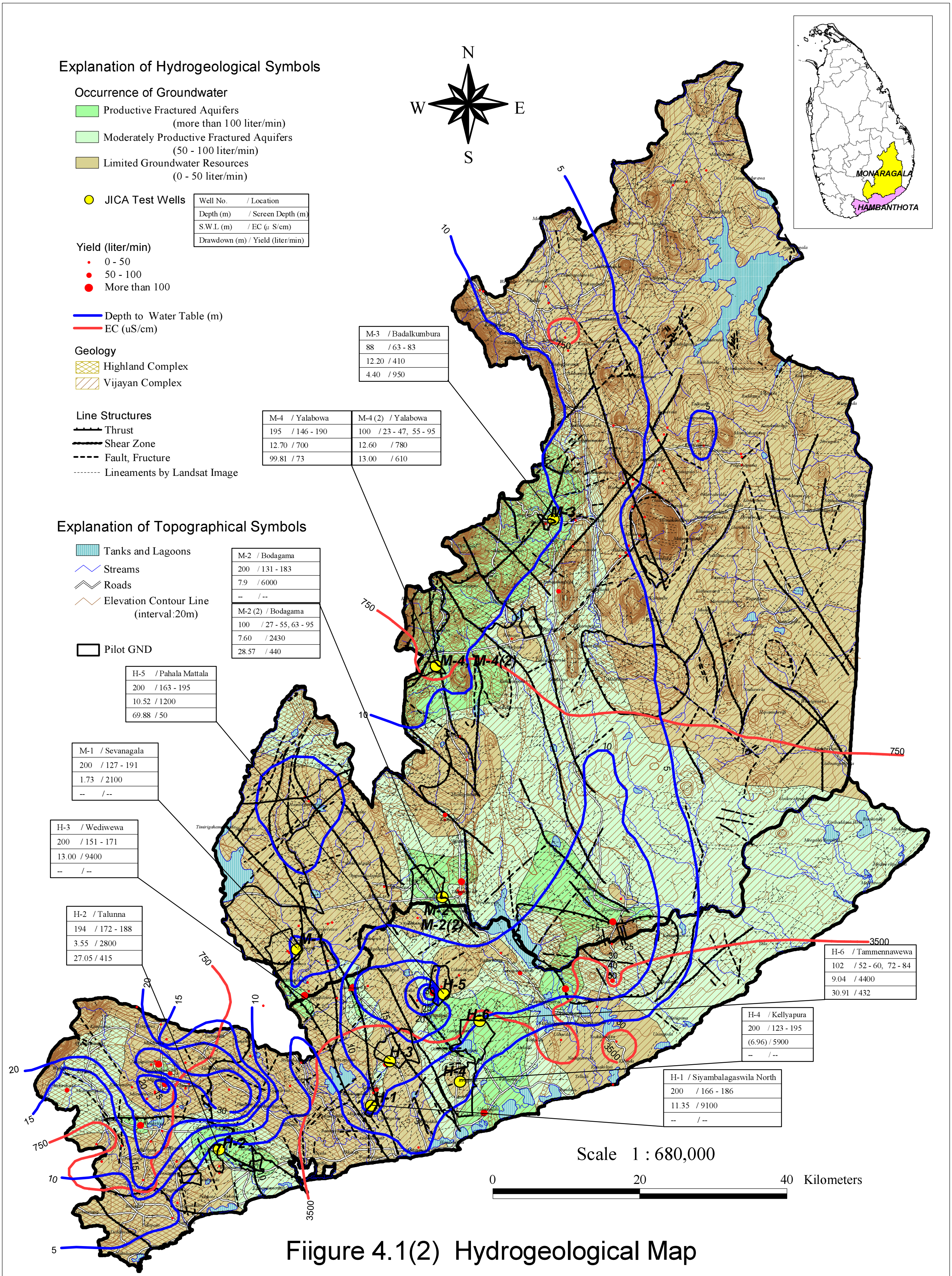


Fiigure 4.1(2) Hydrogeological Map

Lower/Deeper Fractured Aquifer (deeper than 70m)

4.3 GEOLOGICAL STRUCTURE AND GROUNDWATER

Analyses were conducted to confirm the relation between geological structure and groundwater occurrence using GIS with the database. The results of the analyses were tabulated below.

No.	Analysis Item	Relation
1	Relation between Well Yield [a)] and Fault and thrust/shear zone [b)]	A well nearer to fault or thrust/shear zone yields a little more than a distant well.
2	Relation between Well yield [a)] and Lineament [c)]	A well located near the lineament with the direction of NNW-SSE yields more than other wells on average.
3	Relation between Well yield [a)] and Geology [b)]	Not clear
4	Relation between Well yield [a)] and Suface water (river) [d)]	A well nearer to a river yields a little more than a distant well.
5	Relation between Well yield [a)] and Lineament density [c)]	Not clear
6	Relation between Electric conductivity [a)] and Geology [b)]	Not clear
7	Relation between Fluoride [a)] and Geology [b)]	Not clear
8	Relation between Tatal iron [a)] and Geology [b)]	Not clear

Sources; a) Well database (WRB, NWSDB, JICA test well)
b) Geological Map with a scale of 1:100,000 by GSMB
c) Landsat imagery analysis in Chapter 3
d) Digital Map with a scale of 1:250,000 by Survey Department

4.4 GROUNDWATER LEVEL

4.4.1 GENERAL FEATURE OF THE STUDY AREA

(1) Upper Fractured Aquifer (GL - 70m)

92.6 % of the water level is 20 m or above in depth. The hydrogeological map, *Figure 4.1(1)*, shows the depth to water level of the upper fractured aquifer. The wells with relatively deeper water level are mostly located in the western Hambantota.

(2) Lower and Deeper Fractured Aquifer (70 – 200 m)

86.7 % of the water level is 20 m or above in depth. The hydrogeological map, *Figure 4.1(2)*, shows the depth to water level of the lower and deeper fractured aquifer. Similarly to the upper fractured aquifer, the western area of Hambantota seems to be the relatively deeper water level area. In general, the water level becomes deeper to the south eastern coastal side. Even for the deeper aquifer occurring below 100 m or more in depth, its piezometric head is about 10 *mbgl* or above.

4.4.2 WATER LEVEL FLUCTUATION

Periodical measurements of the existing wells and the continuous recording of the test wells were conducted.

(1) Results of Periodic Measurement of Existing Wells

The correlation between water level fluctuations and monthly rainfall variation shows that the rainy season from September to January and also the rain in April have recharged the upper fractured aquifer.

(2) Results of Continuous Water Level Record

The data were graphed in *Figure 4.4*. Influences of water extraction from a nearby well were observed. They indicate the occurrence of interconnections of fractures in the basement rock.

The effect of Earth tide was observed in some test wells.

Generally, the recorded water level fluctuation correlates with rainfall in the area, even when the aquifer occurs below the depth of 150 m. The result suggest that the seasonal rain also recharges a deeper fractured aquifer.

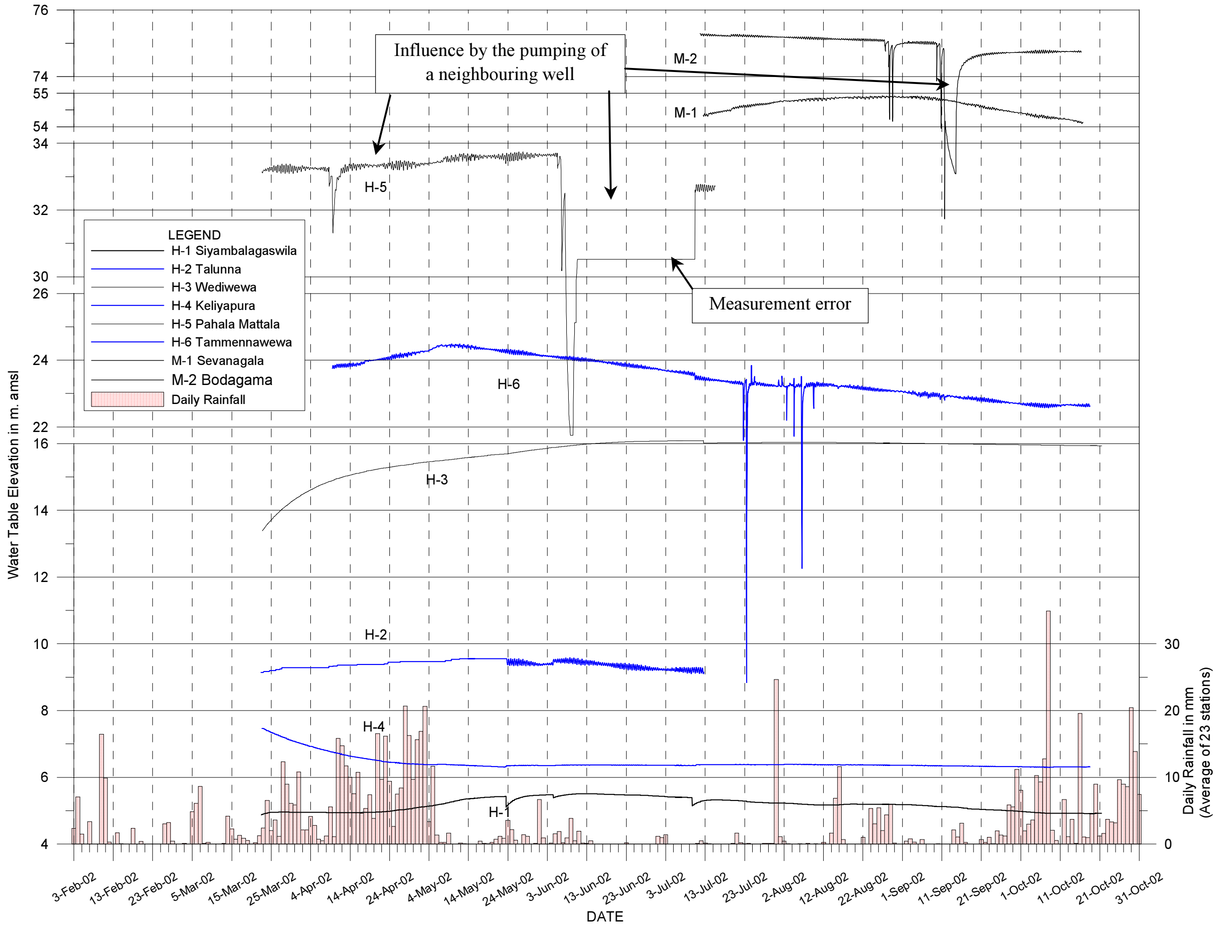


Figure 4.4 Hydrograph of Test Wells

4.5 WATER QUALITY

Based on the results of water quality analysis and the groundwater quality data of the existing tube wells from the database, the groundwater quality characteristics in the Study area is summarized as below.

1) The existing tube well (Upper Fractured Aquifer)

- From 10 % to 20 % of the existing tube wells in the Study area do not satisfy the criteria of EC, total hardness, total alkalinity, total dissolved solids (TDS), magnesium and fluoride for drinking water. Especially for total iron, as high as approximately 50 % of tube wells exceed the criteria of total iron for drinking water.
- Regional distributions of groundwater quality of the existing tube wells in the Study area can be classified into two patterns. One is high concentration of values centering in the central to the western part of Hambantota. The distribution of EC is a distinctive feature for this pattern, TDS, total hardness, calcium, magnesium, chloride and sulphate also shows similar trend.
- The other is the highest concentration area of total iron covers the northern part of Monaragala, and from the western part of Hambantota and Monaragala. The regional distribution of fluoride shows similar distribution to the one of total iron.

2) The test well (Lower/Deeper Fractured Aquifer)

- According to the results of groundwater analysis of 12 test wells in the Study area, it became clear that Pahala Mattala in Hambantota and Yalabowa in Monaragala satisfy the criteria (Maximum permissible level) for drinking water. However, 10 test wells do not have appropriate quality for drinking purpose without purification.

- From the results of analysis of 12 test wells, it is found that 12 items of the requirements for drinking water criteria are not satisfied, namely, pH, EC, total hardness, total alkalinity, TDS, calcium, magnesium, total iron, chloride, fluoride, lead and chromium.
- Six test wells, namely Siyambalagaswila North, Wediwewa, Keliyapura, Talunna and Tammennawewa in Hambantota and Bodagama in Monaragala, have especially high concentration of salt content, which is expressed by electrical conductivity, total hardness, total dissolved solids and other dissolved substances. It is difficult to purify by an ordinary purification method for water supply system such as coagulation-filtration method.
- Furthermore, Wediwewa and Keliyapura have chromium, which exceeds the criteria for drinking water. Also high concentration of lead was detected at Sevanagala. These heavy metals are health-related drinking water contaminants.
- From the comparison of stiff diagrams between the test well and its neighbouring the existing tube well, the similar stiff diagrams between those wells are observed. The result suggest that the hydrogeological correlation of the upper fractured aquifer of the existing wells and lower fractured aquifer of the test wells. In contrast, no similarity of stiff diagrams between the existing tube well and the test well in Monaragala was found.

4.6 AQUIFER PROPERTIES

The obtained aquifer properties of each borehole are summarized in *Table 4.3*.

Table 4.3 Aquifer Properties (Transmissivity; T, Hydraulic Conductivity; k, Storativity; S)

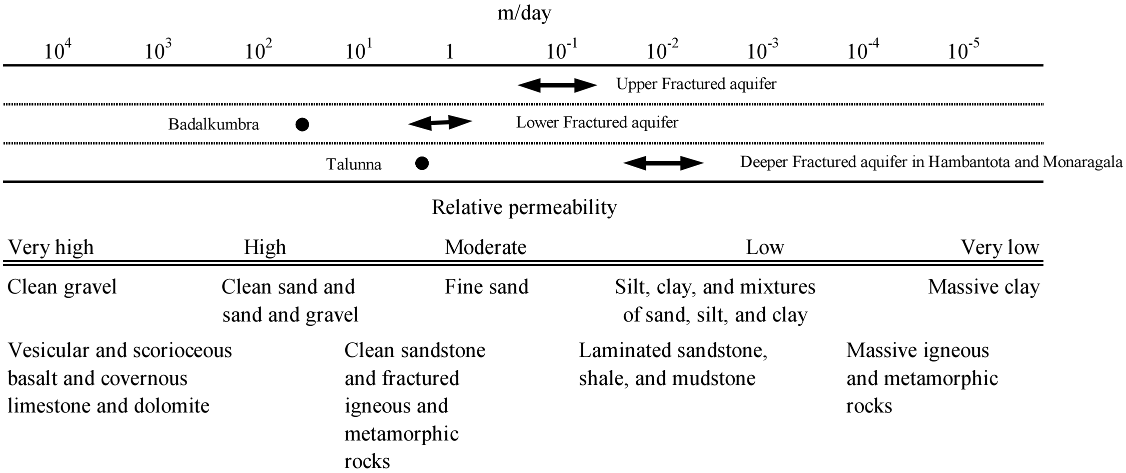
Location	Well	Well Depth	Open Hole/ Screen Length	***Q/s***	***T***	***K***	***S***
		(m)	(m)	(l/min/m)	(m^2/day)	(m/day)	
Siyambalagaswila	H-1	200.4	20	(0.75)	0.14	7.00E-03	---
	JM07	33.53	23.17	2.04	2.02	8.72E-02	---
Talunna (Vitalandeniya)	H-2	194.4	16	15.34	25.29	1.58E+00	---
	JM02	36	25	1.81	4.09	1.64E-01	---
Wediwewa	H-3	200.4	20	(0.65)	0.18	9.00E-03	---
	JM04	44	(35)	0.07	0.17	4.86E-03	---
Keliyapura	H-4	200.2	32	(0.21)	0.14	4.38E-03	---
	JM01	33	(28)	1.72	1.30	4.64E-02	---
Mattala	H-5	200.4	32	0.72	0.85	2.66E-02	
				---	6.77	2.12E-01	2.72E-04
	H-5(2)	52.5	45.7	6.98	9.45	2.07E-01	
				---	4.74	1.04E-01	5.74E-04
	JM06	38	30.5	0.09	0.03	1.08E-03	---
Tammennawewa	H-6	102	20	13.98	31.93	1.60E+00	---
				---	18.83	9.42E-01	1.23E-04
	JM05	35.97	21.34	1.03	1.14	5.34E-02	---
Sevanagala	M-1	200.4	48	0.23	0.06	1.27E-03	---
	M-1(2)	40.8	35	3.05	1.10	3.14E-02	---
	JM14	45	(34)	2.24	1.55	4.56E-02	---
Bodagama	M-2	200.2	32	0.31	0.10	3.13E-03	---
	M-2(2)	100	60	15.40	53.20	8.87E-01	---
				---	81.90	1.37E+00	3.23E-04
	JM09	25.17	21.12	3.09	1.89	8.95E-02	---
Badalkumbra	M-3	88.3	20	215.91	741.00	3.70E+01	---
	JM13b	24.7	(18.7)	3.50	(2.56)	1.37E-01	---
Yalabowa	M-4	195	36	0.73	0.58	1.61E-02	---
	M-4(2)	100	64	46.92	53.70	8.39E-01	---
				---	89.40	1.40E+00	1.87E-03
	JM12	34.69	(22.69)	2.49	1.73	7.62E-02	---

*; Estimated figures **; Test conducted with an observation well.

(o.h); Open Hole

The ranges of the estimated, or apparent, hydraulic conductivity of each aquifer are shown in the table below. Among three aquifer, lower aquifer shows highest range in hydraulic conductivity.

Hydraulic Conductivity



after Kashef, A.I, GROUNDWATER ENGINEERING, 1987,

(U. S. Bureau of Reclamation, Ground Water Manual, U.S. Department of Interior, Washington, 1977.)

CHAPTER 5 GROUNDWATER EVALUATION

5.1 GENERAL

The groundwater resources evaluation maps, *Figure 5.1(1), (2)*, were provided based on the hydrogeological map to contribute to the groundwater development plan.

5.2 GROUNDWATER POTENTIAL EVALUATION

5.2.1 YIELD

The results of test well drilling generally indicate that the boundary between the poor and the fair is about a yield of 50 litres/min and the boundary between the fair and the good is about a yield of 100 litres/min. Therefore this classification of the yield was used to make the hydrogeological map and the groundwater resources evaluation map.

5.2.2 WATER QUALITY

Electric conductivity (EC) is an important representative factor of water quality. According to the water quality standards for drinking water in Sri Lanka, the value of EC is divided into three classes:

- EC under 750 μS/cm, which is the maximum desirable level, is good for drinking.
- EC between 750 and 3500 μS/cm, which is the maximum permissible level, is fair for drinking.
- EC of 3500 μS/cm and over is poor, or not satisfactory, for drinking.

The hydrogeological map shows these boundary lines for EC. The value of EC is useful as the practical indicator of water quality, therefore the above classification is used to make the groundwater resources evaluation map.

5.2.3 DEPTH TO GROUNDWATER

The isobaths of groundwater depth are shown in the hydrogeological map. However, the depth to groundwater is mostly 25 *mbgl* and above in the Study area. Considering the practical pump performance, such range of the depth to groundwater is a less important factor for groundwater development. Therefore this factor was not used to make the groundwater resources evaluation map

5.2.4 GEOLOGICAL STRUCTURE

Geological structures such as a thrust zone and a fault zone concern the possible productivity of groundwater. The classification of the area yielding groundwater was modified from the viewpoint of geological structure.

5.2.5 PROMISING AREA FOR GROUNDWATER DEVELOPMENT

(1) Area Evaluation

The groundwater resources evaluation map was drawn in accordance with the distribution of groundwater yield and quality (EC). *Table 5.1* shows the combination of factors used in the groundwater resources evaluation map.

Table 5.1 Matrix of the Classification for the Groundwater Evaluation

			Yield (litres/min)		
			100 <	50 – 100	< 50
EC (μ S/cm)		Allotment Points	Good	Fair	Poor
			3	2	1
< 750	Good	2	**6**	**4**	**2**
750 - 3500	Fair	1	**3**	**2**	**1**
3500 <	Poor	0	**0**	**0**	**0**
			Weighting		

The evaluation is described as follows.

Weighting	Evaluation	Remarks
6	Very Good: (dark blue)	EC is good for drinking (**A**), and besides the yield is expected 100 litres/min and more. This volume is exploitable using a submersible pump.
4	Good: (blue)	EC is good for drinking (**A**) and the yield is expected from 50 to 100 litres/min. This volume is exploitable using a small submersible pump.
3	Good: (light blue)	EC is fair for drinking (**B**) and the yield is expected 100 litres/min and more.
2	Fair: (light green)	EC is fair for drinking (**B**) and the yield is expected between 50 and 100 litres/min, or EC is good for drinking (**A**) and the yield is expected 50 litres or less. This volume is exploitable by a hand pump.
1	Moderately Fair: (yellow)	EC is fair for drinking (**B**) and the yield is expected 50 litres/min or less.
0	Poor: (light brown)	EC is poor for drinking (**C**). As shown in Table 5.2, an area classified to this class may have a groundwater potential yielding 100 litres/min or more. It may be possible to use as a source for small scale industrial water or livestock water.

Note; **A** (less than 750 μS/cm)
B (750 – 3500 μS/cm)
C (more than 3500 μS/cm)

(2) Promising Area for Groundwater Development

The area evaluated as "Very Good" or "Good" on the groundwater resources evaluation maps is the promising area for groundwater development.