

DB-2

WATER QUALITY ANALYSIS

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SURFACE WATER AND GROUNDWATER QUALITY STUDY TO JICA STUDY TEAM.

1.1 INTRODUCTION

This study intends to identify physical chemical parameters related with groundwater and surface water, in an area close to JICA study area. This analysis is part of the second phase water sampling, which was realized from January 21 to February 25 of 2008.

The groundwater sampling was realized on 16 quaternary aquifer wells and 4 cretaceous aquifer wells, to identify the quality difference between both aquifers. The results were compared with the maximum values established by the Decree 1575 of 2007 and the Resolution 2115 of 2007 to human water consumption.

Also, it had been realized monitories on 15 surface water points, to analyze the general status of the Bogotá River and its main tributaries.

1.2 GROUNDWATER SOURCES

The monitored wells were:

- **Cretaceous Aquifer:** La Salle, Suba, Mariscal Sucre, Vitelma.
- **Quaternary Aquifer:** Siberia, La Diana, Bavaria, Petco, Jardines del Apogeo, Parque Tunal, Carboquimica, Indumil, Frigorífico Guadalupe, Gaseosas Colombiana, Mano facturas Eliot, Quintas de Santa Ana, Districarnazas Luna, Gibraltar, Dersa, GM Colmotores.

1.3 SURFACE WATER

The same selected points from the first phase were monitored. Those are:

- Bogota River Tibitóc. In this point the river does not contain many contaminating discharges.
- Bogota River at Puente la Virgen before entering Bogotá City, where it may be observed the starting contamination produced by the population waste water discharges
- Bogota River Lisboa
- Bogota River Cortijo
- Bogota River Puente Cundinamarca
- Bogota River after the discharge puente metálico
- Bogota River San Bernardino
- Bogota River Cierre
- Juan amarillo River
- Fucha River with alameda
- Tunjuelo River ponton Island San José
- Tunjuelo River 100 metros below Yomasa
- Tunjuelo River San Benito
- Tunjuelo River Usme

1.4 METODOLOGY PHYSICOCHEMICAL ISSUES

The development of the physicochemical methodology includes the laboratory analysis phase. The realized analysis, the employed techniques and the detection limits are showed in the inform annex.

1.4.1 FIELD RESULTS

The realized measuring on field were pH, conductivity, turbidity, Dissolve Oxygen, ambient temperature and water temperature in °C.

1.4.2 SURFACE WATER

On the 15 determinate points were taken five 1500 ml samples tests, each half hour. Where were taken the field parameters.

Lugar	Hora	pH	Temperatura ambiente. °C	Temperatura Agua. °C	Conductividad $\mu\text{s}/\text{m}$	OD mg/L	Turbiedad NTU
Río Juan Amarillo	10:30	7.26	18.1	17.3	69.9	0.8	81
	11:00	7.30	18.7	17.9	73.0	0.4	79
	11:30	7.37	18.9	17.5	75.2	0.8	75
	12:00	7.37	19.7	18.2	74.6	0.6	83
	12:30	7.27	20.1	19.1	70.9	0.9	79
Río Bogotá Lisboa	08:20	7.05	14.6	16.6	36.9	1.51	7
	08:50	7.02	14.7	17.1	36.5	0.68	12
	09:20	7.06	15.7	17.3	36.7	1.29	11
	09:50	7.00	16.4	17.3	36.5	1.20	8
	10:20	6.97	17.4	18.1	36.4	1.15	9
Río Bogotá el Cortijo	12:30	7.16	21.6	19.7	60.5	1.3	53
	13:00	7.15	22.3	19.4	57.9	1.7	51
	13:30	7.17	20.1	19.2	60.6	1.2	55
	14:00	7.21	19.9	19.1	59.3	1.7	53
	14:30	7.18	18.5	18.8	60.6	1.3	52
Río Bogotá Puente la Virgen	12:58	7.10	16.4	14.5	26.4	1.85	32.6
	13:28	7.13	16.9	14.4	27.2	1.80	36.0
	13:58	7.16	17.9	16.3	26.7	1.81	36.6
	14:28	7.14	18.3	14.6	26.4	1.81	50.3
	14:58	7.05	18.3	15.2	26.4	2.54	41.5
Río Bogotá Tibitoc	09:17	7.03	14.3	17.7	13.4	5.68	19.2
	09:47	7.10	14.0	17.8	9.75	6.95	23.2
	10:17	7.11	16.7	18.5	9.23	6.88	18.3
	10:47	7.14	16.7	18.5	6.79	6.90	20.7
	11:17	7.12	16.6	18.9	6.96	6.94	18.0
Río Fucha con Alameda	10:00	7.39	17.3	19.0	96.5	0.6	123
	10:30	7.39	17.2	19.3	97.2	0.6	106
	11:00	7.40	17.4	19.7	98.6	0.8	110
	11:30	7.30	18.0	19.9	102.2	0.4	142
	12:00	7.31	19.1	20.1	110.1	0.2	169
Río Bogotá El cierre	08:30	7.22	16.5	17.9	87.4	0.4	110
	09:00	7.22	17.1	18.9	84.5	0.5	104
	09:30	7.16	18.8	18.6	81.6	0.4	123
	10:00	7.10	20.1	18.6	84.1	0.3	117
	10:30	7.14	20.1	19.5	82.9	0.3	106
Río Tunjuelo Isla Ponton	08:00	7.26	15.7	16.7	77.7	0.4	143
	08:30	7.28	15.9	16.5	76.6	0.3	125
	09:00	7.29	16.0	16.4	79.6	0.3	132
	09:30	7.24	16.4	16.6	85.4	0.4	154
	10:00	7.24	18.3	17.2	88.0	0.4	161
Río Bogotá San Bernardino	12:40:00	7.02	20.3	19.9	68.6	0.2	197
	13:10	6.96	21.4	20.1	68.2	0.2	223
	13:40	6.97	23.7	20.1	68.6	0.3	263
	14:10	7.04	23.6	20.9	65.9	0.7	183
	14:40	7.03	23.7	19.9	67.0	0.7	169
Río Bogotá puente C/marca	07:40	7.19	13.6	17.7	62.1	0.9	208
	08:10	7.18	14.6	17.9	61.8	0.9	202
	08:40	7.20	15.1	17.9	62.2	0.8	205
	09:10	7.18	16.9	18.1	61.8	0.8	203
	09:40	7.21	17.1	18.2	62.0	0.9	201
Río Bogotá después de descarga puente Metálico	12:10	7.11	18.6	19.3	76.4	0.7	194
	12:40	7.18	18.2	19.3	76.7	0.9	223
	13:10	7.16	17.7	19.4	76.8	0.7	209
	13:40	7.20	20.6	19.9	76.7	0.9	231
	14:10	7.17	21.6	20.2	76.8	0.5	223
Río Tunjuelo San Benito	10:30	7.82	18.6	17.6	58.4	0.5	201
	11:00	8.04	18.6	16.5	59.9	0.7	234
	11:30	7.72	19.3	17.5	60.0	0.4	256
	12:00	8.02	19.7	17.7	63.5	0.6	298
	12:30	7.73	19.5	17.9	65.4	0.5	376
Río Tunjuelo Usme	08:15	7.46	14.4	13.4	33.5	3.0	90
	08:45	7.39	14.4	13.5	25.1	3.2	91
	09:15	7.39	13.4	13.4	21.7	3.7	89
	09:45	7.44	16.6	14.0	36.4	3.1	93
	10:15	7.54	16.7	14.4	31.8	3.0	92
Río Tunjuelo 100 m debajo de Yomasa	10:45	7.54	17.5	16.7	217	1.9	789
	11:15	7.70	17.8	16.1	240	1.8	645
	11:45	7.70	18.1	15.8	240	1.8	655
	12:15	7.71	18.4	16.6	266	1.5	679
	12:45	7.71	18.8	17.1	264	1.7	769
Quebrada Quibba	13:40	6.93	16.1	13.6	25.5	5.2	14.3
	14:10	7.10	16.8	13.8	24.7	5.3	12.4
	14:40	7.00	15.6	13.3	26.8	5.0	11.1
	15:10	6.92	15.1	13.3	27.0	5.0	12.3
	15:40	6.70	18.1	13.6	24.9	5.1	11.4

1.4.3 GROUNDWATER SOURCES

Samples from previously selected wells were realized on the 20 determinate points. Unfortunately, the water pumping could not being realize on the wells before obtaining the sample test because the resources unavailability at that moment. It is recommended to realize the well pumping for a time which corresponds to the well volume in order to obtain representatives results of the aquifer water quality.

PARAMETERS	La Salle Well	Suba Well	Mariscal Sucre	Siberia Well	Vitelma	Gibraltar	La Diana Well	Bavaria	Gaseosas Colombiana 2	Indumil Well
Hour	11:12	13:10	14:00	10:10	09:30	09:00	11:20	14:40	08:25	12:00
pH	5.15	7.16	7.91	6.5	7.26	7.21	6.82	7.08	6.97	6.49
Ambient Temperature °C	21.4	21.2	21	21	14.1	11	22.6	20.1	18.8	15.9
Water Temperature °C	19.5	20.8	20.4	19.3	12.6	12.1	19.6	24.3	19.4	19.3
Conductivity µS/m	19.5	115	55	119.5	121	46.1	28.5	86.9	30.8	21.58
OD mg/L	2.3	2	2.16	1.71	1.69	2.9	1.2	0.88	2.1	0.91
Turbidity NTU	5	68	51	13	21	11	14	5	3	4

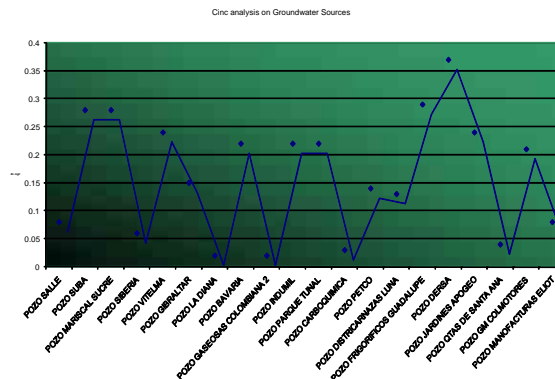
PARAMETERS	Parque el Tunal	Carboquímica Well	Petco Well	Districarnazas Luna	Frigorificos Guadalupe	Dersa Well	Jardines del Apogeo	Quintas de Santa Ana	Pozo GM Colmotores	Manufacturas Eliot
Hour	11:45	09:05	10:40	11:00	08:00	13:45	13:45	09:55	14:20	15:45
pH	7.24	6.93	6.55	6.69	6.67	6.34	7.31	6.86	7.3	6.78
Ambient Temperature °C	23.2	15.5	20.6	21.3	13.4	19.5	15.9	16.6	18.6	23
Water Temperature °C	18.9	19.7	18.5	18.8	18.2	18.7	19.6	23.4	18.1	21.5
Conductivity µS/m	31.1	21.45	19.26	16.66	27.3	29	23.5	13.22	81.1	48.1
DO mg/L	0.53	0.57	1.35	1.01	1.2	1.25	1.35	3.45	2.21	0.8
Turbidity NTU	11	2	2	5	10	3	5	0	9	10

1.5 GROUNDWATER RESULTS

The wells results belonging to the cretaceous aquifer are showed on yellow in the tables. All the other are from the quaternary aquifer.

1.5.1 Zinc

SALLE WELL	0.08
SUBA WELL	0.28
MARISCAL SUCRE WELL	0.28
SIBERIA WELL	0.06
VITELMA WELL	0.24
GIBALTAR WELL	0.15
LA DIANA WELL	0.02
BAVARIA WELL	0.22
GASEOSAS COLOMBIANA 2 WELL	0.02
INDUMIL WELL	0.22
TUNAL PARK WELL	0.22
CARBOQUIMICA WELL	0.03
PETCO WELL	0.14
DISTRICARNAZAS LUNA WELL	0.13
FRIGORIFICOS GUADALUPE WELL	0.29
DERSA WELL	0.37
JARDINES APOGEO WELL	0.24
QTAS DE SANTA ANA WELL	0.04
GM COLMOTORES WELL	0.21
MANUFACTURAS ELIOT WELL	0.08

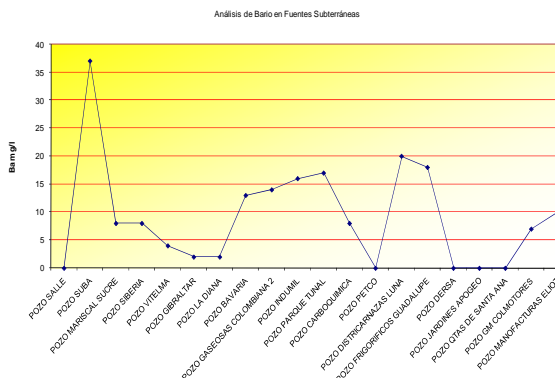


Graphic 1. Zn Results (mg/L Zn)

The resolution number 2125 of 2007 has a Zinc value of 3 mg/L

1.5.2 Barium

SALLE WELL	0
SUBA WELL	37
MARISCAL SUCRE WELL	8
SIBERIA WELL	8
VITELMA WELL	4
GIBALTAR WELL	2
LA DIANA WELL	2
BAVARIA WELL	13
GASEOSAS COLOMBIANA 2 WELL	14
INDUMIL WELL	16
TUNAL PARK WELL	17
CARBOQUIMICA WELL	8
PETCO WELL	0
DISTRICARNAZAS LUNA WELL	20
FRIGORIFICOS GUADALUPE WELL	18
DERSA WELL	0
JARDINES APOGEO WELL	0
QTAS DE SANTA ANA WELL	0
GM COLMOTORES WELL	7
MANUFACTURAS ELIOT WELL	10

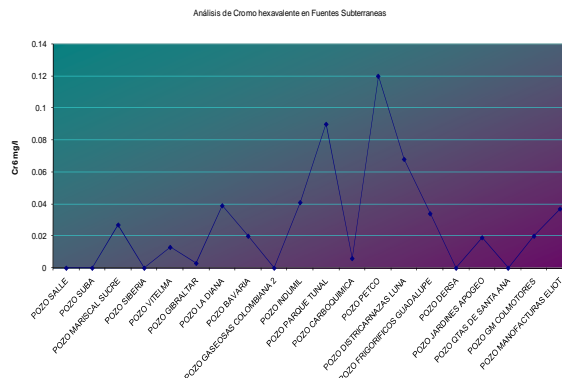


Graphic 2. Ba Results (mg/L Ba)

The resolution number 2115 of 2007 has a Ba value of 0.7 mg/L

1.5.3 Hexavalent Chromium

SALLE WELL	0
SUBA WELL	0
MARISCAL SUCRE WELL	0,027
SIBERIA WELL	0
VITELMA WELL	0,013
GIBRALTAR WELL	0,003
LA DIANA WELL	0,039
BAVARIA WELL	0,02
GASEOSAS COLOMBIANA 2 WELL	0
INDUMIL WELL	0,041
TUNAL PARK WELL	0,09
CARBOQUIMICA WELL	0,006
PETCO WELL	0,12
DISTRICARNAZAS LUNA WELL	0,068
FRIGORIFICOS GUADALUPE WELL	0,034
DERSA WELL	0
JARDINES APOGEO WELL	0,019
QTAS DE SANTA ANA WELL	0
GM COLMOTORES WELL	0,02
MANUFACTURAS ELIOT WELL	0,037

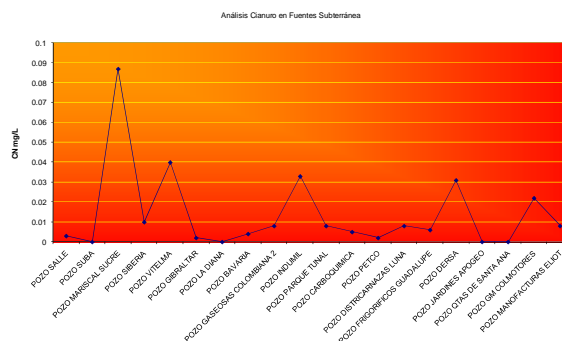


Graphic 3. Cr⁺⁶ results (mg/L Cr⁺⁶)

The resolution number 2115 of 2007 has a Total Chromium value of 0.05 mg/L. This resolution has not a Hexavalent Chromium value. However, the decree 475 of 1998, has a maximum concentration of 0.01 mg/L for the C⁺⁶.

1.5.4 Cyanide

SALLE WELL	0,003
SUB WELL	0
MARISCAL SUCRE WELL	0,087
SIBERIA WELL	0,01
VITELMA WELL	0,04
GIBRALTAR WELL	0,002
LA DIANA WELL	0
BAVARIA WELL	0,004
GASEOSAS COLOMBIANA 2 WELL	0,008
INDUMIL WELL	0,033
TUNAL PARK WELL	0,008
CARBOQUIMICA WELL	0,005
PETCO WELL	0,002
DISTRICARNAZAS LUNA WELL	0,008
FRIGORIFICOS GUADALUPE WELL	0,006
DERSA WELL	0,031
JARDINES APOGEO WELL	0
QTAS DE SANTA ANA WELL	0
GM COLMOTORES WELL	0,022
MANUFACTURAS ELIOT WELL	0,008

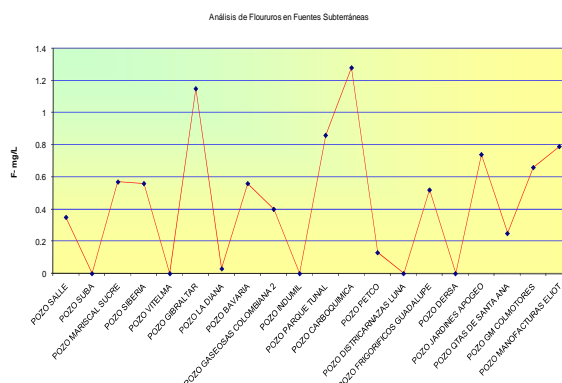


Graphic 4. CN results (mg/L CN)

The resolution number 2115 of 2007 has a Free and dissociable Cyanide value of 0.05 mg/L

1.5.5 Fluorures

WELLSALLE	0,36
WELLSUBA	0
WELL MARISCAL SUCRE	0,57
SIBERIA WELL	0,56
VITELMA WELL	0
GIBRALTAR WELL	1,15
LA DIANA WELL	0,03
BAVARIA WELL	0,56
GASEOSAS COLOMBIANA 2 WELL	0,4
INDUMIL WELL	0
TUNAL PARK WELL	0,86
POZO CARBOQUIMICA WELL	1,28
PETCO WELL	0,13
DISTRICARNAZAS LUNA WELL	0
FRIGORIFICOS GUADALUPE WELL	0,52
DERSA WELL	0
JARDINES APOGEO WELL	0,74
QTAS DE SANTA ANA WELL	0,25
GM COLMOTORES WELL	0,66
MANUFACTURAS ELIOT WELL	0,79

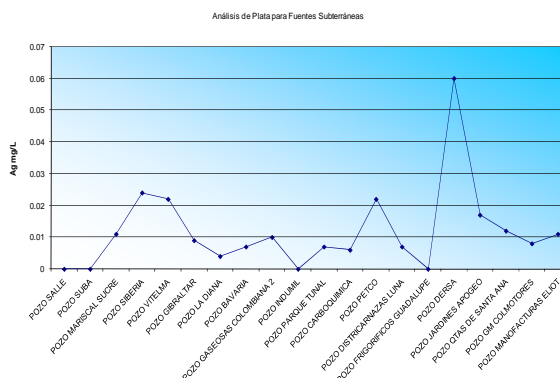


Graphic 5. F results (mg/L F)

The resolution number 2115 of 2007 has a fluorures value of 1.0 mg/L. According with the results, only two wells from the quaternary are exceeding this value.

1.5.6 Silver

SALLE WELL	0
SUBA WELL	0
ARISCAL SUCRE WELL	0,011
SIBERIA WELL	0,024
VITELMA WELL	0,022
GIBRALTAR WELL	0,009
LA DIANA WELL	0,004
BAVARIA WELL	0,007
GASEOSAS COLOMBIANA 2 WELL	0,01
INDUMIL WELL	0
TUNAL PARK WELL	0,007
CARBOQUIMICA WELL	0,006
PETCO WELL	0,022
DISTRICARNAZAS LUNA WELL	0,007
FRIGORIFICOS GUADALUPE WELL	0
DERSA WELL	0,06
JARDINES APOGEO WELL	0,017
QTAS DE SANTA ANA WELL	0,012
GM COLMOTORES WELL	0,008
MANUFACTURAS ELIOT WELL	0,011

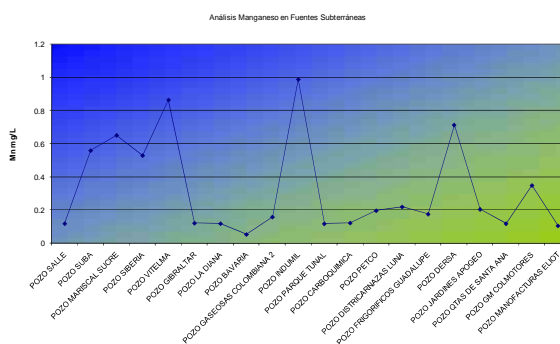


Graphic 6. Ag results (mg/L Ag)

The resolution number 2115 of 2007 has not a silver value. However, the decree 475 of 1998 presents a maximum concentration value of 0.01 mg/L.

1.5.7 Manganese

SALLE WELL	0,12
SUBA WELL	0,56
MARISCAL SUCRE WELL	0,652
SIBERIA WELL	0,53
POZO VITELMA WELL	0,865
GIBRALTAR WELL	0,123
LA DIANA WELL	0,12
BAVARIA WELL	0,055
GASEOSAS COLOMBIANA 2 WELL	0,16
INDUMIL WELL	0,989
TUNAL PARK WELL	0,119
CARBOQUIMICA WELL	0,124
PETCO WELL	0,198
DISTRICARNAZAS LUNA WELL	0,221
FRIGORIFICOS GUADALUPE WELL	0,177
DERSA WELL	0,714
JARDINES APOGEO WELL	0,206
QTAS DE SANTA ANA WELL	0,12
GM COLMOTORES WELL	0,35
MANUFACTURAS ELIOT WELL	0,107

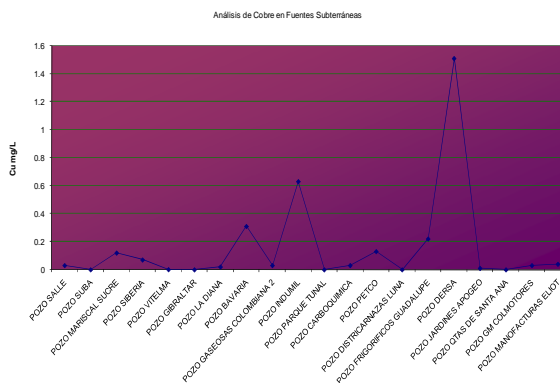


Graphic 7. Mg results (mg/L Mn)

The resolution number 2115 of 2007 has a manganese value of 0.1 mg/L.

1.5.8 Cooper

SALLE WELL	0,03
SUBA WELL	0
MARISCAL SUCRE WELL	0,12
SIBERIA WELL	0,07
VITELMA WELL	0,001
GIBRALTAR WELL	0
LA DIANA WELL	0,02
BAVARIA WELL	0,31
GASEOSAS COLOMBIANA 2 WELL	0,03
INDUMIL WELL	0,63
TUNAL PARK WELL	0
CARBOQUIMICA WELL	0,03
PETCO WELL	0,13
DISTRICARNAZAS LUNA WELL	0
FRIGORIFICOS GUADALUPE WELL	0,22
DERSA WELL	1,51
JARDINES APOGEO WELL	0,01
QTAS DE SANTA ANA WELL	0
GM COLMOTORES WELL	0,03
MANUFACTURAS ELIOT WELL	0,04

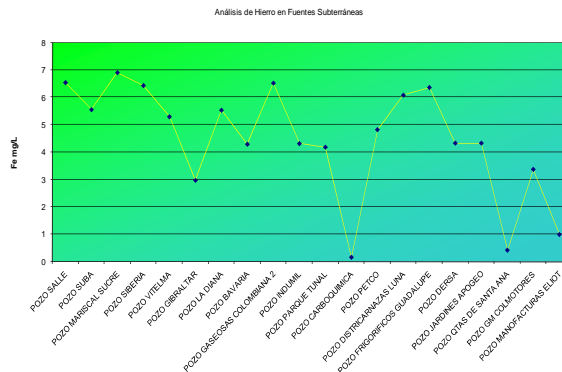


Graphic 8. Cu results (mg/L Cu)

The resolution number 2115 of 2007 has a permissible Copper value of 1.0 mg/L.

1.5.9 Iron

SALLE WELL	6,54
SUBA WELL	5,55
MARISCAL SUCRE WELL	6,9
SIBERIA WELL	6,43
VITELMA WELL	5,29
GIBALTAR WELL	2,97
LA DIANA WELL	5,53
BAVARIA WELL	4,29
GASEOSAS COLOMBIANA 2 WELL	6,52
INDUMIL WELL	4,31
TUNAL PARK WELL	4,18
CARBOQUIMICA WELL	0,16
PETCO WELL	4,82
DISTRICARNAZAS LUNA WELL	6,08
FRIGORIFICOS GUADALUPE WELL	6,36
PERSA WELL	4,33
JARDINES APOGEO WELL	4,33
QTAS DE SANTA ANA WELL	0,42
GM COLMOTORES WELL	3,37
MANUFACTURAS ELIOT WELL	0,99

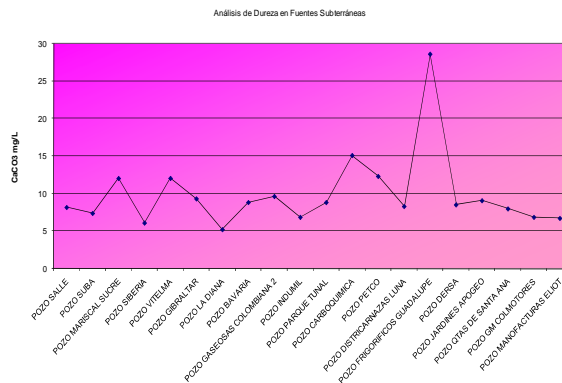


Graphic 9. Fe results (Mg/L Fe)

The resolution number 2115 of 2007 has a permissible Iron value of 0.3 mg/L.

1.5.10 CaCO₃ Hardness

SALLE WELL	8,17
SUBA WELL	7,38
MARISCAL SUCRE WELL	12,03
SIBERIA WELL	6,1
VITELMA WELL	12,04
GIBALTAR WELL	9,31
LA DIANA WELL	5,22
BAVARIA WELL	8,83
GASEOSAS COLOMBIANA 2 WELL	9,63
INDUMIL PARK	6,86
TUNAL PARK WELL	8,82
CARBOQUIMICA WELL	15,08
PETCO WELL	12,3
DISTRICARNAZAS LUNA WELL	8,3
FRIGORIFICOS GUADALUPE WELL	28,56
DERSA WELL	8,52
JARDINES APOGEO WELL	9,07
QTAS DE SANTA ANA WELL	7,98
GM COLMOTORES WELL	6,86
MANUFACTURAS ELIOT WELL	6,72

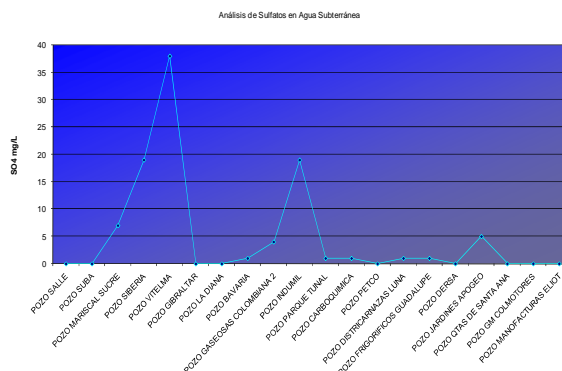


Graphic 10. Hardness results (CaCO3)

The resolution number 2115 of 2007 has a permissible CaCO₃ hardness value of 300 mg/L.

1.5.11 Sulphates

SALLE WELL	0
SUBA WELL	0
MARISCAL SUCRE WELL	7
SIBERIA WELL	19
VITELMA WELL	38
GIBALTAR WELL	0
LA DIANA WELL	0
BAVARIA WELL	1
GASEOSAS COLOMBIANA WELL2	4
INDUMIL WELL	19
TUNAL PARK WELL	1
CARBOQUIMICA WELL	1
PETCO WELL	0
DISTRICARNAZAS LUNA WELL	1
FRIGORIFICOS GUADALUPE WELL	1
DERSA WELL	0
JARDINES APOGEO WELL	5
QTAS DE SANTA ANA WELL	0
POZO GM COLMOTORES	0
MANUFACTURAS ELIOT WELL	0

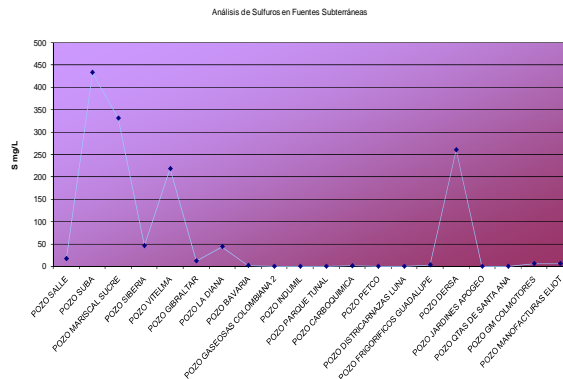


Graphic 11. SO4 results (mg/L SO4)

The resolution number 2115 of 2007 has a permissible Sulphates value of 200 mg/L.

1.5.12 Sulfurous

SALLE WELL	17
SUBA WELL	433
MARISCAL SUCRE WELL	331
SIBERIA WELL	46
VITELMA WELL	218
GIBALTAR WELL	12
LA DIANA WELL	44
BAVARIA WELL	2
GASEOSAS COLOMBIANA 2 WELL	0
INDUMIL WELL	0
TUNAL PARK WELL	0
CARBOQUIMICA WELL	1
PETCO WELL	0
DISTRICARNAZAS LUNA WELL	0
FRIGORIFICOS GUADALUPE WELL	3
DERSA WELL	260
JARDINES APOGEO WELL	0
QTAS DE SANTA ANA WELL	0
GM COLMOTORES WELL	6
MANUFACTURAS ELIOT WELL	6

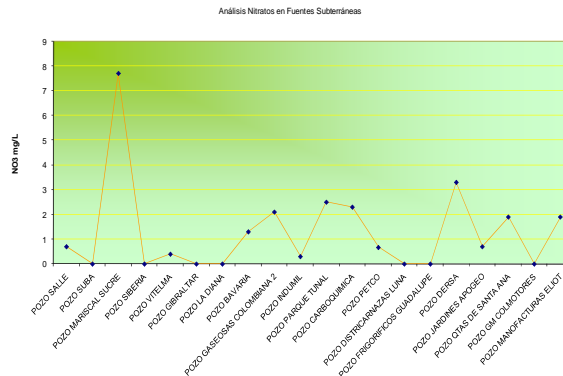


Graphic 12. S results (mg/L S)

In the Colombian legislation, there is not a determinate concentration value to Sulphurous to human water consumption.

1.5.13 Nitrates

SALLE WELL	0,7
SUBA WELL	0
MARISCAL SUCRE WELL	7,7
SIBERIA WELL	0
VITELMA WELL	0,4
GIBALTAR WELL	0
LA DIANA WELL	0
BAVARIA WELL	1,3
GASEOSAS COLOMBIANA WELL2	2,1
INDUMIL WELL	0,3
TUNAL PARK WELL	2,5
CARBOQUIMICA WELL	2,3
PETCO WELL	0,67
DISTRICARNAZAS LUNA WELL	0
FRIGORIFICOS GUADALUPE WELL	0
DERSA WELL	3,3
JARDINES APOGEO WELL	0,7
QTAS DE SANTA ANA WELL	1,9
GM COLMOTORES WELL	0
MANUFACTURAS ELIOT WELL	1,9

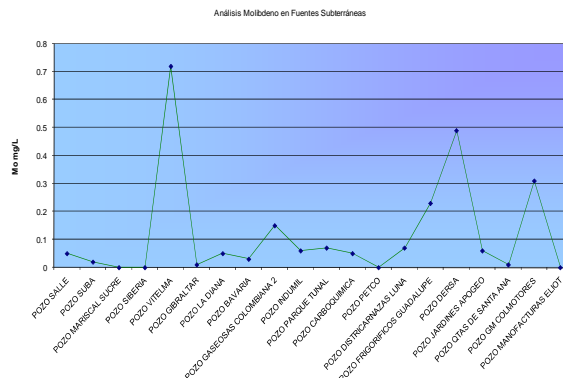


Graphic 13. NO3- results (mg/L NO3-)

The resolution number 2115 of 2007 has a permissible Nitrates value of 10 mg/L.

1.5.14 Molybdenum

SALLE WELL	0,05
SUBA WELL	0,02
MARISCAL SUCRE WELL	0
SIBERIA WELL	0
VITELMA WELL	0,72
GIBALTAR WELL	0,01
LA DIANA WELL	0,05
BAVARIA WELL	0,03
GASEOSAS COLOMBIANA 2 WELL	0,15
INDUMIL WELL	0,06
TUNAL PARK WELL	0,07
CARBOQUIMICA WELL	0,05
PETCO WELL	0
DISTRICARNAZAS LUNA WELL	0,07
FRIGORIFICOS GUADALUPE WELL	0,23
DERSA WELL	0,49
JARDINES APOGEO WELL	0,06
QTAS DE SANTA ANA WELL	0,01
GM COLMOTORES WELL	0,31
MANUFACTURAS ELIOT WELL	0

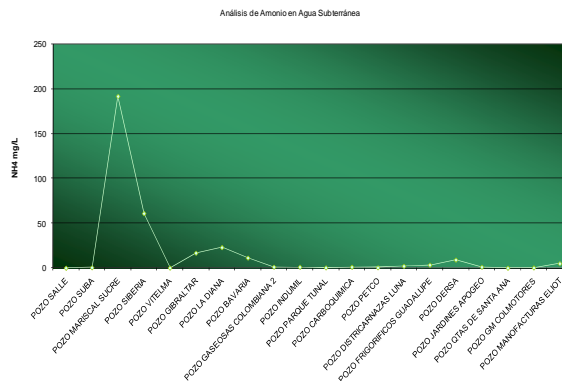


Graphic 14. Mo results (mg/L Mo)

The resolution number 2115 of 2007 has a permissible Molybdenum value of 0.07 mg/L.

1.5.15 Ammonium NH₄

SALLE WELL	0
SUBA WELL	0,39
MARISCAL SUCRE	192
SIBERIA WELL	61
VITELMA WELL	0,08
GIBRALTAR WELL	16,71
LA DIANA WELL	23
BAVARIA WELL	11,29
GASEOSAS COLOMBIANA 2 WELL	1,03
INDUMIL WELL	0,99
TUNAL PARK WELL	0,32
CARBOQUIMICA WELL	1,01
PETCO WELL	0,38
DISTRICARNAZAS LUNA WELL	2,01
FRIGORIFICOS GUADALUPE WELL	3,26
DERSA WELL	9
JARDINES APOGEO WELL	1
QTAS DE SANTA ANA WELL	0,001
GM COLMOTORES WELL	0,26
MANUFACTURAS ELIOT WELL	5,02

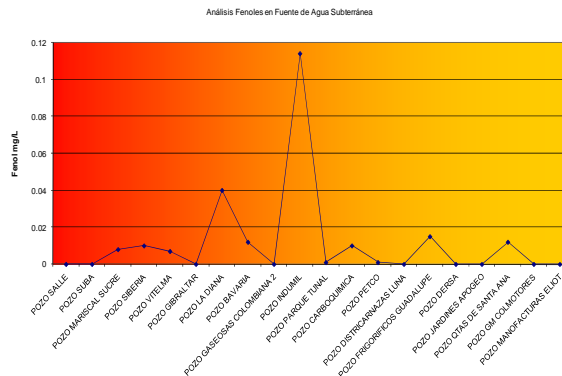


Graphic 15. NH₄ resultados (mg/L NH₄)

In the Colombian legislation, there is not a determinate concentration value to Ammonium to human water consumption.

1.5.16 Phenols

SALLE WELL	0
SUBA WELL	0
MARISCAL SUCRE WELL	0,008
SIBERIA WELL	0,01
VITELMA WELL	0,007
GIBRALTAR WELL	0
LA DIANA WELL	0,04
BAVARIA WELL	0,012
GASEOSAS COLOMBIANA 2 WELL	0
INDUMIL WELL	0,114
TUNAL PARK WELL	0,001
CARBOQUIMICA WELL	0,01
PETCO WELL	0,001
DISTRICARNAZAS LUNA WELL	0
FRIGORIFICOS GUADALUPE WELL	0,015
DERSA WELL	0
JARDINES APOGEO WELL	0
QTAS DE SANTA ANA WELL	0,012
GM COLMOTORES WELL	0
MANUFACTURAS ELIOT WELL	0

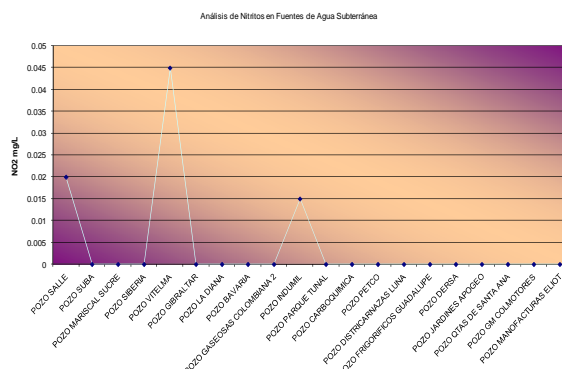


Graphic 16. Phenols results (mg/L Phenols)

The resolution number 2115 of 2007 has not a Phenols value. However, the decree 475 of 1998 presents a maximum concentration value of 0.001 mg/L.

1.5.17 Nitrites

SALLE WELL	0,02
SUBA WELL	0
MARISCAL SUCRE WELL	0
SIBERIA WELL	0
VITELMA WELL	0,045
GIBRALTAR WELL	0
LA DIANA WELL	0
BAVARIA WELL	0
GASEOSAS COLOMBIANA 2 WELL	0
INDUMIL WELL	0,015
TUNAL PARK WELL	0
CARBOQUIMICA WELL	0
PETCO WELL	0
DISTRICARNAZAS LUNA WELL	0
FRIGORIFICOS GUADALUPE WELL	0
DERSA WELL	0
JARDINES APOGEO WELL	0
QTAS DE SANTA ANA WELL	0
GM COLMOTORES WELL	0
MANUFACTURAS ELIOT WELL	0

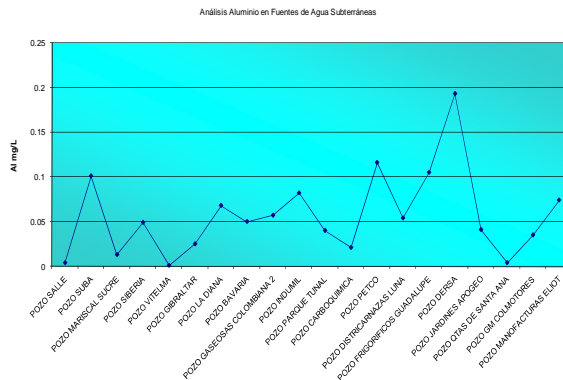


Graphic 17. NO₂ Results (mg/L NO₂)

The resolution number 2115 of 2007 has a permissible Nitrites value of 0.1 mg/L.

1.5.18 Aluminum

SALLE WELL	0,004
SUBA WELL	0,101
MARISCAL SUCRE WELL	0,013
POZO SIBERIA	0,049
VITELMA WELL	0,001
GIBRALTAR WELL	0,025
LA DIANA WELL	0,068
BAVARIA WELL	0,05
GASEOSAS COLOMBIANA WELL2	0,057
INDUMIL WELL	0,082
TUNAL PARK WELL	0,04
CARBOQUIMICA WELL	0,021
PETCO WELL	0,116
DISTRICARNAZAS LUNA WELL	0,054
FRIGORIFICOS GUADALUPE WELL	0,105
DERSA WELL	0,193
JARDINES APOGEO WELL	0,041
QTAS DE SANTA ANA WELL	0,004
GM COLMOTORES WELL	0,035
MANUFACTURAS ELIOT WELL	0,074

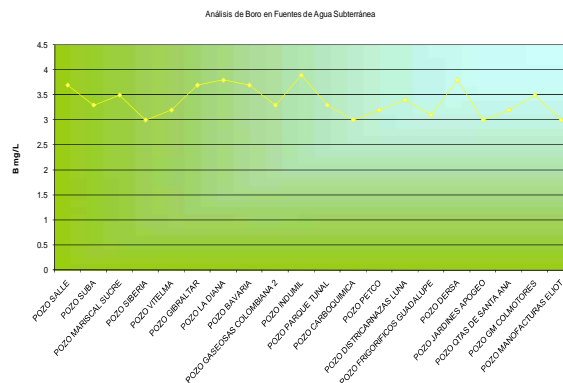


Graphic 18. Al3+ results (mg/L Al3+)

The resolution number 2115 of 2007 has a permissible aluminum value of 0.2 mg/L.

1.5.19 Boron

SALLE WELL	3,7
SUBA WELL	3,3
MARISCAL SUCRE WELL	3,5
SIBERIA WELL	3
VITELMA WELL	3,2
GIBRALTAR WELL	3,7
LA DIANA WELL	3,8
BAVARIA WELL	3,7
GASEOSAS COLOMBIANA 2 WELL	3,3
INDUMIL WELL	3,9
TUNAL PARK WELL	3,3
CARBOQUIMICA WELL	3
PETCO WELL	3,2
DISTRICARNAZAS LUNA WELL	3,4
FRIGORIFICOS GUADALUPE WELL	3,1
DERSA WELL	3,8
JARDINES APOGEO WELL	3
QTAS DE SANTA ANA WELL	3,2
GM COLMOTORES WELL	3,5
MANUFACTURAS ELIOT WELL	3

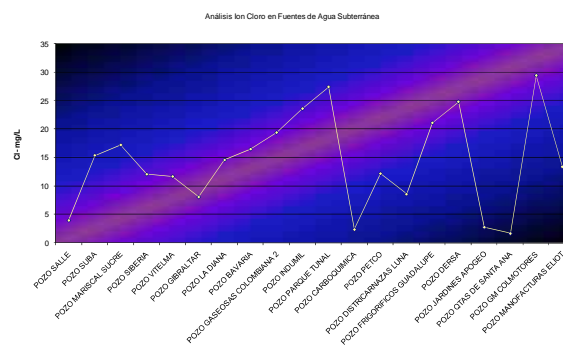


Graphic 19. Boron results (mg/L B)

The resolution number 2115 of 2007 has not a BORON value. However, the decree 475 of 1998 presents a maximum concentration value of 0.3 mg/L.

1.5.20 Chlorides

SALLE WELL	4
SUBA WELL	15,4
MARISCAL SUCRE WELL	17,23
SIBERIA WELL	12,09
VITELMA WELL	11,7
GIBRALTAR WELL	8,1
LA DIANA WELL	14,6
BAVARIA WELL	16,5
GASEOSAS COLOMBIANA 2 WELL	19,4
INDUMIL WELL	23,6
TUNAL PARK WELL	27,4
CARBOQUIMICA WELL	2,4
PETCO WELL	12,2
DISTRICARNAZAS LUNA WELL	8,6
FRIGORIFICOS GUADALUPE WELL	21,1
DERSA WELL	24,8
JARDINES APOGEO WELL	2,8
QTAS DE SANTA ANA WELL	1,7
GM COLMOTORES WELL	29,42
MANUFACTURAS ELIOT WELL	13,4

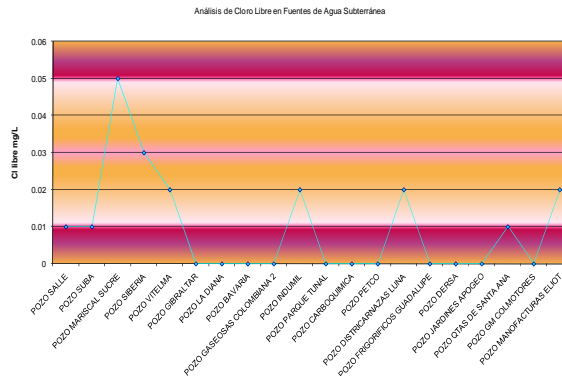


Graphic 20. Cl- results (mg/L Cl-)

The resolution number 2115 of 2007 has a permissible Chlorides value of 250 mg/L.

1.5.21 Free Chloride

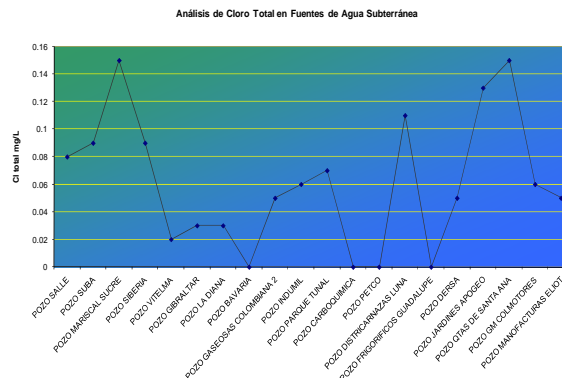
SALLE WELL	0,01
SUBA WELL	0,01
MARISCAL SUCRE WELL	0,05
SIBERIA WELL	0,03
VITELMA WELL	0,02
GIBRALTAR WELL	0
LA DIANA WELL	0
BAVARIA WELL	0
GASEOSAS COLOMBIANA 2 WELL	0
INDUMIL WELL	0,02
TUNAL PARK WELL	0
CARBOQUIMICA WELL	0
PETCO WELL	0
DISTRICARNAZAS LUNA WELL	0,02
FRIGORIFICOS GUADALUPE WELL	0
DERSA WELL	0
JARDINES APOGEO WELL	0
POZO QTAS DE SANTA ANA	0,01
POZO GM COLMOTORES	0
MANUFACTURAS ELIOT WELL	0,02



Graphic 21. Free Chloride results (mg/L)

1.5.22 Total Chloride

SALLE WELL	0,08
SUBA WELL	0,09
MARISCAL SUCRE WELL	0,15
SIBERIA WELL	0,09
VITELMA WELL	0,02
GIBRALTAR WELL	0,03
LA DIANA WELL	0,03
BAVARIA WELL	0
GASEOSAS COLOMBIANA 2 WELL	0,05
INDUMIL WELL	0,06
TUNAL PARK WELL	0,07
CARBOQUIMICA WELL	0
PETCO WELL	0
DISTRICARNAZAS LUNA WELL	0,11
FRIGORIFICOS GUADALUPE WELL	0
DERSA WELL	0,05
JARDINES APOGEO WELL	0,13
QTAS DE SANTA ANA WELL	0,15
GM COLMOTORES WELL	0,06
MANUFACTURAS ELIOT WELL	0,05

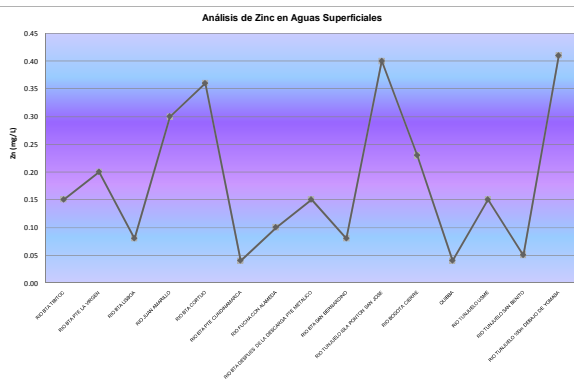


Graphic 22. Total Chloride results (mg/L)

1.6 SURFACE WATER RESULTS

1.6.1 Zinc

RIO BTA TIBITOC	0.15
RIO BTA PTE LA VIRGEN	0.20
RIO BTA LISBOA	0.08
RIO JUAN AMARILLO	0.30
RIO BTA CORTIJO	0.36
RIO BTA PTE CUNDINAMARCA	0.04
RIO FUCHA CON ALAMEDA	0.10
RIO BTA DESPUES DE LA DESCARGA PTE METALICO	0.15
RIO BTA SAN BERNARDINO	0.08
RIO TUNJUELO ISLA PONTON SAN JOSE	0.40
RIO BOGOTA CIERRE	0.23
QUIBBA	0.04
RIO TUNJUELO USME	0.15
RIO TUNJUELO SAN BENITO	0.05
RIO TUNJUELO 100m DEBAJO DE YOMASA	0.41

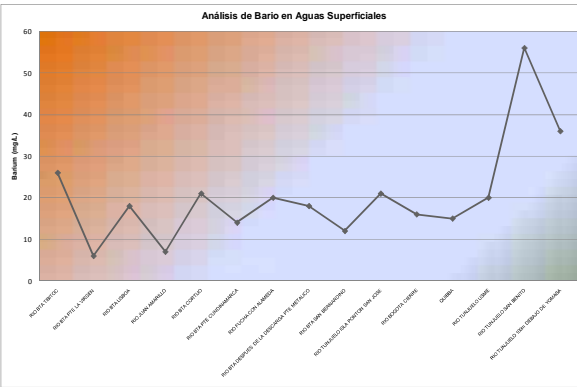


Graphic 23. (mg/L)

The resolution number 1074 of 1997 establishes the discharges environmental standards which has a permissible Zinc value of 5 mg/L.

1.6.2 Bario

RIO BTA TIBITOC	26
RIO BTA PTE LA VIRGEN	6
RIO BTA LISBOA	18
RIO JUAN AMARILLO	7
RIO BTA CORTIJO	21
RIO BTA PTE CUNDINAMARCA	14
RIO FUCHA CON ALAMEDA	20
RIO BTA DESPUES DE LA DESCARGA PTE METALICO	18
RIO BTA SAN BERNARDINO	12
RIO TUNJUELO ISLA PONTON SAN JOSE	21
RIO BOGOTA CIERRE	16
QUIBBA	15
RIO TUNJUELO USME	20
RIO TUNJUELO SAN BENITO	56
RIO TUNJUELO 100m DEBAJO DE YOMASA	36

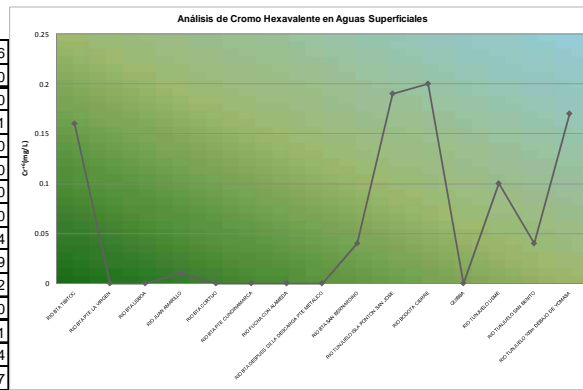


Graphic 24. Ba results Ba (mg/L Ba)

The resolution number 1074 of 1997 establishes the discharges environmental standards which has a permissible Bario value of 5 mg/L. All the surfaces water points are above this value.

1.6.3 Cromo Hexavalent

RIO BTA TIBITOC	0.16
RIO BTA PTE LA VIRGEN	0
RIO BTA LISBOA	0
RIO JUAN AMARILLO	0.01
RIO BTA CORTIJO	0
RIO BTA PTE CUNDINAMARCA	0
RIO FUCHA CON ALAMEDA	0
RIO BTA DESPUES DE LA DESCARGA PTE METALICO	0
RIO BTA SAN BERNARDINO	0.04
RIO TUNJUELO ISLA PONTON SAN JOSE	0.19
RIO BOGOTA CIERRE	0.2
QUIBBA	0
RIO TUNJUELO USME	0.1
RIO TUNJUELO SAN BENITO	0.04
RIO TUNJUELO 100m DEBAJO DE YOMASA	0.17

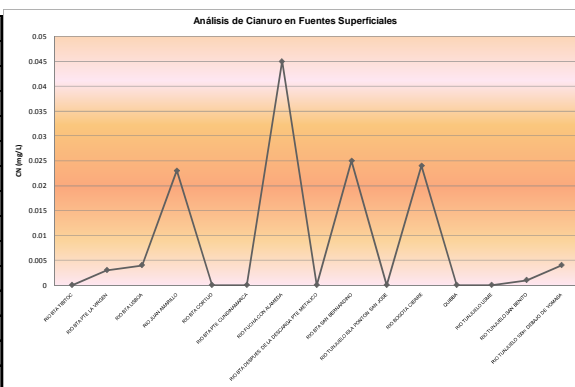


Graphic 25. Cr +6 Results (mg/L Cr +6)

The resolution number 1074 of 1997 establishes the discharges environmental standards which has a permissible Cromo Hexavalent value of 0.5 mg/L.

1.6.4 Cyanide

RIO BTA TIBITOC	0
RIO BTA PTE LA VIRGEN	0.003
RIO BTA LISBOA	0.004
RIO JUAN AMARILLO	0.023
RIO BTA CORTIJO	0
RIO BTA PTE CUNDINAMARCA	0
RIO FUCHA CON ALAMEDA	0.045
RIO BTA DESPUES DE LA DESCARGA PTE METALICO	0
RIO BTA SAN BERNARDINO	0.025
RIO TUNJUELO ISLA PONTON SAN JOSE	0
RIO BOGOTA CIERRE	0.024
QUIBBA	0
RIO TUNJUELO USME	0
RIO TUNJUELO SAN BENITO	0.001
RIO TUNJUELO 100m DEBAJO DE YOMASA	0.004

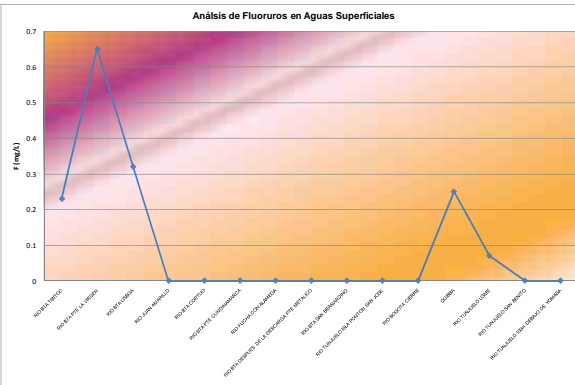


Graphic 26. CN results (mg/L CN-)

The resolution number 1074 of 1997 establishes the discharges environmental standards which has a permissible Cyanide value of 1.0 mg/L.

1.6.5 Fluorures

RIO BTA TIBITOC	0.23
RIO BTA PTE LA VIRGEN	0.65
RIO BTA LISBOA	0.32
RIO JUAN AMARILLO	0
RIO BTA CORTIJO	0
RIO BTA PTE CUNDINAMARCA	0
RIO FUCHA CON ALAMEDA	0
RIO BTA DESPUES DE LA DESCARGA PTE METALICO	0
RIO BTA SAN BERNARDINO	0
RIO TUNJUELO ISLA PONTON SAN JOSE	0
RIO BOGOTA CIERRE	0
QUIBBA	0.25
RIO TUNJUELO USME	0.07
RIO TUNJUELO SAN BENITO	0
RIO TUNJUELO 100m DEBAJO DE YOMASA	0

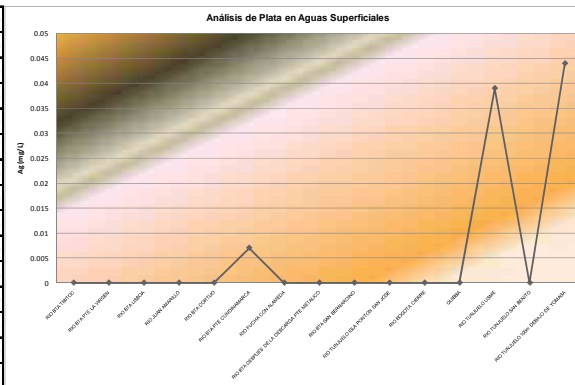


Graphic 27. F results (mg/L F)

The resolution number 1074 of 1997 has not established a Fluorures environmental standard.

1.6.6 Silver

RIO BTA TIBITOC	0
RIO BTA PTE LA VIRGEN	0
RIO BTA LISBOA	0
RIO JUAN AMARILLO	0
RIO BTA CORTIJO	0
RIO BTA PTE CUNDINAMARCA	0.007
RIO FUCHA CON ALAMEDA	0
RIO BTA DESPUES DE LA DESCARGA PTE METALICO	0
RIO BTA SAN BERNARDINO	0
RIO TUNJUELO ISLA PONTON SAN JOSE	0
RIO BOGOTA CIERRE	0
QUIBBA	0
RIO TUNJUELO USME	0.039
RIO TUNJUELO SAN BENITO	0
RIO TUNJUELO 100m DEBAJO DE YOMASA	0.044

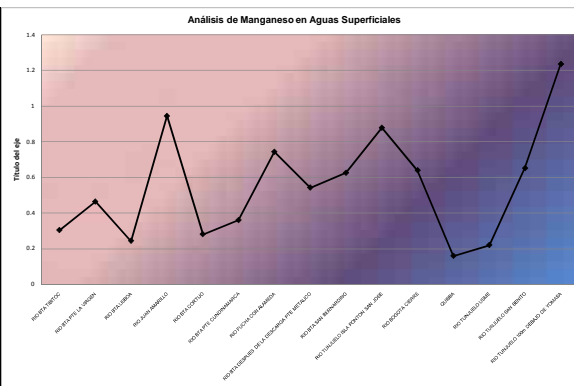


Graphic 28. Ag results (mg/L Ag)

The resolution number 1074 of 1997 establishes the discharges environmental standards which has a permissible Ag value of 0.5 mg/L.

1.6.7 Manganese

RIO BTA TIBITOC	0.303
RIO BTA PTE LA VIRGEN	0.463
RIO BTA LISBOA	0.243
RIO JUAN AMARILLO	0.944
RIO BTA CORTIJO	0.28
RIO BTA PTE CUNDINAMARCA	0.359
RIO FUCHA CON ALAMEDA	0.743
RIO BTA DESPUES DE LA DESCARGA PTE METALICO	0.542
RIO BTA SAN BERNARDINO	0.625
RIO TUNJUELO ISLA PONTON SAN JOSE	0.878
RIO BOGOTA CIERRE	0.639
QUIBBA	0.158
RIO TUNJUELO USME	0.219
RIO TUNJUELO SAN BENITO	0.651
RIO TUNJUELO 100m DEBAJO DE YOMASA	1.236

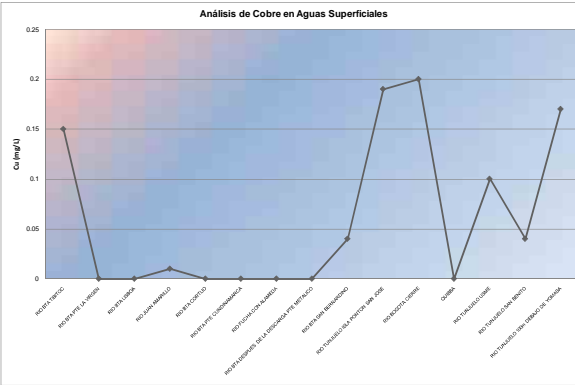


Graphic 29. Mn results (mg/L Mn)

The resolution number 1074 of 1997 establishes the discharges environmental standards which has a permissible Mn value of 0.12 mg/L. All the surfaces water points are above this value.

1.6.8 Cooper

RIO BTA TIBITOC	0.15
RIO BTA PTE LA VIRGEN	0
RIO BTA LISBOA	0
RIO JUAN AMARILLO	0.01
RIO BTA CORTIJO	0
RIO BTA PTE CUNDINAMARCA	0
RIO FUCHA CON ALAMEDA	0
RIO BTA DESPUES DE LA DESCARGA PTE METALICO	0
RIO BTA SAN BERNARDINO	0.04
RIO TUNJUELO ISLA PONTON SAN JOSE	0.19
RIO BOGOTA CIERRE	0.2
QUIBBA	0
RIO TUNJUELO USME	0.1
RIO TUNJUELO SAN BENITO	0.04
RIO TUNJUELO 100m DEBAJO DE YOMASA	0.17

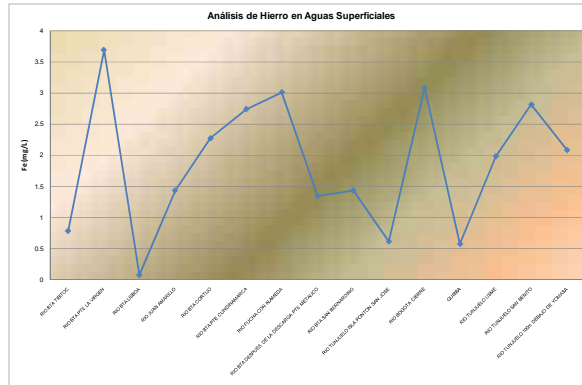


Graphic 30. Cu results (mg/L Cu)

The resolution number 1074 of 1997 establishes the discharges environmental standards which has a permissible Cu value of 0.25 mg/L

1.6.9 Iron

RIO BTA TIBITOC	0.78
RIO BTA PTE LA VIRGEN	3.69
RIO BTA LISBOA	0.07
RIO JUAN AMARILLO	1.43
RIO BTA CORTIJO	2.27
RIO BTA PTE CUNDINAMARCA	2.74
RIO FUCHA CON ALAMEDA	3.01
RIO BTA DESPUES DE LA DESCARGA PTE METALICO	1.34
RIO BTA SAN BERNARDINO	1.43
RIO TUNJUELO ISLA PONTON SAN JOSE	0.61
RIO BOGOTA CIERRE	3.08
QUIBBA	0.57
RIO TUNJUELO USME	1.98
RIO TUNJUELO SAN BENITO	2.81
RIO TUNJUELO 100m DEBAJO DE YOMASA	2.08

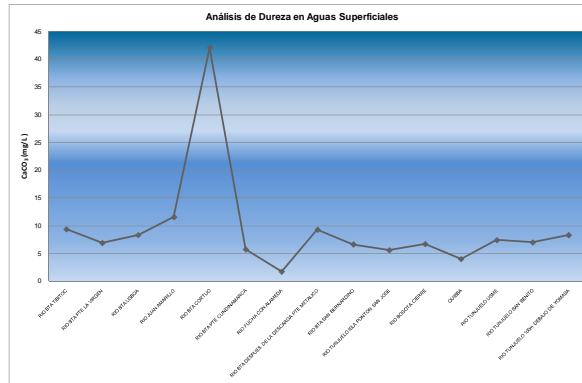


Graphic 31. Fe results (Mg/L Fe)

The Decree number 1594 of 1984 establishes the water uses and liquids wastes environmental standards which has a permissible Iron value for agricultural use of 5 mg/L

1.6.10 CaCO₃ Hardness

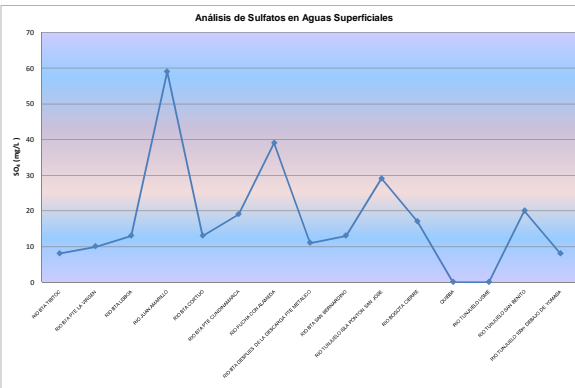
RIO BTA TIBITOC	9.31
RIO BTA PTE LA VIRGEN	6.84
RIO BTA LISBOA	8.27
RIO JUAN AMARILLO	11.5
RIO BTA CORTIJO	42.06
RIO BTA PTE CUNDINAMARCA	5.68
RIO FUCHA CON ALAMEDA	1.67
RIO BTA DESPUES DE LA DESCARGA PTE METALICO	9.24
RIO BTA SAN BERNARDINO	6.58
RIO TUNJUELO ISLA PONTON SAN JOSE	5.53
RIO BOGOTA CIERRE	6.65
QUIBBA	3.95
RIO TUNJUELO USME	7.36
RIO TUNJUELO SAN BENITO	6.94
RIO TUNJUELO 100m DEBAJO DE YOMASA	8.25



Graphic 32. CaCO₃ Hardness

1.6.10 Sulphates

RIO BTA TIBITOC	8
RIO BTA PTE LA VIRGEN	10
RIO BTA LISBOA	13
RIO JUAN AMARILLO	59
RIO BTA CORTIJO	13
RIO BTA PTE CUNDINAMARCA	19
RIO FUCHA CON ALAMEDA	39
RIO BTA DESPUES DE LA DESCARGA PTE METALICO	11
RIO BTA SAN BERNARDINO	13
RIO TUNJUELO ISLA PONTON SAN JOSE	29
RIO BOGOTA CIERRE	17
QUIBBA	0
RIO TUNJUELO USME	0
RIO TUNJUELO SAN BENITO	20
RIO TUNJUELO 100m DEBAJO DE YOMASA	8

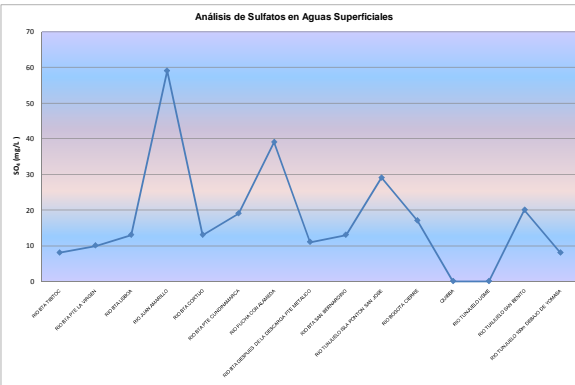


Graphic 33. SO4 results (mg/L SO4)

The Decree number 1594 of 1984 establishes the water uses and liquids wastes environmental standards which has a permissible Sulphates value for water potabilization before conventional treatment and disinfection use of 400 mg/L

1.6.11 Sulphates

RIO BTA TIBITOC	8
RIO BTA PTE LA VIRGEN	10
RIO BTA LISBOA	13
RIO JUAN AMARILLO	59
RIO BTA CORTIJO	13
RIO BTA PTE CUNDINAMARCA	19
RIO FUCHA CON ALAMEDA	39
RIO BTA DESPUES DE LA DESCARGA PTE METALICO	11
RIO BTA SAN BERNARDINO	13
RIO TUNJUELO ISLA PONTON SAN JOSE	29
RIO BOGOTA CIERRE	17
QUIBBA	0
RIO TUNJUELO USME	0
RIO TUNJUELO SAN BENITO	20
RIO TUNJUELO 100m DEBAJO DE YOMASA	8

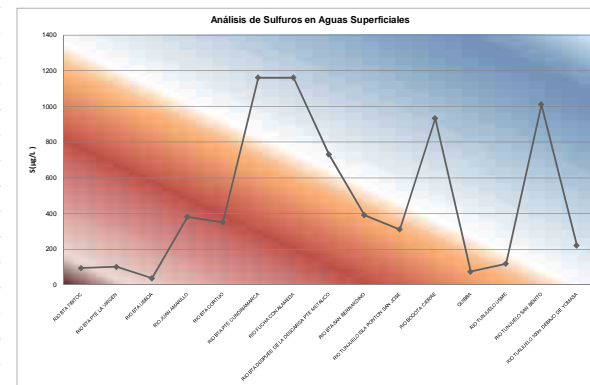


Graphic 34. SO4 results (mg/L SO4)

The Decree number 1594 of 1984 establishes the water uses and liquids wastes environmental standards which has a permissible Sulphates value of 400 mg/L for water potabilization before conventional treatment and disinfection.

1.6.12 Sulfurous

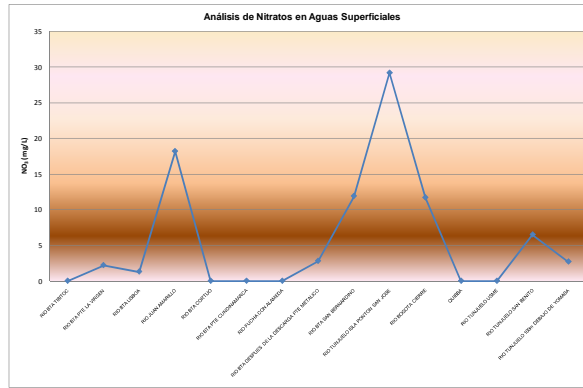
RIO BTA TIBITOC	93
RIO BTA PTE LA VIRGEN	100
RIO BTA LISBOA	36
RIO JUAN AMARILLO	380
RIO BTA CORTIJO	350
RIO BTA PTE CUNDINAMARCA	1160
RIO FUCHA CON ALAMEDA	1160
RIO BTA DESPUES DE LA DESCARGA PTE METALICO	730
RIO BTA SAN BERNARDINO	390
RIO TUNJUELO ISLA PONTON SAN JOSE	310
RIO BOGOTA CIERRE	932
QUIBBA	73
RIO TUNJUELO USME	118
RIO TUNJUELO SAN BENITO	1010
RIO TUNJUELO 100m DEBAJO DE YOMASA	220



Graphic 35. S results (mg/L S)

1.6.13 Nitrites

RIO BTA TIBITOC	0
RIO BTA PTE LA VIRGEN	2.2
RIO BTA LISBOA	1.3
RIO JUAN AMARILLO	18.2
RIO BTA CORTIJO	0
RIO BTA PTE CUNDINAMARCA	0
RIO FUCHA CON ALAMEDA	0
RIO BTA DESPUES DE LA DESCARGA PTE METALICO	2.8
RIO BTA SAN BERNARDINO	11.9
RIO TUNJUELO ISLA PONTON SAN JOSE	29.2
RIO BOGOTA CIERRE	11.7
QUIBBA	0
RIO TUNJUELO USME	0
RIO TUNJUELO SAN BENITO	6.5
RIO TUNJUELO 100m DEBAJO DE YOMASA	2.7

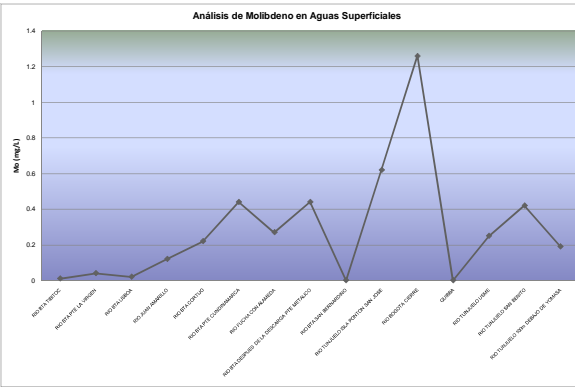


Graphic 36. NO3 results- (mg/L NO3-)

The Decree number 1594 of 1984 establishes the water uses and liquids wastes environmental standards which has a permissible Nitrates value of 10 mg/L, for water potabilization before conventional treatment and disinfection.

1.6.14 Molybdenum

RIO BTA TIBITOC	0.01
RIO BTA PTE LA VIRGEN	0.04
RIO BTA LISBOA	0.02
RIO JUAN AMARILLO	0.12
RIO BTA CORTIJO	0.22
RIO BTA PTE CUNDINAMARCA	0.44
RIO FUCHA CON ALAMEDA	0.27
RIO BTA DESPUES DE LA DESCARGA PTE METALICO	0.44
RIO BTA SAN BERNARDINO	0
RIO TUNJUELO ISLA PONTON SAN JOSE	0.62
RIO BOGOTA CIERRE	1.26
QUIBBA	0
RIO TUNJUELO USME	0.25
RIO TUNJUELO SAN BENITO	0.42
RIO TUNJUELO 100m DEBAJO DE YOMASA	0.19

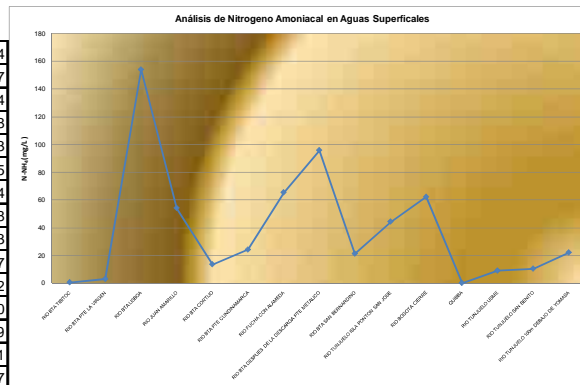


Graphic 37. Mo results (mg/L Mo)

The Decree number 1594 of 1984 establishes the water uses and liquids wastes environmental standards which has a permissible Mo value of 0.01 mg/L, for agriculture use.

1.6.15 Ammoniacal Nitrogen

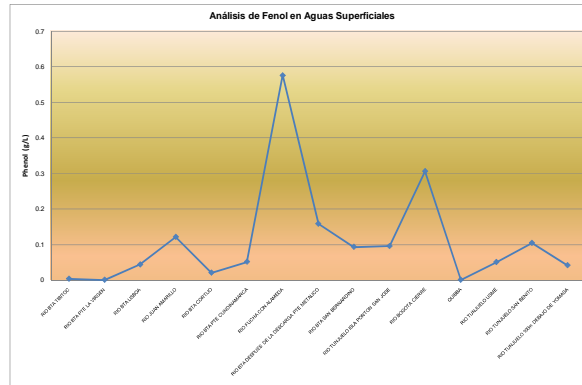
RIO BTA TIBITOC	0.44
RIO BTA PTE LA VIRGEN	2.87
RIO BTA LISBOA	154
RIO JUAN AMARILLO	54.08
RIO BTA CORTIJO	13.43
RIO BTA PTE CUNDINAMARCA	24.05
RIO FUCHA CON ALAMEDA	65.34
RIO BTA DESPUES DE LA DESCARGA PTE METALICO	95.78
RIO BTA SAN BERNARDINO	21.13
RIO TUNJUELO ISLA PONTON SAN JOSE	44.27
RIO BOGOTA CIERRE	62.12
QUIBBA	0
RIO TUNJUELO USME	8.9
RIO TUNJUELO SAN BENITO	10.31
RIO TUNJUELO 100m DEBAJO DE YOMASA	21.97



Graphic 38. mg results L N-NH4

1.6.16 Phenols

RIO BTA TIBITOC	0.003
RIO BTA PTE LA VIRGEN	0
RIO BTA LISBOA	0.043
RIO JUAN AMARILLO	0.121
RIO BTA CORTIJO	0.02
RIO BTA PTE CUNDINAMARCA	0.051
RIO FUCHA CON ALAMEDA	0.576
RIO BTA DESPUES DE LA DESCARGA PTE METALICO	0.158
RIO BTA SAN BERNARDINO	0.093
RIO TUNJUELO ISLA PONTON SAN JOSE	0.095
RIO BOGOTA CIERRE	0.306
QUIBBA	0
RIO TUNJUELO USME	0.05
RIO TUNJUELO SAN BENITO	0.104
RIO TUNJUELO 100m DEBAJO DE YOMASA	0.041

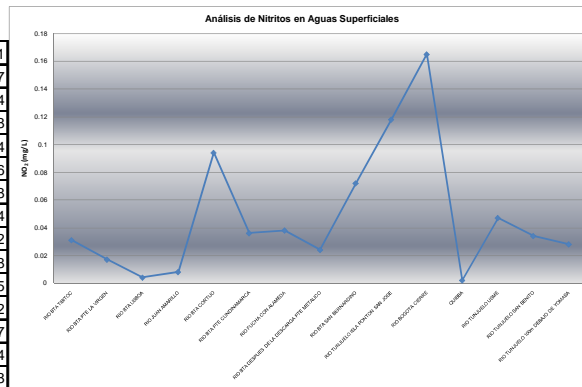


Graphic 39. Phenols results (mg/L Phenols)

The resolution number 1074 of 1997 establishes the discharges environmental standards which has a permissible phenols value of 0.2 mg/L.

1.6.17 Nitrites

RIO BTA TIBITOC	0.031
RIO BTA PTE LA VIRGEN	0.017
RIO BTA LISBOA	0.004
RIO JUAN AMARILLO	0.008
RIO BTA CORTIJO	0.094
RIO BTA PTE CUNDINAMARCA	0.036
RIO FUCHA CON ALAMEDA	0.038
RIO BTA DESPUES DE LA DESCARGA PTE METALICO	0.024
RIO BTA SAN BERNARDINO	0.072
RIO TUNJUELO ISLA PONTON SAN JOSE	0.118
RIO BOGOTA CIERRE	0.165
QUIBBA	0.002
RIO TUNJUELO USME	0.047
RIO TUNJUELO SAN BENITO	0.034
RIO TUNJUELO 100m DEBAJO DE YOMASA	0.028



Graphic 40. NO2 results (mg/L NO2)

The Decree number 1594 of 1984 establishes the water uses and liquids wastes environmental standards which has a permissible Nitrites value of 10 mg/L, for water potabilization before conventional treatment and disinfection.

1.7 CONCLUSIONS AND RECOMMENDATIONS

- To obtain representative results for the analyzed aquifer is necessary to get representative groundwater samples, using standard sampling procedures which includes purge and development the well previous the sampling. This is a high concern for monitoring wells and wells that are not periodically pump.
The purge process must extract at least the water satang inside the pipe well. Unfortunately, during the sample campaign, wells were not purge. It is strongly recommended that well purge and development be carried out previous future sampling, following standard methodologies.
- The cretaceous aquifer water quality is much better than the one for the quaternary aquifer.
- Present at the quaternary aquifer, elements as Barium and Hexavalent Chromium were found to exceed the maximum permissible concentration by the resolution 2115 of 2007. Although the quaternary aquifer does not belong to JICA study which purpose is to analyze water supply for emergency cases, it is very important to continue monitoring and analyzing these elements in this aquifer because contamination possible sources.
- In the cretaceous aquifer Mariscal Sucre, were found a high cyanide concentration, exceeding the permissible value. However, this result cannot be very trustful and it is highly

recommended to realize more testing to check CN level on this well and analyze its possible sources.

- As groundwater features, several wells from both aquifers are over the permissible Iron and Manganese value and these elements need to be treated in order to fulfill water human consumption values. However, because the wells weren't purge before testing, these concentrations are not representatives.
- Because the unavailability of technology to measure H₂S, it is necessary to continue analyzing sulphures and determinate the need to apply aeration process. Nevertheless the Colombian legislation does not show a permissible H₂S value, the WHO indicates a maximum H₂S concentration of 0.03 mg/L to avoid water bad smell and taste.
- The bacteriological part observed the presence of total Coliforms, at Suba, Mariscal Sucre, Siberia, Jardines del apogeo, Gibraltar, Bavaria, Manufacturas Eliot, Vitelma, La Diana y Dersa wells.
- E coli presence at the Gibraltar and La Diana wells was founded.
- Quality water analysis was realized at the surface water to identify the contaminated influence on the quaternary and cretaceous aquifer. It is detected the contamination influence on the quaternary aquifer coming from surface water but it is not detected the contamination influence at the cretaceous aquifer.

DB-3

EXPLORATORY DRILING

DB-3

EXPLORATORY DRILING

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2. Lithology	DB-3-1
3. Final Design.....	DB-3-4
4. Test of Pumping – Ciudad Bolivar	DB-3-7
5. Test of Pumping – Usme.....	DB-3-16
6. Test of Pumping – Quaternary	DB-3-26

1. INTRODUCTION

1.1 ANTECEDENTS

The Japan International Cooperation Agency (JICA) and its equipment of JICA STUDY TEAM in agreement with the Company of Aqueduct and Sewage system of Bogotá E.A.A.B., decided to make two (2) exploratory wells in the cretaceous formation, for the provision of water and a monitoring well in the quaternary formation as a monitoring well. For such aim the company LLANOPOZOS S.A., was contracted for the execution of this work. The exploratory wells was constructed in steel and stainless steel screens to a depth of 300 meters, and the monitoring well was constructed to a depth of 150 meters, in PVC pipe and PVC screens.

Br. No.	Drilling Target	Área	Coordinate	
			X	Y
EX-2	Cretaceous	Ciudad Bolivar Verbenal	4°32'14.4"N	74°09'51.7"W
EX-3	Cretaceous	Usme Cervecería Alemana	4°29'38.1"N	74°04'51.5"W
EX-4	Quaternary	Embalse Seco No. 1	4°33'48.89"N	74°08'18.696"W

2. LITOLOGY: Ciudad Bolivar – Usme - Tunjuelito

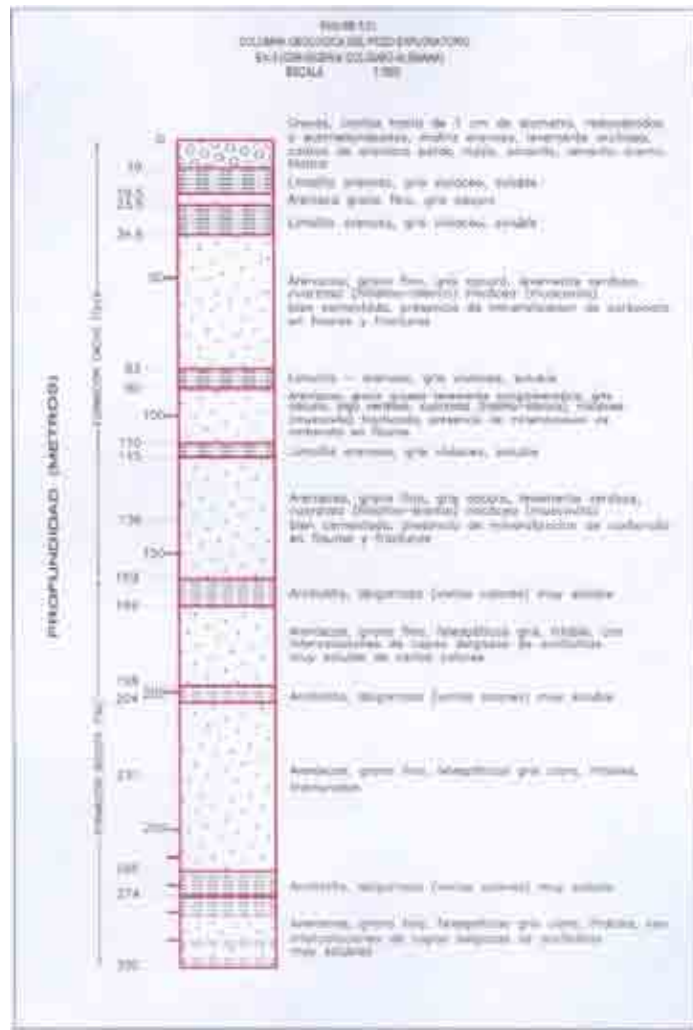
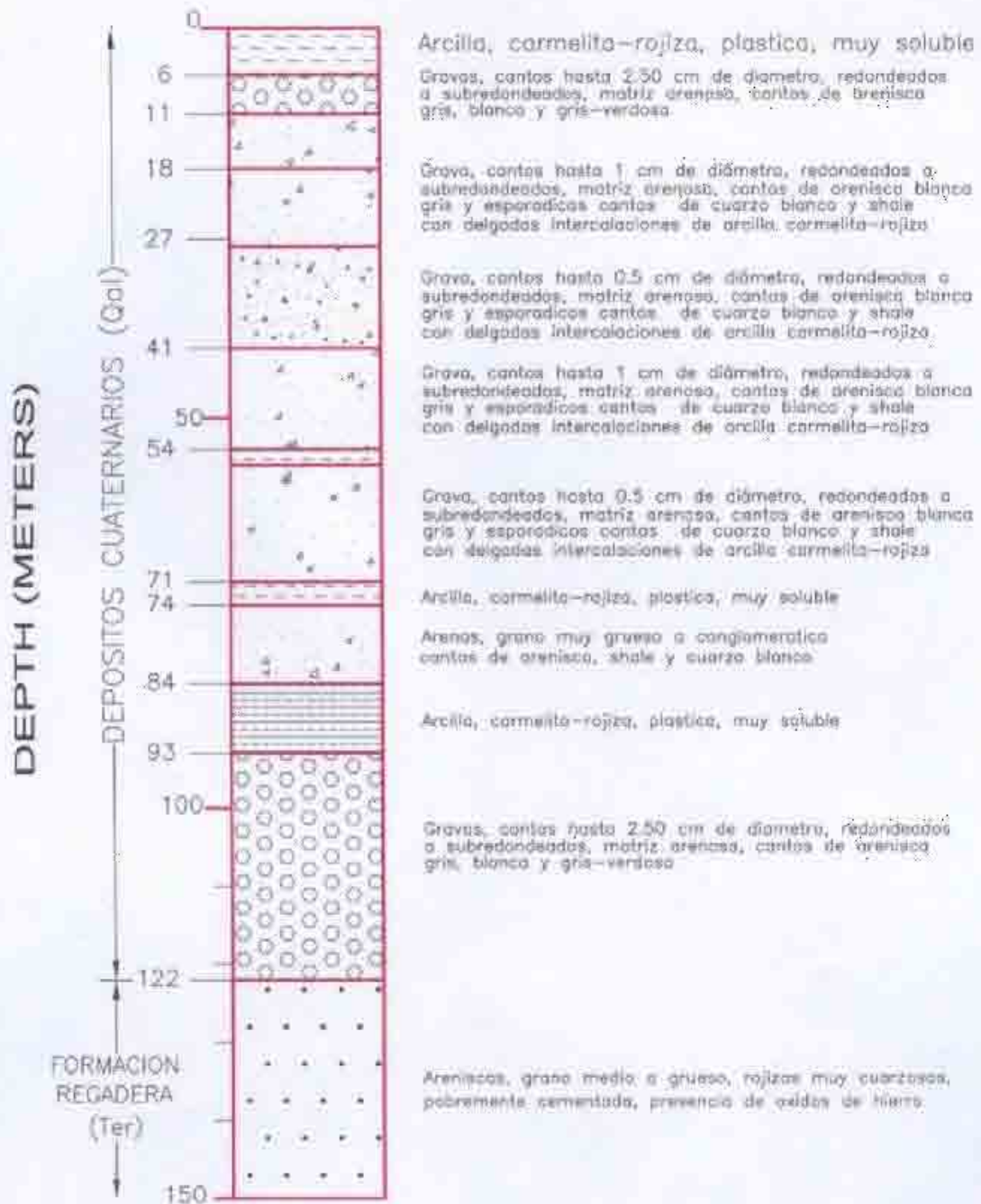
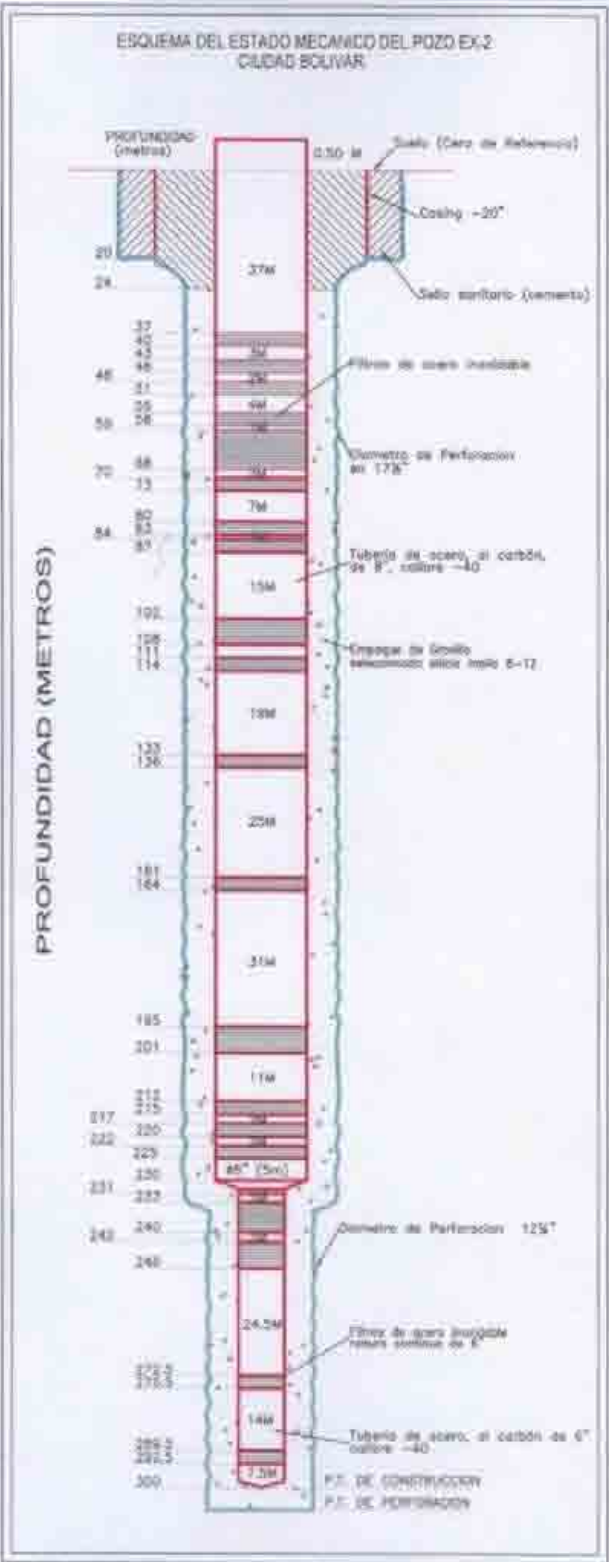


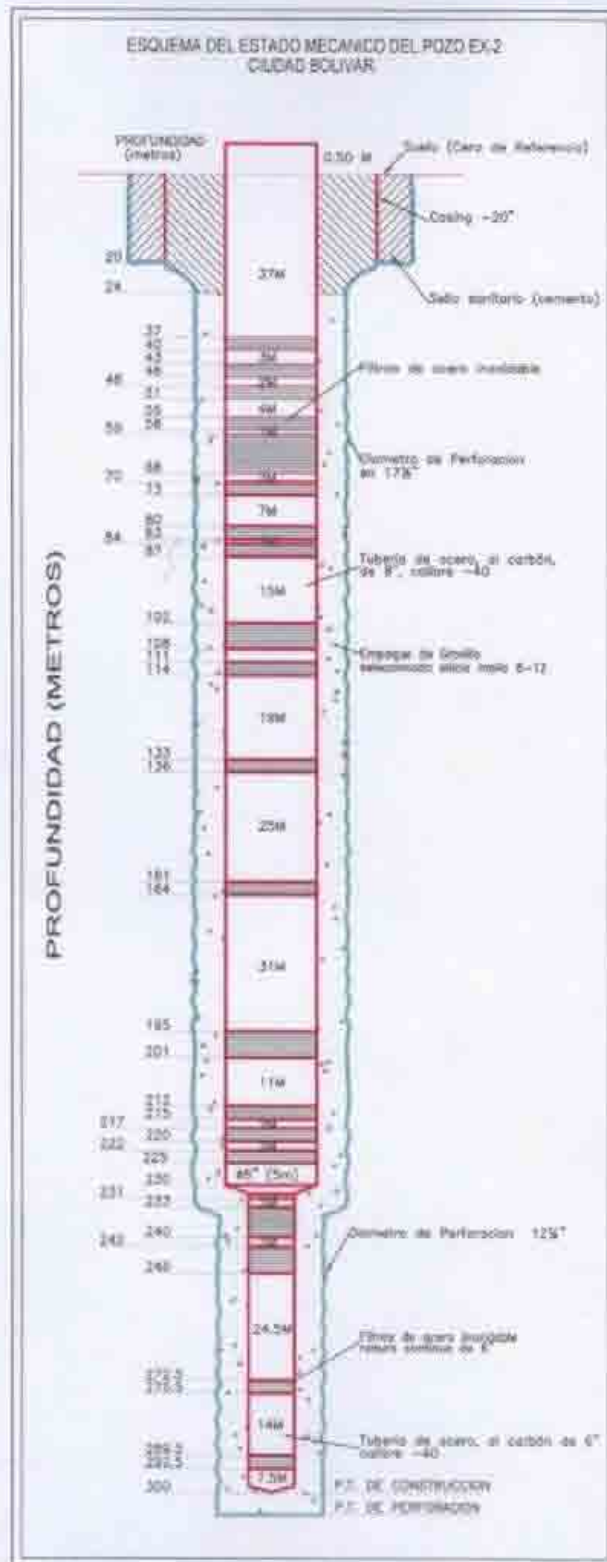
FIGURE - 5.31
 COLUMNA GEOLÓGICA
 DEL POZO DE OBSERVACION
 EX-4 (EMBALSE - 1)

ESCALA 1:3000





3. FINAL DESINGS: Ciudad Bolivar – Usme - Tunjuelito



ESQUEMA MECÁNICO DEL POZO EX-3
(Convocada Cuenta-Almarama)

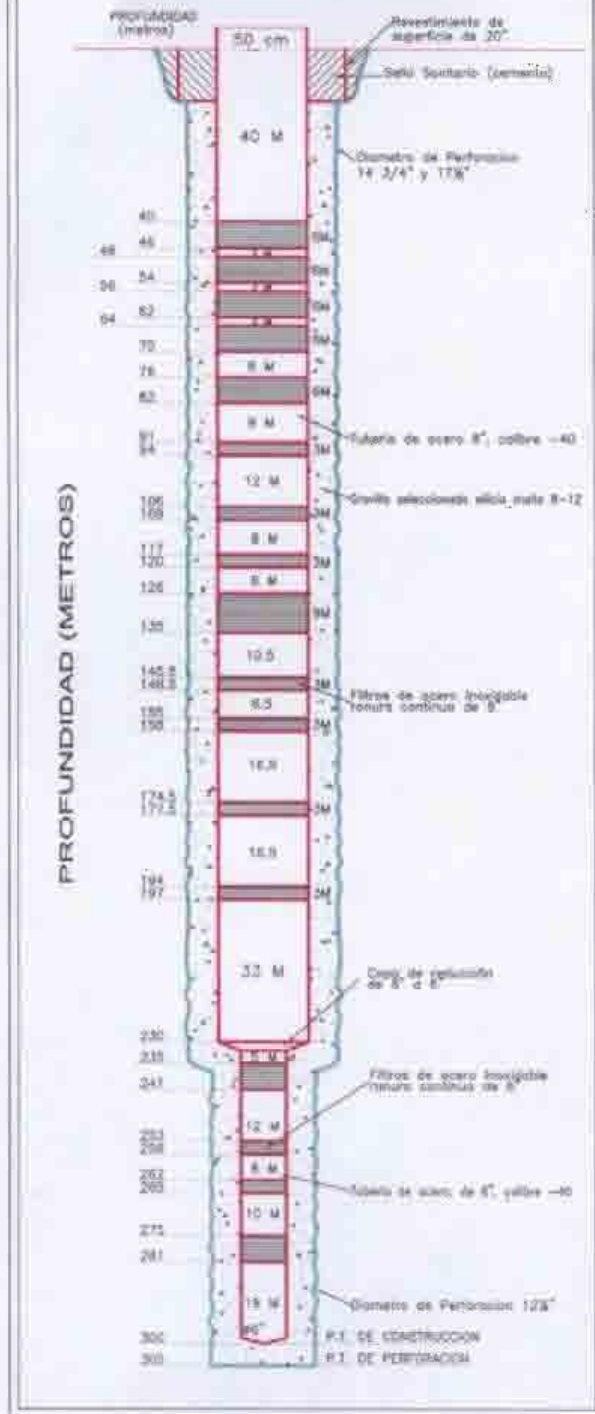
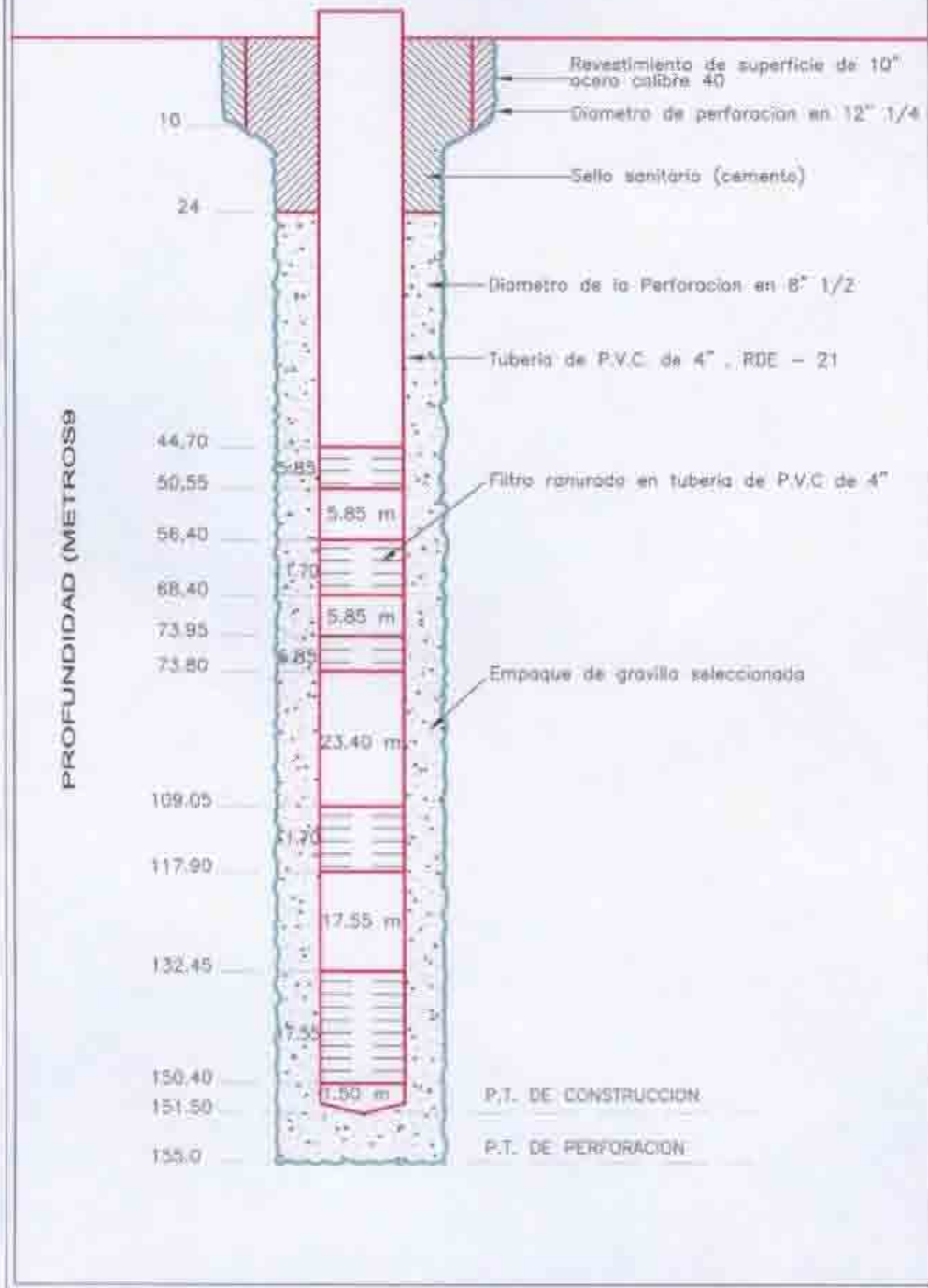


FIGURE - 5.30
ESTADO MECANICO DEL POZO EXPLORATORIO
EX-4 (EMBALSE - 1)



4. PUMPING TEST – CIUDAD BOLIVAR

4.1 CONTINUOUS AND STEP PUMPING TEST

In May 16 the hydraulic pumping test began with a pumping staggered with the purpose of determining the hydraulics constants of the aquifer and the depth of the pump to install. The total duration of each step was of 2 hours for a total of 3 steps and data were taken from recovery during 4 hours.

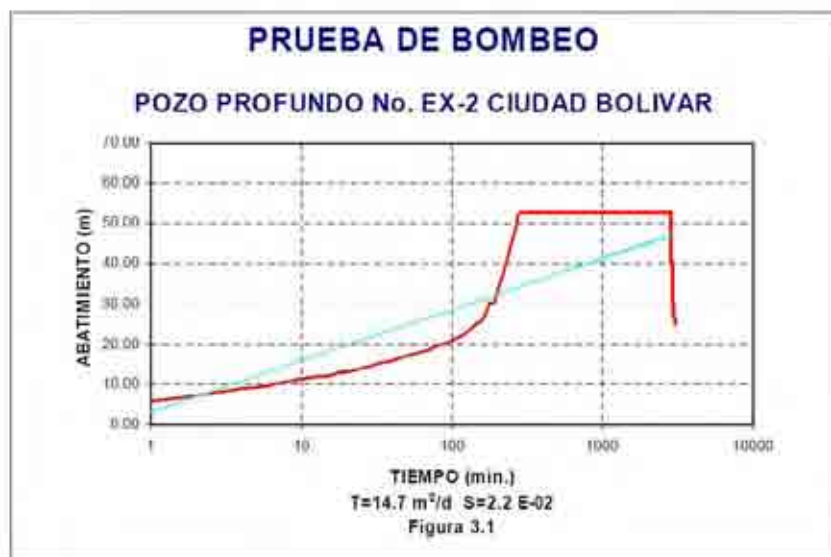
In May 17 the continuous pumping test was during 48 hours and took data from recovery during 24 hours. The data from these tests appear in the table No. 3.1.

4.2 INTERPRETATION

The total duration of the continuous test was of 2880 minutes (48 hours), time sufficient to determine with good trustworthiness the hydraulic parameters of the well and the aquifer.

For the interpretation of the test a generalized procedure was used that uses all the information available including pumping and recovery. Several analyses were made taking simultaneously single pumping or single recovery and both, dividing equally the results.

As it can be observed in the figure No. 3.1 an analysis was done of the test considering the diverse average volumes (including recovery), and fitting the curve with an average value obtaining like result the value of the hydraulic parameters.



RESULTS

Using special software that considers variable flow rates (including recovery) was obtained the following parameters:

Type of aquifer	Unconfined.
Considered Transmisividad:	T = 14.7 m ² /day
Coefficient of Storage	S = 2.2 x 10 ⁻⁰²
Capacity Specifies:	EC = 0.20 lps/mt
Effective Radio	R = 0.10 m (assumption according to the well diameter).

EQUATION OF BEHAVIOR OF THE WELL

Considering the parameters before exposed, the generalized equation of behavior of the well is determined:

$$n_d = n_e + BQ + CQ^n$$

in where:

$B = B(t, T, S, r)$: Pressure drops in the water-bearing one in the walls of the well

n_e = Static level (m)

n_d = Level of pumping (m)

Q = Of great volume of pumping (m^3/day)

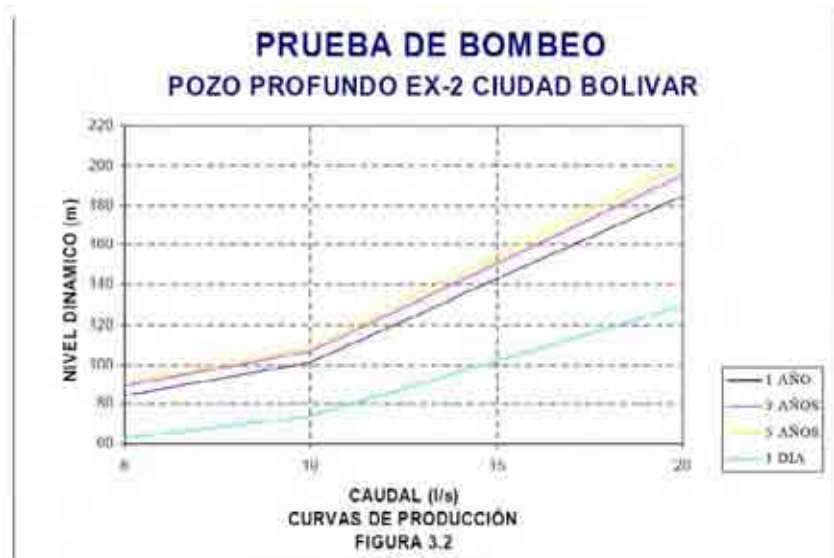
t = Time of pumping (days)

T = Transmisividad (m^2/day)

S = Coefficient of Storage (L°)

r = Radio of the well (m)

This equation of behavior of the well can be visualized in the graph of the figure No. 3.2.



PUMPING TEST DATAFIELD

Pumping Test: Continuous pumping

Project: EX-2 Well
(Ciudad Bolivar)

Flow rate measure: 55 gal
can

Measures: Pumping & Recovery

Pump type: Submersible
30 HP

TIME			DRAWDOWN		FLOW RATE		COMMENTS
(min)			Static Level (mts): 18.2				
<u>t (min)</u>	<u>t'(min)</u>	<u>t/t'</u>	Measure	s o s'(m)	m3/d	l/s	
0	-	-	18.20	0.00	-	-	-
1	-	-	24.09	5.89	1473	17.05	-
2	-	-	25.52	7.32	-	-	-
3	-	-	26.33	8.13	1463	16.93	-
4	-	-	27.02	8.82	-	-	-
5	-	-	27.53	9.33	-	-	-
6	-	-	28.01	9.81	-	-	-
7	-	-	28.43	10.23	-	-	-
8	-	-	28.77	10.57	-	-	-
9	-	-	29.11	10.91	-	-	-
10	-	-	29.42	11.22	1478	17.11	-
12	-	-	29.92	11.72	-	-	-
14	-	-	30.37	12.17	-	-	-
16	-	-	30.77	12.57	-	-	-
18	-	-	31.14	12.94	1426	16.51	-
20	-	-	31.46	13.26	-	-	-
22	-	-	31.76	13.56	-	-	-
24	-	-	32.11	13.91	-	-	-
26	-	-	32.39	14.19	-	-	-
28	-	-	32.65	14.45	1463	16.93	-
30	-	-	32.92	14.72	-	-	-
35	-	-	33.59	15.39	-	-	-
40	-	-	34.17	15.97	-	-	-
45	-	-	34.72	16.52	-	-	-
50	-	-	35.27	17.07	-	-	-
55	-	-	35.77	17.57	-	-	-
60	-	-	36.19	17.99	-	-	-
65	-	-	36.64	18.44	1394	16.14	-
70	-	-	36.96	18.76	-	-	-
75	-	-	37.37	19.17	-	-	-
80	-	-	37.70	19.50	-	-	-
85	-	-	38.10	19.90	-	-	-
90	-	-	38.45	20.25	-	-	-
95	-	-	38.71	20.51	-	-	-
100	-	-	39.17	20.97	1392	16.11	-
110	-	-	39.78	21.58	-	-	-
120	-	-	40.62	22.42	1382	16	-
130	-	-	41.49	23.29	-	-	-

TIME			DRAWDOWN		FLOW RATE		COMMENTS
(min)			Static Level (mts): 18.2				
t (min)	t'(min)	t/t'	Measure	s o s' (m)	m3/d	l/s	
140	-	-	42.57	24.37	-	-	-
150	-	-	43.59	25.39	1402	16.23	-
160	-	-	44.90	26.70	-	-	-
170	-	-	46.92	28.72	-	-	-
180	-	-	48.63	30.43	1363	15.77	-
190	-	-	48.50	30.30	-	-	-
200	-	-	50.65	32.45	1356	15.69	-
220	-	-	56.30	38.10	-	-	-
240	-	-	60.92	42.72	1279	14.8	-
260	-	-	66.24	48.04	1283	14.85	-
280	-	-	70.48	52.28	1289	14.92	-
300	-	-	70.90	52.70	1223	14.15	Gas Presence
320	-	-	70.90	52.70	1223	14.15	-
340	-	-	70.90	52.70	1208	13.98	-
360	-	-	70.90	52.70	1202	13.91	-
380	-	-	70.90	52.70	1165	13.48	-
400	-	-	70.90	52.70	1173	13.58	-
420	-	-	70.90	52.70	1159	13.42	-
440	-	-	70.90	52.70	1093	12.65	-
460	-	-	70.90	52.70	1123	13	-
480	-	-	70.90	52.70	1079	12.49	-
500	-	-	70.90	52.70	1058	12.25	-
530	-	-	70.90	52.70	1070	12.38	-
560	-	-	70.90	52.70	1064	12.31	-
590	-	-	70.90	52.70	1064	12.31	-
620	-	-	70.90	52.70	1064	12.31	-
650	-	-	70.90	52.70	969.4	11.22	-
680	-	-	70.90	52.70	947.8	10.97	-
710	-	-	70.90	52.70	953	11.03	-
740	-	-	70.90	52.70	898.6	10.4	-
770	-	-	70.90	52.70	909.8	10.53	-
800	-	-	70.90	52.70	902.9	10.45	-
830	-	-	70.90	52.70	877	10.15	-
860	-	-	70.90	52.70	866.6	10.03	-
890	-	-	70.90	52.70	862.3	9.98	-
920	-	-	70.90	52.70	834.6	9.66	-
950	-	-	70.90	52.70	830.3	9.61	-
980	-	-	70.90	52.70	823.4	9.53	-
1010	-	-	70.90	52.70	817.3	9.46	-
1040	-	-	70.90	52.70	807	9.34	-
1070	-	-	70.90	52.70	781.1	9.04	-
1100	-	-	70.90	52.70	745.6	8.63	-
1130	-	-	70.90	52.70	756.9	8.76	-
1160	-	-	70.90	52.70	745.6	8.63	-
1190	-	-	70.90	52.70	737	8.53	-
1220	-	-	70.90	52.70	777.6	9	-
1250	-	-	70.90	52.70	746.5	8.64	-
1280	-	-	70.90	52.70	763.8	8.84	-
1310	-	-	70.90	52.70	732.7	8.48	-
1340	-	-	70.90	52.70	781.1	9.04	-
1370	-	-	70.90	52.70	713.7	8.26	-
1400	-	-	70.90	52.70	692.9	8.02	-
1430	-	-	70.90	52.70	673.9	7.8	-
1460	-	-	70.90	52.70	641.1	7.42	-
1490	-	-	70.90	52.70	728.4	8.43	-

TIME			DRAWDOWN		FLOW RATE		COMMENTS
(min)			Static Level (mts): 18.2				
t (min)	t'(min)	t/t'	Measure	s o s'(m)	m3/d	l/s	
1510	-	-	70.90	52.70	715.4	8.28	-
1570	-	-	70.90	52.70	696.4	8.06	-
1630	-	-	70.90	52.70	676.5	7.83	-
1690	-	-	70.90	52.70	709.3	8.21	-
1750	-	-	70.90	52.70	662.7	7.67	-
1810	-	-	70.90	52.70	681.7	7.89	-
1870	-	-	70.90	52.70	661.8	7.66	-
1930	-	-	70.90	52.70	665.3	7.7	-
1990	-	-	70.90	52.70	649.7	7.52	-
2050	-	-	70.90	52.70	657.5	7.61	-
2110	-	-	70.90	52.70	645.4	7.47	-
2170	-	-	70.90	52.70	650.6	7.53	-
2230	-	-	70.90	52.70	632.4	7.32	-
2290	-	-	70.90	52.70	629	7.28	-
2350	-	-	70.90	52.70	627.3	7.26	-
2410	-	-	70.90	52.70	619.5	7.17	-
2470	-	-	70.90	52.70	617.8	7.15	-
2530	-	-	70.90	52.70	599.6	6.94	-
2590	-	-	70.90	52.70	606.5	7.02	-
2650	-	-	70.90	52.70	595.3	6.89	-
2710	-	-	70.90	52.70	582.3	6.74	-
2770	-	-	70.90	52.70	585.8	6.78	-
2830	-	-	70.90	52.70	572	6.62	-
2890	-	-	70.90	52.70	609.1	7.05	-
2891	1	-	-	69.40	51.20		RECOVERY
2892	2	-	-	65.47	47.27	-	-
2893	3	-	-	61.74	43.54	-	-
2894	4	-	-	60.49	42.29	-	-
2895	5	-	-	60.13	41.93	-	-
2896	6	-	-	59.45	41.25	-	-
2897	7	-	-	58.93	40.73	-	-
2898	8	-	-	58.40	40.20	-	-
2899	9	-	-	58.13	39.93	-	-
2900	10	-	-	57.70	39.50	-	-
2902	12	-	-	56.94	38.74	-	-
2904	14	-	-	56.25	38.05	-	-
2906	16	-	-	55.60	37.40	-	-
2908	18	-	-	54.90	36.70	-	-
2910	20	-	-	54.37	36.17	-	-
2912	22	-	-	53.98	35.78	-	-
2914	24	-	-	53.57	35.37	-	-
2916	26	-	-	53.25	35.05	-	-
2918	28	-	-	52.87	34.67	-	-
2920	30	-	-	52.55	34.35	-	-
2925	35	-	-	51.66	33.46	-	-
2930	40	-	-	56.85	38.65	-	-
2935	45	-	-	50.24	32.04	-	-
2940	50	-	-	49.64	31.44	-	-
2945	55	-	-	49.32	31.12	-	-
2950	60	-	-	48.75	30.55	-	-
2955	65	-	-	48.51	30.31	-	-
2960	70	-	-	48.05	29.85	-	-
2965	75	-	-	47.77	29.57	-	-
2970	80	-	-	47.31	29.11	-	-
2975	85	-	-	46.98	28.78	-	-
2980	90	-	-	46.73	28.53	-	-
2985	95	-	-	46.41	28.21	-	-
2990	100	-	-	46.18	27.98	-	-
3000	110	-	-	45.71	27.51	-	-
3010	120	-	-	45.27	27.07	-	-

TIME			DRAWDOWN		FLOW RATE		COMMENTS
(min)			Static Level (mts): 18.2				
t (min)	t'(min)	t/t'	Measure	s o s'(m)	m3/d	l/s	
3020	130	-	-	44.94	26.74	-	-
3030	140	-	-	44.51	26.31	-	-
3040	150	-	-	44.19	25.99	-	-
3050	160	-	-	43.97	25.77	-	-
3060	170	-	-	43.58	25.38	-	-
3070	180	-	-	43.30	25.10	-	-
3080	190	-	-	42.82	24.62	-	-
3090	200	-	-	42.61	24.41	-	-
3110	220	-	-	42.46	24.26	-	-
3130	240	-	-	42.16	23.96	-	-
3150	260	-	-	42.01	23.81	-	-
3170	280	-	-	41.75	23.55	-	-
3190	300	-	-	41.55	23.35	-	-
3210	320	-	-	41.31	23.11	-	-
3230	340	-	-	41.01	22.81	-	-
3250	360	-	-	40.90	22.70	-	-
3270	380	-	-	40.79	22.59	-	-
3290	400	-	-	40.70	22.50	-	-
3310	420	-	-	40.56	22.36	-	-
3330	440	-	-	40.36	22.16	-	-
3350	460	-	-	40.12	21.92	-	-
3370	480	-	-	40.07	21.87	-	-
3390	500	-	-	39.94	21.74	-	-
3420	530	-	-	39.86	21.66	-	-
3450	560	-	-	39.57	21.37	-	-
3480	590	-	-	39.44	21.24	-	-
3510	620	-	-	39.17	20.97	-	-
3540	650	-	-	39.00	20.80	-	-
3570	680	-	-	38.72	20.52	-	-
3600	710	-	-	38.56	20.36	-	-
3630	740	-	-	38.39	20.19	-	-
3660	770	-	-	38.18	19.98	-	-
3690	800	-	-	38.00	19.80	-	-
3720	830	-	-	37.79	19.59	-	-
3750	860	-	-	37.68	19.48	-	-
3780	890	-	-	37.39	19.19	-	-
3810	920	-	-	37.24	19.04	-	-
3840	950	-	-	37.07	18.87	-	-
3870	980	-	-	35.90	17.70	-	-
3900	1010	-	-	36.72	18.52	-	-
3930	1040	-	-	36.40	18.20	-	-
3960	1070	-	-	36.20	18.00	-	-
3990	1100	-	-	36.08	17.88	-	-
4020	1130	-	-	35.70	17.50	-	-
4050	1160	-	-	35.32	17.12	-	-
4080	1190	-	-	35.24	17.04	-	-
4110	1220	-	-	35.10	16.90	-	-
4140	1250	-	-	34.97	16.77	-	-
4170	1280	-	-	34.87	16.67	-	-
4200	1310	-	-	34.75	16.55	-	-
4230	1340	-	-	34.50	16.30	-	-
4260	1370	-	-	34.33	16.13	-	-
4290	1400	-	-	34.16	15.96	-	-
4320	1430	-	-	33.99	15.79	-	-
4350	1460	-	-	33.85	15.65	-	-

TIME			DRAWDOWN		FLOW RATE		COMMENTS
(min)			Static Level (mts): 18.2				
t (min)	t'(min)	t/t'	Measure	s o s'(m)	m3/d	l/s	
4380	1490	-	-	33.59	15.39	-	-
4410	1520	-	-	33.47	15.27	-	-
4440	1550	-	-	33.25	15.05	-	-
4470	1580	-	-	33.11	14.91	-	-
4500	1610	-	-	32.95	14.75	-	-
4530	1640	-	-	31.97	13.77	-	-
4590	1700	-	-	32.47	14.27	-	-
4650	1760	-	-	32.13	13.93	-	-
4710	1820	-	-	31.83	13.63	-	-
4770	1880	-	-	31.55	13.35	-	-
4830	1940	-	-	31.30	13.10	-	-
4890	2000	-	-	31.02	12.82	-	-
4950	2060	-	-	30.58	12.38	-	-
5010	2120	-	-	30.46	12.26	-	-
5070	2180	-	-	30.30	12.10	-	-
5670	2780	-	-	28.10	9.90	-	-

PUMPING TEST DATAFIELD

Pumping Test: Step Test

Project:EX-2 Well (Ciudad Bolivar)

Flow rate measure: 55 gal can

Measures: Pumping & Recovery

Pump type: Submersible 30 HP

TIME (min)			DRAWDOWN		FLOW RATE		COMMENTS
t (min)	t'(min)	t/t'	Static Level (mts):	19.90	m3/d	l/s	
			Measure	s o s'(m)			
0	-	-	19.90	0.00	-	-	-
1	-	-	23.52	3.62	-	-	-
2	-	-	23.94	4.04	-	-	-
3	-	-	24.62	4.72	-	-	-
4	-	-	25.20	5.30	-	-	-
5	-	-	25.90	6.00	994.5	11.51	-
6	-	-	26.28	6.38	-	-	-
7	-	-	26.33	6.43	-	-	-
8	-	-	26.41	6.51	-	-	-
9	-	-	26.52	6.62	-	-	-
10	-	-	26.64	6.74	972	11.25	-
12	-	-	26.90	7.00	-	-	-
14	-	-	27.07	7.17	-	-	-
16	-	-	27.29	7.39	-	-	-
18	-	-	27.41	7.51	-	-	-
20	-	-	27.59	7.69	979.8	11.34	-
22	-	-	27.76	7.86	-	-	-
24	-	-	27.90	8.00	-	-	-
26	-	-	28.06	8.16	964.2	11.16	-
28	-	-	28.26	8.36	-	-	-
30	-	-	28.37	8.47	967.7	11.2	-
35	-	-	28.56	8.66	-	-	-
40	-	-	28.74	8.84	966	11.18	-
45	-	-	28.92	9.02	-	-	-
50	-	-	29.09	9.19	967.7	11.2	-
55	-	-	29.24	9.34	-	-	-
60	-	-	29.40	9.50	966.8	11.19	-
65	-	-	29.60	9.70	-	-	-
70	-	-	29.85	9.95	967.7	11.2	-
75	-	-	30.00	10.10	-	-	-
80	-	-	30.15	10.25	968.5	11.21	-
85	-	-	30.29	10.39	-	-	-

TIME (min)			DRAWDOWN		FLOW RATE		COMMENTS
t (min)	t'(min)	t/t'	Static Level (mts):		m3/d	l/s	
			19.90	Measure			
90	-	-	30.34	10.44	963.4	11.15	-
95	-	-	30.50	10.60	-	-	-
100	-	-	30.60	10.70	966	11.18	-
110	-	-	30.80	10.90	-	-	-
120	-	-	30.99	11.09	964.2	11.16	-
121	-	-	32.00	12.10	1253	14.5	STEP 2
122	-	-	32.25	12.35	-	-	-
123	-	-	32.50	12.60	-	-	-
124	-	-	32.63	12.73	-	-	-
125	-	-	32.78	12.88	1253	14.5	-
126	-	-	32.91	13.01	-	-	-
127	-	-	33.07	13.17	-	-	-
128	-	-	33.19	13.29	-	-	-
129	-	-	33.30	13.40	-	-	-
130	-	-	33.42	13.52	1253	14.5	-
132	-	-	33.61	13.71	-	-	-
134	-	-	33.74	13.84	-	-	-
136	-	-	33.96	14.06	-	-	-
138	-	-	34.15	14.25	-	-	-
140	-	-	34.30	14.40	1244	14.4	-
142	-	-	34.41	14.51	-	-	-
144	-	-	34.55	14.65	-	-	-
146	-	-	34.67	14.77	-	-	-
148	-	-	34.79	14.89	-	-	-
150	-	-	34.89	14.99	1244	14.4	-
155	-	-	35.09	15.19	-	-	-
160	-	-	35.16	15.26	1242	14.38	-
165	-	-	35.34	15.44	-	-	-
170	-	-	35.54	15.64	1244	14.4	-
175	-	-	35.66	15.76	-	-	-
180	-	-	35.79	15.89	1240	14.35	-
185	-	-	35.91	16.01	-	-	-
190	-	-	36.02	16.12	1253	14.5	-
195	-	-	36.12	16.22	-	-	-
200	-	-	36.23	16.33	1244	14.4	-
205	-	-	36.32	16.42	-	-	-
210	-	-	36.42	16.52	1240	14.35	-
215	-	-	36.51	16.61	-	-	-
220	-	-	36.60	16.70	1240	14.35	-
230	-	-	36.81	16.91	-	-	-
240	-	-	36.97	17.07	1240	14.35	-
241	-	-	37.60	17.70	1443	16.7	STEP 3
242	-	-	37.77	17.87	-	-	-
243	-	-	37.92	18.02	-	-	-
244	-	-	38.04	18.14	-	-	-
245	-	-	38.18	18.28	1438	16.64	-
246	-	-	38.31	18.41	-	-	-
247	-	-	38.42	18.52	-	-	-
248	-	-	38.53	18.63	-	-	-
249	-	-	38.61	18.71	-	-	-
250	-	-	38.71	18.81	1434	16.6	-
252	-	-	38.82	18.92	-	-	-
254	-	-	38.92	19.02	-	-	-
256	-	-	39.01	19.11	1439	16.65	-
258	-	-	39.12	19.22	-	-	-
260	-	-	39.21	19.31	1442	16.69	-
262	-	-	39.29	19.39	-	-	-
264	-	-	39.38	19.48	1460	16.9	-
266	-	-	39.45	19.55	-	-	-
268	-	-	39.54	19.64	-	-	-
270	-	-	39.61	19.71	1449	16.77	-
275	-	-	39.76	19.86	-	-	-
280	-	-	39.89	19.99	1447	16.75	-
285	-	-	40.00	20.10	-	-	-
290	-	-	40.09	20.19	1446	16.74	-
295	-	-	40.14	20.24	-	-	-
300	-	-	40.20	20.30	1447	16.75	-
305	-	-	40.27	20.37	-	-	-
310	-	-	40.32	20.42	1444	16.71	-
315	-	-	40.38	20.48	-	-	-

TIME (min)			DRAWDOWN		FLOW RATE		COMMENTS
t (min)	t'(min)	t/t'	Static Level (mts):	19.90	m ³ /d	l/s	
			Measure	s o s'(m)			
320	-	-	40.40	20.50	1447	16.75	-
325	-	-	40.47	20.57	-	-	-
330	-	-	40.51	20.61	1446	16.74	-
335	-	-	40.56	20.66	-	-	-
340	-	-	40.60	20.70	1447	16.75	-
350	-	-	40.70	20.80	-	-	-
360	-	-	40.75	20.85	1448	16.76	-
361	1	-	32.23	12.33	-	-	RECOVERY
362	2	-	30.41	10.51	-	-	-
363	3	-	29.45	9.55	-	-	-
364	4	-	28.84	8.94	-	-	-
365	5	-	28.46	8.56	-	-	-
366	6	-	28.01	8.11	-	-	-
367	7	-	27.76	7.86	-	-	-
368	8	-	27.51	7.61	-	-	-
369	9	-	27.30	7.40	-	-	-
370	10	-	27.15	7.25	-	-	-
372	12	-	26.90	7.00	-	-	-
374	14	-	26.72	6.82	-	-	-
376	16	-	26.52	6.62	-	-	-
378	18	-	26.34	6.44	-	-	-
380	20	-	26.19	6.29	-	-	-
382	22	-	26.07	6.17	-	-	-
384	24	-	25.95	6.05	-	-	-
386	26	-	25.85	5.95	-	-	-
388	28	-	25.74	5.84	-	-	-
390	30	-	25.64	5.74	-	-	-
395	35	-	25.39	5.49	-	-	-
400	40	-	25.19	5.29	-	-	-
405	45	-	24.99	5.09	-	-	-
410	50	-	24.74	4.84	-	-	-
415	55	-	24.54	4.64	-	-	-
420	60	-	24.29	4.39	-	-	-
425	65	-	24.13	4.23	-	-	-
430	70	-	23.96	4.06	-	-	-
435	75	-	23.73	3.83	-	-	-
440	80	-	23.68	3.78	-	-	-
445	85	-	23.50	3.60	-	-	-
450	90	-	23.32	3.42	-	-	-
455	95	-	23.19	3.29	-	-	-
460	100	-	22.90	3.00	-	-	-
470	110	-	22.74	2.84	-	-	-
480	120	-	22.65	2.75	-	-	-
490	130	-	22.43	2.53	-	-	-
500	140	-	22.17	2.27	-	-	-
510	150	-	21.97	2.07	-	-	-
520	160	-	21.87	1.97	-	-	-
530	170	-	21.80	1.90	-	-	-
540	180	-	21.68	1.78	-	-	-
550	190	-	21.54	1.64	-	-	-
560	200	-	21.40	1.50	-	-	-
580	220	-	21.26	1.36	-	-	-
600	240	-	20.93	1.03	-	-	-
620	260	-	20.63	0.73	-	-	-

5. TEST OF PUMPING - USME

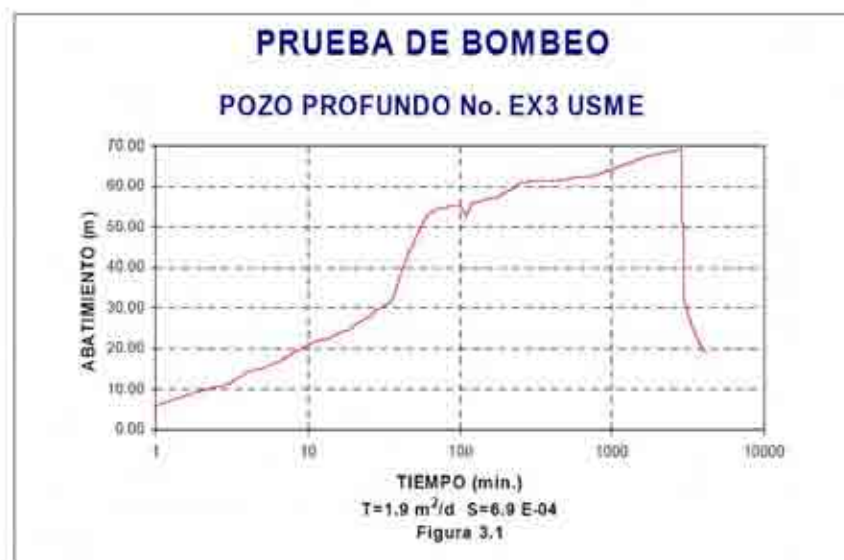
5.1. CONTINUOUS AND STEP PUMPING TEST

In May 9 the hydraulic pumping test began with a pumping staggered with the purpose of determining the hydraulics constants of the aquifer and the depth of the pump to install. The total duration of the pumping was of 48 hours and data were taken from recovery during 20 hours.

In May 12 the step test took place with three (3) stages of pumping with duration of 120 minutes settled down each one and finally the recovery during almost 15 hours (890 min). The data of this test appear in the table No. 3.1.

5.2. INTERPRETATION

The total duration of the continuous test was of 2880 minutes (48 hours), time sufficient to determine with good trustworthiness the hydraulic parameters of the well and aquifer without including the 1200 minutes of recovery. For the interpretation of the test a generalized procedure was used that uses all the information available including pumping and recovery. As it can be observed in the figure No. 3.1. an analysis was done of the test considering the diverse average volumes (including recovery), and fitting the curve with an average value obtaining like result the value of the hydraulic parameters.



RESULTS

Using special software that considers variable flow rates (including recovery) was obtained the following parameters:

Type of aquifer	Confined
Considered Transmisividad:	$T = 1.9 \text{ m}^2/\text{day}$
Coefficient of Storage	$S = 6.9 \times 10^{-04}$
Capacity Specifies:	$EC = 0.03 \text{ lps/mt}$
Effective radio	$R = 0,10\text{m}$ (assumption according to the well diameter).

EQUATION OF BEHAVIOR OF THE WELL

Considering the parameters before exposed, the generalized equation of behavior of the well is determined:

$$n_d = n_e + BQ + CQ^n$$

In where:

$B = B(t, T, S, r)$: Pressure drops in the water-bearing one in the walls of the well

n_e = static level (m)

n_d = Level of pumping (m)

Q = Of great volume of pumping (m^3/day)

t = Time of pumping (days)

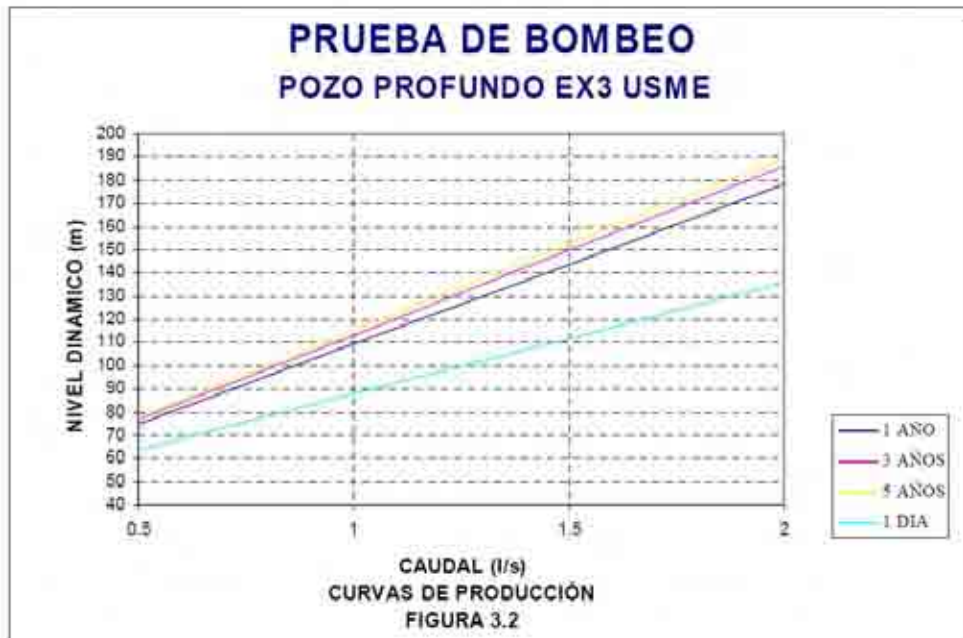
T = Transmisividad (m^2/day)

S = Coefficient of Storage (L°)

Effective r = Radio of the well (m)

This equation of behavior of the well can be visualized in the graph of the figure

No. 3.2.



PUMPING TEST DATAFIELD

Pumping Test: Step Test
 Flow rate measure: 55 gal can
 Pump type: Submersible 30 HP

Project:EX-3 Well (Usme)
 Measures: Pumping & Recovery

TIME (min)			DRAWDOWN		FLOW RATE		COMMENTS
t (min)	t'(min)	t/t'	Static Level (mts):	39.04	m3/d	l/s	
			Lectura	s o s'(m)			
0	-	-	39.04	-	-	-	-
1	-	-	40.10	-	-	-	-
2	-	-	40.92	40.61	0.47	-	-
3	-	-	40.69	-	-	-	-
4	-	-	40.78	-	-	-	-
5	-	-	40.87	-	-	-	-
6	-	-	40.90	-	-	-	-
7	-	-	41.00	-	-	-	-
8	-	-	41.03	40.61	0.47	-	-
9	-	-	41.07	-	-	-	-
10	-	-	41.12	-	-	-	-
12	-	-	41.21	-	-	-	-
14	-	-	41.40	-	-	-	-
16	-	-	41.43	-	-	-	-
18	-	-	41.47	-	-	-	-
20	-	-	41.54	-	-	-	-
22	-	-	41.60	-	-	-	-
24	-	-	41.66	-	-	-	-
26	-	-	41.72	-	-	-	-
28	-	-	41.80	-	-	-	-
30	-	-	41.87	-	-	-	-
35	-	-	41.96	-	-	-	-

TIME (min)			DRAWDOWN		FLOW RATE		COMMENTS
t (min)	t'(min)	t/t'	Static Level (mts):	39.04	m3/d	l/s	
40	-	-	42.10	-	-	-	-
45	-	-	42.18	-	-	-	-
50	-	-	42.26	-	-	-	-
55	-	-	42.32	-	-	-	-
60	-	-	42.37	-	-	-	-
65	-	-	42.44	-	-	-	-
70	-	-	42.50	-	-	-	-
75	-	-	42.58	-	-	-	-
80	-	-	42.61	-	-	-	-
85	-	-	42.67	-	-	-	-
90	-	-	42.70	-	-	-	-
95	-	-	42.72	-	-	-	-
100	-	-	42.83	-	-	-	-
105	-	-	42.89	-	-	-	-
110	-	-	42.93	-	-	-	-
115	-	-	42.97	-	-	-	-
120	-	-	43.02	-	-	-	-
-	-	-	-	-	-	-	-
121	-	-	43.41	-	-	-	STEP 2
122	-	-	43.80	82.47	0.9545	-	-
123	-	-	44.03	-	-	-	-
124	-	-	44.21	-	-	-	-
125	-	-	44.45	-	-	-	-
126	-	-	44.57	-	-	-	-
127	-	-	44.71	-	-	-	-
128	-	-	44.85	-	-	-	-
129	-	-	44.96	-	-	-	-
130	-	-	45.08	-	-	-	-
132	-	-	45.26	82.47	0.9545	-	-
134	-	-	45.42	-	-	-	-
136	-	-	45.61	-	-	-	-
138	-	-	45.76	-	-	-	-
140	-	-	45.97	-	-	-	-
142	-	-	46.14	-	-	-	-
144	-	-	46.22	-	-	-	-
146	-	-	46.30	-	-	-	-
148	-	-	46.41	-	-	-	-
150	-	-	46.56	-	-	-	-
155	-	-	46.78	-	-	-	-
160	-	-	47.02	-	-	-	-
165	-	-	47.23	-	-	-	-
170	-	-	47.39	-	-	-	-
175	-	-	47.48	-	-	-	-
180	-	-	47.61	-	-	-	-
185	-	-	47.75	-	-	-	-
190	-	-	47.91	-	-	-	-
195	-	-	48.00	-	-	-	-
200	-	-	48.10	-	-	-	-
205	-	-	48.26	-	-	-	-
210	-	-	48.33	-	-	-	-
215	-	-	48.47	-	-	-	-
220	-	-	48.56	-	-	-	-
225	-	-	-	-	-	-	-
230	-	-	48.71	-	-	-	-
235	-	-	-	-	-	-	-
240	-	-	48.87	-	-	-	-
-	-	-	-	-	-	-	-
241	-	-	47.28	-	-	-	STEP 3
242	-	-	48.06	-	-	-	-
243	-	-	48.83	-	-	-	-

TIME (min)			DRAWDOWN		FLOW RATE		COMMENTS
t (min)	t'(min)	t/t'	Static Level (mts):	39.04	m3/d	l/s	
244	-	-	Lectura	s o s'(m)			
244	-	-	50.49	-	-	-	-
245	-	-	50.79	121	1.4	-	-
246	-	-	51.02	-	-	-	-
247	-	-	51.21	-	-	-	-
248	-	-	51.42	-	-	-	-
249	-	-	51.57	-	-	-	-
250	-	-	51.69	-	-	-	-
252	-	-	52.11	-	-	-	-
254	-	-	52.28	-	-	-	-
256	-	-	52.49	-	-	-	-
258	-	-	52.68	-	-	-	-
260	-	-	52.87	-	-	-	-
262	-	-	53.06	-	-	-	-
264	-	-	53.27	-	-	-	-
266	-	-	53.45	-	-	-	-
268	-	-	53.62	-	-	-	-
270	-	-	53.72	-	-	-	-
275	-	-	54.18	-	-	-	-
280	-	-	54.45	-	-	-	-
285	-	-	54.66	-	-	-	-
290	-	-	54.92	121	1.4	-	-
295	-	-	55.11	-	-	-	-
300	-	-	55.34	-	-	-	-
305	-	-	55.61	-	-	-	-
310	-	-	55.75	-	-	-	-
315	-	-	56.06	-	-	-	-
320	-	-	56.23	-	-	-	-
325	-	-	56.34	-	-	-	-
330	-	-	56.53	-	-	-	-
335	-	-	56.65	-	-	-	-
340	-	-	56.74	-	-	-	-
345	-	-	-	-	-	-	-
350	-	-	57.00	-	-	-	-
355	-	-	-	-	-	-	-
360	-	-	57.29	-	-	-	-
-	-	-	-	-	-	-	-
361	1	-	54.71	-	-	-	RECOVERY
362	2	-	53.00	-	-	-	-
363	3	-	52.89	-	-	-	-
364	4	-	52.29	-	-	-	-
365	5	-	51.71	-	-	-	-
366	6	-	51.16	-	-	-	-
367	7	-	50.79	-	-	-	-
368	8	-	50.42	-	-	-	-
369	9	-	50.02	-	-	-	-
370	10	-	49.76	-	-	-	-
372	12	-	49.07	-	-	-	-
374	14	-	48.54	-	-	-	-
376	16	-	48.11	-	-	-	-
378	18	-	47.77	-	-	-	-

TIME (min)			DRAWDOWN		FLOW RATE		COMMENTS
t (min)	t'(min)	t/t'	Static Level (mts):	39.04	m3/d	l/s	
380	20	-	Lectura	s o s'(m)	-	-	-
382	22	-	47.49	-	-	-	-
384	24	-	47.23	-	-	-	-
386	26	-	47.00	-	-	-	-
388	28	-	46.80	-	-	-	-
390	30	-	46.62	-	-	-	-
395	35	-	46.47	-	-	-	-
400	40	-	46.19	-	-	-	-
405	45	-	45.80	-	-	-	-
410	50	-	45.62	-	-	-	-
415	55	-	45.27	-	-	-	-
420	60	-	45.03	-	-	-	-
425	65	-	44.82	-	-	-	-
430	70	-	44.63	-	-	-	-
435	75	-	44.45	-	-	-	-
440	80	-	44.26	-	-	-	-
445	85	-	44.06	-	-	-	-
450	90	-	43.92	-	-	-	-
455	95	-	43.78	-	-	-	-
460	100	-	43.61	-	-	-	-
470	110	-	43.42	-	-	-	-
480	120	-	43.29	-	-	-	-
490	130	-	43.05	-	-	-	-
500	140	-	42.85	-	-	-	-
510	150	-	42.69	-	-	-	-
520	160	-	42.48	-	-	-	-
530	170	-	42.32	-	-	-	-
540	180	-	42.17	-	-	-	-
550	190	-	42.02	-	-	-	-
560	200	-	41.80	-	-	-	-
580	220	-	41.68	-	-	-	-
600	240	-	41.50	-	-	-	-
620	260	-	41.29	-	-	-	-
640	280	-	41.05	-	-	-	-
660	300	-	40.87	-	-	-	-
680	320	-	40.70	-	-	-	-
700	340	-	40.52	-	-	-	-
720	360	-	40.33	-	-	-	-
740	380	-	40.18	-	-	-	-
760	400	-	40.03	-	-	-	-
780	420	-	39.92	-	-	-	-
800	440	-	39.78	-	-	-	-
820	460	-	39.64	-	-	-	-
840	480	-	39.53	-	-	-	-
860	500	-	39.38	-	-	-	-
890	530	-	39.29	-	-	-	-
920	560	-	39.15	-	-	-	-
950	590	-	39.00	-	-	-	-
980	620	-	38.83	-	-	-	-
1010	650	-	38.70	-	-	-	-
1040	680	-	38.54	-	-	-	-
1070	710	-	38.41	-	-	-	-
1100	740	-	38.30	-	-	-	-
1130	770	-	38.21	-	-	-	-
1160	800	-	38.00	-	-	-	-
1190	830	-	37.84	-	-	-	-
1220	860	-	37.73	-	-	-	-
1250	890	-	37.57	-	-	-	-
			37.42	-	-	-	-

PUMPING TEST DATAFIELD

Pumping Test: Continuous pumping
 Flow rate measure: 55 gal can
 Pump type: Submersible 10 HP

Project: EX-3 Well (Usme)
 Measures: Pumping & Recovery

TIME (min)			DRAWDOWN		FLOW RATE		COMMENTS
			Static Level (mts):	20.7			
t (min)	t'(min)	t/t'	Lectura	s o s'(m)	m3/d	l/s	
0	-	-	20.70	0.00	-	-	-
1	-	-	26.50	5.80	388.8	4.5	-
2	-	-	30.20	9.50	-	-	-
3	-	-	32.00	11.30	-	-	-
4	-	-	34.70	14.00	362.9	4.2	-
5	-	-	35.95	15.25	-	-	-
6	-	-	37.20	16.50	-	-	-
7	-	-	38.20	17.50	-	-	-
8	-	-	39.52	18.82	-	-	-
9	-	-	40.80	20.10	354.2	4.1	-
10	-	-	41.70	21.00	-	-	-
12	-	-	42.60	21.90	-	-	-
14	-	-	43.53	22.83	-	-	-
16	-	-	44.43	23.73	-	-	-
18	-	-	45.28	24.58	-	-	-
20	-	-	46.34	25.64	328.3	3.8	-
22	-	-	47.24	26.54	-	-	-
24	-	-	48.13	27.43	-	-	-
26	-	-	49.02	28.32	-	-	-
28	-	-	49.92	29.22	-	-	-
30	-	-	50.81	30.11	-	-	-
35	-	-	52.26	31.56	-	-	-
40	-	-	58.10	37.40	-	-	-
45	-	-	63.80	43.10	-	-	-
50	-	-	67.15	46.45	-	-	-
55	-	-	70.50	49.80	-	-	-
60	-	-	73.21	52.51	222	2.57	-
65	-	-	74.18	53.48	-	-	-
70	-	-	75.16	54.46	-	-	-
75	-	-	75.31	54.61	-	-	-
80	-	-	75.51	54.81	-	-	-
85	-	-	75.76	55.06	-	-	-
90	-	-	75.92	55.22	-	-	-
95	-	-	75.98	55.28	-	-	-
100	-	-	76.02	55.32	-	-	-
110	-	-	73.30	52.60	-	-	-
120	-	-	76.62	55.92	-	-	-
130	-	-	77.02	56.32	-	-	-
140	-	-	77.21	56.51	-	-	-
150	-	-	77.52	56.82	-	-	-
160	-	-	77.80	57.10	168.5	1.95	-
170	-	-	78.02	57.32	-	-	-
180	-	-	78.39	57.69	-	-	-
190	-	-	78.85	58.15	-	-	-

TIME (min)			DRAWDOWN		FLOW RATE		COMMENTS
t (min)	t'(min)	t/t'	Static Level (mts):	20.7	m3/d	l/s	
200	-	-	79.28	58.58	-	-	-
220	-	-	80.05	59.35	-	-	-
240	-	-	81.41	60.71	-	-	-
260	-	-	81.81	61.11	-	-	-
280	-	-	81.90	61.20	-	-	-
300	-	-	81.94	61.24	161.6	1.87	-
320	-	-	81.98	61.28	-	-	-
340	-	-	81.99	61.29	-	-	-
360	-	-	82.01	61.31	-	-	-
380	-	-	82.02	61.32	-	-	-
400	-	-	82.04	61.34	155.5	1.8	-
420	-	-	82.10	61.40	-	-	-
440	-	-	82.16	61.46	-	-	-
460	-	-	82.26	61.56	-	-	-
480	-	-	82.40	61.70	-	-	-
500	-	-	82.55	61.85	151.2	1.75	-
530	-	-	82.70	62.00	-	-	-
560	-	-	82.83	62.13	-	-	-
590	-	-	82.96	62.26	-	-	-
620	-	-	83.09	62.39	-	-	-
650	-	-	83.17	62.47	-	-	-
680	-	-	83.26	62.56	-	-	-
710	-	-	83.35	62.65	-	-	-
740	-	-	83.49	62.79	-	-	-
770	-	-	83.61	62.91	-	-	-
800	-	-	83.78	63.08	139.1	1.61	-
830	-	-	83.96	63.26	-	-	-
860	-	-	84.13	63.43	-	-	-
890	-	-	84.30	63.60	-	-	-
920	-	-	84.46	63.76	-	-	-
950	-	-	84.61	63.91	-	-	-
980	-	-	84.78	64.08	-	-	-
1010	-	-	84.93	64.23	-	-	-
1040	-	-	85.09	64.39	-	-	-
1070	-	-	85.26	64.56	-	-	-
1100	-	-	85.41	64.71	129.6	1.5	-
1130	-	-	85.56	64.86	-	-	-
1160	-	-	85.72	65.02	-	-	-
1190	-	-	85.89	65.19	-	-	-
1220	-	-	86.05	65.35	-	-	-
1250	-	-	86.22	65.52	-	-	-
1280	-	-	86.39	65.69	-	-	-
1310	-	-	86.55	65.85	116.6	1.35	-
1340	-	-	86.71	66.01	-	-	-
1370	-	-	86.86	66.16	-	-	-
1400	-	-	87.02	66.32	-	-	-
1430	-	-	87.19	66.49	-	-	-
1460	-	-	87.35	66.65	-	-	-
1490	-	-	87.51	66.81	-	-	-
1500	-	-	87.58	66.88	-	-	-
1560	-	-	87.75	67.05	-	-	-
1620	-	-	87.92	67.22	-	-	-
1680	-	-	88.08	67.38	-	-	-
1740	-	-	88.24	67.54	105.4	1.22	-
1800	-	-	88.38	67.68	-	-	-
1860	-	-	88.51	67.81	-	-	-
1920	-	-	88.64	67.94	-	-	-
1980	-	-	88.76	68.06	100.2	1.16	-

TIME (min)			DRAWDOWN		FLOW RATE		COMMENTS
t (min)	t'(min)	t/t'	Static Level (mts):	20.7	m3/d	l/s	
2040	-	-	88.87	68.17	-	-	-
2100	-	-	89.01	68.31	-	-	-
2160	-	-	89.11	68.41	-	-	-
2220	-	-	89.21	68.51	-	-	-
2280	-	-	89.30	68.60	-	-	-
2340	-	-	89.39	68.69	95.04	1.1	-
2400	-	-	89.48	68.78	-	-	-
2460	-	-	89.57	68.87	-	-	-
2520	-	-	89.66	68.96	95.04	1.1	-
2580	-	-	89.74	69.04	-	-	-
2640	-	-	89.82	69.12	95.04	1.1	-
2700	-	-	89.90	69.20	-	-	-
2760	-	-	89.98	69.28	95.04	1.1	-
2820	-	-	89.99	69.29	95.04	1.1	-
2880	-	-	90.00	69.30	-	-	-
2881	1	-	2,881.0 0	85.46	64.76	-	RECOVERY
2882	2	-	1,441.0 0	84.96	64.26	-	-
2883	3	-	961.00	83.95	63.25	-	-
2884	4	-	721.00	82.43	61.73	-	-
2885	5	-	577.00	81.86	61.16	-	-
2886	6	-	481.00	81.10	60.40	-	-
2887	7	-	412.43	80.08	59.38	-	-
2888	8	-	361.00	79.46	58.76	-	-
2889	9	-	321.00	78.51	57.81	-	-
2890	10	-	289.00	77.83	57.13	-	-
2892	12	-	241.00	75.95	55.25	-	-
2894	14	-	206.71	74.46	53.76	-	-
2896	16	-	181.00	72.82	52.12	-	-
2898	18	-	161.00	71.45	50.75	-	-
2900	20	-	145.00	69.87	49.17	-	-
2902	22	-	131.91	68.26	47.56	-	-
2904	24	-	121.00	66.40	45.70	-	-
2906	26	-	111.77	65.23	44.53	-	-
2908	28	-	103.86	63.88	43.18	-	-
2910	30	-	97.00	62.85	42.15	-	-
2915	35	-	83.29	60.53	39.83	-	-
2920	40	-	73.00	58.81	38.11	-	-
2925	45	-	65.00	57.32	36.62	-	-
2930	50	-	58.60	56.27	35.57	-	-
2935	55	-	53.36	55.20	34.50	-	-
2940	60	-	49.00	54.75	34.05	-	-
2945	65	-	45.31	54.13	33.43	-	-
2950	70	-	42.14	53.84	33.14	-	-
2955	75	-	39.40	53.56	32.86	-	-
2960	80	-	37.00	53.30	32.60	-	-
2965	85	-	34.88	53.09	32.39	-	-
2970	90	-	33.00	52.90	32.20	-	-
2975	95	-	31.32	52.70	32.00	-	-
2980	100	-	29.80	52.53	31.83	-	-
2990	110	-	27.18	52.20	31.50	-	-

TIME (min)			DRAWDOWN		FLOW RATE		COMMENTS
t (min)	t'(min)	t/t'	Static Level (mts):	20.7	m3/d	l/s	
3000	120	-	25.00	51.92	31.22	-	-
3010	130	-	23.15	51.73	31.03	-	-
3020	140	-	21.57	51.53	30.83	-	-
3030	150	-	20.20	51.37	30.67	-	-
3040	160	-	19.00	51.17	30.47	-	-
3050	170	-	17.94	50.98	30.28	-	-
3060	180	-	17.00	50.81	30.11	-	-
3070	190	-	16.16	50.47	29.77	-	-
3080	200	-	15.40	50.23	29.53	-	-
3100	220	-	14.09	50.07	29.37	-	-
3120	240	-	13.00	49.82	29.12	-	-
3140	260	-	12.08	49.56	28.86	-	-
3160	280	-	11.29	49.12	28.42	-	-
3180	300	-	10.60	48.82	28.12	-	-
3200	320	-	10.00	48.53	27.83	-	-
3220	340	-	9.47	48.22	27.52	-	-
3240	360	-	9.00	47.92	27.22	-	-
3260	380	-	8.58	47.63	26.93	-	-
3280	400	-	8.20	47.34	26.64	-	-
3300	420	-	7.86	47.05	26.35	-	-
3320	440	-	7.55	46.75	26.05	-	-
3340	460	-	7.26	46.46	25.76	-	-
3360	480	-	7.00	-20.70		-	-
3380	500	-	6.76	45.88	25.18	-	-
3390	510	-	6.65	-20.70		-	-
3420	540	-	6.33	45.29	24.59	-	-
3450	570	-	6.05	45.00	24.30	-	-
3480	600	-	5.80	44.71	24.01	-	-
3510	630	-	5.57	44.42	23.72	-	-
3540	660	-	5.36	44.14	23.44	-	-
3570	690	-	5.17	43.85	23.15	-	-
3600	720	-	5.00	43.55	22.85	-	-
3630	750	-	4.84	43.25	22.55	-	-
3660	780	-	4.69	42.96	22.26	-	-
3690	810	-	4.56	42.69	21.99	-	-
3720	840	-	4.43	42.43	21.73	-	-
3750	870	-	4.31	42.21	21.51	-	-
3780	900	-	4.20	42.09	21.39	-	-
3810	930	-	4.10	41.79	21.09	-	-
3840	960	-	4.00	41.49	20.79	-	-
3870	990	-	3.91	41.20	20.50	-	-
3900	1020	-	3.82	40.91	20.21	-	-
3930	1050	-	3.74	40.62	19.92	-	-
3960	1080	-	3.67	40.35	19.65	-	-
3990	1110	-	3.59	40.20	19.50	-	-
4020	1140	-	3.53	40.09	19.39	-	-
4050	1170	-	3.46	40.04	19.34	-	-
4080	1200	-	3.40	40.01	19.31	-	-

6. PUMPING TEST - QUATERNARY

6.1. CONTINUOUS AND STEP PUMPING TEST

The hydraulic pumping test began with a pumping staggered with the purpose of determining the hydraulics constants of the aquifer and the depth of the pump to install. The total duration of each step was of 17 hours and data were taken from recovery during 1 hour. The data from these tests appear in the table No. 3.1.

6.2. INTERPRETATION.

The total duration of the continuous test was of 1020 minutes (17 hours), time sufficient to determine with good trustworthiness the hydraulic parameters of the well and the aquifer.

For the interpretation of the test a generalized procedure was used that uses all the information available including pumping and recovery.

As it can be observed in the figure No. 3.1 an analysis was done of the test considering the diverse average volumes (including recovery), and fitting curve with an average value obtaining like result the value of the hydraulic parameters.



RESULTS

Using special software that considers variable flow rates (including recovery) was obtained the following parameters:

Type of aquifer	Unconfined.
Considered Transmisividad:	$T = 2783 \text{ m}^2/\text{day}$
Coefficient of Storage	$S = 4.2 \times 10^{-03}$
Capacity Specifics:	$EC = 0.25 \text{ lps/mt}$
Effective Radio	$R = 0.0508 \text{ m}$ (assumption according to the well diameter).

PUMPING TEST DATAFIELD

Pumping Test: Continuous pumping
 Flow rate measure: 55 gal can
 Pump type: Submersible 5 HP

Project: Quaternary Well (Tunjuelito)
 Measures: Pumping & Recovery

TIME (min)			DRAWDOWN		FLOW RATE		COMMENTS
t (min)	t'(min)	t/t'	Static Level (mts):	25,23			
			Lectura	s o s'(m)	m3/d	l/s	
0			25,23	0			
0,5			29,04	3,81			
1			30	4,77			
2			34,7	9,47			
4			32,25	7,02			
4,5			32,2	6,97			
5			32,24	7,01			
6			32,29	7,06			
7			32,3	7,07			
8			32,32	7,09			
9			32,34	7,11			
10			32,37	7,14			
12			32,42	7,19			
14			32,43	7,2			
16			32,43	7,2			
18			32,43	7,2			
20			32,43	7,2	145,8	1,69	
25			32,4	7,17			
30			32,39	7,16	158,1	1,83	
35			32,4	7,17			
40			32,37	7,14	152,2	1,76	
45			32,38	7,15			
50			32,38	7,15			
60			32,35	7,12	161	1,86	
70			32,38	7,15			
80			32,34	7,11			
90			32,34	7,11			
100			32,36	7,13	141,3	1,64	
120			32,37	7,14			
140			32,33	7,1			
160			32,31	7,08			
180			32,32	7,09			
210			32,33	7,1	164,1	1,9	

TIME (min)			DRAWDOWN		FLOW RATE		COMMENTS
t (min)	t'(min)	t/t'	Static Level (mts):	25,23			
			Lectura	s o s'(m)	m3/d	l/s	
240			32,33	7,1			
270			32,34	7,11			
300			32,35	7,12	156,4	1,81	
330			32,34	7,11			
360			32,34	7,11			
390			32,33	7,1			
420			32,31	7,08			
480			32,32	7,09	146,1	1,69	
540			32,32	7,09			
600			32,32	7,09			
650			32,33	7,1			
720			32,32	7,09			
780			32,32	7,09			
840			32,33	7,1	147,4	1,71	
900			32,31	7,08			
960			32,3	7,07	147,9	1,71	
1020			32,3	7,07			
1020,5			0,5	2.041,00	28,56	3,33	RECOVERY
1021			1	1.021,00	26,41	1,18	
1021,5			1,5	681	26,32	1,09	
1022			2	511	26,29	1,06	
1022,5			2,5	409	26,24	1,01	
1023			3	341	26,19	0,96	
1023,5			3,5	292,43	26,18	0,95	
1024			4	256	26,16	0,93	
1024,5			4,5	227,67	26,14	0,91	
1025			5	205	26,12	0,89	
1026			6	171	26,1	0,87	
1027			7	146,71	26,08	0,85	
1028			8	128,5	26,06	0,83	
1029			9	114,33	26,04	0,81	
1030			10	103	26,03	0,8	
1032			12	86	26,01	0,78	
1034			14	73,86	25,99	0,76	
1036			16	64,75	25,97	0,74	
1038			18	57,67	25,96	0,73	
1040			20	52	25,94	0,71	
1045			25	41,8	25,92	0,69	
1050			30	35	25,91	0,68	
1055			35	30,14	25,9	0,67	
1060			40	26,5	25,9	0,67	
1065			45	23,67	25,89	0,66	
1070			50	21,4	25,88	0,65	
1080			60	18	25,88	0,65	

WELL LOGGING – Ciudad Bolivar



CASING INSTALLATION – Ciudad Bolivar

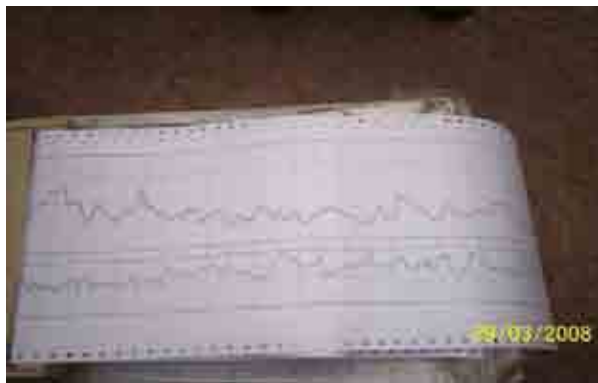




PUMPING TEST – Ciudad Bolivar



WELL LOGGING - Usme



CANSING INSTALLATION - Usme





PUMPING TEST - Usme



