Review of the Evidence Provided by the Southern Nevada Water Authority of Proposed Development on the Hydrogeology of Spring Valley, White Pine and Lincoln County, Nevada

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INTRODUCTION

SNWA is proposing a massive water mining development that violates the spirit, if not the letter, of Nevada groundwater law; let me explain. Nevada's Water Resources—Report 3 defines both perennial yield and storage depletion reserve; I quote:

Perennial yield *of a ground water reservoir may be defined as the maximum amount of ground water that can be salvaged each year over the long term without depleting the ground water reservoir. Perennial yield is ultimately limited to the maximum amount of the natural discharge that can be salvaged for beneficial use. Perennial yield cannot be more than the natural recharge to a ground water basin and in some cases is less.*

Transitional storage reserve *is the quantity of water in storage in a particular ground water reservoir that is extracted during the transition period between natural equilibrium and new equilibrium conditions under the perennial yield concept of ground water development. ... the transitional storage reserve of such a reservoir means the amount of stored water which is available for withdrawal by pumping during the non-equilibrium period of development (i.e., the period of lowering of water levels).*

These definitions imply that one expects that the developed groundwater system will reach a new equilibrium state in which the pumping is balanced by the natural discharge that can be salvaged—i.e. balanced by the amount of the natural discharge captured by the pumping. As a corollary, one expects that the new equilibrium state will be reached in some reasonable period.

GROUNDWATER MODELS

The tool to predict how a groundwater system will behave in the future is the groundwater model. I believe, that the applicant, in this case SNWA, has an obligation to predict the response of the system to pumping, especially since they created an elegant groundwater model. SNWA did not make predictions of the impacts of their proposed pumping because, I believe, it damages their application—more on this below.

Groundwater models are calibrated in two modes: 1) in the virgin state—prior to pumping, 2) in the pumping or development mode. In the case of Spring Valley there is insufficient pumping to calibrate the model in a development mode. This does not preclude a prediction; it means that predictions of the impacts of pumping will have a higher degree of uncertainty—more on this below.

Virgin State Model

SNWA (Durbin) presents a sophisticated model analysis of the system in the virgin state. To do the analysis he needed transmissivity (permeability times thickness) data for the hydrologic elements used in the model to characterize the geology. The aquifer test data are sparse, especially in the area modeled; Durbin examined data from the entire carbonate aquifer terrain. In using the wider data set he obtained good distributions of hydraulic conductivities for the seven geologic model units used in his model.

The parameter values used in the virgin state groundwater model can be optimized using non-linear optimization methods. One of the most widely used of the parameter optimization codes is PEST; Durbin used PEST to obtain optimized parameter values. (Optimized parameter values are those that provide the "best fit" to the observed data. In this case the primary observation are water levels in some 500 wells in the modeled area.)

The optimization also yields "best" estimates for recharge. In Spring Valley Durbin estimated the water budget for Spring Valley (SNWA, 2006b, Table 8-6). Table 1 compares Durbin's optimized values with the other estimates:

Table 1. Water Budget Estimates (ac-ft/yr)

	Rush &	SNWA (2006a)	SNWA (2006b)
	Kazmi (1965)	Table 7-3	Durbin Model
INFLOW			Table 8-6
Recharge--perennial streams (below mountain block)		11,750	18,000
Recharge--groundwater (within mountain block)	65,000	combined	65,000
Recharge--groundwater (on alluvial apron)	10,000	87,000	
Subsurface Inflow--(from Tippetts Valley)	0	2,000	
Total	75,000	100,750	83,000
OUTFLOW			
Groundwater ET	70,000	90,000	75,350
Subsurface Outflow	4,000	4,000	
Groundwater ET (crops)	Combined	5,780	
Other Groundwater Consumptive use	1,000	346	
Total	75,000	100,126	

The optimized parameter values derived from the steady-state model are the best estimates of the values that can be derived given the present data. The mathematics of the model force a certain rigor on the estimates; the model creates both a local and a global water balance. The PEST optimization minimizes the difference between observations and predictions. As suggested above, PEST yields "best" estimates of the parameter values.

The SNWA (2006a) and SNWA (2006b—model) values differ significantly, as Table 1 indicates. The SNWA model encompassed an area much larger than just Spring Valley; this complicates the comparison. However, the recharge numbers for Spring Valley can be compared. The model recharge (SNWA, 2006b) is much closer to the estimates of Rush and Kazmi (1965) than to that of SNWA (2006a). As suggested above, the SNWA

(2006b) optimized parameter values are the most internally consistent values given our total understanding of the hydrologic system, and the present set of empirical data.

Model Predictions

During pumping there will have to be additional water captured from the streams flowing into the valley (induced recharge from the streams) to obtain the system yield of 100,000 ac-ft/yr reported by the State in Report 3.

With all the sophisticated calibration of the virgin system model, SNWA did not project the impacts of pumping on the system. One argument is that there is insufficient development in the area with which to calibrate the transient flow model needed to make predictions—one needs the storage characteristics of the system to make time-dependent predictions. However, the USGS predicted the impacts of pumping with at least two of its models; they used estimates of storage obtained from other developments and pumping tests in the larger carbonate aquifer region.

The most pertinent of the USGS future predictions is Schaefer and Harrill (1995). They modeled the entire carbonate aquifer of eastern and southern Nevada. The Schaefer/Harrill model had large grid cells and only two active layers. Most investigators consider the model too coarse to give good local predictions. However, they suggested several hundred feet of drawdown in Spring Valley as a consequence of the proposed SNWA pumping. Tom Myers made model predictions; his model also shows large drawdowns in the southern part of Spring Valley—several hundred feet, depending upon the duration of the pumping.

The point is that predictions of proposed impacts are not infeasible. Others made predictions of the system, admittedly predictions have a higher degree of uncertainty associated with them. Speculating, I suggest that SNWA did not make predictions of potential impacts because the results are prejudicial to its request.

FUTURE IMPACTS

In my 30 June 2006 statement, I pointed out that the results of Tom Myers' model indicated that the proposed SNWA pumping would still be obtaining more than 50% of the water pumped from a continued depletion of storage in 1000 years—in other words, the system is nowhere near reaching the new equilibrium condition implied by the definitions in Nevada's Water Resources—Report 3 after 1000 years of pumping. Predictions of the impacts of pumping are dependent upon the storage properties of the geologic units in the system. Myers, in recent model runs, attempts to look at the sensitivity of the predictions to storage by varying the storage coefficients in his model. Even with the varying storage coefficients the shortest times to reach a new equilibrium state are more than 1000 years.

SNWA is proposing a giant water-mining scheme that is antithetic to the spirit of Nevada Water Law, if not the letter of the law—without disclosing this fact. The State, including the public, should be aware that this is what is being proposed—SNWA is hiding this fact. They are hoping to slip the development by the State Engineer—keep their proposed pumping below the published system yield, and everything will be fine; except that the system will not reach a new equilibrium in any reasonable period, and therefore they will mine groundwater for more than a thousand years. As a hydrologist, I would like to see Nevada make an informed decision on such a large-scale groundwater mining project.

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