

GTA Aquifer Assessment 08-02mag

by **Robert G. Bradley, P.G.**

Texas Water Development Board
Groundwater Technical Assistance Section
(512) 936-0870
May 1, 2009

REQUESTOR:

Cheryl Maxwell, of the Clearwater Underground Water Conservation District acting on behalf of Groundwater Management Area 8.

DESCRIPTION OF REQUEST:

In a letter dated June 10, 2008, Ms. Cheryl Maxwell provided the Texas Water Development Board (TWDB) with the desired future conditions for the Ellenburger-San Saba, Hickory, and Marble Falls aquifers in Groundwater Management Area 8 and requested that TWDB estimate managed available groundwater values. This aquifer assessment presents the managed available groundwater for the Marble Falls Aquifer in Groundwater Management Area 8.

DESIRED FUTURE CONDITIONS:

- Burnet County should maintain approximately 100 percent of the saturated thickness after 50 years by using approximately 80 percent of the estimated recharge.
- Lampasas County should maintain approximately 90 percent of the saturated thickness after 50 years.

METHODS:

The desired future conditions requested for the Marble Falls Aquifer were based on maintaining a percentage of the estimated saturated thickness left in 50 years. The desired future for Burnet County adds a stipulation of using 80 percent of the estimated recharge. Because this is a volume and not a condition of the aquifer, this part of the statement was disregarded in the calculation of the managed available groundwater.

The amount of data available for the Marble Falls Aquifer is limited; no site-specific information on specific yield from the aquifer is available. A limited number of wells indicate that the saturated thickness assumed by Williams (2008) is reasonable for the estimation of managed available groundwater (TWDB 2009).

A transient hydrologic budget for the saturated portion of an aquifer is (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

In addition, it is assumed that:

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

Then the total rate of groundwater withdrawal equals effective recharge plus the change in storage of the aquifer, or:

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

For the desired future condition in Burnet County, in which no water can be taken from storage, then dS/dt can be set to zero and the budget is simplified to obtain,

$$Q(t) = R(e)$$

County, river basin, and groundwater conservation district boundaries subdivided the aquifer into map areas (Figure 1). The areal extent of each aquifer map area was calculated. These areas were used to calculate estimated average effective recharge and pumped volumes.

To determine the volume from storage used, the areas were multiplied by the estimated aquifer specific yield, and then by the drained saturated thickness necessary to maintain the desired future condition. This volume was then divided by 50 years to obtain a yearly volume.

Average annual effective recharge to the aquifer was calculated by multiplying each area by the average precipitation (1971 to 2000) and an estimated effective recharge rate.

Water-level data from the TWDB groundwater database was used to calculate average saturated thickness.

The calculations were done in a Microsoft Excel worksheet.

The two conditions were assumed to be physically possible individually and collectively across groundwater management area.

PARAMETERS AND ASSUMPTIONS:

- The estimated average total thickness of the Marble Falls Aquifer is 160 feet (CTGCD, 2007, Williams 2008, TWDB 2008)
- The areas for each subdivision were calculated from the Texas Water Development Board (TWDB) shapefile for the Marble Falls Aquifer, projected into the GAM projection (Anaya, 2001).
- Areas, in acres, were calculated within ArcGIS 9.2.
- Average annual precipitation was used to calculate annual average effective recharge volumes.
- The average annual precipitation for each aquifer map area (Table 1) was determined from the Texas Climatic Atlas (Narasimhan and others, 2008) which is for the average for years 1971 to 2000.
- Average effective recharge from precipitation is estimated to be 5 percent of annual precipitation (Muller and Price, 1979, Preston and others, 1996, CTGCD, 2007, Williams, 2008,).
- The managed available groundwater volume estimates are the sum of the annual average effective recharge amount and the volume of water depleted from the aquifer based on the desired future condition.
- Annual volumes are calculated by dividing the total volume by 50 years.
- Specific yield of the aquifer is estimated as 0.15 (Williams, 2008; Heath, 2004; Morris and Johnson, 1967).

RESULTS:

The estimated average effective recharge for the Marble Falls Aquifer in GMA 8 is 4,035 acre-feet per year (Table 1).

The results (Tables 2 and 3) show 4,815 acre-feet per year of managed available groundwater for the Marble Falls Aquifer in Groundwater Management Area 8. The Saratoga Underground Water Conservation District, in Lampasas County, has 2,837 acre-feet per year of managed available groundwater in the Marble Falls Aquifer. Central Texas Groundwater Conservation District has 1,978 acre-feet per year.

Table 1. Estimated total annual average effective recharge volume for the Marble Falls Aquifer by map area subdivisions (See Figure 1).

GMA	Aquifer	County	GCD	Map area	Areal extent (acres)	Average precipitation (inches)	Average precipitation (feet)	Recharge rate (percent)	Estimated annual recharge (acre-feet)
8	Marble Falls	Lampasas	Saratoga UWCD	1	13,434	30	2.5	5	1,679
				2	2,802	32	2.7	5	378
		Burnet	Central Texas GCD	3	715	31	2.6	5	93
				4	15,078	30	2.5	5	1,885
Total									4,035

UWCD = underground water conservation district GCD= groundwater conservation district
 GMA = groundwater management area

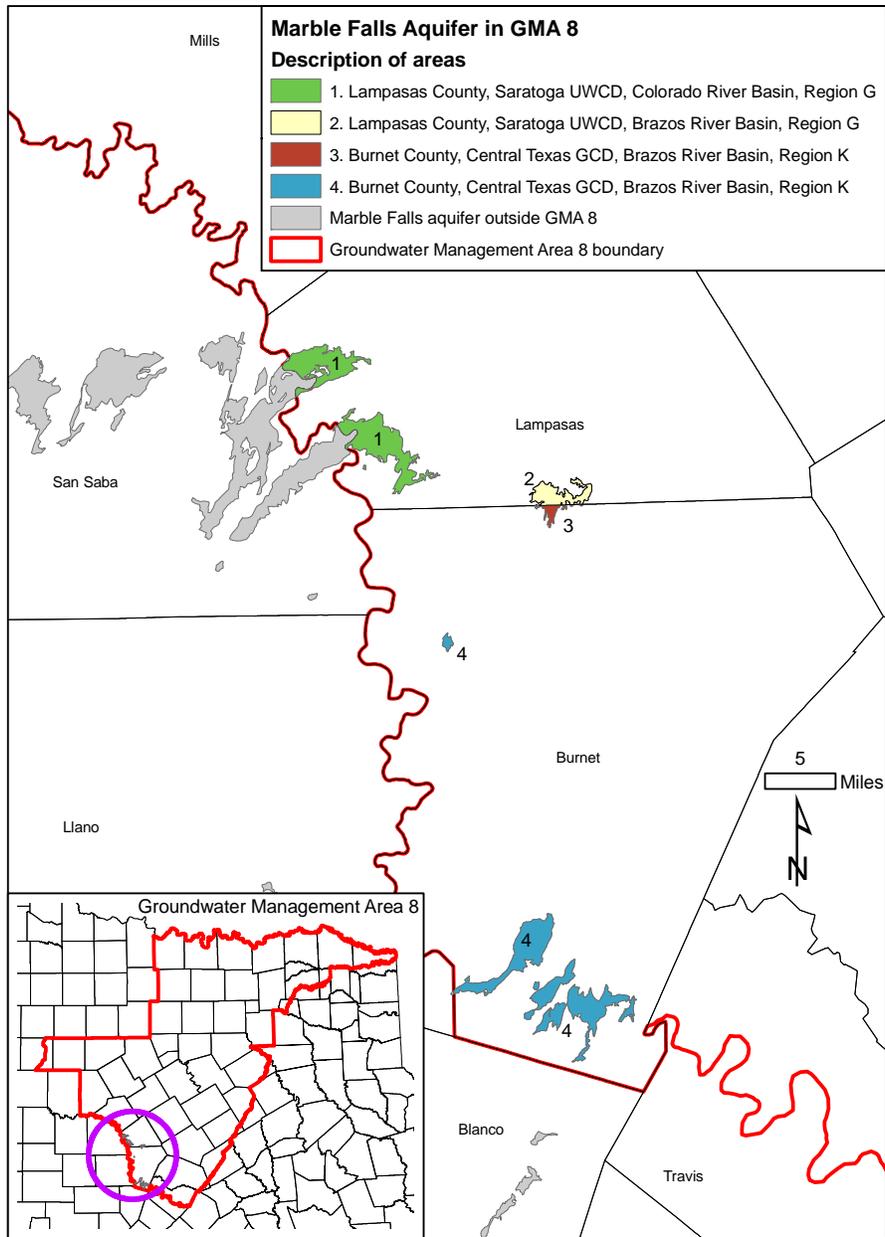


Figure 1. Geographic subdivisions for analyzing managed available groundwater the Marble Falls Aquifer in groundwater management area 8. GMA = groundwater management area, UWCD = underground water conservation district, GCD = groundwater conservation district.

Table 2. Estimates of managed available groundwater for the Marble Falls Aquifer by map area subdivisions (see Figure 1).

GMA	Aquifer	County	GCD	Map area	Specific yield	Areal extent (acres)	Estimated saturated thickness (feet)	Desired future percent of saturated thickness	Desired future saturated thickness (feet)	Saturated thickness drained (feet)	Estimated total volume from storage (acre-feet)	Estimated annual volume from storage (acre-feet)	Estimated annual recharge (acre-feet)	Estimated annual total Volume (acre-feet)	
8	Marble Falls	Lampasas	Saratoga UWCD	1	0.15	13,434	160	90	144	16	32,242	645	1,679	2,324	
				2	0.15	2,802	160	90	144	16	6,725	134	378	513	
		Burnet	Central Texas GCD	3	0.15	715	160	100	160	0	0	0	0	93	93
				4	0.15	15,078	160	100	160	0	0	0	1,885	1,885	
		Total											779	4,035	4,815

GMA = groundwater management area

UWCD = underground water conservation district

GCD= groundwater conservation district

Table 3. Estimates of managed available groundwater for the Marble Falls Aquifer (See Figure 1).

Aquifer	Map Key	County	RWPA	River Basin	GCD	GMA	GeoArea	Year	MAG (acre-feet per year)
Marble Falls	1	Lampasas	G	Colorado	SUWCD	8	n/a	n/a	2,324
Marble Falls	2	Lampasas	G	Brazos	SUWCD	8	n/a	n/a	513
Marble Falls	3	Burnet	K	Brazos	CTGCD	8	n/a	n/a	93
Marble Falls	4	Burnet	K	Colorado	CTGCD	8	n/a	n/a	1,885

RWPG = regional water planning area GCD= groundwater conservation district GMA = groundwater management area
 GeoArea = geographic areas defined by unique desired future conditions as specified by a groundwater management area.
 CTGCD = Central Texas Groundwater Conservation District SUWCD = Saratoga Underground Water Conservation District
 MAG = managed available groundwater in units of acre-feet per year.

STIPULATIONS:

Additional data are needed to create improved estimates; these estimates are a simplistic interpretation of the requested conditions. These solutions assume homogeneous and isotropic aquifers; however, conditions for the Marble Falls Aquifer may not behave in a uniform manner.

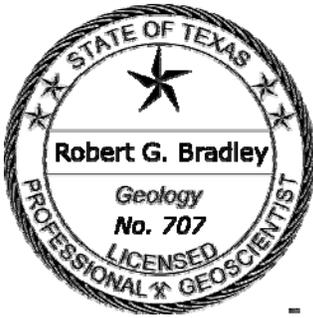
Note that estimates of managed available groundwater are based on the best available scientific tools that can be used to evaluate managed available groundwater and that these estimates can be a function of assumptions made on the magnitude and distribution of pumping in the aquifer. Therefore, it is important for groundwater conservation districts to monitor whether or not they are achieving their desired future conditions and to work with the TWDB to refine managed available groundwater given the reality of how the aquifer responds to the actual magnitude and distribution of pumping now and in the future.

REFERENCES:

- Anaya, R., 2001, GAM technical memo 01-01(rev a): Texas Water Development Board technical memorandum, 2 p.
- CTGCD, 2007, Central Texas Groundwater Conservation District management plan: Central Texas Groundwater Conservation District, 56 p.
- Heath, R.C., 1983, Basic ground-water hydrology: U.S . Geological Survey Water-Supply Paper 2220, 86 p.
- Morris, D.A. and A.I. Johnson. 1967. Summary of hydrologic and physical properties of rock and soil materials as analyzed by the Hydrologic Laboratory of the U.S. Geological Survey 1948-1960. U.S. Geological Survey Water Supply Paper 1839-D. 42 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.
- Narasimhan, B., Srinivasan, R., Quiring, S., and Nielsen-Gammon, J.W., 2008, Digital Climatic Atlas of Texas: Texas A&M University, Texas Water Development Board Contract, Report 2005-483-5591, 108 p.
- Preston, R. D., Pavlicek, D. J., Bluntzer, R. L., Derton, J., 1996, The Paleozoic and related aquifers of Central Texas: Texas Water Development Board, Report 346, 85 p.

Texas Water Development Board, 2009, Groundwater database: Texas Water Development Board, Water Science and Conservation Division.

Williams, C.R, 2008, Adopted desired future conditions of minor aquifers: memorandum to Cheryl Maxwell, Groundwater Management Area 8, 12 p.



The seal appearing on this document was authorized by Robert G. Bradley, P.G., on May 1, 2009



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April 30, 2009

Mr. Gary Westbrook, General Manager
Post Oak Savannah Groundwater Conservation District
P.O. Box 92
Milano, TX 76556

Re: Managed available groundwater estimates for the Marble Falls Aquifer in Groundwater Management Area 8

Dear  Mr. Westbrook:

The Texas Water Code, Section 36.108, Subsection (o), states that Texas Water Development Board's executive administrator shall provide each district and regional water planning group located wholly or partly within a groundwater management area with the managed available groundwater in the management area based upon the desired future condition of the groundwater resource. This letter and the attached report (GTA Aquifer Assessment 08-02mag) are in response to this directive.

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We understand that groundwater conservation districts have options on how to distribute managed available groundwater in a groundwater management area; therefore we encourage open communication and coordination between groundwater conservation districts, regional water planning groups and the TWDB to ensure that managed available groundwater reported in

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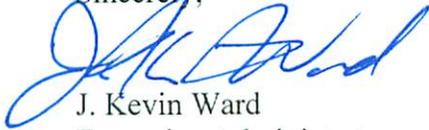
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Sincerely,



J. Kevin Ward

Executive Administrator

Attachment: GTA Aquifer Assessment 08-02mag

c w/att.: Cary Betz, Texas Commission of Environmental Quality, Water Supply Division
Kelly Mills, Texas Commission of Environmental Quality, Groundwater Planning and Assessment Division
Robert E. Mace, Ph.D., P.G., Deputy Executive Administrator, TWDB, Water Science and Conservation
Rima Petrossian, P.G., Manager, TWDB, Groundwater Technical Assistance Section
Cindy Ridgeway, P.G., Manager, TWDB, Groundwater Availability Modeling Section
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April 30, 2009

Mr. Russell Laughlin, Board President
Northern Trinity Groundwater Conservation District
13600 Heritage Parkway, Suite 200
Fort Worth, TX 76177

Re: Managed available groundwater estimates for the Marble Falls Aquifer in Groundwater Management Area 8

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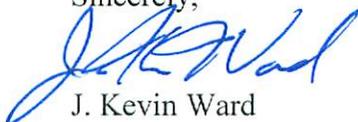
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April 30, 2009

Mr. Joe Cooper, General Manager
Middle Trinity Groundwater Conservation District
150 North Harbin Drive, Suite 434
Stephenville, TX 76401

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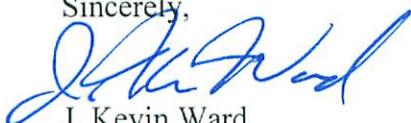
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April 30, 2009
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Ms. Tricia Law, General Manager
McLennan County Groundwater Conservation District
3015 Bellmead Drive
Waco, TX 76705

Re: Managed available groundwater estimates for the Marble Falls Aquifer in Groundwater Management Area 8

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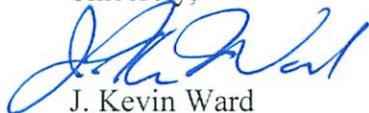
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April 30, 2009

Mr. Rodney Carlisle, Board President
Fox Crossing Water District
P.O. Box 926
Goldthwaite, TX 76844

Re: Managed available groundwater estimates for the Marble Falls Aquifer in Groundwater Management Area 8

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c w/att.: Cary Betz, Texas Commission of Environmental Quality, Water Supply Division
Kelly Mills, Texas Commission of Environmental Quality, Groundwater Planning and Assessment Division
Robert E. Mace, Ph.D., P.G., Deputy Executive Administrator, TWDB, Water Science and Conservation
Rima Petrossian, P.G., Manager, TWDB, Groundwater Technical Assistance Section
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Mark Lowry, AECOM



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Joe M. Crutcher, *Member*

April 30, 2009

Ms. Cheryl Maxwell, General Manager
Clearwater Underground Water Conservation District
P.O. Box 729
Belton, TX 76513

Re: Managed available groundwater estimates for the Marble Falls Aquifer in Groundwater Management Area 8

Dear Ms. Maxwell:

The Texas Water Code, Section 36.108, Subsection (o), states that Texas Water Development Board's executive administrator shall provide each district and regional water planning group located wholly or partly within a groundwater management area with the managed available groundwater in the management area based upon the desired future condition of the groundwater resource. This letter and the attached report (GTA Aquifer Assessment 08-02mag) are in response to this directive.

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Ms. Cheryl Maxwell

April 30, 2009

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Sincerely,



J. Kevin Ward

Executive Administrator

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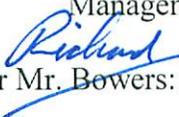
J. Kevin Ward
Executive Administrator

Jack Hunt, *Vice Chairman*
Thomas Weir Labatt III, *Member*
Joe M. Crutcher, *Member*

April 30, 2009

Mr. Richard Bowers, General Manager
Central Texas Groundwater Conservation District
P.O. Box 870
Burnet, TX 78611

Re: Managed available groundwater estimates for the Marble Falls Aquifer in Groundwater Management Area 8


Dear Mr. Bowers:

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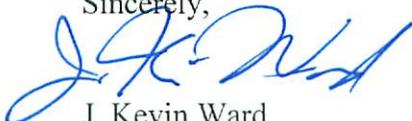
Mr. Richard Bowers

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Joe M. Crutcher, *Member*

April 30, 2009

The Honorable John Firth
Coryell County Judge
Tablerock Groundwater Conservation District
620 East Main
Gatesville, TX 76528

Re: Managed available groundwater estimates for the Marble Falls Aquifer in Groundwater Management Area 8

Dear Judge Firth:

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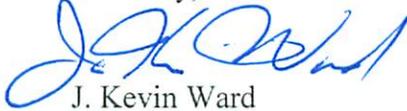
The Honorable John Firth

April 30, 2009

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J. Kevin Ward

Executive Administrator

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April 30, 2009

Mr. Mike Massey, Board President
Upper Trinity Groundwater Conservation District
P.O. Box 1786
Granbury, TX 76048

Re: Managed available groundwater estimates for the Marble Falls Aquifer in Groundwater Management Area 8

Dear Mr. Massey:

The Texas Water Code, Section 36.108, Subsection (o), states that Texas Water Development Board's executive administrator shall provide each district and regional water planning group located wholly or partly within a groundwater management area with the managed available groundwater in the management area based upon the desired future condition of the groundwater resource. This letter and the attached report (GTA Aquifer Assessment 08-02mag) are in response to this directive.

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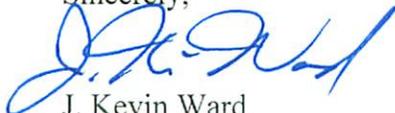
Mr. Mike Massey

April 30, 2009

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J. Kevin Ward

Executive Administrator

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Joe M. Crutcher, *Member*

April 30, 2009

Mr. Thomas G. Mason, General Manager
Lower Colorado River Authority
P.O. Box 220
Austin, TX 78767

Re: Managed available groundwater estimates for the Marble Falls Aquifer in Groundwater Management Area 8

Dear Mr. Mason:

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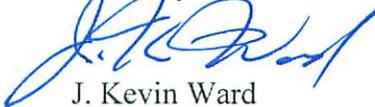
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Thomas Weir Labatt III, *Member*
Joe M. Crutcher, *Member*

April 30, 2009

Mr. Phil Ford, General Manager
Brazos River Authority
P.O. Box 7555
Waco, TX 76714

Re: Managed available groundwater estimates for the Marble Falls Aquifer in Groundwater Management Area 8


Dear Mr. Ford:

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Mr. Phil Ford
April 30, 2009
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Joe M. Crutcher, *Member*

April 30, 2009

The Honorable Dale Spurgin
Jones County Judge
Region G Chairman
P.O. Box 148
Anson, TX 79501

Re: Managed available groundwater estimates for the Marble Falls Aquifer in Groundwater Management Area 8

Dear Judge Spurgin:

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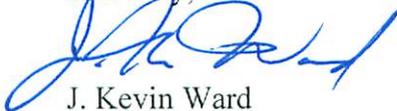
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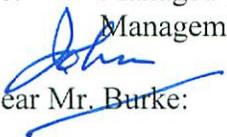
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April 30, 2009

Mr. John Burke
Region K Chairman
Aqua Water Supply Corporation
P.O. Drawer P
Bastrop, TX 78602

Re: Managed available groundwater estimates for the Marble Falls Aquifer in Groundwater Management Area 8


Dear Mr. Burke:

The Texas Water Code, Section 36.108, Subsection (o), states that Texas Water Development Board's executive administrator shall provide each district and regional water planning group located wholly or partly within a groundwater management area with the managed available groundwater in the management area based upon the desired future condition of the groundwater resource. This letter and the attached report (GTA Aquifer Assessment 08-02mag) are in response to this directive.

As noted in your letter dated June 10, 2008, the desired future condition submitted for the Marble Falls Aquifer in Groundwater Management Area 8 was as follows:

- Burnet County should maintain approximately 100 percent of the saturated thickness after 50 years by using approximately 80 percent of the estimated recharge.
- Lampasas County should maintain approximately 90 percent of the saturated thickness after 50 years.

Managed available groundwater is defined in the Texas Water Code as the amount of water that may be permitted by a district for beneficial use in accordance with the desired future condition of the aquifer as determined under Texas Water Code, Section 36.108. For various planning purposes the managed available groundwater estimates have been reported at the combined aquifer, county, river basin, regional water planning area, groundwater management area, groundwater conservation district (if applicable), and geographic area (if designated) level.

We understand that groundwater conservation districts have options on how to distribute managed available groundwater in a groundwater management area; therefore we encourage

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Mr. John Burke

April 30, 2009

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open communication and coordination between groundwater conservation districts, regional water planning groups and the TWDB to ensure that managed available groundwater reported in regional water plans and groundwater management plans are not in conflict. In addition, please note that estimates of managed available groundwater are based on the best available scientific tools that can be currently used to evaluate managed available groundwater and that these estimates may be based on assumptions made on the magnitude and distribution of pumping in the aquifer. Therefore, it is important for groundwater conservation districts to monitor whether or not their management of pumping is achieving their desired future conditions. Districts are encouraged to continue work with the TWDB to better define available groundwater as additional new data could help better assess responses of the aquifer to actual pumpage values and their distribution now and in the future.

Sincerely,



J. Kevin Ward

Executive Administrator

Attachment: GTA Aquifer Assessment 08-02mag

c w/att.: Cary Betz, Texas Commission of Environmental Quality, Water Supply Division
Kelly Mills, Texas Commission of Environmental Quality, Groundwater Planning and Assessment Division
Robert E. Mace, Ph.D., P.G., Deputy Executive Administrator, TWDB, Water Science and Conservation
Rima Petrossian, P.G., Manager, TWDB, Groundwater Technical Assistance Section
Cindy Ridgeway, P.G., Manager, TWDB, Groundwater Availability Modeling Section
Robert G. Bradley, P.G., Groundwater Management Area Liaison, TWDB Groundwater Technical Assistance Section
Carolyn Brittin, Deputy Executive Administrator, TWDB, Water Resources Planning and Information
David Meesey, Planner - Region K, TWDB, Regional Water Planning Section
Matt Nelson, Planner - Region G, TWDB, Regional Water Planning Section
David Dunn, HDR Engineering, Inc.
Mark Lowry, AECOM



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April 30, 2009

Mr. Randy McGuire, Manager
Saratoga Underground Water Conservation District
P.O. Box 231
Lampasas, TX 76550

Re: Managed available groundwater estimates for the Marble Falls Aquifer in Groundwater Management Area 8

Dear Mr. McGuire:

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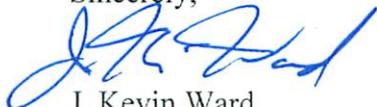
Mr. Randy McGuire

April 30, 2009

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J. Kevin Ward

Executive Administrator

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