Assessment of Well-Log Characteristic of Tube Wells in Hilly Terrain of Cachar District of Assam

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Abstract—*Water is a necessity for the existence of the mankind and also essential for the human development and healthy functioning of eco- system. So, the present study was carried out to explore the existence of ground water of aquifers in hilly terrains of Assam University Silchar, Assam, India. The study area (Department of Agricultural Engineering located at 24°16´ N latitudes and 92°92´ E longitudes, 40.81 m Mean Sea Level) is surrounded by hillocks with small narrow foot hills. Four numbers of tube wells (2 at the foot hills and 2 at hill tops) were dug at four side of the study area using percussion method of drilling up to the maximum depth of 73 m from the ground surface of the study site (40.81 m MSL). The tube wells TW-1, TW-2, TW-3, and TW4 are positioned at 24°44´ N, 24°82´ N, 24°16´ N and 24°47´ N of latitudes; longitude of 92°61´E, 92°82´ E, 92°32´E and 92°92´E; and at Mean Sea Level (MSL) of 36.61 m, 19.69 m, 21.17 m and 29.14 m, respectively. The well logs of the tube wells were analysed by Boucyoucos hydrometer method to find out the depth wise well log characteristics with reference to ground surface and MSL. The aquifer layers (sand profiles) were found from 25-30 m, 55-57 m and 67-73 m MSL for TW-1; 36-37 m and 39-44 m MSL for TW-2; 30-34 m and 38-44 m MSL for TW-3; 15-18 m, 21-24 m and 57-68 m MSL for TW-4 in the study site. The study revealed the existence of aquifer profile of 38-44 m MSL at the foot hill and 62-71 m MSL at hill top where tube wells could be constructed to abstract ground water for different use. However, the water levels fluctuation and the quality parameters to be ascertained before recommending for portable and non-portable use.*

Keywords*: Aquifer, Assam, hilly terrain, tube wells, Boucyoucos hydrometer and well log.*

1. INTRODUCTION

Ground water is one of the most important and valuable resources in any parts of the country, which can be found naturally. Ground water supports in the field of irrigation, drinking and industries purpose. The fresh water estimated to be present on the earth, is about 22% exists as groundwater which constitutes approximately 97% of all liquid fresh water potentially available for human use [4]. Cachar district of Assam is located in the central parts of Barak valley on southern parts of Assam. It is bounded by North Latitudes 24°27´ to 25°08´ and East Longitudes 92°00´ to 95°15´. It covers an area of 3,786 sq. km. The district receives heavy annual rainfall of 387.45 cm. The maximum rainfall occurs during monsoon period between May to August. The district experiences a sub-tropical and humid climate. The temperature varies from 12°C in winter and 35°C in summer. The humidity varies from 32% maximum of 98% during July and October. The soil of the district varies from alluvial to lateritic in nature. Texture is generally clayey loam to clay. The river line tracts are found to be loamy to sandy loamy in nature. The hilly tracts are covered by lateritic soil. For sandy loam the porosity is varying from (32 to 40) % and 43% for clay soil [1, 5]. The average value of saturated hydraulic conductivity for sandy loam is 0.00142 cm/sec and clay is 0.0000146 cm/sec [6]. Analysis of subsurface soil is the promising tools to achieve the ground water study, and to classes the type of wells to be used and to determine the ground water availability that can extracted throughout the years from the wells.

2. MATERIALS AND METHODS

2.1 Study area

The study area is considered in Agricultural Engineering Departmental Farm surroundings of Assam University Silchar, Cachar district, Assam in India. It is located in the southern part of the Assam.

2.2 Details of experimental site

In order to assess the location of the tube wells, topographical land survey was carried out using standard surveying instruments Global Positioning System (GPS). The experimental site is selected in Department of Agricultural Engineering, Assam University, Silchar. The study area in hilly terrain of Assam University has a total area of 968.28 m^2 with a latitude of 24°44´ N to 24°16´ N and a longitude of 92°61´E to 92°92´E with an altitude of 40.81 m above MSL. Four tube wells and method of monitoring are selected based on availability and requirement. Soil samples and water samples of four tube wells were collected. Each tube wells is

having different depth. The location of the experimental site is shown in Fig. 1.

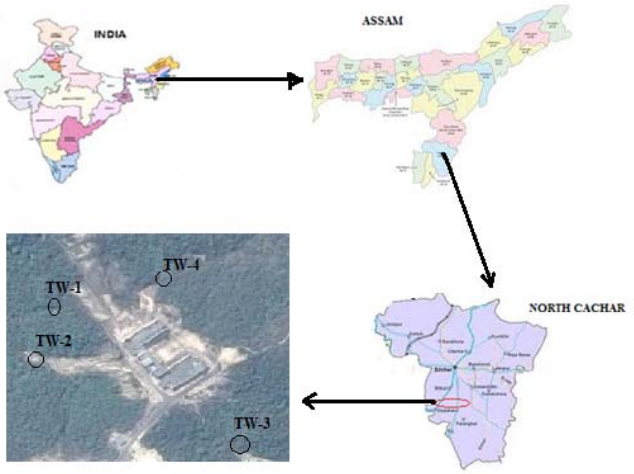

Fig. 1: Layout of the study site.

2.3 Analysis of well-log profile

2.3.1 Sampling

The soil samples were collected from four tube wells after every 1 m and 3 m depth and used for analysis of soil texture as per standard methods [2, 3].

2.4 Experimental approach

The soil samples were tested based on the Boucyoucos hydrometer method. The soil samples from the tube wells were collected by the method of percussion during boring of the tube wells. The soil samples were kept separately according to their depth for textural analysis. The characterization of the tube wells is shown in Table 1.

Table 1: Detailed information of installed tube wells

Well no.	Well dia. (cm)	Drilled depth (m)	MSL from reference point (m)	Strainer length (m)	Blind pipe at bottom (m)
TW-1	15	69	36.605	6	6
TW-2	15	23	19.684	5	2
TW-3	15	24	21.17	Rock layer	2
TW-4	15	57	29.135	8	4

2.4.1 Soil texture

Soil texture is determined by the relative proportion of the three kinds of soil particles (sand, silt, and clay). Soil texture is a word used to describe how soil feels and it refers to relative portion of the soil separates in a specific layer of the soil. The triangle texture is used to determine the textural classes of the soil belongs to base on the specific amount of sand, silt, and clay contains [2, 3]. The minerals in the soil are divided into the following size and classes shown in Table 2.

Table 2: Sizes of the soil particles

Types of soil	Sizes of the soil particles
Coarse fragments (Gravels, Cobbles and Stones)	Larger than 2 mm
Sand	0.05 to 2 mm
Silt	0.002 to 0.05 mm
Clay	Smaller than 0.002 mm

2.4.2 Method of soil textural analysis

The soil samples were dried in oven or in the sun light and sieved (through a 2 mm opening sieve) soil sample were weighed and soaked overnight in a beaker containing 50 ml of Sodium hexametaphosphate solution (50g in 1000 ml dist. H_2O) and 100 ml of dist. H_2O. The samples were dispersed in suspension by transferring it from the beaker to 1 litre mixing cup and then stir with an electric stirrer for 15-20 min. The mixed suspension was then transferred to a special measuring cylinder. The volume of the suspension was made up to 1000 ml by adding dist. H_2O. The soil sample was then plunged 10 times with a plunger and (start stop watch immediately) the sample was allowed to stand for 40 sec. Before 40 sec., the hydrometer was immersed and the reading was taken at 40 sec. and temperature at that time was noted. (The hydrometer is always immersed slowly in the suspension, approximately 10 sec. before each reading and removed it immediately and slowly; each reading is followed). The readings were taken at a temperature of about 28-32˚C. The same sample was allowed to stand for 2 hours and then reading at 2 hours was noted down. The density of the blank solution of sodium hexametaphosphate was measured by making the volume of the solution up to 1000 ml mark, in the cylinder [2, 3].

Sand, silt and clay percentage were calculated and texture was determined with the help of the USDA textural classification triangle.

3. RESULTS AND DISCUSSION

3.1 Tube well 1 (TW-1)

The tube wells TW-1, positioned at 24°44´ N of latitudes; longitude of 92°61´E; and at Mean Sea Level (MSL) of 36.61 m, respectively.

In TW-1, the maximum layer of the well is covered by a mixture of soil samples such as silt loam, clay and loam up to 21 m. The loam and silt soil concentration is more observed. The aquifer layers (sand profiles) were found from 25-30 m, 55-57 m and 67-73 m MSL for TW-1. The mean sea level of TW-1 is elevated 4.2 m below reference point Fig. 2. The sub-merssible pump is placed in the wells to abstract ground water continuously throughout the year.

3.2 Tube well 2 (TW-2)

The tube wells TW-2, positioned at 24°82´ N, of latitudes; longitude of 92°82´ E, and at Mean Sea Level (MSL) of 19.69 m, respectively. In TW-2, the silt loam is observed up to the depth of 12 m below the ground level. The variation of the soil is seen after 12 m. The aquifer layers (sand profiles) were found from 36-37 m and 39-44 m MSL for TW-2. The mean sea level of TW-2 is elevated 21.12 m below reference point Fig. 2. The sub-merssible pump is placed in the wells to abstract ground water continuously throughout the year.

3.3 Tube well 3 (TW-3)

The tube wells TW-3, positioned at 24°16´ N of latitudes; longitude of 92°32´E and at Mean Sea Level (MSL) of 21.17 m, respectively. In TW-3, the top layer of the soil is covered by sand. The concentration of sand soil is more, which indicate that the percolation, permeability and hydraulic conductivity will be high. The aquifer layers (sand profiles) were found from 30-34 m and 38-44 m MSL for TW-3. The mean sea level of TW-3 is elevated 19.64 m below reference point Fig. 2. The sub-merssible pump is placed in the wells to abstract ground water continuously throughout the years.

3.4 Tube well 4 (TW-4)

The tube wells TW-4 are positioned at 24°47´ N of latitudes; longitude of 92°92´E; and at Mean Sea Level (MSL) of 29.14 m, respectively. In TW-4, the sand layer is obtained in three layer, where two can be considered as the semi-aquifers of the area. The aquifer layers (sand profiles) were found from 15-18 m, 21-24 m and 57-68 m MSL for TW-4. The mean sea level of TW-4 is elevated 11.67 m below reference point Fig. 2. The sub-merssible pump is placed in the wells to abstract ground water continuously throughout the years.

According to the present study of soil in the well log, the containing of sand layer in the well from the very beginning, indicate the partial movement of water in the upper layer of the area. Thus, it indicates that the rapid infiltration, percolation, permeability and hydraulic conductivity of the area. In this well the large variation of the soil is not observed. However, the depths of sand layers were observed in between (2 foot hill and 2 top hill) wells are shown in Fig. 2.

3.5 Layout of the geological log profile of the tube wells

Based on the soil texture analyzed the type of soil present in the tube wells with their depth and the geological log profile of each wells were represented with a diagram. The well logs of the tube wells were analyzed by Boucyoucos hydrometer method to find out the depth wise well log characteristics with reference to ground surface and MSL. The aquifer layers (sand profiles) were found from 25-30 m, 55-57 m and 67-73 m MSL for TW-1; 36-37 m and 39-44 m MSL for TW-2; 30-34 m and 38-44 m MSL for TW-3; 15-18 m, 21-24 m and 57-68 m MSL for TW-44 in the study site. The location of (TW-1 and TW-2) is towards south-west direction and (TW-1 and TW-4) is towards north-east direction from the reference point. The textural analyzed of the soil samples gave an idea to predict the ground water level in the studied site, by the help of different type of soil available in the area. The details of the soil presence in each tube wells based on their depth variation is shown in Fig. 2.

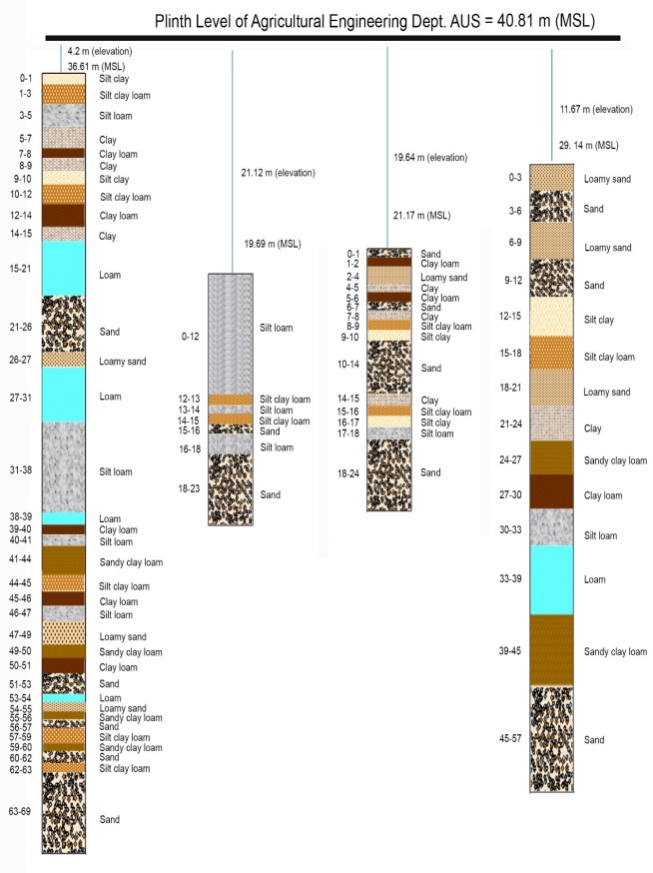

Fig. 2: Geologic log profile of tube wells 1, 2, 3, and 4.

3.6 Comparison study of well-log profile in tube wells

The study of well-log profile of two tube wells were compared based on their availability of (sand, silt and clay) % in USDA soil textural analysis Fig. 3 and 20 m gap were maintained below reference point to the top surface of the tube wells. According to that comparison study of TW-2 and TW-3 in study site sandy loam was obtained from 32-34 m and sand layer were observed from 40-44 m below reference point shown in Table 3.

Table 3: Comparison of soil types in underground geologic-log profile of tube wells (TW-2 and TW-3)

Depth from the soil surface (m)	% Clay	% Silt	% Sand	Textural Class
0-1	8.05	36.95	55.00	Sandy loam
1-2	19.00	63.00	18.00	Silt loam

2-3	9.40	43.60	47.00	Loam
3-4	7.00	42.05	51.00	Loam
4-5	36.00	58.00	16.00	Silt clay loam
5-6	20.00	62.00	18.00	Silt loam
6-7	7.00	38.56	54.50	Sandy loam
7-8	41.67	46.67	11.67	Silt clay
8-9	21.67	59.67	18.67	Silt loam
9-10	31.67	55.67	12.67	Silt clay loam
10-11	8.99	37.01	54.00	Sandy loam
11-12	25.50	56.67	17.84	Silt loam
12-13	13.00	33.04	54.00	Sandy loam
13-14	6.99	40.08	53.00	Sandy loam
14-15	25.00	45.00	30.00	Loam
15-16	21.00	63.00	16.00	Silt loam
16-17	25.00	23.67	51.33	Sandy clay loam
17-18	26.00	49.00	25.00	Loam
18-19	6.00	34.01	60.00	Sandy loam
19-20	3.99	2.10	93.99	Sand
20-21	3.99	1.01	95.00	Sand
21-22	3.99	1.07	95.00	Sand
22-23	3.99	1.08	95.00	Sand
23-24	3.99	4.01	92.00	Sand

Similarly, well-log profile of two tube wells were compared based on their availability of (sand, silt and clay) % in USDA soil textural analysis The comparison study of TW-1 and TW-4, sandy loam were observed from 10-26 m below reference point and sand layer were observed from 68-73 m below reference point shown in Table 4.

4. CONCLUSIONS

The study well-log soil samples revealed the existence of aquifer profile of 38-44 m MSL at the foot hill and 62-71 m MSL at hill top where tube wells could be constructed to abstract ground water for different use. However, the water levels fluctuation and the quality parameters to be ascertained before recommending for portable and non-portable use. The ground water flow direction is toward north direction. Since the type of soil available in the tube wells indicate the ground water availability and gave an idea to predict the aquifer in any hilly terrains related to same characteristics of Cachar District of Assam.

Table 4: Comparison of soil types in underground geologic-log profile of tube wells (TW-1 and TW-4)

Soil depth from reference point (m)	Clay %	Silt %	Sand %	Textural Class
0-1	36.00	30.00	34.00	Clay loam
1-2	28.00	40.00	32.00	Clay loam
2-3	18.00	58.00	24.00	Silt loam
3-4	12.00	52.00	36.00	Silt loam
4-5	14.00	50.00	36.00	Loam
5-6	3.90	26.10	70.00	Sandy loam
6-7	3.90	22.10	74.00	Sandy loam
7-8	20.00	52.00	28.00	Silt loam
8-9	8.67	24.00	67.34	Sandy loam
13-16	12.90	31.84	55.27	Sandy loam
16-19	15.67	22.67	61.67	Sandy loam
19-22	11.95	19.72	68.34	Sandy loam
22-25	24.67	20.00	55.34	Sandy clay loam
25-28	20.35	8.00	71.65	Sandy clay loam
28-31	14.67	40.00	45.34	Loam
31-34	30.67	38.34	31.00	Loam
34-37	22.67	38.00	39.34	Loam
37-40	31.34	31.34	37.33	Clay loam
40-43	20.67	34.67	44.67	Loam
43-46	22.67	47.00	30.34	Loam
46-49	16.67	44.00	39.34	Loam
49-52	16.67	24.00	59.34	Sandy loam
52-55	16.85	35.15	48.00	Loam
55-58	16.17	21.00	62.83	Sandy loam
58-61	13.50	18.35	68.15	Sandy loam
61-64	4.90	5.00	90.10	Sand
64-67	4.30	5.70	90.00	Sand
67-69	3.90	5.10	91.00	Sand

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