SURFACE AND GROUND WATER QUALITY IN THE VICINITY OF DOUBLE DIAMOND RANCH

FOR

DOUBLE DIAMOND DEVELOPMENT
WASHOE COUNTY, NEVADA

JANUARY 1982

COLLINS & RYDER CONSULTING ENGINEERS RENO, NEVADA

Bruce H. Collins
Heinrich J. W. Jurgens
Robert A. Ryder

COLLINS & RYDER
CONSULTING ENGINEERS, INC.

February/12, 1982

Mr. Peter Morros, State Engineer
State of Nevada, Division of Water Resources
201 So. Fall Street
Carson City, Nevada 89710

SUBJECT: Double Diamond Water Monitoring - 1981 (0028)

Dear Mr. Morros:

A report summarizing the water monitoring conducted during 1981 is herewith transmitted for your review and records. This monitoring program was requested by the State Engineer last spring at the time the Water Rights Applications for conversion of several surface water sources to Q-M use for the Phase 1 Double Diamond Development were being considered. At that time, the 1980-81 winter was very dry and a program to verify the validity of quantity and quality projections by testing through the remainder of the year was considered desirable.

Bi-monthly measurements of flow of the various stream and ditch sources traversing the Double Diamond property were obtained. Likewise, surface and groundwater quality samples were periodically collected and analyzed to see seasonal and location variations. These data are tabulated and summarized in the report of "Surface and Groundwater Quality in the Vicinity of the Double Diamond Ranch".

Overall, surface water flows were greater than drought projections for Whites Creek, Steamboat Creek and the Truckee ditches, but less on Thomas Creek. Seepage losses for Thomas and Whites Creeks were close to past measurements. In general, physical and chemical water quality was better, but bacterial water quality somewhat worse than tests made previously.

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In conclusion, this monitoring program does not alter the projections of water adequacy or the type of collection, treatment, and storage, as proposed for the Phase 1 Double Diamond Development.

Very truly yours,

Robert A. Ryder, P.E.

RAR/hd

Encl.

cc: George I. Benny, Owner
J. Stephen Peek, Attorney
Carlos Tamayo
Christine Thiel, Nevada DEP
John Collins, Washoe County Public Works
Bart Hooley, Washoe District Health Dept.
Leonard Crowe, W.C.O.G.

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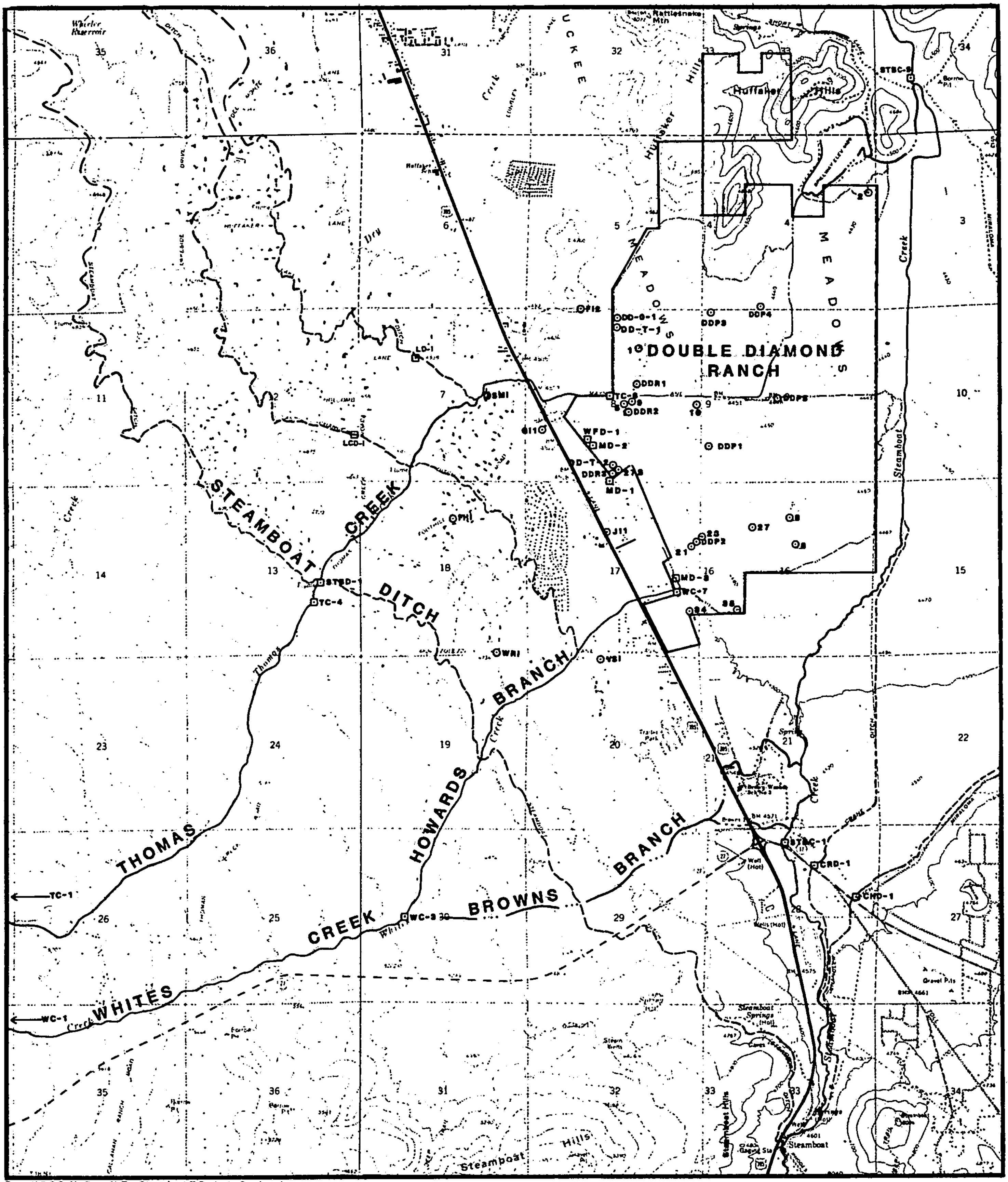
I. GENERAL

A. INTRODUCTION

Phase 1A of Double Diamond Development was approved with conditions by Washoe County Commissioners in March, 1980. The initial phase of this planned residential and commercial development will be located on the northern area of the Double Diamond Ranch. The State Engineer requested, in March, 1981, that during the year following, a water quality and quantity monitoring program be conducted on both surface and groundwater. This would establish baseline conditions when changing the use of existing surface water rights from agricultural to quasi-municipal in April, 1981, and would provide a better quantitative base to drought calculations. Ground and surface water quality and quantity monitoring had begun in April, 1980, and continued through December, 1981. This report contains all monitoring data collected since that period, as well as period precipitation records for Reno, surface water supply flow adequacy, a summary of the Double Diamond Water Treatment Facilities, raw water composites entering the plant, and treated water standards for distribution.

B. BACKGROUND

Surface and groundwater investigations began in April, 1980 by Collins & Ryder, Consulting Engineers (C&R), who collected water quality data on surface water sources as they entered the Double Diamond Ranch. An initial hydrologic investigation of supply sources and yields for Double Diamond was reported by Hydro-Search, Inc. (Ref. 1). This report was followed by several additional reports as more data on water quality and quantity was gathered. (Ref. 2, 3, 4, 5, 6, and 7). All the information in these reports has been further supplemented by information gathered during an extensive monitoring program completed in December, 1981.



Base: U.S.G.S. Mt. Rose N.E., Steamboat 7.5 minute Quadrangles

WATER QUALITY & STREAM FLOW MONITORING STATIONS IN THE VICINITY OF DOUBLE DIAMOND

SCALE
0 2000 4000 6000 feet

DOUBLE DIAMOND DEVELOPMENT	DATE FEB. 1982
	FIGURE I-1

II. PRECIPITATION

A. GENERAL

The Reno area is at an elevation of 4,400 feet above mean sea level, lying in the lee of the Sierra Nevada on a semi-arid plateau. More than one half of the area's mean annual precipitation of 7.63 inches occurs from December through March, and falls largely as mixed rain and snow. Although precipitation is scarce, abundant water is available from reservoirs in the Sierra where precipitation is heavier. The Truckee River drains the western Sierra in its proximity, then flows eastward through Reno to Pyramid Lake.

Reno climatological data is collected by the National Oceanic and Atmospheric Administration (NOAA), at Reno Cannon International Airport monitoring station. All precipitation records used in this report were obtained from NOAA.

B. 1980-1981 WATER YEAR TOTAL PRECIPITATION COMPARISON

The 1980-1981 water year (October to September) was a period of unusually low rainfall and snowfall. The mean water year of record has a total annual precipitation of 7.63 inches, while the 1980-1981 water year had a total precipitation of only 3.88 inches. Table II-1, "Annual Water Year Precipitation", is a compilation of total water years precipitation in Reno since 1899 (Ref. 8). Only two water years in the last 81 years of record have had less total precipitation than water year 1980-1981; these are 1947-48 and 1965-66. Statistically, therefore, a low water year comparable to, or less than, that of 1980-81 will occur once in every 25 years. Several conditions may be noted in relating the low precipitation to the surface water quality data collected during 1980-81. The Truckee ditches originate at the Truckee River, which had less flow, and therefore, less dilution of chemical constituents during the monitoring period. Thomas and Whites Creek are dependent upon rainfall and snowpack in the Sierra; low precipitation would, therefore, result in less than average dilution of chemical constituents here also. It can, therefore, be expected that chemical concentrations of the surface waters samples collected during October, 1980 to September, 1981 will be much in excess of what could normally be anticipated. The projections utilized to forecast water supply adequacy and quality for the Phase 1 Double Diamond project can therefore be scrutinized in stressful drought flow conditions.

TABLE II-1

ANNUAL WATER YEAR PRECIPITATION AT RENO

Water Year	Total Precipitation (Inches)	Water Year	Total Precipitation (Inches)
1899-1900	8.4	1940-1941	7.41
1900-01	12.1	41-42	9.23
01-02	5.78	42-43	5.85
02-03	6.74	43-44	7.44
03-04	9.53	44-45	6.54
04-05	6.87	45-46	4.25
05-06	8.66	46-47	4.15
06-07	11.26	47-48	3.15*
07-08	7.97	48-49	5.6
08-09	7.71	49-50	6.92
09-10	7.46	50-51	6.85
10-11	12.59	51-52	11.19
11-12	5.1	52-53	6.4
12-13	7.2	53-54	11.6
13-14	12.45	54-55	5.62
14-15	5.11	55-56	11.65
15-16	9.66	56-57	4.94
16-17	7.58	57-58	11.56
17-18	8.28	58-59	6.15
18-19	7.74	59-60	4.36
19-20	8.02	60-61	10.63
20-21	6.46	61-62	7.85
21-22	10.15	62-63	11.34
22-23	10.52	63-64	5.93
23-24	4.57	64-65	10.45
24-25	8.87	65-66	3.58*
25-26	4.02	66-67	10.24
26-27	8.75	67-68	4.49
27-28	5.99	68-69	13.95
28-29	5.35	69-70	6.31
29-30	6.87	70-71	10.08
30-31	6.42	71-72	5.98
31-32	7.4	72-73	8.83
32-33	5.09	73-74	7.43
33-34	7.84	74-75	8.19
34-35	6.2	75-76	4.98
35-36	7.14	76-77	4.29
36-37	6.06	77-78	8.64
37-38	11.8	78-79	5.73
39-40	5.79	79-80	10.76
		80-81	3.88*

Mean Water Year Precipitation = 7.63 inches

* Years with precipitation less than or equal to that of 1980-81.

III. SURFACE WATER FLOW

A. TRUCKEE DITCHES

The average 1980 and 1981 annual flows on each of the Truckee ditches which supply the Double Diamond, and a comparison to the long-term average annual flows are shown in Table III-1. The average flow data was developed by Hydro-Search, Inc. (Ref.7), from records of the U.S. Federal Water Master's office (1927-1979).

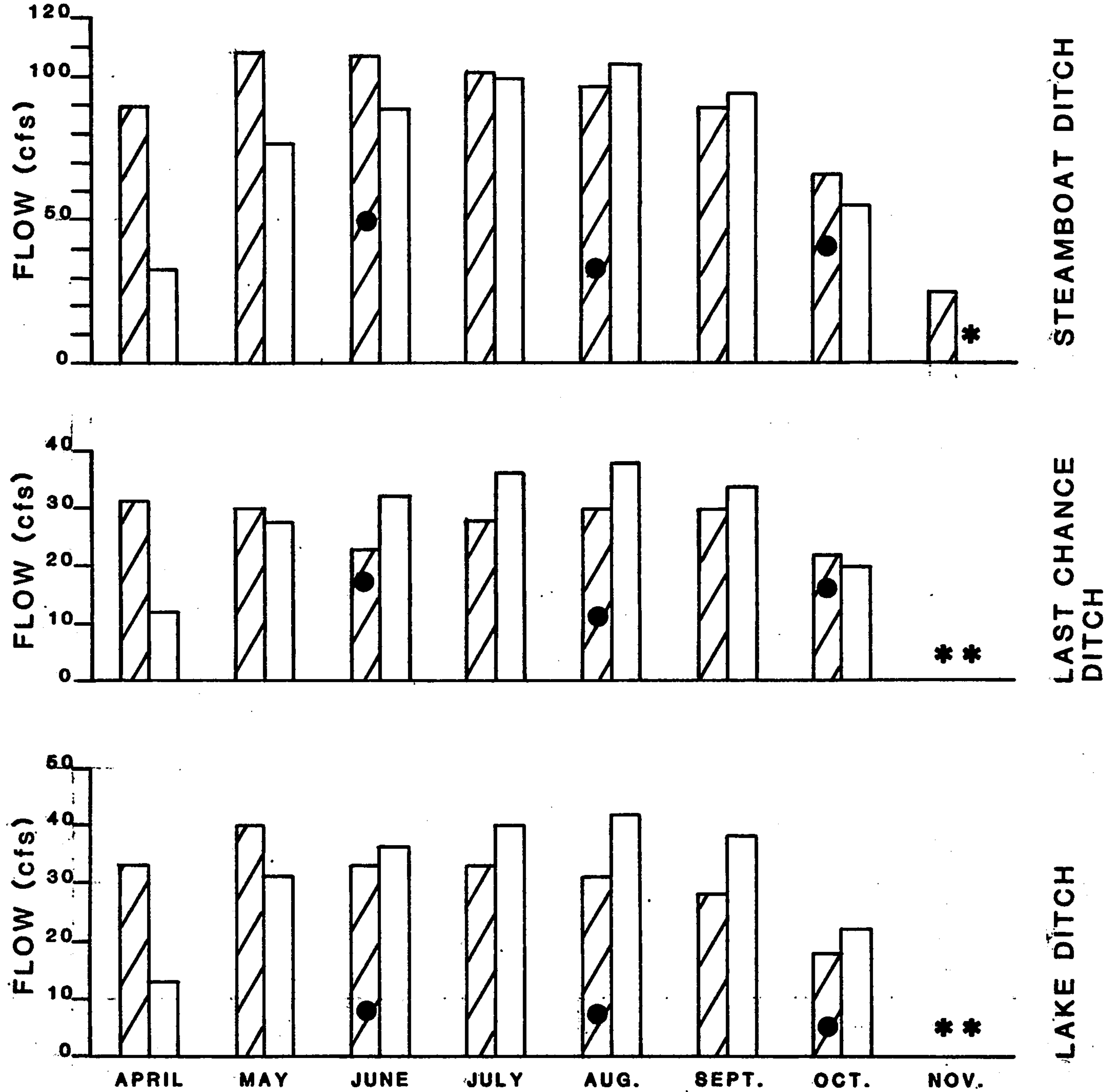
TABLE III-1

1980-1981 WATER YEAR FLOWS ON TRUCKEE DITCHES SERVING DOUBLE DIAMOND

	Flow	Lake Ditch	Last Chance Ditch	Steamboat Ditch
Average Annual	AF	13,317	13,132	33,134
1980	AF	9,950	8,574	40,624
Comparison to Average	%	75	71	123
1981	AF	8,295	8,937	36,550
Comparison to Average	%	63	74	110

(Precipitation - 1980 - 141% and 1981 - 51% of Annual Average Precipitation at Reno)

It should be noted that even during a low precipitation period, such as the irrigation season of 1981, a high percentage of the average annual discharges were still diverted to the Truckee ditches. The following figure (Figure III-1) graphically shows comparisons of 1981 monthly flows to the average monthly flow on each of the ditches. Therefore, the amount diverted to the ditches is not proportionally related to precipitation, but rather seems dependent on policy of operation of the ditches. The precipitation in the irrigation season of 1980 was above average, yet the diversion discharges were not above average and, the precipitation in the irrigation season of 1981 was approximately half of the mean precipitation, yet the diversion discharges were 63%, 74%, and 110% of average on the three ditches.



LEGEND

MONTHLY RECORDED FLOW DURING 1981 SEASON

AVERAGE MONTHLY FLOW

* FLOW NOT MEASURED

● HYDROSEARCH MEASURED FLOW

COMPARISON OF 1981 MONTHLY AND AVERAGE MONTHLY FLOWS ON THE TRUCKEE DITCHES

DOUBLE DIAMOND DEVELOPMENT	DATE FEB. 198
	FIGURE III-1

B. THOMAS AND WHITES CREEKS

1. Seepage & Evapotranspiration Losses

Losses and gains along the lengths of Thomas and Whites Creeks have been monitored during the 1980-1981 period. Collected data supports seepage and evapotranspiration losses report in Ref. 4. Table III-2 below, shows all loss/gain data collected during the monitoring program.

TABLE III-2

STREAMFLOW LOSS/GAIN FROM MOUNTAIN FRONT TO US 395

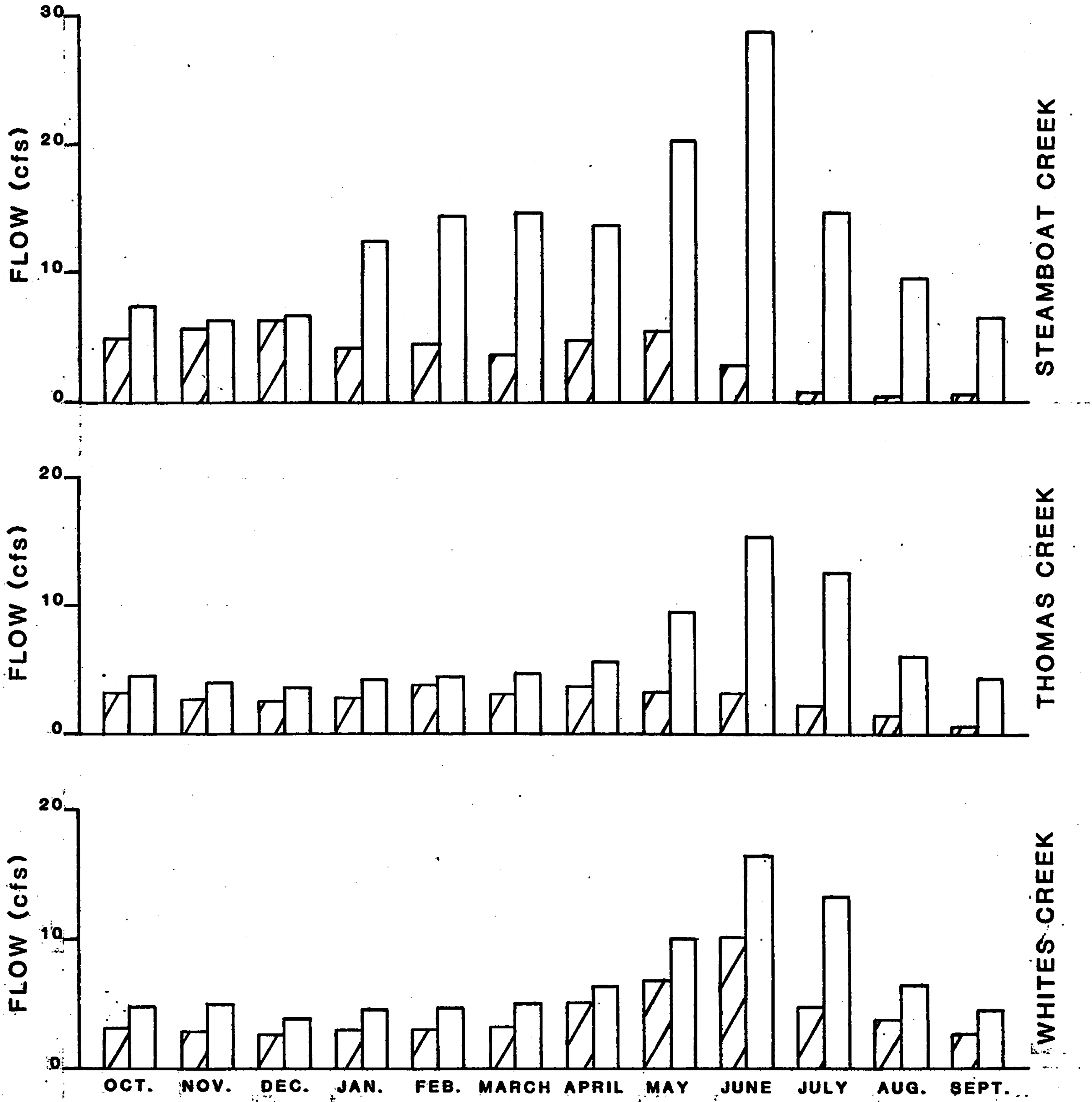
	Date							
Creek	10/80	1/81	4/81	6/81*	8/81	10/81	12/81*	Average
Thomas (cfs)	-0.21	-1.09	-0.73	-0.45	-1.01	-0.10	-2.68	-0.63
Whites (cfs)	-2.62	+0.42	-0.69	-5.32	-1.95	-0.39	+1.33	-1.05

*Note: Anomalies not used in calculation of average; possible diversions and excessive irrigation return waters are indicated.

The previously measured values of 0.7 cfs and 1.0 cfs losses on Thomas and Whites, respectively, compare well with, and are verified by, the average losses reported above. The seepage losses estimated for flow reduction translate to an annual loss of 505 AF and 720 AF from the mountain front to the Double Diamond Ranch on Thomas and Whites, respectively (Ref. 4).

2. Thomas Creek Average, Minimum, and 1980-81 Flows

The calculated average annual discharge on Thomas Creek at the mountain front is 4,760 AF, and the average minimum annual discharge is 2,946 AF (Ref. 4). However, discharges during the 1980-81 water year on Thomas Creek were even less than a predicted average minimum year. A comparison of the 1980-81 flows on Thomas Creek to calculated average and minimum flows are listed in Table III-3. The 1980-81 discharges compared to average monthly discharges is also helpful in assessing this past low flow year on the creeks; refer to Figure III-2. The Double Diamond monitoring program involved flow measurement since April, 1981. There were no flow records on either Thomas or Whites Creeks during the previous winter season and it was necessary to simulate discharge from October, 1980 through March of 1981. The simulation corresponded to monthly precipitation for the period (Ref. 7).



NOTE: STEAMBOAT AT HIGHWAY 17. THOMAS AND WHITES AT MOUNTAIN FRONT

LEGEND

▨ MONTHLY RECORDED FLOW 1980-81. HYDROSEARCH INC. & USGS

☐ AVERAGE MONTHLY FLOW.

COMPARISON OF 1980-81 WATER YEAR MONTHLY AND AVERAGE MONTHLY CREEK DISCHARGES

DOUBLE DIAMOND DEVELOPMENT	DATE FEB. 198?
	FIGURE III-2

TABLE III-3

COMPARISON OF 1980-81 FLOWS TO AVERAGE & MINIMUM CONDITIONS ON CREEKS PROVIDING DOUBLE DIAMOND SUPPLY

		THOMAS CREEK			WHITES CREEK			STEAMBOAT CREEK		
Period	Units	Average(1)	Minimum(1)	80-81(2)	Average(1)	Minimum(1)	80-81(2)	Average(1)	Minimum(1)	80-81(2)
Oct.	cfs	4.42	3.07	2.9*	4.72	3.27	3.07*	7.34	1.25	4.93••
Nov.	"	4.00	2.89	2.6*	4.29	3.09	2.79*	6.17	1.63	5.72••
Dec.	"	3.64	2.78	2.4*	3.90	2.98	2.54*	6.73	3.56	6.12••
Jan.	"	4.18	3.04	2.7*	4.47	3.25	2.91*	12.40	2.99	4.13••
Feb.	"	4.34	3.62	2.8*	4.64	3.87	3.02*	14.28	3.46	4.33••
Mar.	"	4.76	3.84	3.1*	5.09	4.10	3.31*	14.69	2.88	3.61••
Apr.	"	5.85	5.18	3.8•	6.25	5.55	5.2•	13.75	2.15	4.6•
May	"	9.53	7.60	3.2*	10.18	8.13	6.7*	20.20	3.95	5.5••
June	"	15.53	8.10	3.2•	16.61	8.66	10.1•	28.95	1.82	2.82•
July	"	12.56	3.32	2.05*	13.42	3.55	4.55*	15.00	0.91	0.77••
Aug.	"	6.12	2.96	1.5•	6.54	3.16	3.9•	9.65	0.96	0.15•
Sept.	"	4.25	2.44	0.72*	4.54	2.61	2.77*	6.73	1.14	0.44••
Total	cfs	79.2	48.8	31.0	84.88	52.22	50.86	180.54	26.7	43.12
Total	AF	4,760	2,946	1,856	5,088	3,149	3,053	9,408	1,610	2,600
Summer Avg.	%	-	51	22	-	51	55	-	11	12
Avg. Annual	%	-	62	39	-	62	60	-	15	28

Notes: (1) Hydro-Search, Inc., "Water Resources Evaluation, Double Diamond Development, Reno, Nevada", Ref. 7

(2) Measured in 1980-81 Water Year

* Simulated data using precipitation totals; see text for explanation.

• Measured flow by Hydro-Search, Inc.

•• Measured flows by USGS (Ref. 9).

The significant point is that the measured flow in Thomas Creek in 1980-81 is significantly less than the calculated minimum of 100 year recurrence interval. This indicates that assumptions used in the calculation may not reflect accurately the nature of the Thomas Creek watershed.

The flow in Thomas Creek was 39% of the average annual discharge. The 1,856 AF of water, less seepage losses, was available during water year 1980-81 to fill 1,645 AF of decreed water rights. This reduced supply from Thomas Creek for the Phase 1 Double Diamond Development is reflected in Table III-4, which was originally published in Ref. 4. For comparison to Table III-4, water supply and consumption during a normal year is shown in Table III-5. Eighty-two percent (82%), or 453 AF, of Thomas Creek water rights are now considered available during a critical drought period, rather than 552 AF as previously predicted.

3. Whites Creek Average, Minimum, and 1980-81 Flows

The calculated average annual discharge on Whites Creek at the mountain front is 5,088 AF, and the average minimum discharge is 3,149 AF (Ref. 7). As on Thomas Creek, the Double Diamond monitoring program involved flow measurements since April, 1981, and no official records exist for the period of October, 1980 through March, 1981. Simulation of missing data was conducted by the same methodology discussed above.

Sixty percent (60%) of the average annual discharge on Whites Creek occurred during 1980-81, refer to Table III-3 and Figure III-2; a value slightly larger than calculated minimum flow. This translates to 3,053 AF, less 702 AF for seepage loss; which would leave 2,351 AF available to fill 4,142 AF of decreed rights. Double Diamond would then receive 57% of its decreed rights, or 1,096 AF of water. This, too, is shown in the amended Water Supply and Consumption, Phase 1 table, Table III-4.

C. STEAMBOAT CREEK AVERAGE, MINIMUM, AND 1980-81 FLOWS

The calculated average annual discharge on Steamboat Creek at Rhodes Road is 9,408 AF, and the average minimum discharge is 1,610 AF (Ref. 7). USGS flow data (Ref. 9) for 1980-81 showed the 1980-81 flow to be 28% of the average annual, or 2,600 AF; refer to Table III-3 and Figure III-2. Although quantity and quality data has been collected on Steamboat Creek at Highway 17, and at Huffaker Hills, it is not intended for use as a domestic supply source during Phase 1 of Double Diamond Development. Refer to Tables A-7 and A-8 for quality characteristics.

TABLE III-4

WATER SUPPLY AND CONSUMPTION - DOUBLE DIAMOND - PHASE 1
(Drought Conditions)

Month	Water Consumption-AF(3)				Water Supply-AF				Inventory-AF				
	Domes.	Comm.	Irrig.	Total	Whites Creek(1)	Thomas Creek(1)	Truckee Ditches	Total	Net Balance	Injec.	Surface Storage Use	Cumulative Surface Storage	Surplus(2)
Oct.	50	25	10	85	70	29	0	99	14	0	0	125	0
Nov.	45	20	-	65	64	26	-	90	25	0	0	150	0
Dec.	45	30	-	75	64	26	-	90	15	0	0	150	15
Jan.	45	20	-	65	70	29	-	99	34	50	16	139	0
Feb.	40	20	-	60	75	31	-	106	46	50	4	130	0
Mar.	45	20	-	65	88	36	-	124	59	100	41	89	0
Apr.	45	20	10	75	114	47	260	421	346	100	0	150	246
May	55	25	20	100	173	72	260	505	405	100	0	150	155
June	60	30	20	110	180	74	-	254	144	100	0	150	44
July	60	30	20	110	76	31	-	107	-3	0	3	147	0
Aug.	60	30	20	110	68	28	-	96	-14	0	14	133	0
Sept.	50	30	20	100	54	24	-	78	-22	0	22	111	0
Total	600	300	120	1020	1096	453	520	2069	1049	500	84		445

Notes: (1) Whites Creek at 57% and Thomas Creek at 82% of normal water allocation including seepage losses from 1980-81 water year data.

(2) Surplus water will be used for continued agricultural irrigation and stock watering.

(3) Drought restrictions are limited to a 50% reduction in irrigation usage.

TABLE III-5

WATER SUPPLY & CONSUMPTION - DOUBLE DIAMOND - PHASE 1
(Normal Years)

Month	Water Consumption-AF (3)				Water Supply for Q-M Use-AF				Inventory-AF		
	Domes.	Comm.	Irrig.	Total	Whites Creek	Thomas Creek	Truckee Ditches	Total	Net Balance	(2) Inject	(1) Surplus
Oct.	50	25	20	95	110	31	84	225	130	0	130
Nov.	45	20	-	65	96	28	-	124	59	0	59
Dec.	45	30	-	75	91	26	-	117	42	0	42
Jan.	45	20	-	65	104	30	-	134	69	0	69
Feb.	40	20	-	60	98	28	-	126	66	0	66
Mar.	45	20	-	65	107	31	-	138	73	0	73
Apr.	45	20	20	85	140	40	73	253	168	100	68
May	55	25	40	120	236	68	157	461	341	100	241
June	60	30	40	130	373	107	188	668	538	100	438
July	60	30	40	130	313	89	188	590	460	100	360
Aug.	60	30	40	130	152	44	188	384	254	50	204
Sept.	50	30	40	120	102	30	166	298	178	50	128
Total	600	300	240	1140	1922	552	1044	3518	2378	500	1878

Notes:

(1) Surplus water will be used for continued agricultural irrigation and stock watering on Double Diamond and for drought cycle groundwater injection.

(2) Injection into groundwater aquifer for seasonal and drought cycle use.

(3) Water Consumption Estimates:
- Domestic - 7000 persons X 75 gpcd = 600 AF
- Commercial - 3500 persons population equivalent X 75 gpcd = 300 AF
- Irrigation - by potable water - 60 acres X 4 ft/year = 240 AF
  - by reclaimed and other non-potable water - 300 acres at 4 ft/yr. = 1,200 AF (not included in this water balance table)

(4) Water supply for quasi-municipal uses. In addition there are 1,840 AF of waste and flood and 1,937 AF of groundwater for continued irrigation and stock watering.

IV. SURFACE WATER MONITORING

A. SURFACE WATER HYDROLOGY

Double Diamond Ranch is located on the valley floor of the Upper Truckee Meadows, south of the Huffaker Hills. The Truckee Meadows is drained to the north by Steamboat Creek, which lies in a confluence between the Huffaker Hills and the Virginia Range (refer to Figure I-1).

Steamboat Creek, originating in Washoe Valley at Washoe Lake, is the principal stream flowing through the Upper Truckee Meadows. Thomas and Whites Creeks are perennial streams which flow from the Carson Range of the Sierra Nevada, north and east to the confluence at Huffaker Hills. Other surface water enters the Truckee Meadows via irrigation ditches, originating at the Truckee River. Specifically, these ditches are, Steamboat Ditch, Lake Ditch, and Last Chance Ditch. All of these surface waters impact and constitute the water supply for the Double Diamond Ranch; each source, therefore, was included in the monitoring program.

B. MONITORING STATIONS

Surface water was monitored at distances up to 5½ miles from the Double Diamond Ranch boundary, at the ranch boundary itself, and at the confluence where Steamboat Creek drains the Upper Truckee Meadows (refer to Figure I-1 for locations). The following stations were included in the monitoring program, and the results of the analyses are listed in the identified tables.

1. WC-1

   Whites Creek-1 - at the mountain front of the Carson Range of the Sierra Nevada, approximately 5½ miles SW of Double Diamond, Table A-1.

2. WC-3

   Whites Creek-3 - at the Howards Creek/Browns Creek split, Table A-2.

3. WC-7

   Whites Creek-7 - the Howards branch of Whites Creek at the Double Diamond Ranch western boundary, Table A-3.

4. TC-1

   Thomas Creek-1 - at the mountain front of the Carson Range of the Sierra Nevada, approximately 5½ miles SW of Double Diamond, Table A-4.

5. TC-4

Thomas Creek-4 - where Thomas passes over Steamboat Ditch, Table A-5.

6. TC-6

Thomas Creek-6 - at Mays Lane and U.S. 395 before it enters Double Diamond Ranch, Table A-6.

7. SBC-1

Steamboat Creek-1 - at its intersection with Highway 17, Table A-7.

8. SBC-5

Steamboat Creek-5 - at the confluence between Huffaker Hills and the Virginia Range, Table A-8.

9. LCD-1

Last Chance Ditch-1 - at Zolezzi Lane, SW¼, Section 17, Table A-9.

10. LD-1

Lake Ditch-1 - at Holcomb Lane, Table A-10.

11. SBD-1

Steamboat Ditch-1 - at Thomas Creek, Table A-11.

12. CRD-1

Crane Ditch-1 - at Highway 17, Table A-12.

13. CHD-1

Chandler Ditch-1 - at Highway 17, Table A-13.

14. WFD-1

Waste and Flood Ditch-1 - from South Hills subdivision at Old Virginia City Road, Table A-14.

15. MD-1

Minor Drainage Ditch-1 - central portion of Double Diamond at Old Virginia City Road, Table A-15.

16. MD-2

Minor Drainage Ditch-2 - north portion of Double Diamond at Old Virginia City Road, Table A-16.

17. MD-3

Minor Drainage Ditch-3 - south portion of Double Diamond at Old Virginia City Road, Table A-17.

All surface water quality data is presented in Tables A-1 through A-17.

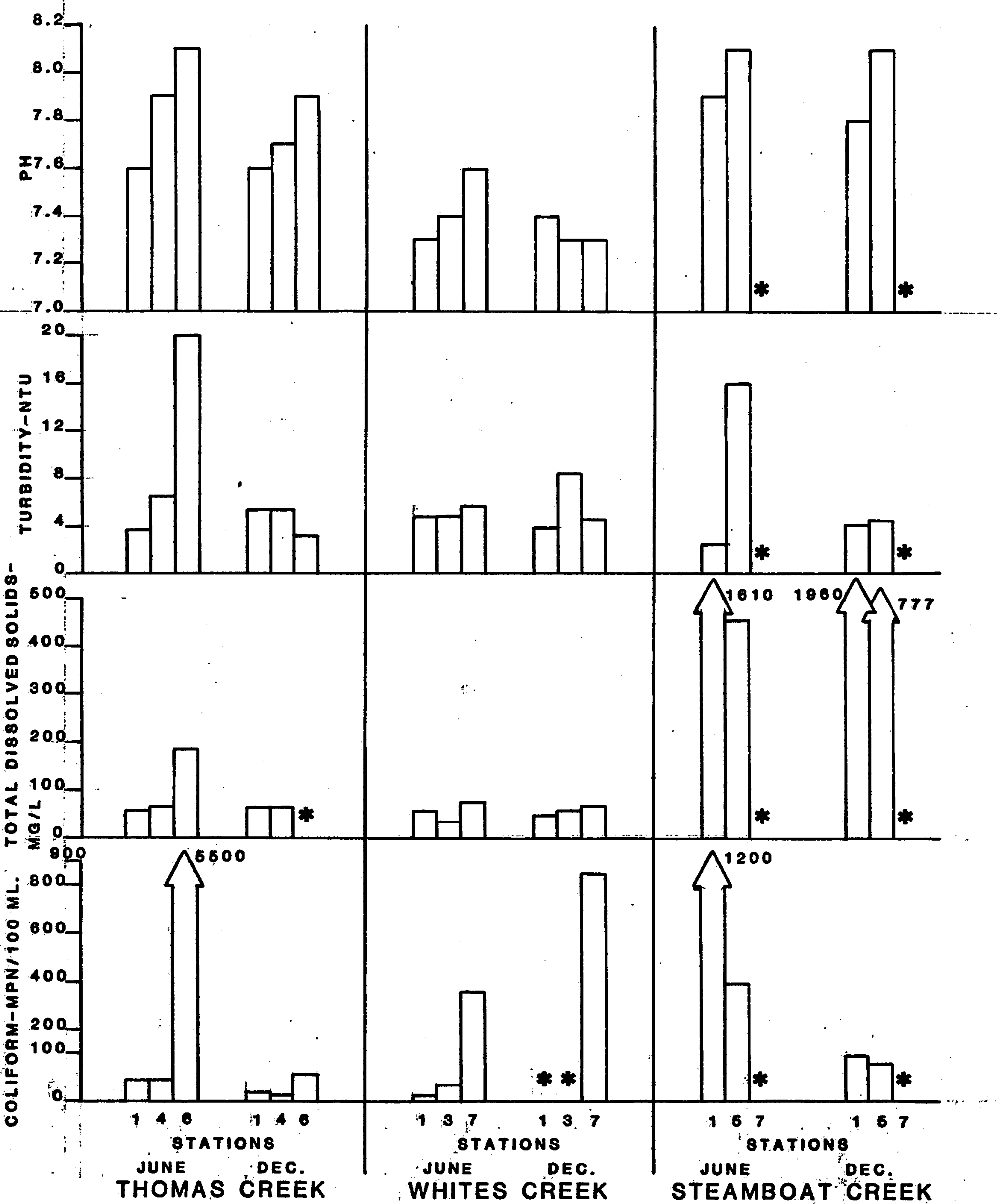
C. QUALITY CHARACTERISTICS

The quality characteristics of the surface water sources of the Double Diamond are quite variable. The Truckee ditches, originating at the Truckee River, are relatively low in minerals and hardness, but have seasonal turbidity, color and iron variations. The variation in characteristics during high and low flow periods on Thomas, Whites, and Steamboat Creek along their lengths to the western edge of Double Diamond are shown in Figure IV-1. Generally, levels of turbidity, TDS, conductivity and coliform increase along the course of the creeks. Return waters during the irrigation season cause apparent variations along the course of the creeks. Elevated levels of iron and phosphates were also indicated on Whites and Thomas Creeks as they entered the ranch.

The waters of Thomas and Whites Creeks, which originate in the Carson Range, are of a quality generally similar to that of the waters of the Truckee ditches. The Total Dissolved Solids concentration was low in all but one sample taken on Whites Creek in September, 1980. This elevated concentration may have resulted from the high proportion of irrigation return water during that time.

Steamboat Creek shows seasonally high concentrations of arsenic, boron, phosphates, iron, and chlorides, apparently due to inflow from the Steamboat Springs geothermal area. This source will continue to be used for agricultural irrigation supply to the southeastern portion of the Double Diamond in Phase 1.

The minor ditches entering Double Diamond result from waste and flood runoff of urbanized and pastured areas in the region. These ditches will not be used in the potable water supply; they will remain in their present use - to irrigate.



* NO DATA COLLECTED

WATER QUALITY CHANGES IN DOUBLE DIAMOND SURFACE WATER SOURCES -1981

DOUBLE DIAMOND DEVELOPMENT	DATE FEB. 1982
	FIGURE IV-1

COLLINS & RYDER CONSULTING ENGINEERS

RENO, NEVADA

In general, those surface water sources intended for potable water usage, the Truckee ditches and Thomas and Whites Creeks, are of good physical and chemical and moderate bacterial water quality. Steamboat Creek, being of poor physical and chemical quality, is not a good source for potable, nor for irrigation water. The waste and flood ditch and lesser minor ditches are to be used for continuing irrigation purposes only, and are suitable for this use.

V. GROUNDWATER MONITORING

A. GROUNDWATER HYDROLOGY

The Double Diamond Ranch is located in the Southeast Truckee Meadows Basin, which is separated from the main Truckee Meadows Basin by the Huffaker Hills. This basin is underlain by consolidated volcanic rock which are relatively impervious and, hence, form the basement rock. Above this basement layer of rocks, lie a thick sequence of fine to medium grained unconsolidated to semiconsolidated sedimentary strata, reportedly in excess of 1,000 feet thick. A more complete geologic explanation of the region appears in Reference 1. The area beneath the ranch is capable of transmitting and producing large quantities of groundwater. The basin area is saturated with groundwater to the surface in many regions and contains artesian flowing wells.

The Carson Drainage and, to a lesser extent, the Virginia Drainage, are the primary sources of the groundwater recharge in the basin. The groundwater moves to the north and east (down gradient) to the regional discharge area located in the central and northeastern portion of the Upper Truckee Meadows. As the groundwater moves from the recharge areas to the regional discharge area, it flows primarily within beds of older and younger alluvial strata. The permeable beds are bounded by impermeable strata, and groundwater is thus confined under artesian pressure. The majority of flow is considered to be moving within the uppermost portion of the aquifer and discharges primarily into Steamboat Creek and adjacent surface water courses at the lower part of the Southeast Truckee Meadows. The remainder of the aquifer is less active and contributes only a small portion of groundwater.

There is also a considerable quantity of geothermal water that upwells from fractures in the basement rock in the southern and eastern margins of the basin. Numerous geothermal artesian wells and springs occur in this region. This water is of markedly different quality and affects the quality of considerable areas of the basin as discussed herein.

Depths to groundwater are variable; along the perimeter of the basin levels range from several feet to 90 feet below the ground surface, with 30 feet being the most common. Groundwater occurs under artesian flowing conditions in lower portions of the valley with positive pressure normally less than 10 feet. During irrigation season, the shallow, unconfined groundwater is at or close to the surface.

B. MONITORING STATIONS

Groundwater was monitored for water quality at 24 locations on Double Diamond Ranch. Nine of the stations were periodically monitored to relate seasonal conditions. The wells used for the monitoring program are deep wells, which were, in all but one case (DD-O-1), already existing and in use on Double Diamond. A brief description of these nine wells follows, refer to Figure\I-1 for locations:

1. <u>DD-R-1</u>

   Domestic well supplying ranch foreman's house, immediately north of Mays Lane, Table B-1.

2. <u>DD-R-2</u>

   Domestic well supplying May house, immediately south of Mays Lane, Table B-2.

3. <u>DD-R-3</u>

   Domestic well supply two houses on Old Virginia City Road, Table B-3.

4. <u>DD-O-1</u>

   Test well drilled in December, 1980 to a depth of approximately 190 feet, Table B-4.

5. <u>DD-P-1</u>

   Flowing piezometer well on southern area of ranch, Table B-5.

6. <u>DD-P-2</u>

   Flowing piezometer well on southwestern area of ranch, Table B-6.

7. <u>DD-P-3</u>

   Flowing piezometer well on northeastern area of ranch, Table B-7.

8. <u>DD-P-4</u>

   Flowing piezometer well on northern area of ranch, Table B-8.

9. <u>DD-P-5</u>

   Flowing piezometer well at eastern end of Mays Lane, Table B-9.

These nine wells were monitored during low and high water level months, June and December, respectively, with a minimum of two samplings. Water quality and pressure heads of each well are contained in Tables B-1 through B-9. Other deep wells were also tested, but were not included in the annual monitoring program. These include:

1. #1

   Irrigation well in northwest area of Double Diamond near ranch feed lots, Table B-10.

2. #3

   Artesian well north of the ranch office, Table B-10.

3. #6

   Irrigation well in southeast, Table B-10.

4. #8

   Irrigation well in southeast, Table B-10.

5. #9

   Domestic well supply ranch office, Table B-10.

6. #21

   Irrigation well in southwest, Table B-10.

7. #23

   Irrigation well in southwest, Table B-10.

8. DD-T-1

   Test well drilled 12/80 in northwest, Table B-10.

9. DD-T-2

   Test well drilled 1/81 in southwest, Table B-10.

Water quality samples were also taken on several shallow wells, for the most part 6 - 8 foot piezometer wells. These included:

1. #2

   Piezometer in northeast corner of ranch, Table B-11.

2. #16

   Piezometer in southwest area of ranch, immediately below Mays Lane, Table B-11.

3. #27

Piezometer in southeast area of ranch, Table B-11.

4. #275

Shallow spring between two houses on Old Virginia City Road, Table B-11.

5. #34

Piezometer in southeastern area of ranch by fire station, Table B-11.

6. #35

Piezometer in southeastern area of ranch, Table B-11.

C. GROUNDWATER QUALITY

1. General

Several factors affect the variations in groundwater quality at Double Diamond. The first factor is the geothermal activity in the Steamboat Springs area that is centered approximately 3½ miles to the south of the Double Diamond with evidence of extension to the Huffaker Hills. It is in this region that geothermal discharges of highly mineralized water blend with groundwater recharge of relatively high quality that primarily originates from recharge from surface water draining the Carson Range on the Mount Rose Fan. The groundwater then moves down gradient from south to north, and west to east.

The mixing of geothermal discharge and high quality groundwater occurs in USGS Quad Sections 17 and 8; it then moves west and north to the confluence east of Huffaker Hills. The higher quality water moving in from the west across the northwestern area of the Double Diamond remains in this state until mixing with geothermally influenced water in the middle area of the Double Diamond Ranch.

In general, groundwater in the northeast and near-surface groundwater on the Double Diamond are of good chemical quality. Therefore, it is planned that surface water injection for drought storage and reuse occur in this portion of Double Diamond in order that resultant intermixing of surface and residual groundwater will not adversely affect quality for water supply.

Isopleths, Figures V-1 through V-4, have been prepared for the groundwater quality characteristics of concern on the Double Diamond; these are TDS, nitrates, arsenic, and boron. These isopleths graphically show that elevated levels were found in groundwater samples taken in the south and east, and are generally similar to, but provide more detail than, those plotted from data collected in April, 1980.

2. <u>Groundwater Quality in the Northwestern Region of Double Diamond</u>.

The movement of groundwater under the northwestern area of the ranch is from the Carson Range to the west; it is, in general, not influenced by the geothermal recharge from Steamboat Springs. The groundwater in the northwestern area of Double Diamond, therefore, is generally of good quality; this includes Section 5, the NE¼ of Section 8, and the SW¼ of Section 4. Well DD-P-3, which is in the northwestern section, begins to show some geothermal influence in its arsenic and boron levels (refer to Table B-7).

3. <u>Groundwater Quality in the Southwestern Region of Double Diamond</u>.

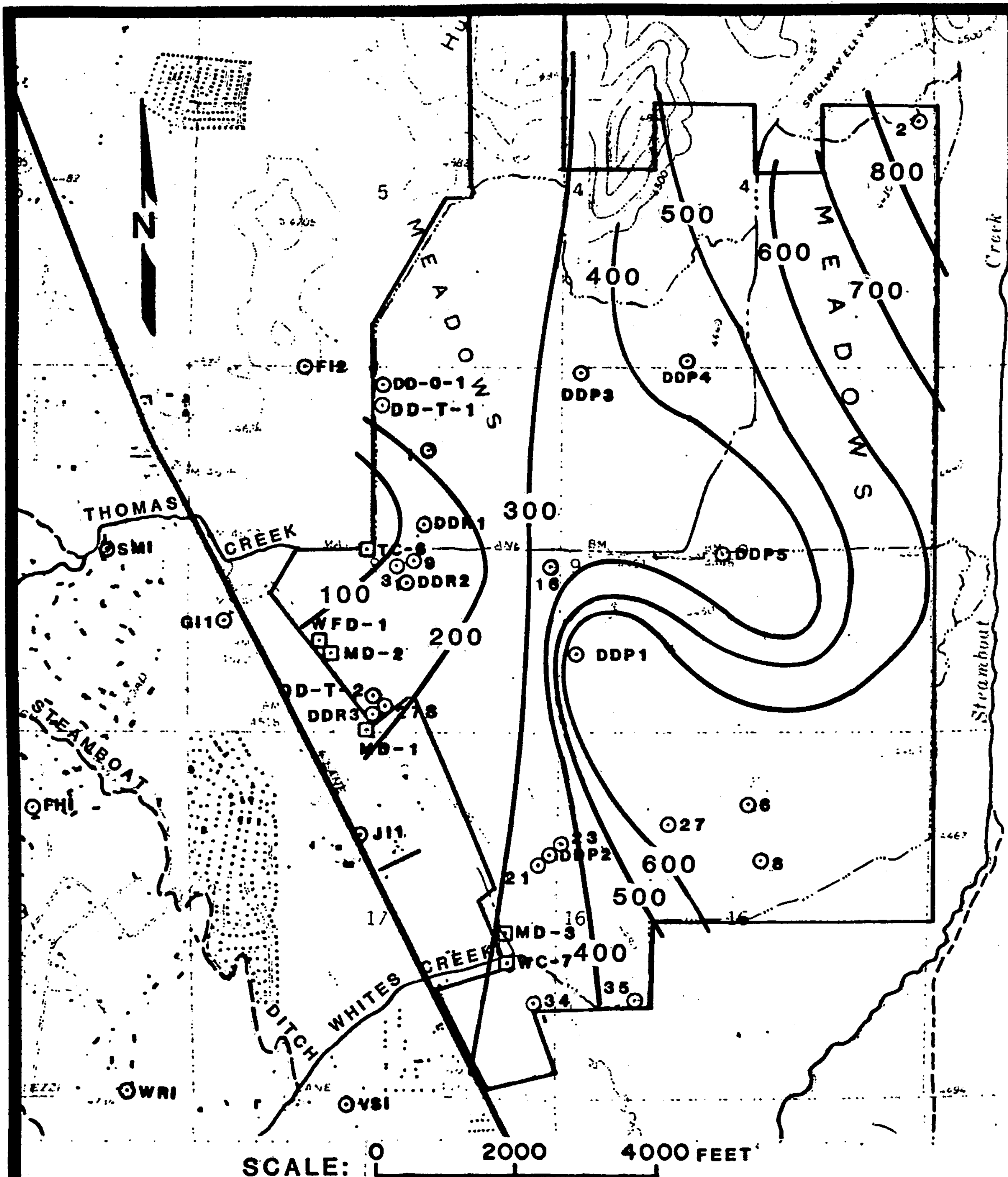
It is in the SE¼ of Section 8 and Section 17 that good quality recharge from the Carson Range and Truckee ditches begins to mix with geothermal water. Elevated concentrations of arsenic, boron, nitrates, and phosphates were found in all but one sampling location; DD-R-3 (refer to tables).

4. <u>Groundwater Quality in the Southeastern Region of Double Diamond</u>.

Wells sampled in the southeastern area of Double Diamond are influenced by geothermal water to the same degree as other wells tested in the southwestern area. Arsenic, boron, nitrates, and phosphate concentrations were elevated.

5. <u>Groundwater Quality in the Northeastern Region of Double Diamond</u>.

Groundwater sampled in the northeastern area of Double Diamond showed elevated levels of arsenic and boron and, in one case, piezometer #2, elevated levels of phosphate were found.



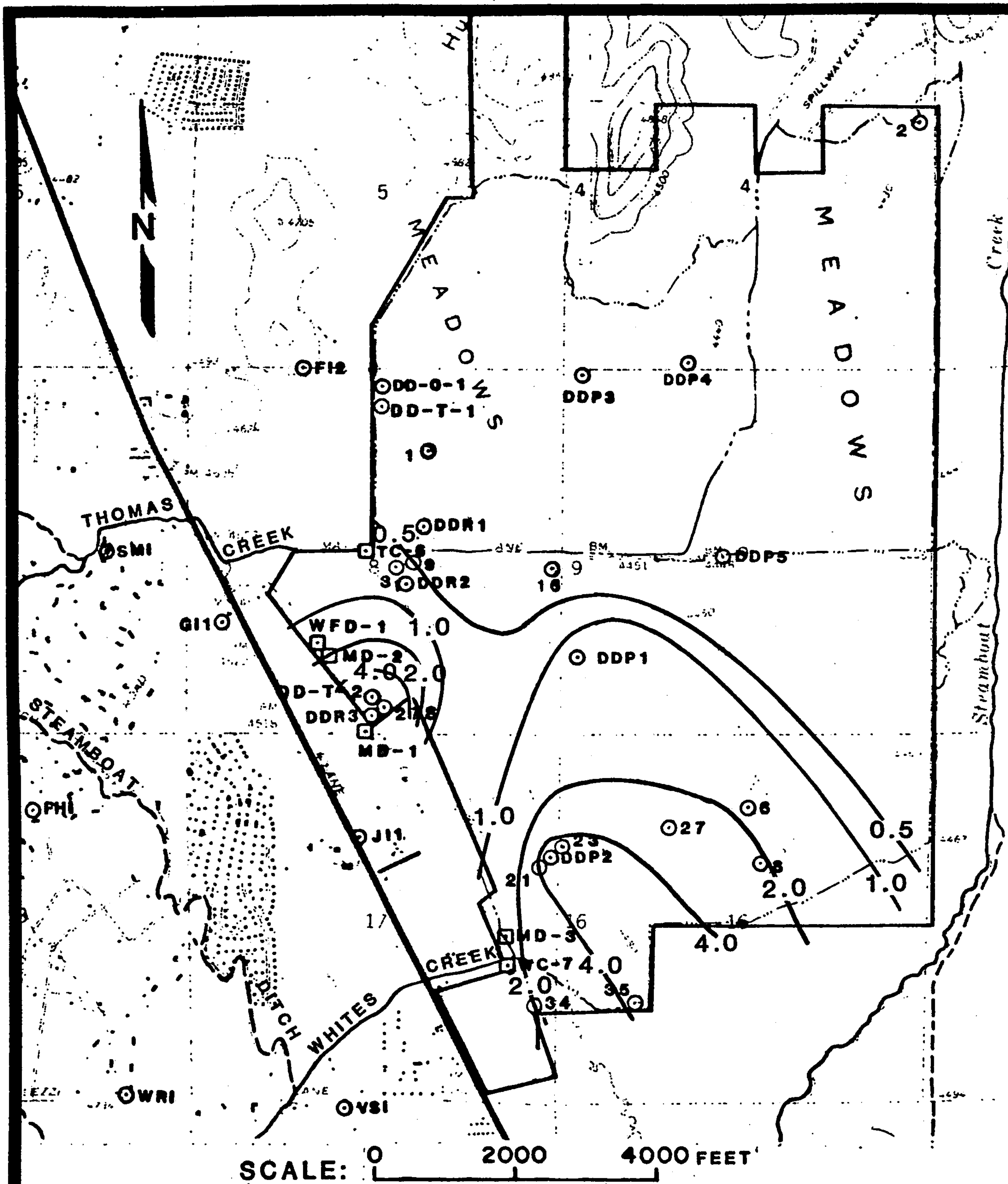
CONCENTRATIONS OF TOTAL DISSOLVED SOLIDS IN GROUNDWATER UNDERLYING DOUBLE DIAMOND RANCH

⊙ GROUNDWATER SAMPLING STATION

LINES OF EQUAL CONCENTRATION

DOUBLE DIAMOND DEVELOPMENT	DATE FEB. 1982
	FIGURE V-1

COLLINS & RYDER CONSULTING ENGINEERS-RENO, NEVADA



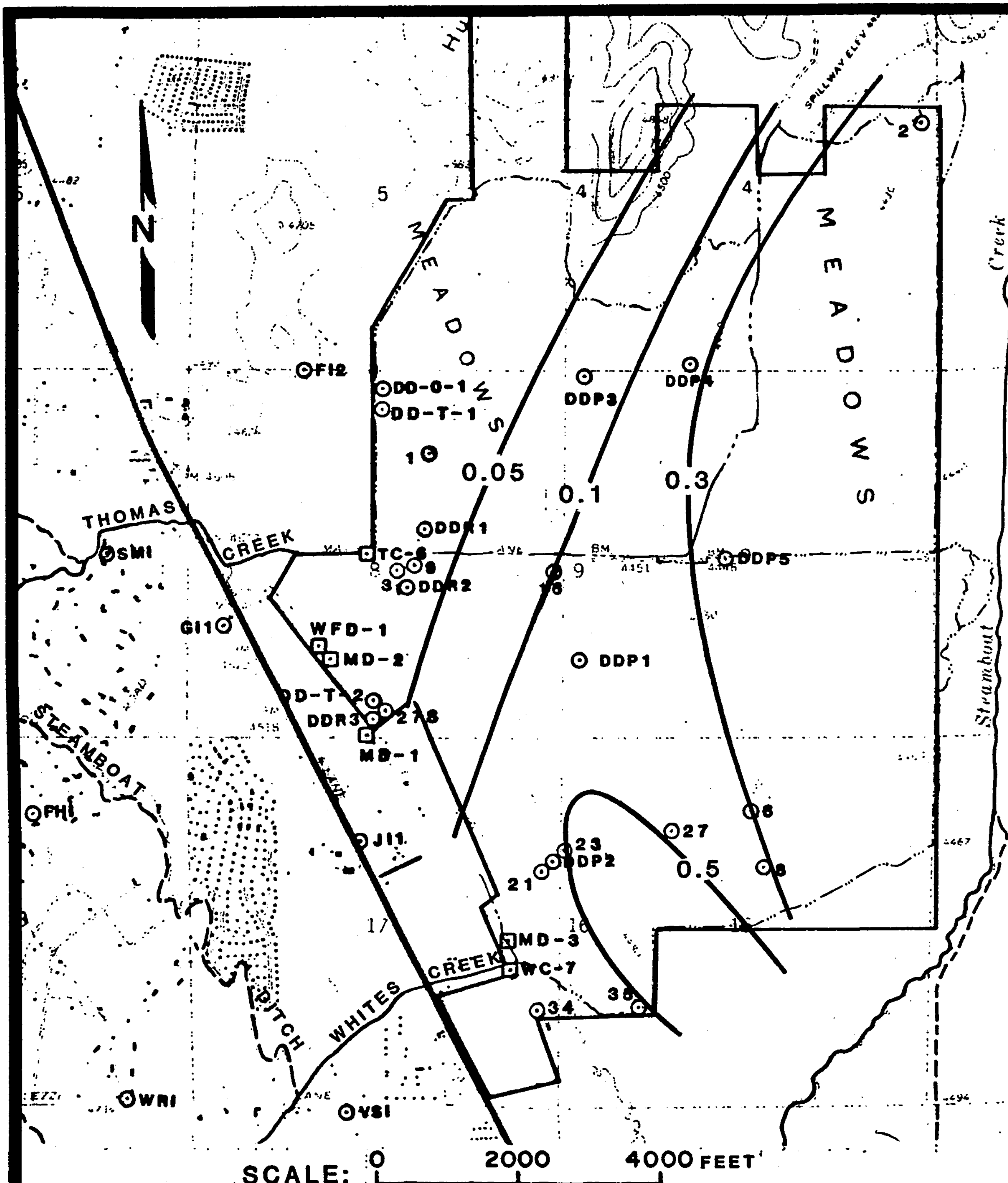
CONCENTRATIONS OF NITRATES IN GROUNDWATER UNDERLYING DOUBLE DIAMOND RANCH

⊙ GROUNDWATER SAMPLING STATION

LINES OF EQUAL CONCENTRATION

DOUBLE DIAMOND DEVELOPMENT	DATE FEB. 1982
	FIGURE V-2

COLLINS & RYDER CONSULTING ENGINEERS-RENO, NEVADA



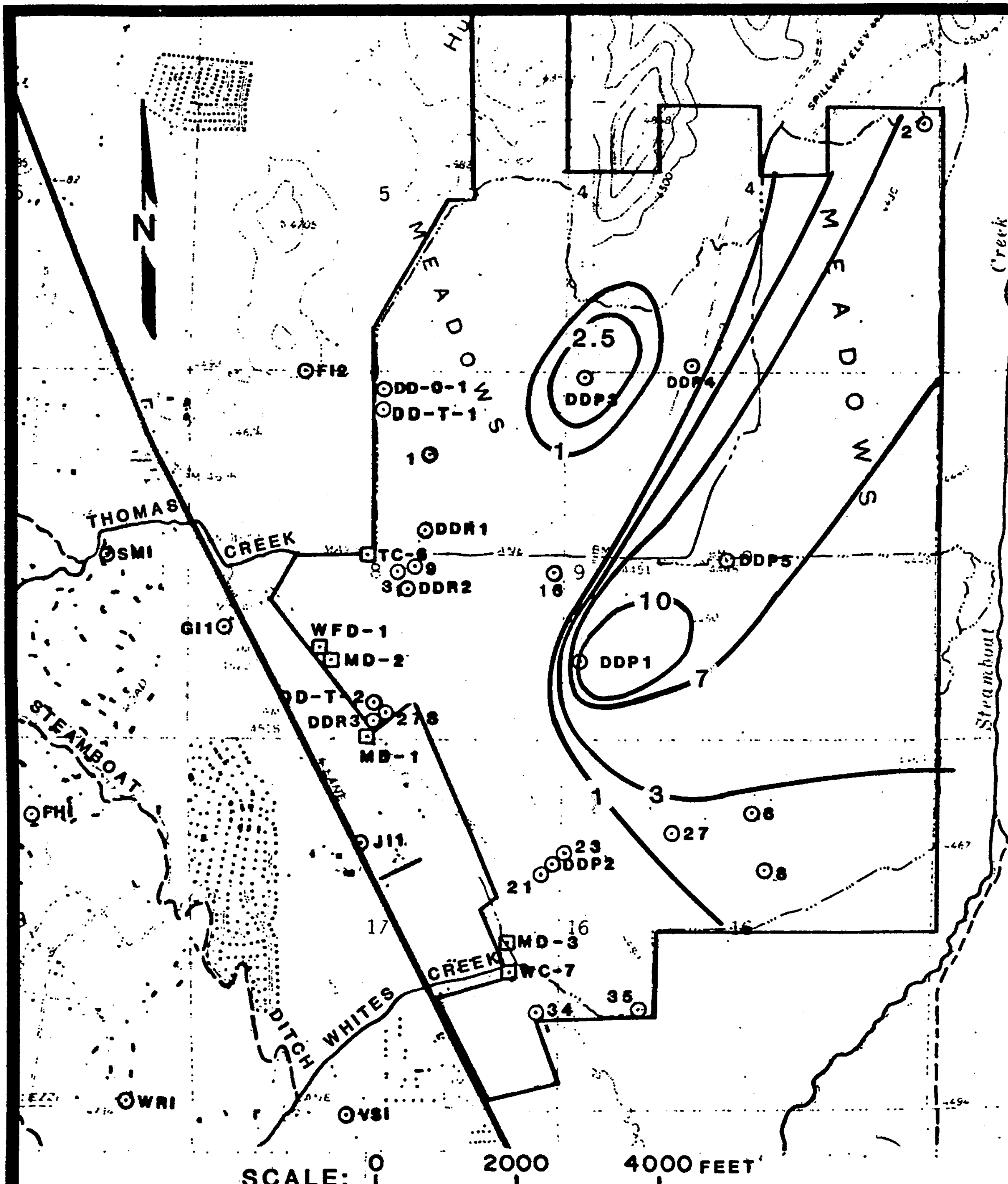
CONCENTRATIONS OF ARSENIC IN GROUNDWATER UNDERLYING DOUBLE DIAMOND RANCH

⊙ GROUNDWATER SAMPLING STATION

⌒ LINES OF EQUAL CONCENTRATION

DOUBLE DIAMOND DEVELOPMENT	DATE FEB. 1982
	FIGURE V-3

COLLINS & RYDER CONSULTING ENGINEERS-RENO, NEVADA



CONCENTRATIONS OF BORON IN GROUNDWATER UNDERLYING DOUBLE DIAMOND RANCH

⊙ GROUNDWATER SAMPLING STATION

LINES OF EQUAL CONCENTRATION

DOUBLE DIAMOND DEVELOPMENT	DATE FEB. 1982
	FIGURE V-4

COLLINS & RYDER CONSULTING ENGINEERS-RENO, NEVADA

VI. WATER QUALITY AND TREATMENT

A. SUMMARY OF WATER QUALITY AND SUPPLY USES

The water sources for potable supply for Phase 1 of the Double Diamond development include the Truckee ditches, Whites and Thomas Creek. The Waste and Flood ditches, as well as Steamboat Creek, will continue to be used for irrigation. Table VI-1 has been developed to show the raw water composite from surface water supply that will be treated at the Double Diamond Water Treatment Facilities. A comparison to expected treated water quality at the Double Diamond facilities is also shown, as well as the previous characteristics as listed in the Water Supply Report, Ref. 4. Comparing the water quality composites of 1981 to 1980, it is seen that the turbidity and coliform values were significantly higher, but the general mineral characteristics somewhat lower, than previously. These should reflect more accurate composite characteristics as they were determined from six, as compared to two, samples.

The proposed plan also includes storage of injected surface water in the ground of the northwestern area of Double Diamond, for pumping and for use to supplement diminished surface supplies in the event of a drought. Table VI-2 shows a comparison of treated water to be injected in this event, and groundwater presently existing in the northwestern region of Double Diamond. In general, there will be an improvement in water quality as compared to what now is in the ground. No significant degradation of groundwater will occur.

B. WATER TREATMENT

A water treatment facility with a capacity of 6 MGD, located adjacent to Whites Creek in the southerly portion of Double Diamond, is projected for the Phase 1 development. A site is available at this location to expand this facility by three additional 6 MGD modules to serve projected needs of the entire Southeast Truckee Meadows region. The proposed facilities will incorporate state-of-the-art water treatment processes that include, raw water storage for quality blending and presedimentation, ozonation, coagulation-sedimentation, mixed-media filtration, chlorination and corrosion stability processes. Space is provided for additional treatment processes, including granular activated carbon contactors (GAC columns) for the removal of organics or selective ion adsorption processes for fluoride or boron removal in the event that need arises.

Excessive levels of any water quality characteristic in all sources intended for potable water usage will be treated to meet drinking water standards. This includes turbidity, color, hardness, alkalinity, TDS, calcium, magnesium, iron, manganese, arsenic, heavy metals, and corrosion stabilization. The use of preozonation and post chlorination as proposed should provide a high degree of disinfection for bacterial and viral contaminants.

TABLE VI-1

SURFACE WATER SUPPLY AND TREATED WATER QUALITY CHARACTERISTICS DOUBLE DIAMOND DEVELOPMENT - PHASE 1

Characteristics	Units	Whites Creek	Thomas Creek	Truckee Ditches	Raw Water Comp. 1981	Raw Water Comp. 1980	Treated Water 1981	Treated Water 1980
Portions of Phase 1 Supply	%	55	16	29	-	-	-	-
pH	-	7.4	8.1	7.6	7.6	7.45	8.5	8.5
Turbidity	NTU	12.6	8.5	13.4	12.2	5.6	<0.1	<0.1
Color	CU	15	15	20	15	20	<5	<5
Hardness	mg/l	59	98	72	60	54	80	60
Alkalinity	"	51	110	54	61	75	60	63
TDS	"	81	157	85	94	140	100	150
Calcium	"	17	21.5	23	19.5	14.1	25	18
Magnesium	"	4.1	11	3.7	5.1	4.7	5.1	4.7
Sodium	"	16.8	9.6	7	12.8	17	13	17
Potassium	"	4.5	5.0	2	3.9	4.6	3.9	4.6
Iron	"	0.6	0.1	0.44	0.47	0.9	0.05	0.05
Manganese	"	0.03	0.026	0.05	0.03	0.04	0.01	0.01
Chloride	"	10.0	4.5	4.7	7.6	7.7	8.0	7.7
Sulfate	"	10.3	5.2	4.7	7.8	7.9	12	12
Nitrate	"	1.0	0.3	0.15	0.64	0.6	0.6	0.6
Phosphate	"	0.15	0.22	0.08	0.14	0.14	0.01	0.01
Fluroide	"	0.15	0.1	0.1	0.12	0.2	0.12	0.2
Silica	"	17	56	17	23	33	23	33
Boron	"	0.24	0.1	0.1	0.17	0.22	0.17	0.22
Arsenic	"	0.006	0.01	0.003	0.006	0.02	0.006	0.02
Barium	"	0.043	0.19	0.04	0.07	0.06	<0.06	< 0.06
Cadmium	"	ND	ND	ND	ND	ND	<0.001	<0.001
Chromium	"	"	"	"	"	"	<0.005	<0.005
Copper	"	"	"	"	"	"	< 0.1	< 0.1
Lead	"	"	"	"	"	"	<0.005	<0.005
Mercury	"	"	"	"	"	"	<0.0005	<0.0005
Nickel	"	"	"	"	"	"	<0.05	<0.05
Silver	"	"	"	"	"	"	<0.01	<0.01
Selenium	"	"	"	"	"	"	<0.01	<0.01
Conductivity	u Mhos/cm	116	224	120	134	240	150	250
S.A.R.	-	1.3	0.4	0.4	0.05	1.01	0.8	0.95
Langelier Index	-	-1.0	0	-0.8	-0.9	-0.4	+0.1	0.0
Total Coliform	MPN/100ml	1190	1590	800	1390	140	<2	<2
Fecal Coliform	MPN/100ml	780	623	250	700	23	<2	<2

TABLE VI-2

COMPARISON OF TREATED INJECTION WATER FOR DROUGHT STORAGE TO EXISTING GROUNDWATER QUALITY IN NORTHWESTERN AREA OF DOUBLE DIAMOND

Characteristics	Units	Injected Water	Northwest D.D. Groundwater
pH	-	8.5	7.8
Turbidity	NTU	0.1	0.5
Color	CU	5	10
Hardness	mg/l	80	115
Alkalinity	"	60	130
T.D.S.	"	100	170
Calcium	"	25	18
Magnesium	"	5.1	12
Sodium	"	13	12
Potassium	"	3.9	4.4
Iron	"	0.05	0.18
Manganese	"	0.01	0.023
Chloride	"	8.0	<1
Sulfate	"	12	3.7
Nitrate	"	0.6	0.35
Phosphate	"	0.01	0.05
Fluoride	"	0.12	<0.1
Silica	"	23	-
Boron	"	0.17	<0.1
Arsenic	"	<0.01	<0.1
Barium	"	<0.06	-
Cadmium	"	<0.001	-
Chromium	"	<0.005	-
Copper	"	< 0.1	-
Lead	"	<0.005	-
Mercury	"	<0.0005	-
Nickel	"	<0.05	-
Silver	"	<0.01	-
Selenium	"	<0.01	-
Conductivity	u Mhos/cm	150	240
S.A.R.	-	0.80	0.50
Langelier Index	-	+0.1	-0.3

\- No data available.

VII. SUMMARY AND CONCLUSIONS

A. SUMMARY

The collection of water quality and quantity data since April of 1980, on all Double Diamond water sources, has supported preliminary water quantity and quality planning. It has been shown that even in the dry water year of 1980-81, there is a surplus of approximately 1,050 AF of water in Phase 1 of Double Diamond Development. A recurrence interval of dry conditions, such as the one recently experienced, is once in every 25 years. The proposed water supply plan also includes a groundwater injection and storage scheme; this will serve to supplement supplies. The data contained herein will also establish a baseline of hydrologic conditions prior to Double Diamond Development Phase 1.

B. CONCLUSIONS

Conclusions of this 1981 sampling program, compared to data provided in the Double Diamond Water Supply Report, that was used as a data source in the Water Rights Change of Use Applications, are as follows:

1. The flow of water in the Double Diamond sources of supply were significantly less for Thomas Creek, but greater for Whites and Steamboat Creeks, than calculated drought flow conditions of a 100 year recurrence interval.

2. The summer flow in Thomas Creek was less than half of the calculated drought flow conditions. Further investigation as to the difference between the Whites and Thomas Creeks watershed is suggested. The height and areal proportions of terrain are similar, but either more spring flow is occurring on Whites than Thomas, or there is an upstream water diversion on Thomas Creek which may explain the indicated differences.

3. The flow in Steamboat Creek is regulated by storage and discharge from Washoe Lake, and is not significantly effected by a one year drought like 1980-81.

4. The flow in the Truckee River ditches during 1980 and 81 were significantly higher than minimum values. Again, a one year drought did not significantly reduce water availability; again, probably due to withdrawal of upstream impounded storage from Lake Tahoe, etc.

5. Measured seepage losses for Thomas and Whites Creek were similar to previous values; an average of 0.7 cfs loss for Thomas and 1.0 cfs for Whites Creek between the mountain front and the Double Diamond.

6. The overall water supply from the quasi-municipal sources for the Double Diamond Phase 1 development would have been 2,069 AF in the 1980-81 water year, as compared to 2,003 AF in the previous drought projection. Water consumption is estimated to be approximately 1,020 AF; and a surplus of 1,050 AF is available for subsurface storage injection or other irrigation on the ranch.

7. The flow availability in the 1980-81 water year was so close to the calculated critical drought of the 100 year recurrence interval that there is reason to suggest that the calculated drought values are too high. This should be further investigated by continuing flow monitoring and, in particular, determining why there was such a departure from Thomas Creek flow as compared to the drought projections.

8. The surface water quality of Thomas and Whites Creek including directed ditch flows as they enter the ranch were somewhat lower in mineral quality but higher in bacterial quality then analyses in 1980 used for projections and design of water treatment facilities. The lower mineral quality is probably due to the greater proportion of Truckee ditch water as compared to Thomas Creek water. The relatively higher bacterial concentrations may be indicative of lower dilution of contaminants entering the streams from seepage from leaching fields or from other urban activities between the ditch diversions and the Double Diamond.

9. The average coliform bacteria concentrations in Lake, Last Chance, and Steamboat ditches, were 4800, 800, and 210 MPN/100ml, respectively. This shows a progressive increase in bacterial concentration in the lower Truckee ditches that traverse through more urbanized areas and the desirability of eventually providing all of the Truckee water for potable treatment through Steamboat Ditch.

10. The proposed treatment processes and storage reservoir for the Double Diamond Phase 1 development can adequately handle raw water quality characteristics experienced in the 1980-81 water year.

11. Groundwater monitoring indicated a relatively uniform concentration of characteristics, not significantly changed from summer to winter conditions.

12. The groundwater quality is much higher in dissolved solids, arsenic, and boron in the southern and eastern portions of the Double Diamond, while higher nitrates are found in the southwestern section.

13. The rationale of injecting surplus surface water in the northeastern section for seasonal drought withdrawal is confirmed by the 1981 measurements. In the northeastern area, the groundwater has much lower dissolved solids, arsenic, and boron, and will not significantly degrade the water quality of injected, stored surface water for future use for water supply.

APPENDIX A

SURFACE WATER QUALITY CHARACTERISTICS

TABLE A-1

WATER QUALITY CHARACTERISTICS FOR: WHITES CREEK AT THE MOUNTAIN FRONT (WC-1)

DOUBLE DIAMOND DEVELOPMENT - PHASE 1

		(DATE)						
Characteristic	Units	1/81	4/81	6/81	8/81	10/81	12/81	Average
Flow	cfs	-	5.19	10.05	3.87	3.45	4.62	5.44
pH	-	-	-	7.3	-	7.5	7.4	7.4
Turbidity	NTU	-	-	5.0	-	-	4.0	4.1
Color	CU	-	-	3.0	-	-	-	3.0
Hardness	mg/l	-	-	23	-	-	-	23
Alkalinity	"	-	-	23	-	30	-	25
TDS	"	-	56	36	47	50	50	43
Arsenic	"	-	-	<0.003	-	-	<0.003	<0.003
Conductivity	μ Mhos/cm	-	80	52	67	72	72	65
Total Coliform	MPN/100 ml	-	-	8	-	-	Ø	4
Fecal Coliform	MPN/100 ml	-	-	Ø	-	-	Ø	Ø

TABLE A-2

WATER QUALITY CHARACTERISTICS FOR: WHITES CREEK AT HOWARD/BROWN DIVISION (WC-3)

DOUBLE DIAMOND DEVELOPMENT - PHASE 1

Characteristic	Units/Date	4/81	6/81	8/81 (DATE)	10/81	12/81	Average
Flow	cfs	4.9	8.03	3.13	3.3	5.02	4.88
pH	-	7.5	7.4	6.9	7.2	7.3	7.3
Turbidity	NTU	1.8	5.0	2.4	1.0	8.5	4.2
Color	CU	5	5	5	< 5	-	5
Hardness	mg/l	29	2	26	28	-	25
Alkalinity	"	29	60	26	32	-	42
TDS	"	52	37	49	50	56	47
Sodium	"	4	-	-	-	-	4
Potassium	"	-	-	-	-	-	-
Iron	"	0.17	-	-	-	-	0.17
Manganese	"	< 0.02	-	-	-	-	< 0.02
Boron	"	< 0.1	-	-	-	-	< 0.1
Arsenic	"	< 0.003	0.003	< 0.003	< 0.003	< 0.003	< 0.003
Conductivity	μ Mhos/cm	74	53	70	72	80	68
Total Coliform	MPN/100 ml	12	32	42	4	Ø	12
Fecal Coliform	MPN/100 ml	4	20	18	2	Ø	4

TABLE A-3

WATER QUALITY CHARACTERISTICS FOR: WHITES CREEK AT DOUBLE DIAMOND RANCH (WC-7)

DOUBLE DIAMOND DEVELOPMENT - PHASE 1

Characteristic	Units/Date	4/80	9/80	1/81	4/81	(DATE) 6/81	8/81	10/81	12/81	Average
Flow	cfs	-	-	-	0.37	0.22	3.99	0.42	1.3	1.26
pH	-	7.2	7.45	7.4	7.4	7.6	7.4	7.6	7.3	7.4
Turbidity	NTU	7.6	3.4	1.2	5.5	5.8	3.6	1.2	4.7	12.6
Color	CU	25	-	5	10	30	15	5	-	15
Hardness	mg/l	37	72	32	28	39	42	33	-	40
Alkalinity	"	28	130	37	47	45	53	41	-	51
TDS	"	70	230	74	88	74	88	70	64	81
Calcium	"		-	-	-	-	-	-	-	-
Sodium	"	4.4	37	-	9	-	-	-	-	16.8
Potassium	"	2.0	6.9	-	-	-	-	-	-	4.5
Iron	"	1.3	-	0.12	0.40	-	-	-	-	0.6
Manganese	"	0.046	-	< 0.02	0.03	-	-	-	-	0.03
Chloride	"	< 1	19	-	-	-	-	-	-	10
Sulfate	"	13	7.7	-	-	-	-	-	-	10.3
Nitrate	"	1.6	0.3	-	-	-	-	-	-	1.0
Phosphate	"	0.1	0.21	-	-	-	-	-	-	0.16
Fluoride	"	< 0.1	0.2	-	-	-	-	-	-	0.15
Silica	"	17	-	-	-	-	-	-	-	17
Boron	"	< 0.1	0.53	-	< 0.1	-	-	-	-	0.24
Arsenic	"	< 0.01	0.05	0.003	0.005	0.005	0.007	0.003	0.005	0.006
Cadmium	"	ND	ND	< 0.01	-	-	-	-	-	< 0.01
Lead	"	ND	ND	< 0.05	-	-	-	-	-	< 0.05
Conductivity	μ Mhos/cm	100	480	106	125	106	125	100	92	116
Total Coliform	MPN/100 ml	-	-	95	> 1600	380	4000	1500	880	1190
Fecal Coliform	MPN/100 ml	-	-	Ø	880	260	1200	1300	680	780

TABLE A-4

WATER QUALITY CHARACTERISTICS FOR: THOMAS CREEK AT THE MOUNTAIN FRONT (TC-1)

DOUBLE DIAMOND DEVELOPMENT - PHASE 1

Characteristic	Units	(DATE) 1/81	4/81	6/81	8/81	10/81	12/81	Average
Flow	cfs	-	3.79	3.20	1.46	1.29	3.69	2.69
pH	-	-	-	7.6	-	7.7	7.6	7.6
Turbidity	NTU	-	-	3.8	-	-	5.4	4.66
Color	CU	-	-	10	-	-	-	10
Hardness	mg/l	-	-	34	-	-	-	34
Alkalinity	"	-	-	47	-	-	54	51
TDS	"	-	67	56	67	70	60	63
Arsenic	"	-	-	<0.003	-	-	<0.003	<0.003
Conductivity	μ Mhos/cm	-	96	80	97	100	86	90
Total Coliform	MPN/100 ml	-	-	48	-	-	15	30
Fecal Coliform	MPN/100 ml	-	-	32	-	-	5	18

TABLE A-5

WATER QUALITY CHARACTERISTICS FOR: THOMAS CREEK AT STEAMBOAT DITCH (TC-4)

DOUBLE DIAMOND DEVELOPMENT - PHASE 1

Characteristic	Units/Date	4/81 (DATE)	6/81	8/81	10/81	12/81	Average
Flow	cfs	3.35	2.93	0.85	1.23	2.07	2.09
pH	-	8.1	7.9	7.6	7.7	7.7	7.8
Turbidity	NTU	5.0	6.5	4.2	4.2	5.4	5.3
Color	CU	10	10	15	< 5	-	10
Hardness	mg/l	36	34	41	43	-	37
Alkalinity	"	49	48	55	62	-	51
TDS	"	64	60	69	74	60	64
Sodium	"	5	-	-	-	-	5
Potassium	"	0.36	-	-	-	-	0.36
Iron	"	< 0.02	-	-	-	-	< 0.02
Manganese	"	-	-	-	-	-	-
Boron	"	< 0.1	-	-	-	-	< 0.1
Arsenic	"	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003
Conductivity	μ Mos/cm	92	85	98	110	86	92
Total Coliform	MPN/100 ml	4	48	280	40	10	40
Fecal Coliform	MPN/100 ml	Ø	32	27	Ø	10	10

TABLE A-6

WATER QUALITY CHARACTERISTICS FOR: THOMAS CREEK AT DOUBLE DIAMOND RANCH (TC-6)

DOUBLE DIAMOND DEVELOPMENT - PHASE 1

		(DATE)								
Characteristic	Units/Date	4/80	9/80	1/81	4/81	6/81	8/81	10/81	12/81*	Average
Flow	cfs	-	-	-	2.76	3.42	2.08	10.86	4.77	4.78
pH	-	8.4	7.6	7.7	8.3	8.1	8.6	8.0	7.9	8.1
Turbidity	NTU	1.6	6.7	18	3.0	20	8.0	7.5	3.5	8.5
Color	CU	20	-	15	10	60	20	< 5	-	15
Hardness	mg/l	150	60	41	127	134	140	76	-	101
Alkalinity	"	150	76	52	132	142	131	91	-	110
TDS	"	250	120	72	210	182	189	130	1610	157
Calcium	"	-	-	-	-	-	-	-	-	-
Sodium	"	12	7.4	-	-	-	-	-	-	9.6
Potassium	"	7.2	2.8	-	-	-	-	-	-	5
Iron	"	n0.1	-	0.30	-	-	-	-	-	0.2
Manganese	"	0.022	-	0.03	-	-	-	-	-	0.026
Chloride	"	5.9	3.0	-	-	-	-	-	-	4.5
Sulfate	"	7.3	3.1	-	-	-	-	-	-	5.2
Nitrate	"	0.1	0.5	-	-	-	-	-	-	0.3
Phosphate	"	0.29	0.15	-	-	-	-	-	-	0.22
Fluoride	"	< 0.1	< 0.1	-	-	-	-	-	-	< 0.1
Silica	"	56	-	-	-	-	-	-	-	56
Boron	"	0.1	0.1	-	-	-	-	-	-	0.1
Arsenic	"	0.01	0.01	-	-	-	-	-	-	< 0.01
Cadmium	"	ND	-	< 0.01	-	-	-	-	-	< 0.01
Lead	"	ND	-	< 0.05	-	-	-	-	-	< 0.05
Conductivity	μ Mhos/cm	360	210	103	300	260	270	185	2300	224
Total Coliform	MPN/100 ml	-	-	180	16	5500	4000	3000	55	1590
Fecal Coliform	MPN/100 ml	-	-	45	12	3900	1200	2200	40	623

* Sample not used in composite calculations. Does not correspond with other Thomas Creek samples.

TABLE A-7

WATER QUALITY CHARACTERISTICS FOR: STEAMBOAT CREEK AT HIGHWAY 17 (SBC-1)

DOUBLE DIAMOND DEVELOPMENT - PHASE 1

		(DATE)								
Characteristic	Units/Date	(1)	9/80	1/81	4/81	6/81	8/81	10/81	12/81	Average
Flow	cfs	-	-	-	5.67	0.14	0.23	0.09	0.23	1.27
pH	-	8.2	7.3	7.9	-	7.9	-	8.0	7.8	7.9
Turbidity	NTU	2.4	3.9	13	-	2.6	-	-	4.2	3.6
Color	CU	25	-	20	-	30	-	-	-	25
Hardness	mg/l	96	35	110	-	98	-	-	-	85
Alkalinity	"	150	65	174	-	220	-	226	-	167
TDS	"	630	210	630	588	1610	73	1750	1960	658
Calcium	"	23	-	-	-	-	-	-	-	23
Sodium	"	130	47	-	-	-	-	-	-	89
Potassium	"	13	4.5	-	-	-	-	-	-	8.8
Iron	"	0.6	-	0.73	-	-	-	-	-	0.67
Manganese	"	0.056	-	0.09	-	-	-	-	-	0.07
Chloride	"	150	52	-	-	-	-	-	-	101
Sulfate	"	32	9.7	-	-	-	-	-	-	20.1
Nitrate	"	0.3	0.1	-	-	-	-	-	-	0.2
Phosphate	"	0.26	0.14	-	-	-	-	-	-	0.2
Fluoride	"	0.5	0.2	-	-	-	-	-	-	0.4
Silica	"	-	-	-	-	-	-	-	-	-
Boron	"	5.1	1.9	-	-	-	-	-	-	3.5
Arsenic	"	0.39	0.19	0.37	-	1.6	-	-	1.5	0.81
Cadmium	"	-	-	$<$ 0.01	-	-	-	-	-	$<$ 0.01
Lead	"	-	-	$<$ 0.05	-	-	-	-	-	$<$ 0.05
Conductivity	μ Mhos/cm	900	380	900	840	2300	104	2500	2800	1575
Total Coliform	MPN/100 ml	-	-	100	-	1200	-	-	100	100
Fecal Coliform	MPN/100 ml	-	-	5	-	920	-	-	30	30

(1) Summarized for 1977-78 data from: Pacific Environmental Laboratory, "Effects of The Reno/Sparks Joint Water Pollution Control Facility on Water Quality of the Truckee River".

TABLE A-8

WATER QUALITY CHARACTERISTICS FOR: STEAMBOAT CREEK AT HUFFAKER HILLS (SBC-5)

DOUBLE DIAMOND DEVELOPMENT - PHASE 1

Characteristic	Units	1/81	4/81	6/81 (DATE)	8/81	10/81	12/81	Average
Flow	cfs	-	12.51	22.18	(1)	22.10	20.58	19.34
pH	-	-	-	8.1	-	8.2	8.1	8.1
Turbidity	NTU	-	-	16	-	-	4.6	10.5
Color	CU	-	-	80	-	-	-	80
Hardness	mg/l	-	-	70	-	-	-	70
Alkalinity	"	-	-	204	-	198	-	201
TDS	"	-	994	455	840	420	777	545
Arsenic	"	-	-	0.16	-	-	0.21	0.18
Conductivity	μ Mhos/cm	-	1420	650	1200	600	110	780
Total Coliform	MPN/100 ml	-	-	400	-	-	80	245
Fecal Coliform	MPN/100 ml	-	-	200	-	-	34	120

(1) Velocity too slow to measure flow.

TABLE A-9

WATER QUALITY CHARACTERISTICS FOR: LAST CHANCE DITCH AT ZOLEZZI LANE (LCD-1)

DOUBLE DIAMOND DEVELOPMENT - PHASE 1

		(DATE)						
Characteristic	Units	1/81	4/81	6/81	8/81	10/81	12/81	Average
Flow	cfs	-	no flow	16.65	11.20	16.29	0.72	8.98
pH	-	-	-	7.8	-	7.3	7.5	7.5
Turbidity	NTU	-	-	15	-	-	30	15
Color	CU	-	-	20	-	-	-	20
Hardness	mg/l	-	-	-	-	-	-	-
Alkalinity	"	-	-	46	-	62	-	54
TDS	"	-	-	68	87	105	175	88
Arsenic	"	-	-	<0.003	-	-	<0.003	<0.003
Conductivity	μ Mhos/cm	-	-	97	124	150	250	125
Total Coliform	MPN/100 ml	-	-	800	-	-	1000	800
Fecal Coliform	MPN/100 ml	-	-	450	-	-	240	250

TABLE A-10

WATER QUALITY CHARACTERISTICS FOR: LAKE DITCH AT HOLCOMB LANE (LD-1)

DOUBLE DIAMOND DEVELOPMENT - PHASE 1

Characteristic	Units	1/81 (DATE)	4/81	6/81	8/81	10/81	12/81	Average
Flow	cfs	no flow	no flow	7.78	6.56	5.37	no flow	3.29
pH	-	-	-	8.1	-	7.8	-	8.0
Turbidity	NTU	-	-	9.6	-	-	-	9.6
Color	CU	-	-	30	-	-	-	30
Hardness	mg/l	-	-	43	-	-	-	43
Alkalinity	"	-	-	52	-	68	-	59
TDS	"	-	-	75	-	-	-	75
Arsenic	"	-	-	0.003	-	-	-	0.003
Conductivity	μ Mhos/cm	-	-	107	-	-	-	107
Total Coliform	MPN/100 ml	-	-	>4,800	-	-	-	>4,800
Fecal Coliform	MPN/100 ml	-	-	4,400	-	-	-	4,400

TABLE A-11

WATER QUALITY CHARACTERISTICS FOR: STEAMBOAT DITCH AT THOMAS CREEK (SBD-1)

DOUBLE DIAMOND DEVELOPMENT - PHASE 1

		(DATE)						
Characteristic	Units	1/81	4/81	6/81	8/81	10/81	12/81	Average
Flow	cfs	-	no flow	47.50	33.32	39.75	no flow	24.11
pH	-	-	-	7.7	-	8.0	-	7.8
Turbidity	NTU	-	-	24	-	-	-	24
Color	CU	-	-	10	-	-	-	10
Hardness	mg/l	-	-	31	-	-	-	31
Alkalinity	"	-	-	33	-	57	-	44
TDS	"	-	-	47	-	77	-	61
Arsenic	"	-	-	0.003	-	-	-	0.003
Conductivity	μ Mhos/cm	-	-	67	-	110	-	87
Total Coliform	MPN/100 ml	-	-	210	-	-	-	210
Fecal Coliform	MPN/100 ml	-	-	100	-	-	-	100

TABLE A-12

WATER QUALITY CHARACTERISTICS FOR: CRANE DITCH AT HIGHWAY 17 (CRD-1)

DOUBLE DIAMOND DEVELOPMENT - PHASE 1

Characteristic	Units	1/81	4/81	6/81 (DATE)	8/81	10/81	12/81	Average
Flow	cfs	-	no flow	15.99	10.54	7.70	5.30	7.91
pH	-	-	-	7.5	-	7.4	7.8	7.5
Turbidity	NTU	-	-	21	-	-	7.5	17.6
Color	CU	-	-	20	-	-	-	20
Hardness	mg/l	-	47	-	-	-	-	47
Alkalinity	"	-	-	60	-	77	-	73
TDS	"	-	-	140	182	245	532	175
Arsenic	"	-	-	0.07	-	-	0.28	0.12
Conductivity	μ Mhos/cm	-	-	200	260	350	760	250
Total Coliform	MPN/100 ml	-	-	600	-	-	200	500
Fecal Coliform	MPN/100 ml	-	-	420	-	-	180	360

TABLE A-13

WATER QUALITY CHARACTERISTICS FOR: CHANDLER DITCH AT HIGHWAY 17 (CHD-1)

DOUBLE DIAMOND DEVELOPMENT - PHASE 1

Characteristic	Units	1/81	4/81	6/81	8/81	10/81	12/81	Average
		(DATE)						
Flow	cfs	-	no flow	12.56	10.26	6.46	no flow	5.86
pH	-	-	-	7.7	-	7.6		7.7
Turbidity	NTU	-	-	18	-	-	-	18
Color	CU	-	-	20	-	-	-	20
Hardness	mg/l	-	-	43	-	-	-	43
Alkalinity	"	-	-	53	-	61	-	56
TDS	"	-	-	84	103	105	-	95
Arsenic	"	-	-	0.01	-	-	-	0.01
Conductivity	μ Mhos/cm	-	-	120	147	150	-	136
Total Coliform	MPN/100 ml	-	-	1,200	-	-	-	1,200
Fecal Coliform	MPN/100 ml	-	-	850	-	-	-	850

TABLE A-14

WATER QUALITY CHARACTERISTICS FOR: WASTE AND FLOOD DITCH AT DOUBLE DIAMOND (WFD-1)

DOUBLE DIAMOND DEVELOPMENT - PHASE 1

Characteristic	Units/Date	9/80	1/81	4/81	6/81 (DATE)	8/81	10/81	12/81	Average
Flow	cfs	-	-	0.50	0.65	0.63	0.67	0.60	0.61
pH	-	7.4	7.8	7.9	7.5	7.6	7.6	7.4	7.6
Turbidity	NTU	1.6	17	2.3	1.0	1.0	0.6	5.8	2.1
Color	CU	-	< 5	15	10	10	< 5	-	10
Hardness	mg/l	-	138	133	137	134	131	-	134
Alkalinity	"	140	148	135	137	144	141	-	141
TDS	"	240	308	224	189	196	196	77	176
Calcium	"	25	-	-	-	-	-	-	25
Magnesium	"	14	-	-	-	-	-	-	14
Sodium	"	13	-	-	-	-	-	-	13
Potassium	"	4.9	-	-	-	-	-	-	4.9
Manganese	"	-	0.03	< 0.02	-	-	-	-	0.02
Chloride	"	5.7	-	-	-	-	-	-	5.7
Sulfate	"	5.7	-	-	-	-	-	-	5.7
Nitrate	"	2.7	-	-	-	-	-	-	2.7
Phosphate	"	0.29	-	-	-	-	-	-	0.29
Fluoride	"	0.2	-	-	-	-	-	-	0.2
Boron	"	0.2	-	0.1	-	-	-	-	0.15
Arsenic	"	< 0.01	0.007	0.008	0.008	0.006	0.007	< 0.003	0.007
Conductivity	μ Mhos/cm	310	440	320	270	280	280	110	250
Total Coliform	MPN/100 ml	-	Ø	36	150	440	30	400	150
Fecal Coliform	MPN/100 ml	-	Ø	Ø	105	98	29	160	64

TABLE A-15

WATER QUALITY CHARACTERISTICS FOR: MINOR DITCH 1 AT DOUBLE DIAMOND (MD-1)

DOUBLE DIAMOND DEVELOPMENT - PHASE 1

		(DATE)						
Characteristic	Units	1/81	4/81	6/81	8/81	10/81	12/81	Average
Flow	cfs	-	no flow	3.91	1.72	3.53	0.35	1.90
pH	-	-	-	7.5	7.2	7.7	-	7.5
Turbidity	NTU	-	-	18	1.0	2.6	-	8.9
Color	CU	-	-	60	120	5	-	50
Hardness	mg/l	-	-	45	56	48	-	48
Alkalinity	"	-	-	48	67	60	-	56
TDS	"	-	-	76	104	95	-	89
Arsenic	"	-	-	0.003	$<$0.003	$<$0.003	-	$<$0.003
Conductivity	μ Mhos/cm	-	-	109	149	135	-	127
Total Coliform	MPN/100 ml	-	-	$>$ 4,800	4,000	320	-	4,000
Fecal Coliform	MPN/100 ml	-	-	4,400	720	270	-	720

TABLE A-16

WATER QUALITY CHARACTERISTICS FOR: MINOR DITCH 2 AT DOUBLE DIAMOND (MD-2)

DOUBLE DIAMOND DEVELOPMENT - PHASE 1

Characteristic	Units/Date	9/80	4/81	6/81	8/81	10/81	12/81	Average
		(DATE)						
Flow	cfs	-	no flow	0.11	0.30	trace	no flow	0.08
pH	-	7.1	-	7.5	7.9	7.9	-	7.7
Turbidity	NTU	9.7	-	14	3.0	3.5	-	6.0
Color	CU	-	-	20	120	5	-	75
Hardness	mg/l	36	-	38	52	47	-	48
Alkalinity	"	46	-	43	65	60	-	60
TDS	"	110	-	66	99	91	-	90
Calcium	"	9.1	-	-	-	-	-	9.1
Magnesium	"	3.2	-	-	-	-	-	3.2
Sodium	"	6.9	-	-	-	-	-	6.9
Potassium	"	2.0	-	-	-	-	-	2.0
Manganese	"	0.05	-	-	-	-	-	0.05
Chloride	"	3.1	-	-	-	-	-	3.1
Sulfate	"	6.3	-	-	-	-	-	6.3
Nitrate	"	0.1	-	-	-	-	-	0.1
Phosphate	"	0.11	-	-	-	-	-	0.11
Fluoride	"	< 0.1	-	-	-	-	-	< 0.1
Boron	"	0.1	-	-	-	-	-	0.1
Arsenic	"	< 0.01	-	0.003	< 0.003	< 0.003	-	< 0.003
Conductivity	μ Mhos/cm	310	-	94	141	130	-	128
Total Coliform	MPN/100 ml	-	-	400	20,000	380	-	400
Fecal Coliform	MPN/100 ml	-	-	230	2,300	320	-	320

TABLE A-17

WATER QUALITY CHARACTERISTICS FOR: MINOR DITCH 3 AT DOUBLE DIAMOND (MD-3)

DOUBLE DIAMOND DEVELOPMENT - PHASE 1

		(DATE)					
Characteristic	Units/Date	4/81	6/81	8/81	10/81	12/81	Average
Flow	cfs	trace	5.62	trace	trace	trace	1.12
pH	-	7.2	8.0	7.6	7.2	7.4	7.4
Turbidity	NTU	6.8	11	6.5	1.3	1.5	5.4
Color	CU	30	30	25	<5	-	20
Hardness	mg/l	93	35	44	80	-	63
Alkalinity	"	101	41	55	90	-	72
TDS	"	175	64	95	140	217	138
Sodium	"	11	-	-	-	-	11
Potassium	"	-	-	-	-	-	-
Iron	"	1.5	-	-	-	-	1.5
Manganese	"	0.29	-	-	-	-	0.29
Boron	"	0.1	-	-	-	-	0.1
Arsenic	"	0.008	0.005	0.008	0.005	0.006	0.006
Conductivity	μ Mhos/cm	250	91	135	200	310	197
Total Coliform	MPN/100 ml	1,200	650	4,000	3,800	80	1,200
Fecal Coliform	MPN/100 ml	820	420	2,500	1,700	32	820

APPENDIX B

GROUNDWATER QUALITY CHARACTERISTICS

TABLE B-1

DEEP GROUNDWATER QUALITY ON NW AREA OF DOUBLE DIAMOND DEVELOPMENT - WELL # DD-R-1

Characteristic	Units/Date	4/18/80	6/3/81	12/1/81	Average
Flow	gpm	< 1	NA	NA	NA
Head	feet	-	+1.72	+1.77	+1.74
pH	-	8.0	7.1	8.0	8.0
Turbidity	NTU	0.2	0.4	0.1	0.23
Color	CU	< 5	< 5	-	< 5
Alkalinity	mg/l	76	79	-	78
Hardness	"	63	63	-	63
TDS	"	126	111	105	114
Calcium	"	11	-	-	11
Magnesium	"	7.5	-	-	7.5
Sodium	"	7.5	-	-	7.5
Potassium	"	3.9	-	-	3.9
Iron	"	< 0.1	-	-	< 0.1
Manganese	"	0.005	-	-	0.005
Chloride	"	< 1	-	-	< 1
Sulfate	"	3.1	-	-	3.1
Nitrate	"	0.3	-	-	0.3
Phosphate	"	0.07	-	-	0.07
Fluoride	"	< 0.1	-	-	< 0.1
Arsenic	"	< 0.01	0.006	0.05	0.022
Boron	"	0.1	0.1	-	0.1
Conductivity	μ Mhos/cm	180	158	150	163
Temperature	°F	60	-	-	60
Total Coliform	MPN/100 ml	-	-	Ø	Ø

TABLE B-2

DEEP GROUNDWATER QUALITY ON SW AREA OF DOUBLE DIAMOND DEVELOPMENT - WELL # DD-R-2

Characteristic	Units/Date	4/16/80	6/3/81	12/1/81	Average
Flow	gpm	4.8	NA	2.3	3.6
Head	feet	-	+2.74	+9.23	6.0
pH	-	8.1	7.4	8.0	8.0
Turbidity	NTU	0.15	0.1	0.2	0.15
Color	CU	< 5	< 5	-	< 5
Alkalinity	mg/l	92	91	-	92
Hardness	"	74	98	-	96
TDS	"	147	131	125	134
Calcium	"	14	-	-	14
Magnesium	"	8.6	-	-	8.6
Sodium	"	9.6	-	-	9.6
Potassium	"	4.8	-	-	4.8
Iron	"	< 0.1	-	-	< 0.1
Manganese	"	< 0.005	-	-	< 0.005
Chloride	"	< 1	-	-	< 1
Sulfate	"	3.2	-	-	3.2
Nitrate	"	0.5	-	-	0.5
Phosphate	"	0.05	-	-	0.05
Fluoride	"	< 0.1	-	-	< 0.1
Arsenic	"	0.01	0.006	0.006	0.007
Boron	"	< 0.1	0.1	-	0.1
Conductivity	μ Mhos/cm	210	187	178	192
Temperature	°F	65	-	-	65
Total Coliform	MPN/100 ml	-	-	Ø	Ø

TABLE B-3

DEEP GROUNDWATER QUALITY ON SW AREA OF DOUBLE DIAMOND DEVELOPMENT - WELL # DD-R-3

Characteristic	Units/Date	4/18/80	6/3/81	12/1/81	Average
Flow	gpm	-	NA	0.54	0.54
Head	feet	-	flowing[1]	+3.44	+3.44
pH	-	7.7	7.3	7.4	7.4
Turbidity	NTU	0.20	0.3	0.3	0.27
Color	CU	< 5	< 5	-	5
Alkalinity	mg/l	160	163	-	162
Hardness	"	150	69	-	110
TDS	"		210	203	207
Calcium	"	26	-	-	26
Magnesium	"	18	-	-	18
Sodium	"	9.9	-	-	9.9
Potassium	"	6.0	-	-	6.0
Iron	"	< 0.1	-	-	< 0.1
Manganese	"	< 0.005	-	-	< 0.005
Chloride	"	1.2	-	-	1.2
Sulfate	"	4.0	-	-	4.0
Nitrate	"	1.4	-	-	1.4
Phosphate	"	0.06	-	-	0.06
Fluoride	"	< 0.1	-	-	< 0.1
Arsenic	"	< 0.01	< 0.003	0.003	0.005
Boron	"	0.1	0.1	-	0.1
Conductivity	µ Mhos/cm	350	300	290	313
Temperature	°F	-	-	Ø	Ø
Total Coliform	MPN/100 ml	-	-		

TABLE B-4

DEEP GROUNDWATER QUALITY ON NWAREA OF DOUBLE DIAMOND DEVELOPMENT - WELL # DD-0-1

Characteristic	Units/Date	6/3/81	12/1/81	Average
Flow	cfs	NA	2.6	2.6
Head	feet	+5.71	+4.80	5.26
pH	-	7.6	7.6	7.6
Turbidity	NTU	0.2	0.3	0.25
Color	CU	<5	-	5
Alkalinity	mg/l	170	-	170
Hardness	"	150	-	150
TDS	"	224	217	221
Arsenic	"	0.01	0.004	0.007
Boron	"	0.1	-	0.1
Conductivity	μ Mhos/cm	320	310	315
Total Coliform	MPN/100 ml	-	Ø	Ø

TABLE B-5

DEEP GROUNDWATER QUALITY ON SW AREA OF DOUBLE DIAMOND DEVELOPMENT - WELL # DD-P-1

Characteristic	Units/Date	4/18/80	6/3/81	12/1/81	Average
Flow	gpm	17.2	23.1	3.5	14.6
Head	feet	-	+15.88	+16.66	+16.27
pH	-	7.7	7.3	7.6	7.6
Turbidity	NTU	0.1	0.2	0.4	0.2
Color	CU	< 5	< 5	-	< 5
Alkalinity	mg/l	180	176	-	178
Hardness	"	47	41	-	44
TDS	"		560	735	648
Calcium	"	7.8	-	-	7.8
Magnesium	"	5.4	-	-	5.4
Sodium	"	160	-	-	160
Potassium	"	12	-	-	12
Iron	"	< 0.1	-	-	< 0.1
Manganese	"	< 0.005	-	-	< 0.005
Chloride	"	140	-	-	140
Sulfate	"	21	-	-	21
Nitrate	"	1.5	-	-	1.5
Phosphate	"	0.18	-	-	0.18
Fluoride	"	0.2	-	-	0.2
Arsenic	"	0.19	0.19	0.12	0.17
Boron	"	6.6	13.0	-	9.8
Conductivity	μ Mhos/cm	800	800	1050	833
Temperature	°F	80	-	-	80
Total Coliform	MPN/100 ml	-	Ø	-	Ø

TABLE B-6

DEEP GROUNDWATER QUALITY ON SW AREA OF DOUBLE DIAMOND DEVELOPMENT - WELL # DD-P-2

Characteristic	Units/Date	4/16/80	6/3/81	12/1/81	Average
Flow	gpm	6.3	12.9	2.3	7.2
Head	feet	-	+10.71	+9.23	9.97
pH	-	7.8	7.4	7.8	7.8
Turbidity	NTU	0.15	0.1	0.2	0.15
Color	CU	< 5	< 5	-	< 5
Alkalinity	mg/l	140	143	-	142
Hardness	"	12	12	-	12
TDS	"	266	231	231	231
Calcium	"	3.1	-	-	3.1
Magnesium	"	0.9	-	-	0.9
Sodium	"	78	-	-	78
Potassium	"	5.0	-	-	5.0
Iron	"	< 0.1	-	-	< 0.1
Manganese	"	< 0.005	-	-	< 0.005
Chloride	"	8.9	-	-	8.9
Sulfate	"	7.3	-	-	7.3
Nitrate	"	4.0	-	-	4.0
Phosphate	"	0.21	-	-	0.21
Fluoride	"	0.8	-	-	0.8
Arsenic	"	0.29	0.41	0.40	0.37
Boron	"	0.37	0.7	-	0.54
Conductivity	μ Mhos/cm	380	330	330	347
Temperature	°F	62	-	-	62
Total Coliform	MPN/100 ml	-	Ø	-	Ø

TABLE B-7

DEEP GROUNDWATER QUALITY ON NWAREA OF DOUBLE DIAMOND DEVELOPMENT - WELL # DD-P-3

Characteristic	Units/Date	6/3/81	12/1/81	Average
Flow	cfs	0.4	0.54	0.47
Head	.feet	+2.3	3.44	2.87
pH	-	7.3	7.7	7.5
Turbidity	NTU	0.1	0.3	0.2
Color	CU	<5	-	<5
Alkalinity	mg/l	127	-	127
Hardness	"	148	-	148
TDS	"	392	385	389
Arsenic	"	0.09	0.08	0.085
Boron	"	6.4	-	6.4
Conductivity	μ Mhos/cm	560	550	555
Total Coliform	MPN/100 ml	-	Ø	Ø

TABLE B-8

DEEP GROUNDWATER QUALITY ON NE AREA OF DOUBLE DIAMOND DEVELOPMENT - WELL # DD-P-4

Characteristic	Units/Date	6/3/81	12/1/81	Average
Flow	cfs	0.8	0.9	0.85
Head	feet	NA	NA	NA
pH	-	7.6	7.8	7.7
Turbidity	NTU	0.2	0.2	0.2
Color	CU	< 5	-	5
Alkalinity	mg/l	111	-	111
Hardness	"	82	-	82
TDS	"	147	147	147
Arsenic	"	0.3	0.3	0.3
Boron	"	0.1	-	0.1
Conductivity	μ Mhos/cm	210	210	210
Total Coliform	MPN/100 ml	-	Ø	Ø

TABLE B-9

DEEP GROUNDWATER QUALITY ON NE AREA OF DOUBLE DIAMOND DEVELOPMENT - WELL # DD-P-5

Characteristic	Units/Date	4/16/80	6/3/81	12/1/81	Average
Flow	gpm	3.4	2.9	2.9	3.1
Head	feet	-	+9.46	+11.12	10.3
pH	-	7.9	7.3	7.8	7.8
Turbidity	NTU	0.1	0.1	0.4	0.2
Color	CU	< 5	< 5	-	< 5
Alkalinity	mg/l	140	134	-	137
Hardness	"	17	16	-	17
TDS	"	-	455	441	448
Calcium	"	3.2	-	-	3.2
Magnesium	"	1.7	-	-	1.7
Sodium	"	11	-	-	11
Potassium	"	6.1	-	-	6.1
Iron	"	< 0.1	-	-	< 0.1
Manganese	"	< 0.005	-	-	< 0.005
Chloride	"	110	-	-	110
Sulfate	"	23	-	-	23
Nitrate	"	< 0.1	-	-	< 0.1
Phosphate	"	0.25	-	-	0.25
Fluoride	"	0.5	-	-	0.5
Arsenic	"	0.21	0.21	0.19	0.20
Boron	"	5.9	8.9	-	7.4
Conductivity	u Mhos/cm	250	650	630	510
Temperature	°F	71	-	-	71
Total Coliform	MPN/100 ml	-	-	Ø	Ø

TABLE B-10

DEEP GROUNDWATER QUALITY ON DOUBLE DIAMOND DEVELOPMENT

Characteristic	Units	1(NW)*	3(NW)*	9(N)*	6(S)*	8(S)*	21(SW)*	23(SW)*	DD-T-1(NW)	DD-T-2(SW)
Date	-	4/16/80	4/18/80	4/18/80	4/16/80	4/16/80	4/16/80	4/16/80	1/9/81	1/27/81
Flow	gpm	-	-	4.8	5.2	1.25	6.3	8.6	250	650
pH	SU	7.8	7.9	8.1	7.7	7.7	7.9	7.9	7.8	7.7
Turbidity	NTU	1.7	0.05	0.15	0.1	0.05	0.20	0.25	-	-
Color	CU	50	< 5	< 5	< 5	< 5	< 5	< 5	-	-
Hardness	mg/l	180	93	74	6.5	15	9.9	9.5	-	-
Alkalinity	"	210	110	92	130	120	130	130	170	121
TDS	"	224	175	147	224	196	266	245	246	197
Calcium	"	32	16	14	< 1	3.2	2.6	2.3	24	17
Magnesium	"	22	11	8.6	0.3	1.0	0.7	0.8	17	13
Sodium	"	20	11	9.6	73	63	76	73	16	10
Potassium	"	4.0	6.1	4.8	6.4	7.4	4.6	5.5	8.2	7.0
Iron	"	0.7	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	-	-
Manganese	"	0.086	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	-	-
Chloride	"	1.4	< 1	< 1	10	8.8	11	7.8	4	4
Sulfate	"	5.2	3.1	3.2	4.7	4.0	9.3	7.7	2	3
Nitrate	"	0.1	0.9	0.5	1.7	1.9	4.5	4.0	5	4.6
Phosphate	"	0.03	0.05	0.05	0.52	0.29	0.21	0.29	0.25	0.61
Fluoride	"	0.2	0.1	< 0.1	0.6	0.8	0.8	0.9	< 0.1	< 0.1
Boron	"	< 0.1	< 0.1	< 0.1	2.1	0.69	0.37	0.43	< 0.1	0.1
Arsenic	"	< 0.01	< 0.01	< 0.01	0.34	0.33	0.29	0.48	0.02	0.004
Conductivity	μ Mhos/cm	320	250	210	320	280	380	350	340	250
Temperature	°F	66	-	65	60	56	62	66	64	62
Type of Well	-	Irrig.	Artes.	Domes.	Irrig.	Irrig.	Irrig.	Irrig.	Test Well	Test Well

Notes: * Existing Well

TABLE B-11

SHALLOW GROUNDWATER QUALITY ON DOUBLE DIAMOND DEVELOPMENT: PIEZOMETERS TO 10 FT. BELOW SURFACE & SPRINGS

Characteristic	Units	16(SW)	34(SW)	35(SW)*	27(S)	2(NE)	27S(SW)
Date	-	11/20/80	9/29/80	9/29/80	9/30/80	10/1/80	4/18/80
Flow	gpm	-	-	-	-	-	-
pH	SU	8.1	7.2	7.9	7.75	8.1	7.9
Turbidity	NTU	140	-	-	-	-	1.7
Color	CU		-	-	-	-	5
Hardness	mg/l	-	-	-	-	-	6.1
Alkalinity	"	260	170	410	490	1300	75
TDS	"	343	360	2200	660	830	112
Calcium	"	32	3.0	46	43	16	11
Magnesium	"	31	1.7	11	13	6.2	7.0
Sodium	"	19	77	730	140	240	7.5
Potassium	"	16	7.2	37	15	16	5.1
Iron	"	-	-	-	-	-	< 0.1
Manganese	"	-	-	-	-	-	0.006
Chloride	"	10	10	30	5.2	1.9	< 1
Sulfate	"	3.3	5.7	140	15	19	2.5
Nitrate	"	0.2	2.3	0.4	0.1	0.1	0.3
Phosphate	"	0.85	0.97	0.18	0.95	0.37	0.05
Fluoride	"		0.7	-	0.8	0.7	< 0.1
Boron	"	0.37	0.45	20	2.5	8.9	< 0.1
Arsenic	"	0.01	0.27	0.23	0.48	0.36	< 0.01
Conductivity	μ Mhos/cm	490	400	3300	900	1300	160
Temperature	°F	-	-	-	-	-	-
Type of Well	-	piezo.	piezo.	piezo.	piezo.	piezo.	shallow spring

Note: * Muddy sample - may not be representative of shallow groundwater in this area.

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