United States Department of the Interior

U. S. GEOLOGICAL SURVEY

2730 N. Deer Run Rd.
Carson City, NV 89701
Phone: (775) 887-7614

April 21, 2011

MEMORANDUM

To: Devin Galloway, Ground-Water Specialist, Western Region

From: Doug Maurer, Hydrologist, Nevada WSC

Subject: AQUIFER TESTS—Analysis of 31 slug tests, Dayton Valley Hydrographic Area, Nevada

Slug tests were conducted in 31 wells in the Dayton Valley Hydrographic Area, Nevada (Figure 1). The tests were conducted to estimate the distribution of aquifer characteristics in the middle Carson River basin in support of a study being conducted in cooperation with the Bureau of Reclamation (project # 9705-D29BE). Results of the slug tests will aid in the development of a numerical ground-water flow model of the Middle Carson River basin. The model will be used to evaluate potential effects of groundwater pumping on streamflow of the Carson River. For this reason, many of the tests were made in wells in the Carson River flood plain and adjacent to the river. Hydraulic conductivities of gravel, sand and gravel, sand, sand and clay, decomposed granite, and fractured volcanic rock were estimated.

SITE

The slug tests occurred in wells that were screened across gravel, sand, clay, and fractured volcanic rock intervals between 5 to 300 ft below land surface (Table 1, Drillers Logs). All sites were 2-inch, PVC observation wells with either schedule-40 or schedule-80 casing. About 80 percent of the screened intervals were completed in sand and gravel, sand, or sand and clay. Three screened intervals were completed in fractured volcanic rock, two wells were completed in gravel, and one was completed in decomposed granite.

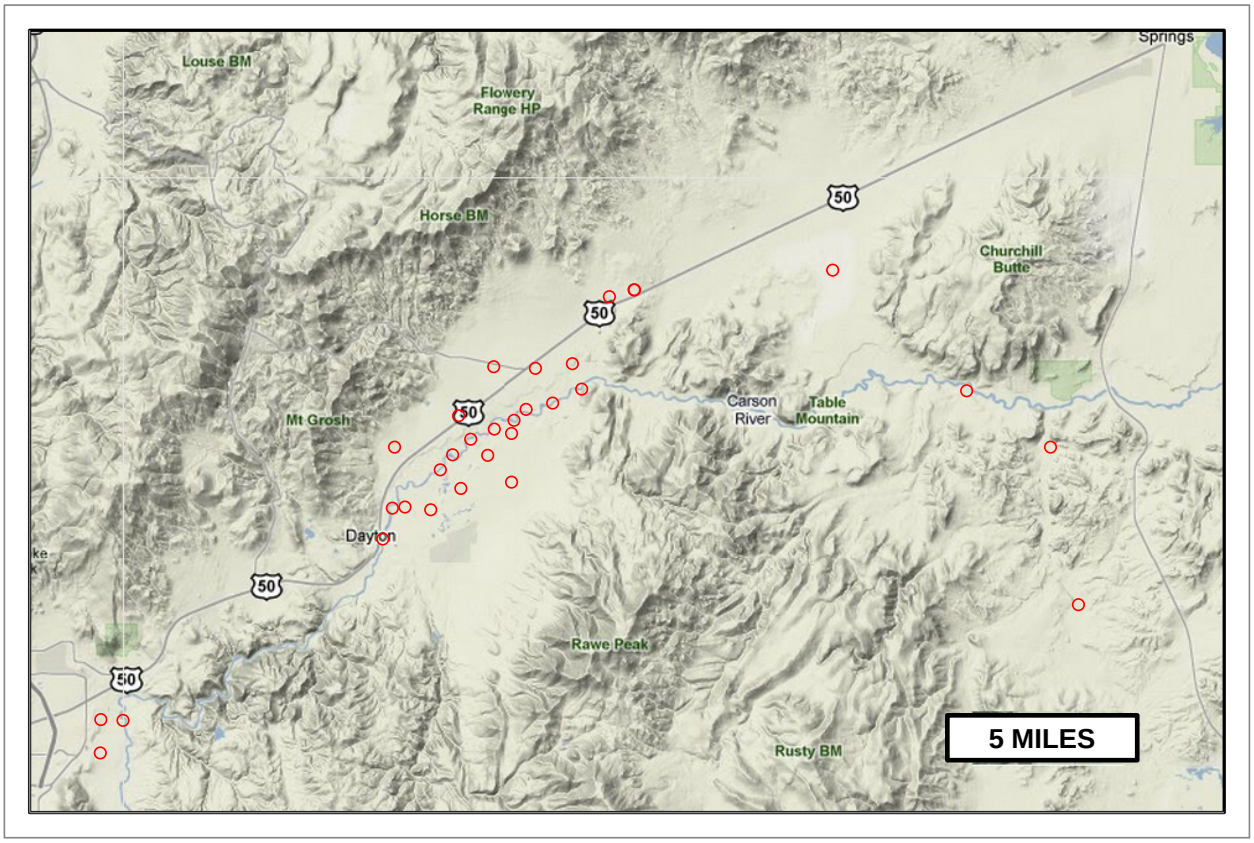

Figure 1.—Location of wells for slug tests in Middle Carson River area, Nevada.

PROCEDURES

The slug tests consisted of single or multiple falling-head and rising-head tests. The tests were made by quickly lowering a PVC cylinder beneath the static water level and recording the resulting rise and decline in water level back to static; often called a falling-head test. Next the cylinder was quickly raised above the static water level and the resulting water-level drop and rise back to static was recorded; often called a rising-head test. The cylinder was sealed at both ends and filled with sand. Cylinder dimensions were either 1.5-inch in diameter by 3.5 ft long or 1.25-inch in diameter by 5 ft long for slugging 2-inch wells with either schedule 40 or 80 casing, respectively. Water levels were recorded at uniform intervals of 0.1 to 5 seconds and were measured with a vented Global transducer (Model WL16, SN 093797303, 0-15 ft range, accuracy ±0.1% of full scale).

Between 1 and 6 slug responses were observed in each well. A single response was analyzed where 90-percent recovery occurred in less than 10 seconds or more than 10 minutes. Clean responses were difficult to induce where recovery was rapid. Long recovery times logistically prohibited multiple slug tests in a well.

ANALYSIS

Slug tests were analyzed using analytical solutions coded in spreadsheet software (Halford and Kuniansky, 2002). Slug-test responses that did not oscillate were analyzed using Bouwer and Rice (1976). Water-level recovery in well Divide Deep was typical (Figure 3) of the 21 non-oscillatory responses. Water levels clearly oscillated during six of the slug tests (Figure 4) and were analyzed using the method of Butler and Garnett (2000) which is an analytical approximation of underdamped through overdamped water-level responses. The slug-test response in the Divide-Shallow well was analyzed with the Cooper-Greene method (Cooper and others, 1967; Greene and Shapiro, 1995). Water-level measurements, analyses, and results from all tests are summarized in the file 00_Maurer_MiddleCarsonRiverNV-SlugTestReport.xlsx.

HYDRAULIC PROPERTY ESTIMATES

Hydraulic conductivity estimates ranged between 1 and 160 ft/d and averaged 60 ft/d in sand and gravel, sand, and sand and clay (Table 1). The hydraulic conductivities of the gravels were 50 and 300 ft/d. Hydraulic conductivities of the fractured volcanic rocks were all less than 1 ft/d.

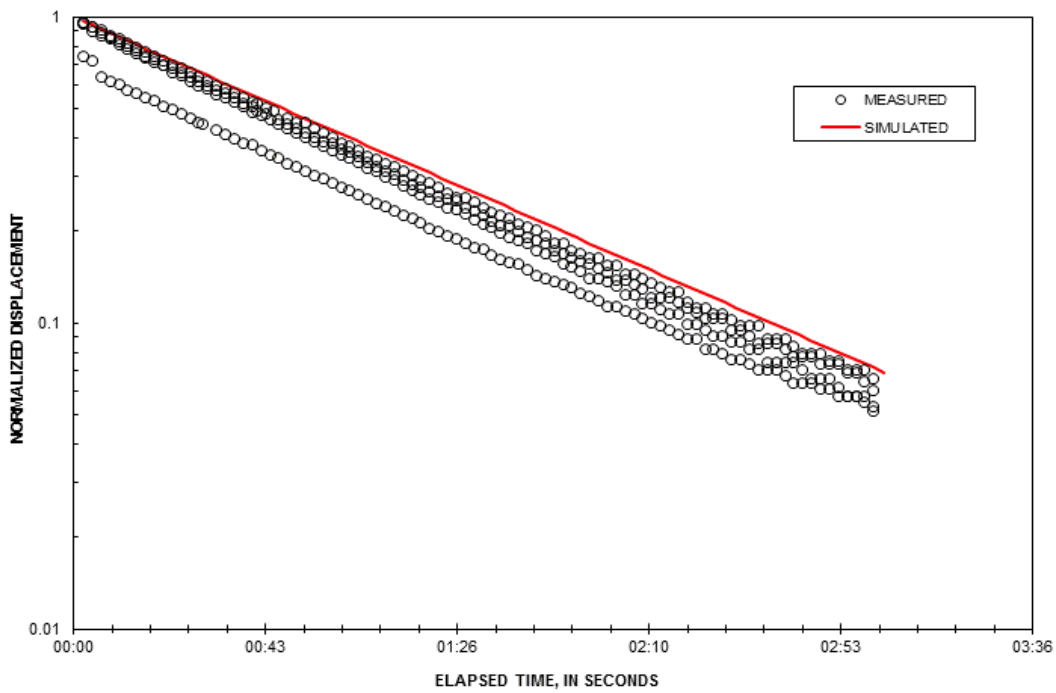

Figure 3.—Normalized water-level recovery in well Divide Deep and estimated slope.

Figure 4.—Normalized water-level recoveries in well Highway 50 that were analyzed using Butler and Garnett (2000).

Table 1.--Site identifiers, well construction, lithology, and hydraulic conductivity estimates the Dayton Valley Hydrographic Area, Nevada.

Local Identifier	USGS Site Identifier	Depth to Water, in feet	Top of Screen, in feet	Bottom of Screen, in feet	Date of Test	Lithology	K, Feet/Day
5th&PasW	390941119425901	15	50	70	09/22/2009	Decomposed Granite	25
Adrian1	391615119164801	13	15	20	06/03/2010	Gravel	50
Adrian 2	391252119160201	7	19	24	06/03/2010	Gravel	300
Borda	391928119285901	82	110	140	09/15/2010	Fractured Volcanic Rock	0.72
Bull Canyon	391727119190701	22	36	41	06/03/2010	Sand and Gravel	2
CR-1	391456119345801	18	25	35	09/02/2009	Sand and Gravel	63
CR-2	391457119343801	17	26	36	09/02/2009	Sand	98
Divide Deep	391937119281801	60	227	265	09/15/2010	Fractured Volcanic Rock	0.62
Divide shallow	391937119281701	85	142	162	09/15/2010	Fractured Volcanic Rock	0.057
DV parkway	391615119345501	50	63	83	09/09/2009	Sand and Clay	2
GC P-2	391023119422101	12	5	20	10/06/2009	Sand and Clay	59
GC P-3	391024119425801	22	10	25	09/22/2009	Sand	22
Eureka	391729119294501	14	22	32	10/07/2009	Sand	160
F.C.	391756119310101	52	70	90	09/28/2009	Sand	3.2
Hiway 50	391655119330901	55	76	96	09/28/2009	Sand	110
House	391522119330501	57	71	91	09/29/2009	Sand and Gravel	50
L.S.-4	391454119335501	19	35	55	09/29/2009	Sand and Clay	8
misfits	392003119224901	40	52	67	09/09/2009	Sand and Gravel	5.1
Pine	391802119300001	28	40	60	09/28/2009	Sand and Gravel	66
R-1	391545119333901	11	20	30	09/17/2009	Sand	37
R-2	391605119331901	8	20	30	09/17/2009	Sand	69
R-3	391625119324801	9	18	28	09/17/2009	Sand	47
R-4	391638119321001	14	25	35	09/15/2009	Sand	16
R-5	391604119322001	57	80	100	09/29/2009	Sand and Gravel	110
R-6	391632119314101	59	70	90	09/29/2009	Sand	38
RA-2	391649119313702	20	145	165	09/15/2009	Sand and Gravel	97
RA-3	391703119311701	7	5	15	09/15/2009	Sand and Gravel	140
RA-4	391711119303301	7	4	14	09/15/2009	Sand	120
Ring	391758119321001	69	64	84	09/28/2009	Sand	1.2
S. Sutro	391529119314101	59	70	90	09/29/2009	Sand and Gravel	0.96
Vet	391416119351401	16	25	35	09/02/2009	Sand and Gravel	62

REFERENCES

Bouwer, Herman and Rice, R.C., 1976, A slug test for determining hydraulic conductivity of unconfined aquifers with completely or partially penetrating wells: Water Resources Research 12(3), p. 423–428.

Butler, J.J., Jr., and E.J. Garnett, 2000, Simple procedures for analysis of slug tests in formations of high hydraulic conductivity using spreadsheet and scientific graphics software: Kansas Geological Survey Open-File Report 2000-40, http://www.kgs.ku.edu/Hydro/Publications/OFR00_40/index.html

Cooper, H.H.Jr, Bredehoeft, J.D., and Papadopulos, I.S., 1967, Response of a finite-diameter well to an instantaneous charge of water: Water Resources Research, v. 3, p. 263-269.

Greene, E.A., and Shapiro, A.M., 1995, Methods of conducting air-pressurized slug tests and computation of type curves for estimating transmissivity and storage: Ground Water, v. 36, no. 2, p. 373-376.

Halford, K.J., and Kuniansky, E.L., 2002, Spreadsheets for the analysis of aquifer-test and slug-test data, version 1.1: U.S. Geological Survey Open-File Report 02-197, 51 p., http://pubs.usgs.gov/of/2002/ofr02197/