社会開発調査部報告書
JAPAN INTERNATIONAL COOPERATION AGENCY(JICA)
FEDERAL DEMOCRATIC REPUBLIC OF ETHIOPIA
MINISTRY OF WATER RESOURCES

THE STUDY
ON
ELEVEN CENTERS WATER SUPPLY AND SANITATION
IN
FEDERAL DEMOCRATIC REPUBLIC OF ETHIOPIA

APPENDIXES
BURE

(Volume III-IX)

FEBRUARY, 1996

SANYU CONSULTANTS INC.
KYOWA ENGINEERING CONSULTANTS CO., LTD.

GOVERNMENT OF JAPAN
JAPAN INTERNATIONAL COOPERATION AGENCY(JICA)
FEDERAL DEMOCRATIC REPUBLIC OF ETHIOPIA
MINISTRY OF WATER RESOURCES

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PREFACE

This is the Appendixes for Bure presenting the results of the Study on Eleven Centers Water Supply and Sanitation (the Study) carried out in accordance with the Scope of Work agreed upon between the Government of Federal Democratic Republic of Ethiopia (GOE) through the Water Supply and Sewerage Agency (WSSA) of the Ministry of Natural Resources Development and Environmental Protection (MNRDEP), which was recently reorganized Water Supply and Sewerage Service Department (WSSD) under Ministry of Water Resources (MWR), on the one part and the Government of Japan (GOJ) through the Japan International Cooperation Agency (JICA) on the other part dated April 8, 1994.

The major objectives of this Study are 1) to conduct a feasibility study on the water supply system in order to improve living condition of the population in the Study area by enhancing the level of the water supply services in terms of water quantity, water quality and its accessibility, 2) to formulate a plan for sanitary education and the diffusion of sanitary facilities in order to raise peoples' awareness on hygiene and improve environmental sanitation, which will be able to prevent the contamination of water source(s) and to secure safe water supply, and 3) to transfer technologies to the Ethiopian counterpart personnel in order to strengthen the managerial aspects of water supply services.

The Study had been conducted over a two (2) Japanese fiscal year-period from 1994/95 to 1995/96 and divided into two (2) phases. The Phase I study was conducted between December 1994 and March 1995, and Phase II was conducted between May 1995 and February 1996, for a total study period of 15 months during which three (3) times of visit to Ethiopia were made.

The survey items and major activities are meteo-hydrological survey, geo-electric prospecting (GEP) survey, water quality, water use condition, sanitary and health condition and people's awareness, social background, socio-economy, initial environmental examination (IEE), environmental impact assessment (EIA), sanitary education practice, and existing pump investigation.

The Study Team extends heartiest thanks to WSSD especially those assigned counterparts for their close cooperation and hard work in both office and the field, and the officers of related agencies of Japan.

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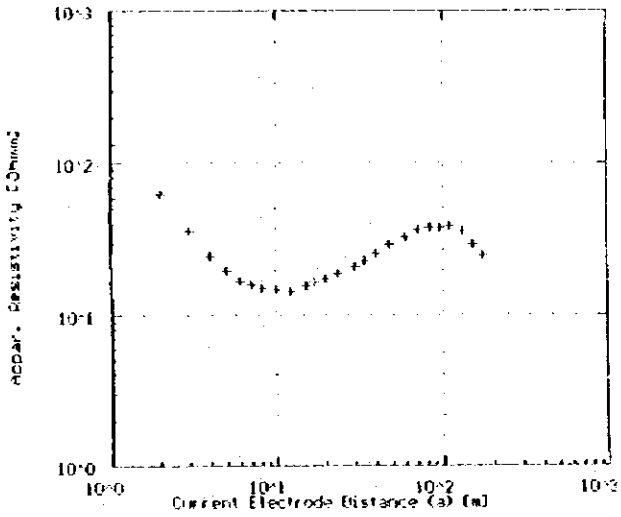
Appendix - 1

Resistivity Interpretation of VEP

Figure 1 Geoelectrical Survey, Wenner Array

VES St. No.1 -BURE

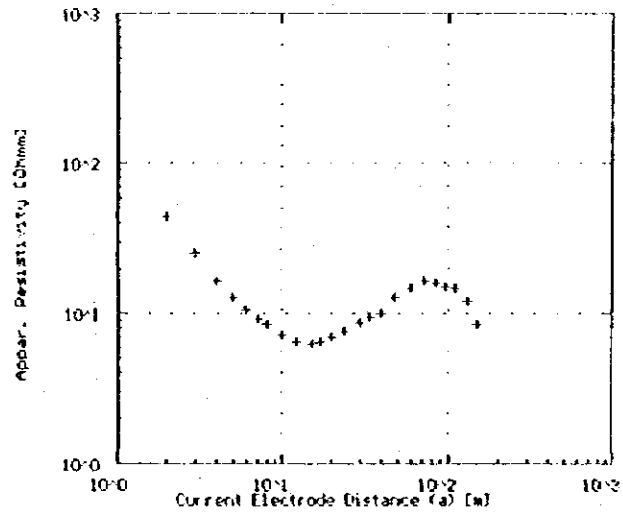


Specific Resistivity(Ω-m)	122	13.56	74	13.27

50.25

Point (N°)	MN/2 (Nr)	a (m)	(ohm)
1	1.00	122.570	
2	2.00	52.833	
3	3.00	35.800	
4	4.00	26.670	
5	5.00	20.100	
6	6.00	16.083	
7	7.00	13.020	
8	8.00	10.870	
9	10.00	8.100	
10	12.00	6.267	
11	15.00	4.560	
12	17.00	3.550	
13	20.00	2.660	
14	24.00	1.920	
15	30.00	1.350	
16	34.00	1.050	
17	40.00	0.870	
18	48.00	0.780	
19	60.00	0.780	
20	72.00	0.870	
21	84.00	0.960	
22	96.00	1.080	
23	110.00	1.260	
24	130.00	1.410	
25	150.00	1.200	
26	170.00	1.050	

VES St. No.2 -BURE

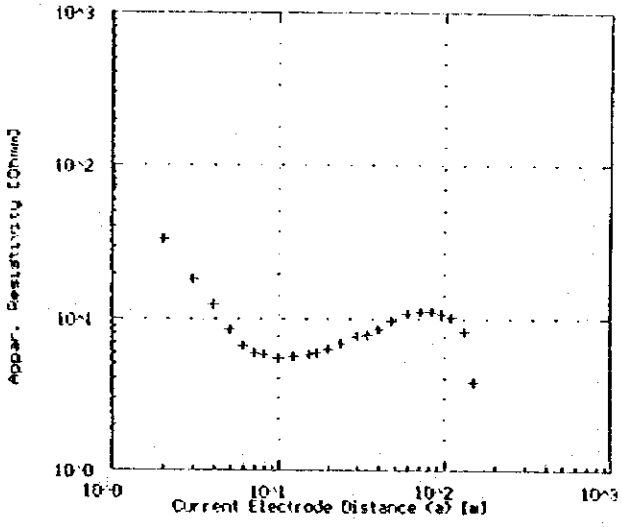


Specific Resistivity(Ω-m)	68	34	7.5	5	28.5	5.63

85.4 40.2

Point (Nr)	MN/2 (Nr)	a (m)	(ohm)
1	1.00	52.150	
2	2.00	33.950	
3	3.00	25.000	
4	4.00	18.650	
5	5.00	12.370	
6	6.00	10.700	
7	7.00	9.100	
8	8.00	8.530	
9	10.00	7.160	
10	12.00	6.490	
11	15.00	6.220	
12	17.00	6.510	
13	20.00	6.910	
14	24.00	7.560	
15	30.00	8.610	
16	34.00	9.500	
17	40.00	10.050	
18	48.00	12.550	
19	60.00	16.700	
20	72.00	16.280	
21	84.00	15.830	
22	96.00	15.020	
23	110.00	14.510	
24	130.00	12.250	
25	150.00	8.600	

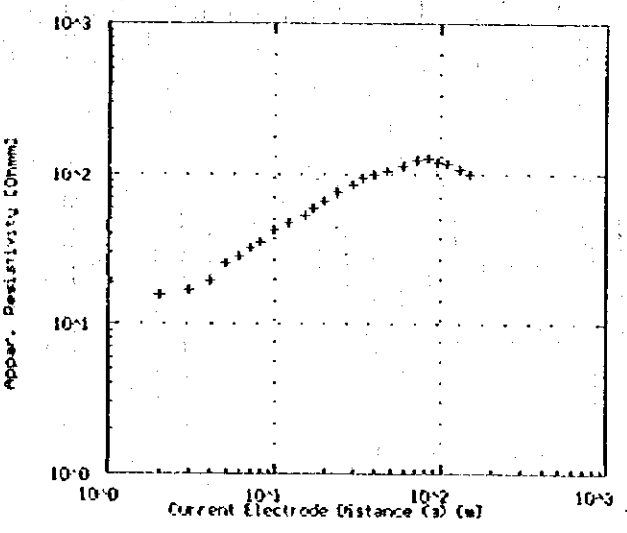
VES St. No.3 -BURE



Point (No)	MN/2 (Mr)	a (m)	Res (ohms)
1	1.00	76.730	
2	2.00	33.203	
3	3.00	18.090	
4	4.00	12.569	
5	5.00	8.000	
6	6.00	6.610	
7	7.00	5.960	
8	9.00	5.730	
9	10.00	5.530	
10	12.00	5.650	
11	15.00	5.350	
12	17.00	5.988	
13	20.00	6.280	
14	24.00	6.730	
15	30.00	7.540	
16	34.00	7.930	
17	40.00	8.540	
18	48.00	9.650	
19	60.00	10.930	
20	72.00	11.300	
21	86.00	11.000	
22	96.00	10.059	
23	110.00	10.360	
24	139.00	8.150	
25	150.00	3.790	

Specific Resistivity(Ω-m)	82	8.2	1.75	6.2	19.2	22	11	3.67

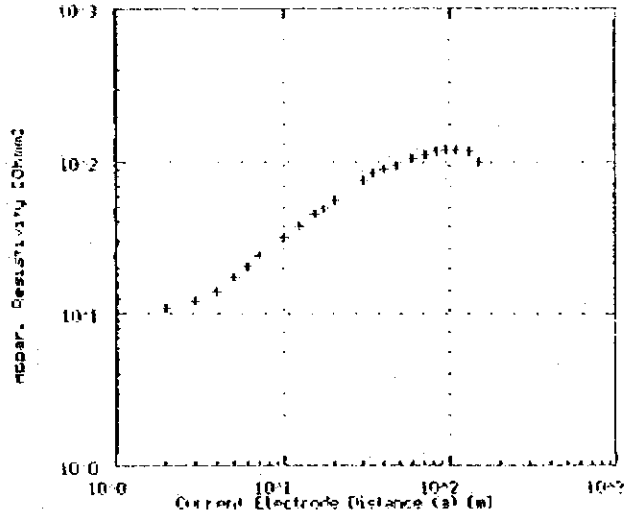
VES St. No.4 -BURE



Point (No)	MN/2 (Mr)	a (m)	Res (ohms)
1	1.00	10.840	
2	2.00	15.458	
3	3.00	16.220	
4	4.00	19.340	
5	5.00	25.120	
6	6.00	28.050	
7	7.00	32.530	
8	8.00	36.920	
9	10.00	43.230	
10	12.00	48.230	
11	15.00	53.690	
12	17.00	58.250	
13	20.00	66.570	
14	24.00	75.510	
15	30.00	85.220	
16	34.00	93.950	
17	40.00	100.480	
18	48.00	105.500	
19	60.00	110.920	
20	72.00	124.000	
21	86.00	120.095	
22	96.00	122.393	
23	110.00	117.440	
24	130.00	109.400	
25	150.00	100.790	

Specific Resistivity(Ω-m)	20.5	10.25	129	232	183.75

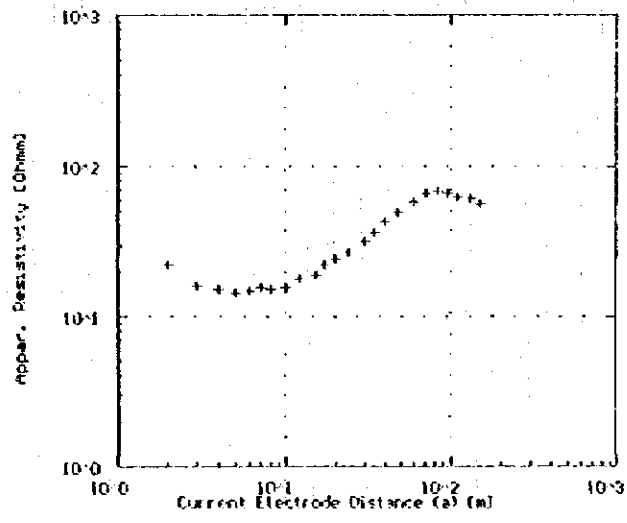
VES St. No.5 -BURE



Point [No]	AB/2 [m]	a [m]	Res [ohm]
1	1.00	12.500	
2	2.00	10.000	
3	3.00	12.050	
4	4.00	13.370	
5	5.00	12.220	
6	6.00	20.350	
7	7.00	23.740	
8	10.00	21.830	
9	12.00	32.350	
10	15.00	45.220	
11	17.00	49.110	
12	20.00	55.520	
13	30.00	78.202	
14	35.00	94.360	
15	40.00	78.450	
16	50.00	92.650	
17	60.00	105.500	
18	72.30	112.591	
19	85.00	107.660	
20	95.00	111.120	
21	110.00	120.990	
22	130.00	111.550	
23	150.00	91.510	

Specific Resistivity(Ω-m)	13.2	8.8	192	216	110

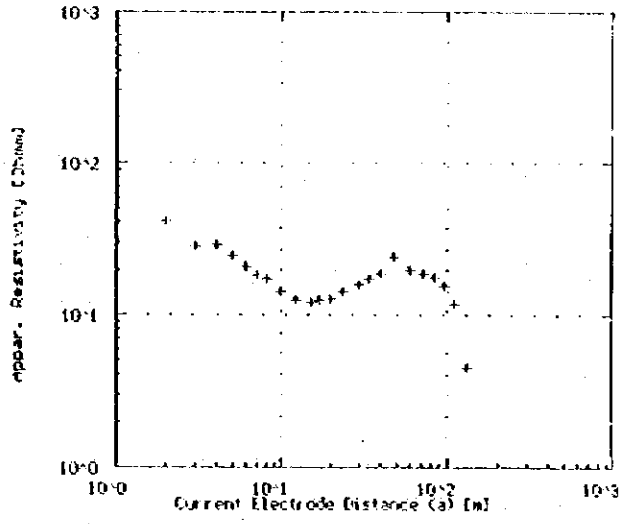
VES St. No.6 -BURE



Point [No]	AB/2 [m]	a [m]	Res [ohm]
1	1.00	20.000	
2	2.00	22.040	
3	3.00	16.110	
4	4.00	15.070	
5	5.00	14.130	
6	6.00	14.300	
7	7.00	15.390	
8	8.00	15.070	
9	10.00	15.040	
10	12.00	17.030	
11	15.00	18.060	
12	17.00	21.991	
13	20.00	23.970	
14	24.00	26.950	
15	30.00	32.030	
16	36.00	38.590	
17	40.00	42.200	
18	48.00	49.530	
19	50.00	50.030	
20	72.00	65.510	
21	84.00	66.580	
22	96.00	65.310	
23	110.00	62.020	
24	130.00	61.230	
25	150.00	56.520	

Specific Resistivity(Ω-m)	41	13.67	15	225	135

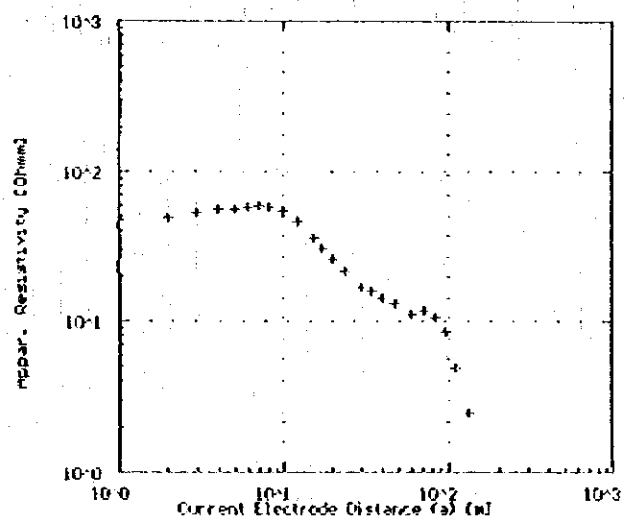
VES St. No.7 -BURE



Point (No.)	MN/2 (m)	a (m)	Res (ohm)
1	1.00	47.000	
2	2.00	41.550	
3	3.00	38.170	
4	4.00	33.590	
5	5.00	26.810	
6	6.00	24.100	
7	7.00	18.460	
8	8.00	17.930	
9	10.00	14.640	
10	12.00	12.530	
11	15.00	11.950	
12	17.00	12.300	
13	20.00	12.690	
14	24.00	14.390	
15	30.00	18.010	
16	36.00	17.510	
17	40.00	18.550	
18	48.00	26.120	
19	60.00	28.590	
20	72.00	18.540	
21	84.00	12.950	
22	96.00	15.270	
23	110.00	11.760	
24	130.00	6.690	

Specific Resistivity(Ω-m)	47	23.5	8.47	31.5	24.3	6.91

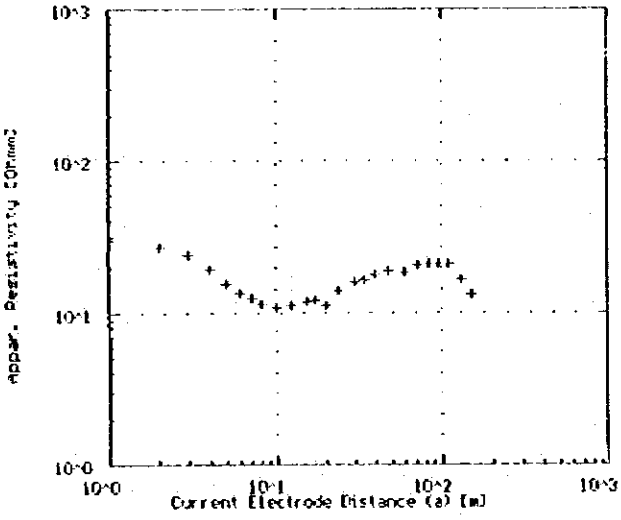
VES St. No.8 -BURE



Point (No.)	MN/2 (m)	a (m)	Res (ohm)
1	1.00	47.730	
2	2.00	48.930	
3	3.00	53.510	
4	4.00	56.270	
5	5.00	56.520	
6	6.00	55.100	
7	7.00	50.910	
8	9.00	53.730	
9	10.00	55.010	
10	12.00	45.020	
11	15.00	35.000	
12	17.00	31.070	
13	20.00	26.360	
14	24.00	21.600	
15	30.00	16.050	
16	36.00	15.010	
17	40.00	14.020	
18	48.00	13.260	
19	60.00	10.200	
20	72.00	11.160	
21	84.00	10.550	
22	96.00	9.630	
23	110.00	6.040	
24	130.00	2.450	

Specific Resistivity(Ω-m)	42	63	9.68	1.57

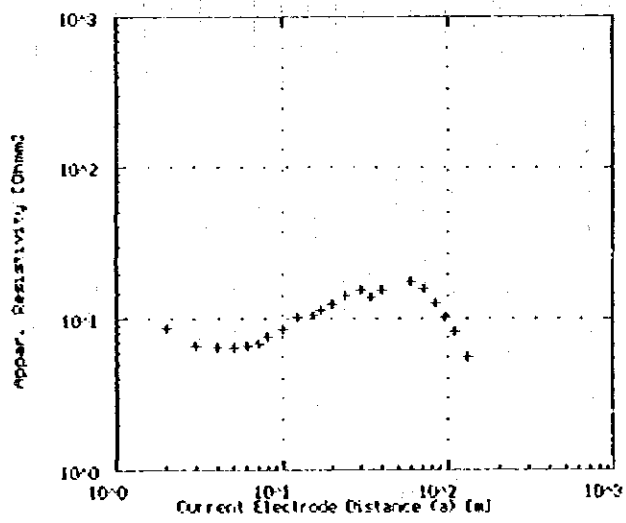
VES St. No.9 -BURE



Point (No)	AB/2 (Hr)	a (m)	Rat (ohm)
1	1.00	32.030	
2	2.00	27.000	
3	3.00	26.120	
4	4.00	19.090	
5	5.00	15.700	
6	6.00	13.519	
7	7.00	12.570	
8	8.00	11.569	
9	10.00	10.869	
10	12.00	11.090	
11	15.00	11.780	
12	17.00	12.139	
13	20.00	11.300	
14	24.00	13.320	
15	30.00	15.030	
16	36.00	16.650	
17	40.00	17.580	
18	45.00	18.090	
19	60.00	18.480	
20	72.00	20.350	
21	80.00	21.500	
22	95.00	21.390	
23	110.00	20.220	
24	130.00	15.330	
25	150.00	13.190	

Specific Resistivity(Ω-m)	33	22	8.13	24.2	7.8

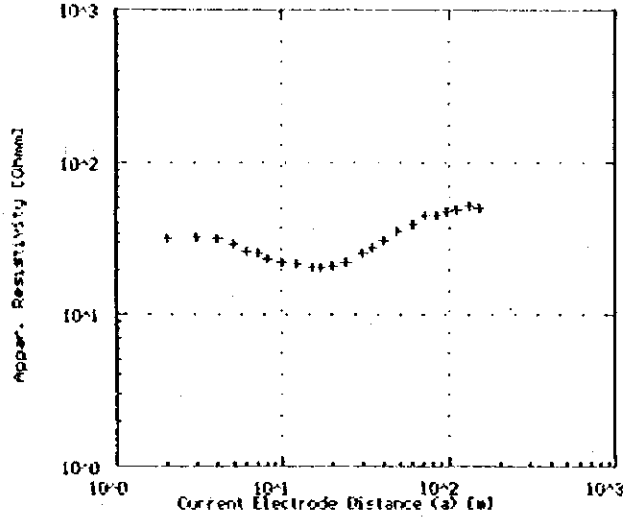
VES St. No.10 -BURE



Point (No)	AB/2 (Hr)	a (m)	Rat (ohm)
1	1.00	16.510	
2	2.00	9.670	
3	3.00	6.590	
4	4.00	6.460	
5	5.00	6.440	
6	6.00	6.550	
7	7.00	6.860	
8	8.00	7.680	
9	10.00	8.590	
10	12.00	10.370	
11	15.00	10.660	
12	17.00	11.630	
13	20.00	12.350	
14	24.00	14.320	
15	30.00	15.590	
16	36.00	17.020	
17	40.00	15.310	
18	50.00	17.630	
19	72.00	15.830	
20	81.00	12.660	
21	95.00	10.360	
22	110.00	9.160	
23	130.00	5.650	

Specific Resistivity(Ω-m)	21	6	9	21.6	2.63

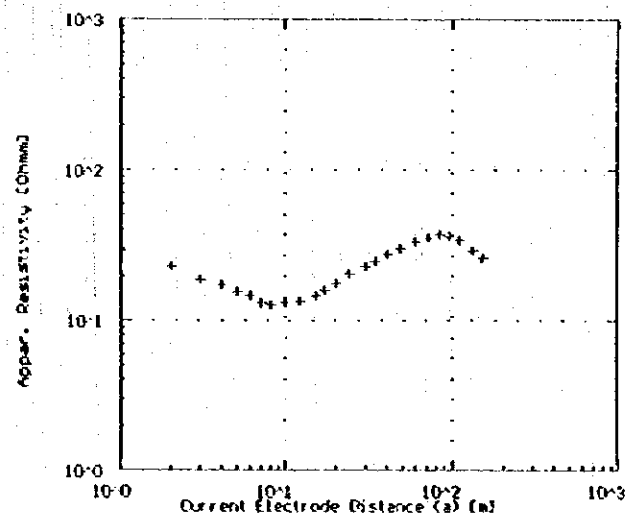
VES St. No.11 -BURE



Point [No]	AN/2 [Mr]	a [m]	Res [ohmm]
1	1.00	31.230	
2	2.00	31.190	
3	3.00	32.010	
4	4.00	31.600	
5	5.00	29.520	
6	6.00	26.880	
7	7.00	25.060	
8	8.00	23.610	
9	10.00	21.980	
10	12.00	20.530	
11	15.00	20.560	
12	17.00	20.200	
13	20.00	20.720	
14	24.00	22.010	
15	30.00	25.430	
16	34.00	27.760	
17	40.00	30.900	
18	48.00	34.910	
19	60.00	39.580	
20	72.00	44.760	
21	84.00	45.370	
22	96.00	48.230	
23	110.00	49.050	
24	130.00	52.250	
25	150.00	50.870	

Specific Resistivity(Ω-m)	46	30.67	13.5	28.2	63

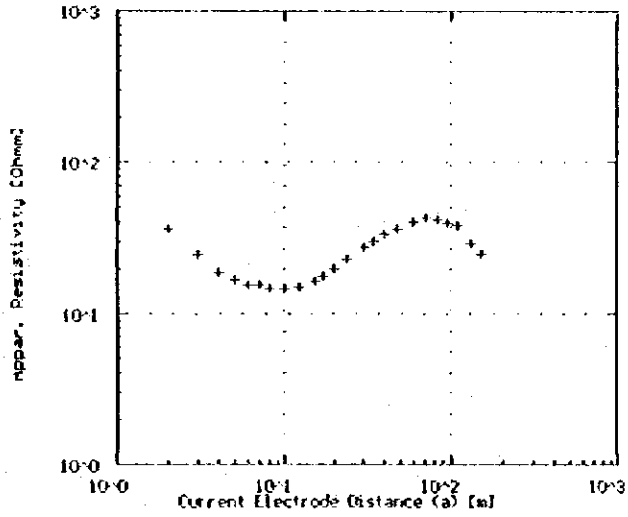
VES St. No.12 -BURE



Point [No]	AN/2 [Mr]	a [m]	Res [ohmm]
1	1.00	20.890	
2	2.00	22.610	
3	3.00	18.840	
4	4.00	17.160	
5	5.00	15.700	
6	6.00	14.260	
7	7.00	13.190	
8	8.00	12.080	
9	10.00	11.030	
10	12.00	13.570	
11	15.00	14.880	
12	17.00	15.120	
13	20.00	17.310	
14	24.00	20.350	
15	30.00	22.890	
16	34.00	24.720	
17	40.00	27.030	
18	48.00	30.300	
19	60.00	33.540	
20	72.00	35.720	
21	84.00	36.930	
22	96.00	36.110	
23	110.00	36.560	
24	130.00	29.390	
25	150.00	28.380	

Specific Resistivity(Ω-m)	36	14.4	7.6	52.5	31.5

VES St. No.13 -BURE

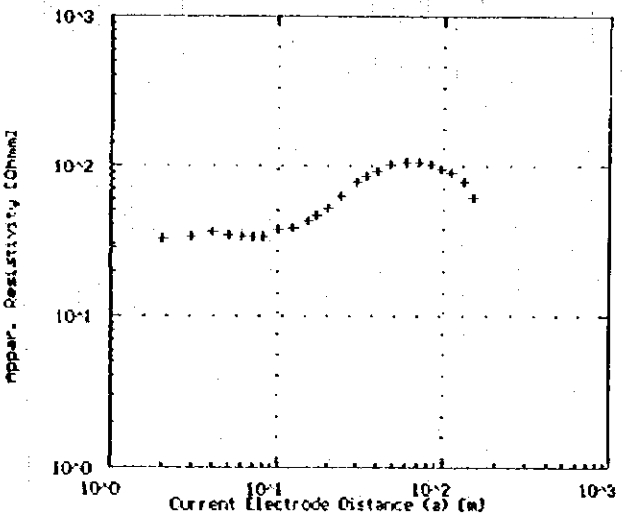


Point [No]	MN/2 [Mr]	a [m]	Res [ohmm]
1	1.00	69.710	
2	2.00	35.300	
3	3.00	24.660	
4	4.00	18.920	
5	5.00	15.960	
6	6.00	15.450	
7	7.00	15.350	
8	8.00	14.920	
9	10.00	14.260	
10	12.00	15.070	
11	15.00	16.490	
12	17.00	17.520	
13	20.00	20.100	
14	24.00	22.610	
15	30.00	27.320	
16	34.00	29.890	
17	40.00	33.610	
18	48.00	36.170	
19	60.00	40.330	
20	72.00	42.500	
21	86.00	41.500	
22	96.00	39.790	
23	110.00	37.990	
24	130.00	29.250	
25	150.00	26.650	

Specific Resistivity(Ω-m)	88	14.67	1	87	16.8

23.7 58.5

VES St. No.14 -BURE

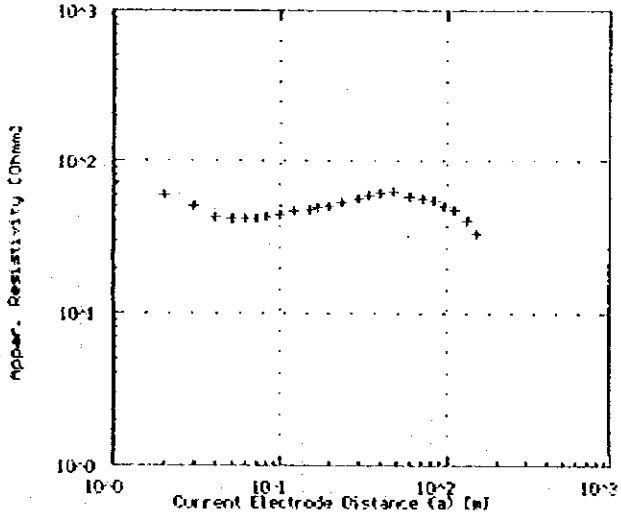


Point [No]	MN/2 [Mr]	a [m]	Res [ohmm]
1	1.00	20.260	
2	2.00	32.280	
3	3.00	33.180	
4	4.00	35.170	
5	5.00	36.540	
6	6.00	33.720	
7	7.00	33.650	
8	8.00	33.610	
9	10.00	37.050	
10	12.00	38.430	
11	15.00	43.330	
12	17.00	46.970	
13	20.00	51.500	
14	24.00	63.350	
15	30.00	77.240	
16	34.00	85.610	
17	40.00	92.940	
18	48.00	102.690	
19	60.00	105.500	
20	72.00	106.260	
21	86.00	102.070	
22	96.00	95.050	
23	110.00	88.000	
24	130.00	77.560	
25	150.00	61.230	

Specific Resistivity(Ω-m)	25.5	38.25	33	1	420	200	44.53

165

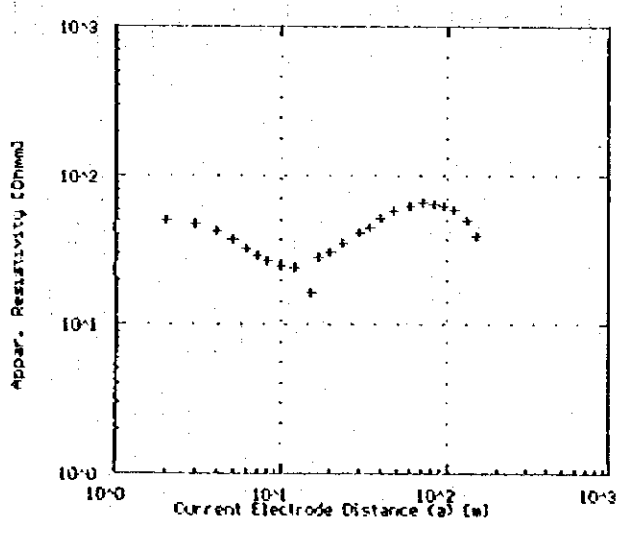
VES St. No.15 -BURE



Point (No)	AB/2 (Mr)	a (m)	Pes (ohmm)
1	1.00	22.220	
2	2.00	51.810	
3	3.00	50.880	
4	4.00	42.950	
5	5.00	42.080	
6	6.00	41.830	
7	7.00	41.500	
8	8.00	43.210	
9	10.00	46.270	
10	12.00	46.720	
11	15.00	48.040	
12	17.00	49.110	
13	20.00	50.240	
14	24.00	52.750	
15	30.00	56.520	
16	34.00	60.210	
17	40.00	61.540	
18	48.00	62.100	
19	60.00	58.600	
20	72.00	56.420	
21	84.00	54.050	
22	96.00	50.640	
23	110.00	48.360	
24	130.00	49.070	
25	150.00	32.870	

Specific Resistivity(Ω-m)	106	35.33	63	40	23.11

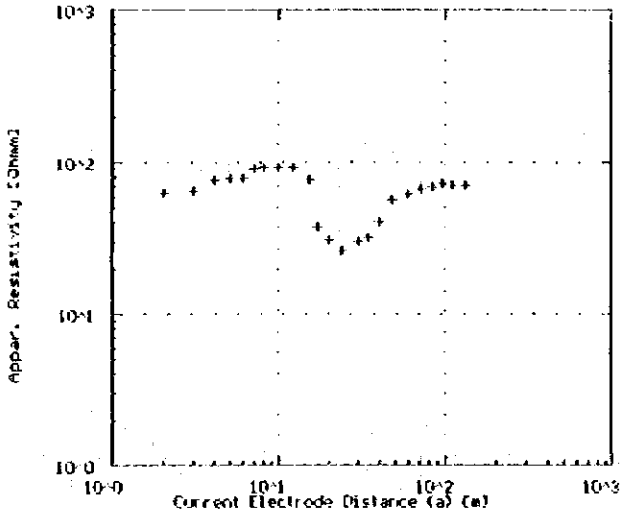
VES St. No.16 -BURE



Point (No)	AB/2 (Mr)	a (m)	Pes (ohmm)
1	1.00	50.240	
2	2.00	50.240	
3	3.00	47.100	
4	4.00	42.030	
5	5.00	37.270	
6	6.00	32.410	
7	7.00	29.010	
8	8.00	26.630	
9	10.00	24.490	
10	12.00	24.120	
11	15.00	16.360	
12	17.00	27.970	
13	20.00	31.050	
14	24.00	35.260	
15	30.00	41.640	
16	34.00	45.050	
17	40.00	52.000	
18	48.00	58.100	
19	60.00	67.300	
20	72.00	65.560	
21	84.00	63.230	
22	96.00	63.300	
23	110.00	59.610	
24	130.00	58.020	
25	150.00	39.560	

Specific Resistivity(Ω-m)	54	36	16.8	84	125	18.86

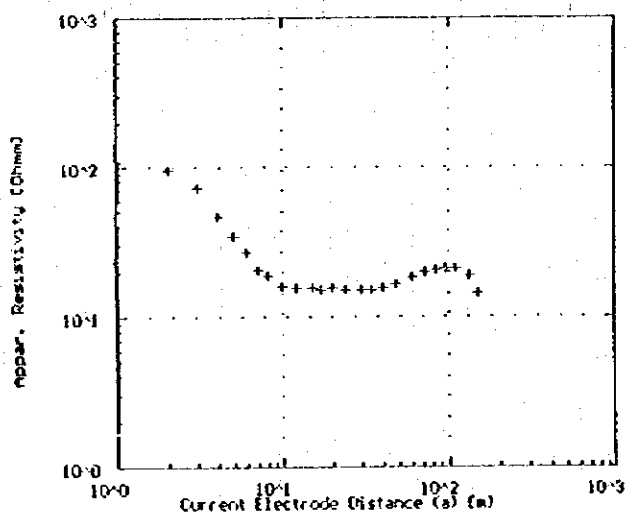
VES St. No.17 -BURE



Point (No)	MN/2 (Mr)	a (m)	Res (ohms)
1	1.00	28.130	
2	2.00	62.890	
3	3.00	84.060	
4	4.00	75.350	
5	5.00	77.870	
6	6.00	78.930	
7	7.00	90.360	
8	9.00	92.950	
9	10.00	94.050	
10	12.00	91.350	
11	15.00	75.830	
12	17.00	37.370	
13	20.00	38.900	
14	24.00	35.390	
15	30.00	39.160	
16	34.00	32.430	
17	40.00	49.550	
18	45.00	55.870	
19	50.00	58.670	
20	72.00	66.920	
21	84.00	69.560	
22	95.00	71.140	
23	110.00	69.370	
24	130.00	62.390	

Specific Resistivity(Ω-m)	90	45	154	14.33	86	390	150

VES St. No.18 -BURE



Point (No)	MN/2 (Mr)	a (m)	Res (ohms)
1	1.00	109.590	
2	2.00	95.480	
3	3.00	71.590	
4	4.00	48.870	
5	5.00	34.560	
6	6.00	27.130	
7	7.00	20.220	
8	8.00	18.590	
9	10.00	16.160	
10	12.00	15.580	
11	15.00	15.560	
12	17.00	14.950	
13	20.00	15.510	
14	24.00	15.230	
15	30.00	15.870	
16	34.00	14.850	
17	40.00	15.320	
18	45.00	16.260	
19	50.00	16.460	
20	72.00	19.900	
21	84.00	20.570	
22	96.00	21.100	
23	110.00	20.720	
24	130.00	19.780	
25	150.00	18.130	

Specific Resistivity(Ω-m)	116	77.33	9.76	15	30	5.53

Appendix - 2

Result of Water Quality Test

Result of Physico-Chemical Analysis in Bure

Sample No.1

Origin of Sample : Spring No.1 (The source)
Date of Collection: 20/Jan./95
Date of Analysis : 09/Feb./95

Physical Characteristics

Appearance	: Very Clear
Odor	: Odorless
Taste	: -
Color	: Nil
Settleable Solids	: Absent
Floating Solids	: Absent
Suspended Solids	: Absent
Total Dissolved Solids	: 130
Turbidity	: Nil
Temperature	: -
Conductivity	: 0.28 ms/cm

General Chemical Characteristics

Total Hardness as $CaCO_3$	: 150
Carbonate Hardness as $CaCO_3$	: 150
Non Carbonate Hardness as $CaCO_3$	: Nil
Total Alkalinity as $CaCO_3$	: 150
Bicarbonate Alkalinity as $CaCO_3$	: 150
Carbonate Alkalinity as $CaCO_3$	: Nil
PH	: 7.50
Silica	: -
Sulphide as Hydrogen Sulphide	: -
Carbondioxide	: -
Residual Chlorine	: -
Dissolved Oxygen	: -

Ionic Contents

Cations		Anions	
NH_4^+	: -	Cl^-	: 5.00
Na^+	: -	NO_2^-	: 0.11
K^+	: -	NO_3^-	: 2.50
Ca^{++}	: 60.00	F^-	: 0.44
Mg^{++}	: 16.79	HCO_3^-	: 183.00
Fe(Total)	: 0.01	CO_3^{--}	: Nil
Mn^{++}	: 0.01	SO_4^{--}	: 1.00
Cu^{++}	: 0.01	PO_4^{---}	: 0.23

Remarks; All the analyzed chemical constituents are within the acceptable range in accordance with WHO drinking water quality guidelines.

Note; Unit is mg/litre unless otherwise stated.

Result of Physico-Chemical Analysis in Bure

Sample No.2

Origin of Sample : Spring No.2 (The source)
Date of Collection: 20/Jan./95
Date of Analysis : 09/Feb./95

Physical Characteristics

Appearance	: Clear
Odor	: Odorless
Taste	: -
Color	: 9 Pt-Co
Settleable Solids	: Absent
Floating Solids	: Absent
Suspended Solids	: Absent
Total Dissolved Solids	: 140
Turbidity	: 2 FTU
Temperature	: -
Conductivity	: 0.29 ms/cm

General Chemical Characteristics

Total Hardness as $CaCO_3$	: 130
Carbonate Hardness as $CaCO_3$	: 130
Non Carbonate Hardness as $CaCO_3$	: Nil
Total Alkalinity as $CaCO_3$	: 150
Bicarbonate Alkalinity as $CaCO_3$	: 150
Carbonate Alkalinity as $CaCO_3$	: Nil
PH	: 7.00
Silica	: -
Sulphide as Hydrogen Sulphide	: -
Carbondioxide	: -
Residual Chlorine	: -
Dissolved Oxygen	: -

Ionic Contents

Cations		Anions	
NH_4^+	: -	Cl^-	: 7.50
Na^+	: -	NO_2^-	: 0.21
K^+	: -	NO_3^-	: 4.40
Ca^{++}	: 60.00	F^-	: 0.34
Mg^{++}	: 19.18	HCO_3^-	: 183.00
Fe(Total)	: 0.04	CO_3^{--}	: Nil
Mn^{++}	: 0.01	SO_4^{--}	: 20.00
Cu^{++}	: 0.05	PO_4^{---}	: 0.24

Remarks; All the analyzed chemical constituents are within the acceptable range in accordance with WHO drinking water quality guidelines.

Note; Unit is mg/litre unless otherwise stated.

Result of Physico-Chemical Analysis in Bure

Sample No.3

Origin of Sample : Manzana Spring
Date of Collection: 05/Jul./95
Date of Analysis : 26/Jul./95

Physical Characteristics

Appearance	: Clear
Odor	: Odorless
Taste	: -
Color	: 10 Pt-Co
Settleable Solids	: Absent
Floating Solids	: Absent
Suspended Solids	: Absent
Total Dissolved Solids	: 132
Turbidity	: 2 FTU
Temperature	: 19.1 °C
Conductivity	: 0.22 ms/cm

General Chemical Characteristics

Total Hardness as $CaCO_3$	: 110
Carbonate Hardness as $CaCO_3$	: 110
Non Carbonate Hardness as $CaCO_3$	: Nil
Total Alkalinity as $CaCO_3$	: 110
Bicarbonate Alkalinity as $CaCO_3$	: 110
Carbonate Alkalinity as $CaCO_3$	: Nil
PH	: 6.95
Silica	: -
Sulphide as Hydrogen Sulphide	: -
Carbondioxide	: -
Residual Chlorine	: -
Dissolved Oxygen	: -

Ionic Contents

Cations		Anions	
NH_4^+	: Nil	Cl^-	: 5.00
Na^+	: -	NO_2^-	: 0.17
K^+	: -	NO_3^-	: 5.72
Ca^{++}	: 32.00	F^-	: 0.197
Mg^{++}	: 7.32	HCO_3^-	: 134.20
Fe(Total)	: Nil	CO_3^{--}	: Nil
Mn^{++}	: Nil	SO_4^{--}	: Nil
Cu^{++}	: 0.01	PO_4^{---}	: 0.31

Remarks; All the analyzed chemical constituents are within the acceptable range in accordance with WHO drinking water quality guidelines.

Note; Unit is mg/litre unless otherwise stated.

Result of Physico-Chemical Analysis in Bure

Sample No.4

Origin of Sample : Manzana River (in which gage inst'led)
Date of Collection: 05/Jul./95
Date of Analysis : 26/Jul./95

Physical Characteristics

Appearance	: Colored-reddish
Odor	: Odorless
Taste	: -
Color	: 10,850 Pt-Co True&apparent Color
Settleable Solids	: Present
Floating Solids	: Absent
Suspended Solids	: Absent
Total Dissolved Solids	: 156
Turbidity	: 1,900 FTU
Temperature	: 20.9 °C
Conductivity	: 0.26 ms/cm

General Chemical Characteristics

Total Hardness as $CaCO_3$	: 155
Carbonate Hardness as $CaCO_3$	: 90
Non Carbonate Hardness as $CaCO_3$	: 65
Total Alkalinity as $CaCO_3$	: 90
Bicarbonate Alkalinity as $CaCO_3$	: 90
Carbonate Alkalinity as $CaCO_3$	: Nil
PH	: 7.60
Silica	: -
Sulphide as Hydrogen Sulphide	: -
Carbondioxide	: -
Residual Chlorine	: -
Dissolved Oxygen	: -

Ionic Contents

Cations		Anions	
NH_4^+	: 0.65	Cl^-	: 10.00
Na^+	: -	NO_2^-	: 0.02
K^+	: -	NO_3^-	: Nil
Ca^{++}	: 48.00	F^-	: 0.226
Mg^{++}	: 8.54	HCO_3^-	: 109.80
Fe(Total)	: 7.55	CO_3^{--}	: Nil
Mn^{++}	: Nil	SO_4^{--}	: 4.00
Cu^{++}	: Nil	PO_4^{---}	: 0.86

Remarks; Color, Turbidity and iron concentrations are above WHO drinking water quality guidelines.

Note; Unit is mg/litre unless otherwise stated.

Result of Physico-Chemical Analysis in Bure

Sample No.5

Origin of Sample : Artesian Well
Date of Collection: 20/Jan./95
Date of Analysis : 10/Feb./95

Physical Characteristics

Appearance	: Clear
Odor	: Odorless
Taste	: -
Color	: 5 Pt-Co
Settleable Solids	: Absent
Floating Solids	: Absent
Suspended Solids	: Absent
Total Dissolved Solids	: 2120
Turbidity	: 8 FTU
Temperature	: -
Conductivity	: 4.26 ms/cm

General Chemical Characteristics

Total Hardness as $CaCO_3$	: 2800
Carbonate Hardness as $CaCO_3$	: 2800
Non Carbonate Hardness as $CaCO_3$	: Nil
Total Alkalinity as $CaCO_3$	: 2920
Bicarbonate Alkalinity as $CaCO_3$	: 2920
Carbonate Alkalinity as $CaCO_3$	: Nil
PH	: 6.80
Silica	: -
Sulphide as Hydrogen Sulphide	: -
Carbondioxide	: -
Residual Chlorine	: -
Dissolved Oxygen	: -

Ionic Contents

Cations		Anions	
NH_4^+	: -	Cl^-	: 15.00
Na^+	: -	NO_2^-	: 3.72
K^+	: -	NO_3^-	: 31.60
Ca^{++}	: 200.00	F^-	: 0.22
Mg^{++}	: 551.56	HCO_3^-	: 3562.40
Fe(Total)	: 0.30	CO_3^{--}	: Nil
Mn^{++}	: 0.02	SO_4^{--}	: 1.00
Cu^{++}	: 0.52	PO_4^{---}	: 2.39

Remarks; The water sample is highly mineralised. The total dissolved solids and total hardness are above WHO drinking water quality guidelines.

Note; Unit is mg/litre unless otherwise stated.

Result of Physico-Chemical Analysis in Bure

Sample No.6

Origin of Sample : Artesian Well (same as sample No.5)
Date of Collection: 05/Jul./95
Date of Analysis : 26/Jul./95

Physical Characteristics

Appearance	: Slightly Colored
Odor	: Odorless
Taste	: -
Color	: 117 Pt-Co
Settleable Solids	: Present
Floating Solids	: Present
Suspended Solids	: Absent
Total Dissolved Solids	: 2,412
Turbidity	: 30 FTU
Temperature	: 19.4 °C
Conductivity	: 4.02 ms/cm

General Chemical Characteristics

Total Hardness as $CaCO_3$	: 2050
Carbonate Hardness as $CaCO_3$	: 2050
Non Carbonate Hardness as $CaCO_3$	: Nil
Total Alkalinity as $CaCO_3$	: 3000
Bicarbonate Alkalinity as $CaCO_3$	: 3000
Carbonate Alkalinity as $CaCO_3$	: Nil
PH	: 6.85
Silica	: -
Sulphide as Hydrogen Sulphide	: -
Carbondioxide	: -
Residual Chlorine	: -
Dissolved Oxygen	: -

Ionic Contents

Cations		Anions	
NH_4^+	: 1.19	Cl^-	: 10.00
Na^+	: -	NO_2^-	: 0.04
K^+	: -	NO_3^-	: 80.08
Ca^{++}	: 660.00	F^-	: 0.226
Mg^{++}	: 97.56	HCO_3^-	: 3660.00
Fe(Total)	: 0.74	CO_3^{--}	: Nil
Mn^{++}	: 0.10	SO_4^{--}	: Nil
Cu^{++}	: 2.06	PO_4^{---}	: 0.88

Remarks; Iron, Copper, Nitrate, TDS and total hardness are above WHO drinking water quality guidelines. The water is highly mineralized and very hard water.

Note; Unit is mg/litre unless otherwise stated.

Result of Faecal Coliform Test in Bure, Sampled and Analyzed on July/5,6/'95

No.	Kebele	Source	Place of Sampling	No of F.C. per 100ml	Remarks
1	1	Spring	Chamber	0	Sampled at collecting chamber, DPT=1ppm
2	1	Spring	Tap	70	First tap after the spring
3	2	Spring	Reservoir	6	WT=22°C
4	3	Spring	P.Foun.2	20	WT=22°C, Ph=7.0
5	1	Spring	P.Foun.4	0	WT=22°C
6	1	Spring	P.Foun.5	1	WT=21°C
7	2	Spring	P.Foun.9	13	WT=22°C
8	2	Spring	P.Foun.11	1	WT=21°C
9	1	Spring	P.Conn.	0	WT=21°C
10	1	Spring	P.Conn.	32	WT=21°C, At Abo ber Hotel
11	3	Spring	P.Conn.	1	WT=19°C
12	2	Spring	Y.Conn.	0	WT=21°C, At Kassie Hotel
13	4	Spring	Y.Conn.	0	WT=21°C, At Beyene Hotel
14	3	Spring	Y.Conn.	0	WT=20°C
15	1	Spring	Clay pot	11	Fetched on the day, Covered by Papyrus
16	1	Spring	Clay pot	2	Fetched on the day, WT=18°C, Covered
17	2	Spring	Clay pot	16	Fetched on the day, WT=20°C, Covered
18	2	Spring	Clay pot	24	Fetched on the day, WT=20°C, Covered
19	2	Spring	Clay pot	16	Fetched on the day, WT=20°C, Covered
20	2	Spring	Clay pot	6	Fetched on the day, WT=20°C, Covered
21	2	Spring	Clay pot	4	Fetched on the day, WT=20°C, Covered
22	3	Spring	Clay pot	TMTC	Fetched 1 day before, WT=18°C, Covered
23	3	Spring	Clay pot	40	Fetched 1 day before, WT=17°C, Covered
24	3	Spring	Clay pot	2	Fetched on the day, WT=20°C, Covered
25	3	Spring	Clay pot	111	Fetched on the day, WT=18°C, Covered
26	3	Spring	Clay pot	13	Fetched on the day, WT=19°C, Covered
27	4	Spring	Clay pot	0	Fetched 1 day before, WT=18°C, Covered
28	4	Spring	Clay pot	27	Fetched 1 day before, WT=18°C, Covered
29	4	Spring	Clay pot	0	Fetched 1 day before, WT=20°C, Covered
30	3	Spring	Manzana	0	WT=22°C, Ph=6.5
31	3	Spring	Edgetbehbret	51	WT=21°C, Ph=6.5, Near elementary school
32	3	Well	Well	202	Mineralized artesian well
Sample No. 1 to 29 are for WSS spring.					

Note; "F.C. means Faecal Coliform.
"BH" means borehole.
"HDW" means hand-dug-well.
"P.Conn." means private connection.
"Y.Conn." means yard connection.
"P.Foun." means public fountain.
"Barrel" means Barrel-container made of steel.
"TMTC" means too many to count.

Appendix - 3

Social and Gender Data

BURE - Activity Profile by gender

Public Fountain/Private Connection Users/Well Users/Spring Users

Activity	Gender			Time	Place
	M	F	Remarks		
Fetches drinking water	n	y	women and sometimes girls		
Does the laundry	n	y	always females		
Waters livestock	y	n	richer households use paid labor		river
Takes water from container	y	y			
Teaches children hygiene	y	y	whoever is about		
Disposes of solid waste	n	y	mostly anywhere		
Digs a compost pit	n	n	some open pits for waste		
Constructs a latrine	y	n	daily labor for higher income groups		
Digs a drainage channel	y	n	some use pits, few use drains		
Tends a kitchen garden	y	n	very few		
Disposes of animal waste	n	y			
Keeps latrine clean	n	y			
Keeps compound clean	n	y			
Takes sick child to clinic	y	y	whoever is about		

y = Yes, n = No

BURE - Daily Schedule

Private Connection Users

Man	Time	Woman
Wakes up, washes, goes to Church	6	Wakes, washes, prepares breakfast
Returns home, eats breakfast	7	Gives breakfast to family
Goes trading (buying and selling	8	Eats breakfast, cleans dishes
food items in town and in other	9	Washing clothes
towns also)	10	Cleaning house
"	11	"
"	12	Prepares lunch
Eats lunch	13	Eats lunch with family
Trading food items	14	Drinks coffee
"	15	Spins cotton for household purpose
"	16	"
"	17	"
"	18	Prepares supper
Returns home, eats supper	19	Eats supper with family
Drinks coffee, talks with family	20	Drinks coffee, clears dishes
Goes to sleep	21	Goes to sleep
	22	

NB. Supply of water is not adequate, supplement with water from the river laundry purposes. This is collected by laborers.

Public Fountain/Spring/Well/PC Vendor Users

Man	Time	Woman
	4	*Wakes up, prepares tea and tela*
Wakes up, goes to work	5	*Sells tea/tela to bus passengers*
(Selling sugar cane/banana	6	"
at bus terminal to passengers)	7	"
"	8	"
Returns home to eat breakfast	9	Prepares and eats breakfast
Selling sugar cane/banana	10	*Sells tea/tela*
"	11	"
"	12	Prepares lunch
Eats lunch	13	Eats lunch with husband
Sells sugar cane/banana	14	*Sells tela/arekie, does other*
"	15	domestic household activities
"	16	**Fetches water**
"	17	*Other domestic and selling*
		activities
"	18	"
"	19	"
Returns home, talks with friends	20	"
Eats supper	21	Prepares supper
Goes to sleep	22	Eats supper, clears dishes, sleeps

NB, Home is infront of the bus terminal

BURE - Access and control profile

Private Connection Users

Resources	Access		Control		Comments
	male	female	male	female	
Money for water	y	y	y	y	
Money for soap	y	y	y	y	
Money for water container	y	y	y	y	
Money for water pot cover	y	y	y	y	
Money for building materials for drying shelf	y	y	y	y	women and men organize
Money for building latrine	y	y	y	y	
Money for medicine	y	y	y	y	
Tools for digging pits	y	y	y	y	daily labor
Tools for constructing latrine	y	y	y	y	daily labor
Seeds and tools for vegetable gardens	y	y	y	n	few have
Land for digging refuse disposal pits	y	y	y	y	some have
Land for digging latrines	y	y	y	y	
Land for digging drains	y	y	y	y	some have
Land for digging vegetable gardens	y	y	y	y	few have
Income from selling water	y	y	y	y	
Income from selling vegetables	y	y	y	y	few do
Improved health	y	y	y	y	mostly women
Reduced time spent collecting water	n	y	n	y	few males
Reduced time spent caring for sick	y	y	y	y	mostly women

Spring/Public Fountain/Well and PC Vendor Users

Resources	Access		Control		Comments
	male	female	male	female	
Money for water	y	y	y	y	money is
Money for soap	y	y	y	y	shared by
Money for water container	y	y	y	y	husband and
Money for water pot cover	y	y	y	y	wife
Money for building materials for drying shelf	y	y	y	y	women and men organize
Money for building latrine	y	y	y	y	may have
Money for medicine	y	y	y	y	may have
Tools for digging pits	y	y	y	y	not all
Tools for constructing latrine	y	y	y	y	not all
Seeds and tools for vegetable gardens	y	n	y	n	few may have
Land for digging pits	y	y	y	y	few have
Land for digging latrines	y	y	y	y	not all have
Land for digging drains	n	n	n	n	few have
Land for vegetable gardens	n	n	n	n	some may have
Income from selling water	n	n	n	n	
Income from selling vegetables	y	y	y	y	provisional
Improved health	n	n	n	n	mostly women
Reduced time spent collecting water	n	y	n	y	
Reduced time spent caring for sick	y	y	y	y	mostly women

*It is likely that the methodology we have used does not disclose this type of data adequately.

All members of the community we spoke with said that money was a shared pot and that purchase of items was a joint decision. The major factor influencing access and control seems to be decided by who is earning money.

BURE - Needs Analysis

Private Connection Users and Well Owners

		Gender		Remarks
		M	F	
Practical needs				
Water	Longer service time from piped system	n	y	Supplementary sources relied upon heavily
	Breaks and inadequacies in piped water service to be reduced/avoided	y	y	Supply to PCs only working 1 day out of 3
Sanitation	Provision of loans for latrine construction or for community latrines and designation of sites for other waste disposal	y	y	Many PC Users live in rented Kebele accommodation without access to latrines
Strategic needs				
Water	Would provide labor for improvements in water supply system	y	y	
Sanitation	Community management of latrines	y	y	Require help with community organization and enforcement
Health education	None identified			

y = Yes, n = No

BURE - Needs Analysis (continued)

Public Fountain/PC Vendor/Well/Spring Users

		Gender		Remarks
		M	F	
Practical needs				
Water	Adequate quantities of water from the water supply system each day	y	y	
	Reduced time spent for water collection	y	y	Reduced queues and reduced distance to water supply facilities
Sanitation	Improved access to latrines. Need for women to have access to latrines even during daylight hours	y	y	Community latrines for those in rented housing and those who can not afford private latrines
	Allocate areas for refuse disposal and provide training and support for the safe disposal of refuse.	y	y	
Health education	Discussion groups for sanitary education required	y	y	No special attention required by Muslims
Strategic needs				
Water	Public fountains possible to be managed by the community with support from Authorities	y	y	
	Additional public fountains to be constructed with the help of community labor.	y	y	All groups could assist with labor and with transportation of materials.
Sanitation	Community latrines to be managed by the community	y	y	Need to have support and even enforcement from Authorities for improvements in sanitation, including the use and management of community latrines.
	Public showers to be managed by the Authorities	y	y	Only would be used if inexpensive
Health education	Support for existing health education initiatives. Increase motivation for people to improve their sanitary behaviors	y	y	

y = Yes, n = No

BURE - Social and Gender Considerations

Social/Gender differences	Underlying factors	Impact of the project	Possible measures to be taken
Variation in type and level of water service demanded	Variations in social and economic status	Richer households will not be satisfied without private connections	Improvements to the water system should include both public fountains and private connections
Households with larger incomes have better access to water and sanitation facilities than lower income households	Larger incomes allow people to construct latrines or install PCs	Middle income people will benefit most from any improvements in water supply or sanitation facilities	Discuss and develop ways of ensuring employment or income generation for lower income groups
Many people in favor of community managed communal latrines. Others felt this might be difficult	Enforcement of community member by other members can cause disharmony in a community	Community latrine management may start well but is likely to fail in the middle-long term	Support and training needs to be given to community groups and leaders. Enforcement must also be provided by authorities
Women only defecate under cover of darkness	The need for privacy determines the time that women can defecate	Women may all require latrine facilities at the same time thus putting pressure on resources	Sharing and management of community latrines must be facilitated with discussion of all community members
Women fetch water most of the time and women usually do the laundry. Girls sometimes help from any source and some boys help collect from PFs	Water collection and laundry are undertaken mostly by women and girls and less often by young males	Females will benefit most from time and energy savings from having a reliable water supply available near their homes	The project needs to help women identify how to spend any time released through improved water supply

Appendix - 4

Summary of Group Meeting

BURE - Summary of group meetings

Group 1 details	Group characteristics	Group needs
General	Kebele 04, Amhara, Mostly Christian, 7 men, 7 Women, some children, tela sellers, weavers and daily labourers	1-Water, 2-Community Latrines, 3-Health Care, 4-Improved road conditions
Water	Spring/swamp users in wet season otherwise PF users. Women fetch water and do laundry at home. Spring water takes 2 hours to collect because of queues and slippery path. PF only functions 1 time in 3 days for short period and is inadequate.	Would like reliable public fountain supplying for 6 hours each day, or with extra public fountain running for shorter time. Prepared to help with labour for construction and with management. Could not afford to pay more for better service.
Sanitation	All use open field for defecation. Women go when it is dark. Can not afford latrine construction and do not have control of land for latrine construction as most live in private rented housing. Rubbish disposal also open field.	Would like community latrines, women would also use them. Would help with construction and management. Would share by groups of families. Would like water for washing hands in the latrine but could not manage this.
Health	Common diseases are Intestinal parasites and diarrhoea and awareness of their transmission is adequate. HEd has been received from the Health Centres but no other way of getting information about water/ sanitation related diseases.	No health needs specified.

Group 2 details	Group characteristics	Group needs
General	Kebele 02, Amhara, Christians, 7 women, 4 men some children, tela sellers, petty traders, teashop proprietors and daily labourers	1-Water (PFs and PCs), 2-Latrines, 3-Electricity
Water	All spring and Public fountain users and occasional users of private vendors, Women fetch the water. Nearest PF (market area) not working. Laundry done at spring or with roof water. When the existing PF operated for 2 hours it was insufficient.	Existing public fountain to be reopened to supply water each day for 4 hours. Some would like private connections. Could help with labour and management for reopening of public fountain. Could pay more for better service.
Sanitation	All use open fields for defaecation, women go under cover of darkness. Can not afford latrines and do not have control over the land for latrines (private rented housing). Refuse disposal also open field.	Community latrines shared by groups of families would be appropriate. Would help with labour for construction, cleaning and management. Would use public showers if not expensive (?). Allocation and enforcement of garbage disposal areas would be used.
Health	Common illnesses include Cholera and dysentery, and intestinal parasites. High level of health awareness. Health education carried out at health centre, at home men and women teach children about health and take sick children to the clinic.	No specific health need identified.

BURE - Summary of group meetings (continued)

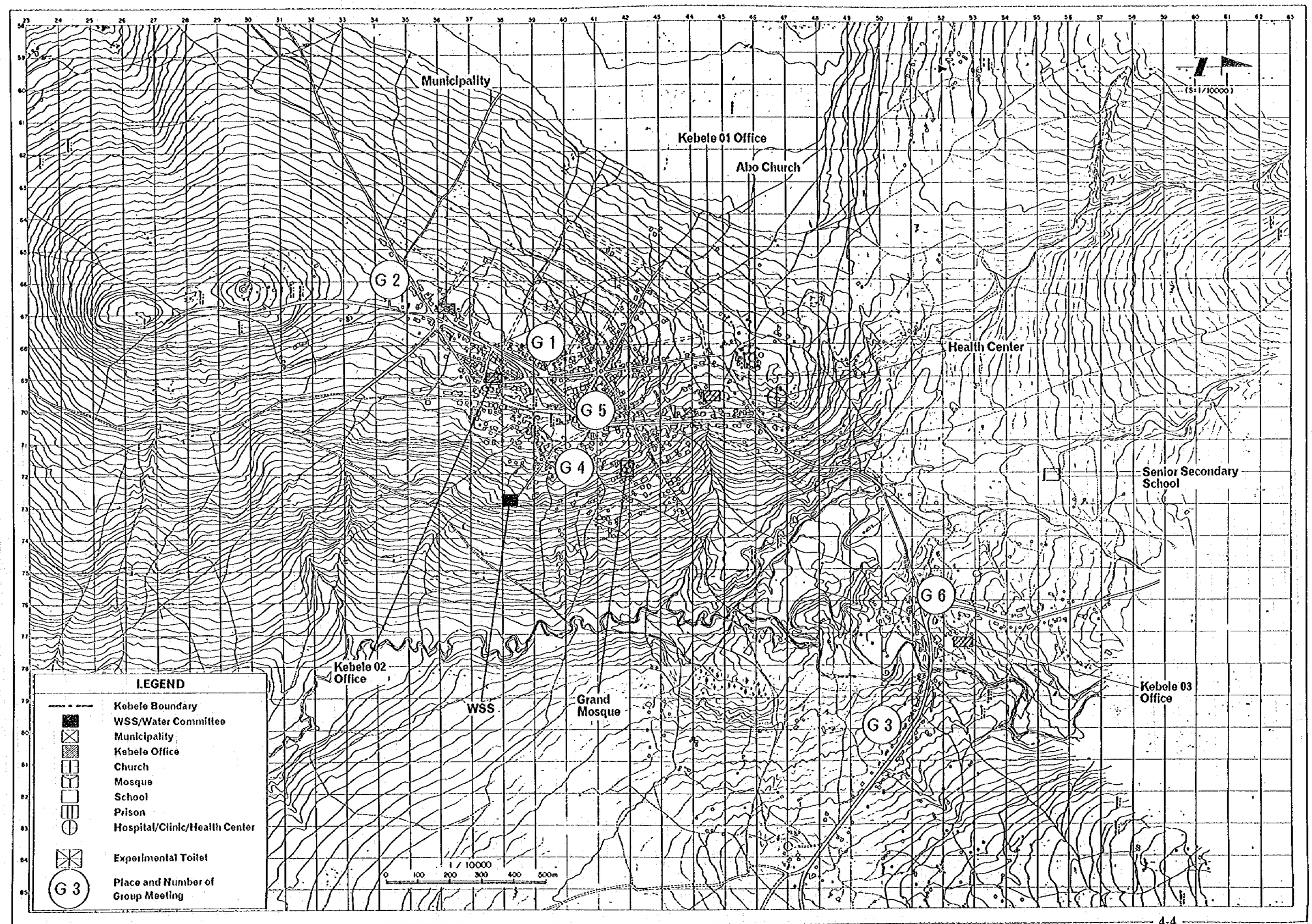
Group 3 details	Group characteristics	Group needs
General	Kebele 03, Amhara, Christians, 9 women, 7 men, many children, Farmers, Petty traders and Government Workers	1-Water (would like to see action fast) 2-Electricity
Water	All use springs, public fountains, private connection vendors and rain water. The public fountain supply is inadequate for the local demand and is a little far. Women fetch the water. Women do laundry at home using spring or rain water.	Would like additional public fountain and would be prepared to assist with labour for construction and management. They are prepared to pay more for a better service. (Actually, the public fountain is not far from the location of the group meeting)
Sanitation	All have private latrines some are poorly constructed so children do not use them. When latrines are filled up they close them and daily labourers are paid to build new ones. Most own their houses or rent privately (prefer renting plots with latrines)	No needs expressed for sanitation. Women able to use latrines even during daylight hours.
Health	Common diseases include TB and diarrhoea (for children). High awareness of link between diarrhoea and water/sanitation. Health education been received from the health centre.	No health needs identified.

Group 4 details	Group characteristics	Group needs
General	Kebele 01, Amhara, Mostly Muslim, 7 women, 6 men, some children, mostly wealthy traders and business people	1-Water, 2-Electricity
Water	All use water from Private Connection Vendors, Public Fountain, river and rain water. The river is sometimes turbid but is nearer than PFs. Pay 15c per pot from PC vendors. Women fetch the water and do laundry with river or rain water	Would like and most can afford private connections. A few would like to have a public fountain and could help with finance/labour for construction and management. Would like to see the water supply situation improved quickly.
Sanitation	Most use open field for defecation because there is lack of wood and money for slabs. Women need privacy therefore only excrete during dark hours. Waste disposed of in open field and not aware of municipality dumping sites	Would like community latrines and some would be interested in loans for private latrines or for concrete or wooden latrine slabs. Public showers also of interest even for women depending on the price.
Health	Common diseases include diarrhoea and intestinal worms. Aware of the health implications for poor water/sanitation. Health education has been received through health centre. People not aware of work of Kebele Health Representatives	Health education may not be appropriate through the Mosque but rather through small discussion groups.

BURE - Summary of group meetings (continued)

Group 5 details	Group characteristics	Group needs
General	Kebele 04, Amhara, Christians, 6 women, 5 men, many children, tela/tea sellers, daily labourers and government workers	1-Health, 2-Water
Water	All are most often private connection users, but supplement the supply with other sources including rain water. Women fetch the water and do the laundry. Water is available from the PCs for 3 hours one day and then no water for the next three days.	Would like to have regular service time each day for the PCs. Additional PCs are needed an also a public fountain. Are prepared to pay more for better water service. Would also be prepared to contribute labour.
Sanitation	Most use open field because they live in rented Kebele houses, women go during dark hours for privacy (shyness). Disposal of solid waste is also open. Public shower is not used as it is too expensive (50c) and women prefer to bath at home.	Would like latrines, community latrines would be an option, but require organisation for helping with management and construction. Would pay for water in the latrines for hand washing. Need container for collection of refuse for Municipality to dump.
Health	Common diseases include TB and dysentery. Health awareness about these is reasonable. Health Education has been received at the health centre but is not always appropriate.	No specific health need identified.

Group 6 details	Group characteristics	Group needs
General	Kebele 03, Amhara, Christians, 7 women, 1 man, few children, Tela/Tea shop/hotel keepers	An argument in the group over land brought a close to this meeting without concluding the priority needs
Water	Public fountain users supplemented on occasions by vendors with private connections and with springs. The public fountain usually functions for two hours each day which is just insufficient and on Sundays there is no water as the water sellers don't work	Would like the public fountain to be open longer hours each day. Not prepared to pay more for a better service as it is considered too expensive already. Not prepared to assist with management of the public fountain, the Government should organise this
Sanitation	All use open field for defecation, some complained that others use the area outside the shops. There is a lack of land for building latrines and no control over the land because houses are rented. Waste disposal also open field.	Would like latrines, community latrines being the most appropriate. They could be shared by groups of households (mostly women headed households in this group) and could contribute to construction with labour and manage/clean them themselves.
Health	Common diseases include diarrhoea, fever (malaria type)	No health needs specifically identified


Municipality
Kebele 01 Office
Abo Church
Health Center
Senior Secondary School
Kebele 02 Office
WSS
Grand Mosque
Kebele 03 Office
G 1
G 2
G 3
G 4
G 5
G 6
(S=1/10000)
1 / 10000
0 100 200 300 400 500m
LEGEND
Kebele Boundary
WSS/Water Committee
Municipality
Kebele Office
Church
Mosque
School
Prison
Hospital/Clinic/Health Center
Experimental Toilet
G 3
Place and Number of Group Meeting

BURE

Appendix - 5

Financial and Socio-Economic Data

Table 1 (1) Summary of Financial Aspects of WSS in Eleven Centers

Item	Dupti	Mille	Bati	Werota	Aykel	Debre Tabor
1. Population	14,737	3,902	14,354	21,845	11,718	25,575
2. Water production & consumption in 1993/1994 (m3)	n.a. 35,565e	n.a. 29,232e	113,523 90,218	58,318 46,104	11,303e 10,173e	11,930 9,773
*Water consumption/ population/day (l)	6.6e	20.5e	17.2	5.8	2.4e	1.0
*Leakage ratio (%)	n.a.	n.a.	20.5	20.9	10.0e	18.1
3. Income & Expenditure in 1993/1994 (birr)	51,267 60,188	48,818 38,182	131,144 132,245	64,648 53,304	50,863e 22,560e	31,337 78,328
*Bill collection rate (%)	85.7	79.1	94.4	99.9	-	67.8
*Income/consumption (birr/m3)	1.44e	1.67e	1.45	1.40	5.00e	3.21
*Expenditure/production (birr/m3)	n.a.	n.a.	1.16	0.91	2.00e	6.57
*Income/Expenditure (%)	85.2	127.9	99.2	121.3	225.5e	40.0
4. No. of personnel, female, temporary/contract	10 1 10	11 5 11	25 5 8	18 4 0	13 4 8	18 5 0
*Production/worker (m3)	n.a.	n.a.	4,541	3,240	3,478e	663
*Income/worker (birr)	5,126	4,438	5,246	3,592	3,913e	1,741
*Expenditure/ worker (birr)	6,019	3,471	5,290	2,961	1,735e	4,352
5. Average monthly salaries (birr)	129	96	204	217	70	173
6. No. of house/ yard connections, public fountains, hydrants	190(70) 8(2) 1	89 8(5) 1	852 12	396 7(6)	- 5(3)	320 13(2)

Notes: 1. e = estimates or assumptions 2. n.a.= not available
3. parenthesized figure = functional

Table 1 (2) Summary of Financial Aspects of WSS in Eleven Centers

Item	Nefas Mewcha	Chagni	Bure	Bichena	Dejen
1. Population	13,726	26,823	14,742	14,629	10,250
2. Water production & consumption in 1993/1994 (m3)	42,216 31,206	74,219 55,045	66,278 55,008	17,810 15,826	46,409 41,201
*Water consumption/ population/day (l)	6.2	5.6	10.2	3.0	11.0
*Leakage ratio (%)	26.1	25.8	17.0	11.1	11.6
3. Income & Expenditure in 1993/1994 (birr)	56,457 79,567	68,590 72,172	66,791 102,309	34,679 71,591	62,089 67,846
*Bill collection rate (%)	91.7	85.8	98.2	96.8	89.0
*Income/consumption (birr/m3)	1.81	1.25	1.21	2.19	1.51
*Expenditure/production (birr/m3)	1.88	0.97	1.54	4.02	1.46
*Income/Expenditure (%)	71.0	95.0	65.3	48.4	91.5
4. No. of personnel, female, temporary/contract	19 5 1	17 6 2	22 7 0	20 6 2	17 3 0
*Production/worker (m3)	2,222	4,366	3,013	891	2,745
*Income/worker (birr)	2,971	4,035	3,035	1,735	3,652
*Expenditure/ worker (birr)	4,188	4,245	4,650	3,580	3,991
5. Average monthly salaries (birr)	153	143	241	170	211
6. No. of house/ yard connections, public fountains, hydrants	383 14(13)	327 12	478 13(12)	238 7	390 7

Notes: 1. e = estimates or assumptions 2. n.a: = not available
3. parenthesized figure = functional

Table 2 (1) Financial Condition of Water Supply Service in Bure

1. Official Water Price: 1 birr/m3 for all clients

2. Production and Consumption of Water, 1993/94

1) Production : 66,278 m3

2) Consumption: 55,008 m3

* Daily water consumption as divided by total population = 10.2 litre

* Leakage ratio = 17.0%

3. Income and Expenditure

1) Income : 66,790.95 birr

Major sources of income

(1) Meter water sales	43,281.00 birr	(64.8%)
(2) Cash water sales	11,134.50 birr	(16.7%)
(3) Water meter rental	5,086.00 birr	(7.6%)
(4) Service charge	1,506.47 birr	(2.3%)

* Bill collection rate = 98.2%

* Income per unit consumption of water = 1.21 birr/m3

2) Expenditure: 102,309.38 birr

Major items of expenditure

(1) Salaries	62,309.38 birr	(60.9%)
(2) Fuel (for generator)	24,448.47 birr	(23.9%)
(3) Office supply	3,928.71 birr	(3.8%)

* Expenditure per unit production of water: 1.54 birr/m3

* Income-expenditure ratio: 65.3%

4. Organization and Personnel

1) No. of personnel: 22 (7)

(1) Head, WSS	1

Table 2 (2) Financial Condition of Water Supply Service in Bure

(2) Administration 1 head, 4 guards, 1 (1) store clerk, 1 store keeper, 1 administrative clerk, 1 (1) cleaner	9 (2)
(3) Finance 1 head, 1 accounting clerk, 1 cashier, 1 water meter reader, 1 (1) bill collector, 4 (4) water sellers	9 (5)
(4) Urban water supply & sewerage 1 motor operator, 2 plumbers	3

Note: Parenthesized figure denotes the number of female workers.

* Production per worker = 3,013 m3/year

* Income and expenditure per worker = 3,036 birr, 4,650 birr/year

2) Average monthly salaries of employees: 241 birr

5. No. of Distribution Facilities

1) House connections : 8

2) Yard connections : 470

(1) Household	: 430
(2) Governmental & public	: 19
(3) Commercial	: 21

3) Public fountains : 13 (12 functional)

Note: There are two hand-dug wells.

6. Problems and Bottlenecks

1) Financial problem.
2) Hard to maintain/repair the damaged office building due to shortage of financial resources.
3) Shortage of water sources. Only one is functional, out of two.
4) Water production from the functional water source is decreasing.
5) Transmission lines lie adjacent to rivers and roads. Necessary to take measures to protect them from damage. But, no financial resources to do so.
6) They cannot buy uniforms due to lack of fund.

Table 3 (1) Summary of Socio-Economic Aspects of Eleven Centers

Item	Dupti	Mille	Bati	Werota	Aykel	Debre Tabor
I. Administrative Conditions						
1. No. of gov't employees	500e	336	366	322	412	1,674
*No. of gov't employees/1,000 population	34	86	25	15	35	65
2. Average salaries of gov't employees (birr)	311	311	355	308	391	397
II. Population						
1. Population	14,737	3,902	14,354	21,845	11,718	25,575
2. Ethinic composition for top two (%) [Amh.=Amhara, Afa.=Afar, Oro.=Oromo, Tig.=Tigre, Kim.=Kimant, Age.=Agew]	Amh.84 Afa. 6	Amh.69 Oro.14	Amh.49 Oro.28	Amh.97 Tig. 3	Amh.73 Kim.20	Amh.100
3. Religious composition, Christians & Moslems (%)	42 58	43 57	12 88	80 19	81 19	95 5
4. Family size	4.5	4.6	6.2	6.3	5.5	5.7
5. Area (ha)	1,600e	68	260	640	322	1,402
*Population density (persons/ha)	9.2e	57.4	55.2	34.1	36.4	18.2
III. Educational Conditions						
1. No. of pupils/ students	3,182	457	2,500	3,817	3,944	7,950
*No. of pupils/ students per 100 population	22	12	17	17	34	31
2. Literacy ratio (%)	70	62	48	63	80e	74
3. Primary school enrollment ratio (%)	62	53	53	57	85e	75
IV. Medical Conditions						
1. No. of medical personnel	36	4	22	9	18	81

Table 3 (2) Summary of Socio-Economic Aspects of Eleven Centers

Item	Dupti	Mille	Bati	Werota	Aykel	Debre Tabor
*No. of medical personnel per 1,000 population	2.4	1.0	1.5	0.4	1.5	3.2
2. No. of cases for top ten diseases	14,943	1,611	11,642	18,084	13,683	21,318
*Estimated No. of cases per year as percentage of population (%)	30.4	12.4	24.3	24.8	35.0	25.0
3. Under 5 mortality rate (/1000)[n.a.=not available]	213	154	163	95	n.a.	73
4. Life expectancy (years)	47	53	52	61	55e	64
5. Households using septic tank / pit latrine (%)	86	45	68	61	39	65
V. Economic Conditions						
1. No. of commercial/industrial establishments [parenthesized figures=No. of hotels/restaurants]	1,105 (331)	204 (162)	243 (68)	812 (201)	450 (115)	1,672 (574)
*No. of establishments per 1,000 population	75 (22)	52 (42)	17 (5)	37 (9)	38 (10)	65 (22)
2. Monthly household income (birr)	334	223	306	262	182	248

Note: e=estimates

Table 3 (3) Summary of Socio-Economic Aspects of Eleven Centers

Item	Nefas Mewcha	Chagni	Bure	Bichena	Dejen
I. Administrative Conditions					
1. No. of gov't employees	541	727	845	499	378
*No. of gov't employees/1,000 population	39	27	57	57	37
2. Average salaries of gov't employees (birr)	297	368	292	374	407
II. Population					
1. Population	13,726	26,823	14,742	14,629	10,250
2. Ethinic composition for top two (%)	Amh.100	Amh.74 Age.19	Amh.94 Age. 4	Amh.99 Oro. 1	Amh.99 Tig. 1
[Amh.=Amhara, Afa.=Afar, Oro.=Oromo, Tig.=Tigre, Kim.=Kimant, Age.=Agew]					
3. Religious composition, Christians & Moslems (%)	94 6	44 56	92 7	67 33	65 35
4. Family size	5.9	6.1	6.8	6.2	6.8
5. Area (ha)	648	920	1,280	200	280
*Population density (persons/ha)	21.2	29.2	11.5	73.1	36.6
III. Educational Conditions					
1. No. of pupils/ students	3,743	5,339	4,388	3,465	2,661
*No. of pupils/ students per 100 population	27	20	30	24	26
2. Literacy ratio (%)	70	74	61	69	61
3. Primary school enrollment ratio (%)	59	77	69	68	64
IV. Medical Conditions					
1. No. of medical personnel	43	25	22	27	5

Table 3 (4) Summary of Socio-Economic Aspects of Eleven Centers

Item	Nefas Mewcha	Chagni	Bure	Bichena	Dejen
*No. of medical personnel per 1,000 population	3.1	0.9	1.5	1.8	0.5
2. No. of cases for top ten diseases	22,002	11,782	15,112	7,441	3,790
*Estimated No. of cases per year as percentage of population (%)	48.1	13.2	30.7	15.3	11.1
3. Under 5 mortality rate (/1000)[n.a.=not available]	196	144	131	173	155
4. Life expectancy (years)	49	54	56	52	53
5. Households using septic tank / pit latrine (%)	58	61	58	45	54
V. Economic Conditions					
1. No. of commercial/industrial establishments	860 (209)	546 (91)	246 (65)	414 (47)	345 (74)
[parenthesized figures=No. of hotels/restaurants]					
*No. of establishments per 1,000 population	63 (15)	20 (3)	17 (4)	28 (3)	34 (7)
2. Monthly household income (birr)	202	203	253	324	312

Note: e=estimates

Table 4 (1) Socio-Economic Condition of Bure

I. Administrative Conditions

1. Administrative Classification: Region 3, Zone = West Gojjam

2. Government Organizations
1) Agricultural Department
2) Natural Resources Development and Environmental Protection (NRDEP)
3) Weroda Council
4) Financial Department
5) Educational Office
6) Municipality
7) Health Center
8) Health Office
9) Agricultural Mechanization Station
10) Culture and Sports Department
11) Road Transport Authority
12) Police
13) Post Office
14) Telecommunications
15) Weroda Court
16) Weroda Attorney
17) Ethiopian Grain Trade Enterprise
18) Commercial Bank of Ethiopia
19) Road Construction Authority
20) Water Supply Service (WSS)

Notes: 1. Schools are not included in the above organizations.
2. There are 1 NGO and 8 public organizations.

3. No. of Government Employees and Their Average Monthly Salaries: 845, 292 birr

* No. of government employees per 1,000 population: 57

4. No. of Kebele: 4

II. Socio-Economic Conditions

1. Population
1) Total population: 14,742

2) Ethnic composition: Amhara (94.1%), Agew (3.9%), Oromo (2.0%)

3) Religious composition: Christians (92.0%), Moslems (7.0%)

Table 4 (2) Socio-Economic Condition of Bure

4) Average family size: 6.8 persons

2. Area: 1,280 ha * Population density: 11.5 persons/ha

3. Educational Conditions
1) No. of schools, class rooms, teachers and pupils/students

Items	Kinder-garten	Elementary School	Junior & Senior High School	Technical & Vocational School
(1) No. of schools	2	3	1	1
(2) No. of class rooms	2	31	16	8
(3) No. of teachers	2	92	52	22
(4) No. of pupils/students	136	2,157	2,031	64

* No. of pupils/students per 100 population: 30

2) Literacy ratio: 61.3% (1984)

3) Primary school enrollment ratio: 69.4% (1984)

4. Medical Conditions
1) No. of medical institutions/establishments:
1 Health Center (5 beds), 2 pharmacies

2) No. of medical personnel:
1 doctor, 9 nurses, 9 health assistants, 1 laboratory technician, 2 pharmacy technicians ... 22 in total

Other related personnel: 2 sanitarians

3) Incidence of diseases (Jul. 1993 - Jun. 1994)

(1) Top ten diseases

i.	All types of intestinal parasites	3,744 cases
ii.	Infection of skin and subcutaneous tissue	2,281
iii.	All types of diarrhea	1,508
iv.	Bronchitis	1,374
v.	All types of T.B.	1,374
vi.	All types of venereal diseases	1,233

Table 4 (3) Socio-Economic Condition of Bure

vii. Upper respiratory tract infection	1,047	
viii. Gastro-interitis	1,025	
ix. All types of rheumatoid arthritis	782	i. to x.
x. All types of pneumonia	744	= 15,112

(2) Estimated number of cases per year as percentage of population:
(15,112 x 1.5) / (14,742 x 5) = 30.7%

Notes: 1.5 = coefficient to estimate the total number of cases,
5 = coefficient to estimate covered population

4) Under 5 mortality rate: 130.9/1000 (1984)

5) Life expectancy: 56.0 years (1984)

6) Households more or less using septic tank and pit latrine: 58.0%

5. No. of Holy Places: 3 churches, 1 mosque

6. Economic Conditions
1) No. of commercial and industrial establishments

Classification	Annual Income (birr)			
	< 1,000	1,000 - 3,000	3,000 <	Total
1. Hotels and restaurants				
Hotels	3	4	3	10
Bars	0	28	0	28
Groceries (Public houses)	0	20	0	20
Tej houses	7	0	0	7
Sub-total	10	52	3	65
2. Shops	25	82	33	140
3. Cottage industry				
Oil factories	0	0	5	5
Flour mills	0	0	23	23
Tyre repairing	0	2	0	2
Sub-total	0	2	28	30
4. Others	4	5	2	11

Table 4 (4) Socio-Economic Condition of Bure

Total	39	141	66	246

Notes: 1. Shops include traders of clothes, thread, textiles, spices and hot sauce, kerosene, leather and skin, leather products, grains, butter & honey, coffee, fruit & vegetables, building materials, bakeries, groceries, tailors, photo shops and stationeries.

2. Others include filling stations, butcheries and gold & silver smiths.

* No. of commercial and industrial establishments per 1,000 population: 17

2) Major occupations
(1) Commercial activities (2) Agriculture (3) Day laborers
(4) Government employees (5) Industry (mineral water factory)

3) Major products: edible oil, flour

4) Market
(1) Major marketable items:
grains, livestock, butter, milk, honey, etc.

(2) Prices of major marketable items

Grains (unit: birr/100 kg)

tef	dagusa	maize	barley
200	140	140	150

Livestock (unit: birr/one)

ox	cow	sheep	goat	donkey	mule	horse	chicken
800	500	150	125	300	700	550	10

Table 4 (5) Socio-Economic Condition of Bure

Consumers' items (unit: birr)		
butter (kg)	honey (kg)	milk (litre)
23	10	2

(3) Market days - Tuesday and Saturday (10,000 and 25,000 people (gather on Tuesday and Saturday, respectively.)

4) Average monthly household income: 252.7 birr

Sources: Water Supply Service, Woroda Council, Financial Bureau, Educational Bureau and Health Center in Bure; Socio-Economic Sampling Questionnaire Survey by JICA; Central Statistical Office

Appendix - 6

Result of Initial Environmental Examination

Project Description on Initial Environmental Examination in Bure

Items	Description
Project Title	Eleven Centers Water Supply and Sanitation
Background	1. Insufficient water supply and low per-capita-consumption due mainly to high population growth , aged facilities and poor O&M. 2. Poor sanitation prevailing the Project site which could contaminate the water source(s).
Objectives	To supply domestic water which meets people's demand and to improve sanitary condition.
Location	Bure, Damot Weroda, Region-3
Executing Agency	Water Supply and Sewerage Service Department Ministry of Water Resource
Beneficiaries	About 14,700 of the population to be benefited.
Dimensions of the Plan	Rehabilitation of existing facilities, and new boreholes, reservoir and distribution network.
Type of Work	Rehabilitation and new construction work
Purpose	1. To provide domestic water and improve sanitation facilities. 2. To initiate people's awareness on water use and sanitation.
Water Resource	Springs and groundwater
Water Quality	There are boreholes which groundwater is highly mineralized.
Main Facilities	Intake of spring water, collecting chamber with disinfection facilities.
Water Storage Facilities	Reservoir (ground tank type) with enough capacity
Filtration Plant	Not to be considered.
Related facilities	Distribution pipes, public fountains, drainage system and latrines
Remarks	1. Chlorine or its derivatives such as mainly calcium hypochlorite is used for disinfection. 2. There are a number of springs, few people fetching water at rivers because of turbidity

Items	Description
Project Title	Eleven Centers Water Supply and Sanitation
Social Environment	
Residents (population, tribe, consciousness)	Population about 14,700, majority Amhara with high conscious in terms of water and sanitation
Facilities related to life (electricity, etc.)	The electricity is hydro-powered one from Fincha and provided for 24 hours.
Health and Sanitation (diseases, clinic, etc.)	0 hospital, 1 health center, 2 drug stores Intestine parasites are the most common.
Natural Environment	
Topography, Geology and Hydrogeology	Located on northern part of the central plateau with altitude of 2100m. Alkali basalt and tuff dominate the area.
Meteo-hydrology Groundwater/spring/river	Annual rainfall about 1120mm. Groundwater is highly mineralized. There are springs and rivers
Endangered fauna and flora	Nil
Public Nuisance	
Nuisances	Water supply condition is relatively good, comparing to other towns. During rainy season, a few stagnant water appear
Regulations and Compensation	Although the land is officially owned by the state, those who lose their dwelling and commercial area because of the project will be given substitute land. Also, Compensation will be made for properties such as houses and trees, which will be damaged.
Remarks	The rehabilitation of the main drainage system has been carried out by the municipality. No water vendor in this town.

Scoping Format for Initial Environmental Examination in Bure

Environmental Components	Classi-fication	Description
1.Social Environment		
1.1 Resettlement	B	The facilities are small and expected to give no resettlement.
1.2 Economic Activities	D	The economic activities will be enhanced by the water supply and sanitation improvement.
1.3 Facilities	B	The construction work and the facilities have little impact on existing facilities such as schools and hospitals.
1.4 Collapse of Communities	B	Nil. If a water users committee was organized by the community itself to look after the facilities especially public fountains, the community would be enhanced
1.5 Archaeological and Cultural Heritage	B	Nil
1.6 Vested Rights	C	Compensation shall be given for land and properties if these were affected by the Project.
1.7 Public Health and Hygienic Condition	D/C	Sanitary improvement will enhance the condition. Drainage system must be accompanied with the improvement of water supply.
1.8 Waste Disposal	B	During construction works, there will be little waste disposal from the view of the small construction scale. After commissionning, no waste disposal is expected.
1.9 Accidental Damages to Facilities	C	Consideration be paid to the alignment of pipelines in order to avoid public nuisance to dwellers.
2. Natural Environment		
2.1 Geographic and Geological Condition	B	No effect is expected to geographic and geological condition.
2.2 Soil Erosion	C	The earth work gives little soil erosion, judging from the construction scale.

Note) A; Advance Impact, B; Negligible Impact C; Unknown Impact D; Enhancement

to be continued.....

2.3 Surface Water Quality and Quantity	B	The analyzed surface water are within the WHO water guidelines.
2.4 Groundwater Quality and Quantity	C	Effect of overpumping be considered. (Groundwater is highly mineralized).
2.5 Hydrological Situation	B	No effect is expected to hydrological situation.
2.6 Terrestrial Fauna	B	Nil
2.7 Aquatic Fauna	B	Nil
2.8 Vegetation	B	Little effect is expected to vegetation.
2.9 Climatic Conditions	B	No effect is expected to climatic conditions.
2.10 Aesthetic Condition	B	The facilities would give little change to the condition judging from the size.
3. Public Nuisance		
3.1 Air Pollution	B	Nil
3.2 Water Pollution	B	Nil
3.3 Soil Pollution	B	Nil
3.4 Noise and Vibration	B	The construction works do not give rise to noticeable noise and vibration.
3.5 Land Subsidence	B	The location of new boreholes is designed away from the dwelling area. The land is composed of basalt lava, giving little expectation of land subsidence.
3.6 Odour	B	Nil
3.7 Traffic Nuisance	C	In case of pipeline being laid across road the traffic will be interrupted.

Note) A; Advance Impact, B; Negligible Impact C; Unknown Impact D; Enhancement

Appendix - 7

Project Cost Break-Down (Water Supply)

Summary of Cost Estimation of Water Supply in Bure

No.	Description	F.C.(B)	L.C.(B)	Total(B)
I.	Target year of 2005			
1	Civil Work			
	Mobilization and Demobilization	100,000	150,000	250,000
	Excavation and Earth-work	6,760	17,300	24,060
	Trench excavation	279,070	625,830	904,900
	Pipe-work	320,290	320,290	640,580
	Reservoir	99,000	99,000	198,000
	Pumping station, R.C.pump house	132,048	87,984	220,032
	Access road	178,000	414,000	592,000
	Bore-hole (200mm casing)	89,600	134,400	224,000
	Water purifiction unit	10,000	15,000	25,000
	Booster pump and necessary works	360,000	600,000	960,000
	Electric submersible pump and necessary works	60,000	90,000	150,000
	Power supply	35,850	38,775	74,625
	Concrete work	179,850	335,800	515,650
	Masonsy work	60,000	245,000	305,000
	Structure	99,180	231,440	330,620
	Temporary work(10% of above total)	200,965	299,730	500,695
	Total of civil work	2,210,613	3,704,549	5,915,162
2	Material & Equipment	7,037,044	492,383	7,529,427
	Sub Total	9,247,657	4,196,932	13,444,589
3	Engineering cost(12% of sub tatal)	1,613,351		1,613,351
4	Contingency (5%)	543,050	209,847	752,897
	Total(birr)	11,404,058	4,406,779	15,810,837
	Total(Yen:1birr=15yen)			237,163,000
5	Buildings		3,368,921	3,368,921
6	WSSD's management cost		383,595	383,595
	Total		3,752,516	3,752,516
7	Prise escalation(6%)	684,243	489,558	1,173,801
	Grand Total	12,088,301	8,648,853	20,737,154
II.	Target year of 2010			
1	Morbilization and demorbilization			300,000
2	Rising line			1,260,000
3	Distribution network			1,200,000
4	Intake and canal			1,318,000
5	Treatment plant			0
6	Booster pump with house			534,000
7	Power supply facilities			170,000
8	Chamber and structures			324,000
9	Buildings			937,000
10	Others			498,000
	Sub total			6,541,000
11	Engineering cost (10%)			654,100
12	Contingency (10%)			719,510
	Total			7,915,000
	Prise escalation(42%)			3,324,000
	Grand Total			11,239,000

Cost Estimation of Construction & Materials/Equipment of Bure : Target year of 2005

No.	Description	Unit	Q'ty	Unit-Rate F.C.(B)	Unit-Rate L.C.(B)	Amount F.C.(B)	Amount L.C.(B)	Remarks
1.	Mobilization and Demobilization	LS				100,000	150,000	
2.	Excavation and Earth-work							
2-1	Clearing and grubbing the site	ha	2	480	2,400	960	4,800	to remove bushes, small forest and trees
2-2	Clear off the site	sqm	2,000	1	2	2,000	4,000	to remove top soil to an average depth of 20cm
2-3	Bulk excavation							
	a) Earth excavation	cum	100	6	14	600	1,400	
	b) Excavation of weathered rock	cum	100	10	20	1,000	2,000	
	c) Soft rock excavation	cum	50	14	32	700	1,600	
	d) Sound rock excavation	cum	50	30	70	1,500	3,500	
3.	Trench excavation							
3-1	Trench excavation for water pipe							
	1) Single pipe in trench							
	a) 0.6~1.0m depth	m	14,790	4	8	59,160	118,320	
	b) 1.0~1.5m depth	m	8,590	7	17	60,130	146,030	
	c) 1.5~2.5m depth	m	700	10	23	7,000	16,100	
3-2	Trench, Rock excavation	cum	300	30	70	9,000	21,000	
3-3	Back-fill with the same material	m	16,660	5	11	83,300	183,260	
3-4	Selected soil bedding	m	6,720	2	5	13,440	33,600	150mm thick below barrel
3-5	Back-fill with selected material	m	6,720	7	16	47,040	107,520	compacted in layers not more than 20cm thick
4.	Pipe-work							
4-1	Presure pipe NP 10							with push-in flexible joints
	1) PVC pipe							
	a) DN 50mm	m	4,720	5	5	23,600	23,600	
	b) DN 75mm	m	10,070	8	8	80,560	80,560	
	c) DN 100mm	m	3,490	10	10	34,900	34,900	
	d) DN 150mm	m	5,100	17	17	86,700	86,700	
4-2	Pressure steal pipe							fitting and supports for bridge and road
	DN 200mm	m	690	137	137	94,530	94,530	
5.	Reservoir							
5-1	Ground level reservoir	m3	110	900	900	99,000	99,000	
6.	Pumping station, R.C.pump house	sqm	72	1,834	1,222	132,048	87,984	with accessaries

No.	Description	Unit	Q'ty	Unit-Rate F.C.(B)	Unit-Rate L.C.(B)	Amount F.C.(B)	Amount L.C.(B)	Remarks
7.	Access road	m	2,000	89	207	178,000	414,000	3m wide gravel road with draine ditch
8.	Borehole							
8-1	New drilling	m	280	320	480	89,600	134,400	including, casing, packing and pumping test
9.	Water purifiction unit	No.	1	10,000	15,000	10,000	15,000	
10.	Booster pump	No.	6	60,000	100,000	360,000	600,000	foundation, pump, and motor with accessories
11.	Electric submersible pump (for deep well)	No.	3	20,000	30,000	60,000	90,000	foundation, and pump with accessories
12.	Power supply							
12-1	Generating set	No.	1	5,850	8,775	5,850	8,775	gererater with accessaries
12-2	High tension line	m	2,000	8	7	16,000	14,000	
12-3	Low tension line	m	1,000	6	4	6,000	4,000	
12-4	Trensformer	No.	2	4,000	6,000	8,000	12,000	transformer with accessaries
13.	Concrete work							
13-1	Normal concrete (250kg of cement per cum)	cum	150	250	500	37,500	75,000	including form-work, vibration and curing
13-2	Reinforced concrete (360kg of cement per cum)							including vibration and curing
	Water retaining structure	cum	350	275	642	96,250	224,700	
13-3	Form-work							including all necessary works
	Wall	sqm	300	37	87	11,100	26,100	
13-4	Reinforcement bars; Steel bars	kg	5,000	7	2	35,000	10,000	including cutting, bending and placing
14.	Masonsy work							
14-1	Roughly dressed 40cm thick stone elevation wall	sqm	1,000	60	245	60,000	245,000	up to 3m height
14-2	Brick work with mortor							
	a) 25cm thick	sqm		23	92	0	0	
	b) 15cm thick	sqm		12	45	0	0	
15.	Structure							
15-1	Construction of public fountains	No.	3	1,580	3,680	4,740	11,040	
15-2	Construction of hydrant	No.	12	230	540	2,760	6,480	
15-3	Construction of R.C.C. aeration chamber	No.	3	5,730	13,370	17,190	40,110	
15-4	Construction of R.C.C. valve chamber	No.	13	5,730	13,370	74,490	173,810	
	Sub-Total of Construction work					2,009,648	3,404,819	

No.	Description	Unit	Q'ty	Unit-Rate F.C.(B)	Unit-Rate L.C.(B)	Amount F.C.(B)	Amount L.C.(B)	Remarks
16.	Material & Equipment (Ref.table)							
16-1	CIF Cost at Addis Ababa					7,037,044		
16-2	Inland transportation cost						492,383	CIF cost x 7 %
	Sub-Total of Material & Equipment					7,037,044	492,383	
	Total					9,046,692	3,897,202	
17.	Building							
17-1	Office	sqm	420		1,910		802,200	
17-2	Workshop	sqm	394		1,624		639,856	
17-3	Store	sqm	459		1,337		613,683	
17-4	Residence	sqm	625		2,101		1,313,125	
	Total						3,368,921	

Imported Cost (Material & Equipment) of Bure :Target year of 2005

No.	Description	Unit	Q'ty	Unit Rate (B)	Amount (B)
1.	Pipe material including joint and accessories				
1.1	PVC pipe NP-10				
	a) DN 50mm	m	4,960	15	74,400
	b) DN 75mm	m	10,570	30	317,100
	c) DN 100mm	m	3,660	40	146,400
	d) DN 150mm	m	5,360	80	428,800
1.2	Suspended pressure steel pipe				
	e) DN 200mm W/O gilt and screw	m	730	288	210,240
1.3	Fitting cost Total cost × 20%				235,388
2	Pumps (Pump with electric motor/accessories)				
2.1	Centrifugal pumps				
	a) Q= 1.1 m3/min H= 46m HP= 22 kw	set	4	500,000	2,000,000
	b) Q= 0.66m3/min H= 90m HP= 30 kw	set	2	500,000	1,000,000
2.2	Submersible pumps with accessories				
	a) Q= 0.12m3/min H= 100m	set		130,000	0
	b) Q= 1.2m3/min H= 20m	set	3	200,000	600,000
3	Power Supply(Materials&accessories)				
3.1	Power supply generating set				
	a) 10 KVA	set		120,000	0
	b) 15 KVA	set		187,000	0
	c) 70 KVA	set	1	510,000	510,000
3.2	Tension line				
	a) High tension over head line 15KV	m	2,000	50	100,000
	b) Low tension over head line	m	1,000	28	28,000
3.3	Plate-form mounted transformer				
	Supply of transformer wiht acccessories				
	Transformer 45 KVA (H-type)	set	2	50,000	100,000
4	Valve (Valve with accessories)				
4.1	Sluice valve				
	a) ϕ50	set		1,000	0
	b) ϕ75	set		1,300	0
	c) ϕ150	set	4	1,700	6,800
	d) ϕ200	set	4	2,200	8,800
	e) ϕ250				
4.2	High speed air valve				
	ϕ50	set	3	7,000	21,000
4.3	Pressure reducing valve				
	ϕ150	set	2	10,000	20,000
4.4	Check valve				
	100mm	set	1	10,000	10,000
5	Flow meter (Meter with accessories ϕ100)	set	1	50,000	50,000
6	Reservoir equipment	set	2	100,000	200,000
7	Well (Materials with accessories)				
7.1	Casing pipe DN200 FRP	m	212	2,093	443,716
7.2	Screen DN200	m	68	5,700	387,600
7.3	Riser pipe, Stainless DN65	m	310	180	55,800
8	Water purification unit	set	1	80,000	80,000
	Total				7,037,044

Investment Cost of Target Year 2010 in Bure

No.	Description	Unit	Q'ty	Unit Rate (B)	Amount (B)
1	Mobilization and demobilization	LS			300,000
2	Rising line	Km	4.2	300,000	1,260,000
3	Distribution network	Km	8	150,000	1,200,000
4	New borehole with pumps & material	Set	2	659,000	1,318,000
5					
6	Booster pump with house	Set	1	534,000	534,000
7	Power supply facilities	Site	1	170,000	170,000
8	Chamber and structures	Set	12	27,000	324,000
9	Buildings	M2	10	93,700	937,000
	Others	LS			498,000
	Sub total				6,541,000
11	Enginering cost (10%)				654,100
12	Contingency (10%)				719,510
	Total				7,914,610

Appendix - 8

Meteorological Data

Table 1 Monthly Precipitation

Station: Bure

Unit:mm

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
1959	--	--	--	--	--	--	303.0	206.5	--	--	25.0	52.0	--
1960	0.0	8.0	7.0	60.0	144.0	138.0	316.0	--	--	--	--	--	--
1961	--	90.0	64.0	68.0	159.0	--	--	225.9	--	--	133.6	--	--
1962	--	47.0	24.0	--	170.0	--	236.0	--	--	--	--	--	--
1963	--	26.0	--	87.0	214.0	101.0	53.3	216.0	--	--	--	--	--
1964	9.0	--	--	--	99.0	38.0	286.0	163.6	162.6	100.0	18.3	38.8	--
1965	10.1	9.5	0.0	101.4	33.6	95.0	271.7	193.7	61.4	123.3	51.3	18.3	969.3
1966	0.0	1.0	50.7	--	--	138.3	210.0	214.0	--	84.0	15.0	0.0	--
1967	0.0	0.0	89.0	--	--	264.0	--	239.9	--	--	--	--	--
1968	--	--	--	--	51.0	121.0	251.0	191.0	75.5	21.9	9.0	0.0	--
1969	--	--	79.0	147.0	40.0	146.0	146.0	103.0	--	118.0	16.0	--	--
1970	5.1	14.1	20.9	56.8	28.0	148.4	251.7	188.8	195.2	--	115.3	--	--
1971	--	--	--	--	--	--	--	--	--	--	--	--	--
1972	--	--	--	--	--	--	--	--	--	--	--	--	--
1973	0.0	0.0	8.9	--	201.9	156.9	284.4	370.8	81.6	121.5	11.4	--	--
1974	--	--	--	--	--	177.5	176.7	203.2	--	17.0	--	--	--
1975	--	--	--	--	63.8	163.7	246.4	541.1	--	--	--	--	--
1976	--	--	--	--	--	222.2	243.8	172.6	132.0	--	--	--	--
1977	--	--	--	--	124.7	204.7	229.3	165.5	--	--	--	--	--
1978	--	--	--	--	--	--	--	--	146.8	54.6	--	--	--
1979	--	--	--	--	--	--	--	--	--	--	--	--	--
1980	--	--	--	--	--	--	--	--	--	--	--	--	--
1981	--	--	--	--	--	--	--	--	--	--	--	--	--
1982	59.6	38.4	34.0	53.7	--	--	--	--	--	--	--	--	--
1983	--	--	--	--	--	--	--	--	--	--	--	--	--
1984	--	--	--	--	--	--	--		--	--	--	--	--
1985	--	--		--	--	--	--	--	--	--	--	--	

1986	--	--	--	--	--	--	--	--	--	--	--	--	--
1987	0.0	2.3	28.5	48.1	--	--	--	--	--	--	--	--	--
1988	24.9	20.9	2.4	0.0	--	--	242.3	221.6	--	--	--	--	--

Note: - = not calculated due to missing data

Table 2 Long Term Monthly Mean Potential Evapotranspiration (PET)

Station: Debre Markos

Unit:mm

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
1st 10 days	38	39	40	39	40	43	44	47	48	47	48	46	
2nd 10 days	46	43	39	38	34	32	32	30	30	31	31	33	
3rd 10 days	33	34	37	39	41	39	36	34	34	35	36	37	
Total	117	116	116	116	115	114	112	111	112	113	115	116	1712

Table 3 Monthly Average Maximum Air Temperature

Station: Debre Markos

Unit: ℃

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
1953	--	--	--	--	--	--	--	--	--	--	23.2	23.2
1954	24.5	25.5	24.7	25.6	25.0	19.9	18.9	19.5	20.8	20.5	22.3	22.4
1955	22.2	23.8	24.8	23.3	23.2	20.4	18.4	17.9	19.6	21.2	22.2	21.9
1956	22.8	25.4	25.9	22.7	22.5	19.5	17.2	17.5	19.3	19.6	20.9	22.5
1957	24.1	23.7	21.5	22.9	23.1	20.7	18.5	18.3	21.2	22.6	23.8	24.5
1958	24.1	24.8	26.3	24.9	25.3	19.8	17.7	18.4	19.7	20.5	22.1	22.7
1959	23.5	24.9	25.6	25.6	24.2	21.7	18.3	18.0	19.5	20.9	22.5	23.7
1960	23.7	24.6	24.5	25.4	23.0	21.2	18.0	19.1	19.7	21.5	23.4	22.9
1961	24.9	24.2	24.9	23.0	24.4	21.2	17.9	17.8	19.3	20.7	21.0	21.6
1962	22.9	24.8	23.8	26.0	23.1	20.6	18.6	17.9	19.5	20.8	21.7	22.8
1963	22.9	24.1	25.7	23.2	--	20.5	--	18.7	20.0	21.9	21.7	20.9
1964	23.2	24.5	26.2	25.0	23.0	20.0	18.1	18.5	18.9	19.8	21.3	20.8
1965	22.2	24.3	25.6	23.5	25.6	21.6	19.1	18.6	20.5	20.6	20.7	21.5
1966	22.9	23.7	24.4	24.5	25.5	21.0	19.1	18.9	20.0	21.6	21.8	22.9
1967	23.9	25.5	24.8	25.1	23.4	21.6	18.0	18.3	19.4	20.5	21.2	22.0

1968	23.8	22.9	25.5	24.4	24.2	20.6	19.3	19.7	20.4	21.7	22.5	23.6
1969	22.8	22.6	22.6	24.6	23.9	21.8	19.3	19.4	20.7	22.4	24.0	24.4
1970	--	--	--	--	--	--	--	--	--	--	--	--
1971	23.9	25.7	--	26.7	23.7	20.8	19.3	19.4	20.3	21.1	21.7	22.0
1972	24.0	24.6	26.0	--	--	22.0	20.3	20.2	20.7	22.8	23.2	24.3
1973	25.1	26.8	27.6	26.7	22.6	21.3	19.0	18.8	20.3	21.1	22.3	22.2
1974	23.6	25.0	23.1	--	22.9	21.0	18.8	19.0	19.7	21.6	21.9	--
1975	--	24.0	25.6	25.4	--	21.2	18.9	19.3	--	21.4	22.2	22.9
1976	23.9	25.3	24.8	24.7	22.4	21.3	19.0	18.9	20.8	22.5	21.3	22.9
1977	23.2	24.2	24.8	27.0	23.5	19.9	18.7	19.0	20.1	20.6	21.5	22.6
1978	23.8	25.3	25.9	25.4	24.1	21.3	17.8	19.1	19.5	21.1	22.0	22.3
1979	21.8	24.2	25.1	25.9	24.0	21.9	19.2	19.7	--	22.3	23.0	23.8
1980	--	--	25.6	24.5	22.9	20.6	18.6	19.0	21.0	21.6	22.6	23.5
1981	24.2	25.7	24.3	24.3	23.8	22.3	--	18.8	--	21.6	22.9	23.2
1982	23.5	24.3	24.7	24.8	23.4	21.3	18.6	18.3	19.9	20.7	21.5	22.4
1983	23.5	24.8	25.6	25.4	23.6	21.8	19.5	18.1	19.2	19.9	20.8	22.1
1984	23.1	25.2	25.4	--	23.4	18.9	18.2	19.0	19.8	22.4	23.2	23.4
1985	24.4	24.8	25.7	24.5	21.4	19.9	17.8	18.1	19.9	--	22.4	22.8
1986	24.0	24.5	24.6	23.3	25.2	19.5	18.5	18.6	--	--	--	--
1987	23.7	24.6	23.3	24.1	22.4	19.8	19.9	19.4	21.6	22.1	23.1	23.9
1988	24.6	24.5	26.7	26.3	25.8	20.8	--	18.9	19.7	--	--	22.6
1989	23.3	23.7	23.6	22.5	23.3	20.5	18.5	19.0	20.2	21.5	23.3	22.0
1990	23.7	24.4	25.1	25.0	24.9	21.3	18.7	18.8	19.9	21.8	23.3	24.0
1991	24.7	--	--	--	--	--	18.0	18.6	20.4	22.0	22.9	22.6
1992	22.7	23.6	25.6	24.8	23.5	20.3	18.2	17.7	19.4	20.6	21.2	23.3
1993	23.7	23.8	25.8	--	22.7	20.5	19.5	--	20.1	--	23.5	24.3
1994	25.3	26.3	--	26.0	24.0	20.3	18.9	18.7	20.8	--	--	--
1995	25.5	26.4	26.7	25.4	23.8	--	--	--	--	--	--	--

Note: - = not calculated due to missing data

Table 4 Monthly Average Minimum Air Temperature

Station: Debre Markos Unit: ℃

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
1953	—	--	—	--	--	--	--	—	--	—	8.8	9.5
1954	8.0	10.3	11.1	—	--	10.2	10.2	10.2	9.4	7.8	7.0	6.4
1955	7.9	8.2	9.4	9.6	9.5	9.2	9.6	9.9	9.6	8.4	7.7	7.9
1956	6.7	8.4	10.8	11.0	10.1	9.0	9.7	9.6	8.9	9.0	6.3	6.9
1957	6.5	8.4	10.5	10.1	10.1	9.2	10.4	10.1	9.3	9.2	9.1	7.7
1958	9.3	9.2	11.5	12.0	11.6	10.1	10.9	10.8	10.2	—	7.5	8.3
1959	8.0	8.3	10.2	—	—	—	10.2	9.8	9.4	8.9	6.9	6.1
1960	6.3	9.2	8.4	9.0	9.6	8.2	9.0	9.4	8.3	7.6	6.7	6.8
1961	6.7	7.6	9.0	9.1	9.1	8.2	8.3	8.1	7.3	6.3	6.7	5.8
1962	3.7	5.2	7.6	7.8	8.0	6.4	7.4	7.2	6.0	4.6	5.2	—
1963	7.1	8.6	10.1	10.3	—	9.3	—	10.3	9.3	8.4	9.3	7.3
1964	8.4	9.3	9.8	10.7	10.8	9.5	10.4	9.9	9.4	8.5	5.9	6.6
1965	6.5	8.2	9.4	9.6	10.4	9.3	10.0	9.4	8.5	7.4	8.4	5.9
1966	7.5	7.6	8.8	9.7	9.7	8.4	9.3	9.4	8.2	8.2	7.1	5.4
1967	5.7	8.1	9.0	9.5	9.6	9.1	9.1	8.7	8.4	7.9	6.9	3.8
1968	4.4	5.6	7.3	8.0	9.4	8.8	8.9	8.4	—	8.7	7.4	6.0
1969	8.2	9.3	11.0	11.1	11.3	9.9	10.6	10.2	9.7	9.1	8.4	6.8
1970	—	—	--	—	--	--	—	—	--	--	—	—
1971	7.6	8.7	—	11.1	10.8	10.3	9.9	9.7	9.1	8.5	7.6	6.2
1972	7.8	8.0	9.9	10.2	11.0	9.5	10.8	9.8	9.3	9.3	8.5	8.3
1973	7.9	9.9	11.7	12.2	10.8	9.9	10.5	10.3	9.4	9.2	7.8	5.8
1974	7.8	9.1	9.6	—	10.9	9.3	9.5	9.9	8.6	8.6	6.0	—
1975	—	9.6	10.5	—	--	9.8	9.6	9.9	—	8.4	7.5	6.6
1976	7.6	8.9	10.5	10.4	10.3	10.1	11.0	9.0	8.6	8.9	7.9	7.4
1977	7.9	8.6	10.3	10.2	10.4	10.0	9.9	9.8	9.2	10.0	7.2	7.3
1978	7.2	8.4	10.0	11.7	10.1	9.7	9.9	9.6	8.9	8.4	7.1	7.5
1979	7.9	8.7	10.4	11.3	10.8	10.5	10.1	10.2	--	9.1	7.9	7.7
1980	--	--	11.0	11.7	11.4	10.4	10.3	10.4	10.1	9.4	8.8	7.8

1981	9.2	9.5	11.0	11.3	11.4	10.3	--	10.1	--	9.2	8.3	7.8
1982	9.3	10.0	11.5	10.9	11.5	10.2	10.2	10.2	9.6	8.9	8.6	8.0
1983	7.5	9.6	10.9	11.1	11.7	10.6	10.5	10.8	10.5	9.7	8.9	7.0
1984	8.0	8.7	11.9	13.0	11.9	10.2	10.3	10.1	9.8	8.6	9.7	8.7
1985	9.3	9.7	12.1	11.3	11.3	10.5	10.2	10.5	9.7	9.2	8.6	--
1986	--	10.1	11.1	11.2	11.9	11.0	10.3	10.1	--	--	--	--
1987	8.6	10.7	11.3	12.1	12.6	--	10.7	10.8	10.0	10.2	8.7	9.3
1988	9.9	11.3	12.0	12.3	12.3	10.9	--	10.8	10.5	--	--	6.1
1989	5.9	8.0	8.9	9.0	9.5	8.7	9.0	8.8	8.8	7.8	7.0	8.8
1990	7.9	9.0	9.7	10.3	11.2	9.8	10.3	10.1	9.7	8.8	9.1	8.3
1991	9.9	--	--	--	--	--	11.3	10.9	10.4	9.4	8.5	8.7
1992	9.5	9.8	12.0	12.0	12.5	10.9	10.7	11.0	10.0	10.1	8.8	8.9
1993	8.5	9.5	10.8	--	11.3	10.7	10.7	--	9.9	--	8.8	8.6
1994	9.1	9.9	--	12.3	11.5	11.1	11.0	10.9	10.1	--	--	--
1995	9.1	10.8	10.8	12.6	12.3	--	--	--	--	--	--	--

Note: - = not calculated due to missing data

Table 5 Monthly Average Air Temperature

Station: Debre Markos Unit: ℃

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
1953	--	--	--	--	--	--	--	--	--	--	16.4	12.6
1954	16.3	17.9	17.9	--	--	15.1	14.6	14.9	15.1	14.2	14.7	14.4
1955	15.1	16.0	17.1	16.5	16.4	14.8	14.0	13.9	14.6	15.0	15.0	14.9
1956	14.8	16.9	18.4	16.9	16.3	14.3	13.5	13.6	14.1	14.3	13.6	14.7
1957	15.3	16.1	16.0	16.5	16.6	15.0	14.5	14.2	15.3	15.9	16.5	16.1
1958	16.7	17.0	18.9	18.5	18.5	15.0	14.3	14.6	15.0	--	14.8	15.5
1959	15.8	16.6	17.9	--	--	--	14.3	13.9	14.5	14.9	14.7	14.9
1960	15.0	16.9	16.5	17.2	16.3	14.7	13.5	14.3	14.0	14.6	15.1	14.9
1961	15.8	15.9	17.0	16.1	16.8	14.7	13.1	13.0	13.3	13.5	13.9	13.7
1962	13.3	15.0	15.7	16.9	15.6	13.5	22.3	12.6	12.8	12.7	24.3	--
1963	15.0	16.4	17.9	16.8	--	14.9	--	14.6	14.7	15.2	15.5	14.1
1964	15.8	16.9	18.0	17.9	16.9	14.8	14.3	14.2	14.2	14.2	13.6	13.7

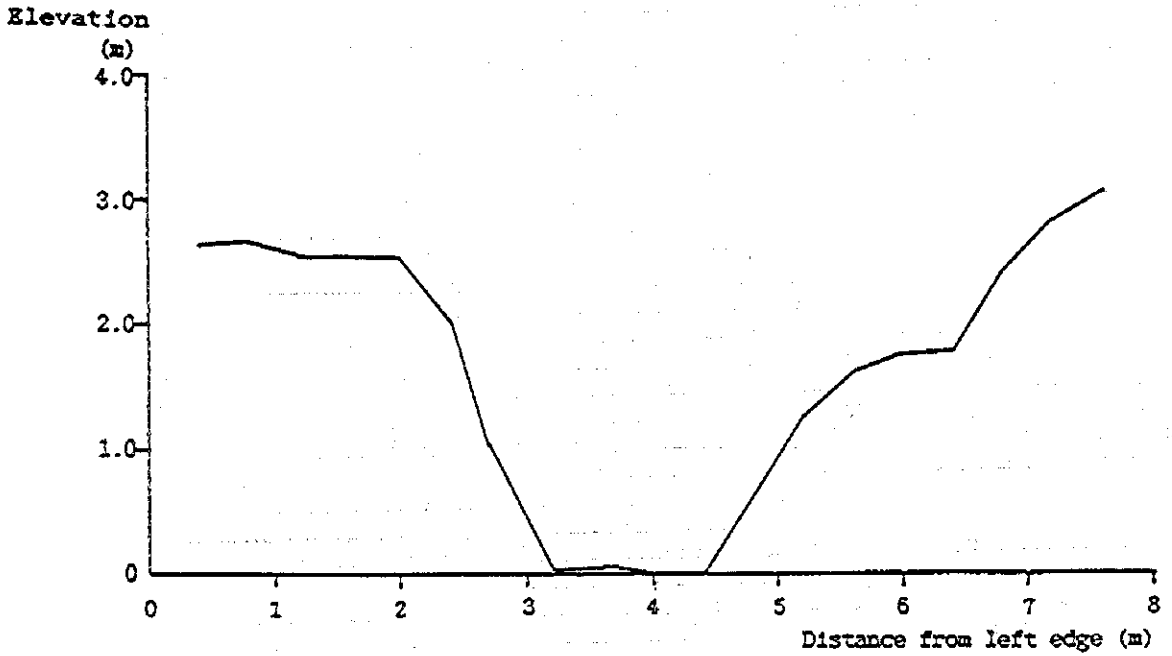
1965	14.4	16.3	17.5	16.6	18.0	15.5	14.6	14.0	14.5	14.0	14.6	13.7
1966	15.2	15.7	16.6	17.1	17.6	14.7	14.3	14.2	14.1	14.9	14.5	14.2
1967	14.8	16.8	16.9	17.3	16.5	15.4	13.6	13.5	13.9	14.2	14.1	12.9
1968	14.1	14.3	16.4	16.2	16.8	14.7	14.1	14.1	--	15.2	15.0	14.8
1969	15.5	16.0	16.8	17.9	17.6	15.9	15.0	14.8	15.2	15.8	16.2	15.6
1971	15.8	17.2	--	18.9	17.3	15.6	14.6	14.6	14.7	14.8	14.7	14.1
1972	15.9	16.3	15.5	--	--	15.8	15.6	15.0	15.0	16.1	16.9	16.3
1973	16.5	18.4	19.7	19.5	16.7	15.6	14.8	14.6	14.9	15.2	15.1	14.0
1974	15.7	17.1	16.4	--	16.9	15.2	14.2	14.5	14.2	15.1	14.0	--
1975	--	16.8	18.1	--	--	15.5	14.3	14.6	--	14.9	14.9	14.8
1976	15.8	17.1	17.7	17.6	16.4	15.7	15.0	14.0	14.7	15.7	14.6	15.2
1977	15.6	16.4	17.6	18.6	17.0	15.0	14.3	14.4	14.7	15.3	14.4	15.0
1978	15.5	16.9	18.0	18.6	17.1	15.5	13.9	14.4	14.2	14.8	14.6	14.9
1979	14.9	16.5	17.8	18.6	17.4	16.2	14.7	15.0	--	15.7	15.5	15.8
1980	--	--	18.3	18.1	17.2	15.5	14.5	14.7	15.6	15.5	15.7	15.7
1981	16.7	17.6	17.7	17.8	17.6	16.3	--	14.5	--	15.4	15.6	15.5
1982	17.4	17.2	18.1	17.9	17.5	15.8	14.4	15.3	14.8	14.8	15.1	15.2
1983	16.5	17.2	19.3	18.3	17.7	16.2	15.0	14.5	14.9	14.8	15.9	14.6
1984	15.6	17.0	18.7	--	17.7	14.6	14.3	14.6	14.8	15.5	16.5	16.1
1985	17.9	17.3	15.9	17.9	16.4	15.2	14.0	14.3	14.8	--	15.5	--
1986	--	17.3	17.9	17.3	18.6	15.3	14.4	14.4	--	--	--	--
1987	16.2	17.7	17.3	13.1	17.5	--	15.3	15.1	15.8	16.2	15.9	16.6
1988	17.3	17.9	18.4	19.3	19.1	15.9	--	14.9	15.1	--	--	14.4
1989	14.6	15.9	17.3	15.8	16.5	14.6	13.8	13.9	14.5	14.7	15.2	15.4
1990	15.8	16.7	17.4	17.7	18.1	15.6	14.5	14.5	14.8	15.3	16.2	16.2
1991	--	--	--	--	--	--	14.7	14.8	15.4	15.7	15.7	15.7
1992	16.1	16.7	18.0	18.4	18.0	15.6	14.5	14.4	14.7	15.4	14.9	16.1
1993	16.1	16.7	18.3	--	17.0	15.6	15.1	--	15.0	--	16.2	16.5
1994	17.2	13.2	--	19.2	17.8	15.7	15.0	14.8	15.5	--	--	--
1995	17.3	18.6	18.8	19.0	18.1	--	--	--	--	--	--	--

Note: - = not calculated due to missing data

Appendix - 9

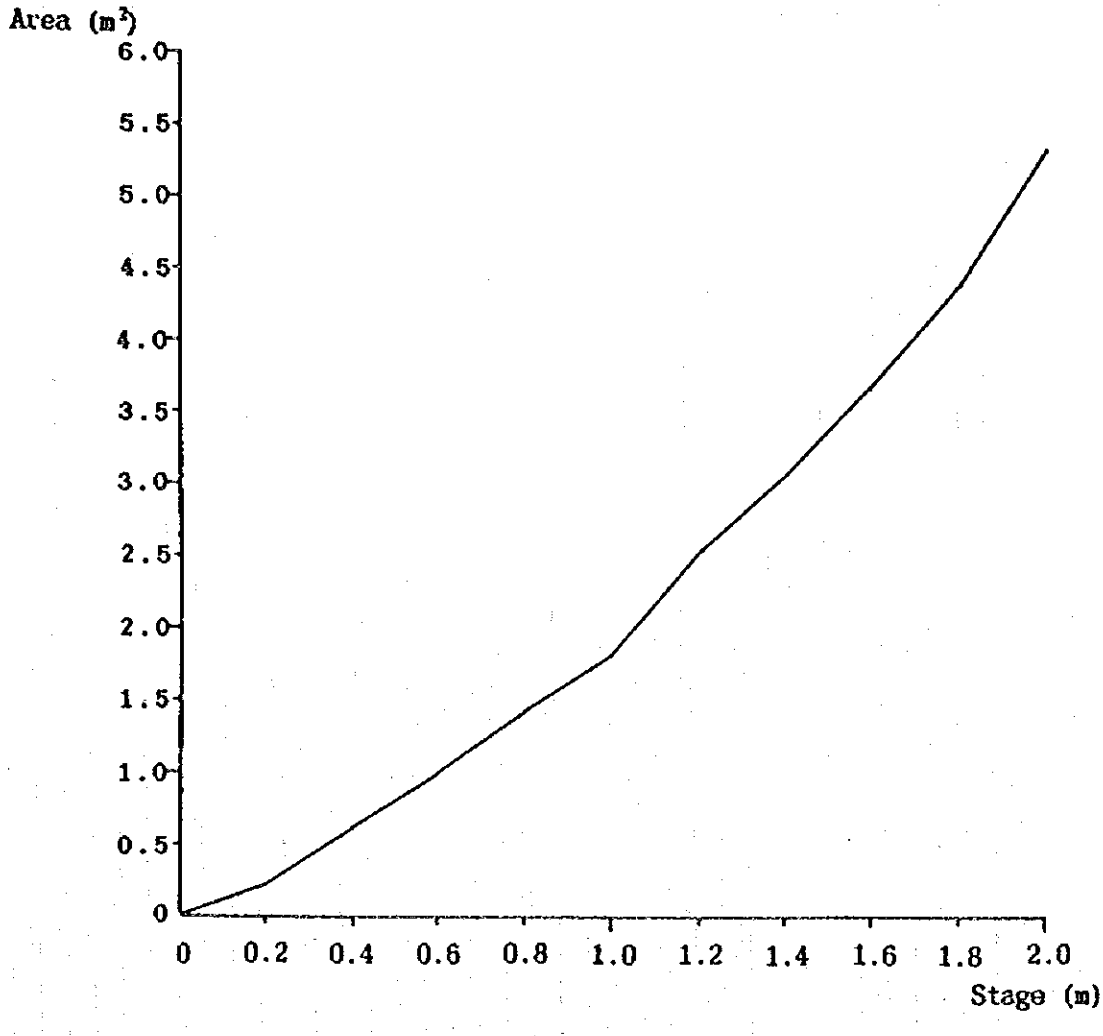
Hydrological Data

Figure 1 Cross Sectional Profile
Manzana River at Bure



Distance from the left edge (m)	Elevation from the reference level (m)
0.40	2.638
0.80	2.668
1.20	2.550
1.60	2.560
2.00	2.538
2.40	2.015
2.70	1.035
3.20	0.035
3.70	0.055
4.00	0.002
4.40	0.022
4.80	0.658
5.20	1.269
5.60	1.610
6.00	1.750
6.40	1.770
6.80	2.400
7.20	2.800
7.60	3.042

Figure 2 Relation Between Stage and Area
Manzana River at Bure



Stage (m)	Cross Sectional Area (m²)
0.20	0.225
0.40	0.625
0.60	1.000
0.80	1.425
1.00	1.825
1.20	2.550
1.40	3.050
1.60	3.675
1.80	4.375
2.00	5.325

Figure 3 The Discharge Rating Curve
Manzana River at Bure

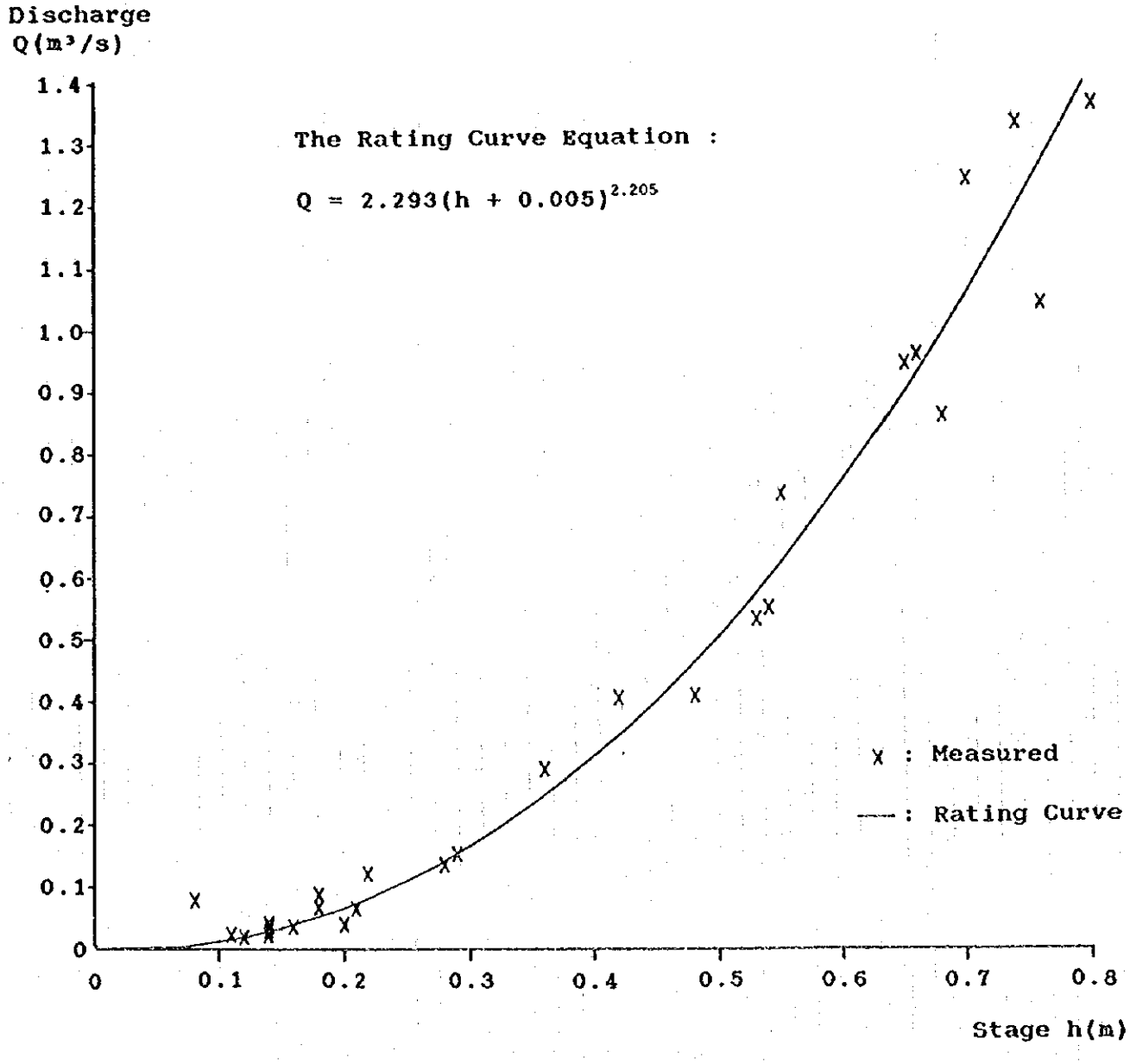


Table 1 Result of Discharge Measurements

Order No.	Date	Rating	Stage (m)	Velocity (m/s)	Area (m^2)	Measured Discharge (m^3/s)	Calculated Discharge (m^3/s)
1	17/7/95		.080	.100	.80	.080	
2	18/7/95	A	.200	.340	.11	.039	.095
3	19/7/95	A	.110	.240	.10	.024	.005
4	19/7/95	A	.120	.260	.08	.021	.012
5	21/7/95	A	.140	.280	.15	.041	.029
6	21/7/95	A	.180	.360	.24	.088	.071
7	23/7/95	A	.220	.600	.20	.121	.121
8	24/7/95	A	.180	.400	.17	.068	.071
9	24/7/95	A	.360	.840	.35	.290	.330
10	26/7/95	A	.280	.440	.30	.133	.204
11	27/7/95	A	.480	1.170	.35	.410	.540
12	27/7/95	A	.210	.310	.21	.066	.108
13	29/7/95	A	.160	.250	.14	.034	.049
14	29/7/95	A	.550	.980	.75	.736	.673
15	29/7/95	A	.530	.720	.74	.535	.634
16	1/8/95	A	.290	.420	.36	.152	.219
17	1/8/95	A	.540	.620	.89	.552	.653
18	1/8/95	A	.420	.590	.68	.404	.432
19	1/8/95	A	.680	.840	1.02	.861	.936
20	1/8/95	A	.760	.880	1.18	1.042	1.107
21	1/8/95	A	.800	1.092	1.25	1.364	1.195
22	4/8/95	A	.140	.270	.14	.037	.029
23	5/8/95	A	.140	.270	.13	.028	.029
24	6/8/95	A	.740	1.127	1.19	1.343	1.063
25	6/8/95	A	.700	1.113	1.12	1.246	.978
26	6/8/95	A	.660	1.050	.91	.960	.894
27	6/8/95	A	.650	1.022	.92	.944	.873
28	6/8/95	A	.140	.200	.11	.022	.029

Note : A = Data is used for obtaining the rating curve

Figure 4 Discharge Hydrograph of Manzana River at Bure
Period : May 28 - August 11, 1995

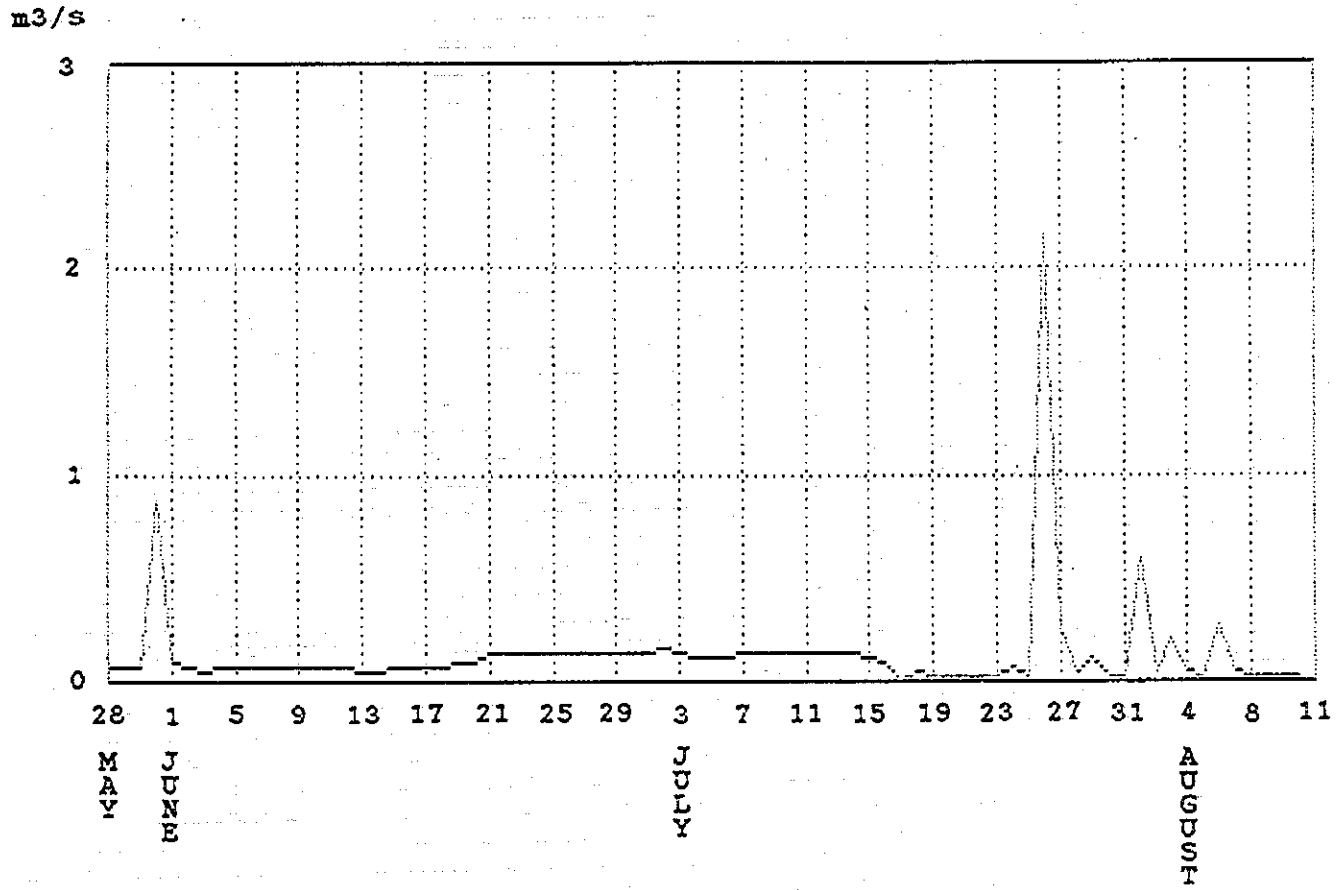


Table 2 Daily Gauge Readings and Discharges, Manzana River at Bure

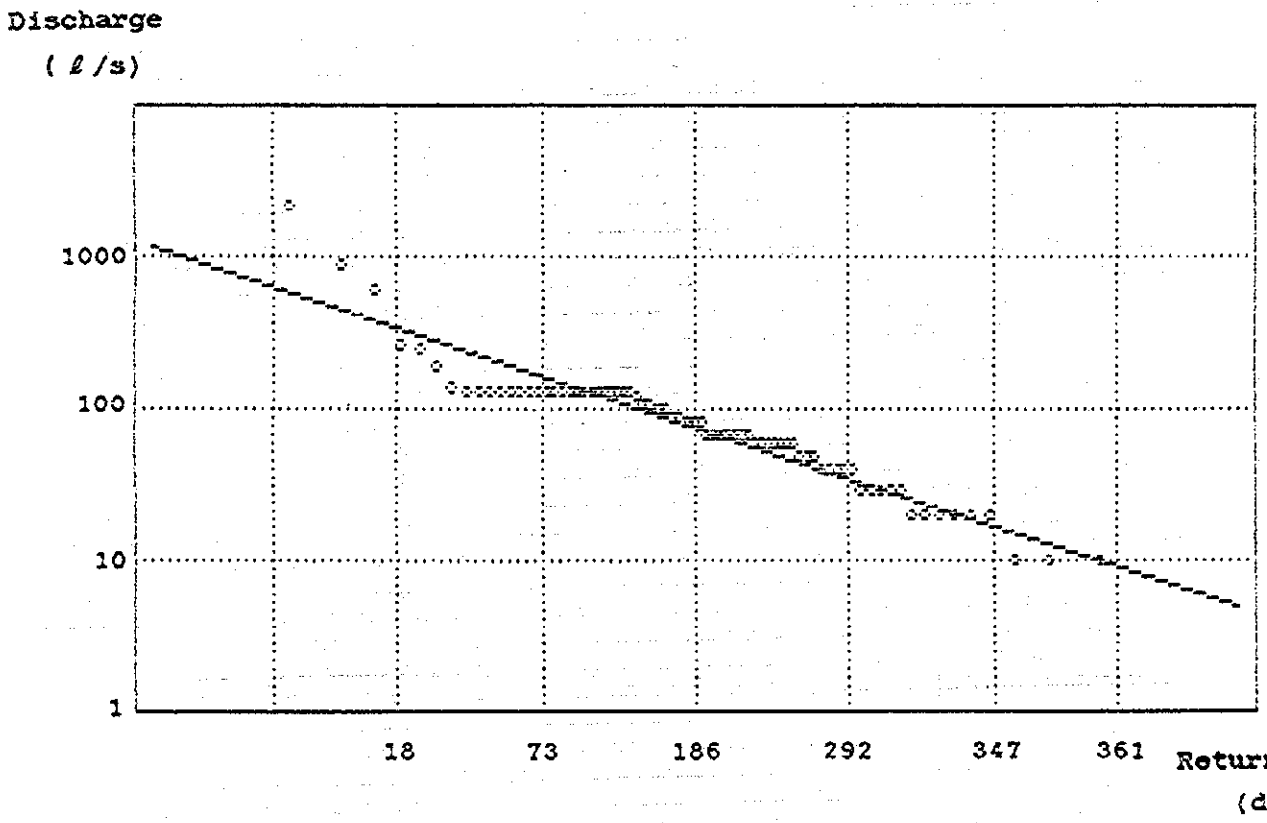
Period : May 28 -- August 11, 1995 1/3

Date	Daily Mean Gauge Readings (m)	Daily Mean Discharge (m^3/s)
May 28	0.200	0.070
29	0.185	0.059
30	0.180	0.056
31	0.645	0.887
June 1	0.225	0.090
2	0.180	0.056
3	0.175	0.052
4	0.180	0.056
5	0.180	0.056
6	0.200	0.070
7	0.205	0.073
8	0.210	0.077
9	0.205	0.073
10	0.205	0.073
11	0.205	0.073
12	0.180	0.056
13	0.175	0.052
14	0.160	0.043
15	0.190	0.062
16	0.200	0.070
17	0.210	0.077
18	0.210	0.077
19	0.215	0.081
20	0.235	0.099
21	0.270	0.133
22	0.265	0.128
23	0.265	0.128
24	0.270	0.133

Date	Daily Mean Gauge Readings (m)	Daily Mean Discharge (m^3/s)
June 25	0.265	0.128
26	0.260	0.123
27	0.265	0.128
28	0.265	0.128
29	0.265	0.128
30	0.265	0.128
July 1	0.270	0.133
2	0.280	0.144
3	0.265	0.128
4	0.255	0.118
5	0.250	0.112
6	0.250	0.112
7	0.260	0.122
8	0.260	0.122
9	0.265	0.128
10	0.265	0.128
11	0.265	0.128
12	0.270	0.133
13	0.270	0.133
14	0.265	0.128
15	0.240	0.103
16	0.225	0.090
17	0.085	0.011
18	0.160	0.043
19	0.100	0.016
20	0.090	0.013
21	0.120	0.023
22	0.100	0.016

Date	Daily Mean Gauge Readings (m)	Daily Mean Discharge (m^3/s)
July 23	0.120	0.023
24	0.200	0.070
25	0.120	0.023
26	0.970	2.169
27	0.360	0.248
28	0.160	0.043
29	0.240	0.103
30	0.140	0.032
31	0.140	0.032
Aug. 1	0.540	0.601
2	0.170	0.049
3	0.320	0.192
4	0.150	0.038
5	0.140	0.032
6	0.370	0.264
7	0.150	0.038
8	0.140	0.032
9	0.130	0.028
10	0.120	0.023
11	0.120	0.023

Figure 5 Probability Analysis on Daily Mean Discharge
Manzana River at Bure
Period : May 28 - August 11, 1995



Results of Analysis

Return Period (day)	Probability of Exceedance	Theoretical Values (m^3/s)
186	.5	.07614
292	.2	.03539
329	.1	.02371
347	.05	.01704
358	.02	.01174

Figure 6 TANK Model for
Silala River at Bure

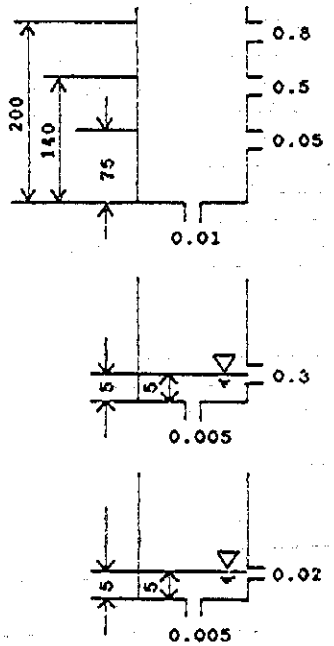


Figure 7 Runoff Analysis by TANK Model
Silala River at Bure

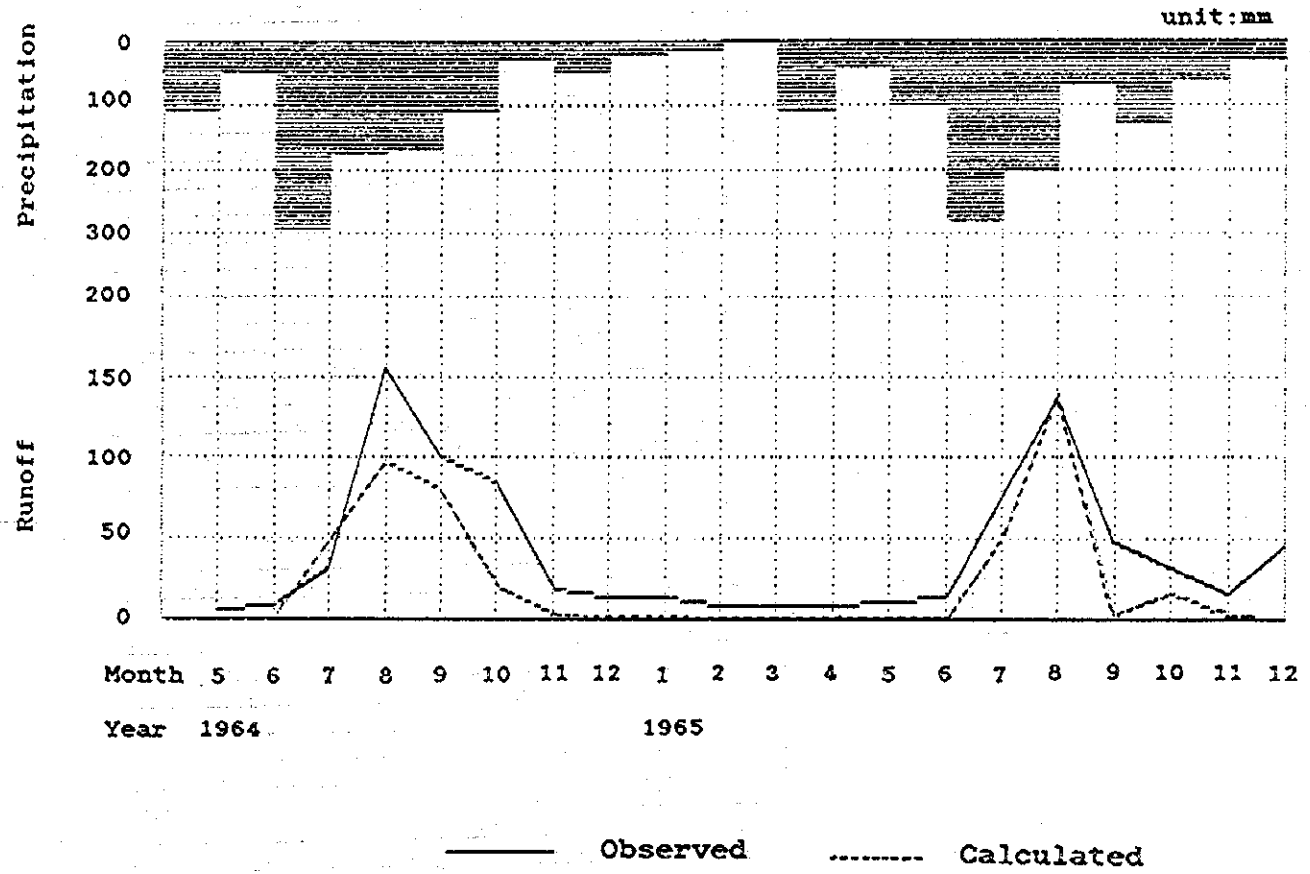


Table 3 Monthly Runoff of Silala River

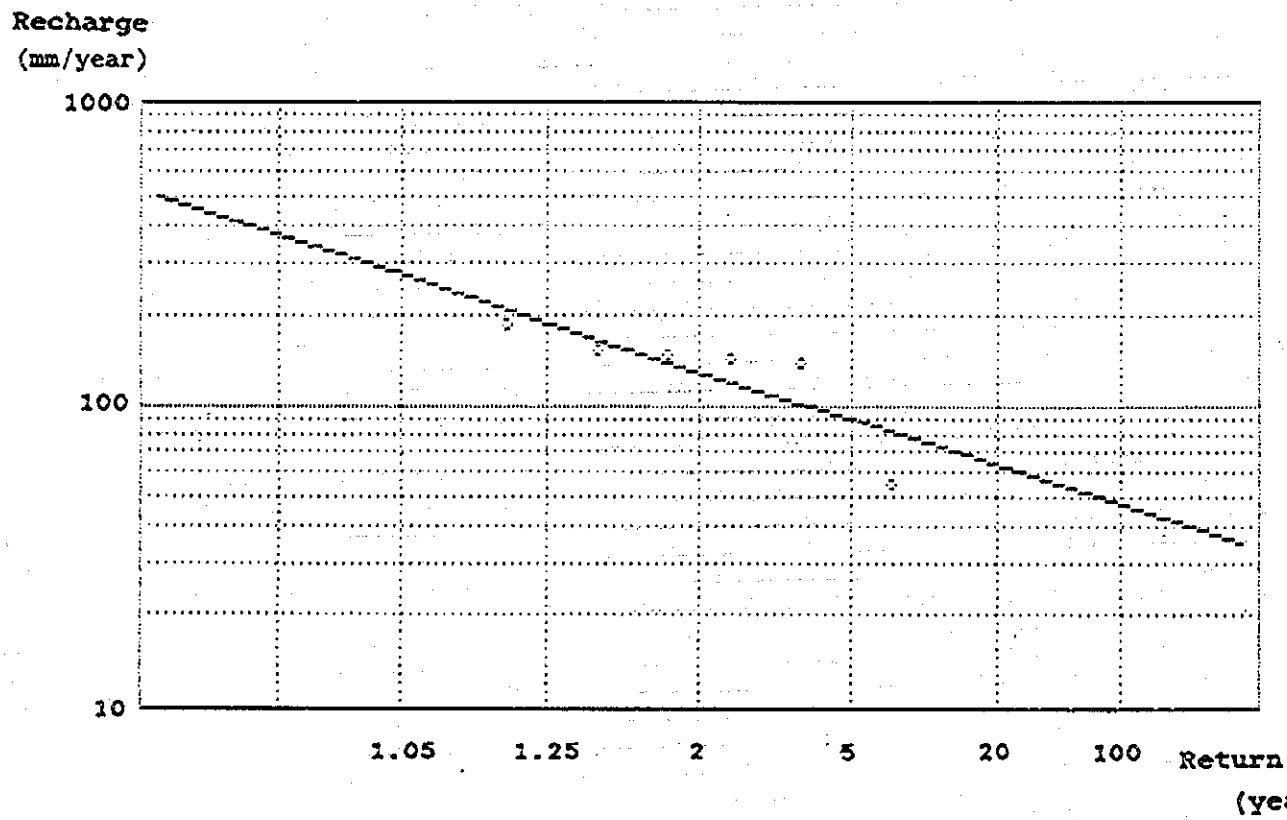
Station: Bure

Unit: Upper in Million m3, Lower in mm

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
1963	0.34 8.9	0.24 6.3	0.30 7.9	0.38 10.0	0.87 22.9	1.10 28.9	2.76 72.6	4.24 111.6	2.28 60.0	--	--	--	--
1964	0.27 7.1	0.18 4.7	0.14 3.7	0.19 5.0	0.19 5.0	0.35 9.2	1.24 32.6	5.85 153.9	3.77 99.2	3.16 83.2	0.74 19.5	0.51 13.4	16.59 436.6
1965	0.48 12.6	0.32 8.4	0.31 8.2	0.35 9.2	0.38 10.0	0.50 13.2	2.78 73.2	5.20 136.8	1.76 46.3	1.15 30.3	0.61 16.1	1.70 44.7	15.54 408.9
1966	0.28 7.3	0.17 4.5	0.28 7.2	0.24 6.3	0.40 10.6	0.72 19.0	3.77 99.2	5.05 132.9	2.08 54.7	1.18 31.1	0.63 16.6	0.27 7.1	15.01 395.0
1967	0.26 6.8	0.23 6.1	0.26 6.8	0.28 7.4	0.42 11.1	0.92 24.2	3.37 88.7	3.83 100.8	2.65 69.7	2.15 56.6	0.70 18.4	0.56 14.7	15.63 411.3
1968	0.37 9.7	0.30 7.9	0.28 7.4	0.24 6.3	0.38 10.0	0.72 19.0	--	--	--	--	--	--	--

Note: - = Not calculated due to missing data

Figure 8 Probability Analysis on Annual Ground Water Recharge, Silala River at Bure



Results of Analysis

Return Period (year)	Probability of Exceedance	Theoretical Values
2	.5	130.91
5	.2	90.044
10	.1	74.050
20	.05	63.017

Table 4 Monthly Water Balance Sheet for Ground Water Recharge, Silala River at Bure

1964

Unit:mm

Elements	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
P	9.0	–	–	–	99.9	38.0	286.0	163.6	162.6	100.0	18.3	38.8	–
Q	7.1	4.7	3.7	5	5	9.2	32.6	154.0	99.2	83.2	19.5	13.74	436.6
P - Q	1.9	–	–	–	94	28.8	253.4	9.6	63.4	16.8	–	25.1	–
ETo	117	116	116	116	115	114	112	111	112	113	115	116	1,372
ET crop	81.9	81.2	81.2	81.2	80.5	79.8	78.4	77.7	78.4	79.1	80.5	81.2	960.4
ETa	1.9	–	–	–	80.5	28.8	78.4	9.6	63.4	16.8	–	25.1	–
△S	0	–	–	–	13.5	0	175.0	0	0	0	–	0	188.5

1965

Unit:mm

Elements	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
P	10.1	9.5	0.0	101.4	33.6	95.0	271.7	193.7	61.4	123.3	51.3	18.3	969.3
Q	12.6	8.4	8.1	9.2	10	13.2	73.2	136.8	46.3	30.3	16.1	44.7	408.0
P - Q	NG	1.1	NG	92.2	23.6	81.8	198.5	56.9	15.1	93	35.2	NG	–
ETo	117	116	116	116	115	114	112	111	112	113	115	116	1,372
ET crop	81.9	81.2	81.2	81.2	80.5	79.8	78.4	77.7	78.4	79.1	80.5	81.2	960.4
ETa	–	1.1	–	81.2	23.6	79.8	78.4	56.9	15.1	79.1	35.2	–	–
△S	–	0	–	11.0	0	2.0	120.1	0	0	13.9	0	–	147.0

1968

Unit:mm

Elements	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
P	–	–	–	–	51.0	121.0	251.0	191.0	75.5	21.9	9.0	0.0	–
Q	–	–	–	–	0.2*	0.3*	55.2*	132.5*	4.3*	1.2*	0.8*	0.6*	–
P - Q	–	–	–	–	50.8	120.7	195.8	58.5	71.2	20.7	8.2	–	–
ETo	117	116	116	116	115	114	112	111	112	113	115	116	1,372
ET crop	81.9	81.2	81.2	81.2	80.5	79.8	78.4	77.7	78.4	79.1	80.5	81.2	960.4
ETa	–	–	–	–	50.8	79.8	78.4	58.5	71.2	20.7	8.2	–	–
△S	–	–	–	–	0	40.9	117.4	0	0	0	0	–	158.3

Note: * = Estimated by the Tank Model
– = not calculated due to missing data or distorted data

1970

Unit:mm

Elements	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
P	5.1	14.1	20.9	56.8	28.0	148.4	251.7	188.8	195.2	--	115.3	--	--
Q	0.4*	0.3*	0.2*	0.1*	0.1*	0.3*	92.8*	116.0*	115.8*	--	--	--	--
P - Q	4.7	13.8	20.7	56.7	27.9	148.1	158.9	72.8	79.4	--	--	--	--
ETo	117	116	116	116	115	114	112	111	112	113	115	116	1,372
ET crop	81.9	81.2	81.2	81.2	80.5	79.8	78.4	77.7	78.4	79.1	80.5	81.2	960.4
ETa	4.7	13.8	20.7	56.7	27.9	79.8	78.4	72.8	78.4	--	--	--	--
△S	0	0	0	0	0	68.3	80.5	0	1.0	--	--	--	149.8

1973

Unit:mm

Elements	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
P	0.0	0.0	8.9	--	201.9	156.9	284.4	370.8	81.6	121.5	11.4	--	--
Q	--	--	--	--	122.5*	60.4*	257.2*	304.6*	3.3*	5.0*	1.6*	--	--
P - Q	--	--	--	--	79.4	96.5	27.2	66.2	78.3	116.5	9.8	--	--
ETo	117	116	116	116	115	114	112	111	112	113	115	116	1,372
ET crop	81.9	81.2	81.2	81.2	80.5	79.8	78.4	77.7	78.4	79.1	80.5	81.2	960.4
ETa	--	--	--	--	79.4	79.8	27.2	66.2	78.3	79.1	9.8	--	--
△S	--	--	--	--	0	16.7	0	0	0	37.4	0	--	54.1

1976

Unit:mm

Elements	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
P	--	--	--	--	--	222.2	243.8	172.6	132.0	--	--	--	--
Q	--	--	--	--	--	42.1*	208.6*	53.6*	53.6*	--	--	--	--
P - Q	--	--	--	--	--	180.1	35.2	119.0	78.4	--	--	--	--
ETo	117	116	116	116	115	114	112	111	112	113	115	116	1,372
ET crop	81.9	81.2	81.2	81.2	80.5	79.8	78.4	77.7	78.4	79.1	80.5	81.2	960.4
ETa	--	--	--	--	--	79.8	35.2	77.7	78.4	--	--	--	--
△S	--	--	--	--	--	100.3	0	41.3	0	--	--	--	141.6

Note: * = Estimated by the Tank Model
- = not calculated due to missing data or distorted data

Appendix - 10

Result of Pumping Test

1. General

The pumping test was conducted at Borehole No.1 located in the compound of the mineral water factory. The dimensions of the well have been reported as stated hereunder.

- Well Depth : Deeper than 65 m
- Casing Type and Diameter : Steel, 6"(150 mm)
- Yield reported by EWWCA : 4.2 l/s

Little is known about the aquifer probably consisted of weathered and fractured basalts and the deeper the aquifer is more confined. The borehole was drilled for water supply but unused because of its water quality i.e. rich in menerals and highly carbonated. The borehole was transfered to the mineral water factory but is not used till the construction of the factory is completed.
EWWCA tested the borehole in 1993 and reported the safe yield to be 4.2 l/s.
For our test, a 6" submersible pump was installed at 58 m below ground level. The static water level was observed at 3.31m below ground level. The well depth was measured and it was 72 m deep. The test is composed of the followings.

- Preliminary pumping test with 8 steps of different pumping rates
- Step drawdown test with 5 steps
- Contineous discharge test for 24 hours and recovery observation

2. Preliminary Pumping Test

The test is aimed to know about the well, measuring the water level with different pumping rates and find a suitable pump position.
During the test, the well was consecutively pumped at 1.05, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0 and 4.5 l/s where each of former 7 steps

lasted 1 hour and the latter lasted 3 hours. The water level reached 19.0 m below ground level after 10 hours of pumping. The total drawdown is therefore 15.69 m.
The variation of water level with time is shown in Figure 1. The drawdown of each step is plotted on the graph of discharge vs. drawdown as shown in Figure 2. The graphs imply that the pumping durations of the earlier steps are insufficient because their drawdowns are small. The drawdowns of the later steps are very large, which is most probably because the pump was installed at the screen position and the turbulent flow was generated around the screen. Since all the plots are in a linear line, critical yield is not found in the graph.

3. Step Drawdown Test

The test is aimed to determine some characteristics of the well such as critical yield, optimal yield, well loss, aquifer loss, well efficiency, etc.. The test was consisted of 5 steps for a total duration of 15 hours, where each step lasts 3 hours. During the test, the well was pumped in increasing discharges at the first three steps, i.e. 2.5, 3.5 and 4.5 l/s and decreasing discharges at the last two steps, i.e. 4.0 and 3.0 l/s and their respective drawdowns were recorded. The recovery was observed after shut-off of the pump and the water level recovered 86 % in 8 hours. The variation of water level with time is shown in Figure 3.
The graph shows the first, the second and the fifth steps reached the pseudo steady states. The drawdowns are plotted on the graph of discharge vs. drawdown as shown in Figure 4 including all the steps. The graph implies that the optimal yield is around 300 m3/day according to the position of the plot of the 4th step. Since the graph does not include a drawdown of small discharge and a drawdown of very large discharge beyond critical yield. It is not suitable for further analysis.

In order to evaluate the characteristics of the well, the data of the step drawdown test conducted by EWWCA is refered hereunder.
The drawdown of each step is plotted on the graph of discharge vs.

drawdown as shown in Figure 5. The critical discharge is found at 412 m3/day with a drawdown of 16.0 m.
The following well function was employed in order to evaluate well loss and aquifer loss.

$$Sw = BQ + CQ^P$$

where Sw : Drawdown
Q : Discharge (Yield)
B,C,p : Coefficients
BQ : Aquifer loss
CQ^P : Well loss

The well loss function fits on the plots as shown in Figure 6, obtaining the following equation :

$$Sw = 0.027Q + 1.92 \times 10^{-11} Q^{4.406}$$

The well efficiency is calculated with the following formula :

$$Ew = BQ/Sw$$

The results of step drawdown test are tabulated hereunder.

STEP	YIELD Q (m3/d) (l/s)	DRAWDOWN Sw (m)	SPECIFIC YIELD Q/Sw (m3/d/m)	AQUIFER LOSS BQ (m)	WELL LOSS CQ^P (m)	WELL EFFICIENCY BQ/Sw
1	172.8 2.0	4.35	39.7	4.67	0.14	1.07
2	198.2 2.3	5.90	33.6	5.35	0.25	0.91
3	267.8 3.1	8.90	30.1	7.23	0.96	0.81
4	354.2 4.1	12.80	27.7	9.56	3.28	0.75
5	479.5 5.55	25.70	18.7	12.95	12.44	0.50

This table clarifies that aquifer loss is predominant in the first 4 steps because the well efficiencies are very high. The well efficiency of the first step exceeds 1.0, which means the drawdown did not reach the pseudo steady state because the pumping duration was not long enough. Assuming the safety factor for optimal yield is 0.8, the critical discharge is multiplied by this factor:

Qopt = 412 x 0.8 = 330 m3/day or 3.82 l/s

The drawdown at the optimal yield is estimated by the well loss equation at 11.31m in which aquifer loss is 8.91m and well loss is 2.40m. The well efficiency is therefore calculated at 0.79.

4. Contineous Discharge Test

This test was aimed to evaluate the aquifer characteristics such as transmissivity, storage coefficient, etc.. The well was pumped at fixed discharge i.e. 3.5 l/s for 24 hours and the drawdown was recorded. Recovery was observed after shut-off of the pump. The variation of water level with time observed at the pumped well is shown in Figure 7. The water level reached 21.49m below ground level after 24 hours of pumping having a drawdown of 14.83m. However, it was still at the pseudo steady state when the pump was shut off. The well was recovered over 100% in 24 hours after shut-off of the pump. The estimated drawdown by the well loss function is 9.78 m, whereas it reached 14.83 m in the test. Since this test was conducted under the condition that well loss caused by turbulent flow around the screen was predominant and none of observation wells were engaged, it is not able to analize the data for evaluating the aquifer characteristics.

5. Conclusion

If one can allow us to estimate the transmissivity by Tiem equation :

$$Sw = \frac{Q}{2\pi KH} \ln \left(\frac{R}{rw}\right)$$

where R : Radius of cone of depression
rw : Radius of well

Transmissivity of the aquifer (KH) is calculated assuming the radius of cone of depression (R) to be 300 m. For the optimal yield of 3.82 l/s or 330 m3/day, the aquifer loss is 8.91 m as mentioned before. Substituting these values to the equation, the

transmissivity is obtained at 48.9 m3/day.
Assuming the thickness of the aqiufer is equivalent to the screen length and the screen length is 30 % of the well depth, the permeability is calculated :

$$K = 48.9/21.6 = 2.26 \text{ m/day}$$

This value can be used for design purposes.

The characteristics of the well are summerized as follows:

Optimal Yield	:	330 m3/day(3.82 l/s)
Drawdown	:	11.31 m
Aquifer Loss	:	8.91 m
Well Loss	:	2.40 m
Well Efficiency	:	0.79

Figure 1 Preliminary Pumping Test
Time Water Level Graph

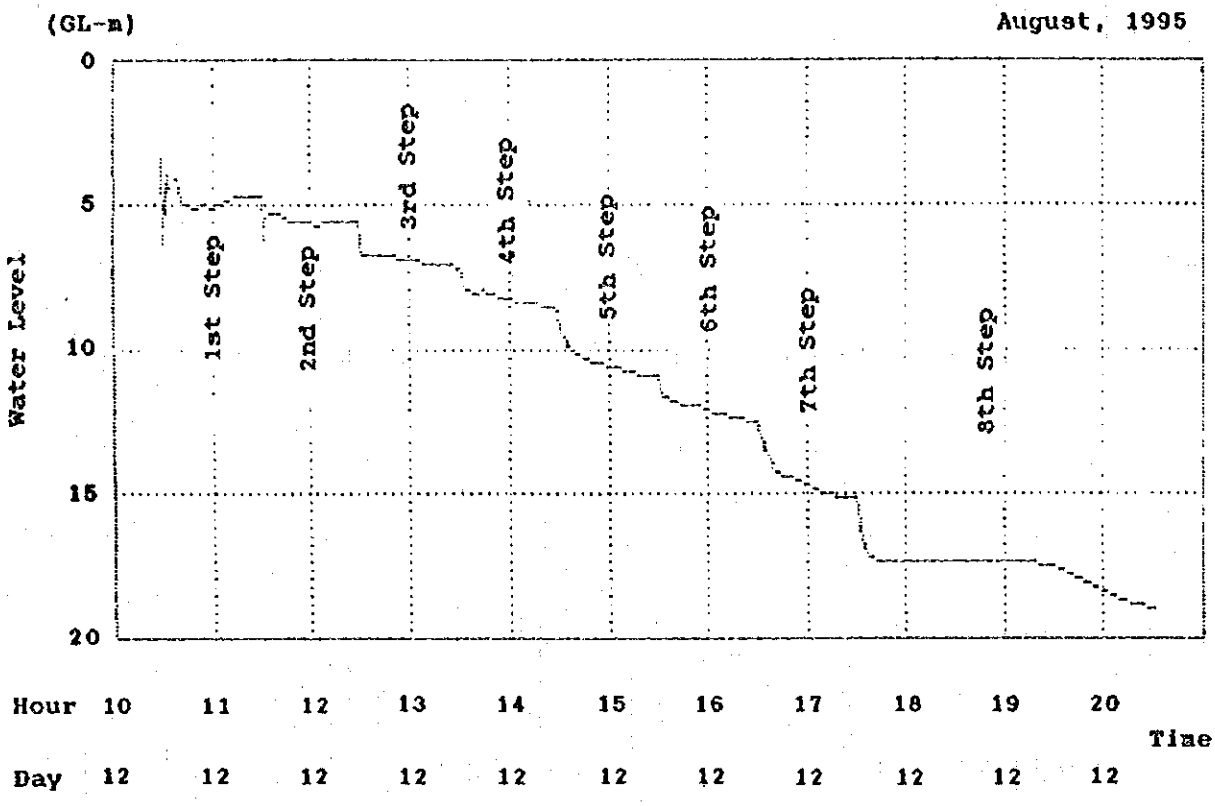


Figure 2 Preliminary Pumping Test
Discharge vs. Drawdown Graph

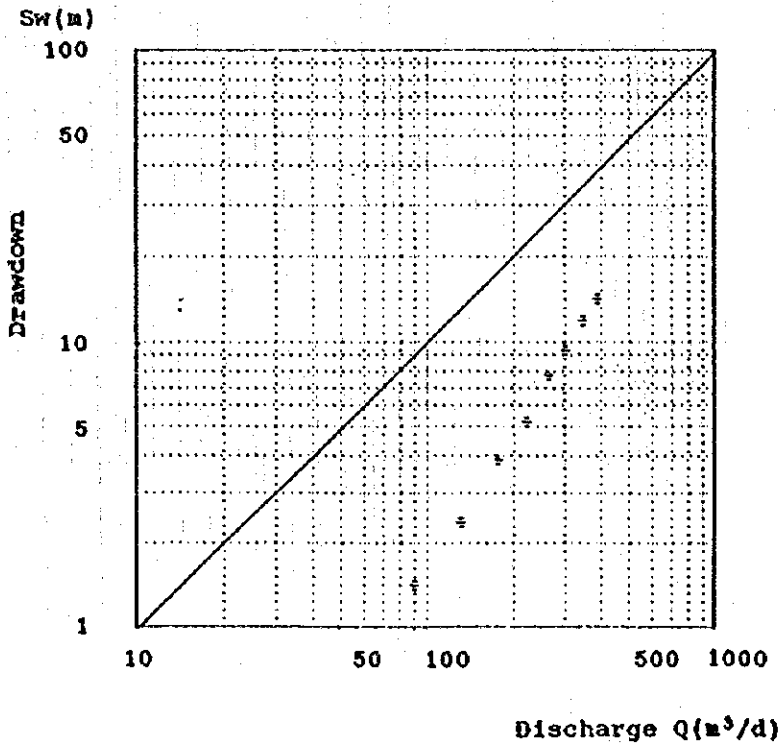


Figure 3 Step Drawdown Test
Time Water Level Graph

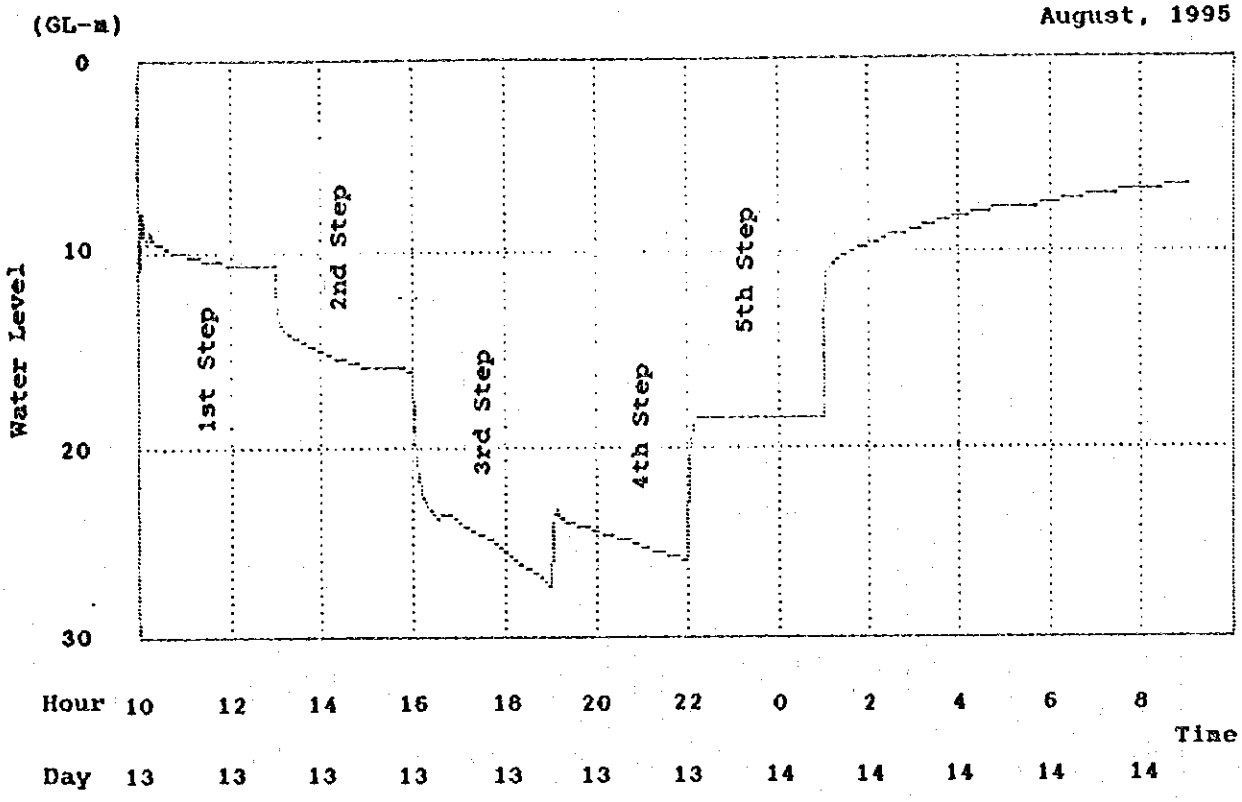


Figure 4 Step Drawdown Test
Discharge vs. Drawdown Graph

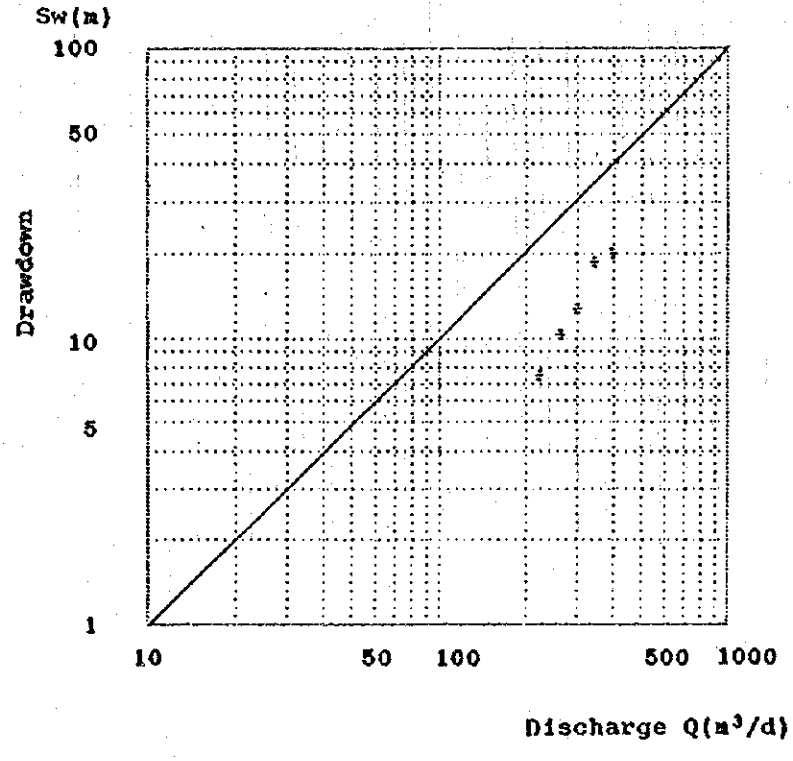


Figure 5 Step Drawdown Test
Discharge vs. Drawdown
Test Conducted by BWWCA

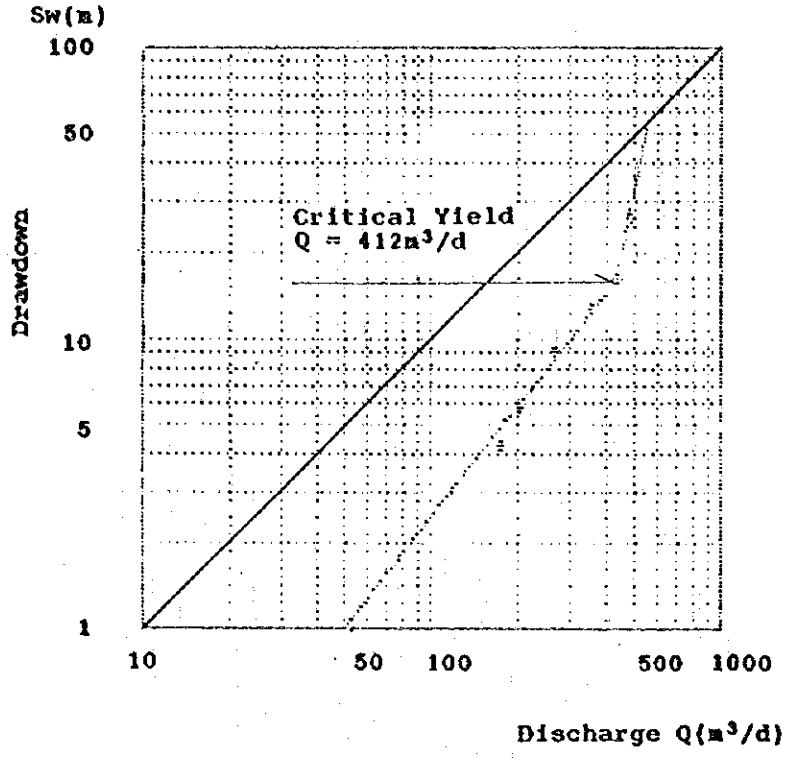


Figure 6 Step Drawdown Test
Well Loss Function
Test Conducted by BWWCA

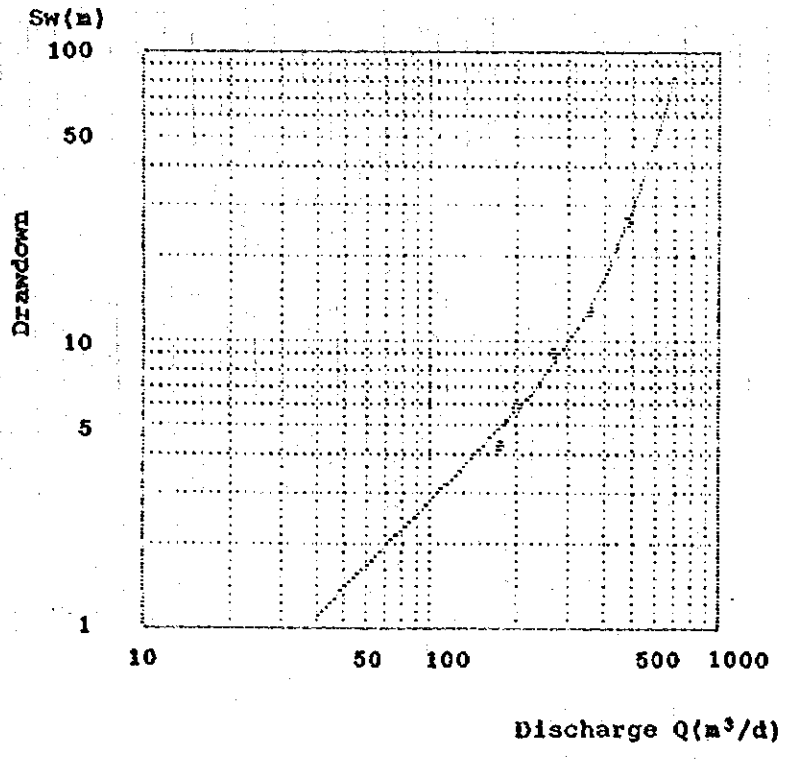
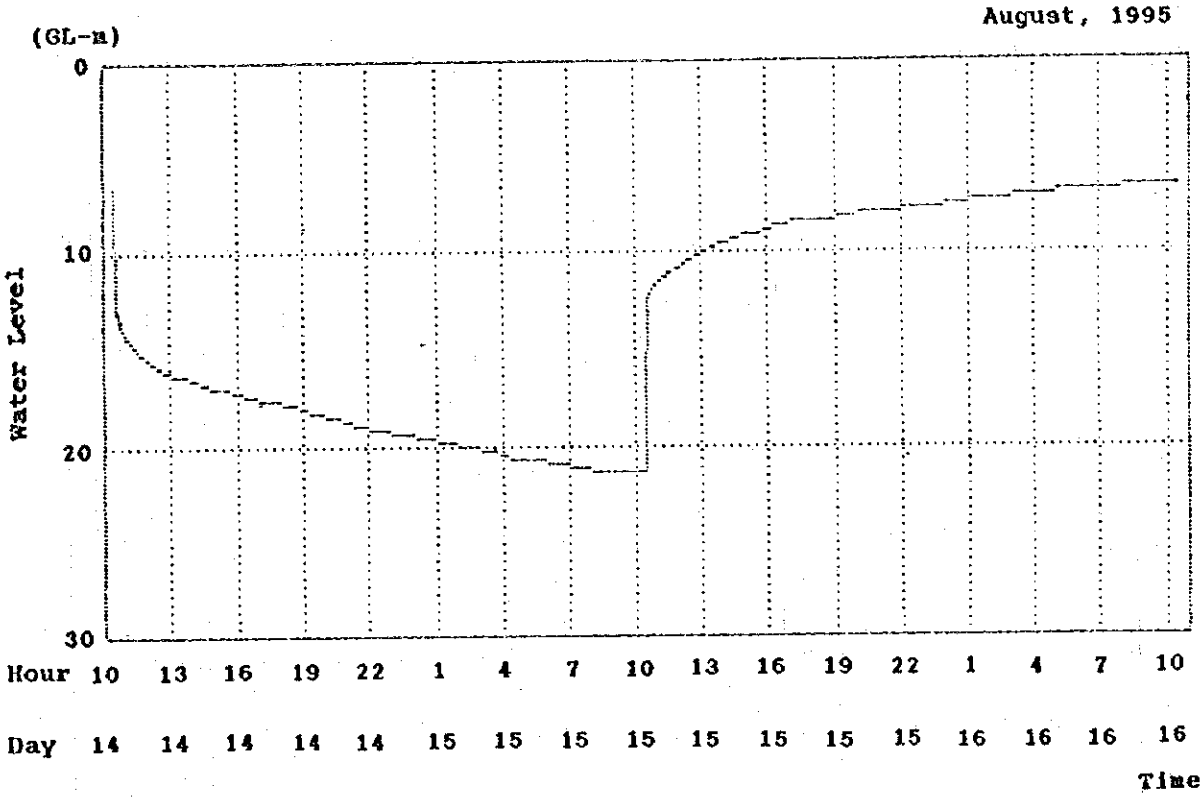


Figure 7 Contineous Discharge Test
Time Water Level Graph



PRELIMINARY TEST
PUMPING STAGE

DATE 12/08/95 — CONDUCTED BY WWDE

WELL No. BH No.1 — SWL 3.31 m — STEP 1

LOCATION BURE — PUMP TYPE Submersible — NOTCH (H) 56 mm

OWNER BAGUNA — HEAD 200 m — DISCHARGE 1.05l/s

WELL DEPTH 72 m — CAP. 10 l/s — 91 m3/day

WELL DIA. 150mm — POSITION 58 GL-m

TIME	TIME SINCE PUMPING STARTED (min.)	WATER LEVEL (GL-m)	DRAWDOWN (m)	REMARKS
10:30	0	3.31	0.00	
	0.5			
10:31	1.0	6.26	2.95	
	1.5	4.17	0.86	Valve Adjusted
10:32	2.0	4.32	1.01	
	2.5	4.40	1.09	
10:33	3.0	4.03	0.72	
	3.5	3.99	0.68	Valve Adjusted
10:34	4.0	4.50	1.19	
	4.5	4.54	1.23	
10:35	5.0	4.42	1.11	
10:36	6.0	4.30	0.99	55 mm
10:37	7.0	4.14	0.83	Valve Adjusted
10:38	8.0	4.16	0.85	
10:39	9.0	4.16	0.85	
10:40	10.0	4.58	1.27	Valve Adjusted
10:42	12.0	4.94	1.63	
10:44	14.0	4.99	1.67	
10:46	16.0	5.03	1.72	
10:48	18.0	5.09	1.78	
10:50	20.0	5.10	1.79	
10:55	25.0	5.03	1.72	
11:00	30.0	5.12	1.81	
11:05	35.0	4.95	1.64	57 mm
11:10	40.0	4.82	1.51	
11:15	45.0	4.76	1.45	
11:20	50.0	4.74	1.43	
11:25	55.0	4.72	1.41	
11:30	60.0	4.70	1.39	

PRELIMINARY TEST
PUMPING STAGE

DATE 12/08/95 — CONDUCTED BY WWDE

WELL No. BH No.1 — SWL 3.31 m — STEP 2

LOCATION BURE — PUMP TYPE Submersible — NOTCH (H) 65 mm

OWNER BAGUNA — HEAD 200 m — DISCHARGE 1.53l/s

WELL DEPTH 72 m — CAP. 10 l/s — 132 m3/day

WELL DIA. 150mm — POSITION 58 GL-m

TIME	TIME SINCE PUMPING STARTED (min.)	WATER LEVEL (GL-m)	DRAWDOWN (m)	REMARKS
11:30	0	4.70	1.39	
	0.5	5.64	2.33	
11:31	1.0	6.24	2.93	
	1.5	6.33	3.02	Valve Adjusted
11:32	2.0	5.56	2.25	
	2.5	5.55	2.24	
11:33	3.0	5.41	2.10	
	3.5	5.37	2.06	Valve Adjusted
11:34	4.0	5.33	2.02	
	4.5	5.33	2.02	
11:35	5.0	5.33	2.02	
11:36	6.0	5.30	1.99	55 mm
11:37	7.0	5.30	1.99	Valve Adjusted
11:38	8.0	5.28	1.97	
11:39	9.0	5.25	1.94	
11:40	10.0	5.24	1.93	
11:42	12.0	5.24	1.93	
11:44	14.0	5.47	2.16	
11:46	16.0	5.48	2.17	
11:48	18.0	5.55	2.24	
11:50	20.0	5.61	2.30	
11:55	25.0	5.65	2.34	
12:00	30.0	5.60	2.29	
12:05	35.0	5.67	2.36	
12:10	40.0	5.60	2.29	
12:15	45.0	5.61	2.30	
12:20	50.0	5.62	2.31	
12:25	55.0	5.62	2.31	
12:30	60.0	5.62	2.31	

PRELIMINARY TEST
PUMPING STAGE

DATE 12/08/95 CONDUCTED BY WWDE

WELL No. BH No.1 SWL 3.31 m STEP 3

LOCATION BURE PUMP TYPE Submersible NOTCH (H) 73 mm

OWNER BAGUNA HEAD 200 m DISCHARGE 2.04l/s

WELL DEPTH 72 m CAP. 10 l/s 176 m3/day

WELL DIA. 150mm POSITION 58 GL-m

TIME	TIME SINCE PUMPING STARTED (min.)	WATER LEVEL (GL-m)	DRAWDOWN (m)	REMARKS
12:30	0	5.62	2.31	
	0.5	6.00	2.69	
12:31	1.0	6.40	3.09	
	1.5	6.59	3.28	
12:32	2.0	6.74	3.43	
	2.5	6.75	3.44	
12:33	3.0	6.75	3.44	
	3.5	6.75	3.44	
12:34	4.0	6.70	3.39	
	4.5	6.70	3.39	
12:35	5.0	6.72	3.41	
12:36	6.0	6.72	3.41	
12:37	7.0	6.73	3.42	
12:38	8.0	6.73	3.42	
12:39	9.0	6.74	3.43	
12:40	10.0	6.74	3.43	
12:42	12.0	6.75	3.44	
12:44	14.0	6.76	3.45	
12:46	16.0	6.76	3.45	
12:48	18.0	6.77	3.46	
12:50	20.0	6.80	3.49	
12:55	25.0	6.86	3.55	
13:00	30.0	6.90	3.59	
13:05	35.0	6.94	3.63	
13:10	40.0	7.00	3.69	
13:15	45.0	7.05	3.74	
13:20	50.0	7.08	3.77	
13:25	55.0	7.10	3.79	
13:30	60.0	7.15	3.84	

PRELIMINARY TEST
PUMPING STAGE

DATE 12/08/95 — CONDUCTED BY WWDE

WELL No. BH No.1 — SWL 3.31 m — STEP 4

LOCATION BURE — PUMP TYPE Submersible — NOTCH (H) 80 mm

OWNER BAGUNA — HEAD 200 m — DISCHARGE 2.55l/s

WELL DEPTH 72 m — CAP. 10 l/s — 220 m3/day

WELL DIA. 150mm — POSITION 58 GL-m

TIME	TIME SINCE PUMPING STARTED (min.)	WATER LEVEL (GL-m)	DRAWDOWN (m)	REMARKS
13:30	0	7.15	3.84	
	0.5	7.36	4.05	
13:31	1.0	7.50	4.19	
	1.5	7.55	4.24	
13:32	2.0	7.64	4.33	
	2.5	7.78	4.47	
13:33	3.0	7.81	4.50	
	3.5	7.85	4.54	
13:34	4.0	7.88	4.57	
	4.5	7.90	4.59	
13:35	5.0	7.93	4.62	
13:36	6.0	7.94	4.63	
13:37	7.0	7.98	4.67	
13:38	8.0	8.02	4.71	
13:39	9.0	8.04	4.73	
13:40	10.0	8.05	4.74	
13:42	12.0	8.05	4.74	
13:44	14.0	8.01	4.70	
13:46	16.0	8.10	4.79	
13:48	18.0	8.15	4.84	
13:50	20.0	8.15	4.84	
13:55	25.0	8.24	4.93	
14:00	30.0	8.26	4.95	
14:05	35.0	8.36	5.05	
14:10	40.0	8.39	5.08	
14:15	45.0	8.42	5.11	
14:20	50.0	8.49	5.18	
14:25	55.0	8.50	5.19	
14:30	60.0	8.61	5.30	

PRELIMINARY TEST
PUMPING STAGE

DATE 12/08/95 CONDUCTED BY WWDE

WELL No. BH No.1 SWL 3.31 m STEP 5

LOCATION BURE PUMP TYPE Submersible NOTCH (H) 86 mm

OWNER BAGUNA HEAD 200 m DISCHARGE 3.04l/s

WELL DEPTH 72 m CAP. 10 l/s 263 m3/day

WELL DIA. 150mm POSITION 58 GL-m

TIME	TIME SINCE PUMPING STARTED (min.)	WATER LEVEL (GL-m)	DRAWDOWN (m)	REMARKS
14:30	0	8.61	5.30	
	0.5	9.03	5.72	
14:31	1.0	9.38	6.07	
	1.5	9.60	6.29	
14:32	2.0	9.61	6.30	
	2.5	9.62	6.31	
14:33	3.0	9.63	6.32	
	3.5	9.63	6.32	
14:34	4.0	9.64	6.33	
	4.5	9.80	6.49	
14:35	5.0	9.86	6.55	
14:36	6.0	7.94	6.60	
14:37	7.0	7.98	6.73	
14:38	8.0	8.02	6.77	
14:39	9.0	8.04	6.80	
14:40	10.0	8.05	6.82	
14:42	12.0	8.05	6.89	
14:44	14.0	8.01	6.97	
14:46	16.0	8.10	7.00	
14:48	18.0	8.15	7.02	
14:50	20.0	8.15	7.08	
14:55	25.0	8.24	7.16	
15:00	30.0	8.26	7.23	
15:05	35.0	8.36	7.33	
15:10	40.0	8.39	7.38	
15:15	45.0	8.42	7.45	
15:20	50.0	8.49	7.51	
15:25	55.0	8.50	5.19	
15:30	60.0	8.61	5.30	

PRELIMINARY TEST
PUMPING STAGE

DATE 12/08/95 CONDUCTED BY WWDE

WELL No. BH No.1 SWL 3.31 m STEP 6

LOCATION BURE PUMP TYPE Submersible NOTCH (H) 91 mm

OWNER BAGUNA HEAD 200 m DISCHARGE 3.5 l/s

WELL DEPTH 72 m CAP. 10 l/s 302.4 m3/day

WELL DIA. 150mm POSITION 58 GL-m

TIME	TIME SINCE PUMPING STARTED (min.)	WATER LEVEL (GL-m)	DRAWDOWN (m)	REMARKS
15:30	0	10.89	7.58	
	0.5	11.13	7.82	
15:31	1.0	11.27	7.96	
	1.5	11.40	8.09	
15:32	2.0	11.46	8.15	
	2.5	11.51	8.20	
15:33	3.0	11.56	8.25	
	3.5	11.59	8.28	
15:34	4.0	11.60	8.29	
	4.5	11.62	8.31	
15:35	5.0	11.64	8.33	
15:36	6.0	11.67	8.36	
15:37	7.0	11.72	8.41	
15:38	8.0	11.73	8.42	
15:39	9.0	11.74	8.43	
15:40	10.0	11.75	8.44	
15:42	12.0	11.77	8.46	
15:44	14.0	11.92	8.61	
15:46	16.0	11.85	8.54	
15:48	18.0	11.87	8.56	
15:50	20.0	11.88	8.57	
15:55	25.0	11.95	8.64	
16:00	30.0	12.13	8.82	
16:05	35.0	12.19	8.88	
16:10	40.0	12.26	8.95	
16:15	45.0	12.34	9.03	
16:20	50.0	12.38	9.07	
16:25	55.0	12.44	9.13	
16:30	60.0	12.50	9.19	

PRELIMINARY TEST
PUMPING STAGE

DATE 12/08/95 CONDUCTED BY WWDE

WELL No. BH No.1 SWL 3.31 m STEP 7

LOCATION BURE PUMP TYPE Submersible NOTCH (H) 96 mm

OWNER BAGUNA HEAD 200 m DISCHARGE 4.0 l/s

WELL DEPTH 72 m CAP. 10 l/s 345.6 m3/day

WELL DIA. 150mm POSITION 58 GL-m

TIME	TIME SINCE PUMPING STARTED (min.)	WATER LEVEL (GL-m)	DRAWDOWN (m)	REMARKS
16:30	0	12.50	9.19	
	0.5	12.68	9.37	
16:31	1.0	12.75	9.44	
	1.5	12.82	9.51	
16:32	2.0	12.92	9.61	
	2.5	13.00	9.69	
16:33	3.0	13.05	9.74	
	3.5	13.10	9.79	
16:34	4.0	13.23	9.92	
	4.5	13.35	10.04	
16:35	5.0	13.46	10.15	
16:36	6.0	13.53	10.22	
16:37	7.0	13.74	10.43	
16:38	8.0	13.84	10.53	
16:39	9.0	13.95	10.64	
16:40	10.0	14.09	10.78	
16:42	12.0	14.23	10.92	
16:44	14.0	14.30	10.99	
16:46	16.0	14.37	11.06	
16:48	18.0	14.40	11.09	
16:50	20.0	14.44	11.13	
16:55	25.0	14.55	11.24	
17:00	30.0	14.65	11.34	
17:05	35.0	14.81	11.50	
17:10	40.0	14.97	11.66	
17:15	45.0	15.06	11.75	
17:20	50.0	15.10	11.79	
17:25	55.0	15.14	11.83	
17:30	60.0	15.22	11.91	

PRELIMINARY TEST
PUMPING STAGE

DATE 12/08/95 CONDUCTED BY WWDE

WELL No. BH No.1 SWL 3.31 m STEP 8

LOCATION BURE PUMP TYPE Submersible NOTCH (H) 101 mm

OWNER BAGUNA HEAD 200 m DISCHARGE 4.5 l/s

WELL DEPTH 72 m CAP. 10 l/s 388.8 m3/day

WELL DIA. 150mm POSITION 58 GL-m

TIME	TIME SINCE PUMPING STARTED (min.)	WATER LEVEL (GL-m)	DRAWDOWN (m)	REMARKS
17:30	0	15.22	11.91	
	0.5	15.46	12.15	100 mm
17:31	1.0	15.80	12.49	
	1.5	15.95	12.64	
17:32	2.0	16.05	12.74	
	2.5	16.15	12.44	
17:33	3.0	16.29	12.98	
	3.5	16.50	13.19	
17:34	4.0	16.69	13.38	
	4.5	16.90	13.59	
17:35	5.0	16.90	13.59	
17:36	6.0	17.15	13.84	
17:37	7.0	17.20	13.89	
17:38	8.0	17.25	13.94	
17:39	9.0	17.26	13.95	
17:40	10.0	17.27	13.96	
17:42	12.0	17.30	13.99	
17:44	14.0	17.32	14.01	
17:46	16.0	17.33	14.02	101 mm
17:48	18.0	17.34	14.03	
17:50	20.0	17.34	14.03	
17:55	25.0	17.34	14.03	
18:00	30.0	17.35	14.04	
18:05	35.0	17.37	14.06	
18:10	40.0	17.40	14.09	
18:15	45.0	17.40	14.09	
18:20	50.0	17.40	14.09	
18:25	55.0	17.40	14.09	
18:30	60.0	17.40	14.09	
18:40	70.0	17.40	14.09	
18:50	80.0	17.41	14.10	101 mm
19:00	90.0	17.42	14.11	
19:10	100.0	17.42	14.11	
19:30	120.0	17.50	14.19	Full Value
19:50	140.0	18.05	14.74	101 mm
20:10	160.0	18.67	15.36	
20:30	180.0	19.00	15.69	

STEP DRAWDOWN TEST
PUMPING STAGE

DATE 13/08/95 CONDUCTED BY WWDE

WELL No. BH No.1 SWL 3.31 m STEP 1

LOCATION BURE PUMP TYPE Submersible NOTCH (H) 80 mm

OWNER BAGUNA HEAD 200 m DISCHARGE 2.5 l/s

WELL DEPTH 72 m CAP. 10 l/s 220 m3/day

WELL DIA. 150mm POSITION 58 GL-m

TIME	TIME SINCE PUMPING STARTED (min.)	WATER LEVEL (GL-m)	DRAWDOWN (m)	REMARKS
10:00	0	4.69	1.38	
	0.5			Value Adjusted
10:01	1.0	11.25	7.94	90 mm
	1.5	11.00	7.69	
10:02	2.0	10.48	7.17	
	2.5	8.87	5.56	
10:03	3.0	8.00	4.69	75 mm
	3.5	8.56	5.25	
10:04	4.0	9.40	6.09	
	4.5	8.90	5.59	
10:05	5.0	8.50	5.19	80 mm
10:06	6.0	8.20	4.89	78 mm
10:07	7.0	8.04	4.73	
10:08	8.0	8.63	5.32	80 mm
10:09	9.0	9.07	5.76	
10:10	10.0	9.36	6.05	81 mm
10:12	12.0	9.46	6.15	
10:14	14.0	8.87	5.56	
10:16	16.0	9.13	5.82	80 mm
10:18	18.0	9.25	5.94	
10:20	20.0	9.33	6.02	
10:25	25.0	9.47	6.16	
10:30	30.0	9.56	6.25	
10:35	35.0	9.65	6.34	
10:40	40.0	9.77	6.46	
10:45	45.0	9.84	6.53	
10:50	50.0	9.89	6.58	
10:55	55.0	9.93	6.62	
11:00	60.0	10.01	6.70	
11:10	70.0	10.12	6.81	
11:20	80.0	10.20	6.89	
11:30	90.0	10.31	7.00	
11:40	100.0	10.40	7.09	
12:00	120.0	10.54	7.23	
12:20	140.0	10.59	7.28	80 mm
12:40	160.0	10.61	7.30	
13:00	180.0	10.66	7.35	

STEP DRAWDOWN TEST
PUMPING STAGE

DATE 13/08/95 — CONDUCTED BY WWDE

WELL No. BH No.1 — SWL 3.31 m — STEP 2

LOCATION BURE — PUMP TYPE Submersible — NOTCH (H) 91 mm

OWNER BAGUNA — HEAD 200 m — DISCHARGE 3.5 l/s

WELL DEPTH 72 m — CAP. 10 l/s — 303 m3/day

WELL DIA. 150mm — POSITION 58 GL-m

TIME	TIME SINCE PUMPING STARTED (min.)	WATER LEVEL (GL-m)	DRAWDOWN (m)	REMARKS
13:00	0	10.66	7.35	
	0.5	11.27	7.96	
13:01	1.0	11.86	8.55	
	1.5	12.27	8.96	
13:02	2.0	12.66	9.35	
	2.5	12.80	9.49	
13:03	3.0	13.07	9.76	
	3.5	13.20	9.89	
13:04	4.0	13.28	9.97	
	4.5	13.38	10.07	
13:05	5.0	13.42	10.11	
13:06	6.0	13.52	10.21	
13:07	7.0	13.62	10.31	
13:08	8.0	13.65	10.34	
13:09	9.0	13.73	10.42	
13:10	10.0	13.80	10.49	
13:12	12.0	13.91	10.60	
13:14	14.0	14.02	10.71	
13:16	16.0	14.10	10.79	
13:18	18.0	14.16	10.85	
13:20	20.0	14.20	10.89	
13:25	25.0	14.33	11.02	
13:30	30.0	14.43	11.12	
13:35	35.0	14.53	11.22	
13:40	40.0	14.60	11.29	
13:45	45.0	14.70	11.39	
13:50	50.0	14.80	11.49	
13:55	55.0	14.91	11.60	
14:00	60.0	15.03	11.72	
14:10	70.0	15.20	11.89	
14:20	80.0	15.36	12.05	
14:30	90.0	15.51	12.20	
14:40	100.0	15.66	12.35	
15:00	120.0	15.79	12.48	
15:20	140.0	15.85	12.54	
15:40	160.0	15.98	12.67	
16:00	180.0	16.18	12.87	

STEP DRAWDOWN TEST
PUMPING STAGE

DATE	13/08/95			CONDUCTED BY	WWDE
WELL No.	BH No.1	SWL	3.31 m	STEP	3
LOCATION	BURE	PUMP TYPE	Submersible	NOTCH (H)	101 mm
OWNER	BAGUNA	HEAD	200 m	DISCHARGE	4.5 l/s
WELL DEPTH	72 m	CAP.	10 l/s		393 m3/day
WELL DIA.	150mm	POSITION	58 GL-m		

TIME	TIME SINCE PUMPING STARTED (min.)	WATER LEVEL (GL-m)	DRAWDOWN (m)	REMARKS
16:00	0	16.18	12.87	
	0.5	16.55	13.24	
16:01	1.0	17.12	13.81	
	1.5	17.55	14.24	
16:02	2.0	18.10	14.79	
	2.5	18.40	15.09	
16:03	3.0	18.75	15.44	
	3.5	19.30	15.99	
16:04	4.0	19.55	16.24	
	4.5	19.90	16.59	104 mm
16:05	5.0	20.50	17.19	
16:06	6.0	20.76	17.45	
16:07	7.0	21.22	17.91	104 mm
16:08	8.0	21.65	18.34	
16:09	9.0	21.91	18.60	
16:10	10.0	22.13	18.82	Value Adjusted
16:12	12.0	22.46	19.15	103 mm
16:14	14.0	22.67	19.36	
16:16	16.0	22.87	19.56	
16:18	18.0	23.00	19.69	
16:20	20.0	23.15	19.84	
16:25	25.0	23.40	20.09	
16:30	30.0	23.72	20.41	Value Adjusted
16:35	35.0	23.93	20.62	101 mm
16:40	40.0	23.60	20.29	
16:45	45.0	23.55	20.24	
16:50	50.0	23.66	20.35	
16:55	55.0	23.82	20.51	101 mm
17:00	60.0	23.98	20.67	
17:10	70.0	24.20	20.89	
17:20	80.0	24.45	21.14	
17:30	90.0	24.70	21.39	
17:40	100.0	24.92	21.61	
18:00	120.0	25.50	22.19	
18:20	140.0	26.20	22.89	
18:40	160.0	26.71	23.40	
19:00	180.0	27.46	24.15	

STEP DRAWDOWN TEST
PUMPING STAGE

DATE 13/08/95 — CONDUCTED BY WWDE

WELL No. BH No.1 — SWL 3.31 m — STEP 4

LOCATION BURE — PUMP TYPE Submersible — NOTCH (H) 96 mm

OWNER BAGUNA — HEAD 200 m — DISCHARGE 4.0 l/s

WELL DEPTH 72 m — CAP. 10 l/s — 346 m3/day

WELL DIA. 150mm — POSITION 58 GL-m

TIME	TIME SINCE PUMPING STARTED (min.)	WATER LEVEL (GL-m)	DRAWDOWN (m)	REMARKS
19:00	0	27.46	24.15	
	0.5	27.00	23.69	
19:01	1.0	26.60	23.29	
	1.5	26.00	22.69	
19:02	2.0	25.58	22.27	
	2.5	25.04	21.73	
19:03	3.0	24.55	21.24	
	3.5	24.30	20.99	
19:04	4.0	24.14	20.83	
	4.5	24.00	20.69	
19:05	5.0	23.82	20.51	
19:06	6.0	23.73	20.42	
19:07	7.0	23.57	20.26	
19:08	8.0	23.47	20.16	94 mm
19:09	9.0	23.55	20.24	96 mm
19:10	10.0	23.64	20.33	
19:12	12.0	23.72	20.41	
19:14	14.0	23.87	20.56	
19:16	16.0	23.91	20.60	
19:18	18.0	23.95	20.64	
19:20	20.0	23.98	20.67	
19:25	25.0	24.08	20.77	
19:30	30.0	24.14	20.83	
19:35	35.0	24.18	20.87	
19:40	40.0	24.21	20.90	
19:45	45.0	24.26	20.95	
19:50	50.0	24.33	21.02	
19:55	55.0	24.40	21.09	
20:00	60.0	24.49	21.18	
20:10	70.0	24.63	21.32	
20:20	80.0	24.75	21.44	
20:30	90.0	24.87	21.56	
20:40	100.0	24.98	21.67	
21:00	120.0	25.27	21.96	
21:20	140.0	25.50	22.19	
21:40	160.0	25.78	22.47	
22:00	180.0	26.10	22.79	

STEP DRAWDOWN TEST
PUMPING STAGE

DATE	13/08/95			CONDUCTED BY	WWDE
WELL No.	BH No.1	SWL	3.31 m	STEP	5
LOCATION	BURE	PUMP TYPE	Submersible	NOTCH (H)	86 mm
OWNER	BAGUNA	HEAD	200 m	DISCHARGE	3.0 l/s
WELL DEPTH	72 m	CAP.	10 l/s		263 m3/day
WELL DIA.	150mm	POSITION	58 GL-m		

TIME	TIME SINCE PUMPING STARTED (min.)	WATER LEVEL (GL-m)	DRAWDOWN (m)	REMARKS
22:00	0	26.10	22.79	
	0.5			
22:01	1.0	23.70	20.39	
	1.5	22.95	19.64	
22:02	2.0	22.35	19.04	
	2.5	21.70	18.39	
22:03	3.0	21.37	18.06	
	3.5	20.58	17.27	
22:04	4.0	20.73	17.42	
	4.5	20.35	17.04	
22:05	5.0	20.10	16.79	
22:06	6.0	19.60	16.29	
22:07	7.0	19.38	16.07	
22:08	8.0	19.10	15.79	
22:09	9.0	18.92	15.61	
22:10	10.0	18.78	15.47	86 mm: 3l/sec.
22:12	12.0	18.63	15.32	
22:14	14.0	18.63	15.32	
22:16	16.0	18.63	15.32	
22:18	18.0	18.63	15.32	
22:20	20.0	18.63	15.32	
22:25	25.0	18.60	15.29	
22:30	30.0	18.57	15.26	86 mm: 3l/sec.
22:35	35.0	18.54	15.23	
22:40	40.0	18.51	15.20	
22:45	45.0	18.50	15.19	
22:50	50.0	18.48	15.17	
22:55	55.0	18.48	15.17	
23:00	60.0	18.47	15.16	
23:10	70.0	18.45	15.14	86 mm: 3l/sec.
23:20	80.0	18.45	15.14	
23:30	90.0	18.44	15.13	
23:40	100.0	18.44	15.13	86 mm: 3l/sec.
24:00	120.0	18.44	15.13	
24:20	140.0	18.44	15.13	
24:40	160.0	18.44	15.13	
1:00	180.0	18.44	15.13	

STEP DRAWDOWN TEST
RECOVERY

DATE 13/08/95 CONDUCTED BY WWDE

WELL No. BH No.1 SWL 3.31 m

LOCATION BURE PUMP TYPE Submersible

OWNER BAGUNA HEAD 200 m

WELL DEPTH 72 m CAP. 10 l/s

WELL DIA. 150mm POSITION 58 GL-m

DISCHARGE OF THE FINAL STEP

3.0 l/s

263 m3/day

TIME	TIME SINCE PUMPING STOPPED (min.)	WATER LEVEL (GL-m)	DRAWDOWN (m)	REMARKS
1:00	0	18.44	15.13	
	0.5			
1:01	1.0	13.47	10.16	
	1.5	11.90	8.59	
1:02	2.0	11.36	8.05	
	2.5	11.23	7.92	
1:03	3.0	11.10	7.79	
	3.5	11.05	7.74	
1:04	4.0	10.96	7.65	
	4.5	10.34	7.03	
1:05	5.0	10.90	7.59	
1:06	6.0	10.85	7.54	
1:07	7.0	10.79	7.48	
1:08	8.0	10.75	7.44	
1:09	9.0	10.69	7.38	
1:10	10.0	10.66	7.35	
1:12	12.0	10.53	7.22	
1:14	14.0	10.52	7.21	
1:16	16.0	10.45	7.14	
1:18	18.0	10.40	7.09	
1:20	20.0	10.35	7.04	
1:25	25.0	10.21	6.90	
1:30	30.0	10.12	6.81	
1:35	35.0	10.02	6.71	
1:40	40.0	9.92	6.61	
1:45	45.0	9.80	6.49	
1:50	50.0	9.70	6.39	
1:55	55.0	9.60	6.29	
2:00	60.0	9.57	6.26	
2:10	70.0	9.43	6.12	
2:20	80.0	9.28	5.97	
2:30	90.0	9.10	5.79	
2:40	100.0	9.05	5.74	
3:00	120.0	8.85	5.54	
3:20	140.0	8.65	5.34	
3:40	160.0	8.45	5.14	
4:00	180.0	8.25	4.94	
4:30	210.0	8.00	4.69	
5:00	240.0	7.83	4.52	
5:30	270.0	7.69	4.38	
6:00	300.0	7.40	4.09	
6:30	330.0	7.19	3.88	
7:00	360.0	7.10	3.79	

CONTINEOUS DISCHARGE TEST
Pumping Stage

DATE 14/08/95 — CONDUCTED BY WWDE

WELL No. BH No.1 — SWL 3.31 m — STEP

LOCATION BURE — PUMP TYPE Submersible — NOTCH (H) 91 mm

OWNER BAGUNA — HEAD 200 m — DISCHARGE 3.5 l/s

WELL DEPTH 72 m — CAP. 10 l/s — 303 m3/day

WELL DIA. 150mm — POSITION 58 GL-m

TIME	TIME SINCE PUMPING STARTED (min.)	WATER LEVEL (GL-m)	DRAWDOWN (m)	REMARKS
10:30	0	6.60	3.29	
	0.5	9.34	6.03	
10:31	1.0	8.70	5.39	80 mm
	1.5	9.00	5.69	
10:32	2.0	10.60	7.29	80 mm
	2.5	11.00	7.69	85 mm
10:33	3.0	11.50	8.19	
	3.5	12.10	8.79	
10:34	4.0	12.30	8.99	91 mm
	4.5	12.42	9.11	
10:35	5.0	12.74	9.43	
10:36	6.0	13.03	9.72	
10:37	7.0	13.10	9.79	
10:38	8.0	13.00	9.69	
10:39	9.0	13.26	9.95	
10:40	10.0	13.32	10.01	
10:42	12.0	13.38	10.07	
10:44	14.0	13.46	10.15	
10:46	16.0	13.61	10.30	
10:48	18.0	13.69	10.38	
10:50	20.0	13.84	10.53	
10:55	25.0	14.10	10.94	
11:00	30.0	14.25	11.07	
11:05	35.0	14.38	11.09	
11:10	40.0	14.40	11.22	
11:15	45.0	14.53	11.69	
11:20	50.0	14.77	11.46	
11:25	55.0	14.88	11.57	
11:30	60.0	14.94	11.63	
11:40	70.0	15.13	11.82	
11:50	80.0	15.30	11.99	
12:00	90.0	15.48	12.17	
12:10	100.0	15.62	12.31	

TIME	TIME SINCE PUMPING STARTED (min.)	WATER LEVEL (GL-m)	DRAWDOWN (m)	REMARKS
12:30	120	15.92	12.61	
12:50	140	16.21	12.90	
13:10	160	16.29	12.98	
13:30	180	16.37	13.06	
14:00	210	16.45	13.14	
14:30	240	16.67	13.36	
15:00	270	16.89	13.58	
15:30	300	17.07	13.76	
16:00	330	17.24	13.93	
16:30	360	17.44	14.13	
17:30	420	17.70	14.39	
18:30	480	17.97	14.66	
19:30	540	18.29	14.98	
20:30	600	18.60	15.29	
21:30	660	18.90	15.59	
22:30	720	19.17	15.86	
23:30	780	19.40	16.09	
0:30	840	19.63	16.32	
1:30	900	19.84	16.53	
2:30	960	20.09	16.78	
3:30	1020	20.34	17.03	
4:30	1080	20.64	17.33	
5:30	1140	20.84	17.53	
6:30	1200	21.00	17.69	
7:30	1260	21.15	17.84	
8:30	1320	21.31	18.00	
9:30	1380	21.39	18.08	
10:30	1440	21.49	18.18	

CONTINEOUS DISCHARGE TEST
Recovery Stage

DATE 14/08/95 — CONDUCTED BY WWDE

WELL No. BH No.1 — SWL 3.31 m

LOCATION BURE — PUMP TYPE Submersible — DISCHARGE AT THE PUMPING STAGE

OWNER BAGUNA — HEAD 200 m — 3.5 l/s

WELL DEPTH 72 m — CAP. 10 l/s — 303 m3/day

WELL DIA. 150mm — POSITION 58 GL-m

TIME	TIME SINCE PUMPING STOPPED (min.)	WATER LEVEL (GL-m)	DRAWDOWN (m)	REMARKS
10:30	0	21.49	18.18	
	0.5	20.33	17.02	
10:31	1.0	19.20	15.89	
	1.5	17.30	13.39	
10:32	2.0	16.00	12.69	
	2.5	15.12	11.81	
10:33	3.0	14.00	10.69	
	3.5	13.34	10.03	
10:34	4.0	13.19	9.88	
	4.5	12.62	9.31	
10:35	5.0	12.77	9.46	
10:36	6.0	12.49	9.18	
10:37	7.0	12.38	9.07	
10:38	8.0	12.30	8.99	
10:39	9.0	12.24	8.93	
10:40	10.0	12.17	8.86	
10:42	12.0	12.11	8.80	
10:44	14.0	12.03	8.72	
10:46	16.0	11.96	8.65	
10:48	18.0	11.90	8.59	
10:50	20.0	11.85	8.54	
10:55	25.0	11.72	8.41	
11:00	30.0	11.60	8.29	
11:05	35.0	11.50	8.19	
11:10	40.0	11.43	8.12	
11:15	45.0	11.33	8.02	
11:20	50.0	11.24	7.93	
11:25	55.0	11.15	7.84	
11:30	60.0	11.03	7.72	
11:40	70.0	10.99	7.68	
11:50	80.0	10.84	7.53	
12:00	90.0	10.70	7.39	
12:10	100.0	10.50	7.19	

TIME	TIME SINCE PUMPING STOPPED (min.)	WATER LEVEL (GL-m)	DRAWDOWN (m)	REMARKS
12:30	120	10.35	7.04	
12:50	140	10.11	6.80	
13:10	160	9.92	6.61	
13:30	180	9.71	6.40	
14:00	210	9.47	6.16	
14:30	240	9.23	5.92	
15:00	270	9.07	5.76	
15:30	300	8.97	5.66	
16:00	330	8.79	5.48	
16:30	360	8.70	5.39	
17:30	420	8.42	5.11	
18:30	480	8.29	4.98	
19:30	540	8.15	4.84	
20:30	600	8.01	4.70	
21:30	660	7.87	4.56	
22:30	720	7.74	4.43	
23:30	780	7.62	4.31	
0:30	840	7.48	4.17	
1:30	900	7.38	4.07	
2:30	960	7.25	3.94	
3:30	1020	7.13	3.82	
4:30	1080	7.02	3.71	
5:30	1140	6.90	3.59	
6:30	1200	6.80	3.49	
7:30	1260	6.76	3.45	
8:30	1320	6.68	3.37	
9:30	1380	6.62	3.31	
10:30	1440	6.55	3.24	

Appendix - 11

Calculation of Water Pipeline

Output data on distribution network for Bure Case: Ordinary, 2005

Serial Number	Pipeline Number	Nord Number Start	Nord Number End	Dia. (mm)	Pipeline Length(m)	Flow (liter/sec.)	Velocity (m/sec.)	Hydraulic Gradient (m/1000)	Loss of Head (m)	Velocity Coefficient	Remarks
1	1	1	2	200	95	17.51	0.56	0.24	2.54	110	
2	2	2	3	75	320	1.21	0.27	0.69	2.15	110	
3	3	2	4	200	525	15.76	0.50	1.10	2.09	110	
4	4	4	5	75	180	3.08	0.70	2.18	12.13	110	
5	5	5	6	75	80	0.65	0.15	0.05	0.68	110	
6	6	5	7	75	250	2.33	0.53	1.81	7.24	110	
7	7	4	8	150	40	12.40	0.70	0.22	5.45	110	
8	8	8	11	150	370	9.82	0.56	1.31	3.54	110	
9	9	11	14	150	220	7.50	0.42	0.47	2.15	110	
10	10	14	15	75	170	1.16	0.26	0.34	1.99	110	
11	11	15	16	75	110	1.29	0.29	0.27	2.42	110	
12	12	15	9	75	755	-0.68	-0.15	-0.56	-0.74	110	
13	13	9	10	75	25	0.71	0.16	0.02	0.80	110	
14	14	9	8	75	360	-1.77	-0.40	-1.56	-4.35	110	
15	15	11	12	75	190	2.08	0.47	1.12	5.88	110	
16	16	12	13	75	390	0.79	0.18	0.38	0.98	110	
17	17	12	17	75	370	0.78	0.18	0.36	0.96	110	
18	18	17	18	75	260	-0.75	-0.17	-0.23	-0.88	110	
19	19	18	14	150	540	-6.00	-0.34	-0.77	-1.42	110	
20	20	18	19	150	870	4.58	0.26	0.75	0.86	110	
21	21	19	20	150	1000	1.34	0.08	0.09	0.09	110	
22	22	19	21	75	760	1.17	0.26	1.54	2.02	110	

Output data on distribution network for Bure Case: Fire Fighting, 2005

Serial Number	Pipeline Number	Nord Number Start	Nord Number End	Dia. (mm)	Pipeline Length(m)	Flow (liter/sec.)	Velocity (m/sec.)	Hydraulic Gradient (m/1000)	Loss of Head (m)	Velocity Coefficient	Remarks
1	1	1	2	200	95	27.54	0.88	0.56	5.88	110	
2	2	2	3	75	320	0.75	0.17	0.28	0.89	110	
3	3	2	4	200	525	26.46	0.84	2.87	5.46	110	
4	4	4	5	75	180	1.92	0.43	0.91	5.06	110	
5	5	5	6	75	80	0.40	0.09	0.02	0.28	110	
6	6	5	7	75	250	1.45	0.33	0.75	3.01	110	
7	7	4	8	150	40	24.37	1.38	0.76	19.03	110	
8	8	8	11	150	370	21.20	1.20	5.44	14.70	110	
9	9	11	14	150	220	17.42	0.99	2.25	10.23	110	
10	10	14	15	75	170	-0.86	-0.20	-0.20	-1.15	110	
11	11	15	16	75	110	0.80	0.18	0.11	1.00	110	
12	12	15	9	75	755	-2.00	-0.45	-4.13	-5.48	110	
13	13	9	10	75	25	0.44	0.10	0.00	0.33	110	
14	14	9	8	75	360	-2.67	-0.61	-3.36	-9.34	110	
15	15	11	12	75	190	3.63	0.82	3.12	16.40	110	
16	16	12	13	75	390	0.49	0.11	0.16	0.40	110	
17	17	12	17	75	370	2.82	0.64	3.80	10.27	110	
18	18	17	18	75	260	1.87	0.42	1.25	4.80	110	
19	19	18	14	150	540	-18.07	-1.02	-5.91	-10.95	110	
20	20	18	19	150	870	19.52	1.10	10.98	12.63	110	
21	21	19	20	150	1000	17.50	0.99	10.32	10.32	110	
22	22	19	21	75	760	0.73	0.17	0.64	0.85	110	

Output data on distribution network for Bure Case: Ordinary, 2010

Serial Number	Pipeline Number	Nord Number Start	Nord Number End	Dia. (mm)	Pipeline Length(m)	Flow (liter/sec.)	Velocity (m/sec.)	Hydraulic Gradient (m/1000)	Loss of Head (m)	Velocity Coefficient	Remarks
1	1	1	2	200	95	27.79	0.88	0.57	5.98	110	
2	2	2	3	75	320	1.21	0.27	0.69	2.15	110	
3	3	2	4	200	525	26.04	0.83	2.78	5.30	110	
4	4	4	5	75	180	3.08	0.70	2.18	12.13	110	
5	5	5	6	75	80	0.65	0.15	0.05	0.68	110	
6	6	5	7	75	250	2.33	0.53	1.81	7.24	110	
7	7	4	8	150	40	22.68	1.28	0.67	16.67	110	
8	8	8	11	150	370	19.15	1.08	4.51	12.18	110	
9	9	11	14	150	220	15.33	0.87	1.78	8.07	110	
10	10	14	15	75	170	0.21	0.05	0.01	0.08	110	
11	11	15	16	75	110	1.29	0.29	0.27	2.42	110	
12	12	15	9	75	755	-1.63	-0.37	-2.83	-3.74	110	
13	13	9	10	75	25	0.71	0.16	0.02	0.80	110	
14	14	9	8	75	360	-2.72	-0.62	-3.47	-9.65	110	
15	15	11	12	75	190	3.58	0.81	3.04	16.03	110	
16	16	12	13	75	390	0.79	0.18	0.38	0.98	110	
17	17	12	17	75	370	2.28	0.52	2.57	6.96	110	
18	18	17	18	75	260	0.75	0.17	0.23	0.89	110	
19	19	18	14	150	540	-14.78	-0.84	-4.07	-7.55	110	
20	20	18	19	150	870	14.86	0.84	6.63	7.62	110	
21	21	19	20	150	1000	11.62	0.66	4.84	4.84	110	
22	22	19	21	75	760	1.17	0.26	1.54	2.02	110	

Output data on distribution network for Bure Case: Fire Fighting, 2010

Serial Number	Pipeline Number	Nord Number Start	Nord Number End	Dia. (mm)	Pipeline Length(m)	Flow (liter/sec.)	Velocity (m/sec.)	Hydraulic Gradient (m/1000)	Loss of Head (m)	Velocity Coefficient	Remarks
1	1	1	2	200	95	34.10	1.09	0.83	8.73	110	
2	2	2	3	75	320	0.75	0.17	0.28	0.89	110	
3	3	2	4	200	525	33.02	1.05	4.32	8.23	110	
4	4	4	5	75	180	1.92	0.43	0.91	5.06	110	
5	5	5	6	75	80	0.40	0.09	0.02	0.28	110	
6	6	5	7	75	250	1.45	0.33	0.75	3.01	110	
7	7	4	8	150	40	30.93	1.75	1.18	29.59	110	
8	8	8	11	150	370	27.14	1.54	8.60	23.24	110	
9	9	11	14	150	220	22.50	1.27	3.61	16.42	110	
10	10	14	15	75	170	-1.48	-0.33	-0.53	-3.11	110	
11	11	15	16	75	110	0.80	0.18	0.11	1.00	110	
12	12	15	9	75	755	-2.62	-0.59	-6.76	-8.96	110	
13	13	9	10	75	25	0.44	0.10	0.00	0.33	110	
14	14	9	8	75	360	-3.29	-0.74	-4.92	-13.66	110	
15	15	11	12	75	190	4.50	1.02	4.64	24.41	110	
16	16	12	13	75	390	0.49	0.11	0.16	0.40	110	
17	17	12	17	75	370	3.69	0.83	6.25	16.90	110	
18	18	17	18	75	260	2.74	0.62	2.53	9.74	110	
19	19	18	14	150	540	-23.76	-1.34	-9.81	-18.17	110	
20	20	18	19	150	870	26.08	1.48	18.77	21.58	110	
21	21	19	20	150	1000	24.06	1.36	18.59	18.59	110	
22	22	19	21	75	760	0.73	0.17	0.64	0.85	110	

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