Title: *UPDATE OF HYDROGEOLOGIC CONDITIONS AT THE DIAMOND TAIL SUBDIVISION, SANDOVAL COUNTY, NEW MEXICO*

Author(s): Roger L. Peery, Annie M. McCoy and Laura H. Petronis

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Key Topics: Hydrogeology, Diamond Tail Subdivision, shared well system, specific yield, storage, saturated thickness, drawdown, ground-water elevation, flow direction,

Summary:

- Diamond Tail Subdivision
    - 1,780 acres, max 300 lots, lot size ranges from 2 to 3.4 acres, "Type Two Subdivision," assumed maximum 0.5 to 0.6 acre-feet (ac-ft) per year diversion
    - Water development: shared water-supply wells (NMOSE 72-12-1 permits), shared well agreements
    - Sandoval County land subdivision regulation
        - Requires hydrogeologic report demonstrating 100-year water supply, characterization of aquifer, 100-year effects on ground water, hydrogeologic data, geologic data, impacts on other wells, water-quality data, and more (p. 2).
- Hydrogeologic Setting
    - Precambrian-age Sandia Granite: yield little water except in fractures, no subdivision wells in this unit (p. 6).
    - Mississippian-age Arroyo Penasco Formation: hydraulically connected to overlying Sandia formation, no subdivision wells in this unit (p. 7)
    - Pennsylvannian-age Sandia Formation: hydraulic communication with overlying Madera Limestone, no subdivision wells in thin unit (p. 7)
    - Pennsylvannian-age Madera Limestone: ground-water flow through rock matrix and fractures, 1 subdivision well in this unit and 4 subdivision wells in the Abo-Madera transition (p. 8)
    - Permian-age Abo Formation: 9 subdivision wells in this unit (p. 8)

- Permian-age Yeso Formation: 2 subdivision wells in this unit (p. 8)
- Permian-age San Andres Formation and underlying Glorieta Sandstone: well-cemented limestone and sandstone, these units are above the water table in the subdivision (p. 9)
- Triassic-age rocks: east of the subdivision, sandstone within the middle Petrified Forest Formation have the best production wells (p. 9)
- Jurassic-age Entrada, Todilto, and Morrison Formations: greatest aquifer potential is the Entrada Formation and the Jackpile Sandstone, Westwater Canyon Sandstone and sandstone beds within the Brushy Basin Shale in the Morrison Formation (p. 9)
- Cretaceous-age Mancos Shale: provide limited water quantities to wells (p. 10)
- Quaternary- to Tertiary-age Santa Fe Group sediments: reported saturated thickness near the fault ranges from 1,200 to 2,200 ft. (p. 10)

- Structural Geology
  - San Francisco Fault: lower permeability than the Madera Limestone, though nearby fault-damaged zones are highly variable (p. 10)
  - South Montezuma Fault: likely "responsible for the significant increase in permeability of the Madera Limestone aquifer south of the fault" indicated by high specific capacity and transmissivity of well RG-69363 (p. 11).
  - Spillway Fault: water may flow preferentially parallel to the east side of the fault in a northeasterly direction (p. 11)
- Wells: 16 well in the Diamond Tail Subdivision, aquifer pump tests on 15
- Ground-Water
  - Ground-water elevation ranges from 6,000 ft in the southern part of the subdivision to 5,700 ft in the northern part (p. 12)
  - Flow direction is generally north-northeast in the southern portion, east and northeast in the central portion, and north, northeast and northwest in the northern portion (p. 12)
    - Moving away from ground-water mound near Cuchilla de San Francisco, recharge areas south of the subdivision along the Crest of Montezuma, and faults (p. 12).
  - Depth to water ranges from a few tens of feet in northwestern portion to more than 400 ft in the north central portion (p. 12)

- Pump Tests:
    - Pennsylvannian-age Madera Limestone and Permian-age Abo and Yeso Formations
    - Rate range 2.5 gpm to 114 gpm (majority were 10 to 30 gpm) (p. 12)
        - Table 3. Summary of pumping-test results for wells completed at the Diamond Tail Subdivision, Southern Sandoval County, New Mexico (p. 14)

- Spring Flow
    - Arroyo de San Francisco: 2 springs discharging the Madera Formation and 4 springs discharging the Santa Fe Group Formation create perennial surface-water flow (p. 18)
    - Stream flow ranged from 0 to over 300 gpm (during storm events) (p. 20)

- Water-use Requirement Calculations
    - Estimated annual water use ranges from 0.223 to 0.304 ac-ft/yr (p. 21) assuming 2.7 persons per household

- Ground water storage
    - Specific yield: Table 9. (p. 25)
        - Upper and Lower Madera Limestone: 0.04
        - Abo Formation: 0.10
        - Yeso Formation: 0.10
    - Saturated thickness: Figure 14
        - 400 to 3,200 feet (p. 26)
        - Increases from west to east
    - Storage: Table 11 (p. 29)
        - Estimates assume no more than 0.33 ac-ft/yr diversion per lot and no recharge to the aquifers (p. 27)
    - Recharge: average recharge estimate for the subdivision area is 35.6 ac-ft/yr

- Ground-Water Flow Model
    - Assumptions:

- 62 shared wells (1 well per 5 lots at full build-out) pumped at a rate of 0.33 ac-ft/yr per lot (0.2 gpm per lot constantly) (p. 32),
- storage and hydraulic properties assigned based on pump tests and known information (p. 33),
- And unconfined aquifer with variable transmissivity (p. 37).

- Results for 100-yr drawdown:
  - Maximum drawdown was about 5 ft in an area of 30 acre in the central part of the subdivision (p. 37)
  - Subdivision boundary drawdowns were estimated to be from 3.9 ft in the northern area to 4.8 ft in the southeastern area (p. 37)
  - Within a 1-mile radius, estimated drawdown was 0.4 to 4.9 ft (p. 38)
  - Mr. Malick's spring reduction was estimated to be 1 gpm after 5 yrs, 4 gpm after 25 yrs, 11 gpm after 100 yrs (p. 39)

Useful Figures:

- Figure 1. Map showing location of Diamond Tail Subdivision, Sandoval County, New Mexico.
- Figure 3. Geologic map after Connell (1999) showing Diamond Tail Subdivision and adjacent area.
- Figure 4-6. Geologic cross-sections for the Diamond Tail Subdivision modified from Johnson (2000).
- Figure 8. Topographic map showing ground-water elevation contours and flow direction at Diamond Tail Subdivision.
- Figure 9. Topographic map showing approximate depth-to-water contours at Diamond Tail Subdivision.
- Figure 14. Map showing minimum total saturated thickness of the aquifers beneath the Diamond Tail Subdivision.
- Figure 15. Map showing hydrogeologic areas and plat, Diamond Tail Subdivision.
- Table 3. Summary of pumping-test results for wells completed at the Diamond Tail Subdivision, Southern Sandoval County, New Mexico (p. 14)

- Table 9. Specific yield values for the primary aquifers present at the Diamond Tail Subdivision (p. 25)
- Table 11. Ground-water in storage for each hydrologic area, 100-year diversion requirement from each area, and remaining ground-water in storage after 100-years of diversions at the Diamond Tail Subdivision, Sandoval County, New Mexico (p. 29)

References:

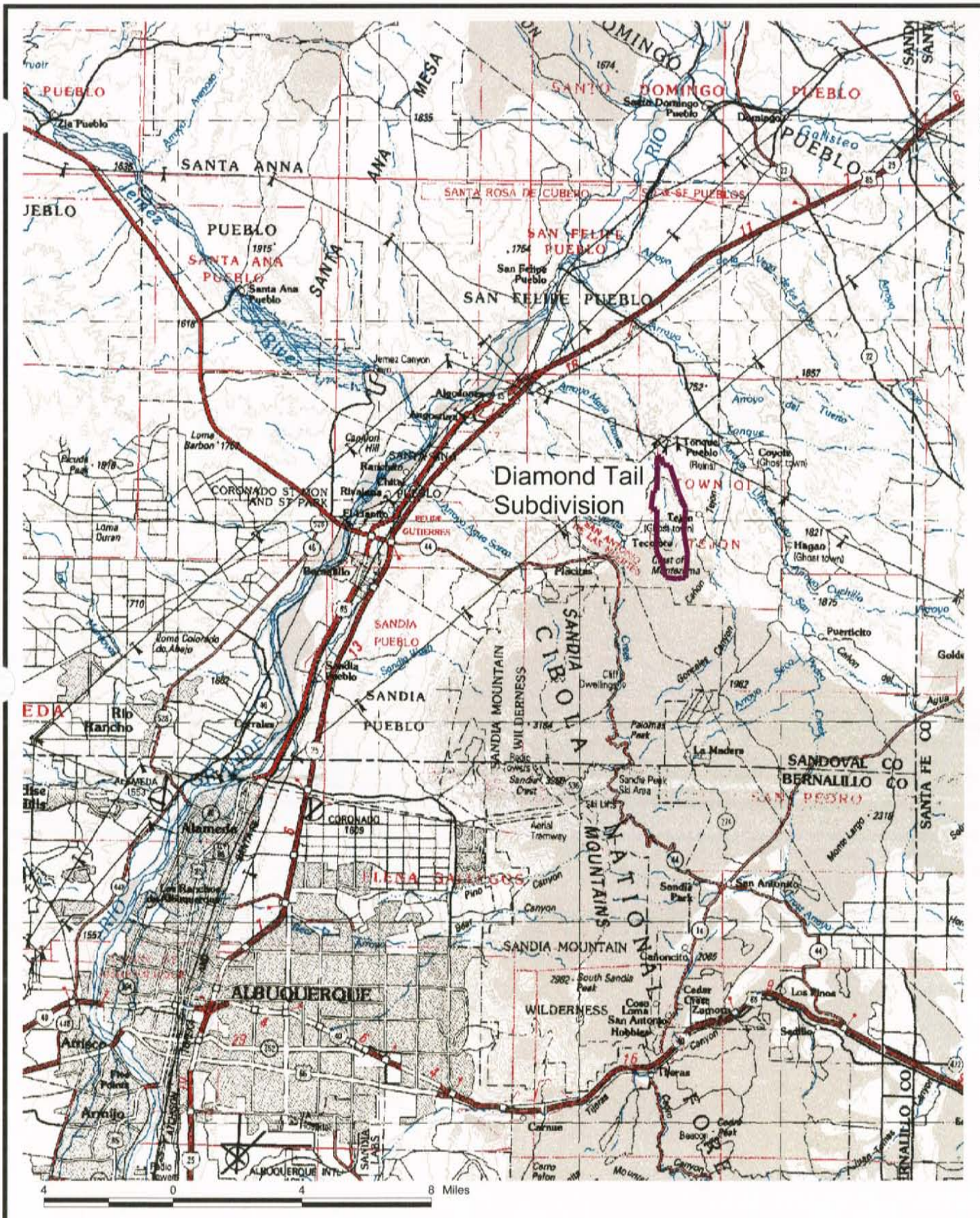
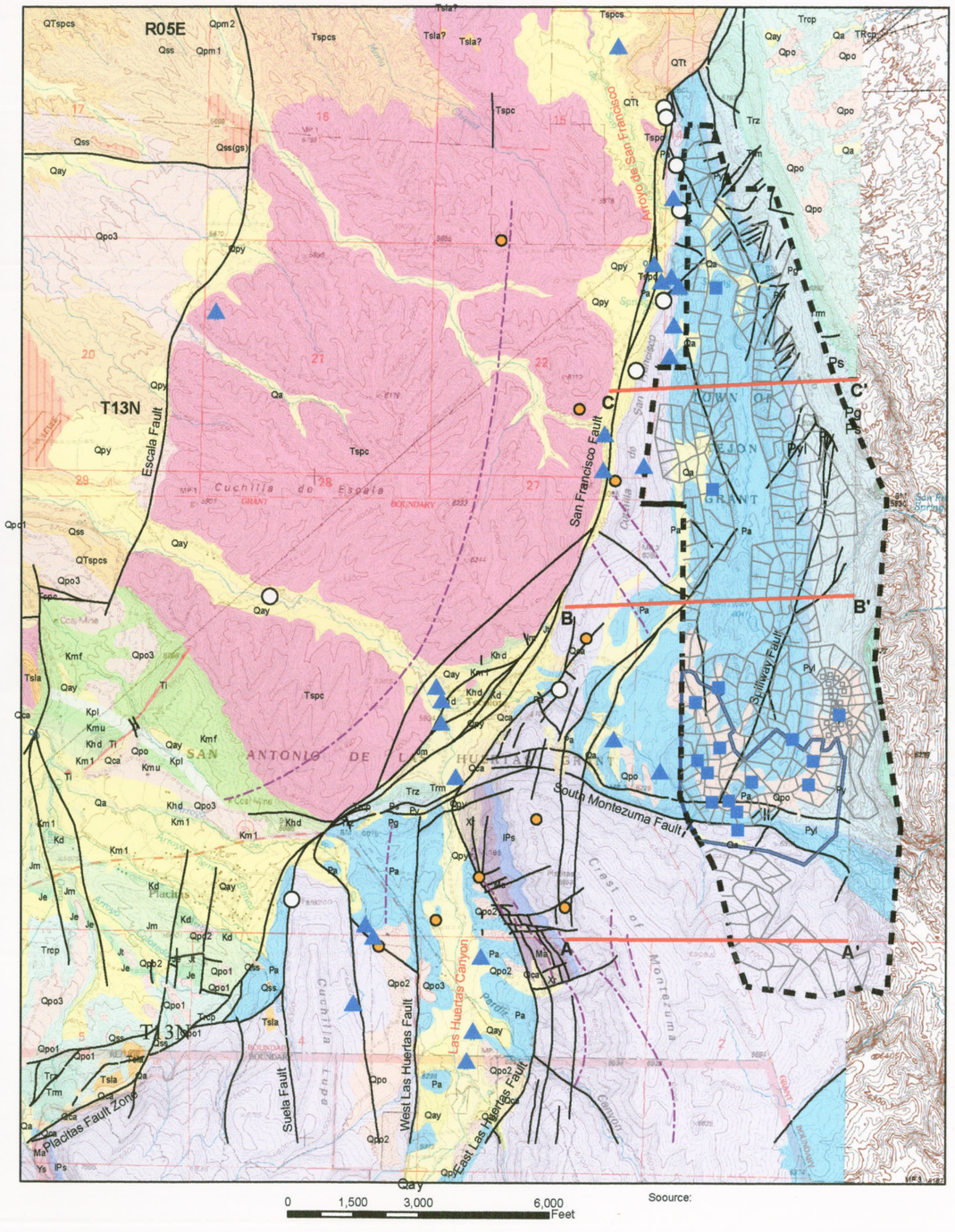


Figure 1. Map showing location of Diamond Tail Subdivision, Sandoval County, New Mexico.



N

Explanation

- Diamond Tail well
- NMOSE well
- Peggy Johnson well
- spring
- lines-of-section
- Diamond Tail property boundary
- Phase 1
- proposed lot line
- fault
- fold

geology (Connell, 1999)

Qa, Qay, Qca, Qls, Qpm, Qpm1, Qpm2, Qpm2(gs), Qpm2a, Qpm2b, Qpo, Qpo1, Qpo2, Qpo3, Qpo4, Qpy, Qre, Qrm, Qrp, Qss, Qss(gs), QTsa, QTspc, QTspcs, QTspcs(gs), QTsps, QTspsm, QTst, QTt, Ti, Tob, Tsla, Tsla?, Tspc, Tspc?, Tspcs, Tsps, Tspuc, Kd, Khd, Km, Km1, Km2, Kmf, Kmf?, Kmu, Kpl, Je, Jm, Jt, TRcp, Trcp, Trm, Trz, Pa, Pg, Ps, Py, Pyl, IPm, IPs, Ma, Xa, Xas, Xmg, Xms, Xr, Xss, Yp, Ys, af

Figure 3. Geologic map after Connell (1999) showing Diamond Tail Subdivision and adjacent area, Sandoval County, New Mexico.

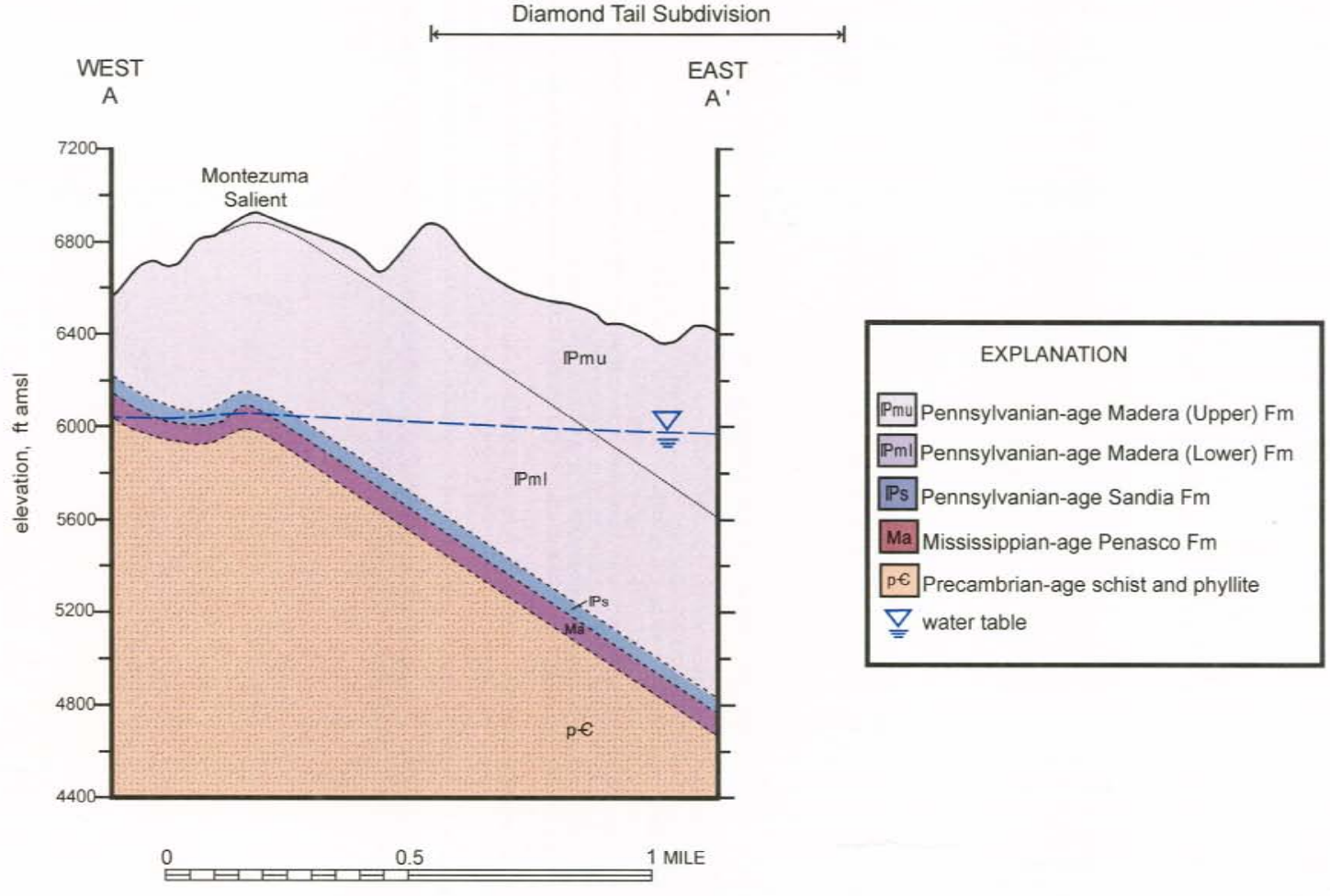


Figure 4. West-east geologic cross-section A-A' near Diamond Tail Subdivision, Sandoval County, New Mexico, modified from Johnson (2000).

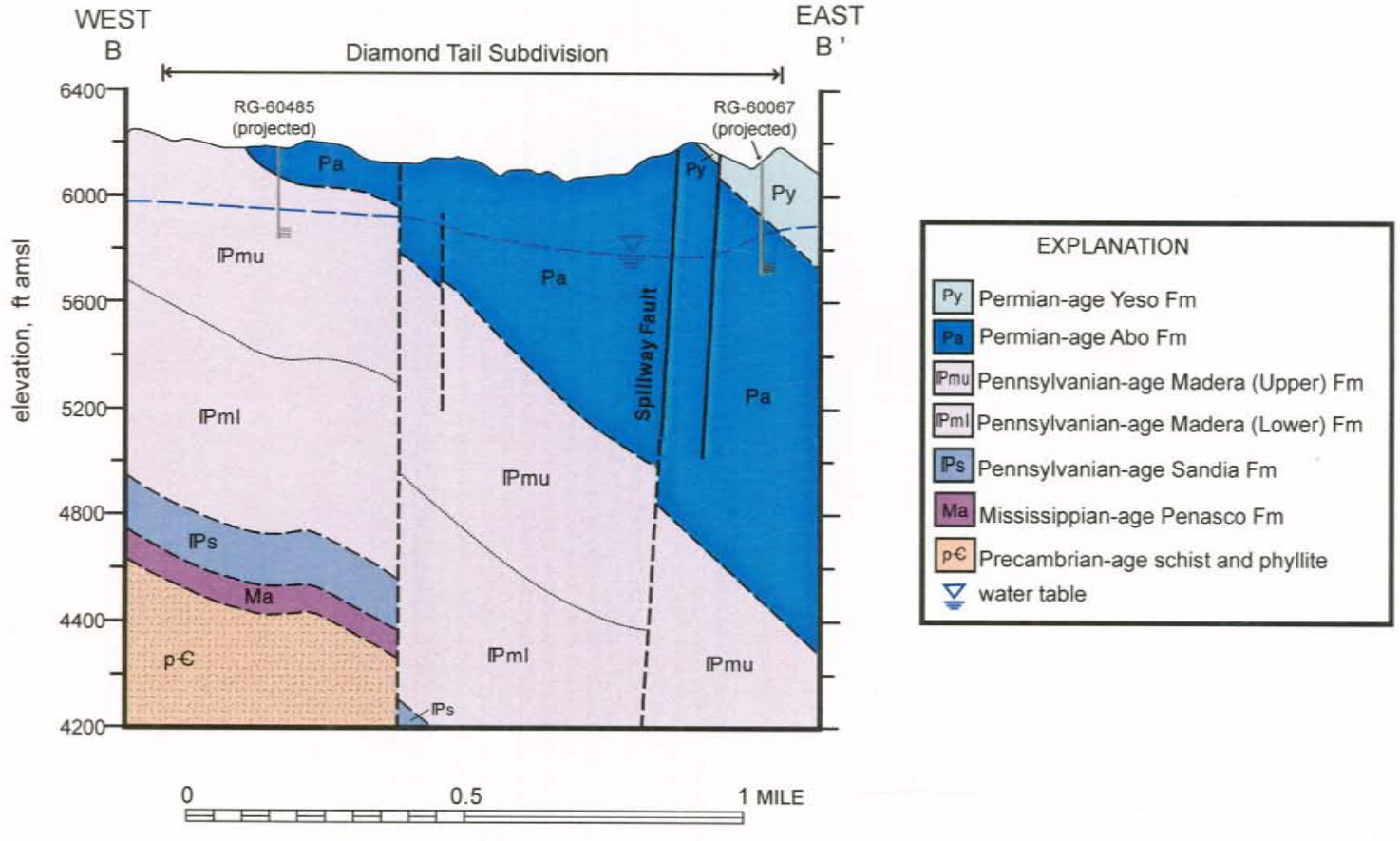


Figure 5. West-east geologic cross-section B-B' through Diamond Tail Subdivision, Sandoval County, New Mexico, modified from Johnson (2000).

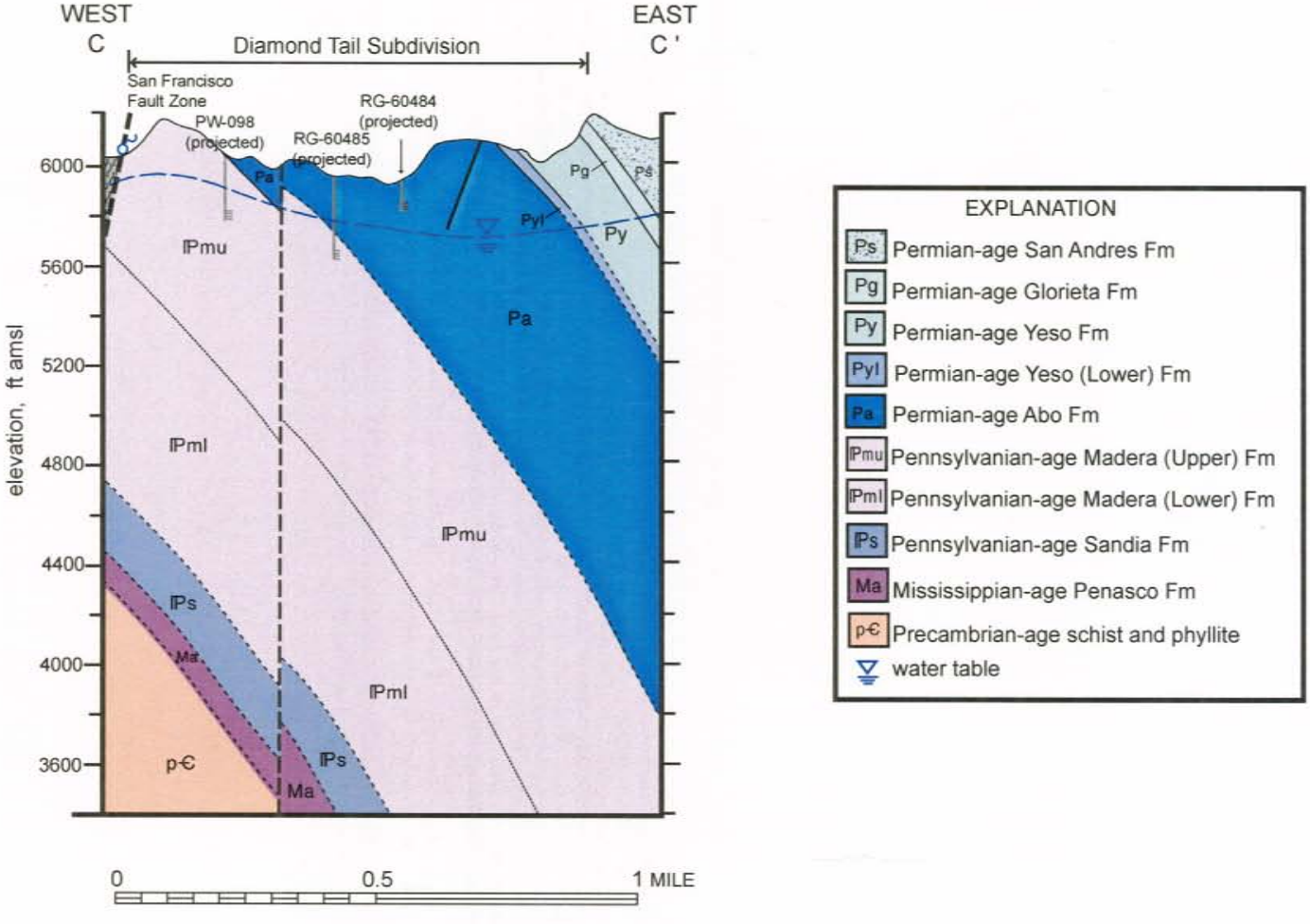


Figure 6. West-east geologic cross-section C-C' through Diamond Tail Subdivision, Sandoval County, New Mexico, modified from Johnson (2000).

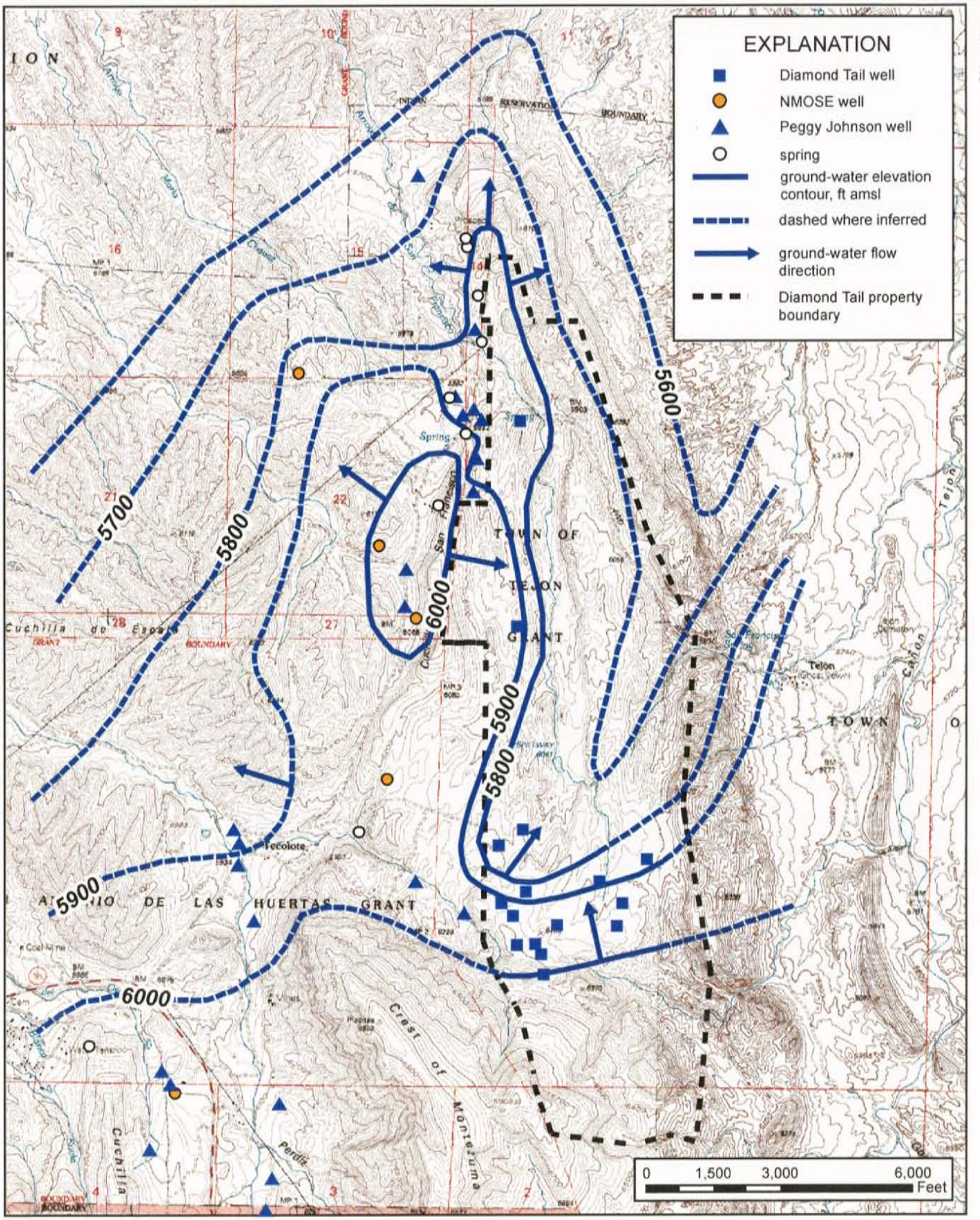


Figure 8. Topographic map showing ground-water elevation contours and flow direction at Diamond Tail Subdivision, Sandoval County, New Mexico.

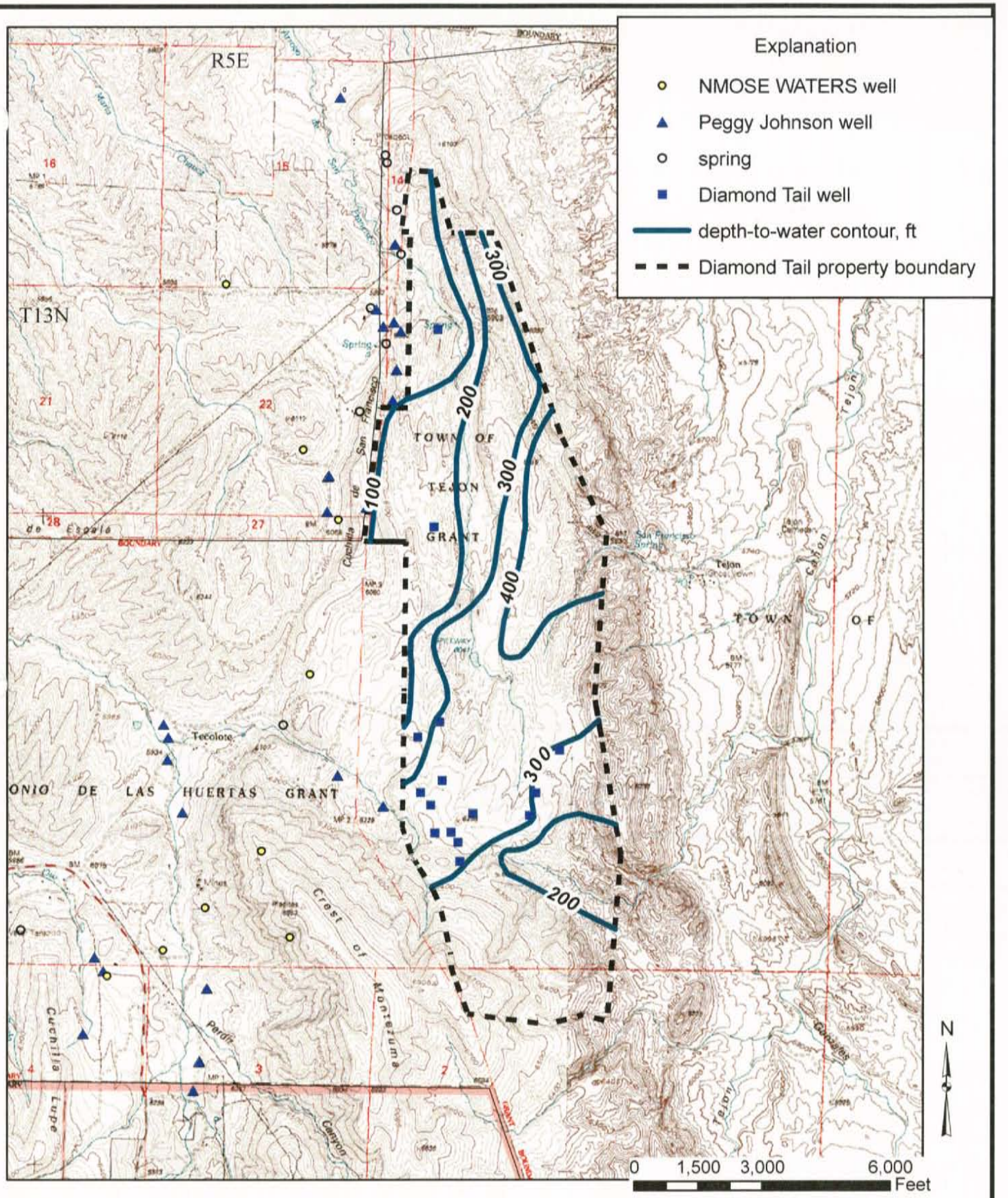


Figure 9. Topographic map showing approximate depth-to-water contours at Diamond Tail Subdivision, Sandoval County, New Mexico.

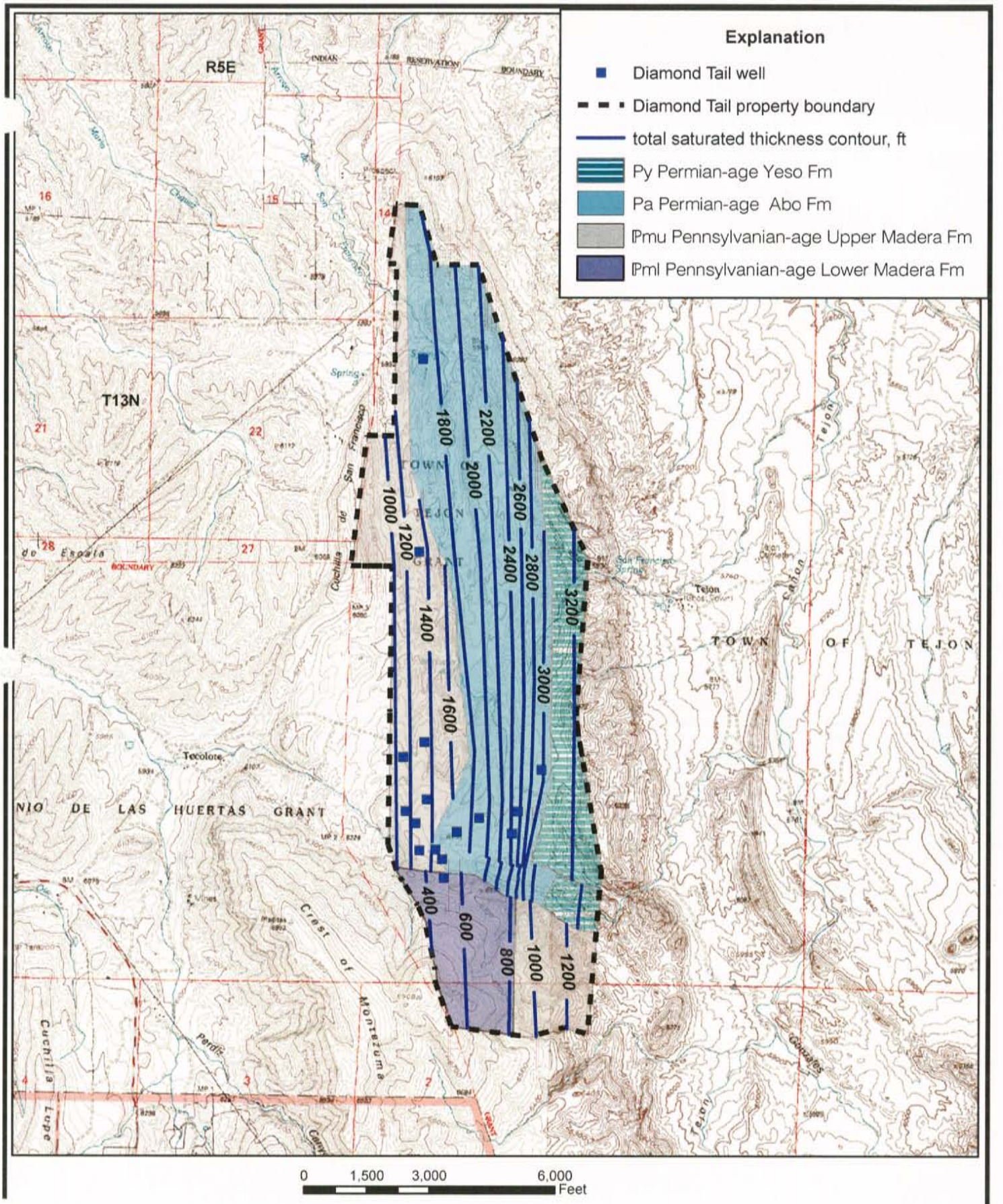


Figure 14. Map showing minimum total saturated thickness of the aquifers beneath the Diamond Tail Subdivision, Sandoval County, New Mexico.

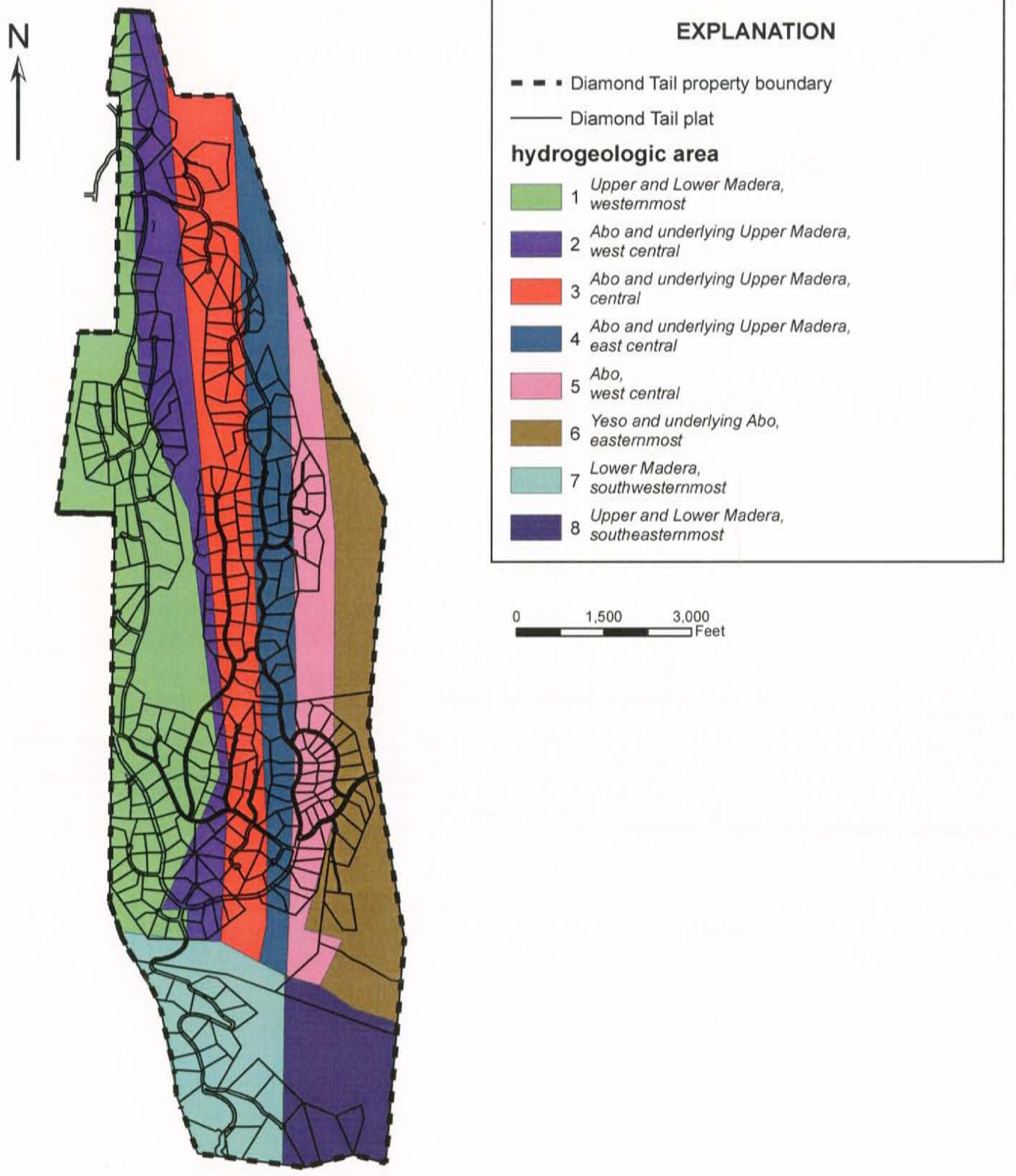


Figure 15. Map showing hydrogeologic areas and plat, Diamond Tail Subdivision, Sandoval County, New Mexico.

Table 3. Summary of pumping-test results for wells completed at the Diamond Tail Subdivision, Southern Sandoval County, New Mexico

well	NMOSE file No.	TD, ft	depth to water prior to pumping, ft bmp	saturated thickness, ft	pumping test rate, gpm	transmissivity, ft²/day		Q/s, gpm/ft	formation
						drawdown	recovery		
No. 1[a]	RG-60484	120	8	112	25	55	38	0.50	Abo/Madera
No. 2[a]	RG-60067	420	245	175	20	176	705	0.29	Yeso
No. 3[a]	RG-60485	380	198	182	10.7	126	566	0.12	Abo/Madera
Phase 1, No. 9 (old No. 4[a])	RG-60066	500	279	221	12	30	60	0.09	Yeso
No. 5[a]	RG-60065	660	359	301	2.5	4.4	44	0.01	Abo
Phase 1, No. 1	RG-69357	495	228	267	33	360[c]	323	1.3	Abo
Phase 1, No. 2 (lot 12)	RG-69361	600	377.12	222.88	16	282	627	0.77	Abo
Phase 1, No. 3 (between lots 15 & 16)	RG-69360	594	368.85	225	14	16	19	0.27	Abo
Phase 1, No. 4	RG-69359	525	363	162	13.5	13.4	13.6	0.22	Abo
Phase 1, No. 6 (fire tank)	RG-69363	420	316	104	38	12,232[c]	b	30.4	Madera
Phase 1, No. 7	RG-69366	610	340	270	not tested[d]				Abo
Phase 1, No. 8	RG-69365	425	309	116	12	173	257	4	Abo
Phase 1, No. 12	RG-69370	580	354	226	10.4	12	b	0.11	Abo/Madera
Phase 1, No. 13	RG-69362	512	387	125	114	8,047	b	22.57	Abo/Madera, primarily Madera
Phase 1, No. 16	RG-69367	540	377	163	9	43	51	0.16	Abo
Phase 1, No. 11	RG-69371	570	322	248	10	72	41	0.13	Abo

[a] well completed and tested during 1993 hydrogeologic study
[b] not measured
[c] transmissivity calculated using Q/s (Walton, 1970)
NMOSE New Mexico Office of the State Engineer
Q/s specific capacity
d not tested because well yielded too little water to be used as a shared well

gpm	gallons per minute
ft²/day	feet squared per day
gpm/ft	gallons per minute per foot
TD	total well depth
ft bmp	feet below measuring point

Table 9. Specific yield values for the primary aquifers present at the Diamond Tail Subdivision, Sandoval County, New Mexico

formation	specific yield
Upper and Lower Madera Limestone	0.04
Abo Formation	0.10
Yeso Formation	0.10

Table 11. Ground-water in storage for each hydrologic area (Fig. 15), 100-year diversion requirement from each area, and remaining ground-water in storage after 100-years of diversions at the Diamond Tail Subdivision, Sandoval County, New Mexico

area	formations and location	S, ac-ft	number of lots	100-year diversion, ac-ft	remaining ground water in storage after 100 years, ac-ft
1	Upper and Lower Madera, westernmost	12,832	91	3,003	9,829
2	Abo and underlying Upper Madera, west central (Abo 0 and 200 ft)	7,397	26	858	6,539
3	Abo and underlying Upper Madera, central (Abo 200 to 600 ft)	15,667	67	2,211	13,456
4	Abo and underlying Upper Madera, east central (Abo 600 to 1,000 ft)	13,517	43	1,419	12,098
5	Abo, west central (Abo 1,000 ft plus)	14,080	36	1,188	12,892
6	Yeso and underlying Abo, easternmost	16,880	12	396	16,484
7	Lower Madera, southwesternmost	2,720	22	726	1,994
8	Upper and Lower Madera, southeasternmost	3,936	3	99	3,837
	Diamond Tail Subdivision	87,029	300	9,900	77,129

maximum diversion of 0.33 ac-ft/yr
ac-ft acre feet