सत्यमेव जयते

DISTRICT SURVEY REPORT,ASSAM

CHARAIDEO

As per Sustainable Sand Mining Management Guidelines, 2016 and Enforcement & Monitoring Guidelines for Sand Mining, 2020, Ministry of Environment, Forest and Climate Change (MoEF & CC)

SEPTEMBER 2024

Prepared by:

RSP Green Development & Laboratories Pvt. Ltd

ACKNOWLEDGEMENT

Managing Director
Mr. Pinaki Roy

Directors
Smt. Mousumi Chakraborty
Smt. Saswati Roy

Mentor, Sr. Geologist
Mr. Subrata Kunar

General Manager & RS-GIS Specialist
Mrs. Piya Chowdhury

Project Manager & RS-GIS Specialist
Mr. Arpan Bhattacharjee

Senior Environmentalist & EIA coordinator
Mr. Amit Podder

Senior Environmentalist
Ms. Madhurima Bakshi

AutoCAD Specialist
Mrs. Iti Sutradhar
Mr. Subhendu Gayan

GIS Executive
Ms. Manisha Bhowmik
Mr. Soham Ghosh

Junior Environmentalist
Mrs. Paromita Chowdhury
Ms. Sreerupa Chatterjee
Ms. Madhumanti Bagh

Junior Geologist & Field Surveyor
Dr. Joyeeta Bhattacharjee
Mr. Debkanta Banerjee
Mr. Soumen Mondal
Mr. Bittu Biswas

CONFIDENTIALITY CLAUSE

This District Survey Report (DSR) of Charaideo District has been prepared by RSP Green Development and Laboratories Pvt. Ltd., Howrah, West Bengal, India. The report covers diversified ranges of subject matters relevant to project objectives and survey based information/ data, therefore, this ‘Confidentiality Clause’ is a legally binding section that is anticipating that, any employee who are directly and/or indirectly involved in the project will not disclose any significant confidential information or any duplicate copies to any third parties without legalized written consent of ‘No Objection’ from company authority and Concerned department of Government of Assam, not even for the specific purpose for which the report has been prepared

Managing Director
Mr. Pinaki Roy
Mob: 9830808501/9830585501

Directors
Smt. Mousumi Chakraborty
Smt. Saswati Roy

LIABILITY CLAUSE

Limitation of Liability

RSP Green Development & Laboratories PVT.LTD undertakes the technical responsibility for the entire report. All the authenticated Secondary data included in the report has been obtained from the Various Government departments and all the report verifying by Sub-Divisional Committee

Managing Director
Mr. Pinaki Roy
Mob: 9830808501/9830585501

Directors
Smt. Mousumi Chakraborty
Smt. Saswati Roy

QUALITY COUNCIL OF INDIA
Creating an Ecosystem for Quality

National Accreditation Board for Education and Training

Certificate of Accreditation

RSP Green Development & Laboratories Pvt. Ltd.,

7F, Dinobandhu Mukherjee Lane, Howrah 711102, West Bengal

*The organization is accredited as **Category-B** under the QCI-NABET Scheme for Accreditation of EIA Consultant Organization, Version 3: for preparing EIA-EMP reports in the following Sectors –*

S. No	Sector Description	Sector (as per)		Cat.
		NABET	MoEFCC	
1	Mining of minerals - opencast mining only	1	1 (a) (i)	B
2	Metallurgical industries (ferrous only)	8	3 (a)	B
3	Distilleries	22	5 (g)	B
4	Aerial ropeways	35	7 (g)	B
5	Common municipal solid waste management facility (CMSWMF)	37	7(i)	B
6	Building and construction projects	38	8 (a)	B

Note: Names of approved EIA Coordinators and Functional Area Experts are mentioned in SAAC minutes dated May 6, 2022 and supplementary minutes dated July 8, 2022 posted on QCI-NABET website.

The Accreditation shall remain in force subject to continued compliance to the terms and conditions mentioned in QCI-NABET's letter of accreditation bearing no. QCI/NABET/ENV/ACO/22/2519 dated September 15, 2022. The accreditation needs to be renewed before the expiry date by RSP Green Development & Laboratories Pvt. Ltd, following due process of assessment.

Sr. Director, NABET
Dated: September 15, 2022

Certificate No.
NABET/EIA/2124/SA 0176

Valid up to
Feb 9, 2024

For the updated List of Accredited EIA Consultant Organizations with approved Sectors please refer to QCI-NABET website.

NABET Certificate of respected Consultant

National Accreditation Board for Education and Training

NABET

QCI

QCI/NABET/ENV/ACO/24/3283 June 18, 2024

RSP Green Development & Laboratories Pvt. Ltd.
7F Dinobandhu Mukherjee Lane
P.O.:Shibpir, Hawara, West Bengal

Sub.: Extension of Validity of Accreditation till September 17, 2024– regarding
Ref.. 1. Certificate no NABET/EIA/2124/SA 0176
2. Request mail June 15, 2024

Dear Sir/Madam

This has reference to the accreditation of your organization under QCI-NABET EIA Scheme, the validity **RSP Green Development & Laboratories Pvt. Ltd.** is hereby extended till September 17, 2024, or completion of the assessment process, whichever is earlier.

The above extension is subject to the submitted documents/required information with respect to your application and timely submission and closure of NC/Obs during the process of assessment.

You are requested not to use this letter after the expiry of the above-stated date.

With best regards.

(A K Jha)
Sr. Director, NABET

Institute of Town Planners India, 6th Floor, 4-A, Ring Road, I.P Estate, New Delhi-110 002, India
Tel. : +91-11-233 23 416, 417, 418, 419, 420, 421, 423 E-mail : ceo.nabet@qcin.org Website : www.qcin.org

Extension of the NABET Certificate of the respected Consultant

Table of Content

List of Figure

List of Tables

List of Annexure

ABBREVIATION

ABBREVIATIONS & SYMBOLS USED	:	FULL FORMS
%	:	Percent
′	:	Minute
″	:	Second
<	:	less than (strict inequality)
=	:	Equal to (strict equality)
>	:	greater than (strict inequality)
≈	:	approximately equal
°	:	Degree
°C	:	Degree Centigrade
°F	:	Degree Fahrenheit
ArcGIS	:	ArcGIS is a GIS for working with maps and geographic information maintained by the ESRI.
CD blocks	:	Community development blocks
cm	:	Centimeter
cum	:	Cubic meter
Dec	:	December
DEIAA	:	District Level Environment Impact Assessment Authority
DSR	:	District Survey Report
E	:	East
e.g.,	:	*‘exempli gratia’*(Latin phrase) means ‘for example’
EC	:	Environmental Clearance
et.al.,	:	*‘et alia’* (Latin phrase) means ‘and others’
G:2 stage	:	General Exploration (stage of exploration as per UNFC norms)
G:3 stage	:	Prospecting (stage of exploration as per UNFC norms)
GIS	:	Geographical Information System
Govt.	:	Government
GPS	:	Global Positioning System
Ha	:	Hectare
i.e.,	:	*‘id est’* (Latin phrase) means ‘that is’/’in other words’
ICAR	:	Indian Council of Agricultural Research
Inch	:	inches
kg/ha	:	Kilogram per hectare
km	:	kilometer

ABBREVIATIONS & SYMBOLS USED	:	FULL FORMS
km/ hour	:	Kilometer per hour
km2	:	kilometer square
LANDSAT	:	Land Satellite stands for Low Altitude Satellite
LULC	:	Land use and land cover
m	:	Meter
Mar	:	March
Max.	:	Maximum
mbgl	:	Meter Below Ground Level
Min.	:	Minimum
mm	:	Millimeter
MoEF&CC	:	Ministry of Environment, Forest and Climate Change
N	:	North
NH	:	National Highways
No.(s)	:	Number(s)
RI value	:	River Index value
S	:	South
SEIAA	:	State Environment Impact Assessment Authority
Sept	:	September
sp.	:	species
sq.km	:	Square kilometer
Temp	:	Temperature
viz.,	:	Latin phrase *'videre licet'*, and is used as a synonym for "namely",
W	:	West

CHAPTER 1: PREFACE

The need for District Survey Report (DSR) has been necessitated by MoEF & CC vide their Notification No. 125 (Extraordinary, Part II Section 3, and Sub-section ii), S.O. 141 (E), dated 15th January 2016. The notification was made to bring certain amendments with respect to the EIA notification 2006 and in order to have better control over the legislation, district level committees for introduction into the system. Preparation of District Survey Reports has been introduced as a part of the above notification. Subsequently, MOEF & CC has published Notification No. 3611 (E), dt. 25th July 2018 regarding the inclusion of the "Minerals Other than Sand" and specified the format of the DSR. Monitoring Guidelines for Sand Mining (EMGSM) January 2020, issued by the Ministry of Environment, Forest and Climate Change is prepared in consideration of various orders/directions issued by Hon'ble NGT in matters pertaining to illegal sand mining and based on the reports submitted by expert committees and investigation teams. This DSR has been prepared in conformity with the S O 141 (E), S O 3611 (E), and other sand mining guidelines published by MOEF & CC from time to time as well as the requirement specified in Assam Minor Mineral Concession rule 2013, (AMMCR), 2013.

The purpose of the District Survey Report (DSR) is to identify the areas of deposition where mining can be permitted and also, to identify the areas where mining will not be permitted due to proximity to infrastructural structures and installations and areas of erosion. The DSR would also help to calculate the total amount of replenishment.

Preparation of this DSR required both primary and secondary data generation. The primary data generation involved the site inspection, survey, ground truthing etc. while secondary data has been acquired through various authenticated sources and satellite imagery studies. The secondary data related to district profile, local geology, mineralization and other activities are available in rather a piecemeal fashion. The district survey report of Charaideo district also describes the general geographical profile of the district, distribution of natural resources, livelihood, climatic condition, inventory of minor minerals and revenue generation.

The state of Assam itself is very rich in mineral resources. Here "liquid gold" (fuel oil) and other natural resources are found. During the last 70 years, the mineral sector has grown considerably in Assam. In spite of this, the economic growth of this state has been slow. In order to expedite the development process, exploitation of available mineral resources by developing mines & establishment of mineral-based value- added industries has an imperative upshot. Developments achieved in the mining & mineral industries so far, availability of resources & existing trend would offer a glimpse of the future of the mineral sector in the state.

Minor minerals include building stones, gravel, ordinary clay, ordinary sand, limestone used for lime burning, boulders, kankar, morrum, brick earth, bentonite, road metals, slate marble, and stones used for making household utensils. But sand is used for stowing purposes. Coal is considered a major mineral. In the case of Assam, exploitation of minor minerals comes under Rule, 2013 52 (1) of the Assam Minor Minerals Concession Rule. Therefore, this District Survey Report (DSR) will give authentic field data sets and relevant information about the presence of riverbed sand deposits, ordinary earth & brick earth along with river bed boulder and/or fossilized channel deposits which in turn will bestow excellent guidance for systematic and scientific utilization of mineral resources, so that present and future generation may be benefitted at large.

It is also mentioned here that the procedure of preparation of this District Survey Report is as per notification guidelines issued by the Ministry of Environment, Forests and Climate Change (MoEFCC), SO No. 141(E), Dated 15.01.2016, and the format given by SO No. 3611(E), New Delhi, dated 25 July 2018 regarding the preparation of District survey report of mining and other minor minerals as specified in appendix 10 of the notification. The district Charaideo has an extremely remarkable value from the geological aspect. In mining, this district has been made to cover minor mineral mining locations, areas, and an overview of mining activity in the district with all its relevant features pertaining to geology & mineral wealth. From this point of view, minor minerals are slightly different from other districts of Assam. Far-reaching geological fieldwork and thorough study of different minerals along with inselbergs and geostatistical studies of different mineralogical attributes of different minerals, the mines, and their proprietors have been undertaken to find out the plausible causes for proper documentation of the geological history of the total Charaideo district. Some precious minerals that are found in Assam is Platinum (Pt), Gold (Au), etc. this report also contains details of the forest, drainage, land use & land cover, etc.

CHAPTER 2: INTRODUCTION

The District Survey Report of Tinsukia District has been prepared as per the guide line of Ministry of Environment, Forests and Climate Change (MoEF& CC), Government of India vide Notification S.O.-1533(E) dated 14th Sept, 2006 and subsequent MoEF& CC Notification S.O. 141(E) dated 15th Jan, 2016. This report shall guide systematic and scientific utilization of natural resources, so that present and future generation may be benefitted at large. Further, MoEF& CC published a notification S.O. 3611(E) Dated 25th July, 2018 and recommended the format for District Survey Report.

The main objective of DSR is identification of areas of aggradations or deposition where mining can be allowed; and identification of areas of erosion and proximity to infrastructural structures and installations where mining should be prohibited and calculation of annual rate of replenishment and allowing time for replenishment after mining in that area. The DSR would also help to calculate the annual rate of replenishment wherever applicable and allow time for replenishment. Besides sand mining, the DSR also include the potential development scope of in-situ minor minerals.

The objectives of the District Survey Report are as follows:

1. To identify and quantify minor mineral resources for its optimal utilization.
2. To regulate sand and gravel mining, identification of site-specific end-use consumers and reduction in demand and supply gaps.
3. To facilitate use information technology (IT) for surveillance of the sand mining at each step.
4. To enable environmental clearance for cluster of sand and gravel mines.
5. To restrict illegal mining.
6. To reduce occurrences of flood in the area.
7. To maintain the aquatic habitats.
8. To protect ground water in the area by limiting extraction of material in riverbeds to an elevation above the base flow.
9. To maintain data records viz. details of mineral resource, potential area, lease, approved mining plan, co-ordinates of lease hold areas, and revenue generation.
10. To design a scientific mining plan and estimate ultimate pit limit.
11. To frame a comprehensive guideline for mining of sand and other minor minerals.

The District Survey Report (DSR) comprises secondary data on geology, mineral resources, climate, topography, land form, forest, rivers, soil, agriculture, road, transportation, and irrigation etc. of the district collected from various published and un-published literatures and reports as well as various websites. Data on lease and mining activities in the district, revenue etc. have been collected from the DL&LRO office of the district and from Government of Assam Mines & Minerals Directorate of Geology & Mining.

2.1 Statutory Framework:

Ministry of Environment, Forest, and Climate Change (MoEF& CC) has published several notifications time to time to formulate and implement the District Survey Report (DSR) for every district. Statutory Framework and its legal aspect with respect to DSR is tabulated in Table 01.

Table 01: Statutory Framework and guidelines on DSR with time scale

Year	Particulars
1957	Mines and Minerals (Development and Regulation) act, 1957 Act is the principal Act for regulation of mines and development of minerals.
1986	The environment (Protection) act, 1986 was enacted in 1986 by the Ministry of Environment and Forests with the objective of providing for the protection and improvement of the environment
1994	The Ministry of Environment, Forest & Climate Change (MoEF&CC) published Environmental Impact Assessment Notification 1994 which is only applicable for the Major Minerals more than 5 ha.
2006	In order to cover the minor minerals also into the purview of EIA, the MoEF & CC has issued EIA Notification SO 1533 (E), dated 14th September 2006, made mandatory to obtain environmental clearance for both Major & Minor Mineral more than 5 Ha.
2012	Further, Hon’ble Supreme Court wide order dated the 27th February, 2012 in I.A. No.12- 13 of 2011 in Special Leave Petition (C) No.19628-19629 of 2009, in the matter of Deepak Kumar etc. Vs. State of Haryana and Others etc., ordered that “leases of minor minerals including their renewal for an area of less than five hectares be granted by the States/Union Territories only after getting environmental clearance from MoEF”; and Hon’ble National Green Tribunal, order dated the 13th January, 2015 in the matter regarding sand mining has directed for making a policy on environmental clearance for mining leases in cluster for minor Minerals.
2013	Assam Minor Mineral Concession rule 2013 recommended rules for regulating the grant of various forms of mineral concessions to prevent illegal mining in the district, The Rules detail restrictions on mining operations near villages, highways, and other structures, and the process for granting mining leases and contracts through competitive bidding or auctions and payments. It also covers General conditions to grant any mineral concession, regulation and control of mining operations, Restoration and Rehabilitation fund, illegal or un-authorised Mining and its consequences. It highlights the significance of scientific mining, detailed reporting, and adherence to environmental and safety regulations. Overall, the Rules aim to ensure responsible mineral extraction, prevent unauthorized activities, and promote sustainable mining practices in Assam, while providing a structured framework for granting and managing mineral concessions in the region.

March 2015	The Mines and Minerals (Development and Regulation) Amendment Act,2015 is an act to amend the Mines and Minerals (Development and Regulation) Act, 1957 which enacted on March 26, 2015,and become effective from January 12, 2015,it introduced several key amendments, including the establishment of Special Courts for mining-related offenses, the requirement for prior approval from the Central Government for certain mining permits, and the extension of mining leases for captive purposes until March 31, 2030. It also revised provisions regarding the auctioning of expired leases and introduced new clauses related to the District Mineral Foundation payments. Additionally, the Act amended definitions and parameters related to mineral content and the powers of the Central Government in regulating mining activity
September 2015	Ministry of Mines notification on 17th September,2015 focuses on exercise of the powers conferred by sub-sections (5) and (6) of Section 9B of the Mines and Minerals (Development and Regulation) Act, 1957 (67 of 1957), the notification focused on specific rules made by Central Government specifying the amount to be paid by holder of a mining lease or a prospecting license-cum-mining lease, in addition to the royalty, to the District Mineral foundation of the district established by the concerned State Government through notification.
2016	The MoEF&CC in compliance of above Hon'ble Supreme Court's and NGT'S order has prepared "Sustainable Sand Mining Guidelines (SSMG), 2016" in consultation with State governments, detailing the provisions on environmental clearance (EC) for cluster, creation of District Environment Impact Assessment Authority, preparation of District survey report and proper monitoring of minor mineral. There by issued Notification dated 15.01.2016 for making certain amendments in the EIA Notification, 2006, and made mandatory to obtain EC for all minor minerals. Provisions have been made for the preparation of District survey report (DSR) for River bed mining and other minor minerals.
2018	MoEF& CC published a notification S.O. 3611(E) Dated 25th July, 2018 and recommended the format for District Survey Report. The notification stated about the objective of DSR i.e. "Identification of areas of aggradations or deposition where mining can be allowed; and identification of areas of erosion and proximity to infrastructural structures and installations where mining should be prohibited and calculation of annual rate of replenishment and allowing time for replenishment after mining in that area."
2020	Enforcement & Monitoring Guidelines for Sand Mining (EMGSM) 2020 has been published modifying Sustainable sand Mining Guidelines, 2016 by MoEF& CC for effective enforcement of regulatory provisions and their monitoring. The EMGSM 2020 directed the states to carry out river audits, put detailed survey reports of all mining areas online and in the public domain, conduct replenishment studies of river beds, constantly monitor mining with drones, aerial surveys, ground surveys and set up dedicated task forces at district levels. The guidelines also push for online sales and purchase of sand and other riverbed materials to make the process transparent. They propose night surveillance of mining activity through night-vision drones.
October 2020	(In IA No 40/2020 41/2020, 46/2020, 47/2020) and vide order dated 14th October 2020 NGT also mandates that DSR/Replenishment Study should be

	prepared by a consultant having accreditation from NABET which further should be appraised by SEAC and approved by SEIAA. The consultant must follow procedure laid down under SSMMG-2016 and EMGSM-2020 during preparation of DSR.
February 2021	Government of Assam through Assam Minerals regulation and dealers' rule 2020 proposed rules to regulate the possession, storage, trading and transport of minerals and mineral products to check evasion of royalty or seigniorage fee, to stop illegal mining and transportation in the state of Assam. The rule is applicable to all Minerals Dealers and all industries/ factories connected with the sale, purchase, transportation, processing and consumption of minerals for commercial purpose in the state of assam.
October 2021	Assam Minor Mineral Concession (Amendment) Rules, 2021 notified on October 7th, 2021, it focuses to reorganize the royalty payment process for minor minerals utilized by government departments and agencies. It establishes specific rates of royalties based on the project cost, excluding taxes, and mandates that these royalties be deducted at the time of payment to contractors or suppliers. Additionally, the rules introduce a structured collection process for urban local bodies, requiring royalties to be collected in installments throughout the construction phase, thereby ensuring compliance and proper financial management in the use of minor minerals.

Important statutory provisions of Assam Minor Mineral Concession rule:

Mining operation under mining a mineral concession.

- No person shall undertake any prospecting or mining operation activity in respect of any minerals in any part of the State, except under and in accordance with the terms and conditions of a permit or a prospecting licence or a mining lease or a mining contract or a permit, or a concession in any other form, as the case may be, granted:

- Provided that nothing in this sub-rule shall apply to any prospecting operation undertaken by the Geological Survey of India, the Indian Bureau of Mines, and the Atomic Minerals Directorate for Exploration and Research of the Central Government, the Directorate of Geology & Mining, Assam or the Mineral Exploration Corporation Limited.

Restriction on grant of mining lease/contract/ permit.

I. No mining lease/contract /permit shall be granted in respect of any land within a distance of: -

(i) Fifty metres from the outer periphery of the defined limits of any village habitation, National Highway, State Highway and other roads where such excavation does not required use of explosives.

(ii) Two hundred fifty metres for the outer periphery of the defined limits of any village habitation, National Highway, State Highway and other roads where use of explosives if required.

(iii)Five hundred metres from major structures like R.C.C. Bridge, Guide bund etc.

Provided that the Government may relax the above distance parameters, wherever required in the interest of working, mineral conservation or for any unforeseen reasons subject to such condition as may be imposed under the said relaxation.

(2) No mining lease/contract/permit or any other mineral concession shall be granted in respect of any such minor mineral or in respect of any specific or general area which the Government may notify.

Condition on which the Permit for mining/quarrying shall be granted

I. Any mining operation in the case of mining of brick earth or ordinary clay or alluvial deposit below a depth of 1.5 metre shall necessarily require formation of benches for safe mining. The benches would be formed in a manner that the width of the bench is not lesser than the height of the bench.

II. Any quarrying permit granted under these rules shall contain information with regard to the following:

a) Manner, mode and place of payment of rent, royalties, permit money, Rehabilitation and Restoration Fund amount and interest on delayed payments or any other dues as admissible under these rules.

b) Particulars of the receipt heads of the Government to which the payments are to be credited.

c) Grant, compensation of damage to the land owner for the land covered by the permit.

d) Felling the trees, pumping of ground water.

e) Restriction of surface operations in any area provided by any authority.

f) Entering and working in any forest area.

g) Reporting all accidents, use of explosives.

h) Indemnity to the Government against claim of third parties.

i) Mineral to be stacked, measured and dispatched.

j) Applicability of the provisions of all other statutes/rules framed by the Central and State Government.

k) Reclamation or restoration of the mining areas and security thereof.

l) Development and conservation of minerals and environment and ecology of the area.

m) Extent of the area or land from where the minor mineral shall be extracted.

n) Period within which the minor mineral shall be extracted and removed and delivery of possession of land on the expiry of such period or on removal of the quantity of the minor mineral for which the permit is valid/granted.

o) Release of security by the authority issuing permit after having satisfied that the permit holder has fulfilled all the conditions of the permit satisfactorily.

p) Any other condition, as may be found expedient by the competent authority to grant the permit, may be imposed in the interest of scientific mining, mineral conservation and mineral development.

III. In case of the permit holder is not able to remove the whole or any part of the mineral for which he obtained the permit within the permissible time for any reason, whatsoever, he shall not be entitled to claim the refund of permit amount/ royalty or any part thereof.

IV. The permit holders for the brick kilns shall furnish a solvent surety within fifteen days of the issue of the permit by submitting an undertaking of such surety that he would be responsible for deposit of all dues in case the permit holder fails to deposit the same.

Special conditions for river-bed

Following condition shall be application for excavation of minor mineral (s) from river beds in other to ensure safety of river-beds, structures and the adjoining areas:

- No mining would be permissible in a river-bed up to a distance of five times of the span of the bridge on up-stream side and ten times the span of such bridge on down-stream side, subject to minimum of 250 meters on the up-stream side and 500 meters on the down-stream side.

- There shall be maintained an un-mined block of 50 meters width after every block of 1000 meters over which mining is undertaking or at such distance as may be directed by the competent authority.

- The maximum depth of mining in the river-bed shall not exceed three meters measured from the un-mined bed level at any point of time with proper bench formation.

- Mining shall be restricted within the central 3/4th width of the river/ rivulet.

- No mining shall be permissible in an area up to a width specified by the competent authority from the action edges of embankments.

- Any others condition as may be required by the competent authority in public interest.

- **Sustainable Sand Mining Management Guidelines (SSMMG), 2016by MoEF& CC.**

The sustainable sand Mining Management Guidelines 2016 has been prepared after extensive consultation with the States and Stakeholders over a period of one year. The main objective of the Guideline is to ensure sustainable sand mining and environment friendly management practices in order to restore and maintain the ecology of river and other sand sources.

1. Parts of the river reach that experience deposition or aggradation shall be identified first. The Lease holder/ Environmental Clearance holder may be allowed to extract the sand and gravel deposit in these locations to manage aggradation problem.

2. The distance between sites for sand and gravel mining shall depend on the replenishment rate of the river. Sediment rating curve for the potential sites shall be developed and checked against the extracted volumes of sand and gravel.

3. Sand and gravel may be extracted across the entire active channel during the dry season.

4. Abandoned stream channels on terrace and inactive flood plains be preferred rather than active channels and their deltas and flood plains. Stream should not be diverted to form inactive channel.

5. Layers of sand and gravel which could be removed from the river bed shall depend on the width of the river and replenishment rate of the river.

6. Sand and gravel shall not be allowed to be extracted where erosion may occur, such as at the concave bank.

7. Segments of braided river system should be used preferably falling within the lateral migration area of the river regime that enhances the feasibility of sediment replenishment.

8. Sand and gravel shall not be extracted within 200 to 500 meters from any crucial hydraulic structure such as pumping station, water intakes, and bridges. The exact distance should be ascertained by the local authorities based on local situation. The cross-section survey should cover a minimum distance of 1.0 km upstream and 1.0 km downstream of the potential reach for extraction. The sediment sampling should include the bed material and bed material load before, during and after extraction period. Develop a sediment rating curve at the upstream end of the potential reach using the surveyed cross- section. Using the historical or gauged flow rating curve, determine the suitable period of high flow that can replenish the extracted volume. Calculate the extraction volume based on the sediment rating curve and high flow period after determining the allowable mining depth.

9. Sand and gravel could be extracted from the downstream of the sand bar at river bends. Retaining the upstream one to two thirds of the bar and riparian vegetation is accepted as a method to promote channel stability.

10. Flood discharge capacity of the river could be maintained in areas where there are significant flood hazard to existing structures or infrastructure. Sand and gravel mining may be allowed to maintain the natural flow capacity based on surveyed cross- section history.

11. Alternatively, off-channel or floodplain extraction is recommended to allow rivers to replenish the quantity taken out during mining.

12. The Piedmont Zone (Bhabhar area) particularly in the Himalayan foothills, where riverbed material is mined, and this sandy-gravelly track constitutes excellent conduits and holds the greater potential for ground water recharge. Mining in such areas should be preferred in locations selected away from the channel bank stretches.

13. Mining depth should be restricted to 3 meter and distance from the bank should be 3 meters or 10 percent of the river width whichever less.

14. The borrow area should preferably be located on the river side of the proposed embankment, because they get silted up in course of time. For low embankment less than 6 m in height, borrow area should not be selected within 25 m from the toe/heel of the embankment. In case of higher embankment, the distance should not be less than 50 m. In

order to obviate development of flow parallel to embankment, cross bars of width eight times the depth of borrow pits spaced 50 to 60 meters centre-to-centre should be left in the borrow pits.

15. Demarcation of mining area with pillars and geo-referencing should be done prior to start of mining.

- **Enforcement & Monitoring Guidelines for sand Mining, 2020 (MoEF& CC)**

Ministry of Environment Forest & Climate Change formulated the Sustainable Sand Management Guidelines 2016 which focuses on the Management of Sand Mining in the Country. But in the recent past, it has been observed that apart from management and systematic mining practices there is an urgent need to have a guideline for effective enforcement of regulatory provision and their monitoring. Section 23 C of MMDR, Act 1957 empowered the State Government to make rules for preventing illegal mining, transportation and storage of minerals. But in the recent past, it has been observed that there was large number of illegal mining cases in the Country and in some cases, many of the officers lost their lives while executing their duties for curbing illegal mining incidence. The illegal and uncontrolled illegal mining leads to loss of revenue to the State and degradation of the environment.

1. Parts of the river reach that experience deposition or aggradation shall be identified. The Leaseholder/ Environmental Clearance holder may be allowed to extract the sand and gravel deposit in these locations to manage aggradation problem.

2. The distance between sites for sand and gravel mining shall depend on the replenishment rate of the river. Sediment rating curve for the potential sites shall be developed and checked against the extracted volumes of sand and gravel.

3. Sand and gravel may be extracted across the entire active channel during the dry season.

4. Abandoned stream channels on the terrace and inactive floodplains be preferred rather than active channels and their deltas and flood plains. The stream should not be diverted to form the inactive channel.

5. Layers of sand and gravel which could be removed from the river bed shall depend on the width of the river and replenishment rate of the river.

6. Sand and gravel shall not be allowed to be extracted where erosion may occur, such as at the concave bank.

7. Segments of the braided river system should be used preferably falling within the lateral migration area of the river regime that enhances the feasibility of sediment replenishment.

8. Sand and gravel shall not be extracted up to a distance of 1kilometre (1 km) from major bridges and highways on both sides, or five times (5x) of the span (x) of a bridge/public civil structure (including water intake points) on up-stream side and ten times (10x) the span of such bridge on down-stream side, subjected to a minimum of 250 meters on the upstream side and 500 meters on the downstream side.

9. The sediment sampling should include the bed material and bed material load before, during and after the extraction period. Develop a sediment rating curve at the upstream

end of the potential reach using the surveyed cross-section. Using the historical or gauged flow rating curve, determine the suitable period of high flow that can replenish the extracted volume.

10. Calculate the extraction volume based on the sediment rating curve and high flow period after determining the allowable mining depth.

11. Sand and gravel could be extracted from the downstream of the sand bar at river bends. Retaining the upstream one to two-thirds of the bar and riparian vegetation is accepted as a method to promote channel stability.

12. The flood discharge capacity of the river could be maintained in areas where there is a significant flood hazard to existing structures or infrastructure. Sand and gravel mining may be allowed to maintain the natural flow capacity based on surveyed cross-section history. Alternatively, off-channel or floodplain extraction is recommended to allow rivers to replenish the quantity taken out during mining.

13. The Piedmont Zone (Bhabhar area) particularly in the Himalayan foothills, where riverbed material is mined, and this sandy-gravelly track constitutes excellent conduits and holds the greater potential for groundwater recharge. Mining in such areas should be preferred in locations selected away from the channel bank stretches.

14. Mining depth should be restricted to 3 meters and distance from the bank should be ¼th or river width and should not be less than 7.5 meters.

15. The borrow area should preferably be located on the riverside of the proposed embankment because they get silted in the course of time. For low embankment, less than 6 m in height, borrow area should not be selected within 25 m from the toe/heel of the embankment. In the case of the higher embankment, the distance should not be less than 50 m. In order to obviate the development of flow parallels to the embankment, crossbars of width eight times the depth of borrow pits spaced 50-to-60-meter centre-to-centre should be left in the borrow pits.

16. Demarcation of mining area with pillars and geo-referencing should be done prior to the start of mining.

17. A buffer distance /un-mined block of 50 meters after every block of 1000 meter over which mining is undertaken or at such distance as may be the directed/prescribed by the regulatory authority shall be maintained.

18. A buffer distance /unmined block of 50 meters after every block of 1000 meters over which mining is undertaken or at such distance as may be the directed/prescribed by the regulatory authority shall be maintained.

19. River bed sand mining shall be restricted within the central 3/4th width of the river/rivulet or 7.5 meters (inward) from river banks but up to 10% of the width of the river, as the case may be and decided by regulatory authority while granting environmental clearance in consultation with irrigation department. Regulating authority while regulating the zone of river bed mining shall ensure that th objective to minimize the effects of riverbank erosion and consequential channel migration are achieved to the extent possible. In general, the area for removal of minerals shall not exceed 60% of the

mine lease area, and any deviation or relaxation in this regard shall be adequately supported by the scientific report.

20. Mining Plan for the mining leases (non-government) on agricultural fields/Patta land shall only be approved if there is a possibility of replenishment of the mineral or when there is no riverbed mining possibility within 5 KM of the Patta land/Khatedari land. For government projects mining could be allowed on Patta land/Khatedari land but the mining should only be done by the Government agency and material should not be used for sale in the open market.

The minerals reserve for riverbed area is calculated on the basis of maximum depth of 3 meters and margins, width and other dimensions as mentioned in para (s) above. The area multiplied by dept gives the volume and volume multiplied with bulk density gives the quantity in Metric Ton. In case of riverbed, mineable material per hectare area available for actual mining shall not exceed the maximum quantity of 60,000 MT per annum.

- **Demand and Utilisation of Sand**

Sand is a multi-purpose topographical material. It is known as one of the three fundamental ingredients in concrete. The composition of sand is diverse. Mostly sand is made of silica which is a common element. It can also come from another source of minerals like quartz, limestone, or gypsum.

From beds to flood plains to coastlines- we can find the sand at almost everywhere. The robustness of sand has played a significant role in everyday life. We use sand practically every other day.

Sand extraction from river beds and brick earth mining for making raw bricks are the main mining activities in the district. With a spurt in construction of real estate sectors and various govt. sponsored projects, the demand for both sand and bricks has increased manifold. The extraction of sand is carried out either manually or through semi- mechanized system. The depth of mining for both river bed sand and brick earth is restricted due to statutory provision in the regulations pertaining to conservation and development of minor minerals.

River sand mining is a common practice as habitation concentrates along the rivers and the mining locations are preferred near the markets or along the transportation route, for reducing the transportation cost.

In the real world, there are a lot of situations where we can find uses of sand. Followings are the common sand uses.

1. While bunging metal, we can mix sand with clay binder for frameworks used in the foundries.

2. Sand can be used for cleaning up oil leak or any spill by dredging sand on that spill. The material will form clumps by soaking up, and we can quickly clean the mess.

3. Sand can be used as a road base which is a protective layer underneath all roads

4. Industrial sand is used to make glass, as foundry sand and as abrasive sand.

5. One creative usage of sand is serving as a candle holder. We can try putting some sand before pouring tea light or any candle in a glass. It holds the candle still and refrain the candle from rolling by giving it an excellent decoration.

6. Adds texture and aesthetic appeal to space.

7. Sand is mostly pure to handle, promptly available and economically wise.

8. We use sand in aquariums, fabricating artificial fringing reefs, and in human-made beaches

9. Sandy soils are ideal for growing crops, fruits and vegetables like watermelon, peaches, peanuts, etc.

10. Sand can light a path by filling mason jars with sand and tea light which is another inexpensive way to make a walkway glow.

11. Sand helps to improve resistance (and thus traffic safety) in icy or snowy conditions.

12. We need sand in the beaches where tides, storms or any form of preconceived changes to the shoreline crumble the first sand.

13. Sand containing silica is used for making glass in the automobile and food industry- even household products for the kitchen.

14. Sand is a strong strand which is used for plaster, mortar, concrete, and asphalt.

15. The usual bricks formulated of clay only are way weaker and lesser in weight than blocks made of clay mixed with sand.

2.2 Methodology of DSR Preparation

The steps followed during the preparation of District Survey Report are given in Figure 2.1. The individual steps are discussed in following paragraphs.

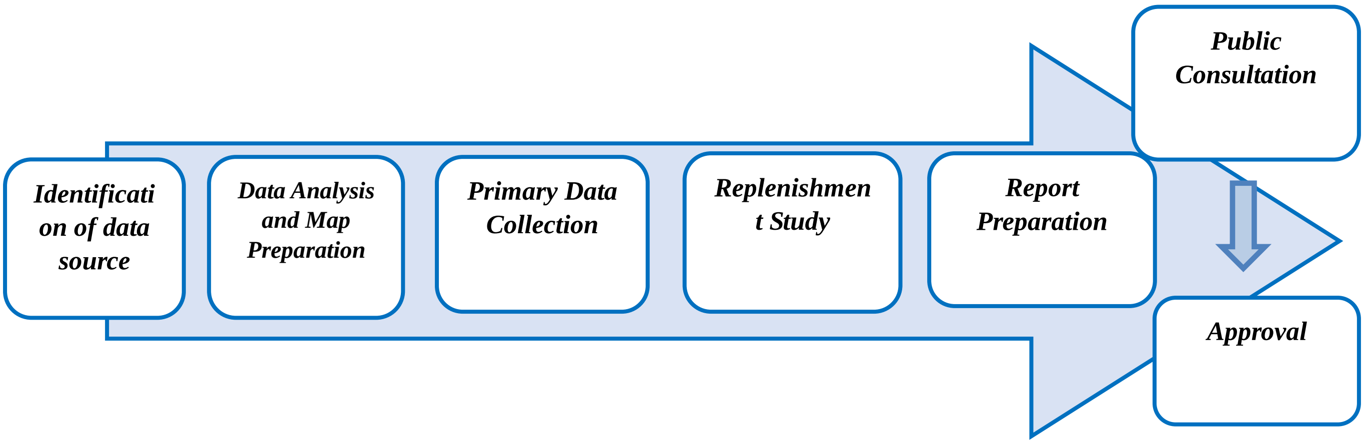
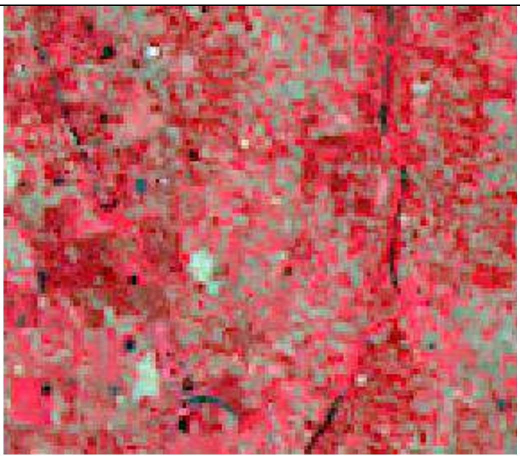


Figure 01: Steps followed in preparation of DSR

Data source Identification: District Survey Report has been prepared based on the primary data base and secondary data base collected and collated from different sources. It is very critical to identify authentic data sources before compiling the data set. The secondary data sources which are used in this DSR are mostly taken from public domain or from the published report in reputed journals. Information related to district profile has been taken from District Census Report, 2011 and District Statistical Handbook published by the Govt. of Assam. Potential mineral resources of the district have been described based on the published report of Geological Survey of India (GSI) or any other govt. agencies like MECL etc. List of mining lease, name of lease holder, lease/block area, resource in already allotted mining lease, revenue from minor mineral sector etc. have been collected from the concern DL & LRO offices of the district. Satellite images have been used for map preparation related to physiography and land use/land cover of the district.

Data Analysis and Map Preparation: To prepare the Maps of the district, we have collected the data set which are captured during the report preparation. They have gone through detail analysis work. District Survey Report involves the analytical implication of captured dataset to prepare relevant maps. Methodology adopted for preparation of relevant maps is explained below:

Land Use and Land Cover Map: Land Use and Land Cover classification is a complex process and requires consideration of many factors. The major steps of image classification include determination of a suitable classification system via Visual Image Interpretation, selection of training samples, Satellite image (FCC-False Color Composite) pre-processing, selection of suitable classification approaches, post classification processing, and accuracy assessment. Here LISS-III satellite imagery has been taken for supervised classification as supervised classification can be much more accurate than unsupervised classification, but depends heavily on the training sites, the skill of the individual processing the image, and the spectral distinctness of the classes in broader scale. According to the Visual Image Interpretation (Tone, Pattern, Texture, Shape, Color etc.) training set of the pixel has been taken. Pictorial descriptions of Land Use classification are explained in Figure 01.

<table>
<tr><td></td><td></td></tr>
<tr><td>Agricultural Land - Based on their Geometrical shape, Red and Pink color tone, Agricultural Land has been identified.</td><td>Vegetation Covered Area - Area with continuous Red color tone, Vegetation Covered Area has been classified.</td></tr>
</table>

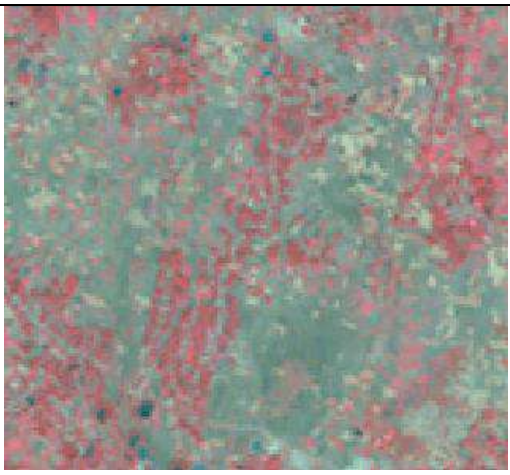
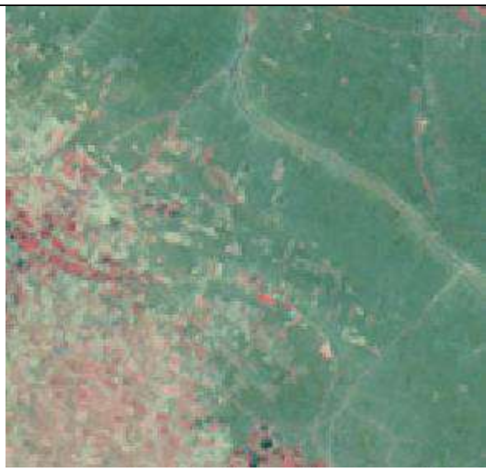
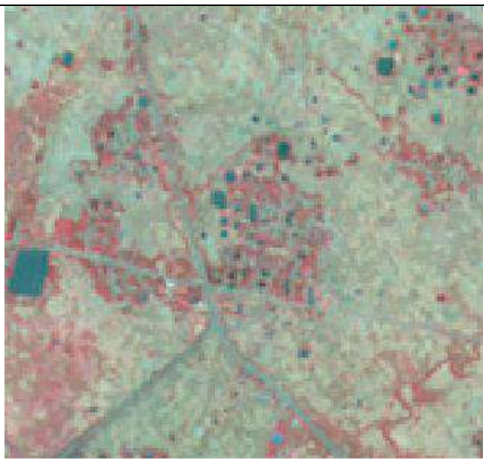
	
Agricultural Fallow Land - Based on their Geometrical shape, Yellowish green color tone, Agricultural Fallow Land has been identified.	Badland Topography- Area with Non geometrical shape and Yellowish green color tone has been identified as Bad Land Topography.
	
Settlement – Area with some geometrical shape in a Linear Pattern including Light Cyan Color has been recognized as Settlement Area.	Water Bodies – Area with Blue color has been classified as Water Bodies.

Figure 02: Pictorial description of Land Use Classification methods

<u>Geomorphological Map:</u> The major step of preparing Geomorphological Map is identifying features like – Alluvial Fan, Alluvial Plain, Hilly Region etc. from Satellite Imagery (FCC- False Colour Composite) via Visual Image Interpretation and then digitisation has been taken into the consideration to prepare map including all the Geomorphological features according to their location. Pictorial descriptions of Geomorphological unit's classification are explained in Figure 03.

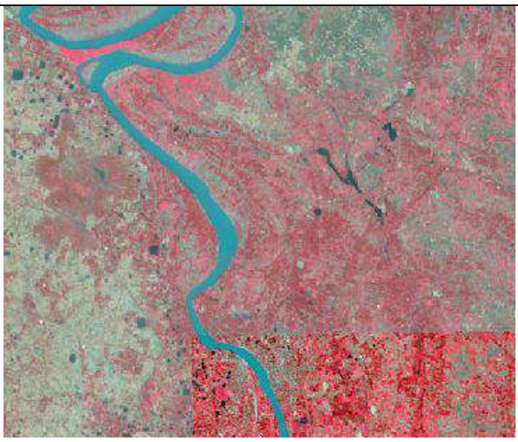
	
Flood plain-Flood plain is a generally flat area of land next to a river or stream. It stretches from the banks of the river to the outer edges of the valley.	OX-BOW Lake- An ox-bow lake starts out as a curve, or meander, in a river. This "U" shaped body of water identified as Ox- Box Lake from Satellite Imagery.

Figure 03: Pictorial description of Geomorphological Units Classification methods

Physiographical Map: The major step of preparing Physiographical Map is generating contour at a specific interval to show the elevation of the area using Cartosat DEM.

Block Map/Transportation Map/Drainage Map:

- Raw Data collected from National Informatics Centre (NIC Website) during May 2024.
- Data has been geo-referenced using GIS software.
- Digitization of block boundary, district boundary, state boundary, international boundary, and district headquarter, sub–district headquarter, places, road, railway, river, nala etc.
- Road name, River name, Railway name has been filled in attribute table of the Layers
- Final layout has been prepared by giving scale, legend, north arrow, etc.

Earthquake Map:

- Raw data collected from Ministry of Earth Science.
- Data has been geo-referenced using GIS software.
- Digitization of Earthquake zone and superimposed it over Block Boundary.
- Zone name has been filled in attribute table of the Layers
- Final layout has been prepared by giving scale, legend, north arrow, etc.

Soil Map:

- Raw data collected from National Bureau of Soil Survey and Land Use Planning during May 2024.
- Data has been geo-referenced using GIS software.
- Digitization of Soil classification zone and superimposed it over District Boundary.
- Soil classification has been filled in attribute table of the Layers.
- Final layout has been prepared by giving scale, legend, north arrow, etc.

Wildlife Sanctuary and National Park location Map:

- Raw data obtained from ENVIS Centre on Wildlife & Protected Areas during August 2020.
- Data has been geo-referenced using GIS software.
- Digitization of Wildlife Sanctuary and National Park and superimposed it over Block Boundary.
- Wildlife Sanctuary & National Park name has been filled in attribute table of the Layers Final layout has been prepared by giving scale, legend, north arrow, etc.

Primary Data Collection: To prepare DSR, primary data has been collected and field work has also been carried out for the district. Field study involves assessment of the mineral resources of the district by means of pitting / trenching in specific interval. This provides clear picture of mineral matters characterization and their distribution over the area.

Replenishment study: One of the principal causes of environmental impacts of river bed mining is the removal of more sediment than the system can replenish. Therefore, there is a need for replenishment study for riverbed sand in order to nullify the adverse impacts arising due to excess sand extraction. We have conducted Physical survey by the help of DGPS to define the topography, contours and offsets of the riverbed. The surveys clearly depict the important attributes of the stretch of the river and its nearby important civil and other feature of importance. This information will provide the eligible spatial area for mining. The annual rate of replenishment carried out on every river of the district to have proper assessment of the sand reserve for mining purposes. The surveys clearly depict the important attributes of the stretch of the river and its nearby important civil and other feature of importance. This information will provide the eligible spatial area for mining.

Report Preparation: The district survey report portrays general profile, geomorphology, land use pattern and geology of the district. The report then describes the availability and distribution of riverbed sands and other minor minerals in the district. Apart from delineation the potential mining blocks, the report also includes Inventorisation of the minerals, recent trends of production of minor minerals and revenue generation there from. Annual replenishment of the riverbed sand has been estimated using field observation, satellite imagery and empirical formula. The road network connecting arterial road to potential mining blocks has been identified. Potential environmental impacts of mining of these minerals, their mitigation measures along with risk assessment and disaster management plan have also been discussed. Finally, the reclamation strategy for already mined out areas is also chalked out.

Public Consultation & Approval: In accordance with the Enforcement and Monitoring Guidelines for Sand Mining, the UT Government would look for public feedback on the list of mining zones that will be placed up for auction. The DSR, which includes the list of zones will be advertised in local and national newspapers as well as in district administration website. The public will have twenty one days to provide their input or any comment which will then be considered by the district committee. Sand mining zones, including clusters and contiguous clusters, will be defined in the final DSR. The final list of sand mining areas, including riverbed, Patta land, Khatedari, desiltation locations and M-sand Plants will be defined in the final DSR, following the public hearing as per Annexure-V. Details regarding clusters and contiguous clusters will be provided in Annexure-VI and Annexure-VII. The process flow diagram is as follows:

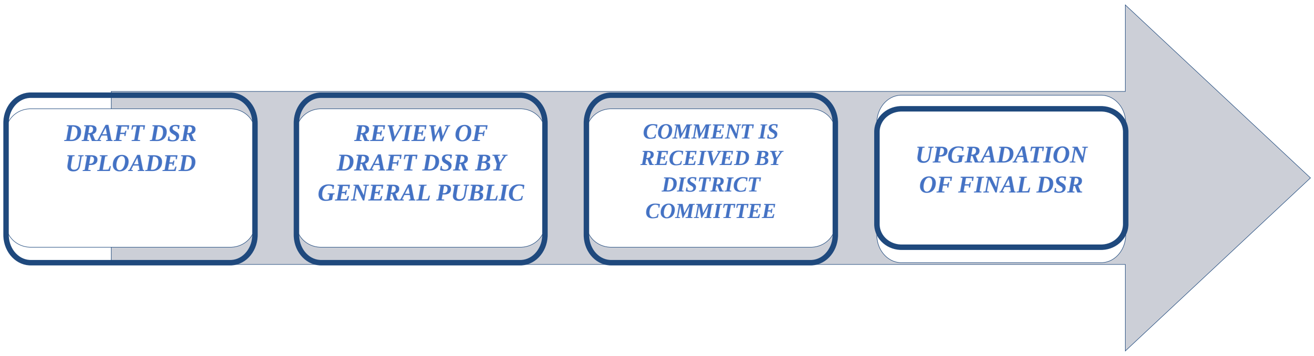


Figure 04: Schematic Representation of Public Consultation

CHAPTER 3: GENERAL PROFILE OF THE DISTRICT

a) General information:

Charaideo district is an administrative district of the state of Assam. It was declared as a new district of the state on 15th of August, 2015. The district has been carved out of Sivasagar district with Sonari as its administrative headquarter. It comes under Upper Assam division. The district bounded by Dibrugarh at north and Sivasagar at south west part and the district has a boundary with Arunachal Pradesh and Nagaland at the east. The district lies between 27.0373° N, 95.0182° E. Toposheet numbers of the district are 83M/4, 83M/8, 83I/16, 83N/1, 83J/13.

Figure 05: Location Map of Charaideo

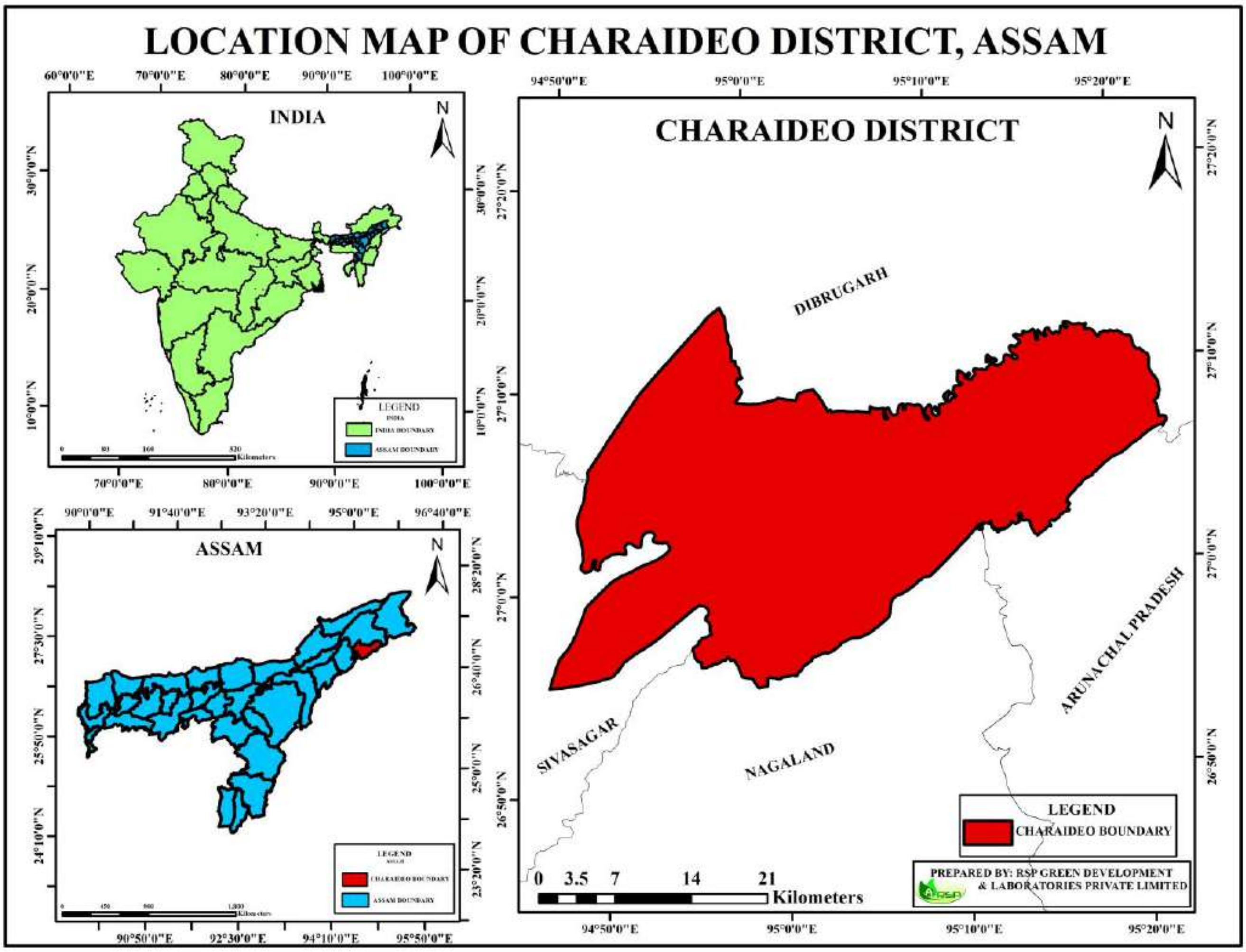


Table 02: Administrative units of the Charaideo District

Sl. No.	ADMINISTRATIVE UNITS	STATISTICS
1	District Head Quarter	Sonari
2	Sub divisions	01
3	Revenue Villages	327
4	No. of CD Blocks	04
5	Revenue Circle	04
6	Mouza	06
7	Legislative Assembly Constituency	02
8	Police Station	09
		*(**Source:** charaideo.assam.gov.in)*

Table 03: Block list of Charaideo District

NAME OF SUB-DIVISION	NAME OF BLOCKS
Charaideo	Abhoypur (Sonari)
	Mahmora
	Sapekhati
	Lakwa

Table 04: Revenue Circle of Charaideo District

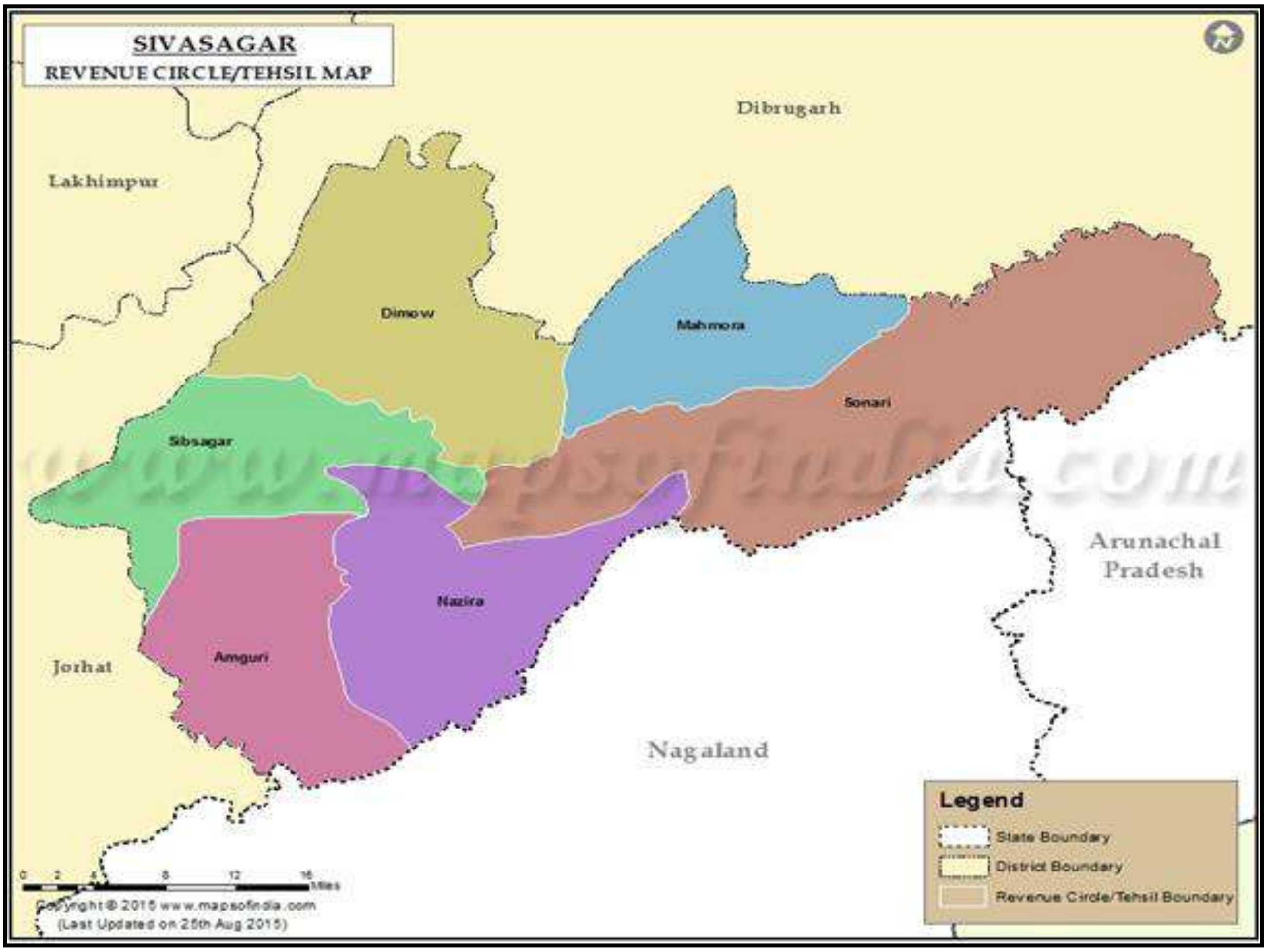
Sl. No.	NAME OF REVENUE CIRCLE
1.	Sonari
2.	Sapekhati
3.	Mahmora
4.	Nazira

Table 05: Mouza list of Charaideo

Sl. no	District	Mouza
1	Charaideo	Baruasali
2		Sapekhati
3		Abhoypur
4		Mahmora
5		Silakutu (part)
6		Dhopabor (Part)

*(**Source**: charaideo.assam.gov.in)*

Figure 06: Administrative Map of Charaideo district



b) Climatic Condition

The average wind speed in Charaideo is 1.7 m/s with the maximum wind speed of around 6 m/s. The average ambient temperature remains 23.2°C, varies from 10.8°C to 35.9°C. The average reletive humidity remains around 78.8%, varies from 39.7% to 99.4%.

The district has a climate which is characterized by a highly humid atmosphere, abundant rains and general coolness. The cold season from December to February is followed by thunder storms from March to May. The south west monsoon sets in June and continues up to the beginning of October.

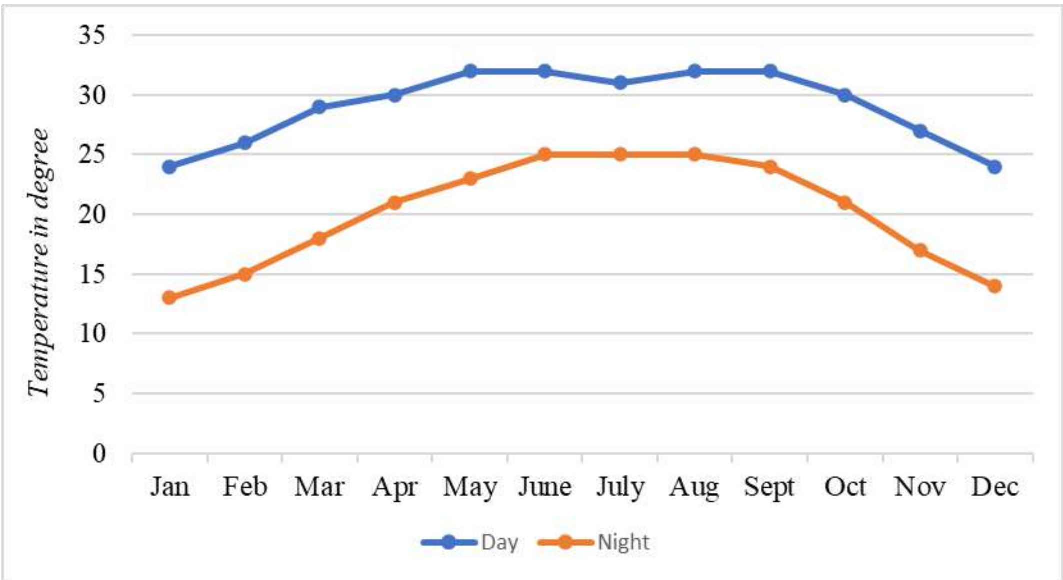
The average annual rainfall in the district is 2504 mm. About 64% of the total rainfall is received during the monsoon season with July being the wettest month. The mean maximum and mean minimum temperatures are 28.600 and 17.400 respectively. July and August are generally the hottest months; while January and December are the coldest months of the year

Table 06 Day night temperature of Charaideo district (in degree)

Month	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**June**	**July**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**
Day	24	26	29	30	32	32	31	32	32	30	27	24
Night	13	15	18	21	23	25	25	25	24	21	17	14

*(**Source:** https://www.worldweatheronline.com)*

Figure 07: Charaideo average temperature



c) Rainfall: Monthwise

The district experiences predominant influence of southwest tropical monsoon which persists from April to October with occasional winter showers. The low clouds of the southwest monsoon after being intercepted by the North Cachar Hills and Naga-Patkai range, cause heavy rainfall in the southern part of Assam and the clouds which pass over this 1800 m ridge, precipitate in the Brahmaputra valley, their intensity increasing towards the foothills of the Himalayas. The approach of the monsoon is marked by strong winds, overcast skies and occasional thunder showers, hailstorm and cyclones during April and May. It starts its full play of heavy showers from June.

Distribution of rainfall pattern reveals that it is negligible during the period January to March and November to December. On an average the total rainfall during these winter months hardly exceeds 100 mm. Otherwise, the average annual rainfall of the district is of the order of 2400mm.

i. Pre-monsoon: March, April, and May

ii. Monsoon: June, July, August and September.

iii. Post-monsoon: October and Novemebr

iv. Winter: December, January, and February

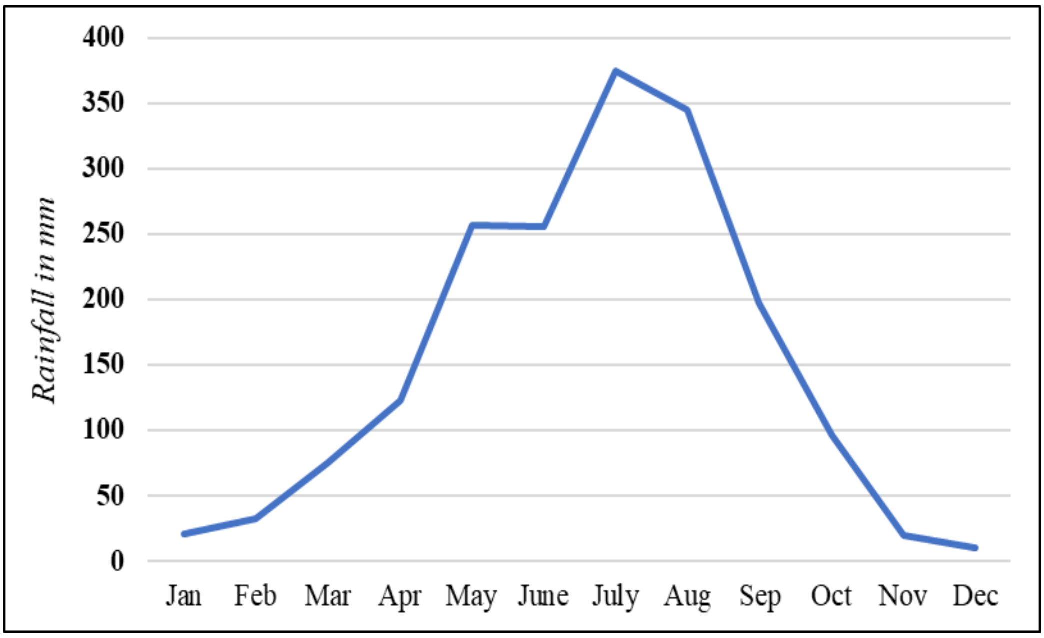
Sometimes, the monsoon commences in mid-May and ends in mid-September. Therefore, the boundaries between the seasons are not very rigid. The months October, November and December are considered to be representative study period.

Table 07: Rainfall Data of Charaideo District

Year	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**June**	**July**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
(2016)	21.1	32.2	75.3	123.5	257.1	255.5	374.8	345.2	196.9	96.3	20.3	10.3

*(**Source**: https://weatherandclimate.com)*

Figure 08: Rainfall Graph of Charaideo District

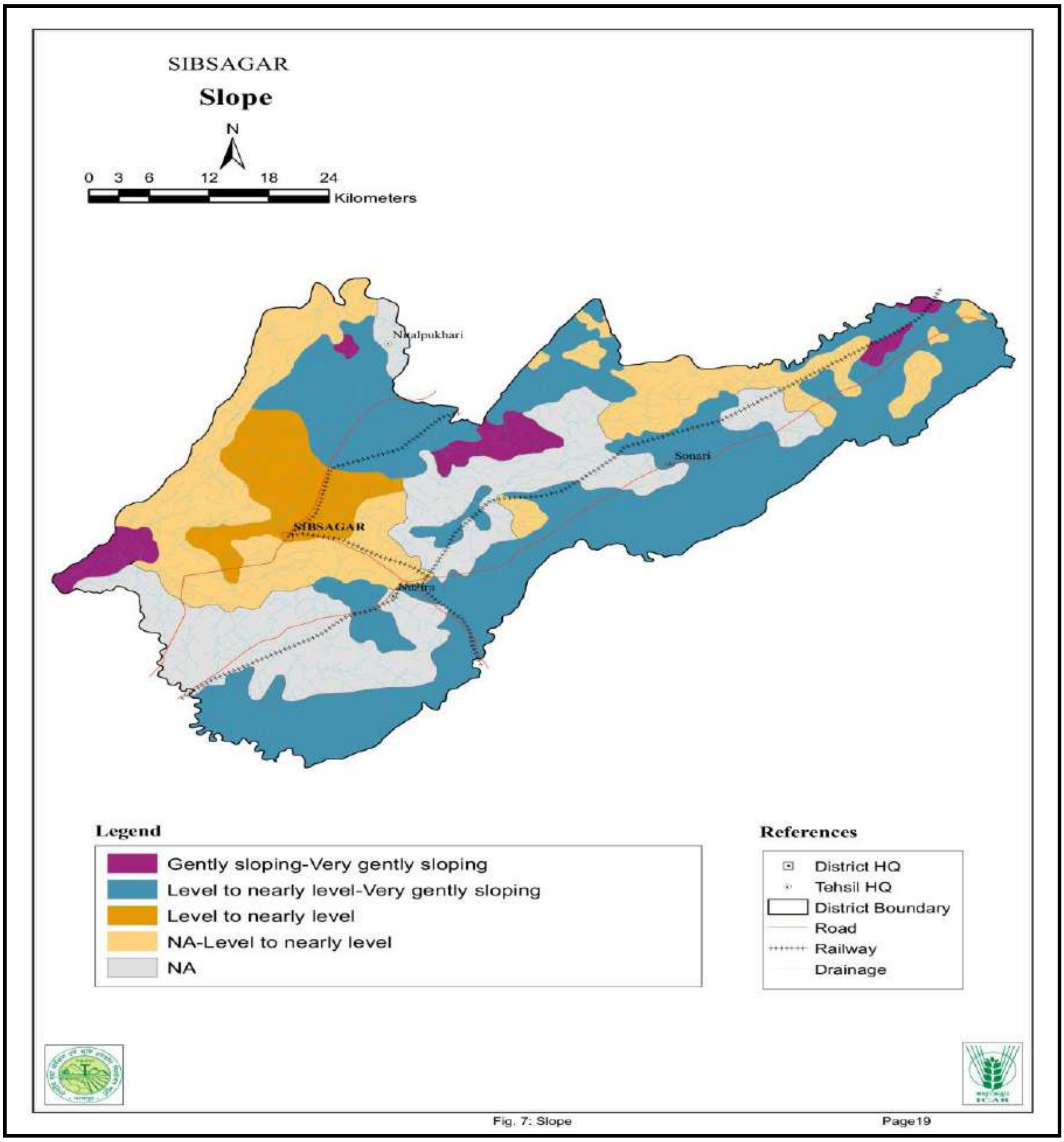


*(**Source:** https://weatherandclimate.com)*

d) Topography & Terrain:

The general elevation of the plain area varies from 85 to 100m above mean sea level which gradually rises to 128 to 150 m towards south and southeast. Being a high rainfall area, the district is characterised by thick and luxurious growth of vegetation.

Figure 09: Relief Map of Charaideo district



e) Water Course & Hydrology:

The geology of Upper Assam as a whole is quite interesting and can be clearly visualised only if we know the geological history of Assam which has been discussed in detail by many workers of the Geological Survey of India, Oil India and the Oil and Natural Gas Commission. References are found in the publications of G.S.I. & O.N.G.C. Without going into the details of the geological history, it can be stated that the sedimentation in Upper Assam particularly covering parts of Jorhat, Charaideo, Dibrugarh and Tinsukia districts has been affected by the Naga Patkai range. The Naga-Patkai range consists of a series of complex over thrusts with an imbricate pattern, one thrust overlapping the other. The outer most boundary thrust of the "belt of schuppen" known as the Naga thrust closely follows the boundary of the Assam valley alluvium for about 350 km and continues southwestward for another 50 km upto Haflong.

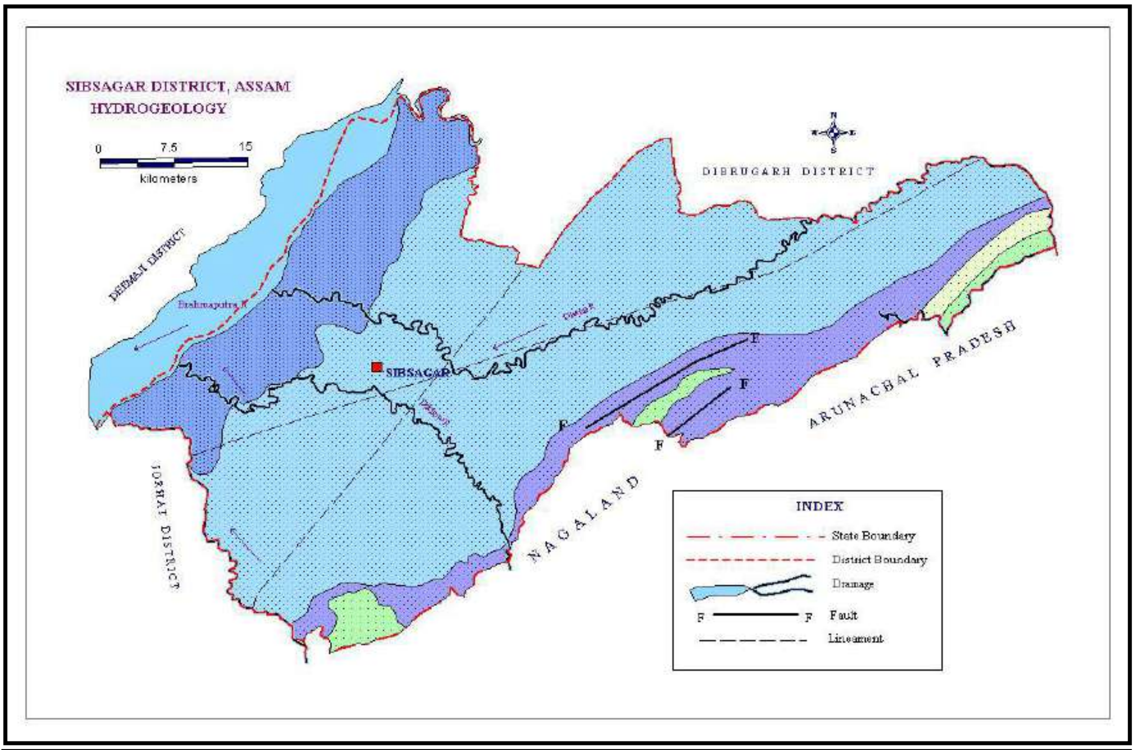
The southern foot hills of Charaideo district falls in the upthrust block of Naga thrust. The various rocks exposed in this strip belong to Barail Group, Tipam Group and post Tipam sediments, oriented in NE-SW to ENE-WSW direction dipping 40-50° in southerly direction.

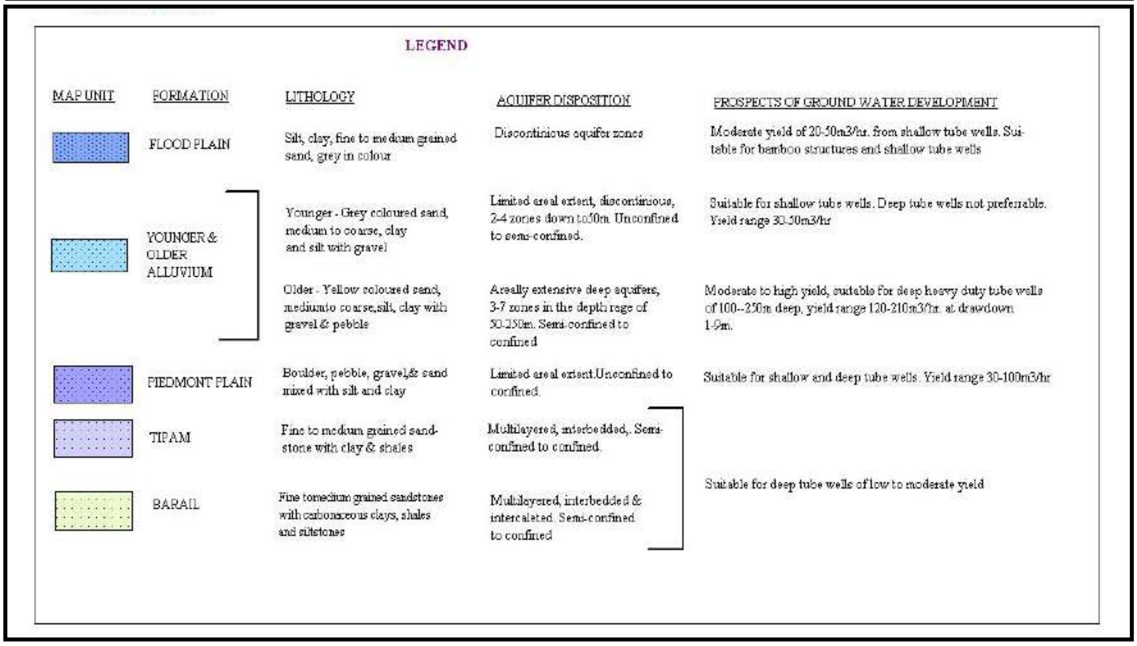
Exploratory drillings carried out down to the depth of 287.10 m by the CGWB has not touched the basement rocks of Archaean age. However, the sediments penetrated are largely soft sandstone, shale and clay and sandy clay belonging to the Tertiary Group of rocks. The sandy horizons whch form the principal aquifers in the district are generally fine to medium grained, occasionally coarse and gritty with typical grey colour. In a few boreholes, carbonised or petrified fossil- wood has also been found. The clay is dark grey, bluish to black which is typical of Tertiary age.

Large number of drilling has been carried out in the district by the CGWB and other State Government agencies like Irrigation, Agriculture and Public Health Engineering departments. The salient features of CGWB tubewells are given in table 25 A critical appraisals of the lithological logs of existing tube wells reveals that the top few metres blanket of sediments is ferruginous, reddish or yellowish silty clay mixed with sand underlain by thick grey sand and clay sequence.

Ground water occurs under unconfined and confined conditions saturating the fine to coarse sandy horizons mostly belonging to Tertiaries. Water table generally rests at depth of 4 m below land surface. In the southern part, it varies from 4 to 6 m below land surface. Water table movement conforms to the topography of the area and moves in north westerly directions. The hydraulic gradient is steep in the undulating tracts of the southern part gradually becoming gentle in the flood plain areas of the Brahmaputra.

Figure 10: Hydrological map of Charaideo district





LEGEND

MAP UNIT	FORMATION	LITHOLOGY	AQUIFER DISPOSITION	PROSPECTS OF GROUND WATER DEVELOPMENT
	FLOOD PLAIN	Silt, clay, fine to medium grained sand, grey in colour	Discontinious aquifer zones	Moderate yield of 20-50m3/hr. from shallow tube wells. Suitable for bamboo structures and shallow tube wells
	YOUNGER & OLDER ALLUVIUM	Younger - Grey coloured sand, medium to coarse, clay and silt with gravel	Limited areal extent, discontinious, 2-4 zones down to50m. Unconfined to semi-confined.	Suitable for shallow tube wells. Deep tube wells not preferrable. Yield range 30-50m3/hr
		Older - Yellow coloured sand, mediumto coarse,silt, clay with gravel & pebble	Areally extensive deep aquifers, 3-7 zones in the depth rage of 50-250m. Semi-confined to confined	Moderate to high yield, suitable for deep heavy duty tube wells of 100--250m deep, yield range 120-210m3/hr. at drawdown 1-9m.
	PIEDMONT PLAIN	Boulder, pebble, gravel,& sand mixed with silt and clay	Limited areal extent.Unconfined to confined.	Suitable for shallow and deep tube wells. Yield range 30-100m3/hr
	TIPAM	Fine to medium grained sandstone with clay & shales	Multilayered, interbedded,. Semi-confined to confined.	Suitable for deep tube wells of low to moderate yield
	BARAIL	Fine tomedium grained sandstones with carbonaceous clays, shales and siltstones	Multilayered, interbedded & intercaleted. Semi-confined to confined	

*(**Source:** Ground Water Information Booklet Sibsagar District, Assam)*

f) Ground Water Development:

Dynamic ground water resources are estimated based on the methodology adopted as per GEC 1997 following Water Level Fluctuation and Rainfall Infiltration Factor Method. The total annual dynamic ground water recharges are calculated to be 1462.81mcm while the net annual ground water draft is 187.04 mcm. The stage of ground water development is 14%. The projected demand for domestic and industrial uses upto 2025 is estimate to be about 36.23mcm. The district is under category and sufficient resources are available for development.

- **Depth of Water level:** Study of water level and its behaviour both in phreatic and confined conditions were carried out in the aquifer mapping area. Sixteen Dug wells were established as key wells for periodical monitoring to know the water level trend and its behaviour in phreatic condition. The depth to water level in these dug wells ranges from 0.93 to 6.5 m bgl during premonsoon and 0.54 to 3.5 m bgl during post-monsoon season and the average water level fluctuation is 0.60 m.

- **Ground water quality:** To know the water quality of the study area, water sampling was done from shallow aquifers. Water samples were collected from the key wells that were established during 2016- 17. A total of 15 water samples were collected from dug wells during pre-monsoon and 13 samples were collected during post monsoon period. The samples were analyzed for the different chemical constituents in the Regional chemical laboratory of CGWB, NER Guwahati.

Figure 11: Depth of Water Level Map Pre-monsoon & post monsoon

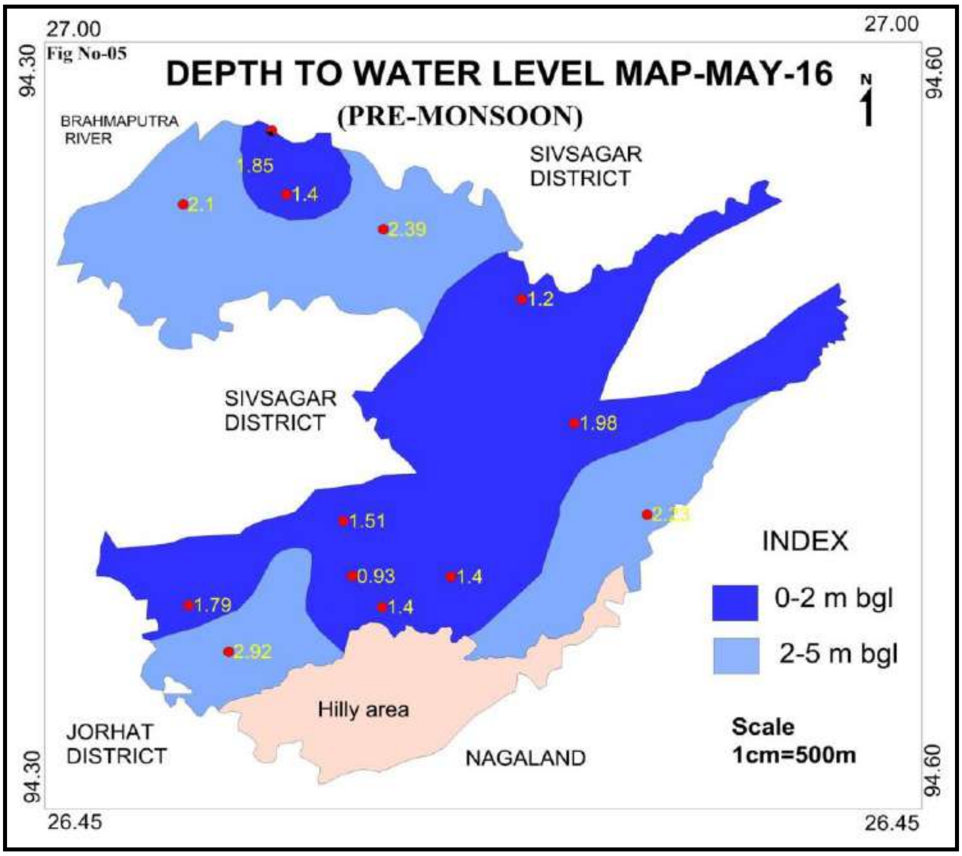
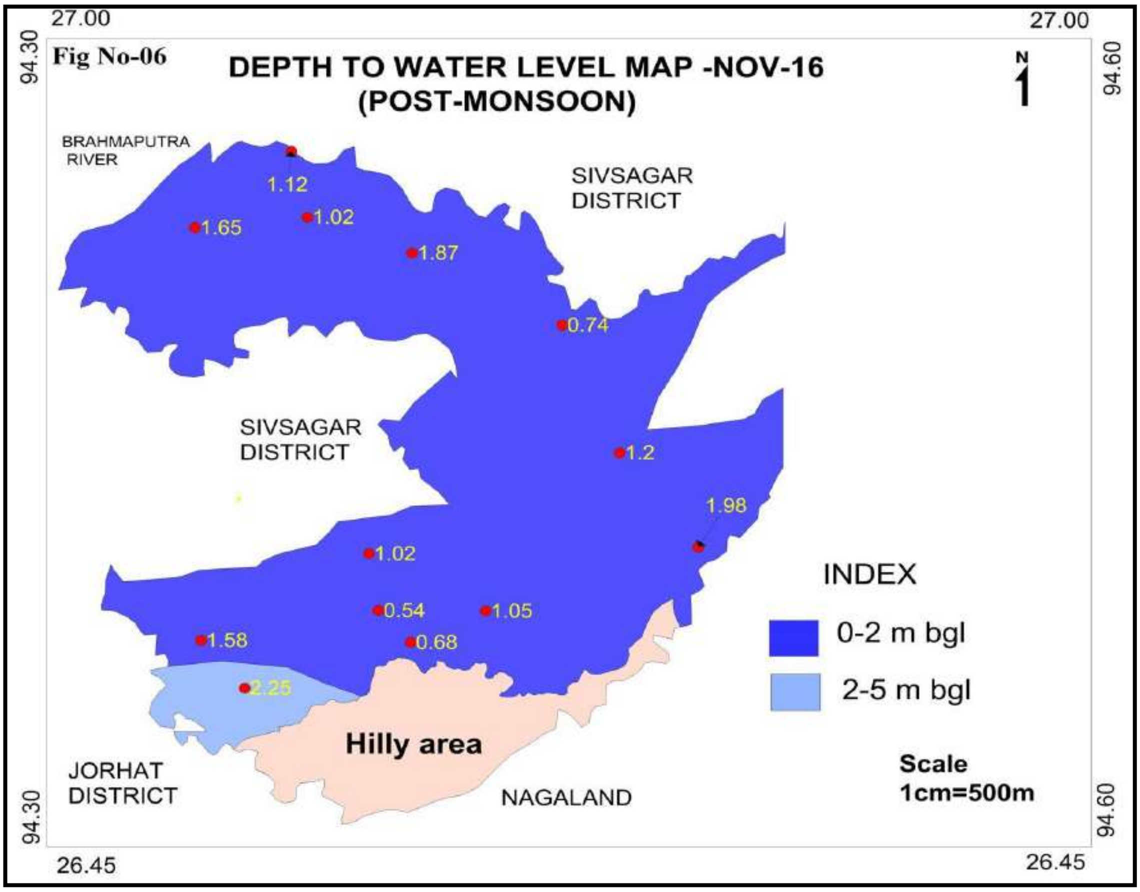


Figure 12: Depth of Water Level Map Post monsoon

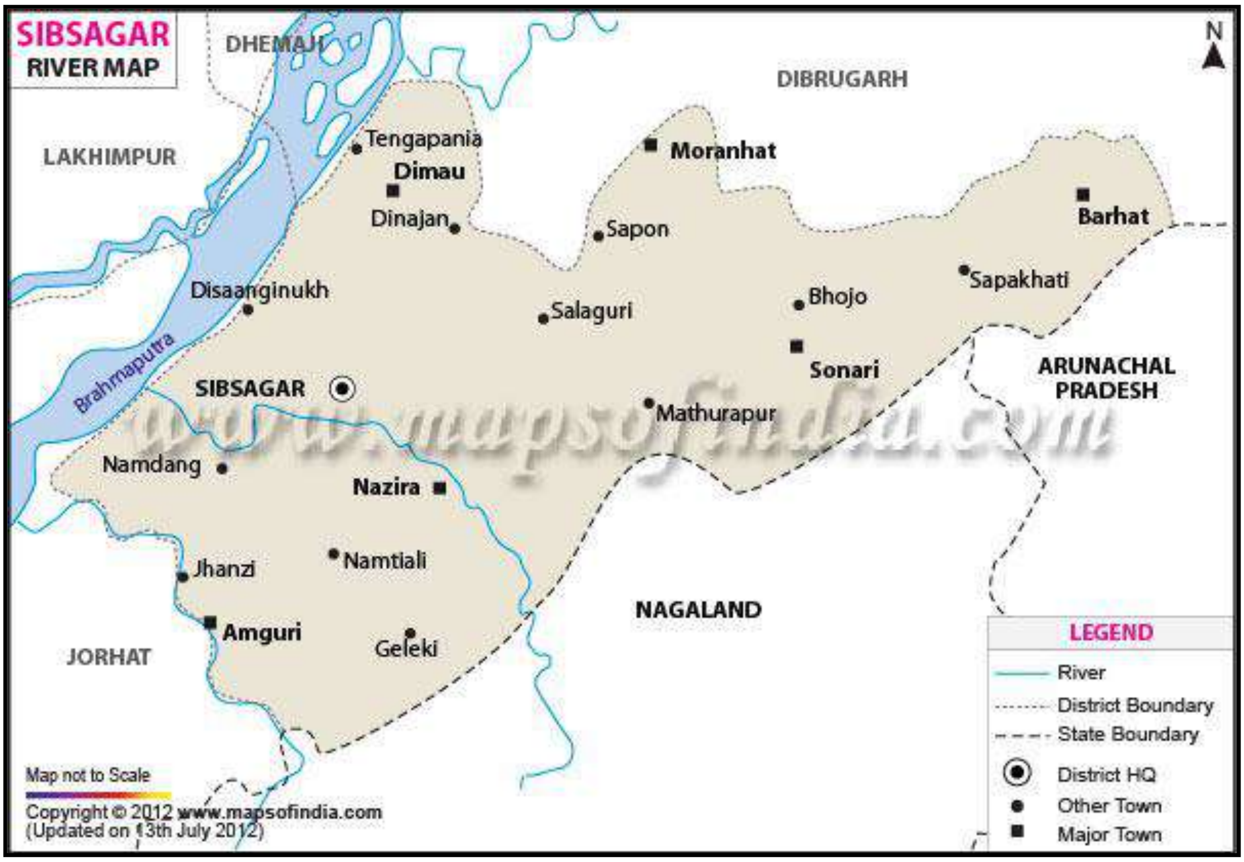


g) Drainage System (general):

Brahmaputra is the major drainage basin which is confined by the Eastern Himalayas on the North and East, the Naga-Patkai range on the southeast and Mikir Hills and Shillong plateau on the southern and southwestern side. The present master slope of this basin finds a gap between the Shillong plateau and the Eastern Himalayas to open in Bangladesh. The Brahmaputra River is one of the largest rivers of the world and discharges about 30 per cent of the total water resources of the country.

The Brahmaputra forms the principal drainage system along with its tributaries mainly Dikhu and Jhanzi originating in the Naga Patkai range and drain the district. The two rivers are having numerous streams in the southern part. The rivers have a highly meandering course. These meandering rivers with abandoned channels form beels and ox-bow lakes along their courses. The rivers of the area represent dendritic and trellis to sub-parallel drainage pattern. A number of physiographic features like oxbow lakes, cut off chutes, meander scrolls, point bars etc. occur in the area. The general slope of the area is from southeast to northwest to which the drainage pattern also conforms. The general elevation of the plain area varies from 85 to 100m above mean sea level and gradually rises to 128 to 150 m towards south and southeast

Figure 13: Drainage Network Map of the Charaideo district



h) Demography:

Table 08: Demographic data table

Considerations	Statistical Data
Area of Charaideo	1069.15 sq.km
Total Population	471418
Male	208344
Female	199281
Density of Population	440/km²
Sex Ratio (Adult)	955 female/1000 male

*(**Source:** https://www.census2011.co.in)*

Table 09: Rural/Urban Population, Literacy rate of Charaideo District

Description	**Rural/Urban**
Child Population (0-6)	51243
Male Child (0-6)	28101
Female Child (0-6)	27200
Child Percentage (0-6)	10.86%
Male Child Percentage	54.83%
Female Child Percentage	53.08%
Literates	71%

*(**Source:** www.census2011.co.in)*

Table 10: Religion wise population table of Charaideo District

Religion	**People (%)**
Hinduism	88.00
Islam	4.58
Christianity	5.24
Buddhism	0.72
Not stated	0.21

*(**Source:** www.census2011.co.in)*

Figure 14: Male Female Population of Charaideo district

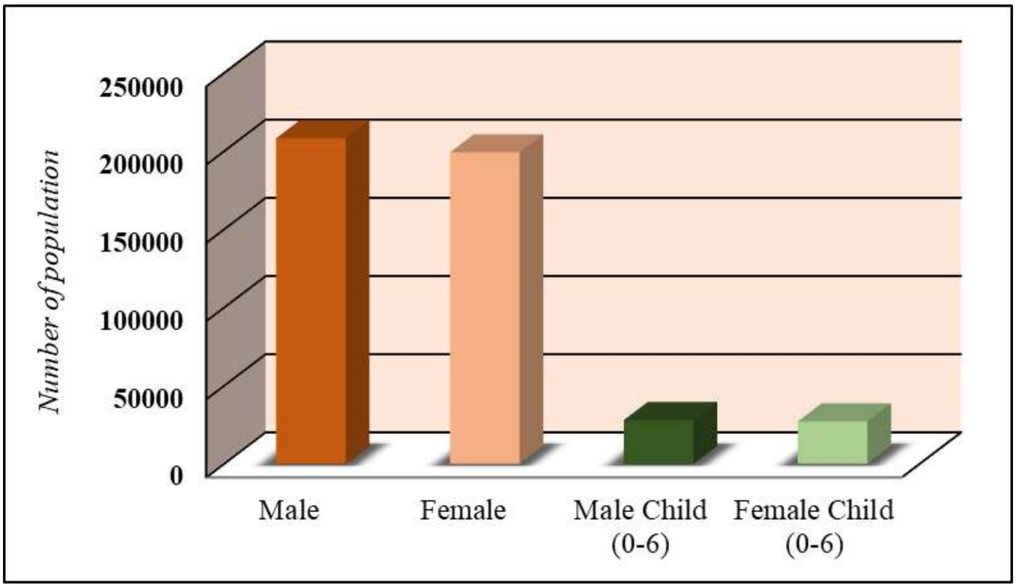
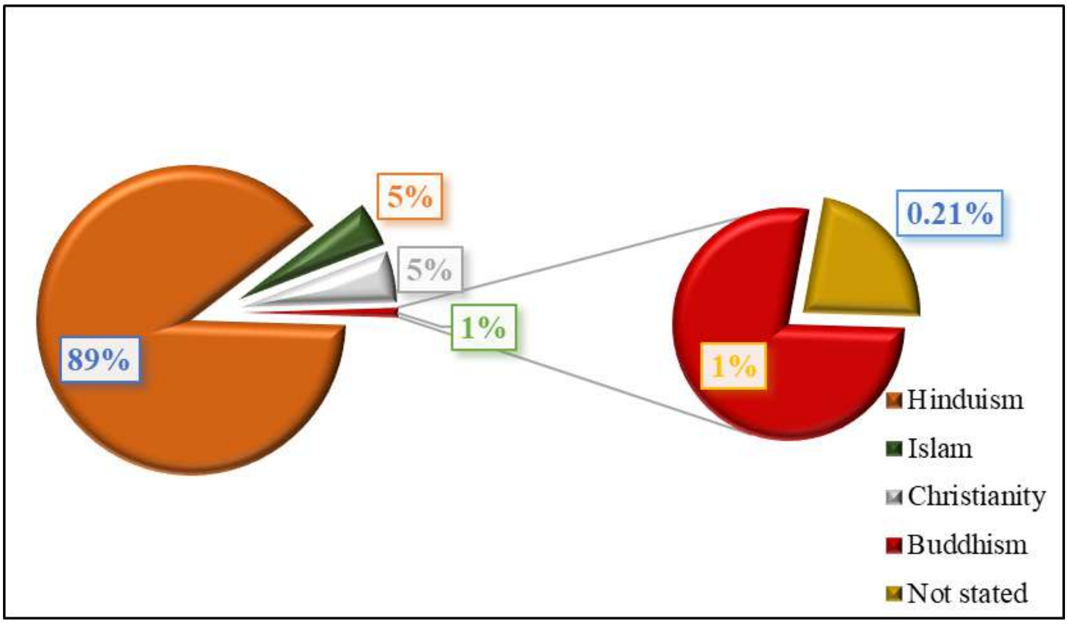


Figure 15: Caste wise population of Charaideo District



(**Source:** *www.census2011.co.in)*

i) Cropping Pattern:

The net area sown of the sample households is 73.24% (1179.52 hectares), 72.35% (1165.24 hectares), 71.48% (1151.13 hectares) 68.97% (1110.8) 30 years ago, 20 years ago 10 years ago and in 2015 respectively. Therefore, the annual growth rate of net sown area has been gradually negative at 0.20 % in the sample villages. Table 1 highlights the downfall of it. It is not a good sign for sustainable development.

As far as double cropping or multiple cropping is concerned the study villages are still far behind. In the modern age of technological innovations, this stagnation of cropping pattern is never favourable. Table 1 indicates the area sown more than once as 1.94%, 2.12%, 2.67% and 3.81% 30 years ago, 20 years ago 10 years ago and in 2015 respectively. The annual compound growth rateis though positive yet the percentage of utilization of land indouble cropping or multiple cropping in the area is quite insignificant. The low growth of double cropping or multiple cropping in the sample villages has resulted in lessening the percentage of cropping intensity in the area. The average percentage of cropping intensity in the area is accounted as 103.6% which is not competent with that of the district and the state – 113% and 146% respectively.

Table 11: Classification of cropping patterns of the surveyed households of the study area over the past 30 years (Area in hectares) Source: Computed from personal field survey, 2015; A period of 30 years is assumed for Compound Growth Rate

SL No	Crops in operation			30 years ago		20 years ago		10 years ago		During the time of survey,2015		Increase or decrease in area/cropping intensity	Compound Annual Growth Rate
				Area	%	Area	%	Area	%	Area	%		
1	Cereals	Autumn paddy		6.05	0.50	4.55	0.38	4.17	0.36	3.57	0.32	-2.48	**-1.74**
		Winter paddy		971.12	80.05	968.47	81.00	963.05	83.29	954.13	86.83	-16.99	**-0.06**
		Summer paddy		8.12	0.67	7.02	0.59	5.04	0.44	1.49	0.14	-6.63	**-5.50**
		Wheat		3.65	0.30	3.51	0.29	3.02	0.26	0.15	0.01	-3.5	**-10.09**
		Maize		6.12	0.50	6.08	0.51	4.36	0.38	7.33	0.67	1.21	**0.60**
		Total		**995.06**	**82.02**	**989.63**	**82.77**	**979.64**	**84.73**	**966.67**	**87.97**	**-28.39**	**-0.10**
2	Other principal crops	Sugarcane		38.09	3.14	36.26	3.03	31.2	2.70	18.11	1.65	-19.98	**-2.45**
		Rape &mustard		30.21	2.49	28.64	2.40	35.44	3.07	14.51	1.32	-15.7	**-2.41**
		Potato		18.23	1.50	16.22	1.36	10.46	0.90	15.25	1.39	-2.98	**-0.59**
		Pulses	*magu mah*	10.22	0.84	12.04	1.01	10.35	0.90	8.72	0.79	-1.5	**-0.53**
			mati mah	13.31	1.10	12.44	1.04	8	0.69	6.54	0.60	-6.77	**-2.34**
			Pea	18.49	1.52	16.03	1.34	11.63	1.01	13.72	1.23	-4.77	**-0.99**
			Others	15.12	1.25	13.77	1.15	8.03	0.69	12	1.08	-3.12	**-0.77**
			Total	**57.14**	**4.71**	**54.28**	**4.54**	**38.01**	**3.29**	**40.98**	**3.68**	**-32.16**	**-2.72**
3	Vegetable	Summer		26.23	2.16	23	1.92	33.15	2.79	43.24	3.70	17.01	**1.68**
		Winter		48.21	3.97	47.68	3.99	58.31	4.92	71.13	6.08	22.92	**1.30**
		Total		**74.44**	**6.14**	**70.68**	**5.91**	**91.46**	**7.71**	**114.37**	**9.78**	**39.93**	**1.44**
4	Net sown area			1179.52	73.24	1165.24	72.35	1151.13	71.48	1110.8	68.97	-68.72	**-0.20**
5	Area sown more than once			30.65	1.94	33.47	2.12	42.08	2.67	59.09	3.81	28.44	**2.21**
6	Gross sown area			**1210.17**	**76.75**	**1198.71**	**75.87**	**1193.21**	**75.74**	**1169.89**	**72.64**	**-40.28**	**-0.11**
7	Cropping intensity			102.60	-	102.87	-	103.66	-	105.32	-	2.72	**0.09**
8	**Total land in operation**			**1576.87**	**100**	**1580.05**	**100**	**1575.44**	**100**	**1551.43**	**100**	**-25.44**	**-0.05**

(***Source:*** *Cropping Pattern in Charaideo District, Assam, India: A Case Study; Manashi Gogoi Assistant Professor, Department of Geography, Arya Vidyapeeth College, Guwahati, Assam, India)*

The cropping pattern in the sample villages has been traditionally mono-cropping in nature. The factors like inconvenience of irrigation, socio-economic conditions, climatic condition, lack of proper planning etc. are responsible for it. 75% cultivators produce both food-grain and non-food grain crops for domestic needs only. Paddy, Maize, Wheat, sugarcane, etc. are the main crop of the district.

j) Land Form and Seismicity:

As Charaideo District is falling under Sesmic Zone (V) of Indian Earthquake Hazard Map, the whole District is most vulnerable to earthquake. Mostly the unban aras of the Distrcit i.e. Charaideo Municipal Board, Amguri Municipal Board, Nazira Municipal Board, Simaluguri Town Committee, Demow Town Committee will have severe damages during any occurrence of earthquake of high magnitude. Possibilities of affect may cause collapses to Residential/Office Buildings, Commericial Institutions (Shop/Cinema Hall etc.), Schools/ AWC/College Buildings, other Buildings, Auditorium, Historical Monuments, Bridges over Roads/Rivers, shopping mall, Apartments, Mobile Tower, Water Tanks, Embankments etc. and casualty to human life.

- **Specific Disaster Mitigation Measures:**

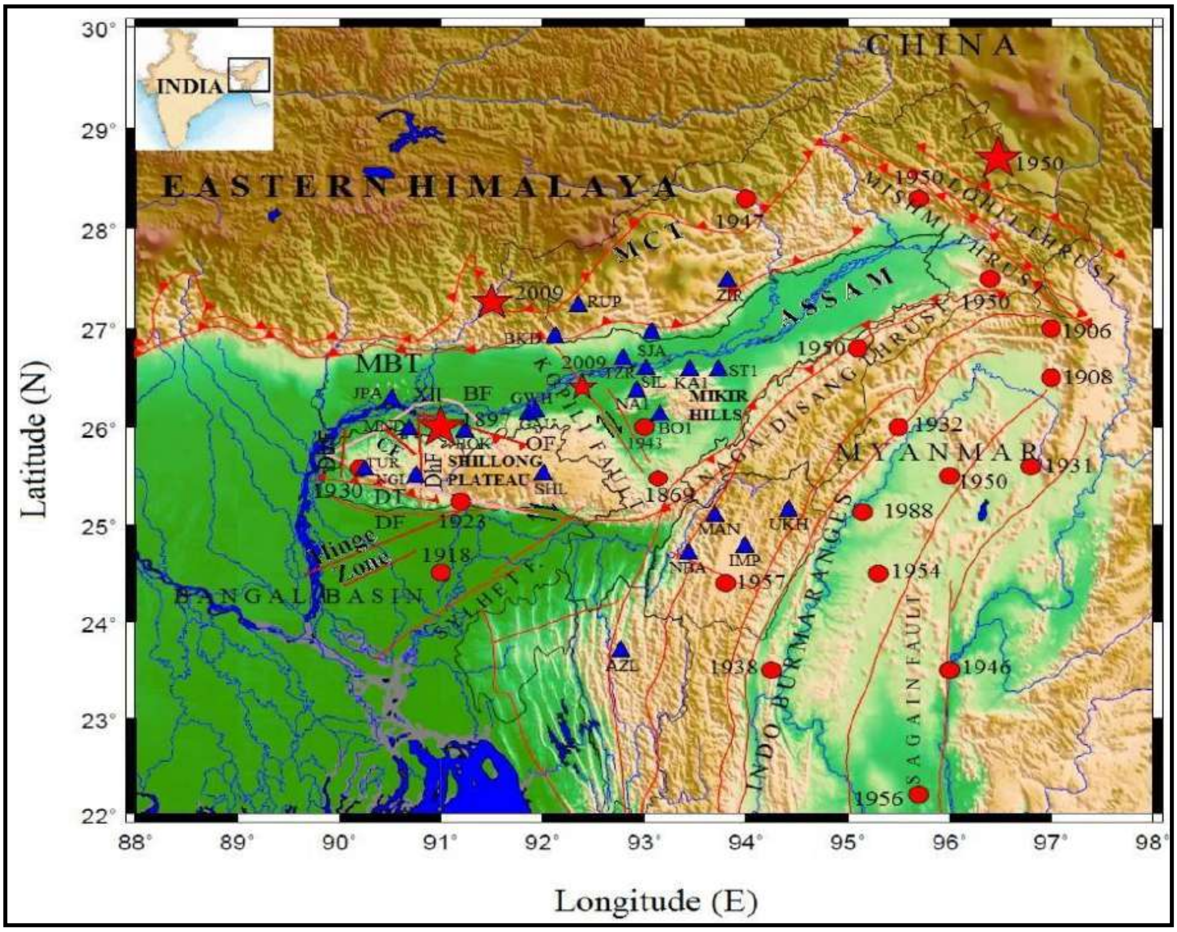
  Charaideo district falls under earthquake zone-V so following mitigation measures should be taken to reduce the impact of earthquake: -

- Adoption and enforcement of building codes for hew construction in various areas. ----- Public utility buildings must be located in stable areas or in consolidated soil.

- Retrofitting of weak structures.

- Relocation of people settling in the steep slope areas and near the river bank to avoid secondary effects viz. floods, landslides, etc.

Figure 16: Seismic map of Charaideo district



k) Major Flora of Charaideo:

Endemic flora are plants which occur in a restricted area. Altogether 165 species of plants have been recorded which are restricted in distribution to certain pockets in Assam, though some of them show extended destruction in the N.E. Region and elsewhere in India. However about 100 such species have distribution restricted to Assam only. These include trees e.g. Accacia gageana, Adiantum assamicum, Alseodaphne andersonii, Alseodaphane khasyana, Angiopteris assamica, Cedrela fabrifuga, Cinnamomum cacharensis, Coelogyne assamica, Combretum wallichii, Dinochloa indica, Diospyros cacharensis, Dipterocarpus mannii, Eugenia cyanophylla, bamboos e.g. Bambusa cacharensis, Bambusa mastersii, Chimnobambusa griffitheana, orchids e.g. Bulbophyllum elassonotum, Bulbophyllum vireus, Dendrobium assamicum etc.

Endanger species, from all available account following categories of threatened plants recognized by the IUCN have been reported from Assam.

Extinct: Bambusa mastersii, Cleisostoma arietinum, Cyperus corymbosus, Dendrobium assamicum, Dendrobium aurantiacum, Hetaeria anomala, Liparis stachyurus and Sapria himalayana. Paphiopedilum specerianum is reported to be extinct in wild.

The Chala reserve forest is full of flora and fauna consisting 65 species under 35 genera.

Chala reserve forest is a significant forest for the Charaideo district due to its richness of flora and fauna. The orchid flora of this forest has been very little studied. So far, no article about the orchids of this reserve have been published. The present work aims to document orchid species for the first time from this forest.

Table 12: The predominant floral species in Charaideo District [Checklist of orchids of Chala Reserve Forest. Abbreviations used: Flo. - Flowering; Vno. - Voucher no; H - Habit [E - Epiphytic, T - Terrestrial]; O - Occurrence [C - Common, R - Rare], Fig. - Figure.]

Sl no.	Taxon	Flo.	Vno.	H	O	Fig.
1	*Acampe praemorsa* (Roxburgh) Blatter &	May – August	0003	E	C	1A
	McCann var. *longepedunculata* (Trimen)					
	Govaerts					
2	*Aerides multiflora* Roxburgh	March – August	0032	E	R	1B
3	*Aerides odorata* Loureiro	March – August	0017	E	C	1C
4	*Aerides rosea* Loddiges ex Lindley &	May – August	0004	E	C	1D
	Paxton					
5	*Agrostophyllum planicaule* (Wallich ex	August –	0005	E	C	1E
	Lindley) Reichenbach f.	November				
5	*Ania penangiana* (Hooker f.)	March – April	0063	T	C	1F
	Summerhayes					
6	*Anoectochilus roxburghii* (Wallich)	August –	0056	T	C	1G
	Lindley	January				
7	*Bulbophyllum affine* Lindley	June –	0018	E	C	1H
		September				
8	*Bulbophyllum careyanum* (Hooker f.)	October –	0033	E	C	1I
	Sprengel	February				
9	*Bulbophyllum delitescens* Hance	June –	0019	E	R	1J
		September				
10	*Bulbophyllum ornatissimum*	June – October	0034	E	R	1K
	(Reichenbach f.) J.J. Smith					
11	*Bulbophyllum roxburghii* (Lindley)	May – August	0020	E	C	1L
	Reichenbach f.					
12	*Bulbophyllum spathulatum* (Rolfe ex	March – June	0035	E	R	2A
	E.W. Cooper) Seidenfaden					
13	*Calanthe sylvatica* (Thouars) Lindley	August –	0036	T	C	2B
		November				

14	*Cleisocentron pallens* (Cathcart ex Lindley) N. Pearce & P.J Cribb	June – September	0021	E	C	2C
15	*Cleisostoma appendiculatum* (Lindley) Bentham & Hooker f. ex B.D. Jackson	August – October	0038	E	R	2D
16	*Cleisostoma subulatum* Blume	March – August	0022	E	C	2E
17	*Collabium chinense* (Rolfe) Tang & F.T. Wang	June – August	0064	T	C	2F
18	*Crepidium purpureum* (Lindley) Szlachetko	June- July	0037	T	R	2G
19	*Cymbidium aloifolium* (Linnaeus) Swartz	April – September	0006	E	C	2H
20	*Dendrobium acinaciforme* Roxburgh	June – September	0007	E	C	2I
21	*Dendrobium aduncum* Lindley	March – September	0023	E	C	2J
22	*Dendrobium aphyllum* (Roxburgh) C.E.C. Fischer	March – July	0008	E	C	2K
23	*Dendrobium fimbriatum* Hooker	March – June	0039	E	R	2L
24	*Dendrobium formosum* Roxburgh ex Lindley	May – September			R	3A
25	*Dendrobium jenkinsii* Wallich ex Lindley	April – August	0040	E	R	3B
26	*Dendrobium lindleyi* Steudel	February – June	0041	E	R	3C
27	*Dendrobium lituiflorum* Lindley	April – July	0009	E	C	3D
28	*Dendrobium moschatum* (Banks) Swartz	June – September	0024	E	C	3E
29	*Dendrobium nobile* Lindley	March – July	0043	E	R	3F
30	*Dendrobium parciflorum* Reichenbach f. ex Lindley	May – August	0044	E	R	3G
31	*Dendrobium sulcatum* Lindley	April – August	0042	E	R	3H
32	*Dendrobium transparens* Wallich ex Lindley	April – July	0010	E	C	3I

*(**Source:** A Checklist of orchids of Chala Reserve Forest, Charaideo district (Assam, India),Khyanjeet Gogoi1*, Ankurraj Gogoi1 & Manas Protim Shyam1)*

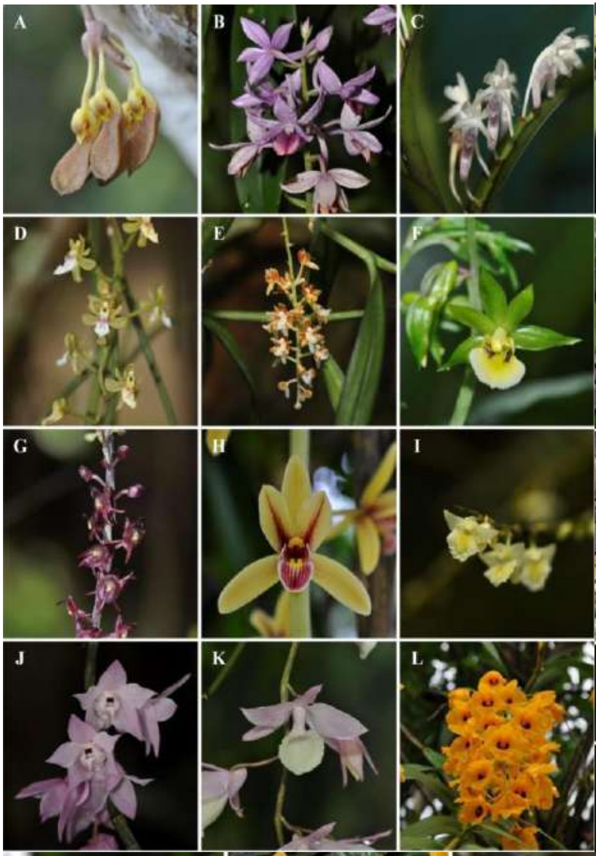


Fig. 16: Orchids of Chala Reserve Forest. A. *Acampe praemorsa var. longepedunculata;* B. *Aerides multiflora;* C. *Aerides odorata;* D. *Aerides rosea;* E. *Agrostophyllum planicaule;* F. *Ania penangiana;* G. *Anoectochilus roxburghii;* H. *Bulbophyllum affine;* I. *Bulbophyllum careyanum;* J. *Bulbophyllum delitescens;* K. *Bulbophyllum ornatissimum;* L. *Bulbophyllum roxburghii*

2: Orchids of Chala Reserve Forest. A. *Bulbophyllum spathulatum;* B. *Calanthe sylvatica;* C. *Cleisocentron pallens;* D. *Cleisostoma appendiculatum;* E. *Cleisostoma subulatum;* F. *Collabium chinense;* G. *Crepidium purpureum;* H. *Cymbidium aloifolium;* I. *Dendrobium acinaciforme;*J. *Dendrobium aduncum;* K. *Dendrobium aphyllum;* L. *Dendrobium fimbriatum*

Fig. 3: Orchids of Chala Reserve Forest. A. *Dendrobium formosum;* B. *Dendrobium jenkinsii;* C. *Dendrobium lindleyi;* D. *Dendrobium lituiflorum;* E. *Dendrobium moschatum;* F. *Dendrobium nobile;* G. *Dendrobium parciflorum;* H. *Dendrobium sulcatum;* I. *Dendrobium transparens;* J. *Dendrolirium lasiopetalum;* K. *Didymoplexis pallens;* L. *Dienia ophrydis*

➢ **Medicine plant :**

Name of the Species	Partused	Medicinal uses	Other Uses
Brugmansia suaveolens	Flower	Paste of matured leavesare applied on the affected area against muscles pain	Ornamental
Capsicum annuum	Fruit	-	Salad, vegetables and preparation of pickles
Capsicum baccatum	Fruit	-	Salad, vegetables and preparation of pickles
Capsicum chinense	Fruit	Fresh fruit used in case of liver problem, acidity, tonsillitis and pharyngitis	Salad, vegetables andpreparation of pickles
Capsicum pubescens	Fruit	-	Salad, vegetables and preparation of pickles
Cestrum diurnum	Flower	-	
Cestrum nocturnum	Flower	-	
Datura innoxia	Flower, Fruit, Seed	Paste of matured leaf isapplied against pain. Young leaves paste are applied on breast againstpain due to deposition of excess milk among lactating mother	Seeds are taken orallywith milk, elaichi, clove, dalchini and sugar as narcotics during puja to prepare 'Ghuta' in Hindu rituals
Datura metel	Flower, Fruit and Seeds	Paste of matured leaf isapplied against pain,	Seeds are taken orallywith milk, elaichi, clove, dalchini and sugar as narcotics during puja to prepare

			'Ghuta' in Hindu rituals
Nicotiana plumbaginifolia	-	-	-
Petunia x hybrida	Flower	-	Ornamental
Physalis minima.	Leaves and Fruit	Young leaves are used inthe form of recipe for removing worms from stomach	Playing purpose by children in rural areas,
Solanum aethiopicum	Fruit	-	Vegetable and preparation of pickles
Solanum indicum	Fruit	Fresh fruit taken orally against diabetes	Vegetable
Solanum lycopersicum	Fruit	Orally in the form of recipe with ginger, garlic, onion, clove, elaichi, roots of *Lygodium* species to treat tonsillitis, pharyngitis and hepatitis	-
Solanum melongena	Fruit		Salad, vegetables and preparation of sauces
Solanum myriacanthum	Fruit	Orally in the form of recipe with jaggery and seeds of piper against tonsillitis and Pharyngitis, Hepatitis B	Vegetable

Solanum americanum	Twig and Fruit	Fresh fruit is used against Hepatitis B	Vegetable
Solanum pimpinellifolium	Fruit	-	Vegetable
Solanum torvum	Fruit , Seeds	Two to five fresh seeds are used daily for cardiovascular problem	Vegetable
Solanum tuberosum	Tuberous stem	Small thin slices are applied locally on minorburns	Vegetable

*(**Source:** Diversity and uses of Solanaceous plants in Sivasagar District of Assam, India)*

l) Major Fauna of Charaideo:

Charaideo, Assam, India is home to a variety of fauna, including birds, mammals, and aquatic animals. A rich wetland eco-system of 33.93 square kilometers (13.10 sq mi) is on the southern bank of the river Brahmaputra, in Charaideo district. A paradise of migratory and resident birds, over 165 species of birds have been identified and recorded here. Among these is a high concentration of geese and other migratory birds. Common species include bar-headed goose, grey leg goose, spot billed duck, mallard, gadwall, wigeon, gargany, shoveller, red-crested pochard, common pochard, ferruginous duck, adjutant stork, lesser adjutant stork, open-bill stork, and the white-necked stork. Aquatic fauna: Several varieties of fish have been identified here, along with various species of frogs, snakes, and other amphibians and reptiles.

Table 13: Scientific names and the species types of few important animals

Animal Type	Local name	Scientific name	Habitat
Mammal	Hati	*Elephas maximus*	Forest and human settlement areas
	Nahor Phutuki	*Panthera pardus*	Woodland
	Johamal	*Viverricula indica*	Woodland
	Meseka	*Prionailurus viverrinus*	Woodland near

			wetland area
	Kerketua	*Callosciurus pygerythrus*	Arboreal
	Neoul	*Herpestes auropunctatus*	Open scrubland & Human habitation
	Hiyal	*Canis aureus*	Woodland & caves near ponds
	Lotamakori	*Felis bengalensis*	Woodland
	Malua bandor	*Macaca mulatta*	Woodland & Human habitation
	Baduli	*Pteropus giganteus*	Large trees near Human habitation
Birds	Salika	*Acridotheres tristis*	Human settlement areas
	Kopou	*Streptopelia chinensis*	Forest and human settlement areas
	Moupia	*Chalcoparia singalensis*	Cosmopolitan
	Patxia	*Orthotomus sutorius*	Forest and human settlement areas
	Kolakhati	*Dendrocitta vagabunda*	Cosmopolitan
	Boga Balimahi	*Motacilla alba*	Cosmopolitan

*(**Source**: https://indiabiodiversity.org)*

- **Butterfly:**

Sl. No.	Local Name	Scientific Name	Family
1.	**Swainson**	*Bibasis oedipodea*	Hesperiidae
2.	Fabricius	*.Pseudocoladenia dan*	
3.	Stoll	*Tagiades japetus*	
4.	de Niceville	*Pelopidas assamensis*	
5.	Fabricius	*Suastus gremius*	
6.	Linn	*Papilio polytes*	Papilionidae
7.	Linn.	*Graphium sarpedon*	
8.	Fabricius	*Atrophaneura aristolochiae*	
9.	Boisduval	*Eurema blanda*	Pieridae
10.	Fabricius	*Catopsilia pomona*	
11.	Linn.	*Catopsilia pyranthe*	
12.	Cramer	*Tirumala limniace*	Nymphalidae
13.	Butler	*Tirumala septentrionis*	
14.	Boisduval	*Discophora sondaica*	

*(**Source**: Butterfly Fauna (Order: Lepidoptera) in Five Major Tea Gardens of Charaideo District, Assam, India)*

A

B

C

D

E

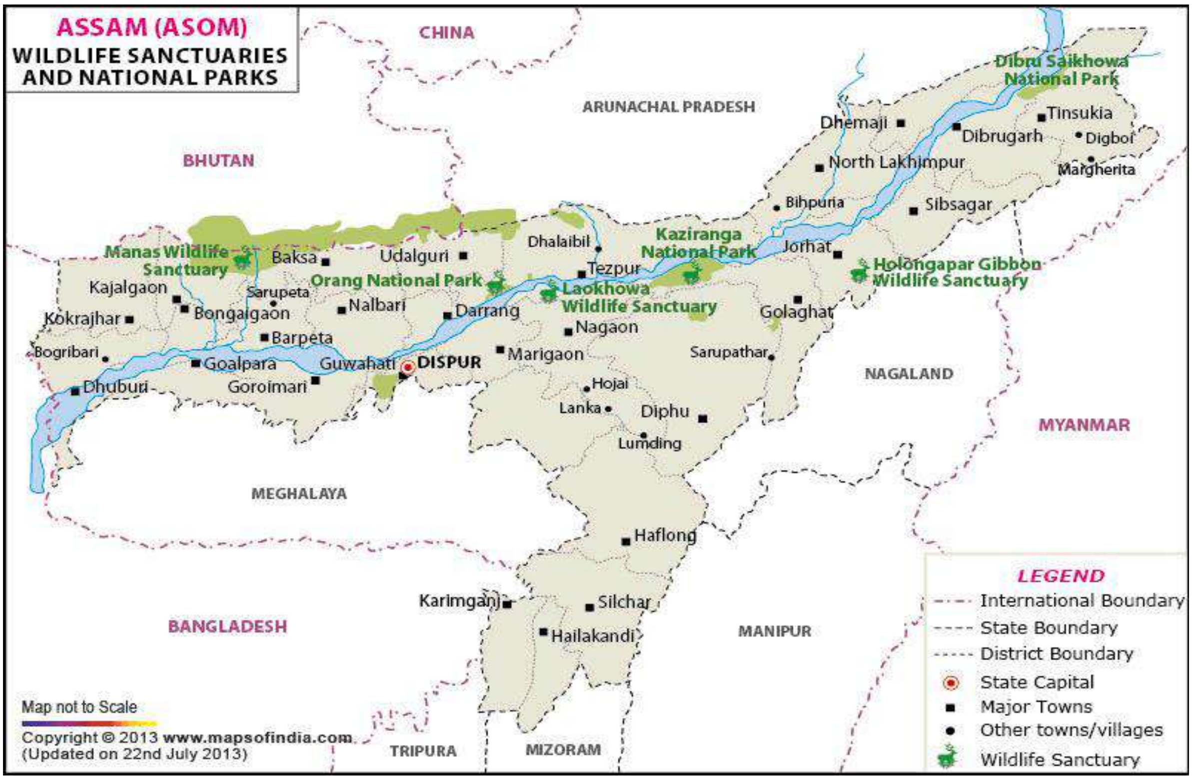
F

G

H

A: stork-billed kingfisher; B: oriental pied hornbill; C: common picture wing; D: Golden Tree Snake; E: Tokay gecko; F: Greylag Goose; G: Great Eggfly; H: Great orange tip

Figure 17: Wildlife Sanctuaries and National Parks of Assam



*(**Source:** https://www.mapsofindia.com/maps/wildlife/wildlife-assam.htm)*

CHAPTER 04: PHYSIOGRAPHY OF THE DISTRICT

4.1 General Land form:

Sibsagar falls into three natural divisions so far as the physiography is concerned viz.

a) Upland

b) Lowland

c) Flood plains.

The upland forms the base of the Nagahills where the geology is sandstones and shales. Many areas in this physiographic unit are under tea plantations and forest species. The lowlands are the areas between the foothills of Naga-hills and the floodplains. The natural depressions cause huge accumulation of both alluvial and colluvial materials.

Geomorphologically the area can be classified mainly into four divisions: naturals levees, Channel Island, younger and older alluvial plain, piedmont zone. Southern part of the study area is covered by Piedmont zone. The piedmont zone is gravel dominated while alluvial plain and the flood plain area are comprised of mixture of sand and silt in varying proportions. The alluvial flood plain consists of younger and older alluvial deposits. It represents various sub-features, viz., palaeochannel, swampy/marshy land, river terraces, flood plains, point bars, channel island and river channel.

4.2 Soil & Rock pattern

Soil Type

The soils are generally sandy loam in the northern flood plain and silty to clayey loam in the southern part. These soils are characteristically different in colours also, being grey in case of sandy loam and yellowish brown in case of silty and clayey type.

Twelve soil series were identified which form five soil series association on different geomorphic units. Each association is described with respect to the soil properties, soil -site characteristics and the land use in the following paragraphs.

- **Soil on upland:** The soils of this association occur on uplands in the floodplains of the district. The Mathurapur and Naharbari soils are deep, fine silty and occur on nearly level lands at less than 1 percent slope. The surface texture of Mathurapur soils ranges from silty loam to silty clay loam underlain by silty loam subsurface horizons with mottles. The organic carbon content decreases from 0.6 percent to 0.1 percent down the profile, .The CEC is low and it decreases with depth. The percentage base saturation reaches its highest value at the bottom layers of the profile. The soils are under tea plantation.

  The surface texture of Naharbari soils varies from silty clay to clay. The organic carbon content decreases with depth. These soils are strongly acidic throughout the profile. The CEC is rather low and shows no definite pattern in its variation with depth. Base saturation ranges from 24 to 45 percent. Exchangeable Al ranges from 2 to 5 cmol (+) kg -1. These soils are also under tea plantation.

- **Soil on low land:** The soils of this association occur on low lands in the alluvial plain. Ikarani soils occur on 1 to 3 per cent slopes, Kalugaon and Desoipathar on 0 to 1 per cent slopes. All the soils have aquic moisture regime. Ikarani soils are silty at the surface underlain by clay subsoil. The soils are very strongly acidic. The CEC is low while the base saturation ranges from 60 to 81 percent. Desoipather soils are medium textured at the surface underlain by moderately fine and fine textured subsoil. They are very strongly acidic to neutral. The CEC value ranges from 6.9 to 12.3 cmol (+) kg-1 and the base saturation varies from 59 to 83 percent. Kalugaon soils are fine textured and very strongly acidic to neutral. The CEC varies from 14.6 to 22.8 cmol (+) kg-1 and the base saturation from 47 to 77 percent. These soils are under paddy cultivation.

- **Soil on active floodplains:** Both the soils are found on nearly level lands on 0 to 1 percent slopes. The Betbari Degaon soils are fine textured in the soil control section. The surface texture varies from silty clay to clay loam which is underlain by silty clay loam sub soils with mottles. The surface soil contains relatively high organic carbon content. These are strongly acidic at the surface and become medium acidic in lower depths. The CEC ranges from 16 to 21 cmol (+) kg-1. The base saturation increases with depth. The surface texture of the Biptaghat series varies from clay loam to clay overlying the sandy clay to clay sub soils with mottles. These soils have also high organic carbon at the surface. The soil reaction is very strongly to extremely acidic throughout the profile. The CEC ranges from 11 to 18 cmol (+) kg-1. These are used for paddy cultivation.

- **Soil on recent floodplains:** Katanipar soils occur generally on slightly undulating lands on 3 to 5 per cent slope. The surface texture varies from loam to silty clay loam underlain by clay loam to clay horizons sub soils with mottles. They are strongly to medium acidic. The CEC value ranges from 12 to 16 cmol (+) kg-1. The organic carbon is high at the surfaces and decreases regularly with depth. The base saturation ranges from 5 to 77 percent.

  The Chengalibari soils occur on nearly level recent floodplains at 0 to 1 per cent slope. The texture of the surface soil varies from loam to silt loam over silty loam to silty sub soils. The surface soils are strongly acidic. The organic carbon content is higher at the top and it decreases with depth. The CEC ranges from 12 to 17 cmol (+) kg-1 and the surface soil exhibited the highest CEC value. The base saturation increases with depth from 56 to 82 percent,

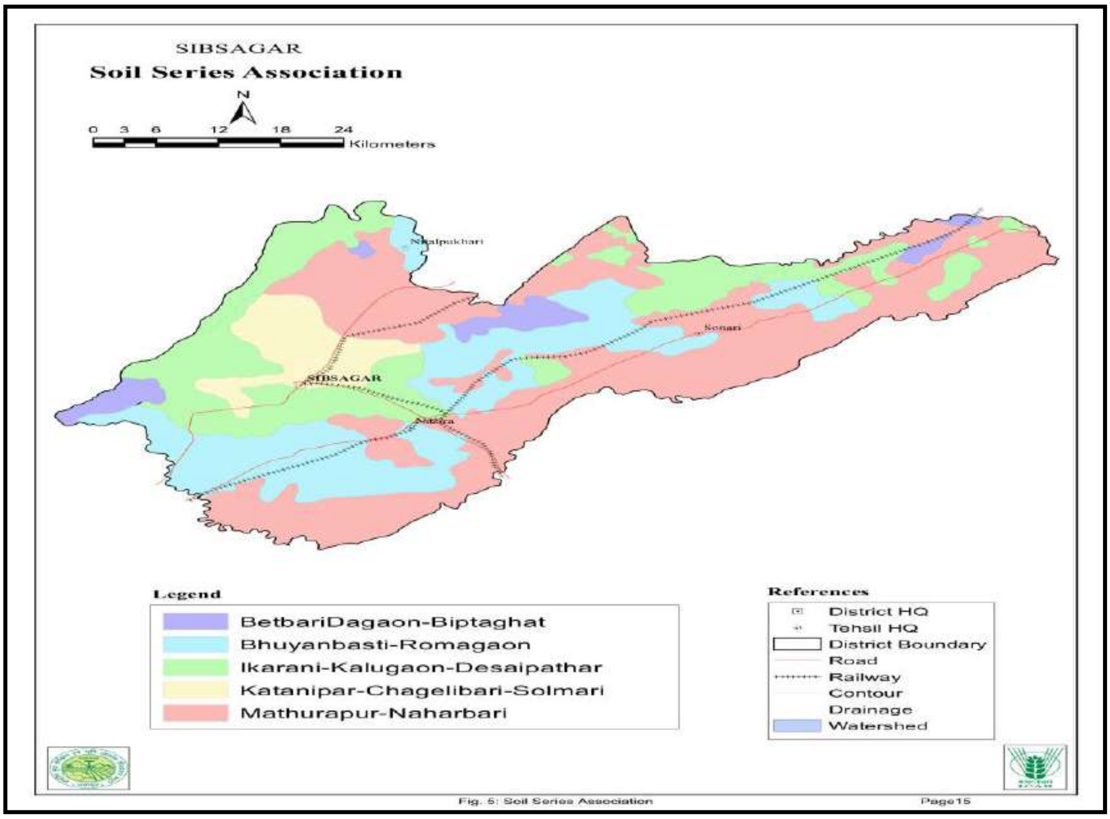
  The Solmari soils occur also on nearly level recent floodplains at 0 to 1 percent slope. The surface texture varies from sandy loam to silty loam while the subsoil texture ranges from loam to silt loam. The soils are very strongly acidic throughout the depth. The CEC value is rather low and gradually increases with depth. The base saturation ranges from 55 to 97 percent. These soils are used for paddy cultivation.

- **Soils on lower floodplains:** These soils occur on lower floodplains of the district at 0 to 1 per cent slope. The soils of Bhuyanbasti series are fine loamy and medium acidic. The organic carbon content is more than the Romagaon soils, though it decreases with depth. The CEC is low but the base saturation is higher ranging from 54 at the surface to 80 at the sub soils.

  Romagaon soils are fine loamy and medium acidic. The surface soils exhibit the highest content of organic carbon and decreases regularly with depth. Ca is the dominant cation in the exchange complex. The CEC value decreases with depth. The base saturation is low and tended to decrease with depth. The soils are cultivated for paddy.

Thematic maps on slope, parent material, surface form, soil depth, drainage, erosion, surface texture, particle size class, soil reaction (pH) are shown in figure 7 to 15, respectively.

Figure 18: Soil Map of the Charaideo district



4.3 Different geomorphological units:

The district lies in the Brahmaputra valley evolved during Quaternary period in between the Himalayan orogenic belt and crystalline massif of the Shillong plateau and owes its origin and development to phases of uplift, glaciation and erosion of the Himalayas, basement tectonics ffecting the Shillong massif and eustatic changes of sea level during the glacial and inter-glacial phases. Physiographic Features

The floodplains are the belt of flooded land situated on the south bank of the Brahmaputra throughout the whole of its course through Sibsagar. The country in this part is covered at places with high reed jungle, interspersed with swamps or “bils” and magnificent stretches of rich fodder grass. Depending on the stage of formation the floodplains are further divided into

i) Active floodplains

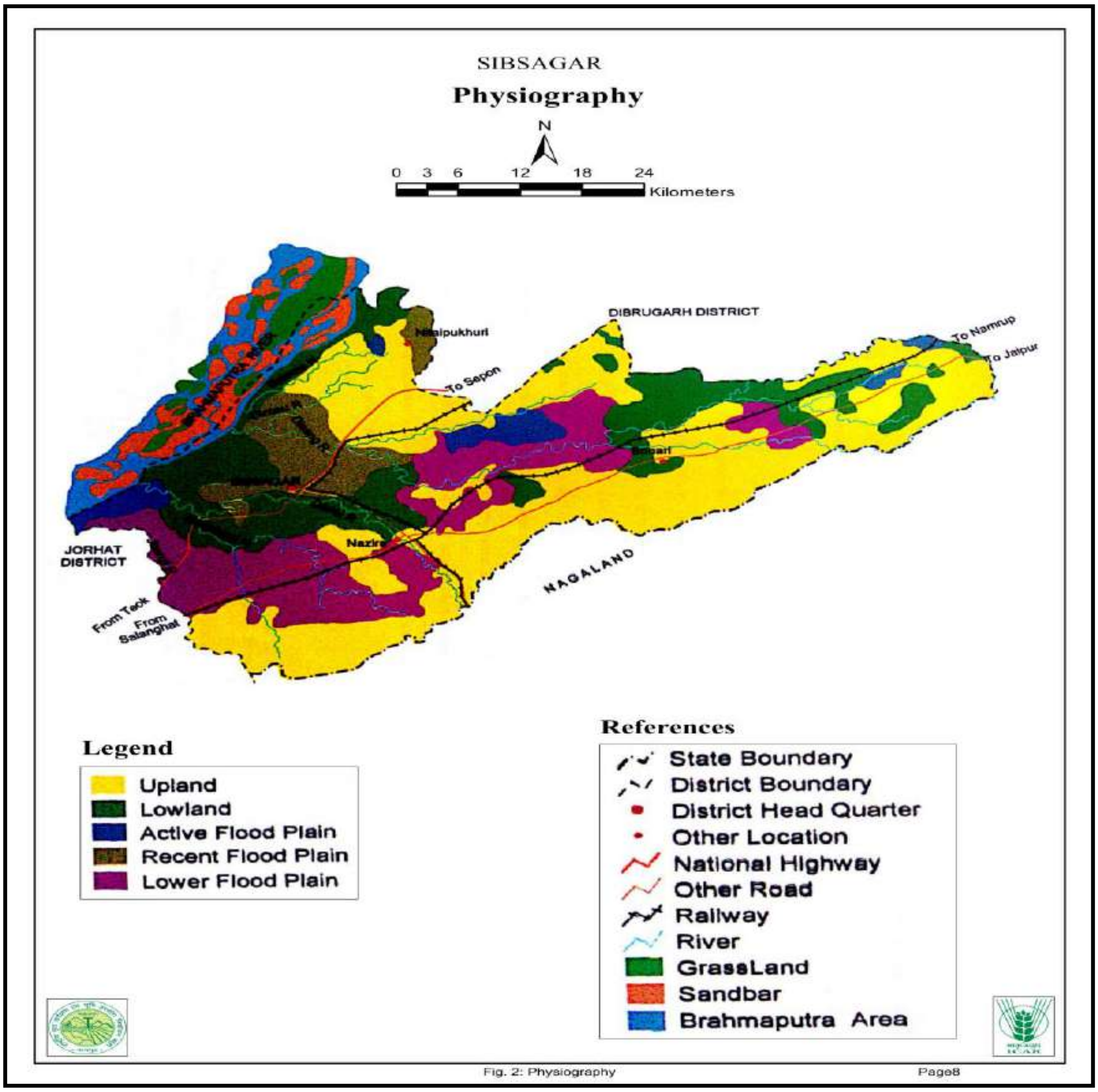
ii) Recent floodplains and

iii) Lower floodplains.

The general slope of the district is from east to west with the highest elevation of 305 m above mean sea level (msl) in Dilli R.F. and the lowest of 80 m above msl in Kalugaon .

The region is drained mainly by the Brahmaputra River. The river along with its tributaries, namely, Disang, Dikhou and Jhanji traverse the district and deposit alluvium carried from the Himalayas in the north and the Assam range in the south.

Figure 19: Geomorphological map of the Charaideo district



CHAPTER 5: LAND USE PATTERN OF THE DISTRICT

The alluvial soil developed in the vast areas of Brahmaputra river system is practically unaltered alluvium generally, light to dark grey in colour and represented by a broad spectrum of sand, silt and humus rich bog clay depending on the land from component. Weathering and geochemical changes are minimal, but incipient changes in the top layer have been noticed due to biological activity. Soil PH is generally feebly alkaline excepting bog soil.

- ***Land cover:*** is the physical material at the surface of the earth. Land covers include grass, asphalt, trees, bare ground, water, etc. Land cover data documents how much of a region is covered by forests, wetlands, impervious surfaces, agriculture, and other land and water types. Water types include wetlands or open water.

- ***Land use:*** shows how people use the landscape – whether for development, conservation, or mixed uses. Land use refers to the purpose the land serves, for example, recreation, wildlife habitat, or agriculture. Land use applications involve both baseline mapping and subsequent monitoring, since timely information is required to know what current quantity of land is in what type of use and to identify the land use changes from year to year.

- ***Forest & Plantation:*** The important forest types found in Charaideo District are: Moist semi-evergreen forests, Moist Mixed Deciduous forests, Rivera in Type Miscellaneous type with scattered pure or mixed patches of bamboos. The Charaideo Soil Conservation Division plants bamboo, medicinal plants, ginger, and broom in areas that are suitable for these crops. They also bring degraded wasteland and riverine non-agricultural land under plantation to provide permanent cover to the top soil. (http://assam.gov.in/).

- ***Cropland:*** Major Island Charaideo is surrounded by newly formed alluvial soil. This is a very fertile soil for cropping. The cropping pattern of Charaideo district in Assam includes rice, oilseeds, potatoes, wheat, garlic, onions, pulses, sugarcane, and vegetables. Rice is an important crop of this area. The main crop of the region, rice is grown in the summer season. Some of the rice varieties grown in Charaideo include Komal Saul, Bao Dhan, and Bora Saul.

- ***Built up land:*** a developed area, any land on which buildings and/or non-building structures are present, normally as part of a larger developed environment such as: developed land lot, rural area, urban area. Land covered by buildings and other man-made structures.

- ***Shrub land:*** Land with woody vegetation less than 2 m in height and with greater than 10% shrub canopy cover. The shrub foliage can be either evergreen or deciduous. Shrub land, scrubland, scrub, brush, or bush is a plant community characterised by vegetation dominated by shrubs, often also including grasses, herbs, and geophytes. Shrub land may either occur naturally or be the result of human activity.

- ***Fallow land:*** Fallow Land is farmland that has no crops on it, usually for a year, to recover its fertility to grow crops. Land taken up for cultivation temporarily allowed remaining uncultivated for one or more seasons. The amount of fallow land in Charaideo district has been increasing.

- ***Wasteland:*** Sparsely vegetated land with signs of erosion and land deformation that could be attributed to lack of appropriate water and soil management, or natural causes. These are land identified as currently underutilized and could be reclaimed to productive uses with reasonable effort. Degraded forest (<10% tree cover) with signs of erosion is classified under wasteland.

- ***An empty area of land***: especially in or near a city, which is not used to grow crops or built on, or used in any way and/or a place, time or situation containing nothing positive or productive, or completely without a particular quality or activity.

- ***Water body:*** Areas with surface water, either impounded in the form of ponds, lakes, reservoirs or flowing as streams, rivers, etc. can be either fresh or salt-water bodies.

- ***Wetland:*** The wetlands of Charaideo form an integral part of river Brahmaputra. These are rich in diverse aquatic and avian bio-forms with immense ecological, floral and faunal values. The wetlands are locally known as Beel or Dubi. These are natural depressions and abandoned channels of river Brahmaputra including its feeder rivers. Some wetlands are man-made. These water bodies are associated with pioneer plants, floating vegetations and trees which form an ideal food and habitat of numerous migratory and resident birds. There are more than 140 such beels and dubies in Charaideo. Beds of some of the beels and dubies got swelled up perhaps as a result of agricultural practice done on the inner fringes of the beels and to some extent for regular flood. Large no. of birds (both resident and migratory) used to come to these beels during winter season which indicate the good health of these beels and dubies but during last year the number was considerably low. This may be because, a number of embankments had been constructed around Charaideo so that no flood water can enter and due to absence of the flooding activities in the last two years, the healths of the wetlands are suffering. These wetlands also harbor turtles, reptiles, fishes, insects and aquatic plants and other life forms.

Table 14: Area under LULC of Charaideo District, 2011 (in hactres)

Total Area	Forest	Not available for cultivation					Permanent pastures and other geaging land	Other uncultivated land excluding fallow land	
		Land put to non-cultivated	Baren Land	Total	Water logged land	Land under still water		Land under misc trees groves pot	Cultivable waste land
266800	30465	1217503	1408042	2625545	3111	7067	7330	20061	1820

(**Source:** *Ground Water Information Booklet Sibsagar District, Assam*)

Figure 20: Changes in LULC in Charaideo District in % in respect to total geographical area

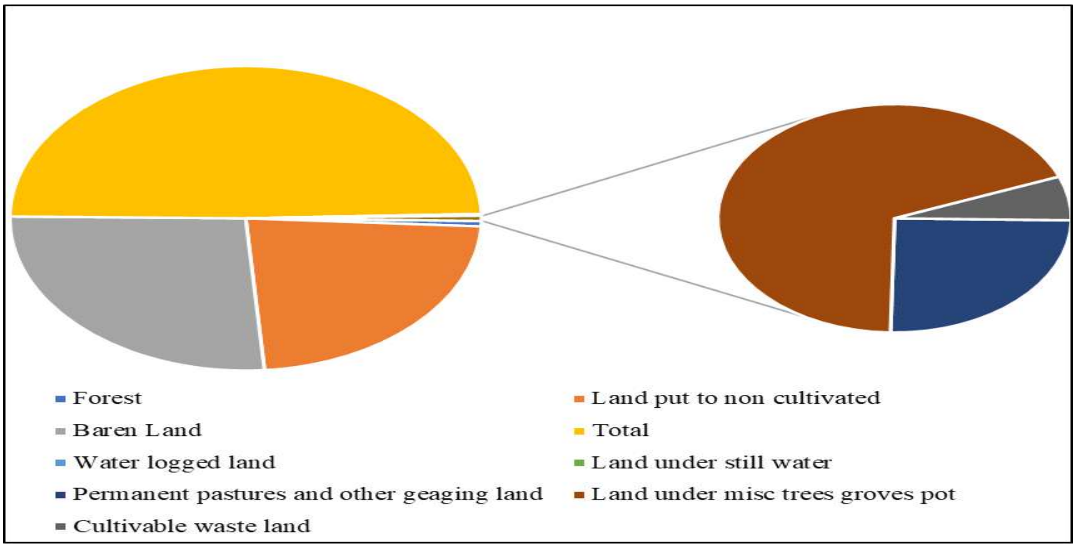
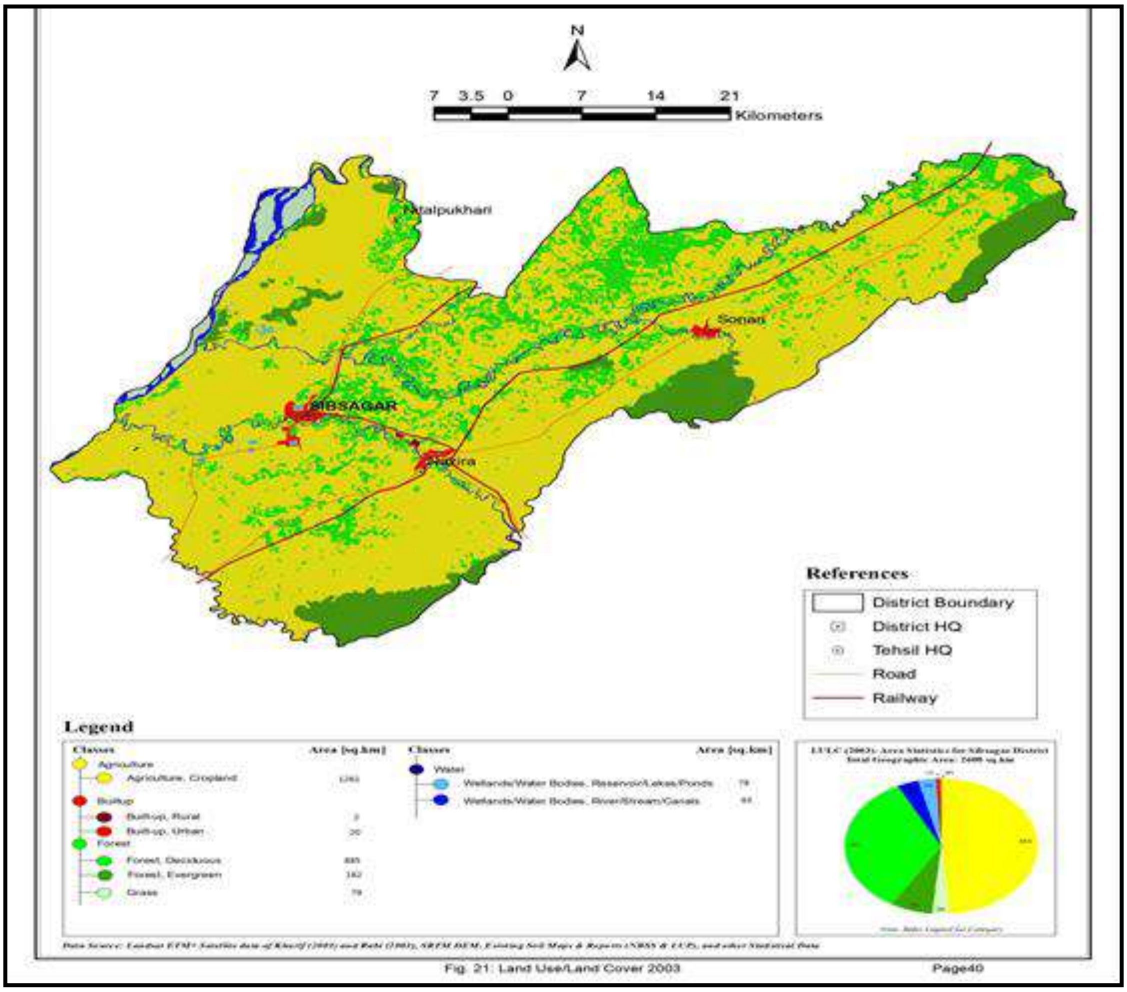


Figure 21: Land Use and Land Cover Map of the Charaideo district



5.1) Forest:

The natural vegetation consists of trees, shrubs, grasses and weeds. The botanical name of the important trees, shrubs and grasses along with their local/english names are given below:

Trees

Acacia arabica (Babul) Albizzia lebbek (Sirish); Azadirachta indica (Neem); Artocarpus integritolia (Jeek

fruit); Butea monospema (Palas); Borassus flabellifer (Tal); Ficus, cunea (Fig); Cacsapinia Pulcherrima (Krishnachura); Dalbergia sisso (Sisso); Emblica officiarnalis (Amloki); Ficus bengalensis (Banyan); Jambulana Indica; (Jam); Jerminalis arjun (Arjun); Mangifera indica (Mango); Terminalia sp (Nollock): Bambusa sp. (Bamboo); Tactona grandis (Teak); Shorea robusta (Sal); Flacontia nemontchi (Boinchi); Jatropa gosovpifoliq (Lal bharenda); Clerodendron inerma (Banjul.); Ziziphus jujuba (Ber).

Grasses

Cynodon dactylon (Doob); Chryopogon aciculatus (Retz); Trin (Bonguti); Eleusina indica (Bobosaban);

Imperata cvlindsica (Ula).

Weeds

cyperus rotundus (Mutha); Chenopodium album (Goose foot): Saccharum spontaneum (Kans).

Table 15: Type of forest

Type of Forest	Name of forest	Area (in Hectre)
Reserve forest	Dilli Forest Reserve	3108
	Abhoypur Forest reserve	5560
	Sapekhati Forest reserve	736
	Diroi Forest reserve	4776
	Chala Forest Reserve	683.64

*(**Source:** charaideo.assam.gov.in)*

5.2 Agriculture and Irrigation

Agriculture is still the main occupation of a large number of the farmers of the CHARAIDEO district. The basic problems for the farmers are that area under irrigation is less and some of the area become waterlogged for whole the year. The main thrust of the district is to increase the profitability of the farmers by way of sustainable agriculture, and by judicious use of water. It is the need of the hour to go for the overall development of the farmers, rural youths and rural women by updating their knowledge level through various extension activities. This district has a wide range of cropping systems like Rice-Potato- Pulses, Rice - Pulses, Rice-Rice, Rice-Vegetables etc. The cropping intensity is 149 %.

Prior to Independence irrigation was not practiced in Assam and most of the people use to depend on monsoon rains for agriculture. Many of the farmers who realised the necessity of irrigation for an assured rice crop during kharif period managed to construct small inundation channels for the purpose... Prior to the First Five Year Plan, a few minor irrigation schemes were taken up with a view to benefiting 810 hectares only. But increase in population, resulting in pressure on land and the annual flood havoc led to serious thinking on the urgency of irrigation development. Moreover, the advent of green revolution in other parts of the country in mid-sixties due to adoption of the new technology of High Yielding Variety (HYV) seeds and application of optimal fertilizer brought about a sea of change in the outlook of the farmers. The success of the new technology depended solely on water because HYV seeds were found to respond well under irrigated conditions only. From the Fourth Plan onwards, the emphasis was on increasing the coverage under HYV which meant bringing more area under irrigation.

Irrigation is called the backbone of changing of cropping patterns. Without it, the concept of green revolution remains bogus. The irrigation facility in the study area is quite pitiable. The survey done in the sample villages exposes the pessimistic picture of irrigation facility. The farmers take canals/ponds and tube-wells as the main source of irrigation. Though the compound annual growth rate of irrigated area is positive in the past thirty years, but irrigation is facilitated in a very scanty cropped area in comparison with the gross cropped and net cropped area over the last thirty years. The table 5 visualizes the negative picture of irrigation in the study area. The compound growth rate of the intensity of irrigation in the concerned area has decreased at 0.23 percent per annum. The intensity of irrigation was at 121.98, 111.81, 115.21 and 114 percent thirty years back, twenty years back, ten years back and in 2015 respectively.

Table 16: Area Irrigated by Different Sources & Intensity of Irrigation in the cropping area of the surveyed households over the past 30 years (area in hectare)

Source	30 years ago	20 years ago	10 years ago	During the time of survey, 2015	Increase or decrease in area	Compound Annual Growth Rate
Canals/Pond	5.41	9.21	11.07	17.54	12.13	4.00
Tube-wells	3.33	5	2.08	1.04	-2.29	-3.80
Other Source	2.25	1.32	4.65	1.23	-1.02	-1.99
Gross area irrigated	10.99	15.53	17.8	19.62	8.63	1.95
Net area irrigated	9.01	13.89	15.45	17.21	8.2	2.18
Intensity of irrigation	121.98	111.81	115.21	114.00	-7.98	-0.23

*(**Source:** Cropping Pattern in Charaideo District, Assam, India: A Case Study; Manashi Gogoi Assistant Professor, Department of Geography, Arya Vidyapeeth College, Guwahati, Assam, India)*

5.3 Plantation & Horticulture:

Main plantation are Tea garden shown here. Assam is the world's largest tea growing region and not only famous for its quality of tea as well as the natural beauty of the tea plantation area. Beautiful tea estates of Assam cover about 2, 16, 200 hectares of land comprises of more than 100 tea estates. Enormously found mountain region, its greenery and pleasant climate make this location popular not only for its tea, but also for being a popular spot for enjoying eco- vacations. The both sides of the famous river, Brahmaputra, constitute the world's largest Tea growing area. The tea plants are grown in the lowlands of Assam, unlike Darjiling and Nilgiris, which are grown in the highlands. The Assam tea bush grows in a lowland region, in the valley of the Brahmaputra River, an area of clay soil rich in the nutrients of the floodplain. The climate varies between a cool, and winter and hot, humid rainy seasons- the conditions ideal for growing tea. Because of its lengthy growing seasons and generous rainfall of about 250-300 mm (during the monsoon season), Assam is one of the most prolific tea-producing region in the world. This region of India is so famous for its tea plantation that Assam tourism has organized the Assam Tea festival in the month of November every year that makes a totally new experience to enjoy this place.

The five major tea gardens of the district where the study was conducted are as follows –

- Sector 1: Maskara Tea Estate, P.O. Rajmai: Total area under tea cover is 44.71 hectares.
- Sector 2: Bezbaruah Tea Estate, P.O. Sapekhati: Total area under tea cover is 89.43 hectares.

- Sector 3: Aideobari Tea Estate, P.O. Sonari: Total area under tea cover is 150.65 hectares.
- Sector 4: Bemolapur Tea Estate, P.O. Borhat: Total area of the estate is 1214 hectares, out of which 527 hectares is under tea cover.
- Sector 5: Behubor Tea Estate, P.O. Nazira: Total area under tea cover is 533.86 hectares.

5.4 Mining:

Coal, petroleum and natural gas, limestone and minor minerals are the chief mineral resource of the state. Coal occurs in United Mikirs, North Cachar Hills, Charaideo districts. Coal extracted from the State is friable and contains high sulphur.

- **Coal:** The Dilli Colliery in Sivsagar is part of a coalfield that also includes the Joypore Colliery in Dibrugarh. The coalfield is connected to Namrup railway station by a 12 km road.
- **Stone:** Stone is mined in the Dikhow Stone Mining Permit Area 'C' (VI-A) District. The stone is transported to government, semi-government, and private consumers for construction purposes.

CHAPTER 6: GEOLOGY AND MINERAL WEALTH

6.0 GEOLOGY

Regional Geology:

The overall geological set up of India is divided into three parts i.e., Extra-peninsula, Peninsula and Indo-Gangetic Plain. The Assam states is partially covered by Himalayan Mountain System as the thick sequence of marine rocks followed by freshwater rocks was deposited in Cenozoic times. Another part of this state is partially occupied by Indo-Gangetic plains.

The different types of rocks from different ages are found in Assam state belonging to

a) Proterozoic Gneissic Complex;

b) Meso-Palaeo Proterozoic Shillong Group;

c) Neo-Proterozoic Lower Palaeozoic Granite Plutons;

d) Permo-carboniferous Lower Gondwana sedimentary rocks.

e) Alkali Complexes of Samchampi, Borpung and volcanic rocks represented by Sylhet Trap of Cretaceous age,

f) Lower Tertiary (Paleocene-Eocene) shelf sediments of the Jaintia Group extending along the southern and eastern flanks of Mikir Hills and geo-synclinal sediments of the Disang Group in parts of the North Cachar Hills;

g) Upper Tertiary (Oligocene to Pliocene) shelf and volcanic rocks represented by the Cretaceous Sylhet Trap and geo-synclinal sediments covering the southern flanks of Mikir Hills, the North Cachar Hills and the hills of the Cachar district in the Surma valley area exposed in the northern foothills of Naga-Patkai range covering the southern margin of Sibsagar, Jorhat and Dibrugarh districts. The northern part of Assam is comprised with southern foothills of Eastern Himalaya forming a narrow strip.

h) The Quaternary deposits consisting of Older and Newer Alluvium present in flood plains and terraces of the Brahmaputra valley, Surma valley and other river basins of Assam.

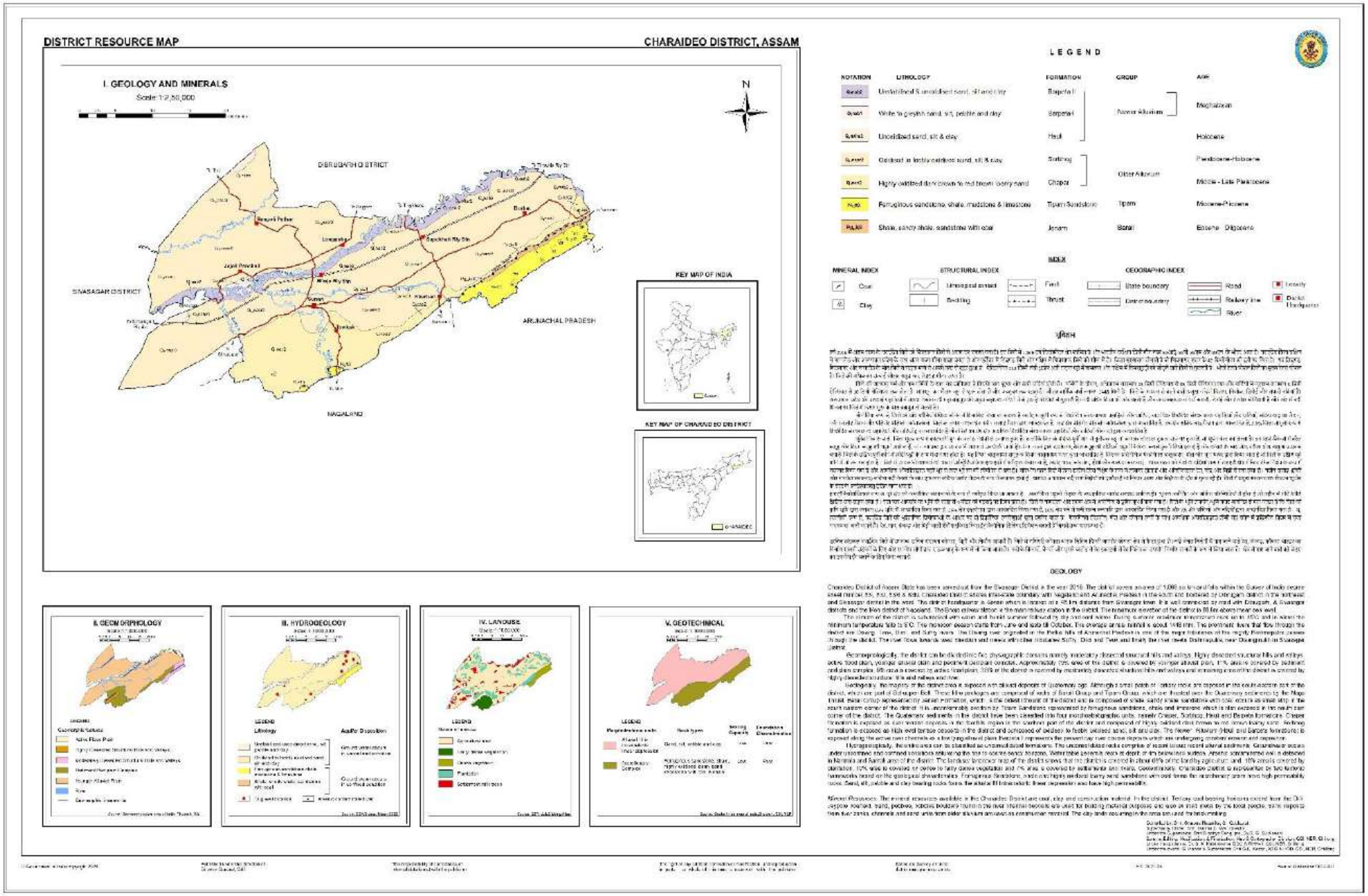
Major formation encountered in Charideo district are Disang Formation, Laisong and Jenam Formations, Tipam Sandstone and Girujan Clay of Tipam Group, Namsung Formation, Chapar and Sorbhog Formations, Barpeta-1 and Barpeta-II Formations of Newer Alluvium Group. In the southeast of the area, the Disang Formation (Paleocene to Eocene) is visible as tiny outcrops and is composed of shale, siltstone, sandstone, greywacke, and rythmite, with pyrite and limestone occurring irregularly. The Liasong Formation, which is made up of splintery shale, siltstone, and occasional plant fossils, is found in an elongated patch in the southeast of the region. The carbonaceous olive-green sandy shale of the Jenam Formation, which is only found in small quantities in the central and northeastern regions, is accompanied by coal and flaky sandstone. The carbonaceous olive-green sandy shale of the Jenam Formation, which is only found in small quantities in the central and northeastern regions, is accompanied by coal and flaky sandstone. The Laisong and Jenam Formations belong to the Eocene-Oligocene Barail Group. The coarse to gritty, micaceous, ferruginous sandstone, siltstone, mudstone, and limestone with mottled clay, shale, and fossil wood make up the Tipam sandstone found on the northeastern and southwest of the district. On the region's southern edge lies the Girujan clay Formation, which is made up of sandy clay, mudstone with ferruginous sandstone, and discontinuous conglomerate. Tipam Sandstone and Girujan Clay belong to the Miocene-Pliocene Tipam Group. The Namsung Formation (Pliocene-Pleistocene age), found in a tiny unit in the region's southwest, is made up of sandstone, gritty conglomerate with coal bands. The Chapar Formation, which is found as an extended area in the south, is made up of boulders, pebbles, and oxidized fine sand in a silty/clayey matrix. The majority of the district is made up of the Sorbhog Formation, which is mostly composed of oxidized grey to grayish-brown sand, silt, and clay with irregular pebbles and cobbles. Both This formation belongs to the age middle Pleistocene to lower Holocene. Newer Alluvium lies over the older alluvium. In the northwest, south central, and south western regions, the Barpeta I Formation is composed of unoxidized gray siltyclay, clay and micaccous sand with adjacent gravels and pebbles. The Barpeta II Formation is comprised of unoxidized grey loose sand, silt, clay with pebbles, gravels, and cobbles. It is located on the district's northwest and northeastern edge. The Tertiary sediments exhibit a general trend towards the northeast, with the beds dipping moderately towards the south.

Table 17: Stratigraphic succession of Charideo District

Age	Group	Formation	Lithological
Recent	Newer Alluvium	Disangmukh-II (=Barpeta – II)	Unoxidized grey loose sand, silt, clay with cobbles, pebbles and gravels.
Holocene to Recent		Disangmukh-I (=Barpeta – I)	Unoxidized grey silty clay, clay and sand all micaceous with associated gravels and pebbles.
Holocene	Older Alluvium	Hauli	Oxidised brownish grey to greyish brown sand silt and clay with occasional pebbles and cobbles.
Upper Pleistocene to Lower Holocene		Sivsagar (=Sorbhog)	Oxidised brownish grey to greyish brown sand silt and clay with occasional pebbles and cobbles.
Middle to Late Pleistocene		Charaideo (=Chchapar)	Oxidised find sand and silt with boulders, cobbles and

			pebbles in silty/clayey matrix.
	Unconformity		
Pliocene- Pleistocene	Dupitila Group	Namsang Formation	Sandstone, gritty conglomerate with coal bands.
	Unconformity		
Miocene-Pliocene	Tipam	Girujan Clay Formation	Mottled sandy clay, mudstone with ferruginous sandstone, and occasional conglomerate
		Tipam Sandstone Formation	Coarse to gritty argillaceous and ferruginous sandstone with siltstone, mudstone and limestone with mottled clay, shale and fossil wood.
	Unconformity		
Eocene to Oigocene	Barail	Jenam Formation	Carbonaceous olive green shales with flaggy sandstone.
		Laisong	Flaggy sandstone, siltstone with splintery shale and plant fossil.
Palaeocene- Eocene	Disang Group		Shale, siltstone, sandstone, greyawacke, rythmite, with occasional pyrite, limestone.
***Source**-GSI (2009), Geology and Mineral Resources of Assam.*			

FIGURE 22: GEOLOGICAL MAP OF THE DISTRICT



Local Geology:

The Charideo district lies in the gently rolling alluvial plains of the Brahmaputra basin. To the northwest is the Brahmaputra River, and to the south and southeast are Tertiary hill ranges. The Tertiary hill ranges are exposed in the form of highly dissected hills. The Brahmaputra River deposits alluvial sediments with three different geomorphic units that stretch to the foothills of Tertiary peaks. he boundary between the pediment plain and the Quaternary alluvial plain is marked by an unconformity at places. The primary drainage system in the region is made up of the river Brahmaputra and its tributaries. The meandering tributaries, such as Disang, Dilli, and so on, converge on the Brahmaputra River's left bank.The geology of Sivsagar encompasses the history of disposition of different types of litho- units are Disang Formation (Paleocene to Eocene), Laisong and Jenam Formations (Eocene-Oligocene), Tipam Sandstone and Girujan Clay of Tipam Group (Miocene-Pliocene), Namsung Formation (Pliocene-Pleistocene), Chapar and Sorbhog Formations (Middle Pleistocene to Lower Holocene), Barpeta-1 and Barpeta-II Formations of Newer Alluvium Group (Middle to Late Holocene).

Following litho-units have been encountered from Sivsagar

- Sand, silt, clay with cobbles, pebbles and gravels.
- Mudstone, limestone with mottled clay, shale and fossil wood.
- Shale, siltstone, sandstone, greyawacke, rythmite

CHAPTER 7: MINERAL WEALTH

7.1 Overview of mineral resources:

There are accounts of minerals and metals being used before the early historic period, Assam's scientific mining and metallurgical industries only began after independence. Today, Assam is known as a "Mineral Paradise," with commercially exploitable major and minor minerals. Here, the mineral industry has expanded significantly during the past 70 years. Dismissing all geological congregations and concerns, it can be claimed that Assam's economic growth takes form of reversion. Establishing target-oriented and value-added enterprises as well as establishing mines with complete safety measures are essential to accelerating economic growth. Development achieved, without jeopardizing the environment, in the mining and mineral beneficiation industries so far, availability of resources and existing trend would offer a glimpse of future, eradicating all types of schism in mineral economy, of mineral sector in the state of Assam.

People won't be able to raise any more queries regarding Assam's mineral richness until systematic research, particularly surface and subsurface mining in all the mineral and ore-bearing prospective zones, is done. A strong foundation in case of mining especially in Charideo of Assam must give perspective and confidence. In the case of mining, particularly in Charideo, Assam, a solid foundation is necessary to provide perspective and assurance. It is important to emphasize that the Charideo DSR preparedness is a remarkable initiative. As a result, maintaining sustainable management of mineral resources is crucial and becoming more so every year. To ensure that these resources endure for future generations, sustainable management of mineral resources necessitates a long-term view.

7.2 Details of Resources:

MAJOR MINERALS

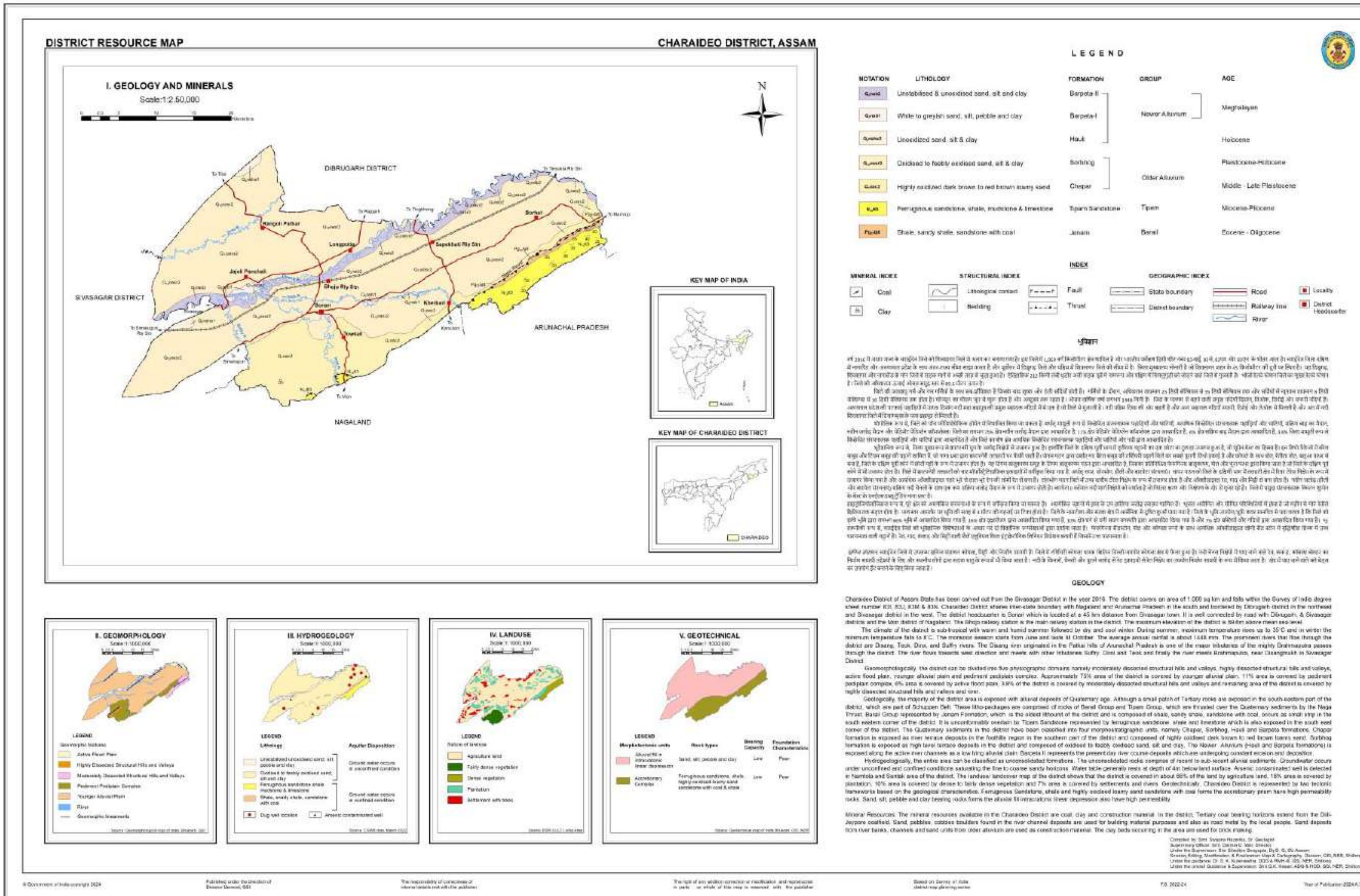
Coal deposit Found in Bimalapur area in Charaideo district.

MINOR MINERALS

When it comes to river bed sand deposits, the global situation regarding reserves and production shows that while India is at the top, Assam is not the only exception. Charideo district is amongst the last few in sand production. Sand production of Desang River and Dilli River play a vital role.

- Riverbed sand and River bank sand deposits
- Ordinary earth and Brick earth material.

Figure 23: ROCKS AND MINERALS MAP OF THE DISTRICT



7.2.1 SAND AND OTHER RIVERBED MINERALS:

I. Drainage System

The drainage pattern of the studied area is the manifestation of the upper catchment of Brahmaputra and its tributaries are Disang and Dilli River, Twokak. In the entire area, drainage pattern is dendritic to sub-parallel and totally is controlled by several of structural features and concealed lithology below the surface.

During the survey of the investigated area of Charideo it is noticed that a number of rivers and rivulets together with their streams of different orders drains the district. All the streams, rivulets and river courses vary depending on the topography and physiography of the area. The streams, rivulets and rivers follow the lowest elevation courses for which the drainage courses vary widely in the district. Generalised streams and river courses are in directions from NE-SW and also from SE – NW as in case of Twokak River.

Disang

The Disang, often called the Dilli River, is a tributary of the Brahmaputra that passes form NE-SW of the Charideo district. This river rises in the highlands to the northeastern part of Arunachal Pradesh and runs west until it meets the Brahmaputra. Before influence point, it shows meandering nature. So Gravel deposit found as point bar with few mid channel bars. It is distinguished by a varying flow regime that experiences notable seasonal variations. In addition to helping with local flood control and water management, the Disang River promotes agriculture, especially in the areas it flows through.

Twokak

The river is a tributary of the Brahmaputra drainage system's Dichang River. The river originates in the hilly region of the state of Nagaland and primarily flows in pool and riffle forms before becoming braided. While it was known as the Tigit River in its upper reaches, it was renamed the Towkak River once it entered the Charideo district of Assam. The river eventually reaches the Dichang River of the Brahmaputra drainage system in Borahi, close to Sonari in the Charideo District, after meeting up with the Tiok River. The river's two primary sub-tributaries are the River Tiok and the Naga Nadi.

Dilli River

A tributary of the Brahmaputra, the Upstram of Disang—also referred to as the Dilli River—flows through the East part of the Charideo district. This river flows westward until it meets the Brahmaputra, having its source in the mountains in northeastern Arunachal Pradesh. Before the influence point, the nature is meandering. Thus, the gravel deposit was discovered as a point bar with a few midchannel bars. It is characterized by a variable flow regime with discernible seasonal fluctuations.

In general, sand extraction (mining) is possible at specific locations particularly where sand bars have been developed. Due to formation of sand bars, river courses are changing. Planning needed to be made for sand mining particularly at places where sand bars height is above the running water flow level during heavy rain. River bed sand mining also need to be carried to keep the river/ stream courses healthy. Care to be taken so that the original river bed should not be cut out. Manual/ semi-mechanised dredging is suggested for sand mining.

a) Drainage System with description of main rivers

Table 18: Drainage system with description of main rivers

Sl. No.	Name of the River	Area drained (sq.km.)	% Area drained in the district
1	Disang	16.47	1.54 %
2	Dilli river	1.49	0.14 %
3	Twokak	3.91	0.36 %

b) Salient Features of important rivers and streams

Table 19: Salient Features of important rivers and streams

Sl. No.	Name of the River or Stream	Total Length in the District (in Km.)	Place of Origin	Altitude of Origin
1	Disang	61	Patkai Hills ranges of Arunachal Pradesh	2200
2	Dilli river	14.9	Patkai Hills ranges of Arunachal Pradesh	2200
3	Twokak	39.1	Hilly region of the state of Nagaland	1409

II. Annual deposition of riverbed minerals

Annual deposition of riverbed minerals is dependent on various factors which are explained below.

A) Geomorphological studies

Geomorphological characteristic of a river is foremost factor for annual deposition of sedimentary load. The study includes following parameter:

i) Place of Origin

Details of origin of rivers of Charideo District are furnished in Table.

Table 20: Place of Origin of important rivers and streams

Sl. No.	Name of the River or Stream	Place of Origin
1	Disang	Patkai Hills ranges of Arunachal Pradesh
2	Dilli river	Patkai Hills ranges of Arunachal Pradesh
3	Twokak	hilly region of the state of Nagaland

ii) Catchment Area

The Charideo district of Assam is mainly drained by the Brahmaputra and it's tributaries are Disang, Dilli river, Twokak which are forming the main catchment area. The catchment area of a river, also known as its drainage basin or watershed, is the region of land where precipitation collects and drains into the river and its tributaries. This area encompasses all the land that contributes to the river's flow, including all the streams, rivers, and other water bodies that feed into it. The land's elevation and slope can influence how water flows and accumulates. Mountains or highlands often define the boundaries of a catchment area. The amount and distribution of precipitation within the catchment area affect the river's flow. Areas with high rainfall contribute more water to the river. Soil type and vegetation cover impact how much water infiltrates into the ground versus how much runs off into the river. Forested or vegetated areas generally reduce runoff and increase groundwater recharge. Land use, such as agriculture, urban development, and deforestation, can alter the natural flow of water within a catchment area.

Table 21: Catchment areas of main rivers of Charaideo district, Assam

Sl. No.	Name of the River or Stream	Catchment Area (sq. km.)
1	Disang	16.47
2	Dilli river	1.49
3	Twokak	3.91

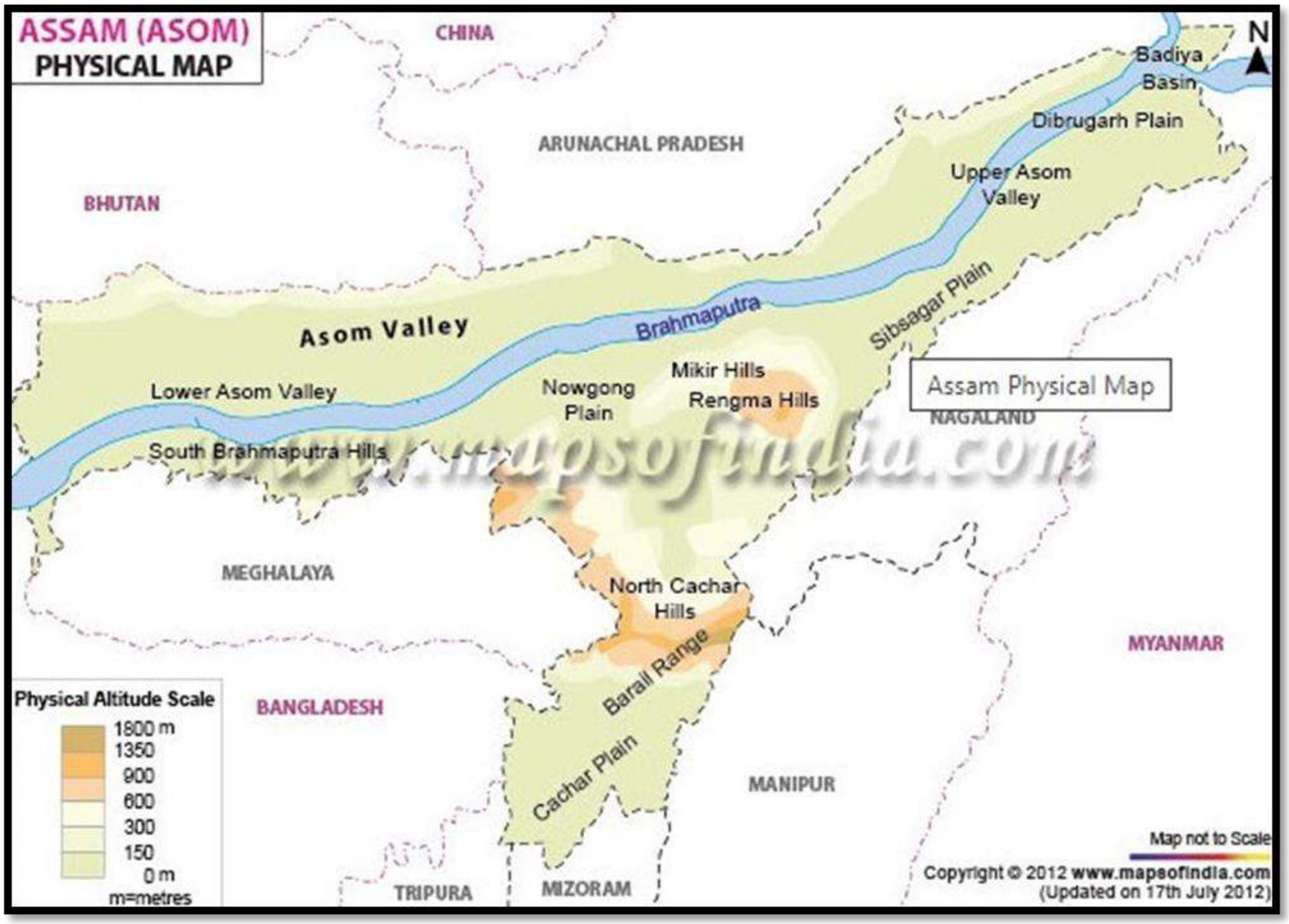
iii) General profile of river stream

If rivers are always straight i.e., if rivers follow straight course the meaning of slope becomes value less, but if the river is curvy and follows a sinusoidal pattern (as is usually the case, at least to some extent), then we have to measure the horizontal distance along the sinuous projection of the course of the river on a horizontal plane. The slope can be measured in feet per mile or some metric units like meters per kilometers. Recalling some trigonometry, we might recognize the tangent of a slope angle although measuring the slope of a river is not an easy matter. The slope of the rivers of the district, in this case, has been measured following the method of Digital Elevation Model (DEM).

To reach the targeted approach, here contour lines are digitized from topographic map using a scale of 1:8000; from this map few contours are also digitized in flat areas. Spot heights are also digitized. From this height data, contour interpolation is completed in ArcGIS approach. This slope map is exported to ERDAS for further processing. The slope map is classified to 0-15 degree or more than 15 degree.

The longitudinal profile and the cross-sectional profile of the streams or rivers is provided in **Annexure IX**.

Figure 24: Elevation of river Map of the Charaideo district, Assam



iv) Annual deposition Factor

Rivers are important geological agents for erosion, transportation and deposition. Deposition and erosion in river valleys can strongly modulate the downstream delivery of sediment (Fan and Cai, 2005; Malmon et al., 2005). A riverine sediment budget provides an effective conceptual framework within which to quantify sediment mobility, transport, deposition, and storage within a drain-age basin, as well as sediment output from the basin (Walling et al., 2002). It is therefore critical to understand this modulation effect (Walling and Horowitz, 2005). Annual deposition of riverbed materials depends on various factors which are as follows:

Geological erosion and soil erosion are the two basic terms used to describe erosion processes. Geological erosion refers to regular or natural erosion brought on by long-term geological processes that wear down mountains and produce floodplains, coastal plains, and other landforms to develop. Soil erosion happens gradually or at an alarming rate, but it is a continual process. It leads to various negative effects, including ongoing topsoil erosion, ecological harm, soil collapse, and many more.

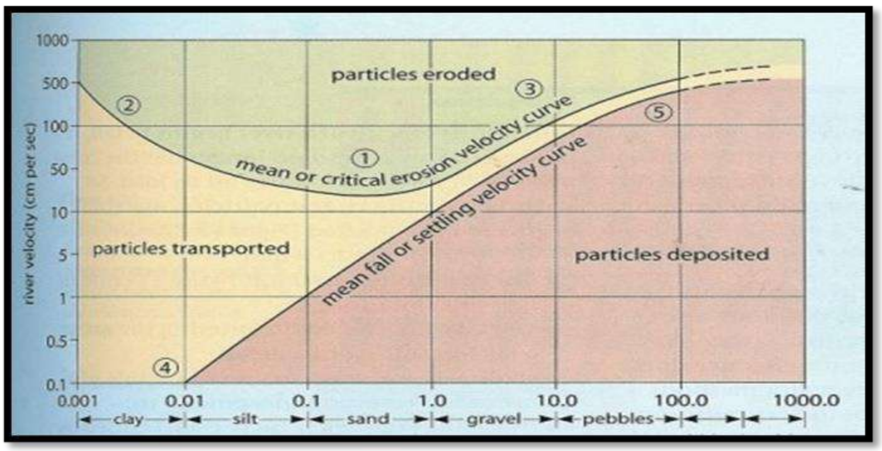
The soil fragments are loosening or being washed away in the valleys, oceans, rivers, streams, or far-off regions throughout this process. Human activities like agriculture and deforestation have contributed to this situation getting worse.

Fluvial erosion is the direct removal of soil particles by moving water. The force of the flowing water and the resistance of the bank material to erosion both affect the pace of fluvial erosion.

1. Process of deposition

After erosion, the eroded materials get transported with running water. When the river losses its energy and velocity falls, the eroded material is deposited. A river can lose its energy when rainfall reduces, evaporation increases, friction close to river banks and when enters a shallow area (flood plain) or towards its mouth where it meets another body of water. Hjulström curve showing the relationship between particle size and the tendency to be eroded, transported or deposited at different current velocities.

Figure 25: HJULSTRÖM CURVE



Source: *Sediment Petrology, Pettijohn*

In this diagram, X-axis indicates the grain size in mm and Y-axis indicates the flow velocity of the river in cm. s^{-1}. The lower line of the diagram shows the relationship between flow velocity and particles in motion, with pebbles at 20-30 cm. s^{-1}, medium sand grains at 2-3 cm.s^{-1}, and clay particles at 0 cm s^{-1}. The grain size of particles can indicate the velocity at the time of sediment deposition. The upper line shows the flow velocity required to move a particle from rest, with smaller particles needing higher velocity to move them below coarse silt size due to the properties of clay minerals, which dominate the fine fraction in sediment. Clay minerals are cohesive and stick together, making it difficult to entrain them in a flow. The behavior of fine particles in a flow which has important consequences for deposition in natural depositional environments. Mud can accumulate in any setting where flow stops for long enough for clay particles to be deposited, and resumption of flow does not re-entrain the deposited clay unless the velocity is relatively high. Alterations of mud and sand deposition are seen in intermittent environments, such as tidal settings.

2. Mode of sediment transport in rivers

Sediment transport is the transportation of detrital particles via air, water, ice, or gravity. When transported by air and water (fluid transport), grains (which may be sand particles) travel as a bed load (by rolling, sliding, and saltation) or in suspension when the turbulence keeps the grains moving.

The amount and size of sediment moving through a river channel are determined by three fundamental controls: competence, capacity and sediment supply.

The sediment load of a river is transported in various ways although these distinctions are to some extent arbitrary and not always very practical in the sense that not all of the components can be separated in practice:

i. Dissolved load

ii. Suspended load

iii. Saltation load

iv. Wash load

v. Bed load

i. **DISSOLVED LOAD:** The amount of sediment carried in solution by a stream's total sediment load, particularly ions from chemical weathering, is known as the dissolved load. Along with suspended load and bed load, it makes up a significant portion of the overall number of debris removed from a river's drainage basin.

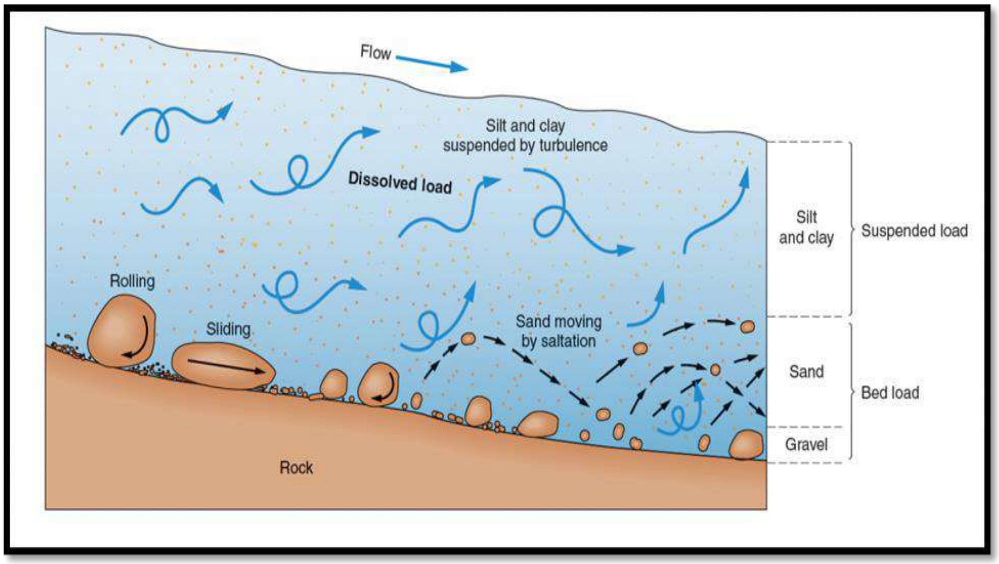
ii. **SUSPENDED LOAD:** The term "suspended load" describes the portion of the total sediment transport that is kept suspended by turbulence in the flowing water for extended periods of time without contact with the stream bottom. Sometimes the particles may float on the surface of the water and thus become the part of the fluid mass. The duration of a particle's suspension is determined by the intensity of turbulence and velocity of the river-flow. It is nearly moving at the same speed as the flowing water.

iii. **SALTATION LOAD:** The portion of the bed load that is moving, either directly or indirectly, as a result of the impact of bouncing, i.e., the intermittent jumping motion of the particles due to presence of eddies, along the stream bed. The smaller particles show higher lift and longer jump.

iv. **WASH LOAD:** Particle sizes smaller than those found in substantial amounts in the bed material make up that portion of the suspended load. It is conveyed through the stream without deposition since it is in almost permanent suspension. The discharge of the wash load through a reach is determined solely by the rate at which these particles become available in the catchment area, not by the flow's transport capacity.

v. **BED LOAD:** Particles that are too large to be carried as suspended load are bumped and pushed along the stream bed as bed load. The larger particles move close to the surface floor by rolling or sliding and occasional low leap. Bed load sediments do not move continuously. Streams with high velocity and steep gradients do a great deal of down cutting into the stream bed, which is primarily accomplished by movement of particles that make up the bed load.

Figure 26: Mode of Sediment Transport In Rivers



Source:*https://www.bgs.ac.uk/discovering-geology/geological-processes/deposition/#:~:text=Deposition%20is%20the%20laying%20down, sea%20shells) %20or%20by%20evaporation. (British Geological Survey)*

3. Sediment Transport Rate

The rate at which sediment is moved past a cross section of the flow is called either the sediment transport rate or the sediment discharge. It is related to the sediment load, but it's different, just because different fractions of the sediment load are transported at different rates. It can be measured in mass per unit time, or in weight per unit time, or in volume per unit time. The sediment transport rate is commonly denoted by Qs.

4. Estimation of Sedimentation

There are two approaches to obtaining values describing sediment loads in streams. One is based on direct measurement of the quantities of interest, and the other on relations developed between hydraulic parameters and sediment transport potential.

The total bed material load is equal to the sum of the bedload and the bed material part of the suspended load; in terms of volume transport per unit width, qt = qb + qs. Here wash load, i.e. that part of the suspended load that is too fine to be contained in measurable quantities in the river bed, is excluded from qs.

There are number of equations to compute the total sediment load. Most of these equations have some theoretical and empirical bases.

In 1973, Ackers and White developed a general theory for sediment transport which was calibrated against the flume-transport data then available. Their functions have been widely accepted as one of the best available procedures for estimating the total bed load over the full width of the flow section.

Dendy Bolton formula is often used to calculate the sedimentation yield. But use of these equations to predict sediment yield for a specific location would be unwise because of the wide variability caused by local factors not considered in the equations development. However, they may provide a quick, rough approximation of mean sediment yields on a regional basis. Computed sediment yields normally would be low for highly erosive areas and high for well stabilized drainage basins with high plant density because the equations are derived from average values. The equations express the general relationships between sediment yield, runoff, and drainage area.

5. Sediment Yield

The water that reaches a stream and its tributaries carries sediment eroded from the entire area drained by it. The total amount of erosional debris exported from such a drainage basin is its sediment load or sediment discharge and the sediment yield is the sediment discharge divided by the total drainage area of the river upstream of the cross section at which the sediment discharge is measured or estimated. Sediment yield is generally expressed as a volume or weight per unit area of drainage basin—e.g., as tons per square kilometre. Further, sediment yield is usually measured during a period of years, and the results are thus expressed as an annual average.

v) Replenishment Study (As per EMGSM guidelines, 2020):

Replenishment defines rejuvenation of riverbed sand deposition phenomena. The word replenishment is the fulcrum of riverbed sedimentation under different depositional environmental conditions especially during rainy seasons. The rate of gross or absolute silt production (erosion) in the watershed and the ability of the stream system to transport the eroded material in a river have a direct relation with the quantity of sediment delivered into a river. The rate of gross erosion is dependent upon many physical factors like climatic conditions, nature of soil, and slope of the area, topography and land use. Hydro-physical conditions of the watershed govern the capability of transporting the eroded material. It has been observed that the average rate of sediment production decreases as the size of drainage area increases. And also, larger the watershed, the lesser is the variation between the rates. The larger watershed presents more opportunity for deposition of silt during its traverse from the point of production. The watershed with maximum land use class of forest, generate very low rate of production unless the forests are degraded or open forest. The cultivated watersheds with unscientific farming produce very high rate of silt production. The total amount of eroded material, which reaches a particular hydraulic control point, is termed as sediment yield. The rotational mining is being adopted to facilitate the replenishment of the excavated pits during rainy season. Thus, the mineable area is to be divided in two blocks i.e., the upstream block and the downstream block. The mining of these blocks is suggested on rotation basis in such a way that pit of previous year mining will act as depository for the monsoon season. Sand is extracted from the said lot during one year; more than the extracted quantity of the same are automatically replenished by rainfall in the monsoon by the river/nallah itself on account of its flow and velocity.

For sustainability of river sand mining, it is necessary that the mine pits formed as a result of sand excavation are refilled with sand by natural process of replenishment in a reasonable period of time so that the area is again available for mining. The rate of excavation should be decided in accordance with the rate of replenishment which is the rate at which sand/gravel is deposited on the river flood plain by the river during monsoon season. However, determination of site-specific rate of replenishment is quite difficult as it is dependent on several factors such as geology and topography of the catchment area of the river, breadth of the flood plain, rainfall in that particular year (which is quite variable and not very much predictable much in advance) etc. Dandy-Bolton formula is generally used to calculate the sediment yield. But it is to be kept in mind that to prepare the mining plans of the mines, the factor of annual replenishment is to be taken into consideration while calculating the mineral reserves. It has also been observed that during flooding, all the pits replenish with sand. Hence, mined out areas in the pre- monsoon season will be completely replenished with sand during monsoon. Therefore, it has been assumed that the pits will be replenished after each monsoon.

Base Flow is influenced by incoming groundwater to aquifers and is closely related to watershed characteristics. Understanding baseflow characteristics is of great importance to river ecosystems and water management. Baseflow is the portion of stream flow that is delayed subsurface flow and generally maintained by groundwater discharge. Regardless of the specific climatic environment, its main features are tightly related to geological catchment properties. Understanding the baseflow process is important to deal with various water resource issues, such as water resources management strategies, low flow conditions assessment, hydrological modeling calibration, and water quality studies. However, no direct approach exists for continuously measuring the variability of streamflow recession under different conditions and the corresponding baseflow, because the baseflow is usually affected by diverse climatological and geological factors, with considerable variations in spatio-temporal watershed characteristics (e.g., geology, land use, soil type, etc.) and climatic conditions influence baseflow discharge to streams. Addressing such processes requires quantitative estimates of baseflow discharge across a gradient of watershed types. The development of quantitative methods for baseflow estimation is also necessary to understand water budgets (Stewart et al., 2007), estimate groundwater discharge (Arnold and Allen, 1999) and associated effects on stream temperature (Hill et al., 2013), and address questions of the vulnerability and response of the water cycle to natural and human-induced change in environmental conditions, such as stream vulnerability to legacy nutrients (Tesoriero et al., 2013). Given the importance of baseflow, many methods have been used to quantify the baseflow component of stream discharge beginning with Boussinesq (1877). Approaches for baseflow estimation can be grouped into two general categories: graphical hydrograph separation (GHS) methods, which rely on stream discharge data alone, and tracer mass balance (MB) methods, which rely on chemical constituents in the stream, stream discharge, and the streamflow end-member constituent concentrations (runoff and baseflow). Many different approaches for GHS exist, including recession curve methods and digital filter methods. Recession curve methods are generally considered more objective than digital filter methods because they provide an assumed integrated signal of basin hydrologic and geologic characteristics through identification of a linear recession constant based on the falling limb of the hydrograph (Barnes, 1939; Hall, 1968; Gardner et al., 2010).

However, in context of the rivers of district, the volume (weight) of the precipitated sand has been derived during Pre-monsoon and Post-monsoon period along with the thickness of the sand layers deposited in the respective periods. But, to erect hydrograph model which is essential for estimation of depth of base flow, data on daily discharge of water volume (weight) is required. Hence, it can be proposed that if these data are provided from the concerned authority of the state government (secondary data- already requested for providence), depth of base flow as well as the hydrograph model can be estimated. The quantitative estimation of the depth of base flow cannot be done due to absence of data. But a relative comparison between the mining depth and depth of baseflow has been done on the basis of collected data by making pit on the river bed.

Usually, replenishment or sediment deposition / depletion quantities can be estimated in the following ways:

- Direct measurement of the sand bar upliftment;
- Monitoring of the new sand bars created in the monsoons within the channel;
- Elimination of sand bars during the monsoon etc.;

With systematic data acquisition over a period of several years, regression equations can be developed for modeling of the sediment yield and annual replenishment with variable components.

Several theoretical and empirical formulae can be used for the calculation of catchment runoff and sedimentation loads as thumb rules. Sedimentation in riverbeds depends on catchment areas / characteristics, peak flood of the river. Some of the common empirical formulae used for rough estimation of the Catchment runoffs, Peak Discharge, Bed load transportation and sediment yields for replenishment studies are as under:

➢ **COMMON METHODS FOR REPLENISHMENT:**

❖ List of instruments: DGPS, GPS and Hammer.

❖ List of software: ARC GIS, Google Earth, Microsoft and Google Maps.

➢ **CATCHMENT YIELD CALCULATION**

The total quantity of surface water that can be expected in a given period from a stream at the outlet of its catchment is known as yield of the catchment in that period. The annual yield from a catchment is the end product of various processes such as precipitation, infiltration and evapotranspiration operating on the catchment. Catchment Yield can be estimated using following formula:

Catchment Yield (m3) =Catchment area (m2) * Runoff coefficient (%) *Rainfall (mts/annum)

The runoff generated from a watershed is estimated using Strange’s Tables Method to get obtain approximate yield results. Runoff from a catchment is dependent upon annual rainfall as well as catchment area and characteristics such as soil types and the type of groundcover / land usage. Remote sensing is used for demarcation of catchment boundaries and computation of catchment area relevant to the drainage system. Strange’s table is used to determine the Runoff coefficient of the catchment.

➢ PEAK FLOOD DISCHARGE CALCULATION

The term "peak discharge" stands for the highest concentration of runoff from the basin area. The accurate estimation of flood discharge remains one of the major challenges as it depends upon physical characteristics of the catchment area and the flood intensity, duration and distribution pattern. There have been many different approaches for determining the peak runoff from an area. As a result, many different models (equations) for peak discharge estimation have been developed. Formulae used for Peak Discharge calculation are as below:

i. As per Dicken's formula, Q = CA3/4

Where: **Q** is Maximum flood discharge (m3/sec); A is Area of catchment in Sq. Km and **C** is Constant whose value varies widely between 2.8 to 5.6 for catchments in plains and 14 to 28 for catchments in hills

ii. As per Jarvis formula, $Q = CA^{1/2}$

Where: **Q** is Maximum flood discharge (m3/sec); A is Area of catchment in Sq. Km and **C** is Constant whose value varies between 1.77 as minimum and 177 as maximum. Limiting or 100 percent chance floods are given by the value of C of 177.

iii. As per Rational formula, Q = CIA

Where: **Q** is Maximum flood discharge (m3/sec); A is Area of catchment in Sq. Km and **C** is the Runoff coefficient (ratio of runoff to total rainfall) which depends on the characteristics of the catchment area.

I is Intensity of rainfall (in m/sec).

➢ BED LOAD TRANSPORT CALCULATION

The most difficult problem in river engineering is to accurately predict bed load transport rates in torrential floods flowing from mountainous streams. Three modes of transport namely; rolling, sliding and saltation may occur simultaneously in bed load transport. The different modes of transportation are closely related, and it is difficult, if not impossible, to separate them completely. There are a number of equations to compute the total sediment load. Most of these equations have some theoretical and empirical bases.

i. Ackers and White Equation:

Ackers and White (1973) used dimensional analysis based on flow power concept and their proposed formula is as follows.

$Ct = Cs\ Gs\ (d50/h)\ (V/U^*)\ n'\ [(Fgr/A1) - 1]\ m$

The dimensionless particle dgr is calculated by:

Dgr = d50 (g(Gs-1)/v2)1/3

The particle mobility factor Fgr is calculated by:

Fgr = (U*n ′/(Gs-1) g d50)1/2 * (V/ (5.66log (10h/ d50))1-n'

Where,

$A1$ = Critical particle mobility factor

Cs = Concentration coefficient in the sediment transport function

Ct = Total sediment concentration

$d50$= Median grain size

dgr= Dimensionless particle diameter

Fgr= Particle mobility parameter

g= Acceleration of gravity

Ds, Sg = Specific gravity

h= Water depth

m= Exponent in the sediment transport function

n'= Manning roughness coefficient

U= Shear velocity

V= Mean flow velocity

v= Kinematic viscosity

ii. Meyer – Peter's equation:

Meyer-Peter's equation is based on experimental work carried out at Federal Institute of Technology, Zurich. Mayer-Peter gave a dimensionless equation based, for the first time, on rational laws. Mayer- Peter equations giving an empirical correlation of bed load transport rates in flumes and natural rivers. The simplified Meyer-Peter's equation is given below:

gb = 0.417[τ0 (η'/ η)1.5 - τc]1.5

Where,

gb = Rate of bed load transport (by weight) in N per m width of channel per second. η'= Manning's coefficient pertaining to grain size on an unrippled bed and Strickler formula i.e., η'= (1/24) x d1/6 where d is the median size (d50) of the bed sediment in m.

η = the actual observed value of the rugosity coefficient on rippled channels. Its value is generally taken as 0.020 for discharges of more than 11cumecs, and 0.0225 for lower discharges.

τc = Critical shear stress required to move the grain in N/m2 and given by equation τc = 0.687da, where dais mean or average size of the sediment in mm. This arithmetic average size is usually found to vary between d50 and d60.

$\tau 0$= Unit tractive force produced by flowing water i.e., γwRS. Truly speaking, its value should be taken as the unit tractive force produced by the flowing water on bed = 0.97γwRS. R is the hydraulic mean depth of the channel (depth of flow for wider channel) and S is the bed slope.

- **SEDIMENT YEILD ESTIMATION**

Sedimentation occurs as the stream velocity decreases thus reducing its ability to carry sediment. Coarse sediments deposit first, which may then interfere with the channel conveyance and may cause rivers to meander and form distributaries. As the area of the flowing water increases, the depth decreases, the velocity is reduced, and eventually even fine sediments begin to get deposited. As a result, deltas may be formed in the upper portion of reservoirs. The deposited material may later be moved to deeper portions of the reservoir by hydraulic processes within the water body.

There are many sediment transport equations which are suitable for use in the prediction of the rate of replenishment of rivers. Some of the common equations used to estimate sediment yields are:

- Dandy – Bolton Equation
- Modified Universal Soil Loss Equation (MUSLE) developed by Williams and Berndt (1977)

Dandy – Bolton Equation:

The formula uses catchment area and mean annual runoff as the key variables. It does not differentiate between the characteristics of basins and streams.

Dandy and Bolton equation estimates all types of sediment yield *i.e.*, through Sheet and rill Erosion, gully Erosion, Channel Bed and bank erosion and mass movement etc. Dandy- Bolton determined the combined influence of runoff and drainage area to compute the sediment yield. They developed two equations *i.e.,* for run off less than 2 inches and for run off more than 2 inches, which are given below:

For run off less than 2 inches:

(Q<2in) S=1289*(Q) 0.46*[1.43-0.26 Log (A)]

For run off more than 2 inches:

(Q > 2 in): S= 1958*(e -0.055*Q) *[1.43-0.26 Log (A)]

Where: S = Sediment yield (tons/sq miles/yr) Q = Mean Annual runoff (inch) A = Net drainage are in sq mile

Modified Universal Soil Loss Equation (MUSLE):

Modified universal soil loss equation (MUSLE) for estimation of sediment yield is also used widely. MUSLE is a modification of the Universal Soil Loss Equation (USLE). USLE is an estimate of sheet and rill soil movement down a uniform slope using rain- fall energy as the erosive force acting on the soil (Wischmeier and Smith 1978). Depending on soil characteristics (texture, structure, organic matter, and permeability), some soils erode easily while others are inherently more resistant to the erosive action of rain- fall.

MUSLE is similar to USLE except for the energy component. USLE depends strictly upon rainfall as the source of erosive energy. MUSLE uses storm-based runoff volumes (weight) and runoff peak flows to simulate erosion and sediment yield (Williams 1995). The use of runoff variables rather than rainfall erosivity as the driving force enables MUSLE to estimate sediment yields for individual storm events. The generalized formula of MUSLE is as below:

Y=11.8*(Q*qP).56 *K*Ls*C*P

Where,

Y = sediment yield of stream (t/yr/km2),

Q = average annual runoff (m3),

K = soil erodibility factor,

qP = Highest discharge recorded (m3/s),

Ls = gradient/slope length,

C = cover management factor,

P = erosion control practice.

A. REPLENISHMENT STUDY BASED ON SATELLITE IMAGERY

To delineate replenishment percentage in the river bed of the district, below mentioned steps have been followed.

- **Satellite imagery studies**

Satellite imagery study involves demarcation of sand/ RBM zones on riverbed of the district. Both pre and post monsoon images need to be analysed to established potential sand/ RBM zones.

- **Field data collation**

Field data collation was carried out during May- June for all the sand/ RBM zones on continuous basis for pre monsoon period and November – December for all the sand/ RBM zones on continuous basis for post monsoon period. In both the cases, relative elevation levels were captured through GPS/DGPS/ Electronic Total Station. Thickness of the sand/ RBM zones was measured through sectional profiles. The field survey for collect post-monsoon data has been conducted November- December time period in 2023 while preparing the District Survey Report of Charaideo district.

- **Selection of study profiles**

Study profiles are selected based on the occurrence of the sand / RBM zones in the channel profiles. Aerial extents of each of the profiles are mapped from satellite imageries. Frequency distribution did while selection of the ground truthing of the zones.

- **Data compilation:**

Following data were compiled for generation of this annual replenishment report:

- Elevation levels of the different sand/ RBM zones as measured at site.
- Extents of the sand/ RBM zones are measured from the pre monsoon satellite imageries.
- Sand/ RBM zones production data of the district.

All these data were compiled while estimation of the replenished sand/ RBM zones in the district.

- **Assessment of sediment load in the river:**

Assessment of sediment load in a river is subjective to study of the whole catchment area, weathering index of the various rock types which acts as a source of sediments in the specific river bed, rainfall data over a period not less than 20 years, and finally the detail monitoring of the river bed upliftment with time axis. Again, the sediment load estimation is not a dependent variable of the imaginary district boundary, but it largely depends upon the aerial extents of the catchment areas, which crossed the district and state boundaries.

➢ METHODOLOGY FOR CALCULATING THE TOTAL POTENTIAL OF MINOR MINERAL IN THE RIVER BED ANNUAL DEPOSITION

For estimating the reserve of River Bed Material [Sand/Gravel (Minor Mineral)], the following parameters were considered:

a) The volumes of the reserves are calculated on the basis of the established width, thickness and length of the deposit as per actual field data.

b) The tonnage of the reserve quantity is obtained by multiplying the above volume with the bulk density of mineral to arrive at tonnes per cum (as per lab report).

c) The depth of the reserves has been estimated considering the available deposit thickness and the water level/red line.

The same procedure shall be followed for acquiring post monsoon data, its reserve estimation and then correlating between pre and post monsoon volumes as per table given below:

Table 22: Estimation of Sand/ RBM zones Reserves in Pre & Post Monsoon periods in sand/ RBM zones

Estimation of Sand Reserves in Pre & Post Monsoon periods in sand bars										
Sl. NO.	**Deposit zone code**	**Area in Sq. m.**	**Ave. Thickness (m)**	**Quantity (CUM)**	**Sl. NO.**	**Deposit zone code**	**Area in Sq. m.**	**Ave. Thickness (m)**	**Quantity (CUM)**	**Difference (cum) 'YY'**
PRE-MONSOON					**POST-MONSOON**					
1					1					
This table would be added after post-monsoon survey										
Source: *Field Survey and DGPS data*										

Table 23: Sediment Load Comparison Pre & Post monsoon period for different rivers of Charaideo District

River Name	Pre-monsoon No of Ghats	Post-monsoon No of Ghats	Pre-monsoon Sediment Load (CUM)	Post-monsoon Sediment Load (CUM)	Difference (CUM) 'YY'	Percentage Variance (%) (Postmosoon - Premosoon / Postmonsoon *100)
Disang						
Dilli river						
Twokak						
(Table would be added after Post Moonsoon Survey)						
Source: *Field Survey and DGPS data*						

B. Geological studies

i) Lithology of the catchment area

- **Disang:** Sand, Silt, Clay with Occasionally Pebbles and cobbles.
- **Dilli River:** Sand, Silt, Clay with Occasionally Pebbles and cobbles.
- **Twokak:** Sand, Silt, Clay with Occasionally Pebbles and cobbles

ii) Tectonics and structural behavior of rocks

The region is a component of the Assam-Arakan basin geologically, and the Brahmaputra valley geomorphologically. Although the Naga-Patkai Hills represent the basin's mobile belt, the Assam Plain comprises the shelf area. The Precambrian granitic bedrock of the Charaideo district is overlain by a sequence of Tertiary sedimentary rocks that were formed in a shelf environment, covering the Quaternary alluvium that makes up the plain area. The NE-SW trending Belt of Schuppen and the roughly E-W trending Jorhat Fault (Dasgupta 1977; Narula et al. 2000) are the two main tectonic features in the district. According to Kunte (1988), the Assam-Arakan basin's shelf region is dominated by epirogenic vertical movements.

C. Climate Factors

i) Intensity of rainfall

Rainfall and humidity are closely allied in terms of climatology. The district has a climate which is characterized by a highly humid atmosphere, abundant rain and general coolness. Therefore, heavy summer rainfall and high humidity affect the weather of Charideo district. The area enjoys a sub-tropical climate with abundance of monsoonal rain. The rainfall is not uniform throughout the district. The average rainfall is about 1400 to 2400 mm. Almost 64% precipitation is received during July being the wettest month.

ii) Climate zone

The Charideo district has sub-tropical tropical/ Equatorial climate as Assam lies in the regime of monsoon climate of the sub-tropical belt. So, people of Charaideo enjoy heavy summer rainfall, abundance of monsoonal rain, experiences winter drought, high humidity.

iii) Temperature variation

In Summer time district experiences hot, humid temperatures, maximum temperature of the district is around 28.600 °C. The winter months bring chilly, dry weather. Minimum temperature is 17.400. The warmest months of the year are typically July and August, while the coldest months are January and December.

Annual Deposition:

Annual deposition of riverbed minerals has been calculated on post-monsoon sand volume. The pre-monsoon sand volume of the river is the depleted resources and is replenished by the monsoon rainfall.

- **TOTAL POTENTIAL OF MINOR MINERAL IN THE RIVER BED ANNUAL DEPOSITION**

According to Sustainable Sand Mining Guidelines, 2016 and Enforcement & Monitoring guidelines, for Sand Mining, 2020 mining depth of the mining zones are 1 meter for hilly area.

The annual deposition of riverbed minerals is shown in the Table given below.

Table 24: Annual deposition

River Name	Zone	Type of Material	Quantity in CUM (as per YY)	60% of quantity in CUM
Disang				
Dilli river				
Twokak				

1. Riverbed minerals zone area recommended for mineral concession in the above table has been calculated as per the Enforcement & Monitoring Guidelines for Sand Mining (EMGSM) 2020.
2. As per guidelines, mining depth has been restricted to 3 meters depth and distance from the bank is ¼th of river width and not be less than 7.5 meters.
3. Also, mining is prohibited up to a distance of 1 kilometer (1 km) from major bridges and highways on both sides, or five times (5x) of the span (x) of a bridge/public civil structure (including water intake points) on up-stream side and ten times (10x) the span of such bridge on down-stream side, subjected to a minimum of 250 meters on the upstream side and 500 meters on the downstream side.
4. Riverbed minerals zone deposits acting as potential sites for sand mining along with other aspects as mentioned above are illustrated in Satellite images in **Annexure VIII.**

III. Riverbed Mineral Potential

Process of disposition etc.:

Sand: Huge quantities of quality sands are found to occur in part of rivers. Smaller patches are also available locally in the other smaller rivers as well.

Table 25: Resources of Potential Riverbed Mineral

Boulder (Mcum)	Pebbles/Gravel (Mcum)	Sand/White sand (Mcum)	Total Mineable, Mineral Potential (Mcum)

DETAILS OF POTENTIAL SOURCES / SITES OF RIVER BED MATERIAL

Potential sensitive sites for mining near forests, protected areas, habitation, bridges etc., shall be avoided. For this, a sub-divisional committee may be formed which after the site visit shall decide its suitability for mining. The list of mining leases as per the recommendation of the Committee needs to be defined in the following format given in as **Annexure –V.**

The Sub-Divisional Committee shall make recommendations regarding the suitability of all potential mining sites and also record the reason for approving the specific mining leases on the basis of its field inspections. The details regarding cluster and contiguous cluster formation will be provided as in **Annexure-VI.**

No mining Zone

Mining of river bed materials is prohibited is some places on the river channel due to presence of notable landmarks like, sanctuary or national parks, forests, bridge/public civil structure or highways.

A definition of a protected area was established by IUCN in 1994, which is described as

"*An area of land and /or sea especially dedicated to the protection and maintenance of biological diversity, and of natural and associated cultural resources, and managed through legal or other effective means.*"

As per the Enforcement & Monitoring Guidelines for Sand Mining (EMGSM) 2020 the restricted zone for mining is a distance from the bank is ¼th of river width and not be less than 7.5 meters. Also, there is a no mining zone up to a distance of 1 kilometre (1 km) from major bridges and highways on both sides, or five times (5x) of the span (x) of a bridge/public civil structure (including water intake points) on upstream side and ten times (10x) the span of such bridge on down-stream side, subjected to a minimum of 250 meters on the upstream side and 500 meters on the downstream side.

No mining zone has been marked for an area up to a width of 100 meters from the active edge of embankments. Also, the concave side of the river is marked as no mining zone, as mining is this area will affect the course of river in future and will erode the river bank.

Mining has a range of environmental consequences for protected areas, whether operations are undertaken within them or nearby. The types of impact may be listed as follows:

- Direct land take and loss of vegetation cover in the mined area and other parts directly affected by associated activities such as deposition of tailings, or consequences such as subsidence;
- Pollution affects, especially on water supplies, aggravated by accidents (e.g., to tailing dams);
- Impacts due to access associated with mining (roads, railways, pipelines, power lines etc.), which permit illegal hunting, habitat fragmentation and alien invasions;
- Secondary effects of human immigration in association with real or perceived livelihood opportunities (e.g., on water supplies, illegal hunting, harvesting of vegetation, alien invasions, illegal land settlements);
- Impacts on other protected area values from noise and visual intrusion, arising from both mining and secondary activities, including transportation.

The 2020 guidelines for sand mining stress on protecting rivers and habitats of species including turtles and calls for such sensitive areas to be declared as no-mining zones. It also called for using the latest technology for surveillance of illegal mining as well as estimating minable reserves.

A United Nations Environment report has said that, led by China and India, the world is mining sand at unsustainable levels exceeding the replenishment rate and that can have far-reaching social and environmental implications. Unsustainable sand mining practices are rampant in India. Despite a set of guidelines in 2016 to curb the practice, illegal and unsustainable sand mining has continued to be common, spurring the Indian government to take another step toward enforcing rules. The environment ministry has now come out with, Enforcement & Monitoring Guidelines for Sand Mining 2020" to regulate sand mining and check illegal mining.

This comes four years after the Government's Sustainable Sand Management Guidelines 2016, which was unsuccessful in putting an end to rampant illegal sand mining across the country. The latest guidelines suggest the use of technologies like drones with night vision for surveillance of sand mining sites, steps to identify sources of sand, procedures for replenishment of sand, post environmental clearance monitoring of sand mining sites, a procedure for environmental audit of such areas and steps to control the instances of illegal mining.

Among these, the focus on monitoring of sand mines after environment clearance is considerable given that so far it has been an area where the performance of authorities, central or state, is considered very poor.

The need for the latest version of the guidelines was felt after illegal and unsustainable sand mining continued despite the 2016 guidelines and many court cases. Since 2016, the National Green Tribunal, in many of the cases, stressed on the need of regulating sand mining and passed several orders. The court in some cases even expressed concern over the death of officials who tried to stop illegal mining and noted that on the ground level, illegal mining is still going on. The guidelines are thus a result of many such orders by the NGT wherein the tribunal passed directions to control it.

The new guidelines also laid special emphasis on the protection of rivers and species from sand mining as it called for surveys for identifying the stretches with freshwater turtles or turtle nesting zones. "Similarly, stretches shall be identified for other species of significant importance to the river ecosystem. Such stretches with adequate buffer distance shall be declared as no-mining zone and no mining shall be permitted," the guidelines said.

It also called for a survey report in every district for identifying the sand bearing area but also the "mining and no mining zones" considering various environmental and social factors like the distance of the mining area from the protected area, forest, bridges, important structures and habitation. According to the Sand Mining Framework 2018 of the central Government's Ministry of Mines, in India, there is a shortage of sand in the country, similar to the situation in other developed and developing countries. It estimated that the demand of sand in the country is around 700 million tons (in the financial year 2017) and it is increasing at the rate of 6-7 percent annually even as the quantity of natural generation of sand is static.

Due to uncertainties and inadequateness in supply, the selling rate of the material varies significantly leading to black marketing and illegal mining of the mineral. It noted that illegal and uncontrolled extraction of sand has an adverse environmental impact.

Protect the rivers from illegal sand mining

The main sources of sand in India are considered to be rivers (riverbed and flood plain), lakes and reservoirs, agricultural fields, coastal/marine sand and manufactured sand.

The guidelines focus on identifying sand mining sources, its quantification and feasibility for mining considering various environmental factors like proximity of protected area, wetlands, creeks, forest etc. and presence of important structures, places of archaeological importance, habitation, prohibited area etc.

To protect the rivers from illegal sand mining, the guidelines said that abandoned stream channels on the floodplains should be preferred rather than active channels and their deltas and floodplains.

CHAPTER 8: OVERVIEW OF THE MINING ACTIVITY IN THE DISTRICT

8.1 GENERAL OVERVIEW

To prepare the DSR of Charideo district of Assam, geological studies along with structural studies in the quest from knowing more and more pertaining to tectonic set up of this regime, suitability for river bed sand mining and time of deposition of different types of minerals are also important. The common hydrological regime plays a pivotal role for deposition of sand and other minor minerals mainly pebbles and boulder. Assam, from climatological aspect gives a best fit result for economic sand deposits. Here brown sand is noticeable in the riverbed of Disang and Dilli River, Twokak. The spatiality of rain is controlled here by the orientation of the axis of monsoon trough. River bed sand mining or sand mining adjacent to a river or stream has a direct impact on the physical characteristics of the stream such as channel geometry, bed elevation, substratum composition and stability, in-stream roughness of the bed, pro velocity, discharge capacity, sediment transport capacity, turbidity, temperature etc. Alteration or modification of the said attributes may cause hazardous impact on ecological equilibrium of riverine regime.

8.2 LIST OF THE EXISTING MINING LEASES OF THE DISTRICT (LOCATION, AREA, PERIOD FOR EACH MINOR MINERAL):

The existing Sand Mahals and stone quarries of the respective ranges in Charideo District are attached in **ANNEXURE II.**

8.3 DETAILS OF PRODUCTION OF SAND AND OTHER MINERALS DURING LAST THREE YEARS:

- **Total Mineral production of Sand in the district during last three years:**

Table 26: Production of the District for the year 2020-21

Sl. No.	Name of the Mineral	Production (In m^3)
1	Sand	2000 m^3

Table 27: Production of the District for the year 2021-22

Sl. No.	Name of the Mineral	Production (In m^3)
1	Sand	

Table 28: Production of the District for the year 2022-23

Sl. No.	Name of the Mineral	Production (In m^3)
1	**Sand**	1500 m^3

- **Total Mineral production of In-situ Minerals (Minerals other than sand) in the district during last three years:**

Table 29: Production of the District for the year 2020-21

Sl. No.	Name of the Mineral	Production (In m^3)
1	**Stone**	6875m^3

Table 30: Production of the District for the year 2021-22

Sl. No.	Name of the Mineral	Production (In m^3)
1	**Stone**	4125 m^3

Table 31: Production of the District for the year 2023-24

Sl. No.	Name of the Mineral	Production (In m^3)
1	**Stone**	22000m^3
2	**Earth**	25500

CHAPTER 9: DETAILS OF REVENUE GENERATED FROM MINERAL SECTOR DURING LAST THREE YEARS

9.1 REVENUE GENERATION FROM MINERAL SECTOR:

- **Revenue generated in the district for Sand for during four years:**

Table 32: Revenue Generated in the district for year 2020-21

Sl. No.	Name of the Mineral	Rate	Royalty (In Rs.)	Cess (Rs.)	Total Revenue
1	**Sand**	140.00	280000.00		

Table 33: Revenue Generated in the district for year 2021-22

Sl. No.	Name of the Mineral	Rate	Royalty (In Rs.)	Cess (Rs.)	Total Revenue
1	**Sand**				

Table 34: Revenue Generated in the district for year 2022-23

Sl. No.	Name of the Mineral	Rate	Royalty (In Rs.)	Cess (Rs.)	Total Revenue
1	**Sand**	140.00	210000.00		

- **Revenue generated in the district for In-situ Mineral (Mineral other than Sand) during last three years:**

Table 35: Revenue Generated in the district for year 2020-21

Sl. No.	Name of the Mineral	Rate	Royalty (In Rs.)
1	**Stone**	200.00	1437500.00

Table 36: Revenue Generated in the district for year 2021-22

Sl. No.	Name of the Mineral	Rate	Royalty (In Rs.)
1	**Stone**	200.00	862500.00

Table 37: Revenue Generated in the district for year 2022-23

Sl. No.	Name of the Mineral	Rate	Royalty (In Rs.)
1	**Stone**	200.00	4440500.00
2	**Earth**	45.00	1147500.00

CHAPTER 10: TRANSPORT

In Charideo District, Assam, road transport is a vital component of the local infrastructure, facilitating the movement of people and goods both within the district and to neighboring regions. National Highway- NH 37, NH 38, NH 715, and NH 717 is passed through this district. Here's an overview of road transport in Sivsagar District. Major district road present. Name of the Major District Road are Amguri Deopani Geleki Kaliapani (Lahdoigarh Ali-1) (M1), Joysagar Namti Kharikatia Deopani (Kharikatia Ali) (M2), Joysagar Nazira Athkhel (Bor ali-Geleki Ali) (M3), Sibsagar station-Chariali Sunpura Balighat (Nazira Ali) (M4), Sepon Sunpura (M5), Garmur Solapathar(Rajgarh Road) (M6), Sepon Suffrai (M7), Moranhat Station feeder road (M8), Kakoti Bari Kachumari Banamali Moran (Mahmora Ali, Kasomari Bonmali, Moran Bonomali) (M9), Sonari Bhojo Kakoti Bari Khamungaon (Rajgarh Bhojo Ali) (M10), Deesang Sapekhati (pithaguti sapekhati) (M11), Bogabagh T.E Dillighat (Lahdoigarh Ali-2) (M12), Sonari Namtola (M13), Gourisagar Nitaipukhuri Laukhowa (Gourisagar Moran Road) (M14), Longding Bimalapur (M15), Simaluguri Naginimara (M16), Dhodar Ali Charaideo (M17) road.
All roads are connected with each other that helping to connect the district to other parts of Assam. Morigaon is connected to major cities and other parts of Assam by National Highway 37. The government frequently invests in road infrastructure to enhance transportation efficiency and support economic growth. The region faces challenges such as maintenance issues, seasonal flooding, and infrastructural development needs. Addressing these challenges is crucial for improving road connectivity. Bus services, both state-run and private, operate in Sivsagar, providing connectivity to various destinations within and outside the district.

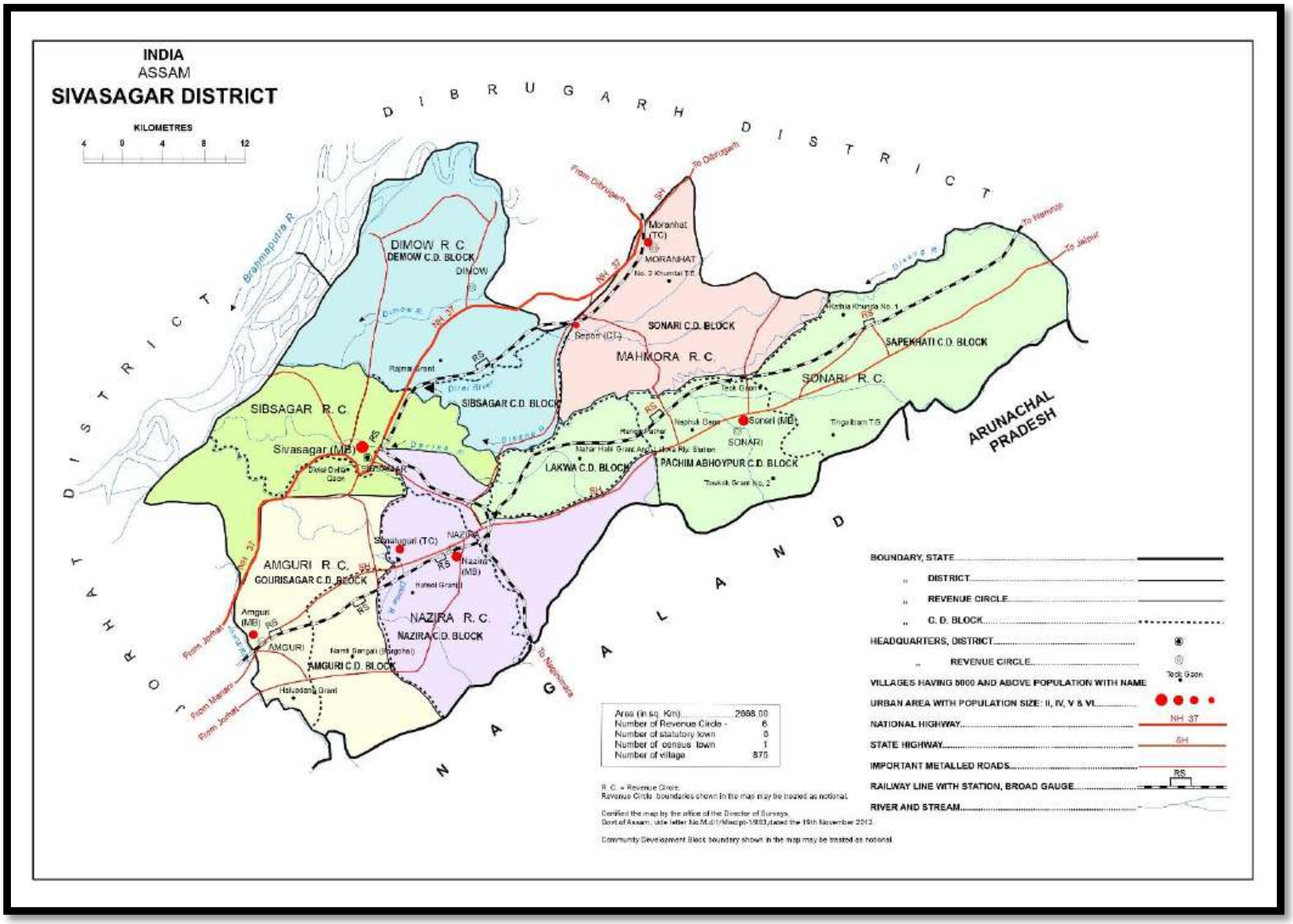
Northeast Frontier Railway network pases through the district. Distict Railway Stations are Simaluguri Railway Station, Sonari 2. Bhojo Railway Station. people are providing access to other parts of assam as well as India. The station itself is equipped with various facilities to cater to passengers, including waiting rooms, ticket counters, and refreshment options. Ongoing improvements and expansions aim to enhance passenger experience and capacity.

Charideo District in Assam, India, is not known for having its own airport. The closest airport is Mohanbari Airport,Dibrugarh (nearest) about 83 km by road from district headquarter,Sonari Regular flights connect the airport to Guwahati, Kolkata, Bangalore, Delhi, and other places. Additionally, Sivasagar is connected to Shillong and Dibrugarh. This airport is well-connected with various cities in India and some international destinations.

Existing sand mining area of the district are connected with the state highways by blacktop or village/link roads. However, there is a scope for development of infrastructural structure. Mining of riverbed sand in the potential areas can generate considerable revenue and can be utilized for development of road network and infrastructure of the district.

A transportation map demarcating approach road to the potential sand blocks from the nearest National Highway/ Sate Highway has been prepared and presented in Figure 27.

Figure 27: Transport Map of the District



CHAPTER 11: IN-SITU MINERALS

11.1 MINERAL RESERVE

The sediments of Tertiary Age formed a treasury of few economic mineral deposits in Assam State. Charaideo District is devoid of any kind of mineral with economic importance except building materials like boulders, pebbles, gravels, sand and silt. Brick Earth or Ordinary Earth is also present in this district as in-situ mineral. Ordinary Earth is used for filling and levelling purposes in construction or embankment, roads, railway or buildings. Brick Earth is also present in this district for manufacturing the bricks. The ideal brick earth has a good balance of clay, silt, and sand. It needs to be able to hold its shape when molded and withstand high temperatures during the firing process. In many areas, especially where brickmaking is a traditional industry, brick earth is often sourced from local deposits. coal, limestone also found in Charideo district. No such stone-quarry is present in this district. Therefore, we have identified some area for excavation of earth. The details of these areas are given in the **Annexure-V**.***(Source:*** *dgm.assam.gov.in, Government of Assam Mines & Minerals Directorate of Geology & Mining.)*

Mineral resources of the district are explained below.

Coal: Coal deposit Found in Bimalapur area in Charaideo district.

CHAPTER 12: REMEDIAL MEASURE TO MITIGATE THE IMPACT OF MINING

12.1 Environment Sensitivity

Charaideo district represents a unique geo-environmental setup. The district consists of five reserve forests i.e, Dilli Forest Reserve, Abhoypur Forest reserve, Sapekhati Forest reserve, Diroi Forest reserve, & Chala Forest Reserve. Those forest reserves are rich in biodiversity including various rare and flora and fauna. As human population increases, forests are being depleted for the extension of agricultural lands, introduction of new settlements, roadways etc. the Government of Assam has complied several legal frameworks to protect the reserve forests and other eco-sensitive zones from all sorts of forest degradation including encroachment, illegal felling, lopping, grazing, illegal collection of NTFP, illegal clearance of forests for coal mining, illegal removal of minor minerals etc.

Due to unprecedented growth of population during the last few decades, nature has started reacting sharply to the accumulated human guilt. Soil erosion and its conservation play an important role. The land use practices play the most important role in determining the stability factors in respect of landslide hazards.

12.2 Sand and Stone mining Impact

Another serious environmental problem around the globe in recent years is of sand and gravel mining. Sand mining is a process of extraction of sand from an open pit, river bed, sea beaches, ocean floor, river banks, deltas and island dunes. The extracted sand could be utilized for various types of manufacturing, such as concrete used in the construction of building and other structures. The sand can also be used as an abrasive. The demand for sand will increase with population growth and urbanization. The high demand of sand has led to unsustainable sand mining process resulting in illegal mining.

Although most jurisdictions have legal limit on the location and volume of sand that can be mined, illegal sand extraction is taking place in many parts of the country due to rapid urbanization and industrialization.

Removal or extraction of too much sand from rivers leads to erosion of river banks. Deltas can recede due to sand mining. These destructive effects of sand mining ultimately result in loss of fertile land and property. It also destabilizes the ground and causes failure of engineering structures.

In-stream mining directly alters the channel geometry and bed elevation. Removing sediment from the channel disrupts the pre-existing balance between sediment supply and transporting capacity, typically inducing incision upstream and downstream of the extraction site. The resultant incision alters the frequency of floodplain inundation along the river courses, lowers valley floor water table and frequently leads to destruction of bridges and channelization structures.

In Charaideo district any minor minerals mining operation would be done under strict supervision of forest officer following all rules and regulations stipulated in Assam Minor Mineral Concession Rules to avoid any environmental and ecosystem degradation.

12.3 Remedial measure

12.3.1. Sustainable Mining Practices:

- The depth mining in riverbed shall not exceed 3 meter or base flow level whichever is less, provided that where the Joint Inspection Committee certifies about excessive deposit or over accumulation of mineral in certain reaches requiring channelization, it can go above 3 meters.

- Mining shall be done in layers of 1 meter depth to avoid ponding effect and after first layer is excavated, the process will be repeated for the next layers.

- No stream should be diverted for the purpose of sand mining. No natural water course and/ or water resources are obstructed due to mining operations.

- No blasting shall be resorted to in river mining and without permission at any other place.

12.3.2 Monitoring the Mining of Mineral and its Transportation:

- For each mining lease site, the access should be controlled in a way that vehicles carrying mineral from that area are tracked and accounted for.

- There should be regular monitoring of the mining activities in the State to ensure effective compliance of stipulated EC conditions and of the provisions under the Minor Mineral Concessions Rules framed by the State Government.

12.3.3 Noise Management:

- Noise arising out of mining and processing shall be abated and controlled at source to keep within permissible limit.

- Restricted sand mining operation has to be carried out between 6 am and 7 pm.

12.3.4 Air Pollution and Dust Management:

- The pollution due to transportation load on the environment will be effectively controlled and water sprinkling will also be done regularly.

- Air pollution due to dust, exhaust emission or fumes during mining and processing phase should be controlled and kept in permissible limits specified under environmental laws.

- The mineral transportation shall be carried out through covered trucks only and the vehicles carrying the mineral shall not be overloaded. Wheel washing facility should be installed and used.

12.3.5 Bio-Diversity Protection:

- Restoration of flora affected by mining should be done immediately. Five times the number of trees destroyed by mining to be planted preferably of indigenous species. Each EC holder shall have to undertake plantation of trees over at least 20% of the total area of lease in the same plot or plots utilised for such working.

- No mining lease shall be granted in the forest area without forest clearance in accordance with the provisions of the Forest Conservation Act, 1980 and the rules made there under.
- Protection of natural home of any wild animal shall have to be ensured.
- No felling of tree near quarry is allowed. For mining lease within 10km of the National Park / Sanctuary or in Eco-Sensitive Zone of the Protected Area, recommendation of Standing Committee of National Board of Wild Life (NBWL) has to be obtained as per the Hon'ble Supreme Court order in I.A. No. 460 of 2004.
- Spring sources should not be affected due to mining activities. Necessary protection measures are to be incorporated.

12.3.6. Management of Instability and Erosion:

- Removal, stacking and utilization of top soil should be ensured during mining. Where top soil cannot be used concurrently, it shall be stored separately for future use keeping in view that the bacterial organism should not die and should be spread nearby area.
- The EC should stipulate conditions for adequate steps to check soil erosion and control debris flow etc. by constructing engineering structures.
- Use of oversize material to control erosion and movement of sediments.
- No overhangs shall be allowed to be formed due to mining and mining shall not be allowed in area where subsidence of rocks is likely to occur due to steep angle of slope.
- No extraction of stone / boulder / sand in landslide prone areas.
- Controlled clearance of riparian vegetation to be undertaken.

12.3.7. Waste Management:

- Site clearance and tidiness is very much needed to have less visual impact of mining**.**
- Dumping of waste shall be done in earmarked places as approved in Mining Plan.
- Rubbish burial shall not be done in the rivers.

12.3.8. Pollution Prevention:

- Take all possible precautions for the protection of environment and control of pollution.
- Effluent discharge should be kept to the minimum and it should meet the standards prescribed.

12.3.9. Protection of Infrastructure:

- Mining activities shall not be done for mine lease where mining can cause danger to site of flood protection works, places of cultural, religious, historical, and archaeological importance.

- For carrying out mining in proximity to any bridge or embankment, appropriate safety zone should be worked out on case-to-case basis, taking into account the structural parameters, location aspects and flow rate, and no mining should be carried out in the safety zone so worked out.

Mining shall not be undertaken in a mining lease located in 300-500 meter of bridge, 300 meter upstream and downstream of water supply / irrigation scheme, 100 meters from the edge of National Highway and railway line, 50 meters from a reservoir, canal or building, 25 meters from the edge of State Highway and 10 meters from the edge of other roads except on special exemption by the Sub-Divisional level Joint Inspection Committee.

CHAPTER 13: SUGGESTED RECLAMATION PLAN FOR ALREADY MINED OUT AREAS

As per statute all mines/quarries are to be properly reclaimed before final closure of the mine. Reclamation plans should include:

1. Baseline survey of river cross section. The study of cross section is basis for delineating channel form. Cross-sections must be surveyed between two monumented endpoints set on the river banks, and elevations should be referenced based on benchmark set in the area;

2. The proposed mining cross-section data should be plotted over the baseline data to illustrate the vertical extent of the proposed excavation;

3. The cross-section of the replenished bar should be the same as the baseline data. This illustrates that the bar elevation after the bar is replenished will be the same as the bar before extraction;

4. A planimetric map showing the aerial extent of the excavation and extent of the riparian buffers;

5. Planting plan developed by a plant ecologist familiar with the flora of the river for any areas such as roads that need to be restored;

6. Each EC holder shall have to undertake plantation of trees over at least 20% of the total area of the plot or plots of land as subject to such working in accordance with a plan approved by the concerned Divisional Forest Officer holding jurisdiction, provided further the competent authority i.e., The Divisional Forest Officer may fix up norms for plantation of trees in a particular area regarding choice of species, spacing, nos of trees and maintenance etc.

7. A monitoring plan has to establish.

CHAPTER 14: RISK ASSESSMENT & DISASTER MANAGEMENT PLAN

Risk analysis is the systematic study of risks encountered during various stages of mining operation. Risk analysis seek to identify the risks involved in mining operations, to understand how and when they arise, and estimate the impact (financial or otherwise) of adverse outcomes. The sand mining operation in the district is mainly done manually.

14.1. Identification of risk due to river sand mining

There is no land degradation due to mining activities as mining is done only on river bed dry surface. There will be no OB or waste generation as the sand is exposed in the river bed and is completely saleable. There will be neither any stacking of soil nor creation of OB dumps. The mining activity will be carried out up to a maximum depth of 3m below the surface level. So, there is no chance of slope failure, bench failure in the mines. However, there are some identified risks in the mining activity which are as follows:

1. Accident during sand loading and transportation
2. Inundation/ Flooding
3. Quick Sand Condition

14.2. Mitigation measures

14.2.1. Measures to prevent accidents during loading and transportation:

- ❖ During the loading, trucks should be brought to a lower level so that the loading operation suits the ergonomic condition of the workers.
- ❖ The workers will be provided with gloves and safety shoes during loading.
- ❖ Opening of the side covers of the truck should be done carefully and with warning to prevent injury to the loaders.
- ❖ Mining operations will be done during daylight only.
- ❖ The truck will be covered with tarpaulin and maintained to prevent any spillage.
- ❖ To avoid danger while reversing the trackless vehicles especially at the embankment and tipping points, all areas for reversing of lorries should be made man free as far as possible.
- ❖ All transportation within the main working will be carried out directly under the supervision and control of the management.
- ❖ Overloading should not be permitted and the maximum permissible speed limit should be ensured.

- There will be regular maintenance of the trucks and the drivers will have valid driving license

14.2.2. Measures to prevent incidents during Inundation/ Flooding:

- To minimize the risk of flooding/ inundation following measures should be under taken:
- Mining will be completely closed during the monsoon months.
- Proper weather information, particularly on rain should be kept during the operational period of mines so that precautionary measures will be undertaken.

14.2.3. Measures for mitigation to quick sand condition:

- Quicksand zone and deep-water zone will be clearly demarcated and all the mine workers will be made aware of the location.
- Mining will be done strictly as per the approved mining plan.

14.3. Disaster Management Plan

As the depth of mining will be maximum of 3m below the surface level considering local condition, the risk related to mining activity is much less. The mining operation will be carried out under the supervision of experienced and qualified Mines Manager having Certificate of Competency to manage the mines granted by DGMS. All the provisions of Mines Act 1952, MMR 1961 and Mines Rules 1955 and other law applicable to mine will strictly be complied. During heavy rainfall and during the monsoon season the mining activities will be closed. Proper coordination with Irrigation Department should be maintained so that at the time of releasing water, if any, from the dam suitable warning/information is given in advance. Special attention and requisite precautions shall be taken while working in areas of geological weakness like existence of slip, fault etc. The mining site will be supplied with first aid facilities and the entire mines worker will have access to that.

CHAPTER 15: CONCLUSION & RECOMMENDATIONS

15.1 CONCLUSION

Sand mining or River Bed Minerals mining (used here as a generic term that includes mining of any riverine aggregates regardless of particle size) is a global activity that is receiving increasing media attention due to perceived negative environmental and social impacts. As calls grow for stronger regulation of mining, there is a need to understand the scientific evidence to support effective management. This paper summarizes the results of a structured literature review addressing the question, the review found that most investigations have focused on temperate rivers where sand or river bed mineral mining occurred historically but has now ceased. Channel incision was the most common physical impact identified; other physical responses, including habitat disturbance, alteration of riparian zones, and changes to downstream sediment transport, were highly variable and dependent on river characteristics. Ecosystem attributes affected included macro invertebrate drift, fish movements, species abundance and community structures, and food web dynamics. Studies often inferred impacts on populations, but supporting data were scarce. Limited evidence suggests that rivers can sustain extraction if volumes (weight) are within the natural sediment load variability. Significantly, the countries and rivers for which there is science-based evidence related to sand or river bed mineral mining are not those where extensive sand mining or gravel, pebbles, boulder extraction is currently reported. The lack of scientific and systematic studies of mining in these countries prevents accurate quantification of mined volumes (weight) or the type, extent, and magnitude of any impacts. Additional research into how river bed mining is affecting ecosystem services, impacting biodiversity and particularly threatened species, and how mining impacts interact with other activities or threats is urgently required.

The rapid rise in urbanization and construction of large-scale infrastructure projects are driving increasing demands for construction materials globally. United Nations Environment Programme (UNEP; 2014) estimated that between 32 and 50 billion tonnes of sand and gravel are extracted globally each year with demand increasing, especially in developing countries (Schandl et al., 2016). Rivers are a major source of sand and gravel for numerous reasons: cities tend to be located near rivers so transport costs are low; river energy grinds rocks into gravels and sands, thus eliminating the cost of mining, grinding, and sorting rocks; and the material produced by rivers tends to consist of resilient minerals of angular shape that are preferred for construction (whereas wind-blown deposits in deserts are rounder and less suitable. Sand mining or river bed minerals mining activities are one of many recognized pressures affecting riverine ecosystems, where biodiversity is already in rapid decline (World Wildlife Fund, 2018). Increasingly, there are media reports about the negative environmental and social impacts of river bed mining, and as calls grow for stronger regulation of mining (Schandl et al., 2016), there is a need to understand the scientific evidence of mining impacts to underpin management.

Impacts of sand mining or river bed mineral mining on rivers may be two types such as direct or indirect. Direct impacts are those in which the extraction of material is directly responsible for the ecosystem impact, such as due to the removal of flood plains habitat. Indirect impacts are related to ecosystem changes that are propagated through the system due to physical changes in the river system resulting from sand extraction. For example, the removal of material from a river can alter the channel, river hydraulics, or sediment budget which in turn can alter the distribution of habitats and ecosystem functioning. These types of impacts can be difficult to attribute to river bed mining, as they may require long time frames to emerge, and other interventions can result in similar changes. The situation is further complicated by the existence of geomorphic thresholds in river systems (Schumm, 1979). Alterations linked to removal of sand, gravel, pebbles, boulder from rivers may not be gradual and/or linear, and only limited changes may be observed for an extended period, but once a threshold is reached, change may become rapid and irreversible. Whether the impacts of sand or river bed mineral mining are positive, neutral, or negative depends on the situation and perceptions of different stakeholders.

During the preparation of the present report prominent rivers/ streams has been studied in detail. These mineral concessions shall also reduce demand load and will be helpful to minimize illegal extraction of minerals, failure of which may result in to illegal mining at odd hours and shall be haphazard and more detrimental to the local ecology. Irrespective of it following geo-scientific considerations are also suggested to be taken into account during the river bed mining in a particular area:

1. Abandoned stream channels or terrace and inactive floodplains may be preferred rather than active channels and their deltas and floodplains.

2. Stream should not be diverted to form inactive channel.

3. Mining below subterranean water level should be avoided as a safeguard against environmental contamination and over exploitation of resources.

4. Mining area should be demarcated on the ground with Pucca pillars so as to avoid illegal unscientific mining.

15.2 Recommendation:

1. The mining lease distribution for the district must be carried out by involving a district level committee constituted with inter-disciplinary members of various departments including irrigation and waterways, DL&LRO, forest, biodiversity, wetland management, SWID or any other relevant department which the district authority may find suitable to include.

2. While recommending for Mining Leases, the District Level Committee should ensure the protection of Biodiversity Zones as recorded by relevant Government Agenesis from time to time.

3. It is recommended to have a periodical review along with primary data collection during pre- and post-monsoon periods to record the seasonal variance of the sedimentation rate on annual basis and update replenishment rate of the district.

4. Efforts should be given to restrict distribution of mining leases along the confluence zone of the rivers where rich aquatic habitats are reported.

CHAPTER 16: REFERENCES

1) Divisional Forest Officer, Charaideo District

2) Census Report of Charaideo district.

3) waterresources.assam.gov.in, Government of Assam Water Resources.

4) National Informatics Centre

5) Website of Indian Meteorological Department, Govt. of India

6) Vulnerability Atlas of India, Assam

7) https://assam.gov.in/

8) https://weatherandclimate.com

9) District Agriculture Office.

10) Govt. of Assam Land Utilisation Statistics(2020-21)

11) Indian Meteorological Department

12) charaideo.assam.gov.in

13) Ground Water Information Booklet Sibsagar District, Assam

14) CGWB (AAP2016-17), Aquifer Map and Management Plan Sivsagar District, Assam.

15) dgm.assam.gov.in, Government of Assam Mines & Minerals Directorate of Geology & Mining.

16) pwdroads.assam.gov.in, Government of Assam Public Works (Roads)

17) Source: GSI Miscellaneous Publication No. 30 Part IV Vol 2 (i) Assam. (2009)

18) M/s Oilmax Energy Private Limited, Environmental Impact Assessment Report for Proposed Development Drilling wells and Testing of Hydrocarbons, EPS & Laying of Pipeline in Charaideo Block in Charaideo District, Assam.

19) Nath Sarma J. N., Sharma S., December 2013; Drainage Analysis in a Part of the Brahmaputra Valley in Sivasagar District, Assam, India, to Detect the Role of Neotectonic Activity.; Journal of the Indian Society of Remote Sensing.

20) VIMTA Labs Limited, Hyderabad.; Environmental Impact Assessment Report for Proposed Exploratory Drilling of 10 wells at Rudrasagar, Geleki, Lakwa, Namti, Mekeypore-Santak-Nazira PML Areas at Sivasagar District, Assam.

21) Baruah H, Lahkar A. D., Bhagabati B., Kar R., Das P.K., (2017).; Geochemistry of Tikak Parbat Sandstones and Tipam Sandstones Occurring in and around Dilli Area, Sivasagar District, Assam, India.; Open Journal of Geology.

22) National Bureau of Soil Survey & Land Use Planning (Indian Council of Agricultural Research) Nagpur - 440 033, Maharashtra, India. Soil Survey Report of Sibsagar District Assam.

ANNEXURE – I

- **Details of Sand / M – Sand Source**

  a) **Rivers,**

  b) **De-siltation location: (Lakes/Ponds/Dams etc.)**

  c) **Patta Lands/khatedari Land**

  d) **M-Sand Plants**

a) Rivers:

Sl. No	River Name / M-Sand plant	Total stretch of River (in Km)	Type Of River
1	Desang	0.65	Perennial
2	Dilli	3.95	Perennial

b) List of De-siltation location (Lake, Pond, Dams, River)

Name	Maintain/Controlled by Sate Govt./PSU etc.	Location	District	Lake/Pond/ Dams/River/Canal	Tehsil	Village	Size (Ha)	Existing /Proposed
NA								

c) List of Patta Lands / Khatedari land

Owner	Area Kanal / Nala / Tilla	GPS Coordinates	Material / Forest Produce/ Mineral	District	Tehsil	Village	Agricultural Land (Yes / No)
NA							

d) M-Sand plants with location:

Sl. No.	Plant Name	Owner	District	Tehsil	Village	Geolocation		Quantity (Tonnes /Annum)
						Latitude	Longitude	
NA								

ANNEXURE – II

- **List of Potential Mining Leases (existing)**
  - **Rivers**
  - **Patta Lands/Khatedari Land: (existing)**
  - **De-Siltation Location: (Lakes/Ponds/Dams etc.) (existing)**
  - **M-Sand Plants: (existing)**

➢ **List of existing mining zones of the district with location, area, period for each minor mineral (River Bed)**

Sl. No.	River Details	Name of the mines or Desilting sites	Area (Ha)	Geolocation		Distance in (km) from PA/BR/WC	Distance from Forest Area (in km)	Mining Leases within 500 meters (if yes cluster area)	Production as per EC (MT)	Mineral to be mined (Sand/ Bajri/RBM etc)	Existing / Proposed
				Latitude	Longitude						
1	Desang River	Desang River Mining Permit Area, I (Bhojo)	2.2	27° 4' 18.0" N 27° 4' 8.02" N	95°1'53.49" E 95°1'50.57" E	40.30Km	10.0 Km	No	20000	Sand	Existing
2	Desang River	Desang River Mining Permit Area, H (Sapekhati)	1.25	27°8' 5.10" N 27°8' 10.40" N	95° 9'50.90" E 95° 9'56.50" E	19.45km (DPNP)	0.10 Km	No	20000	Sand	Existing
3	Dilli River	Dilli River Stone Mining Permit Area, A(VB)	3.2	27°8'47.60"N 27°9'09.00"N	95°21'50.60"E 95°21' 38.20"E	0.67km (DPNP)	0.70 Km	No	20000	RBM	Existing
4	Dilli River	Dilli River Stone Mining Permit Area, B(VA)	3.375	27° 9' 04.19" N 27° 9'24.94"N	95° 21' 43.33" E 95° 21' 25.87" E	1.10km (DPNP)	1.48 Km	No	20000	RBM	Existing
5	Dilli River	Dilli River Stone Mining Permit Area, C(II A)	2.36	27° 9' 44.40" N 27° 9' 27.20" N	95° 21'28.20"E 95° 21' 25.10" E	1.47km (DPNP)	2.55 Km	No	20000	RBM	Existing
6	Dilli River	Dilli River Stone Mining Permit Area, D(II B ii)	3.0	27° 10' 09.50"N 27° 9' 46.30"N	95° 21'21.10" E 95° 21'28.20" E	1.51km (DPNP)	3.35 Km	No	20000	RBM	Existing

7	Dilli River	Dilli River Stone Mining Permit Area, F(III)	3.2	27° 10' 17.50" N 27° 10'49.20" N	95° 20' 49.70" E 95° 20' 38.00" E	2.79km (DPNP)	3.91 Km	No	20000	RBM	Existing
8	Deshang River	Deshangpani	0.51	27° 2'47.61''N 27° 2'47.97''N 27° 2'47.05''N 27° 2'46.05''N	94°54'49.06"E 94°54'54.10"E 94°54'54.07"E 94°54'49.73"E	29(Panide hing Bird Sanctuary	3 (Sola RF)	No	2000-2500 (Approx.)	Sand	Existing
9	Desang River	Rangagarah	0.40	27° 2'17.60"N 27° 2'18.86"N 27° 2'18.69"N 27° 2'16.92"N	94°52'8.26"E 94°52'10.47"E 94°52'11.59"E 94°52'13.23"E	24.6(Pani dehing Bird Sanctuary	5 (Sola RF)	No	2000 (Approx.)	Silt	Existing
10	Desang River	Chengkolighat	0.50	27° 2'14.44"N 27° 2'17.31"N 27° 2'20.74"N 27° 2'14.92"N	94°52'49.61"E 94°52'49.33"E 94°52'51.75"E 94°52'50.43"E	25.5(Pani dehing Bird Sanctuary	4 (Sola RF)	No	2500 (Approx.)	Sand	Existing
11	Desang River	Kanibeel	0.71	27° 2'42.79"N 27° 2'44.89"N 27° 2'44.66"N 27° 2'41.07"N	94°53'4.42"E 94°53'7.25"E 94°53'10.16"E 94°53'4.39"E	26(Panide hing Bird Sanctuary	3.5 (Sola RF)	No	3000 (Approx.)	Silt	Existing
12	Desang River	Deshangpani Grazing	0.41	27° 2'29.17''N 27° 2'27.33''N 27° 2'23.10"N 27° 2'23.15"N	94°55'31.17"E 94°55'31.56"E 94°55'29.76"E 94°55'29.00"E	30(Panide hing Bird Sanctuary	2 (Sola RF)	No	2000 (Approx.)	Silt	Existing
13	Desang River	Suffry Mohan Ghat	0.52	27° 2'27.17"N 27° 2'23.03"N 27° 2'22.42"N 27° 2'26.50"N	94°54'19.32"E 94°54'22.04"E 94°54'21.24"E 94°54'18.06"E	27(Panide hing Bird Sanctuary	1.7 (Sola RF)	No	2500 (Approx.)	Silt	Existing

14	Desang River	Atal Pathar	1.0	27° 8' 26.88"N 27° 8' 26.30"N 27° 8' 18.43"N 27° 8' 17.93"N	95° 10' 36.96"E 95° 10' 36.73"E 95° 10' 28.63"E 95° 10' 28.15"E	18.35 (DPNP)	0.1 (Sapekhati RF)	No	4500 (Approx)	Sand	Existing
15	Desang River	Dilli bari	0.38	27° 9' 41.97"N 27° 9' 42.32"N 27° 9' 45.55"N 27° 9' 44.99"N	95° 11' 11.57"E 95° 11' 12.00"E 95° 11' 05.99"E 95° 11' 05.82"E	17.68 (DPNP)	0.2 (Sapekhati RF)	No	2000 (Approx)	Sand	Existing
16	Desang River	Pachim Nalbari	0.32	27° 9' 54.44"N 27° 9' 53.80"N 27° 9' 56.95"N 27° 9' 56.38"N	95° 13' 11.50"E 95° 13' 11.75"E 95° 13' 16.83"E 95° 13' 16.94"E	14.46 (DPNP)	0.2 (Sapekhati RF)	No	2000 (Approx)	Sand	Existing

b) List of Patta Lands / Khatedari land

Owner	Sl. No	Area (Location)	District	Material Forest Produce Mineral	Village	Total Mineral to be mined	Existing/ Proposed
Sri Ripon Handique	1	Sonari	Charaideo	P P Land Brick Earth	Sonari	300 0	Existing
Md. Babul Ali	2	Ranapathar	Charaideo		Ranapathar	3000	Existing
Sri Ratan Gupta	3	Ranapathar	Charaideo		Ranapathar	3000	Existing
Sri Rishee Raj Thakur	4	Ranapathar	Charaideo		Ranapathar	3000	Existing
Sri Horen Gohain	5	Moran	Charaideo		Moran	3000	Existing
Md. Arif Ali	6	Nimonagh or	Charaideo		Nimonagho r	3000	Existing
Sri Reju Chetia	7	Nimonagh or	Charaideo		Nimonagho r	3000	Existing
Sri Pallab Jyoti Dutta	8	Naphuk	Charaideo		Naphuk	3000	Existing
Sri Bapon Dey	9	Hingoritali	Charaideo		Hingoritali	3000	Existing
Sri Prodip Lekharu	10	Sepon	Charaideo		Sepon	3000	Existing
Sri Durna Changmai	11	Kachomari	Charaideo		Kachomari	3000	Existing
Sri Krity Gogoi	12	Lakuwa	Charaideo		Lakuwa	3000	Existing
Sri Subash Tibrwal	13	Moran	Charaideo		Moran	3000	Existing
	14	Panbari	Charaideo	P P Land Stone	Uttar Sumdar	10000	Existing

c) List of De-siltation location (Lake, Pond, Dams, and River)

Name	Maintain/Controlled by Sate Govt./PSU etc.	Location	District	Lake/Pond/Dams/River/Canal	Tehsil	Village	Size (Ha)	Existing /Proposed
NA								

d) M-Sand plants with location

Sl. No.	Plant Name	Owner	District	Tehsil	Village	Geolocation		Quantity (Tonnes /Annum)
						Latitude	Longitude	
NA								

ANNEXURE – III

➢ list of Cluster and Contiguous Clusters

- **Clusters:**
- **Contiguous Clusters:**

- **Cluster details**

River Name	Cluster No.	Lease No.	Location (Riverbed/Patta Land)	Village	Area (in Ha)	Total Excavation (Ton)	Total Mineral Excavation (Ton)
NA							

- **Contiguous Cluster details**

River Name	Contiguous Cluster No.	Cluster No.	Number of leases in the cluster	Location (Riverbed/Patta Land)	Distance between clusters	Village	Area of Cluster (Ha)	Total Mineral Excavation (Ton)
NA								

ANNEXURE – IV

- **Transportation Routes for Individual leases and leases in Cluster**

➢ Transportation Routes for individual leases details:

Lease No.	Transportation Route No.	Number of tippers /days of lease	Number of tippers /days of all the lease on route	Length of the Route in Km	Type of Road (black Topped/ unpaved)	Recommendation for road (Black Topped/ unpaved)	The road will be constructed by Govt. / Lease Owner	Route Map & Location
NA								

➢ Transportation Routes for leases in Cluster details:

Cluster No.	Transportation Route No.	Number of tippers / days of cluster	Number of tippers / days of all the clusters on route	Length of Route in km	Type of Road (Black Topped / unpaved)	Recommendation for road (Black Topped / unpaved)	The road will be Constructed by Govt. / Lease Owner	Route Map & Location
NA								

ANNEXURE – V

- **Final list of Potential Mining Zones : (Proposed)**
- **Final list of Patta land: (Proposed)**
- **De-siltation Location: (Lakes/Ponds/Dams etc.)(Proposed)**
- **Final list of Sand/M – Sand Source: (Proposed)**

➢ Final List of potential Mining zones: (River Bed)

Sl. No.	Lease Details (Zone Code)	River Details	Area (In Ha)	Latitude	Longitude	Depth	Distance (In Km) From PA/BR/WC	Distance From Forest Area (In Km)	Mining Leases Within 500 meters (if Yes cluster area In Ha)	Total Excavation in (CUM/Yr) (Mine Depth max as 3m)	Mineable Reserve (cum)	Mineral to be mined (Sand/ Bajri/ RBM etc.)	Existing / Proposed
1	CRD_PRO_01	Desang River	1.43	27° 2'17.28"N 27° 2'18.80"N 27° 2'17.65"N 27° 2'16.05"N	94°52'6.17"E 94°52'5.80"E 94°52'14.93"E 94°52'14.03"E	3	No PA/BR/WC available in 500m	No forest available in 500m	No	42900	25740	SILT	Proposed
2	CRD_PRO_02	Desang River	2.19	27° 2'25.16"N 27° 2'23.58"N 27° 2'12.56"N 27° 2'11.13"N	94°52'56.20"E 94°52'53.26"E 94°52'48.55"E 94°52'50.49"E	3	No PA/BR/WC available in 500m	No forest available in 500m	No	65700	39420	SAND	Proposed
3	CRD_PRO_03	Desang River	1.52	27° 2'41.55"N 27° 2'39.98"N 27° 2'44.61"N 27° 2'45.89"N	94°53'3.29"E 94°53'3.89"E 94°53'10.84"E 94°53'10.36"E	3	No PA/BR/WC available in 500m	No forest available in 500m	No	45600	27360	SILT	Proposed
4	CRD_PRO_03A	Desang River	1.31	27° 2'45.71"N 27° 2'46.60"N 27° 2'46.62"N 27° 2'44.55"N	94°53'13.42"E 94°53'16.33"E 94°53'27.56"E 94°53'22.84"E	3	No PA/BR/WC available in 500m	No forest available in 500m	No	39300	23580	SILT	Proposed
5	CRD_PRO_03B	Desang River	2.38	27° 2'41.39"N 27° 2'41.97"N 27° 2'34.87"N 27° 2'27.45"N	94°53'35.39"E 94°53'28.86"E 94°53'19.92"E 94°53'21.24"E	3	No PA/BR/WC available in 500m	No forest available in 500m	No	71400	42840	SILT	Proposed
6	CRD_PRO_04	Desang River	1.87	27° 2'29.61"N 27° 2'30.16"N 27° 2'21.63"N 27° 2'18.12"N	94°54'15.81"E 94°54'16.79"E 94°54'23.35"E 94°54'24.06"E	3	No PA/BR/WC available in 500m	No forest available in 500m	No	56100	33660	SILT	Proposed
7	CRD_PRO_05	Desang	0.87	27° 2'47.93"N	94°54'49.02"E	3	No	No	No	26100	15660	SILT	Proposed

		River		27° 2'46.21"N 27° 2'46.92"N 27° 2'48.98"N	94°54'49.26"E 94°54'54.06"E 94°54'56.61"E		PA/BR/WC available in 500m	forest available in 500m					
8	CRD_PRO_06	Desang River	0.84	27° 2'22.01"N 27° 2'23.11"N 27° 2'28.13"N 27° 2'30.41"N	94°55'27.75"E 94°55'30.02"E 94°55'31.81"E 94°55'31.02"E	3	No PA/BR/WC available in 500m	No forest available in 500m	No	25200	15120	SILT	Proposed
9	CRD_PRO_06A	Desang River	11.4	27° 2'52.84"N 27° 2'51.23"N 27° 2'9.91"N 27° 2'9.87"N	94°55'50.04"E 94°55'50.45"E 94°56'4.74"E 94°56'3.01"E	3	No PA/BR/WC available in 500m	No forest available in 500m	No	342000	205200	SILT	Proposed
10	CRD_PRO_06B	Desang River	40.1	27° 2'16.63"N 27° 2'15.87"N 27° 3'8.18"N 27° 3'6.98"N	94°56'12.54"E 94°56'14.27"E 94°57'22.42"E 94°57'21.61"E	3	No PA/BR/WC available in 500m	No forest available in 500m	No	1203000	721800	SILT	Proposed
11	CRD_PRO_06C	Desang River	29.7	27° 3'15.74"N 27° 3'14.36"N 27° 3'45.44"N 27° 3'46.05"N	94°57'32.83"E 94°57'32.39"E 94°58'16.17"E 94°58'17.67"E	3	No PA/BR/WC available in 500m	No forest available in 500m	No	891000	534600	SILT	Proposed
12	CRD_PRO_06D	Desang River	40.6	27° 3'55.78"N 27° 3'55.55"N 27° 3'55.46"N 27° 3'54.76"N	94°58'29.58"E 94°58'31.17"E 95° 0'43.67"E 95° 0'42.35"E	3	No PA/BR/WC available in 500m	No forest available in 500m	No	1218000	730800	SILT	Proposed
13	CRD_PRO_07	Desang River	3.33	27° 4'5.38"N 27° 4'6.29"N 27° 4'17.39"N 27° 4'18.84"N	95° 1'51.12"E 95° 1'52.22"E 95° 1'56.08"E 95° 1'56.61"E	3	No PA/BR/WC available in 500m	No forest available in 500m	No	99900	59940	SAND	Proposed
14	CRD_PRO_07A	Desang River	20	27° 4'40.67"N 27° 4'39.30"N 27° 5'34.86"N 27° 5'34.54"N	95° 2'47.62"E 95° 2'48.02"E 95° 3'30.63"E 95° 3'28.81"E	3	No PA/BR/WC available in 500m	No forest available in 500m	No	600000	360000	SAND	Proposed
15	CRD_PRO_07B	Desang River	26.6	27° 5'48.16"N 27° 5'49.08"N 27° 6'14.39"N 27° 6'12.75"N	95° 3'49.96"E 95° 3'51.08"E 95° 5'26.77"E 95° 5'27.14"E	3	No PA/BR/WC available in 500m	No forest available in 500m	No	798000	478800	SAND	Proposed
16	CRD_PRO_07C	Desang River	24	27° 6'38.33"N 27° 6'39.56"N	95° 5'29.42"E 95° 5'29.59"E	3	No PA/BR/WC	No forest	No	720000	432000	SAND	Proposed

				27° 7'27.33"N 27° 7'26.92"N	95° 6'43.93"E 95° 6'45.56"E		available in 500m	available in 500m					
17	CRD_PRO_08	Desang River	2.16	27° 8'11.36"N 27° 8'10.02"N 27° 8'2.38"N 27° 8'4.54"N	95°10'1.06"E 95°10'1.36"E 95° 9'50.99"E 95° 9'49.57"E	3	No PA/BR/WC available in 500m	No forest available in 500m	No	64800	38880	SAND	Proposed
18	CRD_PRO_09	Desang River	2.46	27° 8'17.19"N 27° 8'16.35"N 27° 8'26.46"N 27° 8'27.90"N	95°10'25.97"E 95°10'26.93"E 95°10'40.15"E 95°10'40.15"E	3	No PA/BR/WC available in 500m	No forest available in 500m	No	73800	44280	SAND	Proposed
19	CRD_PRO_10	Desang River	0.82	27° 9'44.86"N 27° 9'45.85"N 27° 9'41.39"N 27° 9'40.17"N	95°11'5.73"E 95°11'6.35"E 95°11'13.34"E 95°11'13.04"E	3	No PA/BR/WC available in 500m	No forest available in 500m	No	24600	14760	SAND	Proposed
20	CRD_PRO_11	Desang River	0.88	27° 9'54.02"N 27° 9'53.31"N 27° 9'56.81"N 27° 9'57.70"N	95°13'9.69"E 95°13'9.69"E 95°13'19.36"E 95°13'18.35"E	3	No PA/BR/WC available in 500m	No forest available in 500m	No	26400	15840	SAND	Proposed
21	CRD_PRO_12	Dilli River	9.12	27°10'49.73"N 27°10'50.20"N 27°10'19.42"N 27°10'17.41"N	95°20'38.13"E 95°20'40.69"E 95°20'51.53"E 95°20'49.72"E	3	No PA/BR/WC available in 500m	No forest available in 500m	No	273600	164160	RBM	Proposed
22	CRD_PRO_13	Dilli River	24.7	27°10'9.61"N 27°10'12.74"N 27° 8'48.13"N 27° 8'47.73"N	95°21'20.94"E 95°21'23.61"E 95°21'55.30"E 95°21'51.65"E	3	No PA/BR/WC available in 500m	No forest available in 500m	No	741000	444600	RBM	Proposed
TOTAL			**248.28**							**7448400**	**4469040**		

➢ Final List of potential Mining zones: (In-Situ)

SL. No.	Zone Code	Name of the Mineral	Area of Mineralization (Ha)	Depth of Mineralization (in Meter)	Geological Reserve (cum)	Mineable Reserve (cum)	Latitude	Longitude
1	CRD_PRO_IS_01	ORDINARY EARTH	37.9	3	1137000	682200	27° 2'42.13"N 27° 2'30.01"N 27° 2'21.67"N 27° 2'29.66"N 27° 2'41.18"N	94°50'14.69"E 94°50'13.71"E 94°50'36.61"E 94°50'48.93"E 94°50'33.58"E
2	CRD_PRO_IS_02	ORDINARY EARTH	29	3	870000	522000	27° 4'51.30"N 27° 4'54.82"N 27° 4'37.06"N 27° 4'32.20"N 27° 4'34.60"N	94°50'57.33"E 94°51'7.63"E 94°51'21.48"E 94°51'17.95"E 94°51'1.99"E
3	CRD_PRO_IS_03	ORDINARY EARTH	38.3	3	1149000	689400	27° 4'8.22"N 27° 4'17.62"N 27° 4'5.80"N 27° 3'54.93"N	94°53'6.14"E 94°53'25.22"E 94°53'40.48"E 94°53'33.58"E
4	CRD_PRO_IS_04	ORDINARY EARTH	25.3	3	759000	455400	27° 3'14.97"N 27° 3'1.02"N 27° 3'21.36"N 27° 3'24.39"N	94°58'3.24"E 94°58'10.20"E 94°58'28.78"E 94°58'20.56"E
5	CRD_PRO_IS_05	ORDINARY EARTH	34	3	1020000	612000	27° 5'52.47"N 27° 5'40.41"N 27° 5'33.56"N 27° 5'36.90"N 27° 5'45.41"N	94°55'27.66"E 94°55'8.33"E 94°55'14.12"E 94°55'37.19"E 94°55'47.07"E

6	CRD_PRO_IS_06	ORDINARY EARTH	26.9	3	807000	484200	27° 5'28.28"N 27° 5'32.41"N 27° 5'11.38"N 27° 5'1.39"N	95° 1'4.16"E 95° 1'10.86"E 95° 1'26.56"E 95° 1'19.92"E
7	CRD_PRO_IS_07	ORDINARY EARTH	53.4	3	1602000	961200	27° 0'24.63"N 27° 0'12.88"N 27° 0'15.85"N 27° 0'30.68"N 27° 0'35.81"N	95° 6'7.97"E 95° 6'36.09"E 95° 6'47.96"E 95° 6'49.91"E 95° 6'41.21"E
8	CRD_PRO_IS_08	ORDINARY EARTH	26.2	3	786000	471600	27° 4'22.14"N 27° 4'30.52"N 27° 4'9.30"N 27° 4'5.23"N	95° 4'58.56"E 95° 5'15.32"E 95° 5'15.22"E 95° 5'3.32"E
9	CRD_PRO_IS_09	ORDINARY EARTH	43	3	1290000	774000	27° 6'54.99"N 27° 6'56.47"N 27° 6'17.01"N 27° 6'35.19"N	95° 2'45.44"E 95° 2'58.10"E 95° 2'49.37"E 95° 2'39.72"E
10	CRD_PRO_IS_10	ORDINARY EARTH	31	3	930000	558000	27° 7'3.90"N 27° 7'8.72"N 27° 6'53.97"N 27° 6'49.60"N	27° 7'3.90"N 95° 7'41.80"E 95° 7'40.50"E 95° 7'18.25"E
11	CRD_PRO_IS_11	ORDINARY EARTH	24.5	3	735000	441000	27° 3'21.40"N 27° 3'27.09"N 27° 3'12.50"N 27° 3'8.15"N 27° 3'7.15"N	95° 8'19.72"E 95° 8'34.17"E 95° 8'44.36"E 95° 8'39.29"E 95° 8'29.08"E
12	CRD_PRO_IS_12	ORDINARY EARTH	34.3	3	1029000	617400	27° 4'15.55"N 27° 4'1.26"N 27° 3'47.47"N 27° 3'52.81"N 27° 4'6.19"N	95°11'34.00"E 95°11'46.20"E 95°11'43.27"E 95°11'25.83"E 95°11'23.70"E

13	CRD_PRO_IS_13	ORDINARY EARTH	39.4	3	1182000	709200	27° 8'13.42"N 27° 8'5.60"N 27° 8'11.09"N 27° 8'19.77"N 27° 8'28.61"N	95°14'20.68"E 95°14'25.04"E 95°14'49.16"E 95°14'49.64"E 95°14'40.77"E
14	CRD_PRO_IS_14	ORDINARY EARTH	48.2	3	1446000	867600	27° 6'21.91"N 27° 6'19.02"N 27° 5'53.44"N 27° 5'52.23"N 27° 6'5.18"N	95°15'22.05"E 95°15'36.43"E 95°15'39.22"E 95°15'22.49"E 95°15'12.82"E
15	CRD_PRO_IS_15	ORDINARY EARTH	48	3	1440000	864000	27°10'41.26"N 27°10'44.81"N 27°10'20.75"N 27°10'25.33"N	95°15'44.90"E 95°16'15.61"E 95°16'18.66"E 95°15'52.51"E
16	CRD_PRO_IS_16	ORDINARY EARTH	19.1	3	573000	343800	27° 7'21.17"N 27° 7'29.38"N 27° 7'23.46"N 27° 7'12.59"N	95°17'44.60"E 95°17'57.42"E 95°18'8.77"E 95°17'53.25"E
17	CRD_PRO_IS_17	ORDINARY EARTH	40.5	3	1215000	729000	27° 3'45.36"N 27° 3'34.99"N 27° 3'49.36"N 27° 4'0.35"N	95°13'4.04"E 95°13'5.05"E 95°13'49.68"E 95°13'46.06"E
18	CRD_PRO_IS_18	ORDINARY EARTH	22.4	3	672000	403200	27° 0'23.76"N 27° 0'28.88"N 27° 0'10.57"N 27° 0'9.01"N	94°56'34.13"E 94°56'42.13"E 94°56'57.44"E 94°56'40.96"E
19	CRD_PRO_IS_19	ORDINARY EARTH	67.6	3	2028000	1216800	26°57'42.28"N 26°57'24.61"N 26°57'12.52"N 26°57'30.58"N	94°51'22.31"E 94°51'15.99"E 94°51'43.11"E 26°57'30.58"N
20	CRD_PRO_IS_20	ORDINARY EARTH	16.2	3	486000	291600	27° 2'56.72"N 27° 2'47.76"N	95° 1'33.69"E 95° 1'29.28"E

							27° 2'42.26"N 27° 2'45.72"N 27° 2'55.42"N	95° 1'42.99"E 95° 1'52.10"E 95° 1'42.42"E
21	CRD_PRO_IS_21	ORDINARY EARTH	44.5	3	1335000	801000	27°12'1.33"N 27°12'14.82"N 27°12'6.40"N 27°11'48.24"N 27°11'49.04"N	94°56'52.90"E 94°57'22.68"E 94°57'29.48"E 94°57'8.17"E 94°56'56.44"E
22	CRD_PRO_IS_22	ORDINARY EARTH	20	3	600000	360000	27° 9'35.22"N 27° 9'30.54"N 27° 9'11.75"N 27° 9'23.18"N	94°53'32.67"E 94°53'43.13"E 94°53'30.88"E 94°53'22.60"E
			769.7		**23091000**	**13854600**		

- **Final List of proposed Patta Lands/Khatedari land**

Owner	Sl. No.	Area (hectare)	Latitude	Longitude	District	Tehsil	Village	Khasra No	Type of Material	Total Reserve (CUM)	Total Mineral to be mined (CUM)	Existing/ Proposed
NA												

- **Final List of Proposed De-siltation location (Lake, Pond, Dams, River):**

Name	Maintain/Controlled by Sate Govt./PSU etc.	Location	Khasra No.	District	Tehsil	Village	Size (Ha)	Quantity (CUM/Year)	Existing / Proposed
NA									

- **Final List of Proposed M-Sand Plants:**

Sl. No.	Plant Name	Owner	District	Tehsil	Village	Geolocation		Quantity / Capacity (Tonnes/Annum)	Existing / proposed
						Latitude	Longitude		
NA									

ANNEXURE – VI

- **Final list of Cluster and Contiguous Clusters**

- **Cluster details (Riverbed)**

River Name	Cluster No.	Lease No.	Location (Riverbed/Patta Land)	Tehsil	Area (in Ha)	Total Excavation (CUM)	Total Mineable Mineral Excavation (CUM)
NA							

- **Contiguous Cluster details**

River Name	Contiguous Cluster No.	Cluster No.	Number of leases in the cluster	Location (Riverbed /Patta Land)	Distance between clusters	Tehsil	Area of Cluster (Ha)	Total Mineral Excavation (Ton)
NA								

- **Note: The final Cluster details shall be as per the approved mine plan and as per the environment clearance granted by the competent authority.**

ANNEXURE – VII

- **Final Transportation Routes for individual Zones and Zones in Cluster(s): (Proposed)**

➢ Transportation Routes for individual leases details (Riverbed)

Lease No.	Transportation Route No.	Number of tippers /days of lease	Number of tippers /days of all the lease on route	Length of the Route in Km	Type of Road (black Topped/ unpaved)	Recommendation for road (Black Topped/ unpaved)	The road will be constructed by Govt. / Lease Owner	Route Map & Location
NA								

➢ Transportation Routes for leases in Cluster details (Riverbed)

Cluster No.	Transportation Route No.	Number of tippers / days of cluster	Number of tippers / days of all the clusters on route	Length of Route in km	Type of Road (Black Topped / unpaved)	Recommendation for road (Black Topped / unpaved)	The road will be Constructed by Govt. / Lease Owner	Route Map & Location
NA								

- **Note: The final transportation routes shall be as per the approved mine plan and as per the environment clearance granted by the competent authority.**