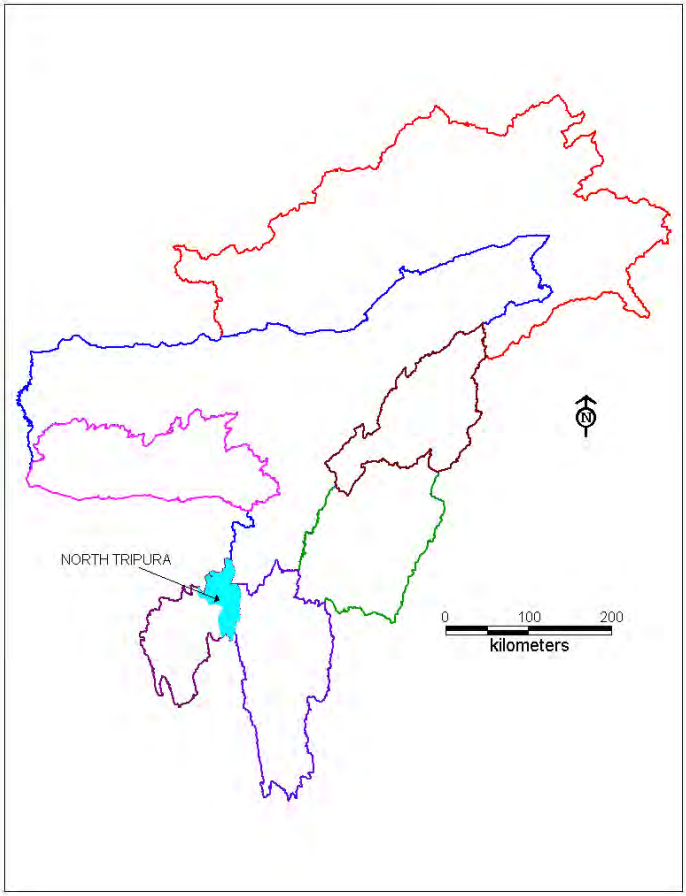
Technical Report Series: D

No: 56/2011-12

Ground Water Information Booklet
North Tripura District, Tripura



Central Ground Water Board

North Eastern Region

Ministry of Water Resources

Guwahati

March 2012

AT A GLANCE
North Tripura District, Tripura

SL. NO.	ITEMS	STATISTICS
1.	**GENERAL INFORMATION**	
	i) Geographical Area (sq. km)	2106.16
	ii) Administrative Divisions (as on 31.3.2008) No. of Blocks No. of Gram Panchayats No. of ADC villages	 8 103 79
	iii) Population (as per 2001 census)	5,90,913
	iv) Average Annual Rainfall (mm)	2430
2.	**GEOMORPHOLOGY**	
	Major Physiographic units	**Hills**- Jampui,Sakhantlang and Longtarai **Valleys**-Dharmanagar and Kailashahar
	Major Drainages	Manu, Juri, Deo and Langai
3.	**LAND USE (SQ. KM)**	
	a) Forest Area	1223.31(58.08%)
	b) Net area sown	424.28(20.14)
	c) Cultivable area	730.23
4.	**MAJOR SOIL TYPES**	Transported soil, residual soil and lateritic soil.
5.	**AREA UNDER PRINCIPAL CROPS (2006 – 07)**	Rice 40815 ha Oil seeds 913 ha Potato 565 ha Maize 341 ha
	Irrigation by Different Sources (Areas and Numbers of Structures)	
	Dug wells	nil
	Tubewells / borewells	360 ha
	Canals	nil
	Other sources - Lift irrigation - Medium irrigation	9534 ha 600 ha
	Net Irrigated Area	8395 ha
	Gross Irrigated Area	14523 ha
7.	**NUMBERS OF GROUND WATER MONITORING WELLS OF CGWB (As on 31.03.08)**	
	No. of Dug wells	7
	No. of Piezometers	0
8.	**PREDOMINANT GEOLOGICAL FORMATION**	Recent formation of Quaternary age and Dupitila, Tipam and Surma formations of Upper Tertiary age

9.	**HYDROGEOLOGY**	
	Major water bearing formation	Tipam sandstone
	Pre-monsoon depth to water level during 2008	1.45 – 8.14 m bgl
	Post-monsoon depth to water level during 2008	1.20 – 4.37 m bgl
	Long term trend for 10yrs (1999-2008) in m/ yr Pre-monsoon Rise-4 stations Fall- 3 stations Post-monsoon Rise-7 stations	 **0.105 - 0.571** **0.047 - 0.112** **0.028 - 0.313**
10.	**GROUND WATER EXPLORATION BY CGWB (As on 31.03.07)**	
	No. of wells drilled (EW, OW, PZ, SH, Total)	EW-13 nos.OW-3 nos.Pz- Nil Total- 16 nos
	Depth Range (m)	145-255
	Discharge (lps)	1.08 to 26.5
	Storativity (S)	2.2×10^{-3} to 4.2×10^{-4}
	Transmissivity (m^2/ day)	4.5 to 1212
11.	**GROUND WATER QUALITY**	
	Presence of chemical constituents more than permissible limit (e.g., EC, F, As, Fe)	Iron up to 12 ppm (in deeper aquifer)
12.	**DYNAMIC GROUND WATER RESOURCES (2004) in mcm**	
	Annual Replenishable Ground Water Resources	341.1
	Net Ground water Draft	23.50
	Projected demand for domestic and industrial uses up to year 2025	46.39
	Stage of ground water development	6.89 %
13.	**AWARENESS AND TRAINING ACTIVITY**	
	Mass Awareness programme organized	Nil
	Water Management Training Programme organized	Nil
14.	**EFFORTS OF ARTIFICIAL RECHARGE & RAINWATER HARVESTING**	Nil
	Projects completed by CGWB (no. & amount spent)	Nil
	Projects under technical guidance of CGWB (nos.)	Nil
15.	**GROUND WATER CONTROL AND REGULATION**	
	No. of OE/ Critical/ Notified blocks	Nil
16.	**MAJOR GROUND WATER PROBLEMS AND ISSUES**	Ground water contain high iron concentration. In shallow aquifer conc. of iron varies from 0.06 to 3.93 ppm and in deeper aquifer it varies from 0.06 to 12 ppm.

1.0 INTRODUCTION

North Tripura district is situated between North Latitudes 23º36′26″ and 24º34′22″ and East Longitude 91º52′20″ and 92º51′00″ falling in the Survey of India degree sheet number 78P, 79M, 83D and 84A. It is bounded by Mizoram and Assam in the east, Bangladesh on north, south and northwestern sides, by Dhalai district on west and southwestern sides. The total geographical area of North Tripura District is **2106.16 sq.km.** Kailashahar, the district headquarters of North Tripura district. Administratively, the district is divided into 3 nos. of sub–divisions which are in turn sub-divided into 8 nos. of blocks. There are 103nos. of gram panchayats and 79 Autonomous District Council (ADC) villages in the district.

Forests cover **1223.31 sq.km (58%)** of the total geographic area of the district. Land not available for agricultural use is **284.68 sq.km (14%)**. The net area sown is **424.28 sq.km** which is only **20%** of the total geographical area.

As per 2001 census, the total population of the district is **5,90,913** persons with a density of 280 persons/ sq.km. The decadal growth rate is 26.49% (1991-2001).

Drainage

The anticlinal hill ranges forms the watersheds from which various drainage channels emerged. The common drainage patterns are sub-parallel to parallel and dendritic. Up to 4^{th} order streams are found in the area. The major rivers in the area are Manu, Deo, Juri and Longai. These perennial rivers are a part of Barak sub-basin which in turn forms a part of Meghna basin.

Irrigation

There is no major irrigation project in the district. However, there is one medium irrigation project viz., Manu irrigation project located at Nalkata in Dhalai district which has command area in North Tripura district. The gross command area under the project is 5220 ha.

The total irrigation potential created so far (2006-07) in the district is **10494 ha** only i.e., only about **25%** of the net sown area. Agriculture is mostly dependent on minor irrigation schemes apart from rainfall. The minor irrigation schemes found in the area are (1) lift irrigation schemes on perennial rivers and cherras, (2) diversions (3) weir (4) tanks, (5) deep tube wells (6) shallow tube wells and (7) artesian wells.

The surface water schemes are the major irrigation sources. During the year 2006-07, out of **10494 ha** of irrigation potential created, the surface water schemes constitute **10134 ha (97%)** and the ground water irrigates only **360 ha (3%)** of the total irrigation potential created. This shows that the ground water utilization is in the primitive stage in the district.

The major crops grown in the area are rice, pulses, oilseeds, potato and other crops. Cropping pattern in the area is paddy oriented. During the year 2006-07, rice is grown in **40815 ha**. During Kharif season farmers cultivate Aman paddy, the main crop of the district. This crop rarely requires any irrigation due to abundant rainfall during the period

Studies / Activities carried out by CGWB

The earlier work on the hydrogeological conditions of Tripura state was carried out by the officers of the Ground Water Divisions of Geological Survey of India and later by the officers of the Central Ground Water Board. Systematic hydrogeological investigations carried out in the district during 1972 – 75. Then the district is covered by Re-appraisal hydrogeological investigations and ground water explorations by CGWB. During 2005-06, ground water management studies in the entire district and exploration at Panisagar were carried out.

2.0 RAINFALL AND CLIMATE

The climate in the area is characterized by moderate temperature and is highly humid in nature. There are three prominent seasons summer, rainy and winter. The summer season spans from March to May and is followed by S W monsoon lasting till September. Winter season starts from November and lasts till the end of February.

Rainfall

The district is having 3 nos. of rain gauge stations located at Dharmanagar, Kailashahar and Kanchanpurr. The **average annual rainfall** for last 35 years (1971 – 2008) of the area is **2430 mm**. Out of that the average monsoon rainfall is 1630 mm. The average nos. of rainy days for last 5 years is 110. Maximum rainfall of 4026 mm (1993) recorded at Kailashahar and minimum rainfall of 1598 mm (2001) recorded at Kanchanpur. The co-efficient of variation of rainfall in the area ranges from 19 – 21% suggested a low variability of annual rainfall.

Other Climatic features

The temperature in the area varies from 5.1^{o}C to 35.6^{o}C. The humidity is generally high throughout the year. In summer season the relative humidity varies between 50 to 90 percent and in rainy season, the relative humidity is over 85 percent in morning and in evening it varies between 70 to 80 percent.

3.0 GEOMORPHOLOGY AND SOIL TYPES

Geomorphology

Physiographically, the area can be divided into two parts, Anticlinal Hill Ranges and Synclinal flat-bottomed valleys. The major hill ranges are Jampui, Sakhantlang and Longtarai. The trend of the hill ranges is almost N – S. The height of the hill ranges increases from west to east. The highest elevation being 975 m above MSL at Betlingshib in Jampui hill ranges. The broad synclinal valleys are Dharmanagar valley and Kailashahar valley. All the valleys become narrow and constricted towards south and widens towards north. The master slope of the valleys is towards north. The valleys are gently undulating with intermittent flood plains of rivers and streams. The undulation formed by 10 – 30 m high mounds with gullies in between them, locally called “loonga.”

Soils

In general, soils of the area are acidic in nature. The pH of soil ranges from 5.50 to 5.64. Nitrogen and phosphate is low, available potash is medium to high, calcium, magnesium and sulfur are deficient in these soils. In the area lateritic soil is found in tilla (hilly / small mounds) area, younger soils or river valley soils are found along all major river courses. Clayey soils are found in paddy fields. Apart from these, sandy loam, clayey loam and loamy soils are also available.

4.0 HYDROGEOLOGY

Water Bearing Formations

There are three hydrogeological units / water bearing formations found in the district. They are Alluvial formation, Dupitila formation and Tipam formation and are shown in fig.1. The details of the water bearing formations are as follows:

(i) **Alluvial formation**: It occurs along the banks of main rivers and its thickness varies 10 to 15 m. Ground water occurs under unconfined condition. Ground water development in the area has not been very significant because of high clay and sandy clay content. Ground water is developed through dug wells and ordinary hand pumps.

(ii) **Dupitila formation**: Dupitila formation is nearly horizontal in disposition and its thickness varies from 10 to 30m. The formation consists of mainly clay and silt with some intercalations of gritty and ferruginous sandstones. It is exposed in the central portion of Dharmanagar and Kailashahar valley. In general, it has low permeability and low storage capacity due to high clay content. It has been developed through dug wells and hand pumps.

(iii) **Tipam formation:** Sandstone of Tipam formation constitutes the principal aquifer in the area. The permeability of this sandstone is much higher than that of Dupitila sandstone or Surma sandstone. The recharge area of the sandstone is in the anticlinal hills. This formation consists of sub-rounded, fine to medium grained, friable sandstone with intercalated clay. Tipam formation is found along the peripheries of valleys. Ground water occurs under semi-confined to confined conditions. This sandstone is developed by deep tube wells and shallow tube wells.

Occurrences of ground water

In shallow aquifer ground water occurs under unconfined and semi-confined to confined conditions. In major part of the area ground water occurs under unconfined condition in shallow depth. Ground water occurs under confined condition within shallow depths in small isolated zones, e.g., in Samrurpar and Jarultali area of Gournagar block, in Radhanagar – Krishnanagar area of Kumarghat block etc. In deeper aquifers of the district ground water occurs under semi-confined to confined conditions.

Nature and depth of Aquifer system in the area

Aquifer system of the area is divided into two types, viz, shallow aquifer within 50 m bgl and deep aquifer between 50 to 300 m bgl.

Dharmanagar valley

This valley is dominated by thick sandstone horizons with thin intervening shale / clay horizons. In the valley 2 to 4 nos. of aquifers can be identified. The first aquifer occurs at 5 to 10 m bgl and its thickness varies from 5 to 15m. In the central part of the valley good productive but comparatively thin granular zones intercalated with shale occur within 90m bgl. However, towards north (Ichailalcherra) and south (Machmara) the thickness of clay / shale is more. Granular zones showing significant thickness are encountered between 110 and 240 m bgl. The deeper aquifers are more consistent and their thickness varies from 15 to 80m.

Kailashahar valley

In the central part of the valley, Kumarghat area, a continuous granular zone of thickness varies from 100 – 135 m occur below 5 m. The thickness of this zone gets reduced towards north and south due to the presence of clay / shale horizons. Other granular zones present at depth are comparatively much thinner and intercalated with clay / shale horizons. Another granular zone of some significance occur below 200m with thickness varies from 25 to 40m.

Depth to water level and seasonal fluctuation

The Board is monitoring water levels of observation wells four times in a year i.e., during January, March, August and November. There are seven observation wells in the district which are located at Bagbasa, Dharmanagar, Gouranagar, Kanchanpur, Kumarghat, Panisagar and Pecharthal. During pre-monsoon period (March 2008), depth to water level in unconfined aquifer varies from 1.45 – 8.14 m bgl. During post-monsoon period (November 2008), depth to water level in unconfined aquifer varies from 1.20 – 4.37 m bgl. The seasonal fluctuation of water level (2008) varies from 0.25 to 4.58 m.

Long term Trend of Water Level

The Board is generating water level data over the years through monitoring of network stations. There are 7 nos. network stations in the district. The data generated was utilised for long-term trend of water levels.

During pre-monsoon season, the trend of water level for the last decade (1999 – 2008) shows a **rise** of water level in **4 stations** ranging from **0.105 to 0.571 m/yr** and **fall** of water level in **3 stations** ranges from **0.047 to 0.112 m/yr.**

During post-monsoon season, the trend of water level for the last decade (1997 – 2008) shows a **rise** in **three** stations with **0.013 to 0.062 m/yr** and **fall** in **three** stations with **0.013 to 0.333 m/yr.**

Aquifer parameters of confined / deeper aquifers

Under Ground Water Exploration programme CGWB has constructed 13 nos. of deep tube wells down to a maximum depth of 255 m bgl tapping Tipam sandstone to determine the aquifer characteristics of the deeper aquifer.

In Dharmanagar valley, 10 nos. of exploratory wells were constructed in the depth range of 145 to 237m. The discharge of the wells varies from 4 to 95 m^3/hr (1 to 26 lps) and the drawdown varies from 4 to 42 m. The transmissivity of the wells varies from 4 to 627 m^2/day, permeability varies from 0.1 to 12.6 m/day and storativity varies from $2.7x10^{-4}$ to $4.20x10^{-4}$.

Exploratory wells constructed at Ichaicherra, Nayapasra, Pecharthal are found to be in flowing / artesian condition. The piezometric head measured varied from 0.42 to 2.85 magl.

In Kailasahar valley, 3 nos. of exploratory wells constructed in the depth ranges from 159 to 255 m. In South Irani a pilot hole was drilled up to 300 m bgl but due to lack of granular zone it was abandoned. The discharge of the wells varies from 85 to 90 m^3/hr and the drawdown varies from 6 to 26 m. The transmissivity of the wells varies from 189 to1212 m^2/day, and the permeability varies from 3 to 24 m/day. The hydrogeological details of exploratory wells constructed is given in table-1.

Springs / seepage zones

Springs / seepage zones are available in the area. Traditionally tribal people living in the hilly areas are using spring water for drinking and domestic purposes. In the foothill areas people used to arrest the spring water by constructing seasonal / permanent bund on small streamlets / cherras and used this water for irrigation purpose and sometimes used for drinking and domestic purposes also. In Kadamtala, Gournagar and Kumarghat seepage zones occur in paddy fields. In hilly areas of Damcherra, Pecharthal and Jampui hill blocks it is reported that springs are available.

Artesian zones

A few artesian zones occur in the district and are depicted in fig.5. These wells are mainly used for drinking and domestic purposes but some of the wells are even used for irrigation purposes. Artesian zones are found in Kadamatala, Panisagar, Dasda, Gournagar and Damcherra blocks. The artesian zones found are discontinuous and are localized phenomenon. It is reported that the wells are constructed within a depth range of 10 to 100 m bgl. Discharge of the wells varies from 0.01 to 0.83 lps during pre-monsoon period and from 0.02 to 1.00 lps during post-monsoon period.

5.0 GROUND WATER RESOURCES

Ground water resources for year 2004-05 of the district were estimated by the GEC'97 methodology. During resource estimation the smallest administrative unit i.e., Block is taken as the unit of computation. The main source of ground water recharge in the district is precipitation.

Other sources of ground water recharge in the area are return flow from irrigation and seepage from ponds / tanks.

Recharge from rainfall in the area accounts for 99% of the total annual recharge. Comparison of monsoon and non-monsoon rainfall recharge shows that monsoon recharge accounts for 51% and non-monsoon recharge accounts for 49% of total rainfall recharge.

Ground water in the area is mostly used for domestic and irrigational purposes. Ground water draft for industrial purpose is negligible and has not been considered. Net ground water available in the district is 341 mcm and ground water draft for all uses is 23.5 mcm. Ground water draft for irrigation and drinking purposes accounts for 47% and 53% of total ground water draft respectively. Block-wise net ground water availability, ground water draft, stage of development and balance ground water available for future irrigation purposes are given in Table–2. It is found that Dasda block having the highest available ground water while Damcherra block is having the lowest. In Panisagar block utilization of ground water is maximum i.e., 582ham**. All the 8 blocks of the district falls under SAFE category.** Panisagar block has the highest stage of development i.e. 12.72% and Jampui hill block has the lowest stage of development i.e. 3.04%.

Table 2: Ground Water Resources Available and Stage of Ground Water Development in the North Tripura district as on 31st March 2004 (in ha m)

Sl. No.	Block	Net Annual Ground Water Availability	Existing Gross Ground Water Draft for All Uses	Allocation for domestic and industrial requirement upto next 25 years	Net Annual Ground Water Availability for future irrigation development	Stage of ground water develop-ment (%)
1	Kadamtala	5113.55	336.98	1053.92	4059.63	6.59
2	Panisagar	4573.83	581.73	758.88	3475.95	12.72
3	Pecharthal	2379.80	79.88	249.83	2129.97	3.36
4	Damcherra	595.20	51.64	161.47	433.73	8.68
5	Dasda	9697.86	424.79	793.50	8733.36	4.38
6	Jampui hill	786.05	23.87	74.69	711.36	3.04
7	Gournagar	5281.76	279.41	873.84	4407.92	5.29
8	Kumarghat	5683.59	572.27	672.85	4653.74	10.07
Total		34111.64	2350.58	4638.98	28605.66	6.89

6.0 GROUND WATER QUALITY

The analytical results show that there is no considerable difference between quality of water from shallow and deeper aquifers.

Suitability of Ground Water for Drinking and Domestic Use:

The p^H values of the ground water ranges from 7.14 to 7.90 for shallow aquifer and from 6.36 to 8.19 for deeper aquifer. The BIS (1991) has recommended acceptable range of p^H from

6.5 to 8.5 for domestic use. The water of the tube well at Panisagar in North Tripura has p^H value of 6.36 otherwise all water of the area is acceptable for domestic use in view of p^H ranges.

Ground water quality in the area is potable and range of all the chemical constituents are within the permissible limit set by BIS (1991), except iron. In shallow aquifer EC values ranges from 75 to 447 and in deeper aquifer it ranges from 105 to 365. Fluoride content in ground water from shallow aquifer ranges from 0.03 to 0.39 ppm and in deeper aquifer it ranges from 0.12 to 0.29ppm.

The iron concentration in ground water from shallow aquifer ranges from 0.06 to 3.93 ppm and in deeper aquifer it ranges from 0.06 to 12.00ppm. During ground water exploration at Panisagar the concentration of iron is found to be 12 ppm.

Suitability of Ground Water for Irrigation Use:

In general, ground water in the area is suitable for irrigation purpose, except concentration of iron is higher than permissible limit.

7.0 STATUS OF GROUND WATER DEVELOPMENT

Ground water is being developed mostly by construction of deep tube wells, shallow tube wells and RCC wells etc .for drinking, domestic and irrigation purposes. These structures are fitted with suitable pumps, Mark II/III or with ordinary hand pumps for withdrawing ground water .In addition to that, there are some shallow tube wells which are auto flow in nature drawing ground water in the district.

Drinking water scenario

In urban areas water supply is done mainly from surface water sources. But in rural areas, deep tube wells and shallow tube wells fitted with suitable pumps provide drinking water to villagers. Water is being supplied directly from deep tube wells without any treatment and certain places water is supplied after iron removal wherever the iron concentration is beyond permissible limit.

There are 138 deep tube wells, 1103 RCC wells in the district. In addition there is one surface water treatment plant in the district.

As on 31-03-2008, out of 1092 habitations, 291 are fully covered, 593 are partially covered and 208 are uncovered so for. The Block-wise no of existing sources and coverage is given in Table-3.

Irrigation scenario

Ground water is being developed for irrigation purposes through deep tube wells; shallow tube wells fitted with pump sets (both electric and diesel pumps) and artesian wells. The use of dug wells for irrigation purpose is negligible. In Kadamtala, Dhamchera, Panisagar and

Gournagar blocks some paddy fields are irrigated through artesian wells / seepage zones. The maximum use of ground water for irrigation purposes is in Panisagar block while in Jampui hills and Pecharthal blocks the use of ground water for irrigation is nil.

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There are 12 nos. deep tube wells, 58 shallow tube wells and 23 artesian wells in the district for irrigation. The Block-wise number of sources as on 31-03-2008 is shown in Table 4.

8.0 GROUND WATER MANAGEMENT STRATEGY

Based on hydro geological situation and yield - draw down relation, the district has been divided into three sectors 'A', 'B' and 'C '. Sector 'A' coincides with the central parts of the valleys, where large yielding tube wells for moderate draw downs are considered feasible, while sector 'B' forms the foothill areas where small yielding tube wells at considerable draw down are considered feasible. Lastly, sector 'C' coincides with the hills of the district which are generally not suitable for tube wells except some intermountain valleys where some very small capacity tube wells may be constructed. Ground water development prospects of shallow tube wells and deep tube wells are depicted in fig 6 and7 respectively.

Shallow tube wells of small yield up to 50m depth can be constructed through 150/100mm diameter well assembly tapping 20 – 30m 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 sector 'A' is expected to be 15 – 20 m^3/hr at 5 – 10m draw down and in sector 'B' the yield of such tube wells is expected to be 10 –15 m^3/hr at draw down 5 – 10m. 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.

Deep tube wells of large yield potentiality down to the depth of 300mbgl can be constructed through 250/150mm diameter assembly tapping 36 – 50m granular zones with 45 – 50m housing length in sector 'A' and with 50 – 55m housing length in sector 'B'. The annular space between the borehole and the well assembly should be shrouded preferably with 100 – 120mm thick zone of pea gravels.

The nature of the aquifer materials shows that gravel packing is required for construction of good tube wells. The slot size is required to be in between 0.50 – 1.00mm and size of gravel between 2 – 4mm. Gravels for shrouding should be composed of quartz and should be sub-rounded to sub-angular.

9.0 WATER CONSERVATION AND ARTIFICIAL RECHARGE

In the area scope for artificial recharge is minimal because water level in the major part of the district lies between 2 – 5 m bgl. As the area receives about 2430mm of annual rainfall construction of rainwater harvesting structures are possible. Apart from roof top rainwater harvesting structures small & medium sized check dams can be constructed.

10.0 GROUND WATER RELATED ISSUES AND PROBLEMS

Water Quality problems

Ground water of the area is characterized by a generally high iron content which ranges from 0.2 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 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.

Drilling Problems

In the area shallow tube wells are drilled manually. It is reported that construction of shallow tube wells is difficult in the foothills and hilly areas of the district due to the presence of hard shale.

11.0 RECOMMENDATIONS

1. The stage of ground water development in the district is only about 7% which indicates that there is ample scope for ground water development in the area. However, the high concentration of iron in ground water may be removed before its use.
2. The present rain gauge density is very low. Additional rain gauge stations may be established both on the wind ward and leeward side of mountains to know any variability in amount of rainfall in the district
3. Research may be taken up on the impact of high iron waters on the soil health and on the growth of various crops, plants etc and their yield because of continuous supply of iron rich ground water for irrigation.
4. Research may also be taken up on the mobility of iron in plants and crops and its concentration in the food grains, seeds, fruits etc, and its impact on human health.
5. More focus should be given to surface water utilization than to ground water because of its high concentration of iron.
6. Conjunctive use of surface and ground water should be taken up in the area for better utilization of waters.
7. The area annually receives nearly 2430 mm of rainfall yet people suffer for drinking water during lean periods. It has been observed that 70 to 80 percent of rainfall occur between May to September and within a few hours most of the rainwater goes as run off and finally enters Bangladesh. Suitable water storage structures may be constructed for utilization of water during lean periods.
8. Ground water contains high concentration of iron in the area. So, iron removal plants are required to be installed wherever necessary for water supply schemes.

9. Roof top rainwater harvesting may be taken up on a large scale for utilization of rainwater in both urban and rural areas for domestic purposes.
10. Safe distance of 500m between two deep tube wells and 150 m between two shallow tube wells should be maintained while constructing tube wells in the district.
11. While constructing deep tube wells or mini deep tube wells gravel packing is a must because the grain size of sandstones (granular zones) is very small. The slot size should be within 0.5 to 1 mm and size of gravel between 2 – 4mm. Gravels should be composed of quartz and should be sub-rounded to sub-angular.
12. Ground water regime including deeper aquifer should be monitored by the State Govt. in view of urbanization and ever increasing population
13. Ground water quality should be monitored both during pre-monsoon and post-monsoon period, especially for iron and arsenic content of ground water because ground water in the neighboring Bangladesh is arsenic infested.
14. In hilly areas springs should be developed. Near by springs, deforestation should be discouraged, spring mouth should remain clean / no clogging should occur to have good discharge.
15. In hilly areas people are facing water crisis during lean periods. Ground water can be developed through dug wells and shallow tube wells in intermountain valleys.
16. Rainwater harvesting should be encouraged, particularly in hilly terrains.
17. Public awareness should be created for proper use and conservation of water.
18. All existing farm ponds and community tanks may be renovated and integrated farming systems involving fisheries and live stock components along with crop production may be taken up to increase the income and water productivity.
19. Installation of low lift points may be intensified throughout the district at suitable locations.
20. Waterlogged areas may be converted into integrated farm ponds.
21. There are around 23 artesian wells in the district, which are continuously discharging ground water. These wells are to be capped suitably so that ground water flow should be regulated according to the needs. It builds up the peizometric head and reduces the wastage of ground water.

Table- 1 Hydrogeological Details Of Ground Water Exploration In North Tripura District

Sl no	Site name /Block /Cordinates	Depth Drilled/ Assembly lowered(m)	Position of slot (m)	Thikness of aquifer tapped(m)	SWL (mbgl)	Discharge		Draw Down (m)	Specific capacity (lpm/mdd)	Transmi - Ssivity (m^2/day)	Permeability (m/day)	Storativity	Rem-arks
						m^3/hr	lps						
Dharmanagar Valley													
1	Ichaicherra	255.2/209	72-85 110-140 182-192 201-206	56	0.42 agl	24.4	6.77	23.4	16.6	7.8	0.1	-	Auto flow
2	Nayapara	251.8/160	66-73 77-103 128-145 148-157	59	2.34 agl	82.4	22.88	25.43	54.3	74.3	12.6		-do-
3	Haflongcherra	232.7/180	80-98 134-154 158-176	44	17.20	3.9	1.08	23.35	2.7	20	0.4	-	Deposit well
4	Dharmanagar	251/210	59-80 135-156 183-204	63	7.15	22.5	6.25	4.30	87.2	340	5.4	-	-do-
5	Sanicherra	250.3/237	73-76 90-95 151-172 184-198 204-213 221-234	59	6.47	11.4	3.16	31	6.1	5.7	-	-	ETW
6	Tilthaigram	250.9/145	45-51 61-76 78-97 113-119 136-142	55	1.12	95.4	26.5	23.2	64.6	627	11.4	-	-do=
7	Panisagar	198/178	83-89 100-137 143-149 162-168	55	23	66	18.33	42.33	26	50	0.9	-	Deposit well
8	Pecharthal N lat $25^0$11'00" E long $92^0$05'07"	292.9/199.8	112-115 144-159 174-198	42	2.85 agl	14.9	4.16	29.50	8.46	4.5	0.1	-	Auto flow

Sl no	Site name /Block /Cordinates	Depth Drilled/ Assembly lowered(m)	Position of slot (m)	Thikness of aquifer tapped(m)	SWL (mbgl)	Discharge		Draw Down (m)	Specific capacity (lpm/ mdd)	Transmi - Ssivity (m^2/day)	Perme-Ability (m/day)	Storativity	Remarks
						m^3/hr	lps						
9	Machmara N lat $24^0$08'19" E long $92^0$07'06"	300.30/184	116-125 128-137 140-149 154-166 175-181	45	0.70	910	25.29	18.44	82.3	222	4.9		ETW
10	Panisagar BSF Camp N lat $23^0$16'30" E long 92^0 09'30"	198/171	83-89 100-134 143-149 162-168	51	23.86	65.98	18.33	41.73	25.98	50.06	0.91	-	-do-
Kailashahar Valley													
1	South Irani	300	Abandoned due to lack of granular zone										ETW
2	Gaurnagar	300/255	88-94 118-124 136-142 172-184 205-208 223-229 250-262	51	1.82	90.4	25.11	6.7	225.9	1212.9	23.7	-	-do
3	Kumarghat N lat $24^0$08'00" E long $92^0$03'00"	250/159	54-72 75-87 92-101 104-111 144-150 150-156	55	1.66	85	23.65	25.75	55.1	189	3.5	$2.2x10^{-3}$	-do-

Table- 3 Block-wise drinking water sources in North Tripura district as on 31.03.08

Sl no	**Name of Block**	**No. of GPs**	**Total No. of Habit a-tions**	**Habita-tion covered by water supply**				No. of existing sources of water					
				FC	PC	NC	% of coverag e	DT W	SBTW	IRPatta-ched to DTW	IRPatta-ched to SBTW	SWTP	M.Well/ RCC Well/ Innovative
1	Dasda	28	193	36	96	61	68.39	23	0	0	0	0	93
2	Panisagar	33	190	67	101	22	88.42	35	0	4	0	0	245
3	Jumpui Hill	7	26	5	9	12	53.84	0	0	0	0	0	15
4	Pecharthal	13	86	11	53	22	74.41	6	0	0	0	1	117
5	Gaurnagar	37	200	55	116	29	85.50	21	0	7	0	0	214
6	Kadamtala	26	140	29	105	6	95.71	21	0	5	0	0	137
7	Kumargha t	29	175	78	87	10	94.28	30	0	10	0	0	221
8	Damcherr a	9	82	10	26	46	43.90	2	0	0	0	0	61
	Total	182	1092	291	593	208	80.95	138	0	26	0	1	1103

Note: DTW= Deep Tube well **SBTW=**Small Bore Tube well **IRP=** Iron Removal Plant
SWTP=Surface Water Treatment Plant **M. Well=**Masonry Well
FC- Fully covered **PC**- Partially Covered **NC**- Not Covered

Table- 4 Block-wise number of Irrigation sources in North Tripura Dist as on 31.03.08.

S.no	Block	No.of GP	Cultivable Land (ha)	Irrigable land (ha)	Present Irrigated land(ha)	No of existing structures									
						L.I	DTW	Div	Sto	STW	Art	Canal	Weir	WSM	Tank
1	Gournagar	37	8167	4615.45	2933.48	47	2	0	0	8	1	0	1	0	0
2	Kumarghat	29	6293	5303.41	3810.15	78	1	0	0	0	0	0	0	0	0
3	Dasda	28	4405	1440.22	831.81	24	0	0	0	3	0	0	2	0	0
4	Jampui hill	7	1000	19.23	0	0	0	0	0	0	0	0	0	0	0
5	Damcherra	9	1402	519.27	270.51	4	0	0	0	5	12	0	2	0	0
6	Pecharthal	13	2626	1373.28	1138.5	29	0	0	0	0	0	0	0	0	0
7	Panisagar	33	7184	4079.57	3242.61	89	5	0	0	6	7	0	3	0	0
8	Kadamtala	26	6801	2875.36	2133.87	32	4	0	0	36	3	0	3	0	216
	Total	182	37887	20225.78	14360.93	303	12	0	0	58	23	0	11	0	216

Note: **LI**= Lift Irrigation, **DTW**= Deep Tubewell, **Div**= Diversion, **Sto**= Storage, **STW**= Shallow tubewell **Art**= Artesian well, **WSM**= Water shed management, **GP**= Grampanchayat