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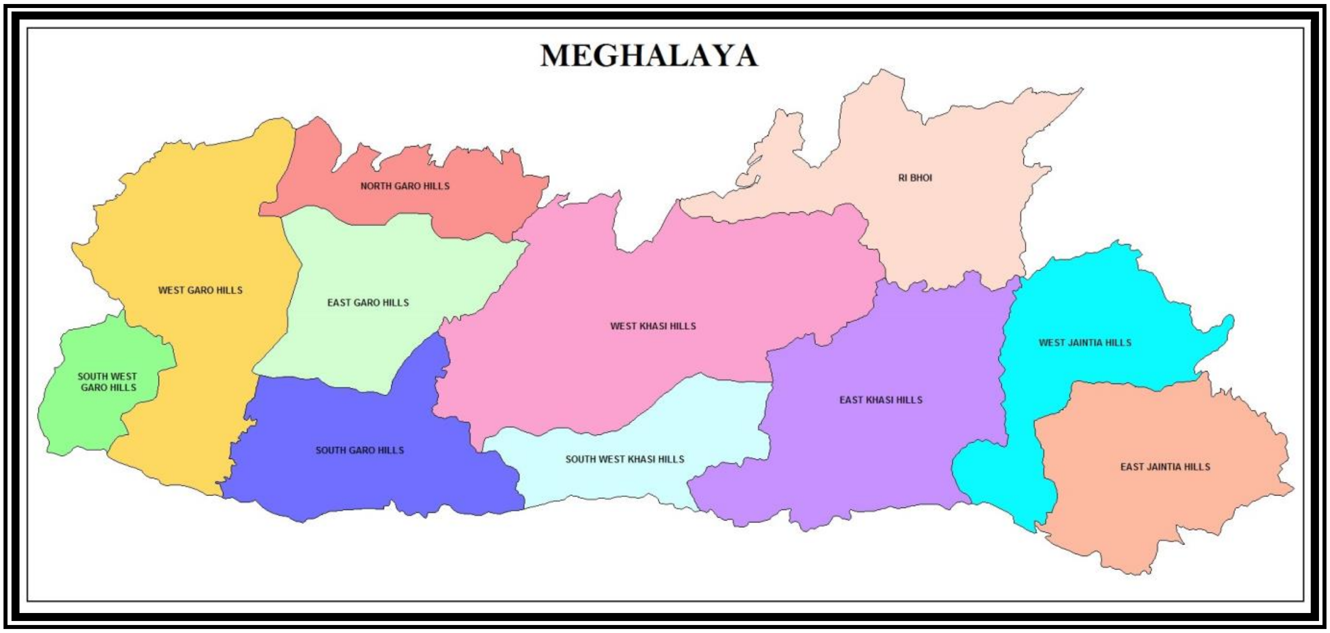
GOVERNMENT OF INDIA
MINISTRY OF JAL SHAKTI
DEPARTMENT OF WATER RESOURCES, RIVER DEVELOPMENT & GANGA REJUVENATION

CENTRAL GROUND WATER BOARD



DYNAMIC GROUND WATER RESOURCES, MEGHALAYA (As on March, 2020)

CENTRAL GROUND WATER BOARD
NORTH EASTERN REGION, GUWAHATI
September 2021

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PREFACE

Meghalaya is a land with verdant hills and fast flowing streams. Development of ground water in the State is practically negligible. Utilising groundwater requires pumping up of water from tube wells, while, it is easy to utilize the surface water from streams and springs by tapping water source at higher altitudes and supply water using gravity flow for drinking/domestic purpose or for irrigation at lower altitudes, sometimes even without proper distribution channels. Moreover, rainfall is abundant. In spite of this, there is acute shortage of water during the summer as the major part of rainfall is lost as surface run-off. Development of ground water resource will help in overall sustainable development of the State and its people and bring about industrial and agricultural revolution in this tribal State

For a scientific planning of development of dynamic ground water resource potential, estimation of ground water resource has been done based on the latest methodology as recommended by Ground Water Resource Estimation Committee-2015(GEC-2015) and duly approved by Govt. of India.

The report on dynamic Ground water resource potential has been assessed based on the field data generated by Central Ground Water Board and statistical information collected from other State Departments. The annual ground water recharge, net ground water availability and existing gross extraction on irrigation and domestic uses, etc, have been estimated for the state. The report also highlights on the net annual ground water availability for future use.

The total annual ground water recharge in the state of Meghalaya is 2.03 BCM. The Annual Extractable Ground Water Resources of the state is 1.82 BCM after deducting the natural discharge. Present Ground Water Extraction is 0.07 BCM out of which 0.03 BCM extraction is on account of irrigation and the annual domestic extraction is 0.05 BCM. The annual allocation for Domestic use has been made as 0.06 BCM based upon the population data projected upto year 2025. The over-all stage of ground water extraction of the state is a meager 4.22%.

I strongly believe that the report with its technical data will help in understanding present ground water scenario in Meghalaya State and prove valuable to policy makers, technical experts, professionals and user agencies for management of ground water development in the state in planned manner.

(Biplap Ray)
Regional Director (i/c)

CONTENTS

CONTRIBUTORS

Estimation of ground water resources of Meghalaya is based on the data provided by Water Resources Department, Govt. of Meghalaya, Public Health Engineering Department, Govt. of Meghalaya, Agriculture Department, Govt. of Meghalaya, Directorate of Economics and Statistics, Govt. of Meghalaya, Directorate of Fisheries, Govt. of Meghalaya, Soil and Water Conservation Department, Government of Meghalaya and Shillong Municipal Board. The computation of the resource estimation is done through INGRES software and preparation of the report is done by Shri Shasinlo Kent, Scientist-B.

1. INTRODUCTION

The state of Meghalaya has eleven districts namely- East Khasi Hills, West Khasi Hills, South West Khasi Hills, East Jaintia Hills, West Jaintia Hills, Ri-Bhoi, East Garo Hills, North Garo Hills, South Garo Hills, West Garo Hills and South West Garo Hills.

As per 2011 Census, the total population of the State is 29,66,889 as against 23,18,822 in 2001 Census and 17,74,778 in 1991. Total area of Meghalaya is 22,429 sq. km. Population Density of Meghalaya is 132 persons per sq km which is lower than national average 382 per sq km. The total population growth in this decade was 27.95 percent while in previous decade it was 29.94 percent. The population of Meghalaya forms 0.25 percent of India in 2011, while in 2001, the figure was 0.23 percent.

Meghalaya is basically an Agricultural State with about 80% of its total population depending entirely on Agriculture for their livelihood.

In Meghalaya, summer is for a period of about 5 months, from May to September, with torrential rains caused by the South West Monsoon. Rainfall varies from place to place and from altitude to altitude. The amount of rainfall over Cherrapunjee and Mawsynram is quite heavy. During the last two decades, it has ranged from 11,995 mm to 14,189 mm in Cherrapunjee and over Mawsynram it was 10,689 mm to 13,802 mm. Nature in its generous abundance, has bestowed Meghalaya a unique array of vegetation ranging from tropical and sub-tropical to temperate or near temperate.

The total cropped area in the State has increased by about 42 per cent during the last twenty-five years. Food grain production sector covers an area of over 60 per cent of the total crop area. With the introduction of different crops of high yielding varieties in the mid-seventies, remarkable increase in food grain production has been made.

The previous assessment of groundwater resources of Meghalaya was carried during 2016-17. The ground water resource of the state has been re-estimated by Central Ground Water Board, North Eastern Region based on GEC 2015 methodology for the assessment year 2019-20. Census figures for population as per 2011 Census are available and whatever data for the year 2019-20 provided by Water Resources Department, Govt. of Meghalaya, Public Health Engineering Department, Govt. of Meghalaya, Agriculture Department, Govt. of Meghalaya, Directorate of Economics and Statistics, Govt. of Meghalaya and Shillong Municipal Board have been used to update and revise the assessment of groundwater resources of Meghalaya.

2. HYDROGEOLGICAL SETUP OF MEGHALAYA

The Meghalaya State is essentially occupied by hard massive rocks belonging to the Archaean gneissic complex with acid and basic intrusives and Precambrian Shillong Group of parametamorphites. The south-western, southern and south-eastern parts of the state is covered by sedimentary rocks comprising sandstones, shales, conglomerates, limestones etc. belonging to Cretaceous – Tertiary age. The unconsolidated sediments comprising sand, gravel, silt clay etc are found to occur as thin veneer along rivulets and as valley-fills. Significant thickness of this unconsolidated formation is found to occur only along extreme north-western fringe of the state in West Garo Hills district.

2.1 Hydrometeorological condition

High altitude areas of the region have temperate climate and the low altitude areas have tropical to sub-tropical climate. Generally the central hills area experiences an ambient annual temperature of 20° C; elsewhere the temperature is greater than that. The summer temperature is as high as 25° C and mean winter temperature ranges from 2° to 9° with periodic deviation to below the freezing point, marked by the appearance of ground frost in the early morning. Meghalaya experiences a remarkably high rainfall profile during the South -West monsoon, which usually starts from the middle of May and declines towards mid October. There are four seasons in Meghalaya namely summer, monsoon or rainy, autumn and winter. The summer season extends from end of March to Mid May, which is characterized by relatively high temperature, occasional thunderstorm, and high wind velocities. The rainy season commences with the onset of southwest monsoon in April and lasts up to October that encourages a lot of wet cultivation in the state. This is followed by short autumn from mid October to November. 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 with mercury dipping to –1°C to –2°C. Winter is basically dry with reducing diurnal range of temperature. Rainfall is abundant and it is the single most dominant element of the climate of Meghalaya. Rainfall during the Monsoon season varies from 100 cm in the west central part to over 1000 cm in the south and southeast. Average rainy days during the season vary from 60 in the west-central part to over 100 days in the southeastern part. Heavy precipitation occurs in areas like Cherrapunjee (Sohra) and Mawsynram. Mawsynram and Cherrapunji in the East Khasi Hills district are geographically considered as the rainiest places in the World. — Cherrapunji, which has an average annual precipitation of about 11,430 mm (450 inches) and Mawsynram, a village directly west of Cherrapunji, where rainfall of around 17,800 mm (700 inches) per year has been recorded. The area receives rainfall on an average for 161 days in a year.

The climate of Meghalaya is mainly controlled by:

a) The maritime air masses coming from south and southwest.

b) Alternating pressure cells of North West India and Bay of Bengal

c) Physiography,

During Post-monsoon i.e., November to May of the following year, potential evapotranspiration exceeds precipitation but soil storage has yet to reach zero (dry soil), whence precipitation is no longer able to meet the demands of potential evapotranspiration. This is Soil Moisture Utilization season. March begins with very little Soil Moisture Storage and the amount in storage falls to zero and the soil dries out. The need for water for potential evapotranspiration is unmet, representing the Soil Moisture Deficit (SMD). The farmers then tap ground water reserves or water in nearby streams and lakes to irrigate their crops.

2.2 Ground Water Occurrence

Ground water in the state is primarily controlled by lithology, structure and also by physiography. Ground water mainly occurs under unconfined to semi-confined condition in both consolidated and unconsolidated formation. However, the deeper aquifer, in the unconsolidated formation of West Garo Hills district bordering Assam state and Bangladesh, ground water occurs under confined condition. The Hydrogeology is summed-up in Table 1.

2.3 Ground Water Quality

Ground water in the State is slightly acidic to alkaline with pH values ranging from 5.4 to 8.2. The electrical conductivity values for ground water in phreatic aquifer in Meghalaya range from 60 to 750 µs/cm at 25ºC indicating the quality of ground water to be of low salinity and the water is potable. Total hardness (Ca+Mg) expressed as $CaCO_3$ in ppm is small indicating that the water is soft in quality. The other chemical constituents of ground water namely HCO_3, Cl, Ca, Mg, Fe etc. all are within permissible limit according to Bureau of Indian Standard (IS: 10500-91**).** The chemical analysis of ground water samples from phreatic aquifer reveals that the ground water of Meghalaya is generally suitable for drinking purposes. Almost all the chemical constituents are within the permissible limits of drinking water standards except for Iron, which is high in isolated locations. Higher concentration of iron above permissible limit in ground water in phreatic aquifer in Meghalaya is observed in places like Shillong (11.25 mg/l), Nongpoh (5.7 mg/l), Balat (7.2 mg/l), Dawki (3.2 mg/l), Bajengdoba (3.8 mg/l) and Kharkutta (4.88 mg/l).

Table 1 : Hydrogeology of Meghalaya

Age	Group	Formation	Lithology	Hydrogeological Conditions	Yield (m^3/hr)
Pleistocene to Holocene	Newer (Recent) and Older Alluvium		Unconsolidated Sediments Sand, silt and clay	Thick, continuous aquifer in the western, northern and southern fringes of the State. Ground water occurs under unconfined to semi-confined conditions; Depth to water level rests at 3 to 5 m.bgl (metres below ground level)	30 - 100
Mio-Pliocene		Dupitla	Mottled clay, sandstone, shale and conglomerate	Thick, discontinuous aquifer encountered down to 250 m.bgl in the West Garo Hills area. Groundwater occurs under semi-confined to confined conditions; Depth to water level rests at 4 to 9 m.bgl	25 - 150
Oligo-Miocene	Garo group	Chengapara	Coarse sandstone, siltstone, clay and marl		
		Baghmara	Coarse sandstone, conglomerate, silty clay and fossiliferous limestone		
		Simsang	Fine sandstone and alternation of siltstone-mudstone		
Eocene-Oligocene	Barail group	-------	Coarse sandstone, shale, minor coal lenses carbonaceous shale,		
Palaeocene-Eocene	Jaintia group	Kopili	Shale, sandstone, marls and coal	Discontinuous aquifer in the cavernous limestones and sandstones area. Groundwater occurs under unconfined to semi-confined conditions; Depth to water level rests at 2 to 4 m.bgl	5 - 15
		Shella	Alternation of sandstone, limestone		
		Langer	Calcareous shale, sandstone, limestone		
Upper Cretaceous	Khasi Group	Mahadek	Arkosic sandstone (Glauconitic)		
			Conglomerate		
		Jadukata	Conglomerate/sandstone		
Paleo-Meso Proterozoic	Shillong Group		Quarzite, phyllite, quartz-sericite schist, conglomerate	Aquifer formed by weathered and fractured zones extending down to 150 m. bgl. Groundwater occurs under unconfined to semi-confined conditions; Depth to water level rests at 7 to 17 m.bgl	2 - 10
Archaean - Proterozoic	Meghalaya Archaean Gneissic Complex		Granite gneiss, Biotite gneiss, mica schist, silliminite- quartz schist, pyroxene granulite, gabbro & diorite, acidic and basic intrusives		

3. GROUND WATER RESOURCES ESTIMATION METHODOLOGY-GEC'2015

The present methodology used for resources assessment is known as Ground Water Resource Estimation Methodology – 2015 (GEC'2015). The revised methodology GEC 2015 recommends aquifer wise ground water resource assessment. Ground water resources have two components – Replenishable ground water resources or Dynamic ground water resources and In-storage resources or Static resources.GEC 2015 recommends estimation of Replenishable and in-storage ground water resources for both unconfined and confined aquifers. In GEC'2015, two approaches are recommended – water level fluctuation method and norms of rainfall infiltration method. The water level fluctuation method is based on the concept of storage change due to difference between various input and output components. Input refers to recharge from rainfall and other sources and subsurface inflow into the unit of assessment. Output refers to ground water draft, ground water evaporation, transpiration, base flow to streams and subsurface outflow from the unit. Since the data on subsurface inflow/ outflow are not readily available, it is advantageous to adopt the unit for ground water assessment as basin/ sub basin/ watershed, as the inflow / outflow across these boundaries may be taken as negligible.

Thus the ground water resources assessment unit is in general watershed particularly in hard rock areas. In case of alluvial areas, administrative block can also be the assessment unit. In each assessment unit, hilly areas having slope more than 20% are deleted from the total area to get the area suitable for recharge. Further, areas where the quality of ground water is beyond the usable limits should be identified and handled separately. The remaining area after deleting the hilly area and separating the area with poor ground water quality is to be delineated into command and non-command areas. Ground water assessment in command and non-command areas are done separately for monsoon and non-monsoon seasons.

3.1 Ground water Recharge

Monsoon season

Recharge from rainfall is estimated by using the following relationship -

Rrf = RFIF * A* (R – a)/1000

Where,

Rrf= Rainfall recharge in ham

A = Area in Hectares

RFIF = Rainfall Infiltration Factor

R = Rainfall in mm

a = Minimum threshold value above which rainfall induces ground water recharge in mm

The threshold limit of minimum and maximum rainfall event which can induce recharge to the aquifer is to be considered while estimating ground water recharge using rainfall infiltration factor method. The minimum threshold limit is in accordance with the relation shown in above equation and the maximum threshold limit is based on the premise that after a certain limit, the rate of storm rain is too high to contribute to infiltration and they will only contribute to surface runoff. It is suggested that 10% of Normal annual rainfall may be taken as minimum rainfall threshold and 3000 mm as maximum rainfall limit.

The resources assessment during monsoon season is estimated as the sum total of the change in storage and gross draft. The change in storage is computed by multiplying water level fluctuation between pre and post monsoon periods with the area of assessment and specific yield. Monsoon recharge can be expressed as –

$$R_{RF} = h \times Sy \times A - R_{OS} \pm VF \pm LF + GE + T + E + B$$

Where,

h = rise in water level in the monsoon season, A = area for computation of recharge,

Sy = specific yield, D_G = gross ground water draft, R_{OS}= Other sources of ground water recharge during monsoon season include R_c, R_{sw}, R_t, R_{gw}, R_{wc} which are recharge from seepage from canals, surface water irrigation, tanks and ponds, ground water irrigation, water conservation structures respectively; LF = Recharge through Lateral flow/ Through flow across assessment unit boundary in the monsoon season for the i^{th} particular year, VF – Vertical inter aquifer flow in the monsoon season for the i^{th} particular year, T- Transpiration in the monsoon season for the i^{th} particular year, E- Evaporation in the monsoon season for the i^{th} particular year, GE = Ground water extraction in monsoon season for the i^{th} particular year, B = Base flow the monsoon season for the i^{th} particular year

The monsoon ground water recharge has two components – rainfall recharge and recharge from other sources. Mathematically it can be represented as –

$$R(Normal) = R_{RF}(normal) + R_{OS}$$

Where,

R_{rf} is the normal monsoon rainfall recharge. R_{OS} is the other sources of ground water recharge during monsoon season include R_c, R_{sw}, R_t, R_{gw}, R_{wc} which are recharge from seepage from canals, surface water irrigation, tanks and ponds, ground water irrigation, water conservation structures respectively

The rainfall recharge during monsoon season computed by Water Level Fluctuation (WLF) method is compared with recharge figures from Rainfall Infiltration Factor (RIF) method. In case the difference between the two sets of data are more than 20%, then RIF figure is considered, otherwise monsoon recharge from WLF is adopted. While adopting the rainfall recharge figures, weightage is to be given to WLF method over adhoc norms method of RIF. Hence, wherever the difference between RIF & WLF is more than 20%, data have to be scrutinized and corrected accordingly.

Non-Monsoon season

During non-Monsoon season, rainfall recharge is computed by using Rainfall

Infiltration Factor (RIF) method. Recharge from other sources is then added to get total non-Monsoon recharge. In case of areas receiving less than 10% of the annual rainfall during non-monsoon season, the rainfall recharge is ignored.

Total annual ground water recharge

The total annual ground water recharge of the area is the sum-total of monsoon and non-monsoon recharge. An allowance is kept for natural discharge in the non-monsoon season by deducting 5% of total annual ground water recharge, if WLF method is employed to compute rainfall recharge during monsoon season and 10% of total annual ground water recharge if RIF method is employed. The balance ground water available accounts for existing ground water withdrawal for various uses and potential for future development. This quantity is termed as Annual Extractable Ground Water Resources.

Annual Extractable Ground Water Resources (AEGR) = Annual Ground Water Recharge – Natural discharge during non-monsoon season

Norms for estimation of recharge

GEC'2015 methodology has recommended norms for various parameters being used in ground water recharge estimation. These norms vary depending upon water bearing formations and agroclimatic conditions. While norms for specific yield and recharge from rainfall values are to be adopted within the guidelines of GEC'2015, in case of other parameters like seepage from canals, return flow from irrigation, recharge from tanks & ponds, water conservation structures, results of specific case studies may replace the adhoc norms.

3.2 Ground Water Extraction

The gross yearly ground water extraction is to be calculated for Irrigation, Domestic and Industrial uses. The gross ground water extraction would include the ground water extraction from all existing ground water structures during monsoon as well as during non-monsoon period. While the number of ground water structures should preferably be based on latest well census, the average unit draft from different types of structures should be based on specific studies or ad-hoc norms given in GEC2015 report.

3.3 Stage of ground water Extraction & Categorization of units

The stage of Ground water Development is defined by,

$$\text{Stage of Ground water Extraction (\%)} = \frac{\text{Existing Gross Ground water extraction for all uses}}{\text{AEGR}} \times 100$$

Validation of Stage of Ground Water Extraction

The assessment based on the stage of ground water extraction has inherent uncertainties. It is desirable to validate the 'Stage of Ground Water Extraction' with long term trend of ground water levels.

If the ground water resource assessment and the trend of long term water levels contradict each other, this anomalous situation requires a review of the ground water resource computation, as well as the reliability of water level data. The mismatch conditions are enumerated below.

SOGWE	Ground Water Level Trend	Remarks
≤70%	Significant decline in trend in both pre-monsoon and post-monsoon	Not acceptable and needs reassessment
>100%	No significant decline in both pre-monsoon and post-monsoon long term trend	Not acceptable and needs reassessment

Categorisation of Assessment Units

As emphasised in the National Water Policy, 2012, a convergence of Quantity and Quality of ground water resources is required while assessing the ground water status in an assessment unit. Therefore, it is recommended to separate estimation of resources where water quality is beyond permissible limits for the parameter salinity.

Categorisation of Assessment Units Based on Quantity: The categorisation based on status of ground water quantity is defined by Stage of Ground Water Extractions given below:

Stage of Ground Water Extraction	**Category**
≤70%	Safe
>70%and ≤90%	Semi-Critical
>90%and ≤100%	Critical
> 100%	Over Exploited

Categorisation of Assessment Units Based on Quality

The committee recommends that each assessment unit, in addition to the quantity based categorisation (safe, semi-critical, critical and over-exploited) should bear a quality hazard identifier. Such quality hazards are to be based on available ground water monitoring data of State Ground Water Departments and/or Central Ground Water Board. If any of the three quality hazards in terms of Arsenic, Fluoride and Salinity are encountered in the assessment sub unit in mappable units, the assessment sub unit may be tagged with the particular quality hazard.

3.4 Allocation of ground water resource for utilization

The net annual ground water availability is to be apportioned between domestic, industrial and irrigation uses. Among these, as per the National Water Policy, 2002, requirement for domestic water supply is to be accorded priority. The requirement for domestic and industrial water supply is to be kept based on population as projected to the year 2025. The water available for irrigation use is obtained by deducting the allocation for domestic and industrial use, from the net annual ground water availability.

3.5 Poor quality ground water

Computation of ground water recharge in poor quality ground water is to be done on the same line as described above. However, in saline areas, there may be practical difficulty due to non availability of data, as there will usually be no observation wells in such areas. Recharge assessment in such cases may be done based on rainfall infiltration factor method.

3.6 Apportioning of ground water assessment from watershed to development unit

Where the assessment unit is a watershed, the ground water assessment is converted in terms of an administrative unit such as block/ taluka/ mandal. This is done by converting the volumetric resource into depth unit and then multiplying this depth with the corresponding area of the block.

3.7 Additional Potential Recharge

In shallow water table areas, particularly in discharge areas, rejected recharge would be considerable and water level fluctuation are subdued resulting in under-estimation of recharge component. In the area where the ground water level is less than 5m below ground level or in waterlogged areas, ground water resources have to be estimated upto 5m bgl only based on the following equation -

Potential ground water recharge = (5-D) x A x Sp. Yield

Where,

D = Depth to water table below ground surface in pre-monsoon season in shallow aquifers;

A = Area of shallow water table zone.

The potential recharge from flood plain is estimated based on the same norms as for ponds, tanks and lakes.

Potential Resource Due to Spring Discharge: Spring discharge constitutes an additional source of ground water in hilly areas which emerges at the places where ground water level cuts the surface topography. The spring discharge is equal to the ground water recharge minus the outflow through evaporation and evapotranspiration and vertical and lateral sub-surface flow.

4: PROCEDURE FOLLOWED IN THE PRESENT ASSESSMENT INCLUDING ASSUMPTIONS

4.1 Data source for each of the data element and how the data was used in the computation (constraint in the data base, if any)

In the present report, district has been taken as the smallest administrative unit for resources computation due to lack of block-wise and /or watershed-wise information, which is essential for computation of ground water resources. Other than this, resources of greater Shillong is estimated separately because here groundwater development is taking fast pace. The following sub-units have been considered for computation of various figures as per GEC-2015 methodology.

- **Hilly area and recharge worthy areas**: The area suitable from the Ground Water recharge point of view has been calculated taking into consideration the area having less than 20% slope, provided by North Eastern Space Application Centre, Umiam, Meghalaya.
- **Poor Water quality area:** There is no such area reported from the state of Meghalaya, hence it has not been considered.
- **Command and non-command area**: There is no major irrigation projects in the state therefore entire area is considered as non-command area.

Domestic Extraction: Due to paucity of data, the domestic extraction has been calculated on projected population for 2020, based 2011 Census data of number of households using groundwater as "Main source of drinking water".

Irrigation Extraction: This has been calculated for SW Garo Hills, West Garo Hills and West Jaintia Hills districts as per data provided by WR Department, Govt. of Meghalaya.

Industrial Extraction: This has been considered, as per the information available, only for East Khasi Hills, East Jaintia Hills, West Jaintia Hills and Ri Bhoi districts.

Recharge from rainfall by rainfall infiltration factor method

Monthly rainfall data of January 2017 to December 2020 for all the districts rain gauges stations was provided by Directorate of Agriculture, Govt. of Meghalaya. During estimation of recharge from rainfall for East Khasi Hills, rainfall data of Shillong was employed. This is done to negate the wrong resource estimation that might have happened if very high rainfall of Cherrapunjee and Mawsynram was considered. Though Cherrapunjee and Mawsynram is having very high rainfall but Hydrogeological studies shown that these areas do not have good groundwater reserve and most of the rainfall runs down very quickly to Bangladesh through the hilly slopes.

During recharge from rainfall, normal rainfall during 1991 – 2020 collected from Agriculture Department was used.

Recharge from Ground water irrigation is estimated only for West Jaintia Hills, South West Garo Hills District and West Garo Hills District as others do not have ground water irrigation.

Recharge from tanks and Ponds is estimated by using data on water spread area provided by Fisheries Department.

Recharge was estimated by Water Table Fluctuation Method (WTFM) only for West & SW Garo Hills districts, as these districts are having good number of representative water level data. Other districts in Meghalaya being mostly hilly water data are representative of only point values.

Groundwater loss by evaporation and transpiration was also estimated only for West & SW Garo Hills districts, as these districts are having good number of representative water level data.

Constraints in database- season-wise and block-wise water spread area / area under water bodies, rivers etc. are not available, unit draft of ground water structures were assumed, block-wise area irrigated by different structures were not available. Data regarding ground water structures is not complete because there are many private shallow bore wells and bore wells under different organizations which have not come under present ground water structure / spot sources survey.

4.2 Changes, if any, applied in the original methodology proposed by GEC along with justification

Return flow from ground water has not been considered for monsoon season, as there is enough rainfall during monsoon and ground water irrigation is not practiced. There is no major or medium irrigation scheme in Meghalaya. Entire area has been considered as non-command area.

Water spread area, days of water availability (monsoon & non-monsoon) and seepage from ponds & tanks given in the methodology have been used to determine the seepage from ponds & tanks for monsoon & non-monsoon separately. Since the aquifer remains fully saturated during the periods of intensive rainfall, additional recharge from ponds & tanks during this period is negligible. Recharge from ponds and tanks during non-monsoon period are considered for 120 days. Computation factor for seepage from ponds & tanks is taken as 0.00144 m/day as per GEC-2015 methodology.

Categorization was done based on stage of extraction only, instead of stage of groundwater extraction and validation. Validation was done for West Garo Hills and SW Garo Hills Districts. Jaintia Hills districts, West Khasi Hills and SW Khasi Hills districts have very scanty water level data, while water level data from East Khasi Hills, East Garo Hills, North Garo Hills and Ri Bhoi districts represent point value rather than representative value on a regional scale because these districts are mostly hilly. Hence, long term trends couldn't utilized for validation purpose.

4.3 Various norms used in the computation

The unit of computation proposed in the methodology is "watershed". However, it also recommends blocks/ tehsil as the unit for the first few years since there can be non-availability of data. In the present report district - the smallest administrative unit is taken as the unit of computation. This is mainly due to lack of data especially on number of ground water structures, draft, population and other vital figures on watershed/ block basis.

The rainfall infiltration factor recommended by GEC-2015 for unconsolidated alluvium is 0.20. This value employed during recharge estimation in parts of North, West & Southwest Garo Hills districts.

For calculating recharge from return flow from irrigation, an average water requirement of 1m & 0.1m for paddy & non-paddy has been taken. Computation factor for return flow from ground water irrigation is taken as 0.25 – 0.45 and from surface water irrigation is taken as 0.30 – 0.50 as per GEC'15 methodology.

The major potential aquifer in the state is Unconsolidated sediments in West & SW Garo hills and in other parts it is formed by weathered residuum along with fractures/ joints in hard rocks.

4.4 Any documented field studies

During NAQUIM studies in Meghalaya, a total of 60 nos. of infiltration studies were carried out to determine rainfall infiltration factor (RIF) in different geological formations. 22 nos. of infiltration studies in East Khasi Hills show that RIF in weathered granitic and quartzite formations are 5% while in valleyfills and Tertiary formations it is 5%. 17 nos. of infiltration studies in Ri Bhoi show that RIF in weathered granitic and quartzite formations are 5% while in alluvium and valley fills it is 13%. 8 nos. of infiltration studies in East Garo Hills show that RIF in weathered Tertiary formations are 4%. 13 nos. of infiltration studies in East & West Jaintia Hills show that RIF in weathered granites and Tertiary formations are 5% while in alluvium it is 10%.

5. Computation of ground water resources in Meghalaya state

Ground water resources of Meghalaya state have been computed according to the methodology and norms described above. The district-wise details along with Greater Shillong have been provided in the Annexures.

a. Salient features of the dynamic ground water resources assessments.

The smallest administrative unit 'district' is taken as the unit of computation. Total number of assessment units in Meghalaya is 12. The resource computations presented in this report is for the ground water year 2019 – 2020 (1st June, 2017 to 31st May, 2020). Population data of 2011 collected from Census report 2011 and projected population of 2020 and 2025 were worked out. Rainfall data collected for 2017-20. Ground water abstraction structures for irrigation purposes were collected for 2019. Ground water abstraction structures for drinking and domestic structures were collected for 2019.

a. Assessment sub-unit-wise method adopted for computing rainfall recharge during monsoon season (WLF/RIF).

Recharge from Rainfall has been computed separately for monsoon and non-monsoon periods for the entire state. The recharge from rainfall during monsoon season has been computed using both water level fluctuation method (WLFM) and rainfall infiltration method (RIFM). The results from the above two methods (WLFM & RIFM) have been compared using Percent Deviation (PD). After the computation of the percent deviation (PD) it is found that all the 12 assessment units were considered by RIF method.

c. Total resources of the state, existing development, balance available for future development etc.

Total ground water recharge is estimated after deducting resultant flow from evaporation and transpiration, and it is 1.99 BCM. Annual extractable groundwater resources are estimated after deducting natural discharge, and it is 1.82 BCM. Ground water extraction for various uses has been estimated for all the assessment units of Meghalaya. Gross annual ground water extraction for all uses is 0.07 BCM and allocation for domestic and industrial supply up to year 2025 is 0.057 BCM. Balance groundwater resources available for future development are 1.73 BCM. The stage of groundwater extraction is 4.22 % and all the 12 assessment units (including Greater Shillong) in Meghalaya state falls under **SAFE** category.

d. Spatial variation of the Ground water recharge and development scenario in Meghalaya

Annual Extractable ground water resources in the state are of the order of 1.82 BCM. Maximum annual extractable ground water resource of 0.45 BCM is found in West Khasi Hills district while the minimum of 0.06 BCM is in East Garo Hills district.

Ground water extraction is done mainly through dug wells and shallow tubewells from unconfined aquifer in the state. The stage of ground water extraction in Meghalaya is 4.22 %. South West Garo Hills district is having the highest stage of ground water extraction of 29.62 % while the minimum is 0.91 %, in South West Khasi Hills district.

e. Comparison with earlier ground water resources estimate and reasons for significant departure from earlier estimates.

A comparison is made between the previous estimate as on March 2017 and present estimate based on GEC'15 as on 2020, and presented in tabular statement given below.

Comparison between ground water resources estimation for Meghalaya for previous (2016-2017) and present (2019-2020)

Sl. No.	ITEM	Year, 2016-17	Year, 2019-20	COMPARISON
	Estimation	Manual	INGRES	
1	Total Annual Ground Water Recharge (BCM)	1.82	1.99	+0.17
2	Annual Extractable Ground Water Resources (BCM)	1.64	1.82	+0.18
3	Irrigation Draft (BCM)	0.03	0.03	
4	Domestic Draft (BCM)	0.01	0.05	+0.04
5	Stage of GW Extraction (%)	2.28%	4.22%	+1.94
6	Provision for Domestic use (BCM)	0.10	0.06	-0.04
7	GW availability for future use (BCM)	1.59	1.73	+0.14
8	No. of **SAFE** Units	11	12	+1
9	No. of O.E. Units	0	0	
10	No. of Dark/ Critical units	0	0	

The comparison depicts that there is an increase in total annual ground water recharge by 0.17 BCM and annual extractable ground water resources by 0.18 BCM in the 2020 estimate. Domestic extraction has increased on the basis of field study, thereby leading to increase in Stage of GW Extraction from 2.28 % to 4.22%.

6. Automation of Estimation of Dynamic Ground Water Resources using GEC-2015

The computation of the resource estimation of Meghalaya for the year 2019-20 is done through IN-GRES software (India Ground Water Resource Estimation System). IN-GRES is the common portal to input, estimate, analyze, and access static and dynamic groundwater resources. India GEC system will take Data Input through Excel as well as through Forms, compute various Ground water components (recharge, draft, flux, etc.), classify assessment unit into appropriate categories, develop visibility dashboards for each of the components. System allows user to view the data in both MIS as well as GIS view. User can also download the reports in formats like CGWB, etc.

India GEC system is divided into 3 modules – Input, Computation and Output.
i. Input module – Input Module refers to the Data Entry module at an Assessment Unit level. Data Input is done via 2 methods i.e.
a. Excel based input – In this, the user needs to download District level data sheet template where he/she can fill the data at an Assessment Unit level. User now needs to upload their fully filled excel sheet into the system.
b. Form based input – In this, the user is shown a form and he/she can fill/edit the data in data sheet in an online mode. Once user is done with editing online, he/she can Submit the data file.

ii. Computation module – Computation Module refers to the ground water calculations for an assessment unit. These computations are based on GEC 2015 methodology and are used to calculate Annual Extractable Ground Water Resource, Total Current Annual Ground Water Extraction (utilization) and the percentage of ground water utilization with respect to recharge (stage of Ground Water Extraction) for an assessment unit. Based on these percentages an assessment unit is categorized into SAFE, SEMI-CRITICAL, CRITICAL AND OVEREXPLOITED categories.

iii. Output module Once categorized the data is shown in two views:
a. MIS Dashboard – MIS dashboard shows the results of the assessment for the entire India, and also State wise in tabular form. The MIS dashboard shows all type of recharges, extractions, inflows and outflows computed for both monsoon and non-monsoon periods of the year and then reflect the overall stage of extraction at the selected Geo-Zoom Level.
b. GIS Dashboard – GIS dashboard shows the data in Web Geo-Server format, implemented in interactive GIS platform allowing user to all GEC related information in the map itself. GIS view represents the data on India map and color codes each District/Assessment unit based on the categorization

Appendix – I : Government order on constitution of Committee

GOVERNMENT OF MEGHALAYA
WATER RESOURCES DEPARTMENT

NOTIFICATION

Dated Shillong, the 9th January, 2020.

No. WR(G)84/2011/467 – The Governor of Meghalaya is pleased to re-constitute the State Level Committee on Ground Water Resources Assessment with the following members with immediate effect:-

1. Additional Chief Secretary/Principal Secretary/ Commissioner and Secretary to the Govt. Of Meghalaya Water Resources Department.	-Chairperson
2. Chief Engineer, Water Resources, Shillong	-Member
3. Principal Chief Conservator of Forests, Shillong	-Member
4. Director, Soil & Water Conservation, Shillong	-Member
5. Director, Fisheries, Shillong	-Member
6. Chief Engineer, MeEPGCL, Shillong	-Member
7. Director, Commerce and Industries, Shillong	-Member
8. Director of Agriculture, Shillong	-Member
9. Director of Horticulture, Shillong	-Member
10. Chief Engineer, Public Health Engineering, Shillong	-Member
11. Director Community & Rural Development, Shillong	-Member
12. Chief Executive Officer, Shillong Municipal Board, Shillong.	-Member
13. Chief Executive Officer, MeWDA, Shillong.	- Member
14. Director, Urban Affairs, Shillong	-Member
15. Regional Director, CGWB, Shillong.	-Member Secretary

- The committee may co-opt any other Members (s) Special invitees (s), if necessary.
- Expenditure on account of TA/DA to official Members of the Committee will be met from the source from which they draw their salaries and that of non- official members will be borne by the Department of Water Resources

TERMS OF REFERENCE:

The broad terms of reference of the Committee would be as follows.

1) To estimate annual replenishable ground water resources of the state in accordance with the ground water resources estimation methodology.
2) To estimate the status of utilization of the annual replenishable ground water resource.
3) The Committee will submit its report within the time limit fixed by the Govt. of India with intimation to the State.
4) The Committee will consult the GC,MeWDA for any matter related to the State.

Sd/- (Sampath Kumar)
Commissioner & Secretary to the Govt. of Meghalaya
Water Resources Department

Appendix – II: Minutes of meeting

Government of India
Ministry of Jal Shakti
Department of Water Resources, River Development & Ganga Rejuvenation
Central Ground Water Board
State Unit Office, Shillong
Keating Road, Shillong 793 001

सत्यमेव जयते

No. 186/T33/GWRE/CGWB/SUO/Shill/21
Date: 31.03.2021

MINUTES OF THE FIRST MEETING OF THE STATE LEVEL COMMITTEE ON GROUND WATER RESOURCES ASSESSMENT HELD ON 31st MARCH 2021 FOR THE STATE OF MEGHALAYA

The meeting of the State Level Committee (SLC) for Assessment of Dynamic Ground Water Resources of Meghalaya was held on 31.03.2021 under the Chairmanship of Shri Subhi C Sadhu, IAS, Secretary, Govt. of Meghalaya, Department of Water Resources, Shillong. The list of Members who attended the meeting is shown in the attendance sheet.

The Chairman welcomed the committee members. Shri S F Hamid, Deputy Secretary, Water Resources gave a brief on the role of the SLCGWRA and the meeting agenda.

Shri T Chakraborty, OIC, CGWB, SUO, Shillong started the presentation with introducing the INGRES software, he said that dynamic groundwater resources in Meghalaya are estimated jointly by CGWB and the State Govt. Departments. He also informed that earlier dynamic groundwater resource estimated manually throughout the country. Later it was observed that some minor computational error might have occurred in calculating the resource, as the process of dynamic groundwater resource estimation is a complicated and lengthy. So to overcome this human error, Ministry of Jal Shakti in collaboration with IIT Hyderabad developed the software INGRES (INDIA GROUNDWATER RESOURCE ESTIATION SOFTWARE). First, he has presented the excel sheets containing data received from the State Govt. Departments that are uploaded in the software. Then he logged into INGRES and shown the dynamic groundwater resources estimated and lastly a comparison sheet showing difference between dynamic ground water resources for 2016-17 and 2019-20 has been presented before the committee members. He also mentioned that the manual calculation has also been done and it matches with the result of INGRES.

Mrs M B Ritshnong, SE, WRD highlighted the difficulties of collection of data from different state department as per format. The Chairman suggested organizing a one day workshop for the respective departments so that in future there won't be any difficulties in collection and uploading of data in INGRES.

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Government of India
Ministry of Jal Shakti
Department of Water Resources, River Development & Ganga Rejuvenation
Central Ground Water Board
State Unit Office, Shillong
Keating Road, Shillong 793 001

After thorough deliberation by various members of the committee, the Dynamic Groundwater Resource Estimation of Meghalaya using INGES was finally approved by the committee.

(T.Chakraborty)
Officer-In-Charge
CGWB, SUO, Shillong
For Regional Director,
CGWB, NER, Guwahati
& Member Secretary, SLCGWRA

Distribution:

1. The Principal Secretary, Govt. of Meghalaya, Water Resources Department
2. Chief Engineer, Water Resources, Govt. of Meghalaya, Shillong
3. Principal Chief Conservator of Forests, Meghalaya, Shillong
4. Chief Engineer, PHED, Govt. of Meghalaya, Shillong
5. The Director, Fisheries, Meghalaya, Shillong
6. The Director, Soil & Water Conservation, Meghalaya, Shillong
7. The Director, Commerce & Industries, Meghalaya, Shillong
8. Chief Engineer, Meghalaya Power Generation Corporation Limited, Shillong
9. Director, Directorate of Horticulture, Govt. of Meghalaya, Shillong
10. The Director, Community & Rural Development, Meghalaya, Shillong
11. The CEO, Municipal Board, Shillong
12. The CEO, MeWDA
13. The Director, Urban Affairs, Meghalaya, Shillong
14. The General Manager, NABARD, Shillong
15. Director, Directorate of Agriculture, Govt. of Meghalaya, Shillong

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0Members present in the first State level Committee on Ground Water Resources Assessment held on 31th March, 2021

Sl. No.	Name	Designation	Signature
1.	Dr. Shakil P. Ahammed, IAS	Principal Secretary, Water Resources	
2.	Shri S.C. Sadhu, IAS	Secretary, Water Resources	[signature]
3.	S.F. [illegible]	Deputy Secretary W.R	[signature]
4.	Mrs MB Rittohoy	S.E. WRD	[signature]
5.	Shri. B. Lato. Jt. Director Urban Affairs	Jt. Director U.A.	[signature]
6.	Shri B. Sylla	Jt Director Horticulture	[signature]
7.	Smt. K. Lyngdoh	J. Director of Agriculture (R&T)	[signature]
8.	Smt D. G. Lyngdoh	Asst Director of Fisheries	[signature]
9.	Shri S. Lyngdoh	SE (PHE) G.S Circle Shillong	[signature]
10.	B. M. WAR	Addl. Chief Engineer (C) MePGCL	[signature]
11.	Lipy Deori.	AGM, NABARD	[signature]
12.	W.A. Sangma	ADSWC Megh. Shillong	[signature]
13.	S. K. Palit	ASWCO Shillong	[signature]
14.	Shasinlo Kent	Sc - B	[signature]
15.	T. Chakraborty	OIC, SUO, Shlg	[signature]
16.	Rinku Rani Das	Sc - B	[signature]
17.			
18.			

Annexure 1A

Sl.No.	District	Monsoon Season		Non-Monsoon Season			Total Natural Discharges	Annual Extractable Ground Water Resource	Current Annual Ground Water Extraction				Annual GW Allocation for Domestic use as on 2025	Net Ground Water Availability for future use	Stage of Ground Water Extraction(%)
		Recharge from rainfall	Recharge from other Sources	Recharge from rainfall	Recharge from other Sources	Total Annual Ground Water Recharge			Irrigation	Industrial	Domestic	Total			
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	EAST GARO HILLS	5190	42	1564	12	6808	681	6127	0	0	415	415	482	5645	7
2	EAST JAINTIA HILLS	14785	11	4901	1	19697	1970	17727	0	4	171	175	209	17514	1
3	EAST KHASI HILLS	7398	65	1410	22	8894	889	8005	0	0	402	402	453	7552	5
4	GREATER SHILLONG	1004	0	191	0	1195	120	1076	0	10	292	302	354	712	28
5	NORTH GARO HILLS	9615	76	2901	6	12598	1260	11083	51	0	437	488	509	10524	4
6	RI-BHOI	6906	191	1487	187	8771	877	7894	0	10	333	343	455	7428	4
7	SOUTH GARO HILLS	8019	62	1900	39	10020	1002	9018	0	0	268	268	327	8690	3
8	SOUTH WEST GARO HIL	8798	83	2172	1024	12077	604	9866	2655	0	267	2922	313	6898	30
9	SOUTH WEST KHASI HI	14012	27	1975	6	16019	1602	14417	0	0	131	131	158	14259	1
10	WEST GARO HILLS	32343	110	6677	149	39279	1964	35118	102	0	1075	1177	1260	33755	3
11	WEST JAINTIA HILLS	13463	79	4463	10	18015	1801	16213	9	5	569	583	680	15520	4
12	WEST KHASI HILLS	44087	118	6213	39	50457	5046	45411	0	0	463	463	551	44860	1
	Total (Ham)	165619	862	35854	1495	203829	17815	181954	2817	29	4824	7670	5750	173358	

Annexure 1B

COMPARISION OF GROUND WATER RESOURCE (2019-2020)

S.No	District	Total Annual Ground Water Recharge			Annual Extractable Ground Water Recharge			Total Current Annual Ground Water Extraction			Stage of Ground Water Extraction (%)		
		2019-2020	2016-2017	Diff	2019-2020	2016-2017	Diff	2019-2020	2016-2017	Diff	2019-2020	2016-2017	Diff
1	EAST GARO HILLS	6808	4833	-1974.394	6127	4350	-1777	415	20	-394	7	0	-7
2	EAST JAINTIA HILLS	19697	18048	-1648.912	17727	16243	-1484	175	54	-121	1	0	-1
3	EAST KHASI HILLS	8894	10632	1737.993	8005	9569	1564	402	235	-168	5	2	-3
4	GREATER SHILLONG	1195	-	-	1076	-	-	302	-	-	28	-	
5	NORTH GARO HILLS	12598	15944	3346.223	11083	14350	3266	488	75	-413	4	1	-3
6	RI-BHOI	8771	12906	4134.906	7894	11615	3721	343	66	-277	4	1	-3
7	SOUTH GARO HILLS	10020	10152	132.437	9018	9137	119	268	9	-259	3	0	-3
8	SOUTH WEST GARO HIL	12077	14423	2346.098	9866	12548	2682	2922	2783	-139	30	22	-8
9	SOUTH WEST KHASI HI	16019	12847	-3171.947	14417	11562	-2855	131	9	-122	1	0	-1
10	WEST GARO HILLS	39279	33290	-5988.745	35118	29366	-5752	1177	415	-762	3	1	-2
11	WEST JAINTIA HILLS	18015	16617	-1398.022	16213	14955	-1258	583	59	-523	4	0	-4
12	WEST KHASI HILLS	50457	33440	-17016.51	45411	30096	-15315	463	14	-449	1	0	-1
	Total(Ham)	203829	183133	-20696	181954	179102	-2853	7670	3739.538	-3930			

Annexure 2

DYNAMIC GROUND WATER RESOURCES OF INDIA, 2019-2020															
MEGHALAYA															
S.NO	States / Union Territories	Ground Water Recharge					Total Natural Discharges	Annual Extractable Ground Water Resource	Current Annual Ground Water Extraction				Annual GW Allocation for Domestic use as on 2025	Net Ground Water Availability for future use	Stage of Ground Water Extraction(%)
		Monsoon Season		Non-Monsoon Season		Total Annual Ground Water Recharge			Irrigation	Industrial	Domestic	Total			
		Recharge from rainfall	Recharge from other Sources	Recharge from Rainfall	Recharge from other Sources										
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	EAST GARO HILLS	5190.2	41.55	1563.67	12.1	6807.52	680.76	6126.76	0	0	414.72	414.72	481.84	5644.92	6.77
2	EAST JAINTIA HILLS	14784.52	10.61	4900.8	0.66	19696.59	1969.66	17726.93	0	4	171.06	175.06	208.68	17514.25	0.99
3	EAST KHASI HILLS	7397.62	64.6	1409.63	22.38	8894.23	889.42	8004.81	0	0	402.34	402.34	452.81	7552	5.03
4	GREATER SHILLONG	1004	0	191.31	0	1195.31	119.53	1075.78	0	10	292.27	302.27	353.8	711.98	28.1
5	NORTH GARO HILLS	9615.24	75.88	2901.1	5.67	12597.89	1259.79	11083.25	51	0	437.47	488.47	508.68	10523.57	4.41
6	RI-BHOI	6905.74	191.1	1487.24	186.69	8770.77	877.07	7893.7	0	10	332.56	342.56	455.25	7428.45	4.34
7	SOUTH GARO HILLS	8018.55	61.7	1900.06	39.31	10019.62	1001.97	9017.65	0	0	268.39	268.39	327.47	8690.18	2.98
8	SOUTH WEST GARO HIL	8798.49	82.6	2172.05	1023.93	12077.07	603.85	9865.93	2655.4	0	266.91	2922.31	312.55	6897.98	29.62
9	SOUTH WEST KHASI HI	14011.54	26.55	1974.64	6.4	16019.13	1601.91	14417.22	0	0	131.36	131.36	158.23	14258.99	0.91
10	WEST GARO HILLS	32343.03	109.75	6677.3	148.69	39278.77	1963.94	35117.59	102	0	1075.14	1177.13	1260.45	33755.15	3.35
11	WEST JAINTIA HILLS	13462.99	79.23	4462.73	9.97	18014.92	1801.49	16213.43	8.5	5	569.17	582.66	679.77	15520.17	3.59
12	WEST KHASI HILLS	44087.07	118	6213.17	38.71	50456.95	5045.7	45411.25	0	0	462.7	462.7	550.86	44860.39	1.02
	Total(Ham)	165618.99	861.57	35853.7	1494.51	203828.77	17815.09	181954.3	2816.9	29	4824.09	7669.97	5750.39	173358.03	
	Total(Bcm)	1.656	0.009	0.359	0.015	2.038	0.178	1.82	0.028	0	0.048	0.077	0.058	1.734	

Annexure 3A

CATEGORIZATION OF BLOCKS/ MANDALS/ TALUKAS IN INDIA (2019-2020)												
S.No	District	Total No. of Assessed Units	Safe		Semi-Critical		Critical		Over-Exploited		Saline	
			Nos.	%	Nos.	%	Nos.	%	Nos.	%	Nos.	%
1	EAST GARO HILLS	1	1	100	-	-	-	-	-	-	-	-
2	EAST JAINTIA HILLS	1	1	100	-	-	-	-	-	-	-	-
3	EAST KHASI HILLS	1	1	100	-	-	-	-	-	-	-	-
4	GREATER SHILLONG	1	1	100	-	-	-	-	-	-	-	-
5	NORTH GARO HILLS	1	1	100	-	-	-	-	-	-	-	-
6	RI-BHOI	1	1	100	-	-	-	-	-	-	-	-
7	SOUTH GARO HILLS	1	1	100	-	-	-	-	-	-	-	-
8	SOUTH WEST GARO HIL	1	1	100	-	-	-	-	-	-	-	-
9	SOUTH WEST KHASI HI	1	1	100	-	-	-	-	-	-	-	-
10	WEST GARO HILLS	1	1	100	-	-	-	-	-	-	-	-
11	WEST JAINTIA HILLS	1	1	100	-	-	-	-	-	-	-	-
12	WEST KHASI HILLS	1	1	100	-	-	-	-	-	-	-	-
	Total States	12	12	100	-	-	-	-	-	-	-	-
	Grand Total	12	12	100	-	-	-	-	-	-	-	-

Annexure 3B

CATEGORIZATION OF BLOCKS/ MANDALS/ TALUKAS IN INDIA (2019-2020)													
S.No	States / Union Territories	Total Geographical Area in 1000 sq km	Recharge Worthy Area in 1000 sq km	Safe		Semi-Critical		Critical		Over-Exploited		Saline	
				Recharge Worthy Area in 1000 sq km	%	Recharge Worthy Area in 1000 sq km	%	Recharge Worthy Area in 1000 sq km	%	Recharge Worthy Area in 1000 sq km	%	Recharge Worthy Area in 1000 sq km	%
1	EAST GARO HILLS	1.443	0.661172	0.661172	100	-	-	-	-	-	-	-	-
2	EAST JAINTIA HILLS	2.04	1.00087	1.00087	100	-	-	-	-	-	-	-	-
3	EAST KHASI HILLS	2.567648	0.894501	0.894501	100	-	-	-	-	-	-	-	-
4	GREATER SHILLONG	0.18035	0.15811	0.15811	100	-	-	-	-	-	-	-	-
5	NORTH GARO HILLS	1.16	0.50528	0.50528	100	-	-	-	-	-	-	-	-
6	RI-BHOI	2.448	0.909146	0.909146	100	-	-	-	-	-	-	-	-
7	SOUTH GARO HILLS	1.887	0.86771	0.86771	100	-	-	-	-	-	-	-	-
8	SOUTH WEST GARO HIL	0.896	0.56023	0.56023	100	-	-	-	-	-	-	-	-
9	SOUTH WEST KHASI HI	1.341	0.608734	0.608734	100	-	-	-	-	-	-	-	-
10	WEST GARO HILLS	2.781	1.830111	1.830111	100	-	-	-	-	-	-	-	-
11	WEST JAINTIA HILLS	1.779	0.997258	0.997258	100	-	-	-	-	-	-	-	-
12	WEST KHASI HILLS	3.906	1.652439	1.652439	100	-	-	-	-	-	-	-	-
	Total States					-	-	-	-	-	-	-	-
	Grand Total	22.429	10.64556	10.64556		-	-	-	-	-	-	-	-

Annexure 3C

CATEGORIZATION OF BLOCKS/ MANDALS/ TALUKAS IN INDIA (2019-2020)													
			Safe		Semi-Critical		Critical		Over-Exploited		Saline		
S.No	States / Union Territories	Annual extractable groud water resource in mcm	Annual extractable groud water resource in mcm	%	Annual extractable groud water resource in mcm	%	Annual extractable groud water resource in mcm	%	Annual extractable groud water resource in mcm	%	Annual extractable groud water resource in mcm	%
1	EAST GARO HILLS	61.2676	61.2676	100	-	-	-	-	-	-	-	-
2	EAST JAINTIA HILLS	177.2692	177.2692	100	-	-	-	-	-	-	-	-
3	EAST KHASI HILLS	80.0481	80.0481	100	-	-	-	-	-	-	-	-
4	GREATER SHILLONG	10.7578	10.7578	100	-	-	-	-	-	-	-	-
5	NORTH GARO HILLS	110.8325	110.8325	100	-	-	-	-	-	-	-	-
6	RI-BHOI	78.937	78.937	100	-	-	-	-	-	-	-	-
7	SOUTH GARO HILLS	90.1765	90.1765	100	-	-	-	-	-	-	-	-
8	SOUTH WEST GARO HIL	98.65927	98.65927	100	-	-	-	-	-	-	-	-
9	SOUTH WEST KHASI HI	144.1722	144.1722	100	-	-	-	-	-	-	-	-
10	WEST GARO HILLS	351.1759	351.1759	100	-	-	-	-	-	-	-	-
11	WEST JAINTIA HILLS	162.1344	162.1344	100	-	-	-	-	-	-	-	-
12	WEST KHASI HILLS	454.1125	454.1125	100	-	-	-	-	-	-	-	-
	Total States	-	-	-	-	-	-	-	-	-	-	-
	Grand Total	1819.543	1819.543	-	-	-	-	-	-	-	-	-

ATTRIBUTES

Sl.No	State	District	Assessment Unit Name	Assessment Unit Type	Recharge from Rainfall-MON	Recharge from Other Sources-MON	Recharge from Rainfall-NM	Recharge from Other Sources-NM	Total Annual Ground Water (Ham) Recharge	Total Natural Discharges (Ham)	Annual Extractable Ground Water Resource (Ham)	Irrigation Use (Ham)	Industrial Use (Ham)	Domestic Use (Ham)	Total Extraction (Ham)	Annual GW Allocation for for Domestic Use as on 2025 (Ham)	Net Ground Water Availability for future use (Ham)	Stage of Ground Water Extraction (%)	Categorization (OE/Critical/ Semicritical/ Safe)
1	MEGHALAYA	EAST KHASI HILLS	GREATER SHILLONG	STATE CAPITAL	1004	0	191.31	0	1195.31	119.53	1075.78	0	10	292.2681	302.27	353.8	711.98	28.09	safe
2	MEGHALAYA	EAST JAINTIA HILLS	EAST JAINTIA HILLS	DISTRICT	14784.52	10.61	4900.8	0.66	19696.59	1969.66	17726.93	0	4	171.0607	175.06	208.68	17514.25	0.98	safe
3	MEGHALAYA	SOUTH WEST GARO HIL	SOUTH WEST GARO HIL	DISTRICT	8798.49	82.6	2172.05	1023.93	12077.07	603.85	9865.93	2655.4	0	266.9092	2922.31	312.55	6897.98	29.62	safe
4	MEGHALAYA	SOUTH GARO HILLS	SOUTH GARO HILLS	DISTRICT	8018.55	61.7	1900.06	39.31	10019.62	1001.97	9017.65	0	0	268.3901	268.39	327.47	8690.18	2.97	safe
5	MEGHALAYA	EAST GARO HILLS	EAST GARO HILLS	DISTRICT	5190.2	41.55	1563.67	12.1	6807.52	680.76	6126.76	0	0	414.7225	414.72	481.84	5644.92	6.76	safe
6	MEGHALAYA	EAST KHASI HILLS	EAST KHASI HILLS	DISTRICT	7397.62	64.6	1409.63	22.38	8894.23	889.42	8004.81	0	0	402.3419	402.34	452.81	7552	5.02	safe
7	MEGHALAYA	RI-BHOI	RI-BHOI	DISTRICT	6905.74	191.1	1487.24	186.69	8770.77	877.07	7893.7	0	10	332.5615	342.56	455.25	7428.45	4.33	safe
8	MEGHALAYA	SOUTH WEST KHASI HI	SOUTH WEST KHASI HI	DISTRICT	14011.54	26.55	1974.64	6.4	16019.13	1601.91	14417.22	0	0	131.3571	131.36	158.23	14258.99	0.91	safe
9	MEGHALAYA	WEST GARO HILLS	WEST GARO HILLS	DISTRICT	32343.03	109.75	6677.3	148.69	39278.77	1963.94	35117.59	102	0	1075.137	1177.13	1260.45	33755.15	3.35	safe
10	MEGHALAYA	WEST KHASI HILLS	WEST KHASI HILLS	DISTRICT	44087.07	118	6213.17	38.71	50456.95	5045.7	45411.25	0	0	462.7027	462.7	550.86	44860.39	1.02	safe
11	MEGHALAYA	WEST JAINTIA HILLS	WEST JAINTIA HILLS	DISTRICT	13462.99	79.23	4462.73	9.97	18014.92	1801.49	16213.43	8.5	5	569.1657	582.66	679.77	15520.17	3.59	safe
12	MEGHALAYA	NORTH GARO HILLS	NORTH GARO HILLS	DISTRICT	9615.24	75.88	2901.1	5.67	12597.89	1259.79	11083.25	51	0	437.4713	488.47	508.68	10523.57	4.40	safe