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C92.01.03

HYDROGEOLOGICAL CONDITIONS

AND

GROUND-WATER POTENTIAL

WITHIN THE

MT. GATE CWSD BOUNDARY

March 19, 1992

Prepared for

Mt. Gate CWSD
7000 Wonderland Blvd.
Redding, CA 96003

Table of Contents

Text **Page**

Introduction 1
Findings 3
Conclusions 5
Recommendations 6

Tables (following text)

1. Spring Branch Creek drainage - 1987 through 1991
2. Spring Branch Creek drainage - average-annual conditions
3. Spring Branch Creek drainage plus West Fork Stillwater Creek 1987 through 1991

Figures (following text)

1. Site location map
2. Area of potential well yield
3. Combined monthly pumpage Mt. Gate CWSD Bass Wells 1 and 2
4. Average-annual isohyetals

Plates (in pocket)

I. Watershed map
II. Geology map Mt. Gate area

Appendix

Miscellaneous well records furnished by District

Introduction

Mountain Gate CWSD obtains water from two sources, Shasta Lake and ground water. Ground water is drawn from two wells, Bass Wells 1 and 2, located within the Mountain Gate Trailer Park and drilled about 300 feet apart.

During the 5-year drought period 1986-87 through 1990-91 the 2 wells produced an average of about 350 AF (acre-feet) per year, or an amount equal to a constant discharge rate of about 220 gpm. This production represents about the maximum the wells can produce under drought conditions because of the drop in ground-water levels. Attempting to withdraw more water causes the pumps to break suction.

The District would like to develop additional ground-water supplies, but the record for drilling "good" (50 gpm or better) wells in the Mt. Gate area has not been too successful. East of Highway I-5 and north of Mt. Gate the District drilled a test hole that was not successful; another well drilled in the same area for dust control by a local quarry was also not successful.

An inspection of drillers logs furnished by the California DWR (Department of Water Resources) for wells drilled in the Mt. Gate area show a similar pattern of wells having very low yields--enough for domestic purposes but not for municipal or industrial needs.

In view of the above, the 2 wells operated by the Mt. Gate CWSD and the Bass School Well are very unusual in that they produce 100 gpm (plus or minus), or about two orders of magnitude greater than the "typical" well in the area. Because these 3 wells are all located very close together, it becomes apparent there must be something very unique about the hydrogeology of the well sites.

Because of the above variability, this study concentrated on defining conditions in the vicinity of the Bass Wells that would result in high-yield wells in a predominantly low-yield area. If these conditions could be identified, then the probability of drilling other good wells would be something more than a hit-or-miss effort.

Findings

1. The Bass Wells produce water from a highly fractured bedrock of the Kennett formation (Plate II).

2. The fractured nature of the Kennett formation in the vicinity of Mt. Gate is related to northwest-southeast trending structural features of folding, faulting, and shearing of the rocks (Plate II).

3. The fractured Kennett formation abuts against massive and less fractured rocks of the Bass Mountain diabase. Contact between the Kennett formation and the Bass Mountain diabase on the east side follows a structural trend that roughly parallels Highway I-5 (Plate II).

4. Recharge to the fractured Kennett formation in the vicinity of the Bass Wells comes from deep percolation of precipitation and streamflow from the 1200-acre drainage of Spring Branch Creek (Plate I).

5. During the 5-year drought 1986-87 through 1990-91, average precipitation was about 76 percent of normal or about 40.5 inches of a normal 53 inches of rainfall (Figure 4 and Table 1).

6. Average-annual recharge within the Spring Branch Creek drainage during the 5-year drought period was estimated to be about 560 AF (Table 1). Long-term average-annual recharge is about 1520 AF (Table 2).

7. Average-annual ground-water production from Bass Wells 1 and 2 during the 5-year drought period was about 350 AF (Figure 3, Tables 1, 2, and 3, Appendix).

8. Average-annual recharge from the East Fork Stillwater Creek drainage during the 5-year drought period is estimated to be

about 1380 AF above Mt. Gate. This recharge appears to be diverted away from the Mt. Gate area because of underlying geologic constraints (Plate II, Table 3).

9. The Kennett formation, where associated with a major rift zone, appears to be the only geologic unit favorable for groundwater development from a standpoint of significant fracturing and having secondary porosity and permeability leading to adequate (50 gpm+) well yield.

10. The formations having the most dense rock with the least amount of fracturing--and the lowest yield potential--are the quartz-hornblend-diorite (Jhd) and the Bass Mountain diabase (Cbm), as shown on Plate II. The District's unsuccessful test hole was drilled into the Bass Mountain diabase.

11. A combination of a (1) highly fractured formation, (2) association of the fractured formation with a rift zone, and (3) a large upgradient drainage area furnishing long-term recharge, are the characteristics typical to the location of the Bass Wells, and are hydrogeologic characteristics required for the development of successful wells within the boundaries of the Mt. Gate CWSD. These conditions have only been identified within the local area of the Bass Wells (Plate II).

12. Insufficient data is available on static levels and pumping levels and instantaneous discharge in the Bass Wells to estimate aquifer coefficients of transmissivity and storage. These coefficients are used for estimating specific capacity (gpm-per-foot-of-drawdown with duration of pumping) and well interference.

13. Evapotranspiration of precipitation was estimated to be 34 inches based on an average-annual precipitation of 53 inches and an average-daily temperature of 62 degrees.

Conclusions

1. Within the immediate area of Mt. Gate exists fractured rock and structural barrier traps providing uncommonly high yields and storage capacity for a "hard-rock" aquifer. These circumstances exist due to a large drainage area and local geologic conditions.

2. The area within and around the Mt. Gate Trailer Park appears to have the capability of furnishing more ground water than is being extracted at this time with Bass Wells 1 and 2. This conclusion is predicated on the estimated recharge occurring to the aquifer during the 5-year drought period 1986-87 through 1990-91.

3. During drought conditions when water levels are low, to fully utilize ground water in storage it is better to have several wells spaced out over a large area producing 50 gpm with less drawdown than a few wells producing 100 gpm having substantial drawdown (causing the wells to break suction and resulting in the wells being throttled and running at low power efficiency).

Recommendations

1. Additional wells should be drilled within the immediate Mt. Gate area, as shown on Figure 2. The wells should be no closer than 500 feet apart, and located at least that distance from the existing Bass Wells 1 and 2.

2. The wells should be drilled to a minimum depth of 200 feet, but not drilled deeper than 300 feet. Drilling should be by the air-rotary method. Drilling with air will allow an estimate of well yield, and should be used as a determination in the field as to whether the well is completed or abandoned.

3. Holes drilled producing between 50 to 75 gpm should be considered a "good" well and completed with 6-inch casing (A 4-inch submersible pump can produce up to about 75 gpm); holes producing more than about 75 gpm should be completed with 8-inch casing.

4. Detailed records of water levels, pumping rates, and hours of pump operation should be maintained on existing and new wells to evaluate well and aquifer performance. Records should include, as a minimum, daily records of pumping and/or static water levels, discharge (gpm), and discharge pressure at the well head. Daily tabulation of meter readings on each well should also be maintained. This data can be used for design of future wells and for evaluating well performance (efficiency of installed pumping unit).

5. Any new wells completed should have a 24-hour constant-discharge aquifer test conducted to determine aquifer coefficients of transmissivity and storage. These values are then used to determine the most efficient pump to be installed and the radius of influence of the pumping well on other wells.

Table 1

Spring Branch Creek Drainage - 1987 through 1991

Water Year (1)	Precip Index (2)	Annual Precip (3)	D.P. Plus Runoff (4)	Runoff (5)	Deep Percolation (6)	(7)	(8)	Average Well Yield (9)
		(In)	(In)	(In)	(In)	(AF)	(GPM)	(GPM)
1987	70.8	37.52	3.52	.70	2.82	282	175	223
1988	87.9	46.59	12.59	2.52	10.07	1007	624	215
1989	88.0	46.64	12.64	2.53	10.11	1011	627	236
1990	75.6	40.07	6.07	1.21	4.85	485	301	239
1991	59.9	31.75	0	0	0	0	0	184
Average	76.4					557	345	219

Column References:

(1) Water year beginning ending September 30.

(2) Based on Redding Fire Station No. 2 record for 60-year long-term period 1931 through 1991 (Redding Fire Station No. 2 correlated with Whiskeytown Reservoir Station beginning May 1979).

(3) Average rainfall at site (53 inches) times Col. (2) divided by 100.

(4) Col. (3) minus 34 inches of evapotranspiration.

(5) Col. (4) times 20 percent estimated runoff.

(6) Col. (4) minus Col. (5).

(7) Col. (6) times 1200 acres divided by 12 (inches to feet).

(8) Col. (7) divided by 1.613 (AF to gpm).

(9) Summation of monthly pumpage reported by District for water year ending September 30.

Table 2

Spring Branch Creek Drainage - Average-Annual Conditions

Water Year (1)	Precip Index (2)	Annual Precip (3)	D.P. Plus Runoff (4)	Runoff (5)	Deep Percolation (6)	(7)	(8)	Average Well Yield (9)
		(In)	(In)	(In)	(In)	(AF)	(GPM)	(GPM)
Avg	100.0	53.00	19.00	3.80	15.20	1520	942	219

Column References:

(1) Average-year conditions.

(2) Average year index of 100.

(3) Average rainfall at site of 53 inches from Mean Annual Precipitation in the California Region, USDI, Geological Survey, 1969.

(4) Col. (3) minus 34 inches of evapotranspiration.

(5) Col. (4) times 20 percent estimated runoff.

(6) Col. (4) minus Col. (5).

(7) Col. (6) times 1200 acres divided by 12 (inches to feet).

(8) Col. (7) divided by 1.613 (AF to gpm).

(9) Average-annual pumpage during drought period 1987-91 reported by District.

Table 3

Spring Branch Creek Drainage Plus West Fork Stillwater Creek

1987 through 1991

Water Year (1)	Precip Index (2)	Annual Precip (3)	D.P. Plus Runoff (4)	Runoff (5)	Deep Percolation (6)	(7)	(8)	Average Well Yield (9)
		(In)	(In)	(In)	(In)	(AF)	(GPM)	(GPM)
1987	70.8	37.17	3.17	.63	2.54	925	573	223
1988	87.9	46.15	12.15	2.43	9.72	3544	2197	215
1989	88.0	46.20	12.20	2.44	9.76	3559	2207	236
1990	75.6	39.69	5.69	1.14	4.55	1660	1029	239
1991	59.9	31.45	0	.00	0	0	0	184
Average for period						1938	1201	219

Column References:

(1) Water year beginning ending September 30.

(2) Based on Redding Fire Station No. 2 record for 60-year long-term period 1931 through 1991 (Redding Fire Station No. 2 correlated with Whiskeytown Reservoir Station beginning May 1979).

(3) Average rainfall for drainage (52.5 inches) times Col. (2) divided by 100.

(4) Col. (3) minus 34 inches of evapotranspiration.

(5) Col. (4) times 20 percent estimated runoff.

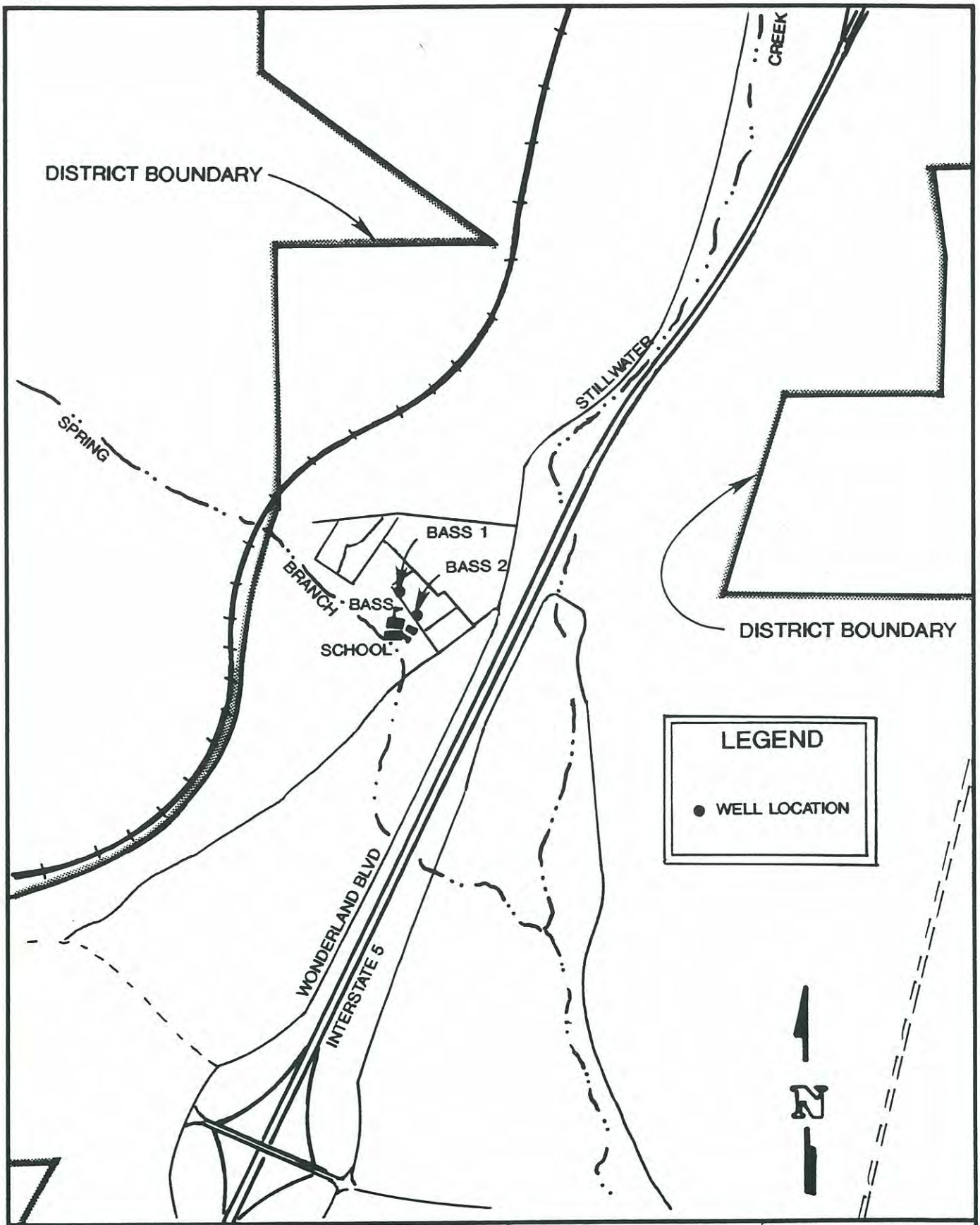
(6) Col. (4) minus Col. (5).

(7) Col. (6) times 4376 acres divided by 12 (inches to feet).

(8) Col. (7) divided by 1.613 (AF to gpm).

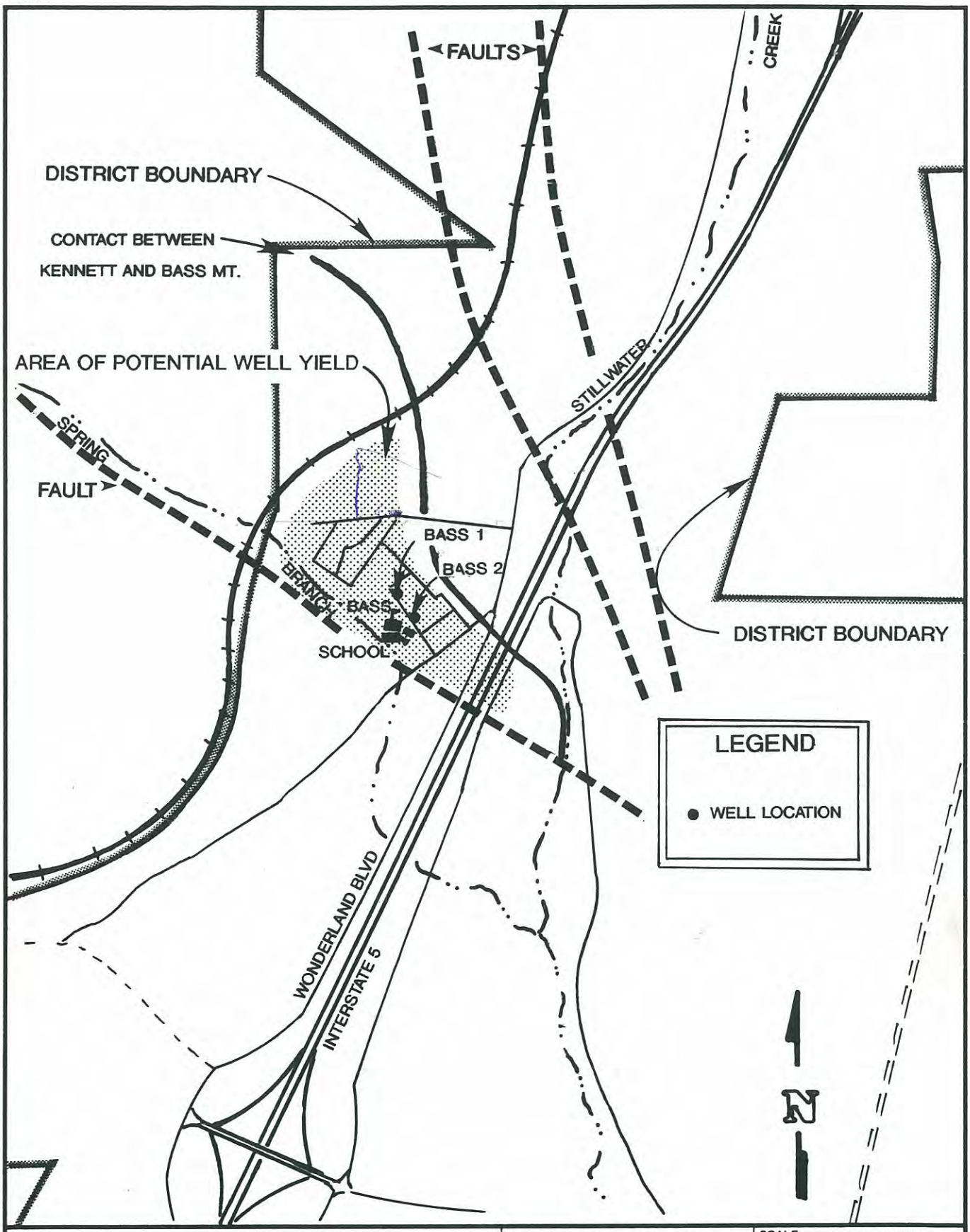
(9) Summation of monthly pumpage reported by District for water year ending September 30.

146901



SITE LOCATION MAP		LAWRENCE & ASSOCIATES 2001 MARKET STREET, RM. 523 REDDING, CA 96001 PHONE (916) 244-9703 FAX (916) 244-5021	SCALE: 1"=1000' DATE: 03-12-92 JOB NO.: C92.01.03
CLIENT: MT. GATE-CSD	PROJECT: GROUNDWATER	DRAWN BY: M. JONES	FIGURE 1

146901



AREA OF POTENTIAL WELL YIELD

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SCALE:	1"=1000'
DATE:	03-18-92
JOB NO.:	C92.01.03

CLIENT: MT. GATE-CSD	PROJECT: GROUNDWATER	DRAWN BY: M. JONES	FIGURE 2

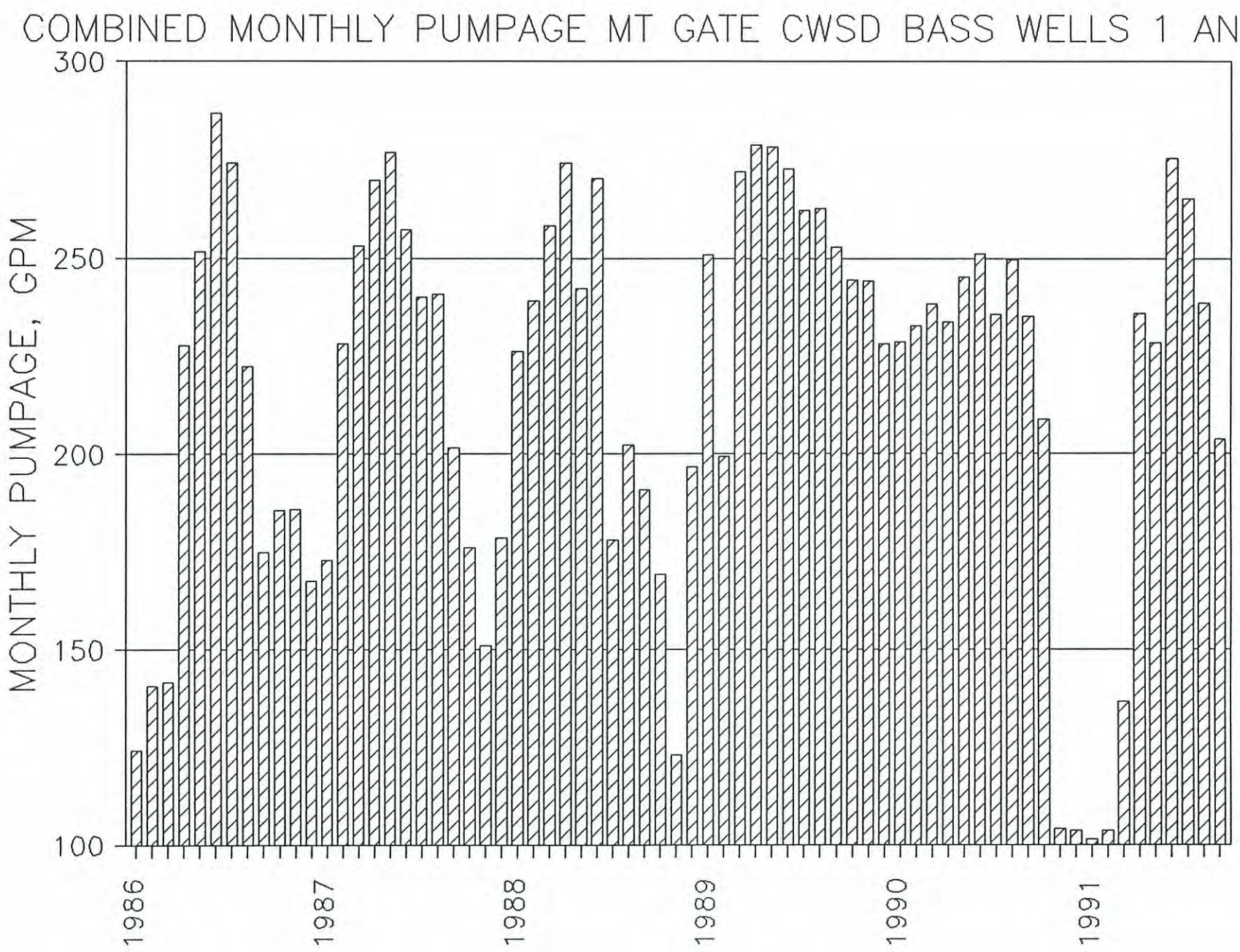
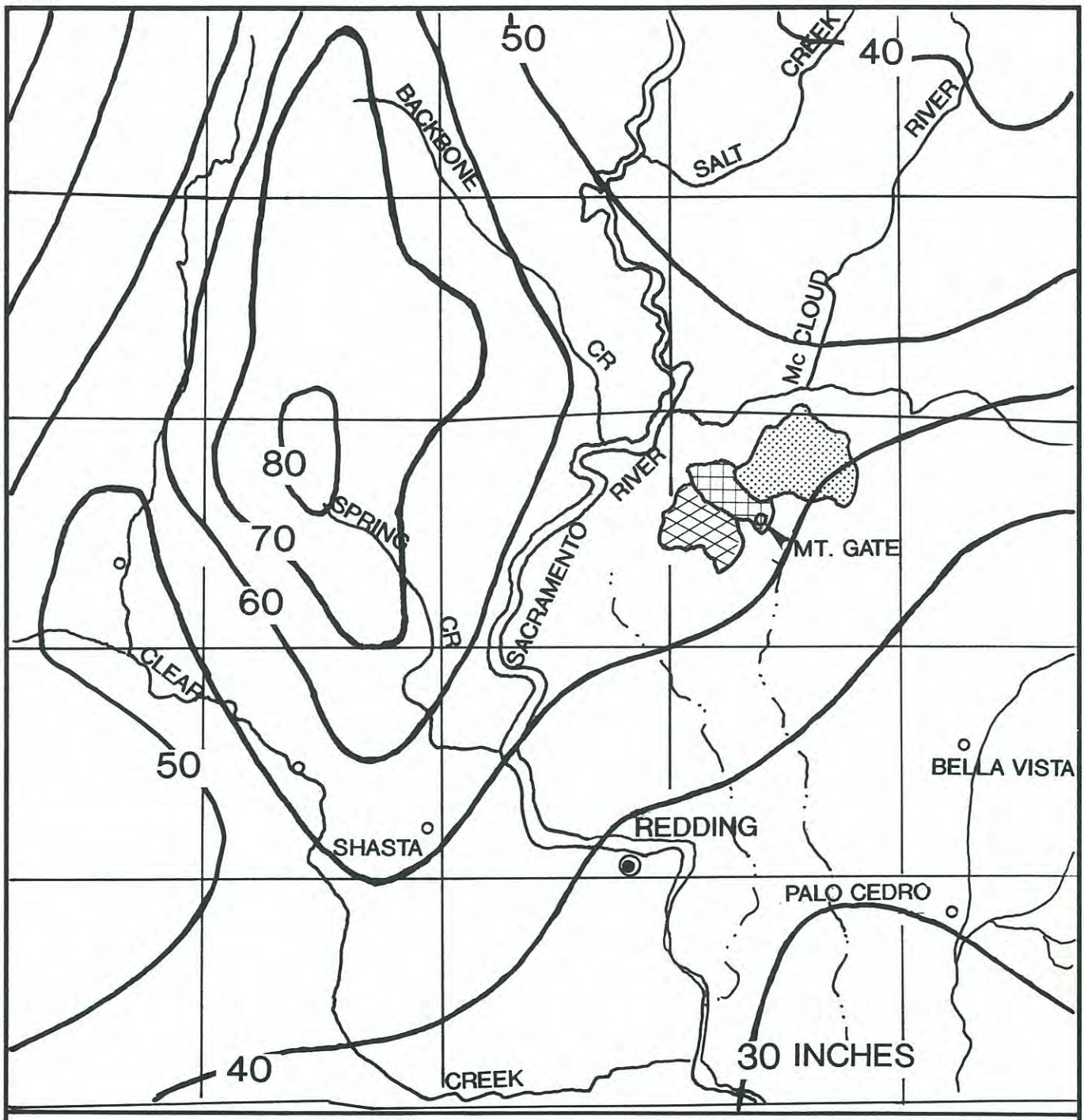

COMBINED MONTHLY PUMPAGE MT GATE CWSD BASS WELLS 1 AND 2
MONTHLY PUMPAGE, GPM
300
250
200
150
100
1986
1987
1988
1989
1990
1991

FIGURE 3

146901



WEST STILLWATER CREEK DRAINAGE

SPRING BRANCH DRAINAGE

MOODY CREEK DRAINAGE

N

AVERAGE-ANNUAL ISOHYETALS

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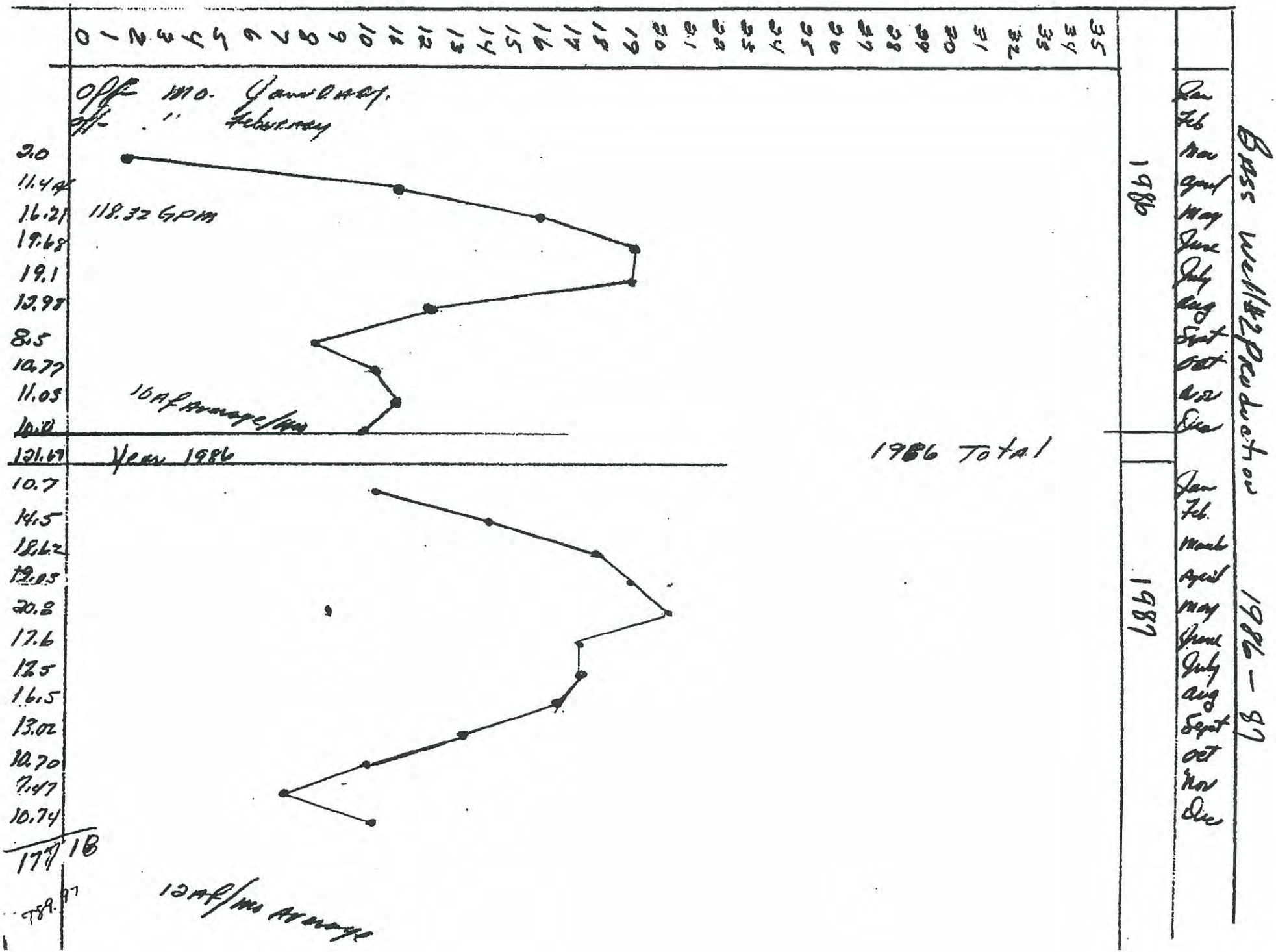
SCALE:	1 : 250 000
DATE:	03-19-92
JOB NO.:	C92.01.03

CLIENT:	PROJECT:	DRAWN BY:	
MT. GATE-CSD	GROUNDWATER	M. JONES	FIGURE 4

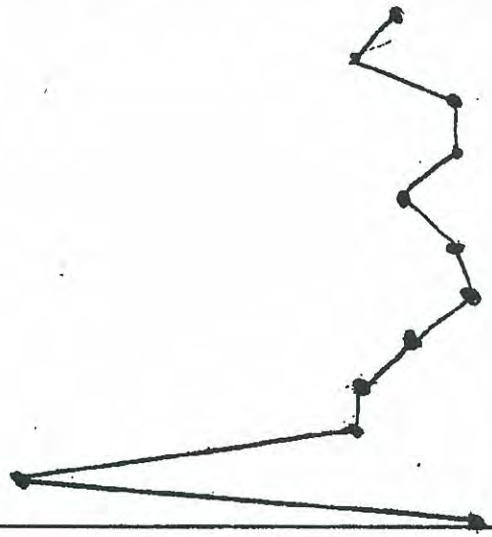
APPENDIX

Bass #1 well production 1986 – 97


Bass well #2 Production 1986 - 87
1986
1987
Jan
Feb
Mar
April
May
June
July
aug
Sept
Oct
Nov
Dec
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35
Off mo. January
" " February
2.0
11.4
16.21
19.68
19.1
13.98
8.5
10.77
11.05
10.18
118.32 GPM
10 Af Average/mo
121.69
Year 1986
1986 Total
10.7
14.5
18.62
19.05
20.8
17.6
12.5
16.5
13.02
10.70
7.47
10.74
177 16
12 Af/mo Average

Barn #1 Well Production

Acre feet		Acre feet	
16.1	1988	Jan.	1988
15.1		Feb.	
17.18		March	
17.65 AF		April	
16.1		May	
17.46 AF		June	
17.94 AF		July	
16.2 AF		aug.	
15.3 AF		Sept.	
15.15 AF		Oct.	
7.9 AF		Nov	
17.9		Dec.	
189.98 AF			
19.5	1989	JAN	1989
17.03		FEB	
19.58		MARCH	
19.83		APRIL	
20.45		MAY	
19.04		JUNE	
18.25		JULY	
18.30		AUG	
16.42		SEPT	
15.84		OCT	
15.31		NOV	
15.61		DEC	
15.72		JAN 90	
14.71			
17.08			
16.70			



Bow well #2 Production

Acre Feet		
14.9		Jan
14.5 Est		Feb
18.2		March
18.69 Est		April
17.1 Est		May
18.37		June
6.48 Est	Pump off - most of month	July
11.5 Est		Aug
10. Est		Sept
8.07 Est		Oct
8.39 Est		Nov
9.05		Dec
155.23		
14.88		JAN
7.58		FEB
EST 17.67	- EST AT 129 GPM	MARCH
17.10		APRIL
17.67		MAY
17.10		JUNE
17.67		JULY
17.68		AUG
17.10		SEPT
17.67		OCT
17.10		NOV
15.67	EST AT 114 GPM	DEC
15.61	" "	JAN 90
14.10		
15.61		
14.10		

1988

1989

Mt N. Gate CSD

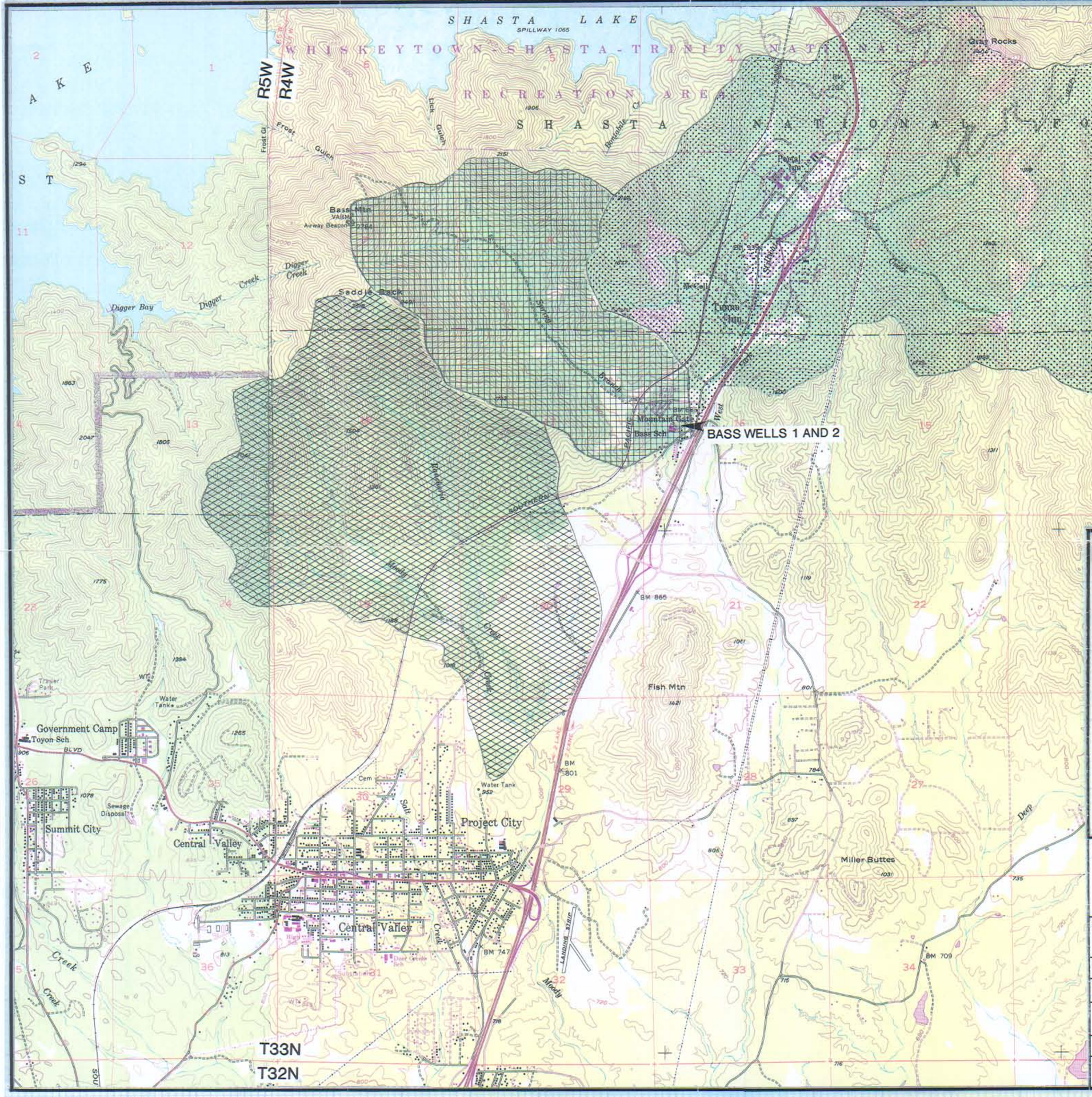
	Bass #1 A.F.	Bass #2 A.F.
Dec 91	7	1
Nov		
Oct	7.65	2.6
Sept	15.1	11.9
Aug	13.6	19.1
July	15.1	21.2
June	16.7	19.8
May	17.6	13.7
April	16.3	Est. 15
March	15.6	3.1
Feb	12.8	—
Jan	13.9	—
Dec 90	14.2	—
Nov	13.8	—
Oct	13.7	14.9
Sept	15.6	Est. 15.6
Aug	17.1	17.1
July	14.6	17.7
June	17.5	15.8
May	17.3	16.3
April	16.9	14.1
March	15.6	17.1
Feb	14.7	14.1
Jan	15.7	15.6

WATER TABLE

		Bass # 1	Bass # 2
Feet Down From Top	11-15-90	118'	120
Pumps Running #1 & 2	4-5-91	86'	89'
" "	4-11-91	84'	87'
" "	4-26-91	79'	83'
" "	5-13-91		103
" "	5-30-91		92'
" "	9-18-91		115'
Both Pumps OFF	10-22-91	147'	
	10-31-91	138'	
	11-13-91	137'	
	12-9-91	128'	
	12-19-91	130'	
Both Pumps Running	1-6-92	134'	
	1-14-92	133'	
	2-20-92	114'	

Redrill Base 2
Static ~142 1st water
Set 167'
~~15~~ 20 HP
175 gpm @ Hi @ 85 psi
150 " @ low

Base 1
15 HP
110 gpm @ 85 psi
120 gpm w/ Hi
85 " w/ low
Set ~167' - 4'
Meter hangs up - just recently Oct-Nov



LEGEND

- STILLWATER CREEK DRAINAGE
- SPRING BRANCH DRAINAGE
- MOODY CREEK DRAINAGE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET
1 0 1 KILOMETRE

CONTOUR INTERVAL 40 FEET
DOTTED LINES REPRESENT 20-FOOT CONTOURS

WATERSHED MAP

CLIENT: MOUNTAIN GATE-CWSD	PROJECT: GROUNDWATER STUDY
DATE: 03-09-92	JOB NO.: C92.01.03
DRAWN BY: M. JONES	CHECKED BY: D. LAWRENCE

ADAPTED FROM THE USGS, 7.5-MINUTE SERIES,
SHASTA DAM AND PROJECT CITY QUADRANGLES, 1969

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SCALE: 1:24000	PLATE I

LEGEND

IGNEOUS ROCKS

- VARIOUS DIKES
- Jad — AUGITE DIORITE
- Jhd — HORNBLENDE DIORITE

LATE JURASSIC OR EARLY CRETACEOUS

- Trd — DEKKAS ANDESITE

TRIASSIC

- Cbm — BASS MOUNTAIN DIABASE

CARBONIFEROUS

SEDIMENTARY ROCKS

- Cn — NOSONI FORMATION
- Cm — McCLOUD LIMESTONE
- Cb — BAIRD FORMATION
- Cbd — BRAGDON FORMATION

CARBONIFEROUS

- cma — COPLEY META-ANDESITE

DEVONIAN

- Dk — KENNETT FORMATION

DEVONIAN

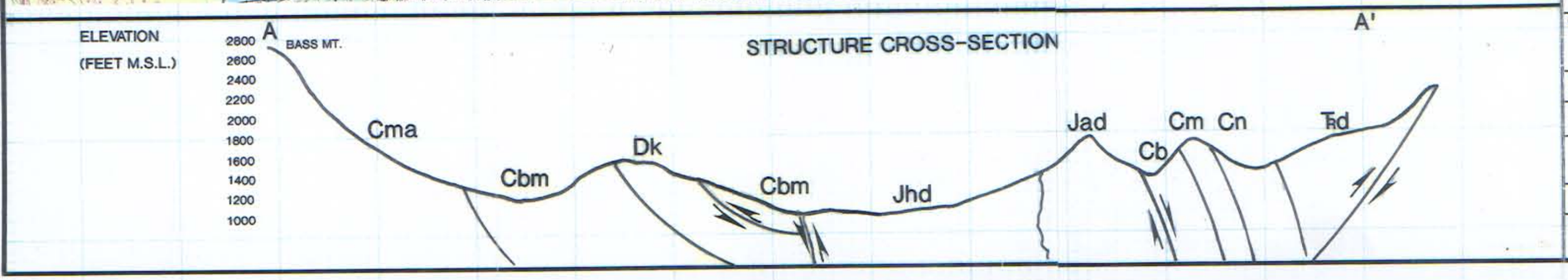
DOUBLY PLUNGING ANTICLINES AND ASSOCIATED SYNCLINE

FAULT TRACES

45 — BEARING AND PLUNGE OF SLICKENSIDES

40 — STRIKE AND DIP OF FOLIATION

STRUCTURE CROSS-SECTION



GEOLOGY MAP
MOUNTAIN GATE AREA

CLIENT: MOUNTAIN GATE-CSD	PROJECT: GROUNDWATER STUDY
DATE: 03-16-92	JOB NO.: C92.01.03
DRAWN BY: M. JONES	CHECKED BY: D. LAWRENCE
GEOLOGY BY J.S. DILLER, 1906, U.S. GEOLOGICAL SURVEY	
LAWRENCE & ASSOCIATES 2001 MARKET STREET, RM. 523 REDDING, CALIFORNIA 96001 (916) 244-9703	
SCALE: 1:24000	PLATE II