

GTA Aquifer Assessment 09-10

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REQUESTOR:

Janet Adams, General Manager of the Jeff Davis County and Presidio County underground water conservation districts, acting on behalf of Groundwater Management Area 4.

DESCRIPTION OF REQUEST:

Ms. Janet Adams provided the Texas Water Development Board (TWDB) with draft desired future conditions for the aquifers in Groundwater Management Area 4 and requested that TWDB evaluate the draft desired future conditions. This aquifer analysis estimates the annual total pumping to achieve the draft desired future conditions for the Presidio-Redford Bolson, Red Light Draw, Green River Valley, and Eagle Flat aquifers in Groundwater Management Area 4.

DRAFT DESIRED FUTURE CONDITIONS:

For the Presidio-Redford Bolson, Red Light Draw, Green River Valley, and Eagle Flat aquifers,

- Culberson County GCD—on average a 50-foot drawdown over 50 years
- Jeff Davis County Underground Water Conservation District (UWCD)—on average a 10-foot drawdown over 50 years
- Presidio County UWCD—on average a 5-foot drawdown over 50 years
- areas outside conservation district boundaries—on average a 20-foot drawdown over 50 years

METHODS:

Due to limited data on these aquifers, a simple method of determining groundwater volume based on a uniform water-level decline was used. A transient hydrologic budget for the saturated portion of an aquifer is described by Freeze and Cherry (1979, p. 365):

$$Q(t) = R(t) - D(t) + \frac{dS}{dt}$$

where $Q(t)$ = total rate of groundwater withdrawal
 $R(t)$ = total rate of groundwater recharge to the basin
 $D(t)$ = total rate of groundwater discharge from the basin
 $\frac{dS}{dt}$ = rate of change of storage in the saturated zone of the basin

For this analysis, it is assumed that

$$R(t) = R(r) + R(e)$$

where $R(r)$ = rejected recharge for the basin
 $R(e)$ = effective recharge

Effective recharge is the amount of water that enters an aquifer and is available for development (Muller and Price, 1979, p. 5). Rejected recharge is the amount of total (or potential) recharge that discharges from an aquifer because it is overfull and cannot accept more water (Theis, 1940, p. 1).

In addition, it is assumed that

$$R(r) \cong D(t)$$

Therefore, the total rate of groundwater pumping equals effective recharge plus the change in storage of the aquifer:

$$Q(t) = R(e) + \frac{dS}{dt}$$

The Presidio-Redford Bolson, Red Light Draw, Green River Valley, and Eagle Flat aquifers are located entirely within the Rio Grande River Basin and the Far West Regional Water Planning Area (Region E). To calculate the total pumping, the aquifers were divided into map areas by county and groundwater conservation district (Figure 1). The areal extent of each aquifer map area was calculated. These areas were used to calculate estimated annual effective recharge.

To determine the volume from storage used to reach the desired water-level drawdown, the areas were multiplied by the estimated aquifer storage coefficient and by the drained saturated thickness necessary to maintain the draft desired future condition. This volume was then divided by 50 years to obtain a yearly volume.

The calculations were completed in a Microsoft Excel worksheet.

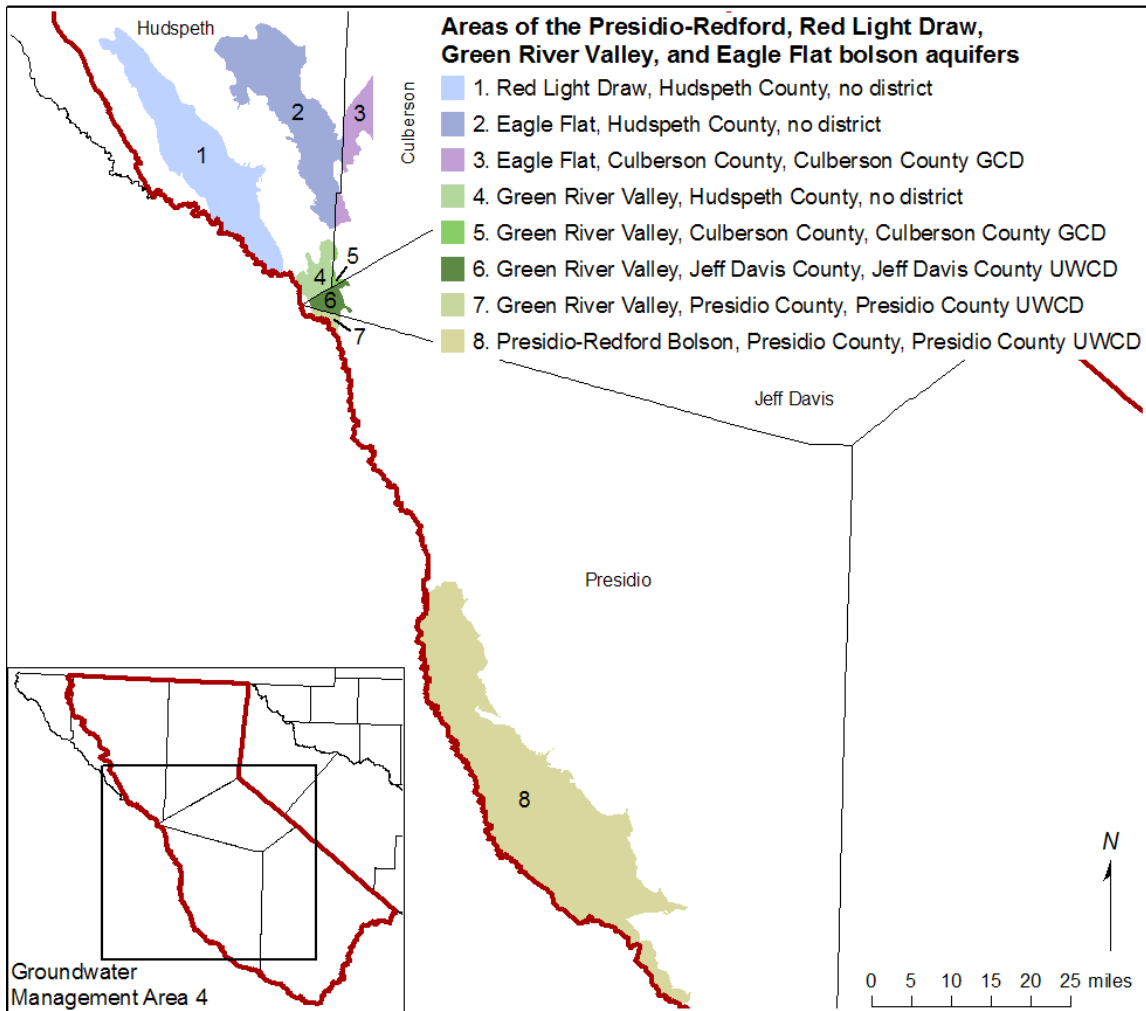


Figure 1. Map areas for estimating total pumping for the Presidio-Redford Bolson, Red Light Draw, Green River Valley, and Eagle Flat aquifers in Groundwater Management Area 4.

PARAMETERS AND ASSUMPTIONS:

- The areas, in acres, for each map area were calculated using the shapefile used for the steady-state groundwater availability model for the Presidio-Redford, Red Light Draw, Green River Valley, and Eagle Flat bolson aquifers, projected into the groundwater availability modeling (GAM) projection (Anaya, 2001), within ArcGIS 9.3.
- Recharge to the Red Light Draw, Green River Valley, and Eagle Flat aquifers is estimated to be 1,631, 248, and 2,869 acre-feet per year,

- respectively, based on a runoff-redistribution method (Beach and others, 2008).
- Recharge to the Presidio-Redford Bolson Aquifer is estimated at 3,630 acre-feet per year, calculated as 1 percent of average annual rainfall over the recharge area of the bolson (FWTRWPG, 2001).
 - Specific yield of the Red Light Draw, Green River Valley, and Eagle Flat aquifers is estimated to be 0.035, based on estimates from the calibrated steady-state groundwater availability model for these aquifers (Beach and others, 2008).
 - Specific yield of the Presidio-Redford Bolson Aquifer is estimated to be 0.075 for the Alamito Creek area of the Presidio Bolson and 0.10 for the Redford Bolson (Gates and others, 1980). The average of these estimates, 0.0875, was used in this assessment.
 - All of the aquifers are assumed to be unconfined.
 - The draft annual total pumping estimates are the sum of the annual effective recharge amount and the annual volume of water depleted from the aquifer based on the draft desired future condition.
 - Annual volumes of water taken from storage are calculated by dividing the total volume of depletion, based on the draft desired future condition, by 50 years.
 - Water-level declines are estimated to be uniform across the aquifer within map areas.
 - It is assumed that the water-level declines do not exceed aquifer thickness.
 - Conditions were assumed to be physically possible across the groundwater management area.

RESULTS:

The total annual effective recharge estimate for the Presidio-Redford Bolson, Red Light Draw, Green River Valley, and Eagle Flat aquifers in Groundwater Management Area 4 is 8,378 acre-feet per year (Table 1).

Tables 1 and 2 show the draft annual total pumping estimates for the Presidio-Redford Bolson, Red Light Draw, Green River Valley, and Eagle Flat aquifers in Groundwater Management Area 4. Based on the draft desired future conditions provided, the estimated total pumping volume for these aquifers in Groundwater Management Area 4 is 15,064 acre-feet per year. Specifically,

- Culberson County GCD has a total of 1,205 acre-feet per year of total pumping in the Eagle Flat Aquifer and 69 acre-feet per year of total pumping in the Green River Valley Aquifer;

- the area of Hudspeth County outside the Hudspeth County UWCD No. 1 has a total of 3,741 acre-feet per year of total pumping in the Eagle Flat Aquifer, 306 acre-feet per year total pumping in the Green River Valley Aquifer, and 3,285 acre-feet per year of total pumping in the Red Light Draw Aquifer;
- Jeff Davis County UWCD has a total of 128 acre-feet per year of total pumping in the Green River Valley Aquifer; and
- Presidio County UWCD has a total of 6,282 acre-feet per year of total pumping in the Presidio-Redford Bolson Aquifer and 48 acre-feet per year of total pumping in the Green River Valley Aquifer.

Table 1. Estimates of annual total pumping for the Presidio-Redford, Red Light Draw, Green River Valley, and Eagle Flat bolson aquifers in Groundwater Management Area 4, summarized by map areas (see Figure 1).

GMA	Aquifer	County	GCD	Map area	Specific yield	Areal extent (acres)	Desired total aquifer drawdown (feet)	Estimated total volume from storage (acre-feet)	Estimated annual volume from storage (ac-ft/yr)	Estimated annual effective recharge (ac-ft/yr)	Estimated annual total volume (ac-ft/yr)	
4	Red Light Draw	Hudspeth	none	1	0.035	118,127	20	82,689	1,654	1,631	3,285	
		Hudspeth	none	2	0.035	97,541	20	68,279	1,366	2,375	3,741	
	Eagle Flat	Culberson	County GCD	3	0.035	20,309	50	35,541	711	494	1,205	
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	Green River Valley	Jeff Davis	County UWCD	Jeff Davis County UWCD	6	0.035	1,537	50	2,690	54	15	69
	Presidio-Redford Bolson	Presidio	County UWCD	Presidio County UWCD	8	0.0875	303,081	5	132,598	2,652	3,630	6,282

GMA = groundwater management area, GCD = groundwater conservation district, ac-ft/yr = acre-feet per year, UWCD = underground water conservation district.

The formulas in this table are:

specific yield * areal extent * desired total aquifer drawdown = estimated total volume from storage

estimated total volume from storage/50 = estimated annual volume from storage

estimated annual volume from storage + estimated annual effective recharge = estimated annual total volume

Table 2. Summary of estimated annual total pumping for the Presidio-Redford, Red Light Draw, Green River Valley, and Eagle Flat bolson aquifers in Groundwater Management Area 4.

Map key	Aquifer	County	RWPA	River basin	GCD	GMA	GeoArea	Year	Total Pumping (ac-ft/yr)	
1	Red Light Draw	Hudspeth	E	Rio Grande	none	4	n/a	n/a	3,285	
2	Eagle Flat	Hudspeth	E	Rio Grande	none	4	n/a	n/a	3,741	
3	Eagle Flat	Culberson	E	Rio Grande	Culberson County	GCD	4	n/a	n/a	1,205
4	Green River Valley	Hudspeth	E	Rio Grande	none	4	n/a	n/a	306	
5	Green River Valley	Culberson	E	Rio Grande	Culberson County	GCD	4	n/a	n/a	69
6	Green River Valley	Jeff Davis	E	Rio Grande	Jeff Davis County	UWCD	4	n/a	n/a	128
7	Green River Valley	Presidio	E	Rio Grande	Presidio County	UWCD	4	n/a	n/a	48
8	Presidio-Redford Bolson	Presidio	E	Rio Grande	Presidio County	UWCD	4	n/a	n/a	6,282

RWPA = regional water planning area, GCD = groundwater conservation district, UWCD = underground water conservation district, GMA = groundwater management area, GeoArea = geographic areas defined by unique desired future conditions as specified by a groundwater management area, ac-ft/yr = acre-feet per year.

LIMITATIONS:

Additional data are needed to create improved estimates; these estimates are a fundamental interpretation of the requested conditions. This analysis assumes homogeneous and isotropic aquifers; however, conditions for the Presidio-Redford Bolson, Red Light Draw, Green River Valley, and Eagle Flat aquifers may not behave in a uniform manner. The analysis further assumes that lateral inflow to the aquifer is equal to lateral outflow from the aquifer and that future pumping will not alter this balance.

REFERENCES:

- Anaya, R., 2001, GAM technical memo 01-01(rev a): Texas Water Development Board technical memorandum, 2 p.
- Beach, J.A., Symank, L., Huang, Y., Ashworth, J.B., Davidson, T., Collins, E.W., Hibbs, B.J., Darling, B.K., Urbanczyk, K., Calhoun, K., and Finch, S., 2008, Groundwater availability model for the West Texas Bolsons (Red Light Draw, Green River Valley, and Eagle Flat) Aquifer in Texas, prepared for Texas Water Development Board, var. pag.
- Freeze, R.A., and Cherry, J.A., 1979, Groundwater: Englewood Cliffs, New Jersey, Prentice Hall, Inc., 604.
- FWTRWPG (Far West Texas Regional Water Planning Group), 2001, Far West Texas Regional Water Plan, var. pag.

GTA Aquifer Assessment 09-10
Groundwater Management Area 4
Presidio-Redford, Red Light Draw, Green River Valley, and Eagle Flat bolson aquifers
Evaluation of draft desired future conditions
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Gates, J.S., White, D.E., Stanley, W.D., and Ackermann, H.D., 1980, Availability of fresh and slightly saline ground water in the basins of westernmost Texas: Texas Water Development Board Report 256, 108 p.

Muller, D.A. and Price, R.D., 1979, Ground-water availability in Texas, estimates and projections through 2030: Texas Department of Water Resources Report 238, 77 p.

Theis, C.V., 1940, The source of water derived from wells—Essential factors controlling the response of an aquifer to development: Civil Engineering, v. 10, p. 277–280.