

# Native Spring Investigation Data Report

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# Naval Air Weapons Station China Lake

## FOREWORD

The research described in this report was performed at the Naval Air Weapons Station (NAWS) China Lake as part of a native springs investigation conducted during fiscal year (FY) 94. This report documents the data collection and results of water quality, geologic mapping, and aerial resistivity properties for each of 31 native springs investigated.

This work was performed in accordance with NAWS Contract No. N60530-90-D-0071, Delivery Order No. 0020. The results of this report were reviewed for technical accuracy by Thomas Campbell and are final in nature. This report is approved for public release with unlimited distribution.

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## INTRODUCTION

A series of native springs in the Indian Wells Valley were investigated by the NAWS China Lake Environmental Project Office during FY94 to gather baseline geophysical and geological data. Thirty-one native springs (Table 1) located in the north and south test ranges (Figures 1 and 2) at NAWS China Lake were sampled for water quality. Air photographs of each spring site were taken for geohydrologic interpretation, and the location of each spring was surveyed for its aerial resistivity properties and geologic mapping.

Springs were selected for investigation by their importance as a water resource for the following:

1. Usage by facilities located in remote areas
2. Usage by grazing cattle in remote areas
3. Wildlife usage
4. Feral horse and burro usage

Results from this investigation will be used as a resource for the FY95 NAWS China Lake Spring Management Plan.

## DATA COLLECTION

### WATER CHEMISTRY/ISOTOPIC COMPOSITION

Water samples were collected from each native spring and analyzed for isotopic composition (oxygen 16:18 ratios, tritium, and deuterium), methylene blue active substances (MBAS), pH, specific conductance, total filterable residue, and general mineral content as follows:

- |                 |                |                   |
|-----------------|----------------|-------------------|
| •Aluminum       | •Arsenic       | •Barium           |
| •Bicarbonate    | •Boron         | •Bromide          |
| •Cadmium        | •Calcium       | •Carbonate        |
| •Chloride       | •Copper        | •Fluoride         |
| •Hydroxide      | •Iron          | •Lead             |
| •Lithium        | •Magnesium     | •Manganese        |
| •Mercury        | •Nitrates      | •Potassium        |
| •Selenium       | •Silica        | •Silver           |
| •Sodium         | •Sulfate       | •Total Alkalinity |
| •Total Anions   | •Total Cations | •Total Chromium   |
| •Total Hardness | •Zinc          |                   |

Field measurements of pH were recorded with a Hanna pH meter, calibrated at least twice a day using two standard reference solutions. Conductivity was measured with a YSI 3000 TLC meter, calibrated daily. Conductivity and pH readings measured in the field are more accurate representations of existing conditions because bacterial reactions in the sample bottles may occur, which can change the pH readings. A field thermometer was used to record the temperature of each native spring.

Water analyses are presented in Table 2. The important mineral species and isotope compositions of each native spring are graphically highlighted in Appendix A. Spring locations are identified by their assigned number (Table 1), and constituents are reported in milligrams per liter (mg/L). Maximum contaminant levels (MCL) are designated on mineral species with applicable state and federal standards.

## RESISTIVITY SURVEYS

Direct current resistivity measurements were completed at 10 spring locations to provide subsurface information that will aid in the interpretation of structural and geohydrologic features that may control the occurrence of each spring.

The surveys were completed with an ABEM Terrameter 300B and several standard electrode arrays. Gradient arrays were set at 800-foot-current electrode separations. A roving receiver dipole was used to map out the areas in between these separations. This array was useful as a "contact finder" in locating features such as basement dikes. Schlumberger depth soundings were used to investigate layering beneath a specific site, such as a water table. Schlumberger profiling was completed by moving a fixed-spacing array along a line of investigation, such as a canyon bottom.

Results of each survey are graphically described as "apparent resistivity" and as graphic symbols superimposed on aerial photographs of the springs. Notations from the survey are included on each graph, such as geographic locations and changes in rock and/or soil types. In the photographic presentations, the width of each profile symbol is proportional to resistivity, thus allowing the reader to correlate resistivity anomalies with features such as joints and faults that are not visible on the United States Geological Survey topographic maps. Plates displaying aerial photographs with resistivity lines superimposed on them are presented in Appendix B.

## GEOLOGIC MAPS

Depending on the individual characteristics and aerial extent of each spring, geologic maps were constructed using the following scales:

1. 1 inch equals 50 feet
2. 1 inch equals 100 feet
3. 1 inch equals 150 feet
4. 1 inch equals 200 feet

Aerial stereographic and ground photographs were used in mapping each spring site. The negative scales for the types of films used are as follows:

1. Stereo-imagery in false-color infrared flown at low altitudes: 1 inch equals 300 feet.
2. True-color aerial color film at slightly higher altitudes: 1 inch equals 600 feet.
3. High-altitude false-color photographs: 1 inch equals 1600 feet.

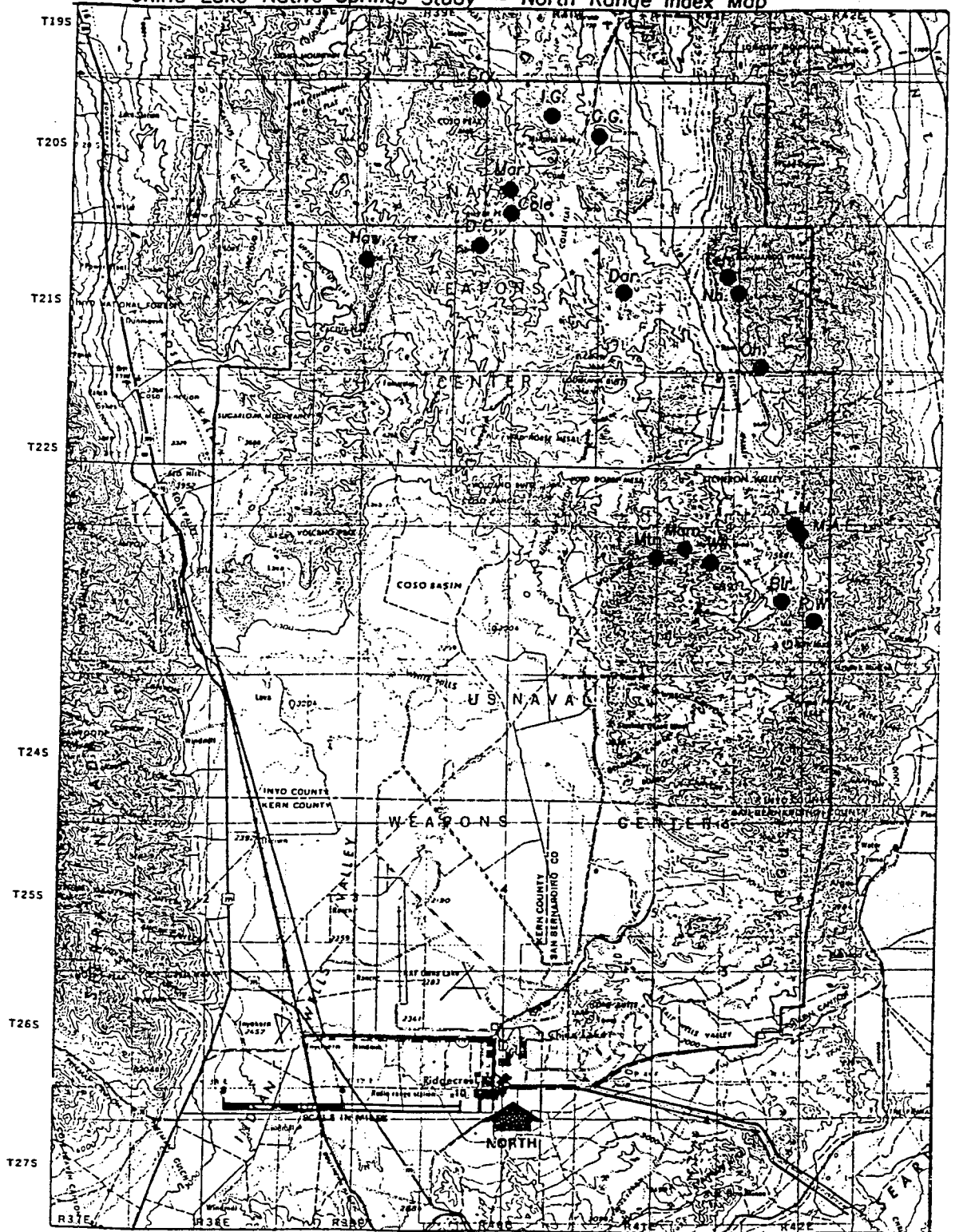
These high-altitude prints, which became available late in the investigation, were extremely useful in providing a more even exposure in areas of steep slopes and deep canyons as a result of higher sun angles.

Each photograph was enlarged with a laser color copier for field use and a digital scanner for computer work. Raster images were overlaid onto the digitized topography to furnish the correct scale and location. These combined ground and photographic interpretations were computer drafted using AutoCad Version 12 and CadOverlay GSX Version 2 to provide a final drawing of each spring site. The geologic maps are listed alphabetically by spring name in Appendix C.

TABLE 1. Spring Site Work Accomplished.

Spring no.	Spring name	Chemical analyses	Resistivity survey	Air photos	Geologic maps
1.	Amity	x	x	x	x
2.	Bircham	x	x	x	x
3.	China Gardens	x		x	x
4.	Cole	x	x	x	x
5.	Crystal	x	x	x	x
6.	Darwin	x		x	x
7.	Dead End	x		x	x
8.	Granite Wells	x		x	x
9.	Haiwee	x		x	
10.	Hidden	x		x	x
11.	Indian	x		x	x
12.	Indian Gardens	x	x	x	x
13.	Lamotte	x		x	x
14.	Layton	x		x	x
15.	Lead Pipe	x	x	x	x
16.	Mammoth Mine	x		x	x
17.	Margaret Ann	x		x	x
18.	Mariposa	x	x	x	x
19.	Mesquite	x		x	x
20.	Myrick	x		x	
21.	Newhouse	x	x	x	x
22.	N. Mountain Springs	x		x	x
23.	Old House	x	x	x	x
24.	Pink Hill	x		x	x
25.	Rudy	x		x	x
26.	Seep	x		x	x
27.	Stone Corral	x		x	x
28.	Tennessee	x	x	x	x
29.	Upper Tunnel	x		x	x
30.	Wild Rose	x		x	x
31.	Wilson Canyon	x		x	x

China Lake Native Springs Study - North Range Index Map



- |                       |                             |                             |
|-----------------------|-----------------------------|-----------------------------|
| Blr. - Blrcham        | How. - Hawiee               | Mtn. - Mountain Cyn., North |
| C.G. - China Garden   | I.G. - Indian Garden        | Nh. - Newhouse              |
| Cole - Cole           | L.M. - La Motte             | Oh. - Oldhouse              |
| Cry. - Crystal        | M.A.E. - Margaret Ann, East | R.W. - Ruby, West           |
| Dar. - Darwln         | Mam. - Mammoth Mine         | Ten. - Tennessee            |
| D.C. - Dead End Cabln | Mar. - Marliposa            | Wll. - Wlldrose             |

FIGURE 1. China Lake Native Spring Study - North Range Index Map.

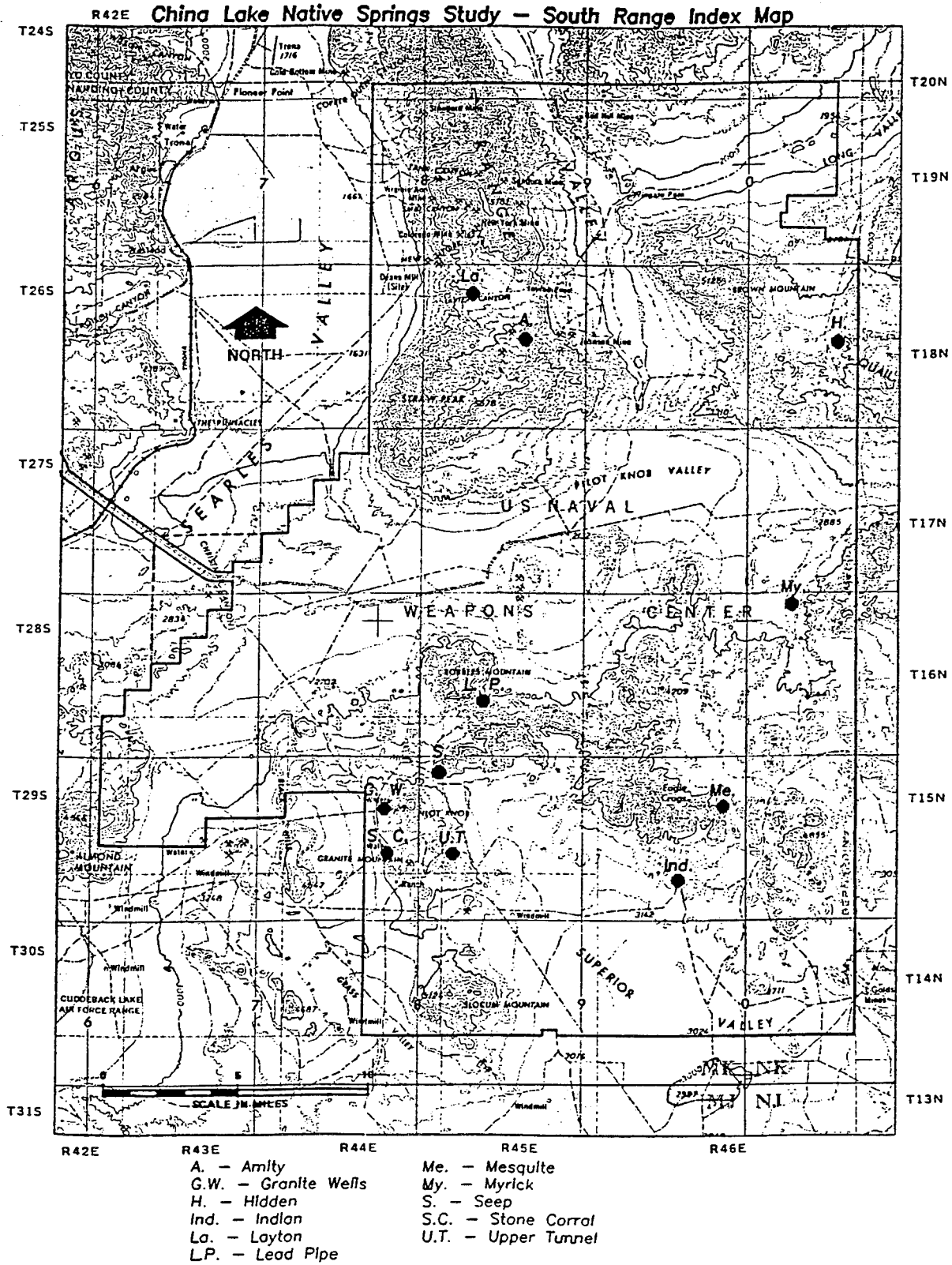


FIGURE 2. China Lake Native Spring Study - South Range Index Map.

TABLE 2. NAWS China Lake Native Spring Study Chemical Analyses.

Species Analyses	Units	China Lake/NAWS Native Spring Study											
		Amity	Bircham	China Garden	Cole	Crystal	Darwin	Dead End	Granite	Haiwee	Hidden		
Aluminum (Al)	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Arsenic (As)	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Barium (Ba)	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Bicarbonate (HCO3)	mg/L	336	238	107	183	137	183	230	244	153	207	207	207
Boron (B)	mg/L	0.3	0.2	0.2	<0.1	<0.1	<0.1	0.2	0.3	<0.1	0.4	0.4	0.4
Bromide (Br)	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Cadmium (Cd)	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Calcium (Ca)	mg/L	93	52	49	143	66	83	61	65	33	50	50	50
Carbonate (CO3)	mg/L	0	0	0	0	0	0	0	0	0	0	0	0
Chloride (Cl)	mg/L	75	27	32	38	30	33	23	42	15	51	51	51
Copper (Cu)	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Fluoride (F)	mg/L	1.1	0.2	0.1	0.2	0.1	0.2	0.3	0.7	0.4	0.8	0.8	0.8
Hydroxide (OH)	mg/L	0	0	0	0	0	0	0	0	0	0	0	0
Iron (Fe)	mg/L	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Lead (Pb)	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Lithium (Li)	mg/L	0.02	<0.01	<0.01	<0.01	<0.01	0.01	0.1	0.03	0.03	0.03	0.03	0.03
Magnesium (Mg)	mg/L	31	14	15	46	11	15	12	9	16	16	16	16
Manganese (Mn)	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Niobas	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Mercury (Hg)	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Nitrate (NO3)	mg/L	24	8	6	4	1	4	<0.1	37	<0.1	<0.001	<0.001	<0.001
pH - lab	pH units	7.8	8.0	8.0	7.5	7.8	7.8	7.4	7.9	8	7.4	7.9	7.9
pH - field	pH units	7.5	7.4	7.7	7.2	7.4	7.2	6.8	7.3	7.8	7.4	7.4	7.4
Potassium (K)	mg/L	3	3	6	4	5	3	2	2	5	7	7	7
Selenium (Se)	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Silica (SiO2)	mg/L	36	32	41	30	30	41	36	58	60	73	73	73
Silver (Ag)	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Sodium (Na)	mg/L	61	28	32	40	18	35	33	59	27	59	59	59
Specific Conductance - lab	µmho/cm	880	460	520	1080	520	670	500	680	410	630	630	630
Specific Conductance - field	µmho/cm	962	480	493	1155	521	675	537	676	418	678	678	678
Sulfate (SO4)	mg/L	100	19	120	430	67	140	40	53	63	57	57	57
Total Alkalinity as CaCO3	mg/L	275	195	88	150	113	150	205	200	135	170	170	170
Total Anions	me/L	10.14	5.20	5.24	13.10	5.08	6.92	5.60	6.92	4.25	6.75	6.75	6.75
Total Cations	me/L	9.96	5.07	5.24	12.82	5.13	7.00	5.53	6.62	4.28	6.58	6.58	6.58
Total Chromium (Cr)	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Total Filterable Residue	mg/L	610	295	375	820	315	520	330	440	285	455	455	455
Total Hardness as CaCO3	mg/L	362	188	185	549	211	270	203	200	149	192	192	192
Zinc (Zn)	mg/L	<0.01	<0.01	<0.01	0.01	<0.01	0.02	0.04	<0.01	<0.01	<0.01	<0.01	<0.01
Isotope Analyses													
Tritium	T. units	1.0	<1.7	<0.7	<1.1	<0.7	0.7	1.4	<1.2	1.4	<1.5	<1.5	<1.5
Statistical significance		±0.3			App. 0.4		±0.3	±0.4	App. 0.6	±0.4	±0.4	±0.4	±0.4
Deuterium	%SMOW	-82	-91	-98	-94	-103	-95	-92	-83	-93	-84	-84	-84
Oxygen 18	%SMOW	-11.5	-12.1	-13.0	-12.8	-13.9	-13.2	-12.7	-10.6	-9.8	-9.8	-9.8	-9.8

TABLE 2. (Contd.)

Species Analyses	Units	China Lake NAWS Native Spring Study											
		Indian	Indian Garden	La Motte	Layton	Lead Pipe	Mammoth Mine	Margaret Ann - E.	Mariposa	Mesquite	Myrick		
Aluminum (Al)	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Arsenic (As)	mg/L	<0.005	<0.005	<0.005	<0.005	0.018	<0.005	<0.005	0.013	<0.005	<0.005	0.11	<0.1
Barium (Ba)	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Bicarbonate (HCO3)	mg/L	107	122	290	366	122	302	427	326	153	1530	1530	1530
Boron (B)	mg/L	0.2	0.2	<0.1	<0.1	<0.1	<0.1	0.4	0.1	0.1	3.6	<0.1	<0.1
Bromide (Br)	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.003	<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium (Cd)	mg/L	18	68	67	114	26	64	175	255	35	10	10	10
Carbonate (CO3)	mg/L	0	0	0	0	0	0	0	0	0	0	0	0
Chloride (Cl)	mg/L	26	32	36	200	37	40	64	54	26	200	200	200
Copper (Cu)	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.03
Fluoride (F)	mg/L	0.3	0.2	0.4	1.6	0.5	0.3	0.8	0.4	0.4	0.4	0.4	0.4
Hydroxide (OH)	mg/L	0	0	0	0	0	0	0	0	0	0	0	0
Iron (Fe)	mg/L	<0.02	<0.02	<0.02	<0.02	<0.02	0.02	<0.02	<0.02	<0.02	<0.02	1.8	1.8
Lead (Pb)	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.006	0.006
Lithium (Li)	mg/L	0.02	<0.01	<0.01	0.06	0.06	<0.01	0.01	<0.01	0.02	0.11	0.11	0.11
Magnesium (Mg)	mg/L	9	18	18	40	4	16	45	46	8	8	8	8
Manganese (Mn)	mg/L	<0.01	<0.01	0.03	<0.01	<0.01	0.43	<0.01	0.11	<0.01	<0.01	<0.01	<0.01
Niobium (Nb)	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Nitrate (NO3)	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
pH - lab	pH units	22	<1	<1	25	13	<1	<1	<1	<1	<1	29	<1
pH - field	pH units	7.8	7.8	8.1	7.7	7.7	7.7	7.8	7.4	7.7	7.7	7.7	7.7
Potassium (K)	mg/L	8.1	7.5	8.0	7.4	7.0	7.4	7.7	6.9	7.4	7.4	7.4	7.4
Selenium (Se)	mg/L	7	6	2	2	6	6	4	4	6	6	6	6
Silica (SiO2)	mg/L	<0.005	<0.005	<0.005	0.006	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Silver (Ag)	mg/L	100	36	41	32	103	32	42	64	92	66	66	66
Sodium (Na)	mg/L	36	39	38	222	55	47	95	45	36	860	860	860
Specific Conductance - lab	µmho/cm	340	670	560	1510	420	600	1400	1530	420	3500	3500	3500
Specific Conductance - field	µmho/cm	362	672	636	1188	449	673	1449	1557	427	3450	3450	3450
Sulfate (SO4)	mg/L	30	190	41	330	46	43	390	560	27	250	250	250
Total Alkalinity as CaCO3	mg/L	88	100	238	300	100	248	350	268	125	1390	1390	1390
Total Anions	me/L	3.48	6.87	6.63	18.99	4.24	7.00	16.97	18.56	4.28	38.97	38.97	38.97
Total Cations	me/L	3.40	6.75	6.55	18.73	4.17	6.72	16.73	18.64	4.14	38.76	38.76	38.76
Total Chromium (Cr)	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Total Filterable Residue	mg/L	300	500	390	1130	355	395	1010	1360	330	2320	2320	2320
Total Hardness as CaCO3	mg/L	83	245	243	452	82	227	625	829	121	38	38	38
Zinc (Zn)	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Isotope Analyses													
Tritium	T. units	1.0	<1.1	<1.0	3.1	0.9	<1.1	2.9	0.9	0.8	<0.8	<0.8	<0.8
Statistical significance													
Deuterium	%SMOW	±0.4	App. 0.4	App. 0.4	±0.4	App. 0.4	App. 0.4	±0.4	±0.3	±0.4	±0.4	±0.4	±0.4
Oxygen 18	%SMOW	-12.4	-12.9	-12.0	-10.1	-12.1	-10.8	-11.3	-12.9	-10.5	-10.5	-10.5	-10.5

TABLE 2. (Contd.)

China Lake NAWS Native Spring Study

CHEMICAL ANALYSES

Species Analyses	Units	New House	North Mountain	Old House	Pink Hill	Ruby - west	Seep	Stone Corral	Tennessee	Upper Tunnel
Aluminum (Al)	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Arsenic (As)	mg/L	<0.005	<0.005	<0.005	0.006	<0.005	0.016	<0.005	<0.005	<0.005
Barium (Ba)	mg/L	<0.1	<0.1	<0.1	<0.1	0.3	<0.1	<0.1	<0.1	<0.1
Bicarbonate (HCO3)	mg/L	137	439	183	174	357	76	195	153	183
Boron (B)	mg/L	<0.1	0.6	<0.1	0.3	0.3	0.3	0.2	<0.1	0.1
Bromide (Br)	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Cadmium (Cd)	mg/L	<0.001	<0.001	<0.001	<0.001	0.002	<0.001	<0.001	<0.001	<0.001
Calcium (Ca)	mg/L	44	113	59	3	86	21	69	51	72
Carbonate (CO3)	mg/L	0	0	0	0	0	0	0	0	0
Chloride (Cl)	mg/L	14	93	16	37	36	24	33	26	41
Copper (Cu)	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Fluoride (F)	mg/L	<0.1	0.4	0.1	0.4	0.2	0.5	0.6	0.2	0.6
Hydroxide (OH)	mg/L	0	0	0	0	0	0	0	0	0
Iron (Fe)	mg/L	<0.02	0.04	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Lead (Pb)	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Lithium (Li)	mg/L	<0.01	<0.01	<0.01	0.09	<0.01	0.02	0.01	<0.01	0.02
Magnesium (Mg)	mg/L	4	30	9	<1	17	4	8	5	11
Manganese (Mn)	mg/L	<0.01	0.22	<0.01	0.01	0.06	<0.01	<0.01	<0.01	<0.01
MIBAS	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05
Mercury (Hg)	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Nitrate (NO3)	mg/L	2	<1	<1	19	<1	16	46	<1	34
pH - lab	pH units	8.1	7.7	8.2	8.1	7.4	8.1	8.0	8.0	7.9
pH - field	pH units	7.6	7.3	7.8	7.3	7.3	7.7	7.4	7.7	7.5
Potassium (K)	mg/L	2	8	1	4	2	6	<1	3	2
Selenium (Se)	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Silica (SiO2)	mg/L	21	47	24	64	55	109	45	24	32
Silver (Ag)	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Sodium (Na)	mg/L	17	83	19	112	47	37	40	24	43
Specific Conductance - lab	µmho/cm	330	1040	440	480	720	340	600	420	670
Specific Conductance - field	µmho/cm	354	1128	443	520	157	346	614	427	667
Sulfate (SO4)	mg/L	35	110	54	39	19	44	61	51	76
Total Alkalinity as CaCO3	mg/L	113	360	150	143	293	63	160	125	150
Total Anions	me/L	3.40	12.13	4.58	5.03	7.84	3.14	6.17	4.30	6.63
Total Cations	me/L	3.32	11.97	4.56	5.12	7.81	3.14	5.86	4.09	6.44
Total Chromium (Cr)	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Total Filterable Residue	mg/L	210	730	275	355	450	305	395	260	415
Total Hardness as CaCO3	mg/L	127	408	185	8	286	69	206	148	226
Zinc (Zn)	mg/L	0.04	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.030
Isotope Analyses										
Tritium	T. units	<0.7	1.4	<1.3	<0.7	<1.4	<1.1	<1.8	<1.1	0.9
Statistical significance			±0.3	App. 0.6	App. 0.6	App. 0.6	App. 0.4	App. 0.9	App. 0.5	±0.4
Deuterium	%SMOW	-97	-85	-92	-89	-88	-86	-82	-97	-76
Oxygen 18	%SMOW	-13.3	-11.9	-13.0	-11.8	-12.3	-11.6	-11.2	-13.6	-8.9

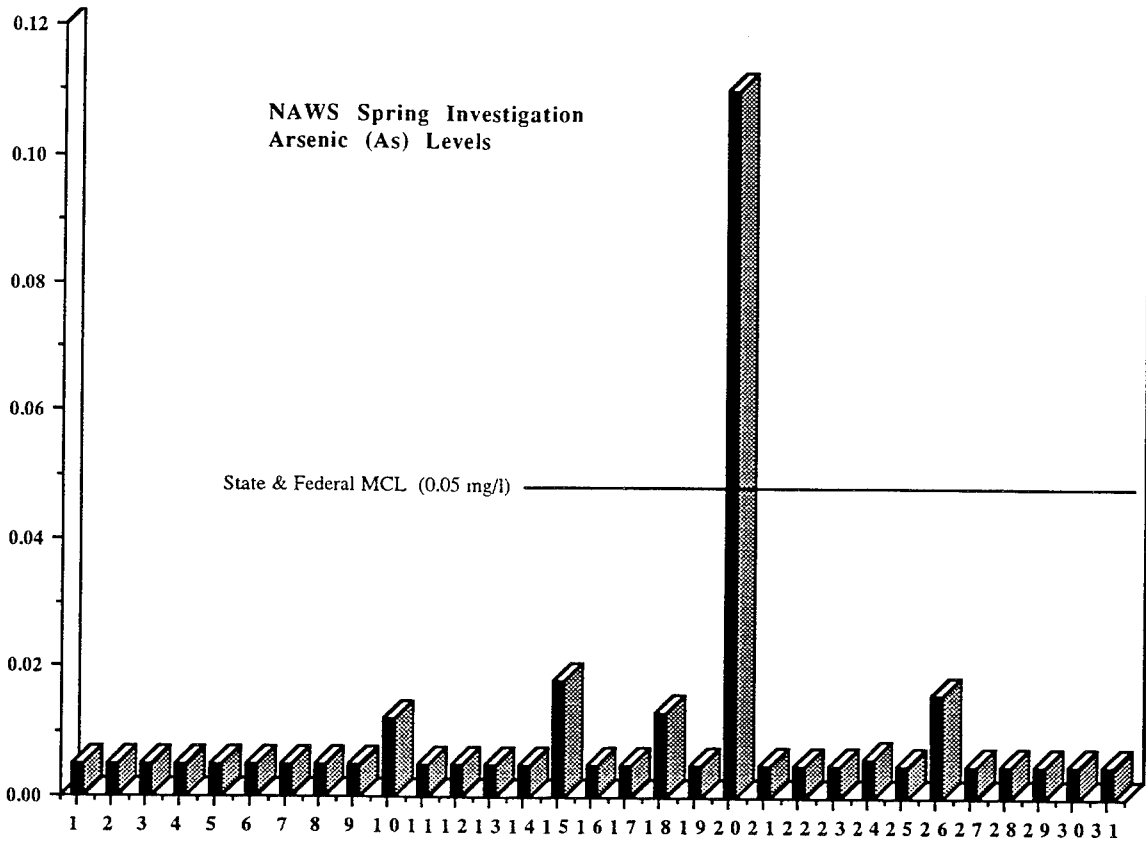
TABLE 2. (Contd.)

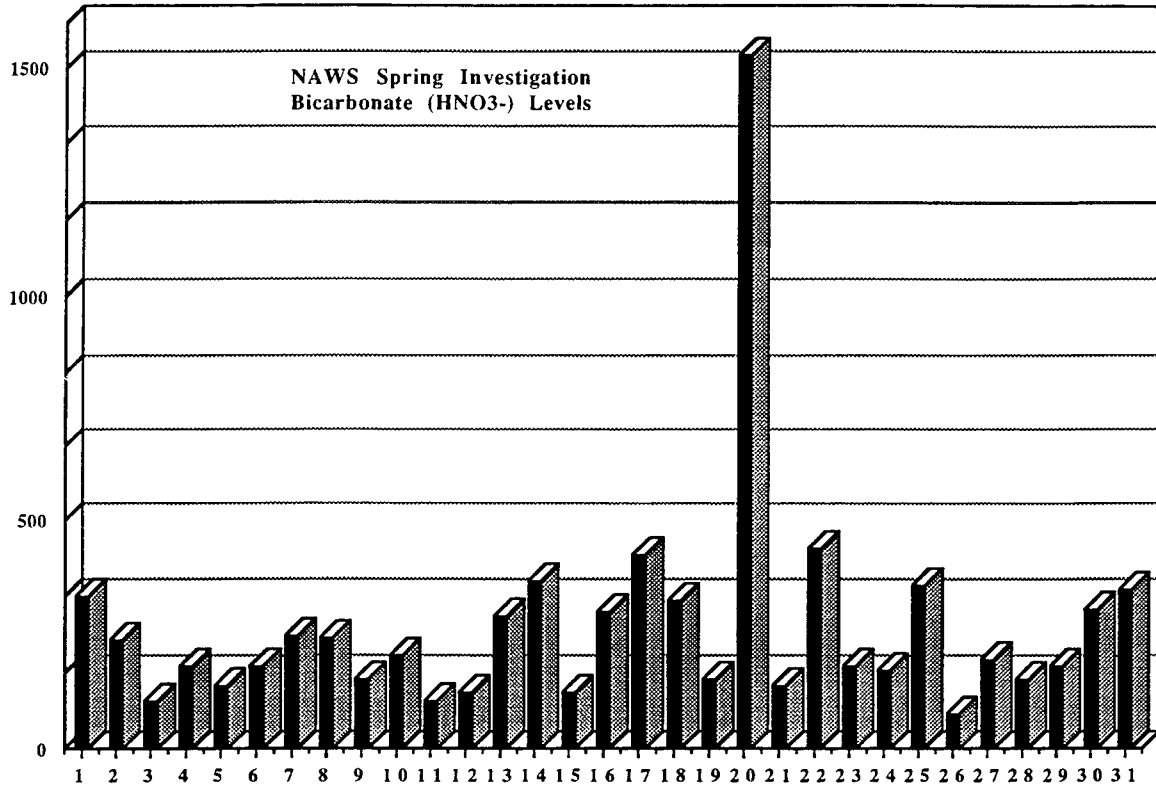
China Lake NAWS Native Spring Study

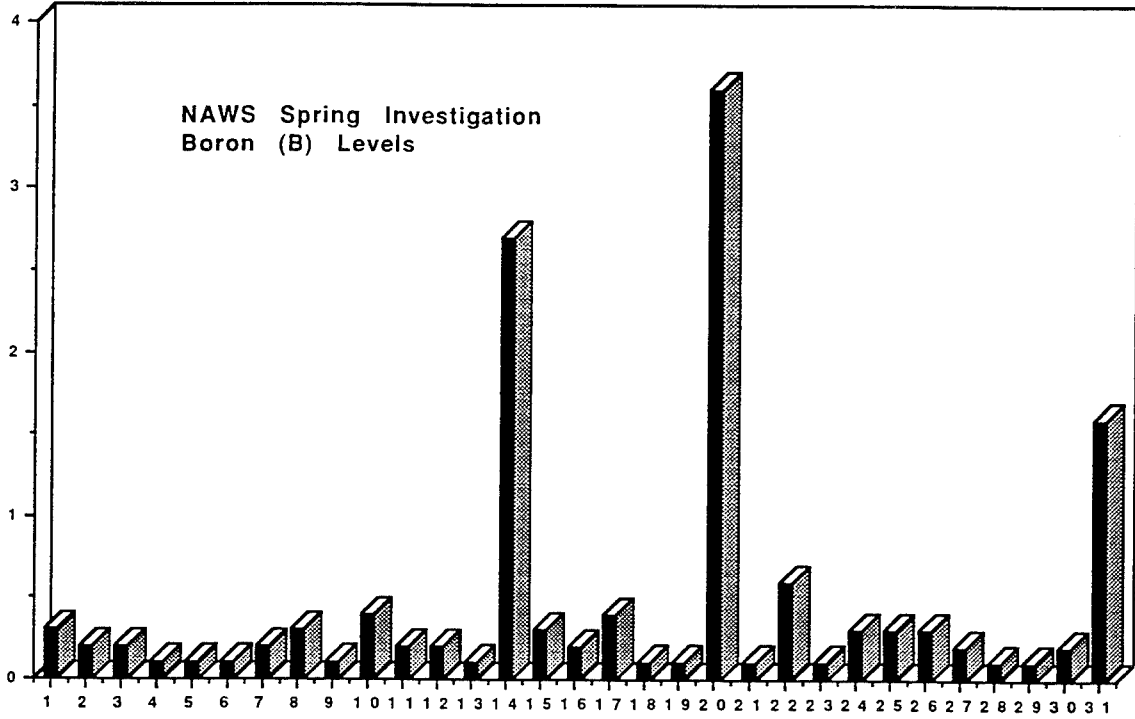
## CHEMICAL ANALYSES

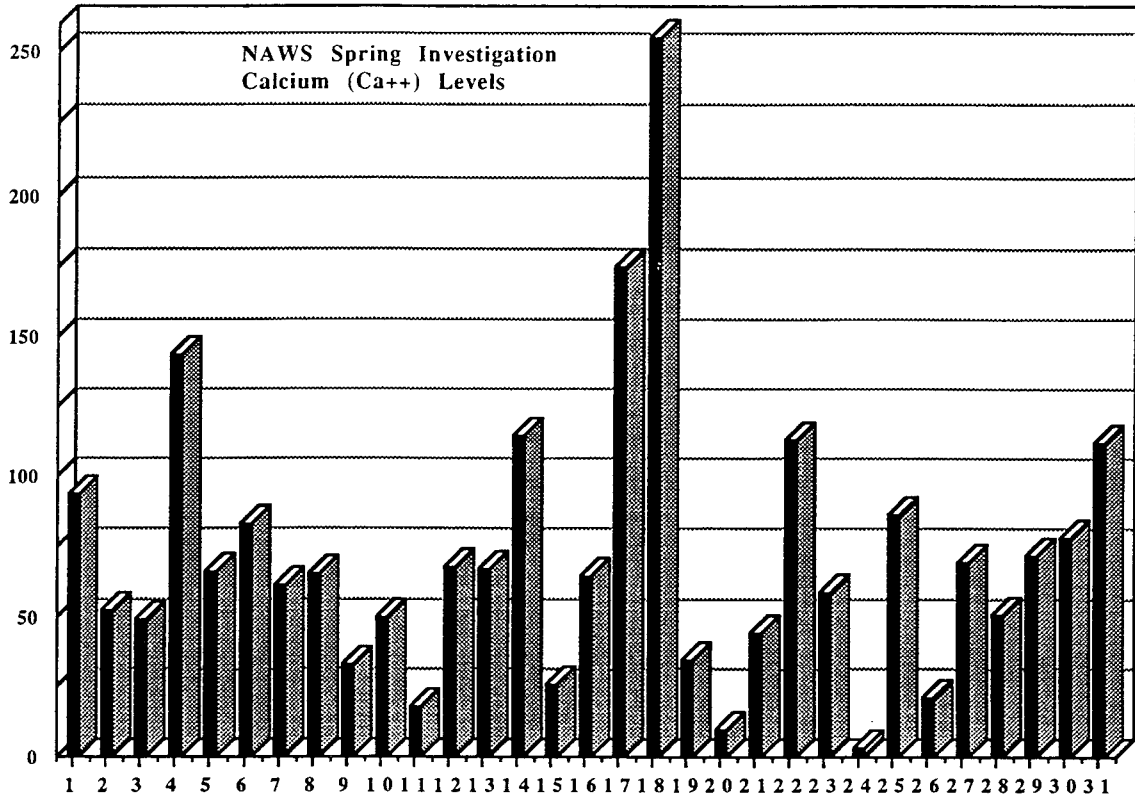
Species Analyzes	Units	Wildrose Mine	Wilson
Aluminum (Al)	mg/L	<0.05	<0.05
Arsenic (As)	mg/L	<0.005	<0.005
Barium (Ba)	mg/L	<0.1	<0.1
Bicarbonate (HCO <sub>3</sub> )	mg/L	305	348
Boron (B)	mg/L	0.2	1.6
Bromide (Br)	mg/L	<1	<1
Cadmium (Cd)	mg/L	<0.001	<0.001
Calcium (Ca)	mg/L	78	112
Carbonate (CO <sub>3</sub> )	mg/L	0	0
Chloride (Cl)	mg/L	42	260
Copper (Cu)	mg/L	<0.01	<0.01
Fluoride (F)	mg/L	0.3	0.6
Hydroxide (OH)	mg/L	0	0
Iron (Fe)	mg/L	<0.02	<0.02
Lead (Pb)	mg/L	<0.005	<0.005
Lithium (Li)	mg/L	<0.01	<0.01
Magnesium (Mg)	mg/L	18	43
Manganese (Mn)	mg/L	0.02	<0.01
NIBAS	mg/L	<0.05	<0.05
Mercury (Hg)	mg/L	<0.001	<0.001
Nitrate (NO <sub>3</sub> )	mg/L	2	4
pH - lab	pH units	7.9	8.1
pH - field	pH units	7.3	8.0
Potassium (K)	mg/L	2	6
Selenium (Se)	mg/L	<0.005	<0.005
Silica (SiO <sub>2</sub> )	mg/L	36	49
Silver (Ag)	mg/L	<0.01	<0.01
Sodium (Na)	mg/L	35	160
Specific Conductance - lab	µmho/cm	520	1450
Specific Conductance - field	µmho/cm	670	1600
Sulfate (SO <sub>4</sub> )	mg/L	43	160
Total Alkalinity as CaCO <sub>3</sub>	mg/L	250	285
Total Anions	me/L	7.13	16.44
Total Cations	me/L	6.97	16.28
Total Chromium (Cr)	mg/L	<0.01	<0.01
Total Filterable Residue	mg/L	385	1080
Total Hardness as CaCO <sub>3</sub>	mg/L	270	459
Zinc (Zn)	mg/L	<0.01	<0.01
Isotope Analyses			
Tritium	T. units	1.7	1.8
Deuterium	‰SMOW	±0.5	±0.4
Oxygen 18	‰SMOW	-92	-85
		-12.5	-10.7

Appendix A  
WATER CHEMISTRY GRAPHICS

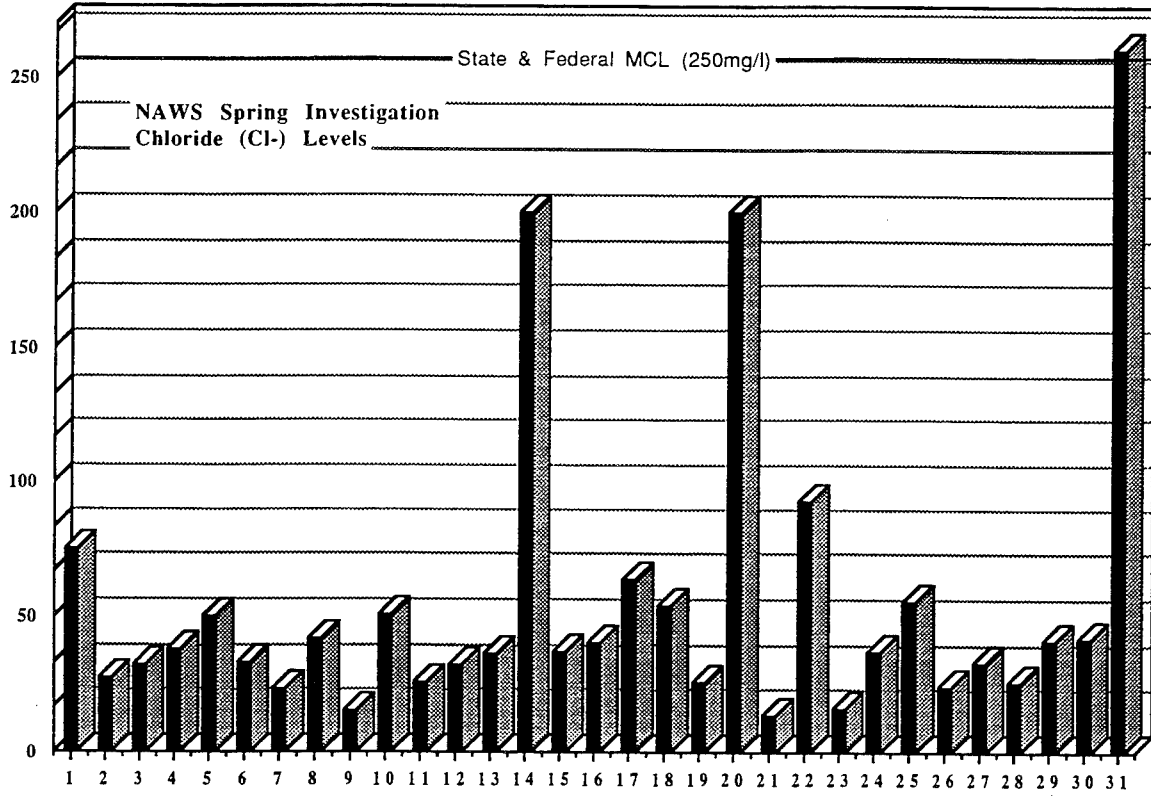


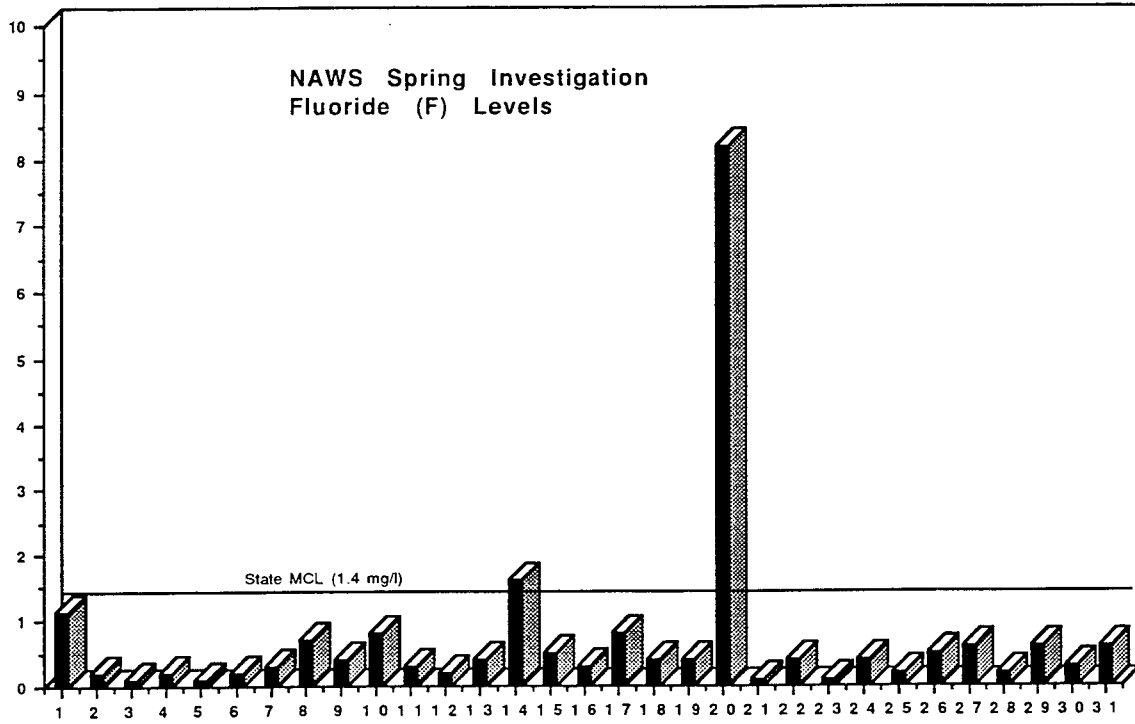


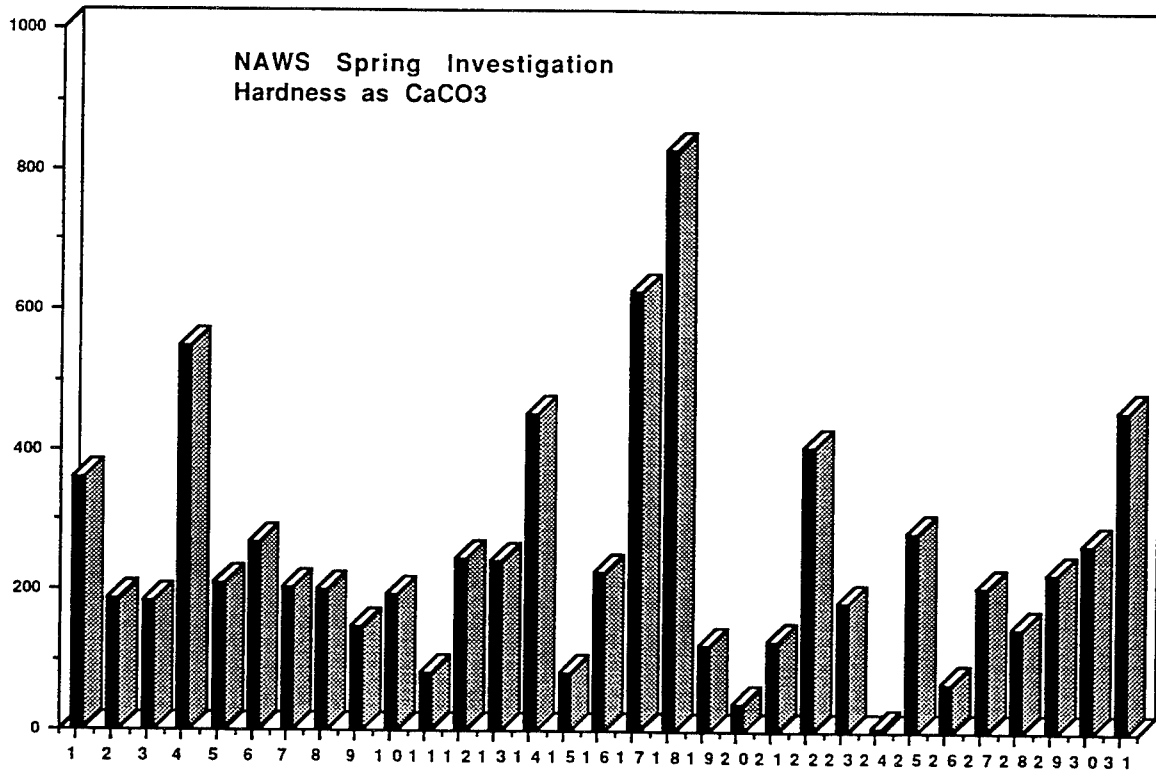


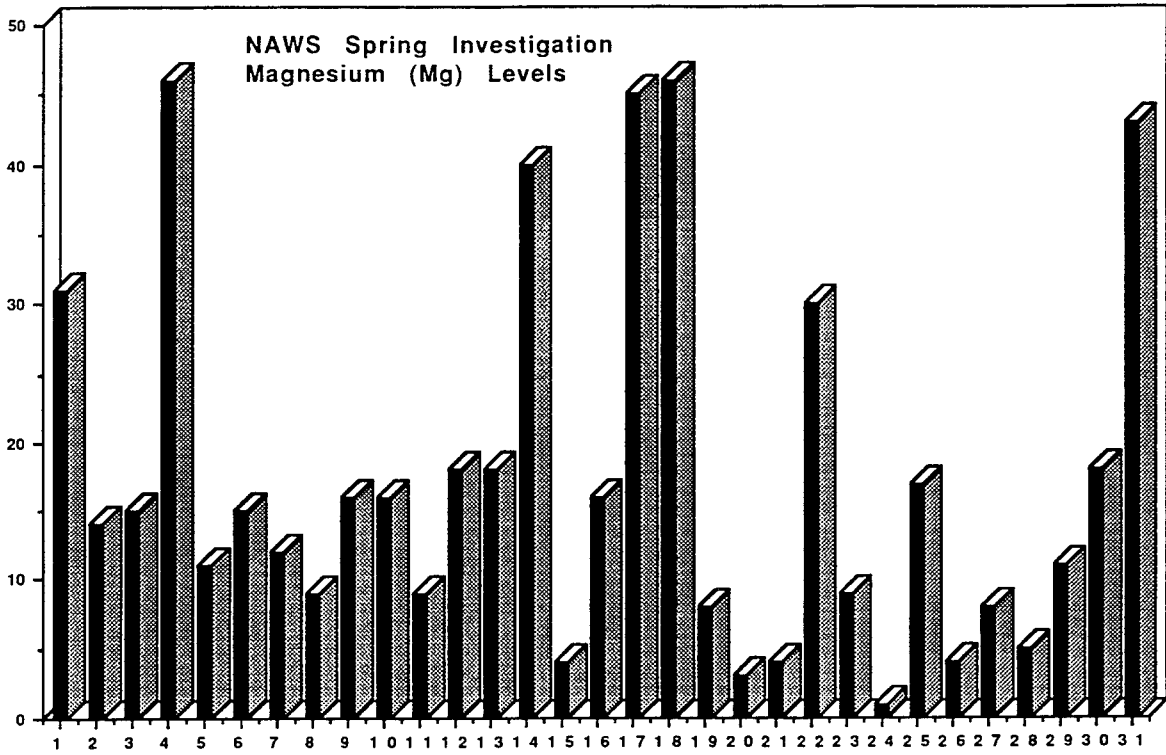


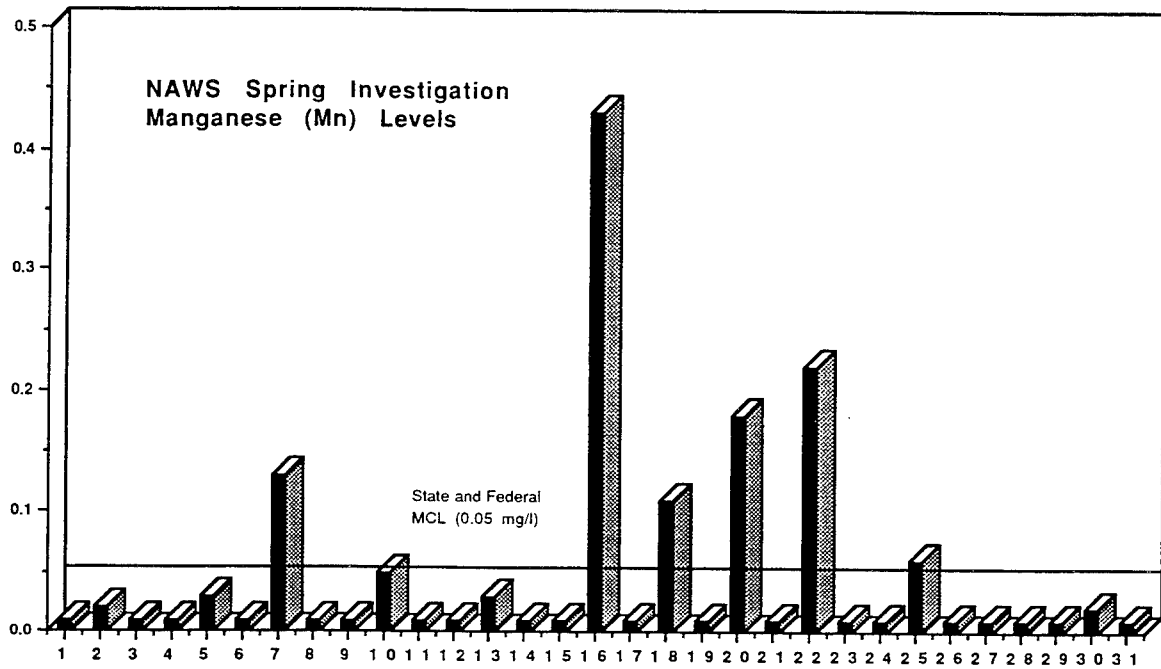
NAWS CL TP 005

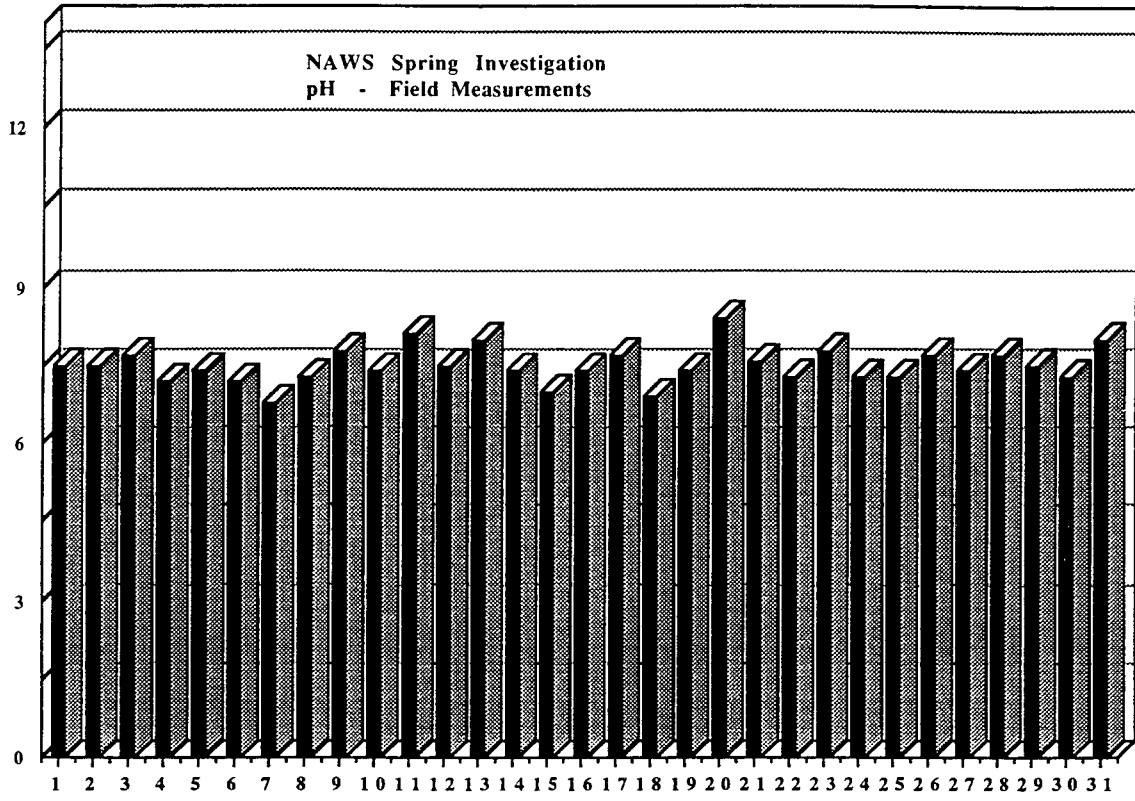


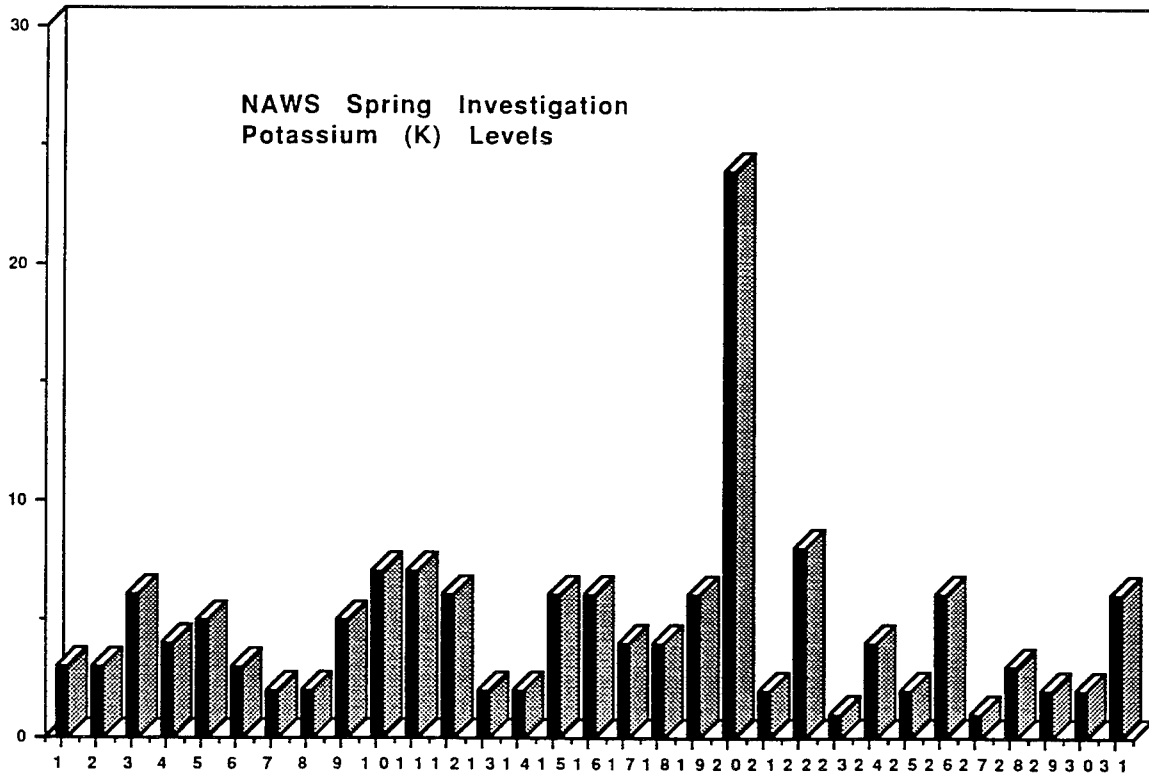


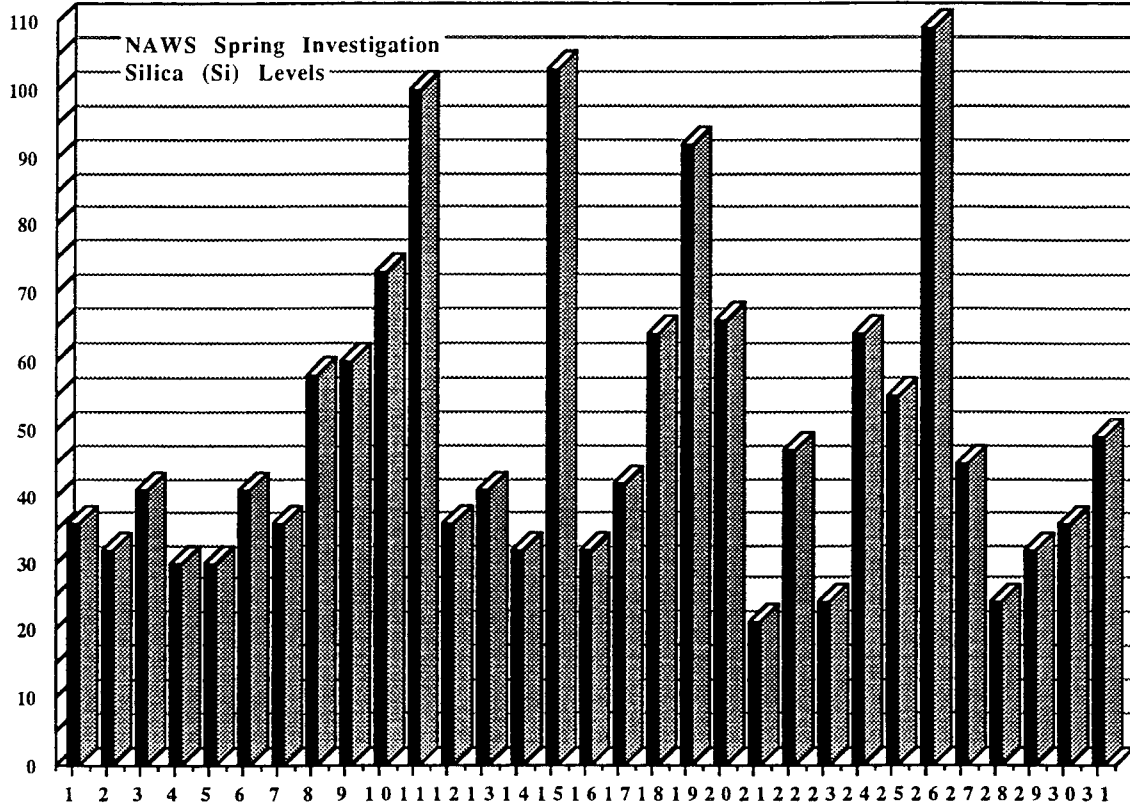


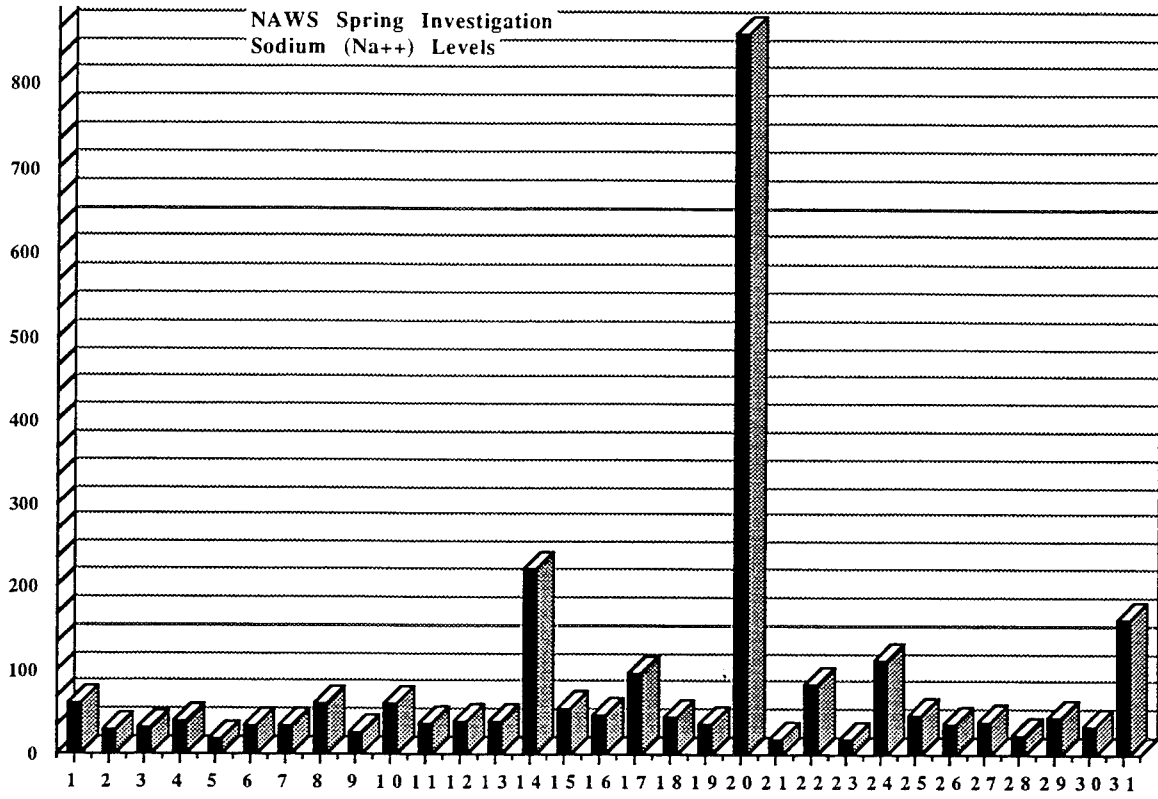


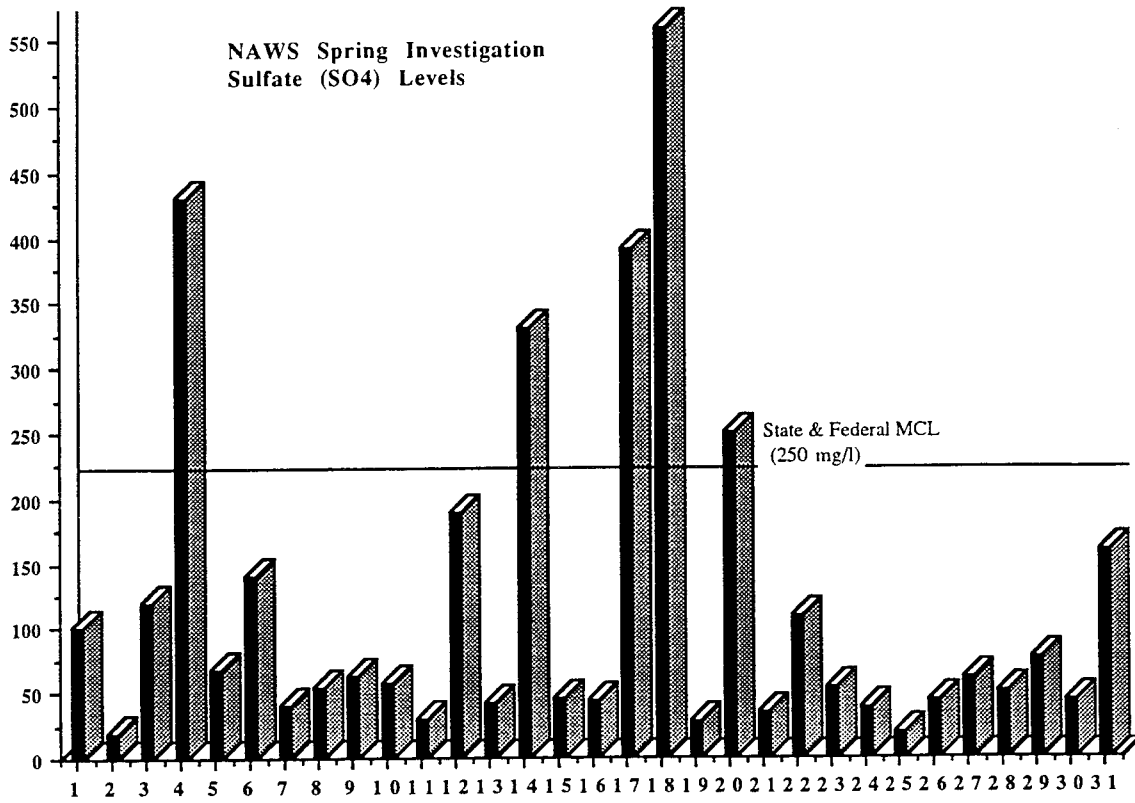


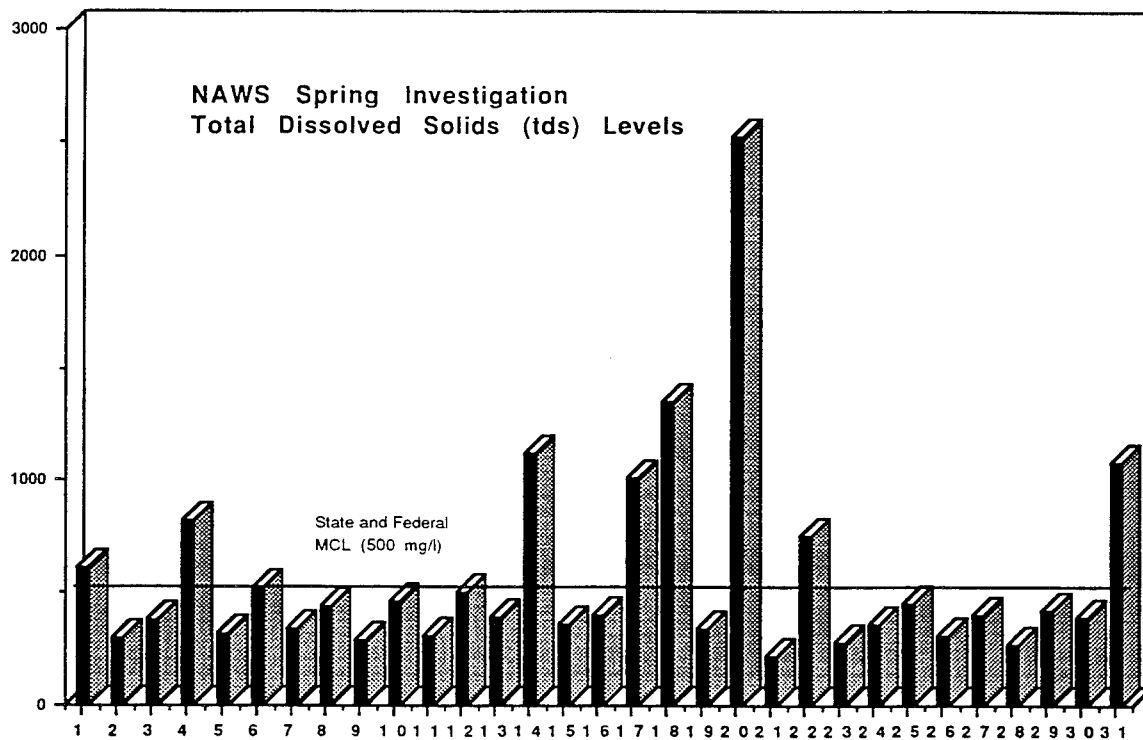


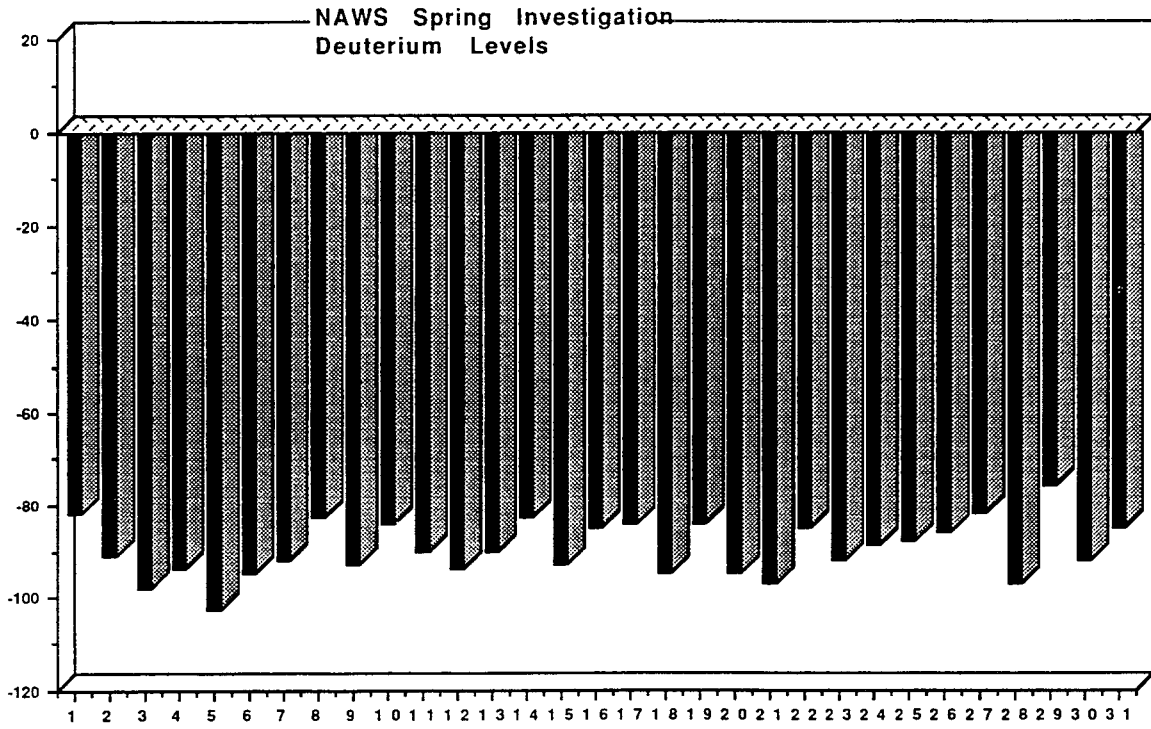


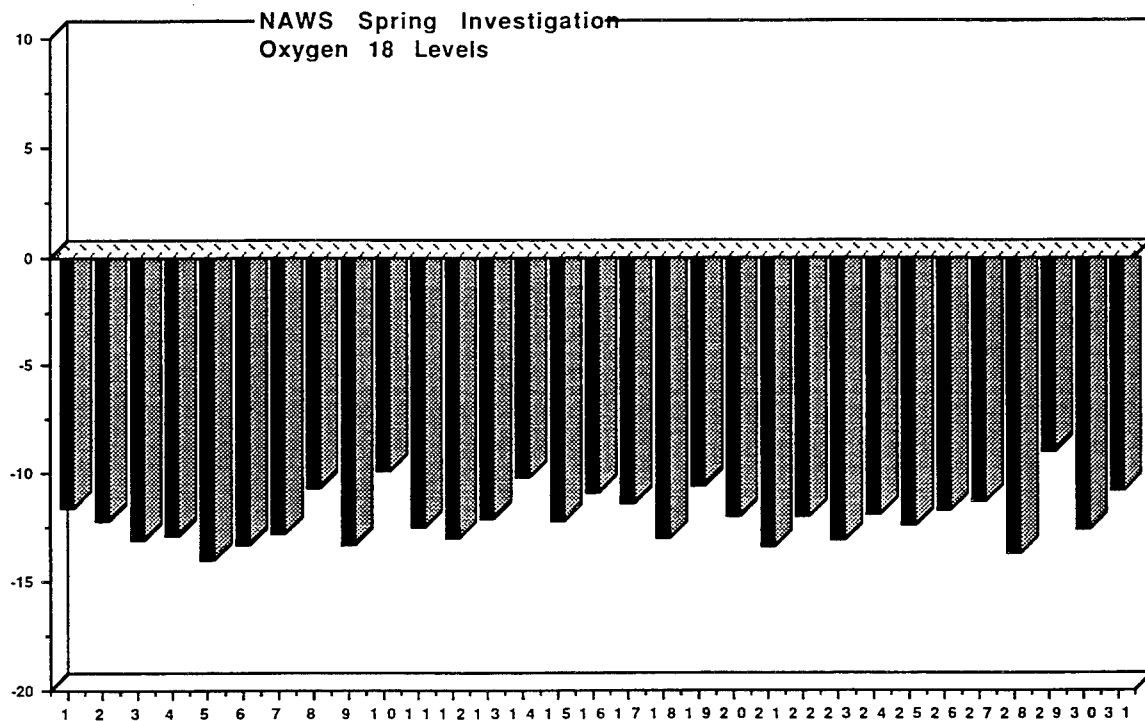


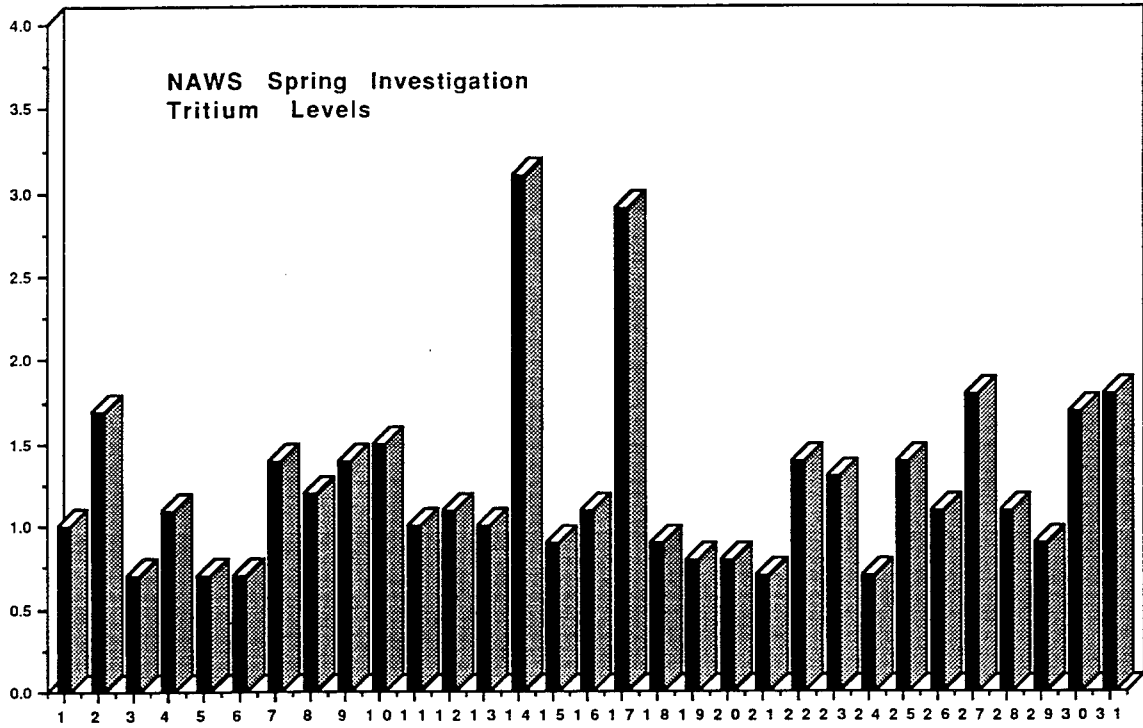




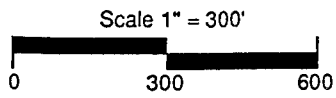
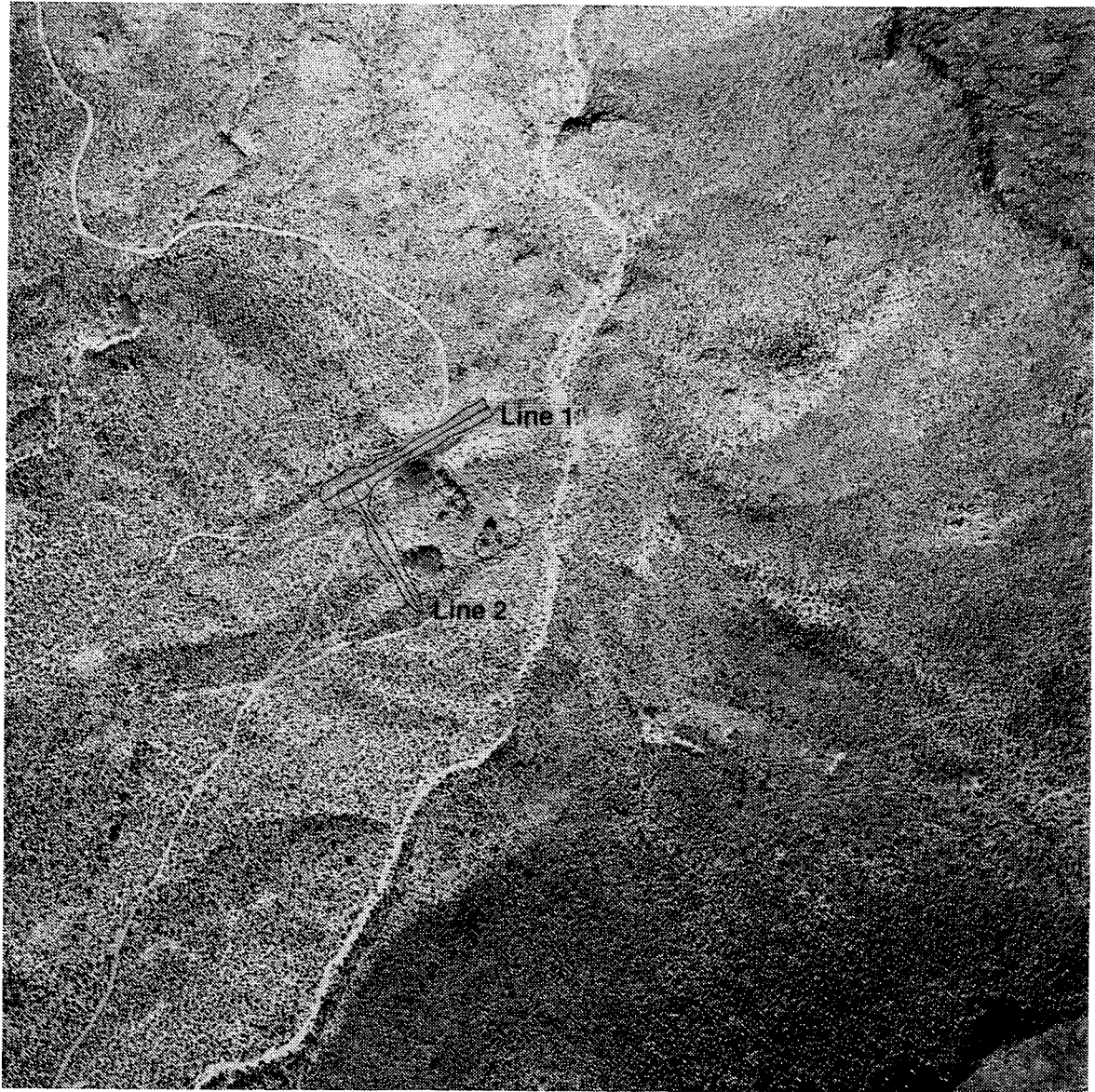






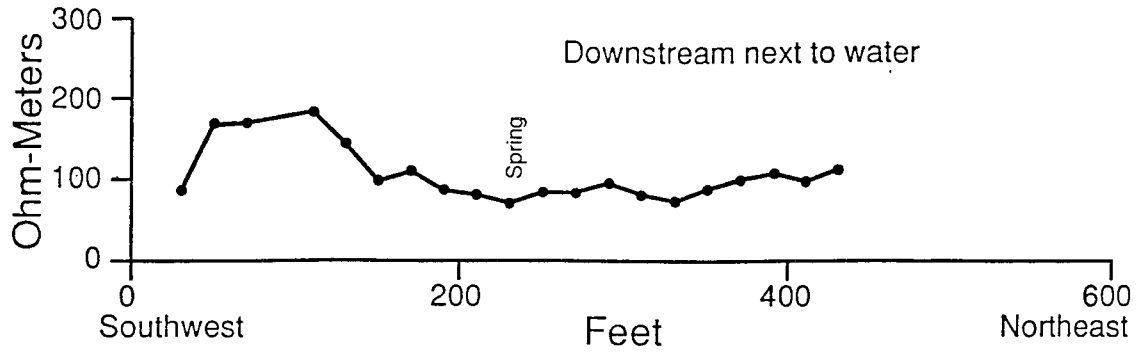


Appendix B  
SPRING RESISTIVITY SURVEYS

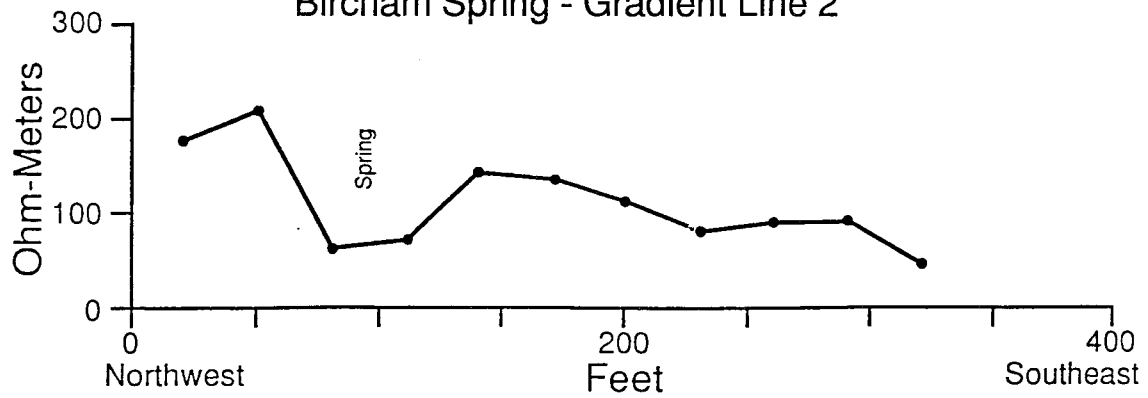


Bircham Spring — Electrical Resistivity Profiles.

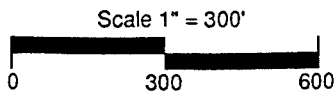
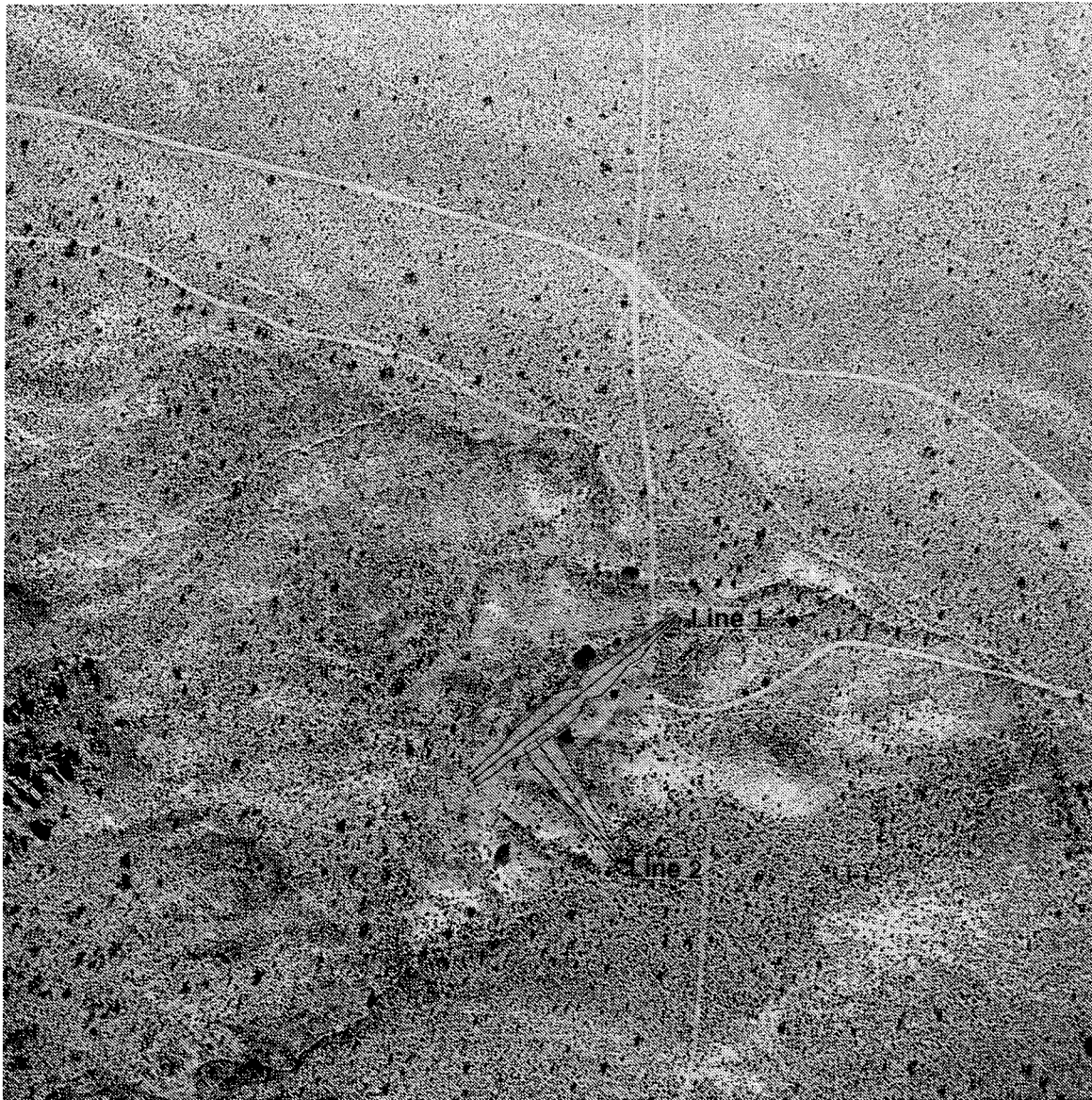
Bircham Spring - Gradient Line 1



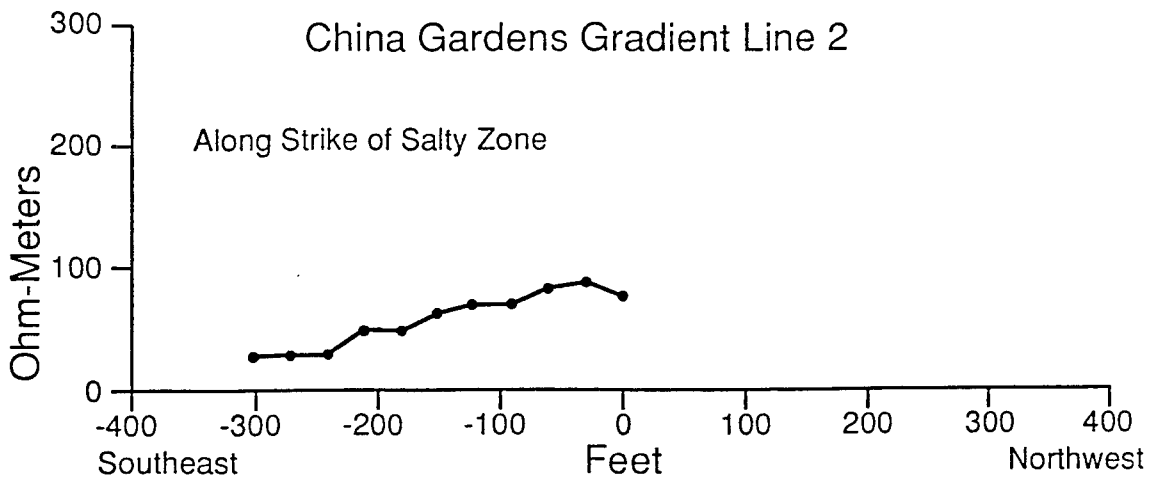
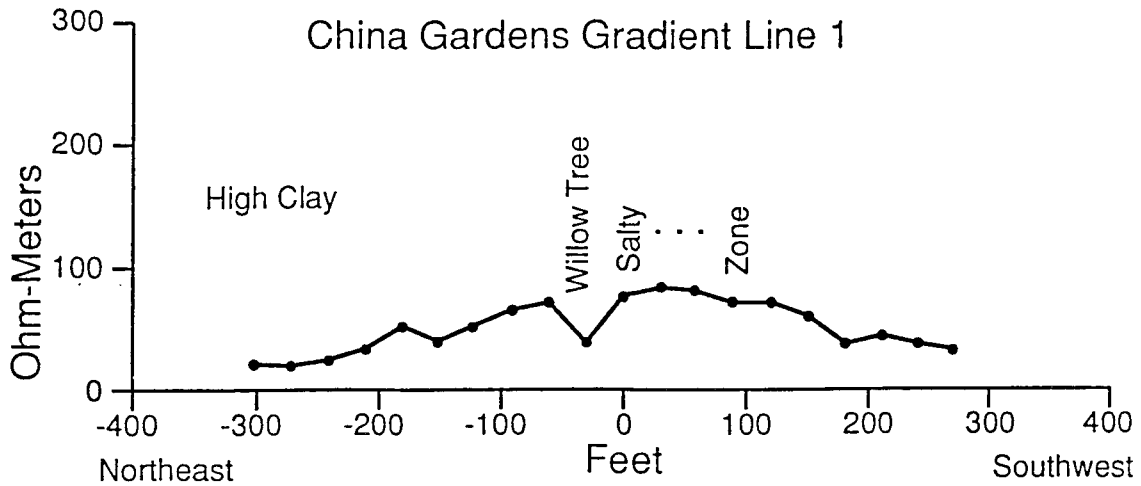
Bircham Spring - Gradient Line 2



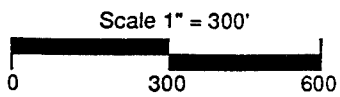
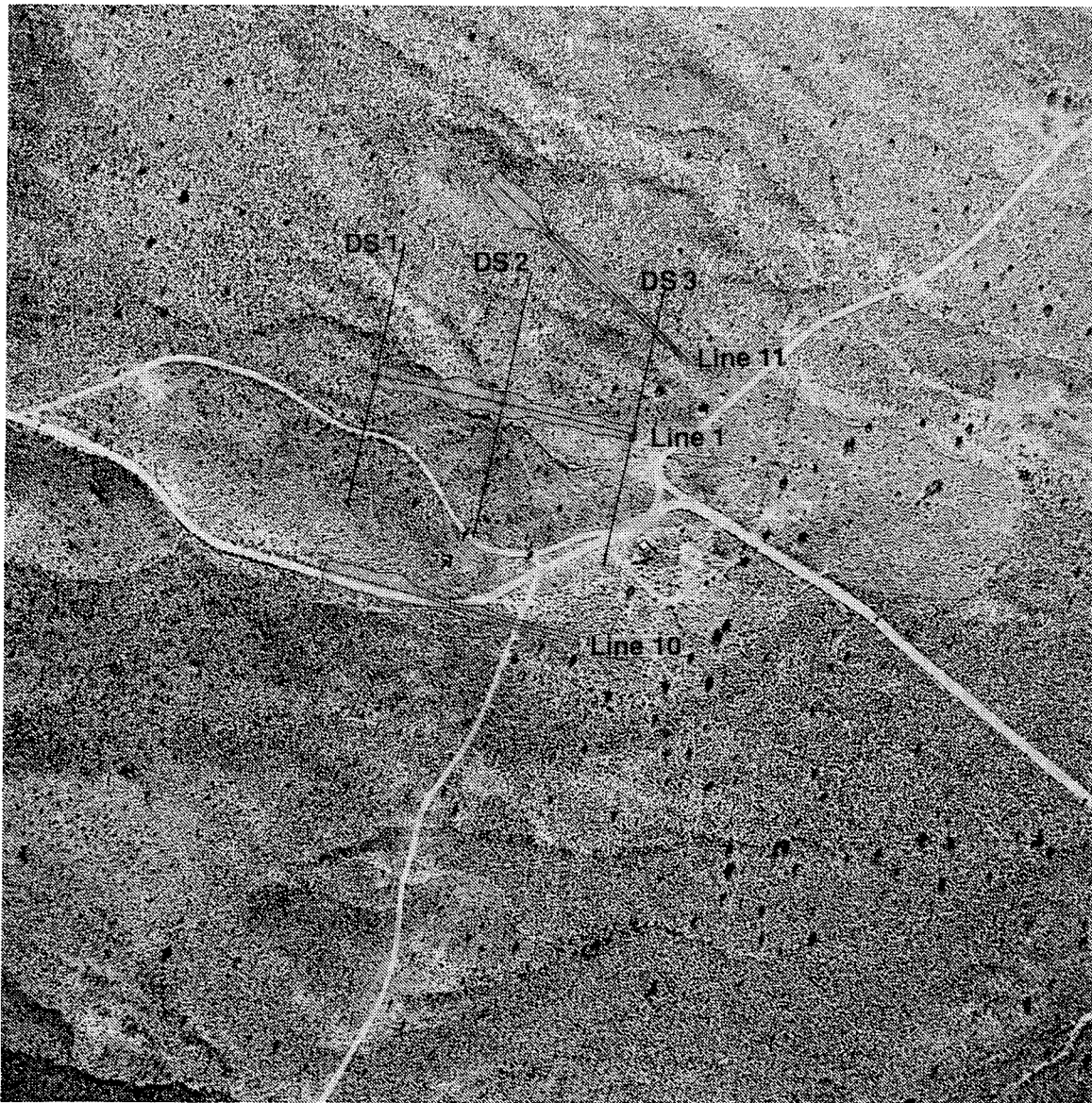
Bircham Spring — Electrical Resistivity Profiles.



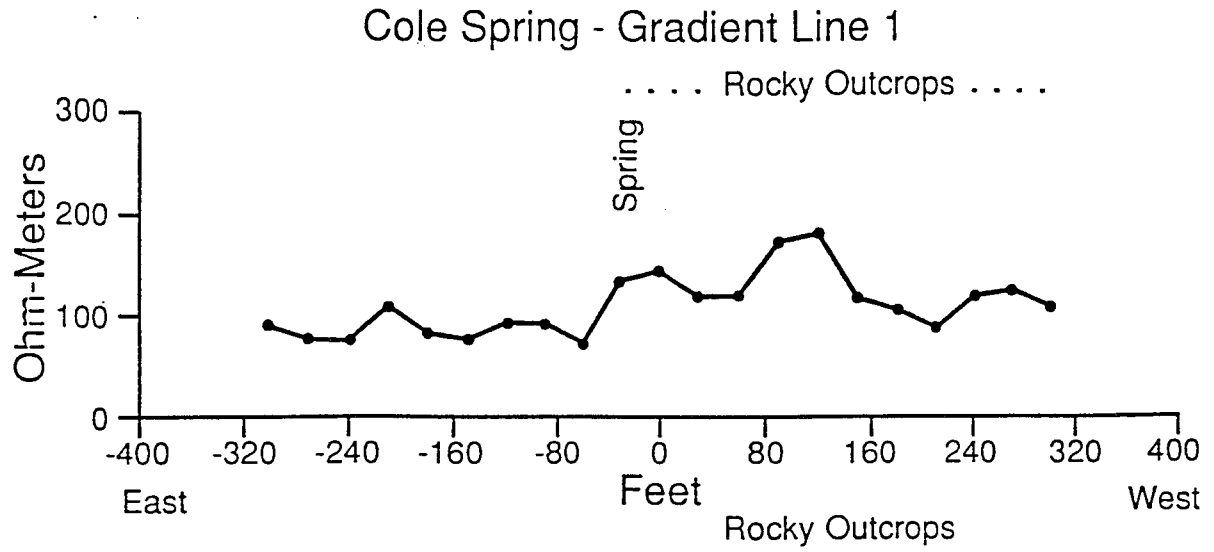
China Garden Spring — Electrical Resistivity Profiles.



China Garden Spring — Electrical Resistivity Profiles.

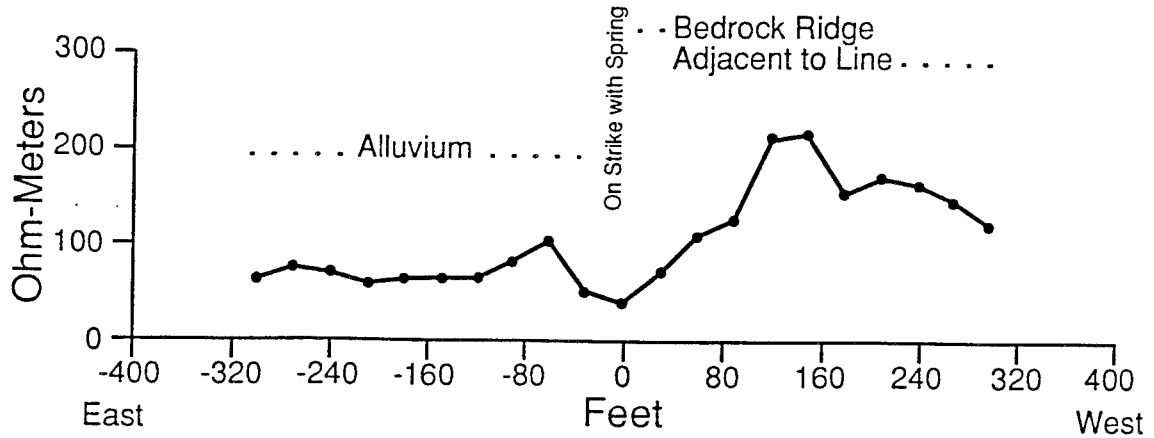


Cole Spring — Electrical Resistivity Profiles.

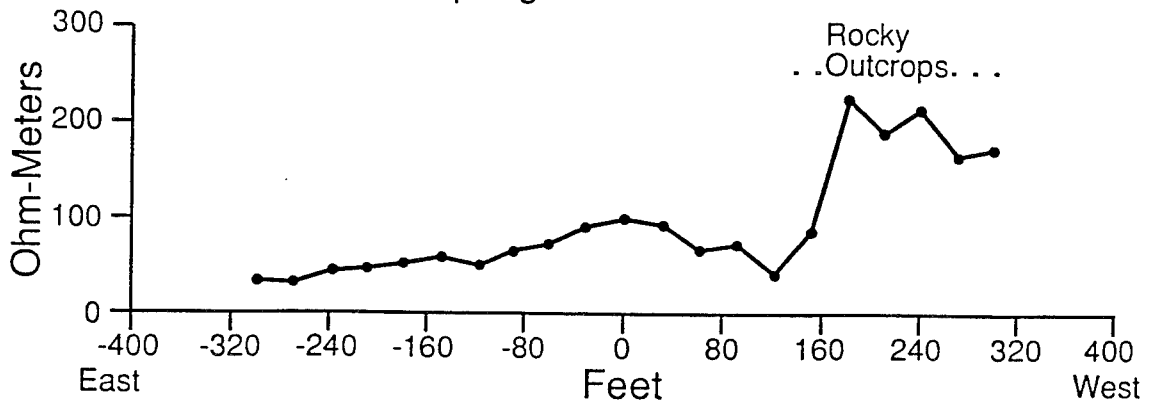


Cole Spring — Electrical Resistivity Profiles.

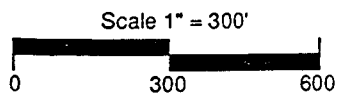
Cole Spring - Gradient Line 10



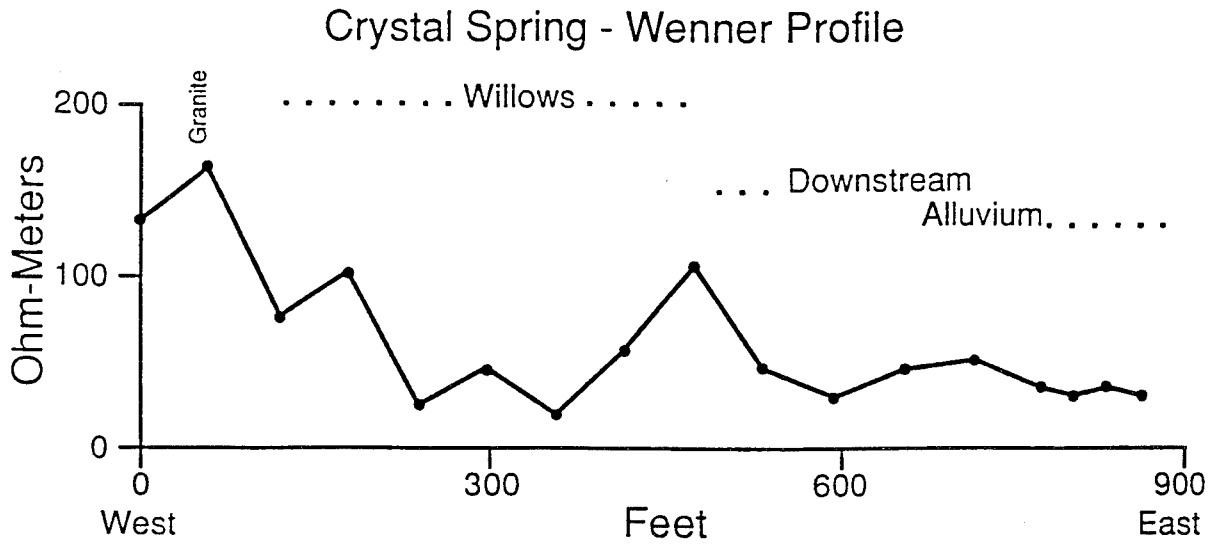
Cole Spring - Gradient Line 11



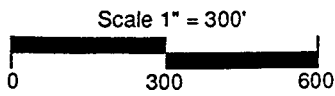
Cole Spring — Electrical Resistivity Profiles.



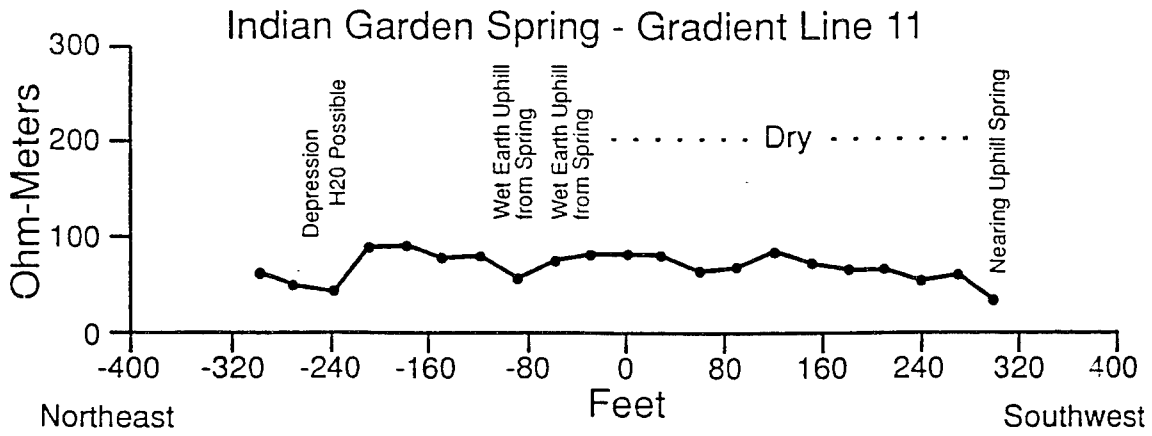
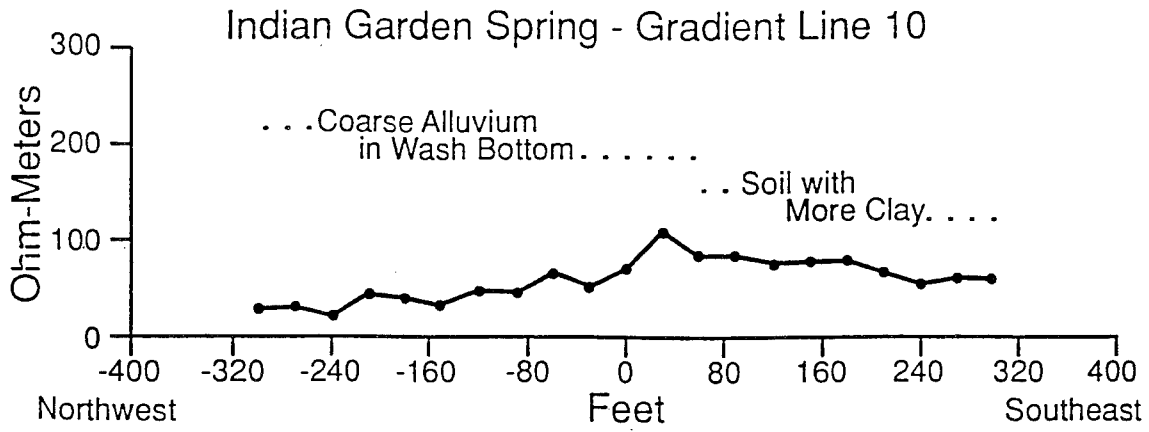
Crystal Spring — Electrical Resistivity Profiles.



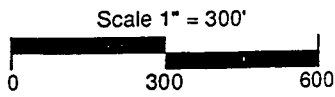
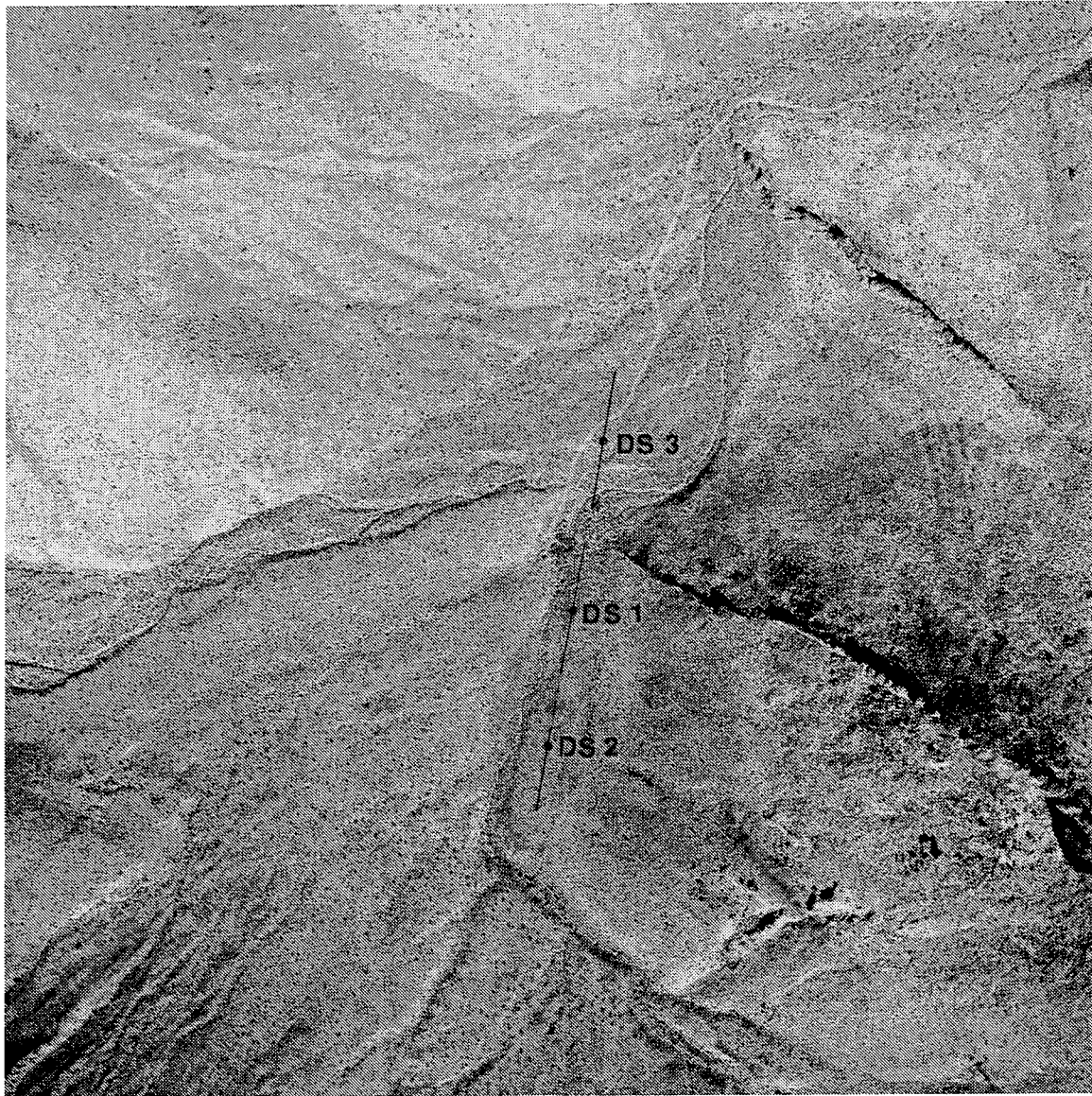
Crystal Spring — Electrical Resistivity Profiles.



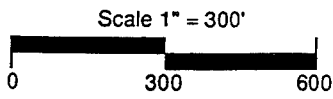
Indian Garden Spring — Electrical Resistivity Profiles.



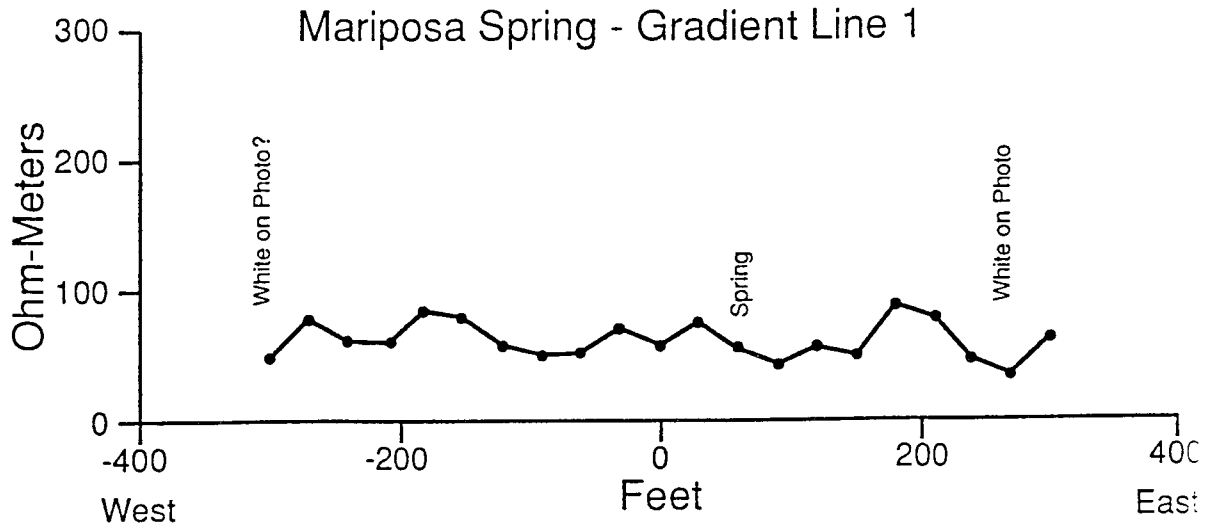
Indian Garden Spring — Electrical Resistivity Profiles.



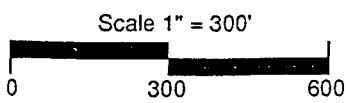
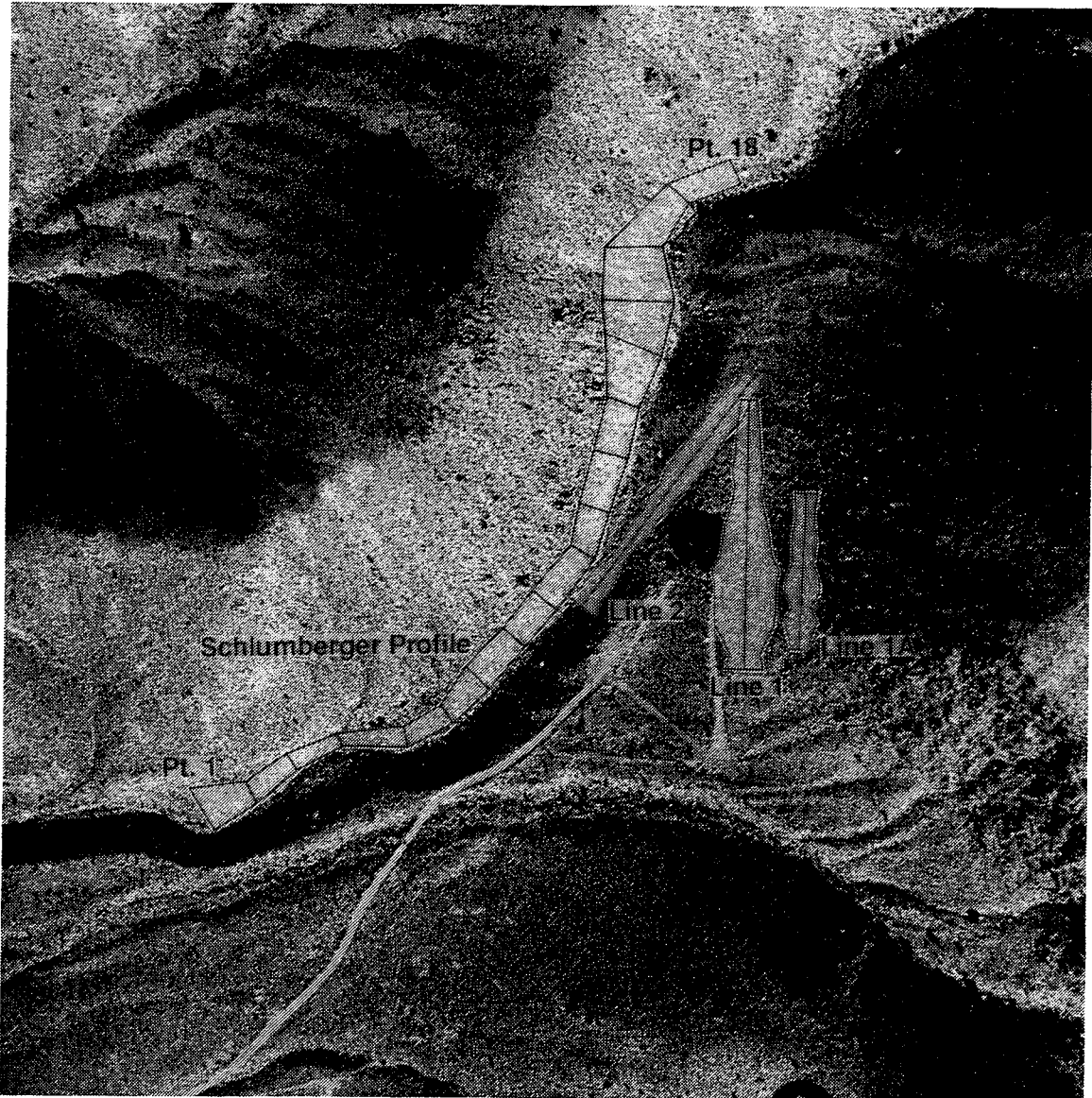
Lead Pipe Spring — Electrical Resistivity Profiles.



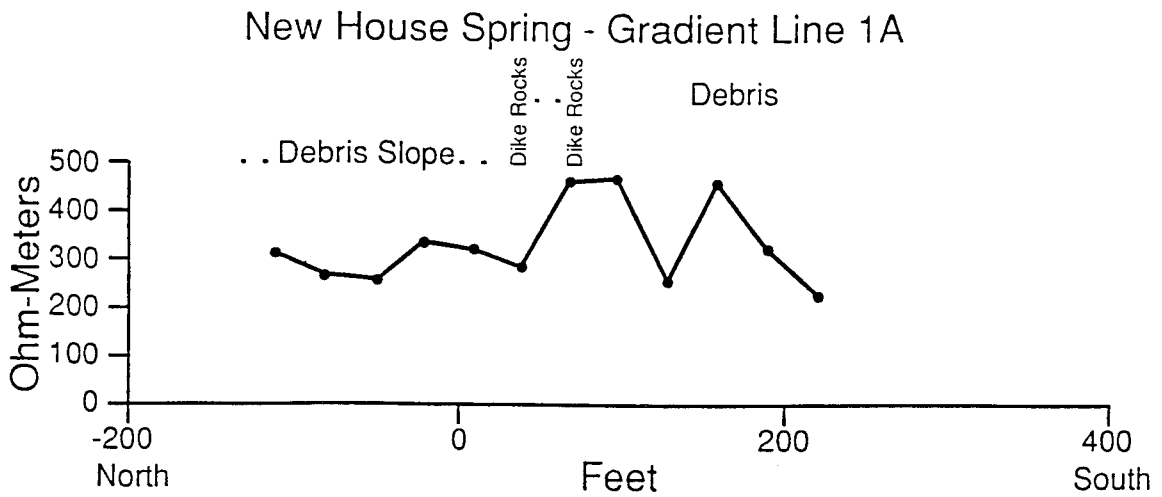
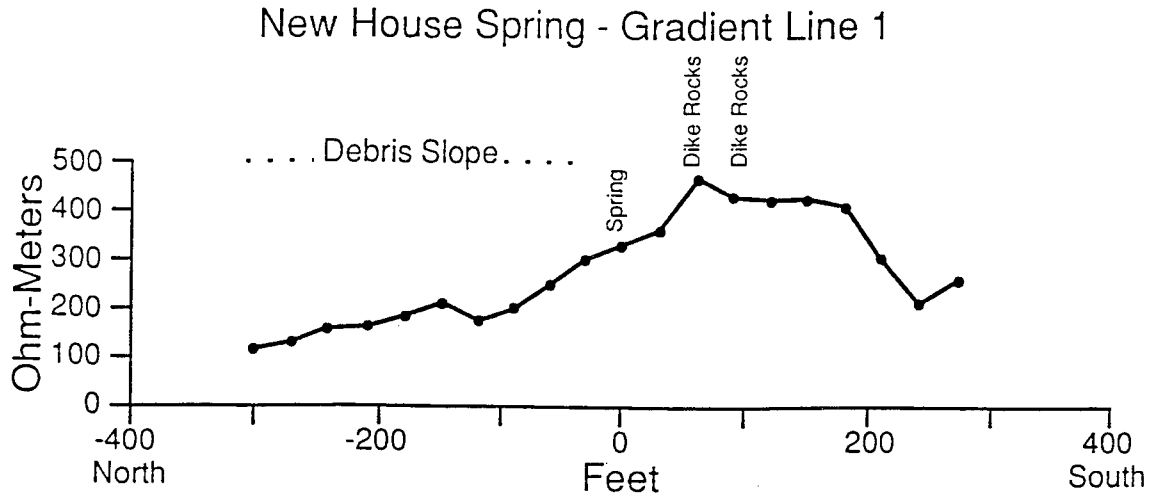
Mariposa Spring — Electrical Resistivity Profiles.



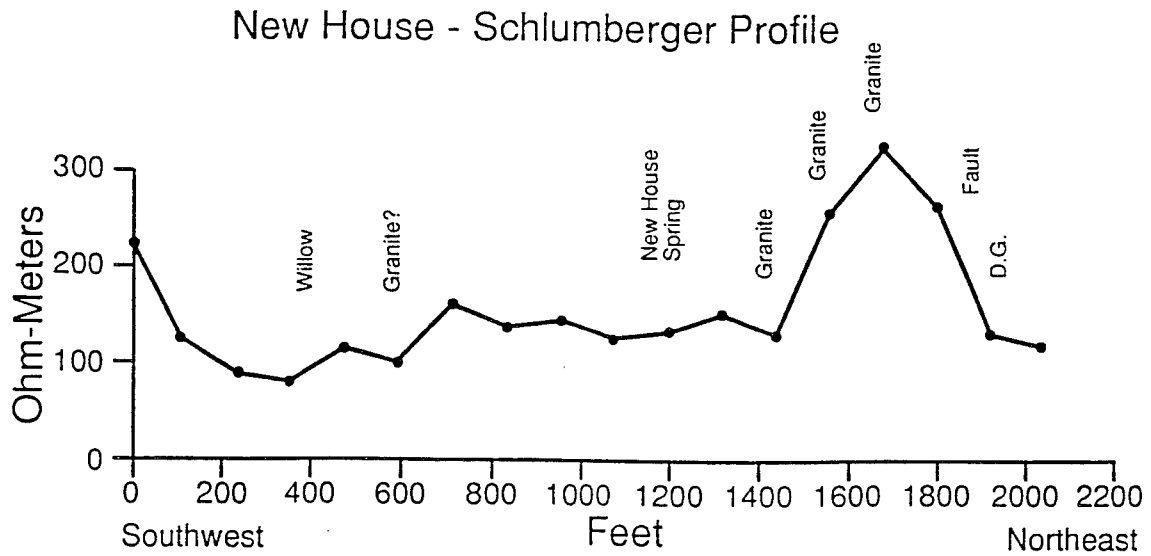
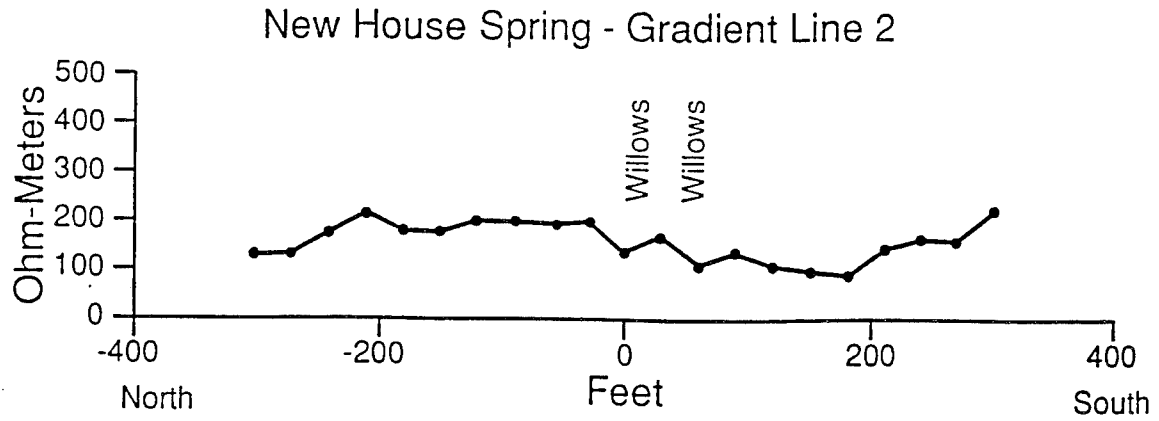
Mariposa Spring — Electrical Resistivity Profiles.



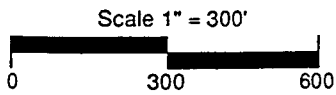
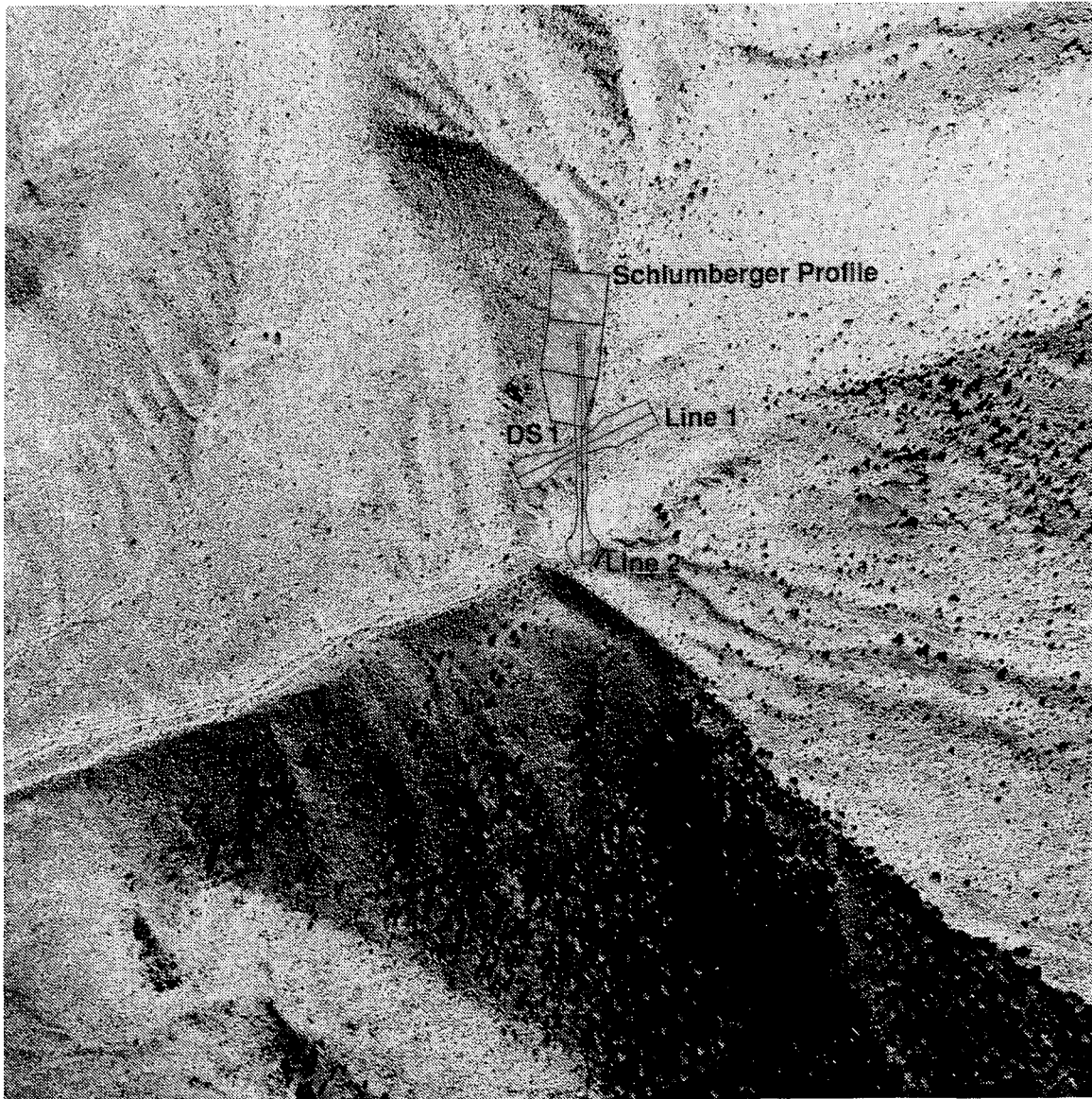
New House Spring — Electrical Resistivity Profiles.



New House Spring — Electrical Resistivity Profiles.

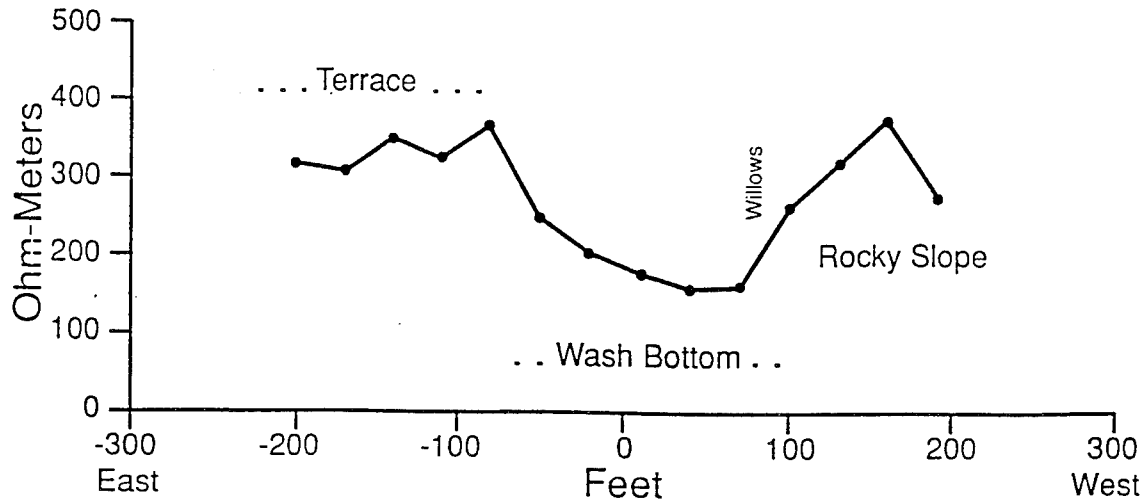


New House Spring — Electrical Resistivity Profiles.

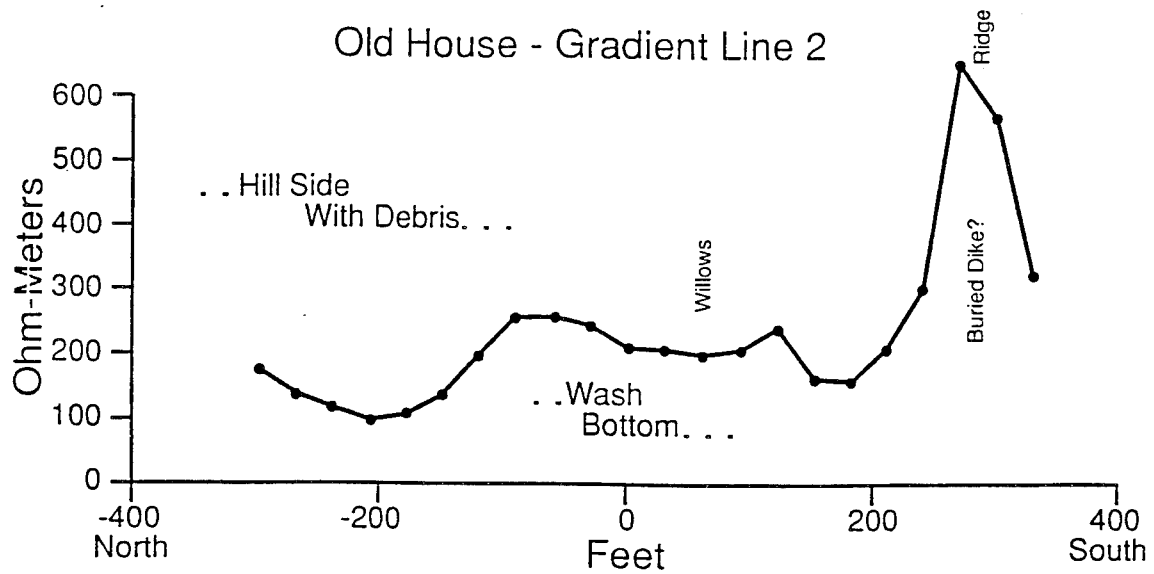


Old House Spring — Electrical Resistivity Profiles.

Old House - Gradient Line 1

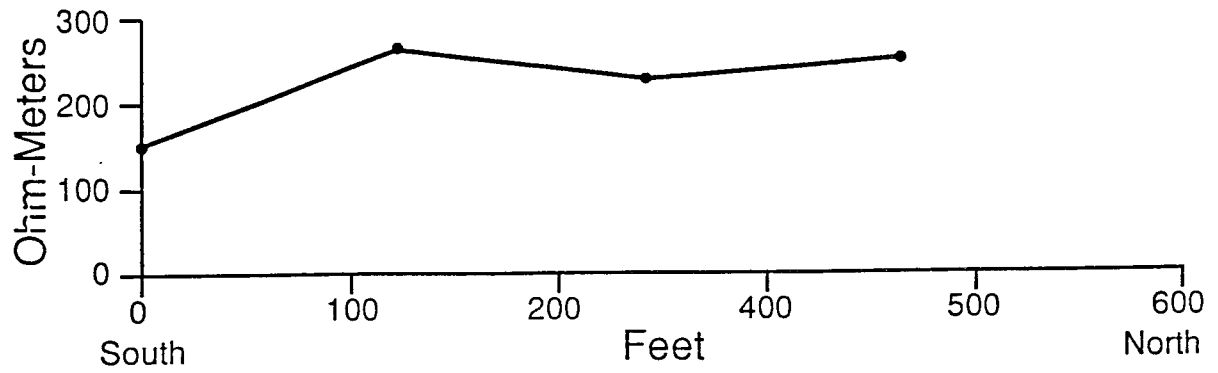


Old House - Gradient Line 2

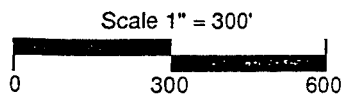


Old House Spring — Electrical Resistivity Profiles.

Old House Spring - Schlumberger Profile

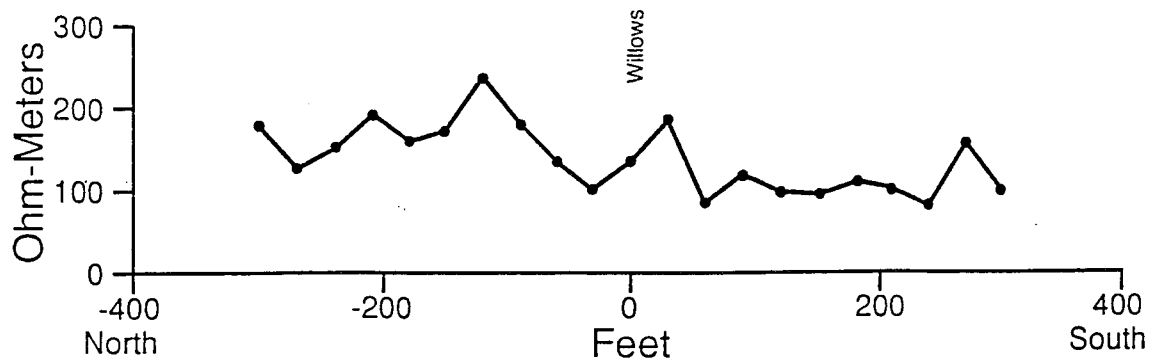


Old House Spring — Electrical Resistivity Profiles.

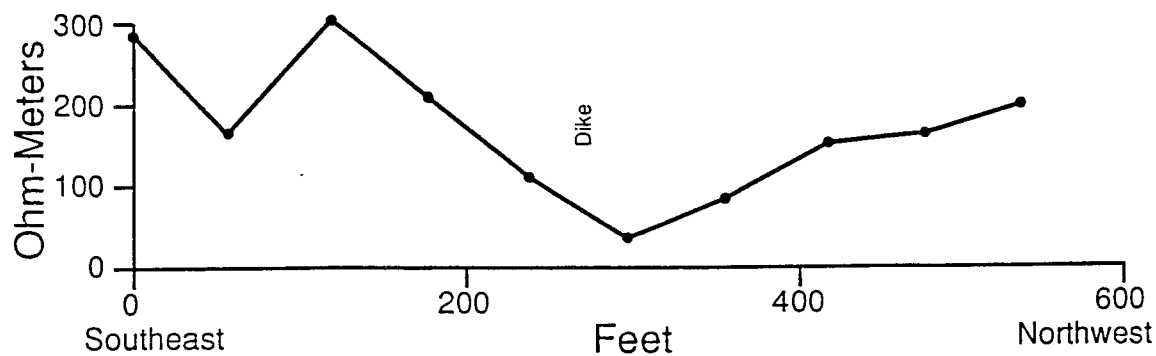


Tennessee Spring — Electrical Resistivity Profiles.

Tennessee Spring - Gradient Line 1



Tennessee Spring - Wenner Line 1

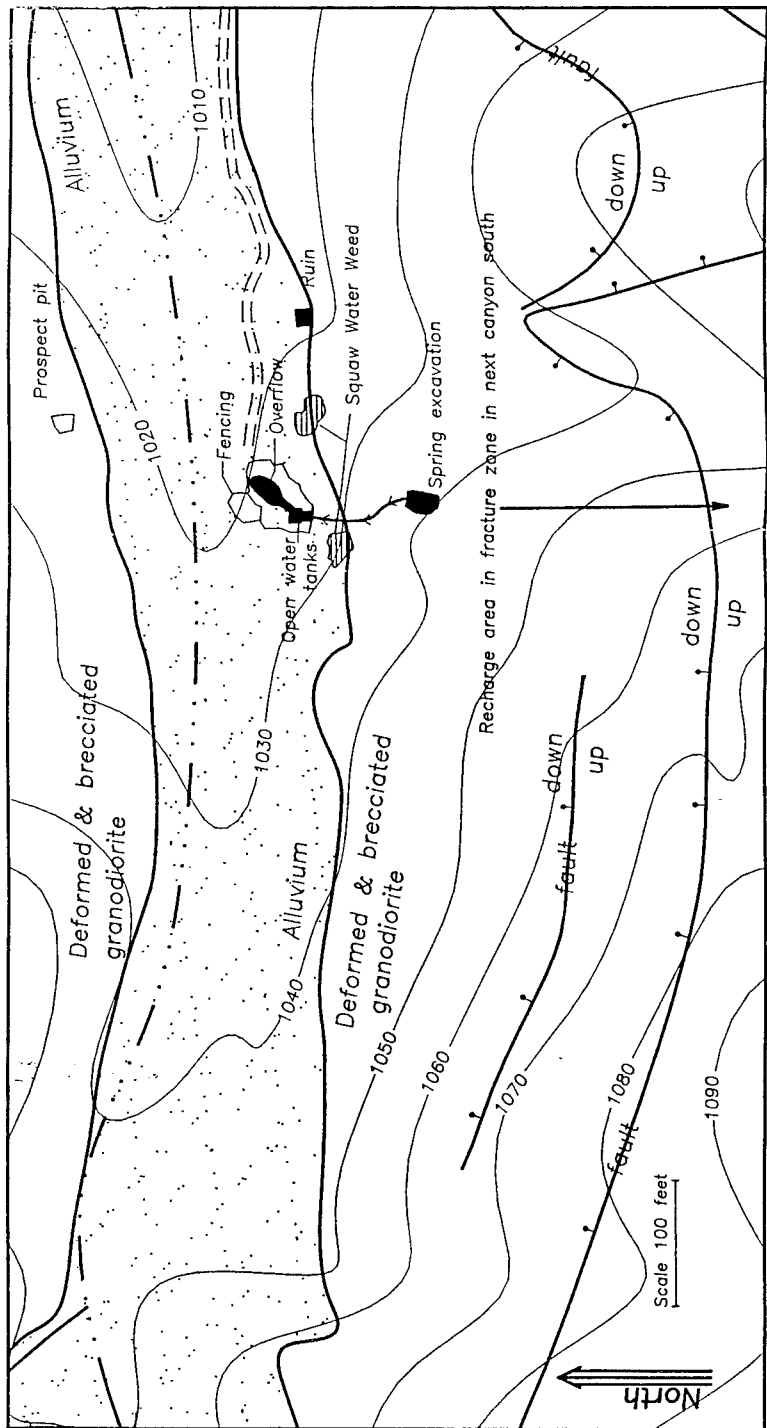


Tennessee Spring — Electrical Resistivity Profiles.

NAWS CL TP 005

Appendix C  
GEOLOGIC MAPS

AMITY



T. W. Bithorn, Earth Sciences Consultants

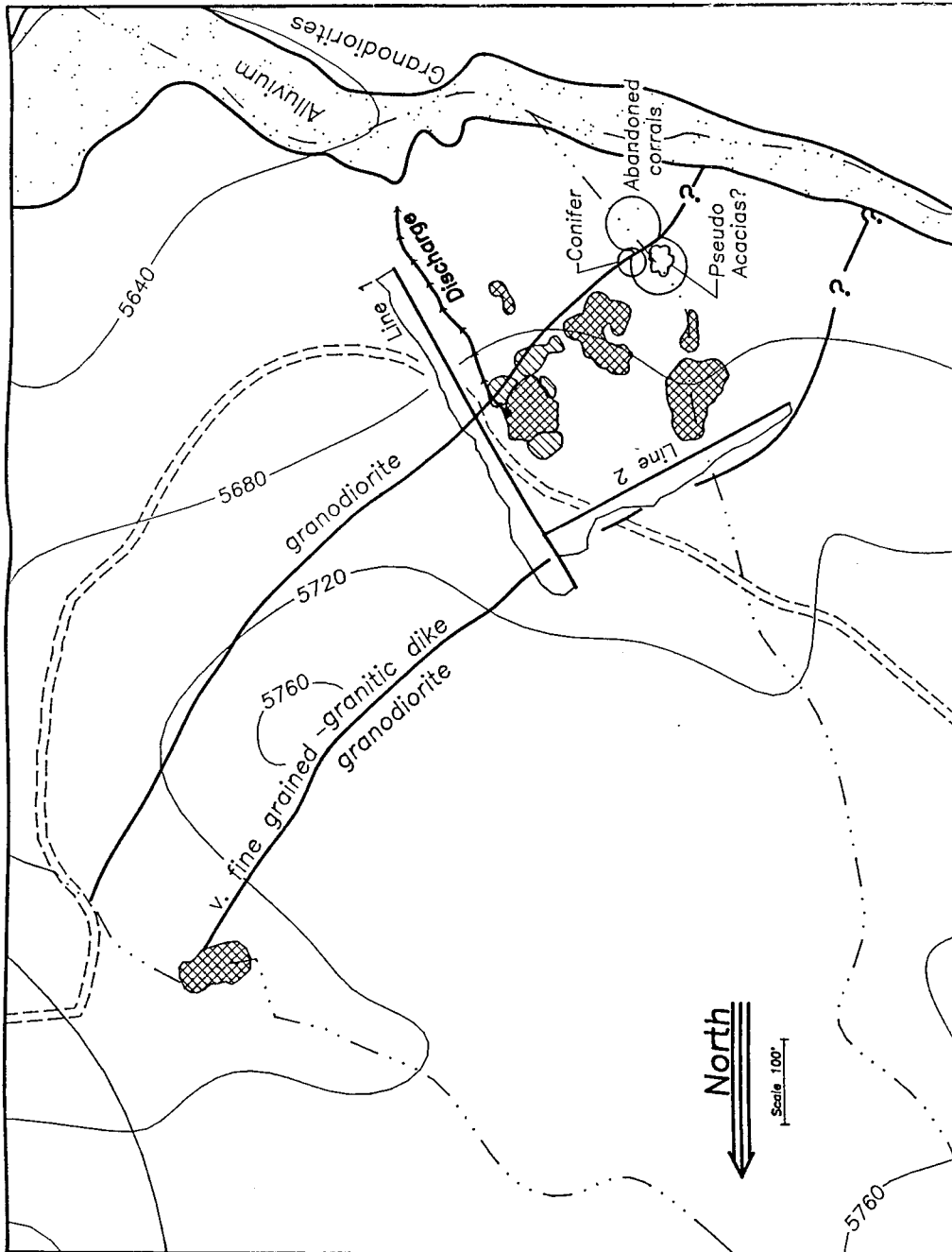
Legend

- 5640 — Ground contour
- == Dirt Road
- granodiorite — Geologic Contact
- alluvium — Intermittent stream
- Fault plane dipping toward symbols

Notes

- Flowing surface water or pipe
  - Resistivity profile showing curve of resistivity
  - Squaw Water Weed (Baccharis sergioides)
  - Alluvium
- Contour Interval is 10 meters  
 Scale 1" = 100'  
 File: Amity-7 3/15/94

BIRCHAM



Legend

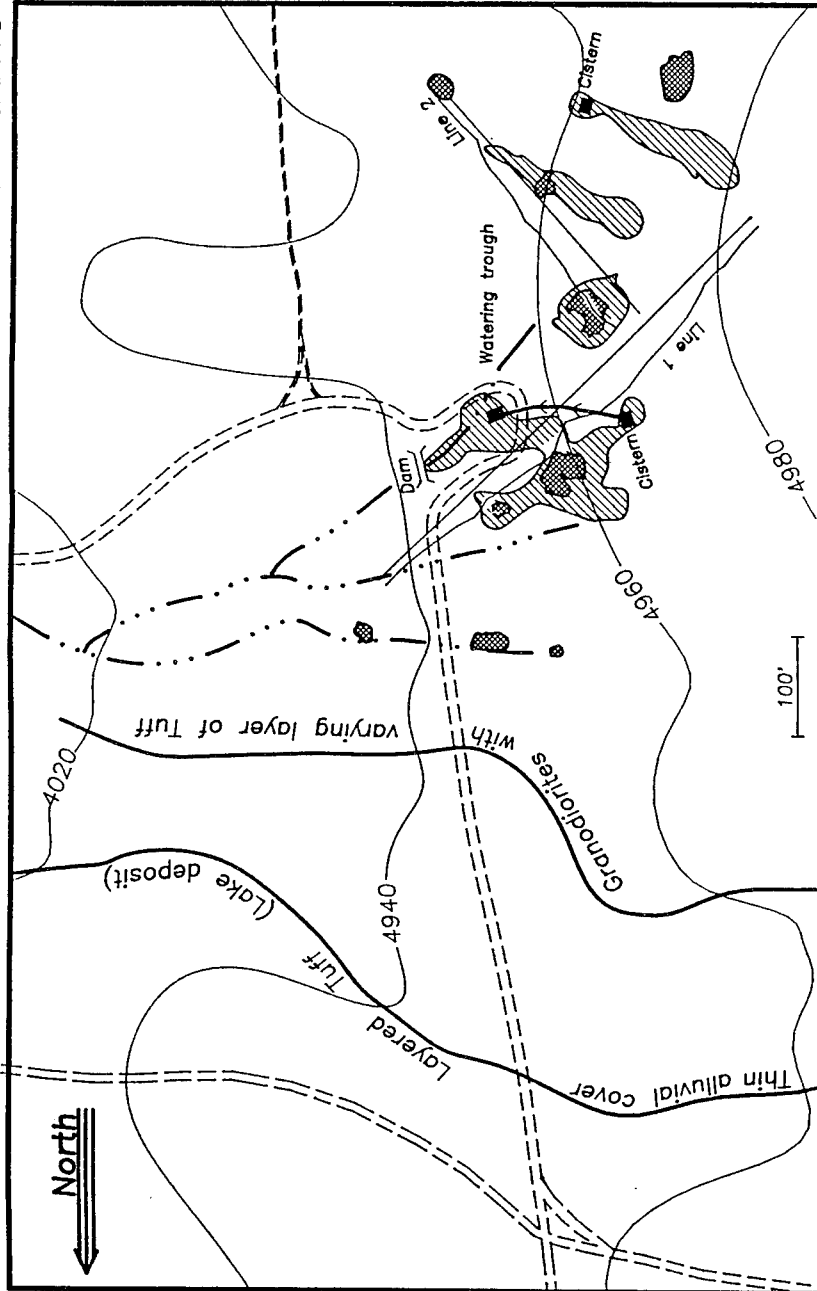
- 5640 — Ground contour
- - - - - Dirt road
- granodiorite — Alluvium
- · - · - Intermittent stream
- · - · - Fault plane, dipping toward symbol
- · - · - Flowing surface water or pipe
- · - · - Resistivity profile showing curve of resistivity
- ▨ Arroyo willow
- ▧ Mesquite
- ▩ Alluvium

Notes

Contour Interval is 40 feet  
 Scale 1" = 150'  
 File: Birchum-7 3/15/94

T. W. Bilhorn, Earth Sciences Consultants

China Gardens



Legend

- 5640 — Ground contour
- - - - - Dirt road
- granodiorite / Aluvium — Geologic contact
- · - · - Intermittent stream
- · - · - Fault plane, dipping toward symbol
- - - - - Flowing surface water or pipe
- - - - - Resistivity profile showing curve of resistivity
- ▨ Arroyo willow
- ▨ Area of seepage from fractures

Notes

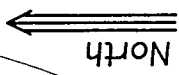
Contour Interval is 20 feet

Scale 1" = 150'

File: China Gardens 6 3/15/94

T. W. Bilhorn, Earth Sciences Consultants

Cole



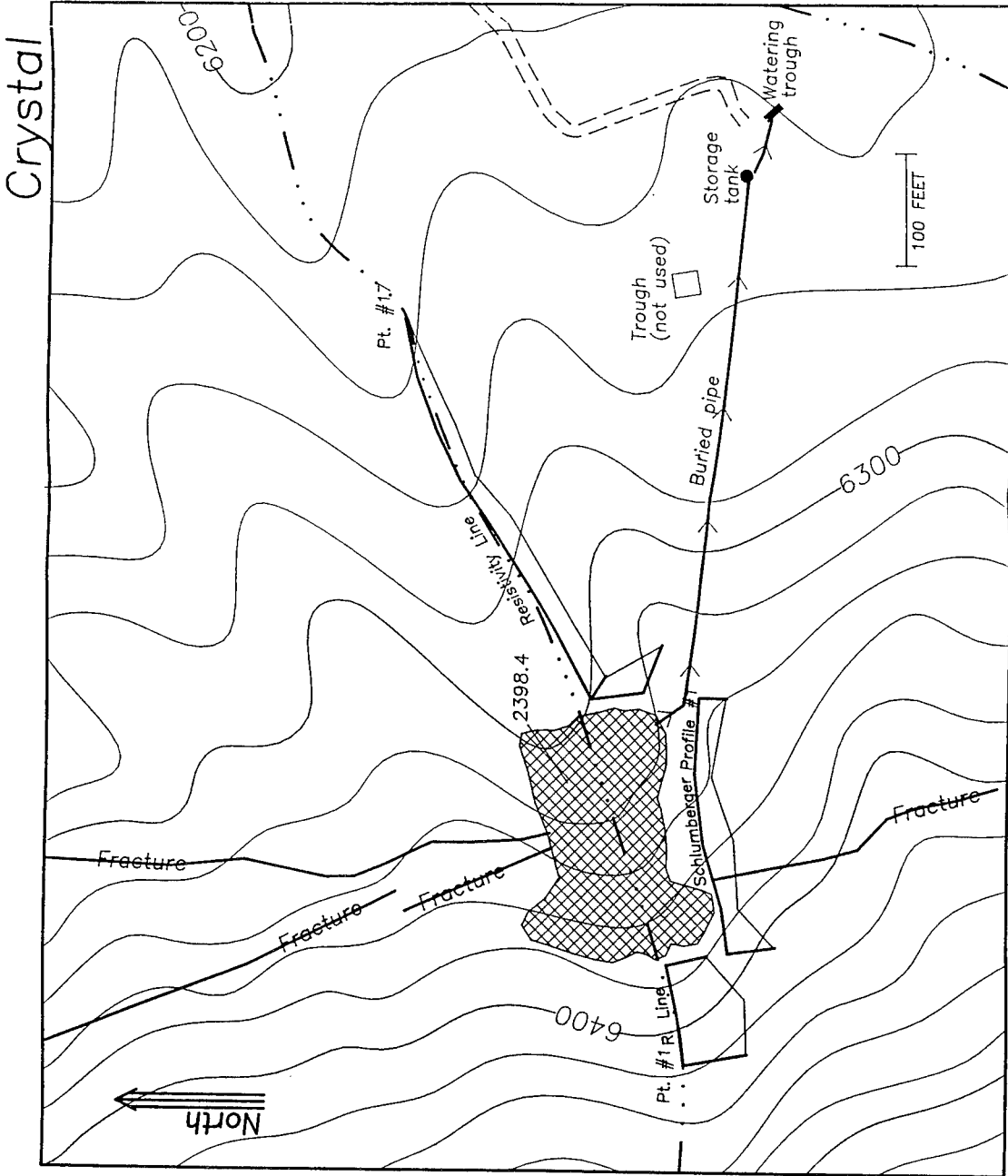
File: Cole-9 3/15/94

Notes

No riparian vegetation at the site  
(See Text)  
Contour interval is 20 feet  
Scale 1" = 150'

T. W. Blihorn, Earth Sciences Consultants

- Legend**
- 5640 — Ground contour
  - - - - - Dirt Road
  - granodiorite — Geologic Contact
  - alluvium — Intermittent stream
  - Fault plane dipping toward symbols
  - Flowing surface water or pipe
  - Resistivity profile showing curve of resistivity
  - Alluvium
  - ▨ Dike, conduit-fracture
  - ▤ Intermixed weathered granitic rocks and tuffs



Crystal

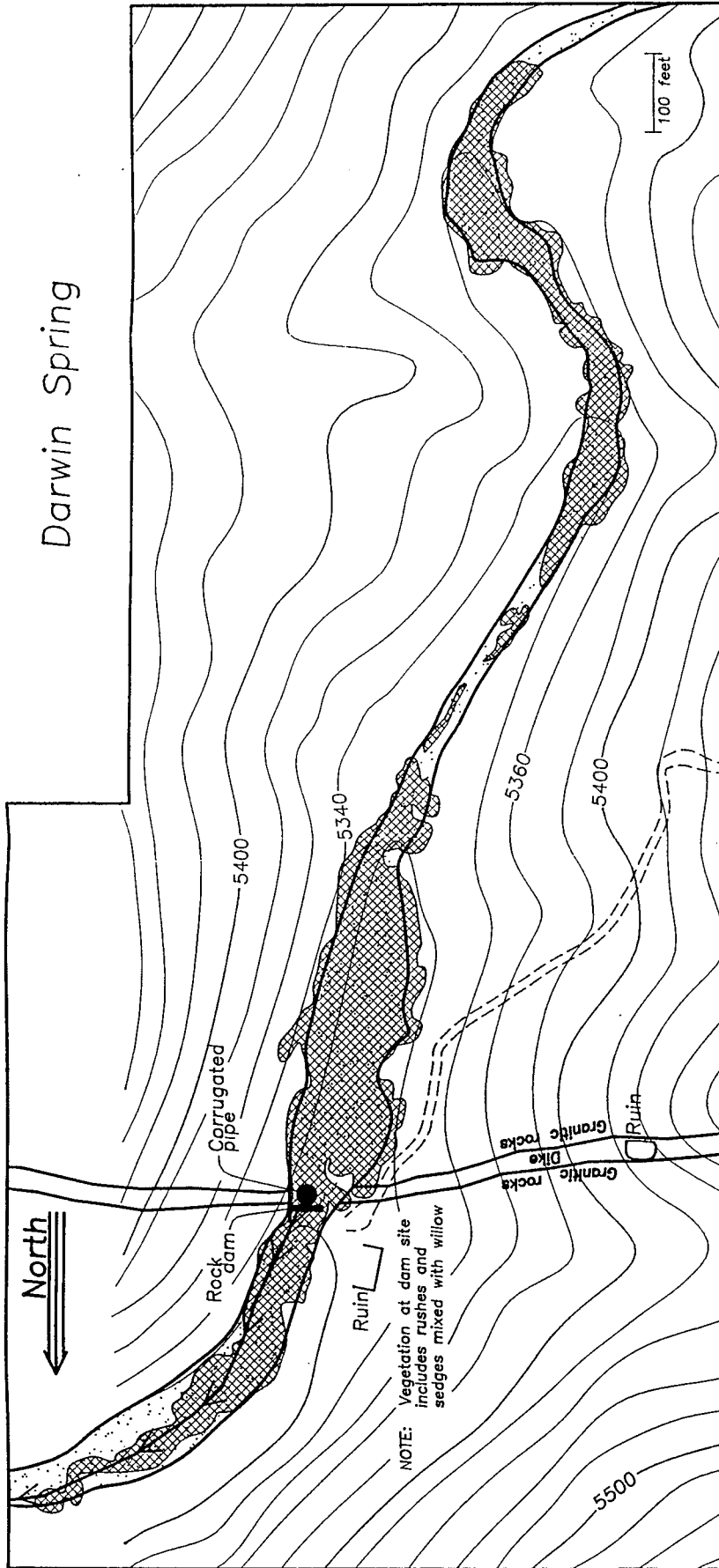
- Legend**
- 5640 — Ground contour
  - == Dirt Road
  - granodiorite — Geologic Contact
  - aluminum —
  - . - . - . Intermittent stream
  - . - . - . Fault plane dipping toward symbols
  - ~ ~ ~ ~ ~ Flowing surface water or pipe
  - ~ ~ ~ ~ ~ Resistivity profile showing curve of resistivity
  - ⊗ Arroyo willow

**Notes**

- Contour Interval is 20 feet
- Scale 1" = 150'

File: Crystal-6 3/16/94

T. W. Bilhorn, Earth Sciences Consultants



T. W. Bihorn, Earth Sciences Consultants

File: Darwin-5 2/20/94

Notes

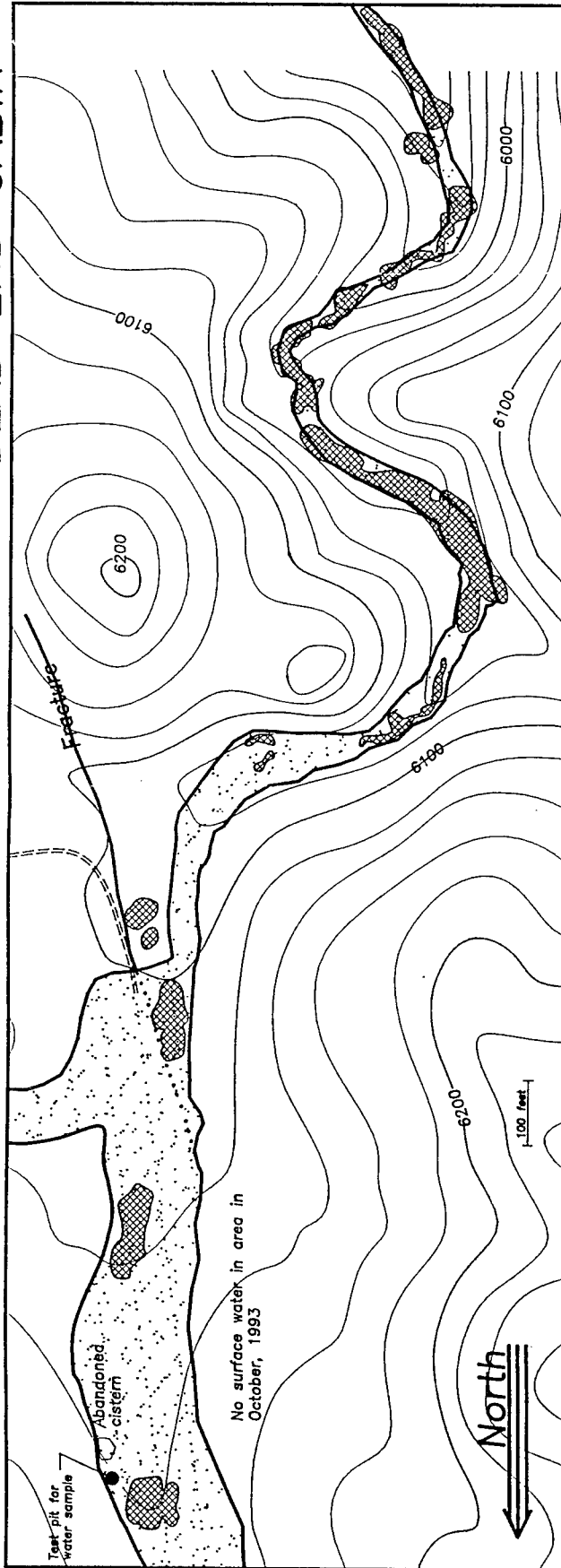
Contour Interval is 20 feet

Scale 1" = 150'

Legend

- 5640— Ground contour
- ==== Dirt road
- granodiorite
- Alluvium
- Geologic contact
- Flowing surface water or pipe
- ▨ Arroyo willow
- ▩ Alluvium

DEAD END CABIN



T. V. Gilhorn, Earth Sciences Consultants

File: 000h-82 1/19/94

Notes

Contour Interval is 20 feet

Scale 1" = 200'

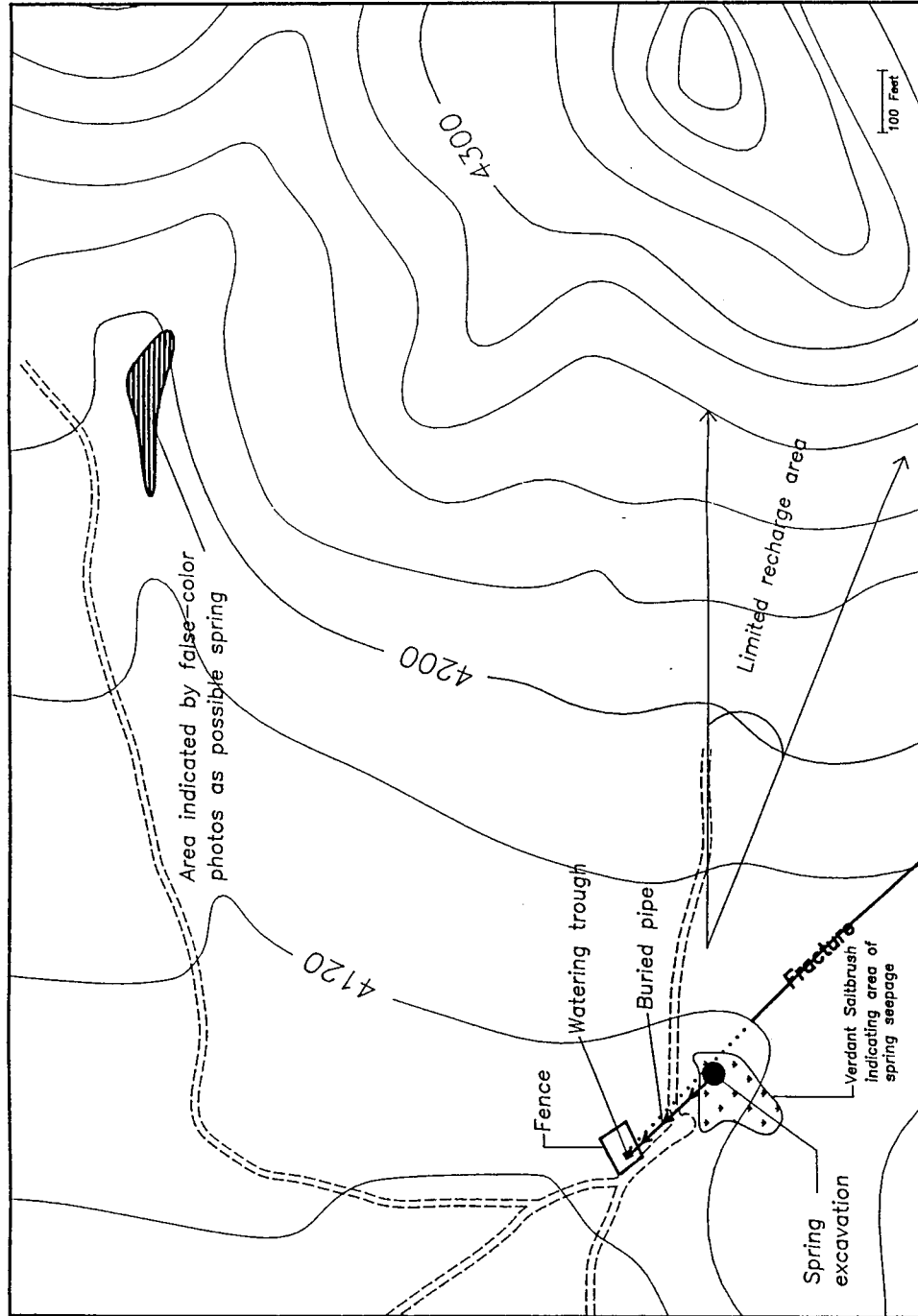
Vegetation identification tentative as full area not examined in field

Photo/topographic match in south half of area is poor.

Legend

- 5640 — Ground contour
- Dirt road
- granodiorite Alluvium
- Geologic contact
- Flowing surface water or pipe
- Arroyo willow
- Alluvium

Granite Wells



Legend

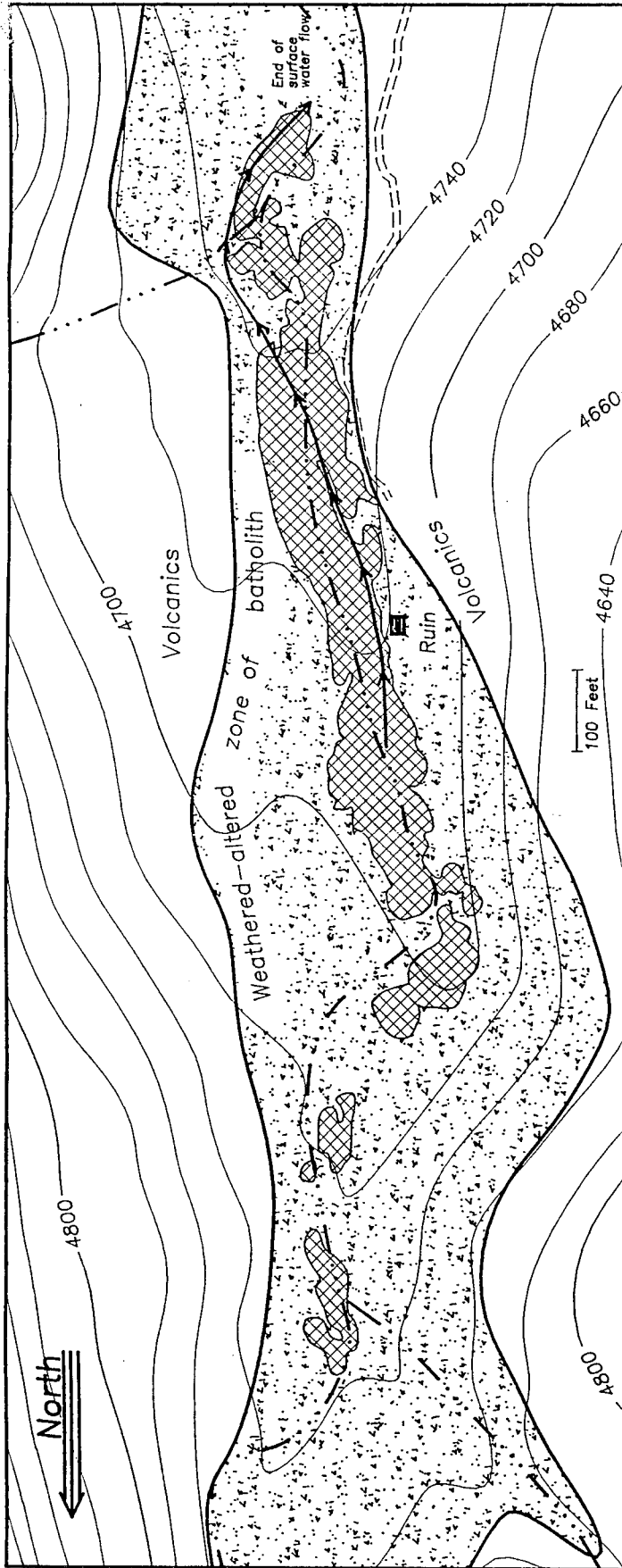
- 5640 — Ground contour
- - - - - Dirt Road
- granodiorite alluvium — Geologic Contact
- · - · - Intermittent stream
- - - - - Fault plane dipping toward symbols
- Flowing surface water or pipe
- Resistivity profile showing curve of resistivity
- Saltbrush

Notes

- Contour Interval is 40 feet
- Scale 1" = 200'
- File: Granit-2 3/16/94

T. W. Bifhorn, Earth Sciences Consultants

HAWIEE



Legend

- 5640 — Ground contour
- Dirt road
- granodiorite
- Alluvium
- Geologic contact

- Flowing surface water or pipe
- ⊞ Arroyo willow
- ⊞ Weathered-altered zone

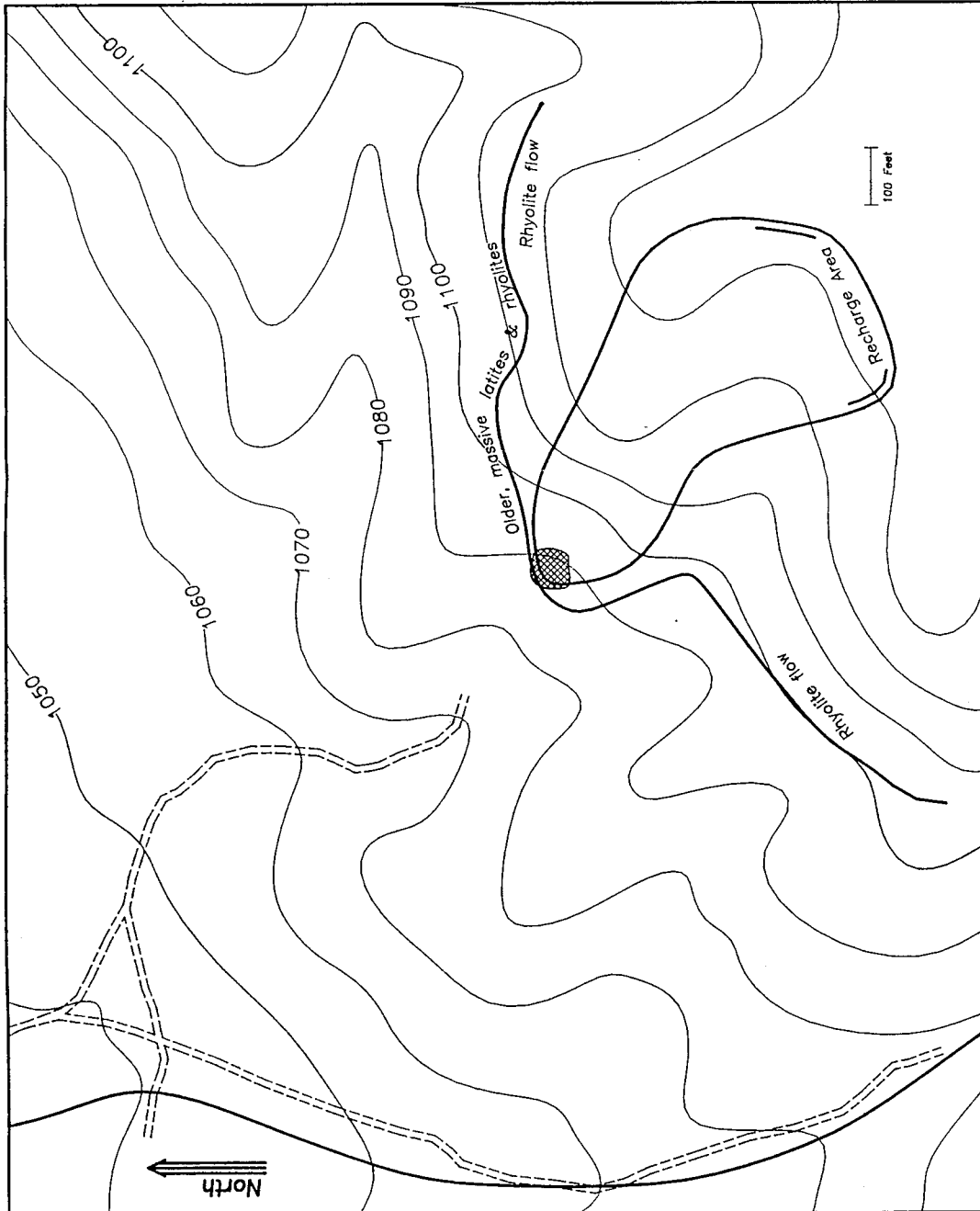
Notes

- Contour Interval is 20 feet
- Scale 1" = 150'

T. W. Bilhorn, Earth Sciences Consultants

File: Hawiee-3 1/20/94

Hidden



Legend

- 5640 — Ground contour
- - - - - Dirt road
- granodiorite  
Alluvium — Geologic contact
- · - · - Intermittent stream
- · - · - Fault plane, dipping toward symbol
- - - - - Flowing surface water or pipe
- - - - - Resistivity profile showing curve of resistivity
- ▨ Arroyo willow

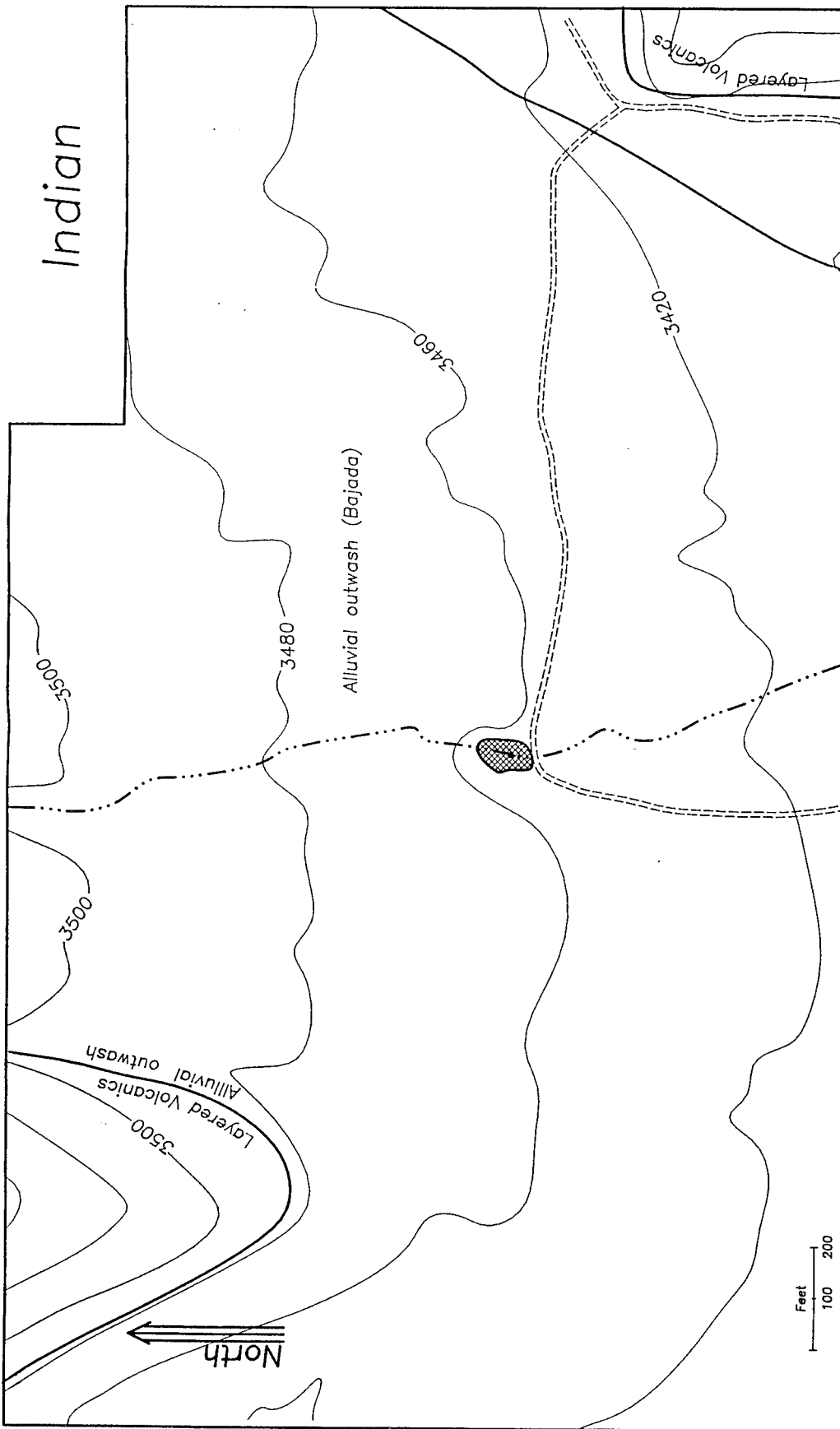
Notes

Contour Interval is 10 meters

Scale 1" = 200'

File: Hidden-4 3/17/94

T. W. Blithorn, Earth Sciences Consultants

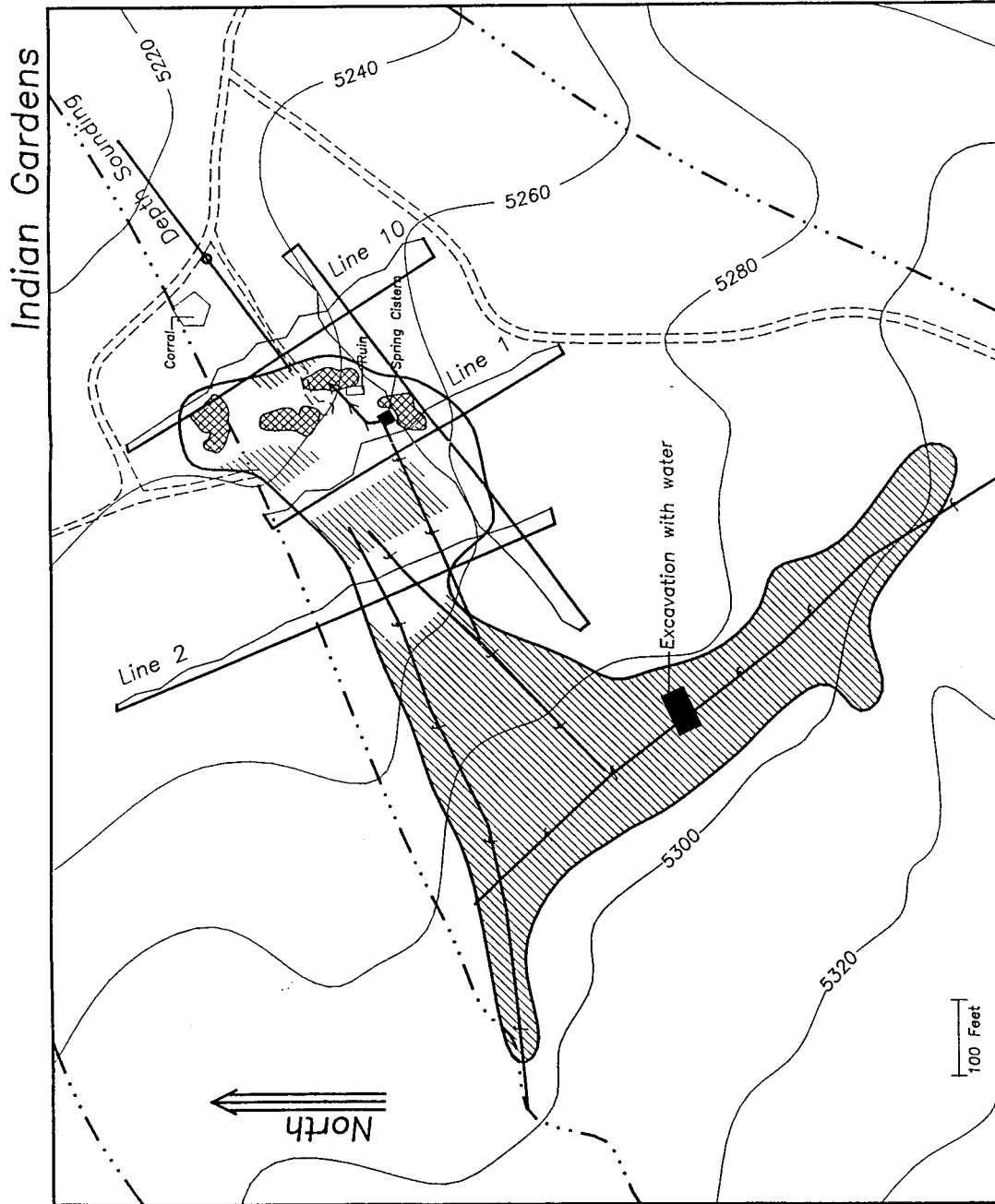


T. W. Bilhorn, Earth Sciences Consultants

File: Indian-5 3/17/94

**Notes**  
 Contour Interval is 20 feet  
 Scale 1" = 200'

- Legend**
- Ground contour
  - Dirt road
  - Volcanics
  - Alluvium
  - Geologic contact
  - Flowing surface water or pipe
  - Intermittent stream
  - ▨ Typha & Juncus



Legend

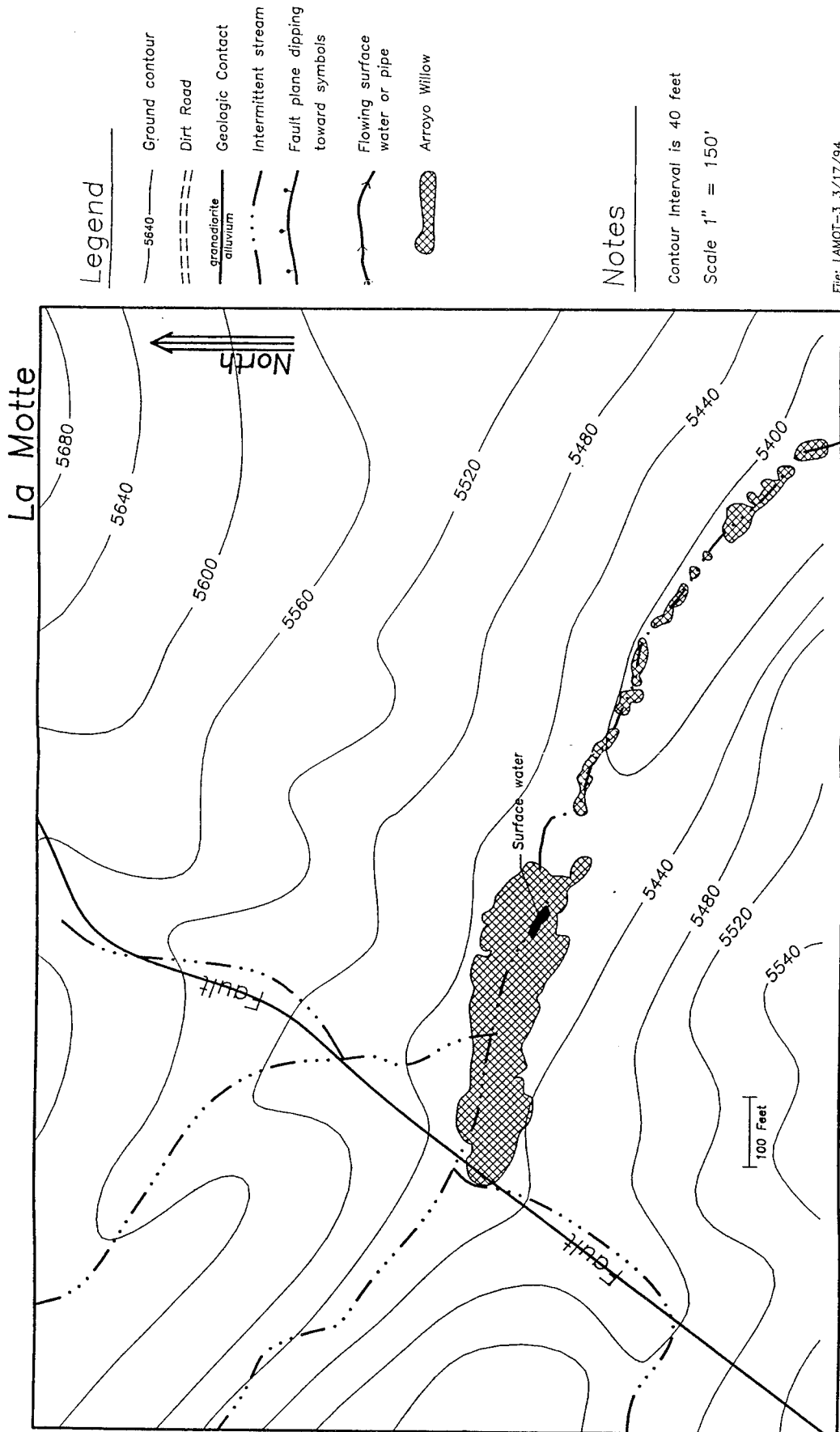
- 5640 — Ground contour
- --- Dirt road
- granodiorite  
--- Alluvium — Geologic contact
- Intermittent stream
- Fault plane, dipping toward symbol
- Flowing surface water or pipe
- Resistivity profile showing curve of resistivity
- Arroyo willow
- Area of seepage from fractures
- Fracture

Notes

Contour Interval is 20 feet  
Scale 1" = 150'

File: INCDRD-5 3/17/94

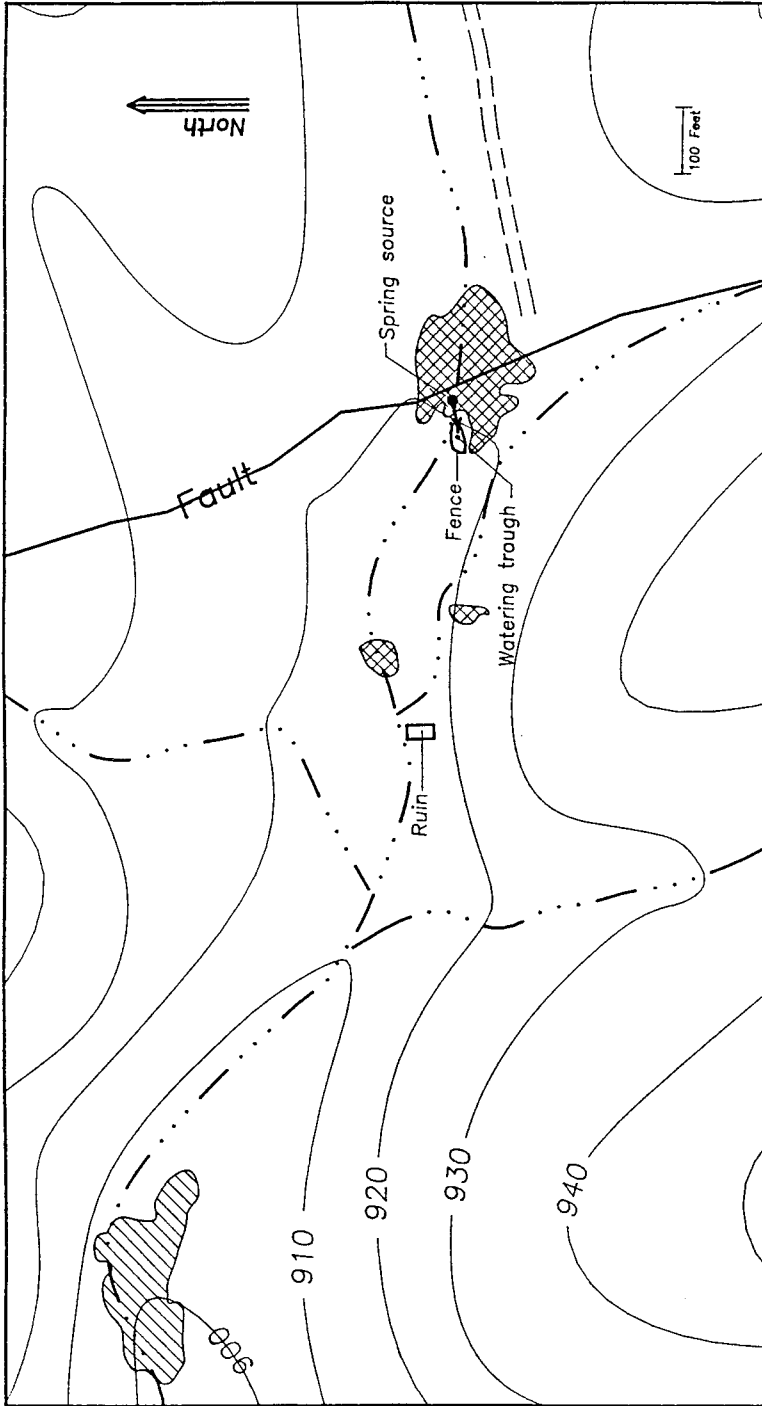
T. W. Bilhorn, Earth Sciences Consultants



File: LAMOT-3 3/17/94

T. W. Bihorn, Earth Sciences Consultants

Layton



T. W. Blihorn, Earth Sciences Consultants

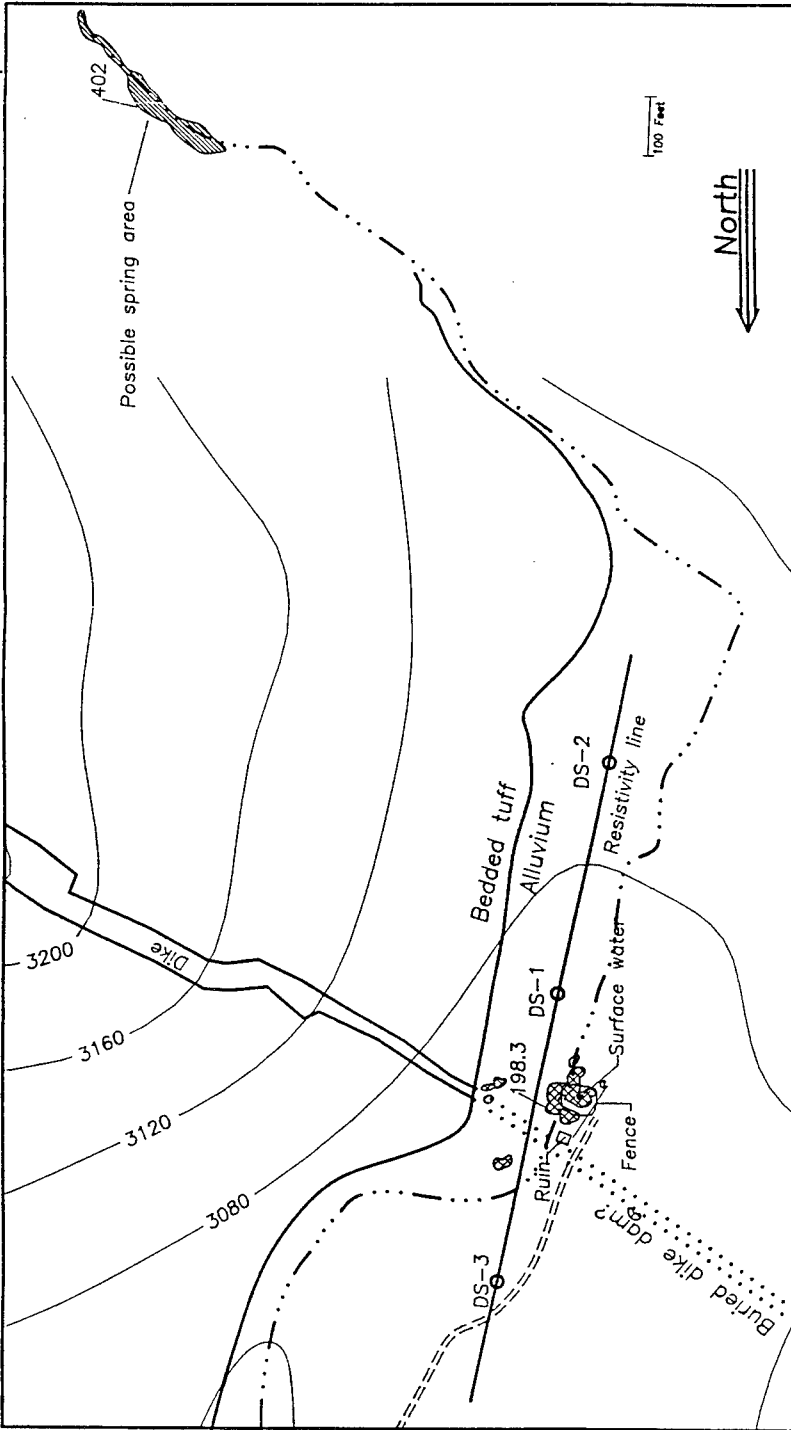
Legend

- 5640 Ground contour
- Dirt Road
- granodiorite  
alluvium
- Intermittent stream
- Fault plane dipping  
toward symbols

Notes

- Flowing surface  
water or pipe
- Squaw water weed
- Phreatophytes  
not ground verified
- Contour Interval is 10 meters
- Scale 1" = 100'
- File: Laytn-3 3/17/94

Lead Pipe



Legend

- 5640 — Ground contour
- - - - - Dirt road
- Tuff —  
— Alluvium —
- · - · - Intermittent stream
- · - · - Fault plane, dipping toward symbol
- · - · - Flowing surface water or pipe
- Resistivity line
- ▨ Squaw water weed
- ▧ Phreatophytes not ground verified

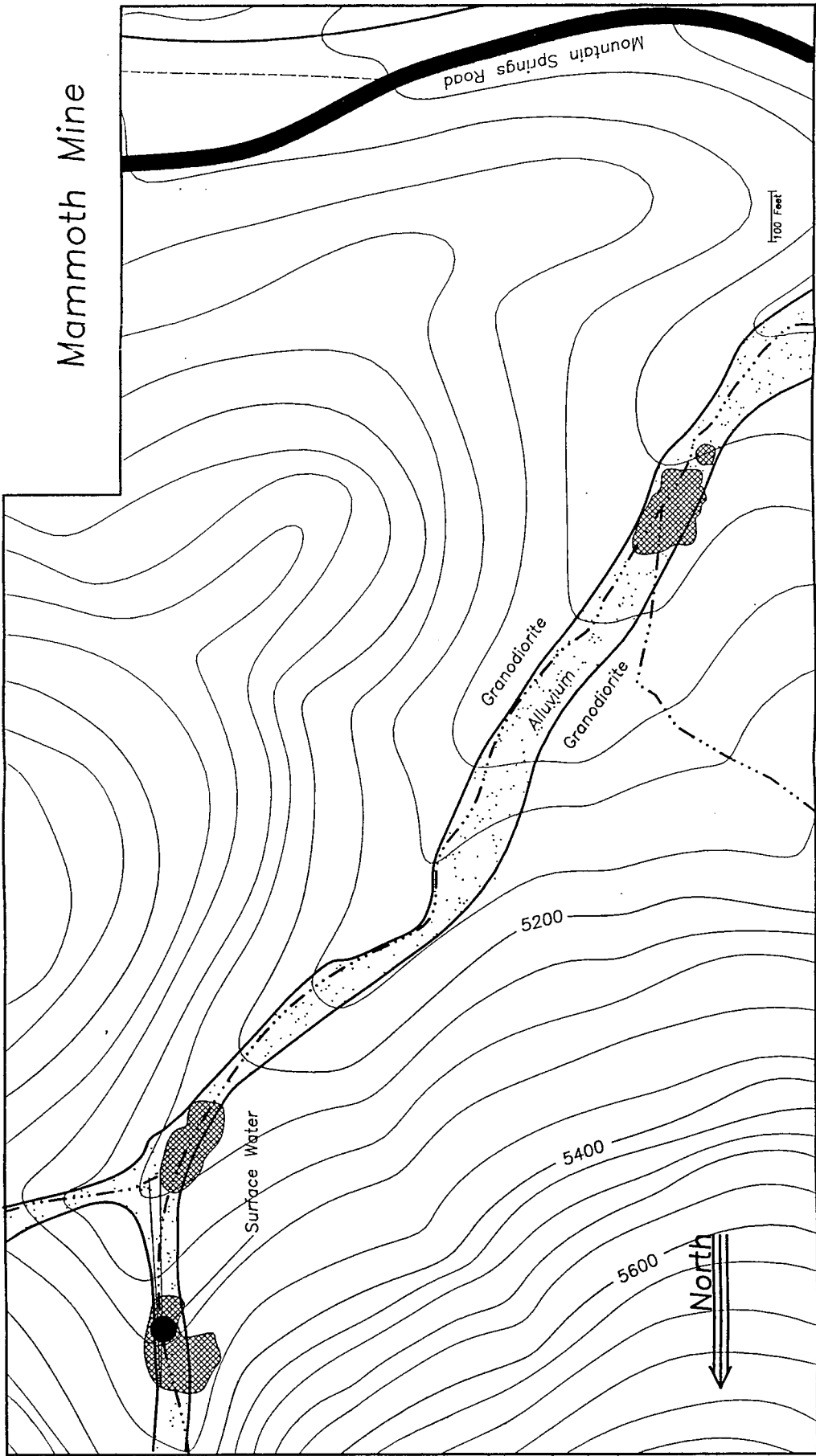
Notes

Contour Interval is 40 feet  
Scale 1" = 150'

File: LDPPE-5 3/17/94

J. W. Bihorn, Earth Sciences Consultants

Mammoth Mine



Notes

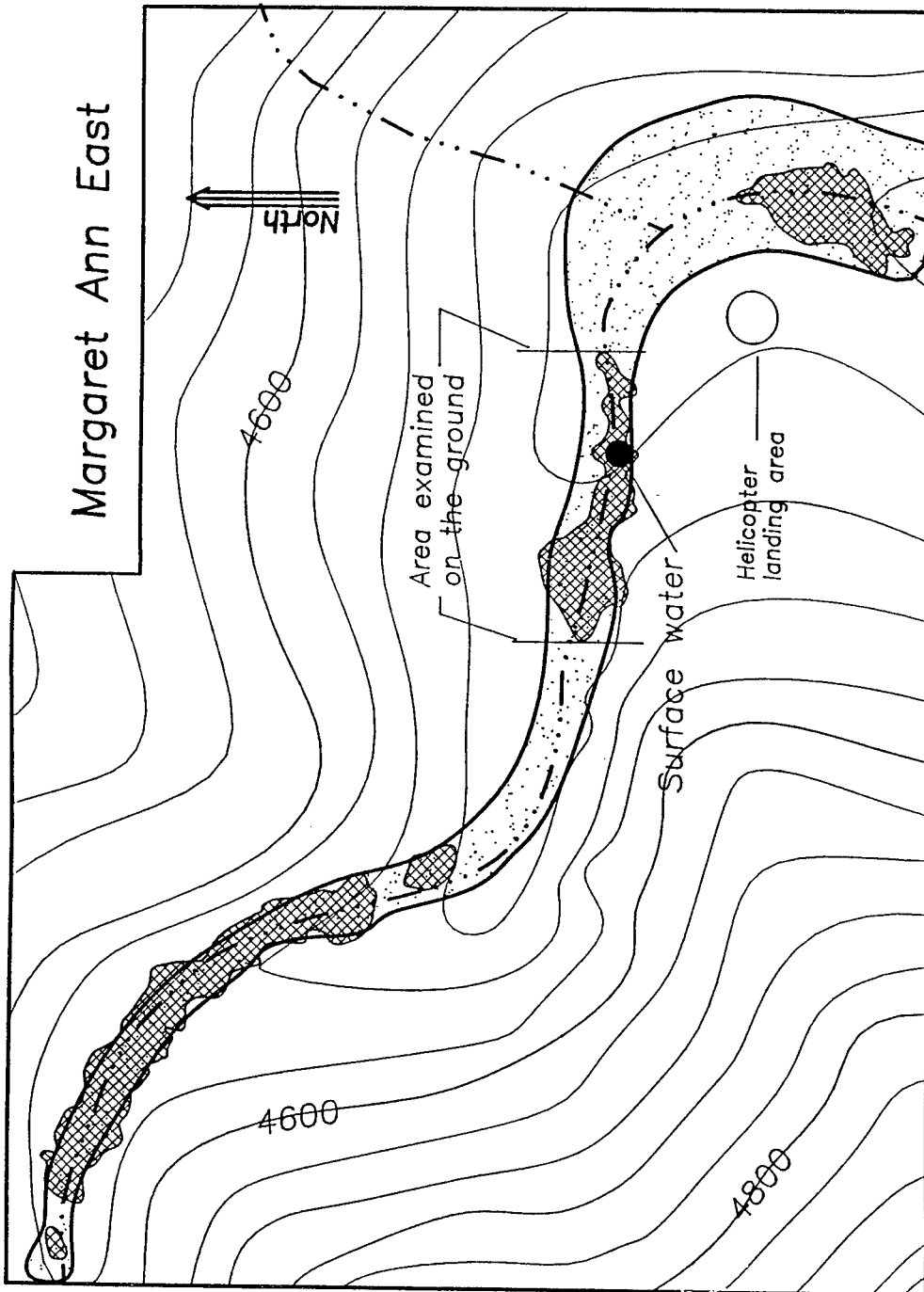
Contour interval is 40 feet  
 Scale 1" = 200'

Legend

- 5640 — Ground contour
- - - - - Dirt road
- — — — — Geologic contact
- — — — — Alluvium
- — — — — Intermittent stream
- — — — — Flowing surface water or pipe
- — — — — Arroyo willow
- — — — — Alluvium

T. W. Bihorn, Earth Sciences Consultants

Margaret Ann East



Legend

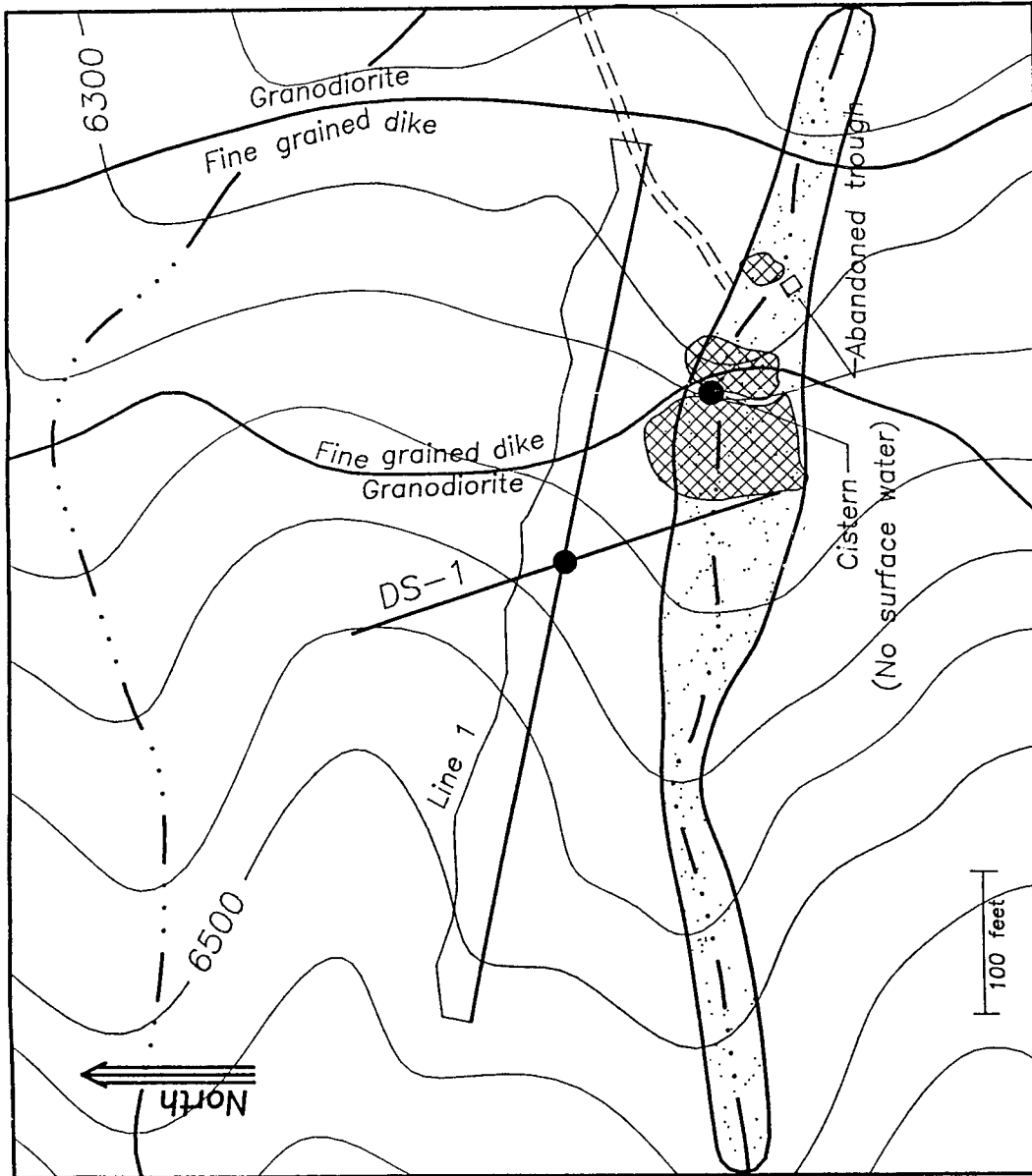
- 5640 — Ground contour
- --- Dirt road
- granodiorite  
Alluvium — Geologic contact
- · - · - Intermittent stream
- · - · - Fault plane, dipping toward symbol
- - - - - Flowing surface water or pipe
- ▨ Arroyo willow
- Alluvium

Notes

Contour interval is 40 feet  
 Scale 1" = 150'  
 File: M-Ann-3 3/17/94

T. W. Bilhorn, Earth Sciences Consultants

Mariposa



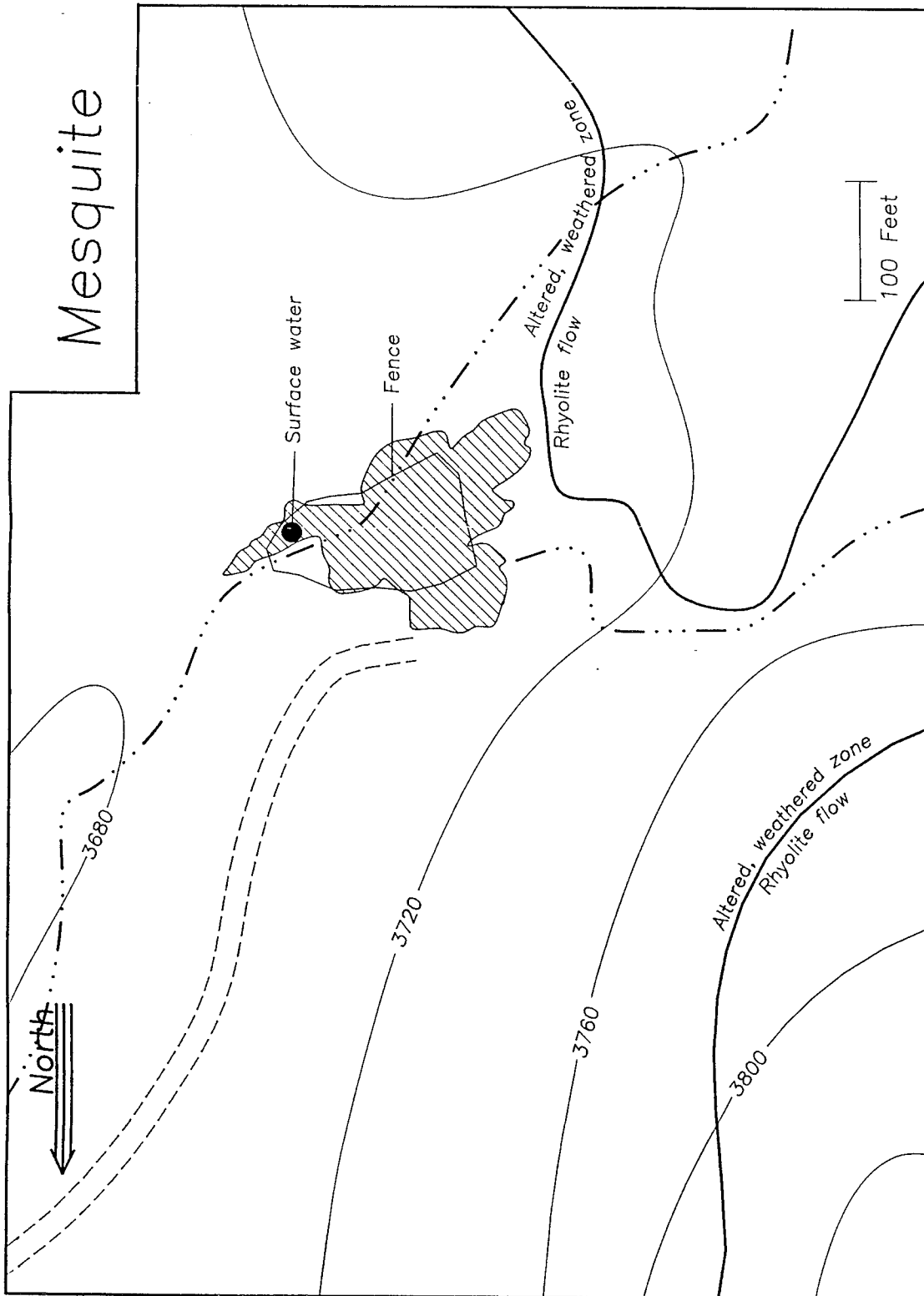
- Legend**
- 5640 — Ground contour
  - == Dashed line == Dirt road
  - granodiorite — Geologic contact
  - Alluvium — Intermittent stream
  - · - · - Fault plane, dipping toward symbol
  - - - - - Flowing surface water or pipe
  - Resistivity profile showing curve of resistivity
  - ⊗ Arrayo willow
  - ⊕ Alluvium

**Notes**

Contour Interval is 40 feet  
 Scale 1" = 100'

File: Marpos-5 3/17/94

T. W. Bilhorn, Earth Sciences Consultants



T. W. Bihorn, Earth Sciences Consultants

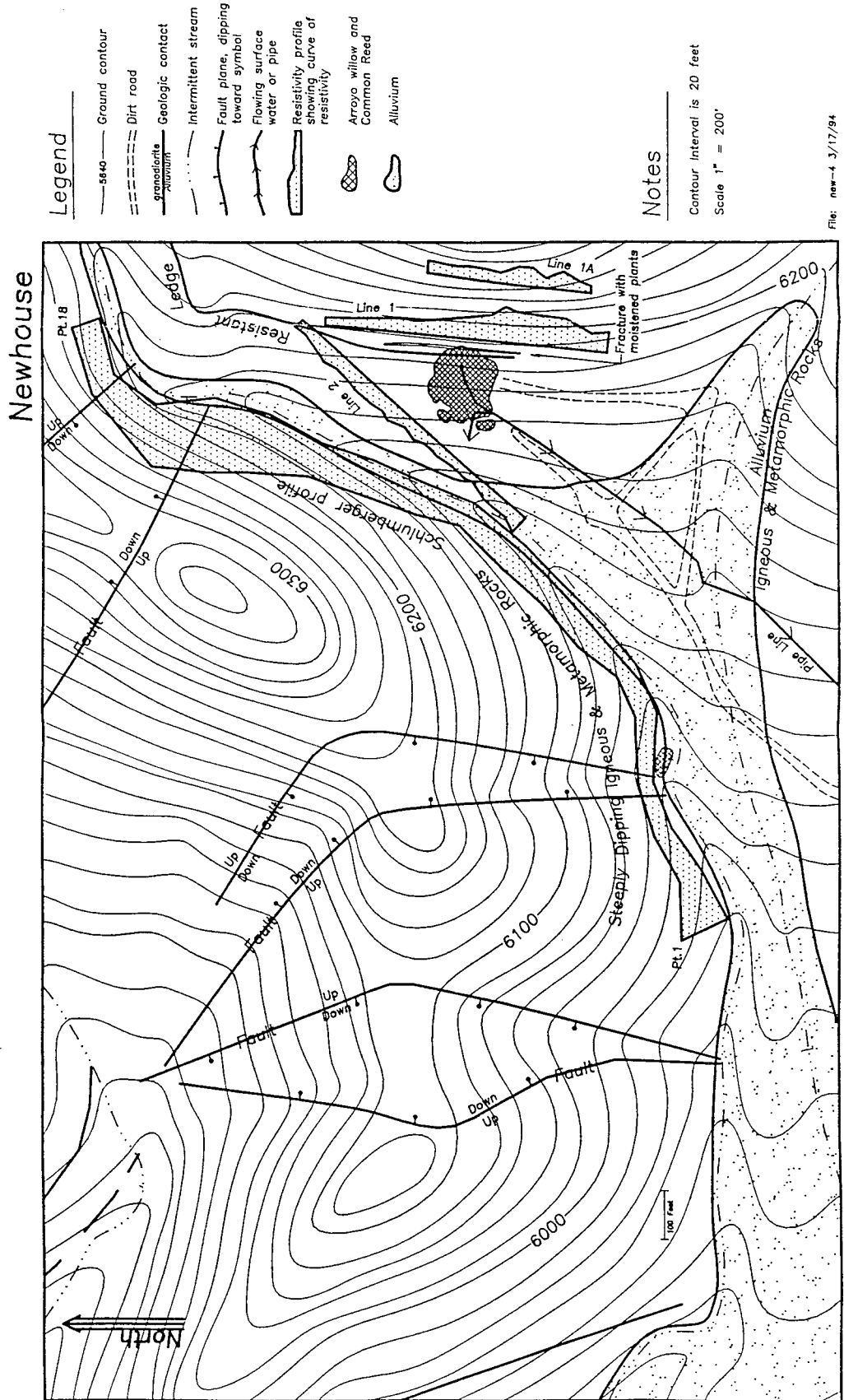
Notes

Contour Interval is 40 feet

Scale 1" = 50'

Legend

- 5640 — Ground contour
- == == == Dirt road
- ▬▬▬▬▬▬ Granodiorite
- ▬▬▬▬▬▬ Alluvium
- - - - - Intermittent stream
- ▬▬▬▬▬▬ Fault plane, dipping toward symbol
- ▬▬▬▬▬▬ Flowing surface water or pipe
- ▬▬▬▬▬▬ Resistivity profile showing curve of resistivity
- ▬▬▬▬▬▬ Mesquite (*Prosopis glandulosa*)



Legend

- 5840 — Ground contour
- --- Dirt road
- granodiorite  
--- plutium --- Geologic contact
- Intermittent stream
- Fault plane, dipping toward symbol
- Flowing surface water or pipe
- Resistivity profile showing curve of resistivity
- Arroyo willow and Common Reed
- Alluvium

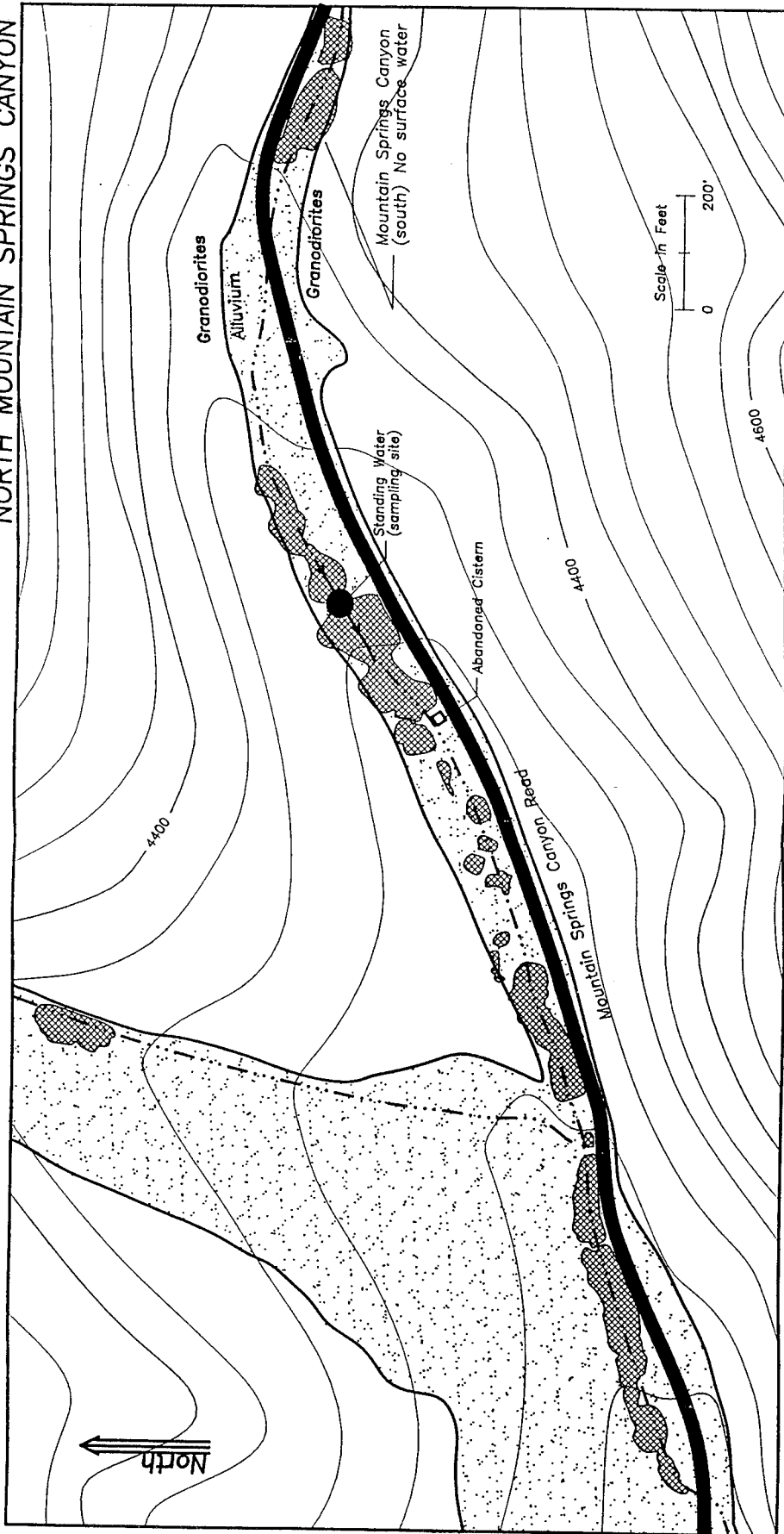
Notes

Contour Interval is 20 feet  
Scale 1" = 200'

File: naw-4\_3/17/94

T. W. Bihorn, Earth Sciences Consultants

NORTH MOUNTAIN SPRINGS CANYON



Legend

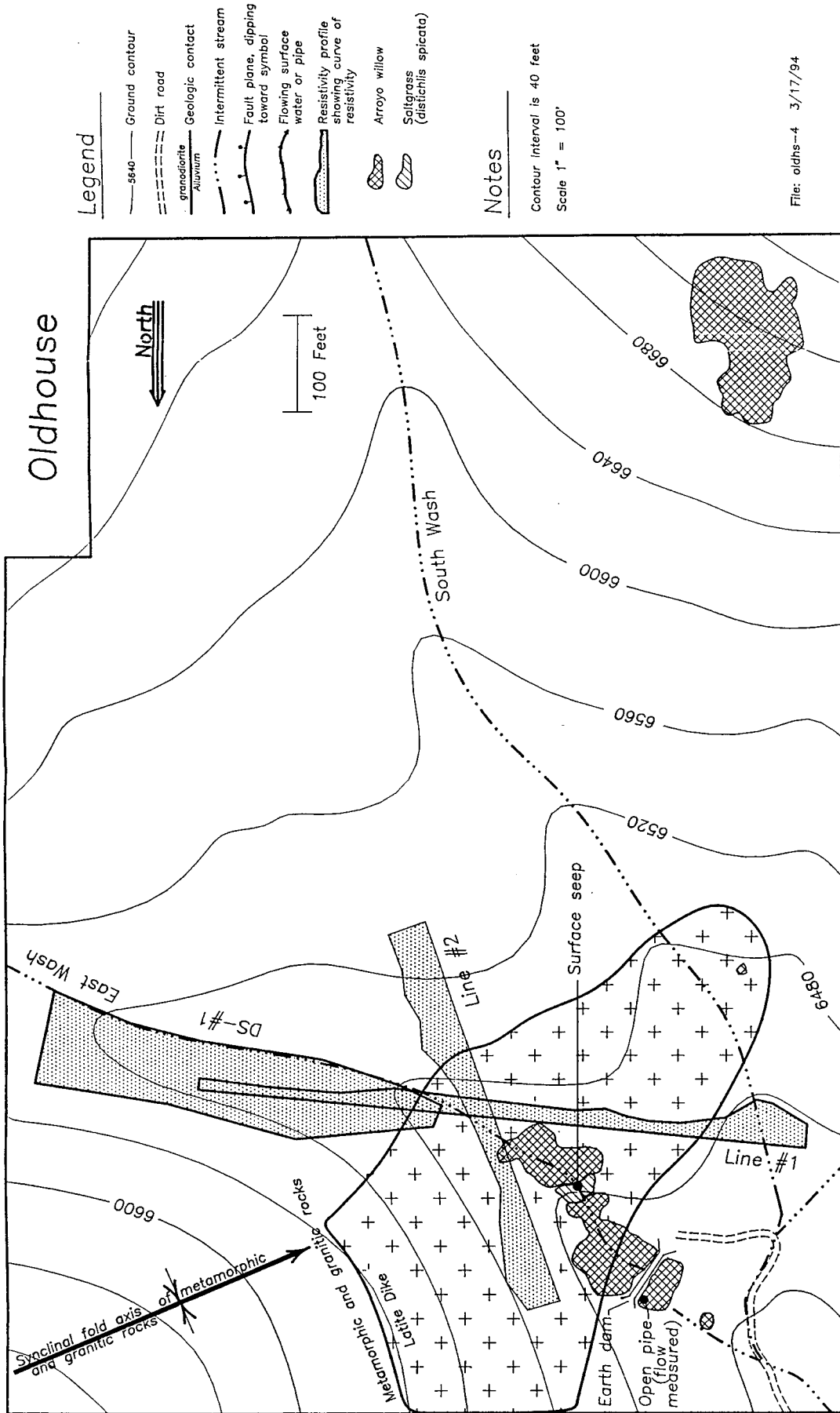
- 5640 — Ground contour
- - - - - Dirt road
- granodiorite
- ..... Alluvium
- Fault plane, dipping toward symbol
- Flowing surface water or pipe
- ⊞ Arroyo willow
- Alluvium

Notes

- Contour Interval is 40 feet
- Scale 1" = 200'

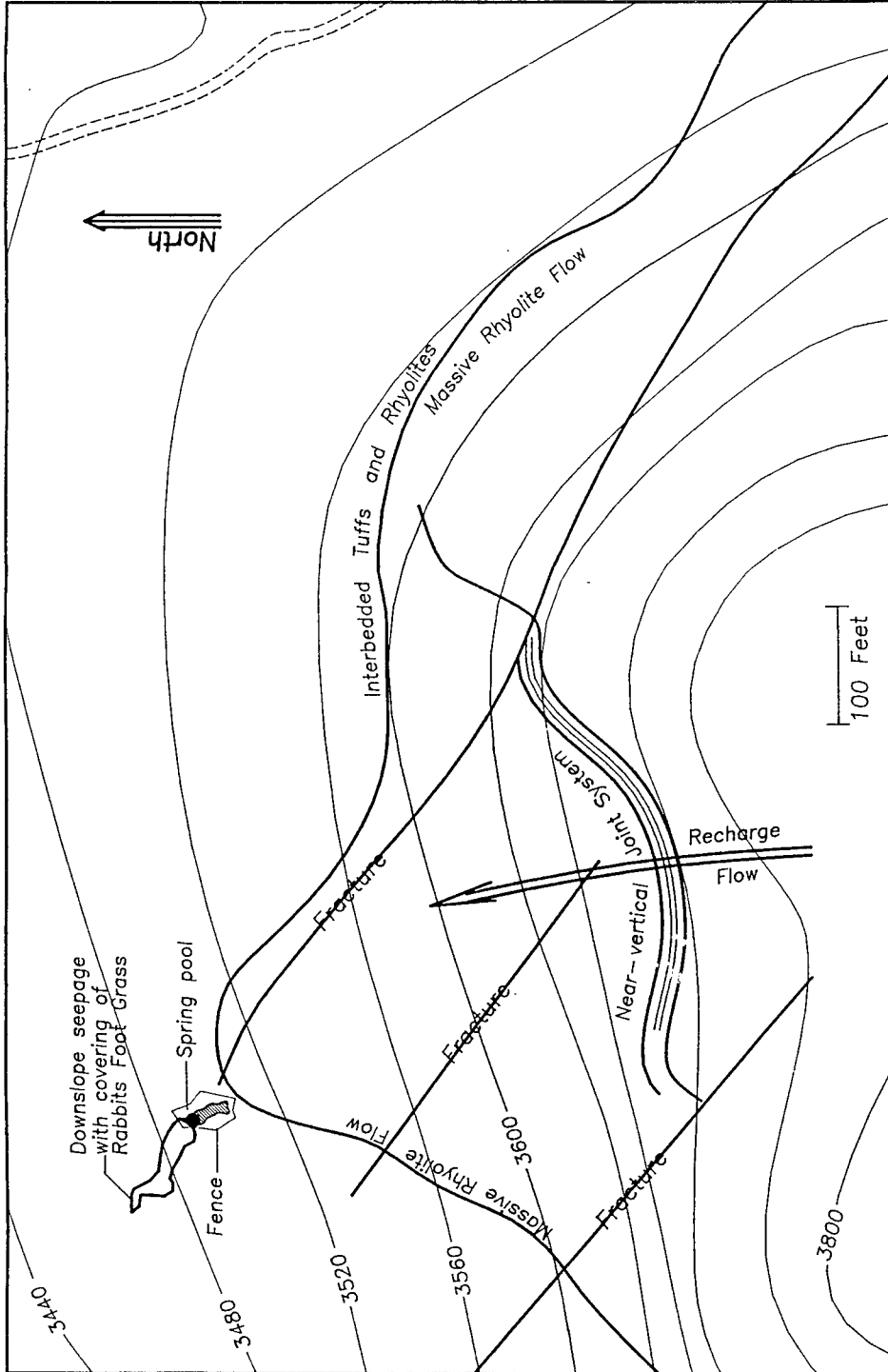
T. W. Bilhorn, Earth Sciences Consultants

File: nmin-5 2/10/94



T. W. Bihorn, Earth Sciences Consultants

Pink Hill



Legend

- 5640 — Ground contour
- --- Dirt road
- ==== granodiorite
- ==== Alluvium
- --- Geologic contact
- --- Intermittent stream
- --- Fault plane, dipping toward symbol
- --- Flowing surface water or pipe
- --- Resistivity profile showing curve of resistivity
- --- Typha

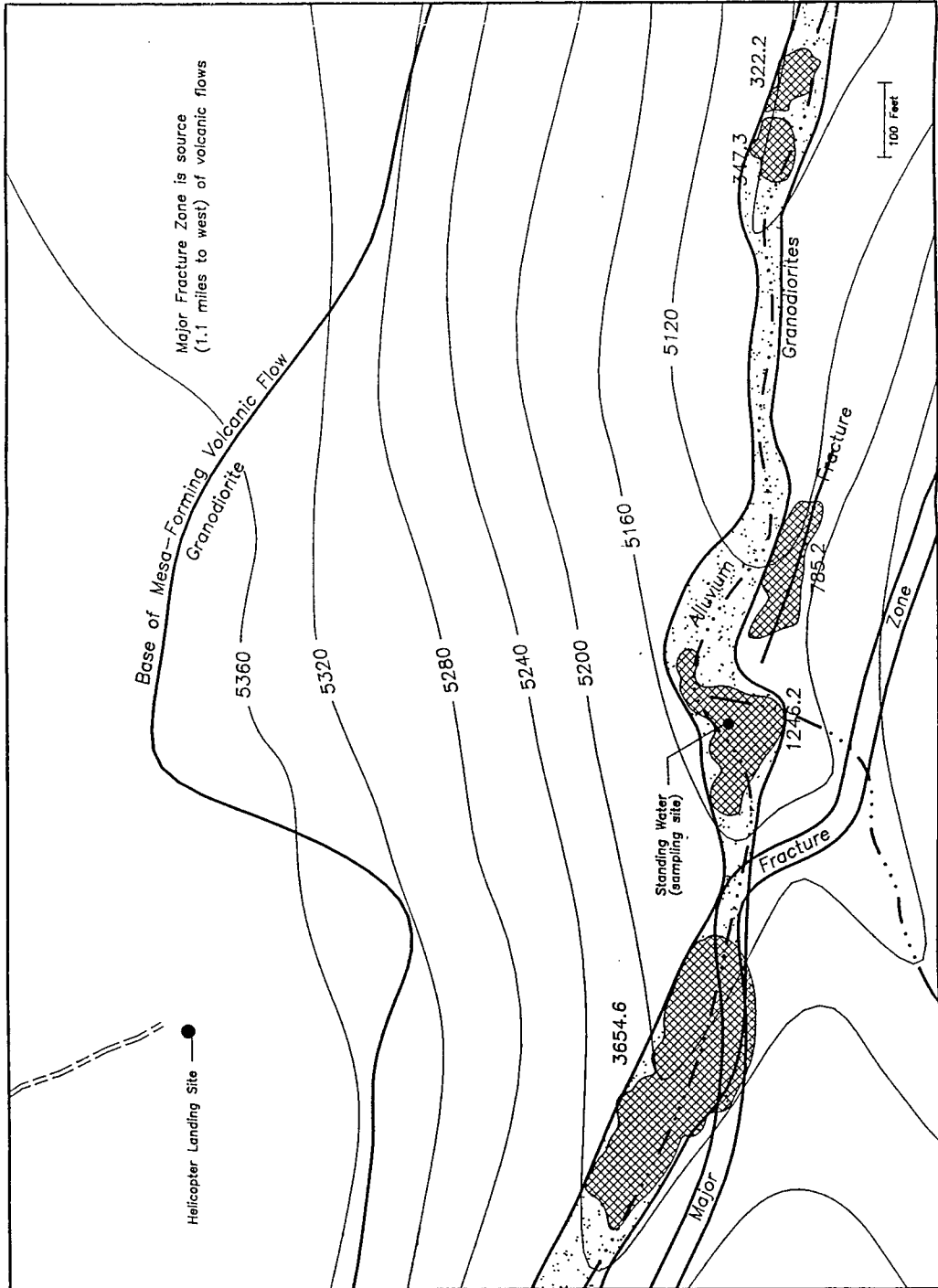
Notes

Contour Interval is 40 feet  
Scale 1" = 100'

File: pkhill-6 3/17/94

T. W. Bihorn, Earth Sciences Consultants

Ruby West



Legend

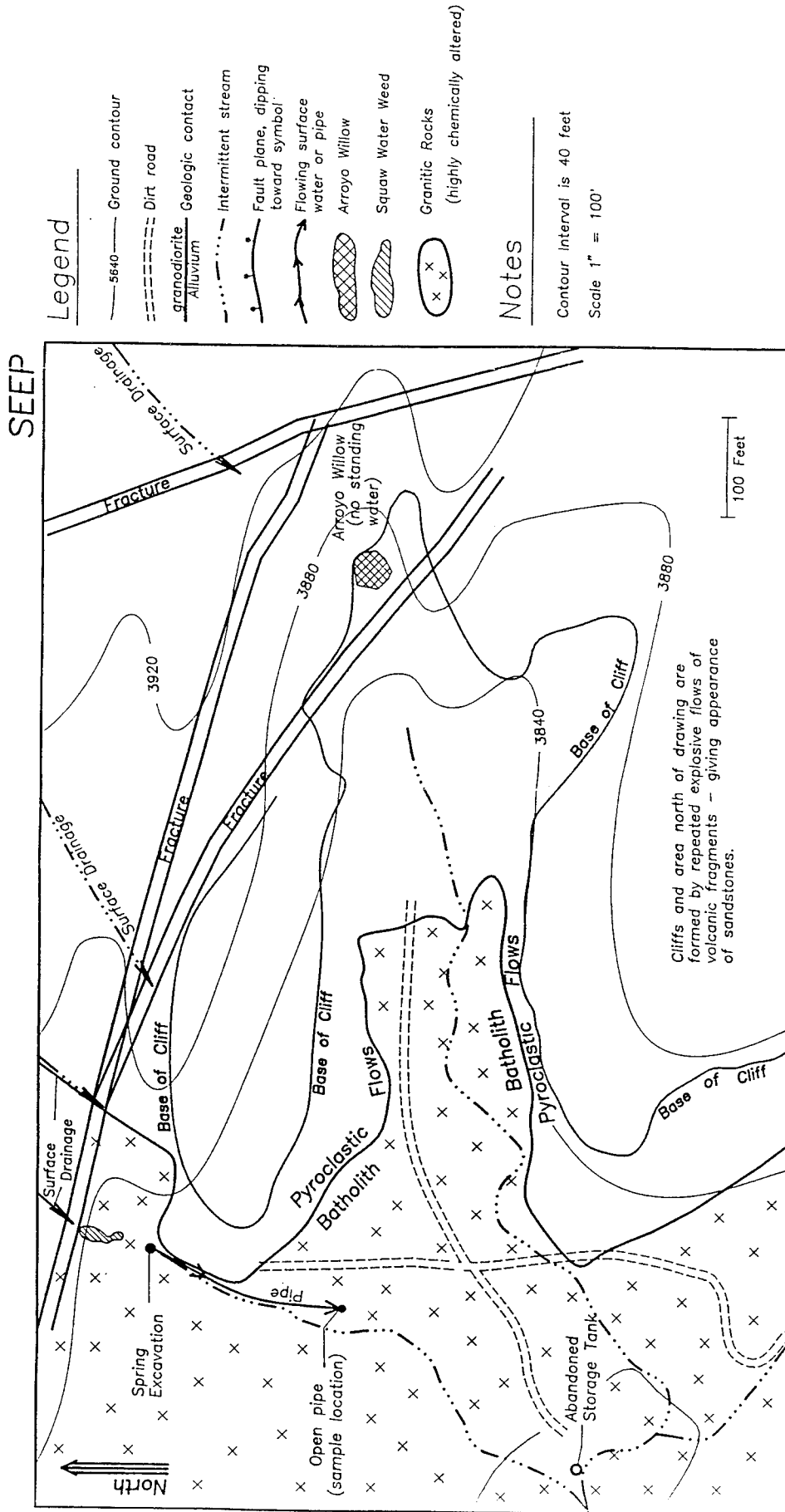
- 5640 — Ground contour
- - - - - Dirt road
- granodiorite — Geologic contact
- Alluvium — Intermittent stream
- Fault plane, dipping toward symbol
- Flowing surface water or pipe
- Resistivity profile showing curve of resistivity
- 6,355.5 Arroyo willow
- Alluvium

Notes

- Contour Interval is 40 feet
- Scale 1" = 150'

File: Ruby 5 3/17/94

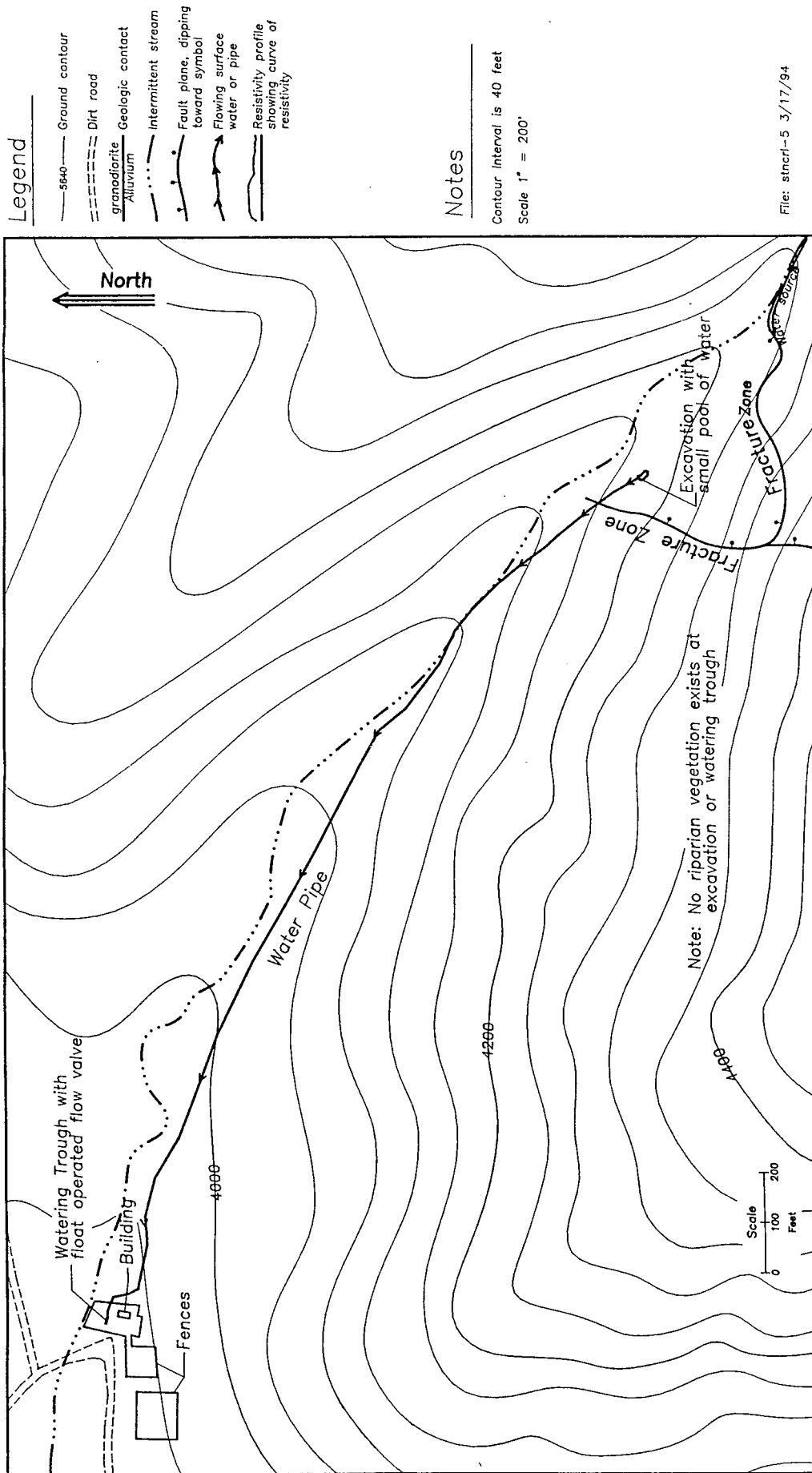
T. W. Bihorn, Earth Sciences Consultants



File: Seep-6 3/17/94

T. W. Bithorn, Earth Sciences Consultants

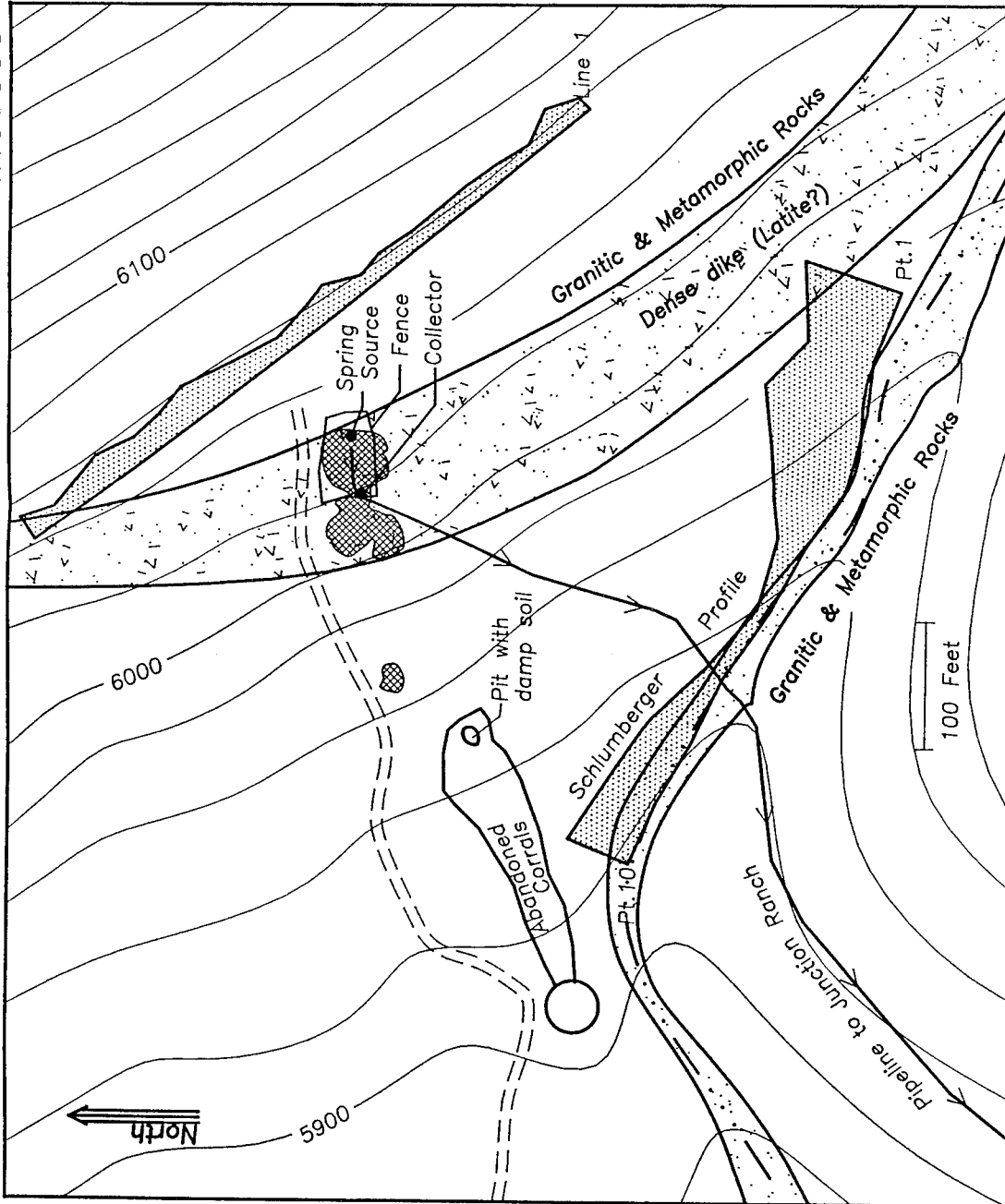
Stone Corral



File: stncr1-5 3/17/94

T. W. Bihorn, Earth Sciences Consultants

Tennessee



Legend

- 5640 — Ground contour
- — — — — Dirt road
- granodiorite  
Alluvium — — — — — Geologic contact
- · · · — Intermittent stream
- · — · — Fault plane, dipping toward symbol
- — — — — Flowing surface water or pipe
- Resistivity profile showing curve of resistivity
- Arroyo willow
- Alluvium

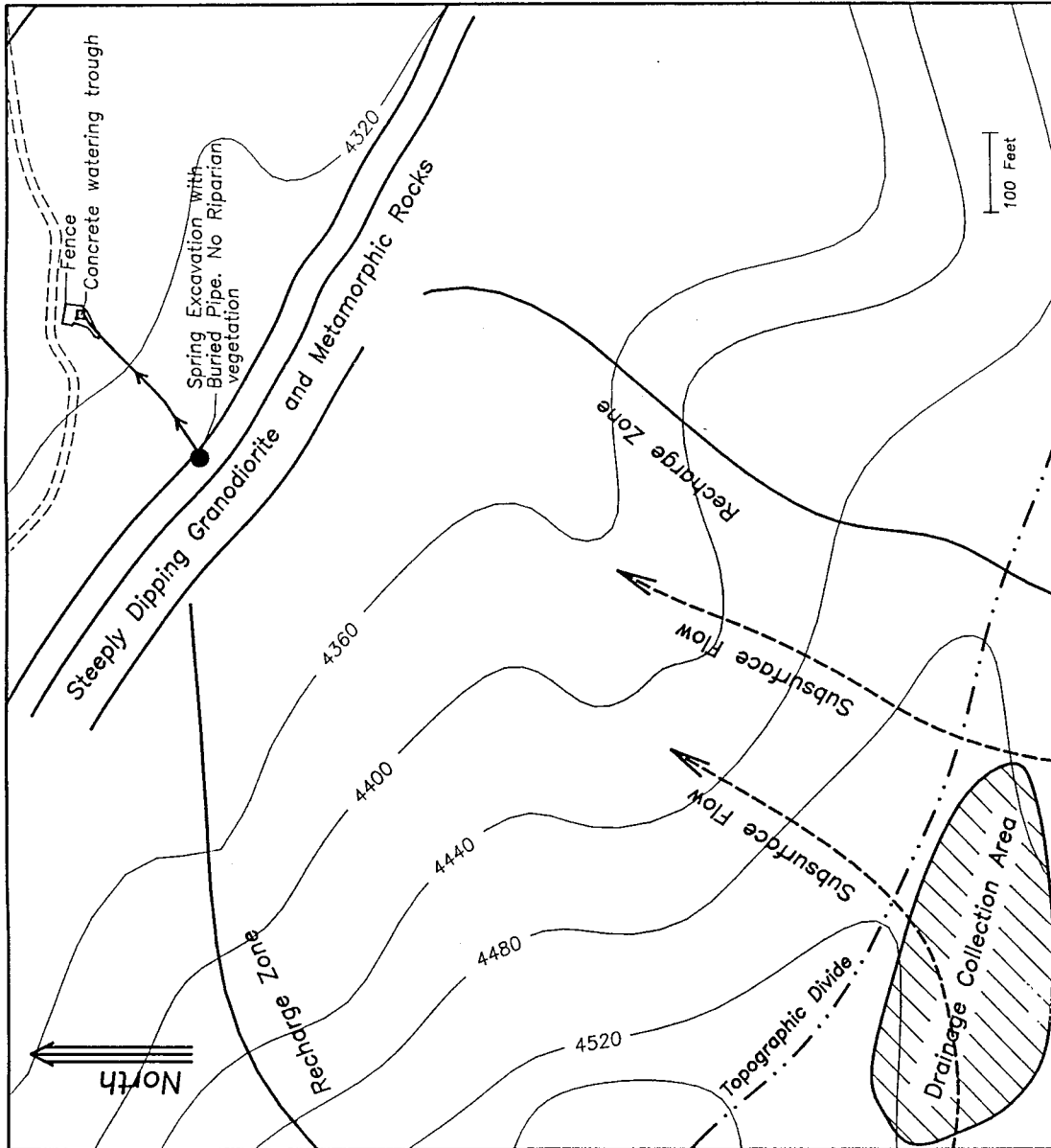
Notes

Contour Interval is 20 feet  
Scale 1" = 100'

File: Tenes-6 3/17/94

T. W. Bilhorn, Earth Sciences Consultants

Upper Tunnel



Legend

- 5640 — Ground contour
- - - - - Dirt road
- granodiorite — Geologic contact
- Alluvium — Intermittent stream
- · - · - Fault plane, dipping toward symbol
- Flowing surface water or pipe
- Resistivity profile showing curve of resistivity

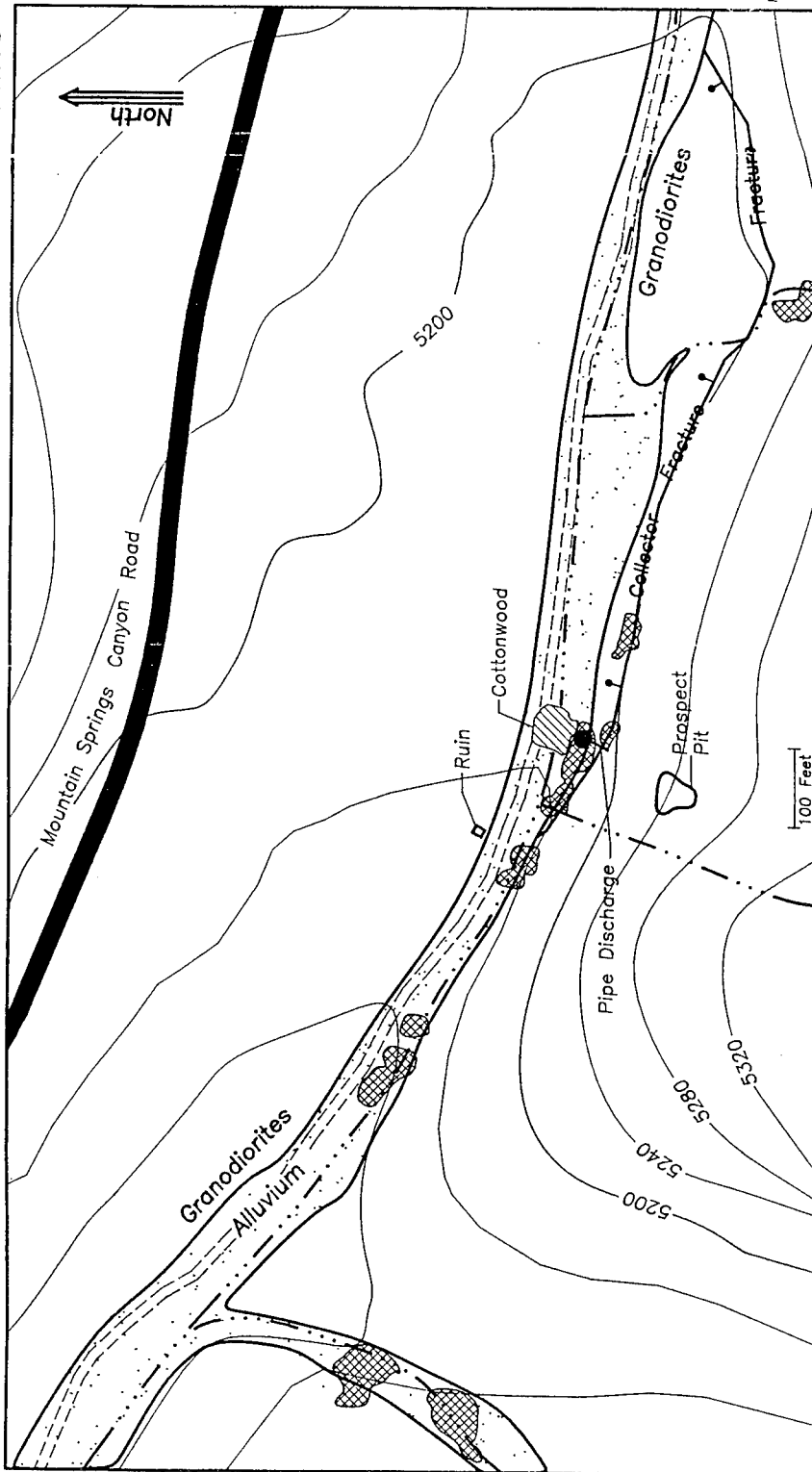
Notes

Contour Interval is 40 feet  
Scale 1" = 150'

File: Uptunn--. 3/17/94

T. W. Bilhorn, Earth Sciences Consultants

Wild Rose Mine



Legend

- 5640 Ground contour
- - - - - Dirt road
- · - · - · - Granodiorite
- · - · - · - Alluvium
- · - · - · - Intermittent stream
- - - - - Fault plane, dipping toward symbol
- - - - - Flowing surface water or pipe
- ▨ Arroyo willow
- Alluvium

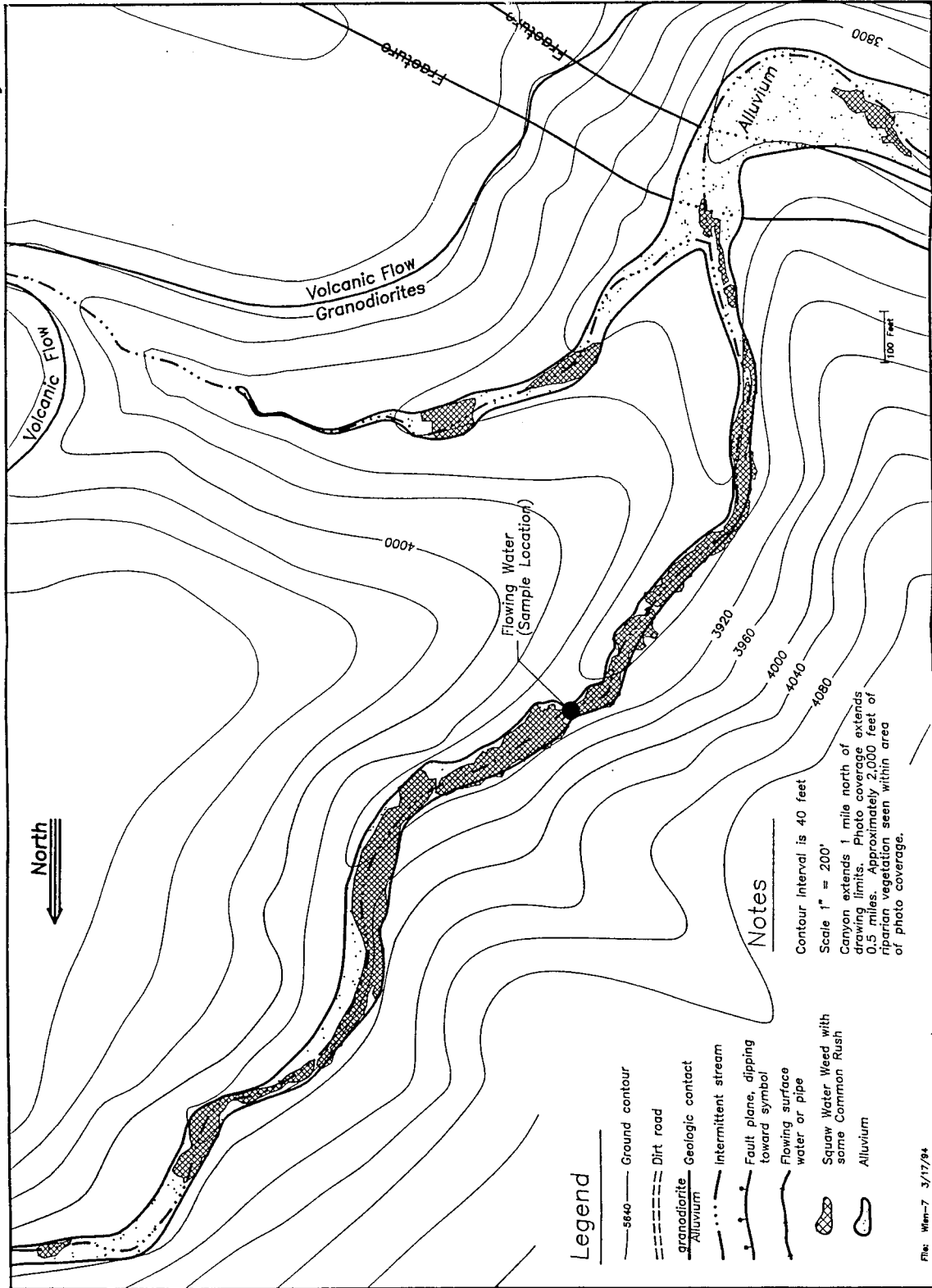
Notes

Contour Interval is 40 feet  
Scale 1" = 150'

File wdros-4 3/17/94

T. W. Bihorn, Earth Sciences Consultants

Wilson Canyon



T. W. Bihorn, Earth Sciences Consultants