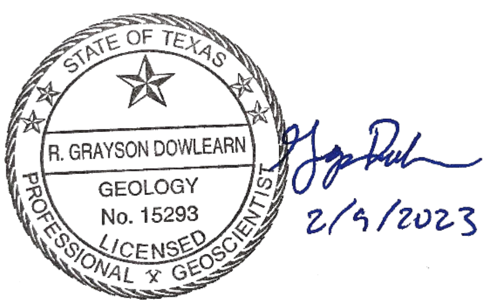
GAM RUN 22-017: PANOLA COUNTY GROUNDWATER CONSERVATION DISTRICT MANAGEMENT PLAN

Grayson Dowlearn, P.G.
Texas Water Development Board
Groundwater Division
Groundwater Modeling Department
512-475-1552
February 9, 2022



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EXECUTIVE SUMMARY:

Texas State Water Code, Section 36.1071, Subsection (h) (Texas Water Code, 2011), 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.

The TWDB provides data and information to the Panola County Groundwater Conservation District in two parts. Part 1 is the Estimated Historical Water Use/State Water Plan dataset report, which will be provided to you separately by the TWDB Groundwater Technical Assistance Department. Please direct questions about the water data report to Mr. Stephen Allen at 512-463-7317 or stephen.allen@twdb.texas.gov. Part 2 is the required groundwater availability modeling information, which includes:

1. the annual amount of recharge from precipitation, if any, to the groundwater resources within the district;
2. 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
3. the annual volume of flow into and out of the district within each aquifer and between aquifers in the district.

The groundwater management plan for the Panola County Groundwater Conservation District should be adopted by the district on or before April 3, 2023 and submitted to the executive administrator of the TWDB on or before May 3, 2023. The current management plan for the Panola County Groundwater Conservation District expires on July 2, 2023.

We used the groundwater availability model for the northern portion of the Queen City, Sparta, and Carrizo-Wilcox aquifers (Panday and others, 2020; Schorr and others, 2020) to estimate the management plan information for the Carrizo-Wilcox Aquifer within the Panola County Groundwater Conservation District.

This report replaces the results of GAM Run 13-006 (Wade, 2013) because it includes results from the updated groundwater availability model for the northern portion of the Queen City, Sparta, and Carrizo-Wilcox aquifers (Panday and others, 2020, and Schorr and others, 2020). Table 1 summarizes the groundwater availability model data required by statute. Figure 1 shows the area of the model from which the values in Table 1 were extracted. Figure 2 provides a generalized diagram of the groundwater flow components provided in Table 1. Full water budgets for the Carrizo-Wilcox Aquifer within the district are provided in Appendix A. These budgets are included to assist the Panola County Groundwater Conservation District in analyzing the effects of pumping and recharge on the Carrizo-Wilcox Aquifer within the district. If, after review of the figures, the Panola County Groundwater Conservation District determines that the district boundaries used in the assessment do not reflect current conditions, please notify the TWDB at your earliest convenience.

METHODS:

In accordance with the provisions of the Texas State Water Code, Section 36.1071, Subsection (h), the groundwater availability model mentioned above was used to estimate information for the Panola County Groundwater Conservation District management plan. Water budgets were extracted for the historical model period for the Carrizo-Wilcox Aquifer (1981-2013) using ZONEBUDGET for MODFLOW 6 (Langevin and others, 2021). The average annual water budget values for recharge, surface-water outflow, inflow to the district, outflow from the district, and the flow between aquifers within the district are summarized in this report.

PARAMETERS AND ASSUMPTIONS:

Carrizo-Wilcox Aquifer

- We used version 3.01 of the groundwater availability model for the northern portion of the Queen City, Sparta, and Carrizo-Wilcox aquifers to analyze the Carrizo-Wilcox Aquifer. See Panday and others (2020) and Schorr and others (2020) for assumptions and limitations of the model.

- The groundwater availability model for the northern portion of the Queen City, Sparta, and Carrizo-Wilcox aquifers contains nine layers represented a:

    - Layer 1: represents Quaternary Alluvium,
    - Layer 2 represents the Sparta Aquifer and equivalent units,
    - Layer 3 represents the Weches Formation (confining unit),
    - Layer 4 represents the Queen City Aquifer and equivalent units,
    - Layer 5: represents the Reklaw Formation (confining unit),
    - Layer 6: represents the Carrizo Formation,
    - Layer 7: represents the Upper Wilcox member,
    - Layer 8: represents the Middle Wilcox member, and
    - Layer 9: represents the Lower Wilcox member.

- Water budget values for the district were determined for the Carrizo-Wilcox Aquifer (Layers 6 through 9). The Sparta and Queen City aquifers do not occur within the Panola County Groundwater Conservation District and therefore no groundwater budget values are included for those aquifers in this report.

- Water budget values from the Quaternary Alluvium (Layer 1) were combined with the Carrizo-Wilcox Aquifer where Quaternary Alluvium falls within the aquifer outcrop boundaries.

- Water budget terms were averaged for the historical calibration period 1981 to 2013 (stress periods 2 through 34).

- The model was run with MODFLOW 6 (Langevin and others, 2017).

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 groundwater availability model results for the Carrizo-Wilcox Aquifer located within the Panola County Groundwater Conservation District and averaged over the historical calibration period, as shown in Table 1.

1. Precipitation recharge—the areally distributed recharge sourced from precipitation falling on the outcrop areas of the aquifer (where the aquifer is exposed at land surface) within the district.

2. Surface-water outflow—the total water discharging from the aquifer (outflow) to surface-water features such as streams, reservoirs, and springs.

3. Flow into and out of district—the lateral flow within the aquifer between the district and adjacent counties.

4. Flow between aquifers—the net vertical flow between the aquifer and adjacent aquifers or confining units. This flow is controlled by the relative water levels in each aquifer and aquifer properties of each aquifer or confining unit that define the amount of leakage that occurs.

The information needed for the district's management plan is summarized in Table 1. Figure 2 provides a generalized diagram of the groundwater flow components provided in Table 1. Full water budgets for the Carrizo-Wilcox Aquifer within the district are provided in Appendix A. These budgets are included to assist Panola County Groundwater Conservation District in analyzing the effects of pumping and recharge on the aquifers within the district.

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.

TABLE 1: SUMMARIZED INFORMATION FOR THE CARRIZO-WILCOX AQUIFER THAT IS NEEDED FOR THE PANOLA COUNTY GROUNDWATER 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	Carrizo-Wilcox Aquifer	25,771
Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers	Carrizo-Wilcox Aquifer	5,939
Estimated annual volume of flow into the district within each aquifer in the district	Carrizo-Wilcox Aquifer	3,319
Estimated annual volume of flow out of the district within each aquifer in the district	Carrizo-Wilcox Aquifer	1,014
Estimated net annual volume of flow between each aquifer in the district	To the Carrizo-Wilcox Aquifer from the Reklaw Formation	3
	To the Carrizo-Wilcox Aquifer from equivalent units in Louisiana	542

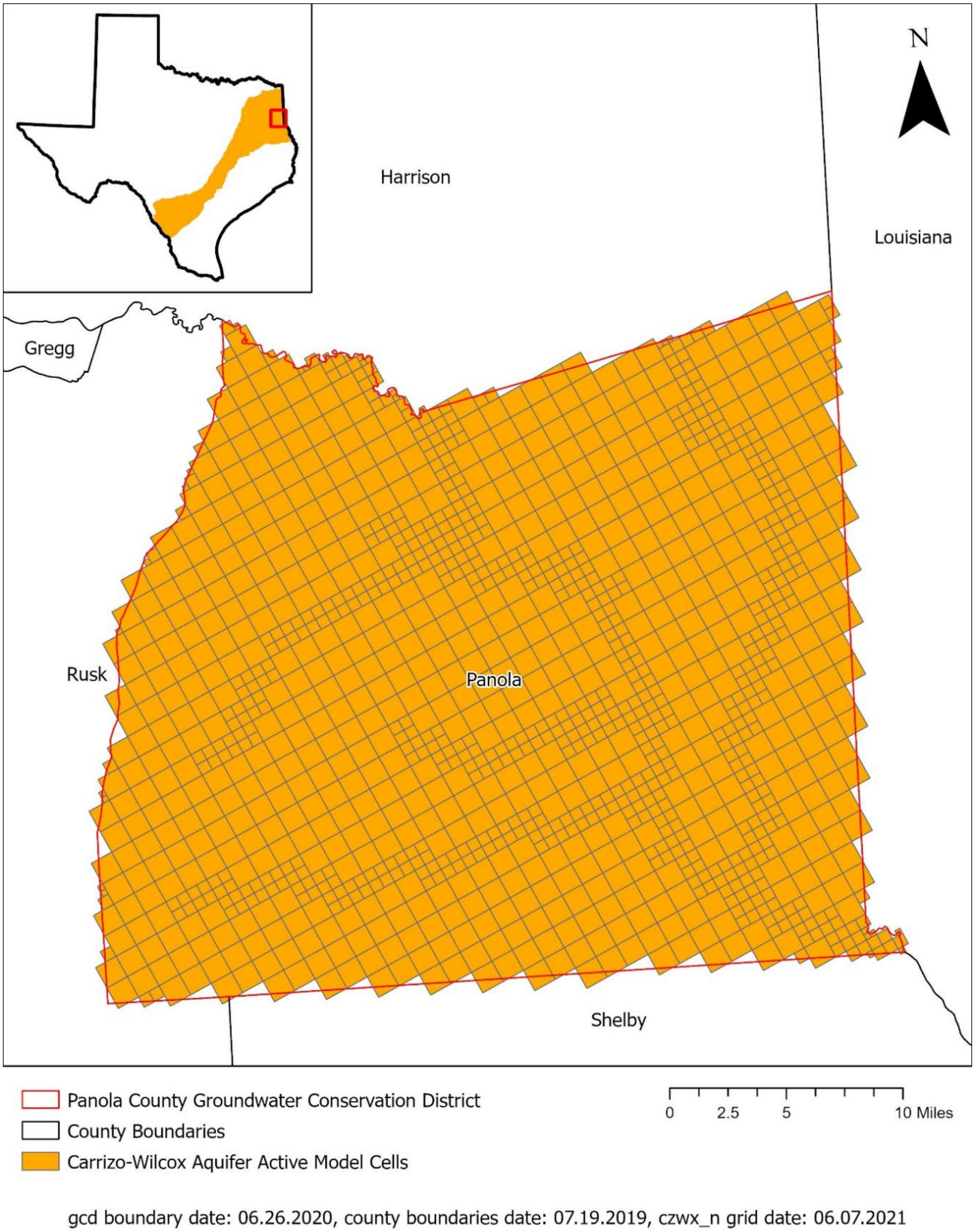
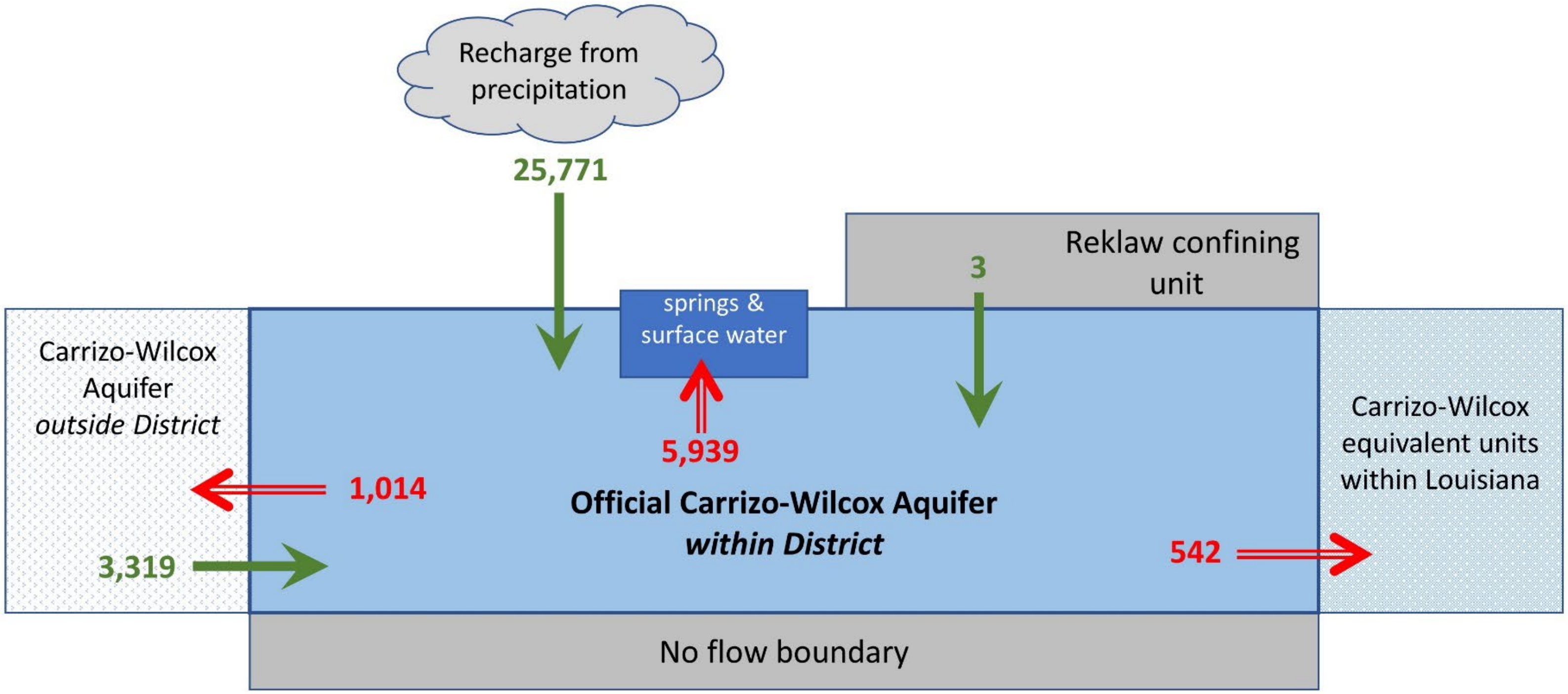


FIGURE 1: AREA OF THE NORTHERN PORTION OF THE QUEEN CITY, SPARTA, AND CARRIZO-WILCOX AQUIFERS GROUNDWATER AVAILABILITY MODEL FROM WHICH THE INFORMATION IN TABLE 1 WAS EXTRACTED (THE CARRIZO-WILCOX AQUIFER EXTENT WITHIN THE DISTRICT BOUNDARY).



Caveat: This diagram only includes the water budget items provided in Table 1. A complete water budget would include additional inflows and outflows. Please see Appendix A for a full water budget.

FIGURE 2: GENERALIZED DIAGRAM OF THE SUMMARIZED BUDGET INFORMATION FROM TABLE 1, REPRESENTING DIRECTIONS OF FLOW FOR THE CARRIZO-WILCOX AQUIFER WITHIN PANOLA COUNTY GROUNDWATER CONSERVATION DISTRICT. FLOW VALUES EXPRESSED IN ACRE-FEET PER YEAR.

LIMITATIONS:

The groundwater models used in completing this analysis are the best available scientific tools that can be used to meet the stated objectives. 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 historical 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:

Panday, S., Rumbaugh, J., Hutchison, W., and Schorr, S., 2020, Numerical Model Report: Groundwater Availability Model for the Northern Portion of the Queen City, Sparta, and Carrizo-Wilcox Aquifers, 201 p., http://www.twdb.texas.gov/groundwater/models/gam/czwx_n/2020_12_08_Numerical_Model_Report_Accessible.pdf

Schorr, S., Zivic, M., Hutchison, W., Panday, S., and Rumbaugh, J., 2020, Conceptual Model Report: Groundwater Availability Model for Northern Portion of the Queen city, Sparta, and Carrizo-Wilcox Aquifers, 240 p., http://www.twdb.texas.gov/groundwater/models/gam/czwx_n/North_QCSCW_GAM_Conceptual_Model_Report_FullRpt_Appendices.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.

Texas Water Code, 2011, http://www.statutes.legis.state.tx.us/docs/WA/pdf/WA.36.pdf

Appendix A – Full Groundwater Budget Diagrams

Full water budget diagrams presented in Figures A-1 and A-2 are included to assist the Panola County Groundwater Conservation District in analyzing the effects of pumping and recharge on the aquifers within the district. These diagrams are intended to provide additional insight for groundwater conservation districts to better understand their aquifers and to provide more detailed information to inform groundwater management.

Figure A-1 shows the full water budgets for the years of minimum and maximum pumping within the Carrizo-Wilcox Aquifer in the district during the historical calibration period described in the Parameters and Assumptions section (years 1981 to 2013). Figure A-2 shows the full water budgets for the years of minimum and maximum recharge within the Carrizo-Wilcox Aquifer in the district during the historical calibration period. Table A-1 lists each component and provides an explanation of each component contained in the full water budget diagrams.

TABLE A-1: EXPLANATION OF EACH BUDGET COMPONENT INCLUDED IN THE FULL WATER BUDGETS FOR PANOLA COUNTY GROUNDWATER CONSERVATION DISTRICT.

Full water budget component	Explanation
Recharge	Representative of recharge to the aquifer from areally distributed rainfall that reaches the water table of the aquifer.
Pumping	The amount of water pumped out of the aquifer through water wells located within the aquifer.
River Leakage	Only representative of the net exchange of water between the rivers/reservoirs and the aquifer in the model.
Evapotranspiration	Only represents the amount of water removed from the water table by vegetation or direct evaporation from the water table. This does not include total evapotranspiration for all plants or water features covering the modeled area.
Groundwater Exchanges	The sum of the net exchange of groundwater between the aquifer of interest within the district and all geologic units within and outside of the district boundaries.

TABLE A-1: EXPLANATION OF EACH BUDGET COMPONENT INCLUDED IN THE FULL WATER BUDGETS FOR PANOLA COUNTY GROUNDWATER CONSERVATION DISTRICT.

Full water budget component	Explanation
Storage	Represents the difference from the previous year in the amount of water contained within the aquifer and indicates a relative water level rise (negative Storage value) or water level decline (positive Storage value). Change in storage (dS) is the difference between inflows and outflows (Equation 1). To solve the zero-sum budget over the volume of the aquifer within the district, the term dS must be subtracted from both sides of Equation 1 (Equation 2). If total inflows are greater than outflow, Storage will be negative. If total outflows are greater than total inflows, Storage will be positive. $dS = Inflows - Outflows$ Equation 1 $0 = Inflows - Outflows - dS$ Equation 2

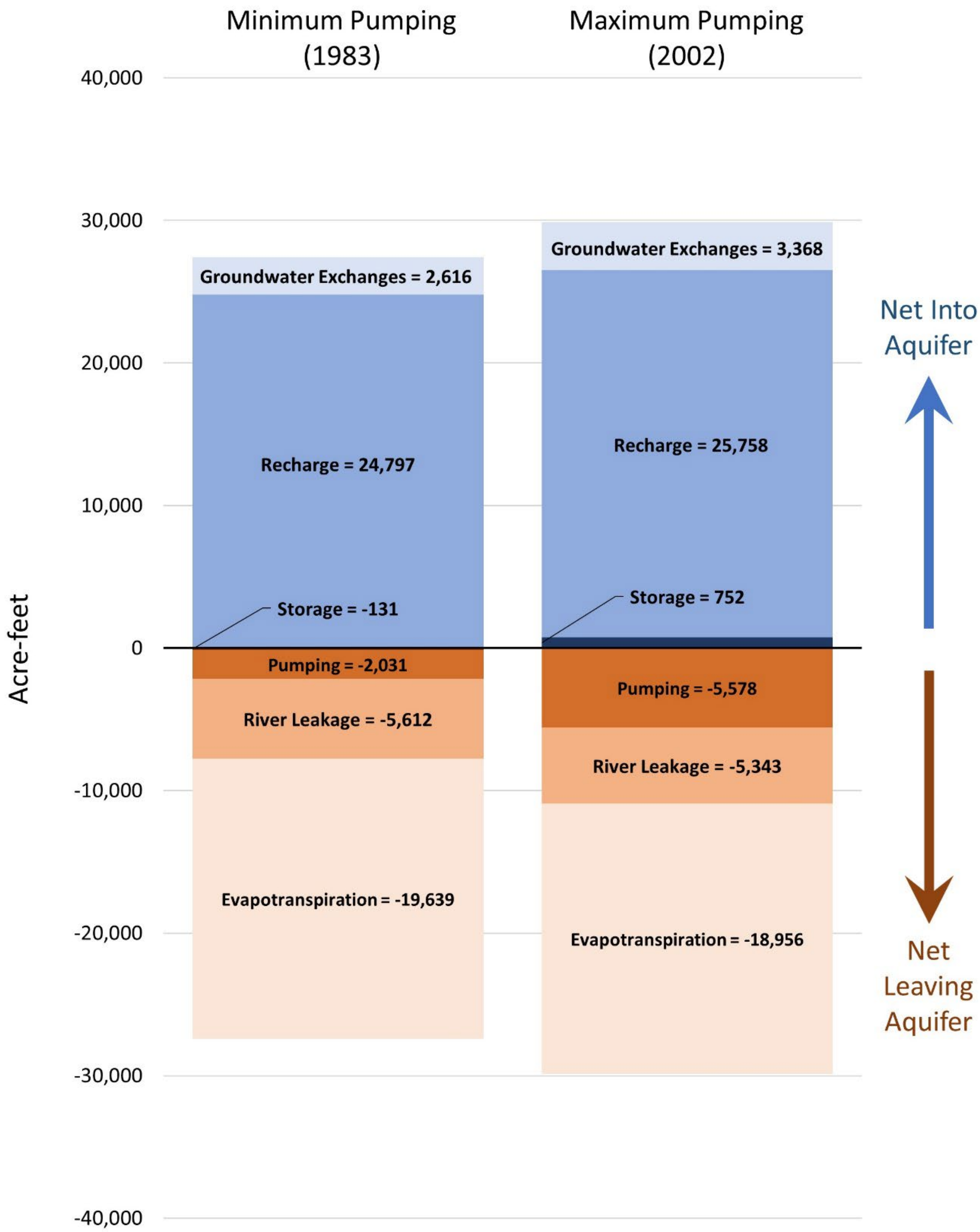

FIGURE A-1: FULL WATER BUDGETS FOR THE CARRIZO-WILCOX AQUIFER WITHIN THE PANOLA COUNTY GROUNDWATER CONSERVATION DISTRICT SHOWING THE YEAR OF MINIMUM PUMPING AND THE YEAR OF MAXIMUM PUMPING BETWEEN 1981 AND 2013.

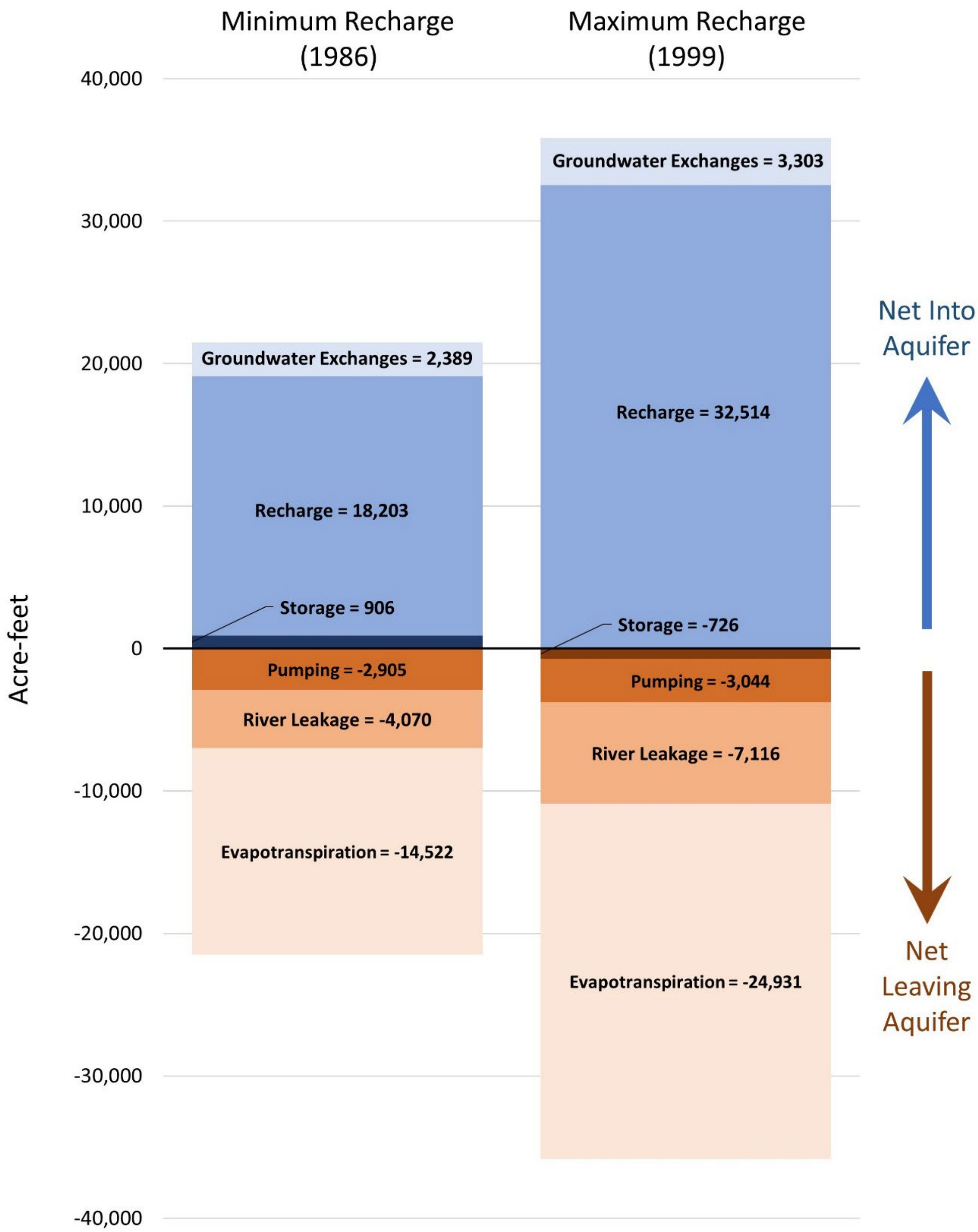

FIGURE A-2: FULL WATER BUDGETS FOR THE CARRIZO-WILCOX AQUIFER WITHIN THE PANOLA COUNTY GROUNDWATER CONSERVATION DISTRICT SHOWING THE YEAR OF MINIMUM RECHARGE AND YEAR OF MAXIMUM RECHARGE BETWEEN 1981 AND 2013.