ARIZONA DEPARTMENT OF WATER RESOURCES
WATER PLANNING DIVISION

MEMORANDUM

TO: File
THRU: Andrew Craddock, Manager, AAWS & Recharge Permitting
FROM: Lou Bota, Hydrologist, AAWS & Recharge Permitting
DATE: March 13, 2012
RE: Application for an Analysis of Adequate Water Supply, Pueblo del Sol Water Company, Tribute Master Planned Community (file 40-700705.0000).

Castle & Cooke Arizona, Inc. (C&C0 is developing the Tribute Master Planned Community (Tribute MPC) located within the City of Sierra Vista. The Tribute plan consists of 6,959 residential units on 1,916 acres and constitutes nearly all the development land within Certificate of Convenience and Necessity (CC&N) of Pueblo del Sol Water Company (PDS). The projected demand at build out is 2,471.48 acre-feet per year. The Tribute MPC is located in portions of Section 5, 7, 8, 9, 17, and 18, Township 23 South and Range 21 East.

Fluid Solutions (FS) has been assisting C&C in evaluating and demonstrating water availability for the project. FS and C&C has retained Brown & Caldwell to perform the groundwater modeling in support of the analysis for Adequate Water Supply.

B&C used the United States Geological Survey (USGS) Upper San Pedro model version 4 for this analysis. The model is broken up into the following simulations: steady-state (prior to 1902); steady-state oscillatory (a seasonal steady-state simulation prior to 1902); transient simulations from 1902 to 1911, 1911 to 1930, 1930 to 1940, 1940 to 1950, 1950 to 1960, 1960 to 1973, 1973 to 1986, and 1986 to 2003. The model, with adjusted aquifer parameters in the Tribute MPC area, based on recent aquifer tests, was used to simulate pumping for 100 years at the proposed development production well locations. The USGS model was updated to year 2008 and calibrated in the proposed development area to better simulate the results of the aquifer tests, and to better match the observed groundwater levels in the area. The output files produced as the result of the simulations were sent for analysis to the Department.

Model Information

Active Model Domain ~1,135 square miles, ~725,000 acres
Units Time: Days
Length: Meters (lateral and vertical)
Coordinate System: UTM NAD83, Zone 12N
GIS: lateral units in meters, vertical units in meters
Model Grid: 440 rows by 320 columns, 704,000 total cells, 81,160 active cells
Origin X: 529,999.951 Y: 3,419,999.983 (No rotation)
Cell Size: 250 meters by 250 meters (uniform)

MODFLOW Packages MODFLOW 2000, Drain, Well, Stream, ET, Recharge, BAS, DIS, LPF, CHD
Stress Periods and Simulation Time:
Base Model: 45 Seasonal Stress Periods, 10 time steps each, 1.5 multiplier
Begins on March 12, 1986 and continues to October 15, 2008.
Predictive Model No. 1: 104 Seasonal Stress Periods, 10 time steps each, 1.5 multiplier
Begins on October 16, 2008 and continues until October 15, 2060
Predictive Model No. 2: 100 Seasonal Stress Periods, 10 time steps each, 1.5 multiplier
Begins on October 16, 2060 and continues until October 15, 2110
Recharge Cell inputs range from 0.001 ft/yr to 28.5 ft/yr

Hydrological Properties of the Study Area

Layering – 5 Layers
Layer 1: Pre and post-entrenchment stream alluvium, and the sand and gravel facies of the upper basin fill. LAYCON = 1 (Unconfined)
Layer 2: Sand, gravel, silt and clay facies of the upper basin fill. LAYCON = 3 (Unconfined/ Confined; T varies)
Layer 3: Sand, gravel, siltstone, and mudstone facies of the lower basin fill. LAYCON = 3 (Unconfined/Confined; T Varies)
Layer 4: Sand and gravel facies of the lower basin fill. LAYCON = 3 (Unconfined/ Confined; T varies)
Layer 5: sand and gravel facies on the perimeter of the alluvial basin of the lower basin fill; siltstone and conglomerate of the Pantano Formation, and consolidated rock. LAYCON = 3 (Unconfined/Confined; T varies)
Hydraulic Parameters
Layer 1: K = 4.0 m/d to 7.5 m/d; Sy = 0.3 ; SS = 0.000001
Layer 2: K = 0.02 to 5 m/d; Sy = 0.05 to 0.25 ; SS = 0.00002
Layer 3: K = 0.001 to 4 m/d; Sy = 0.05 to 0.1; SS = 0.000005 to 0.00001
Layer 4: K = 0.001 to 6.25 m/d; Sy = 0.05 to 0.25; SS = 0.000005
Layer 5: K = 0.000125 to 0.625 m/d; Sy = 0.001 to 0.2; SS = 0.000001

Boundary Conditions:

-Constant Heads at the North end of the model to represent underflow to the remaining portion of the Upper San Pedro Basin;
-Constant Heads along the Mexican Boundary to represent underflow from the Mexico portion of the Basin.
Initial Conditions:
- Resulting heads from the immediately previous transient USGS model

Wells:
- Imported as prescribed flux analytical element wells. (Note: These wells sum to a total pumping value for each model node. They include both pumping and recharge wells.)

Model Calibration

At the end of calibration period (2008) the simulated water levels were compared with the measured water level. The differences between the two, the residuals, were calculated to assess the quality of the simulation. Calibrated statistics based on the residual values were used as a quantitative measure of the overall ability of the model to match observed conditions. Calibration statistics that were calculated to quantify the average of the residuals included: Absolute Residual Mean (ARM - the arithmetic average of the absolute value of the residuals), Residual Mean (RM – the arithmetic average of the residuals), and Residual Standard Deviation (RSD – the standard deviation of the residuals).
The calibration statistics were presented in the following table:

(RM) (feet)	(ARM) (feet)	(RSD) (feet)	Sim. Range of Head Values (feet)	RM/Range %	ARM/Range %	RSD/Range %
1986 to 2008						
-1.09	9.56	23.47	483	0.22	2	4.9
2007 to 2008(365 days)						
-0.9	2.81	5.07	82	1	3.4	6.2

The residuals for the locations were the proposed wells are built are:

Well ID (feet amsl)	Observed Water Level (feet amsl)	Simulated Water Level (feet amsl)	Residual (feet)
Well #2	4334.7	4342.113	-7
Well #3	4181.3	4185.781	-4
Well #4	4174.4	4186.766	-12
Well #5	4200	4184.994	15

Both the statistics and the residuals at the proposed wells indicate that the model was successfully calibrated at the end of transient simulation.

Model Results for 100 Year Runs

In order to simulate the impact of the new proposed development B&C had two runs of 100 years each. In one the total pumping represented the existing pumping in 2008 plus all the approved demand from 2008 to date (Non Tribute simulation). The second 100 year run included the pumping at Tribute development plus all the pumping from first simulation (Tribute simulation). The results were presented in figures showing the water elevation, depth to water, and the drawdown at the end of 100 year simulation for both Tribute and Non Tribute simulations.

The water level map shows that the regional flow proceeds radially from west, south, and east towards Wells No. 3 and Well No. 5. The predicted water altitude for the Tribute simulation is approximately 4050 at Well No 3 and Well No.5.

Depth to water for Non Tribute simulation reached the maximum value of 565 feet near Well No.5. For the Tribute simulation the maximum depth to water reached 613 feet near Well No5.

The drawdown for the Tribute simulation shows an increase of approximately 50 feet as the result of the new proposed development. The maximum difference between drawdown in the Tribute simulation and the Non Tribute simulation is approximately 70 feet near Well No.5.

Conclusion

The 100 year simulation using the Sierra Vista Model, developed by USGS, a three-dimensional numerical groundwater flow model used to simulate water level changes in response to current, committed, and the new proposed development indicates that the depth to water in the area of the basin under the influence of PDS pumping do not exceed 650 feet below land surface. The model shows that the proposed pumping results in water level that do not exceed 1200 feet below land surface, the depth to bedrock or the saturated thickness of the aquifer.