केंद्रीय भूमि जल बोर्ड
जल संसाधन, नदी विकास और गंगा संरक्षण
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भारत सरकार
Central Ground Water Board
Department of Water Resources, River
Development and Ganga Rejuvenation,
Ministry of Jal Shakti
Government of India

AQUIFER MAPPING AND MANAGEMENT OF GROUND WATER RESOURCES

DHALAI DISTRICT, TRIPURA

उत्तर पूर्वी क्षेत्र, गुवाहाटी
North Eastern Region, Guwahati

GOVERNMENT OF INDIA
MINISTRY OF WATER RESOURCES, RIVER DEVELOPMENT & GANGA REJUVENATION
CENTRAL GROUND WATER BOARD

REPORT
ON
"AQUIFER MAPPING AND MANAGEMENT PLAN OF DHALAI DISTRICT, TRIPURA"
(AAP 2016-17)

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1. INTRODUCTION

Central Ground Water Board, North Eastern Region has carried out Aquifer mapping and management plan in Dhalai district, Tripura during AAP 2016-17 covering **1079 sq.km** out of total geographical area of **2314** sq.km. Under National Aquifer Mapping and Management (NAQUIM) program, combination of geologic, geophysical, hydrologic and hydro chemical information is applied to characterize the quantity, quality and sustainability of ground water aquifers. Systematic aquifer mapping will improve our understanding of the geologic framework of aquifers, their hydrogeologic characteristics, quality and also quantifying the available ground water resources potential and proposing plans appropriate to the scale of demand and the institutional arrangements for management. Aquifer mapping at the appropriate scale can help prepare, implement and monitor the efficacy of various management interventions aimed at long-term sustainability of our precious ground water resources, which, in turn, will help achieve drinking water security, improved irrigation facilities and sustainability in water resources development.

1.1 Objectives:

The objectives of this project are to understand the aquifer systems up to 200 m depth, to define the aquifer geometry, type of aquifers, ground water regime behaviors, hydraulic characteristics and to establish groundwater quantity, quality, and sustainability and to estimate the dynamic and static resources accurately through a multidisciplinary scientific approach on 1:50,000 scale and finally formulate a complete, sustainable and effective management plan for ground water development.

1.2 Scope of the Study:

The activities of the Aquifer Mapping and Management Program can be envisaged as follows:

1. Data Compilation & Data Gap Analysis: One of the important aspect of the aquifer mapping programme was the synthesis of the large volume of data already collected during specific studies carried out by Central Ground Water Board and various Government organizations with a new data set generated that broadly describe an aquifer system. The data were assembled, analysed, examined, synthesized and interpreted from available sources. These sources were predominantly non computerized data, which was converted into computer based GIS data sets. On the basis of available data, Data Gaps were identified.

2. Data Generation: There was also a strong need for generating additional data to fill the data gaps to achieve the task of aquifer mapping. This was achieved by multiple activities such as exploratory drilling, geophysical techniques, hydro-geochemical analysis, remote sensing, besides detailed hydrogeological surveys to delineate multi aquifer system; to bring out the efficacy of various geophysical techniques and a protocol for use of geophysical techniques for aquifer mapping in different hydrogeological environs.

3. Aquifer Map Preparation: On the basis of integration of data generated from various studies of hydrogeology & geophysics, aquifers have been delineated and characterized in terms of quality and potential. Various maps have been prepared bringing out Characterization of Aquifers, which can be termed as Aquifer maps providing spatial variation (lateral & vertical) in reference aquifer extremities, quality, water level, potential and vulnerability (quality & quantity).

4. Aquifer Management Plan Formulation: Aquifer Maps and ground water regime scenario will be utilized to identify a suitable strategy for sustainable development of the aquifer in the area.

1.3 Approach and Methodology: Aquifer mapping has been carried out by adopting a multi-disciplinary approach:

(i) Geophysical Surveys through Vertical Electrical Sounding (VES),

(ii) Exploratory drilling and construction of tube wells tapping various groups of aquifers,

(iii) Ground Water Regime monitoring by establishing monitoring wells tapping different aquifers at different depths for long term monitoring of water level and quality,

(iv) Pumping test, soil infiltration test, specific yield determination, slug tests for determination of ground water recharge scope, intensity and potentials and also to determine the characteristics and performances of existing aquifers at various depths

(v) Collection of various relevant technical data from the field in Dhalai district and also from the concerned State Govt. Agencies and other Institutes dealing with ground water and incorporating these data along with CGWB data for final output.

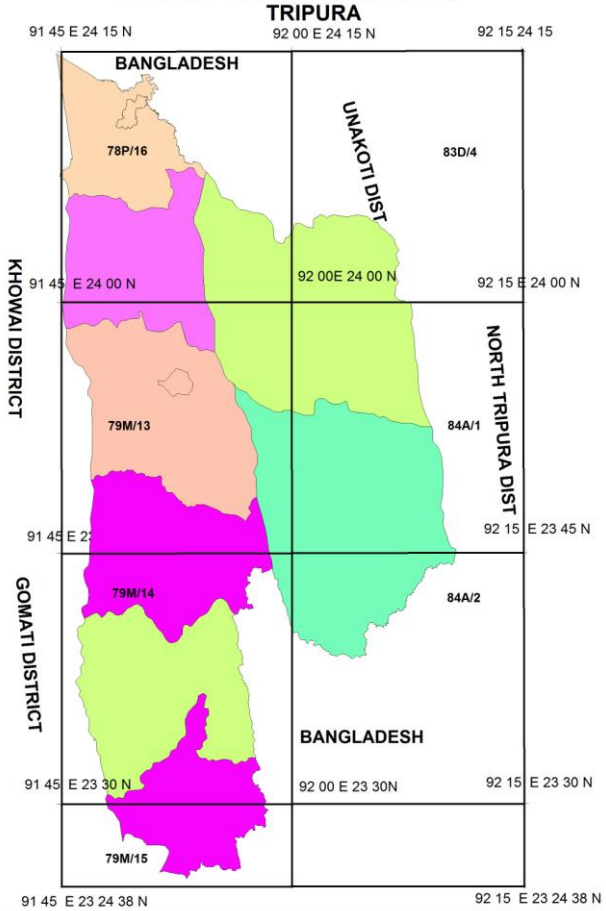
(vi) Preparations of a micro level mapping of existing aquifers, their potentials depth wise and sideways in 2D and 3D forms viewed from different angles by various GIS Layers.

1.4 Area Details:

Aquifer mapping and management programme has been taken up during Annual Action Plan 2016–17 in Dhalai district covering Salema, Durgachaumuhani, Ambasa, Ganganagar, Manu, Chamanu, Dumburnagar and Raishyabari blocks in order to delineate the available aquifers. The district headquarter is at Ambasa. As per Census 2011, the district is having a total population of 3,78,230 dominated by SC, ST and OBCs.

The district confined within North Latitudes $24^0 15'$ and $23^0 24' 38''$ and East Longitudes of $91^0 45'$ and $92^0 15'$. The area is falling mainly and partly in Survey of India Toposheets bearing nos. 78P/16, 79M/13, 79M/14, 79M/15, 83D/4, 84A/1, 84A/2 and is bounded by international boundary of Bangladesh in North and South, by North Tripura District in the East and by Khowai and Gomati in the west.

FIG 1. MAP OF DHALAI DISTRICT, TRIPURA

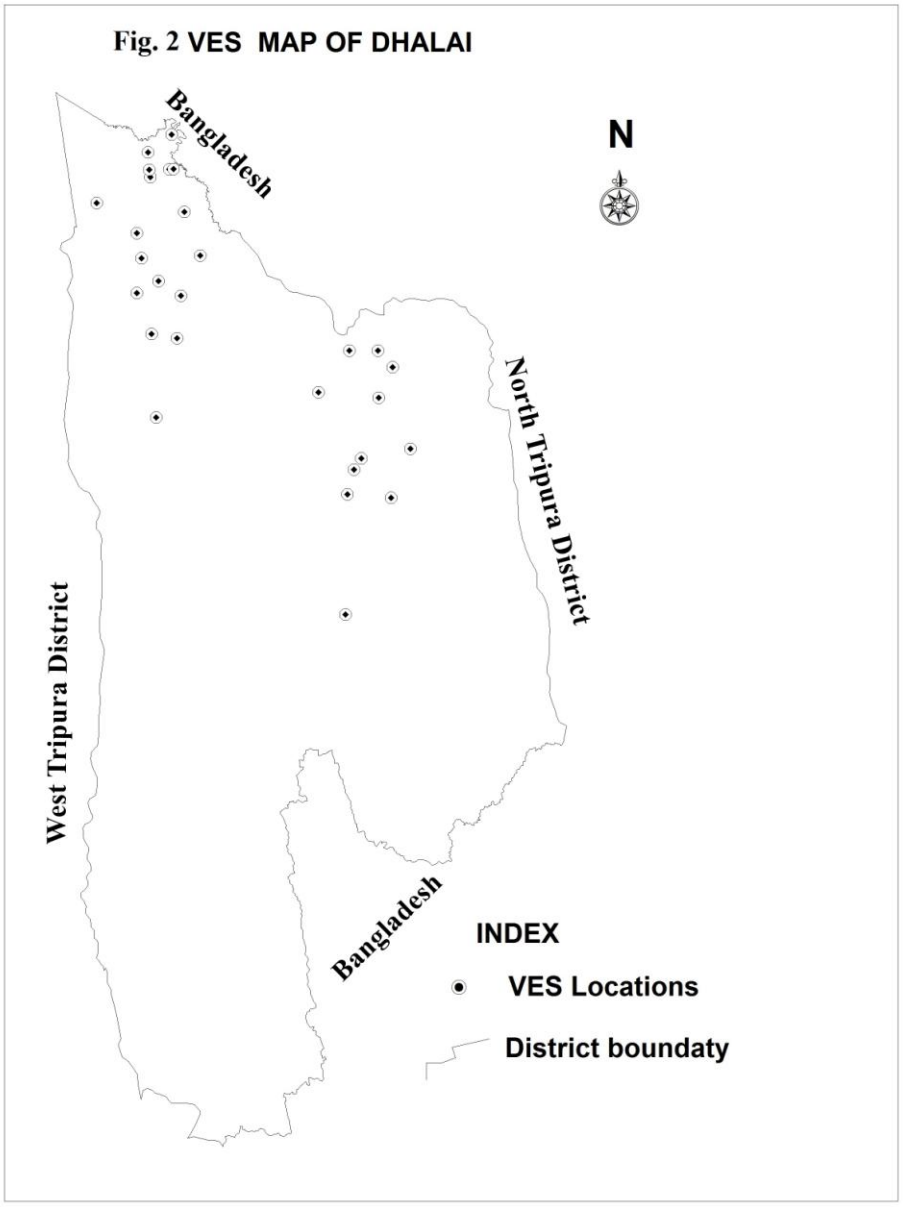


1.5 Data Availability & Data Adequacy before conducting Aquifer Mapping:

Hydrogeological, geophysical and ground water exploration data available in the district are as follows:

- **Exploration Data**: CGWB has constructed 8 (Eight) exploratory wells and 2 (Two) Observation wells in the Dhalai district. Details of these drilling operations, aquifer parameters are furnished in the Annexure 2. State govt. has also drilled about hundreds of tube wells in the district.

- **Geophysical Survey (VES) Data**: Neither CGWB nor the State Govt. departments have conducted any VES survey in this district till 2015. However, CGWB had carried out 28 (Twenty Eight) VES survey during 2015-16.



- **Ground Water Level Monitoring Data:** CGWB has 7 (Seven) GWM wells which were monitored 4 times in a year. State ground water user departments, viz., PWD (WR), PWD (DWS) do not have any monitoring station.

- **Ground Water Quality Monitoring Data**: CGWB collects water samples from 7 GWM wells and carried out chemical analysis in its regional laboratory at Guwahati.

1.6 Data Gap Analysis & Data Generation:

1.6.1 Data Gap Analysis:

➢ **Exploration Data Gap :**

CGWB, NER has constructed 8 (Eight) exploratory well and 2 (Two) Observation wells in the said district. CGWB has not constructed any well in Gandacherra valley.

➢ **VES and Profiling Data Gap :**

Data gap related to Resistivity Surveys i.e., VES and Profiling was extended over the whole Dhalai district containing parts of the Toposheets Nos. 78P/16, 79M/13, 79M/14, 79M/15, 83D/4, 84A/1, 84A/2 as no such Geophysical survey had ever been carried out by CGWB or by any State Govt. Departments in any of the quadrants.

➢ **Ground Water Level Monitoring Data Gap :**

Only 7 (Seven) GWM wells were established in the district. No monitoring station located in Chawmanu and Gandacherra valleys.

➢ **Ground Water Quality Monitoring Data Gap:**

Generally, water samples were collected and analyzed from all the 7 (Seven) GWM wells falling in the district. More wells are to be established to minimize the gap.

1.6.2 Recommendation on Data Generation:

The following quantity of various kinds of data had been suggested to be generated:

➢ **Recommendation for VES and Profiling:**

From the data gap analysis it appears that 28 nos. of VES are required mainly to ascertain the depth and thickness of the individual aquifers as per the recommended norms of additional data generation. Thus a total 36 numbers of VES with a maximum electrode separation (AB) preferably ranging from 500 to 900 meter were recommended for geophysical data generation.

1.7 Physiography:

Physiographically, the area can be divided into two parts, viz., Anticlinal Hill Ranges and Synclinal flat bottomed valleys.

The important hill ranges are Atharamura, Langtarai and Sakhantlang. These hill ranges are tightly folded and trending almost N - S. The height of the hill ranges gradually decreases towards west. The hills are covered with thick forest cover.

The broad synclinal valleys occurring in the district are;

(1) Kamalpur valley

(2) Gandacherra valley and

(2) Manu valley

Kamalpur and Gandacherra valley is situated between Atharamura and Langtarai hill ranges. Manu valley is situated between Langtarai and Sakhantlang hill ranges and it is the southern part of Kailashahar valley of North Tripura district. The Kamalpur and Manu valley slopes towards north and Gandacherra valley slopes towards south. Both the valleys are gently undulating with intermittent flood plains of rivers and streams. The undulated 10 - 30 m high mounds with gullies in between them are locally called "loongas." These valleys are the major areas for human activities

1.8 Geomorphology:

Geomorphologically, the area can be defined as a second order morpho-structural land system similar to that of "**Ridge and Valley Province**" of USA. The erosional and depositional units of land system are confined mainly to the structural valleys. Genetic geomorphological map by GSI enables recognition of 3 genetic types of landform units : (i) units of structural origin, (ii) units of denudational origin and (iii) units of fluvial origin, which can be shown in relation to their bedrock geology and structural pattern.

Units of structural origin characterize the structural pattern of folded rock bodies and include features occurring only in anticlinal hill ranges. Units of denudational origin are confined to structural valleys, where erosional processes predominate, developing an eroded topography, represented by residual hillocks/mounds and an incised net of stream beds. Incised stream beds form the conspicuous geomorphic feature of valley landscape partly filled by alluvial materials derived from adjacent hill slopes. Units of fluvial origin include only the flood plains of major rivers confined to the flat part of structural valleys.

There are two fundamentally different landform domains : **(i) Neogene Fold Ridges**, which constitute the roughly N-S aligned anticlinal ridges with rounded to nearly flat top; (ii) **Terraced alluvial terrain**, on the basis of characteristic relief, slope, degree of dissection, soil character, landform assemblage and nature of alluvial fill, is again divisible into three groups in chronological order : **(1)** table lands (tilla lands) and rolling mounds formed by the Upper Pleistocene terraces characterized by maximum dissection, drainage density and weathering; **(2)** low lands ('loonga') of Holocene terrace comprising stabilized, un-dissected, high flood plains; **(3)** recent flood plains constituting the present-day flood-prone belts fringing the rivers. 3 distinct physiographic zones i.e. terrains are **(i)** N-S Hill Ranges, **(ii)** Undulating Plateau Land and High Lands **(iii)** Low lying Alluvial Plains on valleys.

1.9 Land Use:

Land use data for 2014-15 of the district shows that net sown area is only about 9% and forest area is 80% of the total geographical area. Land use data for 2014-15 has been shown in Table 1.1.

Table 1.1: Block wise land utilization of the Dhalai district (as on 2013)

Sl. No.	Items			Land Classification Area in Ha
1	District			Dhalai
2	Geographical Area			231394
3	Reporting area for land utilisation Statistics **(col 4+7+11+14+15)**			231394
4	Forest			185940
5 (a)	Not available for cultivation	Area under non-Agri cultural uses	Water logged land	NA
5 (b)			Social Forestry	NA
5 (c)			Land under still water	NA
5 (d)			Other land	NA
5 (e)			Total (col. 5a to 5d)	NA
6		Barren & unculturable land		NA
7		**Total (clo 5e + 6)**		**22589**
8	Other uncultivated land excluding Fallow Land	Permanent pastures & other grazing land		170
9		Land under mosc.tree crops & groves (not incl.in net area sown)		1319
10		Culturable waste land		273
11		**Total (clo 8 + 9 + 10)**		**1762**
12	Fallow Land	Fallow lands other than current fallows		647
13		Current fallows		241
14		**Total (clo 12 + 13)**		**887**
15	**Neat Area Sown**			**20216**
16	**Total cropped Area**			**37697**
17	Area sown more than once **(clo 16-15)**			17481

1.10 Soil:

In general, soils of the area are acidic in nature. The pH of soil ranges from 4.50 to 6.5. Nitrogen and phosphate in the soils is low, available potash is medium to high, and calcium, magnesium, sulphur are deficient in these soils.

The soils of Dhalai district have been developed on many types of rock formations. The humid subtropical climate of the district has helped high rate of chemical weathering leading to different kinds of soils. The soils of the district can be classified in to two major groups on the basis of their origin, namely, residual soils and transported soils. These soils are further sub divided into four broad groups; they are 1) Reddish yellow brown sandy soils, 2) Red loam and sandy soils, 3) Older alluvial soils and 4) Younger alluvial soils.

i) Reddish yellow brown sandy soils: The soils are residual in nature, and occurred on the north south oriented hill ranges, crowned with lush ever green tropical forests.

ii) Red loam and sandy soils: These soils are also residual in nature and are generally associated with the intermountain valleys and under undulating uplands.

iii) Older alluvial soils: These soils are generally transported, but fairly matured in nature. These soils are situated on the river terraces and high plains in the district. This type of soils is fairly rich in the nutrient salts.

iv) Younger alluvial soils: These soils are mainly confined to the flood plains of the Dhalai and Khowai rivers. These soils generally comprise of clay loam and highly suitable for agriculture.

1.11.1 Irrigation Projects: Major, Medium and Minor

Agriculture in the Dhalai district is dependent mostly on minor irrigation schemes. There is no major irrigation project in the area. One medium irrigation project near Nalkata on Manu river is under progress. Most of the minor irrigation projects depend on surface water sources. Amongst all minor irrigation projects the most important type is lift irrigation projects. There is around 184 lift irrigation projects are there in the district.

Rural Development Department, Govt. of Tripura constructs sluice gates, pick up weirs, permanent bund across cherras / streams to arrest water and supports irrigation. Farmers also construct permanent or seasonal bund across cherras / nalas/ streamlets to collect the water and cater for irrigation through pump sets.

Table 1.2: Structure wise Irrigation Potential Created by PWD (WR) and Potential Utilisation (as on March 2013)

Potential Created (ha)					Total Potential Created (ha)	Net Potential Utilised (ha)
Lift Irrigation (LI + HPLI)	DTW	Diversion	Medium Irrigation	Low/High Pickup Weir		
5941	113	652	1027	26	13208	10228

Table 1.3: Block wise Nos. of different Irrigation Structures and Irrigation Coverage Area (ha) (as on March 2013)

Block	Lift Irrigation (LI)	High Power Lift Irrigation (HPLI)	Diversion	Low & Medium Pick-up Weir	Deep Tube Well	Small Bore TW/ Mini Deep TW (80 - 100 m)	Shallow Tube Well
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Salema	37 (1122)	---	2 (180)	---	1 (40)	41 (113)	0 (0)
Durga Chaumuhani	47 (1466)	2 (158)	5 (272)	---	---	15 (41)	0 (0)
Ambasa	34 (1132)	---	1 (200)	---	1 (25)	33 (91)	10 (97)
Chawmanu	8 (260)	---	---	---	---	2 (6)	0 (0)
Manu	36 (1265)	---	---	Medium (683)	1 (30)	10 (28)	0 (0)
Dumburnagar (Gandacherra)	22 (538)	---	---	---	1 (20)	10 (27)	0 (0)
DHALAI district	**184 (5783)**	**2 (158)**	**8 (652)**	**1 (683)**	**4 (113)**	**111 (306)**	**10 (97)**

1.11.2 Ponds, Tanks and other Water Conservation Structures: There are thousands of small ponds available in entire part of the study area. These ponds are used mainly for fish cultivation and also used for domestic purpose like washing, bathing, water for cattle's etc. But rarely these ponds are used for irrigation purpose because these ponds do not have much water during dry periods. There are around 20 irrigation tanks in the district. The forest, Agricultural, rural development departments, Block development offices, Dhalai district have constructed many rain water harvesting structures like ponds, check dams, Bunds etc

1.12 Drainage: Dhalai River originates from the Dolajari peak of Longtarai range and passes through Ambasa, Salema and Kamalpur towns in northern direction and enters Bangladesh. The Dhalai basin lies in between Atharamura anticline in the west and Longtarai anticline in the cost. The general slope of the valley is to the north. It has a length of 117 km with a catchment area of 695 sq km**.** It is bounded by Manu-Deo basin in the east, By Bangladesh in the North and Khowai basin in the west and south. The drainage pattern is dendritic.

The Manu river originates from Kohoisibe peak in Sakhan Tlang and passes through the Kailasahar valley with flow due north. Manu, and Chawmanu are importants towns in this basin. It is bounded by Jampui hills in the east (Longai basin) By Dhalai basin in the west , by Bangladesh in the south, by Khowai basin. The total catchment of the basin is 1979 sq.km. and falls in North Tripura and Dhalai districts. The Deo River originates in the Jampui hills, flows in the northern direction up to Petcharthal and then turns west, cuts through Sakhan Tlang range and joins the Manu river, Deo south of Fatikcherra, near Fatikrai. It is separated from the Juri river basin by water divides around Kachubari, which nearly coincides with the 24^{o} $12^{/}$ latitude.

The general slope of the valley is towards north and it also widens in the same direction. The river Manu with its tributary Deo forms the main drainage system of the valley and flows from south to north.

Khowai river originates in Longtarai hill ranges and cutting across Atharomura hill range about 3 km east of Teliamura town and flows through Khowai valley in northern direction and entrance Bangladesh about 1 km north of Khowai town. The total catchment of the basin is 1378 km^2 and falls in west Tripura and Dhalai districts. It is bounded by Dhalai basin in the east, Howrah basin in the west, Gumti basin in the south and Bangladesh in the north.

The synclinal valley of Khowai lies in between the Atharamura and Baramura anticlines. It covers an area of about 630 sq. km. The general slope of valley is northward and it also widens in the same direction. The river Khowai and its tributaries drain the valley.

Gomati river originates in Longthrai hills and flows into South Tripura district. It is found that every year the river show peak discharge (in a single day) between May to July and the lowest discharge (in a single day) is recorded during the months of March & April.

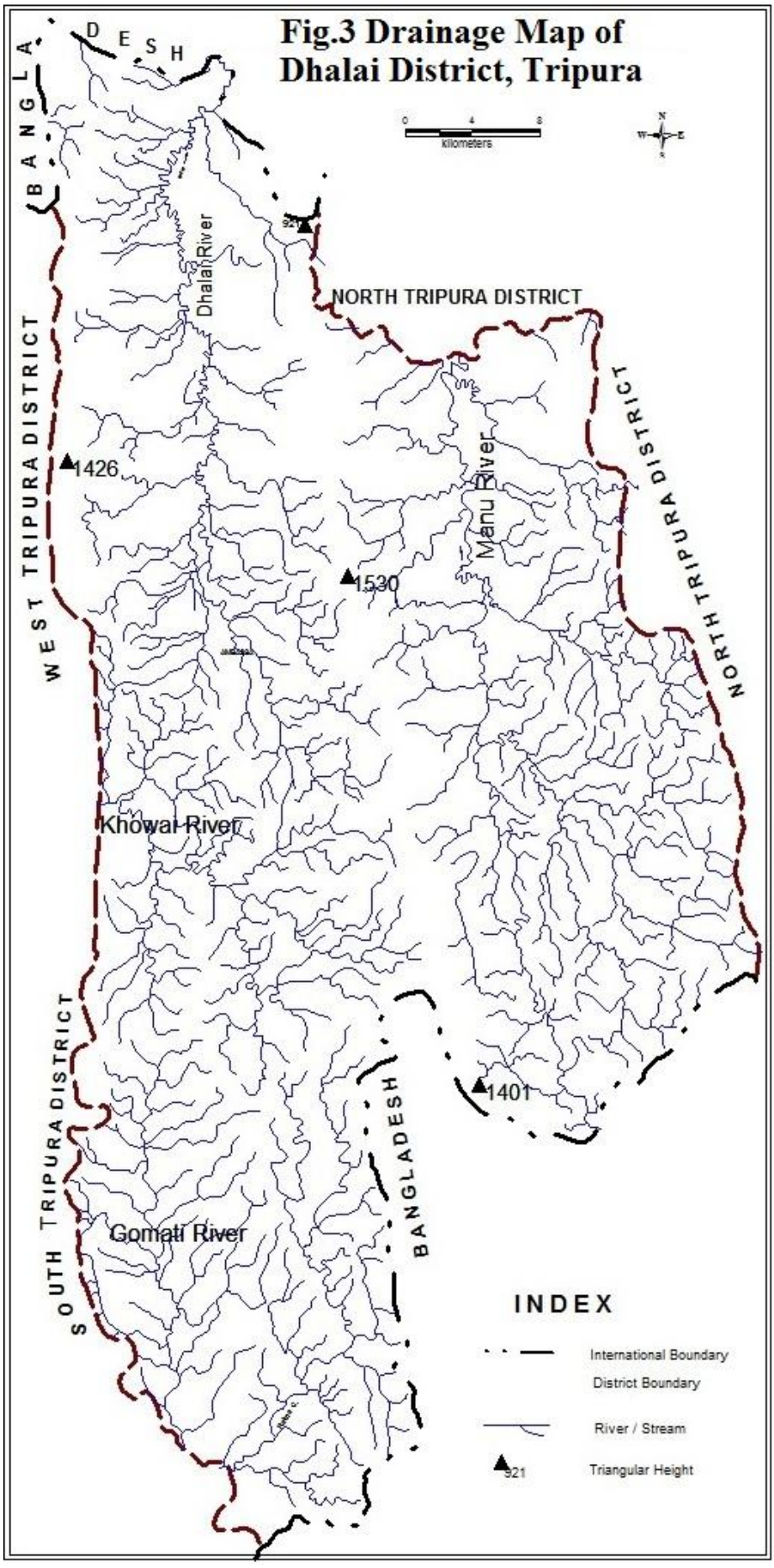


Fig.3 Drainage Map of
Dhalai District, Tripura
BANGLADESH
WEST TRIPURA DISTRICT
NORTH TRIPURA DISTRICT
SOUTH TRIPURA DISTRICT
BANGLADESH
Dhalai River
Manu River
Khowai River
Gomati River
1426
1530
1401
kilometers
INDEX
International Boundary
District Boundary
River / Stream
Triangular Height

1.13 Agriculture:

Agriculture in Dhalai district depends mainly on the timely monsoon. Fertile soils of the valleys and the abundant rainfall are very conducive to growing of better-quality agricultural and horticultural crops. Net area under agriculture (net area sown) is **20216** ha (in 2014-15), which is 8.7 % of total geographical area (**231394** ha).

Economy of the area is basically agrarian and about 55 % of the population is dependent on agriculture and allied activities for their livelihood as agricultural work is the single largest provider of employment to the rural people of Dhalai district. Favorable agro-climatic conditions, fertile soils, sub-tropical climate with pockets of temperate zones, large 'tilla' lands and high rainfall also promotes growing of horticultural plants like fruits, vegetables, spices, floriculture, medicinal and aromatic plants etc.

People cultivate on high hill slopes by practicing traditional '**JHUM'** process (shifting cultivation) to grow mainly rice in the monsoon.

The main crop is paddy; all three i.e. summer paddy (Aus), monsoon paddy (Aman) and winter paddy (Boro) are being raised, which are followed by maize, wheat, mesta, jute, cotton, pulses and oilseeds. Over a limited area cashew nut and pineapple are also grown. Rubber and tea plantations are also seen in a large scale on small mounds and foothills.

Table 1.4: Principal Crop Area (Ha), & Yield (Kg/Ha or Bales/Ha), 2013-14

Agricultural Sub-Division	Aush Paddy		Aman Paddy		Boro Paddy		'Jhum' Paddy		Maize		Wheat		Khariff Pulses		Rabi Pulses	
	A	**Y**	**A**	**Y**	**A**	**Y**	**A**	**Y**	**A**	**Y**	**A**	**Y**	**A**	**Y**	**A**	**Y**
Chamanu	2830	2275	5320	2630	132	2720	2661	953	287	1115	1	2000	463	652	56	56
Salema	6650	2651	8894	3036	615	2977	1900	928	308	1344	95	1989	307	664	185	185
Gandacherra	461	2382	768	2421	246	2439	1374	1267	228	1105	0	0	211	602	51	51
Total	9941	7308	14982	8087	993	8136	5935	3148	823	3564	96	3989	981	1918	**292**	**292**

Agricultural Sub- Division	Sesamum		Khariff Ground Nut		Rabi Ground Nut		Reap & Mustard		Jute (P : Bales) (Y : Bales/Ha)		Mesta(P: Bales) (Y : Bales/Ha)		Cotton (P : Bales) (Y : Bales/Ha)	
	A	**Y**	**A**	**Y**	**A**	**Y**	**A**	**Y**	**A**	**Y**	**A**	**Y**	**A**	**Y**
Chamanu	158	424	3	1000	5	1000	92	688	17	10.95	95	8.56	117	1.46
Salema	127	472	68	1074	103	1301	134	806	45	8.56	75	4.65	135	1.57
Gandacherra	125	456	3	1000	5	1000	38	763	9	4.56	34	8.15	22	1.53
Total	410	1352	74	3074	113	3301	264	2257	71	24.07	204	21.36	274	4.56

A – Area (Ha); Y – Yield (Kg/Bales per Ha)

1.14 Cropping Pattern:

The cropping pattern of the district is mainly paddy oriented and production amount of paddy is more than any other crop. Depending on the period of its growth the paddy is divided into three varieties – (i) monsoon paddy (Aman), (ii) winter paddy (Boro) and (iii) summer paddy (Aush). Aush is cultivated in a very limited area. After the

cultivation of Aman paddy and before the cultivation of Boro paddy, different vegetables viz. potato, cabbage, gourds etc., oil seeds and pulses are cultivated. After Boro paddy, jute is also grown in a small scale. In most of the cultivable land only one paddy (Aman) is grown. In double-cropped areas, two paddies are grown (Aman & Boro) but in some places one paddy (Aman) and vegetables are also grown. Triple cropped area is very limited and here the cropping pattern is two paddies and one vegetable or one paddy with two times vegetables. Cropping pattern not only depends on fertility of land and availability of water but also depends on individual cultivator. Over a limited area, orchards of pineapples, jackfruits, mangoes and cashew are raised. Rubber plantations are also in vogue on small mounds and foothills over a considerable area, which is ever increasing.

The cropping pattern of the district shows that among paddy varieties Aman paddy is cultivated in maximum area followed by Boro, 'Jhum' paddy (cultivated on the hill slopes by the tribals) and Aush. After paddy, vegetables which includes potato followed by pulses are the major cultivated crops in the area.

1.15 Prevailing Water Conservation/ Recharge Practices:

In Dhalai district, small/medium check dams are highly feasible to be constructed in foothill areas to store water which can be used during lean periods. Forest, Agriculture, Rural Development Department and Block Development Offices have constructed many rain water harvesting structures like ponds, check dams, nala bundhs.

1.16 General Geology:

Geologically, the study area is occupied by Quaternary & Upper Tertiary groups of rocks. The geological succession of the district is given in Table 1.5.

Table 1.5: Geological Succession in Dhalai district

AGE	GROUP	FORMATION	LITHOLOGY
Quarternary	Recent	Recent	Alluvium, represented by unconsolidated pale to dirty gray, silt, sand, clay, silty clay, sandy clay etc and yellowish brown coarse river sand, gravels & concretions.
	---------- UNCONFORMITY----------		
Upper Tertiary	Dupitila	Dupitila	Brown to buff sandy clay with grayish sandy loam, clayey sandstone with ferruginous materials & laterites.
	---------- UNCONFORMITY----------		
	Tipam	Champaknagar Manubazar	Massive medium to coarse sandstone with sandy shale. Fairly bedded fine to medium sub-arkosic sandstone with sandy shale and siltstone.
	---------- UNCONFORMITY----------		
	Surma	Bokabil Bhuban	Thinly laminated, bedded sandstone and silt (repetition) with ferruginous material, medium to coarse micaceous sandstone with mudstone. Intruded, hard compact, both massive & well-bedded sandstone, dark to olive shale repeated.

Base not known

The distribution of the geological formations is described as under:

a) Surma Group: The Surma Group is represented by Upper Bhuban and Bokabil Formations. The rocks of Bhuban Formation, constituting compact sandstones and shales, which are exposed in the core of the anticlines of the district, viz., SakhanTlang, Jampui hills and Longtarai etc. These formations usually form high hills with steep slopes and are conformably overlain by Bokabil Formation. The rocks of Bokabil Formation are predominantly of argillaceous composition and are exposed on both limbs of the anticlines.

b) Tipam Group: The Tipam Formations are conformable and transitional to the underlying Bokabil Formation. These Formations are arenaceous in nature and comprised of fine to medium grained, yellow to light buff and brownish yellow colour, friable sandstones, and occur along the outer flanks of the anticlinal hill ranges with moderate dip to near horizontal disposition. The sequence of these formations shows variations due to facies changes within the group. The maximum thickness of these formations is estimated to be around 1400 m, the minimum being 400 m.

c) Dupitila Group: The Dupitila sediments consisting of earthy brown to buff sandy clay, mottled clay, clayey sandstone and coarse to gritty ferruginous sandstone unconformably overlie the Tipam Formation, and are well developed in central portion of the synclinal valleys. These formations occur in the form of disconnected mounds. The thickness of this formation varies from 10 – 30m.

d) Recent Group: Recent alluvium occurs along the streams and the flood plains of major rivers. It consists of coarse sand, sandy clay, silt, silty clay and clay etc.

1.17 Sub-Surface Geology:

It has been interpreted on the basis of the lithological logs of boreholes drilled by Central Groundwater Board and various State Government Agencies. The granular zones encountered down to the depth of 300 m belong to semi-consolidated Tipam and Dupitila groups and constitute medium to coarse grained, sub-rounded quartz, feldspathic material. The occurrence and thickness of these zones very laterally as well as vertically.

The Manu - Chawmanu area is a part of southern extension of Kailashahar (North Tripura district) valley. The panel diagram showing subsurface geology of Manu valley is given as Figure 9. It shows the presence of fairly good thickness of fine to medium grained sandstone horizon in the northern part of the valley covering Karamchera (Manu) area. However, when the tube wells are located in the fringe area of Langtarai and Sakhantlang hill ranges, clay/ shale predominates in the top horizon. Possibly this may be due to change of lithofacies. But in the south while the thickness of granular zone within the first 120 m bgl depths gets reduced due to appearance of tongues of clay/ shale horizon the entire thickness of sandstone appears to have been displaced by clay/ shale at Chawmanu. This might have happened due to faulting or change in lithofacies. Below 100-120 m the first thick granular horizons observed in the central part of the valley, the other granular horizons at depth are of thin and intercalated with clay/shale horizons. However, another significant granular horizon occurs at a depth of above 200 m bgl with almost uniform thickness of 25-40 m. These granular horizons form the productive aquifers in this valley.

Kamalpur valley is largely dominated by shaly horizons except in the central part of the valley at Bhatkhowri and Srirampur, where three distinct sandstone layers of significant thickness can be seen. These granular horizons appear to have been displaced due to subsurface faulting towards north.

Gandacherra valley is also dominated by shaly horizons. In northern and extreme southern parts granular zones of about 30 – 40 m are encountered while in the central part the shale dominated from ground surface to 100m depth. Only in Gandacherra area granular zones are available in the top 100 m.

2. DATA COLLECTION & GENERATION

- **Actual achievement in generating geophysical survey data :**

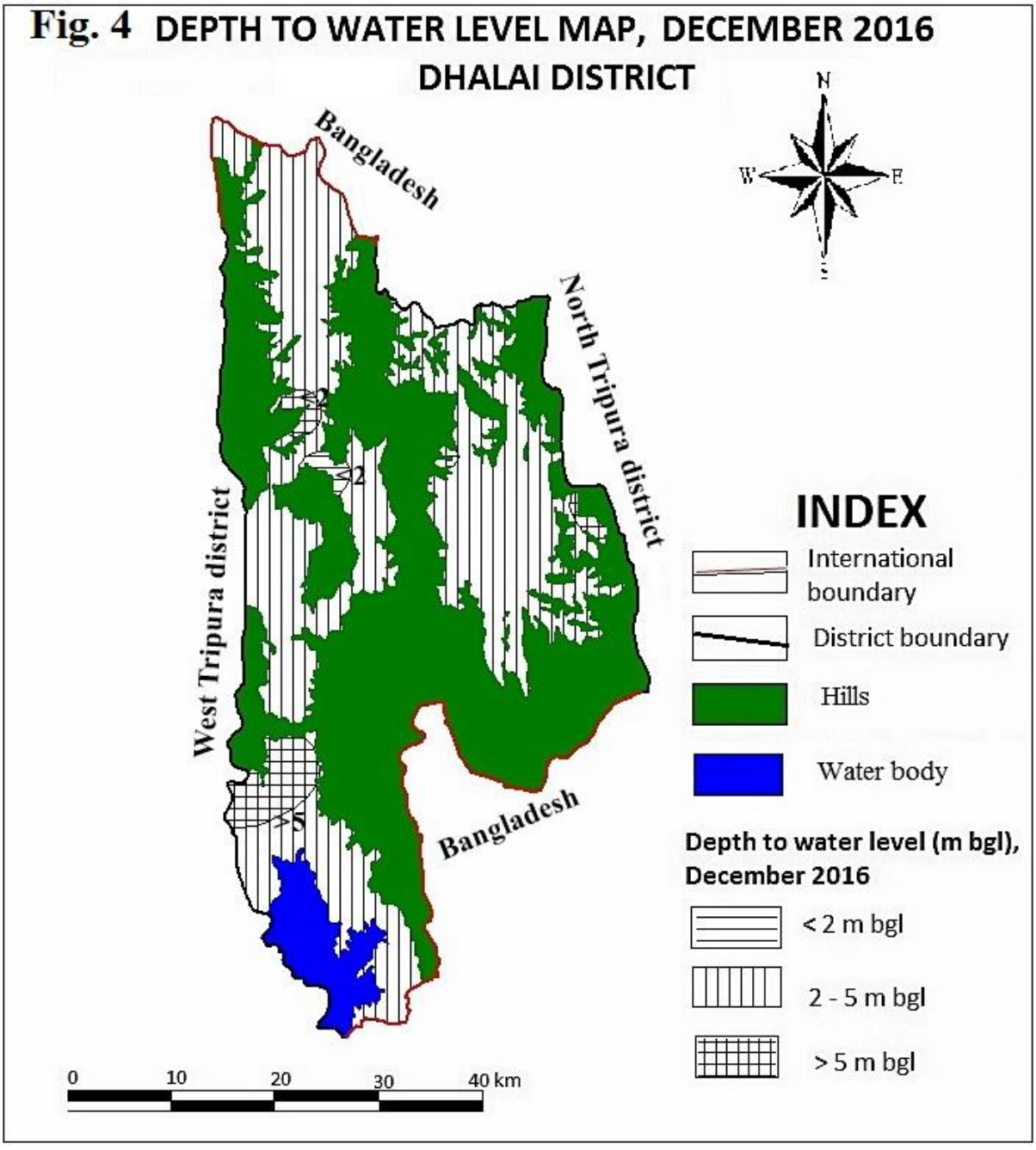
28 nos. of Vertical Electrical Soundings (VES) at 28 nos. of different site spread all over the Dhalai district conducted and locations of VES sites were depicted in Fig No.2.

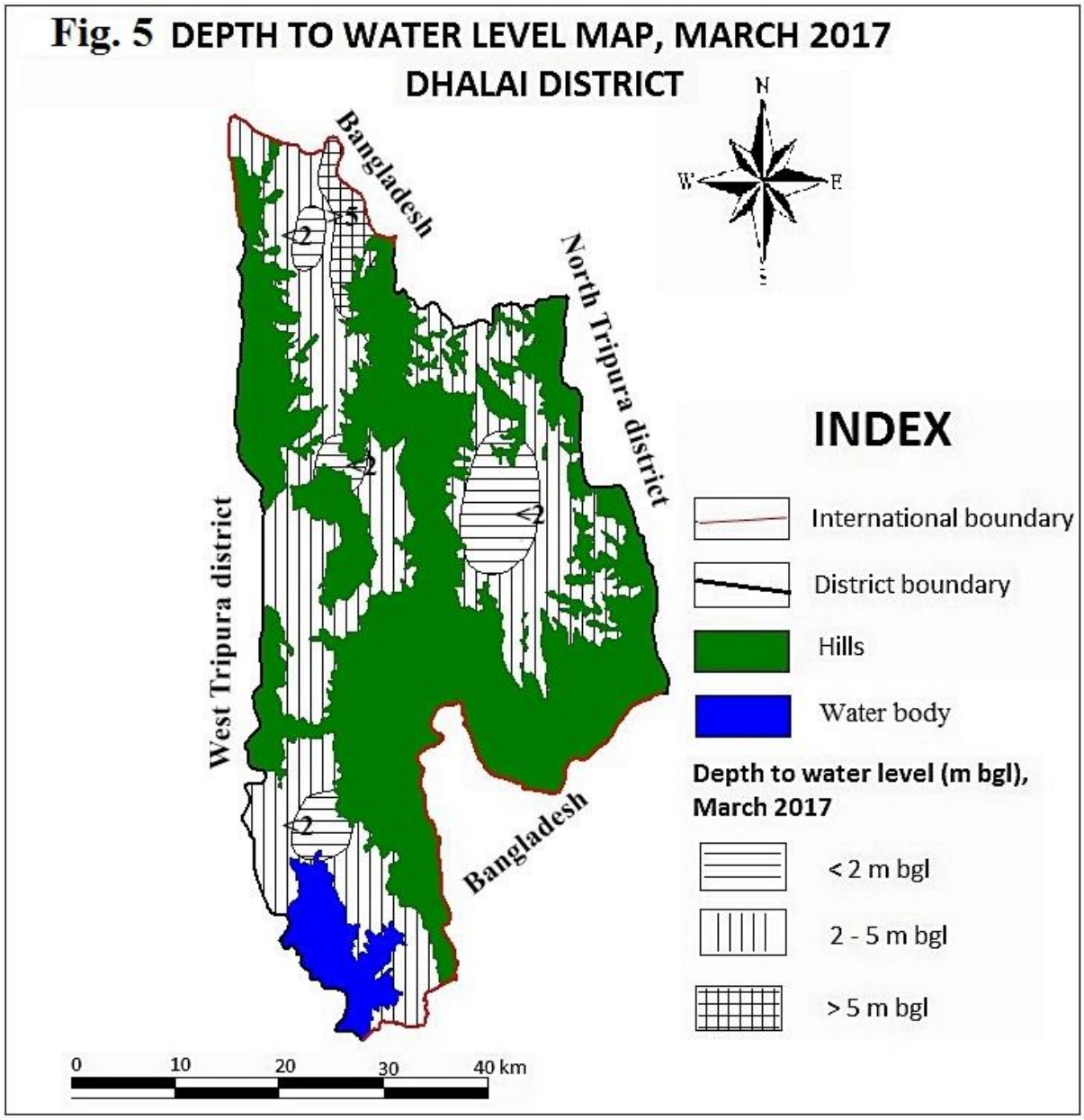
- **Actual achievement in generating Water Quality data :**

In addition to previously existing GMS wells, 17 more dug wells have been established as NAQUIM Key Wells and since pre-monsoon of 2017, water samples from these 24 wells are being collected. Distribution of iron and EC in groundwater in the NAQUIM area is depicted in the Fig 12 & 13 on the basis of GMS well data.

3. DATA INTERPRETATION, INTEGRATION AND AQUIFER MAPPING

3.1 Depth to water level: The ground water occurs in unconfined condition in the shallow aquifer and in semi-confined to confined condition in deeper aquifer. The main potential zone is formed by Tipam sandstone. Depth to water level (DTWL) during December,2016 monitored from dug wells (first Aquifer) ranges from 1.80 to 6.45 m bgl while in March,2017 depth to water level ranges from 0.88 to 7.55 m bgl. Depth to water level during December, 2016, 2017 is shown in Fig 4 and for DTWL for March, 2017 is shown in Fig 5.





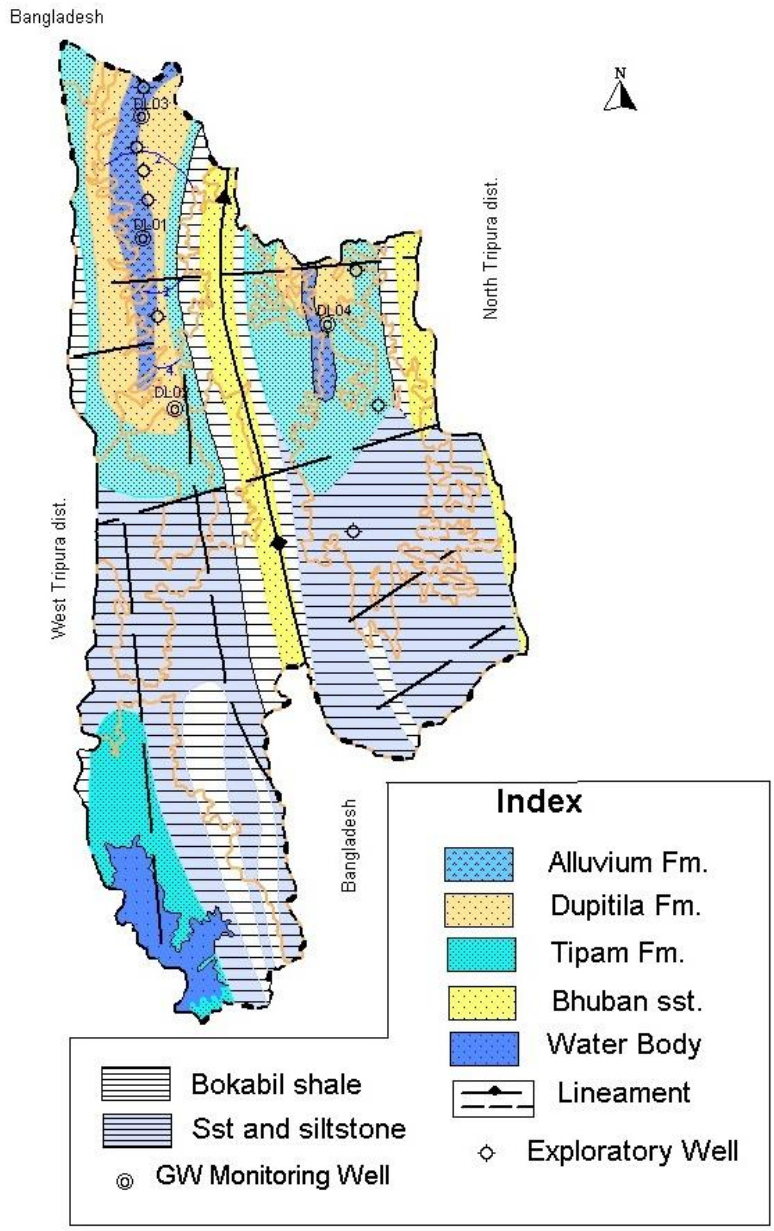
3.2 General Hydrogeology and Occurrences of Ground Water:

The main hydrogeological formation of the aquifer mapping area is Quaternary to Tertiary semi-consolidated formations, more specifically Recent Alluvium of Quaternary age and Dupitila & Tipam formation of Tertiary age. The fine to medium grained semi-compact buff colored thick Tipam Sandstone forms the principal aquifer in the area. The ground water in this aquifer mapping area occurs under unconfined, semi-confined and confined conditions. Study of dug wells, shallow tube wells and deep exploration data of CGWB reveals the presence of phreatic, shallow and deeper aquifers in North Tripura district. Hydrogeological map of the district is shown in Fig 6.

Occurrences of Ground Water in Shallow Aquifers: Shallow aquifers generally extend within the depth range of 5 to 30 m bgl. In shallow aquifer, ground water generally occurs under unconfined condition. In major part of the area, ground water in shallow depths occurs under unconfined condition but it occurs under confined condition within shallow depths in small isolated zones in the Latiabil – Abhanga – Santirbazar (Maharani) area and in Lambucherra – Nabinbari area.

Occurrences of Ground Water in Deeper Aquifers: In deeper aquifers ground water occurs under semi-confined to confined conditions. Most of the heavy duty ground water abstraction structures for different purposes are tapping these deeper aquifers. Many deep tube wells constructed by PHED, Govt. of Tripura are located along eastern side of Dhalai river (from Bhatkhowri (Santirbazar) to Bilascherra) and found to be in artesian condition. The deeper artesian zone is also found in Ambasa area, at Jagannathpur and another at Harincherra (in Gandacherra valley). Deeper artesian wells are reported to be constructed within a depth range of 125 to 256 m bgl. The piezometric head in wells varies from 0.40 to 4 m agl. Discharge varies from 0.04 to 2 lps during pre-monsoon and from 0.19 to 2.5 lps during post-monsoon (during 2009 – 10).

Fig 6 : Hydrogeology, Dhalai district



LEGEND

Age		Group	Formation	Lithology	Aquifer Disposition	Ground Water Potential
Quaternary	Unconsolidated	Recent	Recent Alluvium	Clay, Silt and Sand	Limited thickness along river valleys	Yield Prospects very limited due to superficial thickness
Upper Tertiary	Semi Consolidated	Dupitila	Dupitila	Coarse to gritty Sandstone with dominated Clay layers	Forms Unconfined aquifer in dug well zones near surface. Maximum thickness : 30 m	Limited yield prospect due to poor permeability
		Tipam	Champaknagar/ Manu Bazar	Fine to coarse Sandstone with intercalations of Shale layers	Forms major aquifer system for shallow and deep tube wells up to 300 m depth at favourable locations.	Moderate yield prospect, yields varies from 20 to 150 m^3/hr for drawdown up to 30 m
		Surma	Bokabil/ Bhuban	Thinly bedded Sandstone, Siltstone and Shale	Occurs on anticlinal hill ranges	Not potential for ground water development, due to argillaceous nature of formations

3.3 Number of Aquifers:

The areas under mapping possess two aquifer systems. The first aquifer is phreatic/ unconfined aquifer. Based on existing exploration data, it is ascertained that the depth of the first aquifer is within 30 m bgl. The soft Tipam sandstone occurring below 30 m and having a reasonably higher permeability forms the second aquifer. The maximum depth of the second aquifer is encountered down to the explored depth of 300 m bgl. Thus the aquifer system of the mapping area is divided into two groups, viz., shallow aquifer group within 30 m bgl and deep aquifer group between 30 to 300 m bgl.

3.4 Aquifer Systems:

The aquifers mostly consist of sedimentary formations of Tertiary age. Three hydrogeological units/ water bearing formations identified in the area are alluvial formation, Dupitila formation, Tipam formation and Bokabil formation.

(A) Alluvial Formation : It occurs along the banks of main rivers and thickness varies from 5 to 10 m. Ground water occurs under unconfined condition and its development is not very significant because of high clay and sandy clay content of this formation. Ground water is developed through dug wells and shallow tube wells fitted with hand pumps.

(B) Dupitila Formation: Dupitila formation is nearly horizontal in disposition and its thickness varies from 10 to 30 m. The formation consists of mainly clay and silt with some intercalations of gritty & ferruginous sandstones. It is exposed in the western middle part of Udaipur - Subroom valley. Due to high clay content, it has low permeability, low storage capacity and the ground water extraction occurs through dug wells and shallow tube wells fitted with hand pumps.

(C) Tipam Formation: Sandstones of Tipam formation forms the principal aquifer system in mapping area. Permeability of this sandstone is much higher than that of Dupitila sandstone or Bokabil (Surma Group) sandstones. This formation consists of sub-rounded, fine to medium grained, friable sandstone with intercalated clay. The recharge area of these sandstones is in the neighboring anticlinal hills. Ground water occurs under unconfined, semi-confined to confined conditions. Sandstones are mostly developed by deep tube wells, mini deep tube wells, shallow tube wells and dug wells.

3.5 Aquifer Geometry

The main objective of the study is to delineate the horizontal and vertical disposition of aquifer as well as to study the aquifer character. To know the aquifer

disposition in the district, exploratory wells data, VES data available with CGWB and lithologs of state departments, Govt. of Tripura were utilized.

CGWB has drilled 8 tube wells within a depth range of 260 m. It can be deciphered from the lithologs of different exploratory wells drilled by CGWB and tube wells by State Govt. that mono aquifer system occurs in the area in regional scale. The district is underlain by potential water-bearing formation of Tipam Group comprising of medium to fine grained, semi-consolidated, friable, soft, sandstones. This sandstone aquifer is having shale/ clay intercalations in places. In some places due to the presence of clay intercalations 2 to 4 granular zones occur in the district. Separations of two or more granular zones by clay beds often misguide to classify the aquifers into a multiple aquifer system. However, these clay beds are mostly in lensoid shape and they pinches out within a short distance. Thickness of the saturated zone varies from 50 to 150 m within a depth range of 200 m. Sub-surface geology of the district is depicted through a few sections and panel diagrams and is shown in Fig 8, 9, 10 and 11. The exploratory tube well at Kamalpur, Durai Sibbari and Santirbazar up to 250 m depth bgl have revealed the predominance of argillaceous sediments and lack of sufficient granular zones.

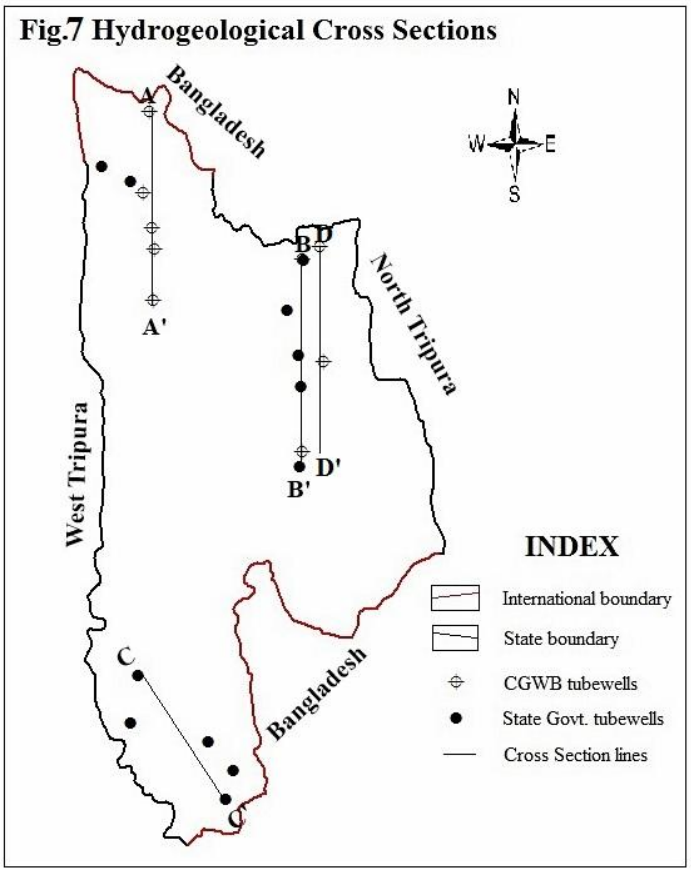


Fig 8 : Panel diagram showing sub-surface geology of Kamalpur Valley, Dhalai district (A-A')

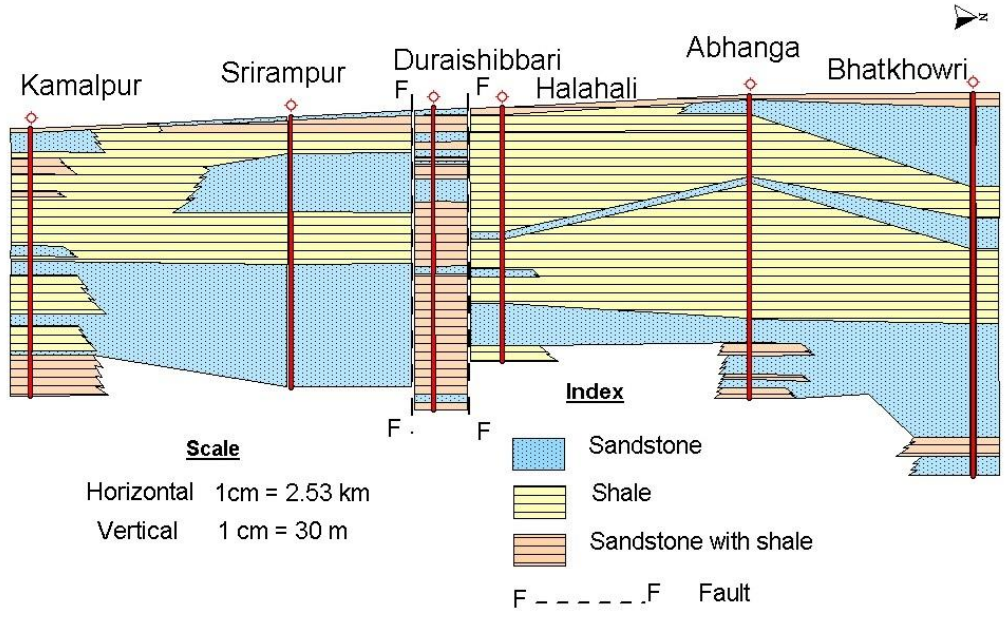


Fig. 9 Panel diagram along D-D' of Manu valey, Dhalai District

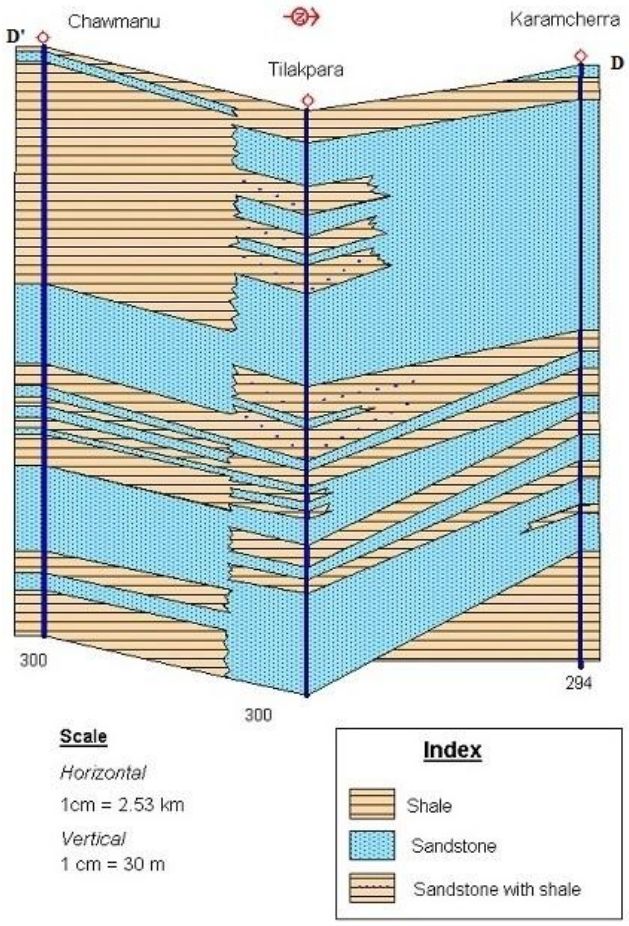


Fig.10 Cross Section along B-B'

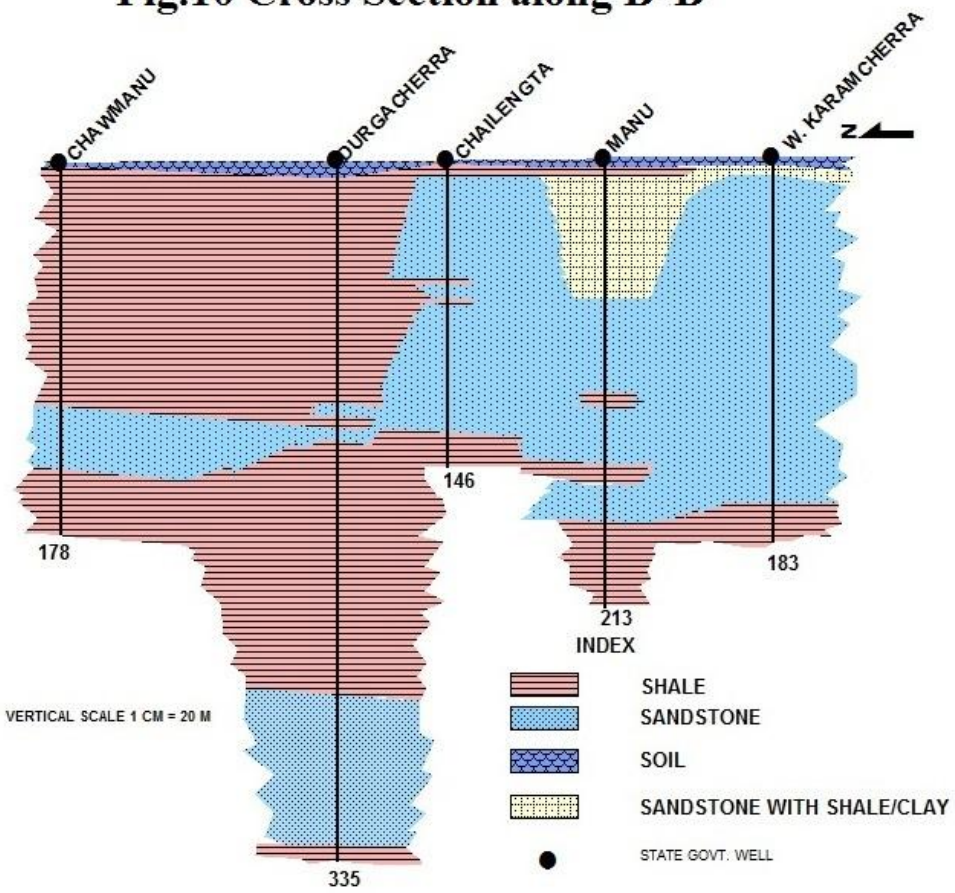
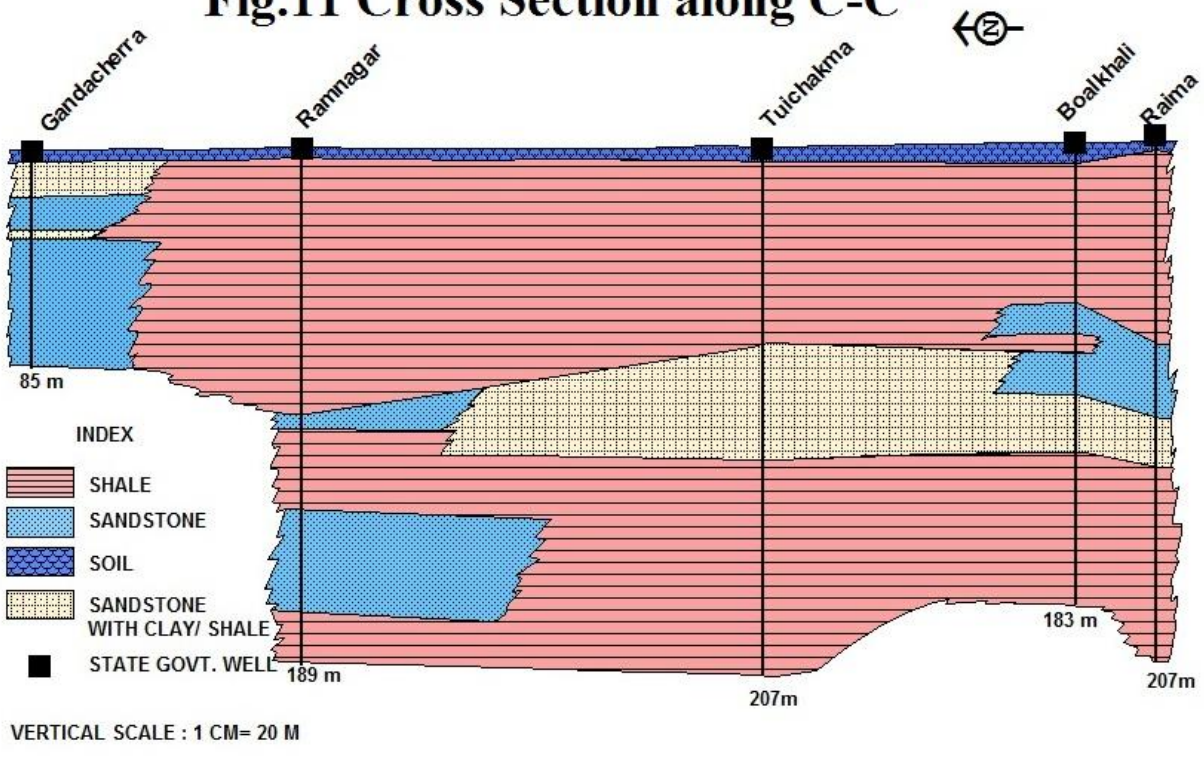


Fig.11 Cross Section along C-C'



3.6 Aquifer Properties (Yield, Parameters etc.)

Aquifer I: During the 2005-06, 8 nos. of pumping tests in dug wells were carried out to determine aquifer characteristics of the unconfined aquifer. It is found that specific capacity varies from 1.66 to 20.10 lpm/m of drawdown. Dug wells and shallow tube wells are constructed in shallow aquifer. In some parts of the district shallow tube wells are found to be overflowing i.e., in artesian condition. The piezometric head and discharge of the artesian wells varies from 0.05 – 0.80 m agl and 0.04 - 1.00 lps.

Aquifer II: Exploratory well constructed by CGWB at Abhanga and Bhatkhowri are found to be in artesian condition. CGWB has drilled 8 nos. of deep tube wells down to the depth of 260 m bgl. Heavy-duty deep tube wells constructed between 100 – 300 m bgl by tapping Tipam sandstones. CGWB has constructed deep tube wells in the district under exploratory programme to determine the characteristics of the deeper aquifer (semi-confined to confined condition). The discharge of the wells varies from 38 – 211 m^3/hr and the drawdown varies from 15 – 38 m. The transmissivity of the wells varies from 26 – 1582 m^2/day, permeability varies from 0.4 – 43.9 m/day and storativity varies from 2.85 X 10^{-4} to 5.89 X 10^{-4}. Piezometric head was observed up to 5.70 m above ground level at Abhanga.

4. GROUNDWATER ISSUES

Major ground water related issues can be summarized as under:

- Low stage of groundwater development (2.49%).
- Higher concentration of iron both in shallow and deeper aquifer

4.1 Ground Water Resources

Estimation of Ground Water Resources in the Dhalai district has been carried out based on the methodology recommended by Ground water Estimation Committee (GEC'97), where two approaches are recommended: (i) water level fluctuation method and (ii) rainfall infiltration method. The latest dynamic resource computation based on the basis of various available technical data, the results of exploratory drilling and other hydrogeological testing by CGWB and State Govt. departments such as PWD (Water Resources), PWD (DWS) & Agriculture Dept., Govt. of Tripura, is done for the year 2012 – 2013 (1st April, 2012 to 31st March, 2013), where the smallest and undisputed administrative unit, the rural development block is taken as the unit of computation in absence of actually GEC-97 recommended assessment unit watershed wise number of ground water structures, amount of ground water draft, population and other vital geographical and economical figures or statistics. Hydrogeological formations comprising Sandstones and Shales named as Dupitila, Tipam and Surma Formations of Upper Tertiary age are spread all over the Dhalai distrct and all are considered as a single hydrogeological unit. Area with more than 20% slope has been excluded for the recharge computation. The dynamic reserve which is seasonally renewable in response to monsoon recharge has been assessed based on the seasonal fluctuation of water table and specific yield of shallow aquifer materials and also based on rainfall recharge by infiltration. The main potential aquifer in the Dhalai district is Tipam sandstone and the specific yield value for Tipam sandstone is taken here as 0.08 (GEC'97). As the upper aquifers are made up of medium to fine grained sandstone, which are very porous and permeable, the rainfall infiltration factor is here taken as 0.16 and the value is approved by the R&D advisory committee on Dynamic Ground Water Resource Estimation.

Dynamic resources of ground water, extent of current utilization, balance available for further development have been estimated and presented in Table 4.1 and 4.2. There is no saline/brackish water aquifer or any other poor ground water quality area. There is no major or medium canal irrigation scheme and thus the whole Dhalai district has been considered as a non-command area.

Table 4.1 Dynamic Groundwater Resources, Dhalai District, 2012-13

District (p)	Stage of Ground Water development (%)	Net GW Availability (ham)	Existing Ground Water Draft for Irrigation	Existing Gross Ground Water Draft for All Uses	Provision for Domestic & Industrial requirement for up to 2025	GW Availability for Future Irrigation
Salema	3.20	8376.62	0.00	267.82	619.12	7757.50
Ambasa	2.30	7638.19	30.00	175.90	338.36	7269.83
Manu	4.97	3486.57	0.00	173.25	400.24	3086.33
Chawmanu	0.84	8232.02	0.00	69.10	159.94	8072.08
Dumburnagar	1.13	10786.24	0.00	122.23	282.45	10503.79
Dhalai district	**2.49**	**38519.65**	**30.00**	**808.30**	**1800.11**	**36689.54**

Table 4.2 Dynamic Groundwater Resources, Dhalai District, 2012-13

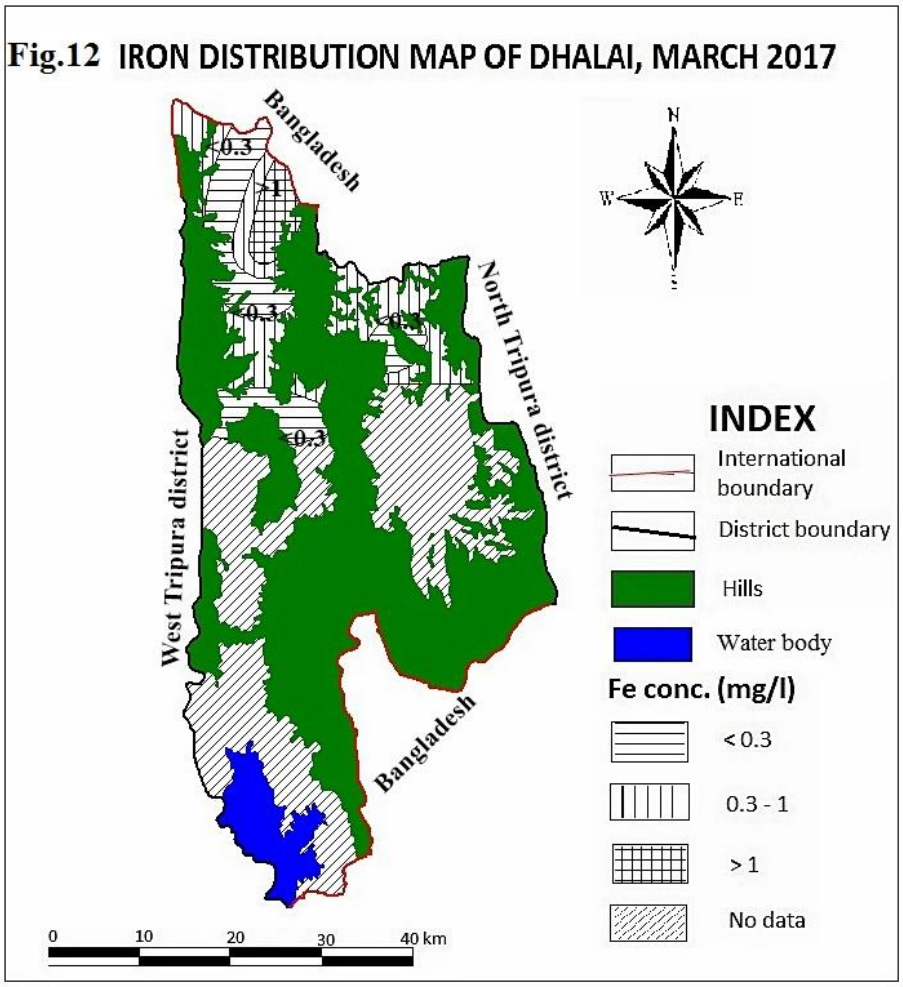
Sl. No.	Assessment Unit	Stage of Ground Water Development (%)	Pre-monsoon		Post-monsoon		Category (Safe/ Semi-critical/ Critical/ Over-exploited)
1	2	16	Water level Trend	Is there a significant decline (Yes/ No)	Water level Trend	Is there a significant decline (Yes/ No)	
1	Salema	3.20	Rising	No	Rising	No	Safe
2	Ambasa	2.30	Rising	No	Rising	No	Safe
3	Manu	4.97	Rising	No	Rising	No	Safe
4	Chawmanu	0.84	-	No	-	No	Safe
5	Dumburnagar	1.13	-	No	-	No	Safe
Dhalai district		**2.49**	Rising	No	Rising	No	Safe

4.2 Water Quality problems

The pH values of the ground water ranges from 7.36 to 8.24 for shallow aquifer and from 7.2 to 8.5 for deeper aquifer. The BIS has recommended acceptable range of pH is from 6.5 to 8.5 for domestic use. Ground water quality in the area is potable and range of all the chemical constituents are within the permissible limit set by BIS, except iron. In shallow aquifer EC values ranges from 123.70 to 304.60 and in the deeper aquifer it ranges from 110 to 449. Fluoride content in ground water from shallow aquifer ranges from 0.16 to 0.38 ppm.

Ground water of the area is characterized by a generally high iron content which ranges from 0 to 12 ppm. The concentration of iron in ground water is generally much

above the prescribed desirable limit of 0.3 ppm and maximum permissible limit of 1 ppm. The iron concentration in water from open well is comparatively less than that of tube wells. This is due to the fact that the scope of aeration is more in open wells allowing the precipitation of ferrous iron as ferric iron. The enrichment of iron in water of the area is due to the ferruginous nature of Tipam sandstones, which forms the major aquifers. The high contents of iron renders ground water unsuitable for drinking purpose, hence the level of concentration should be brought down to the desirable limit before use for drinking purpose, to avoid any health hazards. The iron concentration in ground water from shallow aquifer ranges from 0.27 to 3.24 ppm and in deeper aquifer it ranges from 0.06 to 12.00 ppm.



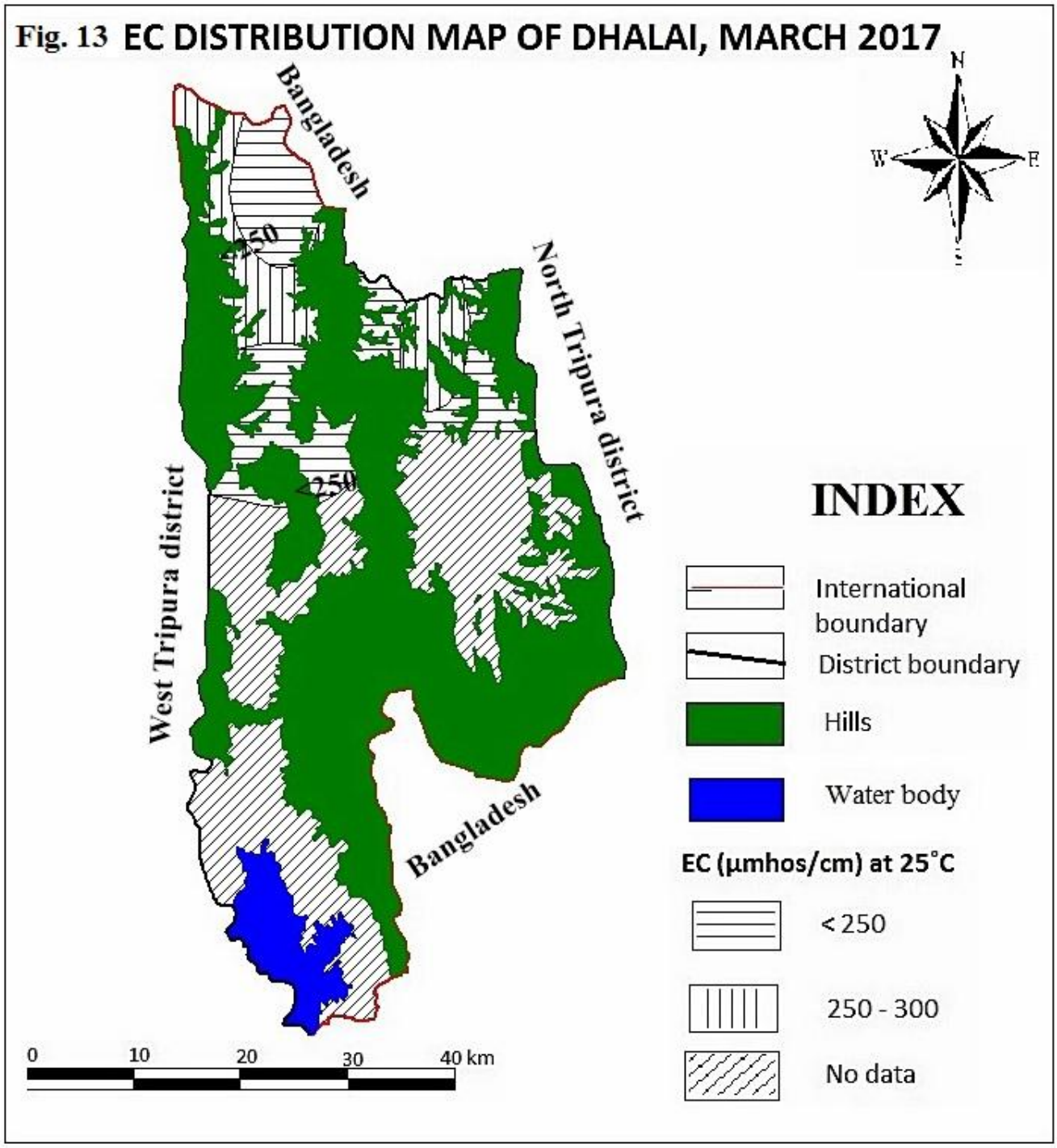


Fig. 13 EC DISTRIBUTION MAP OF DHALAI, MARCH 2017
Bangladesh
North Tripura district
West Tripura district
Bangladesh
<250
N
W
E
INDEX
International boundary
District boundary
Hills
Water body
EC (µmhos/cm) at 25°C
< 250
250 - 300
No data
0
10
20
30
40 km

5. MANAGEMENT STRATEGIES

As per dynamic ground water resource estimation of Dhalai district for 2012-13, net ground water availability is 38520 ham and stage of development is only 2.49%. The district is having balance net ground water availability for future irrigation use in the tune of 36,690 ham. If an irrigation plan is made to develop 60% of the balance dynamic ground water resources available, then 22,014 ham of groundwater resources is available in the district for the future irrigation uses. From this available resource (planned for future development) 11,500 nos. of shallow tube wells (considering a unit draft of 1.9 ham/year) can be constructed. Therefore, there is enough scope for future development of ground water in the district to bring more area under irrigation practice.

During Kharif season (2015-16), land under cultivation (field crops only) in the district is 20354 ha while during Rabi season it is 17477 ha. Land use data for 2015-16 shows that cropping intensity in the district is 186%. Irrigation potential created in the district is 9929 ha. It can be seen that land cultivated during rabi season is more than the irrigation potential created. This may due to the fact that apart from the assured minor irrigation projects farmers use pump sets to collect water directly from rivers and some artesian wells; in some narrow valleys during dry season also water seeps from hills, some temporary bunds are constructed on small rivers / streamlets for irrigation in the district, which were not accounted.

After Kharif crops are over a part of this cultivable area remains fallow during Rabi season. Gap between area cultivated during Kharif season and Rabi season is 2877 ha. The intention of this plan is to utilize this fallow land of about 2877 ha under assured irrigation during Rabi season which will help to increase gross cropped area to 5754 ha and thereby increase in cropping intensity up to 200%. Since stage of dynamic ground water is only about 3%, this area of 2877 ha can easily be covered by constructing ground water based irrigation projects. To use the groundwater for irrigation purpose a cropping plan has been designed for the district by using CROPWAT model developed by FAO. A suitable cropping plan for the district was prepared and is presented in Table 5.1.

In rice fallow, potato, mustard, pulses and rabi vegetables can be grown with the support of irrigation. Present cropping pattern, proposed cropping pattern, targeted increase in cropping intensity were shown in Table 5.2a and 5.2b.

Crop-wise and month-wise irrigation water requirement (Precipitation deficit) has been estimated from CROPWAT after giving necessary meteorological, soil, crop plan

inputs and the same has been shown in Table 5.3. Crop-wise and month-wise Irrigation water requirement in ham has been further calculated in Table 5.4.

CROPPING PATTERN DATA
(File: untitled)

Cropping pattern name: Kamalpur

No.	Crop file	Crop name	Planting date	Harvest date	Area %
1	...Data\CROPWAT\data	Rice	15/06	12/10	13
2	...Data\CROPWAT\data	Rice	21/06	18/10	13
3	...Data\CROPWAT\data	Rice	30/06	27/10	12
4	...Data\CROPWAT\data	Rice	07/07	03/11	12
5	...CROPWAT\data\crop	Small Vegetables	07/11	09/02	13
6	rape___mustard.CRO	Mustard	15/11	29/03	12
7	...a\CROPWAT\data\cr	Pulses	07/12	26/03	13
8	...\CROPWAT\data\cro	Potato	15/12	23/04	12

Source: CROPWAT

Table 5.2 a. Proposed cropping pattern with water deficit months and IWR, Dhalai district.

Crop	**Growing period (Months)**	**Periods/months of water deficit**	**Irrigation requirement (ha m)**
Rice	4	1 – 2	414
Potato	5	5	105
Mustard	6	6	111
Vegetables	3	3	117
Pulses	4	1	125

.

Table 5.2 b. Cropping pattern, proposed cropping pattern, intended cropping intensity, for mono-cropped un-irrigated area in Dhalai district

Mono-cropped Un-irrigated area in Dhalai district				
Rice based cropping pattern				
1. Rice-Potato 2. Rice-Mustard 3. Rice-Vegetables 4. Rice-Pulses	Present Cultivated area (**ha**) **1**	Area to be cultivated (**%**) **2**	Area to be cultivated (**ha**) **3(= % of 1)**	Irrigation requirement (**ha m**) **4**
Rice (main crop)	2877	2877		414
Vegetables	0	720	25	105
Mustard	0	719	25	111
Pulses	0	719	25	117
Potato		719	25	125
Net cultivated area	2178	**2877**		
Gross cultivated area (1+potato/+mustard/+Veg/+Pulses)	2178	**5754**		
Total irrigation requirement				**872**
Cropping intensity	**100% (Present)**	**200% (Intended)**		

The total area of rice cultivation is comprised of 2877 ha. During kharif season, rice is cultivated from June to mid-July. Since this huge area cannot be cultivated in a single day (one planting date), so it is considered/ planned to cultivate rice in two to four stages during this period.

It is planned to utilize rice fallow of 2877 ha for the cultivation of pulses, potato, mustard and vegetables. It is considered to cultivate Vegetables in 720 ha and pulses, potato and mustard in 719 ha each.

The peak water requirement for irrigation for rice is in the month of June, for potato, mustard and pulses it is in the month of February.

Table 5.3: Crop-wise and month-wise precipitation deficit (mm) using CROPWAT 8 for Dhalai District.

Crops	Precipitation deficit (mm)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1. Rice	0	0	0	0	49.1	98	0	0	0	6.6	0	0
2. Rice	0	0	0	0	0	147.7	0	0	0	0	0	0
3. Rice	0	0	0	0	0.5	146.5	0	0	0	0	0	0
4. Rice	0	0	0	0	0	27.6	98	0	0	3.6	0.1	0
5. Small Vegetables	51.8	18.9	0	0	0	0	0	0	0	0	27.3	54.2
6. Mustard	43.8	55.5	7.8	0	0	0	0	0	0	0	10.2	42.9
7. Pulses	43.9	72.6	23	0	0	0	0	0	0	0	0	17.2
8. Potato	30.6	71.1	49.5	0	0	0	0	0	0	0	0	15.5

Table 5.4: Irrigation water requirement (ham) of Dhalai district

Crops	% of total area of 5754 ha	Precipitation deficit												
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1. Rice	12	0.00	0.00	0.00	0.00	33.90	67.67	0.00	0.00	0.00	4.56	0.00	0.00	106.13
2. Rice	13	0.00	0.00	0.00	0.00	0.00	110.48	0.00	0.00	0.00	0.00	0.00	0.00	110.48
3. Rice	12	0.00	0.00	0.00	0.00	0.35	101.16	0.00	0.00	0.00	0.00	0.00	0.00	101.50
4. Rice	13	0.00	0.00	0.00	0.00	0.00	20.65	73.31	0.00	0.00	2.69	0.07	0.00	96.72
5. Small Vegetables	12	35.77	13.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	18.85	37.42	105.09
6. Mustard	12	30.24	38.32	5.39	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.04	29.62	110.61
7. Pulses	13	32.84	54.31	17.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	12.87	117.21
8. Potato	13	22.89	53.18	37.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	11.59	124.69
Total	100	121.74	158.86	59.62	0.00	34.25	299.95	73.31	0.00	0.00	7.25	25.97	91.51	872.44

Under ground water exploration programme, CGWB has drilled 8 nos. of exploratory (including observation wells) tube wells in the district down to the depth of 260 m bgl. It has been established that the aquifer in most part of the valleys in the district is having moderate to high potentiality, having an average discharge of about 48 m^3/hr and can be sustainably developed and use for irrigation purpose. Shallow tube wells of small yield up to 50 m depth can be constructed through 150/100 mm diameter well assembly tapping 20 – 30 m granular zones having 25m housing and 10m slotted portion. The annular space between the borehole and the well assembly should be shrouded preferably with 100mm thick zone of pea gravels. The yield of such tube wells in central part of the valleys is expected to be 15 – 20 m^3/hr at 5 to 10 m drawdown and in foothills yield of such tube wells is expected to be 10 –15 m^3/hr at draw down 5 – 10 m. Shallow tube wells in valley portions where draw down is less than 5m and where non-pumping water level is less than 2 m bgl, enable the use of centrifugal pumps.

In the considered area of 2877 ha, 725 nos. of shallow bore wells can be constructed (considering 200 m distance between any two shallow bore well). 725 nos. of tube wells can extract 1377 ham of water annually.

Annual irrigation water requirement is 872 ham while irrigation water requirement during dry season spanning from October to March it is 465 ham.Annual irrigation water requirement can be catered by constructing 460 nos. of tube wells. However, proportionate dynamic groundwater resources available for future irrigation use (proposed to use 60% of availability) in 2877 ha in the district is 587 ham. Therefore, this rice fallow area can be irrigated by constructing ground water abstraction structures and can bring under double cropped area. This amount of groundwater resources can be harnessed by constructing 460 tube wells. It is also proposed to construct water harvesting structures at suitable places. As per available ground water resources (60% availability) 11500 nos. of tube wells can be constructed and State Govt. has already constructed 4 deep tube wells, 111 mini deep tube wells and 10 shallow tube wells. For drinking purposes also there is thousands of shallow tube wells drilled by State Govt. and by public/private. Still there is scope for drilling this 460 tube wells.

Groundwater in the area is infested with iron, therefore before consumption aeration/ filtering/ installation of Iron Removal Plant is necessary.

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Annexure 1: Water Quality Data of Dhalai District for the Year 2016

Village/ Location	Taluka/ Block	Lat	Long Year	Depth (mbgl)	Aquifer Type	p^H	EC (µS/cm)	TRBD (NTU)	TDS	CO_3	HCO_3	TA	Cl^-	SO_4^{-2}	NO_3^-	F^-	Ca^{+2}	Mg^{+2}	TH	Na^+	K^+	Fe
										(mg/lt)												
Ambasa	Ambasa	23˚ 55' 26.3"	91˚ 50' 49.5"	6.78	(Uncon-fined)	7.97	304.60	BDL	126.70	0.00	95.00	95.00	15.00	30.50	1.80	0.38	24.00	14.56	120.00	9.06	5.22	0.27
Abhanga	Salema	24˚ 03' 14.9"	91˚ 49' 51"		(Uncon-fined)	7.70	133.20	BDL	34.28	0.00	55.00	55.00	15.00	10.16	0.20	0.34	10.00	6.07	50.00	14.19	2.08	0.22
Kamalpur	Durga Ch'muhani	24˚ 10' 10.7"	91˚ 48' 54.7"	-	(Uncon-fined)	7.36	185.70	BDL	98.24	0.00	65.00	65.00	19.99	19.38	0.40	0.40	16.00	6.07	65.00	16.13	6.23	3.24
Durga Chaumuhani	Durga Ch'muhani	24˚ 07' 18"	91˚ 51' 37"	7.8	(Uncon-fined)	7.45	257.80	BDL	137.40	0.00	60.00	60.00	32.49	33.34	2.10	0.16	16.00	10.92	85.00	24.15	5.71	0.00
Darlong basti	Durga Ch'muhani	24˚ 06' 33"	91˚ 54' 14.5"	5.27	(Uncon-fined)	8.24	223.70	BDL	120.60	10.00	75.00	85.00	17.49	32.91	0.50	0.37	26.00	10.92	110.00	11.21	2.05	0.00
Sudharampara					(Uncon-fined)	7.90	123.70	BDL	65.80	0.00	30.00	30.00	19.99	10.05	4.20	0.17	8.00	4.85	40.00	10.22	4.13	0.53
Salema					(Uncon-fined)	7.60	145.96	BDL	75.68	0.00	15.00	15.00	29.99	32.66	5.30	0.18	6.00	10.92	60.00	14.17	6.29	0.00

Annexure 2: Details of Exploratory Wells Drilled By CGWB

1. Kamalpur Valley, Dhalai District

Details Of Pumping Tests Carried out in Dhalai District, Tripura

Sl No	Village	Type of Well	Type of Test	Date	SWL (m bgl)	Step/ Duration (min)	Discharge (lps)	Draw down (m)	Specific Cap (lpm/m)	Sp.Drawdown (m/m^3/min)	Formation loss (m)	Well loss (m)	Well effeciency (%)	Caliculated Drawdown (m)	Transmissivity (m^2/day)	Permeability (m/day)	Storativity
1	**2**	3	**4**	5	**6**	7	**8**	9	**10**	11	**12**	13	**14**	15	**16**	17	18
Dhalai Basin																	
1	Abhanga	EW	SDT	7.6.79	5.7	1-90	27.1	16.7	97.4	10.27	14.22	3.3	-	17.52	-	-	-
						2-90	31.2	20.6	91.2	10.97	16.38	4.38	-	20.76	-	-	-
						3-90	34.6	23.5	88.3	11.32	18.14	5.37	-	23.51	-	-	-
						4-90	36.8	26.0	84.9	11.77	19.33	6.1	-	25.43	-	-	-
						5-90	39.1	29.0	80.8	12.37	20.52	6.87	-	27.39	-	-	-
			APT	8.6.79	5.7	600	36.0	28.1	76.8	-	-	-	-	-	1425	40.4	2.85×10^{-4}
		OW			5.7		-	1.4	-	-	-	-	-	-	-	-	-
2	Bhatkhowri	EW	SDT	3.7.79	2.5	1-120	34.5	11.0	189.2	5.28	0.93	9.94	-	10.87	-	-	-
						2-120	42.1	13.9	181.5	5.51	1.14	12.12	-	13.26	-	-	-
						3-120	52.2	17.7	176.9	5.65	1.4	15.02	-	16.42	-	-	-
			APT	7.7.79	2.5	510	46.5	14.7	189.8	-	-	-	-	-	1187	26.9	-

2. Manu Valley, Dhalai District

S I No	Village	Type of Well	Type of Test	Date	SWL (m bgl)	Step/ Duration (min)	Discharge (lps)	Draw down (m)	Specific Cap (lpm/m)	Sp.Drawdown (m/m^3/min)	Formation loss (m)	Well loss (m)	Well effeciency (%)	Caliculated Drawdown (m)	Transmissivity (m^2/day)	Perme ability (m/day)	Stora tivity
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Manu Basin																	
						1- 60	31.2	9.6	195	5.13	8.38	1.23	-	9.61	-	-	-
						2- 60	43.7	14.4	182	5.49	11.72	2.4	-	14.12	-	-	-
						3- 60	53.9	18.2	178	5.6	14.48	3.66	-	18.14	-	-	-
			SDT	25.4.80	0.4	4- 60	63.2	21.2	178	5.59	16.97	5.03	-	22	-	-	-
3	Karamcherra	EW	APT	26.4.80	0.4	960	58.5	20.9	168	-	-	-	-	-	603	10.4	-
						1- 60	15.8	9.5	100.1	9.98	7.79	1.34	-	9.13	-	-	-
						2- 60	21.8	13.9	94.1	10.63	11.07	2.57	-	13.64	-	-	-
						3- 60	26.8	17.8	90.2	11.08	13.59	3.88	-	17.47	-	-	-
			SDT	28.2.79	2.4	4- 60	30.8	20.8	88.9	11.25	15.64	5.14	-	20.78	-	-	-
		EW			2.4		25.2	18.2	83.1	-	-	-	-	-	225	4	
4	Tilakpara	OW	APT	25.5.79	2.4	1440	24.1	5.1	-	-	-	-	-	-	229.3	-	$6.3x10^{-4}$
						1- 60	6.6	19.6	20.1	49.87	17.87	1.74	91	19.6	-	-	-
						2- 60	9.3	28.9	19.4	51.63	25.42	3.51	87	28.94	-	-	-
						3- 60	11.5	36.9	18.8	53.31	31.44	5.37	85	36.81	-	-	-
			SDT	12.5.81	1.7 m agl	4- 60	13.2	36.9	21.5	46.47	30.04	7.08	80	37.12	-	-	-
5	Chawmanu	EW	APT	13.5.81	1.74 m agi	480	10.5	38.1	16.5	-	-	-	-	-	26.4	0.52	-

Annexure 3: Water Level of Ground Water Monitoring Stations of Dhalai District(March, 2017)

S.N	District*	Block*	Village	Lat*	Long*	Well* Type	MP*	RL*	Depth*	Dia*	Water Level (mbmp) Jan-17	Water Level (mbgl) Mar-17*
STATE : TRIPURA												
1	Dhalai	Salema	Abhanga New	24˚ 03' 15"	91˚ 49' 51"	DUG	0.77	58.695	8.15		**3.1**	**4.1**
2	Dhalai	Ambasa	Ambasa	23˚ 55' 26"	91˚ 50' 50"	DUG	0.92	58.885	6.78	1.05	**1.33**	**1.18**
3	Dhalai	Durga Ch'muhani	Durga Chowmuhani	24˚ 07' 18"	91˚ 51' 37"	DUG	0.8		7.8	1.1	**3.85**	**5.05**
4	Dhalai	Durga Ch'muhani	Darlang Basti	24˚ 06' 33"	91˚ 54' 15"	DUG	0.9		5.27	1.1	**1.8**	**1.69**
5	Dhalai	Durga Ch'muhani	Kamalpur	24˚ 10' 11"	91˚ 48' 55"	DUG	0.66	32.59	5.64		**2.01**	**2.08**
6	Dhalai	Manu	Manu New	24˚ 00' 09"	91˚ 59' 32"	DUG	0.95	39.5	8.32		**4.7**	**5.23**
7	Dhalai	Manu	Sindhu Kumar	23˚ 57' 09"	91˚ 57' 38"	DUG	0.9		8.44	1.12	**3.24**	**3.38**

Annexure 4: Water Level Data of the Key Wells of Dhalai District (March, 2017)

S.N	District*	Block*	Village	Lat*	Long*	Well* Type	MP*	RL*	Depth*	Dia*	Water Level (mbmp) Jan- 17*	Water Level (mbgl) Mar-17*
STATE : TRIPURA												
1	DHALAI	MANU	MAINAMA	23˚58' 20"	91˚59' 36"	DUG	0.85		7.70		3.44	2.45
2	DHALAI	CHHAMANU	DURGACHHARA	23˚53' 58"	92˚07' 01"	DUG	0.95		9.10		5.63	4.37
3	DHALAI	CHHAMANU	CHHAMANU	23˚51' 44"	91˚59' 57"	DUG	0.90		9.10		2.62	1.42
4	DHALAI	CHHAMANU	jm COMPLEX CHALLENGTA	23˚56' 38"	92˚00' 19"	DUG	0.95		4.50		2.10	1.20
5	DHALAI	SALEMA	NAKFUL	24˚05' 44"	91˚49' 11"	DUG	0.96		6.45		4.30	3.84
6	DHALAI	SALEMA	DURAICHHARA	24˚07' 26"	91˚48' 49"	DUG	0.96		6.84		2.54	1.69
7	DHALAI	SALEMA	LAMBU CHHARA	24˚08' 55"	91˚47' 44"	DUG	1.14		7.10		4.80	4.48
8	DHALAI	SALEMA	BARASUMA	24˚10' 53"	91˚50' 46"	DUG	1.05		9.60		3.45	7.55
9	DHALAI	SALEMA	CHULBARI	24˚07' 17"	91˚51' 37"	DUG	0.94		8.57		4.65	4.41
10	DHALAI	SALEMA	JANTHUR BARI	24˚03' 07"	91˚50' 55"	DUG	0.95		7.76		4.50	3.68
11	DHALAI	AMBASA	LALCHHARI	23˚56' 03"	91˚51' 16"	DUG	0.90		9.70		6.45	7.02
12	DHALAI	DUMBURNAGAR	RANIPIKUR	23˚33' 59"	91˚50' 27"	DUG	1.00		5.10		2.12	5.74
13	DHALAI	DUMBURNAGAR	DURGAPUR	23˚36' 32"	91˚49' 34"	DUG	1.14		5.52		3.80	1.86
14	DHALAI	DUMBURNAGAR	JAGABANHU PARA	23˚39' 10"	91˚48' 22"	DUG	1.06		5.60		3.94	2.62
15	DHALAI	DUMBURNAGAR	NUNA CHARA	23˚36' 55"	91˚50' 34"	DUG	0.92		6.85		1.97	0.88
16	DHALAI	CHHAMANU	SUDHARAMPARA	23˚58' 47"	91˚49' 44"	DUG	0.66	91	5.44	1.20	-	2.72
17	DHALAI	SALEMA	SALEMA	24˚01' 06"	91˚50' 00"	DUG	0.96	37	5.45	1.20	3.10	3.17

Annexure 5: Vertical Electric Survey Details Prepared By Geo-physicist

Unique ID	VES 23DHAL	**Date/Year**	21/01/2016
Village	OFISARPARA	**Nearby DW/DCBW/BW Depth**	
Taluka/Block	MANU	**Yield / discharge**	
District	DHALAI	**Whether borehole was drilled at this point? If yes,**	
Toposheet No.	79 M/13	**Depth Drilled**	
Lat	N 23°57'14.2"	**Discharge (lps)**	
Long	E91°59'51.0"	**Transmissivity (m^2 /day)**	
RL (m amsl)		**Storativity**	

Unique ID: VES 23DHAL

Depth range (m bgl)		**Thickness (m)**	**Resistivity (ohm-m)**	**Inferred Lithology**
From	**To**			
0	0.9	0.9	236	Top soil with sands, clays etc
0.9	4.06	3.16	86	Sands etc
4.06	8.61	4.56	19	Clay with intercalation of sands
8.61	83	74.4	69	Sands etc
Below 83		-	42	Sands with clay etc.

Unique ID	VES 24DHAL	**Date/Year**	21/01/2016
Village	KHETRICHERRA	**Nearby DW/DCBW/BW Depth**	
Taluka/Block	CHOWMANU	**Yield / discharge**	
District	DHALAI	**Whether borehole was drilled at this point? If yes,**	
Toposheet No.	79 M/13	**Depth Drilled**	
Lat	N 23°50'27.2"	**Discharge (lps)**	
Long	E91°59'25.0"	**Transmissivity (m^2 /day)**	
RL (m amsl)		**Storativity**	

Unique ID: VES 24DHAL

Depth range (m bgl)		**Thickness (m)**	**Resistivity (ohm-m)**	**Inferred Lithology**
From	**To**			
0	0.501	0.501	164	Top soil with sands, clays etc
0.501	2.068	1.566	46	Sands etc
2.068	10.59	8.518	11	Clays with fine sand etc
10.59	141.9	131.3	7	Clays
Below 131.3		-	173	Consolidated shale/sandstone etc

Unique ID	VES 25DHAL	**Date/Year**	25/01/2016
Village	GAINAMA	**Nearby DW/DCBW/BW Depth**	
Taluka/Block	MANU	**Yield / discharge**	
District	DHALAI	**Whether borehole was drilled at this point? If yes,**	
Toposheet No.	79 M/13	**Depth Drilled**	
Lat	N 23°56'04.0"	**Discharge (lps)**	
Long	E91°59'32.0"	**Transmissivity (m^2 /day)**	
RL (m amsl)		**Storativity**	

Unique ID: VES 25DHAL

Depth range (m bgl)		**Thickness (m)**	**Resistivity (ohm-m)**	**Inferred Lithology**
From	**To**			
0	1.821	1.821	143	Top soil with sands, clays etc
1.821	7.461	5.64	71	Sands etc
7.461	15.09	7.631	36	Sands with intercalation of clay etc

15.09	62.48	47.39	66	Sands etc
Below 62.48		-	47	Sands with intercalation of clay

Unique ID	VES 26DHAL	**Date/Year**	25/01/2016
Village	PALDRAM POINT	**Nearby DW/DCBW/BW Depth**	
Taluka/Block	MANU	**Yield / discharge**	
District	DHALAI	**Whether borehole was drilled at this point? If yes,**	
Toposheet No.	83 D/4	**Depth Drilled**	
Lat	N 24°02'48.1"	**Discharge (lps)**	
Long	E92°01'05.1"	**Transmissivity (m^2 /day)**	
RL (m amsl)		**Storativity**	

Unique ID: VES 26DHAL

Depth range (m bgl)		**Thickness (m)**	**Resistivity (ohm-m)**	**Inferred Lithology**
From	**To**			
0	0.455	0.455	111	Top soil with sands, clays etc
0.455	6.83	6.37	24.7	Clays with intercalation of sands etc.
Below 6.83		-	59	Sands etc

Unique ID	VES 28DHAL	**Date/Year**	15/02/2016
Village	CHINJAKMANI	**Nearby DW/DCBW/BW Depth**	
Taluka/Block	MANU	**Yield / discharge**	
District	DHALAI	**Whether borehole was drilled at this point? If yes,**	
Toposheet No.	83 D/4	**Depth Drilled**	
Lat	N 24°02'00.6"	**Discharge (lps)**	
Long	E92°01'50.4"	**Transmissivity (m^2 /day)**	
RL (m amsl)		**Storativity**	

Unique ID: VES 28DHAL

Depth range (m bgl)		**Thickness (m)**	**Resistivity (ohm-m)**	**Inferred Lithology**
From	**To**			
0	0.886	0.886	135	Top soil with sands, clays etc
0.886	3.58	2.7	38	Sands with clay etc
3.58	9.96	6.38	19	Clay with intercalation of sand
9.96	16.3	6.29	216	Consolidated shale etc
16.3	46.1	29.8	38	Sands with clay etc
46.1	98	51.9	399	Consolidated shale / sandstone etc
Below 98		-	2	Clay etc

Unique ID	VES 29DHAL	**Date/Year**	15/02/2016
Village	PURBA MACHHALI	**Nearby DW/DCBW/BW Depth**	
Taluka/Block	MANU	**Yield / discharge**	
District	DHALAI	**Whether borehole was drilled at this point? If yes,**	
Toposheet No.	83 D/4	**Depth Drilled**	
Lat	N 24°00'35.5"	**Discharge (lps)**	
Long	E92°01'06.9"	**Transmissivity (m^2 /day)**	
RL (m amsl)		**Storativity**	

Unique ID: VES 29DHAL

Depth range (m bgl)		**Thickness (m)**	**Resistivity (ohm-m)**	**Inferred Lithology**
From	**To**			

0	1.2	1.2	61	Top soil with sands, clays etc
1.2	2.683	1.483	16	Clay with intercalation of sands etc
2.683	30.02	27.33	70	Sands with intercalation of clay etc
30.02	153.6	123.5	85	Sands etc
Below 153.6		-	163	Consolidated shale/ sandstone etc

Unique ID	VES 33DHAL	**Date/Year**	17/02/2016
Village	VHAWANCHERRA	**Nearby DW/DCBW/BW Depth**	
Taluka/Block	DURGA CHOWMUHANI	**Yield / discharge**	
District	DHALAI	**Whether borehole was drilled at this point? If yes,**	
Toposheet No.	78 P/16	**Depth Drilled**	
Lat	N 24°07'15.1"	**Discharge (lps)**	
Long	E91°52'02.2"	**Transmissivity (m^2 /day)**	
RL (m amsl)		**Storativity**	

Unique ID: VES 33DHAL

Depth range (m bgl)		**Thickness (m)**	**Resistivity (ohm-m)**	**Inferred Lithology**
From	**To**			
0	2.11	2.11	310	Top soil with sands, clays etc
2.11	11.95	9.83	52	Sands etc
11.95	48.3	36.07	87	Consolidated sand etc
48.3	120.2	72.15	259	Consolidated dry shale/sandstone
Below 120.2		-	3	Clay etc

Unique ID	VES 34DHAL	**Date/Year**	17/02/2016
Village	CHHOTA SURMA	**Nearby DW/DCBW/BW Depth**	
Taluka/Block	DURGA CHOWMUHANI	**Yield / discharge**	
District	DHALAI	**Whether borehole was drilled at this point? If yes,**	
Toposheet No.	78 P/16	**Depth Drilled**	
Lat	N 24°09'18.0"	**Discharge (lps)**	
Long	E91°51'13.3"	**Transmissivity (m^2 /day)**	
RL (m amsl)		**Storativity**	

Unique ID: VES 34DHAL

Depth range (m bgl)		**Thickness (m)**	**Resistivity (ohm-m)**	**Inferred Lithology**
From	**To**			
0	0.742	0.742	301	Top soil with sands, clays etc
0.742	10.63	9.892	39	Sands with intercalation of clay etc
10.63	14.86	4.226	101	Sands etc
14.86	250	235.1	34	Sands with intercalation of clay
Below 250		-	12	Clay with fine sand etc

Unique ID	VES 35DHAL	**Date/Year**	17/02/2016
Village	BARASURMA	**Nearby DW/DCBW/BW Depth**	
Taluka/Block	DURGA CHOWMUHANI	**Yield / discharge**	
District	DHALAI	**Whether borehole was drilled at this point? If yes,**	
Toposheet No.	78 P/16	**Depth Drilled**	

Lat	N 24°11’17.7”	**Discharge (lps)**	
Long	E91°50’27.7”	**Transmissivity (m^2 /day)**	
RL (m amsl)		**Storativity**	

Unique ID: VES 35DHAL

Depth range (m bgl)		**Thickness (m)**	**Resistivity (ohm-m)**	**Inferred Lithology**
From	**To**			
0	1.217	1.217	59	Top soil with sands, clays etc
1.217	8.298	7.081	32	Sands with intercalation of clay etc
8.298	99.91	91.61	107	Consolidated Sands etc
Below 99.91		-	17	Clay with intercalation of sand etc

Unique ID	VES 36DHAL	**Date/Year**	20/02/2016
Village	SOUTH MANIKBHANDAR	**Nearby DW/DCBW/BW Depth**	
Taluka/Block	DURGA CHOWMUHANI	**Yield / discharge**	
District	DHALAI	**Whether borehole was drilled at this point? If yes,**	
Toposheet No.	78 P/16	**Depth Drilled**	
Lat	N 24°08’18.4”	**Discharge (lps)**	
Long	E91°48’47.8”	**Transmissivity (m^2 /day)**	
RL (m amsl)		**Storativity**	

Unique ID: VES 36DHAL

Depth range (m bgl)		**Thickness (m)**	**Resistivity (ohm-m)**	**Inferred Lithology**
From	**To**			
0	0.9	0.9	55	Top soil with sands, clays etc
0.9	1.869	0.969	17	Clay with intercalation of sand etc
1.869	3.882	2.013	43	Sands with intercalation of clay etc
3.882	16.98	13.1	140	Consolidated shale etc
16.98	72.53	55.54	75	Sands etc
Below 72.53		-	34	Sands with intercalation of clay

Unique ID	VES 37DHAL	**Date/Year**	20/02/2016
Village	HARERKHOLA	**Nearby DW/DCBW/BW Depth**	
Taluka/Block	DURGA CHOWMUHANI	**Yield / discharge**	
District	DHALAI	**Whether borehole was drilled at this point? If yes,**	
Toposheet No.	78 P/16	**Depth Drilled**	
Lat	N 24°10’56.1”	**Discharge (lps)**	
Long	E91°49’30.5”	**Transmissivity (m^2 /day)**	
RL (m amsl)		**Storativity**	

Unique ID: VES 37DHAL

Depth range (m bgl)		**Thickness (m)**	**Resistivity (ohm-m)**	**Inferred Lithology**
From	**To**			
0	0.248	0.248	327	Top soil with sands, clays etc
0.248	5.49	5.25	36	Sands with intercalation of clay etc
5.49	44	38.5	79	Sands etc
Below 44		-	20	Clay with intercalation of sand

Unique ID	VES 38DHAL	**Date/Year**	20/02/2016
Village	CHANDAN NAGAR	**Nearby DW/DCBW/BW Depth**	
Taluka/Block	DURGA CHOWMUHANI	**Yield / discharge**	
District	DHALAI	**Whether borehole was drilled at this point? If yes,**	
Toposheet No.	78 P/16	**Depth Drilled**	
Lat	N 24°11'18.7"	**Discharge (lps)**	
Long	E91°50'40.5"	**Transmissivity (m^2 /day)**	
RL (m amsl)		**Storativity**	

Unique ID: VES 38DHAL

Depth range (m bgl)		**Thickness (m)**	**Resistivity (ohm-m)**	**Inferred Lithology**
From	**To**			
0	0.75	0.75	129	Top soil with sands, clays etc
0.75	6.73	5.98	25	Clay with sand etc
6.73	29	22.3	34	Sands with intercalation of clay etc
29	60.2	31.2	99	Sands etc
Below 60.2		-	22	Clay with sands

Unique ID	VES 39DHAL	**Date/Year**	21/02/2016
Village	MALAYA	**Nearby DW/DCBW/BW Depth**	
Taluka/Block	DURGA CHOWMUHANI	**Yield / discharge**	
District	DHALAI	**Whether borehole was drilled at this point? If yes,**	
Toposheet No.	78 P/16	**Depth Drilled**	
Lat	N 24°12'55.1"	**Discharge (lps)**	
Long	E91°50'34.7"	**Transmissivity (m^2 /day)**	
RL (m amsl)		**Storativity**	

Unique ID: VES 39DHAL

Depth range (m bgl)		**Thickness (m)**	**Resistivity (ohm-m)**	**Inferred Lithology**
From	**To**			
0	0.818	0.818	163	Top soil with sands, clays etc
0.818	7.16	6.34	29	Clay with intercalation of sand
7.16	52.9	45.8	120	Consolidated shale /weathered formation
52.9	343	290	30	Sands with clay etc
Below 343		-	4	Clay etc

Unique ID	VES 40DHAL	**Date/Year**	21/02/2016
Village	BALIGAON	**Nearby DW/DCBW/BW Depth**	
Taluka/Block	DURGA CHOWMUHANI	**Yield / discharge**	
District	DHALAI	**Whether borehole was drilled at this point? If yes,**	
Toposheet No.	78 P/16	**Depth Drilled**	
Lat	N 24°12'05.5"	**Discharge (lps)**	
Long	E91°49'23.1"	**Transmissivity (m^2 /day)**	
RL (m amsl)		**Storativity**	

Unique ID: VES 40DHAL

Depth range (m bgl)	**Thickness (m)**	**Resistivity (ohm-m)**	**Inferred Lithology**

From	To			
0	1.27	1.27	1994	Top soil with sands, boulders/pebbles, clays etc
1.27	6.84	5.57	385	Dry Sands/consolidated shale etc
6.84	17.5	10.6	65	Sands etc
17.5	63.2	45.7	460	Consolidated shale/sandstone
Below 63.2		-	4	Clay etc

Unique ID	VES 41DHAL	**Date/Year**	21/02/2016
Village	SIBARI	**Nearby DW/DCBW/BW Depth**	
Taluka/Block	DURGA CHOWMUHANI	**Yield / discharge**	
District	DHALAI	**Whether borehole was drilled at this point? If yes,**	
Toposheet No.	78 P/16	**Depth Drilled**	
Lat	N 24°07'07.8"	**Discharge (lps)**	
Long	E91°49'02.6"	**Transmissivity (m^2 /day)**	
RL (m amsl)		**Storativity**	

Unique ID: VES 41DHAL

Depth range (m bgl)		Thickness (m)	Resistivity (ohm-m)	Inferred Lithology
From	**To**			
0	1.111	1.111	54	Top soil with sands, clays etc
1.111	5.223	4.112	38	Sands with clay etc
5.223	27.38	22.16	73	Sands etc
Below 27.38		-	26	Clay with intercalation of sand etc

Unique ID	VES 42DHAL	**Date/Year**	22/02/2016
Village	PHULCHARI	**Nearby DW/DCBW/BW Depth**	
Taluka/Block	DURGA CHOWMUHANI	**Yield / discharge**	
District	DHALAI	**Whether borehole was drilled at this point? If yes,**	
Toposheet No.	78 P/16	**Depth Drilled**	
Lat	N 24°11'16.5"	**Discharge (lps)**	
Long	E91°49'26.2"	**Transmissivity (m^2 /day)**	
RL (m amsl)		**Storativity**	

Unique ID: VES 42DHAL

Depth range (m bgl)		Thickness (m)	Resistivity (ohm-m)	Inferred Lithology
From	**To**			
0	1.3	1.3	107	Top soil with sands, clays etc
1.3	2.55	1.25	229	Shale etc
2.55	11.1	8.58	59	Sands etc
11.1	59.5	48.3	147	Consolidated sands etc
Below 59.5		-	Very less	Clay dominated

Unique ID	VES 43DHAL	**Date/Year**	22/02/2016
Village	LAMBUCHERRA	**Nearby DW/DCBW/BW Depth**	
Taluka/Block	DURGA CHOWMUHANI	**Yield / discharge**	

District	DHALAI	**Whether borehole was drilled at this point? If yes,**	
Toposheet No.	78 P/16	**Depth Drilled**	
Lat	N 24°09'43.1"	**Discharge (lps)**	
Long	E91°46'45.9"	**Transmissivity (m^2 /day)**	
RL (m amsl)		**Storativity**	

Unique ID: VES 43DHAL

Depth range (m bgl)		**Thickness (m)**	**Resistivity (ohm-m)**	**Inferred Lithology**
From	**To**			
0	1.333	1.333	210	Top soil with sands, clays etc
1.333	28.16	26.83	73	Sands etc
Below 28.16		-	58	Sands with intercalation of clay etc

Unique ID	VES 44DHAL	**Date/Year**	22/02/2016
Village	NAKASHIPARA	**Nearby DW/DCBW/BW Depth**	
Taluka/Block	SALEMA	**Yield / discharge**	
District	DHALAI	**Whether borehole was drilled at this point? If yes,**	
Toposheet No.	78 P/16	**Depth Drilled**	
Lat	N 24°05'29.9"	**Discharge (lps)**	
Long	E91°48'48.0"	**Transmissivity (m^2 /day)**	
RL (m amsl)		**Storativity**	

Unique ID: VES 44DHAL

Depth range (m bgl)		**Thickness (m)**	**Resistivity (ohm-m)**	**Inferred Lithology**
From	**To**			
0	0.498	0.498	231	Top soil with sands, clays etc
0.498	1.071	0.573	24	Clay with intercalation of sand
1.071	3	1.93	150	Shale/ dry sands etc
3	20.66	17.66	19	Clay with intercalation of sand
20.66	46.05	25.39	12	Clay etc
Below 46.05		-	30	Sands with intercalation of clay

Unique ID	VES 45DHAL	**Date/Year**	23/02/2016
Village	DEBICHERRA	**Nearby DW/DCBW/BW Depth**	
Taluka/Block	DURGA CHOWMUHANI	**Yield / discharge**	
District	DHALAI	**Whether borehole was drilled at this point? If yes,**	
Toposheet No.	78 P/16	**Depth Drilled**	
Lat	N 24°06'03.3"	**Discharge (lps)**	
Long	E91°49'54.4"	**Transmissivity (m^2 /day)**	
RL (m amsl)		**Storativity**	

Unique ID: VES 45DHAL

Depth range (m bgl)		**Thickness (m)**	**Resistivity (ohm-m)**	**Inferred Lithology**
From	**To**			
0	0.826	0.826	40	Top soil with sands, clays etc
0.826	1.944	1.118	20	Clay with intercalation of sand
1.944	23.37	21.42	62	Sands etc
23.37	232.7	209.3	25	Sands with intercalation of clay etc
Below 232.7		-	857	Consolidated shale/dry sandstone etc

Unique ID	VES 46DHAL	**Date/Year**	23/02/2016
Village	ABHANGA	**Nearby DW/DCBW/BW Depth**	
Taluka/Block	SALEMA	**Yield / discharge**	
District	DHALAI	**Whether borehole was drilled at this point? If yes,**	
Toposheet No.	78 P/16	**Depth Drilled**	
Lat	N 24°03'35.1"	**Discharge (lps)**	
Long	E91°49'33.4"	**Transmissivity (m^2 /day)**	
RL (m amsl)		**Storativity**	

Unique ID: VES 46DHAL

Depth range (m bgl)		**Thickness (m)**	**Resistivity (ohm-m)**	**Inferred Lithology**
From	**To**			
0	0.397	0.397	1052	Top hard soil with sands, clays etc
0.397	2.023	1.625	409	Hard dry soil etc
2.023	6.59	4.567	47	Sands with intercalation of clay etc
6.59	13.58	6.991	109	Sands etc
13.58	56.57	42.99	14	Clay with intercalation of sand
Below 56.57		-	49	Sands with intercalation of clay

Unique ID	VES 47DHAL	**Date/Year**	24/02/2016
Village	PURBA DEBICHERRA	**Nearby DW/DCBW/BW Depth**	
Taluka/Block	DURGA CHOWMUHANI	**Yield / discharge**	
District	DHALAI	**Whether borehole was drilled at this point? If yes,**	
Toposheet No.	78 P/16	**Depth Drilled**	
Lat	N 24°05'22.1"	**Discharge (lps)**	
Long	E91°51'02.5"	**Transmissivity (m^2 /day)**	
RL (m amsl)		**Storativity**	

Unique ID: VES 47DHAL

Depth range (m bgl)		**Thickness (m)**	**Resistivity (ohm-m)**	**Inferred Lithology**
From	**To**			
0	1.2	1.2	354	Top hard soil with sands, clays etc
1.2	2.88	1.68	551	Dry Sands/hard soil etc
2.88	6.93	4.04	270	Consolidated Sands/shale etc
6.93	16.6	9.72	77	Sands etc
Below 16.6		-	27	Clay with intercalation of sand

Unique ID	VES 48DHAL	**Date/Year**	24/02/2016
Village	CHANKAP	**Nearby DW/DCBW/BW Depth**	
Taluka/Block	SALEMA	**Yield / discharge**	
District	DHALAI	**Whether borehole was drilled at this point? If yes,**	
Toposheet No.	78 P/16	**Depth Drilled**	
Lat	N 24°04'18.1"	**Discharge (lps)**	
Long	E91°51'06.7"	**Transmissivity (m^2 /day)**	
RL (m amsl)		**Storativity**	

Unique ID: VES 48DHAL

Depth range (m bgl)		Thickness (m)	Resistivity (ohm-m)	Inferred Lithology
From	To			
0	0.331	0.331	373	Top hard soil with sands, clays etc
0.331	36.7	36.3	118	Hard soil/ Sands etc
36.7	104	66.9	46	Sands etc
Below 104		-	93	Consolidated Sands/shale etc

Unique ID	VES 49DHAL	**Date/Year**	24/02/2016
Village	JAMTHUMCHINISINGHPARA	**Nearby DW/DCBW/BW Depth**	
Taluka/Block	SALEMA	**Yield / discharge**	
District	DHALAI	**Whether borehole was drilled at this point? If yes,**	
Toposheet No.	78 P/16	**Depth Drilled**	
Lat	N 24°03'23.7"	**Discharge (lps)**	
Long	E91°50'51.1"	**Transmissivity (m^2 /day)**	
RL (m amsl)		**Storativity**	

Unique ID: VES 49DHAL

Depth range (m bgl)		Thickness (m)	Resistivity (ohm-m)	Inferred Lithology
From	To			
0	2.96	2.96	112	Top soil with sands, clays etc
2.96	7.32	4.36	489	Hard dry soil/sand etc
Below 7.32		-	42	Sands /with intercalation of clay

Unique ID	VES 53DHAL	**Date/Year**	26/02/2016
Village	EAST DOLUCHERRA	**Nearby DW/DCBW/BW Depth**	
Taluka/Block	SALEMA	**Yield / discharge**	
District	DHALAI	**Whether borehole was drilled at this point? If yes,**	
Toposheet No.	79 M/13	**Depth Drilled**	
Lat	N 23°59'40.6"	**Discharge (lps)**	
Long	E91°49'47.5"	**Transmissivity (m^2 /day)**	
RL (m amsl)		**Storativity**	

Unique ID: VES 53DHAL

Depth range (m bgl)		Thickness (m)	Resistivity (ohm-m)	Inferred Lithology
From	To			
0	1.08	1.08	47	Top soil with sands, clays etc
1.08	2.14	1.07	13.3	Clay with fine sand etc
2.14	9.61	7.46	43	Sands with intercalation of clay etc
9.61	29.7	20.1	135	Consolidated shale/weathered formation etc
29.7	42.6	12.9	25	Clay with sand etc
Below 42.6		-	112	Consolidated Sands/sandstone etc

Unique ID	VES 55DHAL	**Date/Year**	27/02/2016
Village	MAINAMA BENGALIPARA	**Nearby DW/DCBW/BW Depth**	
Taluka/Block	MANU	**Yield / discharge**	
District	DHALAI	**Whether borehole was drilled at this point? If yes,**	
Toposheet No.	84 A/1	**Depth Drilled**	
Lat	N 23°57'45.0"	**Discharge (lps)**	
Long	E92°00'13.8"	**Transmissivity (m^2 /day)**	
RL (m amsl)		**Storativity**	

Unique ID: VES 55DHAL

Depth range (m bgl)		**Thickness (m)**	**Resistivity (ohm-m)**	**Inferred Lithology**
From	**To**			
0	1.2	1.2	3515-!!	Top hard soil with sands etc
1.2	5.75	4.55	128	Sands etc
5.75	12.6	6.81	215	Consolidated shale /dry sand etc
Below 12.6		-	93	Sands with intercalation of clay

Unique ID	VES 56DHAL	**Date/Year**	27/02/2016
Village	LALCHERRA	**Nearby DW/DCBW/BW Depth**	
Taluka/Block	MANU	**Yield / discharge**	
District	DHALAI	**Whether borehole was drilled at this point? If yes,**	
Toposheet No.	84 A/1	**Depth Drilled**	
Lat	N 23°55'54.4"	**Discharge (lps)**	
Long	E92°01'44.7"	**Transmissivity (m^2 /day)**	
RL (m amsl)		**Storativity**	

Unique ID: VES 56DHAL

Depth range (m bgl)		**Thickness (m)**	**Resistivity (ohm-m)**	**Inferred Lithology**
From	**To**			
0	0.537	0.537	104	Top soil with sands, clays etc
0.537	3.27	2.73	152	Consolidated Sands etc
3.27	14.5	11.3	23	Sands with intercalation of clay etc
14.5	101	87	7	Clay etc
Below 101		-	35	Sands with intercalation of clay

Unique ID	VES 57DHAL	**Date/Year**	27/02/2016
Village	DINAMOHANKARPARIPARA	**Nearby DW/DCBW/BW Depth**	
Taluka/Block	MANU	**Yield / discharge**	
District	DHALAI	**Whether borehole was drilled at this point? If yes,**	
Toposheet No.	84 A/1	**Depth Drilled**	
Lat	N 23°58'11.6"	**Discharge (lps)**	
Long	E92°02'43.7"	**Transmissivity (m^2 /day)**	
RL (m amsl)		**Storativity**	

Unique ID: VES 57DHAL

Depth range (m bgl)		Thickness (m)	Resistivity (ohm-m)	Inferred Lithology
From	To			
0	0.749	0.749	56	Top soil with sands, clays etc
0.749	5.873	5.123	24	Sands with intercalation of clay
Below 5.873		-	12	Clay with fine sand etc

Unique ID	VES 62DHAL	**Date/Year**	29/02/2016
Village	PASCHIM KARAMCHERRA	**Nearby DW/DCBW/BW Depth**	
Taluka/Block	MANU	**Yield / discharge**	
District	DHALAI	**Whether borehole was drilled at this point? If yes,**	
Toposheet No.	78 P/16	**Depth Drilled**	
Lat	N 24°02'47.8"	**Discharge (lps)**	
Long	E91°59'37.7"	**Transmissivity (m^2 /day)**	
RL (m amsl)		**Storativity**	

Unique ID: VES 62DHAL

Depth range (m bgl)		Thickness (m)	Resistivity (ohm-m)	Inferred Lithology
From	To			
0	1.421	1.421	56	Top soil with sands, clays etc
1.421	2.637	1.217	8	Clay etc
2.637	14.6	11.96	35	Sands with intercalation of clay etc
Below 14.6		-	47	Sands etc

Unique ID	VES 63DHAL	**Date/Year**	29/02/2016
Village	DHUMACHERRA SOUTH	**Nearby DW/DCBW/BW Depth**	
Taluka/Block	MANU	**Yield / discharge**	
District	DHALAI	**Whether borehole was drilled at this point? If yes,**	
Toposheet No.	78 P/16	**Depth Drilled**	
Lat	N 24°00'50.4"	**Discharge (lps)**	
Long	E91°58'03.4"	**Transmissivity (m^2 /day)**	
RL (m amsl)		**Storativity**	

Unique ID: VES 63DHAL

Depth range (m bgl)		Thickness (m)	Resistivity (ohm-m)	Inferred Lithology
From	To			
0	1.411	1.411	73	Top soil with sands, clays etc
1.411	6.614	5.203	30	Sands with intercalation of clay etc
6.614	15.08	8.467	20	Clay with sands etc
15.08	91.25	76.17	53	Sands etc
Below 91.25		-	42	Sands/with clay etc