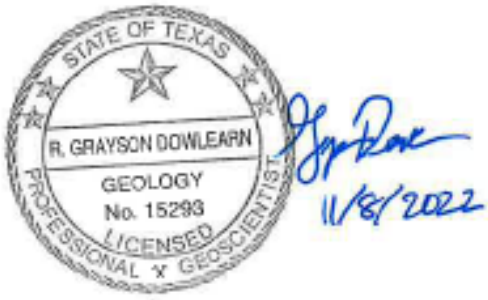
GAM Run 22-011: Kinney County Groundwater Conservation District Management Plan

Ki Cha, Ph.D. and Grayson Dowlearn, P.G.
Texas Water Development Board
Groundwater Division
Groundwater Modeling Department
512-463-5604
November 8, 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 Kinney 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 Kinney County Groundwater Conservation District should be adopted by the district on or before January 11, 2023 and submitted to the executive administrator of the TWDB on or before February 10, 2023. The current management plan for the Kinney County Groundwater Conservation District expires on April 11, 2023.

We used the Groundwater Flow Model of the Kinney County Area (Hutchison and others, 2011) to estimate the management plan information for the aquifers within the Kinney County Groundwater Conservation District. The model has four layers representing the following hydrogeologic units (from top to bottom): Carrizo-Wilcox Aquifer (layer 1), Upper Cretaceous Unit (layer 2), Edwards (Balcones Fault Zone) Aquifer/Edwards portion of the Edwards-Trinity (Plateau) Aquifer (layer 3), and Trinity portion of the Edwards-Trinity (Plateau) Aquifer (layer 4).

This report replaces the results of GAM Run 12-014 (Shi and Wade, 2013). Values may differ from the previous report as a result of 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 and 2 summarize the groundwater availability model data required by statute. Figures 1 and 3 show the area of the model from which the values in Tables 1 and 2 were extracted. Figures 2 and 4 provide a generalized diagram of the groundwater flow components provided in Tables 1 and 2, respectively. If, after review of the figures, the Kinney 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 Kinney County Groundwater Conservation District management plan. Water budgets were extracted for the historical model period (1980 through 2005) for the Edwards (Balcones Fault Zone) Aquifer and the Edwards-Trinity (Plateau) Aquifer 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, and the flow between aquifers within the district are summarized in this report.

PARAMETERS AND ASSUMPTIONS:

Edwards (Balcones Fault Zone) and Edwards-Trinity (Plateau) Aquifers

- We used the Groundwater Flow Model of the Kinney County Area. See Hutchison and others (2011) for assumptions and limitations of the model.
- The model was calibrated to water level and spring flux collected from 1950 to 2005; however, budget values were extracted only for the period from 1980 to 2005 for the management plan.
- The model has four layers representing the following hydrogeologic units (from top to bottom): Carrizo-Wilcox Aquifer (layer 1), Upper Cretaceous Unit (layer 2), Edwards (Balcones Fault Zone) Aquifer/Edwards portion of the Edwards-Trinity (Plateau) Aquifer (layer 3), and Trinity portion of the Edwards-Trinity (Plateau) Aquifer (layer 4). Please note that the Edwards (Balcones Fault Zone) Aquifer was simulated in model layer 3, while the Edwards-Trinity (Plateau) Aquifer was simulated in model layers 3 and 4
- 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 groundwater availability model results for the Edwards (Balcones Fault Zone) Aquifer and the Edwards-Trinity (Plateau) Aquifer within the Kinney County Groundwater Conservation District and averaged over the 1980 to 2005 calibration period, as shown in Tables 1 and 2.

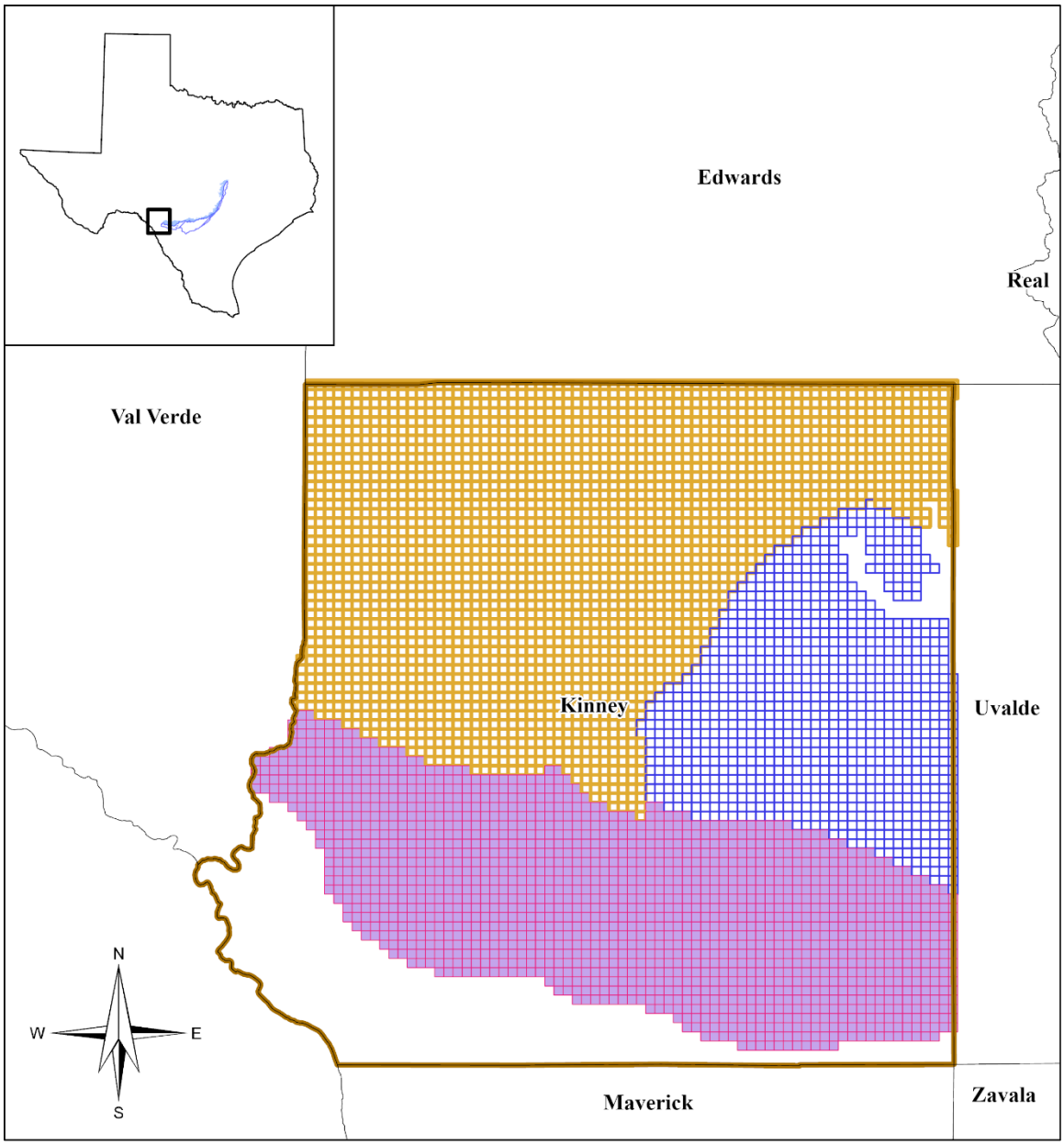
1. Precipitation recharge—the areally distributed recharge sourced from precipitation falling on the outcrop areas of the aquifers (where the aquifer is exposed at land surface) within the district.
2. Surface-water outflow—the total water discharging from the aquifer (outflow) to surface-water features 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 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 district or county boundaries, 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.

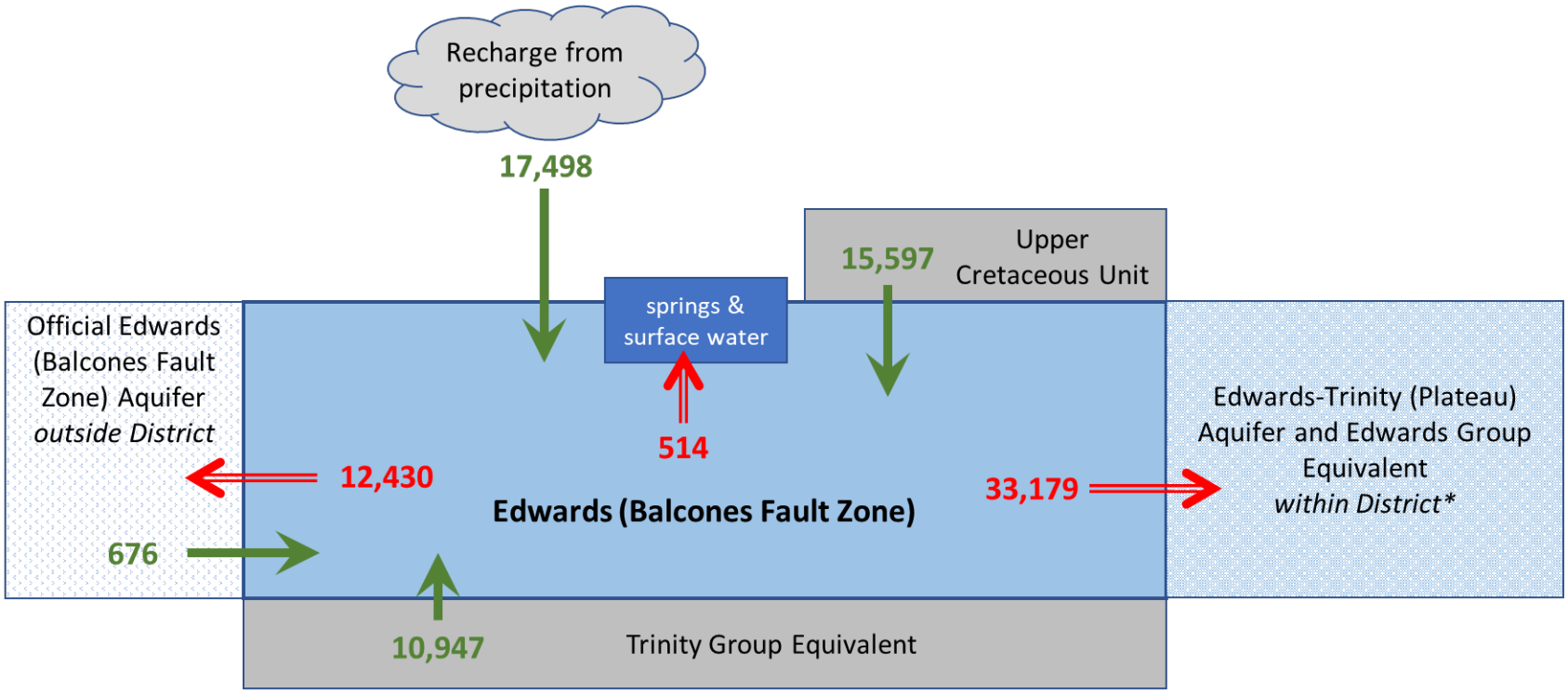
TABLE 1: SUMMARIZED INFORMATION FOR THE EDWARDS (BALCONES FAULT ZONE) AQUIFER THAT IS NEEDED FOR KINNEY COUNTY GROUNDWATER CONSERVATION DISTRICT'S GROUNDWATER MANAGEMENT PLAN. ALL VALUES ARE REPORTED IN ACRE-FEET PER YEAR AND ROUNDED TO THE NEAREST 1 ACRE-FOOT.

Management Plan requirement	Aquifer and other units	Result
Estimated annual amount of recharge from precipitation to the district	Edwards (Balcones Fault Zone) Aquifer	17,498
Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers.	Edwards (Balcones Fault Zone) Aquifer	514
Estimated annual volume of flow into the district within each aquifer in the district	Edwards (Balcones Fault Zone) Aquifer	676
Estimated annual volume of flow out of the district within each aquifer in the district	Edwards (Balcones Fault Zone) Aquifer	12,430
Estimated net annual volume of flow between each aquifer in the district	To Edwards (Balcones Fault Zone) Aquifer from Upper Cretaceous Units	15,597
	To Edwards (Balcones Fault Zone) Aquifer from Edwards-Trinity (Plateau) Aquifer	11,514
	From Edwards (Balcones Fault Zone) to Edwards-Group Equivalent Unit	44,693
	To Edwards (Balcones Fault Zone) from Trinity Group Equivalent Unit	10,947



alt1_knny_gird_poly date = 09.15.22, groundwater conservation district boundaries date = 06.26.2020, county boundaries date = 07.03.2019

FIGURE 1: THE EDWARDS (BALCONES FAULT ZONE) AQUIFER, THE EDWARDS PORTION OF EDWARDS-TRINITY (PLATEAU) AQUIFER, AND THE EDWARDS GROUP EQUIVALENT UNIT IN MODEL LAYER 3 FROM WHICH THE INFORMATION IN TABLES 1 AND 2 WAS EXTRACTED FOR THE KINNEY COUNTY GROUNDWATER CONSERVATION DISTRICT.



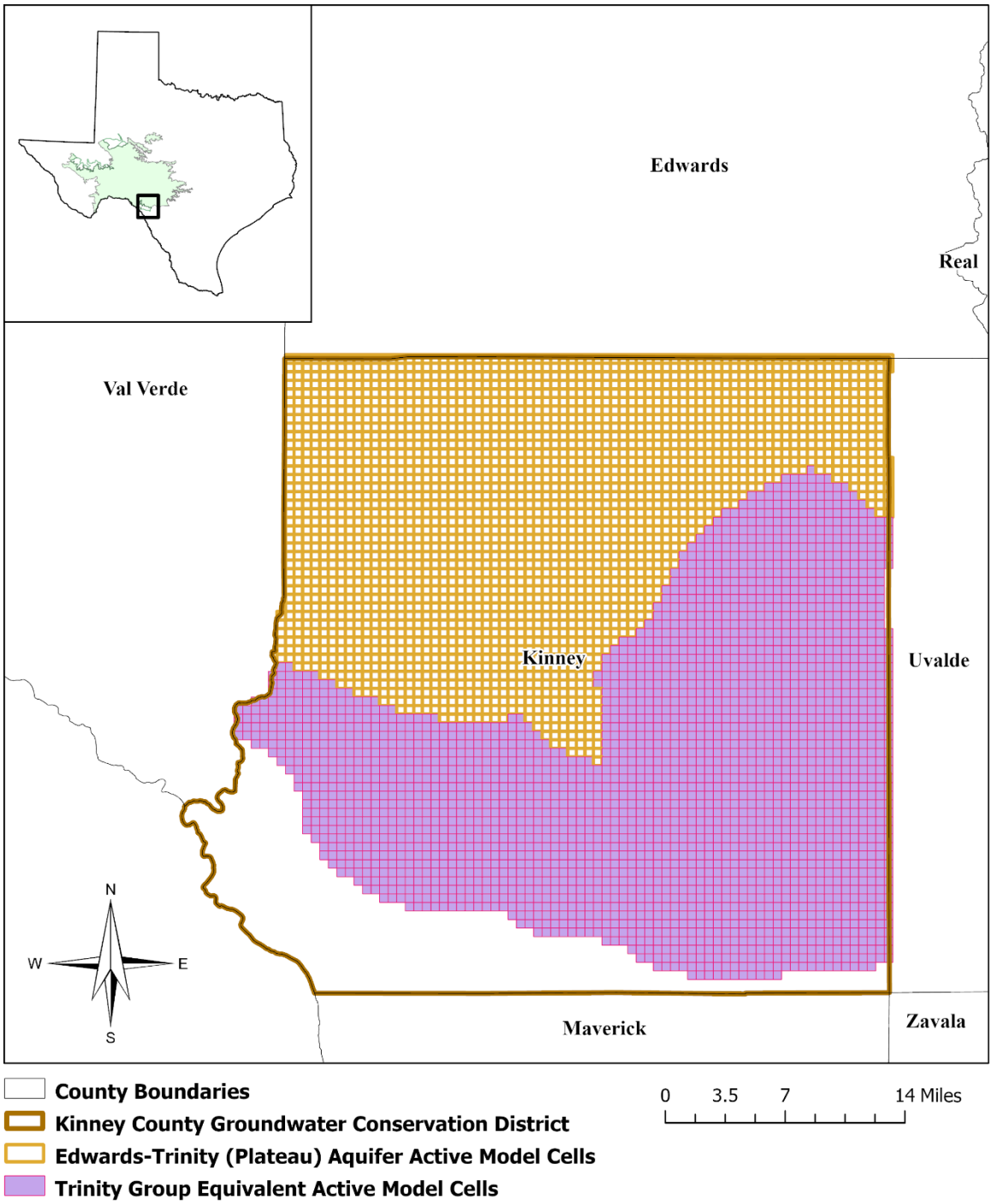
**Includes 11,514 acre-feet per year flow from the Edwards-Trinity (Plateau) Aquifer and 44,693 acre-feet per year flow to the Edwards Group Equivalent within District.*

Caveat: This diagram only includes the water budget items provided in Table 1. A complete water budget would include additional inflows and outflows. If the District requires values for additional water budget items, please contact TWDB.

FIGURE 2: GENERALIZED DIAGRAM OF THE SUMMARIZED BUDGET INFORMATION FROM TABLE 1, REPRESENTING DIRECTIONS OF FLOW FOR THE EDWARDS (BALCONES FAULT ZONE) AQUIFER WITHIN KINNEY COUNTY GROUNDWATER CONSERVATION DISTRICT. FLOW VALUES EXPRESSED IN ACRE-FEET PER YEAR.

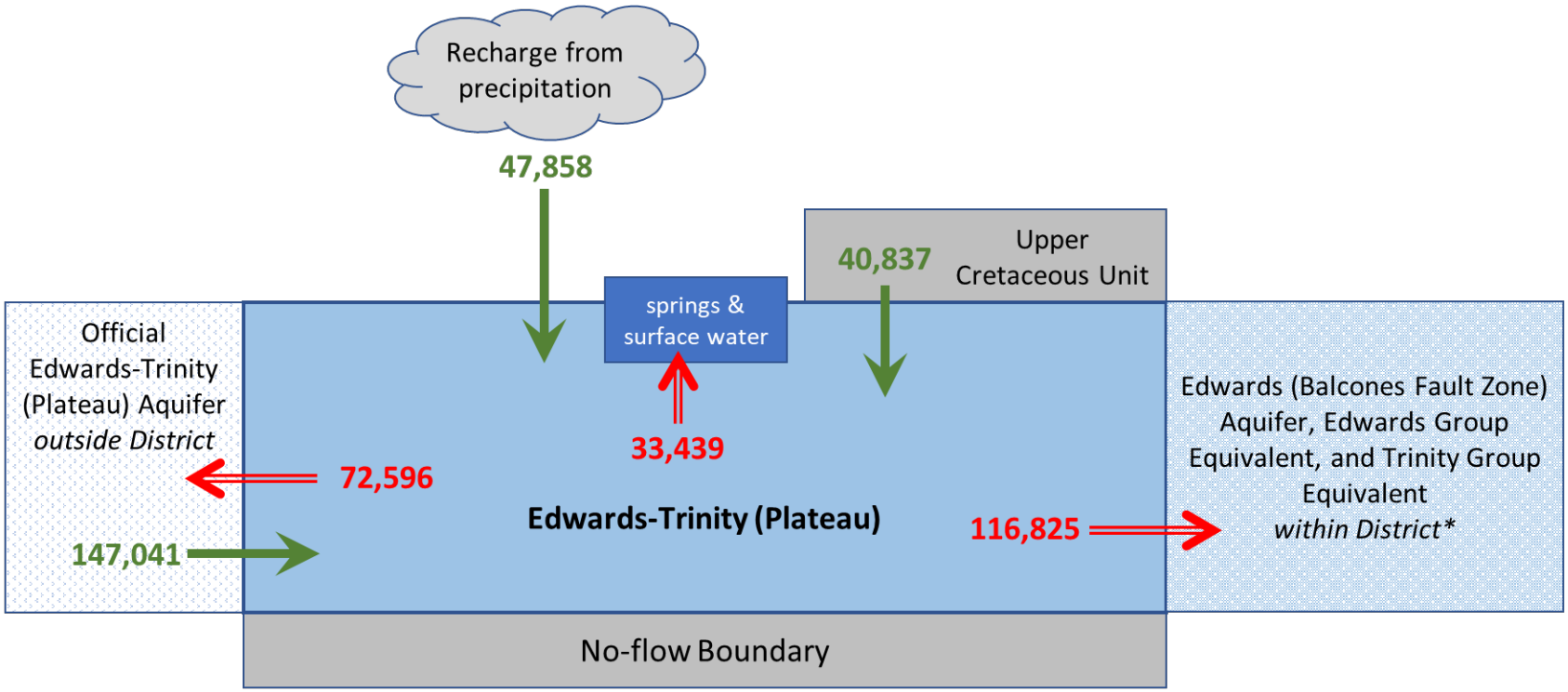
TABLE 2: SUMMARIZED INFORMATION FOR THE EDWARDS – TRINITY (PLATEAU) AQUIFER THAT IS NEEDED FOR KINNEY COUNTY GROUNDWATER CONSERVATION DISTRICT'S GROUNDWATER MANAGEMENT PLAN. ALL VALUES ARE REPORTED IN ACRE-FEET PER YEAR AND ROUNDED TO THE NEAREST 1 ACRE-FOOT.

Management Plan requirement	Aquifer and other units	Result
Estimated annual amount of recharge from precipitation to the district	Edwards-Trinity (Plateau) Aquifer	47,858
Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers.	Edwards-Trinity (Plateau) Aquifer	33,439
Estimated annual volume of flow into the district within each aquifer in the district	Edwards-Trinity (Plateau) Aquifer	147,041
Estimated annual volume of flow out of the district within each aquifer in the district	Edwards-Trinity (Plateau) Aquifer	72,596
Estimated net annual volume of flow between each aquifer in the district	To Edwards-Trinity (Plateau) Aquifer from Upper Cretaceous Units	40,837
	From Edwards-Trinity (Plateau) Aquifer to Edwards (Balcones Fault Zone) Aquifer	11,514
	From Edwards-Trinity (Plateau) Aquifer to Edwards Group Equivalent Unit	31,383
	From Edwards-Trinity (Plateau) Aquifer to Trinity Group Equivalent Unit	73,928



alt1_knny_gird_poly date = 09.15.22, groundwater conservation district boundaries date = 06.26.2020, county boundaries date = 07.03.2019

FIGURE 3: THE TRINITY PORTION OF THE EDWARDS-TRINITY (PLATEAU) AQUIFER AND THE TRINITY GROUP EQUIVALENT UNIT IN MODEL LAYER 4 FROM WHICH THE INFORMATION IN TABLES 1 AND 2 WAS EXTRACTED FOR THE KINNEY COUNTY GROUNDWATER CONSERVATION DISTRICT.



**Includes 11,514 acre-feet per year flow to the Edwards (Balcones Fault Zone) Aquifer, 31,383 acre-feet per year flow to the Edwards Group Equivalent, and 73,928 acre-feet per year flow to the Trinity Group Equivalent within District.*

Caveat: This diagram only includes the water budget items provided in Table 2. A complete water budget would include additional inflows and outflows. If the District requires values for additional water budget items, please contact TWDB.

FIGURE 4: GENERALIZED DIAGRAM OF THE SUMMARIZED BUDGET INFORMATION FROM TABLE 2, REPRESENTING DIRECTIONS OF FLOW FOR THE EDWARDS-TRINITY (PLATEAU) AQUIFER WITHIN KINNEY COUNTY GROUNDWATER CONSERVATION DISTRICT. FLOW VALUES EXPRESSED IN ACRE-FEET PER YEAR.

LIMITATIONS

The groundwater model used for this analysis is the best available scientific tool to meet the stated objective. 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 streamflow are specific to a particular historic time period.

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 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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Harbaugh, A. W., 2009, Zonebudget Version 3.01, A computer program for computing subregional water budgets for MODFLOW ground-water flow models, U.S. Geological Survey Groundwater Software.

Harbaugh, A.W., Banta, E.R., Hill, M.C., and McDonald, M.G., 2000, MODFLOW-2000, The U.S. Geological Survey modular ground-water model-user guide to modularization concepts and the ground-water flow process: U.S. Geological Survey Open-File Report 00-92, 121 p.

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http://www.twdb.texas.gov/groundwater/docs/GAMruns/GR12-014.pdf

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