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CONSERVE WATER – SAVE LIFE

भारत सरकार

GOVERNMENT OF INDIA

जल संसाधन मंत्रालय

MINISTRY OF WATER RESOURCES

केंद्रीय भूजल बोर्ड

CENTRAL GROUND WATER BOARD

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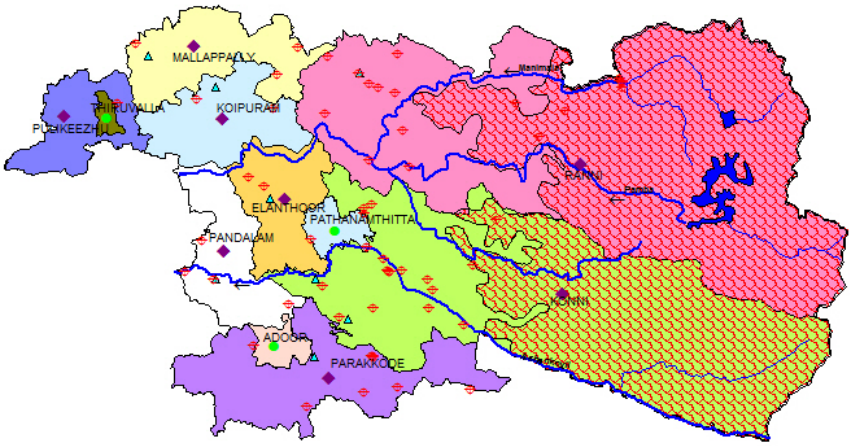
KERALA REGION

भूजल सूचना पुस्तिका,पतनमतिट्टा जिल्ला, केरल राज्य

GROUND WATER INFORMATION BOOKLET OF PATHANAMTHITTA DISTRICT, KERALA STATE



तिरुवनंतपुरम

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GOVERNMENT OF INDIA
MINISTRY OF WATER RESOURCES
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द्वारा

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GROUND WATER INFORMATION BOOKLET OF PATHANAMTHITTA DISTRICT, KERALA STATE

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DISTRICT AT A GLANCE

Sl No.	ITEMS	STATISTICS
1.	**GENERAL INFORMATION**	
	I) Geographical area (Sq km)	2731
	ii) Administrative Divisions (As on 31-03-2007) Number of Tehsil/Block Number of Panchayat/Villages **POPULATION (2011 census)** Population (Total) Density of Population per sq.km. Literacy Rate (Total) % ***CLIMATE*** Normal rainfall Number of rainy days Mean maximum temperature Mean minimum temperature Annual (PET)	Taluks : 5 Blocks : 9 Municipalities : 3 Panchayats : 54 1186561 449 94.86 3133.9 mm 128 30.7^0 C 23.9^0 C 1430 mm
2.	**GEOMORPHOLOGY**	
	Major physiographic units	Coastal Plain, Midland and Hill ranges
	Major Drainages	Pamba and its tributaries viz Achenkovil and Manimala rivers
3.	**LAND USE (Sq km)**	
	Total geographical area Forest land Land put to Non-Agricultural use Cultivable waste Net area sown Area sown more than once Total cropped area	273177 155214 14946 1585 83332 31755 115087
4.	**MAJOR SOIL TYPES**	Forest loams, Lateritic soil, Brown hydromorphic, Riverine Alluvium, Greyish Onattukara
5.	**AREA UNDER PRINCIPAL CROPS**	Rubber : 34794 ha Paddy : 13537 ha Tapioca : 12776 ha Banana : 7173 ha Coconut : 21467 ha
6.	**IRRIGATION BY DIFFERENT SOURCES (Area)**	
	Wells(Dug wells &Tube wells / Bore wells)	1891 hectares

	Tanks / Ponds	109 hectares
	Canals	1649 hectares
	Other Sources	2470 hectares
	Net Irrigated area	6119 hectares
7.	**NUMBER OF GROUNDWATER MONITORING WELLS OF CGWB (AS ON 31-3-2011)** No. of Dug wells No. of Piezometers	 30 08
8	**PREDOMINANT GEOLOGICAL FORMATIONS**	Archaean Crystalline formation (Gneiss, Charnockite, etc), Tertiary sedimentary formation, Sub-Recent laterite and Recent Alluvium.
9.	**HYDROGEOLOGY** Major Water bearing formation Depth to water level in mbgl (Pre-monsoon, April 2010) Depth to water level in mbgl (Post-monsoon, August 2010)	 Weathered fractured crystalline formations; semi consolidated Tertiary formations, laterites and Recent alluvium. 1.65 to 10.44 0.99 tom8.79
10.	**GROUND WATER EXPLORATION BY CGWB (As on 31-03-2011)**	
	No. of wells drilled (EW, OW, PZ, SH, Total)	EW – 52, PZ –10, SH – Nil. Total – 43
	Depth Range (m)	30- 250
	Discharge (litres per second)	up to 14.51
	Transmissivity (m^2/day)	1.1 to 11.3
11.	**GROUND WATER QUALITY**	
	Presence of chemical constituents more than permissible limits(e.g. EC, F, As, Fe)	Quality is good. Major chemical constituents lie within the permissible limits. Fe > 1mg/l is seen in Ranni & Konni blocks
12.	**DYNAMIC GROUNDWATER RESOURCES (2009) – in MCM**	
	Annual Replenishable Ground Water Resources	284.11
	Net Annual Groundwater Draft	94.24
	Projected demand for Domestic and Industrial Uses up to 2025	63.04
	Stage of Ground Water Development	33.13%
13.	**AWARENESS AND TRAINING ACTIVITY** Water Management Training Programmes organized Date Place No. of Participants	 1 October 2003 Pathanamthitta 200

14.	**GROUND WATER CONTROL AND REGULATION**	
	Number of Over Exploited blocks	Nil
	Number of Critical blocks	Nil
	Number of blocks notified	Nil
15.	**MAJOR GROUND WATER PROBLEMS AND ISSUES**	Decline in water level, Water scarcity during summer months.

GROUND WATER INFORMATION BOOKLET OF PATHANAMTHITTA DISTRICT KERALA STATE

1.0 INTRODUCTION

Pathanamthitta is an inland district of Kerala State covering an area of 2731 sq.km. It is bordered by Kollam district in the south and Alappuzha in the west, Kottayam and Idukki districts in the north and Tamil Nadu state in the east. It lies between North latitude 905' and 9028' and East longitudes 76030' and 77017' falling in parts of Survey of India degree sheet No.58 C and G.

1.1 Administration

The district has two revenue divisions namely Thiruvalla and Adoor and consists of five taluks as Adoor, Kozhencherry, Thiruvalla, Mallapally and Ranni. The five taluks are having 8 blocks with only three municipalities - Pathanamthitta, Adoor and Thiruvalla. There are eight blocks viz Parakode, Pandalam, Elanthoor, Konni, Mallappally, Rani, Koipuram and Pulikeezhu. Ranni is the biggest block of Thiruvalla division with an area of 1004.6 sq.km and Konni block of Adoor division constituting an area of 841.26 sq.km. There are fifty four Grama panchayats and sixty eight revenue villages in the district. The Location and administrative division is shown in **Figure 1.**

As per census 2011, Pathanamthitta district had a population of 1,195,537 of which male and female population were 561,620 and 633,917 respectively. There was change of -3.12% in the population compared to the population as per 2001 census. The density of population is 453 in 2011 compared to 468 of 2001. There are no major industries in the district and few small scale industries exists. Agriculture based industries dominate in the district. The industrial development is more or less restricted to the coastal block of Pulikeezh.

1.2 Drainage and Irrigation Practices

The district is drained mainly by two rivers viz. Pamba and Kallada. The major tributaries of the Pamba River are Achenkovil, Manimala, Kakki, Arudai, Kakkad and the Kallar that drains through major part of the district. The Kallada River flows through the southern portion of the district. Both the Pamba and Kallada rivers are perennial with a drainage density of 0.30 km/sq.km and both are fifth order streams. These rivers with their tributaries exhibit a trellis pattern of drainage in the eastern portion of the hills, sub-trellis pattern in the middle and dendritic pattern in the western part of the district.

Almost 57% of the district area is occupied by forest and only about 31% is the net area sown. Important crops are Coconut, Rubber, Paddy, Banana and Pepper. Though the total cropped area in the district is 1151 sq km, area sown more than once is restricted to 317 sq km. The irrigation facilities are confined to the valleys in the midland area. Only 2.2% of the district area has irrigation facilities i.e. 6119 hectares and groundwater irrigation is restricted to 1891 hectares only. A small part (600 hectares) of the command area of major irrigation project of Pamba falls in the district. The project uses the tail end water from the Sabirigiri hydroelectric project located in the upstream of Pamba River. Under minor irrigation schemes, surface water through lift irrigation and tanks and ground water through wells are utilised.

1.3 Works carried out by CGWB

Geological mapping was carried out in the district by various officers of the Geological Survey of India. Systematic Hydrogeological Surveys were carried out by Shri. Lakshminarayanan. P of CGWB during 1975-76 & 1982-83. The SIDA Assisted Coastal Kerala Ground Water Project carried out detailed hydrogeological studies with exploration in the district during the period 1983 – 88. Shri. D.D. Sharma carried out reappraisal hydrogeological surveys during 1989-90. The district reports were prepared by Sri. K.Md. Najeeb, Sc D., Smt Mini Chandran Sc C in different periods and Dr S.Sakthi Murugan, AHG carried out Groundwater Management studies in 2010-11. The ground water explorations were carried out in 2001-03, 2009-10 and 2010-11 in Pathanamthitta District.

2.0 RAINFALL & CLIMATE

Wet type of climatic condition prevails in the district. The district receives an average rainfall of 3133.9 mm annually. The major rainfall contribution is from south-west monsoon season during June to September. Based on 1901-99 data, rainfall during south-west monsoon contributes nearly 56.8% to the annual rainfall. Followed by this season, the north-east monsoon season from October to December contributes about 21.7% and the balance 21.5% is received from the rainfall during January to May months.

The eastern part of the district receives maximum rainfall in comparison with the western part. The area around Konni receives the highest rainfall and the area around Adoor receives the lowest. The month wise rainfall distribution in the district is presented in **Table 1**

Table 1 Normal monthly rainfall in Pathanamthitta (2006-2011) in mm

	2006	2007	2008	2009	2010	2011
January	16.3	0.0	0.0	5.5	31	46
February	0.0	10.0	65.3	12.0	0.7	74
March	148.3	24.50	157.7	105.7	66.3	93
April	135.6	261.6	198.4	115.4	210	352
May	488.7	156.8	61.5	156.8	268.2	96
June	452.0	632.8	287.0	378.0	502.5	591
July	476.0	755.2	644.1	454.0	432.5	304
August	271.3	325.6	346.1	227.4	402.2	288
September	320.9	444.1	368.2	290.3	259.4	334
October	480.4	456.2	345.9	222.7	454.9	179
November	253.7	176.5	142.9	299.9	526.4	121
December	0.0	8.1	40.7	34.9	89.1	175
Total	3043.2	3251.4	2657.8	2302.6	3243.2	2653

The humidity is higher (about 87%) during the monsoon period i.e. from June to September. Generally March and April months are the hottest and December and January are the coldest. The maximum temperature ranges from 28.5o to 32.7oC whereas the minimum temperature ranges from 22.6o to 25.5oC.

3.0 GEOMORPHOLOGY AND SOIL TYPES

3.1 Geomorphology

Physiographically, the district can be divided into three units viz. the coastal plain in the west, the mid land region in the centre and the hill ranges in the east. **(Table 2)** The elevation of the land varies from <5 to 1500 m amsl. The coastal plain in the western part of the area is restricted to Pulikeezh block of the district with an area of 82 sq km. The mid land region in the western part of the district is of undulating terrain of low and broad valleys with some valleys becoming narrow close to the foothills. The major part of the area in this region is characterized by thick laterite cover. The foothills of Western Ghats form the hill ranges in the eastern part of the district. The area is characterised by steep hills, narrow gorges and precipitous escarpments and is thickly forested. The elevation rises steadily from 80 to 300 m.amsl beyond which it abruptly increases. Thambimalai with a highest elevation of 1520 m amsl forms a prominent hill in the area.

Table 2 Physiographic units in Pathanamthitta District

Sl.No.	Physiographic units	Arial extent (km2)	Elevation (m.amsl)
1	Coastal plain	82	< 5
2	Mid land	700	5 - 80
3	Hill ranges	1950	80-1500

3.2 Soil Types

Based on the morphology, physical and chemical properties, the soils of the district are classified as Forest Loam, Lateritic, Brown hydromorphic, Riverine alluvium and Greyish Onattukara soils.

The diversity of the parental rock, the climatic conditions and differential weathering has led to the formation of these different soil types. Forest loam is the product of weathering of the country rock under forest cover. Forest loamy soil is encountered in the eastern parts of the district, in major parts of Ranni and Konni blocks. Lateritic soil is the most widely occurring soil type in the district. This soil is the product of lateralization of the crystallines and sedimentaries under humid tropical conditions. Brown hydromorphic soil occurs mostly in valley portions in the midland area of the district. The soil is formed as a result of transportation and deposition of material from the adjoining hill slopes under impeded drainage conditions. Riverine alluvium occurs mostly along the banks of rivers and their tributaries. Greyish Onattukara soil is having very limited occurrence in the district and is restricted to the western parts of Pulikeezh block.

4.0 GROUND WATER SCENARIO

Pathanamthitta district is underlain by geological formations ranging in age from Archaean to Recent. About 96% of the area of the district is underlain by crystalline rocks of Archaean age, which have under gone weathering and lateralization. The Archaean group of rocks comprises charnockites and gneisses along with minor occurrence of pyroxene granulites and are traversed by pegmatite and quartz veins. There are several basic dykes of doleritic and gabbroic composition cutting across the crystalline rocks. The crystalline rocks have undergone several phases of deformation and have suffered intensive fracturing and dislocations. The regional strike of foliation in charnockites and gneisses is generally NW – SE with variation from NNW – SSE to WNW – ESE with steep southerly dips ranging between 60o and 80o. There is one major shear zone – the Achenkovil Shear trending in NW – SE direction along which the Achenkovil River flows. The rest of the area in the north-western parts of the district is underlain by Tertiary sediments equivalent to the Cuddalore and Rajahmundry sandstones of east coast with a capping of Recent Alluvium. Lithologically these rocks are composed of carbonaceous clay with lignite, sandstone and grit with alternate lenses and beds of variegated clays.

4.1 Ground water Condition

Ground water in Pathanamthitta district occurs under phreatic condition in the alluvium, laterites and weathered crystallines. It occurs under semi-confined to confined conditions in Tertiary sediments and deep seated fractured aquifers in crystalline rocks.

The important aquifer systems in the district are:

The weathered, fissured and fractured crystalline formations, semi-consolidated Tertiary formations, laterites and the alluvial formation.

The hydrogeological map of Pathanamthitta district is shown in **Figure 4.** The description of various hydrogeological units, their aquifer and hydraulic parameters are discussed below

Crystalline formation

Weathered mantle, partly weathered and fractured zones in the crystallines form potential phreatic shallow aquifer supporting a large no. of dug wells. Charnockite is the dominant rock type in the district except in the southern part where gneisses occur. The thickness of weathered zone in the district ranges less than 1 to more than 10m. The depth of the wells in crystalline rock areas ranges from 2 to 12 mbgl with general depth to water levels in the range of 1.55 to 9.35 mbgl. The yield of open wells in hard rock ranges from 5 to 10 m3/day.

The SIDA assisted Coastal Kerala Groundwater Project of CGWB explored the potentialities of the deep fractured rocks in the district. During the project 9 exploratory bore wells were drilled. Subsequently 43 bore wells were drilled by CGWB in the ensuing Field Season Programs during the years 2001-03, 2008-09 and 2010-11. The yield of these wells widely ranged from 0.5 to 990 lpm with transmissivity ranging from 1.1 to 11.3 m2/day. But barring a few wells, yield of bore well was mostly less than 180 lpm. The only bore well along the NNW- SSE lineament had the highest yield of 990 lpm. Boreholes located along NW lineament yielded little water. The depth of borehole drilled ranged from 44 to 257.97 mbgl and depth to weathering varied from 2.50 to 16.50 mbgl. The Static Water Level of these wells ranged From 1.1 to 3.84 mbgl. The summarized details of the exploratory bore wells drilled in Pathanamthitta district is presented in **ANNEXURE I**.

Semi-consolidated Tertiary formation

The Tertiary sediments belonging to Vaikom bed occur below the alluvium at a depth between 13.7 and 85.7 mbgl with a thickness of 72 m as revealed from the only tube well constructed under SIDA Project, CGWB at Pulikeezh. Groundwater occurs under semi-confined to confined conditions. The static water level is 4.50 m bgl with a high discharge of 16.76 lps. The quality of water from the tube well is brackish.

Laterite formation

The ground water occurs under phreatic condition and is developed by dug wells used for domestic use. The depth of wells in laterite ranges from 5.0 to 13.50 m bgl and depth to water level varies from 3.40 to 11.40 mbgl during pre-monsoon. The wells in laterites have specific capacity ranging from 1.728 to 15.55 m^3/d/m and yield in the range of 5 to 30 m^3/d depending on the size and location of the well.

Unconsolidated Alluvial formation

The alluvial deposits occur along the north-western portion of the district in Pulikeezh block. This is one of the most potential shallow aquifers and is extensively developed by dug wells for domestic needs. The groundwater occurs in phreatic condition in this formation. The thickness of alluvium is about 13.7 m bgl as indicated by the data of borehole at Pulikeezh. The depth of dug wells range from 2 to 5 m bgl. The depth to water level during pre-monsoon period is between 1.40 to 3.35 m bgl. The yield of these wells ranges between 10 to 30 m^3/day.

Water levels

Ground water level is being monitored through a network of Ground Water Monitoring wells (GWMW) established since 1969. Water level is measured four times a year in the months of January, April, August and November. As on 31.03.2011 the total number of monitoring wells in the district were 38 which include 30 dug wells and 08 piezometers (bore wells). The data from these monitoring wells are analysed and discussed below.

During April 2011, the depth to water levels in monitoring wells in the district ranged from 1.00 to 9.10 mbgl **(Figure 2)**. Shallow water level of less than 2 mbgl is observed in 7 % of wells and depth to water level in the range of 2 to 5 m bgl in about 44% of the wells analysed, whereas it was between 5.0 to 10.00 in 48 % of wells. The shallowest water levels in the district were recorded in Pulikeezh block. Water levels in the range of 2.0 -5.0 m bgl were observed in this block. Majority of observation wells in Koipuram, Elanthoor, Kulanada and Konni blocks had water levels in the range of 5-10.0 m bgl. Water levels in the range of 10.0 to 12.0 m bgl were observed in certain parts of Mallappally block.

During post monsoon period (November 2011) the depth to water levels in observation wells in the district ranged from 0.45 to 8.65 mbgl **(Figure 3).** Shallow water level of less than 2 mbgl is observed in 23% of wells and depth to water level in the range of 2 to 5 m bgl in about 42% of the wells analysed, whereas it was between 5.0 to 10.00 in 35% of wells. No wells had water levels deeper than 10.0 m bgl. The shallowest water levels during the period were observed predominantly in Pandalam, Elanthoor and Pulikeezh blocks. Water levels in the depth range of 5-10 m bgl were observed predominantly in Konni, Ranni, Parakode and Mallappally blocks.

The block-wise minimum and maximum depth to water level during April 2011 and November 2011 is presented in the **Table 3**.

The difference in groundwater levels during November 2011 compared with the water levels during April 2011 indicate the extent of replenishment of shallow aquifers due to the southwest and northeast monsoon rainfall. The analysis indicates that the water levels have risen during post monsoon period in comparison to pre monsoon in major part of the district. Rise in water levels during the period is in the range of 0.0 to 2.0 in about 82% of wells, while the water level between 2.0 to 5.0m in about 18.00% of the wells.

Table 3 Block-wise depth to water level range

Name of Block	No. of wells analysed	DTW in mbgl (April 11)		DTW in mbgl (November 11)	
		Min	Max	Min	Max
Elanthoor	3	2.00	6.10	1.55	5.50
Koipuram	1	8.80	8.80	6.80	6.80
Konni	5	3.85	8.75	3.45	8.00
Kulanada	2	4.15	6.95	6.70	6.70
Mallappally	3	3.25	4.30	3.25	8.65
Parakkode	2	6.75	9.10	5.05	6.55
Pandalam	2	1.60	4.45	1.30	3.65
Pulikeezhu	2	2.10	3.30	2.45	3.35
Ranni	11	1.00	6.25	0.45	5.24

Mean water level trend

The mean water level trend from 2002 to 2011 has been analysed from the national hydrograph station water level. It is observed that during the pre monsoon the deepest water is observed in Kaviyur (12.56m bgl) and shallow water level observed during the period is at Thatta (1.69 m bgl). The post monsoon period the deepest water level observed at Laha Perumon (8.75 m bgl) and the shallowest water level observed at Thatta (0.87 mbgl).The average water level during the pre monsoon period 5.20 mbgl and 3.40 m bgl during the post monsoon period.

Long term Water level Fluctuations

The long-term water level fluctuations in the district have been analysed using the historical water level data of observation wells in the district.

The trend of groundwater levels was computed using Simple Linear Regression for pre-monsoon periods for the last decade (2002-2011). The trend analysis for the pre and post monsoon period indicates that the water levels are showing a rising trend in about 76% and 62 % respectively. The trend shows the rise in ground water levels in the district ranges from 0.008 to 0.350 m/yr

during pre monsoon and 0.0003 to 0.35 m/yr during post monsoon period. Declining trends of water levels ranging from 0.001 to 0.291 and 0.0057 to 0.3139 m/yr pre and post monsoon periods have been observed in the district.

4.2 Groundwater Resources

Pathanamthitta district receives a normal rainfall of 3133 mm, which forms the most important source of recharge. Recharge also takes place partly by irrigation and seepage from canals. Other sources of recharge include surface water bodies. The groundwater assessment was done block wise using GEC 1997 methodology and is computed during the year 2008-09 and these figures are used in this report.

Computation of Recharge

The total annual groundwater recharge of the district has been computed block wise using the data of average water level fluctuations in GWMW and specific yield of the aquifers in the district. The monsoon (after providing for natural discharge) recharge in the district is worked out as 207.37 MCM/Year. The recharge from rain fall during non monsoon is 67.09 MCM/year and recharge from other sources during non monsoon season computed it is around 34.61 MCM giving a net annual resource to 284.11 MCM/year. The resources available vary considerably from block to block depending on the geographical area of the block and ranges from 13.19 MCM in Kulanada block to 62.72 MCM in Parakode block. The block wise details are given below in **Table 4**.

Table 4 Block wise groundwater resources in Pathanamthitta District (Assessment year 2008-09) (in ha.m)

Sl. No.	Block	Net Annual Groundwater Availability	Existing Gross Groundwater Draft for all uses	Allocation for domestic and industrial requirement supply in2025	Stage of Groundwater development (%)	Categorization of block
1	Pulikeezh	2394.53	1019.96	797.17	42.60	Safe
2	Mallappally	2232.96	892.29	644.89	39.96	Safe
3	Koipuram	2133.34	997.29	672.65	46.75	Safe
4	Ranni	5465.80	1165.98	926.50	21.33	Safe
5	Elanthur	2287.02	831.67	516.26	36.36	Safe
6	Konni	4952.94	1135.87	882.00	22.93	Safe
7	Parakode	6272.41	1982.20	1131.10	31.60	Safe
8	Pandalam	1353.11	669.20	359.84	49.46	Safe
9	Kulanada	1319.13	729.88	374.00	55.33	Safe
	Total	28411.26	9424.34	6304.40	33.13	

Groundwater Draft

Groundwater withdrawal is mainly for irrigation, domestic and industrial purposes. The domestic and industrial requirements were computed as per the norms considering the population of 2001 and also based on the projected population for the year 2025. The irrigation draft was calculated based on the number of groundwater abstraction structures and the number of hours the well is in use per day and average number of days of irrigation in a year. The ground water draft is showing an increasing trend during the recent years. In the Pandalam block there is a significant rise in the draft since 1999. Groundwater draft for 9 blocks based on 1999, 2004 and 2008-2-09 year's data is given in **Table 4**.

Based on the stage of groundwater development, the blocks are categorised as safe, semi-critical, critical and over-exploited. The stage of development in Pathanamthitta district is 33.17 %. Maximum development is seen in Pandalam block (55.33%) and minimum in Ranni block (21.33%). All the blocks are under safe category in the district.

4.3 Ground Water Quality

The range of chemical parameters in the ground water samples taken from GWMW during April 2005 and 2008 are presented in **Table 5** and the result of analysis water sample during 2008 is given in **Appendix III.**

Table 5: Range of chemical constituents in shallow aquifer

Sl.No.	Constituent	Range in mg/l (2005)		Range in mg/l (2008)	
		Minimum	Maximum	Minimum	Maximum
1	pH	5.05	8.06	4.6	8.2
2	EC µs/cm at 250C	50	454	29	459
3	Total hardness	8	114	6	102
4	Calcium	2.4	19	1.6	33
5	Magnesium	0.5	7.8	0	9.7
6	Na	2.1	16	1.8	34
7	Potassium	0.5	7.6	0.2	13
8	Carbonate	0	0	-	-
9	Bicarbonate	0	151	0	112
10	Sulphate	0.08	34	0	33
11	Chloride	4.3	67	2.8	65
12	Fluoride	0.01	0.47	0	.18
13	Nitrate	0.8	52	2.3	79

The above data indicates that the groundwater in this area is of excellent quality. The electrical conductivity values are less than 500µs/cm at 250C. The higher electrical conductivity values are recorded in the well tapping alluvium (Pulikeezh) and this could be due to proximity of these

wells to backwaters. The minimum and maximum values of electrical conductivity suggest that the groundwater in most of the area is very fresh. The fluoride content is <0.1. The pH of groundwater varies from 5.05 to 8.06 indicating that the water are slightly acidic to neutral and are occasionally alkaline. The groundwater is of bicarbonate type falling within the range of nil to 151 mg/l. The iron content more than permissible limit of 1 mg/l is seen in Ranni and Konni blocks. The chloride content is between 4.3 to 67 mg/l.

Water quality of Deeper Aquifers

Fractured Aquifer

The chemical quality data of water samples collected from exploratory bore wells indicate that the pH ranges between 6.4 and 6.98 indicating that at places it is slightly acidic and at other places it varies between 7.1 and 8.2 indicating the water is alkaline. EC values range between 60 and 670 micro Siemens per cm at 25^0C. All other parameters analysed fall under the permissible limit. Thus water from all the bore wells tapping fractured aquifer in the hard rocks of the district is suitable for domestic and agricultural purposes. The ground water quality in the deeper aquifer is presented **Table 6**

Table 6: Ground Water quality of Deeper Aquifers

	Location	pH	EC	TH	Ca	Mg	Na	K	CO_3	HCO_3	Cl	F	NO_3
1	Kadiga	7.43	380	130	36	9.8	45	1.7	0	250	13.0	0.1	-
2	Kalanjur	6.98	230	84	28	3.4	15	2.2	0	134	8.5	0.11	-
3	Mudiyurkonam	8.21	670	35	8	3.7	146	2.8	0	287	78.5	0.4	-
4	Konni	6.40	90	18	4	1.9	9.8	3.2	0	19	18.0	-	-
5	Theodical	7.73	300	50	11	5.5	47	Traces	0	183	1.0	0.2	-
6	Valliakavu	7.10	340	22	8	.5	71	3.5	0	195	16.0	-	-
7	Perumpatti	7.18	200	85	12	13	12	3.5	0	117	9.9	0.4	-
8	Chetackal	8.28	335	134	24	18	11	0.6	0	212	4.3	0.4	0
9	Pamba	7.94	224	82	20	7.8	11	0.4	0	149	5.7	0.12	0
10	plapally	7.78	283	90	18	11	13	12	0	156	5.7	0.42	4.10
11	Angamoozhy	7.69	363	118	32	9.2	24	3	0	224	5.7	0.4	1.30
12	Kodumon	8.25	236	85	26	4.9	11	2	0	152	4.3	0.16	2.40
13	Konni	8.56	298	125	26	15	13	1.1	24	146	5.7	0.111	2.10
14	Adur	7.92	179	36	5.6	5.4	14	4.6	0	71	5.7	0.25	7.0
15	Vadaserikara	7.85	211	64	17	5.4	12	1.8	0	90	9.9	0.02	6.20
16	Vennikulam	8.41	334	130	34	11	11	1.9	30	122	8.5	0	0.66
17	Kadumancheera	7.9	277	120	18	18	8	1.7	0	173	9.9	0.3	1.3
18	Kottangal	8.4	278	72	23	3.4	26	3.9	12	79	20	0.11	22
19	Koipuram	7.87	221	70	20	4.9	16	3	0	134	5.7	0	4.3
20	Pathanamthitta	7.35	133	34	8.8	2.9	9.9	2.1	0	68	5.7	0.2	8

Vaikom aquifer of Tertiary formation

One tube well was drilled tapping the deeper zones of Vaikom aquifer. The chemical analysis of water samples from this tube well at Pulikeezh is summarized in **Table 7**

Table 7 Quality of water from Pulikeezh tube well

Constituent	Value
pH	5.89
TH	1040
Calcium mg/l	184
Mg ,,	141
CO3 ,,	0
HCO3 ,,	29
Cl ,,	2244
F ,,	0.21
Na ,,	960
K ,,	31
EC µs/cm at 250C	6300

The data indicates that the Vaikom aquifer is brackish with the electrical conductivity value is of 6300 µs/cm at 250C. Thus the water is unfit for domestic and irrigation purposes.

Status of Groundwater Development

Groundwater in the district is mostly developed through dug wells and bore wells for domestic, agricultural and industrial purposes. Apart from this the Kerala Water Authority is developing the resources for the principal water supply in the rural area and for supplementing the urban water supply schemes **(Table 8).** A good percentage of the households in the district have their own drinking water wells. The groundwater development in the district as elsewhere in Kerala is mostly through dug wells. Recently the bore well culture has picked up and gained momentum in the district. In the crystalline terrain the groundwater is developed through dug wells, dug cum bore wells and bore wells. Along the valley fills and laterite terrain the groundwater is developed through dug wells.

Table 8: Drinking water supply schemes in Pathanamthitta district

1. Number of public wells			1250		
2. Number of public tanks/ponds			462		
3. Number of public taps			12336		
4. Number of tube wells			971		
Sl No.	Name of the block	Public tube wells	Public wells	Public tanks/ pond	Public taps
1	Elanthur	26	16	4	415
2	Koipuram	33	82	10	822
3	Konni	187	112	27	185
4	Kulanada		52	6	44
5	Mallapally	61	65	15	464

6	Pandalam	26	51	60	266
7	Parakode	54	130	107	472
8	Pulikeezh	264	150	19	1271
9	Ranni	147	73	29	678
	Total	797	731	277	4616

5.0 GROUNDWATER MANAGEMENT STRATEGY

The groundwater development in the district is feasible through different abstraction structures tapping the shallow phreatic aquifers in the hard rocks, laterite, and alluvium and deep fractured crystalline rocks. Depending upon the hydrogeological set up and requirement, the development can be planned with suitable structures.

Groundwater development

It can be seen that the stage of groundwater development in the district is only 31.75% leaving a vast scope for future development. The government may give more incentives to farmers for developing well irrigation apart from providing the requisite infrastructure. Since all the blocks fall under safe category abstraction structures can be constructed keeping in view of the groundwater sustainability of the region.

In the western part of the district i.e. in Pulikeezh block dug well with a depth of 6 to 8 m and a diameter of 3 m can be constructed for irrigation purpose. These wells require protection with concrete rings with weep holes allowing inflow of ground water. The gap between the rings should not be cemented. Centrifugal pumps of around 3 HP will be ideal for these wells. The total cost of construction and energisation will be about Rs.30, 000/-

In the mid land areas the dug wells with a diameter of 4 - 5 m and depth to 8 -12 m may be required and the same can be energized with 3-5 HP centrifugal pump positioned 2 - 4 m below ground level depending upon the pre-monsoon and post monsoon water levels. Alternatively jet pumps and compressor pumps can be used in areas of deep water table even though the efficiency is comparatively less. For submersible pump, the investment is quite high. The cost of dug well and the pump set in the mid land area is around Rs.30, 000 to Rs.50, 000 depending upon the options used and the depth and diameter of dug well.

In the mid lands and high lands bore wells can be constructed after proper scientific site selection procedures. The bore wells can be of 6" (152) mm diameter for agricultural purpose, so that submersible pumps can be lowered. Alternatively air compressor pump/jet pump can be used in a well of 100 mm diameter, which will work out cheaper but have low efficiency. The cost of structure will be highly variable depending on depth of bore hole, diameter of bore hole and the pump used. It generally varies from Rs.25, 000 to Rs.75, 000 per structure.

Sustainable development of Groundwater in hard rock area

Groundwater potential maps on a micro water shed basis should be generated for effective and functioning of managing groundwater resources. Such maps should contain all the available information on groundwater availability, present abstraction practices, surface irrigation details, water budget, including groundwater balance, socio-economic details, cropping pattern etc.

Groundwater legislation should be enacted and the abstraction monitored properly and strictly.

Artificial recharge structures wherever needed should be constructed only after a detailed study on the availability of excess run off in each micro watershed.

Water conservation and Artificial Recharge

The major problem in the district is the non availability of ground water in the dug wells located along the hill slopes of the mid land area. It is not due to over development but due to the natural discharge on the sloping bedrock topography. Even though the rainfall is widely distributed through out the year except a dry spell for 3-4 months in the summer, the topography is not suitable to retain the ground water. Major parts of the rain escapes as surface run off within hours of rainfall. The other part, which infiltrates into ground water escapes as sub surface run off.

In these areas the solution will be to check/retard the subsurface out flow of ground water by construction of sub surface dams wherever feasible which will arrest the sub surface flow and create a build-up in the upstream side.

In addition to the conservation measures like sub surface dam, artificial recharge measures like contour bunding, trenching, gully plugging, terracing, check dams etc will help in impounding part of the rainfall and allow slow percolation into the ground water. This will also help to tide over the water scarcity for 2-3 months. Check dams across small streams help in arresting surface runoff as well as rising of water table in the adjoining area. Recommended artificial recharge structures in Pathanamthitta district is shown in **Figure**.6.

6.0 GROUND WATER RELATED ISSUES AND PROBLEMS

Vulnerable area

Even though the rainfall is quite high and is spread over the year, acute water scarcity is felt in the mid land and high areas of the district during the five months of January to May. The limited thickness of weathered / lateritised mantle gives limited thickness of saturated zones. The sloping nature of the ground accelerates the fast subsurface out flow of the ground water. This is the case in most of the hill slopes in the district where dug wells dry up in extreme summer. Then water will be available only in the valley portion. As the district is dissected by

innumerable hills and valleys of different magnitude, the problems and the vulnerable area are also scattered and alternates with potential zones.

The problems of water logging are not present in the district due to its topography. Since the district is industrially backward, there are no pollution problems in the district. The problems of water scarcity during summer months are not due to over development. As seen in earlier chapters though the ground water development is on a low key still water scarcity is experienced in certain areas of the district in mid land, because of its geomorphology.

7.0 AWARENESS & TRAINING ACTIVITY

A Water Management Training Programme was organized by Central Ground Water Board at Pathanamthitta on 22.10.2003 to raise the awareness on need for conservation and recharge of groundwater. The programme was inaugurated by Shri. Mathew Kulathinkal, President, District Panchayat, Pathanamthitta. The programme attained wide publicity and was attended by about 200 participants.

8.0 AREAS NOTIFIED BY CGWA&SGWA

As all the blocks of Pathanamthitta district are falling in safe category, no area has been notified by CGWA or SGWA.

9.0 RECOMMENDATIONS

The net available groundwater resource in the district is about 284.11 MCM of which the present draft is about 94.24 MCM and the stage of groundwater development is about 33.17 %.

For development of groundwater 3 m diameter dug wells with cement rings can be constructed down to 6-8m in Pulikeezh block. In mid land large diameter dug wells down to 8-12 m can be constructed. Bore wells of 100 to 152mm diameter) down to 200 m can be constructed along potential lineaments.

The alternating hills and valleys present ideal sites for construction of subsurface dams for conservation of groundwater, which will mitigate the water scarcity of the upstream side. Several such structures can be constructed.

Artificial recharge measures like check dams, contour bunding, trenching, gulley plugging, terracing etc should be constructed in the mid land area of Parakode , Kulanada, Elanthoor, Pandalam , parts of Ranni, Konni blocks, Adoor and Pathanamthitta Municipality, which will improve groundwater availability in summer.

For isolated habitation in the eastern hilly parts of the district roof water harvesting can be the assured source of drinking water.

Community irrigation schemes using groundwater resources have to be given a thrust backed up by scientific investigations.

The available spring can be developed and can be used for drinking purpose where ever possible. The detailed hydrogeological map should be prepared in Panchayat or block level to guide the local people for ground water developments. Groundwater legislation should be enacted and the abstraction and usage of ground water should be monitored properly by panchayat or block level groundwater committee.

Figure 1: Index map of Pathanamthitta District, Kerala

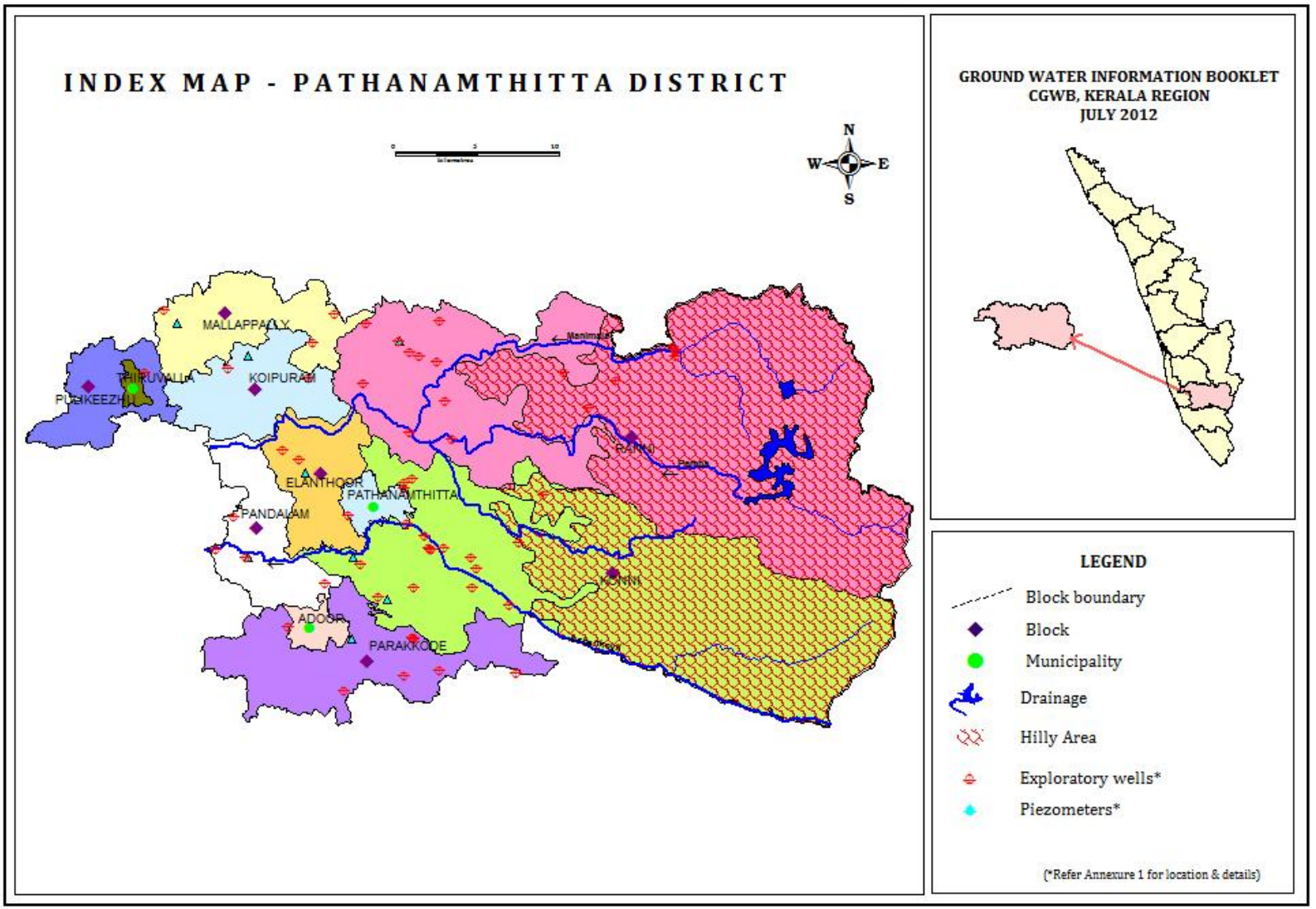


Figure 2: Pre-monsoon Depth to Water Level, Pathanamthitta District (April 2002-11)

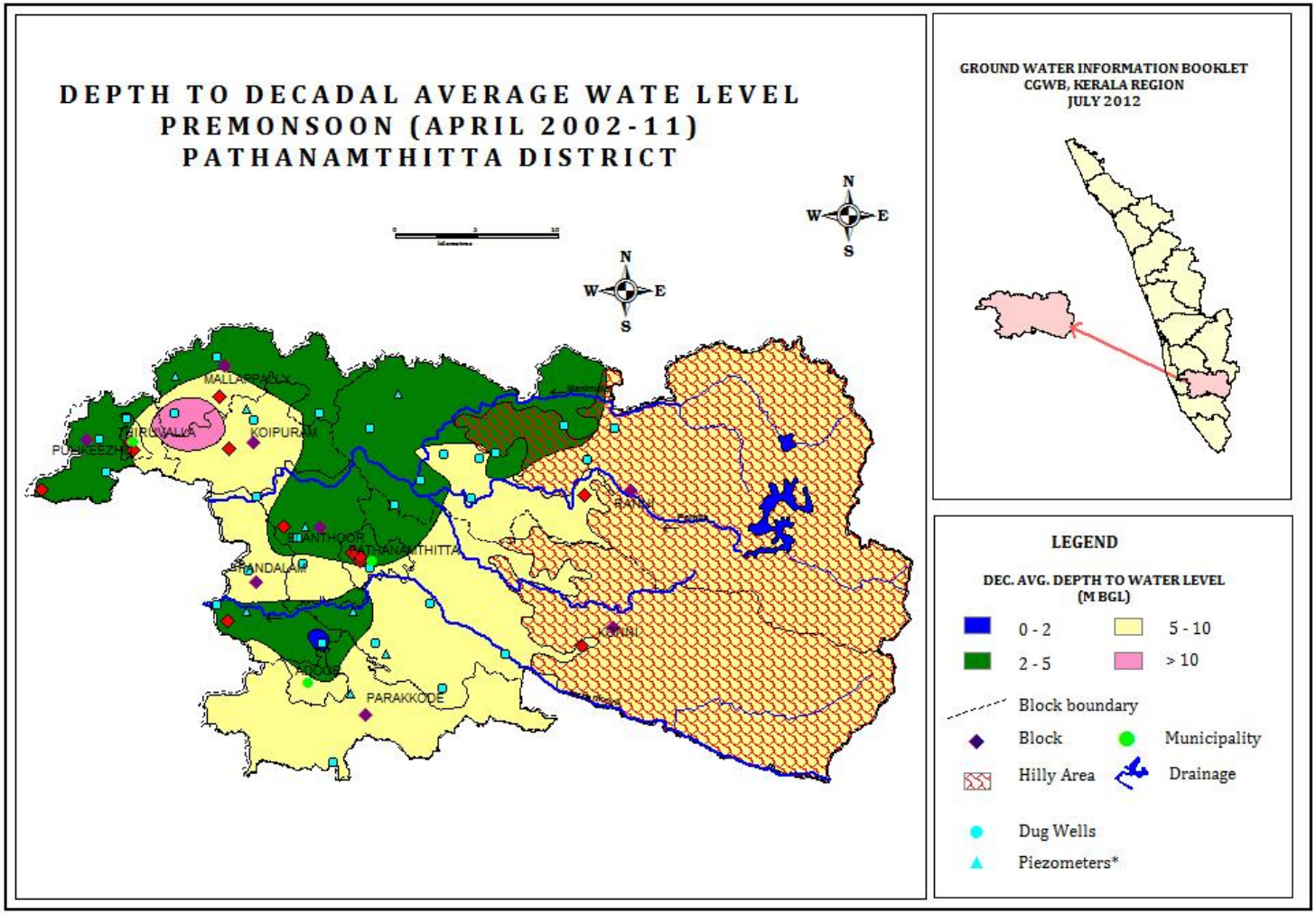


Figure 3: Post Monsoon Depth to Water Level, Pathanamthitta District, Kerala (Nov-2002-2011)

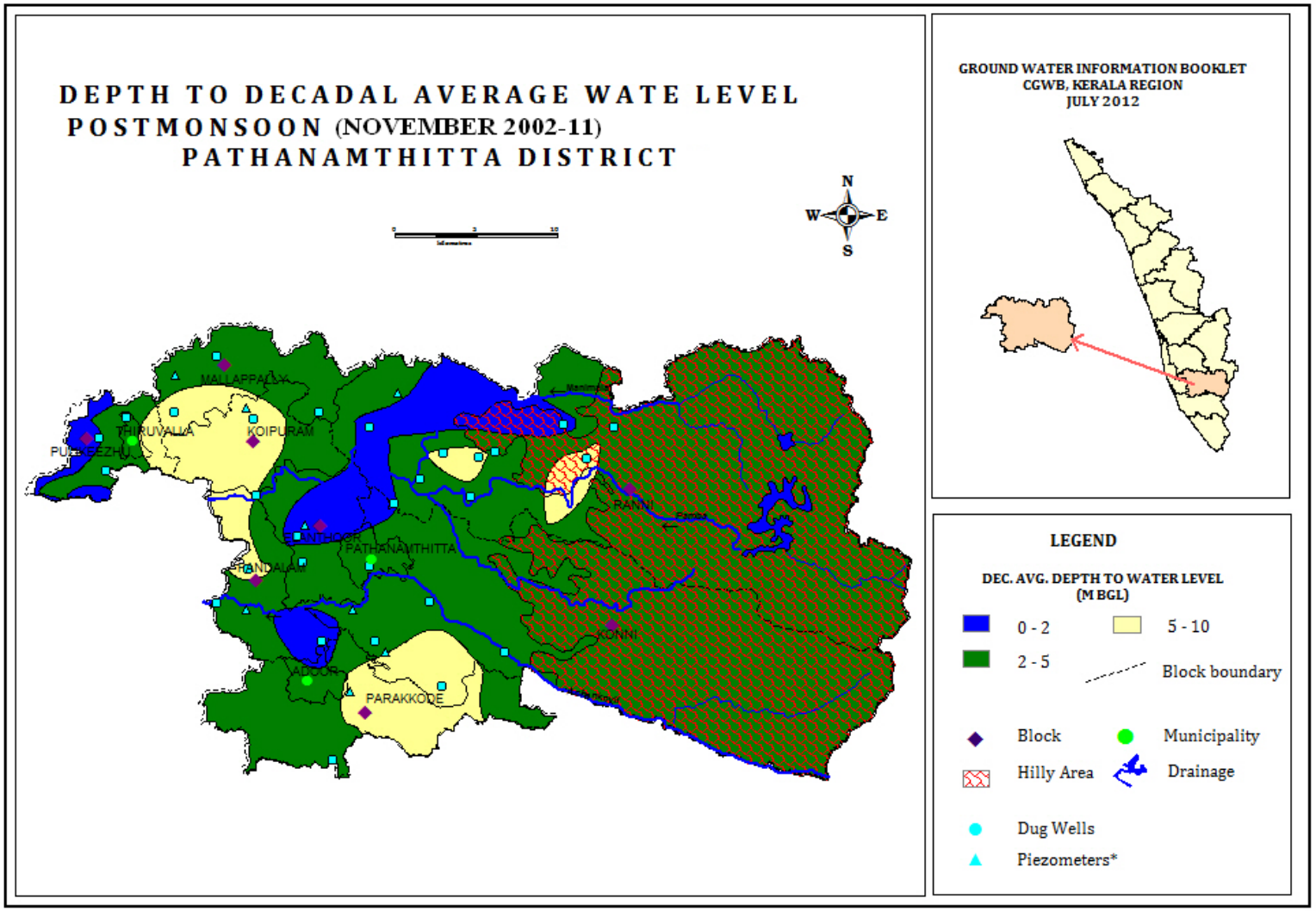


Figure 4: Hydrogeology of Pathanamthitta District, Kerala State

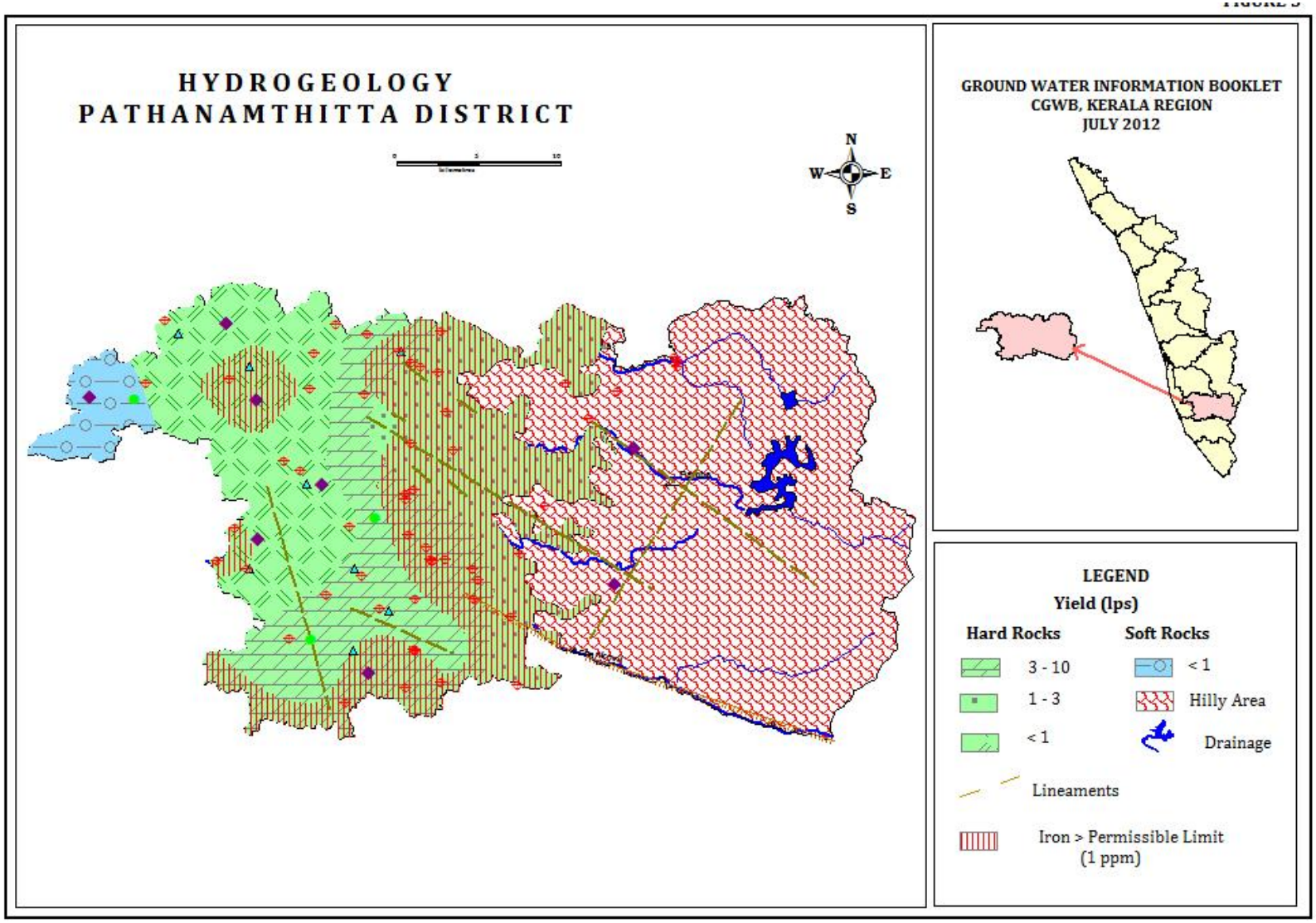


Figure 5: Categorization of Blocks in Pathanamthitta District

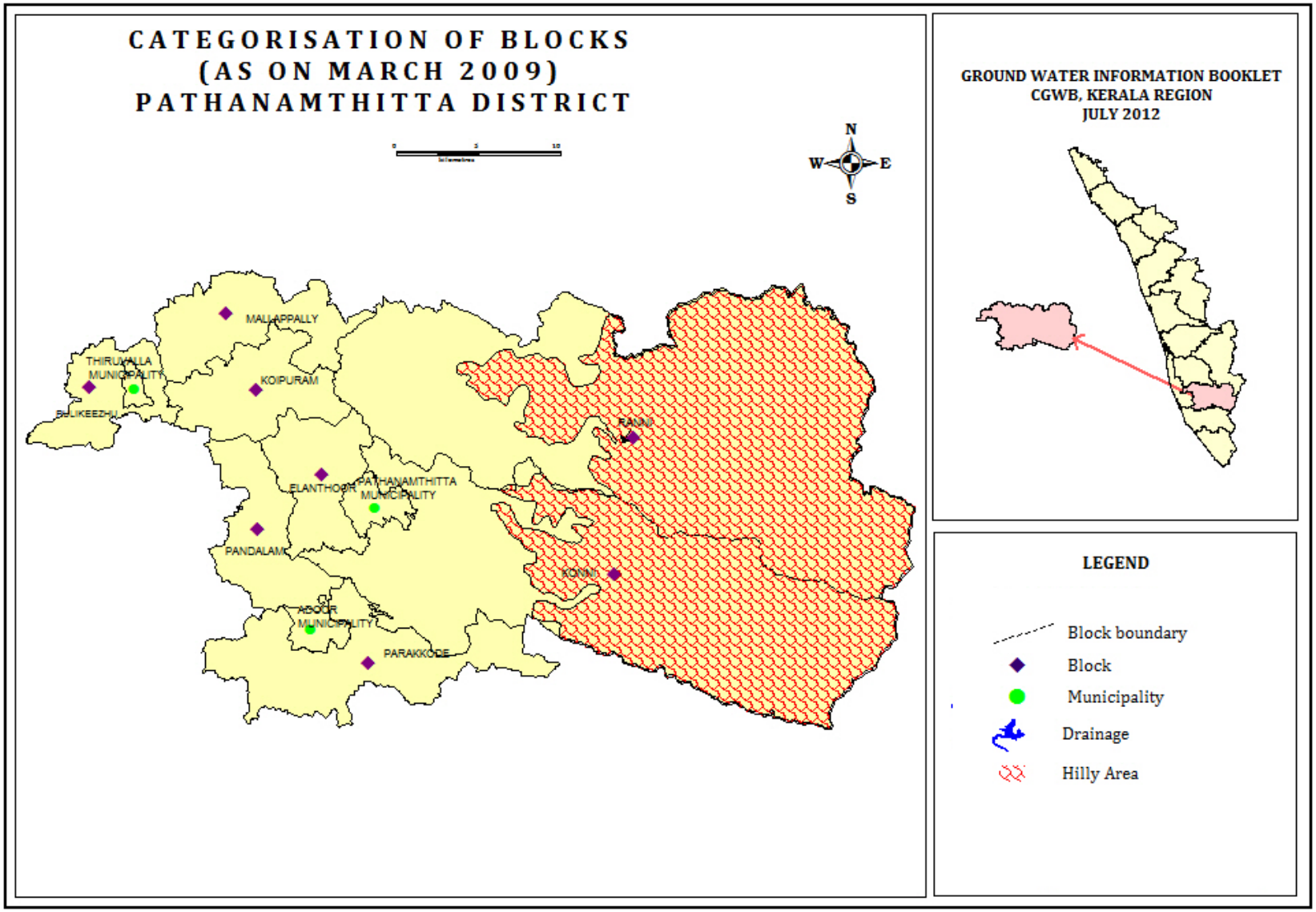
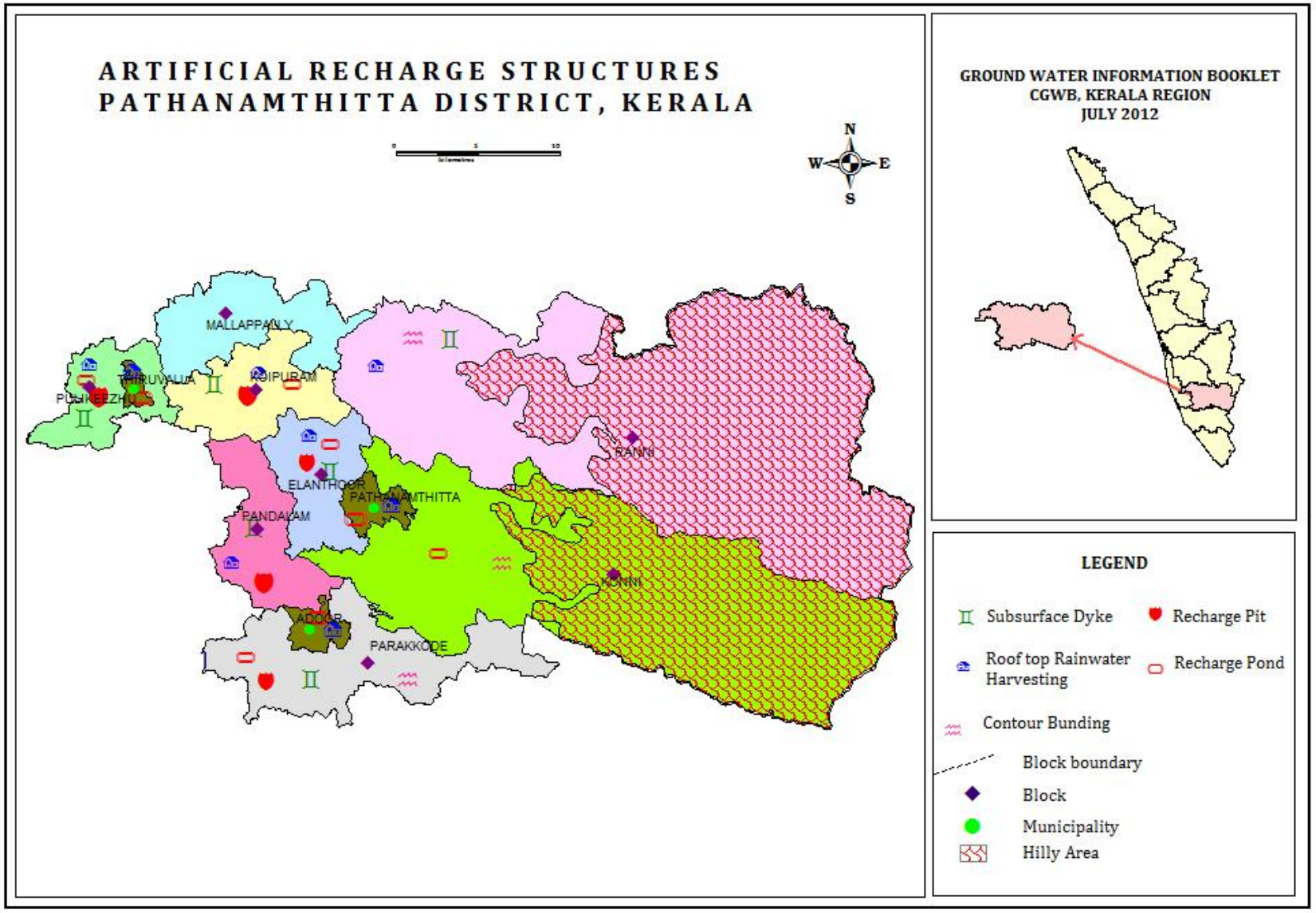


Figure 6: Artificial Recharge Structures proposed in Pathanamthitta District



Annexure I

Details of Exploratory bore wells drilled by CGWB in Pathanamthitta district.

Well No	Location	Year of construc-tion	Depth drilled (mbgl)	Discharge during drilling (lpm)	SWL mbgl	T m^2/day	EC micromhos/ cm at 25^0C	Cl ppm
1	Kadika	1983-87	200.53	90	1.09	1.33	380	13
2	Marur	1983-87	200.53	Nil	dry	-	-	-
3	Kalanjur	1983-87	221.39	180	1.10	7.30	280	8.5
4	Mudiyurkonam	1983-87	244.22	240	3.90	1.11	670	78
5	Konni	1983-87	206.15	30	5.38	1.35	90	18
6	Vadaserikkara	1983-87	248.25	Nil	4.92	-	-	-
7	Theodical	1983-87	175.70	240	1.90	6.66	300	11
8	Perumpatti	1983-87	129.95	990	1.62	11.3	200	9.9
9	Valiakavu	1983-87	257.97	150	3.67	0.5	510	11
10	Chetheckal-West	2001-02	92.00	120	3.50	11.85	335	4.3
11	Chetheckal-East	2001-02	101.00	6	3.25	-	120	11
12	Pothipad	2001-02	101.00	6	5.28	-	91	9.9
13	Edamuri	2001-02	101.15	6	3.20	-	-	-
14	Pamba KSEB	2001-02	101.00	6	9.75	-	-	-
15	Pamba KSRTC	2001-02	101.00	60	2.14	-	-	-
16	Thriveni	2001-02	44.00	6	10.00	-	-	-
17	Vettur	2001-02	101.00	6	-	-	-	-
18	Kalleli	2001-02	101.00	6	5.20	-	-	-
19	Naduvathumoozhi	2001-02	101.15	30	6.85	2.16	-	-
20	Arikkakavu	2001-02	101.15	36	7.10	1.6	316	8.5
21	Mekkozhur	2001-02	100.00	36	8.00	0.84	307	-
22	Nilackal	2002-03	100.00	30	7.00	-	225	8.5
23	Angamoozhi	2002-03	101.15	40	6.10	-	363	5.7
24	Plappally	2002-03	101.15	30	17.91	-	283	5.7
25	Elakollur	2002-03	101.15	30	9.13	-	-	-
26	Vallikode	2002-03	101.00	6	-	-	-	-
27	Ranni	2002-03	100.00	12	-	-	-	-
28	Vechoochira	2002-03	101.00	36	7.52	-	344	21
29	Kummannur	2002-03	101.35	dry	-	-	-	-
30	Konni Elephant Camp	2002-03	64.75	120	14.51	2.88	141	5.7
31	Padam	2002-03	101.35	5	10.25	12.34	156	32
32	Perinad	2002-03	101.00	30	5.90	-	-	-
33	Koduman	2009-10	200	6.80	5.18	33.55	236	4.3
34	Chandanapally	2009-10	200	0.50	2.30	-	-	-
35	Ottethekku	2009-10	200	0.50	4.00	-	-	-
36	Konni	2009-10	190	4.50	3.50	23.45	298	5.7
37	Mundumuzhy	2009-10	200	Dry	Dry	-	-	-
38	Thannithodu (Medappara	2009-10	200	0.50	5.00	-	-	-
39	Adur	2010-11	123	18	18	-	179	5.7
40	Mamood	2010-11	200	.72	below 50 mbgl	-	-	-
41	Pampa	2010-11	200	.72	below 50 mbgl	-	-	-
42	Vadasserikkara EW	2010-11	200	10.8	2.72		211	9.9

43	Vennikkulam	2010-11	200	1.8	8.5	-	334	8.5
44	Kadumeenchira EW	2010-11	200	15.84	8.31		277	9.9
45	Kottangal	2010-11	200	1.8	2.65	-	278	20
46	Kozhancheri	2010-11	200	4.32	3.75	-	-	-
47	Koipuram	2010-11	108.1	46.008	12.78		221	5.7
48	Mandan am	2010-11	200	negligible	23	-	-	-
49	Manjadi	2010-11	200	1.8	10.65	-	-	-
50	Malayalappuzha	2010-11	200	negligible	below 100 mbgl	-	-	-
51	Pathanamthitta EW	2010-11	153	21.24	1.6		133	5.7
52	Pandalam	2010-11	23.5	negligible	2.5	-	-	-

Annexure II

Chemical analysis data of water samples from Ground Water Observation wells in Pathanamthitta District (April 2008)

S:No	Location	pH	Ec in us/cm	TH as	Ca	Mg	Na	K	CO3	HCO3	SO4	Cl	F	NO3	TC	TA	IB %
			250C	CaCO3													
1	Angadikkal	6.72	60	18	4.8	1.5	3.5	0.6	0	24	0.88	4.3	0.03	4.5	0.53	0.61	-6.55
2	Ankamuzhi	7.23	54	10	1.6	1.5	3.9	3.2	0	9.8	0.68	7.1	0.01	7.7	0.46	0.50	-4.61
3	Aranmula	7.91	181	50	9.6	6.3	13	1.3	0	51	7.2	17	0.08	25	1.60	1.87	-7.82
4	Enathu	7.65	459	102	25	9.7	34	13	0	49	33	65	0.18	52	3.86	4.16	-3.75
5	Ilanthur	7.62	81	14	4	1	6.7	2.2	0	20	0.96	13	0.02	2.7	0.63	0.76	-9.20
6	Karikulam	7.62	88	22	5.6	1.9	5.6	1.4	0	17	3	13	0.01	7.1	0.72	0.82	-6.90
7	Kaviyur	7.95	167	58	22	0.5	6	3.3	0	73	0.92	14	0.09	8.5	1.49	1.75	-8.06
8	Konni	7.3	155	26	5.6	2.9	14	2.4	0	15	0.08	36	0.01	10	1.19	1.42	-8.96
9	Koodal	7.23	57	14	3.2	1.5	4.3	1	0	7.3	0.36	9.9	0	11	0.50	0.58	-8.10
10	Kootanadu	7.29	128	20	3.2	2.9	12	3.7	0	7.3	2.4	24	0.01	16	1.02	1.10	-4.18
11	Kumplanipoika	6.91	92	28	7.2	2.4	3.9	1.6	0	17	1.8	8.5	0.01	17	0.77	0.83	-3.86
12	Laha Balawadi	6.79	57	12	4	0.5	3.5	3	0	7.3	2.4	7.1	0	10	0.47	0.53	-6.06
13	Laha Perumon	6.94	29	6	2.4	0	1.8	1.7	0	9.8	0.16	2.8	0	3.4	0.24	0.29	-9.05
14	Mallapally	6.79	43	8	2.4	0.5	3.8	1.2	0	4.9	1	7.1	0	4.7	0.36	0.38	-2.70
15	Maniyar	6.66	52	14	3.2	1.5	3.1	1.3	0	7.3	0	7.1	0	11	0.45	0.50	-4.80
16	Muthoor	4.6	242	50	18	1.5	12	9.3	0	0	20	24	0.11	79	1.78	2.37	14.05
17	Naduvathumuzhi	7.37	77	24	5.6	2.4	3.6	1.7	0	22	1.9	5.7	0.02	11	0.68	0.74	-4.28
18	Nilakkal	6.93	48	14	3.2	1.5	3.3	1	0	7.3	0.12	8.5	0.05	8.8	0.45	0.50	-4.28
19	Pandalam-1	7.59	66	20	4	2.4	4.6	0.2	0	27	0.2	8.5	0	2.6	0.60	0.73	-9.43
20	Pathanamthitta	6.74	239	44	12	3.4	17	5.9	0	9.8	3.3	30	0.14	56	1.77	1.98	-5.54
21	Plapally	6.67	46	16	3.2	1.9	2.4	2.2	0	15	1.8	5.7	0.02	3.4	0.48	0.50	-2.22
22	Prakkanam	6.88	65	10	3.2	1	5.8	3.3	0	12	0.28	11	0	7	0.58	0.63	-3.84
23	Pulikeezh	8.2	215	92	33	2.4	4.4	0.9	0	112	3.3	8.5	0.08	2.3	2.06	2.18	-2.81
24	Ranni 1	7.47	41	8	2.4	1	3.3	1.5	0	7.3	0.48	7.1	0.02	5.2	0.38	0.41	-3.67
25	Ranni Perunad	8.14	190	70	25	1.9	4.8	4.6	0	95	1.6	2.8	0.15	13	1.73	1.88	-4.05
26	Thatta	7.56	72	20	7.2	1	4.6	1	0	24	2	8.5	0.02	2.8	0.67	0.72	-3.73
27	Thelliyur	7.63	93	24	4.8	2.9	6.7	2.6	0	20	2	11	0.08	9.4	0.84	0.83	0.34
28	Ullannur	7.43	55	14	4	1	2.8	2.1	0	12	0.72	5.7	0.08	7.8	0.46	0.50	-4.21
29	Vadasserikkara	7.93	95	36	11	1.9	2.7	0.5	0	32	8.3	5.7	0.05	8.9	0.84	1.00	-8.98