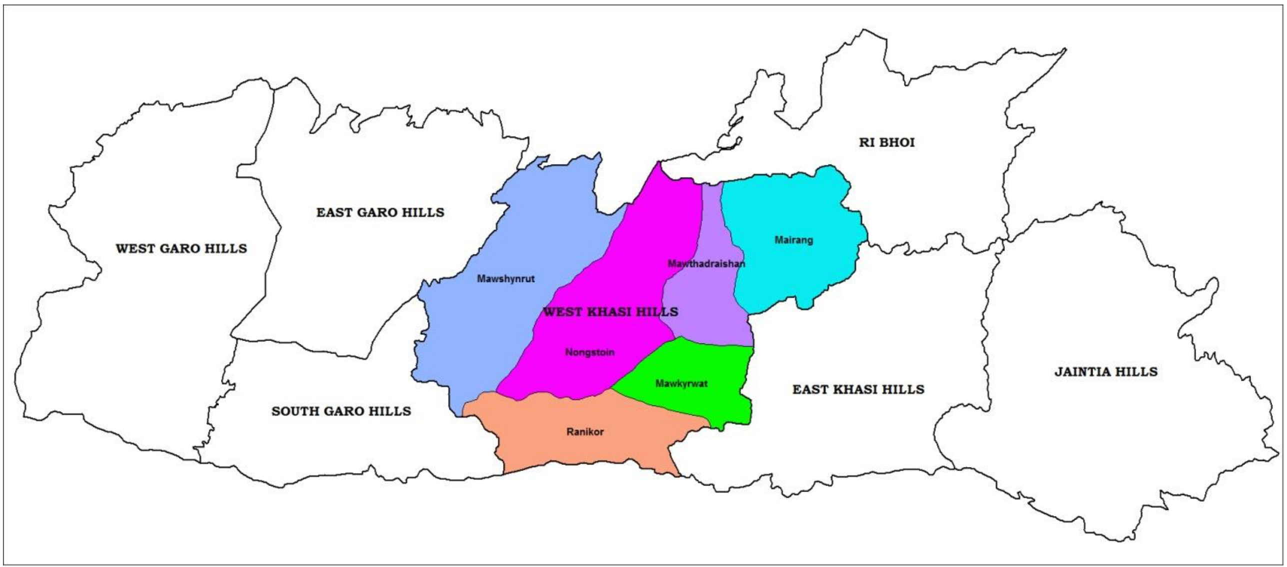
Technical Report Series: D No:

GOVERNMENT OF INDIA
MINISTRY OF WATER RESOURCES
CENTRAL GROUND WATER BOARD

GROUND WATER INFORMATION BOOKLET
WEST KHASI HILLS DISTRICT, MEGHALAYA



North Eastern Region
Guwahati
September, 2013

GROUND WATER INFORMATION BOOKLET
WEST KHASI HILLS DISTRICT, MEGHALAYA

DISTRICT AT A GLANCE

S.No.	ITEMS	STATISTICS
1.	**GENERAL INFORMATION**	
	i) Geographical area (sq. km.) ii) Administrative Divisions Blocks Number of Villages Sub-divisions Towns	5,247 6 a) Mawshynrut b) Nongstoin c) Mairang d) Ranikor e) Mawkrywat f) Mawthadraishan 943 3 2
	iii) Population (*as per provisional 2011 census*)	3,85,601
	iv) Average Annual Rainfall (mm) Source: *Dept. of Agriculture, GOM*	3485
2.	***GEOMORPHOLOGY***	
	Major physiographic units	Denudational low hills and highly dissected plateau in the south with minor valleys. The district is hilly with deep gorges and narrow valleys.
	Major Drainages	Kynshi,Wahkri, Rilang, Rwiang, Umngi Rivers
3.	**LAND USE (Sq Km) (**in 2010-2011**)**	
	a) Forest area	2065.30
	b) Net area sown	301.22
	c)Gross Cropped area	366.89
4.	**MAJOR SOIL TYPES** Source: *Dept. of Agriculture, GOM*	Red Gravelly Soil and Red Loamy Soil
5.	**AREA UNDER PRINICIPAL CROPS** (*as on 2010-11, in sq Km*)	Rice, Maize, Millets, Oilseeds and pulses. Kharif: Rice:77.63, Maize:42.55 Rabi : Rice:0.52, Millets:2.32, Pulses:0.33, Oilseeds:0.56, Sugarcane:0.06 & Tobacco:0.32
6.	**IRRIGATION BY DIFFERENT SOURCES** a. Surface water (sq km) b. Ground water (sq km)	 10 Sq.Km. Mainly by surface water. Negligible.
7.	**PREDOMINANT GEOLOGICAL FORMATIONS**	a. Archaean Gneissic Complex b. Shillong Group of rocks Granitic, Gneissic and schistose rocks with sedimentary rocks like sandstone and limestone.
8.	**NUMBERS OF GROUND WATER MONITORING WELLS OF CGWB** (*as on 31.3.2013*) No of dug wells No of Piezometers	 1 Nil
9.	**GROUND WATER EXPLORATION BY CGWB** (*as on 31.3.2013*)	
	No. of wells drilled (*EW,OW,PZ, SH. Total*)	10 EW and 1 SH Total: 11
	Depth Range (m)	31.5 to 161.35
	Discharge (m^3/hr)	1.5 to 36

10.	**HYDROGEOLOGY** Major water bearing formation • (Pre-monsoon depth to water level, 2009) • (Post-monsoon depth to water level, 2012) • Long term water level trend (2000 – 2009) years, in m/yr	Major water bearing formation are the fractured, fissured and jointed granitic, gneissic rock, Quartzites of Shillong Group, and sedimentary rocks of Khasi Group and Jaintia Group. Weathered zones of these formations are also potential water bearing zones. The sedimentary rocks (sandstone and limestone) also hold good amount of ground water. Mairang: 1.65m bgl Mairang: 1.16 m bgl Rise in water level trend 0.024
11.	**GROUND WATER QUALITY**	
	Presence of chemical constituents more than permissible limits	Sporadic occurrence of high concentration of Fe in few pockets in deeper aquifer
	Type of water	Generally good for drinking & irrigation purposes
12.	**DYNAMIC GROUND WATER RESOURCES** (2008 - 09) (in Ham)	
	Annual Ground Water Recharge	4704 Ham
	Net Annual Ground water draft	2.03 Ham
	Projected demand for domestic and industrial uses upto 2025	1293 Ham
	Stage of Ground Water Development	0.04%, 'Safe' Category
13.	**AWARENESS AND TRAINING ACTIVITY**	
	Mass awareness Programme Organized	Nil
	Water Management Training Programme Organized	Nil
14.	**EFFORTS OF ARTIFICIAL RECHARGE & RAINWATER HARVESTING**	
	Project Completed by CGWB	Nil
	Project under technical guidance of CGWB (nos.)	1 (Mazzarello Orphanage cum Vocational Training Center, Nongkroh, Rambrai has implemented multipurpose rain water harvesting ponds for ground water augmentation).
15.	**GROUND WATER CONTROL & REGULATION**	
	Number of OE Block	Nil
	Number of Critical Block	Nil
	Number of Blocks notified	Nil
16.	**MAJOR GROUND WATER PROBLEMS AND ISSUES**	1. Management and utilization in the steep slopes and limited natural recharge areas. 2. The approach and accessibility to the hamlets and villages is a difficult task and a major impediment in developing the ground water resources. 3. Some pockets are affected with higher concentration of Iron in water (higher than permissible limit prescribed by BIS, WHO), so the water supply agencies should take precautionary measures to provide Iron free water for potable purpose.

GROUND WATER INFORMATION BOOKLET

WEST KHASI HILLS DISTRICT, MEGHALAYA

1.0 Introduction

West Khasi Hills district is the largest district of Meghalaya covering 23% of the total area of the state. The district lies between Latitude 25°10' and 25°51' N and Longitude 90°44' and 91°49' E with a total geographical area of 5,247 sq. km. It is bounded on the north-west by Kamrup district of Assam, on the north-east by Ri Bhoi district, on the east by East Khasi Hills district, on the south by Bangladesh, on the west by East Garo and South Garo Hills districts. West Khasi Hills district was carved out from Khasi hills on 28.10.1976. The district headquarters is Nongstoin which covers an area of 76 sq. km. Mairang, Mawshynrut and Mawkyrwat are the three civil Sub-Divisions of the district. As per provisional 2011 census, the population in this hilly and tribal district is 3,85,601 with male population of 1,94,628 and female population of 1,90,973. The main occupation of the population in the district is agriculture.

2.0 General Features

2.1 Land Use

The land utilization of the district is presented in the **Table 1.1.**

Table 1.1: Land utilization statistics of West Khasi Hills (2010-11)

Land Classification	Area (sq. km.)
Geographical area	5247
Forest area	2065.30
Non-Agricultural area	732.01
Cultivable Waste Land	1437.38
Fallow Land	658.73
Net Area Sown	301.22
Area Sown more than once	65.67
Gross cropped area	366.89

Source: Directorate of Economic and Statistics, Meghalaya

The district has a forest area of 2065.30 sq. km. that is about 40% of the total area. The net area sown is 301.22 sq. km. and the total cropped area is 366.89 sq. km. Thus, in West Khasi Hills district, fallow land covers about 13%, net area sown is about 6%, and the total cropped area is about 7%.

2.2 Rainfall & Climate

The Climate of the district varies in latitudinal and longitudinal directions and is influenced mainly by physiography. There are four seasons in the district namely summer, monsoon or rainy, autumn and winter. The summer season extends from the end of March to mid May, which is characterized by relatively high temperature, occasional thunderstorm with high wind velocities. The rainy season commences with the onset of southwest monsoon in April and lasts up to October. This is followed by short autumn from mid October to November. This season indicates the slow retreating of monsoon with clear and sunny sky. The winter season extends from December to the end of March. This is the coldest season of the year with sharp decline in the temperature. During winter, some high altitude areas of the state experiences very cold nights. Winter is basically dry with lower diurnal range of temperature.

In general, the district has a mildly tropical climate in the northern and southern foothills, whereas central upland portion experiences temperate climate and the places of medium altitude of the northern, southern and western parts of the district experience sub-tropical climate.

The district receives a fairly high rainfall throughout the year. Most of the precipitation occurs during the rainy season i.e. between April and October due to SW monsoon. The average rainfall in some of the selected stations of the district is presented in **Table 1.3.**

Table1.3: Average Rainfall (mm) of Selected Stations in West Khasi Hills

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Nongstoin	15.4	19.5	110.7	245.2	355.5	707.9	985.8	542.6	361.3	224.6	32.41	7.21	3608.06
Mairang	21.1	17.2	61.9	115	276	520	637	342	255	220	32.6	7.02	2505.7
Riangdo	21.3	30.4	58.3	198	359	563	677	575	358	202	30.2	7.32	2986.6

Source: Directorate of Agriculture, Shillong

It is observed that June, July and August are the periods when the district receives the maximum rainfall and highest rainfall occurs in the month of July.

2.3 Geomorphology and Drainage

Geomorphologically the district is an undulatory terrain with the E-W trending Khasi hill ranges of Central Upland zone. The West Khasi Hills district also represents the remnant of ancient plateau of Indian Peninsular shield that is deeply dissected suggesting several geotectonic and structural deformities that the plateau has undergone. The average altitude of the Central Upland is about 1,300 m above Mean Sea Level. The highest peak is “Kyllang rock” touching a height of 1774 m.amsl (metres above Mean Sea Level). Mawthadraishan range, trending east – west, is the most significant hill range of West Khasi Hills District. Other northern, southern and western parts have a general altitude of 150 to 900 m.amsl. Geomorphologically, the district represents denudational hills of old gneissic and schistose rocks except in the southern parts where highly dissected plateau are observed. Few narrow elongated intermontane valleys are seen along major lineaments. The drainage system of the district is controlled by topography. The east-west trending central upland acts as water divide dissecting the district into two drainage basins. The northern system drains out into the mighty Brahmaputra River in the adjoining Assam state and the major drainage system in the south drains into the Meghna basin merges into the Bangladesh plains. Kynshi is the major river that originates in the southern slope of Marpna peak near Mawmaram village. This river is joined by number of tributaries on its westerly course ultimately draining into Bangladesh. Another River Khri rises near Kyllang rock flowing northward into Assam plains. Other important Rivers of the district are Umngi, Wahblei, Riangdo, Rilang, Tyrsung, Ryndi, Rwiang etc. The drainage pattern of the district is angular to sub-angular and is found to be structurally controlled.

Broadly, the district can be differentiated into the following geomorphic units.

- **Denudational Low and High Hills:** It occupies the major part of the district comprising of hard rocks like granite and gneiss. It is moderately dissected by fractures and joints forming a good number of narrow intermontane valleys.
- **Dissected Plateau:** It is found in the southern portion of district comprising of soft and friable rocks like shale, sandstone and quartzite.
- **Deep Gorges:** It is exposed in the southern parts comprising of Tertiary rocks like sandstone, shale and limestone.

2.4 Soil Type

The district shows different types of soil as the provenance differs widely. Red Gravelly and Red Loamy Soil are the common soil types. The soils are acidic in nature and comparatively rich in organic matter and nitrogen but poor in phosphorous.

2.5 Agriculture and Irrigation

Agriculture, though not much, is still the main occupation of the poor rural people. Only 3% of the total geographical area is sown. Mainly shifting or Jhum cultivation is practiced. About 12.44% of the total population is engaged in such cultivation.

The principal crops grown in the district are rice, maize, millets, oilseeds and pulses. Horticulture products include orange, pineapple and banana. Vegetables like potato, sweet potato, ginger, garlic etc. are grown. Broadly the low lying areas are put under paddy during Kharif and with pulses, paddy, vegetables and oilseeds during the Rabi season depending on the availability of residual moisture and irrigation facilities. Gentle slopes up to 20% are put under other crops like wheat, paddy, maize, pulses, oilseeds, vegetables etc, which not only contribute towards food security but also yield substantial revenue returns per unit of land and labour. On such slopes the concept of watershed management of land and water is encouraged. Horticulture is taken up on slopes above 20% and Border Areas, which are traditional horticultural areas. Forest cover in the State (40%) is below the national norm of 60% recommended for hilly areas. This is because a sizable proportion of the Forest area is reportedly under shifting cultivation resulting in depletion of the Forest Cover. A very meager proportion of the geographical area is net sown area, including area under shifting cultivation. The potential net sown area could be increased if and when the fallow lands are utilised for cultivation purposes. The cultivable waste land of the state is 27.4% of the geographical area a part of which might be progressively utilised for cultivation purpose in the long run. The cropping intensity of the state is 121%.

Although at present no hydel/thermal project is existing in the district, some are in the execution stage like the 240 MW Nongjiri and 450 MW Kynshi project. There are only minor irrigation schemes in Mairang Block and hence the agricultural development in the area is dependent on it. The existing irrigation schemes are based only on surface water. Majority of the projects are flow irrigation type as the district is hilly. **Table 1.2** presents the salient features of some of the minor irrigation schemes in Mairang Block.

Table 1.2: Salient Features of Minor Irrigation Projects in Mairang

Name of the project	Block	Year of Completion	Command Area (sq. km.)
Kynshi LIP	Mairang	1976-1977	2.56
Mawnai-Mawkshu FIP	-do-	1991-92	0.31
Tienglam FIP	-do-	1993-1994	0.14
Pdem FIP	-do-	1996-1997	1.31
Bynther FIP	-do-	1996-1997	0.42
Kynrud FIP	-do-	1997-1998	0.93
Patharsyngkhaw FIP	-do-	2000-2001	0.75
Phudumjer FIP	-do-	2000-2001	0.31
Madan Umthied FIP	-do-	2004-2005	0.32
Ladpnarrim FIP	-do-	2005-2006	0.24
Total			7.29

(Source: Irrigation Department, Government of Meghalaya)

2.6 Work done by CGWB

Central Ground Water Board has carried out Water Supply Investigations, Ground Water Exploration and District Ground Water Management Studies in the district. Under Technology Mission on drinking water in villages, water management feasibility studies in West Khasi Hills were prepared by CGWB along with PHED during 1986. During the Annual Action Plan for 2001-02, District Ground Water Management Studies were carried out in the district. Further, a part of the district i.e. Mairang Block was covered as part of District Ground Water Management Studies in the year 2006-07. Study for scope of development of water supply through springs in the district was carried out during AAP 2010-11.

Ground water exploration was initiated in the district for the first time during the AAP of 1996-97 with the drilling of one exploratory well in Sohiong. And till date about 11 wells have been drilled in the district.

3.0 Geological Set-up

The district area falls mainly within the Shillong or Meghalaya Plateau which is constituted mainly of Precambrian rocks of gneissic composition in which granites, schists, amphibolits, calc-silicate rocks occur as inclusions of various dimensions.

The gneisses form the Basement Complex for the overlying Shillong Group of rocks and these are separated from the later by an unconformity indicated at places by the occurrence of a conglomerate bed. Occurrence of an isolated exposure (Strike: NE-SW) of conglomerate bed is seen at Nongbri. The presence of primary structures like current bedding, ripple marks etc. indicate that quartzites of the Shillong Group are of sedimentary derivative later metamorphosed to quartzites. These occur mostly as thick layers.

The Khasi basic ultrabasic Intusives comprising basic intusive like epidiorite, metagabro, metadoleraite etc occur mostly as sills, dykes in the various sub-facies of Shillong Group. In the study area one such exposure noticed in the North-Western part of the district where it intruded the Basement Gneissic Complex.The rocks are generally dark green, medium to coarse graines and massive.In weathered outcrops, the basic rocks give a reddish brown colour.

Grainite Plutons occur as isolated patches in the district and cover an area next to area covered by Basement Gneissic complex.The South Khasi Granites (?) occur as intrusive body in the Basement Gneissic complex. Both Porphyritic and fine-grained pink granite form the South Khasi Granite.

The Sylhet Traps are of the nature of plateau basalts exposed in a narrow E-W strip along the southern border of the area and their anticipated thickness is 550-680 m. The Sylhet traps comprise predominantly basalts, rhyolites and acid tuffs.

The Cretaceous sediments exposed in the Meghalaya Plateau are classified as Khasi Group. The Mahadek Formation, the top unit of the Khasi Group, consisting of coarse arkosic sandstone, often gluconitic, are found exposed in the extreme southern part of the district.

The Shella Formation of Jaintia Group consists of alteration of sandstone and limestone occurs in the south-central and south-western part of the district.

The Quaternary fluvial sediments occur in the extreme northern part of the district bordering Assam.

Generalised geological succession of the area is given in **Table. 3.1**

Table 3.1General Geological Succession

Geological Age	Group	Formation	Rock Type
Quaternary			Undifferentiated fluvial sediments
~~ Unconformity ~~~~~~~~~~~~~~~~~~~~~~~~~~~			
Palaeo- Eocene	Jaintia Group	Shella (600m)	Alteration of sandstone and limestone.
Cretaceous	Khasi Group	Mahadek (150 m)	Arkosic sandstone (Often Gluconitic & Ureniferous)
~~ Unconformity ~~~~~~~~~~~~~~~~~~~~~~~~~~~			
Cretaceous	Sylhet Trap (600 m)		Basalt, Rhyolite, acid tuff.
~~ Unconformity ~~~~~~~~~~~~~~~~~~~~~~~~~~~			
Neo-Proterozoic – Lower Palaeozoic		Granite Plutons	Porphyritic coarse granite, pegmatite, aplite/quartz vein etc.
Intrusive Contact			
Proterozoic (Undiff)	Khasi Basic-Ultrabasic intrusives		Epidiorite, dolerite, Amphibolite and pyroxenite dykes and sills
Palaeo-Mesoproterozoic	Shillong Group	Upper Division Lower Division	Mainly Quartzites intercalated with phyllites. Mainly schists with Calc Silicate rocks,carbonaceous phyllite and thin quartzite layers.
~~ Unconformity (Shared conglomerate) ~~~~~~~~~~~~~~~~~			
Archaean(?)-Proterozoic (Undiff)	Gneissic Complex (Basement Complex)		Mainly quartzofeldspathic gneiss with enclaves of granites,amphibolites, schists etc.

4.0 Ground Water Scenario

4. 1 Hydrogeology

Hydrogeologically, the district can be divided into two units, namely consolidated and semi consolidated formations.

4.1.1 Consolidated Formation

About two third of the district is occupied by consolidated formation. Consolidated formations are like the Archaean Gneissic Complex, acid / basic intrusive, and the Pre-Cambrian quartzite and phyllites of Shillong Group of rocks. The northern part of the unit is considerably more compact and the development of fractures is limited. These formations lack primary porosity and the movement and occurrence of ground water is controlled by physiography, depth of weathering and interconnected zones of weakness or secondary porosity like joints, faults etc. Yield is expected to be moderate in the intermontane valleys and moderate to good along the fractures where intersection of more than one set of fractures and joints are present. The weathered portion acts as ground water reservoir within shallow depth. Groundwater occurs under unconfined conditions in the weathered residuum and semi-confined conditions in secondary porosity like fractures, fissures etc.

At hydrogeologically feasible situations, well drilled down to a depth of about 80 -150 m below ground level may yield a moderate discharge of 5-15 m^3/hr in Archaean and Pre-Cambrian Group of rocks whereas the acid and basic counterparts have a discharge of 5-10 m^3/hr. Water level is found to occur between 2 to 15 m bgl. The valley areas are found to be favourable for the construction of dug wells and bore wells. The exploratory well at Mairang Town, drilled down to 161.35 in Granitic gneiss has yielded about 36 m^3/hr.

The southern portion of this consolidated unit is dissected plateau with a number of low hills giving rise to undulating topography. As compared to the northern section, this unit is more dissected by a good number of fractures which allows a good amount of ground water for its recharge. Here, the weathered zone is also thick (about 10-12 m) though it is not distributed over large area. Therefore, in this area, ground water prospect is better than the northern belt.

4.1.2 Semi-consolidated Formations

The southern and south-western belt comprises sedimentary formations. It includes limestone, sandstone and shale inter bedded with the coal seams. In these areas where dissection is severe, the ground water prospects are good. As the rocks of this place are argillaceous in nature, the permeability is low. Sandstone with limited porosity yields water through secondary fissures like joints. Shale in many cases acts as aquiclude. The aquifers are thick and discontinuous in nature. Ground water is found to occur under confined to semi-confined conditions with yield of 10-25 m^3/hr. Water level is found to rest between 2 and 4 m bgl. The areas which are favourable for construction of shallow as well as deep tube well are the synclinal and intermontane valleys.

4.2 Water Supply

Public Health Engineering Department, Government of Meghalaya is responsible for supplying drinking water for this district. The source of water supply of the state and the district is given in **Table 4.1** From the figure in the table it is observed that 26% of the total household water supply of the district is meeting through spring water.

Table 4.1 Source of water supply

Location	Tap	H.P.	T.W.	Well	Tank/ Pond/ Lake	River/ Canal	Spring	Others
West Khasi Hills District	24	1	3	32	8	5	26	1
Meghalaya	199	12	19	227	44	47	228	15

4.2.1 Springs as source of Irrigation and Drinking Water

Springs are naturally occurring discharge features of groundwater flow systems. A large number of rural villagers are utilising the naturally available springs in this district to fulfill their various needs. One thermal spring is present at Jakrem under Mawyrwat Block. In West Khasi Hills district different type of springs are noticed. As per genesis these are Depression/Topographic, Contact/Stratigraphic, Seepage, Tubular/Fracture and Artesian/Thermal spring. As per Meinzers classification the springs of the district are mainly of 7^{th} to 8^{th} order. Long term spring discharge analysis shows that except Nongstoin block in all other blocks, the discharge is progressively declining. From the spring source area size calculation, using water balance method, it is observed that individual spring of the district is getting recharged from rainfall and varies from 18.3 mm to 100.0 mm. From this it can be concluded that though the area is receiving a huge average annual rainfall of 3485 mm but, ground water recharge component is negligible. Except one spring rest of springs are having a catchment area of less than 0.01 ham. Therefore, development of spring catchment area needs to be done to make more scope for rainfall recharge or where development process cannot be taken up, at least existing catchment area should be protected. It is observed that though a large number of rural villagers are utilising naturally available springs in this district to fulfill their various need, there is hardly any action taken for spring catchment area development. On the contrary, in Mairang block at Mawnai village, a case has been observed that at a spring catchment area is traditionally developed by the villagers for its sustainable use. In the upstream of the spring two small pond like structure has been constructed to store the rainwater. Also, the stored water is recharging the ground water and the nearby spring in the downstream is getting direct benefit and thereby running throughout the year. It is observed that 26% of the total household water supply of the district is met through spring water.

Though the agriculture of the district mainly depends on monsoon rainfall, during rest of the months i.e. during dry spell, villagers are using spring water for their individual agricultural plot.

4.3 Ground Water Exploration

11 numbers of wells have been drilled in West Khasi Hills and 3 wells were abandoned due to poor discharge. A perusal of the drilling data reveals the depth-drilled ranges from 31.5 m up to 161.35 m bgl. The aquifer system of the district is mainly Granitic gneiss and quartzite. The discharge value ranges from 1.5 to 36 m^3/hr with a maximum draw down of 15 m. The exploratory well at Mairang Town, drilled during March 2012 has yielded about 36 m^3/hr, which is the highest discharge recorded from borewells so far. The depth to water level varies from 0.9 to 7.37 m bgl.

Table: 4.2 Summarised Details of Ground Water Exploratory Wells

Location	Depth drilled (m.bgl))	Aquifer type	Aquifer tap/zone (m)	SWL (mbgl)	Discharge (m^3/hr)	DD (m)
Mawkhap	80.3	Granitic gneiss		2	3	8
Nongrynkiew	80	Granitic gneiss		1.5	10	
Nongjyllieh	80	Granitic gneiss	41.0-42.0,67.5-68.5	1.35	8.4	12
Parsohsad	80	Granitic gneiss		0.9	1.5	15
Diengiong	80	Quartzite		--	---	---
Mairang	39.5	Granitic gneiss		---	1.5	---
Mawpat Dongkiigdiang	61.8	Quartzite	23.0-25.0	1.7	1.55	---
Nongbari	31.5	Granitic gneiss		---	0.6	---
Sohiong	64	---	14.1-15.1,21.2-23.2,24.2-27.3	1.7	5.32	---
Umtholong	80	Granitic gneiss	17.9-26.1,35.2-40.3, 61.7-65.7,75.9-80.0	1.69	5.33	12
Mairang Town	161.35	Granitic gneiss	12.5-14,20.6-22,142-161.35	7.37	36	---

4.4 Ground Water Resources

The dynamic groundwater resources have been assessed based on Ground Water Resources Estimation Methodology of 1997 (GEC 97). In this methodology, two approaches are recommended – water level fluctuation method and rainfall infiltration method. As the data of ground water level is insufficient, the rainfall infiltration method is used for calculating the resource estimation of the district. Moreover, hilly area having slope of more than 20% are not taken into consideration as they are not worthy of recharge. Hence, the remaining area is delineated into command and non-command area and assessment is done for both monsoon and non-monsoon seasons. As per the Rainfall Infiltration Factor method, recharge from rainfall is given by the following formula.

(R_f) = RIF *A * NMR

Where RIF = Rainfall Infiltration Factor

A = Area of computation for recharge.

NMR = Normal Monsoon Rainfall

Recharge from sources other than rainfall, ground water irrigation, recharge from ponds and tanks, check dams, nalla, bunds are taken as **nil** for the district and only surface water irrigation is taken into account. The total annual recharge is obtained as the arithmetic sum of recharge from rainfall and the recharge from sources other than rainfall. Thus, Ground Water Resource Potential (as on March 2009) in ham is as follows **(Table 4.2 and Table 4.3).**

Table: 4.2 Net ground water availability (ham)

Annual Replenishable GW resources				Total annual ground water recharge	Natural discharge during non-monsoon season	Net ground water availability
Monsoon season		Non-monsoon season				
Rainfall recharge	Recharge from other source	Recharge from rainfall	Recharge from other source			
4312	Nil	914	Nil	5226	522	4704

Table 4.3: Categorization of ground water resources

Net Ground water availability	Annual GW draft			Domestic and industrial uses upto 2025	Ground water availability for future irrigation	Stage of ground water development (%)	Categorization
	Irrigation	Domestic and industrial uses	Total				
4704	Nil	2.03	2.03	1293	3411	0.04	**Safe**

The total annual ground water recharge in the West Khasi Hills District is 5226 Ha m (Hectare metre). The Net annual Ground Water Availability of the West Khasi Hills District works out to be 4704 Ham after deducting the natural discharge during non-monsoon season. At present there is no Ground Water draft for irrigation and the annual domestic draft is 2.03 Ha m, the Gross Ground Water draft for all uses is 2.03 Ha m. The annual allocation for Domestic and Industrial uses has been made as 1293 Ha m based upon the population data projected upto the year 2025. Thus the Net Ground Water Availability for Future Irrigation use works out to 3411 Ha m. The over-all stage of ground water development of the West Khasi Hills District is a meager 0.04% and hence categorised as **SAFE**. Ground water development is yet to be picked up in the district. Thus, there is abundant scope for utilization of available ground water resources in the district.

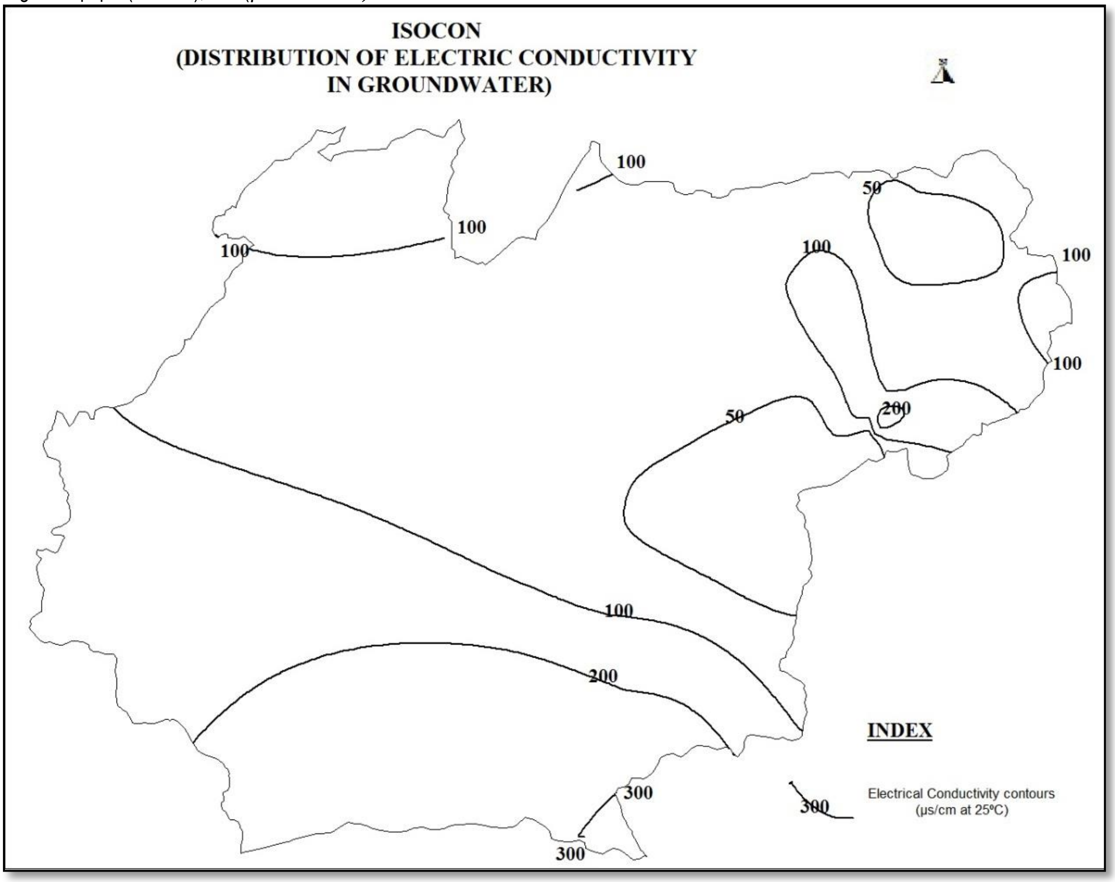
4.5 Ground water quality

In order to study the chemical quality of ground water, representative water samples were collected from selected dug wells and springs (**Table 4.4**). The parameters analyzed in the Chemical Laboratory of CGWB, NER, Guwahati are pH, EC, TDS, CO_3, Cl, SO_4, F, Ca, Mg, TH and Fe. Overall, the chemical constituent present in the ground water is within permissible limit set by BIS (1991), and is good for drinking, irrigation and industrial purposes. Sporadic occurrence of higher concentration of Iron is reported from some localities. The iron content ranges from 0.03 to 0.93 mg/lit (high iron content in spring water is observed at Sakwing village under Mawkirwat block. In Mawkirwat iron content is 2.00 mg/lit which is higher than the permissible limit). Iron is not hazardous to health, but it is considered a secondary or aesthetic contaminant.

Table 4.4: Chemical Analysis of Ground Water of West Khasi Hills District

Location	Type	Date	pH	EC	TDS	HCO_3	Cl	SO_4	F	Ca	Mg	TH	Fe
Kynrud	Spring	14/6/06	6.4	86	56	31	11	1.0	0.1	8.0	2.4	30	0.18
Mawkarah	-do-	-do-	6.58	128	83	37	6.1	11	0.6	12	2.4	40	0.3
Mawphaniew	-do-	-do-	6.6	110	72	18	14	BDL	0.0	4.0	1.2	15	0.08
Nongkhlaw	Dug Well	-do-	6.6	55	36	18	3.5	-do-	0.0	6.0	1.2	20	0.5
Mawshut	Spring	17/6/06	6.5	116	75	12	18	-do-	0.0	8.0	2.4	30	0.09
Mawlong	-do-	15/6/06	6.68	52	34	24	3.5	-do-	0.3	4.0	1.2	10	0.05
Nongbri	-do-	15/6/06	6.62	41	27	12	7.1	-do-	BDL	6.0	2.4	25	0.03
Laitshed	-do-	17/6/06	6.64	31	20	12	7.1	-do-	-do-	2.0	1.2	10	0.20
Laidom	-do-	-do-	6.74	93	60	24	11	5.0	0.18	8.0	2.4	25	0.93
Mawkhap	-do-	-do-	6.82	128	83	43	11	9.0	0.30	10	3.6	40	0.14
Mawpat	Dug Well	21/6/06	6.95	28	18	18	3.5	BDL	0.21	4.0	1.2	15	0.09
Maranglang	Spring	1989	7.7	53	---	31	7.0	---	---	4.0	1.0	15	---
Nongmowlein	-do-	-do-	8.2	21	---	18	14	---	---	6.0	2.0	25	0.10
Rongthang	-do-	-do-	7.7	24	---	18	11	---	---	6.0	1.0	20	0.30
Pohjaud	-do-	-do-	7.7	31	---	18	11	---	---	4.0	2.0	20	0.40
Mawthapdaw	-do-	-do-	8.0	21	---	18	11	---	---	4.0	1.0	15	0.05
Mawsaw	-do-	-do-	8.1	19	---	49	7	---	---	6.0	4.0	30	0.40
Nongbothalong	-do-	-do-	7.8	21	---	24	11	---	---	4.0	4.0	25	0.05
Mairang	Dug Well	March 2008	7.30	270	617	43	43		0.02	22	4.9	75	0.10

All units in mg/l except pH (no units), E.C (µS/cm at 25°)



5.0 Ground Water Management Strategy

5.1 Ground Water Development

As the district is underlain by consolidated and semi-consolidated formations, the fractures and joints act as a good repository for the development of ground water. Lineaments studies through

Remote Sensing and Electrical Resistivity Surveys can be of great help in this field. Structures like ring wells, shallow as well as deep tube wells are the feasible ground water structures.

All the minor irrigation schemes in the district are dependent upon the surface water resources. As per ground water resource estimation by CGWB, the stage of ground water development is only 0.04 % and there is enough scope for future development of ground water resource in the district. Ground water development is being done through dug well and bore well in the intermontane valleys. This is mainly used for domestic purposes such as washing and drinking. Springs play a pivotal role in rural water supply scheme. The development of spring as a source of water is seen mainly along the foothills or fracture zones. As a part of ground water exploration programme of CGWB, the Board had drilled ten exploratory wells in the district. The depth of the exploratory well ranges from 31.5 to 161.35 m below ground level. The depth to water level ranges from 0.9 to 7.37 m below ground level. The discharge of the wells varies from 1.5 to 36 m^3/hr. However, the ground water development is yet to be picked up in the district

6.0: Ground Water Related Issues and Problems

West Khasi Hills district is basically a hilly one. Steep slopes and rugged terrain offers limited scope for recharge and development of ground water. Moreover, approachability is a big constraint for an assured water supply in the hamlets/ villages situated on hilltops or steep slopes. Population stress and thereby scarcity of potable water is rising day by day in the district.

There is no major or medium irrigation projects in this district. Major part of the minor irrigation schemes are running only in Mairang block. Irrigation practice utilising ground water by constructing bore well is negligible in this district.

Spring catchment areas need to be protected. It is observed that peoples are destroying the spring catchment by construction of houses or through agricultural practice whereby the soil is eroding. No specific data is available with the State Government that how much area of the district is irrigated by utilising spring water.

7.0: Recommendations

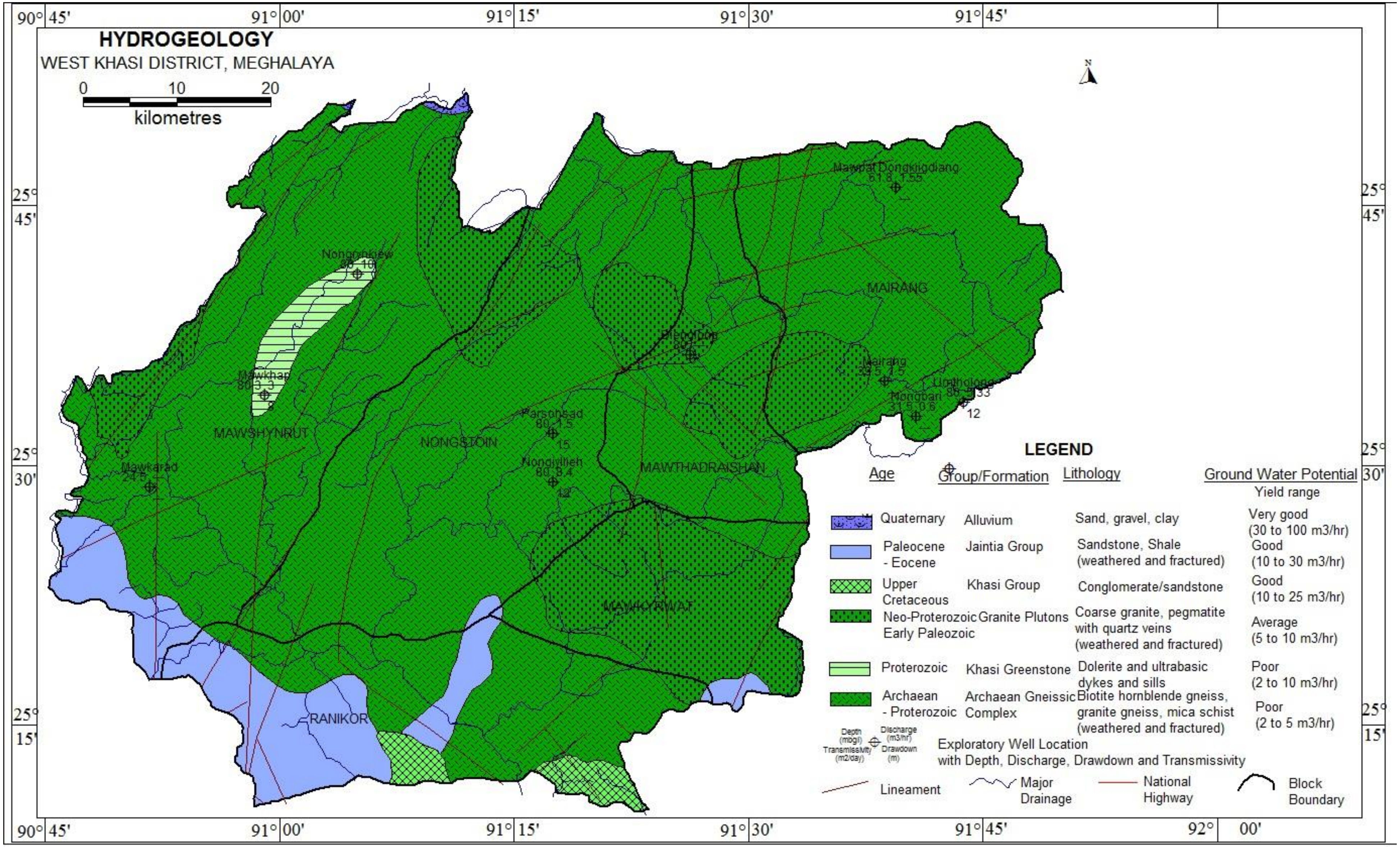
Development of ground water in the district is still in nascent stage. Thus, there is ample scope for future development of ground water in the district. It is being done through dug well and bore well in the intermontane valleys and linear ridges. In the foothills where most of the precipitation get wasted as surface runoff, rain water harvesting should be promoted by constructing structures such as gully plugs, check weirs and check dams and also roof-top rain water harvesting structures. In doing so, the water level on the upstream can be raised to a considerable extent. For roof-top rain water harvesting, rainwater can be collected from the PVC/GI or concrete rooftops through bamboo, GI or PVC gutters and pipes. This water can be used for domestic uses including drinking purposes after treatment.

The intermontane valleys are the most favorable places for ground water development. Structures like ring/dug well, shallow and deep bore well are feasible for ground water abstraction. Hydrogeological studies have indicated that lineament, joint, fracture and fault are the main controlling factors for the occurrence and distribution of ground water. These structures can be targeted for ground water development. Thus, the potential fractured zones must be confirmed by Geophysical Survey and lineaments studies by Remote Sensing Studies.

As the people in the rural areas are mainly dependent on spring water, there is an urgent need for scientific approach for proper development and management of these springs. It may be recommended that the development of springs will help in mitigating the water requirement of the people to a large extent.

The chemical quality of ground water indicates that groundwater in the area is good for domestic, irrigation and industrial uses. Chemical analysis shows that the spring water is of excellent quality and is suitable for drinking purposes as per BIS standard. However, sporadic occurrence of high concentration of Iron in ground water has been reported in some pockets in the district. So, the water supply agencies should take precautionary measures to provide Iron free water for potable purpose.

Mass Awareness Programme to the users and stakeholders on water consumption and protection of water quality will help in managing the precious resource in scientific ways for optimum benefits.


HYDROGEOLOGY
WEST KHASI DISTRICT, MEGHALAYA
0 10 20
kilometres
90° 45'
91° 00'
91° 15'
91° 30'
91° 45'
92° 00'
25° 45'
25° 30'
25° 15'
MAWSHYNRUT
NONGSTOIN
MAWTHADRAISHAN
MAIRANG
MAWKYRWAT
RANIKOR
LEGEND
Age
Group/Formation
Lithology
Ground Water Potential
Yield range
Quaternary
Alluvium
Sand, gravel, clay
Very good (30 to 100 m3/hr)
Paleocene - Eocene
Jaintia Group
Sandstone, Shale (weathered and fractured)
Good (10 to 30 m3/hr)
Upper Cretaceous
Khasi Group
Conglomerate/sandstone
Good (10 to 25 m3/hr)
Neo-Proterozoic Early Paleozoic
Granite Plutons
Coarse granite, pegmatite with quartz veins (weathered and fractured)
Average (5 to 10 m3/hr)
Proterozoic
Khasi Greenstone
Dolerite and ultrabasic dykes and sills
Poor (2 to 10 m3/hr)
Archaean - Proterozoic
Archaean Gneissic Complex
Biotite hornblende gneiss, granite gneiss, mica schist (weathered and fractured)
Poor (2 to 5 m3/hr)
Depth (mbgl)
Discharge (m3/hr)
Transmissivity (m2/day)
Drawdown (m)
Exploratory Well Location with Depth, Discharge, Drawdown and Transmissivity
Lineament
Major Drainage
National Highway
Block Boundary