Old Woman Springs Ranch

- GEOSCIENCE – OWS -1 TEST RESULTS & COST ESTIMATES FOR THE PRODUCTION WELL (JUNE 25,1991)
- BECHTEL – ASSESSMENT OF GROUND WATER RESOURCE (JUNE 1992)
- GEOSCIENCE – REVIEW OF BECHTEL ASSESSMENT (AUGUST 26, 1992)
- GEOSCEINCE – RIPARIAN / WETLAND STATEMENT (MARCH 10, 1993)

GEOSCIENCE Support Services Incorporated

Ground Water Planning, Development and Management

GBC1-3909

June 25, 1991

Old Woman Springs Inc.
c/o
Mr. C. Cortland Hooper
Senior Consultant
Southland Financial Group
3535 Inland Empire Blvd.
Ontario, CA 91764

re: ***OWS-1 Test Results***
and Cost Estimate for Production Wells

Dear Cort:

This report summarizes results from a brief pumping test conducted on well OWS-1 and includes an estimate of construction costs for four production wells. The number of production wells is considered compatible with the proposed exploitation (15,000 acre-ft/yr). Also included are transmission pipe sizes from the wells.

1 SUMMARY OF PUMPING AND WATER QUALITY TEST ON OWS-1

Old Woman Springs well OWS-1 is located above the Main Spring. The well was drilled to a depth of 400 ft and completed with six inch diameter casing and screen (see Figure 1).

On May 29, 1991 a six inch submersible pump was installed at a depth of 140 ft below land surface. The well was developed by surging and pumping at various discharge rates ranging from 50 to approximately 200 gpm. On May 30, 1991 a pumping test was run to determine well yield and obtain a water sample.

The well was pumped at a rate of of 232 gpm (0.33 mgd) for approximately 40 minutes. Before start of pumping, the static water level depth was measured as 92 ft. During the test, pumping levels could not be measured due to the small clearance between the pump column and well casing. However, one minute after cessation of pumping, the depth to water was measured as 93 ft reflecting probably low drawdowns and fast recovery.

A water sample was collected immediately prior to shutdown and a full Title 22 analysis run. Results of this analysis are included with this letter in Appendix A. Total dissolved solids of the sample were 496 mg/l and all chemical constituents analyzed were below the MCL (Maximum Contaminant Level).

2 COST ESTIMATE FOR PRODUCTION WELLS

Four production wells are proposed. The locations of the wells are shown on Figure 2. Based on results from OWS-1, the wells will be drilled to a total depth of approximately 400 ft and completed with 18 in. casing and screen. Estimated production from each of the wells was assumed to average 2,325 gpm (15,000 acre-ft/yr / 4).

The cost for the four wells is estimated as $421,979 ($105,495/well). A breakdown of costs is included in Appendix B.

NOTE

On the cost estimate, Item 1, (mobilization and demobilization) would only be a one-time charge.

3 ESTIMATED TRANSMISSION PIPELINE SIZES

An estimate of pipeline sizes was made based on keeping flow velocities within the 5-7 ft/sec range. The transmission pipe was assumed to be smooth uncoated steel having a roughness factor (e) of 0.0008. The Darcy-Weisbach equation was used to calculate head losses. Details of the calculations are included in Appendix C.

If you need further clarification or information please call at your convenience.

Sincerely,

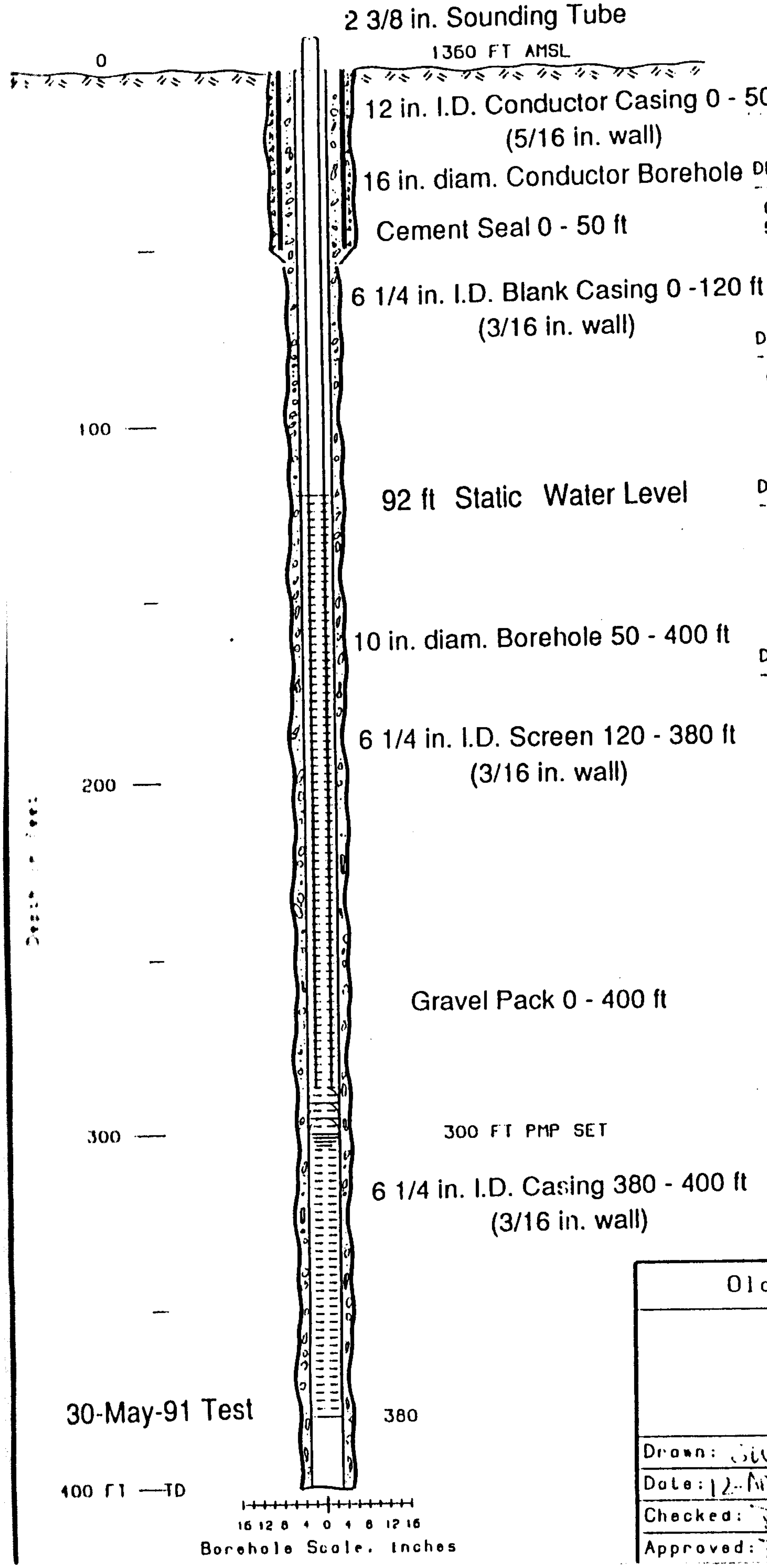
Dennis E. Williams, Ph.D.
President

DEW:mw

FIGURES

Q = 232 gpm (0.33 mgd)

Figure 1



30-May-91 Test

CASING/SCREEN/BOREHOLE SCHEDULE

BOREHOLE

DEPTH IN FEET	DIAMETER IN INCHES
0 to 50	16
50 to 400	10

CONDUCTOR CASING

DEPTH IN FEET	DIAMETER IN INCHES
0 to 50	12

BLANK CASING

DEPTH IN FEET	DIAMETER IN INCHES
0 to 120	6
380 to 400	6

WELL SCREEN

DEPTH IN FEET	DIAMETER IN INCHES
120 to 380	6

Gravel Pack-
Lone Star Monterey
CA "Coarse Aquarium".

Screen-
Vertical Machined Slots.
Slot 3/32 opening.

Old Woman Springs Well No. 1

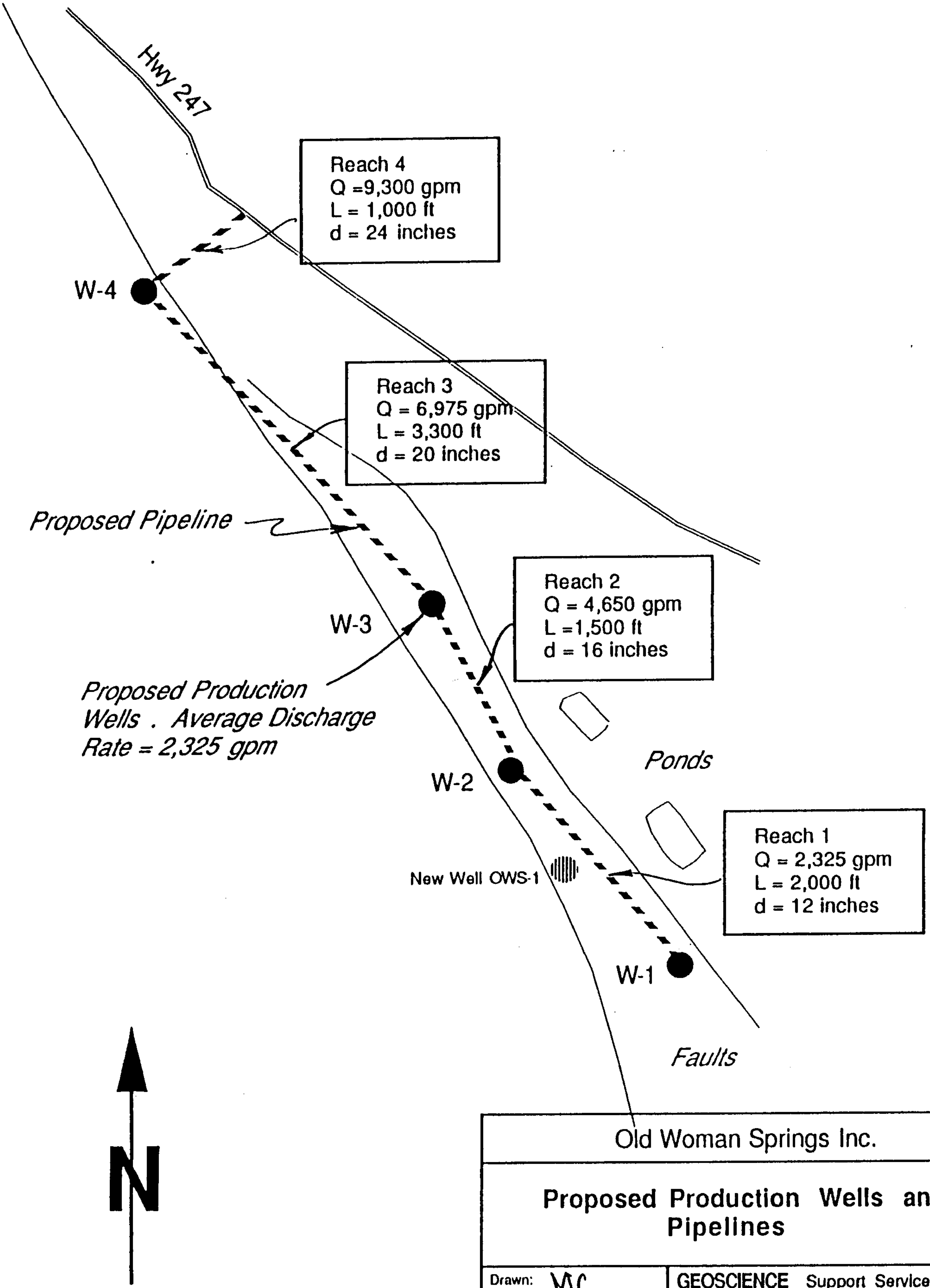
OWS WELL NO. 1

Drawn: JJU
Date: 12-APR-91
Checked:
Approved:

GEOSCIENCE Support Services Inc.

Job: 0
Fig:

Figure 2



Old Woman Springs Inc.

Proposed Production Wells and Pipelines

Drawn: MC
Date: 25-JUN-91
Checked:
Approved:

GEOSCIENCE Support Services Inc.
1164 North Padua Avenue, Suite 4
P.O. Box 220 Claremont, CA 91711
Tel: (714) 920-0707 Fax: (714) 920-0403

Job:
Fig:

APPENDIX A

OWS-1 Water Quality Results

Clinical Laboratory of San Bernardino, Inc.

P. O. Box 329
1595 North " D " Street
San Bernardino, California 92405
(714) 885-3216

PURVEYOR: GEO SCIENCE LABORATORIES

SAMPLE I.D.#: 91-3936

STREET ADDRESS:

DATE OF REPORT: 6/5/91

CITY,STATE,ZIP:

DESCRIPTION OF SAMPLING POINT: OWS - 1

DATE/TIME COLLECTED: 5/30/91

NAME OF SAMPLER: JOHNSON YEH

CONSTITUENT	RESULTS	UNITS	MCL
TOTAL HARDNESS	272.0	mg/L	
CALCIUM HARDNESS	149.2	mg/L	
CALCIUM	59.8	mg/L	
MAGNESIUM	29.8	mg/L	
SODIUM	61.3	mg/L	
POTASSIUM	4.9	mg/L	
TOTAL ALKALINITY	102.4	mg/L	
HYDROXIDE	< 1.0	mg/L	
CARBONATE	< 1.0	mg/L	
BICARBONATE	124.9	mg/L	
SULFATE	30.8	mg/L	
CHLORIDE	253.7	mg/L	
NITRATE	3.7	mg/L	45
FLUORIDE	0.6	mg/L	
TOTAL ANIONS	8.2	mEq/L	
TOTAL CATIONS	8.3	mEq/L	
RPD ANIONS/CATIONS	0.2	PERCENT	
pH	8.1	STANDARD UNITS	
E.C.	810.0	umho/cm	
TDS	495.8	mg/L	
MBAS	< 0.02	mg/L	

CONSTITUENT	RESULT	UNITS	MCL
MANGANESE	< 30	ug/L	50
COPPER	< 50	ug/l	1000
IRON	< 100	ug/L	300
ZINC	< 50	ug/L	5000
SILICA	27.5	mg/L	
COLOR	< 3.0	UNITS	
ODOR	1.0	TON	
TURBIDITY	0.3	NTU	

DATE(S) RECEIVED: 5/30/91 STARTED: 5/30/91 COMPLETED: 6/5/91

ALL ANALYSES ARE PERFORMED IN ACCORDANCE WITH APHA'S STANDARD METHODS, (17TH EDITION) OR EPA'S METHODS FOR CHEMICAL ANALYSIS OF WATER AND WASTE

CLINICAL LABS/SAN BERNARDINO
1595 NORTH "D" STREET
SAN BERNARDINO, CA. 92405

ORGANIC CHEMICAL ANALYSIS

Sample ID No.91-3947

e of Report: 06/17/91
oratory
e: CLINICAL LABORATORIES OF SAN BERNARDINO

Signature Lab Director:

Employed By:GEOSCIENCE SUPPORT SERVICE

e of Sampler:JOHNSON YEH

e/Time Sample
llected: 91/05/30/0000

Date/Time Sample
Received @ Lab: 91/05/30/1700

Date Analyses
Completed: 91/06/12

stem
e: GEOSCIENCE SUPPORT SERVICES, INC.
e or Number of Sample Source: OWS-1

System
Number: 36-9906

User ID: 36C
Date/Time of Sample: |91|05|30|0000|
YY MM DD TTTT

Station Number: 000/000-00X0010
Laboratory Code: 3761

Date Analysis Completed: |91|06|12|
YY MM DD

Submitted by: ____________________

Phone #: ____________________

l neg method: 502.2

REGULATED ORGANIC CHEMICALS

TEST METHOD	CONSTITUENT ALL CONSTITUENTS REPORTED ug/L	ENTRY #	ANALYSES RESULTS	MCL ug/L	DLR ug/L
502.2	Bromodichloromethane	32101	ND		0.5
502.2	Bromoform	32104	ND		0.5
502.2	Chloroform (Trichloromethane)	32106	ND		0.5
502.2	Dibromochloromethane	32105	ND		0.5
502.2	Total Trihalomethanes (THM'S/ TTHM)	82080	ND	100	0.5
502.2	Benzene	34030	ND	1	0.5
502.2	Carbon Tetrachloride	32102	ND	.5	0.5
502.2	Ethyl Benzene	34371	ND	680	5.0
502.2	1,4-Dichlorobenzene (p-DCB)	34571	ND	5	0.5
502.2	1,1-Dichloroethane (1,1-DCA)	34496	ND	5	0.5
502.2	1,2-Dichloroethane (1,2-DCA)	34531	ND	.5	0.5
502.2	1,1-Dichloroethylene (1,1-DCE)	34501	ND	6	0.5
502.2	cis-1,2-Dichloroethylene (c-1,2-DCE)	77093	ND	6	0.5
502.2	trans-1,2-Dichloroethylene (t-1,2-DCE)	34546	ND	10	0.5
502.2	1,2-Dichloropropane	34541	ND	5	0.5
502.2	Total 1,3-Dichloropropene	34561	ND	.5	0.5
502.2	Monochlorobenzene (Chlorobenzene)	34301	ND	30	1.0
502.2	1,1,2,2-Tetrachloroethane	34516	ND	1	0.5
502.2	Tetrachloroethylene (PCE)	34475	ND	5	0.5
502.2	1,1,1-Trichloroethane (1,1,1-TCA)	34506	ND	200	1.0
502.2	1,1,2-Trichloroethane (1,1,2-TCA)	34511	ND	32	1.0
502.2	Trichloroethylene (TCE)	39180	ND	5	0.5

REGULATED ORGANIC CHEMICALS CONTINUED

TEST METHOD	CONSTITUENT ALL CONSTITUENTS REPORTED ug/L	ENTRY #	ANALYSES RESULTS	MCL ug/L	DLR ug/L
502.2	Trichlorofluoromethane (FREON 11)	34488	ND	150	1.0
502.2	Trichlorotrifluoroethane (FREON 113)	81611	ND	1200	1.0
502.2	Vinyl Chloride (VC)	39175	ND	.5	0.5
502.2	m,p-Xylene	A-014	ND		10.0
502.2	o-Xylene	77135	ND		10.0
502.2	Total Xylenes (m,p, & o)	81551	ND	1750	10.0
	Dibromochloropropane (DBCP)	38761		.2	0.01
	Ethylene Dibromide (EDB)	77651		.02	0.02
505	Endrin	39390	ND	.2	0.1
505	Lindane (gamma-BHC)	39340	ND	4	0.2
505	Methoxychlor	39480	ND	100	10.0
505	Toxaphene	39400	ND	5	1.0
	Chlordane	39350	ND	.1	0.1
	Diethylhexylphthalate (DEHP)	39110		4	3.0
505	Heptachlor	39410	ND	.01	0.01
505	Heptachlor epoxide	39420	ND	.01	0.01
	Atrazine (AATREX)	39033		3	1.0
	Molinate (ORDRAM)	82199		20	2.0
	Simazine (PRINCEP)	39055		10	1.0
	Thiobencarb (BOLERO)	A-001		70	1.0
515.1	Bentazon (BASAGRAN)	38710	ND	18	2.0
515	2,4-D	39730	ND	100	10.0
515	2,4,5-TP (SILVEX)	39045	ND	10	1.0
	Carbofuran (FURADAN)	81405		18	5.0
	Glyphosate	79743		700	25.0

UNREGULATED ORGANIC CHEMICALS

TEST METHOD	CONSTITUENT ALL CONSTITUENTS REPORTED ug/L	ENTRY #	ANALYSES RESULTS	MCL ug/L	DLR ug/L
502.2	Bromobenzene	81555*	ND		0.5
502.2	Bromochloromethane	A-012	ND		0.5
502.2	Bromomethane (Methyl Bromide)	34413*	ND		0.5
502.2	n-Butylbenzene	A-010	ND		0.5
502.2	sec-Butylbenzene	77350	ND		0.5
502.2	tert-Butylbenzene	77353	ND		0.5
502.2	Chloroethane	34311*	ND		0.5
502.2	2-Chloroethylvinyl Ether	34576	ND		1.0
502.2	Chloromethane (Methyl Chloride)	34418*	ND		0.5
502.2	2-Chlorotoluene	A-008*	ND		0.5
502.2	4-Chlorotoluene	A-009*	ND		0.5
502.2	Dibromomethane	77596*	ND		0.5
502.2	1,2-Dichlorobenzene (o-DCB)	34536*	ND		0.5
502.2	1,3-Dichlorobenzene (m-DCB)	34566*	ND		0.5
502.2	Dichlorodifluoromethane	34668*	ND		1.0
502.2	1,3-Dichloropropane	77173*	ND		0.5
502.2	2,2-Dichloropropane	77170*	ND		0.5
502.2	1,1-Dichloropropene	77168*	ND		0.5
502.2	Hexachlorobutadiene	34391	ND		0.5

GE 3 OF 3 UNREGULATED ORGANIC CHEMICALS CONTINUED 91-3947

TEST METHOD	CONSTITUENT ALL CONSTITUENTS REPORTED ug/L	ENTRY #	ANALYSES RESULTS	MCL ug/L	DLR ug/L
02.2	Isopropylbenzene (Cumene)	77223	ND		0.5
02.2	p-Isopropyltoluene	A-011	ND		0.5
02.2	Methylene chloride	34423*	ND		1.0
02.2	Naphthalene	34696	ND		0.5
02.2	n-Propylbenzene	77224	ND		0.5
02.2	Styrene	77128*	ND		0.5
02.2	1,1,1,2-Tetrachloroethane	77562*	ND		0.5
02.2	Toluene	34010*	ND		10.0
02.2	1,2,3-Trichlorobenzene	77613	ND		0.5
02.2	1,2,4-Trichlorobenzene	34551	ND		0.5
02.2	1,2,3-Trichloropropane	77443*	ND		0.5
02.2	1,2,4-Trimethylbenzene	77222	ND		0.5
02.2	1,3,5-Trimethylbenzene	77226	ND		0.5
	Methyl ethyl ketone (MEK, Butanone)	81595			5.0
	Methyl isobutyl ketone (MIBK)	81596			5.0
	bis (2-Chloroethyl) ether	34273			0.5
	Alachlor (ALANEX)	77825			1.0
	Bromacil (HYVAR)	82198			10.0
	Diazinon	39570			0.02
	Prometryn (CAPAROL)	39057			2.0
	Chlorothalonil (DACONIL, BRAVO)	70314			5.0
	Dimethoate (CYGON)	38458			10.0
	Aldicarb (TEMIK)	39053			3.0
	Diuron	39650			1.0

boratory comments and description of any additional compounds found:

CLINICAL LABS/SAN BERNARDINO
1595 NORTH "D" STREET
SAN BERNARDINO, CA. 92405

RADIOACTIVITY ANALYSIS

Sample ID No.91-3936

of Report: 06/04/91
oratory
: CLINICAL LABORATORIES OF SAN BERNARDINO
of Sampler:JOHNSON YEH
/Time Sample
lected: 91/05/30/0000

Signature Lab Director:
Employed By:GEOSCIENCE SUP(SVC.INC)

Date/Time Sample Received @ Lab: 91/05/30/1700

Date Analyses Completed: 91/06/04

System Number: 36-9906

tem
: GEOSCIENCE SUPPORT SERVICES, INC.
or Number of Sample Source: OWS-1

Station Number: 000/000-00X0010
Laboratory Code: 3761

User ID: 36C
Date/Time of Sample: |91|05|30|0000|
YY MM DD TTTT

Date Analysis Completed: |91|06|04|
YY MM DD

Phone #: ____________________

Submitted by: ____________________

MCL.	REPORT UNITS	CONSTITUENT	STORET CODE	ANALYSES RESULTS	DLR
15	pC/l	Total Alpha	01501	1.4	
	pC/l	Total Alpha Counting Error	01502	0.4	
50	pC/l	Total Beta	03501		4.
	pC/l	Total Beta Counting Error	03502		
20	pC/l	Natural Uranium	28012		2.
	pC/l	Total Radium 226	09501		.
	pC/l	Total Radium 226 Counting Error	09502		
	pC/l	Total Radium 228	11501		.
	pC/l	Total Radium 228 Counting Error	11502		
5	pC/l	Ra 226 + Ra 228	11503		
	pC/l	Ra 226 + Ra 228 Counting Error	11504		
20000	pC/l	Total Tritium	07000		1.
	pC/l	Total Tritium Counting Error	07001		
8	pC/l	Total Strontium - 90	13501		2.
	pC/l	Total Strontium - 90 Counting Error	13502		
	pC/l	Total Radon 222 Counting Error	82302		100
	pC/l	Total Radon 222	82303		

Clinical Laboratory of San Bernardino, Inc.

1595 N. "D" St., San Bernardino, CA 92405
Phone (714) 885-3216
P. O. Box 329
San Bernardino, CA 92402

BACTERIOLOGICAL TEST FOR DRINKING WATER

SET UP TIME	HOURS
2 PM. - 4 PM	
MEETS HOLDING TIME	
[✓ YES]	NO

5-10 ml PORTIONS PLANTED

PURVEYOR: Geoscience

ADDRESS: 1164 N. Padua Ave Suite 4

DATE COLLECTED: 5/30/90

COLLECTED BY: Johnson Yeh

TYPE OF SAMPLE		REASON FOR TEST	
1	SOURCE (Well, etc.)	A	ROUTINE
		B	RECHECK
2	DISTRIBUTION SYSTEM	C	SPECIAL

						FOR LAB USE ONLY							
						NUMBER OF POSITIVE TUBES							
						PRESUMPTIVE		CONFIRMED					
BOT. NO.	TIME COLL.	SAMPLING POINT	CL$_2$ RES. Mg/L	Type of Sample	Reason for test	24 HR	48 HR	24 HR	48 HR	Coli mpn/ 100 ml	FECAL	Plate Count Per 1 ml	Membrane Filter
		OWB-1				0	0			≤ 2.2			

analyses are done by APHA"s " Standard Methods " , (17th Edition)

SET UP BY FW READ BY CJ

Date Started: MAY 30 1991 Date Completed: JUN 0 1 1991

REQUIRED NOTIFICATION: ____ NONE

BY: C. Jolliff

APPENDIX B

Cost Estimate for One Production Well

McCalla

A Division of Layne-Western Company, Inc.

GENERAL OFFICE: 41-943 Boardwalk, Suite K • Palm Desert, California 92260 • 619/341 5004 Fax: 619/341 5083

BRANCH
3132 West 17th Street
Santa Ana, California 92703
(714) 554-4142
Fax: 714-554-5177

BRANCH
13855 Central Avenue
Chino, California 91710
(714) 627 1521
Fax: 714-628-1233

BRANCH
502 Nevada Street
Redlands, California 92373
(714) 793 2913
Fax. 714 792 3484

BRANCH
53-381 Highway 111 • P.O. Box 866
Coachella, California 92236
(619) 398 8887
Fax: 619 398 7514

June 24, 1991

GeoScience
1164 N. Padua Avenue, Ste. 4
P.O. Box 220
Claremont, CA 91711
FAX: 920-0403

Attention: Dr. Dennis Williams

Re: Old Woman Springs Well

Per our conversation, this quotation is based on a 400' deep 18" well.

ITEM		UNIT	TOTAL
1.	Mobilize and Demobilize Equipment, Including Conductor:	L/S	43,675.00
2.	Drill 400' 17-1/2" Pilot Hole:	$50/ft.	20,000.00
3.	E-Log:	L/S	2,500.00
4.	Ream 400' to 28" Hole:	$50/ft.	20,000.00
5.	Furnish and Install 100' 18" Blank Casing:	$49.30/ft.	4,930.00
6.	Furnish and Install 300' 18" Full-Flo Louver Casing:	$71.34/ft.	21,402.00
7.	Furnish and Install 350' Gravel Pack:	$15.44/ft.	5,404.00
8.	Develop by Airjet, 24 Hours:	$200/hr.	4,800.00
9.	Furnish and Install 50' Sanitary Seal:	$54/ft.	2,700.00
10.	Furnish and Install Test Pump:	L/S	10,200.00

Geoscience
June 24, 1991
Page 2.

11.	Test Pump and Develop, 24 Hours: $110/hr.	2,640.00
	TOTAL:	$138,251.00

Please call me with any questions or concerns.

Sincerely,

Terry Smith
Operations Manager
McCalla Division
Layne-Western

TS:ljt

APPENDIX C

Proposed Transmission Pipelines Hydraulic Calculations

Head Loss Calculations for Production Well Pipelines

Reach 1 between W-1 and W-2

Head Loss [ft] = 26.03

Flow Rate (Q) [gpm] = 2325.00
Pipe Diameter (d) [in.] = 12.00
Pipe Length (L) [ft] = 2000.00
Size of Surface Imperfections (e) [ft] = 0.0008
Relative Roughness (e/d) = 0.0008
Reynold's Number (Re) = 0.53495E+06
Darcy-Weisbach Friction Factor (f) = 0.0193
Area of Pipe [ft2] = 0.785
Flow Velocity [ft/sec] = 6.60

Reach 2 between W-2 and W-3

Head Loss [ft] = 17.27

Flow Rate (Q) [gpm] = 4650.00
Pipe Diameter (d) [in.] = 16.00
Pipe Length (L) [ft] = 1500.00
Size of Surface Imperfections (e) [ft] = 0.0008
Relative Roughness (e/d) = 0.0006
Reynold's Number (Re) = 0.80243E+06
Darcy-Weisbach Friction Factor (f) = 0.0179
Area of Pipe [ft2] = 1.396
Flow Velocity [ft/sec] = 7.42

Reach 3 between W-3 and W-4

```
                          Head Loss [ft] =    26.66

                   Flow Rate (Q) [gpm] =   6975.00
               Pipe Diameter (d) [in.] =  20.00
                  Pipe Length (L) [ft] =   3300.00
Size of Surface Imperfections (e) [ft] =  0.0008
            Relative Roughness (e/d) =  0.0005
            Reynold's Number   (Re) = 0.96292E+06
    Darcy-Weisbach Friction Factor (f) = 0.0171
                    Area of Pipe [ft2] =   2.182
              Flow Velocity [ft/sec] =   7.12
```

Reach 4 between W-4 and Highway 247

```
                          Head Loss [ft] =     5.56

                   Flow Rate (Q) [gpm] =   9300.00
               Pipe Diameter (d) [in.] =  24.00
                  Pipe Length (L) [ft] =   1000.00
Size of Surface Imperfections (e) [ft] =  0.0008
            Relative Roughness (e/d) =  0.0004
            Reynold's Number   (Re) = 0.10699E+07
    Darcy-Weisbach Friction Factor (f) = 0.0165
                    Area of Pipe [ft2] =   3.142
              Flow Velocity [ft/sec] =   6.60
```

Yucca Valley &
Cathedral City Offices
TRANSMITTED FROM:

☒ 7245 Joshua Lane
Yucca Valley California 92284
(619) 365-7638
FAX 365-2146

☐ 68-860 Perez Road, Suite C-1
Cathedral City California 92234
(619) 321-4017
FAX 770-1917

Warner engineering
CIVIL ENGINEERING PLANNING LAND SURVEYING

LETTER OF TRANSMITTAL

TO: GEOSCIENCE SUPPORT SERVICES INC.
P.O. BOX 220
CLAREMONT, CALIFORNIA 91711

DATE: 7-31-92 **PROJECT NO.** 7580-CU

RE: OLD WOMAN SPRINGS ROAD

ATTENTION: DENNIS E. WILLIAMS, PRESIDENT

We are sending you ☒ **Attached** ☐ **Via Messenger** ☒ **Other** U.S. MAIL
☐ **Originals** ☐ **Prints** ☐ **Copy of Letter** ☒ **Other** REPORT

COPIES	DATE	NO.	DESCRIPTION
1	6/92		MOJAVE WATER AGENCY REPORT"ASSESSMENT OF GROUND WATER RESOURCE."

These are transmitted as checked below:

☒ **For your use** ☒ **As requested** ☐ **For Approval** ☐ **For review & comment**

☐ **Other**

REMARKS:

DEAR DENNIS,

I AM SENDING THIS COPY OF MOJAVE WATER AGENCY REPORT TO YOU AS REQUESTED BY CORT HOOPER.

THANKS,

WARNER ENGINEERING
By: JOHN A. SMITH/is

Copy to:

RECEIVED
JUL 20 1992
WARNER ENGINEERING
W.O.

RECEIVED
JUL 23 1992
Hi-Desert Water Dist.

ASSESSMENT
OF
GROUND WATER RESOURCE

OLD WOMAN SPRINGS RANCH

for

Mojave Water Agency

Bechtel Corporation

BECHTEL

June 1992

TABLE OF CONTENTS

TABLE

FIGURE

ASSESSMENT OF GROUND WATER RESOURCE OLD WOMAN SPRINGS RANCH

A preliminary assessment of the ground–water resources of the Old Woman Springs Ranch has been made to determine the potential firm yield that could reasonably be expected to be developed. The purpose is to provide the Mojave Water Agency a basis for determining if more extensive investigation for development is warranted. The scope of this first phase of effort included:

- Collection and review of reports concerned with the hydrogeology and water resources of the area. The reports reviewed are provided in the reference list

- Field inspection of the Old Woman Springs area, which included a general reconnaissance, inspection of lithology, faulting, and springs, and an inspection of recently completed monitoring wells

- Determination of the probable maximum perennial yield of ground water, and the factors that can restrict the quantity available for development. This is based primarily on a review of estimates made by others

- Preparation of this report that describes the findings and conclusions resulting from the activities described

1.0 HYDROGEOLOGIC SETTING

Old Woman Spring Ranch is located in the Johnson Valley hydrologic basin. The basin includes several alluvial-filled basins which are either enclosed by non-water bearing bedrock or separated by faults that generally act as barriers to ground-water flow. These basins are named for the valleys or areas that they underlie (Reference 1); Rattlesnake, Fry, Johnson, and Upper Johnson Valleys, and the Means-Reche area. The general areal geology and basins as described by J.J. French (Reference 1), are shown on Figure 1. The Old Woman Springs Ranch property extends across the ground-water barrier of Old Woman Springs Fault, illustrated on Figure 1. This fault zone separates Rattlesnake Valley and Fry Valley basins.

The bedrock that underlies and surrounds the alluvial-filled basins has very low permeability and is considered to be non-water bearing. The interbedded sand, gravel, silt and clay filling the basins are more permeable than the bedrock, and contain considerable quantities of ground water that is available for extraction (water bearing). Faults, such as the Old Woman Springs fault, have disrupted the basins, developing crushed zones in the alluvium and older rocks that are barriers or impediments to the movement of ground water. As a result, water infiltrating the alluvium will fill up the basin on one side of the fault barrier until it flows over the barrier. Such overflows can appear as springs when the barriers extend to the ground surface. Basin ground water can also seep through the barrier in response to the hydrostatic pressure. The several springs along the Old Woman Springs fault zone are examples of the barrier effect.

Along the fault-zone complex at Old Woman Springs Ranch, basalt is the predominant rock-type exposed. As interpreted by T.W. Dibblee (Reference 2), the basalt was extruded as flows from fissures associated with the fault zone. Exposures

FAX TRANSMITTAL SHEET

To: Mr. Franklin I. Remer
Remer, Civincenzo & Griffith -- Fax: (714) 759-0788

From: Meridee Williams

Date: Tue, Jun 22, 1993

Subject: Old Woman Springs, Inc.

Number of Pages Including Cover Page: 1

Message:

Frank:

I received your fax this morning. Our copy of the Bechtel report is also missing page 3 (it is blank, page but has page number 3 at the bottom.)

Upon further inspection, it appears Warner Engineering has made a mistake. The wording from page 2 continues on page 4, and it appears all information is there.

Please call with any questions.

Meridee

GEOSCIENCE Support Services Incorporated

Ground Water Resources Development

Tel: (909) 920-0707 FAX: (909) 920-0403

2/93

near Cottonwood Springs indicate that the basalt is underlain to the northwest by Old Woman sandstone, but to the south of the ranch basalt lies directly on bedrock.

The recent exploratory drilling on the ranch (Reference 3) has shown that the sandstone is present beneath the ranch. Exposures of the basalt are present throughout the basins, but the Old Woman sandstone is restricted to Rattlesnake Valley (Reference 2). Both the basalt and the Old Woman sandstone are apparently permeable enough to be considered water–bearing in the vicinity of the fault zone. The basalt is a dense, non–porous rock, but it is jointed and fractured in exposures along the fault zone, indicating significant secondary permeability. However, as reported by Dibblee (Reference 2), exposures of the basalt away from the effects of faulting are massive, with few joints, and is not considered a part of the water–bearing material of the basins. The Old Woman sandstone is porous, and will be likely to yield water where encountered in Rattlesnake Valley. However, primary permeability of the Old Woman sandstone, based on observations of exposures away from the fault zone, is low (Reference 1).

2.0 GROUND–WATER RESOURCE

The quantity of ground water available for extraction from beneath the Old Woman Springs Ranch is affected by many factors. The extractions will come from the basins of the Johnson Valley hydrologic unit, and these extractions will have the potential to impact other users and the local environment. Other factors that will affect the amount that can be extracted include the number and location of wells and whether the ground water is exported or used within the basin. If there is to be no long–term net extraction from storage, the limiting factor will be the long–term average rate of recharge to the basin. Sources of recharge to the Johnson Valley hydrologic basin ground water include infiltration of direct precipitation on the valley fill and of stream runoff from the adjacent highlands. The primary source of recharge is the San Bernardino Mountains bordering the basin to the south. Drainage from this area first discharges onto the basin of Rattlesnake Valley. Arrastre Creek drainage is a major part of this area. Lesser drainages include Rattlesnake Canyon. Assessing quantity of recharge from these drainages to Rattlesnake Valley basin must consider discharge to other basins of the Johnson Valley unit. Most investigators believe that the majority of the San Bernardino Mountains stream flow (floodflow) leaves the valley and infiltration is relatively small (References 1, 4, 6, 7).

2.1 *Estimated Recharge*

Several different investigators have made estimates of the recharge to the Johnson Valley basins. Because of the sparse development, typical of the desert basins, data on the occurrence and movement of groundwater is very limited. As a result, recharge estimates are based on relationships of rainfall, runoff, and consumptive use determined for those basins that have been developed and have data. These relationships can be transposed to similar basins and combined with the limited hydrologic data to develop quantity estimates. The earliest estimate for Johnson Valley found in our literature review, was developed by the State of California (Reference 4). According to Reference 4, the Johnson Valley ground-water recharge is 2,300 acre–feet per year, however the basis for this estimate was not reported. More recent estimates, made by two investigators at the request of the Hi Desert Water District, were based on a method developed specifically for the mountain basins of southern California ("Crippen method", Reference 5). This method determines "recoverable water", the residual from precipitation after accounting for evapotranspiration and water retention. The residual includes surface–water runoff and percolation to the ground water.

The first investigator, S. D. Heule (Reference 6), estimated recoverable water within the Rattlesnake Valley drainage to be about 1,900 acre–feet annually. He states that a significant amount of that would leave the basin as surface flow and estimates that as much as 960 acre–feet per year is recharged to the ground water in Rattlesnake Valley. The second investigator, R. C. Fox (Reference 7), limits his estimate of recharge to that of Arrastre Creek within the Rattlesnake Valley drainage. He estimated recoverable water as 4,280 acre–feet per year, and the quantity of recharge to ground water as 856 acre–feet per year.

The last estimate of recharge reviewed in this study is that made by Geoscience Support Services, Inc. (Reference 3). This company has been conducting exploratory work on the Old Woman Springs Ranch for the purpose of selecting production well sites for the development of the ground water resource. The Geoscience estimate of recharge has been prepared for Arrastre Creek within Rattlesnake Valley, as was the Fox estimate. However, Geoscience has estimated recharge by two different methods.

The first estimate method, described as the "hydrologic balance method", is similar to the Crippen method. That is, they determined only the residual from precipitation after accounting for evapotranspiration. Their estimate for evapotranspiration is based on the Blaney–Criddle method (Reference 8), rather than that described by Crippen (Reference 5). To be complete, a hydrologic "balance" should equate items of water supply with items of water disposal. The residual determined (an item of supply) is not accounted for by items of water disposal. The calculated residual, essentially equivalent to the recoverable water of the Crippen method, is 13,600 acre–feet/yr, considerably larger than the estimates made by either Fox or Heule. The Geoscience work assumes that no water leaves Rattlesnake Valley as surface flow and that all of the residual percolates to the ground water in Rattlesnake Valley.

The second approach to estimating the ground-water resource by Geoscience is described as the "underflow method". This method calculates the quantity of ground water migrating through a section of the basin aquifer, applying average estimated values of the hydraulic conductivity, thickness, width of the aquifer, and the hydraulic gradient. This second method was initially applied before the exploratory drilling was completed. However, after the exploratory work was completed and monitoring wells installed, parameter values used in the underflow calculation were revised, and the estimated underflow was reduced from 18,600 acre-feet/yr to 8,100 acre-feet/yr. A summary of the estimates of average annual recharge made by the different investigators is provided in Table 1.

TABLE 1
Estimates of Recharge to Johnson Valley Hydrologic Basin

Source (Reference)	Drainage Unit	Analysis Method	Recoverable Water [a] (acre-feet/yr)	Recharge to Groundwater (acre-feet/yr)
DWR (4)	Total hydrologic basin	Not described	No estimate	2,300 [b]
Heule (6)	Rattlesnake Valley	Crippen	1,900	<960 [c]
Fox (7)	Arrastre Creek in Rattlesnake Valley	Crippen	4,280	856 [c]
Geoscience (3)	Arrastre Creek in Rattlesnake Valley	water balance	13,600	13,600 [c]
Geoscience (3)	Rattlesnake Valley	underflow	No estimate	8,100 [c]

Notes:

a) Recoverable water includes surface runoff and percolation to ground water resulting from precipitation in the drainage area.

b) Recharge to all ground-water basins in the hydrologic unit.

c) Recharge to Rattlesnake Valley ground-water basin.

A large range in estimated quantities is evident from the table. Although the differences in drainage areas contributes to the different values, the variations illustrate the lack of site-specific data on which the estimates are based. Values for nearly all of the parameters used in making the estimates are based on correlation or extrapolation of data from other areas. The only site-specific measurements used are water levels from the recent exploration conducted to determine hydraulic gradients. These measurements are all within the Old Woman Springs fault-zone complex. Extrapolating these data to represent the hydraulic gradient in Rattlesnake Valley, as was done by Geoscience for the underflow estimate, is approximate at best. The hydraulic conductivity estimates used by Geoscience were guided by qualitative information derived from the exploratory holes, but still required correlation with values measured elsewhere.

2.2 *Comparison with Lucerne Valley*

One other approach to assessing the potential Johnson Valley basin recharge and ground-water yield is to compare the basin to Lucerne Valley, the hydrologic basin immediately adjacent to and west of Johnson Valley basin. Lucerne Valley is very similar to Johnson Valley in size, hydrogeologic and climatic conditions, and receives the major portion of ground-water recharge from a San Bernardino Mountain drainage of similar size and rainfall conditions (References 6 and 10). Additionally, development in Lucerne Valley is extensive, and many existing wells provide historical data on extractions and water levels. Using these data, the California Department of Water Resources (Reference 9) determined the total long-term average recharge to Lucerne Valley ground-water basin to be 1,740 acre-feet/yr.

Why use 1963 data?
*1975 DWR Bulletin 118
5700 AF/yr

2.3 *Water Balance Considerations*

The Johnson Valley Hydrologic Basin is a closed basin, in respect to ground-water recharge and discharge. That is to say, because the basin is enclosed by non-water bearing bedrock, recharge to the ground water must be balanced, ultimately, by an equivalent discharge within the basin. Without any significant utilization of ground water in the basin, or extensive vegetation, the source of discharge of any significant quantity of recharge would be as evaporation from the playas within the basin. These potential areas would be at Soggy, Melville and Means dry lakes. However, there is little evidence that extensive areas of shallow ground water are present beneath these playas. Measurements of deuterium content, an isotope of hydrogen, provide a method of evaluating evaporative discharge from ground water. Samples of ground water taken from beneath these playas have shown no isotopic evidence of evaporative discharge (Reference 11). This suggests that natural discharge in the basin is small and so natural recharge would be expected to be small.

3.0 ASSESSMENT OF POTENTIAL YIELD

The limited amount of data precludes a refined estimate of the potential ground-water yield from beneath Old Woman Springs Ranch. However, the available estimates of recharge, and correlation to the experience in Lucerne Valley provides a basis for estimating the maximum amount that can be reasonably expected. All of the estimates discussed, except that of Geoscience, suggest the annual ground-water recharge to the Johnson Valley basins is less than 4,000 acre-feet/yr. and more probably closer to 2,000 acre-feet/yr. The comparison with Lucerne Valley, an area of similar characteristics, and with significantly more data with which to evaluate the recharge, is consistent with this conclusion. It must be recognized that these estimates are far from precise, and that there is little direct evidence to support the assessment. On the other hand, if the basin recharge is significantly larger than 4,000 acre–feet/yr., then there should be some evidence of ground-water build up and/or basin water transfers. Until now, basin water use is much less than the estimated recharge, and there does not seem to be evidence of natural discharge in the basin to account for larger quantities.

The portion of ground water extracted by wells on the Old Woman Springs Ranch should be limited to that portion of the total recharge that infiltrates the Rattlesnake Valley and Fry Valley basins. Both Heule and Fox estimate that Rattlesnake Valley receives less than an average of 1,000 acre–feet/yr. (References 6 and 7). For the Fry Valley, Heule (Reference 6) noted that basin recharge must be by underflow from Rattlesnake Valley.

Ground-water extraction may be further limited by the capacity of wells constructed on ranch property. Reportedly, test production wells are currently planned on the ranch which should provide a measure of well capacities.

4.0 SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

The primary objective of this study was to assess what quantity of ground water might be extracted with wells on Old Woman Springs Ranch without permanent withdrawal from storage. This can be termed the perennial yield. The ultimate limiting factor is the average rate of recharge, but the amount that can be extracted is also affected by the usage (if it is applied within the basin, returns to the basin can allow extractions higher than the natural recharge), and the impact on others.

The ranch is within the Johnson Valley Hydrologic system. The data and reports reviewed indicate that the maximum perennial yield that can be expected from the Johnson Valley Hydrologic system is no more than 4,000 acre–feet/yr, and more probably is 2,000 acre–feet/yr. Considering the more probable quantity, and assuming it is available without unacceptable impacts on the environment, or on others in Johnson Valley, a field of about 4 wells, extracting an average of about 300 gpm per well, would provide the estimated yield. This, of course, is a hypothetical case, provided only to illustrate the extent of development to consider.

To better determine the amount of ground water that can be developed from the Old Woman Springs Ranch, a second phase of investigation should be conducted. The purpose of this investigation would be to define more closely the amount of ground water available, potential impacts to the basin due to ground–water extractions, and the most feasible well locations.

The next phase of study should be directed to developing a water balance of the total Johnson Valley. Such an effort will be limited by the sparse data. Nevertheless, such an analysis will provide a base of reference for planning, and can provide insight on the quantity of water available, the interdependency between the ground–water subbasins, and can be the basis for a program of development. Certain aspects of the hydrologic system are more significant than others, and studies would concentrate on them. These include:

- Calculate basin long–term recharge and deep percolation based on precipitation and runoff characteristics of the San Bernardino Mountains and desert drainage areas.

- Delineate shallow ground water beneath playas and provide estimates of ground–water discharge by evaporation.

- Conduct a water well and spring canvass of the basin to determine current ground water utilization.

- Conduct aquifer tests utilizing existing wells identified in the well canvass where appropriate.

- Prepare best estimates of ground-water subbasin system recharge-discharge characteristics, and ground-water basin storage capacities.

- With data collected, prepare a best estimate of potential ground water extraction and identify recommended well sites for effective development.

REFERENCES

1. French, James J., April 1978, "Ground-Water Storage in the Johnson Valley Area, San Bernardino County, California", U.S. Geological Survey, W.R.I. 77-130.

2. Dibblee, T. W. Jr., 1967, "Geologic Map of the Old Woman Springs Quadrangle, San Bernardino County, California", U.S. Geological Survey Misc. Geol. Invest. Map I-518.

3. Geoscience, February 20, 1992, Old Woman Springs Area – Results of Exploratory Drilling and Revised Safe Yield Estimate", report submitted to Old Woman Springs, Inc.

4. California Department of Water Resources, September 1975, "California's Ground Water", Bulletin 118-75.

5. Crippen, John R., 1965, "Natural Water Loss and Recoverable Water in Mountain Basins of Southern California", U.S. Geological Survey Prof. Paper 417-E.

6. Heule, Scott D., December 6, 1990, "Feasibility for Water Supply, Lucerne and Johnson Valleys, San Bernardino County, California", report to Hi Desert Water District.

7. Fox, Robert C., March 26, 1991, "Review of report entitled 'Hydrogeologic Investigation and Water Treatment Feasibility Study Old Woman Springs Ranch'", letter report submitted to Hi Desert Water District.

8. Geoscience Support Services Inc., March 1991, "Geohydrologic Investigation and Water Treatment Feasibility Study – Old Woman Springs Ranch, Final Draft", report submitted to Old Woman Springs, Inc.

9. California Department of Water Resources, August 1967, "Mojave River Ground Water Basins Investigation", Bulletin No. 84.

10. Schaefer, Donald H., January 1979, "Ground-Water Conditions and Potential for Artificial Recharge in Lucerne Valley, San Bernardino County, California", U.S. Geological Survey, WRI 78-118.

11. Gleason, Jim D., Guida Veronda, George I. Smith, Irving Friedman, Peter Martin, 1992, "Deuterium Content of Water from Wells and Perennial Springs, Southeastern California", U.S. Geological Survey Open-File Report 91-470.

12. Dibblee, T.W. Jr., 1967, "Geologic Map of the Emerson Lake Quadrangle, San Bernardino County, California, U.S. Geological Survey Misc. Geol. Invest. Map I-490.

GEOSCIENCE

August 26, 1992

Mr. C. Cortland Hooper
P.O. Box 2118
Lake Arrowhead, CA 92352

Re: **Review Comments on "Assessment of Ground Water Resource Old Woman Springs Ranch"**

Dear Cort:

As per our telephone conversation, GEOSCIENCE has reviewed the report entitled *Assessment of Ground Water Resource Old Woman Springs Ranch* by Bechtel Corporation, dated June 1992. The followings are our comments and recommendations.

- **Comments on Water Balance Considerations**

Page 9 of Bechtel's report :

"The Johnson Hydrologic Basin is a closed basin, in respect to ground-water recharge and discharge. That is to say, because the basin is enclosed by non-water bearing bedrock, recharge to the ground water must be balanced, ultimately, by an equivalent discharge within the basin."

Comments:

Based on the same reference (reference number 10) used by Bechtel and the Geologic Map of the San Bernardino Quadrangle (Bortugno and Spittler, 1986), it is apparent that the Johnson Valley ground water basin is separated from the Deadman Valley ground water basin by the Younger Alluvium and is not a closed basin. Therefore, ground water outflow into Deadman Valley ground water basin has to be considered as a component for the water balance analysis. This may explain the reason why that there is little evidence that extensive areas of shallow ground water are present beneath the Soggy, Melville and Means dry lakes.

GEOSCIENCE SUPPORT SERVICES INCORPORATED
Ground Water Resources Development
P.O. Box 220, Claremont, CA 91711
FAX 714-920-0403

- **Comments on Comparison with Lucerne Valley**

Page 8 of Bechtel's report :

"Using these data, the California Department of Water Resources (Reference 9) determined the total long-term average recharge to Lucerne Valley ground-water basin to be 1,740 acre-feet/yr."

Comments:

We did not check reference 9, however, based on reference number 10 cited by Bechtel, the recharge to Lucerne Valley ground water basin is 5,700 acre-ft/yr.

- **Comments on Assessment of Potential Yield**

Page 9 of Bechtel's report :

"All of these estimates discussed, except that of Geoscience, suggest the annual ground-water recharge the Johnson Valley basins is less than 4,000 acre-feet/yr. and more probably closer to 2,000 are-feet/yr. The comparison with Lucerne Valley, an area of similar characteristics, and with significantly more data with which to evaluate the recharge, is consistent with this conclusion."

Comments:

As mentioned previously, the recharge to Lucerne Valley is 5,700 acre-ft/yr (Bechtel Reference 10), and is not consistent with Bechtel's conclusion. In addition, all recharge estimates quoted by Bechtel were determined for different areas. Bechtel's report failed to compare recharge estimates for the same hydrologic areas. (i.e Arrastre Creek Drainage basin). Furthermore, **the estimates of 4,000 acre-ft/yr and 2,000 acre-ft/yr made by Bechtel, represent some kind of averaging of previous values and do not represent an independent calculation by Bechtel.**

- **Recommendations**

The recommendations suggested by Bechtel to develop a water balance of the total Johnson Valley is acceptable. However, amount and availability of data should be considered prior to project approval so that a true objective estimate can be made.

If you need clarification or further information, please call at your convenience.

Sincerely,

Dennis E. Williams, Ph.D.
President

DEW:JY,te

FAX TRANSMITTAL SHEET

To: Ms. Debbie Cummins
Warner Engineering (Fax: 619-365-2146)

From: Dennis E. Williams, Ph.D.

Date: Wed, Mar 10, 1993

Subject: Riparian/Wetland Statement - Old Woman Springs Ranch

Number of Pages Including Cover Page: 4

Message:

GEOSCIENCE Support Services Incorporated

Ground Water Resources Development

Tel: (909) 920-0707 FAX: (909) 920-0403

2/93

DOCUMENT TRANSMITTAL

To: Ms. Debbie Cummins
Warner Engineering

VIA US MAIL

From: Dennis E. Williams, Ph.D.

Date: Wed, Mar 10, 1993

Subject: Old Woman Springs Ranch

Number	Description
1	Riparian/Wetland Statement - Old Woman Springs Ranch

The Above Items Are Submitted

- ☐ At Your Request
- ☐ For Your Files
- ☐ For Your Information
- ☒ For Your Review
- ☐ For Your Action

Message

cc: Mr. C. Cortland Hooper
Dr. Glory Ludwick

GEOSCIENCE Support Services Incorporated

Ground Water Resources Development

Tel: (909) 920-0707 FAX: (909) 920-0403

DOCUMENT TRANSMITTAL

VIA US MAIL

To: Mr. C. Cortland Hooper
Old Woman Springs, Inc.

From: Dennis E. Williams, Ph.D.

Date: Wed, Mar 10, 1993

Subject: Old Woman Springs Ranch

Number	Description
1	Riparian/Wetland Statement - Old Woman Springs Ranch

The Above Items Are Submitted

☐ At Your Request
☐ For Your Files
☐ For Your Information
☒ For Your Review
☐ For Your Action

Message

cc: Debbie Cummins/Warner Engineering
Dr. Glory Ludwick/Old Woman Springs, Inc.

GEOSCIENCE Support Services Incorporated

Ground Water Resources Development

Tel: (909) 920-0707 FAX: (909) 920-0403

2/93

DOCUMENT TRANSMITTAL

To: Dr. Glory Ludwick
Old Woman Springs, Inc.

VIA US MAIL

From: Dennis E. Williams, Ph.D.

Date: Wed, Mar 10, 1993

Subject: Old Woman Springs Ranch

Number	Description
1	Riparian/Wetland Statement - Old Woman Springs Ranch
1	Invoice for Work Performed on Old Woman Springs, Inc.

The Above Items Are Submitted

☐ At Your Request
☐ For Your Files
☐ For Your Information
☒ For Your Review
☐ For Your Action

Message

cc: Debbie Cummins/Warner Engineering (Riparian Statement Only)
Mr. C. Cortland Hooper/Old Woman Springs, Inc. (Riparian Statement Only)

GEOSCIENCE Support Services Incorporated

Ground Water Resources Development

Tel: (909) 920-0707 FAX: (909) 920-0403

2/93

GEOSCIENCE

March 10, 1993

Ms. Debbie Cummins
Warner Engineering
7245 Joshua Lane
Yucca Valley, CA 92284

Re: Riparian/Wetland Statement - Old Woman Springs Ranch

Dear Debbie:

As per your request, the following riparian/wetland statement has been prepared with regard to the Old Woman Springs Ranch located in the Johnson Valley area of San Bernardino County, California. The following statement incorporates present and future ground water hydrologic processes and focuses on the following three points:

1. Occurrence and movement of ground water through aquifer systems in the area;
2. Origin of springs and sources of natural recharge water to the ranch ponds,
3. Relationship of natural spring discharge to proposed future ground water extraction.

1.0 OCCURRENCE AND MOVEMENT OF GROUND WATER THROUGH AQUIFER SYSTEMS IN THE AREA

The Old Woman Springs Ranch is located in the northern flood plain of the San Bernardino Mountains of Southern California. Specifically, the Ranch lies within Johnson Valley east of Lucerne Valley in San Bernardino County. Late Tertiary to Recent sedimentary and volcanic strata unconformably overlie Plutonic and Metamorphic Basement Rocks. The Old Woman Springs fault transects the area in a northwest to southeast direction. In the vicinity of the fault, geologic formations have been offset creating a barrier to ground water flow.

Aquifers in the area consist of a sequence of basalt, continental deposits (Old Woman Sandstone), and weathered and fractured zones within the upper surface of the bedrock. Ground water flows from the mountainous recharge areas through both primary and secondary porosity features in the sandstone, basalt, and upper weathered surface of the granitic bedrock. Flow is generally northeasterly following the same direction as the slope of the land. Estimates of the amount of natural recharge flowing through aquifers in the ranch area range between approximately 4,000 to 10,000 acre-ft/yr.

2.0 ORIGIN OF SPRINGS AND SOURCES OF NATURAL RECHARGE WATER TO THE RANCH PONDS

The occurrence of the springs in the vicinity of the Old Woman Springs Ranch area is the result of high permeability formations (e.g. basalt, sandstone and fractured bedrock) being truncated against lower permeability alluvium. Ground water moving in a southwest to northeast direction encounters a "barrier" effect (in the fault zone) and is forced near the surface in order to create the necessary hydraulic head to maintain flow. Springs result when the water table contacts the land surface near the fault escarpment. All springs found in the area occur at or near the Old Woman Springs Fault.

Discharge from the springs provides recharge to two large ponds found in the ranch area. One pond is located north of the ranch house and the other pond lies southeast of the house. The "Main Spring" is located above the southern pond in an excavated ravine where ground water flows from fissures in a basalt cliff into a small man made pond. An 8 in. diameter pipe conveys water by gravity flow from the Main Spring area to the lower ranch ponds. The discharge from the main spring (through the 8 in. pipe) has been measured as approximately 216,000 gallons per day (gpd). A portion of this amount (approximately 20,000-30,000 gpd), is required to maintain the two ranch ponds. Water from the Main Spring in excess of that required to maintain pond levels (i.e. overflow), flows northerly and seeps into the alluvium of Johnson Valley.

3.0 RELATIONSHIP OF NATURAL SPRING DISCHARGE TO PROPOSED FUTURE GROUND WATER EXTRACTION

Ground water extraction is planned from several wells which will be located upgradient from the Old Woman Springs fault zone. The wells will produce water from a combination of basaltic, sandstone and fractured bedrock aquifers.

The ground water management plan for the Old Woman Springs Ranch includes an operational scheme with annual ground water production well below "Safe Yield Levels." Total production from aquifers in the area will be regulated by distribution of pumping (i.e. variation in individual well operational schedules) such that the natural outflow from the Main Spring will not be degraded below that necessary to maintain supply to the two ranch ponds.

To accomplish this, ground water levels and spring flows will be continuously monitored during pumping periods and appropriate action taken to prevent excessive lowering of ground water levels or decline in spring flows. For example, Well TH-1 which was constructed in the vicinity of the Main Spring, will provide a supplemental supply, should outflow from the Main Spring drop below minimum amounts required to maintain the ponds within historic levels.

Thus, the proposed ground water management plan will ensure that the historic flow regime of the two ranch ponds will be maintained both in quantity and quality during future ground water development operations.

Sincerely,

Dennis E. Williams, Ph.D.
President

DEW:te

cc: Mr. C. Cortland Hooper
Dr. Glory Ludwick