3.3.18 SEASIDE (MIRIJJAVILA AREA) (H10) --- SURVEY LINE, FIGURE 3.39, RESISTIVITY CROSS SECTION, FIGURE 3.40

In order to study the effect of seawater invasion, a survey line was taken along the road running N-S from the beach at station 27 towards north. The line length was 2,600 meters and the data were taken at every 300 m of intervals.

No saline water invasion effect was confirmed on this section, and the only conductive zone was detected at the northern end of the line. The groundwater from the north seems to be blocked by resistive body at stations 8 to 10. Resistivity over 100 Ohm-m implies a zone without seawater invasion. A geological boundary may be cut across the line at around station 21.





3.4 TECHNOLOGY TRANSFER

3.4.1 ON-THE-JOB-TRAINING

As a technology transfer in the geophysical field, the following on-the-job-training activities were conducted for the counterpart personnel;

- Line survey by using a pocket compass and a measuring tape
- Schlumberger data acquisition with Syscal R2 system
- Proper usage of instruments and its maintenance

As for the data processing and interpretation, practical trainings were given on the following subjects;

- (1) Data transfer from the Syscal receiver to a WRB desk-top computer
- (2) Calculation of electrode separation factor K by using X-Y coordinates
- (3) Editing of transferred data
- (4) 1-D analysis of each station and its display
- (5) Profiling of the survey line (apparent and interpreted resistivity)
- (6) Interpretation of the sections

The counterparts in geophysical exploration have a good comprehension over the proper operation of hardware and software.

3.4.2 WORKSHOP

The workshop was held on September 16, 2001, under kind arrangement of WRB. About 25 participants from WRB and NWSDB attended the workshop.

In the morning session, general concept of geophysics and on geophysical exploration for water resources development, basic geophysical exploration tool and principles of gravity survey as well as electrical and electro-magnetic surveys were explained. Furthermore, the results of Schlumberger and CSAMT data taken in the field were shown and the most promising areas for drilling were proposed. The necessity of resistivity survey for deep-seated water resource exploration was emphasized.

The subjects of the workshop were as follows;

(1) Introduction of Geophysical Exploration

- Geophysics
- Geophysical Exploration
- Gravity Survey
- Corrections of Gravity Survey
- Gravimeter and Bouguer Anomaly Map

(2) Resistivity Method

- Electrical Survey
- Basic Theory
- Electrode Configurations
- Field Set-up
- Line Survey
- Interpretation and Modelling

- CSAMT Method
- Basic Theory
- Field Procedure
- 1-D, 2-D analysis

(3) Results of the Measurement

- 2-D Inversion Analysis
- Proposed Drilling Sites

3.5 CONCLUSIONS

(1) Selected Promising Points

The geophysical exploration is significantly less expensive than the drilling program in this area, and provides essential information for the success of the project. When it comes to the deep drillings, it would be very risky to drill without any geophysical basis. In this regard, the results of geophysical exploration will be helpful to target the deep-seated water resources in these areas. The sites were selected among the areas showing low resistivity anomalies in the basement rock with high resistivity. By interpreting the results for resistivity structures, 10 promising drilling sites listed below were identified:

Monaragala District

Bodagama Area (M2) ----- Station 6

Yalabowa Area (M5) ----- Station 13-14

Badalkumbura (M6) ----- Station 11-12

Sevanagala (M7) ----- Station 13

Hambantota District

Keliyapura Area (H1) ----- Station 7

Talunna Area (H3) ----- Station 3

Wediwewa Area (H4) ----- Station 10-11

Tammennawewa Area (H5) ---- Station 1-2

Mattala Area (H6)----- Station 10

Siyambalagaswila Area (H7) --- Station 6-7

(2) Review of the Geophysical Survey Result

As a result of test well drilling, the wells constructed in five areas yielded more than 400 litres/min and two test wells yielded 85 to 100 litre/min or more. The results show that the geophysical survey is highly effective to decide a well location.

The result of geophysical survey was reviewed after the completion of the test well drilling and it is summarized below.

- The subsurface layer with the low resistivity of 10 to 200 ohm-m is a weathered zone. The thickness is from a few meters to 10 meters or more.

- The hard basement rock with the resistivity of 1000 to 10000 ohm-m is distributed below the subsurface weathered zone.
- A part showing the resistivity of less than 400 ohm-m in the basement rock indicates the zone of water bearing faults or fractures.
- In Hambantota, a part with the resistivity below 100 ohm-m is most likely the zone bearing water with high electric conductivity, which is not acceptable for drinking water.
- In general, the fault and fracture with the direction of NNW-SSE yield comparatively large amount of water.

(3) Recommendation

1) Utilization of the Schlumberger Method

In order to select a drilling site after conducting Schlumberger resistivity survey, the following points must be taken into consideration;

At first, ground contact resistance of the current electrodes must be decreased as much as possible by increasing number of electrode rods with deeper penetration of the grounded electrodes and decrease resistance by watering around them. To investigate deeper formation, the current electrode spacing must be expanded as long as possible. The Schlumberger method is used independently in the future, the bigger AB/2 up to 400-500 meters must be taken into consideration. In this case, the SN ratio will worsen, as the signal is weak compared with noise level. Station interval can be taken as 100 meters on the line to make 2D inversion analysis.

2) Determination of the Drilling Site

In the Study area, namely Hambantota and Monaragala district, it is recommended that a geophysical survey will be carried out by the following procedure.

Preliminary geological study will be conducted to decide effectively the number and location of survey stations and survey lines in a target area. It will pay attention especially to geological structure such as lineaments.

A main survey line is set to be orthogonal to geological structure extracted by the preliminary geological study. In addition the setting of some other survey lines, especially grid survey lines, is preferable to analyse more accurately. Besides, an interval between survey stations is 50 to 100 m.

A well location will be selected in the areas showing low resistivity anomalies by the result of geophysical survey. The areas with the resistivity of less than 400 ohm-m are recommended as a drilling point of a production well in Monaragala, while the areas with the resistivity between 100 to 400 ohm-m are recommendable in Hambantota.

SUPPORTING 4 SOCIOECONOMIC CONDITIONS

4.1 GENERAL

4.1.1 OBJECTIVES AND METHODS

Purposes of sosioeconomic study are to provide i) socioeconomic information of Sri Lanka as a general background of the Study, ii) basic information of the two districts in the Study area, necessary for the formulation of the groundwater development plan and iii) base-line information required for the evaluation of effects of the groundwater development plan to be proposed.

During the 1st and 2nd Study in Sri Lanka, existing data/information were collected and reviewed and a questionnaire survey was conducted to acquire necessary information.

4.1.2 Administrative Settings

In Sri Lanka, administrative unit consists of Provinces, Districts, Divisional Secretary's Division (DSD), Grama Niladhari Divisions (GND) and villages. There are 9 Provinces and 25 Districts as shown in *Table 4.1*.

Province	District	
	Colombo	
Western	Gampaha	
	Kalutara	
	Kandy	
Central	Matale	
	Nuwara Eliya	
	Galle	
Southern	Matara	
	Hambantota	
	Jaffna	
	Kilinochchi	
Northern	Mannar	
	Vavuniya	
	Mullaitivu	
	Batticaloa	
Eastern	Ampara	
	Trincomalee	
Northwestern	Kurunegala	
WorthWestern	Puttalam	
Northcontrol	Anuradhapura	
INOLUCEITUAL	Polonnaruwa	
Livo	Badulla	
Uva	Monaragala	
Saharagamuuua	Ratnapura	
Sabaragamuwa	Kegalle	

Table 4.1	Provinces	and Districts	in	Sri Lanka
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Currently the government administration is not completely in effect in the two provinces, namely Northern and Eastern Provinces due to prevailing ground situations, thus most statistics exclude those areas.

The Study covers two districts, Monaragala and Hambantota districts. The former belongs to Uva Province and the latter to Southern Province. The two districts occupy the country's southern part where water shortage is significant in the dry season.

4.1.3 MAJOR SOCIOECONOMIC CONDITIONS OF SRI LANKA

Major socioeconomic conditions are summarized in *Table 4.2*.

Indicators		Unit	Year	Values
Total Population ¹⁾		'000	2001	16,865
	Population Density	Per Sq. Km.	1999	1.4
	Crude Birth Rate	Per 1000 Population	1999	17.5
	Crude Death Rate	Per 1000 Population	1999	6
Labour Force Part	icipation Rate	Percent	1999	51
Unemployment Rat	e	Percent	1999	8.9
G.D.P Growth Rate		Percent	1999	4.3
G.D.P Growth Rate first 6 months data)	for 2000 (Based on	Percent	2000	5.5
Per Capita GNP at C	Current Price	Rs.	1999	59,920
Per Capita GNP at Current Price		US\$	1999	809
Per Capita GNP at 0	Constant Price	Rs.	1999	25,791
GDP Implicit price	deflator (1990=100)		1999	220
Annual Average Pri (GDP-Implicit)	ce Change	percent	1999	4.4
Annual rate of Incre	ease of CCPI	No.	1999	4.7
(Based on 12 months moving average upto June 2000)		percent	July 1999 to June 2000	3.7
Annual rate of Increase of CCPI		percent	1999	1.3
Average Yield of paddy				
	Maha	Kg./Net Hactare	1999	3,612
	Yala	Kg./Net Hactare	1999	3,752

Source: Household Income and Expenditure Survey 1995/1996, Department of Census and Statistics, Ministry of Finance and Planning, except 1)

¹⁾: The result of Census of Population and Housing 2001, which does not include seven districts in Northern and Eastern Provinces.

(1) Population

The census of population and housing was conducted on July 2001, the population of the Sri Lanka was estimated as 18.73 million. The population density is 285 person/km², it can be classified as a highly populated region. The average annual growth rate is estimated to be 1.14 during the period of 1990 to 2000 (past 10 years average). The annual growth rate is as high as 1.8 at Monaragala, as low as 1.1 at Hambantota.

(2) Ethnic Characteristics and Region

In Sri Lanka, there are three major ethnic groups of Singhalese (74% of the total population), Tamils (18%) and Moore (8%). Regarding the religions, the majority (69%) are Buddhists consisting of mainly Singhalese, 15% are Hindu (mainlu Tamils) and the rest are Christians and Muslims. Authorized national languages are Singhalese and Tamil while English is popular in schools in urban area. The literacy rate is as high as 90%.

(3) Economy

Sri Lanka experienced a major economic crisis in the latter half of the 1980s, having a financial deficit, international trade deficit and high rate inflation. The government started basic social structural changes with the assistance of IMF and the World Bank. As a result, the actual GDP growth rate got out of the low level of 2% and has maintained the level of 5% since 1990. An increase of capital from foreign countries, growth of demand and smooth export business may be accounted as the background. However, in 1999, the actual GDP came down to the 4% level due to the showing down of industrial growth and the low tea market activities.

The great international trade deficit of Sri Lanka has been counter balanced by money sent from oversea workers, direct foreign investments and development assistance from donor countries. The 1998 international trade was in the red, with the total export income being 4.7 billion US\$ and the import expenditure 5.9 billion US\$. The international balance was 8.7 billion US\$, which was 0.55 billion US\$ more than the previous year. Of the debt, 94% was medium to long range loans mainly by the Asian Development Bank and Japanese government's loan. According to the annual report of the Central Bank of Sri Lanka, the annual average exchange rate in 2001 against the US dollar was assumed to be 64.59Rs/US\$, with GDP/capita being US\$837 (CBSL,2001).

The constituents of the industries related to GDP in 1998 statistics were the primary industries of agriculture, logging and marine products, 21.3%; wholesale/retail, 22.35%; manufacturing, 16.9%; transport/communications, 11.2%; and electricity/water/gas, 1.4%. The population distribution among the industries was reported as primary industries 33.2%, secondary industries 17.6%, and tertiary industries 49.2%.

A civil war has been continuously fought in Sri Lanka, and the national finance has been pressed by the enormous military expenditure. At February 2002, ceasefire agreement was agreed, early ending of the civil war is anticipated by everyone, but in such circumstance there must be a limit to the economical development.

4.2 MONARAGALA DISTRICT

4.2.1 ADMINISTRATIVE SETTING

Monaragala district, which is one of two districts of Uva province, consists of 11 DSDs. These DSDs are further divided into GNDs. In Monaragala district, each DSD has a Pradeshiya Sabhas and there is no Urban Council in any DSDs.

The GND is considered the smallest administrative unit provided with statistical data. Therefore, GND is defined as a unit for groundwater development plans concerning to the 15 requested sites and such GNDs are named "Pilot GND". There are seven Pilot GNDs in Monaragala district.

Location of the DSDs and the Pilot GNDs are shown in the figure in the first page of the Report, and the numbers of GNDs are shown in *Table 4.3*.

Name of DSDs	Number of GNDs
BIBILE	40
MADULLA	38
MEDAGAMA	35
BADALKUMBURA*	41
MONARAGALA*	26
SIYAMBALANDUWA	48
BUTTALA*	29
WELLAWAYA*	29
KATHARAGAMA	5
SEVANAGALA*	14
TANAMALWILA*	14

 Table 4.3
 Number of GND in DSD of Monaragala District

Note:"*" shows DSD that has Pilot GND(s)

4.2.2 POPULATION

According to the Census of Population and Housing in 2001, the populations of each DSD in Monaragala district are estimated as shown in *Table 4.4*.

Name of D.S. Division	Population
Badalkumbura	36,693
Bibile	35,435
Buttala	47,086
Katharagama	16,372
Madulla	28,302
Medagama	32,083
Moneragala	42,575
Sevanagala	36,683
Siyambalanduwa	47,437
Thanamalvila	23,158
Wellawaya	50,349
District Total	396,173

 Table 4.4
 Population of DSDs in Monaragala District

Source: The results of Census of Population and Housing, 2001, Department of Census and Statistics, Sri Lanka,

(http://www.statistics.gov.lk/Documents/census2001/resultindex.htm)

The results of the Census show an annual population growth rate from the last census in 1981 of the district is 1.8%, while the one for all the country is 1.2%. It is the third highest growth rate among 18 districts (Census of Population and Housing in 2001 does not cover seven districts in Northern and Eastern Province). However, it has considerably decreased compared to the annual growth rate for Monaragala district estimated in Demographic Survey 1994 Sri Lanka, conducted by Department of Census and Statistics, that was 2.23%, and the District's population growth seems on the decrease.

4.2.3 ETHNIC AND RELIGIOUS COMPOSITIONS

The distribution of the population by ethnic groups is shown in *Table 4.5*. In Monaragala, Sinhalese, Sri Lanka Tamil, Indian Tamil and Sri Lanka Moor population comprises of 94.5%, 1.4%, 1.9% and 2% respectively, while those for Sri Lanka are 81.9 %, 4.4 %, 5.1 % and 8.0 % respectively. Predominance of Sinhalese to other ethnic groups is significant in the district.

Table 4.5	Percentage Distribution	of Ethnicity in Monaragala District and Sri Lanka
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(Unit: %)

	Sinhalese	Sri Lanka Tamil	Indian Tamil	Sri Lanka Moor	Burgher	Malay	Sri Lanka Chetty	Bharatha	Other
Monaragala	94.5	1.4	1.9	2	0	0	0	0	0
Sri Lanka [*]	81.9	4.4	5.1	8	0.2	0.3	0.1	0	0.1

Source: The results of Census of Population and Housing, 2001, Department of Census and Statistics, Sri Lanka, (http://www.statistics.gov.lk/Documents/census2001/resultindex.htm)

*: Excluding seven Districts in Northern and Eastern Provinces

The distribution of the population by religions is shown in *Table 4.6*. The religious affiliations in the District show that out of the total population 94.4% are Buddhists, 3% are Hindus, 2.1% are Muslims, 0.4% are Roman Catholics and 0.2% are other Christians. The Buddhist distribution of

the District is considerably higher than that of Sri Lanka. This may reflect the higher percentage of Sinhalese group in the District.

						(Unit: %)
	Buddhist	Hindu	Muslim	Roman Catholic	Other Christian	Other
Monaragala	94.4	3	2.1	0.4	0.2	0
Sri Lanka [*]	76.7	7.9	8.5	6.1	0.8	0.1

 Table 4.6
 Percentage Distribution of Religion in Monaragala and Sri Lanka

Source: The results of Census of Population and Housing, 2001, Department of Census and Statistics, Sri Lanka, (http://www.statistics.gov.lk/Documents/census2001/resultindex.htm)

*: Excluding seven Districts in Northern and Eastern Provinces

4.2.4 ECONOMY

(1) Employment

Employment composition in Monaragala district was made clear by the questionnaire survey conducted in this Study, as shown in *Table 4.7*. The employment in the agriculture sector counts 51.5%. Compared to that of all the country, which is 36% (Registra General's Department, Department of Census & Statistics, and Central Bank of Sri Lanka, http://www.lanka.net/centralbanky-demo_employeement. html), the main employment of Monaragala district is considered to be agriculture.

Table 4.7 Employment Composition in Monaragala District				
Sectors	Numbers	%		
A ami analtanna	101	515		

Sectors	Numbers	%
Agriculture	121	51.5
Manufacturing	30	12.8
Service	61	26.0
Public Service	23	9.8
Total	235	100.0

Source: Results of the Questionnaire survey

(2) Income and Poverty

Monthly income distribution of the District obtained by the questionnaire survey is as shown in *Table 4.8*. Families of which monthly income is less than 4,000 Rupee exceed 60% of the total households. According to the Household Income and Expenditure Survey, shown in *Table 4.9*, a median of the monthly household income for the rural sector of Sri Lanka is about 4,000 Rupee in 1995/1996. The median for the district inferred from the questionnaire survey result is apparently lower than that of national level of five years ago. Therefore, the District is considered to be a poorer area in the country.

 Table 4.8
 Distribution of Monthly Income in Monaragala District

Range of Income (Rs/Family)	Number of Family	%
<2,000	98	33.8
2,000 - 4,000	83	28.6
4,000 - 6,000	53	18.3
6,000 - 8,000	24	8.3
8,000 - 10,000	11	3.8
>10,000	21	7.2
Total	290	100.0

Source: Results of the Questionnaire survey

Sector	Mean	Median	(Mean - median)x100 Mean
	Rs.	Rs.	%
All Island*	6,476	3,793	41.4
Urban	11,240	6,308	43.9
Rural	5,852	3,621	38.1
Estate	4,059	3,377	16.8
Uva Province	3,888	2,620	32.6
Monaragala Distirict	4,231	2,813	33.5
Southern Province	5,540	3,548	36.0
Hambantota District	4,397	2,770	37.0

Table 4.9 Mean and median household income per month by sector 1995/96

Source: Household Income and Expenditure Survey 1995/1996, Department of Census and Statistics, Ministry of Finance and Planning

Monthly income distribution of the seven Pilot GNDs in Monaragala district analysed by the questionnaire survey is shown in *Figure 4.1*. Families of which monthly income is less than 4,000 Rupees varies from 59% at Badalkumbura to 100 % at Hambegamuwa. Out of these GNDs, the distribution at five GNDs (Unawatuna, Hambegamuwa, Yalabowa, Hulandawa Left, and Sevanagala) is more than 80 %. The other two GNDs also show rather high percentage, it is more than 60 %. Major occupation of residents in these five GNDs is farming.

While families of which monthly income is less than 2,000 Rupees varies from 35 % at Badalkumbura to 73 % at Hulandawa Left. These percentages, however, are much higher than that of average percentage of 33.8 of the district that is shown in *Table 4.8*.

Therefore, it is considered that these Pilot GNDs are the low income area among the Monaragala district.

Table 4.10 shows the ratios of poor families in 1990/1991 and 1995/1996. The percentage of poor families in Monaragala district widely exceeds that in the rural sector of Sri Lanka. Furthermore, it should be noted that the ratio has been worsened since 1990/1991, although it has been considerably improved for all the country during the period.

Area	1990/91	1995/96
Sri Lanka	30.4	26.7
Urban Sector	18.2	13.4
Rural Sector	34.7	28.7
Monaragala District	36.5	47.7
Hambantota District	36.8	30.3

 Table 4.10
 Percentage of Poor Families

Source: Household Income and Expenditure Survey 1995/1996, Department of Census and Statistics, Ministry of Finance and Planning



(3) Water Use

To understand the water use conditions of the Study area, the field reconnaissance and questionnaire survey ware carried out. The survey sheets are attached *Appendix C and D* of this report.

Through field reconnaissance, it was found that in the areas out of NWSDB water supply scheme, the residents obtain water from dug wells and tube wells and/or surface water sources. Even area covered by NWSDB water supply scheme, people often have to rely on other water sources during the dry season. Popular water activities are that one of family members goes to wells that locate in their own premise or nearby places to bring water by a bucket, pot or some other containers for several times in a day. The water brought into home is used for mainly drinking and cooking purposes, while washing and bathing mostly rely on other water sources.

Dug wells often dry up during the dry season, and the people who rely on the dug wells change their water source to nearby tube wells or other available water source such as irrigation channels and tanks. Therefore, distance to a daily water source ranges from 1m to over 1 km, according to the questionnaire survey.

Table 4.11 shows comparisons of differences in the water consumption rate and the distance to the water source between the satisfied group and the unsatisfied group. An average water consumption rate estimated from the questionnaire survey is 35 l/day/capita in the district. For the above water supply conditions, 46% of surveyed people felt satisfaction and 54% unsatisfaction, in terms of quantity. However, there is no significant difference between the two groups.

Table 4.11 Satisfaction to Current Water Supply in Monaragala District

Satisfaction to Water	No.s	Average Water	Average Distance to
Quantity	(%)	Consumption	Water source
		(l/day/Capita)	(m)
Yes	130 (46)	31	114
No	153 (54)	39	131

Source: Results of the Questionnaire survey

(4) Willingness to Pay

Figure 4.2 shows the distribution of willingness to pay by the monthly income levels. As these data suggest, a range of willingness to pay of less than 40 Rs/month is the majority among the families of its income level of less than 4,000 Rupees.

Low willingness to pay observed in the income level of less than 2,000 Rs/month, which is a majority group in the District, should be reminded in the formulation of the groundwater development plan.



Source: Results of the Questionnaire survey

Figure 4.2 Willingness To Pay by Income Levels in Monaragala

The relationship between willingness to pay and monthly income at each Pilot GND was analysed. A total of 15 Pilot GNDs of both districts was classified into four groups as follows.

- **Group I** : Low willingness to pay
- **Group II** : Medium willingness to pay
- **Group III** : High willingness to pay
- **Group IV** : Two peaks of low and high willingness to pay

In Monaragala district, seven Pilot GNDs are classified to Group I, III and IV as follows (See, *Figure 4.3*);

Group I: Yalabowa, Unawatuna, Bodagama, Sevanagala and Hambegamuwa (five GNDs)

The willingness to pay is generally low. Income level is also low, it is generally less than 4,000 Rupees. In Sevanagala and Hambegamuwa, the majority of income level is less than 2,000 Rupees. The result suggests that the low income level is one of the main factors of the low willingness to pay.

Group III: Hulandawa Left (one GND)

Willingness to pay is high, although a low income level of less than 2,000 Rupees is a majority. In this GND, 95% of water source is dug wells. Most of such dug wells often dry up during dry season. This GND is the one of the most suffering area from water shortage. The result suggests that the accessibility to water is also one of the factors of high willingness to pay.

Group IV: Badalkumbura (one GND)

In this GND, the proportion of farming employment is very low as 20%, and the service employment is rather higher than other GNGs. The population having its income level of less than 4,000 Rupees is the lowest among seven GNDs.

It is concluded that the willingness to pay is concerned strongly in the level of income and the degree of accessibility to water.



4.3 HAMBANTOTA DISTRICT

4.3.1 Administrative Setting

Hambantota district, which belongs to Southern province, consists of 11 DSDs. These DSDs are further divided into GNDs that are the smallest administrative units. In Hambantota district, each DSD has a Pradeshiya Sabha which is the local authority. Hambantota and Tangalla DSDs have an urban council. There are eight Pilot GNDs in Hambantota district.

Locations of the DSDs are shown in the figure in the first page of the Report, and numbers of GNDs are shown in *Table 4.12*.

Name of DSDs	Numbers of GNDs
AMBALATHOTA	55
ANGUINUKOLAPELESSA	51
BELIATTA	71
HAMBANTHOTA*	30
KATUWANA	84
LUNUGAMWEHERA*	36
OKEWELA	27
SURIYAWEWA*	21
TANGALLE*	72
TISSAMAHARAMA	44
WEERAKETIYA	85

 Table 4.12
 Number of GND in DSD of Hambantota District

*: DSD that has Pilot GND(s)

4.3.2 POPULATION

According to the Department of Census and Statistics (2001), the populations of each DSD in Hambantoa district are estimated as shown in *Table 4.13*.

DSD	Population
Ambalantota	63,930
Angunakolapelessa	42,420
Beliatta	52,280
Hambantota	46,777
Katuwana	62,222
Lunugamvehera	25,148
Okewela	18,204
Sooriyawewa	35,620
Tangalle	62,804
Thissamaharama	60,941
Weeraketiya	55,024
District Total	525,370

 Table 4.13
 Population of DSD in Hambantota District

Source: The results of Census of Population and Housing in 2001, Department of Census and Statistics, Sri Lanka, (DCS, 2001)

Supporting 4 Socioeconomic Conditions

The results of the Census show an annual population growth rate from the last census in 1981 of the District is 1.1%, while that of all the country is 1.2%. It is considerably lower than the annual growth rate for Hambantota district estimated in Demographic Survey 1994 Sri Lanka, conducted by Department of Census and Statistics, that was 1.51%. Therefore the District's population growth is assumed to be on a decrease.

4.3.3 ETHNIC AND RELIGIOUS COMPOSITIONS

The distribution of the population by ethnic groups is shown in *Table 4.14*. Sinhalese, Sri Lanka Tamil, Indian Tamil and Sri Lanka Moor population comprises of 97.1%, 0.4%, 0.1% and 1.1% respectively, while those for Sri Lanka are 81.9%, 4.4%, 5.1% and 8.0%, respectively. Predominance of Sinhalese to other ethnic groups is significant in the District.

 Table 4.14
 Percentage Distribution of Ethnicity in Hambantota District and Sri Lanka

 (Unit: %)

								(0)	
	Sinhalese	Sri Lanka Tamil	Indian Tamil	Sri Lanka Moor	Burgher	Malay	Sri Lanka Chetty	Bharatha	Other*
Hambantota	97.1	0.4	0.1	1.1	0	1.4	0	0	0
Sri Lanka [*]	81.9	4.4	5.1	8.0	0.2	0.3	0.1	0	0.1

Source: The results of Census of Population and Housing in 2001, Department of Census and Statistics, Sri Lanka, (DSC, 2001)

*: Excluding seven Districts in Northern and Eastern Provinces.

The distribution of the population by religions is shown in *Table 4.15*. The religious affiliations in the District show that out of the total population 96.9% are Buddhists, 0.3% are Hindus, 2.5% are Muslims, 0.2% are Roman Catholics and 0.2% are other Christians. The Buddhist distribution of the District is considerably higher than that of all Sri Lanka. This may reflect the higher percentage of Sinhalese group in the District.

 Table 4.15 Percentage Distribution of Religion in Hambantota District and Sri Lanka

					((Unit: %)
	Buddhist	Hindu	Muslim	Roman Catholic	Other Christian	Other
Hambantota	96.9	0.3	2.5	0.2	0.2	0
Sri Lanka [*]	76.7	7.9	8.5	6.1	0.8	0.1

Source: The results of Census of Population and Housing, 2001, Department of Census and Statistics, Sri Lanka, (DSC,2001)

*: Excluding seven Districts in Northern and Eastern Provinces

4.3.4 ECONOMY

(1) Employment

According to the results of questionnaire survey, major employment in Hambantota district is agriculture as shown in *Table 4.16*. The percentage of agricultural employment, which is more than 80%, is higher than that of Monaragala district.

Table 4.16	Employment	Composition	in Hambantota	District
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Sectors	Numbers	%
Agriculture	214	81.1
Manufacturing	5	1.9
Service	27	10.2
Public Service	18	6.8
Total	264	100.0

Source: Results of the Questionnaire survey

(2) Income and Poverty

Monthly income distribution of the District analysed by the questionnaire survey is shown in

Table 4.17. The percentage of families of which income is less than 4,000 Rs/month, which is around 80%, is higher than that of Monaragala district. The result reveals that the income level in Hambantota district is lower than Monaragala district.

Range of Income (Rs/Family)	Number of Family	%
<2000	122	42.4
2000 - 4000	104	36.1
4000 - 6000	35	12.1
6000 - 8000	17	5.9
8000 - 10000	6	2.1
>10000	4	1.4
Total	288	100.0

 Table 4.17
 Distribution of Monthly Income in Hambantota District

Source: Results of the Questionnaire survey

Monthly income distribution of the eight Pilot GNDs in Hambantota district analysed by the questionnaire survey is shown in *Figure 4.4*. Families of which monthly income is less than 4,000 Rupees varies from 31% at Talunna to 86 % at Wediwewa. In three GNDs (Keliyapura, Siyambalagaswila North and Wediwewa), the distribution of families with income of less than 4,000 Rs/month, which is arround 80%, is higher than other GNDs. The distributions in other four GNDs excluding Talunna, are in a range of 60 to 70%. The income level of Talunna is apparently higher than others.

Therefore, it is considered that these Pilot GNDs are the average income level in the Hambantota district, from the view point of the level of less than 4,000 Rs/month.

While families of which monthly income is less than 2,000 Rupees varies from 5 % at Talunna to 73 % at Siyambalagaswila North. The proportion of the range of income of less than 2,000 Rupees in these Pilot GNDs are lower than the average of the District as (refer to *Table 4.17*).

According to Department of Census and Statistics (2000), the ratios of poor families in Hambantota in 1990/1991 and 1995/1996 are 36.8 and 30.3%, respectively (See, *Table 4.10*). Economic condition in Hambantota has been improved. The degree of poverty in Hambantota is lower than Monaragala.



(3) Water Use

Table 4.18 shows comparisons of the differences in the water consumption rate and the distance to the water source between the satisfied group and the unsatisfied group. According to the results of questionnaire survey, average water consumption rate is 19 liter/day/capita in Hambantota district, which is lower than that in Monaragala (35 litre/day/capita). Under such water supply conditions, 28.5% of surveyed people felt satisfaction and 71.5% unsatisfaction, in terms of quantity. The number of the persons who satisfy with the current water supply are the half of the group of unsatisfied, although the average water consumption rate of these two groups are almost same.

Satisfaction to Water Quantity	No.s (%)	Average Water Consumption (l/day/Capita)	Average Distance to Water source (m)
Yes	75 (28.5)	20	202
No	188 (71.5)	19	311

|--|

Source: Results of the Questionnaire survey

(4) Willingness to Pay

Figure 4.5 shows the distribution of willingness to pay by monthly income levels. It is observed that the peak of distribution is a range of 21 to 80 Rs/month at monthly income less than 4,000 Rs. The distribution shows the higher willingness to pay compared with that of Monaragala. It may be because of shortage of water, it is severe than Monaragala district.



Source: Results of the Questionnaire survey

Figure 4.5 Willingness to Pay by Income Levels

As mentioned in *clause 4.2.4*, 15 Pilot GNDs of both districts are classified into four groups. In Hambantota district, Pilot GNDs are distributed to all groups as described below (See, *Figure 4.6*).

Group I: Ranna West (one GND)Willingness to pay is low, although higher level income families exist. Most of families in this district obtain the water from pipe borne.

Group II: Vitarandeniya South, Wediwewa, Keliyapura, Tammennawewa and Pahala Mattala (five GNDs)

Willingness to pay is in middle. The majority of income level in these districts is less than 4,000 Rupees.

Group III: Talunna (one GND)

Willingness to pay is higher than other GNDs. The income level is also higher than others. In this GND, most of residents depend on unstable water source such as dug wells and others.

Group IV: Siyambalagaswila North (one GND)

Willingness to pay is separated to the low and high level. The percentage of low income level of less than 2,000 Rupees is obviously higher than other GNDs. In this GND, most of residents depend on dug well to obtain water.

Willingness to pay in Hambantoa can be characterized as a middle range, while Monaragala is low. Considering water consumption rate, in Hambantota, it is concluded that the willingness to pay highly depends on the degree of accessibility to water.



4.4 WATER SUPPLY CONDITIONS

4.4.1 GENERAL

The objectives of the study for the water supply conditions are 1) to clarify the administrative performance related to the existing water supply schemes, 2) to understand the water supply situation, in the Study area. For these purposes, the existing water source survey and the data collection of existing water supply schemes were carried out. As regards to the said survey, the word of "water source" represent the "wells". In this chapter, the methodology of the existing water source survey and the conditions of water supply schemes are mainly described.

4.4.2 EXISTING WATER SOURCE (WELL) SURVEY

The existing water source survey is composed of the water usage survey by questionnaire and hydrogeological investigations at selected water sources. The results of the water usage survey by the questionnaire are described in *Section 4.5*. The results of hydrogeological investigations are utilized for the hydrogeological analysis in the study area, which is described in *Supporting 7*. The flow of existing water source survey is shown in *Figure 4.7*.



Figure 4.7 Flow of the Existing Water Source Survey

(1) Selection of Water Sources

In the existing water source survey, 192 wells were selected uniformly to cover the entire area in consideration of hydrogeological aspects and locality consideration. Basically, these water sources should be distributed over all DSD irrespective of the existence of Pilot GNDs. On the other hand, the detailed information of each Pilot GND will be required for further hydrogeological and water usage condition analysis. Therefore, at least 10 water sources were selected from each Pilot GND. The 192 wells were selected in the following procedure.

The well inventory (database) was supplied by WRB and NWSDB (refer to *Data Book A*). The two databases were combined after the deletion of duplicated data. Consequently, 1,380 wells for Hambantota district and 1,427 wells for Monaragala district were listed.

From among these listed wells, the tube wells were selected for each DSD, as to be provided with the hydrogeological information of each well, i.e. drilled depth, yield, water level and coordination. In case a DSD included the Pilot GNDs, basically, 10 wells were selected from a Pilot GND. The additional few wells were selected from the rest of area in the DSD. As for a DSD without the Pilot GND, five to 10 wells were selected.

On the other hand, in the area where no tube well exists, some important public dug wells were selected instead. Since the database does not cover the dug well, the selection was made by the field investigation through the interview to the inhabitants.

As a result, 69 and 123 existing sources were selected from 15 Pilot GNDs and the other GNDs, respectively. The number of selected water sources are shown in *Table 4.19*.

	DCD		Nos. of Selected Water Sources			
	DSD	Requested GND	with in Pilot GND	out of Pilot GND	Total	
	Bibile	none	not selected	6	6	
ict	Medagama	none	not selected	8	8	
Distri	Badalkumbura	Badalkumbura	3	8	11	
	Monaragala	Hulandawa	4	20	24	
la	Buttala	Unawatuna	4	12	16	
ga	Wellawaya	Yalabowa	4	7	11	
ara	Tonomoluvilo	Hambegamuwa	9	1	10	
Mona	Tanamatwita	Bodagama	6	4	17	
	Sevanagala	Sevanagala	7	6	13	
	Sub Total		37	71	108	
	Lunugamvehera	Mattala	9	2	11	
	Sooriyawewa	Wediwewa	1	1	2	
ct	Hambantota	Bandagiriya	6			
tric		Keliyapura	liyapura 6		28	
)is		Siyambalagaswila	1			
аĽ	Weeraketiya	none	not selected	5	5	
oti	Katuwana	none	not selected	14(+2*)	16	
ant	Okewela	none	not selected	2	2	
nb		Thalunna	1			
lan	Tangalle	Ranna	0	8	17	
Η		Vitharandeniya	8			
	Beliatta	none	not selected	3	3	
	Sub Total		32	52	84	
Total			69	123	192	

Table 4.19Number of Selected Water Sources

Note: "*" shows out of Hambantota district

(2) Methodology of Water Usage Survey by Questionnaire

The water usage survey by questionnaire is composed of the "whole study area survey" and the "Pilot GND survey". The questionnaire was prepared based on the discussion between the Study team and counterpart team.

The "whole study area survey" was carried out for the selected 192 wells to understand the present situation of water usage in the study area. The survey sheet is attached in *Appendix C*. Basically, at least three families among the users of the wells were visited and interviewed in accordance with the questionnaire provided. In total, 286 families in Monaragala district and 287 families in Hambantota district were interviewed (See, *Data Book B*).

The "Pilot GND survey" was carried out to obtain the specified data from eight GNDs in Hambantota district and seven GNDs in Monaragala district. The survey sheet is attached in *Appendix D*. In this survey, 10% of total families in each GND were visited and interviewed in

Supporting 4 Socioeconomic Conditions

accordance with the questionnaire provided. The families to be surveyed were selected uniformly to cover the entire area of each GND. In total, 300 families in Monaragala and 175 families in Hambantota were interviewed (See, *Data Book C*).

4.4.3 WATER SUPPLY CONDITION OF THE STUDY AREA

(1) Existing Water Supply Scheme

In the study area, water supply schemes have been mainly operating by the NWSDB. The NWSDB operates 269 water supply schemes throughout the Island. In the year of 2000, an amount of 332 million m^3 of water was produced (NWSDB 2001). In Hambantota district, the monthly production amount is 822,250 m^3 (the surface water is main source), it is only 3% of the total production amount of whole Sri Lanka. In Monaragala district, the monthly production amount is less than that of Hambantota.

In the Study area, a total of 30 water supply schemes ware operated by NWSDB and local administrative organization (Pradeshiya Sabha). These schemes supply water to about 234,000 people in the both districts.

1) Hambantota District

In Hambantota district, 19 water supply schemes are operated by the NWSDB. The local authorities, namely the Pradeshiya Sabha operate two water supply schemes. Details of these schemes are given in *Table 4.20*. Total population served by these water supply schemes is at least 170,851, which corresponds to 33% of the total population of Hambantota district.

There are five schemes sourced by wells and two schemes sourced by springs with partial treatment. These schemes depend their sources on groundwater. The groundwater covers only 10% of total population supplied water by schemes.

The locations of water supply schemes in the Hambantota district are shown in *Figure 4.8*. The covered areas of five schemes of Hambantota, Ambalantota, Hungama, Ranna and Tangalla are also shown the *Figure 4.8*. For the other schemes however, since the data of coverage areas are not available, only the locations of the facilities are presented.

Figure 4.9 shows the coverage rate by water supply schemes at each GND (data is shown in *Data Book D*). In Hambantota district, the covered area is mainly distributed along the coastal area. The others are distributed in the east and west part of the district.

2) Monaragala District

In Monaragala district, six water supply schemes are operated by NWSDB. The local authorities, namely Pradeshiya Sabha operate three schemes. Details of these schemes are given in *Table 4.21*. Total population served by these water supply schemes is at least 63,394, which corresponds to 16% of the total population of Monaragala district.

The water sources of the schemes are rivers and tanks except in Buttala WSS. The only scheme in Buttala has extracted water from a river and two wells since 1992. Each scheme has the treatment facility for the distribution. Out of seven Pilot GNDs, the only a part of Yalabowa in Wellawaya DSD, is covered by the water supply scheme.

In Monaragala district, locations of covered areas are dispersed as shown in *Figure 4.8* (data is shown in *Data Book D*). The numbers of GND covered by schemes is less than that of Hambantota (See, *Figure 4.9*).

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	Remarks					Rehabilitated in 1987					Preliminary Assesment(Abstract
	Treatment	"Dolomite Filter for Fe+, Razin Filter for Hardness	Razin Filter for Hardness"	Slow sand filtration	Chlorination	Infiltration laterals and Slow sand filtration	Rafine sand filter, Chlorination	Slow sand filtration	Horizontal flow roughing filtration and Slow sand filtration	no data	er in Monaragala District/F
	Non Revenue Water %	35	49	no data	68	20	25	61	60	no data	Drinking Wate
	Source	Two(2) Boreholes and Menik Ganga	Stream(gravity scheme)	Kirindi Oya	Senanayake Samdraya Tank	Menik Ganga	Gala Oya, gravity	Naya Kandura Oya, gravity scheme	lce Philla Gravity Scheme	no data	face Water Potential for L
	Supply Hours	16	24	14	10	24 except dry period	24	6	10	no data	DB (1999) Sui
	Population Surved	8,000	11,340	6,000	2,000	21,580	5,000	2,000	5,200	2,274	a: 1) NWSI
	Year of Construction	1992	1992	1992	1944	1975	2000	no data	no data	no data	Source
	Maintenance Autholity	B CSWN	BUSWN	BUSWN	BDSWN	BUSWN	NWSDB	Pradeshiya Sabha	Pradeshiya Sabha	Pradeshiya Sabha	
	Scheme	Buttala	Monaragala	Thanamalwila	Inginiyagala	Kataragama	Medagama	Bibile	Wellawaya	Badalkumbura	
	Local Authority	Buttala	Monaragala	Thanamalwila	Inginiyagala	Kataragama	Medagama	Bibile	Wellawaya	Badalkumbura	
	No.	1	2	Э	4	5	6	7	8	6	

2) NWSDB Uva Province Office (2002) Present Situation of the Drinking Water in Uva Province

Supporting 4 Socioeconomic Conditions





(2) Irrigation and Industrial Use

1) Irrigation

In Hambantota and Monaragala districts, with a total area of 8,284 km², a considerable portion is used for forestry and agricultural purposes such as tea, rice and crop cultivations. The surface water such as river and tank water has been mainly used for irrigation of rice and other crops. The areas for these purposes are 2,038 km² (36%) in Monaragala and 1,024 km² (39%) in Hambantota (NWSDB, 1999 and PIU, 2000). The total amount of water consumption for irrigation purpose in Monaragala is twice of that of Hambantota.

There are two major rivers in Hambantota district and five major rivers in Monaragala district. The annual irrigation water amount released from major tanks volumes for the recent three years, are shown in *Table 4.22*. The largest reservoir of Lunugamvehera tank, that is located on the border between Hambantota and Monaragala district, has been utilized approximately 200 million m³ of water at every year. Generally, the water in the reservoir is mainly utilized during less rainfall season in these districts.

2) Industry

In Hambantota district, the amount of $1,000m^3/day$ of water is consumed by the industrial sectors. This amount corresponds to about 4% of water produced by the NWSDB in the district. The water is distributed by pipe borne with 48 connections in the district.

On the other hand, there is no industrial water consumption in Monaragala district. According to the NWSDB, the production amount in the district is not enough to supply water to the industrial sector.

MONARAGALA DISTRICT							
River Basin & Name	Capacity	Ann	ual Irrigation	Release (MC	CM)		
of Tank or Anicut	MCM	1998	1999	2000	Average		
HEDA OYA							
Muthukandiya Tank	30.33	24.66	25.89	29.59	26.72		
WILA OYA							
Ethimale Wewa	6.78	6.17	6.29	6.41	6.29		
Kotiyagala Wewa	2.59	2.47	2.47	2.56	2.50		
Sub-total	9.37	8.63	8.75	8.97	8.79		
KUMBUKKAN OYA	1						
Kumbukkan Anicut	0.00	19.73	19.97	20.22	19.97		
Hulandawa Anicut	0.00	3.08	3.17	3.21	3.15		
Sub-total	0.00	22.81	23.14	23.43	23.13		
MENIK GANGA							
Buttara Anicut	0.00	18.50	18.86	19.73	19.03		
Yudaganawa Tank	0.97	5.55	5.80	6.17	5.84		
Karawila-Maila Wewa	1.72	7.89	8.08	8.61	8.19		
Kukurampola Anicut	0.00	3.95	4.32	4.44	4.23		
Polwatta Anicut	0.00	3.45	3.58	3.70	3.58		
Halmillapillewa Tank	1 48	2.96	3.08	3 21	3.08		
Horabokka Anicut	0.00	2.96	3.08	3 21	3.08		
Sub-total	4 17	45.25	46 79	49.05	47.03		
KIRINDI OYA							
Handapanagala Wewa	7.15	5.67	5.80	5.92	5.80		
Sudupanawela Anicut	0.00	4.93	5.06	5.18	5.06		
Mallatawela-Radapola A.	0.00	2.40	2.47	2.59	2.49		
Debara Ara Tank	1.20	1.97	2.03	2.07	2.03		
Dambe Wewa	1.44	1.05	1.11	1.13	1.10		
Balaharuwa Tank	0.78	2.00	2.03	2.07	2.03		
Sub-total	10.57	18.03	18.50	18.96	18.50		
WALAWE GANGA							
Hambegamuwa Tank	4.16	5.67	5.80	5.83	5.76		
Kandiyapita Wewa	1.38	1.60	1.73	1.78	1.70		
Kahakulullanpelessa Wewa	0.37	2.07	2.10	2.16	2.11		
Maha Wewa	0.76	1.13	1.25	1.29	1.22		
Sub-total	6.68	10.48	10.86	11.05	10.80		
HAMBATOTA DISTRICT							
KIRINDI OYA							
Lunugambehera Res.	226.00	243.55	205.20	174.02	207.59		
Debara Wewa	7.93	12.66	13.94	15.34	13.98		
Tissa Wewa	4.32	18.39	19.76	18.82	18.99		
Yoda Wewa	9.74	23.26	21.62	20.84	21.91		
Weerawila Wewa	12.95	45.17	41.86	33.85	40.29		
Sub-total	260.94	343.03	302.39	262.86	302.76		
MALALA OYA							
Bandagiriya Tank	11.16	16.36	16.06	16.03	16.15		

Table 4.22Annual Irrigation Water Amount Released from Major Tanks and
Anicuts (Intakes)

Source: Irrigation Department of Monaragala and Hambantota

(3) Type of Domestic Water Source

The water sources for water supply scheme can be classified to groundwater and surface water. The groundwater, which can be extracted from tube wells, dug wells and springs, is mainly utilized for the domestic purposes. The surface water, which can be extracted from rivers, streams and tanks, is mainly utilized for an irrigation purpose. The surface water is also used for a bathing and washing purposes by local inhabitants.

NWSDB (1997a) (1997b) classified the water source for the drinking purpose in Hambantota and Monaragala districts, based on the results of demographic survey done by the Department of Census and Statistics (1994).

In Monaragala district, the ratio of population served by "House Connection and Stand Post" is 12%. This ratio is lower than Hambantota district of 28% as shown in *Figure 4.10*. On the other hand, the ratio of population served by "others" sources that includes river, tank and stream, is higher than Hambantota district. There is no significant difference of the ratio served by tube wells between the two districts. This result reveals that the water supply condition of Hambantota district is rather advanced than Monaragala, in terms of adoption rate of pipe borne water supply condition. However, the ratios of dug wells are same in both districts.





Source: Department of Census and Statistics (1996) Demographic Survey 1994 Sri Lanka, Report on Housing and Basic Amenities, Release 2

In Hambantota district, there are four DSDs that include Pilot GNDs. Among these, three DSDs of Tangalle, Hambantota and Lunugamwehera show relatively high ratio of population served by pipe borne (See, *Table 4.23(1)*). On the other hand, Sooriyawewa has very low ratio of pipe borne supply. Majority of residents depend on dug wells to obtain domestic water. In Monaragala district, six DSDs include the Pilot GND. A similar proportion of water source type is observed at each DSD (See, *Table 4.23(2)*).

		Dug Well	Tube Well	Stand Post	House Connection	others
1	Ambalantota	67.0	1.9	8.0	19.7	3.4
2	Angunakolapelessa	90.6	4.0	3.0	0.3	2.1
3	Beliatta	85.8	4.2	1.6	8.4	0.0
4	Hambantota*	32.0	10.7	25.3	31.4	0.7
5	Katuwana	60.2	13.5	8.9	7.9	9.5
6	Lunugamwehera*	20.2	6.6	57.9	11.5	3.8
7	Okawela	90.6	7.0	0.6	1.7	0.0
8	Sooriyawewa*	87.1	7.5	0.0	1.2	4.3
9	Tangalle*	37.6	7.7	28.4	25.9	0.3
10	Tissamaharama	46.9	4.5	32.1	14.7	1.8
11	Weeraketiya	75.8	19.8	1.2	2.3	1.0
	Hambantota District	61.3	8.0	15.3	12.7	2.6

 Table 4.23 (1)
 Ratio of Water Source at DSD in Hambantota District (%)

Note: 1) DSD* includes Pilot GNDs 2) "others" includes river, tank and stream

Source: Department of Census and Statistics (1996) Demographic Survey 1994 Sri Lanka, Report on Housing and Basic Amenities Release 2

		Dug Well	Tube Well	Stand Post	House Connection	others
1	Badalkumbura	68.9	6.3	8.6	2.4	13.8
2	Bibile	70.7	5.5	4.7	6.6	12.4
3	Buttala	63.8	9.7	2.8	4.4	19.3
4	Kataragama	8.2	2.5	10.9	68.0	10.3
5	Madulla	71.1	9.2	0.9	5.1	13.6
6	Medagama	78.9	4.1	0.3	0.0	16.7
7	Monaragala	56.7	4.1	1.3	18.6	19.4
8	Siyambalanduwa	85.5	6.5	0.0	0.0	8.0
9	Tanamalwila	49.5	8.2	5.9	3.1	33.3
10	Wellawaya	51.9	10.3	9.1	8.3	20.3
	Monaragala District	62.9	7.1	4.3	7.6	18.1

 Table 4.23 (2)
 Ratio of Water Source at DSD in Monaragala District (%)

Note: 1) DSD* includes Pilot GNDs

2) "others" includes river, tank and stream

Source: Department of Census and Statistics (1996) Demographic Survey 1994 Sri Lanka, Report on Housing and Basic Amenities Release 2

4.4.4 FUTURE PLAN (ONGOING PROJECT)

In Hambantota and Monaragala districts, the small-scale water supply project has been implemented by NWSDB. The GNDs that were not covered by existing water supply schemes were selected prior to others. The types of water source in the project are house connection, tube well and dug well. After the implementation of such project, water supply coverage will be increased. This increase of coverage by implementation of ongoing project will be taken into consideration of the future water demand projection.

The NWSDB has a policy in connection with water supply, which is that the all of residents should be supplied water through piped water. Therefore, the coverage by pipe borne supply will be taken into consideration of water demand projection.

In Hambantota district, 78 GNDs will be covered by pipe borne water supply until the end of year

2004 (See, Table 4.24).

In Monaragala district, residents in 68 GNDs will be supplied water by the project until the end of year 2002 (See, *Table 4.25*). Out of these GNDs, house connection water supply is planned for 27 GNDs. "Population covered by house connection in 2002" is calculated by using "the number of household covered by house connection in 2002" that is provided by the NWSDB.

DSD	GND Names	GND Code for GIS	Scheme	Mode of Supply	Number of Household in 2001	Population Covered by House Connection in 2001 (Nos. of HH x 5)
Ambalantota	Liyangastota	AMB133	Village Schemes	Pipe Borne	242	1210
	Koggala	AMB134	Village Schemes	Pipe Borne	305	1525
	Modarapilwela	AMB135	Village Schemes	Pipe Borne	206	1030
	Godakoggalla	AMB138	Village Schemes	Pipe Borne	179	895
	Walawewatte West	AMB164	Village Schemes	Pipe Borne	260	1298
	Mamadala North	AMB166	Village Schemes	Pipe Borne	239	1195
	Hadawinna	AMB169	Village Schemes	Pipe Borne	315	1575
	Siyambalakote	AMB170	Small Towns	Pipe Borne	210	1050
	Barawakumbuka	AMB171	Small Towns	Pipe Borne	339	1693
	Taligala	AMB172	Small Towns	Pipe Borne	304	1520
	Wetiya	AMB173	Small Towns	Pipe Borne	189	946
	Pingama	AMB175	Village Schemes	Pipe Borne	193	967
	Deniya	AMB176	Village Schemes	Pipe Borne	193	967
	Ihalagama	AMB179	Village Schemes	Pipe Borne	279	1395
	Athbatuwa	AMB180	Village Schemes	Pipe Borne	270	1352
	Mulana	AMB181	Village Schemes	Pipe Borne	299	1495
	Handunkatuwa	AMB183	Village Schemes	Pipe Borne	103	515
	Muraweshihena	AMB186	Small Towns	Pipe Borne	116	580
	Modarapilwela	AMB135	Village Schemes	Rain Water	1	5
	Liyangastota	AMB133	Village Schemes	Dug Wells	19	95
	Koggala	AMB134	Village Schemes	Dug Wells	30	150
	Modarapilwela	AMB135	Village Schemes	Dug Wells	16	80
	Mamadala North	AMB166	Village Schemes	Dug Wells	2	10
	Hadawinna	AMB170	Village Schemes	Dug Wells	8	40
	Athbatuwa	AMB180	Village Schemes	Dug Wells	31	155
	Ihalagama	AMB180	Village Schemes	Dug Wells	18	90
	Handunkatuwa	AMB183	Village Schemes	Dug Wells	61	305
	Pingama	AMB175	Village Schemes	Dug Well	1	5
	Deniya	AMB176	Village Schemes	Dug Well	1	5
Angunakolapelessa	Rathmalwala	ANG232	Village Schemes	Pipe Borne	150	750
Beliatta	Dedduwawala	BEL372	Village Schemes	Pipe Borne	150	750
Hambantota	Julgamuwa	HAM084	Small Towns	Pipe Borne	170	850
	Bandagiriya	HAM085	Small Towns	Pipe Borne	267	1335
	Tammannawa	HAM086	Small Towns	Pipe Borne	340	1700
	Yahangala West	HAM087	Small Towns	Pipe Borne	215	1075
	Yahangala East	HAM088	Small Towns	Pipe Borne	220	1100
	Keliyapura	HAM091	Village Schemes	Pipe Borne	214	1070
	Katanwewa	HAM096	Village Schemes	Pipe Borne	117	583
	Elalla	HAM097	Village Schemes	Pipe Borne	176	880
	Siyambalagaswila North	HAM116	Village Schemes	Pipe Borne	236	1180
	Siyambalagaswila South	HAM117	Village Schemes	Pipe Borne	300	1500
	Galwewa	HAM118	Village Schemes	Pipe Borne	386	1930
	Arawanamulla	HAM122	Village Schemes	Pipe Borne	221	1105
	Walawala	HAM125	Village Schemes	Pipe Borne	70	350
	Koholankala	HAM089	Village Schemes	Kain Water	254	1270
	Elalla	NAM097	Village Schemes	Rain Water	40	200

Table 4.24Population Covered by House Connection under the Ongoing Project in
Hambantota District (1/3)

Source : NWSDB Hambantota Office (2002)

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DSD	GND Names	GND Code for GIS	Scheme	Mode of Supply	Number of Household in 2001	Population Covered by House Connection in 2001 (Nos. of HH x 5)
Katuwana	Kudagoda East	KAT493	Village Schemes	Pipe Borne	111	555
	Kudagoda West	KAT494	Village Schemes	Pipe Borne	131	655
	Murungasyaya East	KAT495	Small Towns	Pipe Borne	270	1350
	Murungasyaya West	KAT496	Small Towns	Pipe Borne	271	1355
	Dambetalawa	KAT497	Village Schemes	Pipe Borne	177	885
	Middeniya North	KAT498	Small Towns	Pipe Borne	202	1008
	Middeniya West	KAT499	Small Towns	Pipe Borne	205	1027
	Middeniya East	KAT500	Small Towns	Pipe Borne	186	930
	Hellala	KAT501	Village Schemes	Pipe Borne	167	835
	Labuhengoda	KAT503	Village Schemes	Pipe Borne	131	655
	Andalugoda	KAT504	Village Schemes	Pipe Borne	108	539
	Mallakatigoda	KAT505	Village Schemes	Pipe Borne	112	561
	Welipitiya East	KAT507	Village Schemes	Pipe Borne	105	525
	Welipitiya West	KAT508	Village Schemes	Pipe Borne	166	831
	Ulahitiyawa	KAT509	Village Schemes	Pipe Borne	76	382
	Talwatta	KAT514	Village Schemes	Pipe Borne	227	1136
	Ambagasara	KAT515	Village Schemes	Pipe Borne	158	791
	Siyabalamuraya	KAT519	Village Schemes	Pipe Borne	183	915
	Bengamukanda	KAT528	Village Schemes	Pipe Borne	1	7
	Gallidamulla	KAT529	Village Schemes	Pipe Borne	141	705
	Pangamwilayaya	KAT536	Village Schemes	Pipe Borne	155	775
	Bintanna	KAT549	Village Schemes	Pipe Borne	168	838
	Kaballaketiya	KAT557	Village Schemes	Pipe Borne	151	755
	Kohomporuwa	KAT517	Village Schemes	Rain Water	10	51
	Siyabalamuraya	KAT519	Village Schemes	Rain Water	14	70
	Uda Alupothdeniya	KAT523	Village Schemes	Rain Water	19	96
	Bengamukanda	KAT528	Village Schemes	Rain Water	22	110
	Kohomporuwa	KAT517	Village Schemes	Dug Wells	12	62
	Uda Alupothdeniya	KAT523	Village Schemes	Dug Wells	3	14
	Bengamukanda	KAT528	Village Schemes	Dug Wells	2	10
Sooriyawewa	Ihalakumbukwewa	SUR100	Small Towns	Pipe Borne	103	513
	Mahagalwewa	SUR101	Small Towns	Pipe Borne	327	1637
	Meegahajandura	SUR102	Small Towns	Pipe Borne	188	942
	Suruwirugama	SUR104	Village Schemes	Pipe Borne	374	1870
	Weeriyagama	SUR115	Village Schemes	Pipe Borne	394	1970
	Weliwewa	SUR098	Village Schemes	Rain Water	214	1070
	Habarattawela	SUR137	Village Schemes	Rain Water	181	905
	Weliwewa	SUR098	Village Schemes	Dug Wells	1	5
	Habarattawela	SUR137	Village Schemes	Dug Wells	16	80

Table 4.24Population Covered by House Connection under the Ongoing Project in
Hambantota District (2/3)

Source : NWSDB Hambantota Office (2002)
DSD	GND Names	GND Code for GIS	Scheme	Mode of Supply	Number of Household in 2001	Population Covered by House Connection in 2001 (Nos. of HH x 5)
Tangalle	Talunna	TAN248	Village Schemes	Pipe Borne	97	485
	Medagama	TAN258	Village Schemes	Pipe Borne	94	470
	Pattiyapola South	TAN262	Village Schemes	Pipe Borne	120	600
	Walgameliya	TAN265	Village Schemes	Pipe Borne	111	555
	Aluthgoda	TAN266	Village Schemes	Pipe Borne	122	610
	Palatuduwa	TAN267	Village Schemes	Pipe Borne	202	1010
	Nalagma West	TAN299	Village Schemes	Pipe Borne	87	435
	Wagegoda	TAN300	Village Schemes	Pipe Borne	72	360
	Wagegoda	TAN300	Village Schemes	Pipe Borne	110	550
	Uduwilagoda	TAN302	Village Schemes	Pipe Borne	98	490
	Athgalmulla	TAN303	Small Towns	Pipe Borne	166	830
	Talapitiyagama	TAN304	Small Towns	Pipe Borne	72	360
	Tenagama North	TAN305	Small Towns	Pipe Borne	92	458
	Tenagama South	TAN306	Small Towns	Pipe Borne	107	535
	Witharandeniya North	TAN308	Small Towns	Pipe Borne	148	740
	Witharandeniya South	TAN309	Small Towns	Pipe Borne	300	1500
	Andupalana	TAN247	Village Schemes	Rain Water	58	290
	Wigamuwa	TAN245	Village Schemes	Rain Water	170	850
	Talunna	TAN248	Village Schemes	Rain Water	37	185
	Gotimbaragama	TAN250	Village Schemes	Rain Water	39	195
	Pattiyapola West	TAN261	Village Schemes	Rain Water	126	630
	Pattiyapola East	TAN263	Village Schemes	Rain Water	133	665
	Wigamuwa	TAN245	Village Schemes	Dug Wells	12	60
	Talunna	TAN248	Village Schemes	Dug Wells	19	95
	Gataimbaragama	TAN250	Village Schemes	Dug Wells	28	140
	Pattiyapola West	TAN261	Village Schemes	Dug Wells	14	70
	Pattiyapola East	TAN263	Village Schemes	Dug Wells	11	55
	Andupalana	TAN247	Village Schemes	Dug Wells	43	215
Weeraketiya	Madamulana	WEE399	Village Schemes	Pipe Borne	198	990

Table 4.24Population Covered by House Connection under the Ongoing Project in
Hambantota District (3/3)

Source : NWSDB Hambantota Office (2002)

DSD	GND	GND Code for GIS	No. of Household Covered by Ongoing Project	Population (x 4.5)	Number of Householed covered by House Connection in 2002	Population Covered by House Connection in 2002
Bibile	Badullagammana	BIB003	315	1418	308	1386
	Egodakotagama	BIB009	156	702	149	671
	Kotagama	BIB021	220	990	220	990
	Mudiyala	BIB027	195	878	192	864
	Udamallahawa	BIB035	212	954	200	900
	Ambagolla	BIB001	156	702	no plan	NA
	Bokagonna	BIB005	193	869	no plan	NA
	Bulupitiya	BIB006	178	801	no plan	NA
	Hamapola	BIB011	139	626	no plan	NA
	Kawdalla	BIB018	146	657	no plan	NA
	Kokunnawa	BIB020	200	900	no plan	NA
	Nagala	BIB028	210	945	no plan	NA
	Rathupasketiya	BIB032	95	428	no plan	NA
	Wegama South	BIB039	203	914	no plan	NA
Buttala	Mahagodayaya	BUT005	123	554	13	59
	Horabokka	BUT007	250	1125	96	432
	Weheragala	BUT011	174	783	36	162
	Mahasenpura	BUT013	311	1400	120	540
	Unawatuna	BUT014	356	1602	76	342
	Palwatta	BUT015	409	1841	174	783
	Udaarawa	BUT019	260	1170	124	558
	Ulugala	BUT024	277	1247	216	972
	Konketiya	BUT009	145	653	no plan	NA
	Gonagan-Ara	BUT012	168	756	no plan	NA
	Kumarapura	BUT017	62	279	no plan	NA
	Rahathangama	BUT020	177	797	no plan	NA
	Kumaragama	BUT021	192	864	no plan	NA
	Kukurampola	BUT028	143	644	no plan	NA
	Minipuragama	BUT029	94	423	no plan	NA
Monaragala	Kaudawa	MON008	199	896	167	752

Table 4.25Population Covered by House Connection under the Ongoing Project in
Monaragala District (1/2)

Source: NWSDB Monaragala Office (2002)

DSD	GND	GND Code for GIS	No. of Household Covered by Ongoing Project	Population (x 4.5)	Number of Householed covered by House Connection in 2002	Population Covered by House Connection in 2002
Siyambalanduwa	Beraliyapola	SIY003	168	756	161	725
5	Ethimale Colony	SIY007	202	909	202	909
	Kimbulawela	SIY016	148	666	112	504
	Mahakalugolla	SIY025	150	675	12	54
	Wila Oya	SIY043	246	1107	130	585
	Dombagahawela	SIY005	263	1184	no plan	NA
	Gemunupura	SIY009	127	572	no plan	NA
	Guruhela	SIY011	169	761	no plan	NA
	Karambegoda	SIY015	172	774	no plan	NA
	Kooragammana	SIY019	93	419	no plan	NA
	Kotagoda	SIY020	140	630	no plan	NA
	Liyangolla	SIY023	137	617	no plan	NA
	Minipura	SIY028	130	585	no plan	NA
	Napay	SIY030	125	563	no plan	NA
	Nawgala	SIY031	106	477	no plan	NA
	Pallegama	SIY034	152	684	no plan	NA
	Pallewela	SIY035	190	855	no plan	NA
	Tissapura	SIY042	202	909	no plan	NA
	Wattegama	SIY045	259	1166	no plan	NA
	Weragoda	SIY046	145	653	no plan	NA
Thanamalwila	Mahagama	SEV002	522	2349	436	1962
	Katupilagama	SEV003	452	2034	583	2624
	Haburugala	SEV006	209	941	199	896
	Indikolapelassa	SEV010	148	666	148	666
	Samagipura	SEV011	299	1346	280	1260
	Habaraluwewa	SEV012	79	356	97	437
	Punchiwewa	SEV014	155	698	155	698
	Divulana	THA014	291	1310	159	716
	Nugegalayaya	SEV007	324	1458	no plan	NA
	Habarattawela	SEV008	347	1562	no plan	NA
	Wali-Ara	SEV013	76	342	no plan	NA
	Seenukkuwa	THA002	83	374	no plan	NA
	Nikawewa	THA003	190	855	no plan	NA
	Suriya-Ara	THA006	405	1823	no plan	NA
	Mahawewa	THA007	211	950	no plan	NA
	Hambegamuwa	THA009	325	1463	no plan	NA
	Ahakurullanpalassa	THA011	248	1116	no plan	NA
	Habaranuwewa	SEV012	154	693	no plan	NA

Table 4.25Population Covered by House Connection under the Ongoing Project in
Monaragala District (2/2)

Source: NWSDB Monaragala Office (2002)

4.5 WATER USAGE

The conditions of water usage at 15 Pilot GNDs are analysed based on the results of questionnaire survey. The methodology of the questionnaire survey carried out by the Study team with collaboration from NWSDB.

4.5.1 WATER CONSUMPTION

Water consumption rate during rainy season for domestic purpose shows a range between 11 to 33 liter/day/capita at each Pilot GND in Hambantota district, and a range between 15 to 36 litre/day/capita at each Pilot GND in Monaragala district. On the other hand, water consumption rate during dry season for domestic purpose shows a range between 11 to 28 liter/day/capita at each Pilot GND in Hambantota district, and a range between 11 to 28 liter/day/capita at each Pilot GND in Hambantota district, and a range between 16 to 33 litre/day/capita at each Pilot GND in Monaragala district (See, *Figure 4.11*). These results reveal that the condition of water consumption at Pilot GNDs in Hambantota district is lower than that of Pilot GNDs in Monaragala district.



Source: Results of Questionnaire survey

Figure 4.11 Water Consumption Ratio in Rainy and Dry Season

According to the Design Criteria provided by the NWSDB, designed rate of domestic use for the standpost is 45 litre/day/capita. The water consumption rate obtained by this survey in the Pilot GNDs in Hambantota and Monaragala districts shows the quarter to three-fourth of designed rate.

4.5.2 DISTANCE TO THE MAJOR DOMESTIC WATER SOURCE

The relationship between distance to the water source and water consumption rate at each Pilot GND in Hambantota and Monaragala districts is examined by the results of the questionnaire survey.

The water consumption rate decreases as distance to the water source increase (See, *Figure 4.12*). The distances to the water source at Hambantota district are generally longer than that at Monaragala district. This result suggests that the accessibility to the water source at Hambantota district is lower than that at Monaragala district with minor exceptions.



Figure 4.12 Relationship between Distance to Water Source and Water Consumption Rate

Figure 4.13 shows the ratio of distance to the water source. The Figure clearly shows that the ratio of short distance to the water source is large in Monaragala and small in Hambantota. This result also suggests that better accessibility to the water source in Monaragala.



Figure 4.13 Distribution of Distance to Major Water Source

4.5.3 MAJOR TYPE OF THE WATER SOURCE

(1) Major Source Type of Domestic Water

The distribution of five major types of water source, namely dug well, tube well, stand post, house connection and others, are examined at each Pilot GND. The "others" includes surface water such as river, stream and tank, and bowser water supply.

As shown as *Figure 4.14*, in Hambantota district, more than 80% of families in three GND (Ranna West, Pahala Mattala and Tammennawewa) depend mainly on stand post. On the other hand, the majority of the water source at other GNDs is dug well. Especially in the case of Talunna and Siyambalagaswilla North, percentage of dug well shows more than 90%.

The poor accessibility to the water source is noted at Wediwewa, the percentage of "others" in the GND shows 20%, which is apparently higher than other GNDs.

In Monaragala district, more than 70% of families depends its water source on dug well, except Yalabowa (See, *Figure 4.15*). In Yalabowa, about 60% families are supplied domestic water through stand post, but the ratio of dug well is not as small, it is still over 40%.

(2) Condition of Water Source in Dry Season

To understand the condition of water source in dry season, the ratio of the service interruption and dried up is examined based on the results of questionnaire survey.

As shown in the *Figure 4.16*, the ratio of service interruption and dried up in the Pilot GNDs in Hambantota district is higher than that of Monaragala district.

In Hambantota district, ratio of service interruption and dried up in two GNDs (Ranna West and Tammennawewa) exceeds 80%, although the major water source is stand post. On the other hand, in the Pahala Mattala, there is no service interruption and dried up at both stand post and dug well. This fact suggest that the stability of the service by the water supply scheme highly depends on its water source.







Figure 4.16 Ratio of Service Interruption and Dried Up of Water Source

Source: Results of questionnaire survey

4.5.4 WATER BEARERS IN FAMILY

Labor to obtain water is a heavy physical labor where there is no water supply by house connection. Someone in family member have to go to water supply points, such as dug wells, tube wells, stand posts and other water sources, fill up water containers and bring them back home to provide for water demands of the family. Required labor to obtain water is often a major factor that hampers women's social advancement and children's school enrollment ratio.

Form the above view point, water bearers in a family were surveyed in the questionnaire survey. To examine the existence of impositive of the water obtaining labor to the socially vulnerable, martial deviation, gender deviation and age deviation in the distribution of the water bearers were compared as shown in *Table 4.26*.

In the martial and gender deviations, ratios of wife and female are slightly higher than those of husband and male in the both districts. However, such small differences in the ratios rather indicate that the water obtaining labor is distributed between wives and husbands and female and male. For the age deviation, engagement of children counts about 50%. However, the engagements of children are only 12.1% and 6.3% in Hambantota and Monaragala districts respectively and the deviation to children is not significant.

Meanwhile, according to Summary Indicators of Child Activity Survey conducted by the Department of Census and Statistics in 1999 (http://www.statistics.gov.lk/Documents/ labourforce/child_activity%20_survey.pdf), children engaged in education between age 5 to 14 years counts as high as 97%. Adult literacy rates in 1999 are 89% for female and 94% fro male (Key Indicators in Developing Asia and Pacific Countries, Asian Development Bank, 2001).

As such high educational opportunity and no difference between gender in Sri Lanka support the fact, that there is no inequity in the distribution of water obtaining labor, observed by the questionnaire survey.

C	I	Hambar	ntota	Monaragala			
Comparison	Items	Number	%	Number	%		
Mential de ladien	Wife	171	50.6%	180	56.3%		
Martial deviation	Husband	167	49.4%	140	43.8%		
Cardan In intim	Female	202	50.9%	200	55.4%		
Gender deviation	Male	195	49.1%	161	44.6%		
	Adult	154	53.3%	121	45.0%		
Age deviation	Adult + Children	100	34.6%	131	48.7%		
	Children	35	12.1%	17	6.3%		

 Table 4.26
 Deviation of Water Obtaining Labor

4.6 **PROJECTION OF FUTURE WATER DEMAND**

4.6.1 CONDITIONS FOR THE ESTIMATION

Future water demand of the Study area was estimated based on the population and the data related socio-economic conditions. The estimation was carried out by each GND in two districts. The basic criteria for the water demand projection provided by the Planning and Design Division of National Water Supply and Drainage Board (NWSDB) were applied for the estimation. The following items are the considerations for water demand estimation, which agreed upon among the WRB, the NWSDB and the Study team, through the course of discussions during 3rd Study in Sri Lanka. A sample of the estimation table for the future water demand projection is shown in *Table 4.27*.

(1) Target Year

Vision 2010 (National Planning Department 2001) indicates that the national goal is to provide access to safe drinking water to all by the year 2010. The target year of 2010, for the development plan that will be formulated by this project, is applied in accordance with the concept of Vision 2010.

(2) **Projection of Population**

The populations of each GND in the year of 2010 were estimated by the projected population of 2005 and 2015 by the NWSDB. The populations both of present (2001) and target year (2001) are presented in the column A of *Table 4.27*.

(3) Water Supply Coverage Ratio

The coverage ratio, both by existing water supply scheme and future plan, were determined to obtain the demand to be covered by groundwater resources development plan by this project. Both ratio and amount of the water supply coverage of the target year of 2010 are shown in the column B of *Table 4.27*.

(4) Coverage Plan

For the domestic water use, water supply scheme is to be selected from the following three levels, considering groundwater development potential and socio-economic conditions of the project area.

- Level I: Water distribution through a single public hydrant with hand pump.
- Level II: Water distribution through several public hydrants (stand post). Water is pumped up by powered pumps to an elevated water tank and sent to the hydrants.
- Level III: Water distribution through hydrants of each house. Water is pumped up by powered pumps to an elevated water tank and sent to the hydrants through distribution pipelines.

The demarcation of such levels in the GNDs by the criteria of NWSDB is summarized as follows. The coverage plan by the levels are shown in the column C of *Table 4.27*.

Level 1 (Hand Pump):

The water supply by the hand pumps is not planned by the NWSDB. Therefore, coverage plan of the Level 1 will not be figured.

Level 2 (Stand Post) and Level 3 (House Connection):

The designed percentage of the coverage plan of Level 2 and Level 3 is allocated as follows.

	GND that is covered by Scheme	GND has existing scheme partly	GND has no existing scheme
Level 2	0 %	10 %	20 %
Level 3	100 %	90 %	80 %

(5) Consumption Rate

The consumption rates for the levels are defined by the design the criteria of NWSDB. The consumption rates for each level are described as follows, and presented in the column D of *Table 4.27*.

Level 1 (Hand Pump):	Not applicable
Level 2 (Stand Post):	45 litre/capita/day, which is defined by the design criteria of the NWSDB.
Level 3 (Direct Connection):	140 litre/capita/day, which is defined by the NWSDB, as the consumption rate for the large rural community with population of $1,500$ to $5,000$

(6) Non Domestic Demand

The percentages of non domestic demand are allocated as follows, and presented in the column E of *Table 4.27*.

- GND that is partly or fully covered by the existing water supply scheme shall be 30% of "Total Domestic Demand".
- GND that is not covered by existing water supply scheme shall be 25% in Monaragala and 20% in Hambantota of "Total Domestic Demand".

(7) Non Revenue Water (NRW)

The percentages of NRW are allocated as follows, and presented in the column F of Table 4.27.

- GND that is covered by existing water supply scheme shall be applied the actual percentage of each scheme. However, if there is the GND that the actual NRW exceed 40%, the ratio of 30% shall be applied.
- GND that is not covered by existing water supply scheme shall be 30 %.

(8) Total Demand

Total demand is obtained as the sum of "Total Domestic", "Non Domestic" and "Non Revenue Water". The results of each GND are shown in the column G of *Table 4.27*.

(9) Water Demand to be examined under the Project

This demand will be calculated by the subtraction of "Served Amount" from "Total Demand". The results of each GND are shown in the column H of *Table 4.27*.

-	Г		Project*	m ³ /day																							
0	5		Total	m³/day																							
<u> </u>			NRW	m³/day																							
L	L		NRW	%																							
		Demand	Non Domestic	m³/day																							
L	ц		Non Domestic	%																							
			Total Domestic	m³/day																							
			level 3 (D.C)	m³/day																							
			level 2 (S.P)	m³/day																							
			level 1 (H.P)	m³/day																							
		in Rate	2 level 3 (D.C)	pod					-			-															
6	ב	Consumptic	1 level: (S.P)	d lpod																							
		0	el 3 level C) (H.P	boc																							
	、	ge Plan	el 2 leve P) (D.1	% %																							
		Covera	/el 1 lev H.P) (S	%																							
			ved lev	S																							
			Int of Ser	ay N																							
		age 2010	Seved p. Amou	ss m³/d																							
		upply Cover	tal	% Nc																							
		Water S	arage n To	° s																							
0	ם		Cow ing Pla	No	00'1	00:0	00.0	5.00	00't	3.00	00.0	00:0	00;	00.7	3.00	3.00	3.00	00:0	00.0	00.0	00.0	9.00	5.00	00:00	00:00	5.00	00
	_	viity	10 Exis	/km² %	11,	80		3	à	ۍ م			8	9	~		33	-	-			22	19			4	12
		pulrion Der	001 20	s/km ² Nos	041.4	527.9	308.0	172.5	310.4	173.8	976.3	451.8	113.8	461.9	362.0	543.4	187.8	152.6	191.9	559.7	361.2	367.1	8.4	369.7	226.9	258.8	279.4
<	۲	ion Pc	2010 2	Nos No			-																				
L		Populat	2001	Nos	1706	1319	1832	1171	1613	862	1246	1582	654	1427	502	826	1396	1362	1034	1253	1320	679	1739	1424	1090	544	791
			89	acre	404.8	213.3	346.1	1677.0	1284.3	1225.8	315.4	865.2	1419.9	763.3	342.7	375.6	1836.5	2205.6	1331.7	553.2	903.2	457.1	51209.3	951.8	1186.9	519.4	699.6
			Ā	km²	1.638	0.863	1.401	6.787	5.197	4.961	1.276	3.501	5.746	3.089	1.387	1.520	7.432	8.926	5.389	2.239	3.655	1.850	207.234	3.852	4.803	2.102	2.831
			GN Code		AMB144	AMB143	AMB171	AMB157	AMB158	AMB159	AMB139.	AMB140	AMB176	AMB149	AMB162	AMB161	AMB182	AMB180	AMB138	AMB169	AMB183	AMB156	AMB178	AMB179	AMB168	AMB153	AMB154
			SN Division Name		Ambalantota Iorth	Ambalantota South	larawaku mbuka	tata Ata North	lata Ata South	leminiyanvila	tolana North	olana South	leniya	kkassa	lagoda West	legoda East	raminiya ya	tbatuwa	ko dakoggala	ladavinna	landunkatuwa	latagala	lungama	nalagama	ansagama	Tvula North	Jivula South
			S Division Name 6		MBALATHOTA N	ABALATHOTA S	MBALATHOTA B	MBALATHOTA B	MBALATHOTA B	MBALATHOTA B	MBALATHOTA B	MBALATHOTA B	MBALATHOTA D	MBALATHOTA E	MBALATHOTA E	MBALATHOTA E	MBALATHOTA E	VIBALATHOTA E	MBALATHOTA 6	MBALATHOTA H	MBALATHOTA H	MBALATHOTA H	MBALATHOTA H	MBALATHOTA II	MBALATHOTA J	MBALATHOTA K	MBALATHOTA K
			Diatrict Name D.		HAMBANTOTA A	HAMBANTOTA AI	HAMBANTOTA	HAMBANTOTA	HAMBANTOTA A	HAMBANTOTA A	HAMBANTOTA AI	HAMBANTOTA A	HAMBANTOTA A	HAMBANTOTA AI	HAMBANTOTA	HAMBANTOTA AI	HAMBANTOTA	HAMBANTOTA A	HAMBANTOTA	HAMBANTOTA	HAMBANTOTA	HAMBANTOTA AI	HAMBANTOTA A	HAMBANTOTA A	HAMBANTOTA A	HAMBANTOTA AI	HAMBANTOTA

 Table 4.27
 Preparation Sheet for Future Water Demand Projection

4.6.2 FUTURE WATER DEMAND

The projected future water demand of each GND of Hambantota and Monaragala is presented in *Appendix E* of the supporting report, and summarized in the *Table 4.28* by DSDs.

The total population of two districts was estimated as 1,113,500, and the total water demand was estimated as $249,970 \text{ m}^3/\text{day}$. On the other hand, some areas have already been supplied water by existing water supply schemes and can be expected to be supplied water in the year 2010. Such population in these areas should be excluded from the target of the formulation of groundwater resources development plan by the Study.

Therefore, the actual population estimated to be covered under the Study was estimated as 831.184 by the two districts. Consequently. The actual water demands to be covered by the Study are estimated as 95,268 m³/day in Monalagara, 115,183 m³/day in Hambantota, and 210,451 m³/day by the two districts.

	Entire Wat	er Demand	Water Demand to be C	Water Demand to be Covered by the Study				
DS Division	Population	Demand (m ³ /day)	Population	Demand (m ³ /day)				
Monaragala District								
Badalkumbura	44,134	9,717	41,894	9,403				
Bibile	40,225	8,901	32,063	7,758				
Buttala	52,577	12,412	44,304	11,253				
Kataragama	18,054	3,828	9,661	2,653				
Madulla	32,817	7,138	32,535	7,099				
Medagama	38,048	8,032	27,189	6,511				
Monaragala	48,671	10,987	41,410	9,971				
Siyambalanduwa	57,298	12,475	54,521	12,086				
Sevanagala	47,565	10,709	39,022	9,513				
Tanamalwila	29,630	6,506	26,688	6,093				
Wellawaya	62,478	13,748	56,620	12,928				
Sub Total	471,497	104,453	405,907	95,268				
Hambantota District								
Weeraketiya	67,621	14,126	65,281	13,799				
Beliatta	64,087	13,577	57,729	12,687				
Katuwana	76,099	16,352	52,687	13,074				
Angunakolapellessa	51,133	10,676	49,302	10,420				
Okuwela	22,618	4,692	22,618	4,692				
Tissamaharama	73,898	18,565	46,247	14,694				
Ambalantota	76,616	17,923	34,848	12,075				
Hambantota	57,268	14,761	11,797	8,395				
Lunugamvehera	31,375	8,571	9,331	5,485				
Tangalle	77,771	16,913	45,472	12,392				
Suriyawewa	43,472	9,361	29,965	7,470				
Sub Total	641,958	145,517	425,277	115,183				
Total	1,113,455	249,970	831,184	210,451				

Table 4.28 Future Water Demand in 2010 (DS Division)

SUPPORTING 5 EXISTING WELL SURVEY

5.1 GENERAL

The objectives of the existing well survey are to provide the hydrogeological information related to the existing wells, i.e. tube well, dug well, and to analyse the hydrogeological conditions of the study area. The survey consists of elevation survey, water level survey and water quality analysis. During the period of September 2001 to July 2002, on a total of seven occasions, the periodical measurements of water level and water quality were carried out.

A total of 30 wells for the survey were selected based on the results of the investigation of existing water sources. The details of selected 30 wells and their locations are shown in *Table 5.1* and *Figure 5.1*, respectively. The procedure of the selection of existing wells to be surveyed is described in *Section 4.4 of Supporting 4*, and its results are shown in *Data Book E*. The selected 30 wells consist of 14 wells, which are located at the Pilot GNDs excluding Ranna West, and 16 wells from the other GNDs.

Well No.			D C Division	GN Division	Coor	dinate	Depth	Orthometric Height	
This	Study	Existing	D.S.Division	O.IV.DIVISION	Latitude	Longitude	(m)	(m)	
JM-1	none	none	Hambantota	Keliyapura	6.21444	81.12917	33.00	9.73	
JM-2	none	none	Tangalle	Vitharandeniya	6.08944	80.79722	36.00	21.27	
JM-3	none	none	Angunakolapelessa	Talunna	6.10417	80.82806	no data	23.71	
JM-4	none	none	Sooriyawewa	Wediwewa	6.25861	81.04111	44.00	37.66	
JM-5	none	none	Hambantota	Bandagiriya	6.27667	81.15111	35.97	32.92	
JM-6	none	none	Lunugamvehera	Mattala	6.30861	81.10444	38.00	43.40	
JM-7	none	none	Ambalantota	Siyambalagaswila	6.17611	81.03694	33.53	12.06	
JM-8	none	none	Tanamalwila	Hambegamuwa	6.53806	80.94389	no data	117.17	
JM-9	none	none	Tanamalwila	Bodagama	6.43278	81.11000	25.17	92.01	
JM-10	none	none	Monaragala	Hulandawa	6.85889	81.34194	no data	137.83	
JM-11	none	none	Buttala	Unawatuna	6.75750	81.21583	no data	194.19	
JM-12	none	none	Wellawaya	Yalabowa	6.70417	81.10889	34.69	70.48	
JM-13	none	none	Badalkumbura	Badalkumbura	6.89639	81.23750	24.70	372.43	
JM-14	none	none	Tanamalwila	Sewanagala	6.36111	80.92222	45.00	61.40	
JM-15	J0532	056-0953	Ambalantota	Punchiheneyagama	6.18583	80.98222	44.20	16.45	
JM-16	J0734	056-1155	Angunakolapelessa	Thalawa	6.23583	80.81528	32.01	97.84	
JM-17	J1391	R-590	Beliatta	Aranwela North	6.05750	80.74694	no data	14.09	
JM-18	J0169	08-0198	Weeraketiya	Bowala North	6.19972	80.71556	45.00	91.28	
JM-19	J0279	12-0173	Katuwana	Kudagoda	6.25639	80.79833	30.00	109.85	
JM-20	J0906	56-1351	Ambalantota	Ellegoda West	6.14917	80.96361	25.40	25.32	
JM-21	J0383	14-0176	Weeraketiya	Mulkirigala	6.13583	80.75833	75.00	55.29	
JM-22	J0322	12-0228	Sooriyawewa	Happoruwa	6.30194	80.94917	45.00	69.00	
JM-23	M13	016-0145	Medagama	Polgahapitiya	6.99750	81.28472	60.00	262.57	
JM-24	B27	009-0043	Bibile	Kehelattawela	7.17889	81.15556	79.00	252.82	
JM-25	U24	020-0005	Buttala	Mahasenpura	6.74500	81.18778	36.00	163.45	
JM-26	M10	016-0126	Medagama	Ellekona	7.06194	81.25694	36.00	247.75	
JM-27	H63	20-0059	Monaragala	Kumbukkana	6.79889	81.28944	40.00	145.40	
JM-28	SE87	01-0293	Sevanagala	Kiriban Ara	6.38361	80.94833	36.00	69.05	
JM-29	BO10	056-1519	Tanamalwila	Kivul Ara	6.45444	81.13056	37.45	74.72	
JM-30	W3	056-1530	Wellawaya	Uva-Kudaoya	6.52778	81.11972	46.47	89.19	

Table 5.1 List of Selected 30 Wells



5.2 ELEVATION

5.2.1 GENERAL

During the 2^{nd} Study in Sri Lanka (November 2001 to March 2002), the elevation survey for 30 existing wells were carried out by using differential GPS equipment, to evaluate the groundwater level by the elevation above sea level. The results of the survey are shown in *Table 5.1*.

5.2.2 METHODOLOGY

Considering that a water body is sensitive to the local gravity, the orthometric height is required rather than ellipsoidal hight. In order to obtain orthometric heights for the existing wells, it is necessary to establish both orthometric as well as ellipsoidal heights for a suitable and evenly spread sample of the control points. Once the control network has been established, the survey of individual wells will be connected to the control points by means of static differential GPS and with the application of least squares adjustments for quality control.

In this Study, a DSNP SCORPIO 6502 Differential GPS instruments were utilized to obtain the elevation of the wells. To carry out the survey, three base stations at Wellawaya, Udawalawe and Mirijjawila that were established by the Survey Department, were utilized as a base station. As a sub base station, Ranna was established using Mirijjawila base station.

After the survey at the field, post processing was carried out using "GeoGenius" software. The orthometric and ellipsoidal heights was used to build a model of the geoid covering the Study area. This model is then used to reduce GPS determined ellipsoidal heights to orthometric heights.

Basically, elevation of wells was measured at the bottom of the hand pump stand. However, when GPS observations could not be made directly at this point, two reference GPS points were established near the well, and tie measurements were taken.

5.3 WATER LEVEL

5.3.1 GENERAL

From September 2001 to May 2002, the water levels of the selected 30 existing wells were measured every about one and half month. The results are summarized in *Table 5.2* and *Figure 5.2*.



Figure 5.2 Water Level and Monthly Rainfall

	sl	1st	ase	2nd	ase	3rd	ase	4th	ase	5th	ase	6th	ase	7th
Well No.	Elevation m 2	18-21/Sep/01	increase/decre	1-4/Nov/01	increase/decre	11-14/Dec/01	increase/decre	17-20/Jan/02	increase/decre	9-12/Mar/02	increase/decre	20-23/May/02	increase/decre	8-11/Jul/02
JM-01	9.73	12.51 -2.78	4.55	7.96 1.77	2.93	5.03 4.70	-6.67	11.70 -1.97	7.40	4.30 5.43	1.37	2.93 6.80	-2.82	5.75 3.98
JM-02	21.27	12.53 8.74	-25.73	38.26 -16.99	24.63	13.63 7.64	-0.15	13.78 7.49	5.78	8.00 13.27	-4.28	12.28 8.99	-3.37	15.65 5.62
JM-03	23.71	1.33 22.38	-0.03	1.36 22.35	-0.14	1.50 22.21	-0.80	2.30 21.41	0.20	2.10 21.61	-0.07	2.17 21.54	-0.93	3.10 20.61
JM-04	37.66	9.67 27.99	-0.79	10.46 27.20	-0.37	10.83 26.83	0.48	10.35 27.31	-0.75	11.10 26.56	0.70	10.40 27.26	2.10	8.30 29.36
JM-05	32.92	11.85 21.07	-0.01	11.86 21.06	0.43	11.43 21.49	0.38	11.05 21.87	-2.10	13.15 19.77	2.54	10.61 22.31	-0.69	11.30 21.62
JM-06	43.40	14.28 29.12	4.22	10.06 33.34	-0.47	10.53 32.87	-1.82	12.35 31.05	2.15	10.20 33.20	-0.11	10.31 33.09	-0.99	11.30 32.10
JM-07	12.06	10.67 1.39	-0.24	10.91	0.05	10.86 1.20	-0.18	11.04 1.02	-0.26	11.30 0.76	0.74	10.56 1.50	-0.04	10.60
JM-08	117.17	6.28 110.89	-0.58	6.86 110.31	-0.55	7.41 109.76	2.41	5.00 112.17	-1.65	6.65 110.52	2.00	4.65 112.52	-0.58	5.23 111.94
JM-09	92.01	11.77 80.24	-0.49	12.26 79.75	-13.12	25.38 66.63	-4.37	29.75 62.26	-9.25	>39.00 53.01	-1.00	>40.00 52.01		>40.00 52.01
JM-10	137.83	9.74 128.09	-1.12	10.86 126.97	0.11	10.75 127.08	-0.25	11.00 126.83	3.20	7.80 130.03	2.80	5.00 132.83	-2.20	7.20 130.63
JM-11	194.19	11.29 182.90	-0.30	11.59 182.60	3.21	8.38 185.81	-2.27	10.65 183.54	3.70	6.95 187.24	-4.06	11.01 183.18	-0.44	11.45 182.74
JM-12	70.48	10.25 60.23	0.19	10.06 60.42	1.11	8.95 61.53	-0.05	9.00 61.48	-1.00	10.00 60.48	-0.10	10.10 60.38	-1.06	11.16 59.32
JM-13	372.43	13.82 358.61	-9.90	23.72 348.71	15.93	7.79 364.64		not measured	-	18.65 353.78	-3.95	22.60 349.83	3.60	19.00 353.43
JM-14	61.40	1.61 59.79	-0.27	1.88 59.52	-0.25	2.13 59.27	0.88	1.25 60.15	-0.75	2.00	0.72	1.28 60.12	-0.22	1.50 59.90
JM-15	16.45	9.61 6.84	-0.25	9.86 6.59	-0.17	10.03 6.42	6.18	3.85 12.60	-6.20	10.05 6.40	0.24	9.81 6.64	-0.34	10.15 6.30
JM-16	97.84	20.52 77.32	5.79	14.73 83.11	0.52	14.21 83.63	-5.54	19.75 78.09	5.75	14.00 83.84	0.50	13.50 84.34		not measured
JM-17	14.09	8.32 5.77	-0.19	8.51 5.58	-0.31	8.82 5.27	-0.03	8.85 5.24	-0.10	8.95 5.14	0.35	8.60 5.49	-0.75	9.35 4.74
JM-18	91.28	15.85 75.43	0.29	15.56 75.72	-0.44	16.00 75.28	9.90	6.10 85.18	-11.35	17.45 73.83	0.29	17.16 74.12	-1.44	18.60 72.68
JM-19	109.85	17.07 92.78	-1.42	18.49 91.36	0.17	18.32 91.53	0.22	18.10 91.75	0.30	17.80 92.05	-0.66	18.46 91.39	0.01	18.45 91.40
JM-20	25.32	4.51 20.81	-1.85	6.36 18.96	3.68	2.68 22.64	-0.77	3.45 21.87	0.40	3.05 22.27	0.34	2.71 22.61	-0.19	2.90 22.42
JM-21	55.29	not measured	-	not measured	-	not measured	-	not measured	-	14.10 41.19	2.42	11.68 43.61	-0.97	12.65 42.64
JM-22	69.00	13.62 55.38	-0.24	13.86 55.14	-0.22	14.08 54.92	0.53	13.55 55.45	-0.95	14.50 54.50	1.40	13.10 55.90	-0.60	13.70 55.30
JM-23	262.57	7.57 255.00	-1.07	8.64 253.93	2.13	6.51 256.06	0.26	6.25 256.32	0.25	6.00 256.57	-0.23	6.23 256.34	-0.37	6.60 255.97
JM-24	252.82	2.16 250.66	-29.65	31.81 221.01	15.70	16.11 236.71	3.41	12.70 240.12	-0.70	13.40 239.42	-0.60	14.00 238.82	8.60	5.40 247.42
JM-25	163.45	5.40 158.05	0.84	4.56 158.89	0.58	3.98 159.47	0.23	3.75 159.70	-0.45	4.20 159.25	0.42	3.78 159.67	-0.42	4.20 159.25
JM-26	247.75	5.25 242.50	0.69	4.56 243.19	0.68	3.88 243.87	0.88	3.00 244.75	0.40	2.60 245.15	-0.51	3.11 244.64	-1.09	4.20 243.55
JM-27	145.40	19.34 126.06	10.98	8.36 137.04	-9.82	18.18 127.22	4.28	13.90 131.50	-0.40	14.30 131.10	0.73	13.57 131.83	-0.78	14.35 131.05
JM-28	69.05	9.79 59.26	-18.77	28.56 40.49	19.31	9.25 59.80	-0.65	9.90 59.15	0.30	9.60 59.45	0.65	8.95 60.10	-5.65	14.60 54.45
JM-29	74.72	5.81 68.91	0.75	5.06 69.66	0.98	4.08 70.64	0.18	3.90 70.82	-0.60	4.50 70.22	0.99	3.51 71.21	-1.24	4.75 69.97
JM-30	89.19	4.72 84.47	0.06	4.66 84.53	1.80	2.86 86.33	-1.84	4.70 84.49	1.10	3.60 85.59	0.40	3.20 85.99	-0.80	4.00 85.19
		Upper co Lower c	olumn; E olumn; H	Depth to v Elevation	vater tab of wate	le in m. r level in								

 Table 5.2
 Periodical Water Level Measurement of Existing Wells

m asl.

5.3.2 RESULT

(1) General Tendency

General tendency of the groundwater level fluctuation in the area are described as below.

- The water levels of 19 wells decreased from September to November and the levels of 18 wells increased from November to December. The number of the water level falling well was the same as the number of the water level rising well from December to January and the same tendency occurred from January to March. Then the water levels of 19 wells increased from March to May and the levels of 24 wells decreased from May to July.
- In general, the groundwater level had decreased from September to November 2001, and then had increased in December in the Study area. The level slightly fell in January 2002 and had risen from March to May. Then again the level dropped from May to July.
- The water levels of some wells had declined in ten meters or more from September to November, namely JM02, JM13, JM24, and JM28. The levels had recovered at December. The passing decline might be affected by a pumping just before the measurement.
- The water level of JM27 had increased in 10.98 m at the measurement in December.

(2) Seasonal Variation and Rainfall

Figure 5.2 also shows the bar charts indicating the mean value of the monthly rainfall recorded at 23 stations in Hambantota and Monaragala.

Although the rainfall had increased from September to November, the groundwater level had not been affected yet in November. The effect of rainfall seemed to appear in December. Rainfall decreased in December and the water level had fallen a little in January. As rainfall increased over from January to April, the groundwater level had risen slightly from March to May. *Figure 5.3*, the contour maps of water level, was prepared by the result of each periodical measurement. *Figure 5.3* also indicated that the water level had increased in December. The fluctuation of groundwater level seems to follow the variation of rainfall a few months later. The continuous monitoring for a long term, however, is necessary to say more accurate correlation.

The contours of water level recorded in 1980's were drawn in *Figure 5.3* (Silva, 1984). Generally no change of water level seems to have occurred for the decades in Hambantota, though it cannot compare with other data simply.





5.4 WATER QUALITY

5.4.1 MEASURED AND ANALYSED ITEMS

Water quality measurements were also carried out for the 30 wells, as a part of existing well survey. In this survey, on site measurements of water quality, water level, and the laboratory chemical analysis were carried out. Measured and analysed items and date of sampling are given in the following tables.

Measured and Analysis Items

	Item
On-Site Measurement	Water Level, Appearance, Temperature, Electric Conductivity (EC), pH, TDS, Dissolved Oxygen, Coliform Bacteria, Other Bacteria
Laboratory Analysis	Appearance, Temperature, Color, Odor, Taste, pH value, Electric Conductivity(EC), Chloride(Cl ⁻), TDS, Total Alkalinity(as CaCO ₃), Total Hardness(as CaCO ₃), Nitrate(as N), Total Iron(as Fe), Sodium(as Na ⁺), Potassium(as K ⁺), Calcium(as Ca ²⁺), Magnesium(Mg ²⁺), Sulphate(as SO ₄ ²⁻), Fluoride(F ⁻), Bicarbonate(as CaCO ₃)

Date of Sampling

	1 st	2 nd	3 rd	4 th	5 th	6 th	7 th
	Sampling						
Date	18-21	1-4	12-14	17-21	9-12	20-25	8-11
	/Sep/01	/Nov/01	/Dec/01	/Jan/02	/Mar/02	/May/02	/Jul/02

5.4.2 RESULT

The results of the measurements and analysis are shown in *Data Book F*. Based on the above results of groundwater quality analysis, the characteristics of the existing wells are described in *Supporting 7, of this report*.

5.5 PUMPING TEST

5.5.1 GENERAL

The pumping tests for 10 existing tube wells were carried out to obtain aquifer properties in the selected areas. WRB conducted the test with their equipment for the four wells in Monaragala and NWSDB conducted the test for the six wells in Hambantota.

The 10 wells for the pumping test are listed in *Table 5.3*.

Table 5.3 The Wells Pumping Test – JICA Study

No. Distri	t	DSD	GND	Location	Const. Date	Coordinate	Ttl Depth	Over Bur.	Yield (Ipm)	Cs. Di. (mm)	Type of Source	Constru- ction
35 Hambantota Hambant	Hambanto	ota	Keliyapura	Gonnoruwa	no data	6-12-52/ 81-7-45	33.00	no data	15.00	140.00	Hand pump	WRB
80 Hambantota Tangalle	Tangalle	()	Vitharandeniya	Arakoratuwa	1987 / 05 / 28	6-5-21/ 80-47-50	36.00	11.00	48.00	140.00	Hand pump	NWSDB
Hambantota Sooriyawe	Sooriyawe	wa	Wediwewa	Andarawewa	1985	6-15-31/ 81-2-28	no data	no data	no data	140.00	Hand pump	NWSDB
31 Hambantota Hambanto	Hambanto	ta	Bandagiriya	Tammanawa	1987 / 2 / 4	6-16-42/ 81-9-10	35.97	14.63	6.75	140.00	Hand pump	WRB
45 Hambantota Lunugamveh	Lunugamveh	era	Mattala	P.M.School	no data	6-18-40 / 81-6-26	38.00	7.50	12.00	140.00	Hand pump	NWSDB
Hambantota	Ambalantot	а	Siyambalagas.	Be. Hospital	no data	6-10-34/ 81-2-13	33.53	10.36	5.00	140.00	Hand pump	WRB
03 Moneragala Tanamalvil	Tanamalvila	E.	Bodagama	no data	1987 / 5 / 11	6-25-45/ 81-6-18	33.57	4.05	90.00	140.00	Hand pump	
Moneragala Wellaway	Wellaway	m	Yalabowa	Nugayaya	no data	6-42-15/ 81-6-32	no data	no data	no data	140.00	Hand pump	NWSDB
Moneragala Badalkumb	Badalkumb	ura	Badalkumbura	no data	1995 / 09 / 05	6-53-47/ 81-14-15	47.55	33.65	20.00	140.00	Hand pump	WRB
Moneragala Tanamal	Tanamalv	vila	Sewnagala	no data	no data	6-21-40/ 80-55-20	no data	no data	no data	200.00	Hand pump	UNICEF

5.5.2 METHOD OF TEST AND ANALYSIS

The following stages were applied to the pumping test in general, if possible. The yield of some wells, however, were too low to perform the test completely. Therefore, the number of steps for step drawdown test and the duration time for constant discharge test were controlled depending on the site condition.

- Stage 1: Provisional Test
- Stage 2: Step Drawdown Test
- Stage 3: Constant Discharge Test
- Stage 4: Recovery Test

(1) Measurement

Throughout the duration of each test, the water level in the borehole was measured and recorded according to the observation time schedule listed below:

Time from s	tart of	pumping	Time interval
or pumping rate increase			between observations
(mi	inutes)		(minutes)
0	-	5	0.5
5	-	10	1
10	-	30	2
30	-	60	5
60	-	120	10
120	-	240	20
240	-	360	40
360	-	720	60
720	-	2880	120

Electric conductivity of water from the well was recorded during the pumping test.

(2) Analysis

Transmissivity was calculated based on the results of constant discharge test and recovery test. Three fundamental analyzing methods, namely Theis type curve analysis, Jacob' time drawdown method and recovery method, were applied.

5.5.3 RESULTS OF THE TESTS

The results of the pumping tests were graphed in *Figure 5.4* to *5.13* and summarized in *Table 5.4*.

The pumping rate for a constant discharge test ranges from 1.3 litters/min, in Mattala, to 61 litters/min, in Sevanagala. In Hambantota, 4 of 6 wells discharged groundwater with a rate less than 10 litters/min, ranging from 1.3 to 3.5 litters/min. The drawdown ranges from 1.47 to 27.16 meters in Hambantota and from 3.86 to 27.26 meters in Monaragala. The wells in Monaragala yielded water from 13.5 to 61 litters/min.

The transmissivity of seven wells ranges between 1 and 3 m³/day/m. The lowest value of transmissivity is 0.02 m³/day/m in Mattala and the highest is 5.29 m³/day/m in Vitarandeniya. The value in Wediwewa is less than 1.0 m³/day/m.







Supporting 5 Existing Well Survey







Supporting 5 Existing Well Survey





Supporting 5 Existing Well Survey


























Supporting 5 Existing Well Survey



Supporting 5 Existing Well Survey



Well	Location	Well Dept h	Over burde n	Step No. / Constant	Pumping rate	Duration	Drawdown	Specific Capacity	Jacob time-drawdown	Theis type curve	Recovery
		(m)	(m)		Q (l/min.)	(min)	s (m)	Q/s (l/min/m)		T (m3/day/m)	
JM01	Keliyapira			1st	3.6	60	0.22	16.4	1.09		
		33	(5)	2nd	6.4	60	0.51	12.5		1.37	1.45
				3ra 4th	9.6 12.0	60 60	0.75	12.8			
				4ui 5th	12.0	60 60	23.46	0.7	Average =		
				Constant	12.0	2880	6.97	1 72		1.30	
JM02	Vitalandeniya	36	11	1st	8.0	60	2.95	2.7	3.42	3.57 5.29	
				2nd	12.0	60	5.37	2.2			5 29
				3rd	21.0	60	6.94	3.0			5.29
				4th	25.0	60	12.29	2.0			
				Sth	31.6	35	20.33	1.6	Average =	4.	09
				Constant	20.0	2880	11.07	1.81			-
	Wediwewa	44	(9)	nd	1.4	60 60	4.42	0.5	0.26	0.22	0.02
JM04				3rd	5.1	60	14.11	0.4			
				4th	7.0	6	17.36	0.4	Average =	0.17	
				Constant	1.9	960	27.16	0.07		0.17	
	Tammennawewa	35.97		1st	2.0	60	1.65	1.2	1.34	1.42	0.66
				2nd	3.5	60	2.70	1.3			
JM05			14.63	3rd 4th	4.5	60	4.10	l.l			
				4tii 5th	8.5	60 60	13.99	1.0	Average =	1.14	
				Constant	3.5	2880	3 40	1.03			
JM06	Mattala	38	7.5	1st	1.5	60	2.98	0.5			
				2nd	2.5	60	10.34	0.2	0.02	0.05	0.03
				3rd	3.4	60	25.07	0.1	Average =	0.033	
				Constant	1.3	2880	15.25	0.09			
	Siyambalagaswila		10.36	1st	2.0	60	0.32	6.3	2.07	1.91 2.08	2.08
				2nd 3rd	2.9	60 60	0.60	4.8			
JM07		33.53		4th	4.5 6.0	60	1.34	4.5			
				5th	9.5	60	2.62	3.6	Average =	2.02	
				Constant	3.0	2880	1.47	2.04			
	Bodagama	25.17	4.05	1st	15.3	120	2.72	5.6	1.96	2 37	1 34
IM09				2nd	22.0	80	7.06	3.1	1.90	2.57	. 1.51
511107				3rd	25.5	200	8.63	3.0	Average =	1.89	
				Constant	22.5	600	7.29	3.09			
	Yalabowa	34.69	(12)	lst Ond	20.7	140	6.28	3.3	2.31	2.01	0.87
				2na Brd	20.0	120	9.10	2.8			
JM12				4th	36.4	120	10.00	2.6			
				5th	46.0	120	19.91	2.3		1	72
				Constant	35.0	960	14.05	2.49	Average =	1.	/3
DA12	Badalkumbra	24.7	-	1st	12.0	20	2.78	4.3	2.45	3.10	2.12
JM13 b				2nd	15.8	14	3.87	4.1	Average =	2	56
				Constant	13.5	110	3.86	3.50	i i eiuge		2.50
JM14	Sevanagala	45	(11)	lst Ond	14.6	90	2.71	5.4	1.72		
				211u Brd	20.0	110	4.00	5.0 4.7		1 72	2 1.21
				4th	40.3	220	11.65	3.5			
				5th	58.5	140	21.25	2.8	Average = 1		
				6th	77.5	30	27.52	2.8		1	1.55
				Constant	61.0	720	27.26	2.24			

 Table 5.4
 The Results of Existing Well Pumping Test

(); Presumed figures

*; Duration time of constant discharge test was only 110 min

5.6 **GROUNDWATER USAGE**

The daily extraction amount from each tube well is calculated by the results of investigation of existing well survey, to estimate the total amount of groundwater extraction by wells. The daily extraction amount is shown in *Table 5.5*. The average rate of the daily extraction amount is $3.6m^3/day$. In the databases of the WRB and the NWSDB, on a total of 2,566 tube wells are registered. Therefore, using these figures, the total amount of groundwater extraction is estimated as $9,250 \text{ m}^3/day$.

	Well No		DSD	GND	Water Consumption (litre/day/family)	No. of Families	Extraction Amount (m ³ /day)
1	JM-15	J0532	Ambalantota	Punchiheneyagama	77	15	1.1
2	JM-16	J0734	Angunakolapelessa	Thalawa	185	35	6.5
3	JM-17	J1319	Beliatta	Aranawela North	72	15	1.1
4	JM-18	J0169	Weeraketiya	Bowala-North	119	30	3.6
5	JM-19	J0279	Katuwana	Kudagoda	45	200	9.0
6	JM-20	J0906	Ambalantota	Ellegoda West	376	22	8.3
7	JM-21	J0383	Weeraketiya	Mulkirigala	140	25	3.5
8	JM-23	M13	Medagama	Polgahapitiya	180	5	0.9
9	JM-24	B27	Bibile	Kehelattawela	75	15	1.1
10	JM-25	U24	Buttala	Mahasenpura	171	10	1.7
11	JM-26	M10	Medagama	Ellekoon	96	12	1.2
12	JM-27	H63	Monaragala	Kubukkana	180	40	7.2
13	JM-28	SE87	Sevanagala	Kiriibban-ara	102	15	1.5
14	JM-29	B010	Thanamalwila	Kivul-ara	126	30	3.8
15	JM-30	W3	Wellawaya	Uva-Kudaoya	140	25	3.5

 Table 5.5
 Extraction Amount from Well