27	32
Terry	2	14	25	32	37	40
Yoakum	1	6	10	13	15	17

For purposes of developing total pumping and managed available groundwater numbers, it was assumed that by referencing Scenario 3 of GAM Task 10-023, the groundwater conservation districts in Groundwater Management Area 2 intended to fully incorporate the drawdown and pumping estimates of the Edwards-Trinity (High Plains) Aquifer. Thus, this analysis included those pumping numbers.

METHODS:

Groundwater Management Area 2, located in the Texas Panhandle, contains a portion of the Ogallala Aquifer and the entire Edwards-Trinity (High Plains) Aquifer. The location of Groundwater Management Area 2, the Ogallala and Edwards-Trinity (High Plains) aquifers, and the groundwater availability model cells that represent the aquifers are shown in Figure 1.

The Texas Water Development Board previously completed several predictive groundwater availability model simulations of the Ogallala and Edwards-Trinity (High Plains) aquifers to assist the members of Groundwater Management Area 2 in developing desired future conditions. As stated in Resolution No. 2010-01 and the narrative of the methods used for developing desired future conditions provided by Groundwater Management Area 2, the simulation on which the desired future conditions above are based is Scenario 3 of GAM Task 10-023 (Oliver, 2010). The estimated pumping for Groundwater Management Area 2 presented here, taken directly from the above scenario, has been divided by county, regional water planning area, river basin, and groundwater conservation district. These areas are shown in Figure 2.

PARAMETERS AND ASSUMPTIONS:

The parameters and assumptions for the model run using the groundwater availability model for the southern portion of the Ogallala Aquifer and the Edwards-Trinity (High Plains) Aquifer are described below:

- The results presented in this report are based on "Scenario 3" in GAM Task 10-023 (Oliver, 2010). See GAM Task 10-023 for a full description of the methods, assumptions, and results for the groundwater availability model run.

- Version 2.01 of the groundwater availability model for the southern portion of the Ogallala Aquifer and the Edwards-Trinity (High Plains) Aquifer (Blandford and others, 2008) was used for this analysis. This model is an expansion on and update to the previously developed groundwater availability model for the southern portion of the Ogallala Aquifer described in Blandford and others (2003). See Blandford and others (2008) and Blandford and others (2003) for assumptions and limitations of the groundwater availability model.

- The model includes four layers representing the southern portion of the Ogallala and Edwards-Trinity (High Plains) aquifers. The units comprising the Edwards-Trinity (High Plains) Aquifer (primarily Edwards, Comanche Peak, and Antlers Sand formations) are separated from the overlying Ogallala Aquifer by a layer of Cretaceous shale, where present.

- The mean absolute error (a measure of the difference between simulated and measured water levels during model calibration) for the Ogallala Aquifer in 2000 is 33 feet. The mean absolute error for the Edwards-Trinity (High Plains) Aquifer in 1997 is 25 feet (Blandford and others, 2008).

- Cells were assigned to individual counties, river basins, regional water planning areas, and groundwater conservation districts as shown in the August 3, 2010 version of the file that associates the model grid to political and natural boundaries for the southern portion of the Ogallala Aquifer and the Edwards-Trinity (High Plains) Aquifer. Note that some minor corrections were made to the file to better reflect the relationship of model cells to political boundaries.

- The recharge used for the model run represents average recharge as described in Blandford and others (2003).

Determining Managed Available Groundwater

As defined in Chapter 36 of the Texas Water Code, "managed available groundwater" is the amount of water that may be permitted. The pumping output from groundwater availability models, however, represents the total amount of pumping from the aquifer. The total pumping includes uses of water both subject to permitting and exempt from permitting. Examples of exempt uses include domestic, livestock, and oil and gas exploration. Each district may also exempt additional uses as defined by its rules or enabling legislation.

Since exempt uses are not available for permitting, it is necessary to account for them when determining managed available groundwater. To do this, the Texas Water Development Board developed a standardized method for estimating exempt use for domestic and livestock purposes based on projected changes in population and the distribution of domestic and livestock wells in the area. Because other exempt uses can vary significantly from district to district, and there is much higher uncertainty associated with estimating use due to oil and gas exploration, estimates of exempt pumping outside domestic and livestock uses have not been included. The districts were also encouraged to evaluate the estimates of exempt pumping and, if desired, provide updated estimates. Once established, the estimates of exempt pumping were subtracted from the total pumping output from the groundwater availability model to yield the estimated managed available groundwater for permitting purposes.

RESULTS:

The estimated total pumping from the Ogallala Aquifer in Groundwater Management Area 2 that achieves the above desired future conditions declines from approximately 2,367,000 acre-feet per year in 2010 to 1,307,000 acre-feet per year in 2060. This pumping has been divided by county, regional water planning area, and river basin for each decade between 2010 and 2060 for use in the regional water planning process (Table 2). The corresponding estimated total pumping from the Edwards-Trinity (High Plains) Aquifer declines from approximately 96,000 acre-feet per year to 23,000 acre-feet per year over the same time period (Table 3).

The total pumping estimates for the combined Ogallala and Edwards-Trinity (High Plains) aquifers are also summarized by county, regional water planning area, river basin, and groundwater conservation district as shown in tables 4, 5, 6, and 7, respectively. In Table 7, the total pumping both excluding and including areas outside of a groundwater conservation district is shown. Table 8 contains the estimates of exempt pumping for the Ogallala and Edwards-Trinity (High Plains) aquifers by groundwater conservation district. The managed available groundwater, the difference between the total pumping in the districts (Table 7, excluding areas outside of a district) and the estimated exempt use (Table 8) is shown in Table 9. The total managed available groundwater for the Ogallala and Edwards-Trinity (High Plains) aquifers in Groundwater Management Area 2 declines from approximately 2,368,000 acre-feet per year to 1,266,000 acre-feet per year between 2010 and 2060.

LIMITATIONS:

Managed available groundwater numbers included in this report are the result of subtracting the estimated future exempt use from the estimated total pumping that would achieve the desired future condition adopted by the groundwater conservation districts in the groundwater management area. These numbers, therefore, are the result of (1) running the groundwater model to estimate the total pumping required to achieve the desired future condition and (2) estimating the future exempt use in the area.

The groundwater model used in developing estimates of total pumping is the best available scientific tool that can be used to estimate the pumping that will achieve the desired future condition. Although the groundwater model used in this analysis is the best available scientific tool for this purpose, it, like all models, has limitations. In reviewing the use of models in environmental regulatory decision making, the National Research Council (2007) noted:

> *"Models will always be constrained by computational limitations, assumptions, and knowledge gaps. They can best be viewed as tools to help inform decisions rather than as machines to generate truth or make decisions. Scientific advances will never make it possible to build a perfect model that accounts for every aspect of reality or to prove that a given model is correct in all respects for a particular regulatory application. These characteristics make evaluation of a regulatory model more complex than solely a comparison of measurement data with model results."*

A key aspect of using the groundwater model to develop estimates of total pumping is the need to make assumptions about the location in the aquifer where future pumping will occur. As actual pumping changes in the future, it will be necessary to evaluate the amount of that pumping as well as its location in the context of the assumptions associated with this analysis. Evaluating the amount and location of future pumping is as important as evaluating the changes in groundwater levels, spring flows, and other metrics that describe the condition of the groundwater resources in the area that relate to the adopted desired future condition.

In addition, certain assumptions have been made regarding future precipitation, recharge, and streamflow in developing these total pumping estimates. Those assumptions also need to be considered and compared to actual future data when evaluating compliance with the desired future condition.

In the case of TWDB's estimates of future exempt use, key assumptions were made as to the pattern of population growth relative to the need for domestic wells or supplied water, per capita use from domestic wells, and livestock uses of water. In the case of district estimates of future exempt use, including exempt use associated with the exploration of oil and gas, the assumptions are specific to that district. In either case, these assumptions need to be considered when reviewing future data related to exempt use.

Given these limitations, users of this information are cautioned that the total pumping numbers should not be considered a definitive, permanent description of the amount of groundwater that can be pumped to meet the adopted desired future condition. Because the application of the groundwater model was designed to address regional scale questions, the results are most effective on a regional scale. The TWDB makes no warranties or representations relating to the actual conditions of any aquifer at a particular location or at a particular time.

It is important for groundwater conservation districts to monitor future groundwater pumping as well as whether or not they are achieving their desired future conditions. Because of the limitations of the groundwater model and the assumptions in this analysis, it is important that the groundwater conservation districts work with the TWDB to refine these managed available groundwater numbers given the reality of how the aquifer responds to the actual amount and location of pumping now and in the future.

REFERENCES:

Blandford, T.N., Blazer, D.J., Calhoun, K.C., Dutton, A.R., Naing, T., Reedy, R.C., and Scanlon, B.R., 2003, Groundwater availability of the southern Ogallala aquifer in Texas and New Mexico—Numerical simulations through 2050: Final report prepared for the Texas Water Development Board by Daniel B. Stephens & Associates, Inc., 158 p.

Blandford, T.N., Kuchanur, M., Standen, A., Ruggiero, R., Calhoun, K.C., Kirby, P., and Shah, G., 2008, Groundwater availability model of the Edwards-Trinity (High Plains) Aquifer in Texas and New Mexico: Final report prepared for the Texas Water Development Board by Daniel B. Stephens & Associates, Inc., 176 p.

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Oliver, W., 2010, GAM Task 10-023: Texas Water Development Board, GAM Task 10-023 Report, 27 p.

Texas Water Development Board, 2007, Water for Texas – 2007—Volumes I-III; Texas Water Development Board Document No. GP-8-1, 392 p.

Table 2. Estimated total annual pumping for the Ogallala Aquifer in Groundwater Management Area 2. Results are in acre-feet per year and are divided by county, regional water planning area, and river basin.

County	Region	Basin	Year					
			2010	2020	2030	2040	2050	2060
Andrews	F	Colorado	17,584	15,085	13,678	12,014	10,016	7,377
		Rio Grande	54	50	41	41	41	41
Bailey	O	Brazos	62,538	41,283	34,907	30,064	24,021	21,429
Borden	F	Brazos	292	292	292	292	292	292
		Colorado	107	107	107	107	107	107
Briscoe	O	Red	33,622	26,457	19,722	14,220	13,037	11,933
Castro	O	Brazos	90,367	90,367	90,367	90,367	88,630	84,458
		Red	37,055	36,936	36,141	35,449	34,650	33,540
Cochran	O	Brazos	16,324	7,707	6,556	4,770	4,410	4,179
		Colorado	32,021	28,501	27,085	25,926	23,674	21,192
Crosby	O	Brazos	133,239	133,058	133,058	133,058	133,058	133,058
		Red	1,624	1,624	1,624	1,624	1,624	1,624
Dawson	O	Brazos	5,350	5,350	5,350	5,138	4,075	1,099
		Colorado	196,260	192,758	180,531	156,477	131,379	92,681
Deaf Smith	O	Red	129,167	118,166	106,868	97,057	80,382	65,931
Floyd	O	Brazos	95,488	93,749	92,041	90,930	86,458	84,300
		Red	59,482	55,617	53,320	47,453	43,351	40,061
Gaines	O	Colorado	350,369	240,110	175,175	130,951	97,498	71,544
Garza	O	Brazos	19,203	19,073	18,942	18,812	18,032	17,121
Hale	O	Brazos	130,097	129,291	127,492	125,488	119,612	111,734
		Red	525	525	525	525	525	525
Hockley	O	Brazos	87,712	84,378	80,285	76,847	69,445	60,771
		Colorado	8,256	8,004	8,004	7,571	7,324	7,009
Howard	F	Colorado	3,075	3,075	2,731	2,731	2,731	2,703
Lamb	O	Brazos	147,368	137,304	125,466	111,509	95,696	85,190
Lubbock	O	Brazos	124,519	120,044	115,348	108,699	100,762	91,073
Lynn	O	Brazos	98,003	97,740	96,954	94,600	86,945	78,543
		Colorado	6,020	6,020	6,020	6,020	6,020	5,925
Martin	F	Colorado	13,570	13,570	13,570	13,140	12,299	12,277
Parmer	O	Brazos	50,258	45,572	39,624	35,624	29,978	27,692
		Red	18,436	17,493	16,960	16,525	15,642	13,289
Swisher	O	Brazos	28,248	28,248	26,603	19,889	14,084	8,304
		Red	82,677	79,158	74,399	64,929	59,764	55,994
Terry	O	Brazos	13,342	13,342	13,342	9,793	5,348	4,092
		Colorado	192,317	182,880	121,267	77,305	48,557	29,555
Yoakum	O	Colorado	82,297	59,745	43,575	33,882	26,717	20,040
Total			**2,366,866**	**2,132,679**	**1,907,970**	**1,699,827**	**1,496,184**	**1,306,683**

Table 3. Estimated total annual pumping for the Edwards-Trinity (High Plains) Aquifer in Groundwater Management Area 2. Results are in acre-feet per year and are divided by county, regional water planning area, and river basin.

County	Region	Basin	Year					
			2010	**2020**	**2030**	**2040**	**2050**	**2060**
Bailey	O	Brazos	279	279	279	279	279	279
Borden	F	Brazos	65	65	65	65	65	65
		Colorado	41	41	41	41	41	41
Cochran	O	Brazos	137	137	137	137	137	137
		Colorado	127	127	127	127	127	127
Dawson	O	Brazos	0	0	0	0	0	0
		Colorado	1,103	1,103	1,103	1,103	1,103	1,103
Floyd	O	Brazos	521	521	521	518	505	499
		Red	695	695	695	695	695	683
Gaines	O	Colorado	85,058	46,202	30,316	22,997	16,523	12,904
Garza	O	Brazos	18	18	18	18	18	18
		Colorado	0	0	0	0	0	0
Hale	O	Brazos	3,523	3,523	3,523	3,523	3,523	3,419
Hockley	O	Brazos	96	96	96	96	96	96
		Colorado	0	0	0	0	0	0
Lamb	O	Brazos	164	164	164	164	164	164
Lubbock	O	Brazos	690	690	690	690	690	690
Lynn	O	Brazos	221	221	221	221	221	221
		Colorado	9	9	9	9	9	9
Terry	O	Brazos	23	23	23	23	23	23
		Colorado	959	959	922	922	922	922
Yoakum	O	Colorado	2,532	1,893	1,757	1,642	1,642	1,524
Total			**96,261**	**56,766**	**40,707**	**33,270**	**26,783**	**22,924**

Table 4. Estimated total annual pumping for the Ogallala and Edwards-Trinity (High Plains) aquifers summarized by county in Groundwater Management Area 2 for each decade between 2010 and 2060. Results are in acre-feet per year.

County	Year					
	2010	2020	2030	2040	2050	2060
Andrews	17,638	15,135	13,719	12,055	10,057	7,418
Bailey	62,817	41,562	35,186	30,343	24,300	21,708
Borden	505	505	505	505	505	505
Briscoe	33,622	26,457	19,722	14,220	13,037	11,933
Castro	127,422	127,303	126,508	125,816	123,280	117,998
Cochran	48,609	36,472	33,905	30,960	28,348	25,635
Crosby	134,863	134,682	134,682	134,682	134,682	134,682
Dawson	202,713	199,211	186,984	162,718	136,557	94,883
Deaf Smith	129,167	118,166	106,868	97,057	80,382	65,931
Floyd	156,186	150,582	146,577	139,596	131,009	125,543
Gaines	435,427	286,312	205,491	153,948	114,021	84,448
Garza	19,221	19,091	18,960	18,830	18,050	17,139
Hale	134,145	133,339	131,540	129,536	123,660	115,678
Hockley	96,064	92,478	88,385	84,514	76,865	67,876
Howard	3,075	3,075	2,731	2,731	2,731	2,703
Lamb	147,532	137,468	125,630	111,673	95,860	85,354
Lubbock	125,209	120,734	116,038	109,389	101,452	91,763
Lynn	104,253	103,990	103,204	100,850	93,195	84,698
Martin	13,570	13,570	13,570	13,140	12,299	12,277
Parmer	68,694	63,065	56,584	52,149	45,620	40,981
Swisher	110,925	107,406	101,002	84,818	73,848	64,298
Terry	206,641	197,204	135,554	88,043	54,850	34,592
Yoakum	84,829	61,638	45,332	35,524	28,359	21,564
Total	**2,463,127**	**2,189,445**	**1,948,677**	**1,733,097**	**1,522,967**	**1,329,607**

Table 5. Estimated total annual pumping for the Ogallala and Edwards-Trinity (High Plains) aquifers summarized by regional water planning area in Groundwater Management Area 2 for each decade between 2010 and 2060. Results are in acre-feet per year.

Regional Water Planning Area	Year					
	2010	2020	2030	2040	2050	2060
F	34,788	32,285	30,525	28,431	25,592	22,903
O	2,428,339	2,157,160	1,918,152	1,704,666	1,497,375	1,306,704
Total	**2,463,127**	**2,189,445**	**1,948,677**	**1,733,097**	**1,522,967**	**1,329,607**

Table 6. Estimated total annual pumping for the Ogallala and Edwards-Trinity (High Plains) aquifers summarized by river basin in Groundwater Management Area 2 for each decade between 2010 and 2060. Results are in acre-feet per year.

Basin	**Year**					
	2010	**2020**	**2030**	**2040**	**2050**	**2060**
Brazos	1,108,085	1,052,535	1,012,364	961,614	886,567	818,946
Colorado	991,705	800,189	626,018	492,965	386,689	287,040
Red	363,283	336,671	310,254	278,477	249,670	223,580
Rio Grande	54	50	41	41	41	41
Total	**2,463,127**	**2,189,445**	**1,948,677**	**1,733,097**	**1,522,967**	**1,329,607**

Table 7. Estimated total annual pumping for the Ogallala and Edwards-Trinity (High Plains) aquifers summarized by groundwater conservation district (GCD) in Groundwater Management Area 2 for each decade between 2010 and 2060. Results are in acre-feet per year. UWCD refers to Underground Water Conservation District.

Groundwater Conservation District	**Year**					
	2010	**2020**	**2030**	**2040**	**2050**	**2060**
Garza County UWCD	19,221	19,091	18,960	18,830	18,050	17,139
High Plains UWCD No. 1	1,421,975	1,343,554	1,282,656	1,208,126	1,109,582	1,019,597
Llano Estacado UWCD	435,427	286,312	205,491	153,948	114,021	84,448
Mesa UWCD	202,713	199,211	186,984	162,718	136,557	94,883
Permian Basin UWCD	16,403	16,403	16,099	15,669	14,828	14,795
Sandy Land UWCD	84,829	61,638	45,332	35,524	28,359	21,564
South Plains UWCD	207,257	197,820	136,170	88,659	55,466	35,208
Total (excluding non-district areas)	**2,387,825**	**2,124,029**	**1,891,692**	**1,683,474**	**1,476,863**	**1,287,634**
No District	75,302	65,416	56,985	49,623	46,104	41,973
Total (including non-district areas)	**2,463,127**	**2,189,445**	**1,948,677**	**1,733,097**	**1,522,967**	**1,329,607**

Table 8. Estimates of annual exempt use for the Ogallala and Edwards-Trinity (High Plains) aquifers in Groundwater Management Area 2 by groundwater conservation district (GCD) for each decade between 2010 and 2060. Results are in acre-feet per year. UWCD refers to Underground Water Conservation District.

Groundwater Conservation District	Source	Year					
		2010	2020	2030	2040	2050	2060
Garza County UWCD	TA	68	71	69	67	64	59
High Plains UWCD No. 1	D	15,482	16,253	16,712	16,925	17,087	17,043
Llano Estacado UWCD	D	2,242	2,332	2,397	2,443	2,435	2,420
Mesa UWCD	TA	542	558	573	582	566	545
Permian Basin UWCD	TA	575	596	605	608	605	599
Sandy Land UWCD	TA	366	402	424	448	436	422
South Plains UWCD	TA	502	537	569	601	603	599
Total		**19,777**	**20,749**	**21,349**	**21,674**	**21,796**	**21,687**

TA = Estimated exempt use calculated by TWDB and accepted by the district

D = Estimated exempt use calculated by the district

Table 9. Estimates of managed available groundwater for the Ogallala and Edwards-Trinity (High Plains) aquifers in Groundwater Management Area 2 by groundwater conservation district (GCD) for each decade between 2010 and 2060. Results are in acre-feet per year. UWCD refers to Underground Water Conservation District.

Groundwater Conservation District	Year					
	2010	2020	2030	2040	2050	2060
Garza County UWCD	19,153	19,020	18,891	18,763	17,986	17,080
High Plains UWCD No. 1	1,406,493	1,327,301	1,265,944	1,191,201	1,092,495	1,002,554
Llano Estacado UWCD	433,185	283,980	203,094	151,505	111,586	82,028
Mesa UWCD	202,171	198,653	186,411	162,136	135,991	94,338
Permian Basin UWCD	15,828	15,807	15,494	15,061	14,223	14,196
Sandy Land UWCD	84,463	61,236	44,908	35,076	27,923	21,142
South Plains UWCD	206,755	197,283	135,601	88,058	54,863	34,609
Total	**2,368,048**	**2,103,280**	**1,870,343**	**1,661,800**	**1,455,067**	**1,265,947**

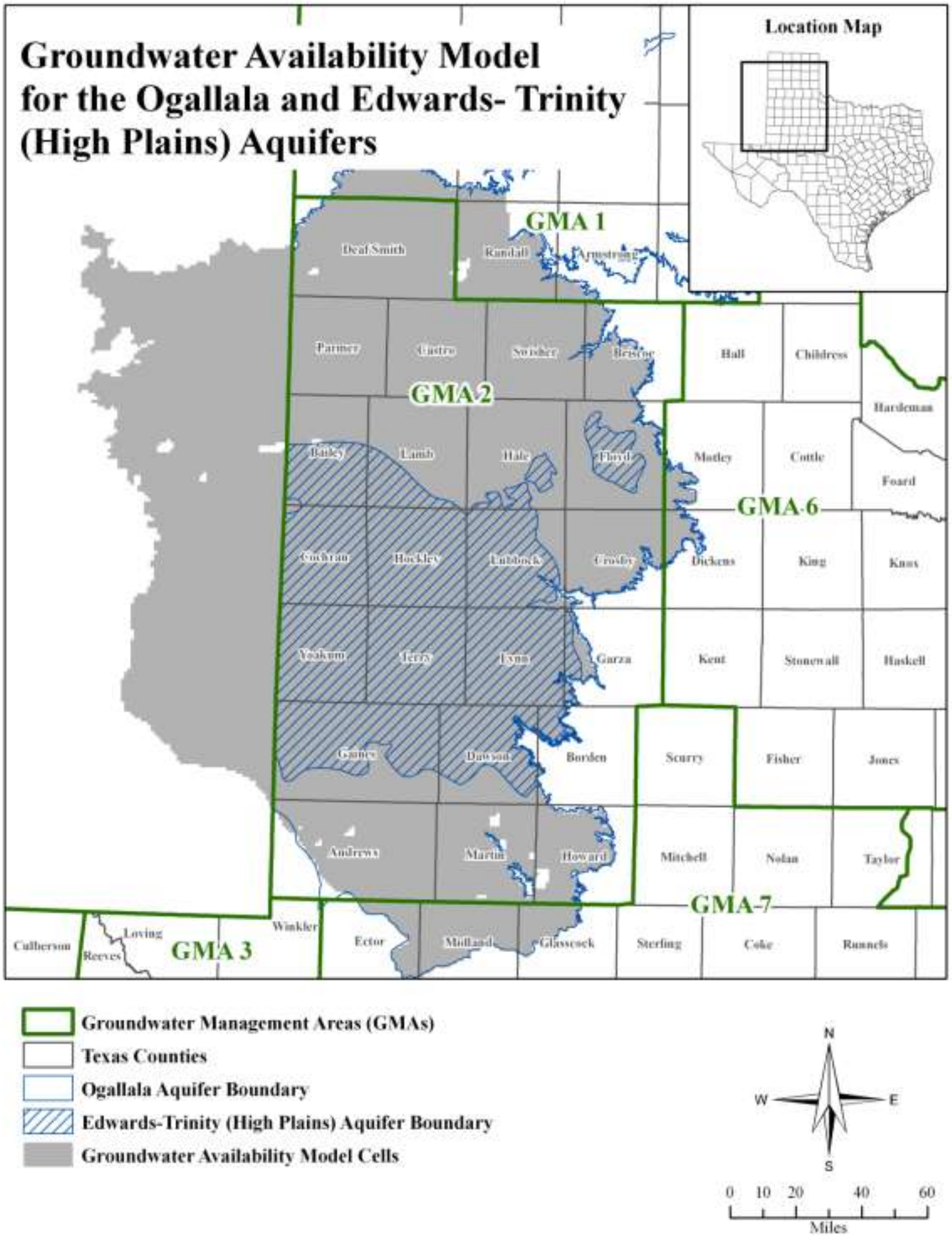

Figure 1. Map showing the areas covered by the groundwater availability model for the southern portion of the Ogallala Aquifer and the Edwards-Trinity (High Plains) Aquifer.

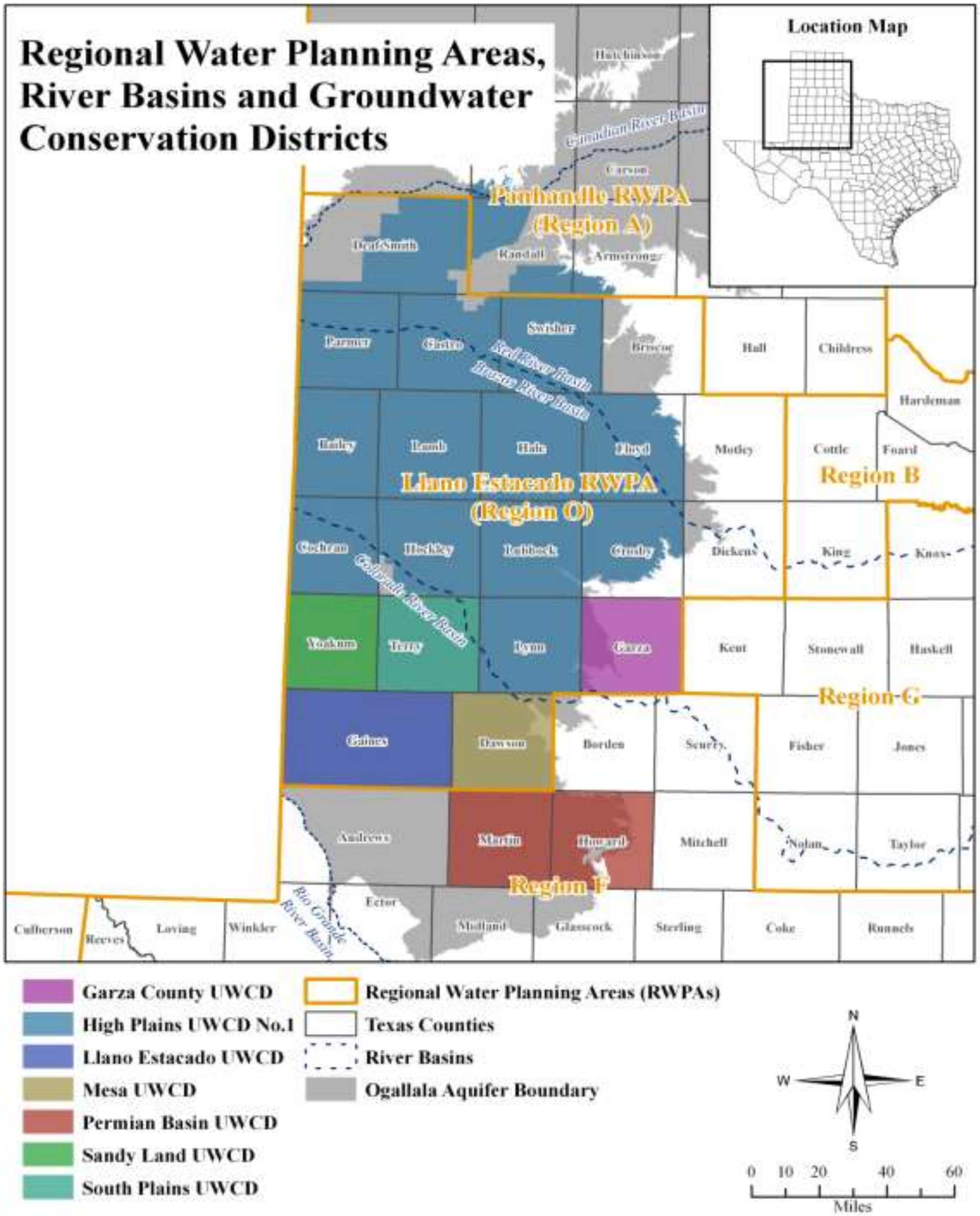

Figure 2. Map showing regional water planning areas (RWPAs), groundwater conservation districts (GCDs), counties, and river basins in Groundwater Management Area 2. UWCD refers to Underground Water Conservation District.