GAM Run 24-001: Mid-East Texas Groundwater Conservation District Management Plan

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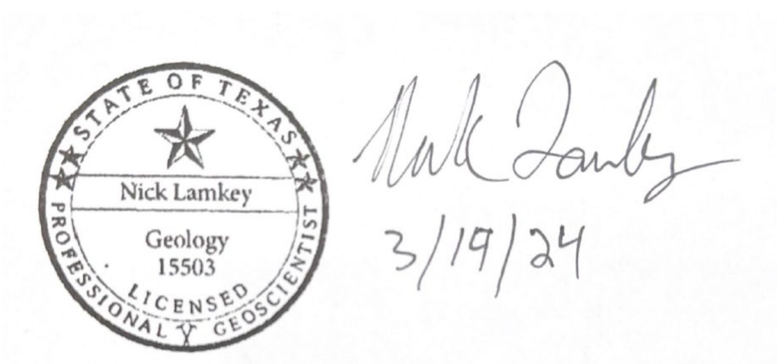
Texas Water Development Board
Groundwater Division
Groundwater Modeling Department
512-475-1788
March 19, 2024



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EXECUTIVE SUMMARY

Texas Water Code § 36.1071(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.

The TWDB provides data and information to the Mid-East Texas 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. the annual volume of water that discharges from the aquifer to springs and any surface-water bodies, including lakes, streams, and rivers, for each aquifer within the district; 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 Mid-East Texas Groundwater Conservation District should be adopted by the district on or before June 5, 2024 and submitted to the executive administrator of the TWDB on or before July 5, 2024. The current management plan for the Mid-East Texas Groundwater Conservation District expires on September 3, 2024.

We used two groundwater availability models for the Mid-East Texas Groundwater Conservation District. Information for the Carrizo-Wilcox, Queen City, and Sparta aquifers is from version 3.02 of the groundwater availability model for the central portion of the Carrizo-Wilcox, Queen City, and Sparta aquifers (Young and Kushnereit, 2020). Information for the Yegua-Jackson Aquifer is from the groundwater availability model for Yegua-Jackson Aquifer (Deeds and others, 2010).

This report replaces the results of GAM Run 18-020 (Wade, 2019). Values may differ from the previous report as a result of a model update to the groundwater availability model for the central portion of the Carrizo-Wilcox, Queen City, and Sparta aquifers from Version 3.01 to Version 3.02 as well as routine updates to the spatial grid file used to define county, groundwater conservation district, and aquifer boundaries, which can impact the calculated water budget values. Additionally, the approach used for analyzing model results is reviewed during each update and may have been refined to better delineate groundwater flows.

Tables 1 through 4 summarize the groundwater availability model data required by statute. Figures 1, 3, 5, and 7 show the area of the models from which the values in Tables 1 through 4 were extracted. Figures 2, 4, 6, and 8 provide a generalized diagram of the groundwater flow components provided in Tables 1 through 4. If the Mid-East Texas Groundwater Conservation District determines that the district boundaries used in the assessment do not reflect current conditions after reviewing the figures, please notify the TWDB Groundwater Modeling Department at your earliest convenience.

The flow components presented in this report do not represent the full groundwater budget. If additional inflow and outflow information would be helpful for planning purposes, the district may submit a request in writing to the TWDB Groundwater Modeling Department for the full groundwater budget.

METHODS

In accordance with the provisions of the Texas Water Code § 36.1071(h), the groundwater availability models mentioned above were used to estimate information for the Mid-East Texas Groundwater Conservation District management plan. Water budgets were extracted for the historical model periods in the respective groundwater availability models. For the Carrizo-Wilcox, Queen-City, and Sparta aquifers, water budgets were extracted over the historical calibration period (1980 through 2010) using ZONEBUDGET USG Version 1.00 (Panday and others, 2013). Water budgets were extracted using ZONEBUDGET Version 3.01 (Harbaugh, 2009) for the Yegua-Jackson historical calibration period (1980 through 1997). 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

Groundwater availability model for the central portion of the Carrizo-Wilcox, Queen City, and Sparta aquifers

- We used version 3.02 of the groundwater availability model for the central portion of the Carrizo-Wilcox, Queen City, and Sparta aquifers (Young and Kushnereit, 2020) to analyze the Carrizo-Wilcox, Queen City, and Sparta aquifers. See Young and Kushnereit (2020) for assumptions and limitations of the model.

- The groundwater availability model for the central portion of the Carrizo-Wilcox, Queen City, and Sparta aquifers contains ten layers, which represent the following:

    - Layer 1 represents the Colorado River and Brazos River alluvium.

    - Layer 2 represents the shallow flow system of all units in layers 3 through 10.

    - Layer 3 represents the Sparta Aquifer and equivalent units.

    - Layer 4 represents the Weches Formation.

    - Layer 5 represents the Queen City Aquifer and equivalent units.

    - Layer 6 represents the Reklaw Formation.

    - Layers 7 through 10 represent the Carrizo-Wilcox Aquifer and equivalent units.

- The MODFLOW River package was used to simulate groundwater exchange with major rivers and perennial streams. Outflow from ephemeral streams, intermittent streams, and seeps were simulated using the MODFLOW Drain package.

- The model was run with MODFLOW-USG (Panday and others, 2013).

- Water budget terms were averaged for the period 1980 through 2010 (stress periods 52 through 82).

Groundwater availability model for the Yegua-Jackson Aquifer

- We used version 1.01 of the groundwater availability model for the Yegua-Jackson Aquifer (Deeds and others, 2010) to analyze the Yegua-Jackson Aquifer. See Deeds and others (2010) for assumptions and limitations of the model.

- This groundwater availability model for the Yegua-Jackson Aquifer includes five layers, which represent the following:

    - Layer 1 represents the Yegua-Jackson Aquifer outcrop, the Catahoula Formation, and other younger overlying units.

    - Layer 2 represents the upper portion of the Jackson Group.

    - Layer 3 represents the lower portion of the Jackson Group.

    - Layer 4 represents the upper portion of the Yegua Group.

    - Layer 5 represents the lower portion of the Yegua Group.

- The model was run with MODFLOW-2000 (Harbaugh and others, 2000).

- An overall water budget for the district was determined for the Yegua-Jackson Aquifer (layers 1 through 5, collectively).

- Water budget terms were averaged for the period 1980 through 1997 (stress periods 10 through 27).

RESULTS

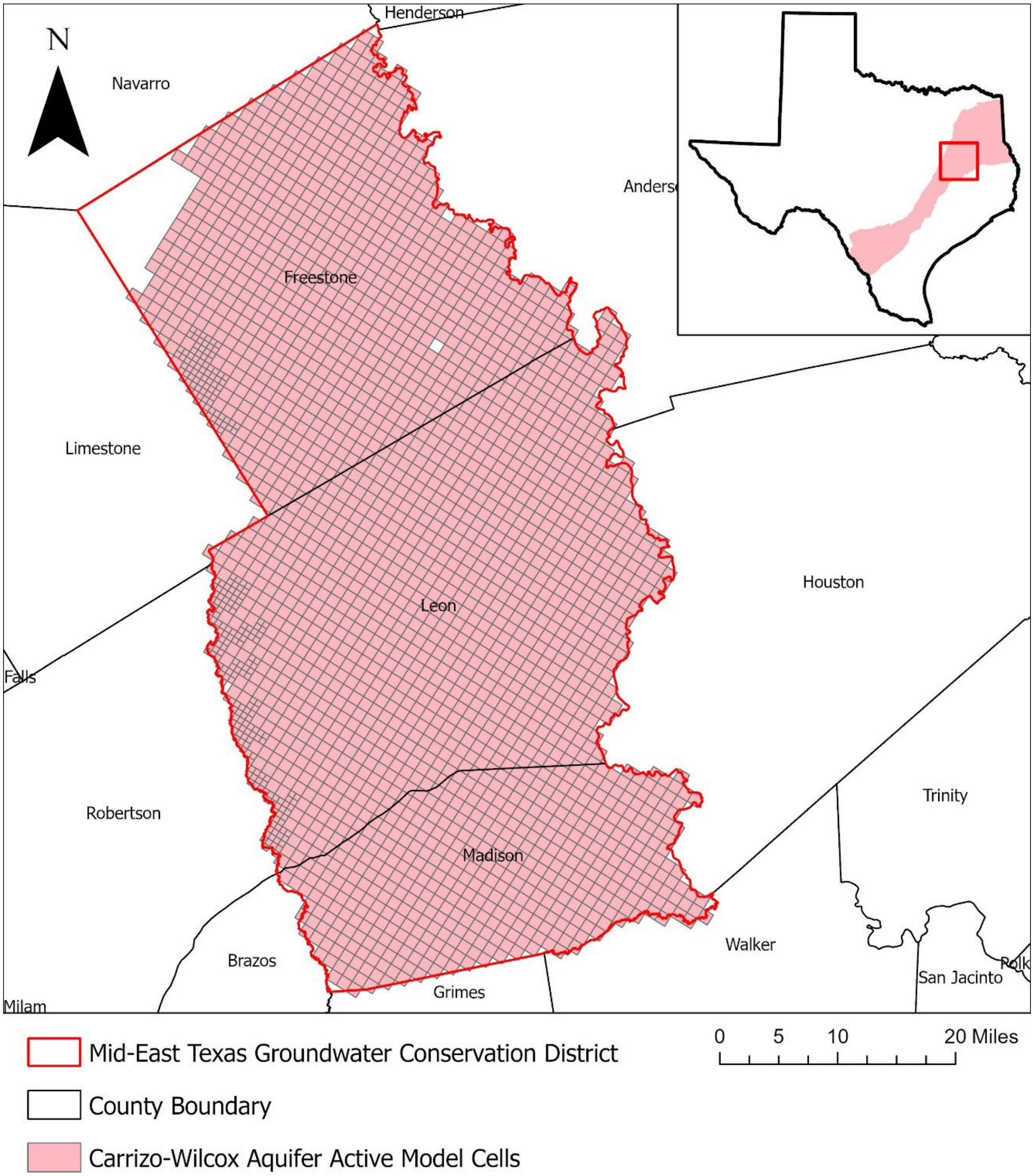
A groundwater budget summarizes the amount of water entering and leaving the aquifer according to the groundwater availability model. Selected groundwater budget components listed below were extracted from the groundwater availability model results for the Carrizo-Wilcox, Queen City, Sparta, and Yegua-Jackson aquifers located within the Mid-East Texas Groundwater Conservation District and averaged over the historical calibration period, as shown in Tables 1, 2, 3, and 4.

1. 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.
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 Tables 1 through 4. Figures 1, 3, 5, and 7 show the area of the models from which the values in Tables 1 through 4 were extracted. Figures 2, 4, 6, and 8 provide a generalized diagram of the groundwater flow components provided in Tables 1 through 4. 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.

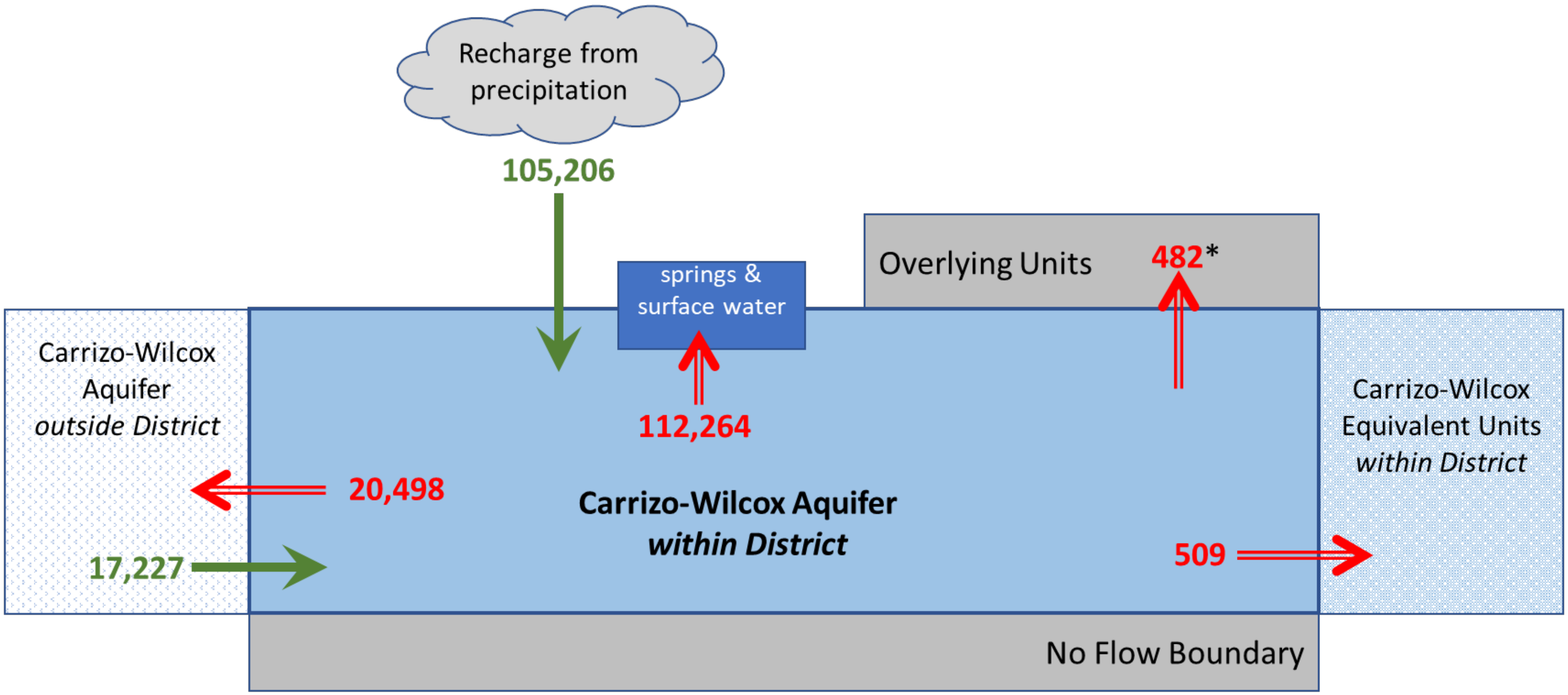
Table 1: Summarized information for the Carrizo-Wilcox Aquifer that is needed for the Mid-East Texas Groundwater Conservation District groundwater management plan. All values are reported in acre-feet per year and rounded to the nearest 1 acre-foot.

Management plan requirement	Aquifer or confining unit	Results
Estimated annual amount of recharge from precipitation to the district	Carrizo-Wilcox Aquifer	105,206
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	112,264
Estimated annual volume of flow into the district within each aquifer in the district	Carrizo-Wilcox Aquifer	17,227
Estimated annual volume of flow out of the district within each aquifer in the district	Carrizo-Wilcox Aquifer	20,498
Estimated net annual volume of flow between each aquifer in the district	From Carrizo-Wilcox Aquifer to Reklaw confining unit	750
	To Carrizo-Wilcox Aquifer from Queen City Aquifer	268
	From Carrizo-Wilcox Aquifer to Carrizo-Wilcox equivalent units	509



county boundary date: 07.03.2019, gcd boundary date: 08.07.2023, czwx_s grid date: 12.18.2023

Figure 1: Area of the groundwater availability model for the central portion of the Carrizo-Wilcox, Queen City, and Sparta aquifers from which the information in Table 1 was extracted (the Carrizo-Wilcox Aquifer extent within the district boundary).



* Flow to overlying units includes net inflow of 268 acre-feet per year from the Queen City Aquifer and net outflow of 750 acre-feet per year to the Reklaw confining unit.

Caveat: This diagram only includes the water budget items provided in Table 1. A complete water budget would include additional inflows and outflows. For a full groundwater budget, please submit a request in writing to the Groundwater Modeling Department.

Figure 2: Generalized diagram of the summarized budget information from Table 1, representing directions of flow for the Carrizo-Wilcox Aquifer within the Mid-East Texas Groundwater Conservation District. Flow values are expressed in acre-feet per year.

Table 2: Summarized information for the Queen City Aquifer that is needed for the Mid-East Texas Groundwater Conservation District 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	Queen City Aquifer	67,646
Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers	Queen City Aquifer	71,112
Estimated annual volume of flow into the district within each aquifer in the district	Queen City Aquifer	4,039
Estimated annual volume of flow out of the district within each aquifer in the district	Queen City Aquifer	3,809
Estimated net annual volume of flow between each aquifer in the district	To Queen City Aquifer from Sparta Aquifer	1,397
	From Queen City Aquifer to Weches confining unit	826
	To Queen City Aquifer from Queen City equivalent units	6
	To Queen City Aquifer from Reklaw confining unit	549
	From Queen City Aquifer to Carrizo-Wilcox Aquifer	268

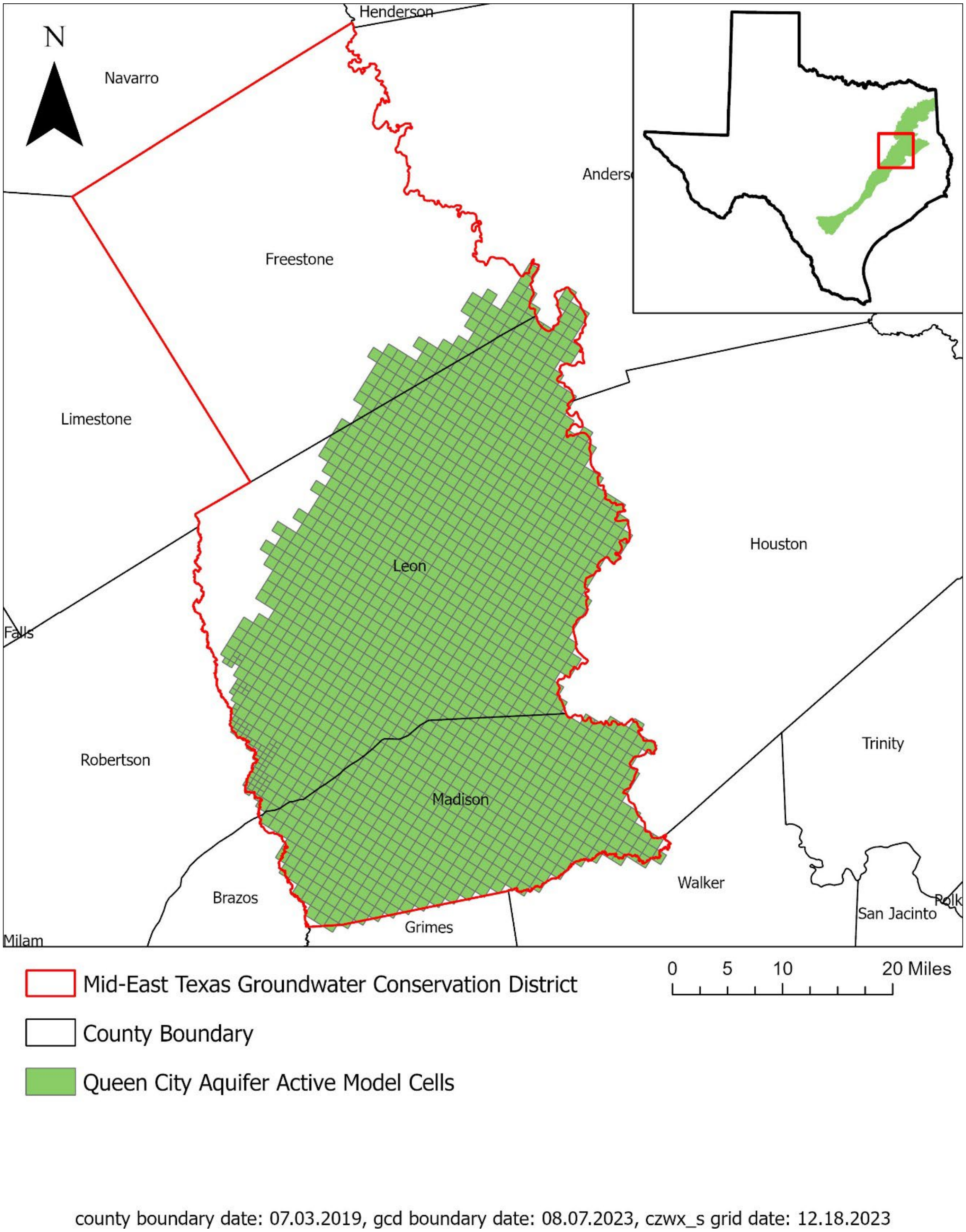
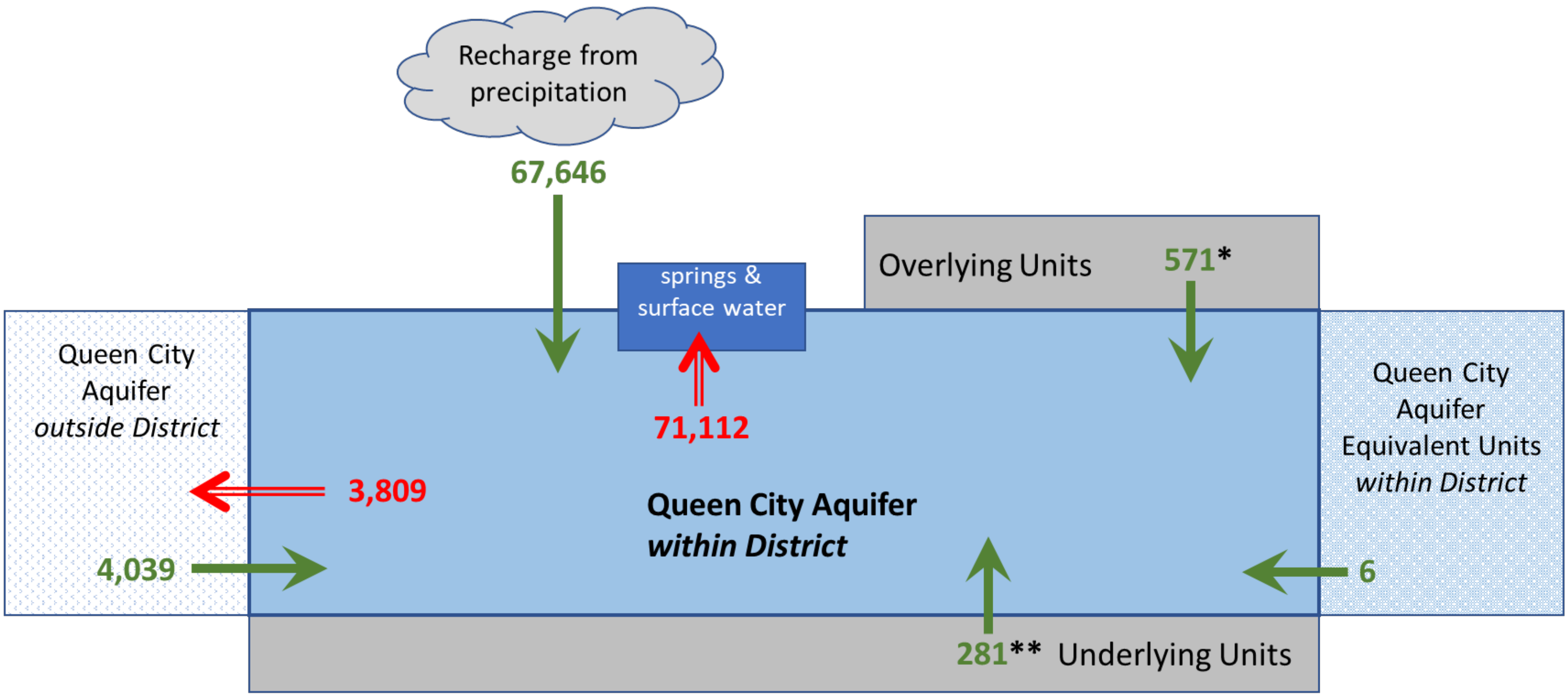


Figure 3: Area of the groundwater availability model for the central portion of the Carrizo-Wilcox, Queen City, and Sparta aquifers from which the information in Table 2 was extracted (the Queen City Aquifer extent within the district boundary).



* Flow from overlying units includes net inflow of 1,397 acre-feet per year from the Sparta Aquifer and net outflow of 826 acre-feet per year to the Weches confining unit.

** Flow from underlying units includes net inflow of 549 acre-feet per year from the Reklaw confining unit and net outflow of 268 acre-feet per year to the Carrizo-Wilcox Aquifer.

Caveat: This diagram only includes the water budget items provided in Table 2. A complete water budget would include additional inflows and outflows. For a full groundwater budget, please submit a request in writing to the Groundwater Modeling Department.

Figure 4: Generalized diagram of the summarized budget information from Table 2, representing directions of flow for the Queen City Aquifer within the Mid-East Texas Groundwater Conservation District. Flow values are expressed in acre-feet per year.

Table 3: Summarized information for the Sparta Aquifer that is needed for the Mid-East Texas Groundwater Conservation District 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	Sparta Aquifer	20,538
Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers	Sparta Aquifer	23,939
Estimated annual volume of flow into the district within each aquifer in the district	Sparta Aquifer	1,396
Estimated annual volume of flow out of the district within each aquifer in the district	Sparta Aquifer	1,035
Estimated net annual volume of flow between each aquifer in the district	From Sparta Aquifer to younger units	847
	To Sparta Aquifer from Weches Confining Unit	1,686
	From Sparta Aquifer to Queen City Aquifer	1,397

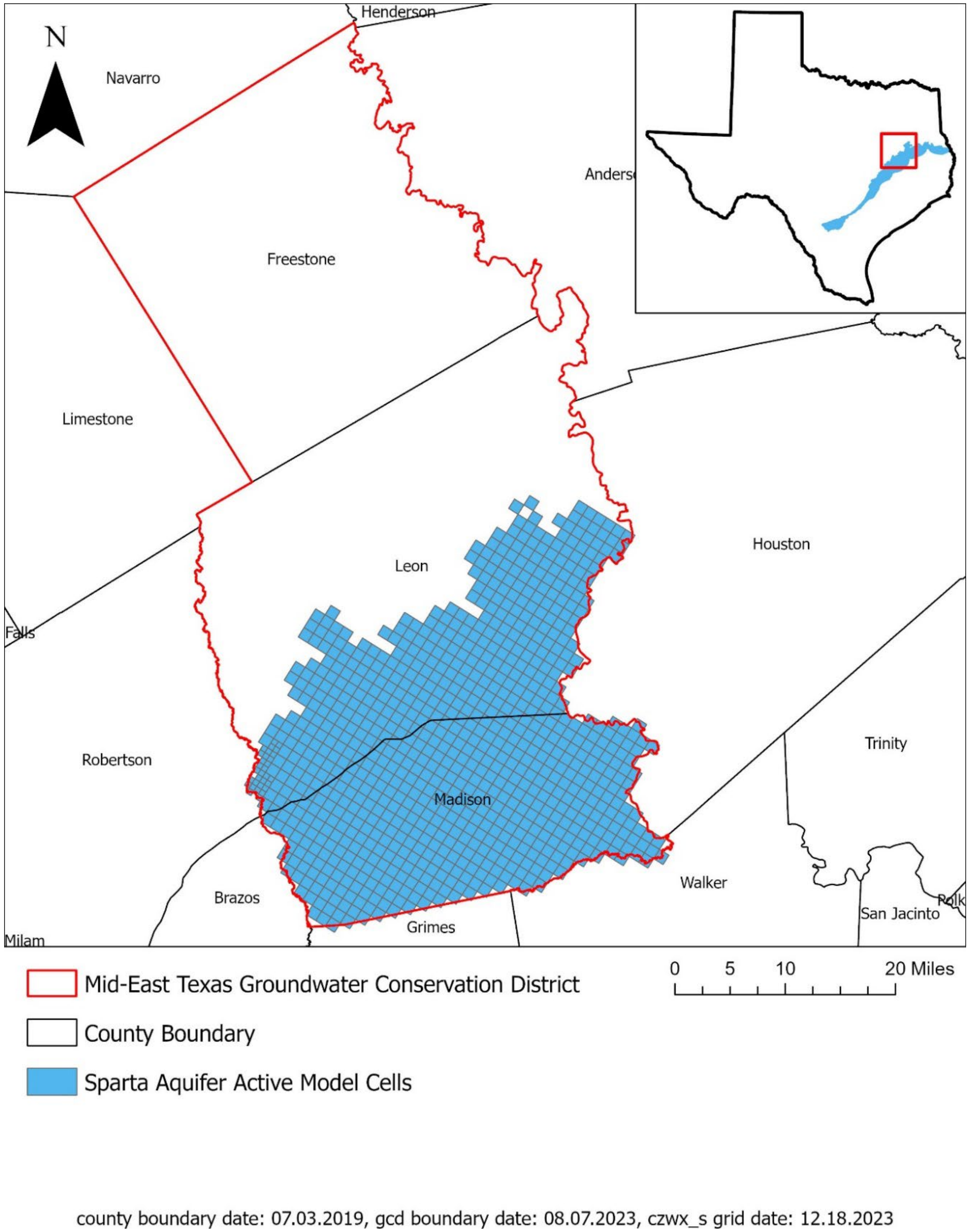
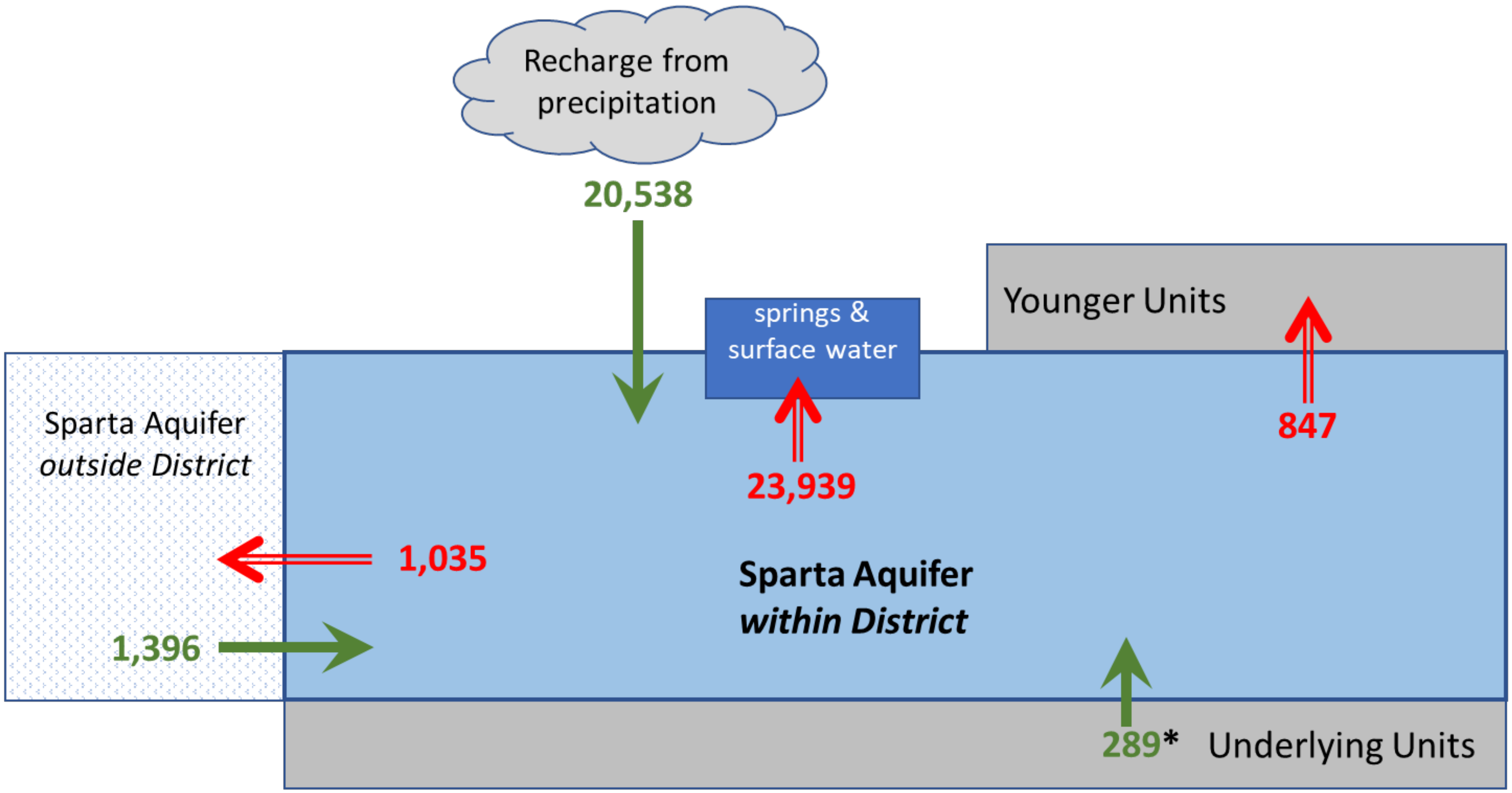


Figure 5: Area of the groundwater availability model for the central portion of the Carrizo-Wilcox, Queen City, and Sparta aquifers from which the information in Table 3 was extracted (the Sparta Aquifer extent within the district boundary).



* Flow from underlying units includes net inflow of 1,686 acre-feet per year from the Weches confining unit and net outflow of 1,397 acre-feet per year to the Queen City Aquifer.

Caveat: This diagram only includes the water budget items provided in Table 3. A complete water budget would include additional inflows and outflows. For a full groundwater budget, please submit a request in writing to the Groundwater Modeling Department.

Figure 6: Generalized diagram of the summarized budget information from Table 3, representing directions of flow for the Sparta Aquifer within the Mid-East Texas Groundwater Conservation District. Flow values are expressed in acre-feet per year.

Table 4: Summarized information for the Yegua-Jackson Aquifer that is needed for the Mid-East Texas Groundwater Conservation District 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	Yegua-Jackson Aquifer	31,108
Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers	Yegua-Jackson Aquifer	43,985
Estimated annual volume of flow into the district within each aquifer in the district	Yegua-Jackson Aquifer	12,950
Estimated annual volume of flow out of the district within each aquifer in the district	Yegua-Jackson Aquifer	10,455
Estimated net annual volume of flow between each aquifer in the district	Not applicable	Not applicable

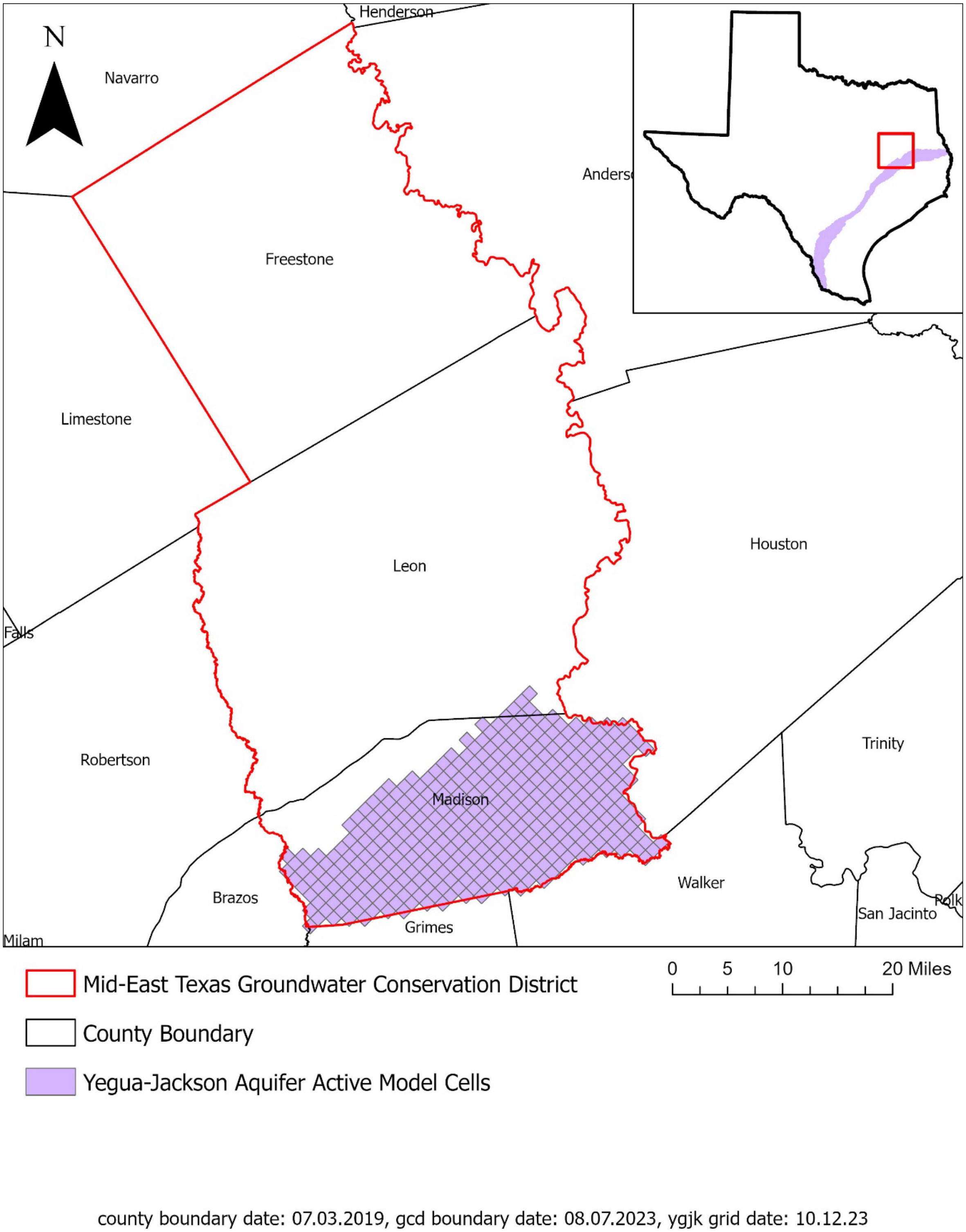


Figure 7: Area of the groundwater availability model for the Yegua-Jackson Aquifer from which the information in Table 4 was extracted (the Yegua-Jackson Aquifer extent within the district boundary).

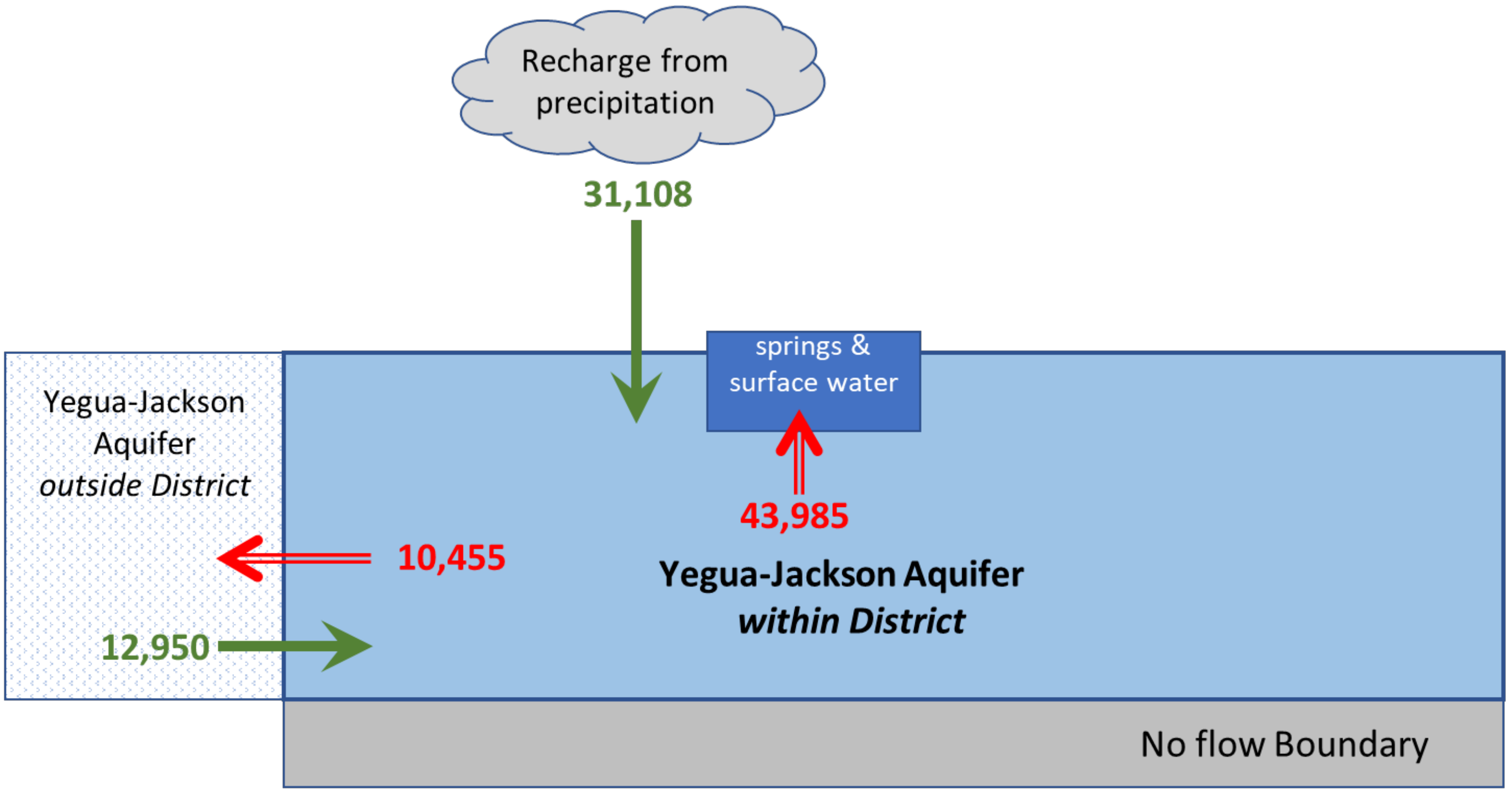


Figure 8: Generalized diagram of the summarized budget information from Table 4, representing directions of flow for the Yegua-Jackson Aquifer within the Mid-East Texas Groundwater Conservation District. Flow values are expressed in acre-feet per year.

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.

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Texas Water Code § 36.1071