CONTACT INFORMATION
Mining Records Curator
Arizona Geological Survey
3550 N. Central Ave, 2nd floor
Phoenix, AZ, 85012
602-771-1601
http://www.azgs.az.gov
inquiries@azgs.az.gov

The following file is part of the Walter E. Heinrichs, Jr. Mining Collection

ACCESS STATEMENT

These digitized collections are accessible for purposes of education and research. We have indicated what we know about copyright and rights of privacy, publicity, or trademark. Due to the nature of archival collections, we are not always able to identify this information. We are eager to hear from any rights owners, so that we may obtain accurate information. Upon request, we will remove material from public view while we address a rights issue.

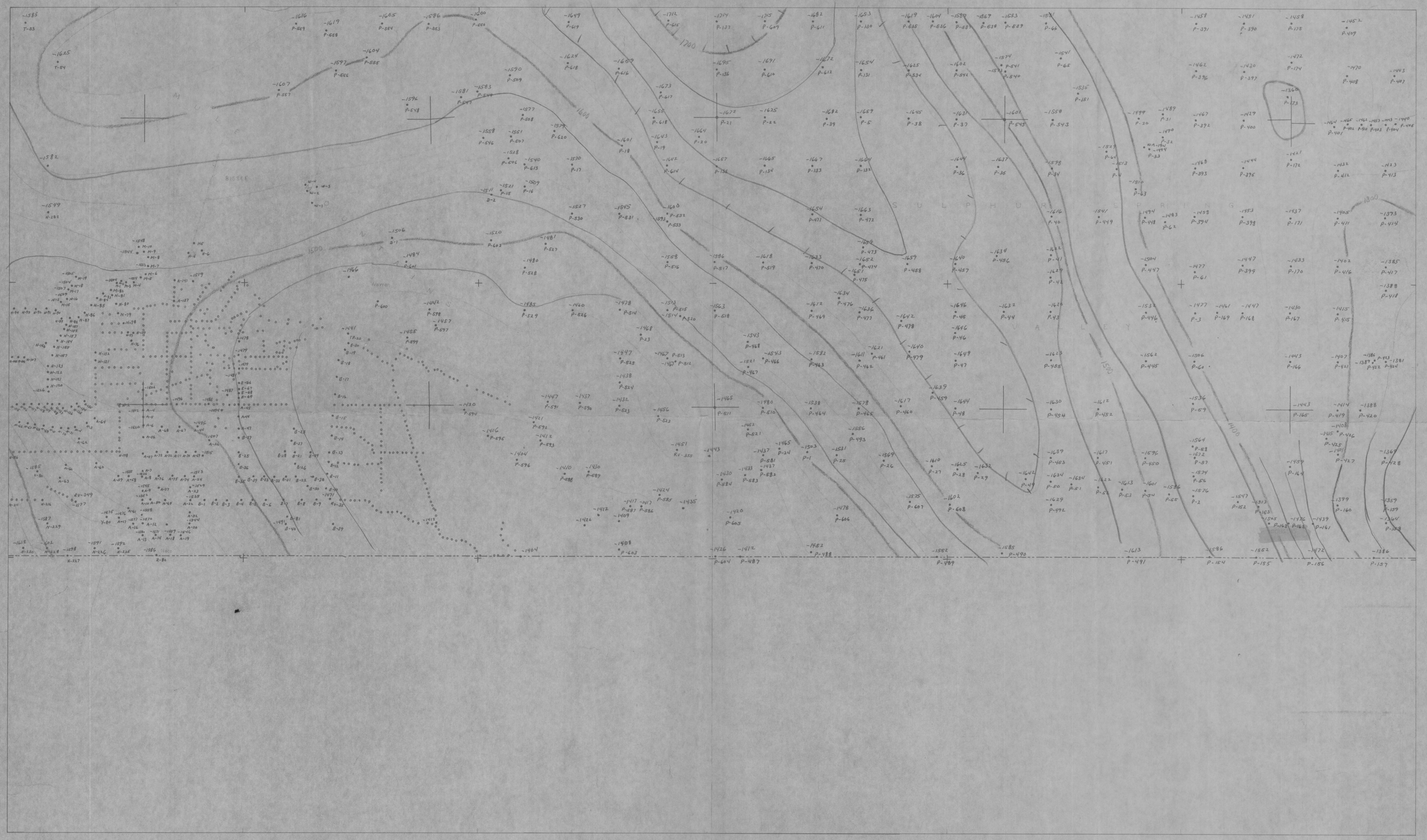
CONSTRAINTS STATEMENT

The Arizona Geological Survey does not claim to control all rights for all materials in its collection. These rights include, but are not limited to: copyright, privacy rights, and cultural protection rights. The User hereby assumes all responsibility for obtaining any rights to use the material in excess of "fair use."

The Survey makes no intellectual property claims to the products created by individual authors in the manuscript collections, except when the author deeded those rights to the Survey or when those authors were employed by the State of Arizona and created intellectual products as a function of their official duties. The Survey does maintain property rights to the physical and digital representations of the works.

QUALITY STATEMENT

The Arizona Geological Survey is not responsible for the accuracy of the records, information, or opinions that may be contained in the files. The Survey collects, catalogs, and archives data on mineral properties regardless of its views of the veracity or accuracy of those data.



LEGEND

- P-214 — GRAVITY STATION
- 160 — BOUGUER GRAVITY CONTOUR
- MINE
- SHAFT
- PROSPECT
- DRILL HOLE
- WELL, CHARACTER NOT INDICATED
- OUTCROP BOUNDARY
- 9 — SAMPLE SITE
- A — A' — SECTION

N

SEP 29 1978

1 MILE 0 1 2 3 4 MILES

WESTERN EXPLORATION OFFICE PHELPS DODGE CORPORATION

SCALE	H. 1: 62,500	CONTOUR INTERVAL:		REVISIONS
	V:	DATE:	BY:	
SHEET OF		DRAWING NO:		FILE:

SAN BERNARDINO VALLEY

MOUNTAINS

-1460
P-436

-1425
P-434
-1428
P-432
-1418
P-431
-1438
P-433
-1429
P-429

-1412
P-430
-1427
P-436

-1430
P-439
-1395
P-435
-1384
P-437
-1404
P-438

-1378
P-444
-1389
P-443
P-440
-1396
P-442
-1392
P-441
-1400

-1369
P-500
-1369
P-501
-1393
P-502
-1356
P-504
-1367
P-499
-1337
P-503
-1346
P-505
-1347
P-498
-1343
P-496
-1326
P-495

-1337
P-481
-1336
P-497
-1322
P-494
-1351
P-482
-1324
P-480

-1335
P-484
-1364
P-485
-1351
P-486
-1377
P-483

LEGEND

P-214 ○ GRAVITY STATION	○ DRILL HOLE
~160~ BOUGUER GRAVITY CONTOUR	○ WELL, CHARACTER NOT INDICATED
⚒ MINE	OUTCROP BOUNDARY
SHAFT	✓9 SAMPLE SITE
× PROSPECT	A — A' SECTION

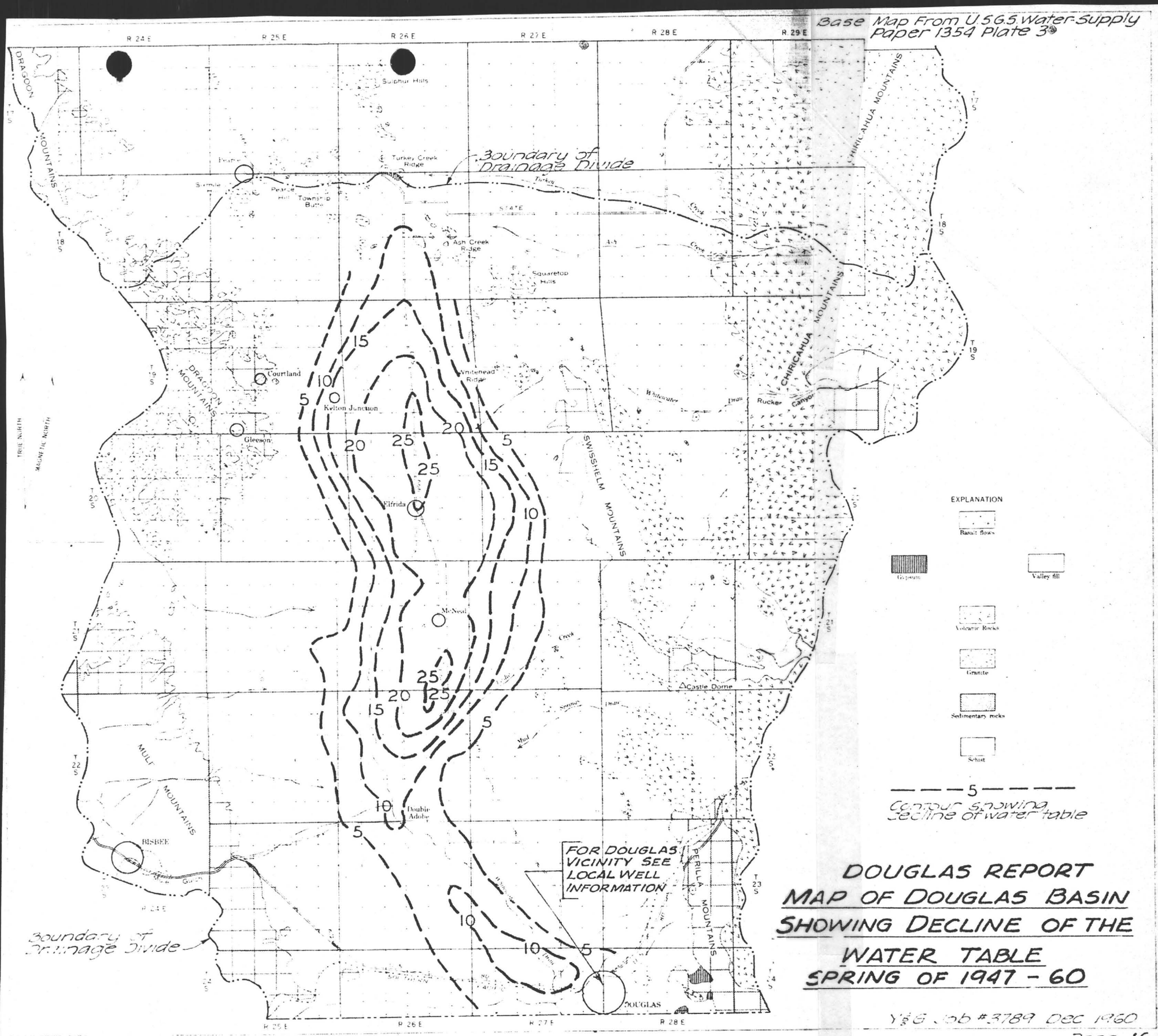
N

SEP 29 1978

1 MILE 0 1 2 3 4 MILES

WESTERN EXPLORATION OFFICE PHELPS DODGE CORPORATION

SCALE	H: 1:62,500	CONTOUR INTERVAL:	REVISIONS
	V:	DATE: BY:	
SHEET OF		DRAWING NO:	FILE:



DOUGLAS REPORT
MAP OF DOUGLAS BASIN SHOWING DECLINE OF THE WATER TABLE SPRING OF 1947 - 60

Y&E Job #3789 Dec 1960

MEMO TO: Walt

TIME: 9:15

DATE: 1.22.79

Re: Jo 6129 5

NAME: Mc Bee

FIRM: Willcox

PHONE:

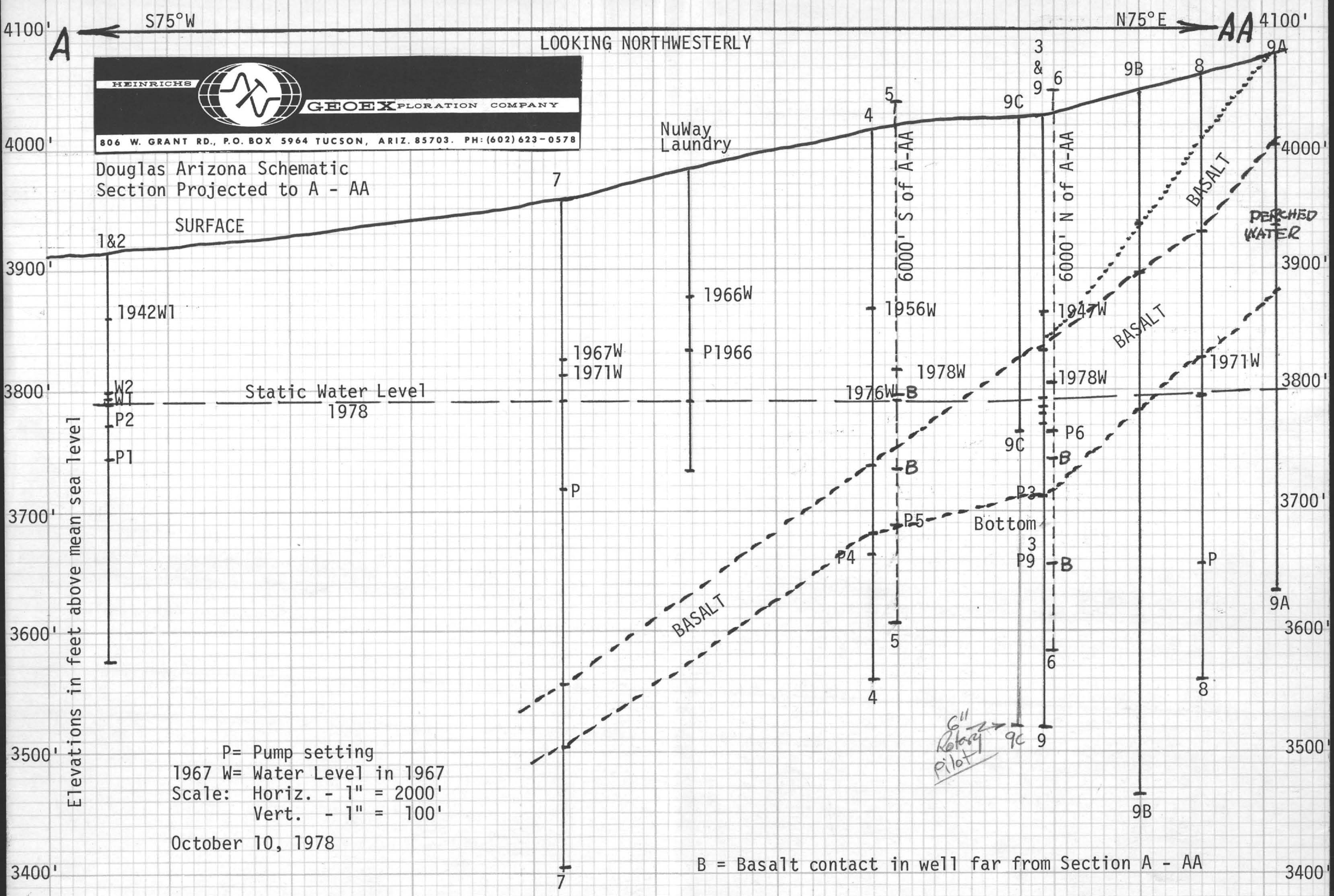
- [x] TELEPHONED
- [ ] RETURNED YOUR CALL
- [ ] PLEASE CALL
- [ ] WILL CALL AGAIN
- [ ] WAS IN
- [ ] WILL CALL AGAIN
- [ ] _____

Is coming to Tucson today for Drs appt. He will call you when he gets here

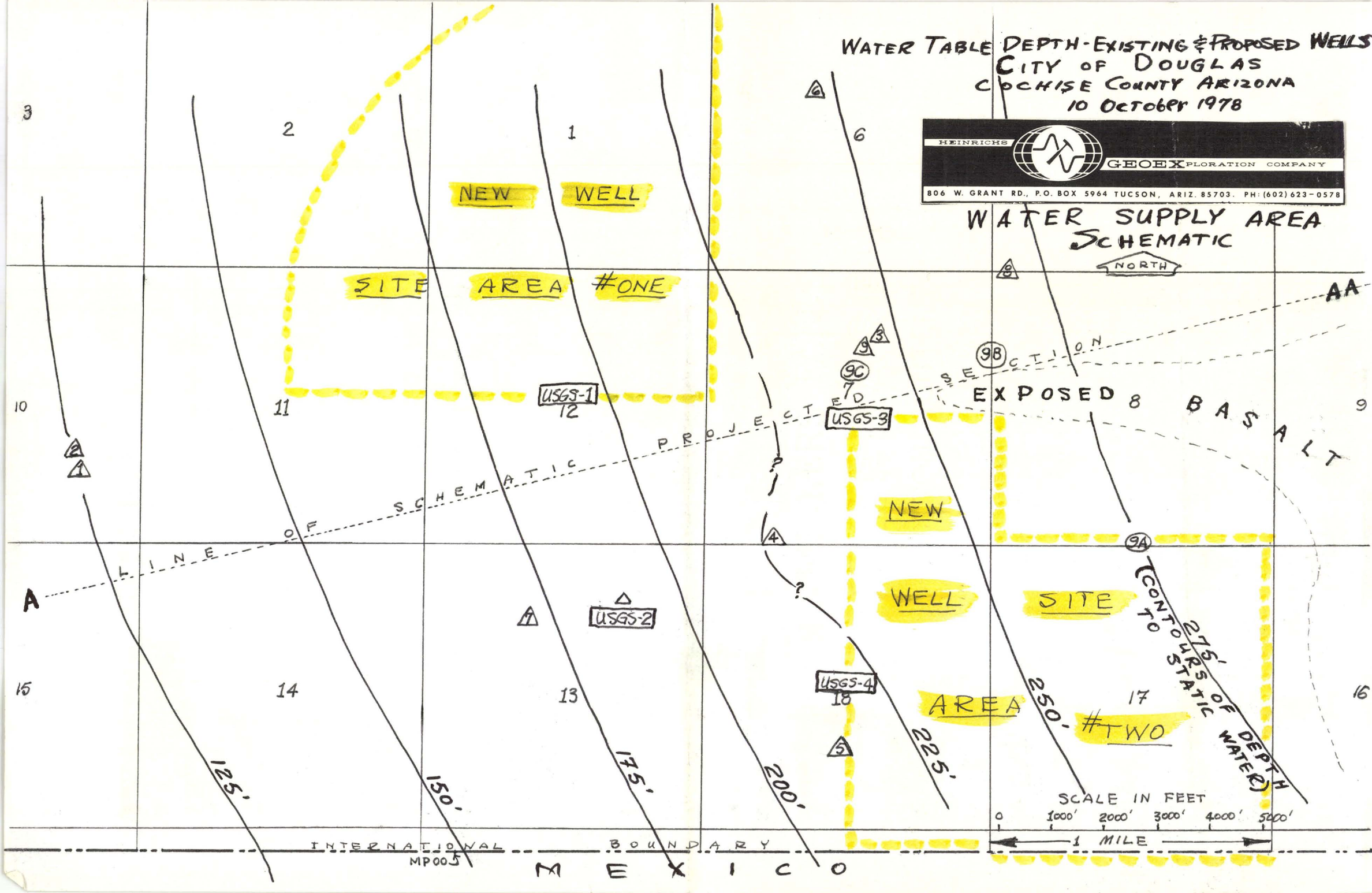
M.

ZELLERBACH PAPER COMPANY

ZB-530 REV. 10-70



A
S75°W
N75°E
AA
LOOKING NORTHWESTERLY
HEINRICHS GEOEXPLORATION COMPANY
806 W. GRANT RD., P.O. BOX 5964 TUCSON, ARIZ. 85703. PH: (602) 623-0578
Douglas Arizona Schematic
Section Projected to A - AA
SURFACE
NuWay Laundry
Static Water Level 1978
Elevations in feet above mean sea level
4100'
4000'
3900'
3800'
3700'
3600'
3500'
3400'
1&2
1942W1
W2
W1
P2
P1
7
1967W
1971W
P
1966W
P1966
4
5
6000' S of A-AA
1956W
1978W
1976W
B
P5
P4
9C
3 & 9
6
6000' N of A-AA
1947W
1978W
P6
P3
Bottom
3
P9
9
9B
8
9A
BASALT
1971W
PERCHED WATER
6" Rotary Pilot
9C
P= Pump setting
1967 W= Water Level in 1967
Scale: Horiz. - 1" = 2000'
Vert. - 1" = 100'
October 10, 1978
B = Basalt contact in well far from Section A - AA


WATER TABLE DEPTH - EXISTING & PROPOSED WELLS
CITY OF DOUGLAS
COCHISE COUNTY ARIZONA
10 OCTOBER 1978
HEINRICHS GEOEXPLORATION COMPANY
806 W. GRANT RD., P.O. BOX 5964 TUCSON, ARIZ. 85703. PH: (602) 623-0578
WATER SUPPLY AREA SCHEMATIC
NORTH
NEW WELL SITE AREA #ONE
NEW WELL SITE AREA #TWO
USGS-1
USGS-2
USGS-3
USGS-4
EXPOSED BASALT
SECTION
AA
A
LINE OF SCHEMATIC PROJECTED
INTERNATIONAL BOUNDARY
MP005
MEXICO
125'
150'
175'
200'
225'
250'
275' CONTOURS OF STATIC DEPTH TO WATER)
SCALE IN FEET
0 1000' 2000' 3000' 4000' 5000'
1 MILE

CITY OF DOUGLAS
WATER DEPT.
425 - 10th ST.
DOUGLAS, AZ. 85607

Pump Test

Agua Prieta Well #4

Pump Setting 220'

6" Pump

1750 to 2000 RPM

For 24 Hours

240 gpm

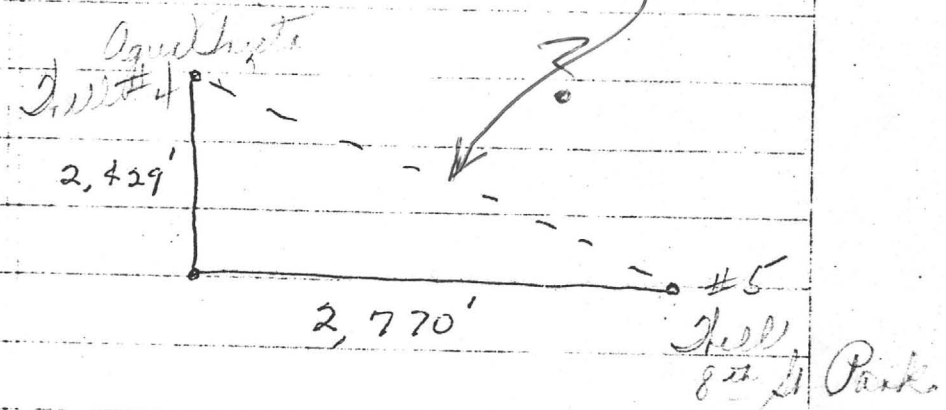
DIST FROM WELL
8TH ST. PART TO
WELL IN AGUA PRIETA SON.
MEX

SOUTH = ±2,429 FT.

EAST = ±2,770 FT

Hypotnes - 3684"

Tony Rivera figured this.



$$\sqrt{(2,429)^2 + 2,770^2}$$

+

CITY OF DOUGLAS
WATER DEPT.
425 - 10th ST.
DOUGLAS, AZ. 85607

Pozo no.—

Propietario,— J.F.A.P.

Predio.—

Lugar.—

Mpio. Edo.— Agua Prieta, Sonora

Perforó.—

Niv. Est. de la Región.— 75.70 m.

Interpreto.—

Operó Reg. Eléctrico.— Eustorgio Vejar D.

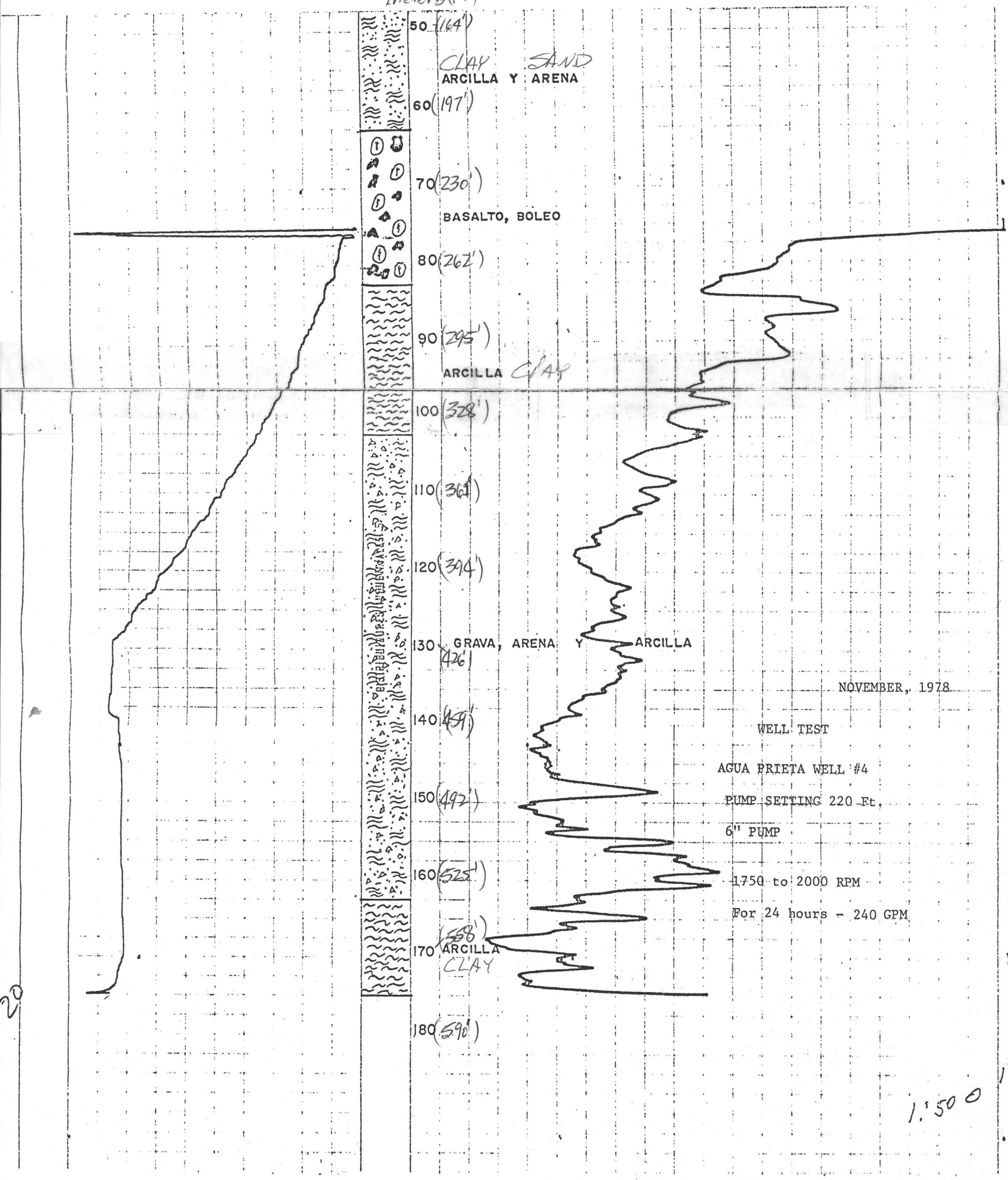
Profundidad del Sondeo.— 176.70 m.

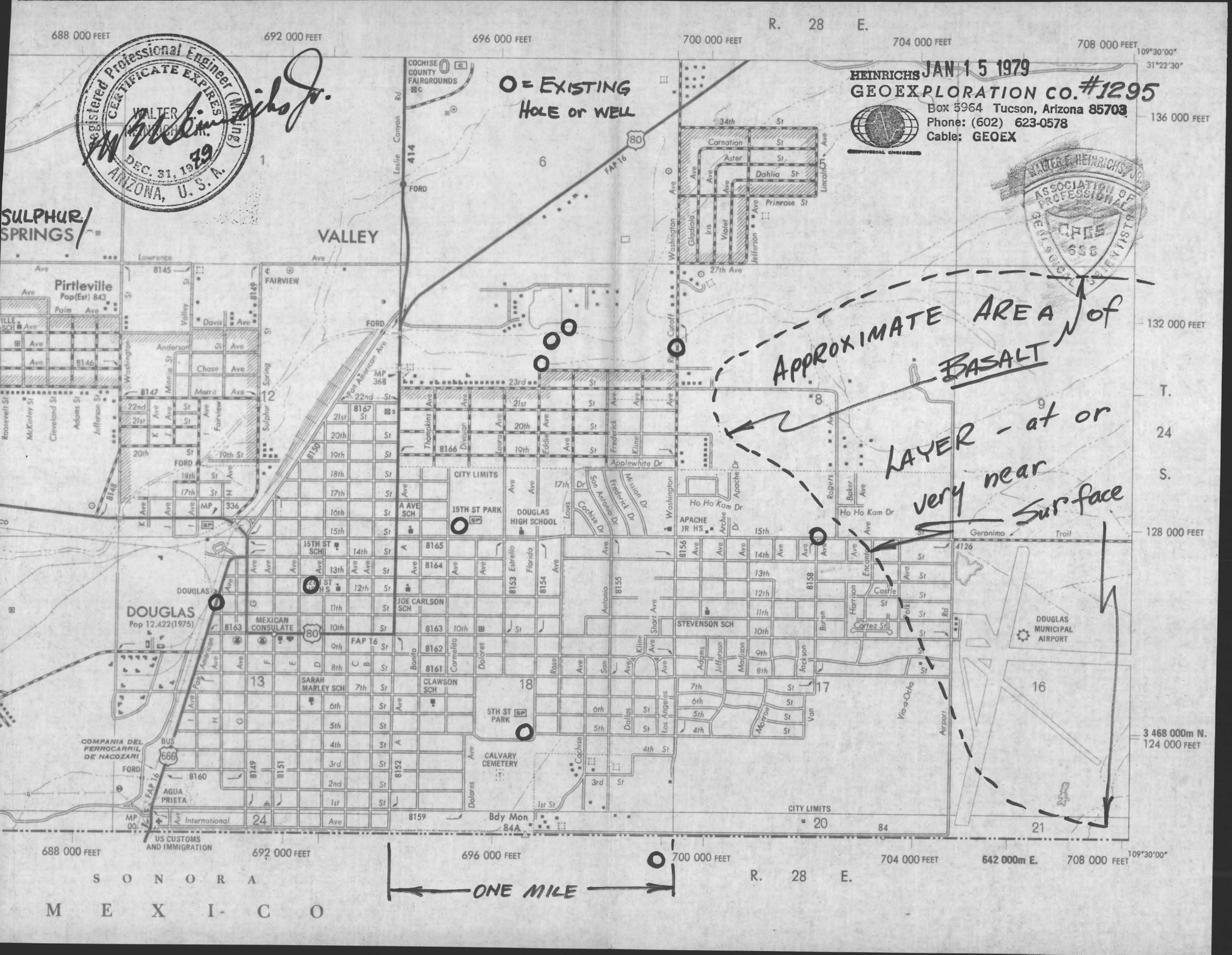
Esc. Vertical.— 1: 500

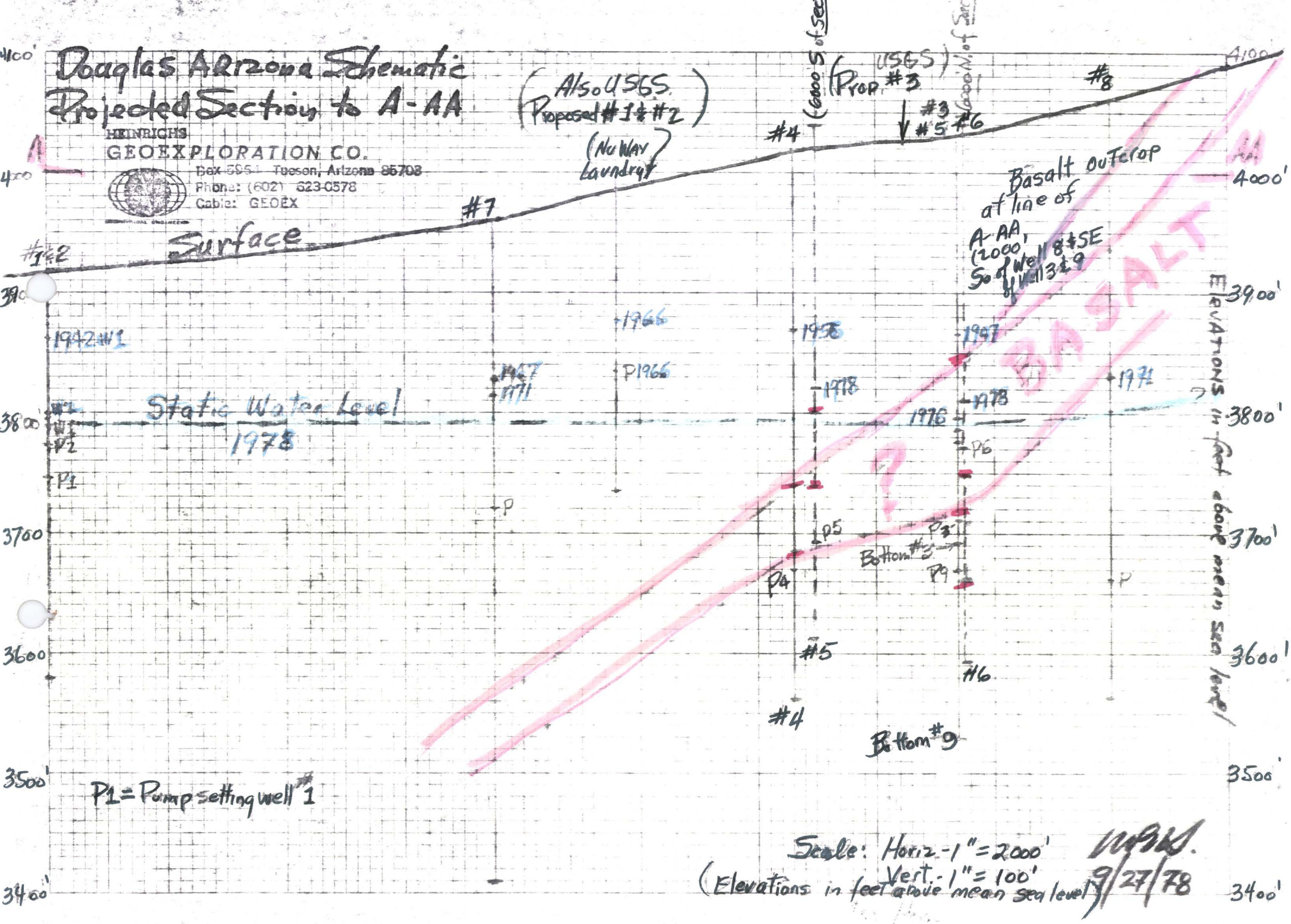
Fecha.— Julio 21 de 1976

20 MV/pulgada (INCH)

2.5 OHM-M/pulgada (INCH)

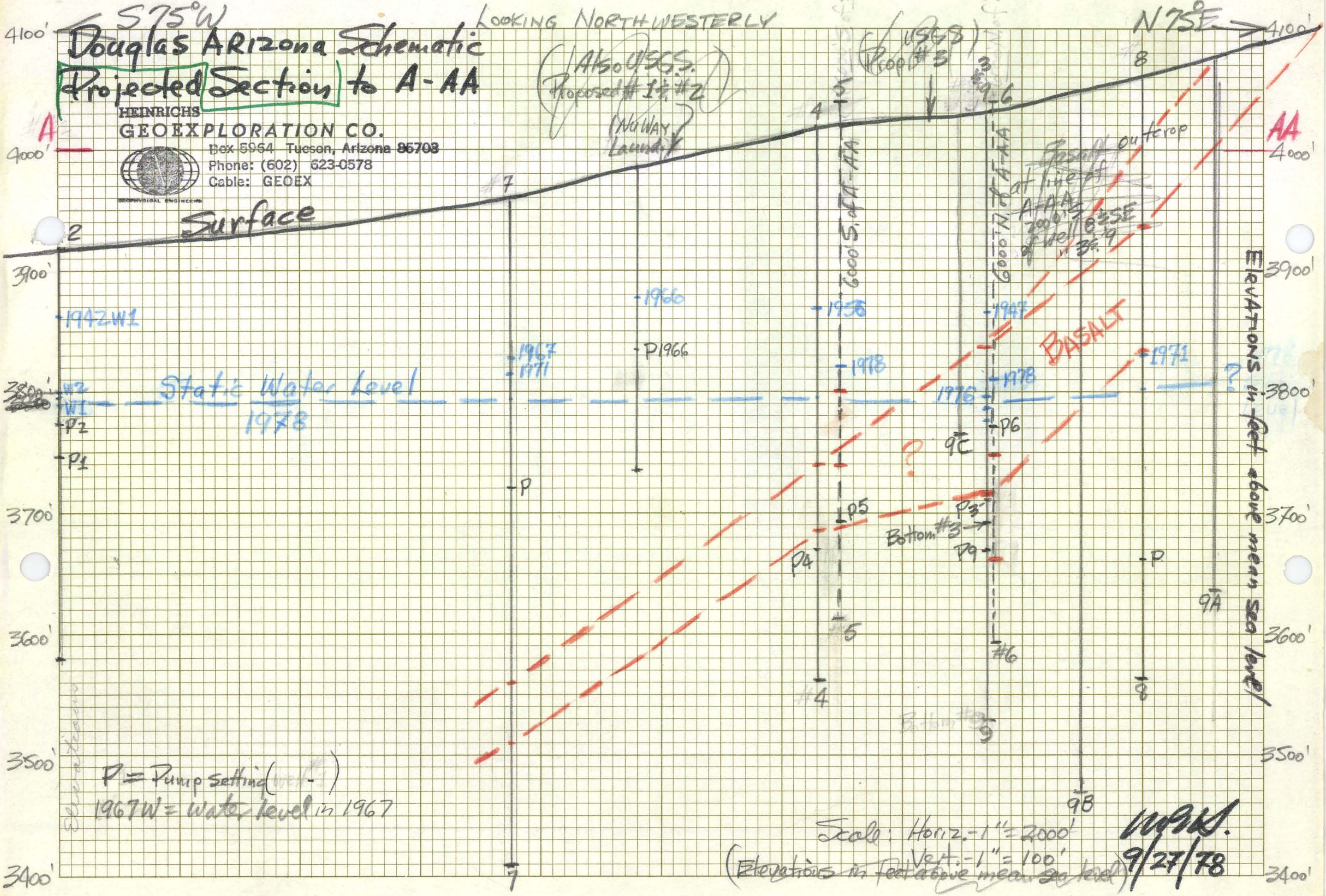



R. 28 E.
688 000 FEET
692 000 FEET
696 000 FEET
700 000 FEET
704 000 FEET
708 000 FEET
109°30'00"
31°22'30"
136 000 FEET
132 000 FEET
128 000 FEET
3 468 000m N.
124 000 FEET
642 000m E.
T. 24 S.
Registered Professional Engineer (Mining)
CERTIFICATE EXPIRES
DEC. 31, 19 79
ARIZONA, U. S. A.
W. E. Heinrichs Jr.
HEINRICHS GEOEXPLORATION CO. #1295
JAN 15 1979
Box 5964 Tucson, Arizona 85703
Phone: (602) 623-0578
Cable: GEOEX
WALTER E. HEINRICHS JR.
ASSOCIATION OF PROFESSIONAL GEOLOGICAL SCIENTISTS
CPGS 696
O = EXISTING HOLE or WELL
APPROXIMATE AREA of BASALT LAYER - at or very near Surface
SULPHUR SPRINGS VALLEY
Pirtleville Pop(Est) 843
DOUGLAS Pop 12,422(1975)
COCHISE COUNTY FAIRGROUNDS
FAIRVIEW
CITY LIMITS
15TH ST PARK
DOUGLAS HIGH SCHOOL
APACHE JR HS
15TH ST SCH
JOE CARLSON SCH
STEVENSON SCH
SARAH MARLEY SCH
CLAWSON SCH
5TH ST PARK
CALVARY CEMETERY
MEXICAN CONSULATE
COMPANIA DEL FERROCARRIL DE NACOZARI
AGUA PRIETA
US CUSTOMS AND IMMIGRATION
DOUGLAS MUNICIPAL AIRPORT
ONE MILE
SONORA
MEXICO


Douglas Arizona Schematic
Projected Section to A-AA
HEINRICHS GEOEXPLORATION CO.
Box 5964 Tucson, Arizona 85703
Phone: (602) 623-0578
Cable: GEOEX
(Also USGS Proposed #1 & #2)
(Nu Way Laundry)
(6000' S of Section)
(Prop. #3 USGS)
(6000' N of Section)
Surface
#1&2
#7
#4
#3
#5 #6
#8
A
AA
Basalt outcrop at line of A-AA, (2000' SE of Well 8 & So of Well 3 & 9
BASALT
?
Elevations in feet above mean sea level
4100'
4000'
3900'
3800'
3700'
3600'
3500'
3400'
1942 #1
1966
P1966
1967
1971
1956
1978
1947
1976
1978
1971
Static Water Level 1978
P1
P2
P5
P4
P6
P3
P9
Bottom #3
#5
#6
#4
Bottom #9
P1 = Pump setting well #1
Scale: Horiz - 1" = 2000'
Vert. 1" = 100'
(Elevations in feet above mean sea level)
9/27/78

NO. 340-10 DIETZGEN GRAPH PAPER 10 X 10 PER INCH

EUGENE DIETZGEN CO. MADE IN U. S. A.



Geo. Valley

Steve Conder | Grace Merrill

Vic Daniel

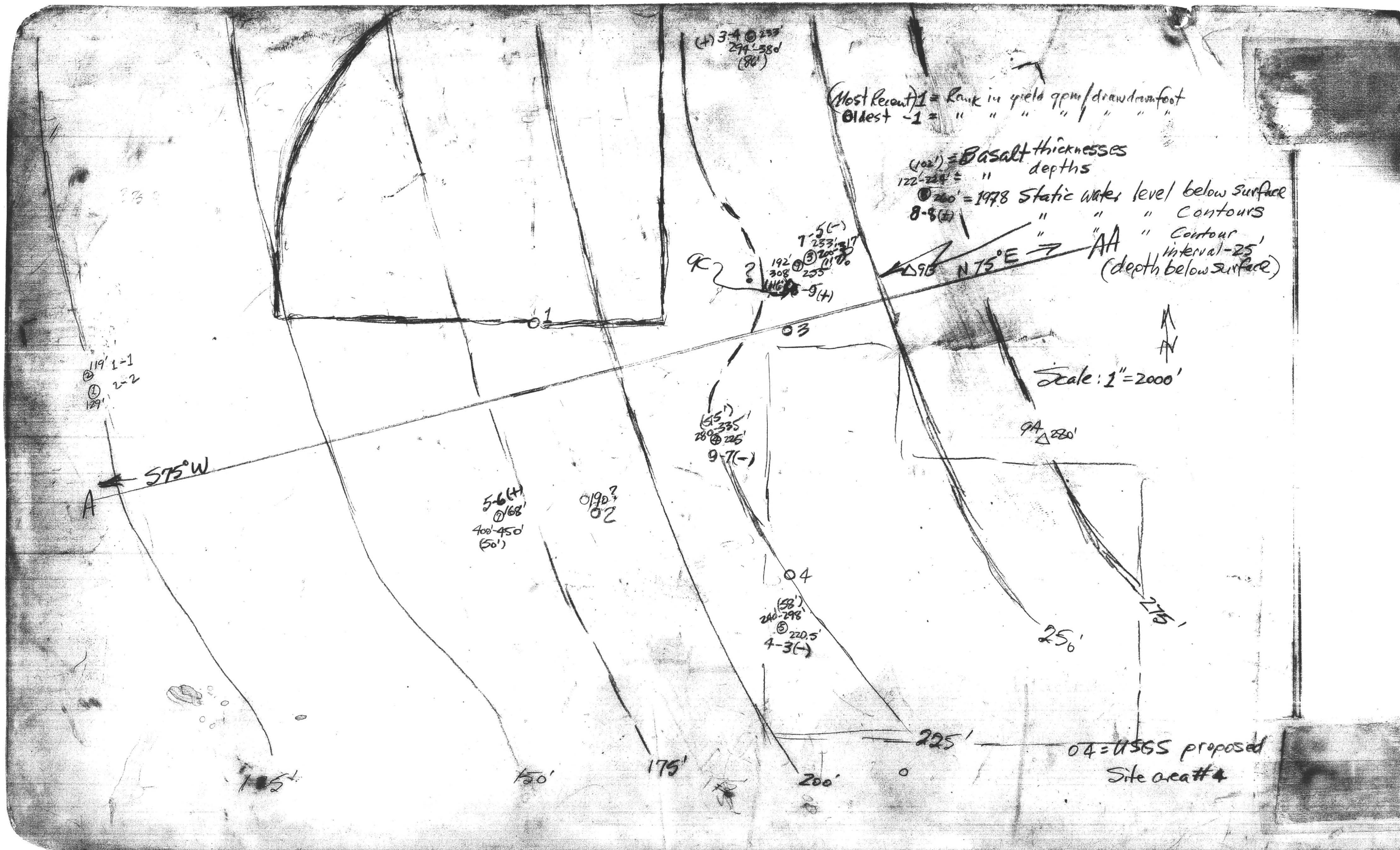
Louis Acosta

Bill Mercer

Joe Cornejo

Teresa Scott.


(Most Recent) 1 = Rank in yield gpm/drawdown foot
Oldest -1 = " " " " / " " "
(102') = Basalt thicknesses
122'-224' = " depths
⑧ 260' = 1978 Static water level below surface
8-8 (±)
" " " Contours
" " Contour interval - 25'
(depth below surface)
Scale: 1" = 2000'
N
A
S 75° W
N 75° E
AA
125'
150'
175'
200'
225'
250'
275'
O1
O2
O3
O4
O4 = USGS proposed
Site area #4
(+) 3-4 ⑥ 233'
294'-380'
(86')
7-5 (-)
233'
8-9 (+)
△ 9B
9A △ 280'
(55')
280'-335'
225'
9-7 (-)
(58')
240'-298'
⑤ 220.5'
4-3 (-)
5-6 (+)
168'
400'-450'
(50')
O 190'?
119' 1-1
2-2
129'


(Most Recent) 1 = Rank in yield gpm/drawdown foot
Oldest -1 = " " " " " "
(102') = Basalt thicknesses
122-224' = " depths
240' = 1978 Static water level below surface
8-8(+)
" " " Contours
"AA" " Contour interval-25' (depth below surface)
N 75°E
S75°W
A
AA
Scale: 1" = 2000'
N
04 = USGS proposed Site area #4
175'
200'
225'
250'
275'
(+) 3-4 255' 294'-380' (86')
7-5(-) 233'-317' 200'
192' 308' 255'
-9(+)
9B
03
01
02
190'?
5-6(+) 168' 400'-450' (50')
(55') 280-335' 225'
9-7(-)
04
(58') 240-298' 220.5'
4-3(-)
9A 280'
119' 1-1
2-2
129'

PRELIMINARY GEO-HYDROLOGICAL ANALYSIS

For

THE CITY OF DOUGLAS, ARIZONA

Sept. - Oct. 1978

by

Heinrichs GEOEXploration Company

P.O. Box 5964 Tucson, AZ 85703

GEOEX #1295

Preliminary Geo-hydrological Analysis

Introduction

Pursuant to correspondence initiated by Mr. George D. Nalley, Superintendent of the Douglas Water and Sewer Department on 17 July 1978, GEOEX, on 18 September 1978, was engaged to conduct a brief preliminary hydrological survey for the City. Objective of the survey was to assist in the siting of a proposed new water well under consideration for the purpose of augmenting, in the most efficient manner feasible, the present nine-well-system. Data and technical records requested by GEOEX on 19 September, 1978, were received on 22 September 1978. These, together with material already on hand and other pertinent locally acquired information, were studied with results as summarized in this preliminary report.

Conclusions and Recommendations:

1. United States Geological Survey (U.S.G.S.) Trip Report of 18 February 1977, copy of which was supplied by the City, tentatively recommended an area (1), proposed to be located near the middle of Section 12, T.24S., R.27E. This is concurred to be a satisfactory primary new well site.

2. Alternatively, anywhere roughly near or within a pie-shaped wedge area bordered approximately on the south by 22nd Street and Merrit Avenue in Pirtleville, and on the east by A Avenue and Leslie Canyon Road, is considered equally satisfactory except for perhaps distribution and rights of way considerations which are not necessarily part of this immediate study.

3. U.S.G.S. proposed areas numbers (3) and (4), are not recommended from the most preferable geologic point of view as suggested by present data on hand.

Based on the city records provided, and although there is some exception and variation indicated, there seems to be a definite general quantity decrease of well yields in an easterly direction away from White Water Draw. Therefore, on that basis alone, it appears generally desirable at this point to keep closer to White Water Draw. Possible exceptions to this generalization include a question of why well 6 is a relatively better producer and why well 4 is relatively poorer. Conceivably, the basalt and the pre-basalt topography and related shallow formations, may be at least partially responsible. If it becomes necessary and important to further pursue these particular types of discrepancies, surface geophysical work, such as electrical resistivity, may warrant testing and could be helpful if tests' results proved favorable.

4. If rights of way and distribution factors outweigh maximum added quantity considerations, then U.S.G.S. area (2) should also be satisfactory and, in some respects may almost equal their area (1). Indicated possible exceptions to this are the proposed site's proximity to poorer well site 4 and its indicated more adverse subsurface conditions, possible interference with well 7, and probable interference with Nu Way Laundry's well if it is still producing and, if so, if that should be a necessary factor to consider.

5. Existence of "several other test wells" is mentioned in the U.S.G.S. Trip Report of February 1977. Although these are reportedly negative in terms of quantity results, the data still should be integrated with the results of this study because such information could change the conclusions and recommendations herein considerably.

6. Long range implications of an anticipated continued increasing rate of ground water level decline and consumptive uses should be kept in mind, both as

to quantity and quality. Ideally,a replenishable surface water system, combined with conservation measures and balanced ground water recharge and withdrawal arrangements should be the ultimate objective of all responsible municipalities. Although beyond the scope of this particular study, problems and possibilities along such lines should be investigated and implemented as rapidly as ways and means will allow.

Observations and Speculation:

1. At present the lowest static water table measurement is at an elevation of about 3790 feet near White Water Draw at well #1. This is at about 130 feet below surface. Three and one quarter miles eastward, at Well 8, present static water elevation measures just above the 3800 foot elevation. This represents a rise in static water table elevation of roughly 3 feet per mile from White Water Draw toward the east as far as Well site #8.

2. Top of basalt at Well 4 is 40 feet deeper than at well 5, with a total thickness of 55 feet at well 4 and 58 feet at well 5. This is indicative of a possible small northerly dipping component to the basalt layer and perhaps a somewhat southeasterly source, conceivably, even fairly close by. However, as indicated in U.S.G.S. Trip Report of 18 February 1977, specific significance of the basalt relative to local ground water supplies, if any,is relatively undetermined.

3. Basalt thickness varies from 50 feet at Well 7 to 117 feet at Well 3. It outcrops about 2000' south of Well 8 and roughly 2000 feet southeast of wells 3 and 9. Average locally measured down-slope components on the top of the basalt, are roughly 200 feet per mile in a westerly direction and about 50 feet per mile in a northerly direction. However, in the vicinity of wells 3, 8 and

9, the slopes on top and bottom of the basalt seem to vary, at least locally, and the basalt roughly doubles in average thickness from about 54 feet in the wells toward the west to over 100 feet in these three wells, and 86 feet at Well 6 about one mile away toward the northwest.

Latest (most recent) (1977-1978 Pump Testing Results:

Year	Well #	(Relative) Rank	Feet(Inches) Total Draw Down		GPM	Gals.Per Min.Yield Per Foot Draw Down	Relative to original
1978	1	1	(4'5")	4.42	1000	226.24	+
1978	2	2	(12'9"	12.75	1000	78.43	-
(1977)	3	7	(30')	30.00	735	24.50	-
1978	4	9	(70'4")	70.33	800	11.37	-
1978	5	4	(20'10")	20.83	1100	52.80	-
1978	6	3	(20'1")	20.08	1175	58.52	+
1978	7	5	(27')	27.00	1250	46.30	+
1978	8	8	(58')	58.00	800	13.79	-
1978	9	6	(26')	26.00	1170	45.00	+

First, (Original) or Oldest Pump Testing Records on Hand:

1968	1	1	(6'4")	6.33	1100	173.78	
1968	2	2	(13'8")	13.67	1230	89.98	
1974	3	5	(18')	18.00	520	28.89	
1968	4	7	(47'2")	47.17	900	19.08	
1968	5	3	(13'3")	13.25	950	71.70	
1968	6	4	(27')	27.00	1350	50.00	
1971	7	6	(73')	73.00	1718	23.53	
1974	8	8	(68')	68.00	1250	18.38	
1976	9	9	(90')	90.00	1500	16.67	

Very likely, the city has its own well ratings and these should be compared with the preceding two tables.

Relative to the pump tests data from wells #1 and #2 and wells #3 and #9, these respective well pairs locations are about (?) 500' apart according to the maps. Data suggests in 1977 and 1978, that #3 pump may have been pumping when #9 well was tested. Obviously, because of close proximity the draw-down cones of depression may overlap each other when these wells are simultaneously in production. Approximate similarities are indicated at wells #1 & #2. Is this a possible explanation or are there other aspects involved?

Is the Nu Way Laundry well still being pumped and if so at what rate and from what depth?

Static Water Level Statistics

Well Numbers	1974-1978 Average	1974-1978 Year Average	(1977-1978)
1 & 2	-7.0 feet	-1.75 ft./yr.	-6.125 ft/Avg.
3, 4 & 6	-17.5 "	-4.38 "	-6.0 "
5	+17.3 " (?)	+4.33 " (?)	-3.8 "
7	-11.0 "	-2.75 "	-8.0 "
8	- 8.0 "	-2.00 "	-6.0 "
9 (1976-1978)	-31.0 "	-7.75 "	+1.0 "

Question regarding the 17.3 foot rise in static water level at well 5 over the 1974-1978 period should be raised and explained if possible.

Present average annual rate of lowering of the water table appears to be something around 1.5 to a little over two feet per year in the area immediately around Douglas. This is compared to estimates of something from three feet to

over 3.5 feet per year in the irrigated farming areas of McNeal and Elfrida to the north.

Well records over the years are often not perfectly consistent and therefore there may tend to be some questions regarding trying to make completely absolute determinations from them. These apparent inconsistencies are probably partly caused by periodic variations in rainfall and runoff in relation to the particular times the records were taken. Mechanical and chemical changes in the wells, pumps and casing for a variety of reasons can have effect. Also, an occasional measurement, technique or recording error will occur. Otherwise, the records provided by the city suffice quite nicely for the important fundamental and relative considerations made in this report.

Respectfully submitted,

Heinrichs GEOEXploration Co.

Walter E. Heinrichs, Jr.
P.E. & R.P.G.S.

WEH:mt

Discussion Sketches:

1. Schematic Plan, 1" = 2000' scale.
2. Projected Schematic Section (-N75° E., from near Wells 1 & 2 to near Well 8.)

GEOEX #1295

2 October 1978

Box 5964

Tucson, AZ 85703

(602) 623-0578

true when considering non-renewable energy resources. In other words, precise determination as to when we are due to run out is not nearly as relevant as what we are doing now to delay running out or to find new replacements.

An example of such continuing governmental futility is some of the stated needs for the currently emerging Department of Energy, such as to more accurately inventory [illegible]. A specific example [illegible]

NOTE

These corrected pages are to replace page 4 in the two report copies you already have.

Also, please cross out completely the reference to Well 5 on page 2 of the report on lines 6 and 7 so that it reads: - - - "and why well 4 is relatively poorer."

OCT 1 1 1978

October 10, 1978

The City of Douglas
Water and Sewer Department
P.O. Drawer 1198
Douglas, AZ 85607

Attention: Mr. George D. Nalley, Superintendent

Re: Water System Supply Study
GEOEX #1295

Transmittal Letter

After assimilating these data, I will look forward to meeting again with you and the Board whenever mutually convenient.

P.S.: Meanwhile, don't hesitate to call if there are questions.

Sincerely,

Walter E. Heinrichs, Jr.
P.E. & C.P.G.S.

Registered Professional Engineer
CERTIFICATE NO. 5
WALTER E. HEINRICHS, JR.
DEC. 31, 19
ARIZONA, U. S. A.

ATTACHED CONTENTS

Two-Discussion Schematics, plan and profile - attached.

October 10, 1978

The City of Douglas
Water and Sewer Department
P.O. Drawer 1198
Douglas, AZ 85607

Attention: Mr. George D. Nalley
Superintendent

Re: Water System Supply Study
Geoex #1295

Summary Letter Report

Introduction

This letter confirms the conference held in your office on Tuesday 3 October 1978, attended by yourself, members of your department, Joseph Cornejo and Bill Mercer and myself.

Receipt of the data, which accompanied your letter of 20 September 1978, and additional material received from your office on 2 October 1978, are acknowledged. The latter includes the drillers logs on holes 9A, 9B, and 9C.

General Conclusions and Recommendations

Based on all of the above information, on relevant matter procured from the U.S.G.S. in Tucson, and material from GEOEX files, a report titled Preliminary Geo-hydrological Analysis was prepared. This is the report which was referred to during our conference at your office. Two carbon copies of this report were left with you for further reference and three corrected machine copies are being resubmitted herewith.

Conclusions arrived at from this initial study are:

1. Generally, wells nearest White Water Draw are best for quantity and perhaps worst for quality, except that quality may also improve to some extend in an up-stream direction, and

2. that some wells producing from above the basalt are better producers than some wells producing from below the basalt, but that probably more directly important, are certain as yet undefined paleo-stringers or channels and permeability factors associated with depositional age and formational character and history in general, rather than the basalt in particular.

Important expeptions to any generalizing are indicated by the relative quantity favorability of wells 5 and 6 and unfavorability of well 4. Careful comparison of the drill logs does not provide any definite explanations. There is some temptation to speculate that factors associated with the exposed or surface trend of the basalt may be responsible, but then, what about relatively fair producing wells 9 and 3 which are closest of any wells to the exposed basalt? Also, capacity deterioriation of Well 4 from 1968 to 1978 suggests that it may need recompletion, clean out and rehabilitation if this has not been done before. Are plugged perforations or screens possible?

Obviously, better quantitative data is necessary before we can begin to answer these tougher questions. One important means to initiate achieving this, in future drilling operations, is to insist on more thoroughly detailed and quantitative drill logs, preferably logged by a competent geologist as drilled and not after drilling or just by the drillers as drilled. In addition, in order to minimize time variation questions and the element of human interpretation from one individual logger to another, calibrated standard "electric" or instrumental well logging is to be highly recommended. This would definitely help to begin sorting out the quandry suggested in the previous paragraph and mentioned later in discussing the sulfide water situation encountered at site 9A.

As a general rule, regardless of how good a well is logged, truly full

evaluation of larger capacity wells, can only be made by adequate pump testing - usually for about a twenty-four hour period. Then, if the well is properly perforated, cased, sealed, and packed, maximum life and output efficiency will be achieved. Moreover, all of the quantitative data acquired, including logging, will materially assist and benefit picking the best future well sites and providing for the best future overall program of system planning and development.

For the time being, the initial recommendation to move any immediate or near future new drill site considerations toward a northwesterly direction away from the presently developed area, still stands. This approach should get further away from the basalt and perhaps more into younger and more permeable formations. Holes which avoid the basalt entirely should be cheaper to drill and as long as any particular site doesn't get too close to White Water Draw, present indications are that the quality should be satisfactory and the overall quantity potential generally improved.

Current Program Considerations

After discussingtthe first report and other pros and cons to be considered with Mr. Nalley and staff, a tentative program for early consideration and implementation was mutually outlined as follows.

Well 8 is presently the well located farthest easterly from the valley center and originally, when first pump tested in 1974, was the second worst producer in terms of gallons per minute yield per foot draw down, i.e.: 18.38 versus 16.67 for well 9 which was originally tested in 1976. Since 1974, well 8 deteriorated to 13.79 gallons per minute yield per foot draw down in 1978. This is still the second worst production factor of the nine wells tested in 1978, and is only slightly better than well 4 which in 1978 tested at 11.37 gallons per minute per foot draw down. Well 8 apparently has a congenital

history of electrical-mechanical difficulties and problems. Because of this and the relatively rapid means and lower cost of pulling, inspecting and, depending on results of that, considering the application of appropriate improvement and/or re-development measures and pump testing, such activity is tentatively set as immediate priority one.

The rationale of this approach is to maximize utilization of present facilities at least cost, and to better help confirm to everyone's satisfaction whether or not hole 9B is warranted as priority number two. This assumes, of course, that hole 9B is straight and can be satisfactorily completed, perforated and cased if it is not already.

If well 9B is satisfactorily developed, a minimum of new pipe line would be required to establish it into the system. Location of well 9B, although fairly close to wells 3, 8 and 9, is still probably far enough separated to not likely cause any immediate mutual interference and perhaps none for some time to come. If this procedure proves at all successful, then additional assured new capacity will be provided with a minimum of required capital investment.

It is regrettable that Well 9A was abandoned before being thoroughly pump tested. The well log definitely indicates that perched water was encountered at 140-144 feet and that the true or "permanent" water table was encountered at 275 feet - right where it should be. Most likely the reported "sulfide" taste and odor was from the perched water. Although such water also could have come from one or more of the deeper aquifers in the hole, no similar problems have been encountered in any of the producing wells to date. In any case, bad-water aquifers can usually be positively identified and located by instrumental logging of the hole and cemented off. Probably in this case they should have

been cemented off regardless so as to avoid possible contamination of the other primary aquifers. Possibility of redrilling this hole should be considered and posed to the drilling fraternity for comment. The site is ideally located for easy tyeing into the present system and it is not near any other wells. There is no evident reason at this point why this site should not provide at least a fair producer.

Hole 9C probably lacked about 40 to 50 feet or so of penetrating the basalt and was abandoned crooked at 260 feet after much reported effort to straighten. Because of that and the close proximity to wells 3 and 9, no further consideration of this site is recommended.

In the preliminary report, a mistake was made on the draw down footages used as shown in the tables on page 4. These have been corrected together with the relevant changes in conclusions in the report copies accompanying this report. The most significant change caused by this correction is an upgrading of wells 5 and 6 from the previous rating. The importance of this is that it tends to enhance indicated possibilities for favorable site development in the S.E. 1/4 of Section 7; the east half of Section 18 and all of Section 17.

Drilling

There was some discussion of the relative merits of rotary versus cable-tool drilling. Technically, rotary should be preferable, but practically, cable-tool results can be as good or even better if the rotary facilities provided are inadequate for properly handling the minimum requirements - such as a straight hole,penetration of hard basalt formation, etc. Theoretically a good rotary drill and driller can perform a fair pump test by using compressed air, while cable-tool bailing tests are generally inadequate for testing

larger capacity wells. Whatever choice is made, the detailed specifications called for by the City and those offered by the drillers should be very carefully examined and weighed and included in any ultimate contract. Pump testing, well preparation, perforating, gravel packing, cementing, casing and pump installation etc., procurement should follow similar procedures.

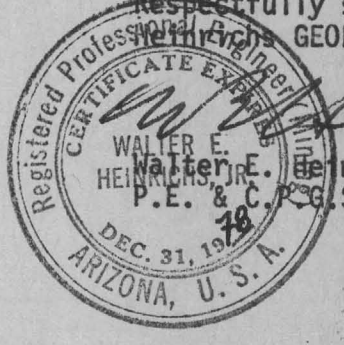
Geophysics

Surface surveys of electrical resistivity and induced polarization geophysics have been mentioned. It is possible for such surveys to be able to differentiate areas of tighter and or more brackish subsurface zones from more porous, permeable and fresher water zones. This is best done usually by correlating definitive test survey results from over good producing well areas with definitive test survey results from poor producing well areas and then making appropriate comparison surveys over new or unknown areas of interest.

This technique does not always work everywhere and unfortunately absolute determination of that can only be established by trial and error. Although the Douglas area appears generally amenable for this type of work, brackish perched water such as possibly encountered at well site 9A can be misleading. Also, culture features such as pipe lines, fences, power lines, etc., can practically prohibit cost-effective geophysical surveys.

Unless the problems become much more acute than presently indicated, geophysical work is not considered worthwhile for the moment.

Respectfully submitted,
Heinrichs GEOExploration Co.



Walter E. Heinrichs, Jr.
P.E. & C.P.G.S.

GEOEX #1295, 10 October, 1978
Box 5964, Tucson,AZ 85703
(602) 623-0578

WEH:mt

HEINRICHS GEOEXPLORATION COMPANY

P. O. BOX 5964. TUCSON, ARIZONA 85703. 806 WEST GRANT ROAD. PHONE: (602) 623-0578

October 10, 1978

The City of Douglas
Water and Sewer Department
P.O. Drawer 1198
Douglas, AZ 85607

Attention: Mr. George D. Nalley, Superintendent

Re: Water System Supply Study
GEOEX #1295

Transmittal Letter

After assimilating these data, I will look forward to meeting again with you and the Board whenever mutually convenient.

PS: Meanwhile, don't hesitate to call if there are questions.

Sincerely,

Walter E. Heinrichs, Jr.
P.E. & L.P.G.S.

Registered Professional Engineer (Mining) CERTIFICATE EXPIRES DEC. 31, 19 ARIZONA, U.S.A.

ATTACHED CONTENTS

Two-Discussion Schematics, plan and profile - attached.

October 10, 1978

The City of Douglas
Water and Sewer Department
P.O. Drawer 1198
Douglas, AZ 85607

Attention: Mr. George D. Nalley
Superintendent

Re: Water System Supply Study
Geoex #1295

Summary Letter Report

Introduction

This letter confirms the conference held in your office on Tuesday 3 October 1978, attended by yourself, members of your department, Joseph Cornejo and Bill Mercer and myself.

Receipt of the data, which accompanied your letter of 20 September 1978, and additional material received from your office on 2 October 1978, are acknowledged. The latter includes the drillers logs on holes 9A, 9B, and 9C.

General Conclusions and Recommendations

Based on all of the above information, on relevant matter procured from the U.S.G.S. in Tucson, and material from GEOEX files, a report titled Preliminary Geo-hydrological Analysis was prepared. This is the report which was referred to during our conference at your office. Two carbon copies of this report were left with you for further reference and three corrected machine copies are being resubmitted herewith.

Conclusions arrived at from this initial study are:

1. Generally, wells nearest White Water Draw are best for quantity and perhaps worst for quality, except that quality may also improve to some extent in an up-stream direction, and

2. that some wells producing from above the basalt are better producers than some wells producing from below the basalt, but that probably more directly important, are certain as yet undefined paleo-stringers or channels and permeability factors associated with depositional age and formational character and history in general, rather than the basalt in particular.

Important exceptions to any generalizing are indicated by the relative quantity favorability of wells 5 and 6 and unfavorability of well 4. Careful comparison of the drill logs does not provide any definite explanations. There is some temptation to speculate that factors associated with the exposed or surface trend of the basalt may be responsible, but then, what about relatively fair producing wells 9 and 3 which are closest of any wells to the exposed basalt? Also, capacity deterioriation of Well 4 from 1968 to 1978 suggests that it may need recompletion, clean out and rehabilitation if this has not been done before. Are plugged perforations or screens possible?

Obviously, better quantitative data is necessary before we can begin to answer these tougher questions. One important means to initiate achieving this, in future drilling operations, is to insist on more thoroughly detailed and quantitative drill logs, preferably logged by a competent geologist <u>as drilled</u> and not <u>after</u> drilling or just by the drillers as drilled. In addition, in order to minimize time variation questions and the element of human interpretation from one individual logger to another, calibrated standard "electric" or instrumental well logging is to be highly recommended. This would definitely help to begin sorting out the quandry suggested in the previous paragraph and mentioned later in discussing the sulfide water situation encountered at site 9A.

As a general rule, regardless of how good a well is logged, truly full

evaluation of larger capacity wells, can only be made by adequate pump testing - usually for about a twenty-four hour period. Then, if the well is properly perforated, cased, sealed, and packed, maximum life and output efficiency will be achieved. Moreover, all of the quantitative data acquired, including logging, will materially assist and benefit picking the best future well sites and providing for the best future overall program of system planning and development.

For the time being, the initial recommendation to move any immediate or near future new drill site considerations toward a northwesterly direction away from the presently developed area, still stands. This approach should get further away from the basalt and perhaps more into younger and more permeable formations. Holes which avoid the basalt entirely should be cheaper to drill and as long as any particular site doesn't get too close to White Water Draw, present indications are that the quality should be satisfactory and the overall quantity potential generally improved.

Current Program Considerations

After discussing the first report and other pros and cons to be considered with Mr. Nalley and staff, a tentative program for early consideration and implementation was mutually outlined as follows.

Well 8 is presently the well located farthest easterly from the valley center and originally, when first pump tested in 1974, was the second worst producer in terms of gallons per minute yield per foot draw down, i.e.: 18.38 versus 16.67 for well 9 which was originally tested in 1976. Since 1974, well 8 deteriorated to 13.79 gallons per minute yield per foot draw down in 1978. This is still the second worst production factor of the nine wells tested in 1978, and is only slightly better than well 4 which in 1978 tested at 11.37 gallons per minute per foot draw down. Well 8 apparently has a congenital

history of electrical-mechanical difficulties and problems. Because of this and the relatively rapid means and lower cost of pulling, inspecting and, depending on results of that, considering the application of appropriate improvement and/or re-development measures and pump testing, such activity is tentatively set as immediate priority one.

The rationale of this approach is to maximize utilization of present facilities at least cost, and to better help confirm to everyone's satisfaction whether or not hole 9B is warranted as priority number two. This assumes, of course, that hole 9B is straight and can be satisfactorily completed, perforated and cased if it is not already.

If well 9B is satisfactorily developed, a minimum of new pipe line would be required to establish it into the system. Location of well 9B, although fairly close to wells 3, 8 and 9, is still probably far enough separated to not likely cause any immediate mutual interference and perhaps none for some time to come. If this procedure proves at all successful, then additional assured new capacity will be provided with a minimum of required capital investment.

It is regrettable that Well 9A was abandoned before being thoroughly pump tested. The well log definitely indicates that perched water was encountered at 140-144 feet and that the true or "permanent" water table was encountered at 275 feet - right where it should be. Most likely the reported "sulfide" taste and odor was from the perched water. Although such water also could have come from one or more of the deeper aquifers in the hole, no similar problems have been encountered in any of the producing wells to date. In any case, bad-water aquifers can usually be positively identified and located by instrumental logging of the hole and cemented off. Probably in this case they should have

been cemented off regardless so as to avoid possible contamination of the other primary aquifers. Possibility of redrilling this hole should be considered and posed to the drilling fraternity for comment. The site is ideally located for easy tieing into the present system and it is not near any other wells. There is no evident reason at this point why this site should not provide at least a fair producer.

Hole 9C probably lacked about 40 to 50 feet or so of penetrating the basalt and was abandoned crooked at 260 feet after much reported effort to straighten. Because of that and the close proximity to wells 3 and 9, no further consideration of this site is recommended.

In the preliminary report, a mistake was made on the draw down footages used as shown in the tables on page 4. These have been corrected together with the relevant changes in conclusions in the report copies accompanying this report. The most significant change caused by this correction is an upgrading of wells 5 and 6 from the previous rating. The importance of this is that it tends to enhance indicated possibilities for favorable site development in the S.E. 1/4 of Section 7; the east half of Section 18 and all of Section 17.

Drilling

There was some discussion of the relative merits of rotary versus cable-tool drilling. Technically, rotary should be preferable, but practically, cable-tool results can be as good or even better if the rotary facilities provided are inadequate for properly handling the minimum requirements - such as a straight hole,penetration of hard basalt formation, etc. Theoretically a good rotary drill and driller can perform a fair pump test by using compressed air, while cable-tool bailing tests are generally inadequate for testing

larger capacity wells. Whatever choice is made, the detailed specifications called for by the City and those offered by the drillers should be very carefully examined and weighed and included in any ultimate contract. Pump testing, well preparation, perforating, gravel packing, cementing, casing and pump installation etc., procurement should follow similar procedures.

Geophysics

Surface surveys of electrical resistivity and induced polarization geophysics have been mentioned. It is possible for such surveys to be able to differentiate areas of tighter and or more brackish subsurface zones from more porous, permeable and fresher water zones. This is best done usually by correlating definitive test survey results from over good producing well areas with definitive test survey results from poor producing well areas and then making appropriate comparison surveys over new or unknown areas of interest.

This technique does not always work everywhere and unfortunately absolute determination of that can only be established by trial and error. Although the Douglas area appears generally amenable for this type of work, brackish perched water such as possibly encountered at well site 9A can be misleading. Also, culture features such as pipe lines, fences, power lines, etc., can practically prohibit cost-effective geophysical surveys.

Unless the problems become much more acute than presently indicated, geophysical work is not considered worthwhile for the moment.

Respectfully submitted,
Heinrichs GEOExploration Co.

Walter E. Heinrichs, Jr.
P.E. & C.P.G.S.

GEOEX #1295, 10 October, 1978
Box 5964, Tucson,AZ 85703
(602) 623-0578

WEH:mt

November 21, 1978

The City of Douglas
Water and Sewer Department
P.O. Drawer 1198
Douglas, AZ 85607

Attention: Mr. George D. Nalley, Superintendent

Re: Water System Supply
Study "Phase II"
GEOEX #1295

Dear George:

We have your letter of 14 November 1978.

I understand your decision about not drilling a test hole. Under present circumstances, the cost aspects alone are a little difficult to argue against - especially when such costs stand a good chance of not directly reducing the cost of a subsequent production well.

Right now the only factors to go on in choosing one part of New Well Site Two Area over another part are as follows:

1. The farther east you go, the deeper the water table (presently approximately 3800' elevation) will be below the surface (roughly 50 to 60 feet per mile) in the area of interest - thus requiring more well, lift, and casing, etc.

2. The farther east and south you go the better the chances are for thicker basalt. Indications so far suggest a rough increasing thickness factor of about 35 feet per mile, but this could change very suddenly and most probably it would be thicker rather than thinner and probably the farther away from the nearest tie point you get, the better is the chance for a sudden change to occur.

3. Since the local formations appear conformably bedded and dipping or slightly tilted westward then, as you go eastward and deeper to the water table you will be gradually intersecting increasingly older formations. As a generalization, and without specific and contrary information or data to go on, this is apt to mean proportionately decreasing permeability of the aquifer, i.e.: de-

creasing yield.

4. Much of the SE 1/4 of Sec. 8 and most of Sec. 16, the airport section, T. 24 S., R.28E., has basalt at or very near the surface. This may make for more costly and difficult collaring and drilling of a straight hole - especially if the churn drilling method is used.

5. Existing system considerations as to location of reservoirs, size of pipe line already in and of other producing well sites. At this point, and as a general consideration for now, it is not recommended that producing wells be located closer to each other than roughly 1/2 mile apart - unless of course there is some other major overriding consideration involved.

6. Detailed demographic factors as to where added supply is apt to be needed most and soonest.

In lieu of complete and detailed consideration of items 5 and 6 above, my personal choices right now are tentatively the corner of 5th and Washington (NW corner of Sec. 17), or 15th and Airport (NE corner of Sec. 17).

Indications from your existing wells suggest a specific capacity of roughly 50 gallons per minute per foot of draw down should be achievable at these three sites if properly drilled and prepared. Regarding the latter, the enclosed article from the March-April 1978 issue of The Johnson Drillers Journal by George H. Lesch may be of interest. The only local small company that seems to have successfully specialized in this technique ~~are~~ Ventures Drilling Company of Tucson - (see their pamphlet enclosed). 15

Local estimates on churn holes are $22.00/foot 12 inches diameter, $32.00 per foot 16 inches diameter and $40-44 per foot for 20 inches diameter for holes 500 to 600 feet deep with about 100 feet of basalt. One rotary-air estimate for the same specification of hole was $40 to $45 per foot for a 15" to 16" diameter hole and with the added statement that 12 3/4" (casing in 16" hole) will nicely handle a 10" bowl pump - rated at 500 to 900 gpm capacity.

If you will give me your pro and con thoughts on these various trade off details as you see them, I would like to assist in working up a proposed well drilling and testing contract and specifications which presumably would ultimately be let out for bid. I gather from previous discussions that there is considerable doubt if much sealing off of the aquifers has occurred in your drilling operations to date. If we could be absolutely categorical about this, then I would feel better about eventually trying to do some quantitative subsurface differential geology and geophysics. Otherwise, right now, I would prefer seeing an equivalent investment put into improved drilling and well development techniques at this stage. Somehow, I cannot help but feel that with all of the reported clay in the drillers logs that the newer and deeper wells besides being in older and tighter formation, did lose some potential yield during the actual drilling process and whether or not they were drilled rotary or churn.

We finally received a frosted mylar transparent original of the map of Douglas today from the State Department of Transportation. What a struggle it was!

Your and Mrs. Scott's help in straightening out my latent confusion on which part of which holes were drilled churn versus rotary and where the various troubles occurred and what remedies were attempted, etc., will be appreciated. Also, the same for your current drilling cost estimates to compare with those I have acquired here.

I will look forward to any comments you may have or which may be made by any of the board memebers.

Sincerely,

Heinrichs GEOEXploration Co.

Walter E. Heinrichs, Jr.
Geol. Engr., P.E. & G.P.G.S.

WEH:mt

P.S. To other well site choices in addition to the two others already mentioned in Paragraph four of page two of this letter, are near 8th Street and Washington and near the center of section 17, at 8th Street and Jackson. Geologically, from what we know now, both of these sites seem slightly preferable to the site at 15th Street and Airport.

GEOPHYSICAL LOGGING OF WATER DEPARTMENT ROTARY DRILLED
EXPLORATION AND PRODUCTION HOLES

Because of the recent controversy and confusion involving geophysical logging of rotary drilled holes, I have undertaken to review the situation. Recommendations were solicited from Ed Davidson of the USGS and Don Madsen. Attached to this review is an appendix containing brief explanations of the various types of logging. The numbers in parentheses contained in the recommendations refer to the numbers used in the appendix.

Ed Davidson recommends:

A) For slim holes (which will not be converted into production holes) drilled in areas where little or no data is available - spontaneous potential (1); induction resistivity (4); porosity log - either a borehole compensated formation density log or a borehole compensated neutron log. (These logs are adjusted for the varying width of the hole and are obtained by running a caliper log (9) in conjunction with either a formation density log (6) or a neutron log (8)); sonic log (5).

B) For production holes he feels that since we have not made use of the logs to blank off undesirable formation, no logs were needed. However, he did concede that when the well was being drilled in an area where only a limited amount of information is known, that a spontaneous potential (1) and some sort of resistivity (2) (4) (10) log could be run.

Don Madsen recommends:

A) For all slim and pilot holes, regardless of the area in which they are drilled - spontaneous potential (1); multiple curve resistivity (2).

B) For production holes in new areas - spontaneous potential (1); multiple curve resistivity (2) or induction resistivity if available; caliper log (9); neutron log (8); sonic log (5).

C) Production holes in known areas - no logs.

Johnson Drilling Company recommends:

Spontaneous potential (1); multiple curve resistivity (2); gamma ray log (7). They use these in combination with a driller's penetration rate log. They believe that the gamma ray log is the best for locating clay beds. This is a Michigan based firm and it is difficult to say if this

would be the most effective group to use here. In the Michigan area the clays probably tend to occur in isolated formations, rather than widely disseminated, as in this area.

Of course, it is to be understood that grain size samples are to be kept and a grain size analysis log is available for use in conjunction with the geophysical logs.

My own recommendations are that for each slim or pilot hole, regardless of location, a spontaneous potential log (1) and multiple curve resistivity (2) log be run. (If available, an induction resistivity log (4) is preferable to a conventional resistivity log (2)). These logs aid in interpretation of the grain size log. Under no circumstances should a point resistivity log (10) be permitted to be substituted for a multiple curve resistivity or induction resistivity log (4). The point resistivity log (4) does not permit the calculations of water quality, porosity, and permeability that are possible from the other types of resistivity logs.

When the slim hole or pilot hole is in an area where little or no hydrologic data is available, consideration should be given to running two additional geophysical logs, a porosity log as defined by Ed Davidson, and a sonic log. (5). Among things to be considered are: the additional cost of such logging; the amount of additional information to be gained and its value to the Water Department. Only a limited amount of geophysical logging has been done in this basin, seeking hydrologic information. Even in other areas, the use of geophysical logging in the search for fresh water is still in the developmental stages. Our ideas of which type of logs to run and the information available from them will change as time goes on.

Walt Stein
Sept. 1970

APPENDIX

This section contains a brief summary for each kind of geophysical log which might be run in an exploration or production water well.

The descriptions for the first eight types of logs are taken from Log Interpretation Principles by Schlumberger.

1) The Spontaneous-Potential (or SP) curve is a recording versus depth of the difference between the potential of a movable electrode in the borehole and the fixed potential of a surface electrode.

   The SP is useful in holes filled with fresh muds to:

   1. Detect the permeable beds.

   2. Locate their boundaries and to permit correlation of such beds.

   3. Determine values of formation-water resistivity, R_w

   4. Give qualitative indications of bed shaliness (or clay).

   The SP is generally recorded on Track 1 (left-hand track) of the log, usually in conjunction with resistivity surveys, but it may also be recorded along with other logs, such as the Sonic Log.

   Opposite the shales (clays) the readings of the SP curve are usually fairly constant and tend to follow a straight line on the log, called the shale (clay) base line. Opposite the permeable formations, the SP curve shows excursions from the shale (clay) base line; in thick enough beds they often tend to reach an essentially constant deflection defining a sand line. The deflection may be either to the left (negative) or to the right (positive), depending mostly on the relative salinities of the formation water and of the mud filtrate.

   The position of the shale (clay) base line on the log recording has no useful meaning for interpretation purposes. The SP sensitivity scale is chosen and the shale (clay) base-line position is set by the engineer running the log so that the SP curve deflections remain in the SP track.

2) Conventional Resistivity Logs. (ES) (Multiple Curve Resistivity).

During the first quarter century of well logging, the only electrical surveys available were the conventional resistivity logs plus the SP. Thousands of them were run each year in holes drilled all over the world. Since then, new logging methods have been developed to measure values much closer to R_{xo} or R_t, which are the values sought. Nevertheless, the Conventional ES (Electrical Survey, consisting of SP, 16-inch Normal, 64-inch Normal, and 18'8" Lateral) is still being run in many parts of the world.

In conventional resistivity logs, currents are passed through the formation via certain electrodes, and voltages are measured between certain others. These measured voltages provide the resistivity determinations. So that there will be a current path between electrodes and formation, the sonde must be run in holes containing electrically conductive mud or water.

In homogeneous, isotropic formation of infinite extent, the equipotential surfaces surrounding a single current-emitting electrode are spheres. The voltage between an electrode situated on one of these spheres and one at infinity is proportional to the resistivity of the homogeneous formation, and the galvanometer deflection corresponding to such voltage can be scaled in resistivity units.

3) The Laterolog® method of resistivity measurement minimizes the influence of the borehole and of surrounding formation by forcing the measuring current to flow radially, as a thin sheet of current, into the formation being logged.

The Laterolog is therefore much superior to conventional resistivity devices (ES log) for resolution of formations of moderate-to-small bed thicknesses. It is also superior for determination of R_t in case of large resistivity contrasts (R_t/R_s or R_s/R_t) and in case of large R_t/R_m values (salt muds/ or resistive formations).

4) The Induction Log was developed to measure formation resistivity in boreholes containing oil-base muds. Electrode devices do not work in these non-conductive muds, and attempts to use wall-scratcher electrodes proved unsatisfactory. Experience soon demonstrated that the Induction tools had many advantages over Conventional ES for logging wells drilled with water-base muds.

Induction Logging devices are focused in order to minimize the influence of the borehole and of the surrounding formation. They are also designed for deep investigation and reduction influence of the invaded zone.

Practical Induction sondes include a system of several coaxial transmitter and receiver coils. However, the principle can be understood by considering a sonde with only one transmitter coil and one receiver coil.

High-frequency alternating current of constant intensity is sent through the transmitter coil. The alternating magnetic field thus created induces secondary currents in the formations. These currents flow in circular ground-loop paths coaxial with the transmitter coil. These ground-loop currents, in turn, create magnetic fields which induce signals in the receiver coil. The receiver signals are essentially proportional to the conductivity of the formations. Any signal produced by direct coupling of transmitter and receiver coils is balanced out by the measuring circuits.

The Induction Log operates to advantage when the borehole fluid is an insulator -- even air or gas. But the tool will also work very well when the borehole contains conductive mud, provided that the mud is not too salty, the formations not too resistive, and the borehole diameter is known.

5) The Sonic Log is a recording versus depth of the time Δ_t, required for a compressional sound wave to traverse one foot of formation. Known as the interval transit time Δ_t is the reciprocal of the velocity of the compressional sound wave. The interval transit time for a given formation depends upon its lithology and porosity. Its dependence upon porosity, when the lithology is known, makes the Sonic very useful as a porosity log. Integrated Sonic transit times are helpful in interpreting seismic records.

Sonic tools in current use are of the BHC (borehole compensated) type. This type sonde substantially eliminates spurious effects at hole-size changes as well as errors due to sonde tilt.

The BHC system uses one transmitter above and one transmitter below two pairs of sonic receivers. When one of the transmitters is pulsed, the sound wave generated enters the formation; the time elapsed between detection of the first arrival at the two corresponding receivers is measured.

The speed of sound in the Sonic sonde and in the drilling mud is less than that in the formations. Accordingly, the first arrivals of sound energy at the receivers correspond to sound-travel paths in the formation near the hole wall.

The BHC transmitters are pulsed alternately, and Δ_t values are read on alternate pairs of receivers. The Δ_t values from the two sets of receivers are averaged automatically by a computer at the surface. The computer also integrates the transit-time readings to obtain total travel times.

Sometimes the first arrival, although strong enough to trigger the receiver nearer the transmitter, may be too weak by the time it reaches the far receiver to trigger it. Instead, the far receiver may be triggered by a different, later arrival in the sonic wave train, and the travel time measured on this pulse cycle will then be too large. When this occurs, the Sonic curve shows a very abrupt and large excursion toward higher Δt values; this is known as "cycle skipping". Such skipping occurs only when the signal is strongly attenuated by unconsolidated formations, formation fractures, gas saturation, or aerated muds.

6) The Formation Density Log, also known as a Gamma Gamma Log, is useful as a porosity-logging tool. Other uses of density measurements include identification of minerals in evaporite deposits, detection of gas, evaluation of shaly (clay) sands and complex lithologies, and determination of oil-shale yield.

A radioactive source, applied to the hole wall in a shielded sidewall skid, emits medium-energy gamma rays into the formations. These gamma rays may be thought of as high-velocity particles which collide with the electrons in the formation. At each collision a gamma ray loses some, but not all, of its energy to the electron, and then continues with diminished energy. This type of interaction is known as Compton Scattering. The Schlumberger source and detector are so designed that the tool response is predominately due to this phenomenon. The scattered gamma rays reaching the detector, at a fixed distance from the source, are counted as an indication of formation density.

The number of Compton-scattering collisions is related directly to the number of electrons in the formation. Consequently, the response of the Density tool is determined essentially by the electron density (number of electrons per cubic centimeter) of the formation. Electron density is related to the true bulk density, ρ_b, in gms/cc, which in turn depends on the density of the rock matrix material, the formation porosity, and the density of the fluids filling the pores.

7) The Gamma Ray Log is a measurement of the natural radioactivity of the formations. The log is therefore useful in detecting and evaluating deposits of radioactive minerals such as potash or uranium ore.

In sedimentary formations the Gamma Ray Log normally reflects the shale (clay) content of the formations. This is because the radioactive elements tend to concentrate in clays and shales. Clean formations usually have a very low level of radioactivity, unless radioactive contaminants such as volcanic ash or granite wash are present, or when the formation waters contain dissolved potassium salts.

The Gamma Ray Log can be recorded in cased wells, which makes it very useful in completion and workover operations. It is frequently used as a substitute for the SP in cased holes where the SP is unavailable or in open holes where the SP is unsatisfactory. In both cases it is useful for the location of the non-shaly beds and for correlation.

8) Neutron Logs are used principally for delineation of porous formations and determination of their porosity. They respond primarily to the amount of hydrogen present in the formation. Thus, in clean formations whose pores are filled with water or oil, the Neutron Log reflects the amount of liquid-filled porosity.

A combination of the Neutron Log with one or two other porosity logs yields even more accurate porosity values and lithology identification, including evaluation of shale content.

Neutrons are electrically neutral particles, each having a mass almost identical to the mass of a hydrogen atom.

High-energy (fast) neutrons are continuously emitted from a radioactive source which is mounted in the sonde. These neutrons collide with nuclei of the formation materials in what may be thought of as elastic "billiard-ball" type collisions. With each collision a neutron loses some of its energy.

The amount of energy lost per collision depends on the relative mass of the nucleus with which the neutron collides. The greatest energy loss occurs when the neutron strikes a nucleus of practically equal mass, -- i.e., a hydrogen nucleus. Collisions with heavy nuclei do not slow the neutron down very much. Thus, the slowing-down of neutrons depends largely on the amount of hydrogen in the formation.

Within a few microseconds the neutrons have been slowed down by successive collisions to thermal velocities, corresponding to energies of around .025 electron volts. They then diffuse randomly, without losing any more energy, until they are captured by the nuclei of atoms such as chlorine, hydrogen, silicon, etc.

The capturing nucleus becomes intensely excited and emits a high-energy gamma ray of capture. Depending on the type of Neutron Logging tool, either these capture gamma rays or neutrons themselves are counted by a detector in the sonde.

When the hydrogen concentration of the material surrounding the neutron source is large, most of the neutrons are slowed down and captured within a short distance of the source. On the contrary, if the hydrogen concentration is small, the neutrons travel farther from the source before being captured. Accordingly the counting rate at the detector (with the source-detector spacings commonly used) increases for decreased hydrogen concentration, and vice versa.

Two other types of geophysical logs are also of interest because of their involvment in Water Department contract specifications.

9) A Caliper Log records the measurements of the diameter of the hole throughout its depth. Variations in the nature of the formations will cause variations in the diameter of the hole, even though the same size bit is used throughout. Factors which influence hole diameter include: grain size, amount of cementation, caving, and formation thickness.

10) Point Resistivity. This was the earliest type of resistivity logging. One electrode is grounded at the surface and the other lowered down the well. The amount of current passing from one electrode to the other is a function of the resistivity of the materials through which the current travels. This method allows only very shallow penetration into the formations, perhaps not beyond the zone disturbed by drilling mud penetration. Also, as each deeper formation is measured, the cumulative effect of this resistivity from the formations above gets larger. No quantitative calculations are possible with the data obtained. These problems led to the development of more sophisticated types of resistivity logging (See 2, 3, 4).

January 15, 1979

The City of Douglas
Water & Sewer Department
P.O. Drawer #1198
Douglas, AZ 85607

Attention: Mr. George D. Nalley
Superintendent

(GEOEX #1295 cont'd.)
Re: Water Well Drillers,
Drilling Contracts and
Specifications

Dear George:

Reviewing matters more or less covered at the 12-15-78 board meeting and the way I remember they stood at conclusion of that meeting, a decision was made to forego preliminary "slim hole" drilling for purely testing purposes and go directly to a hole for production purposes. It was also decided that some general production well specifications should be drawn up, together with objectives and known facts, for submittal to several prospective contract drillers for the purpose of soliciting proposals from them for drilling the proposed well. I agreed to get back to you on this in January and, hopefully, with additional recommendable contract driller candidates.

So far, I have located at least one more likely candidate presently headquartered in Willcox, and expect to hear from one or two more this week or next. Some of the qualified rotary drillers are presently involved in multiple hole or deep hole contracts. These of course are of more interest to them than one 600' water well, but I do not think this problem is universal or apt to remain perpetual.

Meanwhile, I have prepared a summary draft letter which generally covers the situation, for your review. This is herewith enclosed and if it is satisfactory, I recommend that copies be dispatched right away to at least:

ROTARY

1. Venture Drilling Company
P.O. Box 50325
Tucson, AZ 85703

Telephone No:
(602) 623-2211

Recommended reliable by Cities Service, Geo. Kushmaul & others. Only ones encountered so far who specialize in polymer muds for clean holes and maximum production

2. McBee Drilling Company
Room 106, Sands Motel
Willcox, AZ 85643
Telephone No:
(602) 384-3501

Sounds qualified in talking over phone. Reportedly just completed a 3110 foot irrigation well near Willcox for a Mr. Larry Layton, phone 384-2656. Well not yet successfully tested. Apparently polymer mud was not used. Recommended by Connors Drilling Company who are reliable specialists in diamond core drilling for mining prospecting purposes.

3. Layne Western Company, Inc.
3000 Emory Road
El Paso, Texas
1521 So. Lindsay Road
Tempe, AZ 85281
Telephone No:
(915) 581-5423
~~154~~
(602) 831-5585

CABLE TOOL

1. ~~Al~~ A. L. Cotton Boring Well Drilling
9401 N. Verch Way
Tucson, AZ 85704
Telephone No:
(602) 297-4444

(Trustworthy, have known personally for approximately 20 years)

2. Earl H. Williams Drilling Company
P.O. Box 41210
Tucson, AZ 85717
Telephone No:
Tucson, AZ (602) 888-325
(David Williams)
Hereford, AZ (602) 366-5553
(Earl Williams)

PUMP COMPANIES

1. Gilbert Pump of Tucson, Inc.
2840 Ruthrauff Road
Tucson, AZ 85705
Telephone No:
(602) 887-1212

(Have done work for the City before)

2. The Hanson Pump Corporation
2310 W. McDowell Road
Phoenix, AZ 85009
Telephone No:
Casa Grande (602) 836-7466
Phoenix (602) 258-8111

3. A. L. Cotton Boring Well Drilling
(Berkeley Pumps)
Telephone No:
(602) 297-4444

(See above under cable tool drillers)

4. Crow Company, Inc.
4408 E. Speedway
Tucson, AZ 85712

Telephone No:
(602) 881-0886

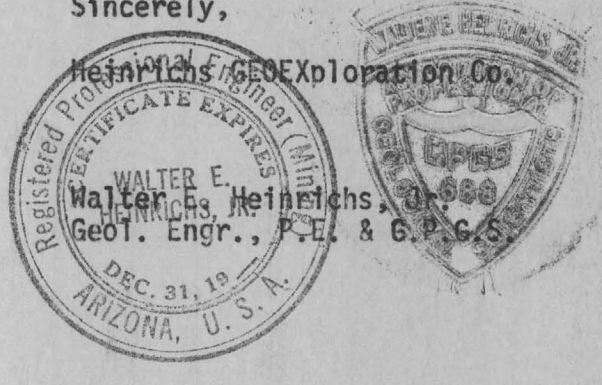
(Similar reference as A.L.Boring)

Depending on the drilling character of the basalt, both as first estimated and later as initial drill penetration rates indicate, rotary drillers may start with a small diameter bit to pilot through the basalt and then come back and ream to the final diameter specified. The reason for this is to maximize bottom hole tool pressures when minimum tool weights are available and when the rock is hard. Churn or cable tool drillers may or may not use similar procedures, but they generally have less available means of control to maintain a straight hole under these and most circumstances.

Incidentally, regarding the reported poor tests from the new Agua Prieta well, mentioned at the December 1978 Board Meeting, my records here show that the test pump was set at 220 feet when the test was made. If that is correct, it was set much too shallow - in fact almost right at the static water table level and if that is so, then a good test would not be expected. If this is not the explanation, then the next most likely reason is that natural and/or artificial mud has effectively sealed off the aquifer during drilling, or that geologic conditions in the hole are quite different than encountered in the nearest Douglas city well #5. If Joe Cornejo could get drill logs, or other factual data on the Agua Prieta wells for us, it would definitely be useful. Unless there is some specific reason against it, information trading of this sort can be mutually very worth while.

Sincerely,

Heinrichs GEOExploration Co.



Walter E. Heinrichs, Jr.
Geol. Engr., P.E. & G.P.G.S.

WEH:mt
Enclosure

P.S. With your approval, I would be glad to mail out the letter and screen the responses on your behalf. This would tend to shield you and the City of Douglas if that's desired - at least until final decision is made on specifically who will or who will not be definitely dealt with. Of course, I will need copies of all responses anyway for my evaluation and recommendations. Meanwhile, any comments from your end are most welcome or, if you should want me to come down for more discussion first that's fine too.

Regards,

P.P.S.: You likely have some additional names of dealers and jump people you may wish to add to my list.

M.

January 15, 1979

The City of Douglas, Cochise County, Arizona

Preliminary Considerations for Proposed Water Well

Drilling Contract and Letter of Solicitation

The City of Douglas, Arizona Water and Sewer Department is contemplating adding an additional well to the present nine well system. Following are the basic considerations and particulars involved.

General Site Location: Flat terrain of Douglas Basin, approximately three miles or less from downtown Douglas on city controlled property.

Geology: Top soil, valley fill or alluvium with a shallow westward and northward dipping basaltic volcanic flow interbed, which is exposed at the surface over much of the eastern portion of the proposed site area. This interbed varies from roughly 50 to 100 feet in thickness where it has been previously penetrated by eight city drill holes located over an adjacent six square mile area. This same area will include or be immediately adjacent to the proposed new well site. Exact location of the new site has not been finally decided but, in any case, it is expected that drilling will have to penetrate roughly 100 feet of basaltic volcanic flow rock. This would be either from the surface down to roughly 100 feet deep in the hole, if the hole is drilled in vicinity of the Douglas airport, Section 16, T24S., R.28E or in Section 8 (northwest of the airport) or in Section 9 (north of the airport).

Specific Site Location and Geology: If the site is located to the north or west of these said Sections 8, 9 or 16, then the basalt layer will be first encountered at some depth below the surface in the hole and may be thinner than 100 feet thick. The maximum average slope of the top of the basalt, as encountered in eight previously drilled city wells, is about 200 feet per mile from east to west, and about 50 feet per mile from south to north. Thus, the estimated depth to the top of the basalt will be fairly accurately known when the final exact site is chosen. In addition, at that point, there may also be a little more specific data on predicted absolute thickness of the basalt.

Material beneath the basalt, in all of the drilling done to date, is more but older valley fill.

Water Table: Static water table elevation is at 3790 to 3800 feet above sea level in the present well field. Surface elevations vary from about 3900 feet to 4100 feet. Therefore, depth to the "permanent" water table in the proposed new well site area, will be between 200 feet and 300 feet below the surface. Thus, the static water table may be located above, within, or below the basalt layer (depending on final site location).

Well Specifications

Depending on the final exact site location, the presently maximum programmed well depth is 600 feet. Some kind of pump or air jet capacity and draw down testing is ultimately desired, in addition to setting adequate size and properly perforated casing, gravel packing and final production pump setting and testing. A production capacity of at least 1000 gpm is hopefully achievable but, the range of 500 to 2000 gallons per minute capacity is technically possible based on existing wells.

Based on the above, a straight hole and casing which will comfortably accommodate bowl assemblies of a minimum of 10 inches diameter to a maximum of 14 inches diameter will be required. Therefore, quotes on nominal hole sizes from a maximum of roughly 18 inches final drilled diameter down to as small as 14 inches final drilled diameter and/or whatever increments in between may be chosen, will be considered, but please be specific in indicating alternatives and costs. Depending on pump test results, most likely, a 10" or 12" bowl turbine pump will be installed. However, this could vary if unexpectedly favorable pump test results were obtained.

Proposals: Your formal or informal quotation or proposal for handling all or any portion of this work is hereby solicited. Please indicate your time estimate, size and type of equipment, materials charges and recommendations such as special muds, etc., - also, such things as your fees, expenses, mobilization, demobilization or travel charges, etc. Date you could start or notice usually required and your estimated incremental times to mobilize, set up, drill, test and/or ream, case, gravel pack, set pump, production test and demobilize, are requested. It is realized that drillers may not wish to quote the production pump setting and testing, but this information is included, because it (is) (maybe) of advantage to the city to consolidate as much of the whole project's contracting as is feasible.

The extent to which you will or will not warrant or guarantee hole completion and/or protect the city from lost time and/or equipment losses, in case of trouble or accident in or out of the hole should be addressed.

Proposals
Continued:

If you wish further information you may call or write. Written data from you including certificate of insurance, etc., will of course be required before an award or contract will be let. In any event, some definitive response from you would be appreciated within the next 15 days.

Walter E. Heinrichs Jr., P.E.
Geol. & Geophysicist &

Registered Professional Engineer
CERTIFICATE EXPIRES
WALTER E. HEINRICHS JR.
DEC. 31, 19 79
ARIZONA, U. S. A.

Certified Professional Geological Scientist

Proposals
Continued: If you wish further information you may call or write. Written data from you including certificate of insurance, etc., will of course be required before an award or contract will be let. In any event, some definitive response from you would be appreciated within the next 15 days.

A map of the area showing the location of existing wells or holes and the area of the exposed basalt is attached for your information.

Heinrichs GEOExploration Company

Walter E. Heinrichs, Jr.
Geol. Engr. P.E. & C.P.G.S.

September 19, 1978

The City of Douglas
Water and Sewer Department
Post Office Drawer 1198
Douglas, Arizona 85607

Attention: Mr. George D. Nalley
Superintendent

Re: New Wellsite
Hydrological Survey
GEOEX #1295

Gentlemen:

Thank you for your letter of 18 September 1978, received today.

First off, it would be most desireable that I briefly review all readily available factual data that can conveniently be mailed to Tucson right away. A plan map copy or copies showing city controlled lands, by legal subdivision, locations and boundaries, would be most helpful, as would copies of any existing well logs, data and reports from prior work done by or for the city on its own land, as well as any similar data from adjacent or nearby land not under city control but which could still be quite pertinent, such as private land (ranches or Phelps Dodge) and possibly state land. These need not be at all comprehensive or exhaustive and, if bulky or otherwise inconvenient, whatever is immediately and easy to send will suffice, at least initially or for the time being. Whatever you do send will be kept intact and returned after I have finished with them.

Should you have any other suggestions, thoughts or questions at any time, please do not hesitate to let me know right away. Meanwhile, I will be looking forward to your response and working for you on this project.

Very truly yours,

Heinrichs GEOEXplorationCCo.

Walter E. Heinrichs, Jr.
P.E. & C.P.G.S.

WEH:mt

TELEPHONE (602) 364-8446
(602) 364-8447

POST OFFICE DRAWER 1198

The City of Douglas

Water & Sewer Department
Douglas, Arizona 85607

September 18, 1978

Heinricks Geoexploration Co.
Box 5964
Tucson, AZ 85703

Dear Sir:

Referring to your letter of July 21st regarding a hydrological survey relative to locating a site for a new well for the City's water supply.

Will you please arrange to do this job for us. If there is any information you need from us, please let us know, also if we can compile information for you we will do what we can.

Very truly yours,

Geo. D. Nalley

George D. Nalley
Superintendent

tes

July 21, 1978

The City of Douglas P.O. Drawer 1198
Water and Sewer Department
Douglas, AZ 85607

Re: New Well Site Hydrological Survey
GEOEX #1295

Attention: Mr. George D. Nalley
Superintendent

Gentlemen:

Thank you for your inquiry letter of 17 July 1978 regarding a hydrological survey in connection with considerations relative to drilling a new well for the City of Douglas water supply.

Fees for this type of work are $25.00 per professional man hour, plus necessary directly incidental job expenses at our invoice cost plus 15%. Transportation is $17.50 per vehicle day plus $0.23 per mile per vehicle.

Usual routine is to briefly review and assimilate current and relative facts and data, ideas, problems if any, and possibilities or intended general objectives. This would take one or two office days and if a trip to Douglas is required or desired, about ten hours minimum additional or more, if extenuating factors or special difficulties or circumstances were involved. However, we are aware of none of these and you mention none in your letter and none are therefore anticipated at this stage.

Should for some reason more extensive research or study be indicated, or such work as ground water geophysical methods be needed, then we could proceed either on a day to day basis or preferably, ~~recommendations, and estimates~~ proposals, and estimates submitted for your consideration and prior approval.

My estimate at this instant without benefit of all the available facts, is that a $750.00 - $1,000 study over a period of 5 to 10 days from start to finish, including one field day at Douglas, would be at least initially adequate and possibly all that would be necessary or recommended. Sometimes we need roughly two or three weeks notice or more before we can schedule new work and proceed with it. Sometimes we can get at it almost immediately. It all depends on our work load at the time.

Please do not hesitate to contact us further should you need more details or have further questions.

Sincerely,

Heinrichs GEOEXploration Co.

Walter E. Heinrichs, Jr.
P. E. & C.P.G.S.

WEH:mt

TELEPHONE (602) 364-8446
(602) 364-8447

POST OFFICE DRAWER 1198

GEOEX
Cable: GEOEX
RECD JUL 20 1978 RECD
BOX 5984 TUCSON, ARIZONA 85703
Phone: (AREA 602) 623-0578

The City of Douglas

Water & Sewer Department
Douglas, Arizona 85607

July 17, 1978

Heinrichs Geoexploration Co.
808 W. Grant Rd.
Tucson, Az 85705

Gentlemen:

We are considering drilling a new well for the City of Douglas water supply.

We would like to have an hydrological survey of the area and would need to know the cost and length of time it takes for this type of work.

Any information you can send us would be helpful. Your prompt attention will be appreciated.

Very truly yours,

George D. Nalley
Superintendent

tes

November 2, 1978

The City of Douglas
Water and Sewer Department
P. O. Drawer 1198
Douglas, AZ 85607

Attn: Mr. George D. Nalley, Superintendent

Re: Water System Supply
Study "Phase II"
GEOEX # 1295

Dear George:

This letter confirms the conference held with you, your staff and the City of Douglas Water Board in Douglas on Thursday, October 26, 1978.

Interest was expressed in gaining more detailed information regarding the feasibility of developing new production wells further to the east in the same direction as favored by the indicated trends of real estate development. Accordingly, it was requested to consider methods, costs and time required to analize the situation along two profile sections, each one about one and one half miles long, oriented north-south along the eastern and western sides of Sections 16 and 9 respectively and extending from the east-west center line of Section 16 (8th Street) on the south, to the north side of Section 9 on the north.

In addition, it was requested that available alternatives and present drilling facilities and costs be preliminarily investigated and recommendations made, especially from the standpoint of test drilling purposes, as opposed to production drilling purposes..

Taking the last matter first, more specific investigation is continuing but meanwhile the following generalizations will apply:

1. Churn or cable tool drilling is cheapest, but slowest and will encounter more difficulty with hard-rock formations and especially so in drilling relatively shallower or smaller diameter holes primarily for testing purposes.

2. Churn rigs are commonly only capable of bail testing which is usually inadequate for reliable ultimate production yield estimating for larger yield wells, i.e.; 100 gpm plus.

3. Ultimate production yield estimates can be most reliably accomplished by major pump testing and associated measurements, however, compressed air jet testing may be a worthwhile compromise under some conditions and this can be done by some available "slim hole" rotary drilling equipment at a basic cost of from $7.00 to $10.00 per foot plus extras such as positioning, biodegradable polymer-mud, casing, perforating, etc.

4. Rotary rigs are capable of collaring in hard rock and maintaining a straight hole with a maximum speed of penetration if properly drilled with a minimum of proper equipment.

5. Rotary drilling usually requires more equipment and people on the crew than does cable-tool drilling.

6. Most expensive method, but one which can provide superior in-hole control and ultimate production yields, is reverse circulation rotary. This is the method currently employed by the City of Tucson. It has also been used by the Salt River Project in the Phoenix area. In both cases this is mainly for production drilling and not for test drilling however.

7. The better rigs and crews seem to be keeping fairly busy and are scheduled six weeks or more ahead.

Referring to the two proposed study-profile-sections, one concern is the amount of relief in the older pre-basalt surface. Present indications are that the basalt thickens toward the east gradually and although this could change suddenly, the odds still favor that the basal surface or floor of the basalt will lie above the 3,800 foot water table elevation under the area of Sections 9 and 16.

Short of actual test drilling, electrical resistivity geophysics might possibly help map depth to the basalt floor along the two proposed profile sections and give some indirect areal correlation with water productivity potential of the saturated sedimentary aquifer section underlying the basalt. Such work would cost about $3,000.00. However definitely interpretable and useful results cannot be reliably assured at this point.

At a cost similar to the geophysical testing, if done separately or, at a 10% - 20% savings if both were done together, the surrounding exposed sediments which would be expected to underly the basalt under Sections 9 and 16, could be studied and mapped geologically. If the results were clear enough, conceivably useful interpreted projections to depth under the area of Sections 9 and 16 could be made. However, it is also possible that such data would be too obscure or variable or both to either map or project successfully.

Success of these indirect non-drilling approaches will depend primarily on whether or not meaningful correlations can be made with existing well data or other factual information as may be acquired later. Of course it is possible that such studies would give some categorical do or don't drill-here answers, but that is much less likely.

Summarizing tentatively, one 8" diameter rotary test hole, 600 feet deep, production tested by compressed air, estimate $7,500.00; geophysics $3,000.00; geology $3,000.00; geology and geophysics combined in concurrent survey $5,000.00; recommended technical supervision, contract negotiation, bidding, etc. $1,750.00; instrumental logging of drill hole $2,500.00. Probably not very much could be initiated before around mid-December 1978 even if decided immediately. In the mean time, I should have additional or more refined specific figures for you and meanwhile this letter-report should raise a few questions from your end which I will try to answer right away.

Sincerely,
Heinrichs GEOEXploration Company

Walter E. Heinrichs, Jr.
P.E. & C.P.G.S.

WEH/jh

TELEPHONE (602) 364-8446
(602) 364-8447

POST OFFICE DRAWER 1198

The City of Douglas

Water & Sewer Department

Douglas, Arizona 85607

GEOEX
Cable: GEOEX
RECD SEP 22 1978 RECD
BOX 5964 TUCSON, ARIZONA 85703
Phone: (AREA 602) 623-0578

September 20, 1978

Heinricks Geoexploration Co.
Box 5964
Tucson, AZ 85703

Dear Sir:

Referring to your answer to our letter of September 18 regarding the survey for a new well site.

We are enclosing 3 maps of the City, one has the existing wells located on it. A map of the Douglas basin, Logs of our 9 wells and pumping information for the last 5 years. A report from the River Basin-Watershed Planning Staff dated February, 1977.

Also copies of logs of wells in the vicinity. Airport Well, Nu-Way International Laundry Well, Douglas Dees Well, Cochise Junion College Well No. I, El Paso Natural Gas Co. Well, Agua Prieta Mexico well.

Any additional information you need let us know.

Very truly yours,

George D. Nalley

George D. Nalley
Superintendent

tes

2/24/77 Bart Ambrose
Douglas F.O.

River Basin-Watershed Planning Staff
Suite 326, Arizona Title Bldg., 111 W. Monroe, Phoenix, Arizona 85003

ENG - Trip Report - Geologic Assistance to Douglas Field Office — February 18, 1977

Ronnie L. Clark
RBWP Staff Leader

Tuesday, February 1, 1977, was spent in Douglas providing geological assistance to the Douglas Field Office. The purpose of this trip was to assist the city of Douglas in regard to the development of additional ground water supplies.

Bart Ambrose, District Conservationist, and I met with city officials to discuss the problems confronting the water department in regard to providing an adequate water supply to the residents of Douglas. Personnel in the water department had assembled a considerable amount of data relating to existing water supply and wells which have been drilled. This data greatly facilitated the investigation.

The potential for severe water shortages has been recognized by water department officials. A breakdown of any of the existing wells during periods of high useage would create immediate problems in providing an adequate supply of water to its customers.

A steadily declining ground water level has reduced the yield of some wells, and pumps have been lowered in some wells to accommodate the continued useage of these wells. Fluoride levels in wells numbers 1 and 2 exceed established health department limits for human consumption. Water from these wells has to be diluted with water from other wells before it can be used.

The present water supply is obtained from nine wells. Several other test wells have failed to yield an adequate quantity of water to justify their completion. Wells numbers 5 and 8 pump into a five-million gallon reservoir. The city officials desire to develop an additional source of water to provide water for the storage reservoir. This is the area of most immediate concern.

(near S.W. Cor Sec., 10 T. 24S R. 28E.)

The existing wells obtain their water supply from the valley-fill sediments and the associated interlayered basalt. The valley-fill sediments consist of gravel, sand, silt and clay of Tertiary and Quaternary Age. The basalt which underlies the city of Douglas is also of Quaternary Age. Although the older sedimentary igneous and metamorphic rocks which underlie and border the Douglas Basin contain some water, they are of no great importance as aquifers since the yield of water from them is generally quite small.

The role of the basalt in relation to ground water movement and yield is not completely known. Available well logs for the city of Douglas indicate that all wells except numbers 1 and 2 penetrated basalt. From the well logs it can be deduced that the basalt flow originated east of Douglas and flowed over an irregular alluvial surface. On this assumption, it is concluded that some of the irregularities on the base of basalt may represent the location of channels cut into the alluvium. This conclusion is substantiated to some extent by the presence of sand and gravel layers which may represent channel deposits under the basalt.

Correlation of individual alluvial strata between the various wells can only be tentative and subject to considerable question due to the lenticularity of alluvial sediments deposited in such a basin as the Douglas Basin. For that reason it is recommended that any additional drilling to develop water supplies should be done by drilling small diameter test holes. These holes should be completed at considerably less cost than large diameter wells required for production. After running pumping tests, a decision can be made as to the advisability of attempting to complete a production well at a given location. In undertaking the drilling of any test well a good log of materials penetrated should be obtained. Collection and preservation of well cutting samples should be required. The running of electric logs on test holes should prove to be of great value in the evaluation of a given test well.

With regard only to interpreted geologic conditions, several areas were selected as meriting further investigation by the drilling of test wells. No consideration was given to the availability of property for test sites or the location of existing water lines to collect and distribute water which might be developed. The locations need not be exact as existing data is not adequate to make very precise determinations.

Tentatively recommended areas for test wells are: (1) near the center of Section 12, Range 27 E, Township 24 S, (2) center of NE¼ of Section 13, Range 27 E, Township 24 S, (3) near the center of Section 7, Range 28 E, Township 24 S, and (4) near the center of Section 18, Range 28 E, Township 24 S. (See attached map.)

These sites are selected on the basis of geologic conditions as inferred by available well logs. Data obtained from drilling test wells at any specific location should be evaluated prior to initiating drilling at other locations.

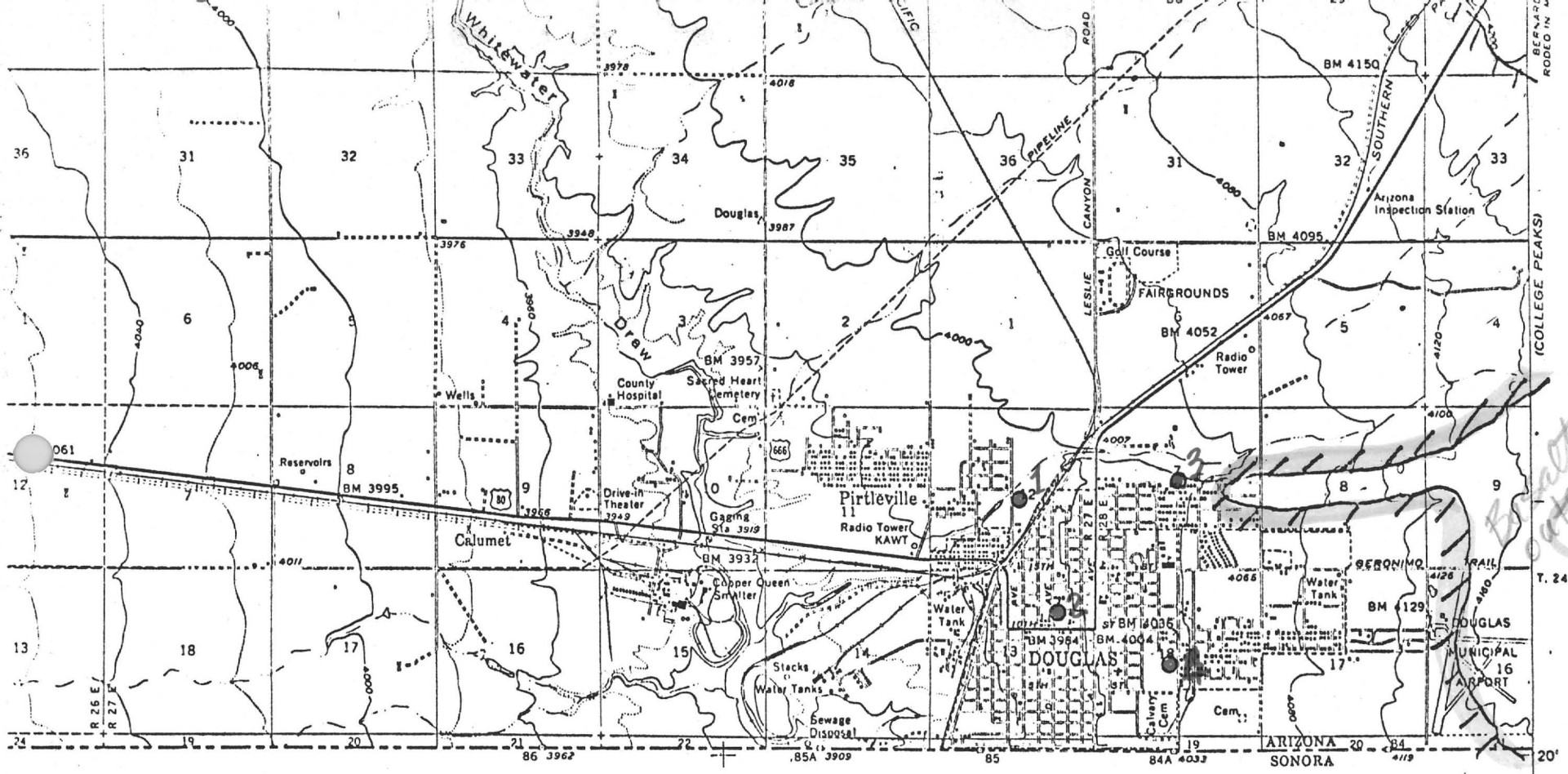
If test drilling is undertaken it is recommended that the test holes in Sections numbers 12 and 18 be drilled to a depth of about 500 feet. Wells in Sections numbers 7 and 13 should be drilled to about 600 feet. These are tentative depths and should be subject to change based upon information obtained during drilling.

Further water development in the immediate vicinity of Douglas will contribute toward increasing the rate of ground water level decline. Future water needs may necessitate the development of water supplies from the outlying area. In order to plan for the most efficient development for long range needs, a more comprehensive geohydrological study should be undertaken.

Aubrey C. Sanders, Jr.
Geologist

Attachment

cc: (w/att.)
John W. Peterson (1 copy)
Ralph M. Arrington (1 copy)
Joseph L. Knisley, Jr. (1 copy)
Barton E. Ambrose (6 copies)



LEGEND

● PROPOSED TEST WELL SITE

SUPERINTENDENT'S REPORT -- SEPTEMBER 1978

Listed below is the well information, and a comparison of the last five years.

PUMP #1

LOCATION:	Pumping Plant, west of Douglas.
DRILLED:	1942
DEPTH:	337'
EQUIPPED:	Cook - 8" Turbine
PUMP SETTING:	160'
SUCTION:	10'
TOTAL SETTING:	170'
AIR LINE:	170'

	1974	1975	1976	1977	1978
STATIC WATER LEVEL:	124'6"	124'9"	123'4"	121'3"	129'3"
DRAW DOWN:	140'	129'	127'9"	130'	133'8"
GPM:	1000	1000	1000	1000	1000
PUMPING LEVEL ABOVE TOTAL SETTING:					30'

PUMP #2

LOCATION:	Pumping Plant, west of Douglas.
DRILLED:	1943
DEPTH:	340'
EQUIPPED:	Cook - 8" Turbine
PUMP SETTING:	130'
SUCTION:	16'
TOTAL SETTING:	146'

	1974	1975	1976	1977	1978
STATIC WATER LEVEL:	128'8"	118'6"	116'7"	115'	119'3"
DRAW DOWN:	140'	129'	128'6"	130'	132'
GPM:	1200	1000	1000	1000	1000
PUMPING LEVEL ABOVE TOTAL SETTING:					16'

PUMP #3

LOCATION:	Overlock Add - 25th Street and Louis Avenue
DRILLED:	1947
DEPTH:	320'
EQUIPPED:	Byron Jackson 10" Turbine was replaced with Gould 8" Turbine
PUMP SETTING:	312' Corrected 9-76 and 20' in 12-76
SUCTION:	10'
TOTAL SETTING:	322'
AIR LINE:	320' Sounding Tube

	1974	1975	1976	1977	1978
STATIC WATER LEVEL:	215'6"	222'	228'5"	226'	232'8"
DRAW DOWN:	233'6"	256	264'	256'	
GPM:	520	730	900	735	
PUMPING LEVEL ABOVE TOTAL SETTING:					66'

SUPERINTENDENT'S REPORT -- SEPTEMBER 1978

PUMP #4

LOCATION:	15th Street Park
DRILLED:	1956
DEPTH:	461'
EQUIPPED:	Johnson 8" Turbine
PUMP SETTING:	340'
SUCTION:	10'
TOTAL SETTING:	350'
AIR LINE:	340'

	1974	1975	1976	1977	1978
STATIC WATER LEVEL:		208	212'9"	218'	224'8"
DRAW DOWN:		272'6"	286'	290'	295'
GPM:	850	950	850	800	800
PUMPING LEVEL ABOVE TOTAL SETTING:					50'

PUMP #5

LOCATION:	8th Street Park
DRILLED:	1960
DEPTH:	430'
EQUIPPED:	Johnson 8" Turbine. Aug. 76, 40' extension installed.
PUMP SETTING:	340
SUCTION:	10'
TOTAL SETTING:	350

	1974	1975	1976	1977	1978
STATIC WATER LEVEL:	238'	234'	219'10"	216'8"	220'6"
DRAW DOWN:	257'	254'	245'	240'	241'4"
GPM:	1150	1100	1190	1100	1100
PUMPING LEVEL ABOVE TOTAL SETTING:					110'

PUMP #6

LOCATION:	Near Golf Course
DRILLED:	1964
DEPTH:	450'
EQUIPPED:	Fairbanks Morse - 8" Turbine
PUMP SETTING:	250'
SUCTION:	10'
TOTAL SETTING:	260'

	1974	1975	1976	1977	1978
STATIC WATER LEVEL:	214'	218'	219'10"	228'8"	232'8"
DRAW DOWN:	241	241'	245'	252'8"	252'9"
GPM:	1250	1200	1190	1175	1175
PUMPING LEVEL ABOVE TOTAL SETTING:					7'4"

SUPERINTENDENT'S REPORT -- SEPTEMBER 1978

PUMP #7

LOCATION:	11th Street and Pan American
DRILLED:	1967
DEPTH:	554'
EQUIPPED:	Layne Turbine 10"
PUMP SETTING:	230'
SUCTION:	10'
TOTAL SETTING:	240'
AIR LINE:	240'

	1974	1975	1976	1977	1978
STATIC WATER LEVEL:	157'	158'	155'	160'	168' Airline
DRAW DOWN:	193'	188'	198'	185'	195' Airline
GPM:	1150	1000	1250	1250	1250
PUMPING LEVEL ABOVE TOTAL SETTING:					55'

PUMP #8

LOCATION:	27th Street and Washington
DRILLED:	1971
DEPTH:	500'
EQUIPPED:	1972-Peerless 8" Turbine
PUMP SETTING:	390'
SUCTION:	10'
TOTAL SETTING:	400'
AIR LINE:	407'

	1974	1975	1976	1977	1978
STATIC WATER LEVEL:	252'	252'	256'	254'	260' Airline
DRAW DOWN:	320'	317'	330'	320'	318' Airline
GPM:	1250	830	900	850	800
PUMPING LEVEL ABOVE TOTAL SETTING:					80'

PUMP #9

LOCATION:	Overlock Addition
DRILLED:	1976
DEPTH:	503'
EQUIPPED:	Goulds 10" Turbine
PUMP SETTING:	352'
SUCTION:	10'
TOTAL SETTING:	362'
AIR LINE:	340'

	~~1974~~	~~1975~~	1976 FIRST TEST PUMP	1977	1978
STATIC WATER LEVEL:			224'	256'	255' Airline
DRAW DOWN:			314'	281'	281' Airline
GPM:			1500	1100	1170
PUMPING LEVEL ABOVE TOTAL SETTING:			86'	81'	

CITY OF DOUGLAS WATER & SEWER DEPT.
DOUGLAS, AZ 85607

WELL LOG

WELL # 1

STATE I.D. (D 24-27)10-1
PUMP HOUSE - SEC. 10, NW of SE,
Township 24, Range 27

DEPTH: 337 Feet
DRILLED: September, 1942 by J. L Eicks
CASED: 12" to 277 feet
WATER LEVEL: 57 feet - depth to water ~~280'~~ 12/15/42

LOG

0'	to 14'	Surface Soil
14'	to 25'	Sand, gravel, water
25'	to 75'	Clay
75'	to 80'	Sand, gravel, water
80'	to 268'	Clay
268'	to 277'	Brown rock, water
277'	to 337	Blue lime rock, water

(H2O-129')(1978)

DECEMBER, 1958 Repairs - J. R. Sharp - columns were lengthen 20 feet: total depth 334'

Casing: 12" I.D. - 0" to 248' - 8" I.D. 248' to 334'
Perforated full length 10" bell welded on top of 8" liner.

WATER LEVEL: 55 feet

MAY, 1966 - WATER LEVEL - STATIC 90'1"
DRAWN DOWN - 96'8"

February, 1967 Static Water Level 88'9"
Drawn Down 92'10"

MAY, 1968 STATIC WATER LEVEL 100'
DRAWN DOWN 106'4"
Gals. pumped per Min. 1100 g.p.m.

MAY, 1970 STATIC WATER LEVEL 105'
DRAW DOWN 108'
GALS. pumped per m. 990

STATE I.D. (D 24-27)10-2

WELL # 2 PUMP HOUSE - SEC. 10, NW of SE, TOWNSHIP 24, RANGE 27

DEPTH: 340 Feet

DRILLED: February, 1943 by J. L. Eicks

CASED: 12" Standard T & G 13 Casing

WATER LEVEL: 55 Feet

LOG

0'	To 20'	Soil
20'	to 30'	Sand, Gravel, water
30'	to 83'	Clay
83'	to 95'	Gravel (water)
95'	to 120'	Clay
120'	to 130'	Gravel (water)
130'	to 200'	Clay & Gravel
200'	to 260'	Clay, Sand, Gravel
260'	to 335'	Black gravel (Water)
335'	to 340	Red Clay Gravel

← (H2O 109') (1978)

DECEMBER, 1958 Repairs - J. R. Sharp - columns were lengthen 20 feet. total depth 336'

CASING: 12" I.D. 0' to 250' - 8" I.D. 250' to 336', perforated full length 10" bell welded on top of 8" liner

MAY, 1966 - WATER LEVEL - STATIC 90'8"

FEBRUARY, 1967 - Static Water Level 80'8"

Drawn Down 91'5"

MAY, 1968 STATIC WATER LEVEL 89'

DRAWN DOWN 102'8"

Gallons Pump per min. 1230 g.p.m.

MAY, 1970 STATIC WATER LEVEL 107'

DRAW DOWN 112'

Gals. pumped 1100 g.p.m.

STATE I.D. (D 24=28)18-3

WELL # 3 - OVERLOCK

DRILLED : May, 1947 - Joe L. Eicks

LOCATION: North half of Block 28 - Overlock Addition ~~SE~~ ½, ~~NE~~ ½, of ~~SW~~ ½, Section ~~18~~ 7 Township 24S, Range 28E. G & S.R. B & M Cochise County

Lots - 1 thru 5
Lots - 8-9 + (illegible)
Lots - 13 thru 24 (#3 ...)

DEPTH: 320'

LOG OF WELL

0	- 2	Top Soil
2	- 15	Black Soil & Boulders
15	- 35	Gravel & Clay
35	-118	Red Clay
118	-122	Gravel
122	- 160	Sandy Soil
160	- 165	Sand, gravel, water
165	- 170	Clay & Gravel
170	- 175	Clay & Gravel
175	- 190	Clay & Boulders
190	- 200	Sand, (water)
200	- 211	Porous Malapai
211	- 227	Hard Black malapai
227	- 231	Porous black malapai
231	- 242	Hard black malapai
242	- 248	Porous malapai
248	- 258	Hard black malapai
258	- 267	Porous Red Malapai with water crystals
267	- 280	Extra hard black malapai
280	- 283	Porous Malapai
283	- 291	Extra hard black malapai
291	- 306	Hard black malapai with crevices full of mud
306	- 317	Porous malapai with water crystals
317	- 320	Tight hard mixture of clay & gravel like concrete

165' Static Water Level

233' (1978)

117'

STATE I.D. (D 24-28) 7-4
WELL # 4 - 15TH STREET PARK

DRILLED: January, 1956 - Valley Tractor & Equip. Co

LOCATION: Section 7, Twp. 24S, Range 28W
SW ¼, SE ¼, SW ¼, 15th St. Park

DEPTH: 461"

LOG OF WELL

0 - 3	Top Soil
3 - 53	Red Clay
53 - 90	Brown Clay
90 - 145	Red Clay
145 - 170	Red and Brown Shale
170 - 190	White Sand
190 - 240	Clay & Gravel
240 - 270	Sand & Gravel
270 - 280	Boulders
280 - 335	Malapai Rock
335 - 461	Sand & Gravel
150	Static Water Level

H2O - 227' (1970) 225 (1978)

55'

8/23/75 477'

MAY, 1966 - WATER LEVEL - DRAWNDOWN 188'6"

FEBRUARY, 1967 - Static Water Level - - 177'4"
Drawn down - 225' returns
within 25 minutes.

MAY, 1968 STATIC WATER LEVEL 182'6" — 47'2"
DRAWN DOWN 229'8"
Gals. pumped per min. 900 g.p.m.

MAY, 1970 STATIC WATER LEVEL 227'
DRAW DOWN 245'
Gals. Pumped 800 g.p.m.

APRIL, 1971 STAtIC WATER LEVEL
DRAW DOWN
G.P.M. 800

STATE I.D. (24-28)18-5

WELL # 5 8TH STREET PARK

DRILLED: August, 1960 - J. R. Sharp

Location: Twp. 24S, Range 28E, Section 18

SE ¼, NE ¼, SW¼, 8th St. Park near 5th St

DEPTH: 430'

LOG OF WELL

0 - 60	Red Clay with Caliche streaks
60 - 80	Rocky clay
80 - 105	Red Clay
105 - 110	Rocky Clay
110 - 135	Red Clay
135 - 240	Rocky Clay
175	first water (Not very strong)
240 - 264	Black Malapai
264 - 270	Red Malapai
270 - 298	Black Malapai
298 - 430	Gray Conglomerate
169	Static Water Level

(197' H20) (1971) (220.5' - 1978)

58'

MAY, 1966 WATER LEVEL - DRAWNDOWN 202'11"

FEBRUARY, 1967 Static Water Level 184'5"

Draw down 198'

MAY, 1968 STATIC WATER LEVEL 190'9" — 13'-3"

DRAW DOWN 204'

Gals. pumped per min 950 g.p.m.

MAY, 1970 StATIC WATER LEVEL 195'6"

DRAW DOWN 210'

Gals. Pumped 950 g/p/m.

APRIL, 1971 STATIC WATER LEVEL 197'

DRAW DOWN 210'

G.P.M. 1000

STATE I.D. (D-23-28) 6-6
WELL # 6 - NEAR THE GOLF COURSE

DRILLED: May, 1964 - J. R. Sharp

LOCATION: Township 24S, Range 28E, Section 6
SE ¼, SW ¼; of NW ¼

DEPTH: 450'

LOG OF WELL

0 - 160	Red Clay & Boulders
160 - 190	Sandy Clay & Gravel
190 - 290	Conglomerate
290 - 294	Sandy clay & Gravel
294 - 345	Grey Malapai
345 - 380	Red Malapai
380 - 450	Conglomerate
180.5	Static Water Level
221'	Drawdown at 1400 G.P.M.

203' H_2O (~~233'~~ - 1978)

86'

40'-6"

220.0
180.5
40.5

May, 1966 Water Level - Static 186'2"
Drawdown 189'

FEBRUARY, 1967 -- Static Water Level - 187'6"
Draw Down 219'8"

MAY, 1968 STATIC WATER LEVEL 195' — 27'
DRAWN DOWN 222'
Gals. pumped per min. 1350 g.p.m.

MAY, 1970 STATIC WATER LEVEL 200' — 28'
DRAW DOWN 228'
Gals. Pumped 1300 g.p.m.

APRIL, 1971 STATIC WATER LEVEL 203' — 30'
DRAW DOWN 233'
G.P.M. 1300

(B-24-27) 12-1

WELL # 7 - 340 - 11TH STREET "H" Ave.

DRILLED: MAY, 1967 - EARL LOHN DRILLING CONTRACTOR

LOCATION: Twp. 24 South: Range 27 East, Section 13 NW ¼; SE ¼; NW ¼.

DEPTH: 554'

LOG OF WELL

0 - 5	Surface Soil
5 - 25	Light Yellow Clay
25 - 85	Brown Clay
85 -160	Brown Shale & Clay ← H_2O 142'
160 -165	Gravel (not much) Water
165 -215	Brown Some Gravel
215 -385	Brown Clay & Gravel
385 -400	Black Clay Gumbo
400 -410	Black Hard Malapai
410 -422	Black Extra Hard Malapai
422 -450	Black Hard Malapai
450 -470	Red Clay & Gravel
470 -512	Brown Clay & Gravel
512 -542	Gravel
542 -554	Hard Sand & Gravel
132'	Static Water Level
205'	Drawn Down pumping 1718 G.P.M. recovery to 134'6" in three minutes.

APRIL, 1971	STATIC WATER LEVEL	142'
	DRAW DOWN	185'
	G.P.M.	1250

168' → (1978)

↑ 50' ↓

132' - 73'

142' - 43' =

=25.53 gpm/ft drawdown.

" "

29.07 " "

STATE I.D. D(24-28)8 Bbb /
WELL #8 EAST OF WASHINGTON AVENUE

DRILLED: JUNE, 1971 - EARL LOHN, JR. $ 7,616.00

LOCATION: Twp. 24 South; Range 28East; Section 8
NW ¼, NW¼, NW¼

DEPTH: 500 Feet

LOG OF WELL

0 - 3	SOIL
3 - 6	CALICHE
6 - 12	SAND
12 - 27	CLAY AND GRAVEL
27 - 55	SANDY CLAY
55 - 95	SAND AND GRAVEL
95 - 122	SAND-GRAVEL WITH CLAY
122 - 163	BLACK MALAPAI
163 - 167	BROWN "
167 - 173	BLACK " (Very Hard)
173 - 190	Brown "
190 - 196	Black " (Very Hard)
196 - 208	Brown "
208 - 210	Brown Burnt Clay
210 - 224	Black Malapai (Very Hard)
224 - 259	Brown decomposed malapai
259 - 295	Brown Conglomerate
295 - 302	Sand and Gravel
302 - 319	Brown Conglomerate
319 - 321	Hard Conglomerate
321 - 480	Brown Conglomerate
480 - 488	Conglomerate with hard streaks
488 - 498	Hard Conglomerate
498 - 500	Brown Sticky Clay
230'	Static Water Level

102'

(260' - 1978) (H_2O)

9

STATE I.D. D(24-28)7 acc

WELL # 9 - OVERLOCK

DRILLED: JULY, 1976 - EARL LOHN, JR.

LOCATION: SOUTH half of Block 28 - Overlock Addition NW ¼, SW ¼, of NE ¼ Section 7, Township 24S, Range 28E, G & S. R. B & M Cochise County.

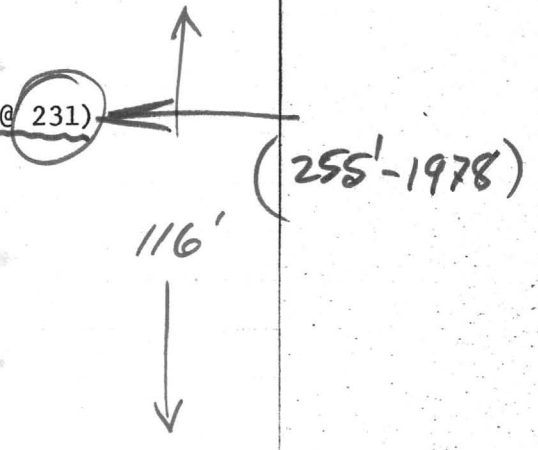
On Lots 8 and 9

Labor 15,000.00
Grant 260.40
Test 4,240.00
Casing 2,082.71
19583.11

DEPTH: 503'

LOG OF WELL

0	-	2	Top Soil
2	-	4	Brown Clay with Boulders
4	-	13	Sandy Clay
13	-	20	Sand
20	-	42	Gravel
42	-	55	Brown Sticky Clay
55	-	83	Brown Sandy Clay
83	-	189	Brown Gravel with Clay
189	-	192	Gravel & Boulders
192	-	195	Brown Malapai
195	--	210	Very Hard Black Malapai
210	-	234	Brown Malapai (1st water @ 231)
234	-	260	Black Hard Malapai
260	-	272	Brown Malapai
272	-	283	Very Hard Black Malapai
283	-	300	Brown Malapai
301	-	306	Extra Hard Black Malapai
306	-	308	Black & Red Malapai
308	-	315	Gravel In Clay
315	-	405	Cemented Conglomerate
405	-	410	Clay & Conglomerate
410	-	503	Brown Cemented Conglomerate



POST OFFICE DRAWER 1198
TELEPHONE 364-3331

The City of Douglas

Water Department
Douglas, Arizona 85607

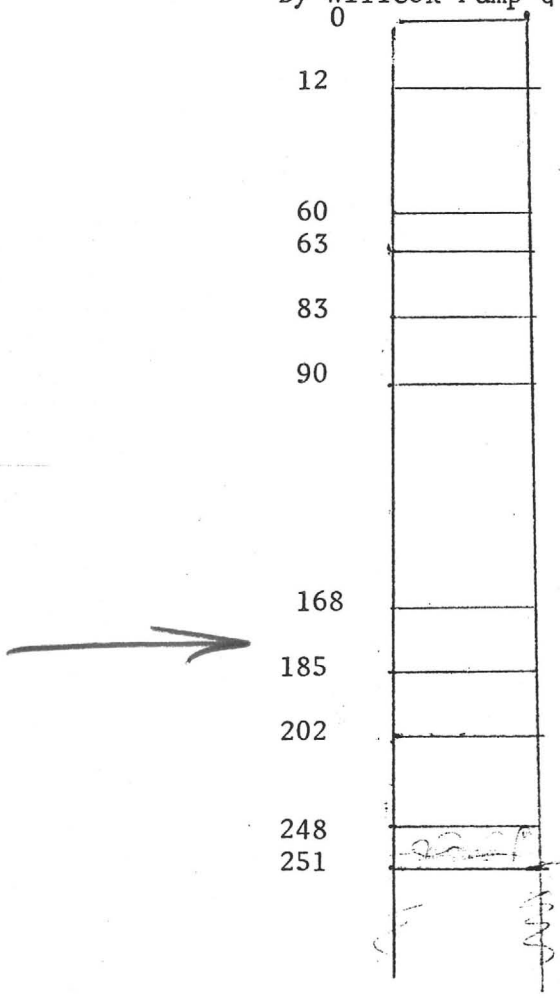
March 25, 1966

Located on map?

1431 - 12th St. Douglas.

Un-Way International Laundry - Well Drilled March 23, 1966

By Willcox Pump & Equipment Co.



Basalt

Basalt

Basalt: 280' deep 1/2 mile east (City #4)
" : 400' " 1/3 " west (" #7)

Static Water Level	105'
Pumping Water level	151'

East of Agua Prieta - approx. Dash. Ave. Sept. 1970

SECRETARIA DE RECURSOS HIDRAULICOS
GERENCIA GENERAL EN EL ESTADO DE SONORA (ZONA NORTE)
AGUA POTABLE Y ALCANTARILLADO.
AGUA PRIETA, SONORA.

CLASIFICACION LITOLOGICA DE CAMPO DEL POZO No. 3 PARA AGUA POTABLE DE AGUA PRIETA, SONORA.

(No water level indicated)

PROFUNDIDAD (pies) De	a	(Mts.) De	a	CLASIFICACION
00.00 -	20.0	0.0 -	6.00	Arenas, poca gravilla y arcilla (x)
20 -	30	6.00 -	9.15	Arenas, poca gravilla, poca grava y arcilla.
30 -	60	9.15 -	18.30	Arenas, gravilla y arcilla.
60 -	70	18.30 -	21.35	Arenas, gravilla, poca grava y poca arcilla.
70 -	80	21.35 -	24.40	Arenas, gravilla, poca grava y muy poca arcilla.
80 -	100	24.40 -	30.50	Arenas, gravilla y arcilla.
100 -	150	30.50 -	45.70	Arenas, gravilla y grava.
150 -	160	45.70 -	48.80	Grava, arenas y gravilla.
160 -	170	48.80 -	51.80	Gravilla, grava y arena.
170 -	180	51.80 -	54.90	Grava, gravilla y arenas.
180 -	200	54.90 -	61.00	Arenas, gravilla y grava.
200 -	210	61.00 -	64.00	Arenas, gravilla y poca grava.
210 -	220	64.00 -	67.00	Arenas y poca gravilla.
220 -	230	67.00 -	70.10	Arenas, gravilla y poca grava. ← H2O ? table
230 -	270	70.10 -	82.30	Arenas, gravilla y grava.
270 -	290	82.30 -	88.40	Arena, poca gravilla y poca grava.
290 -	330	88.40 -	100.60	Arenas, gravilla y grava.
330 -	400	100.60 -	121.92	Grava, gravilla, arenas y arcilla.
400 -	460	121.92 -	140.21	Arenas, gravilla, grava y poca arcilla.

(x) "ARENAS" Comprende: Arena de grano fino, medio y grueso, distribuidas - uniformemente.

ARENA - SAND
GRAVILLA - GRAVEL (FINE)
ARCILLA - CLAY
GRAVA - GRAVEL (COARSE)

GR - B

GIRP'icv.

5/6/75

Douglas Dees

County Hospital Road — Locate on map.

Well Log:

0 ft. to 3 ft. Top soil
3 ft. to 47 ft. Clay
47 ft. to 51 ft. sand (First water)
51 ft. to 71 ft. Sandy clay
71 ft. to 75 ft. Sand and gravel (water bearing)
75 ft. to 180 ft. Clay with large gravel embedded
180 ft. to 183 ft. Sand and gravel (water bearing)
183 ft. to 223 ft. clay with small embedded gravel (black, green, red)
223 ft. to 229 ft. Sand and small gravel (water bearing)
229 ft. to 248 ft. Clay
248 ft. to 266 ft. Sand and gravel (water bearing)
266 ft. to 295 ft. Clay with large gravel embedded
295 ft. to 306 ft. Sand and gravel

No Basalt.?

Total depth of hole-- 306 ft.
Type of casing--steel 8"
Method of sealing at reduction points--welded
Perforated from 200 ft. to 291 ft.
Size of cuts--1/8" by 12" No. of cuts per ft. 4
Method of construction--drilled
Date started-- April 8, 1975
Date completed--April 16, 1975

Drilled by Bobby McDonald
Box 30E
McNeal, Arizona

PUMP SALES
SERVICE

WELL DRILLING
PROSPECTS

J. R. Sharp

GENERAL CONTRACTOR
BOX 01175 -:- PHONE HE 2-4597
BISBEE, ARIZONA

COCHISE COLLEGE AUG 3 '63

JULY 1963

L O G

COCHISE JUNIOR COLLEGE WELL NO. I Locate on map

DEPTH		FORMATION
0 - 5	feet	Top soil
5 - 12	"	Gravel
12 - 18	"	Clay
18 - 26	"	Gravel
26 - 173	"	Clay
173 - 177	"	Sand and gravel ---FIRST WATER AT 173 feet
173 - 203	"	Clay
203 - 215	"	Gravel with some clay
215 - 350	"	Tan clay. Thin layers of gravel
350 - 400	"	Alternate thin bedded shales, conglomerate and clay

no basalt ?

0 - 354	"	16" O.D. pipe
163	"	STATIC LEVEL
354 - 400	"	Open hole
172 - 344	"	Perforated Mills Knife $\frac{1}{2}$" x 3$\frac{1}{2}$" 6 each foot
344 - 349	"	Perforated Torch 3/8" x 6" 6 each foot.
215	"	One hour bailer test at 25 gpm at drilling depth of 215 feet. Static level 173 feet. Water lowered to 182 feet in twenty minutes with no further change for duration of test.
400	"	One hour bailer test with casing at 354 feet before knifing, bailing at 25 rpm rate. Static level 163 feet. Water lowered to 173 feet in twenty minutes with no further change for duration of test.

The City of Douglas
Water Department
DOUGLAS, ARIZONA

Dec. 1941.

LOG OF AIR PORT WELL

9 and 1/2 miles north of Douglas Locate exact on map?

Feet from top		Feet to
0'	Top Soil	1 1/2'
1 1/2'	Caliche	4'
4'	Clay and small rock	147'
147'	Water, sand & gravel	150'
150'	Joint Clay	162'
162'	Water, Sand & gravel	164'
164'	Clay & large gravel	292'
292'	Boulders	297'
297'	Concrete formation	299'
299'	Water, Gravel	328'
328'	Clay	332'
332'	Water, Gravel	337'

H2O H2O

No basalt?

330' 3" of 10" Casing with 88' of perforation

DRILLED BY JOE HICKS & ONEY REYNOLDS

LICENSED DRILLERS.

Copy

Form 5-7

EL PASO NATURAL GAS COMPANY

WATER WELL DATA REPORT

No. 5 STATION

(N.E. Douglas 7-8 mi ?)
(Sec 9, T. 23S, R. 28E.)

Water Well No. Howard
Water Well Drilled By
Drilling Completion Date 1946

WATER DATA

TOTAL WELL DEPTH - FEET 400
STATIC LEVEL (TOP TO BOTTOM) - FEET ..... 190' ? (See log)
PUMPING LEVEL (TOP TO BOTTOM) - FEET .....
DRAW DOWN - FEET .....
PUMP SETTING ..... ~~210 ? ± 4'~~ 210 RK
PUMPING CAPACITY G.P.M. .....
NO. OF FLATS IMPELLER RAISED FOR TEST ..... 1 3/4"
DATE ABOVE TEST TAKEN .....
TEST SUPERVISED BY .....

PUMP DATA

MAKE ..... Peerless
MODEL .....
TYPE ..... Hi-Lift
RATED CAPACITY G.P.M. .....
SERIAL NUMBER OF PUMP 80739
ROD SIZE ..... 1"
COLUMN SIZE ..... 4"
NO. OF BOWLS 1

PUMP MOTOR DATA

MAKE ..... General Electric
MODEL 5K6505XA2B
RATED HP 15
AMPS 39.2/19.6
VOLTS ..... 220/440, 3 phase, 60 cycle
SERIAL NUMBER OF MOTOR N116959333

CASING DATA (TOP TO BOTTOM)

_____ FT. CASING SIZE 8 5/8
_____ FT. CASING SIZE _____
_____ FT. CASING SIZE _____
_____ FT. CASING SIZE _____
_____ FT. SCREEN INSTALLED
_____ FT. SCREEN INSTALLED
_____ FT. PERFORATION
NUMBER OF PERFORATIONS PER FOOT _____
APPROXIMATE LENGTH EACH PERFORATION _____ IN.
TYPE CASING SEAL _____

Type K
Code F
Frame 6503
RPM 1755

Pumping Column	
21 X 10	210
Bowles	6
Total	216

REMARKS:

NOTE: ATTACH DRILLERS LOG & COPY OF WATER ANALYSIS WHERE AVAILABLE

D. C. Kelly
PREPARED BY
Dec. 15, 1954
DATE

(4)

EL PASO NATURAL GAS COMPANY

COMPRESSOR DEPARTMENT

NO. 5 STATION

WELL NO. HOWARD WELL DATE

LOG

TO	FORMATION	NO. FEET
35'	Gravel and Caliche	
50'	Sand	
70'	Lime	
110	Gravel and Clay	
130	Lime	
180	Gravel and Clay	
190	Water Sand	
200	Clay	
250	Hard Gravel	
360	Clay and Gravel	
370	Fine Gravel and Water	
400	Gravel	

Information:

Form 5-46 (4-52)

El Paso Natural Gas Company
COMPRESSOR DEPARTMENT LABORATORY

W E L L W A T E R A N A L Y S I S

Sample Description - Station No. 5
Howard Well

Sample Appearance - and Odor

	2/3/50	2/6/50	2/13/50
pH	7.5	7.8	7.8
Total hariness as $CaCO_3$	148	166	146
Calcium as $CaCO_3$	104	118	111
Magnesium as $CaCO_3$	44	48	35
P Alkalinity as $CaCO_3$	0	0	0
Total Alkalinity as $CaCO_3$	245	250	245
Chloride as Cl	32	32	32
Sulfate as SO_4	82	90	92
Silica as SiO_2	26	27	27
Iron as Fe	0.2	0.2	0.2
Total Solids	468	468	502
Specific Conductance, micromhos			

ALL RESULTS EXPRESSED AS PARTS PER MILLION

REMARKS:

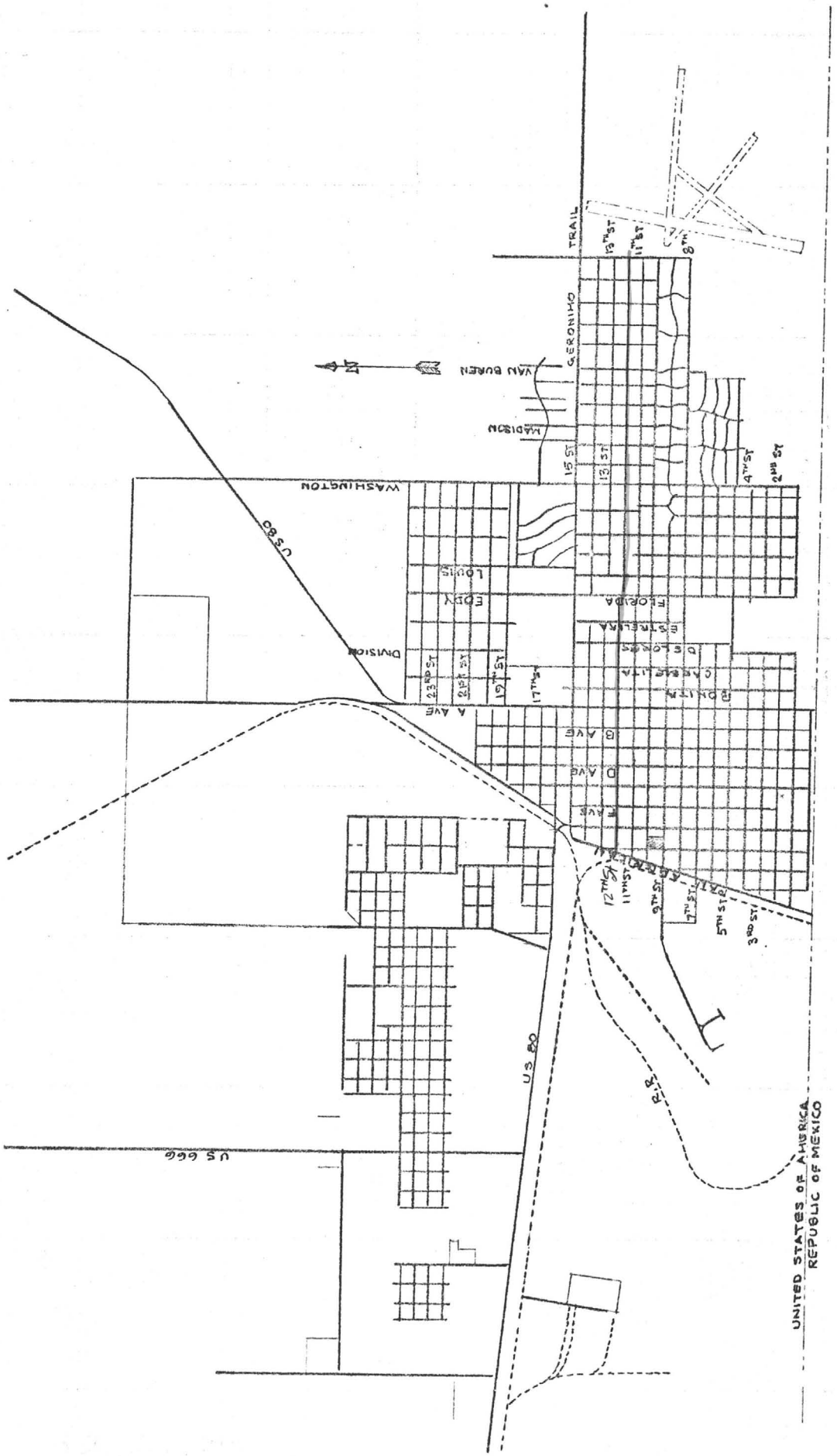
Clint de la Houssaye

(2)

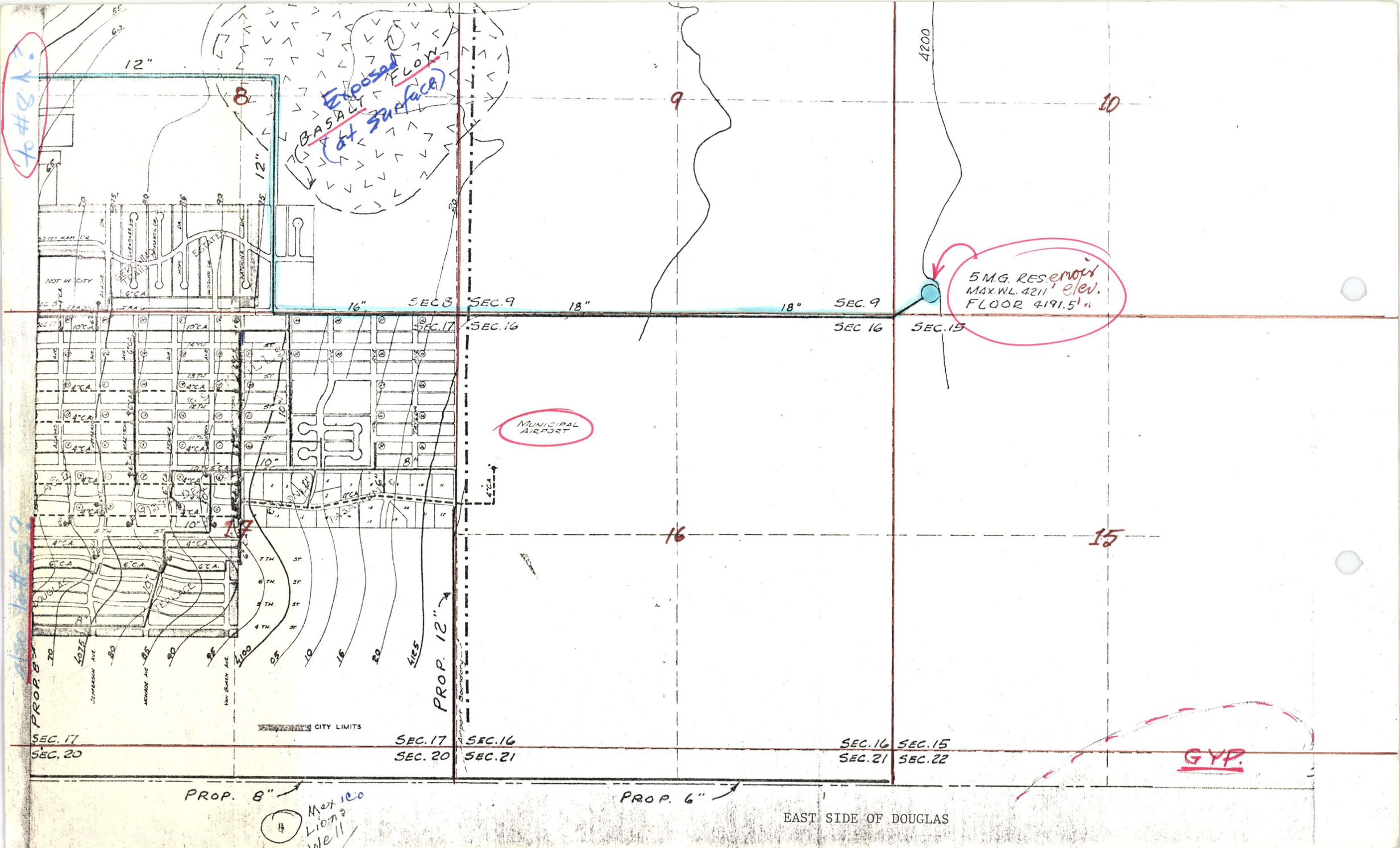
BY..... DATE..... SUBJECT..... SHEET NO..... OF.....

CHKD. BY..... DATE..... JOB NO.....

MAY 3 1978



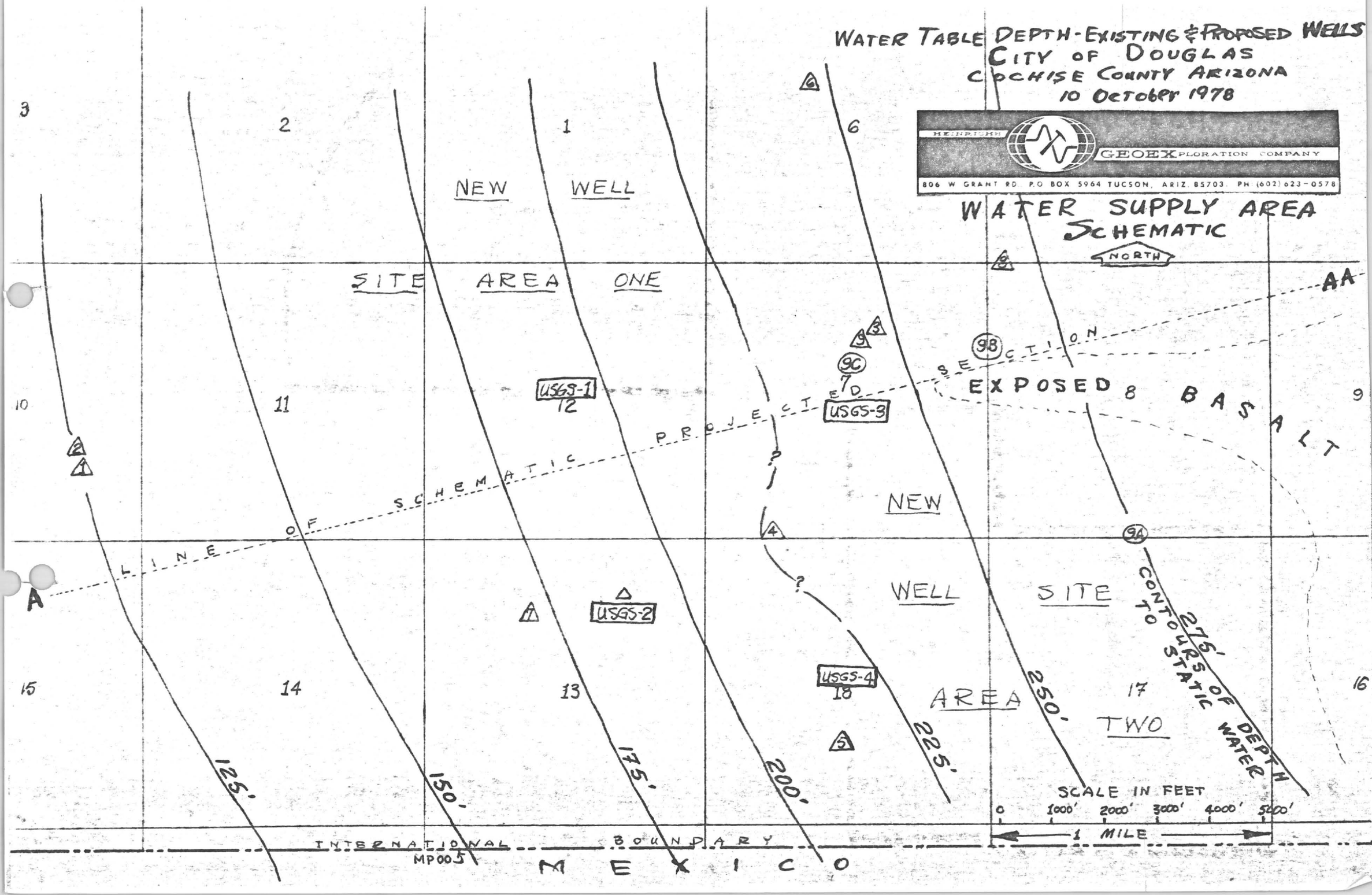
City of Douglas


12"
8
12"
Exposed BASALT FLOOR (at surface)
9
10
4200
16"
SEC 8
SEC. 9
18"
18"
SEC. 9
SEC 16
SEC. 15
5 M.G. RES. reservoir
MAX. WL. 4211' elev.
FLOOR 4191.5' "
SEC. 17
SEC. 16
MUNICIPAL AIRPORT
17
16
15
PROP. 8"
PROP. 12"
CITY LIMITS
SEC. 17
SEC. 20
SEC. 17
SEC. 20
SEC. 16
SEC. 21
SEC. 16
SEC. 21
SEC. 15
SEC. 22
GYP.
PROP. 8"
PROP. 6"
EAST SIDE OF DOUGLAS

WATER TABLE DEPTH - EXISTING & PROPOSED WELLS
CITY OF DOUGLAS
COCHISE COUNTY ARIZONA
10 OCTOBER 1978

HENRICHER GEOEXPLORATION COMPANY
806 W GRANT RD P.O BOX 5964 TUCSON, ARIZ. 85703 PH (602) 623-0578

WATER SUPPLY AREA SCHEMATIC



PHONE 887-1212

PUMP of Tucson, Inc. >>>
2840 RUTHRAUFF ROAD
TUCSON, ARIZONA 85705

Rec: 10/3/78

May 19, 1977

City of Douglas
Water Department
Douglas, AZ 85607
Attn: George Nalley

Dear George:

Enclosed is a copy of the results on the test we conducted on Well No. 9, May 18, 1977, under normal conditions. If you can recall and I doubt without any problem the normal conditions did not last too long.

I have made a list of items that need your immediate attention or repair:

1. Reset the timer on the starter so that when energized the motor will run in start for no more than three seconds.

2. Contact A.P.S. and have them correct the high voltage problem. All three legs read out at 495 Volts when the pump is in operation.

3. Install voltage meter in panel (to be installed by Gilbert Pump).

4. Realign pump with discharge piping and provide means to secure discharge head to the pump foundation. (This work to be performed by Gilbert Pump after receiving authorization from the City of Douglas)

5. Examine all discharge piping for possible cracks or flange leakage due to the stress on the line during the malfunction of the system.

If you have questions or if you have anything further to add to the above please don't hesitate to call me.

Sincerely,

GILBERT PUMP OF TUCSON, INC.

Al Ciasca
Sales Engineer

cc: R.L. Sears
encl.

GILBERT PUMP & EQUIPMENT C

PUMP TEST

Tested By: A. Ciasca

Date: 5-18/77? - 76?

OWNER: City of Douglas Well #: 9 Power Meter#: 433310

LOCATION: _____

ASSEMBLED INFORMATION

FLOW METER: WATER SPECIALISTS PIPE I.D.: _____ GPM: 1200

METER KH: 4.8 C.T. MULT.: 80 10 REV. IN 83.5 SEC.

PUMPING LEVEL: 304' FT. STATIC LEVEL 235' FT.

93#
EXT. HD. OF 214.8 FT. DRAW DOWN 69' FT.

*TOTAL PUMP HD. 518.8' FT. GAL/FT. D.D. 17.4 GAL.

FRICT. LOSS OF 4.9' FT. AMPS 225 218 218

TOTAL BOWL HEAD 523.7 FT. VOLTS 495 495 495

PUMP SETTING 352' FT. COL. SIZES 10"x2½"x1 11/16"

BOWLS: 9-STAGE 12 SHMC GOULDS COL. SIZES _____

PUMP RPM 1760 MOTOR HP 200

CALCULATIONS

KH 4.8 x MULT. 80 x 36 ÷ SEC. 83.5 10 REVS = KWI 165.5

KWI 165.5 x 1.34 = IHP 221.8 x .92 = BHP 204

GPM 1200 ÷ 226 = 5.31 ACRE FT./24 HRS.

GPM 1200 x TPH* 518.8 ÷ 3960 ÷ IHP 221.8 = O.A.EFF. 70.8 %

OVERALL EFF. (O.A. EFF.) 70.8 ÷ .92 = PUMP EFF. 77 %

POWER COST

KWI _____ x RATE/HR. _____ x 24 = COST/24 HR. _____

24 HR. COST _____ ÷ AC/FT/24 HR. _____ = COST/ACRE FT. _____

REMARKS: _____

GP 07-2M-2-75

Water + Sewer Dept. 7/8/76

#9 City of Douglas

Started Pump @ 4:00 PM
Pumped through night
back washing till 8:30 AM
Started testing @ 8:30 AM 7/9/76

static level 224'

Air Line Pressure	Pumping Level	GPM	RPM	Time
65	249'	540	1350	8:30 A.M.
62	256	610	1400	8:45
60	261	700	1450	9:00
58	266	815	1500	9:15
56	270	890	1550	9:30
53	277	990	1625	9:45
52	279	1100	1650	10:00
50	284	1150	1700	10:15
48	289	1200	1725	10:30
45	295	1250	1800	10:45
42	302	1350	1850	11:15
41	305	1400	1900	11:30
39	309	1450	1950	11:45
37	314	1500	2000	12:45 P.M.
Recovery from 314 - 272 - 1 min 10 sec) from 272 - 224 - 5 min				
65	249	550	1360	1:30 PM
61	259	700	1450	1:45
58	266	800	1500	2:00
53	277	1000	1600	2:15
49	286	1200	1700	2:30
46	294	1300	1800	3:00
42	303	1400	1900	3:15
38	312	1500	2000	3:30
35	319'	1600	2100	4:00

AUG 1976
RECEIVED
CITY OF DOUGLAS
ARIZ.

Test #9 Overlook

5 SQUARES TO THE CENTIMETER

CITY OF DOUGLAS
7/8 & 9 /76
Static level 224'

Recovery from 314-272 in 1 Min. 10 Sec. From 272-224 in 5 Min.

GPM	DEPTH
1600	319'
1500	312'
1400	303'
1300	294'
1200	286'
1000	277'
800	266'
700	259'
550	249'

2100 RPM

1750 RPM.

1750 RPM.

2100 RPM

FARMERS PUMP CO., INC.

V. W. Owens

V. W. Owens, Pres.

Rec'd: 10/3/78

Table 4.2 - Chemical examination of water, City of Douglas Water Department wells, reports of analyses by the Arizona State Health Department Laboratory, March 15, 1972. Values shown are in parts per million.

	Main St. South Well #1	Main Sta. North Well #2	Overlock Well #3	15th Street Park Well #4	8th St. Park #5	Near Golf Course #6	340 11th St. #7	27th St. & Washington #8
Total Solids	650	635	290	333	390	278	335	340
Total Hardness	12	14	140	120	210	128	10	204
Calcium	4	4	35	29	55	29	2	54
Magnesium	1	1	12	12	17	13	1	17
Sodium	196	194	42	54	37	47	103	37
Total Iron	< .05	< .05	< .05	< .05	< .05	< .05	< .05	< .05
Alkalinity Phenolphthalein	4	8	0	2	0	6	8	0
Methyl Purple	132	132	162	154	162	190	182	178
Chlorides	198	194	19	19	20	12	25	15
Fluorides	1.6	1.7	1.0	0.6	0.8	0.6	0.6	0.57
Nitrates	2	2	6	4	4	2	4	8
Sulfates	90	88	37	58	87	23	34	78
Chromium	0.01	0.01	< 0.1	< .01	< .01	< .01	< .01	< .01
Specific Resistance (Ohms)	900	930	2200	1950	1650	2300	1930	1900
Turbidity	< 5	< 5	< 5	< 5	< 5	< 5	< 5	Clear
Color	< 5	< 5	< 5	< 5	< 5	< 5	< 5	Colorless
Odor	< 3	< 3	< 3	< 3	< 3	< 3	< 3	Odorless
Special Tests								
Manganese	< .05	< .05	< .05	< .05	< .05	< .05	< .05	
PH	8.6	8.8	8.3	8.4	7.8	8.6	8.8	
Copper	< .05	< .05	< .05	< .05	< .05	< .05	< .05	
Chemist's Remarks	ZN 0.05	ZN .05	ZN .05	ZN .05	ZN .05	ZN 0.08	ZN 0.08	

MAP	LOCATION	STATIC LEVEL	DRAW DOWN	G.P.M.	DATE & YEAR	TAKEN BY:
1	HIWAY 80 WEST	121' 3"	150'	1000	30 AUG. 77	
1	HIWAY 80 WEST	129'3"	133'8"	1000	13 SEPT 78	FIERROS LEON
2	HIWAY 80 WEST	115'	130'	1000	30 AUG. 77	
2	HIWAY 80 WEST	119'3"	132'	1000	13 SEPT 78	FIERROS LEON
3	OLD OVERLOOK	226'	256'	735	30 AUG 77	
3	OLD OVERLOOK	232'8"			13 SEPT 78	FIERROS LEON
4	15th ST. PARK	218'	290'	800	30 AUG 77	
4	15th ST. PARK	224'8"	295'	800	13 SEPT 78	FIERROS LEON
5	8th ST. PARK	216'8"	240'	1100	30 AUG. 77	
5	8th ST. PARK	220'6"	241'4"	1100	13 SEPT 78	FIERROS LEON
6	GOLF COURSE	223'8"	252'8"	1175	30 AUG 77	
6	GOLF COURSE	232'9"	252'9"	1175	13 SEPT 78	FIERROS LEON
7	11th ST.	160'	185'	1250	30 AUG 77	
7	11th ST.	168' AIRLINE	195' AIRLINE	1250	13 SEPT 78	FIERROS LEON
8	27th & WASH.	254'	320'	850	30 AUG 77	
8	27th & WASH.	260' AIRLINE	318' AIRLINE	800	13 SEPT 78	FIERROS LEON
9	NEW PUMP	250'	291'	1100	30 AUG 77	
9	NEW PUMP	255' AIRLINE	281' AIRLINE	1170	13 SEPT 78	FIERROS LEON

CITY OF DOUGLAS
WATER AND SEWER DEPARTMENT
WATER REVENUE ANALYSIS
FOR THE FISCAL YEAR ENDED JUNE 30, 1977

Rec'd 10/3/78 Wells.

	Meters in Service	Average Revenue Per M Gallons Sold	Monthly Meter Charges	Gallons Sold	Gallons Pumped	Gallonage Not Metered
1976 - July	4210	$.4457	$ 40,460	90,786,300	117,515,200	26,728,900
August	4214	.4375	37,598	85,943,800	121,178,600	35,234,800
September	4217	.4424	35,054	79,235,900	102,950,200	23,714,300
October	4221	.5176	29,084	56,187,400	80,577,500	24,390,100
November	4223	.6021	26,384	43,818,000	63,097,400	19,279,400
December	4215	.6116	27,455	44,887,500	63,192,800	18,305,300
1977 - January	4233	.6210	26,315	42,378,600	51,331,000	8,952,400
February	4235	.6453	26,632	41,271,900	55,911,100	14,639,200
March	4240	.5170	30,121	58,260,000	73,479,500	15,219,500
April	4236	.5406	30,490	56,399,200	83,012,800	26,613,600
May	4252	.6538	43,608	66,699,800	89,921,600	23,221,800
June	4247	.6556	55,833	85,157,200	125,017,000	39,859,800
F.Y.E. 6/30/77	4247	$.5446	$409,034	751,025,600	1,027,184,700	276,159,100
F.Y.E. 6/30/76	4203	.4786	393,943	823,129,900	1,104,096,000	208,966,100
6/30/75	4139	.4834	377,415	780,766,900	1,007,983,200	227,216,300
5/31/74	4038	.4901	407,645	831,810,500	1,168,354,100	336,543,600
5/31/73	3970	.5241	362,213	691,159,700	899,421,900	208,262,200
5/31/72	3871	.4274	326,766	764,521,300	969,755,500	205,234,200

NOTE: Above figures do not include water used by and charged to the City of Douglas as follows:

F.Y.E.	6/30/77	$81,778	168,455,600
F.Y.E.	6/30/76	71,637	170,275,900
F.Y.E.	6/30/75	48,710	73,217,700
F.Y.E.	5/31/74	57,308	152,057,800
F.Y.E.	5/31/73	45,525	104,227,600
F.Y.E.	5/31/72	36,302	100,225,400

Rec'd. 10/3/78 Wells.

CITY OF DOUGLAS WATER & SEWER DEPT.

425 10th S DRAWER 1198
DOUGLAS, ARIZONA 85607
PHONE 364-8446

MEM-O-GRAM

☐ URGENT – REPLY IMMEDIATELY
☐ NO REPLY REQUIRED

Heinricks Geoexploration Co.

DATE: Sept.29, 1978

TO

Box 5964
Tucson, AZ 85703

SUBJECT:

FOLD

MESSAGE

Mr. Heinricks:

Enclosed are copies we secured from Phelps Dodge Corp.
The copies attached to this note must be returned to us.
The other copies you may keep.

George D. Nalley

SIGNED Geo. D. Nalley

REPLY

Data per above rec'd: 10/2/78 and will be handled accordingly. Many thanks.

FOLD

SIGNED [signature] DATE 10/2/78

RECIPIENT - RETAIN WHITE COPY - RETURN PINK COPY - TO MAIL IN WINDOW ENVELOPE - USE FOLD MARKS

ALOHA FORM 00-873-1

CITY OF DOUGLAS
WA[illegible] DEPT.
425 - 10th ST.
DOUGLAS, AZ. 85607

9A

Rec'd: 10/2/78

WELL ABANDONED AT 15TH ST. & VAN BUREN
MARCH, 1975

Driller: Earl Lohn, Jr.

State ID D924-28)17baa
31325

Location: 15th St. & Van Buren - NE ¼, NE¼, NW ¼, Section 17, Twp. 24 South, Rge 28E

LOG

0	-	2	Top Soil
2	-	6	Caliche
6	-	13	Sandy Clay - Brown
13	-	18	Sand
18	-	47	Clay - Brown
47	-	55	Gravel
55	-	63	Sandy Clay & Gravel - Borwn
63	-	83	Gravel & Boulders
83	-	99	Malapai - Black
99	-	105	Hard Malapai - Black
105	-	109	Malapai - Black
109	-	115	Hard Malapai - Black
115	-	117	Malapai - Black
117	-	120	Very Hard Malapai - Black
120	-	122	Very Very Hard Malapai - Black
122	-	125	Extremely Hard Malapai - Black
125	-	126	Very Hard Malapai - Black
126	-	130	Malapai - Grey
130	-	145	Malapai - Brown - Water 140 - 144 perched?
145	-	174	Malapai - Brown
174	-	210	Conglomerate - Brown
210	-	230	Conglomerate - Brown (Possible Decomposed Malapai)?
230	-	245	Clay with Gravel - Brownish
245	-	258	Sandy Clay - Brown
258	-	265	Sandy Clay with Gravel - Brown
265	-	275	Gravel & Clay
275	-	285	Decomposed Rock - Water at 275' Table
285	-	300	Decomposed Rock with some Clay
300	-	334	Decomposed rock with some clay - Brown
334	-	344	Decomposed rock - Brown
344	-	351	Hard Decomposed rock - Brown
351	-	372	Hard Cemented Conglomerate - Brown
372	-	378	Clay with Boulders - Brown
378	-	384	Boulder & Clay - Brown
384	-	394	Hard Cemented C onglomerate - Brown
394	-	397	Very Hard cemented conglomerate - Brown
397	-	443	Hard cemented conglomerate - Brown
443	-	445	Very Hard cemented conglomerate - Brown Bottom

Water provisionally accepted for public usage.
Not tested. - Casing salvaged.

Bg fm. Cadmiq-Sulfide

CITY OF DOUGLAS
WATER DEPT.
425 - 10th ST.
DOUGLAS, AZ. 85607

9-B

Well Abandoned at 25th St. and Washington

November, 1975 State ID D(24-28)7 ada 33145

Rotary.

DRILLER: Earl Lohn, Jr.

Location: 25th St. & Washington NE ¼, SE ¼, NE ¼, Twp. 24 South, Rge. 28 East Section 7 Block 24 - Lots 13 and 14 Overlock Addition

LOG

0	-	2	Top Soil
2	-	7	Caliche & Boulders
7	-	22	
22	-	30	Sandy Clay - Brown
30	-	80	Sandy Clay with some gravel - brown
80	-	100	Gravel with some clay - brown
100	-	103	Gravel
103	-	115	Malapai - Black
115	-	120	Hard Malapai - Black
120	-	125	Malapai - Black
125	-	127	Very Hard Malapai - Black
127	-	131	Hard Malapai - Black
131	-	138	Malapai - Black
138	-	146	Malapai - Dark Brown
146	-	160	Malapai - Brown
160	-	175	Malapai - Black
175	-	178	Very Hard Malapai - Black
178	-	196	Malapai - Brown
196	-	200	Very Hard Malapai - Black
200	-	205	Malapai - Black
205	-	220	Malapai - Grey
220	-	235	Very Hard Malapai - Black
235	-	247	Malapai - Brown
247	-	249	Extremely hard malapai with some quartz - First water - small amount
249	-	252	Hard malapai - Black
252	-	256	Gravel (water) - Brown
256	-	259	Gravel - Brown
259	-	271	Clay with gravel - Brown
271	-	283	Conglomerate - Brown
283	-	291	Hard Conglomerate - Greenish-gray
291	-	294	Conglomerate - Brown
294	-	300	Hard Conglomerate - Grey
300	-	335	Very Hard Conglomerate - Gray
335	-	338	Conglomerate - Gray
338	-	349	Very Hard Conglomerate - Gray

Hole 24" to 150'

196 Malpai

Table ✓

Hole 18" to 339'

over

CITY OF DOUGLAS
WATER DEPT.
425 - 10th ST.
DOUGLAS, AZ. 85607

Hole: 9B contd.:

LOG

349	-	361	Hard Conglomerate - Gray
361	-	404	Very Hard Rock - Gray
404	-	407	Very Hard Rock - Gray
407	-	416	Broken Hard Rock - Gray - WATER
416	-	502	Very Hard Rock - Gray
502	-	504	Broken Rock - Brownish
504	-	564	Broken rock with some soft areas - brown
564	-	584	Broken rock with hard streak at 570

6" pilot hole.

24" Hole to 150' — gravel & approx. 50' into
18" " to 339' & from top of basalt (103')
6 5/8" casing installed - 346'10"

6" pilot hole from 349 to 584

~~Rotary~~ Driller — air — 500 gpm.
~~Submersible~~ ~~turbine test~~ - Gilbert (Bob Sears)
12 3/4" OD
1000' - 1500' — 12" min ID
~~Straight~~

500' — $2800.00
set
$3200 — 1500 gpm =

1000 gpm = 180 HP. Min $37.50/hr.
min 8 hrs - 24 hrs best
$25.00/hr.

$240.00 R.T. travel.
$38.40/ per diem, 2 Men.

CITY OF DOUGLAS
WATER DEPT.
425 - 10th ST.
DOUGLAS, AZ. 85607

9-C

WELL ABANDONED IN BLOCK 28 - OVERLOCK
MARCH, 1976

Driller : Earl Lohn, Jr. - Bernard Drilling Co.
Location: Block 28 -

LOG

0	-	3	Top Soil
3	-	10	Sandy Clay - Brown
10	-	40	Gravel & Boulders - Brown
40	-	48	Sandy Clay - Brown
48	-	57	Gravel
57	-	77	Sand - Gravel in Clay - Brown
77	-	95	Sandy Clay
95	-	103	Sand
103	-	188	Sand, Gravel, Small Boulders in Clay-Brown
188	-	195	Sand - Gravel
195	-	208	Sand - Gravel with boulders (Malapai)
208	-	222	Malapai - Black - First Water 222 FT.
222	-	224	Hard Malapai - Black
224	-	233	Malapai - Black
233	-	260	Malapai

Table

52'

Hole Crooked

Increase of Malapai?

Rotary.

Pump tested

Churn.

QUESTIONS:

1. Relative to the pump tests data from wells #1 & #2 and wells #3 and #9, these respective well pairs locations are about (?) 500' apart according to the maps. Data suggests in 1977 and 1978, that #3 pump may have been pumping when #9 well was tested. Obviously, because of close proximity the drawdown cones of depression may overlap each other when these wells are simultaneously in production. Approximate similarities are indicated at wells #1 & 2. Is this a possible explanation or are there other aspects involved?

2. Is the Nu Way Laundry well still being pumped and if so at what rate and from what depth?

3. Well 5 1974-1978 Static level +17.3 feet - why?

4. Exact location of abandoned well 9C, and are there any other dry or abandoned locations and data?

5. Regarding abandoned wells 9A, 9B, 9C, were none of these pump tested and, except for 9C which couldn't be straightened and was apparently too crooked, why not?

6. S.E. Douglas area mentioned as a preferable location if geohydrologically feasible - why is this area preferable?

PRELIMINARY GEO-HYDROLOGICAL ANALYSIS

For

THE CITY OF DOUGLAS, ARIZONA

Sept. - Oct. 1978

by

Heinrichs GEOEXploration Company

P.O. Box 5964 Tucson, AZ 85703

GEOEX #1295

Preliminary Geo-hydrological Analysis

Introduction

Pursuant to correspondence initiated by Mr. George D. Nalley, Superintendent of the Douglas Water and Sewer Department on 17 July 1978, GEOEX, on 18 September 1978, was engaged to conduct a brief preliminary hydrological survey for the City. Objective of the survey was to assist in the siting of a proposed new water well under consideration for the purpose of augmenting, in the most efficient manner feasible, the present nine-well-system. Data and technical records requested by GEOEX on 19 September, 1978, were received on 22 September 1978. These, together with material already on hand and other pertinent locally acquired information, were studied with results as summarized in this preliminary report.

Conclusions and Recommendations:

1. United States Geological Survey (U.S.G.S.) Trip Report of 18 February 1977, copy of which was supplied by the City, tentatively recommended an area (1), proposed to be located near the middle of Section 12, T.24S., R.27E. This is concurred to be a satisfactory primary new well site.

2. Alternatively, anywhere roughly near or within a pie-shaped wedge area bordered approximately on the south by 22nd Street and Merrit Avenue in Pirtleville, and on the east by A Avenue and Leslie Canyon Road, is considered equally satisfactory except for perhaps distribution and rights of way considerations which are not necessarily part of this immediate study.

3. U.S.G.S. proposed areas numbers (3) and (4), are not recommended from the most preferable geologic point of view as suggested by present data on hand.

Based on the city records provided, and although there is some exception and variation indicated, there seems to be a definite general quantity decrease of well yields in an easterly direction away from White Water Draw. Therefore, on that basis alone, it appears generally desirable at this point to keep closer to White Water Draw. Possible exceptions to this generalization include a question of why well 6 is a relatively better producer and why wells 4 and 5 are relatively poorer. Conceivably, the basalt and the pre-basalt topography and related shallow formations, may be at least partially responsible. If it becomes necessary and important to further pursue these particular types of discrepancies, surface geophysical work, such as electrical resistivity, may warrant testing and could be helpful if tests' results proved favorable.

4. If rights of way and distribution factors outweigh maximum added quantity considerations, then U.S.G.S. area (2) should also be satisfactory and, in some respects may almost equal their area (1). Indicated possible exceptions to this are the proposed site's proximity to poorer well site 4 and its indicated more adverse subsurface conditions, possible interference with well 7, and probably interference with Nu Way Laundry's well if it is still producing and, if so, if that should be a necessary factor to consider.

5. Existence of "several other test wells" is mentioned in the U.S.G.S. Trip Report of February 1977. Although these are reportedly negative in terms of quantity results, the data still should be integrated with the results of this study because such information could change the conclusions and recommendations herein considerably.

6. Long range implications of an anticipated continued increasing rate of ground water level decline and consumptive uses should be kept in mind, both as

to quantity and quality. Ideally,a replenishable surface water system, combined with conservation measures and balanced ground water recharge and withdrawal arrangements should be the ultimate objective of all responsible municipalities. Although beyond the scope of this particular study, problems and possibilities along such lines should be investigated and implemented as rapidly as ways and means will allow.

Observations and Speculation:

1. At present the lowest static water table measurement is at an elevation of about 3790 feet near White Water Draw at well #1. This is at about 130 feet below surface. Three and one quarter miles eastward, at Well 8, present static water elevation measures just above the 3800 foot elevation. This represents a rise in static water table elevation of roughly 3 feet per mile from White Water Draw toward the east as far as Well site #8.

2. Top of basalt at Well 4 is 40 feet deeper than at well 5, with a total thickness of 55 feet at well 4 and 58 feet at well 5. This is indicative of a possible small northerly dipping component to the basalt layer and perhaps a somewhat southeasterly source, conceivably, even fairly close by. However, as indicated in U.S.G.S. Trip Report of 18 February 1977, specific significance of the basalt relative to local ground water supplies, if any,is relatively undetermined.

3. Basalt thickness varies from 50 feet at Well 7 to 117 feet at Well 3. It outcrops about 2000' south of Well 8 and roughly 2000 feet southeast of wells 3 and 9. Average locally measured down-slope components on the top of the basalt, are roughly 200 feet per mile in a westerly direction and about 50 feet per mile in a northerly direction. However, in the vicinity of wells 3, 8 and

9, the slopes on top and bottom of the basalt seem to vary, at least locally, and the basalt roughly doubles in average thickness from about 54 feet in the wells toward the west to over 100 feet in these three wells, and 86 feet at Well 6 about one mile away toward the northwest.

Latest (most recent) (1977-1978 Pump Testing Results:

Year	Well #	(Relative) Rank	Feet(Inches) Total Draw Down		GPM	Gals.Per Min.Yield Per Foot Draw Down	Relative to original
1978	1	1	(4'5")	4.42	1000	226.24	+
1978	2	2	(12'9"	12.75	1000	78.43	-
(1977)	3	7	(30')	30.00	735	24.50	-
1978	4	9	(70'4")	70.33	800	11.37	-
1978	5	4	(20'10")	20.83	1100	52.80	-
1978	6	3	(20'1")	20.08	1175	58.52	+
1978	7	5	(27')	27.00	1250	46.30	+
1978	8	8	(58')	58.00	800	13.79	-
1978	9	6	(26')	26.00	1170	45.00	+

First, (Original) or Oldest Pump Testing Records on Hand:

1968	1	1	(6'4")	6.33	1100	173.78
1968	2	2	(13'8")	13.67	1230	89.98
1974	3	5	(18')	18.00	520	28.89
1968	4	7	(47'2")	47.17	900	19.08
1968	5	3	(13'3")	13.25	950	71.70
1968	6	4	(27')	27.00	1350	50.00
1971	7	6	(73')	73.00	1718	23.53
1974	8	8	(68')	68.00	1250	18.38
1976	9	9	(90')	90.00	1500	16.67

9, the slopes on top and bottom of the basalt seem to vary, at least locally, and the basalt roughly doubles in average thickness from about 54 feet in the wells toward the west to over 100 feet in these three wells, and 86 feet at Well 6 about one mile away toward the northwest.

Latest (most recent) (1977-1978) Pump Testing Results:

Year	Well #	(Relative) Rank	Feet (inches) total Draw Down	GPM	Gals. per minute Yield Per Foot Draw Down	Relative to Original
1978	1	~~1~~ 1	(4'-5") ~~133.67~~ 4.42	1000	~~7.48~~ 226.24	+
1978	2	~~2~~ 2	(12'-9") ~~132.~~ 12.75	1000	~~7.58~~ 78.43	−
(1977)	3	~~7~~ 7	(30') ~~256.~~ 30.00	735	~~2.87~~ 24.50	−
1978	4	~~8~~ 9	(70'-4") ~~295.~~ 70.33	800	~~2.71~~ 11.37	−
1978	5	5 4	(20'-10") ~~241.3~~ 20.83	1100	~~4.56~~ 52.80	−
1978	6	~~4~~ 3	(20'-1") ~~252.75~~ 20.08	1175	~~4.65~~ 58.52	+
1978	7	~~3~~ 5	(27') ~~195.~~ 27.00	1250	~~6.41~~ 46.30	+
1978	8	~~9~~ 8	(58') ~~318.~~ 58.00	800	~~2.52~~ 13.79	−
1978	9	~~6~~ 6	(26') ~~281.~~ 26.00	1170	~~4.16~~ 45.00	+

First, (Original) or Oldest Pump Testing Records on Hand:

1968	1	1 ~~3~~	(6'-4") ~~106.3~~ 6.33	1100	~~10.35~~ 173.78	
1968	2	2 ~~2~~	(13'-8") ~~102.67~~ 13.67	1230	~~11.98~~ 89.98	
1974	3	5 ~~8~~	(18') ~~233.5~~ 18.00	520	~~2.23~~ 28.89	
1968	4	7 ~~7~~	(47'-2") ~~229.67~~ 47.17	900	~~3.92~~ 19.08	
1968	5	3 ~~6~~	13'-3" ~~204.~~ 13.25	950	~~4.66~~ 71.70	
~~1964~~ 1968	6	4 ~~4~~	27' ~~221.~~ 27.00	~~1400~~ 1350	~~6.33~~ 50.00	
1971	7	6 ~~1~~	73' ~~134.5~~ 73.00	1718	~~12.77~~ 23.53	
1974	8	8 ~~8~~	68' ~~320.~~ 68.00	1250	~~3.90~~ 18.38	
1976	9	9 ~~5~~	90' ~~314.~~ 90.00	1500	~~4.78~~ 16.67	

Very likely, the city has its own well ratings and these should be compared with the preceding two tables.

Relative to the pump tests data from wells #1 and #2 and wells #3 and #9, these respective well pairs locations are about (?) 500' apart according to the maps. Data suggests in 1977 and 1978, that #3 pump may have been pumping when #9 well was tested. Obviously, because of close proximity the draw-down cones of depression may overlap each other when these wells are simultaneously in production. Approximate similarities are indicated at wells #1 & #2. Is this a possible explanation or are there other aspects involved?

Is the Nu Way Laundry well still being pumped and if so at what rate and from what depth?

Static Water Level Statistics

Well Numbers	1974-1978 Average	1974-1978 Year Average	(1977-1978)
1 & 2	-7.0 feet	-1.75 ft./yr.	-6.125 ft/Avg.
3, 4 & 6	-17.5 "	-4.38 "	-6.0 "
5	+17.3 " (?)	+4.33 " (?)	-3.8 "
7	-11.0 "	-2.75 "	-8.0 "
8	- 8.0 "	-2.00 "	-6.0 "
9 (1976-1978)	-31.0 "	-7.75 "	+1.0 "

Question regarding the 17.3 foot rise in static water level at well 5 over the 1974-1978 period should be raised and explained if possible.

Present average annual rate of lowering of the water table appears to be something around 1.5 to a little over two feet per year in the area immediately around Douglas. This is compared to estimates of something from three feet to

over 3.5 feet per year in the irrigated farming areas of McNeal and Elfrida to the north.

Well records over the years are often not perfectly consistent and therefore there may tend to be some questions regarding trying to make completely absolute determinations from them. These apparent inconsistencies are probably partly caused by periodic variations in rainfall and runoff in relation to the particular times the records were taken. Mechanical and chemical changes in the wells, pumps and casing for a variety of reasons can have effect. Also, an occasional measurement, technique or recording error will occur. Otherwise, the records provided by the city suffice quite nicely for the important fundamental and relative considerations made in this report.

Respectfully submitted,

Heinrichs GEOExploration Co.

Walter E. Heinrichs, Jr.
P.E. & C.P.G.S.

WEH:mt

Discussion Sketches:

1. Schematic Plan, 1" = 2000' scale.
2. Projected Schematic Section (-N75° E., from near Wells 1 & 2 to near Well 8.)

GEOEX #1295

2 October 1978

Box 5964

Tucson, AZ 85703

(602) 623-0578

9, the slopes on top and bottom of the basalt seem to vary, at least locally, and the basalt roughly doubles in average thickness from about 54 feet in the wells toward the west to over 100 feet in these three wells, and 86 feet at Well 6 about one mile away toward the northwest.

Latest (most recent) (1977-1978) Pump Testing Results:

Year	Well #	(Relative) Rank	Feet Draw Down	GPM	Gals. Yield Per Foot Draw Down
1978	1	2	133.67	1000	7.48
1978	2	1	132.	1000	7.58
(1977)	3	7	256.	735	2.87
1978	4	8	295.	800	2.71
1978	5	5	241.3	1100	4.56
1978	6	4	252.75	1175	4.65
1978	7	3	195.	1250	6.41
1978	8	9	318.	800	2.52
1978	9	6	281.	1170	4.16

First, (Original) or Oldest Pump Testing Records on Hand:

1968	1	3	106.3	1100	10.35
1968	2	2	102.67	1230	11.98
1974	3	9	233.5	520	2.23
1968	4	7	229.67	900	3.92
1968	5	6	204.	950	4.66
1964	6	4	221.	1400	6.33
1971	7	1	134.5	1718	12.77
1974	8	8	320.	1250	3.90
1976	9	5	314.	1500	4.78

10/5/78

10:11
10:02

9 Minutes

Empire 4-8410
Douglas AZ

J. P. Matthews, P. D.
Job # 1295 1/4
Superior etc.

W.

Well Rodded.

Gravel packed.

Formation finish.

Screen size.

Sept 30

6150.

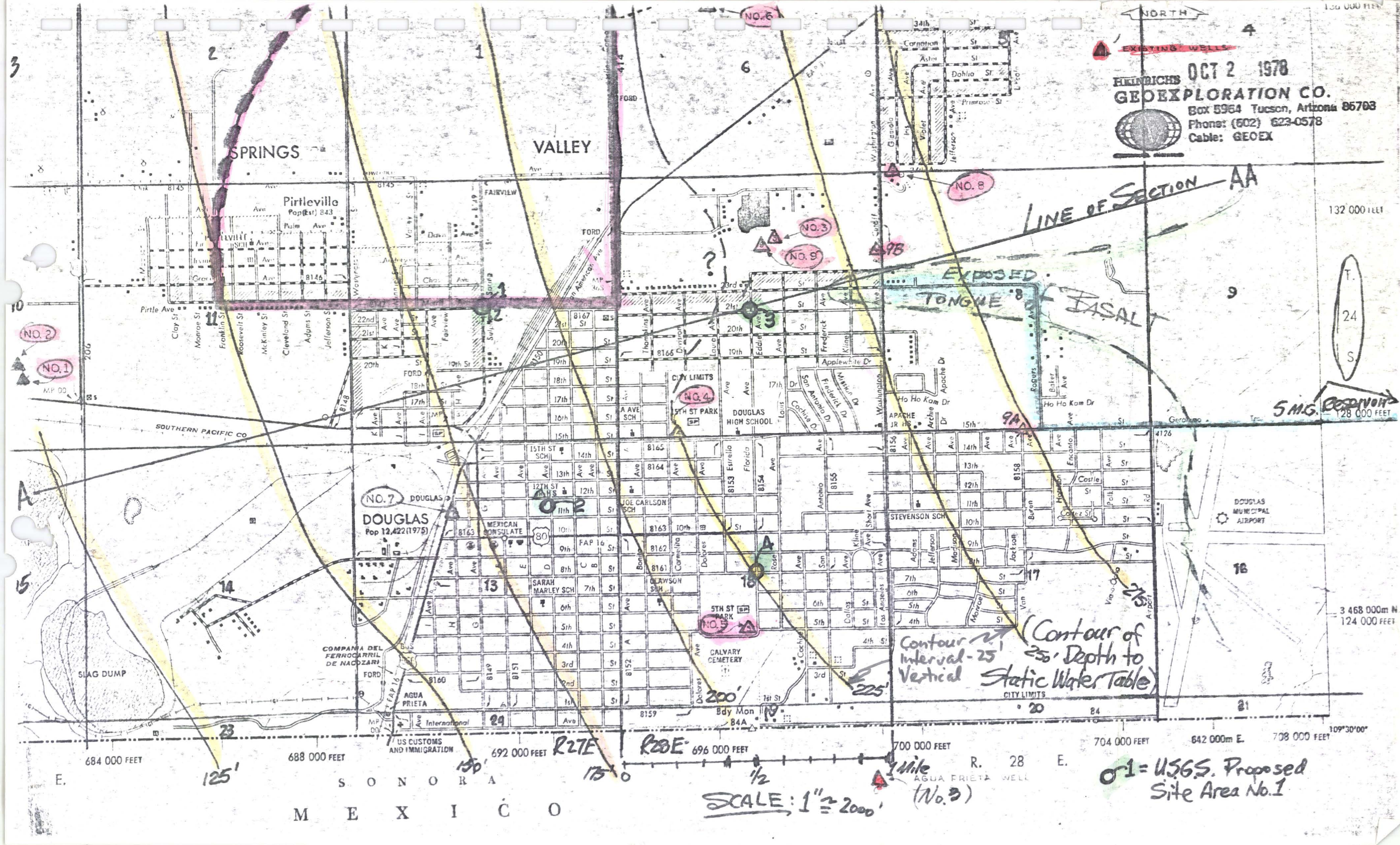
RENCO

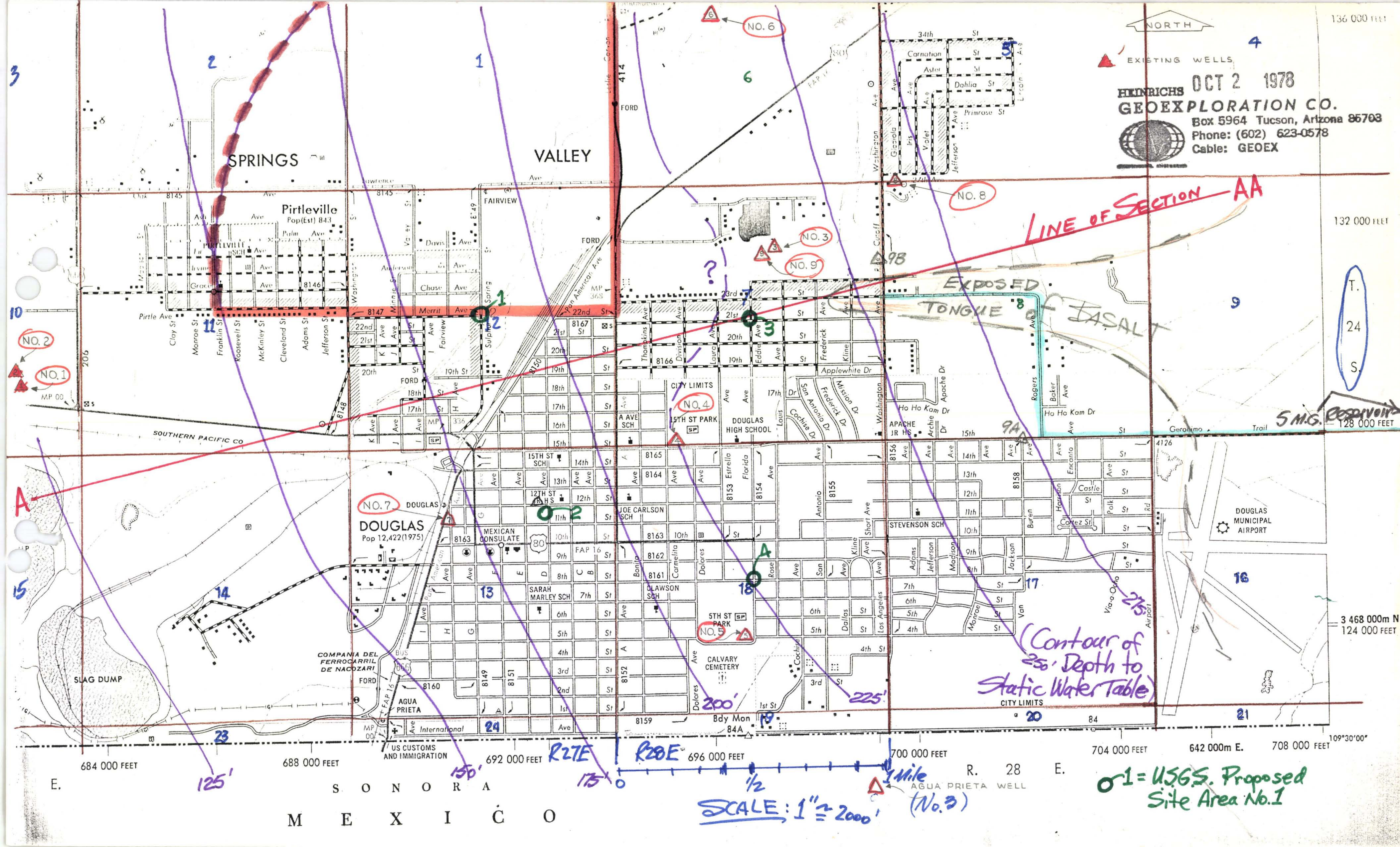
Lee Heisingh.

Birdwell.

Tucson 9/15/71

792-1613


EXISTING WELLS
HEINRICHS OCT 2 1978
GEOEXPLORATION CO.
Box 5964 Tucson, Arizona 85703
Phone: (602) 623-0578
Cable: GEOEX
NORTH
LINE OF SECTION AA
A
EXPOSED TONGUE OF BASALT
SPRINGS
VALLEY
Pirtleville
DOUGLAS
Pop 12,422 (1975)
NO.1
NO.2
NO.3
NO.4
NO.5
NO.6
NO.7
NO.8
NO.9
9A
9B
SOUTHERN PACIFIC CO
SLAG DUMP
COMPANIA DEL FERROCARRIL DE NACOZARI
US CUSTOMS AND IMMIGRATION
AGUA PRIETA
DOUGLAS HIGH SCHOOL
CALVARY CEMETERY
DOUGLAS MUNICIPAL AIRPORT
CITY LIMITS
125'
150'
175'
200'
225'
275
Contour Interval-25' Vertical
(Contour of 250' Depth to Static Water Table)
5 MG. RESERVOIR
R27E
R28E
R. 28 E.
684 000 FEET
688 000 FEET
692 000 FEET
696 000 FEET
700 000 FEET
704 000 FEET
708 000 FEET
642 000m E.
109°30'00"
3 468 000m N
124 000 FEET
128 000 FEET
132 000 FEET
AGUA FRIETA WELL (No. 3)
SCALE: 1" = 2000'
0
1/2
1 Mile
O-1 = U.S.G.S. Proposed Site Area No. 1
SONORA
MEXICO



NORTH
EXISTING WELLS
OCT 2 1978
HEINRICHS
GEOEXPLORATION CO.
Box 5964 Tucson, Arizona 85703
Phone: (602) 623-0578
Cable: GEOEX
LINE OF SECTION
A
AA
EXPOSED TONGUE OF BASALT
SPRINGS
VALLEY
Pirtleville
Pop(Est) 843
DOUGLAS
Pop 12,422(1975)
SOUTHERN PACIFIC CO
DOUGLAS HIGH SCHOOL
DOUGLAS MUNICIPAL AIRPORT
SLAG DUMP
COMPANIA DEL FERROCARRIL DE NACOZARI
AGUA PRIETA
US CUSTOMS AND IMMIGRATION
CALVARY CEMETERY
CITY LIMITS
NO. 1
NO. 2
NO. 3
NO. 4
NO. 5
NO. 6
NO. 7
NO. 8
NO. 9
5 MG. Reservoir
(Contour of 25' Depth to Static Water Table)
125'
150'
175'
200'
225'
275'
684 000 FEET
688 000 FEET
692 000 FEET
696 000 FEET
700 000 FEET
704 000 FEET
642 000m E.
708 000 FEET
109°30'00"
3 468 000m N
124 000 FEET
128 000 FEET
132 000 FEET
136 000 FEET
R27E
R28E
R. 28 E.
T. 24 S.
SCALE: 1" ≈ 2000'
1/2
1 Mile
AGUA PRIETA WELL (No. 3)
SONORA
MEXICO
1 = USGS. Proposed Site Area No. 1