केंद्रीय भूमि जल बोर्ड

जल संसाधन, नदी विकास और गंगा संरक्षण

विभाग, जल शक्ति मंत्रालय

भारत सरकार

Central Ground Water Board

Department of Water Resources, River Development and Ganga Rejuvenation,

Ministry of Jal Shakti

Government of India

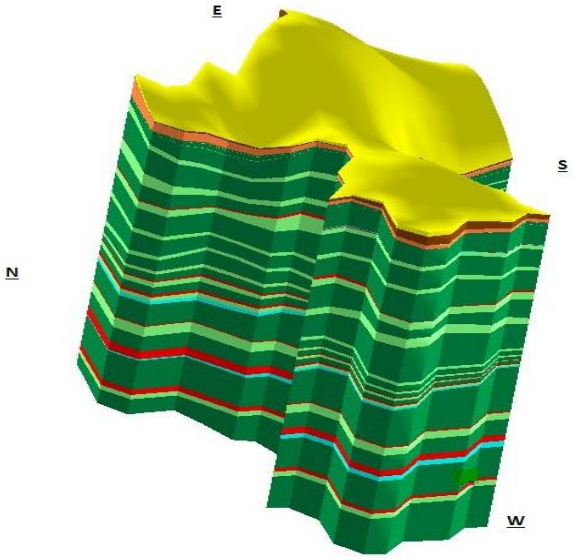
AQUIFER MAPPING AND MANAGEMENT OF GROUND WATER RESOURCES

SEHORE DISTRICT, MADHYA PRADESH

उत्तर मध्य क्षेत्र, भोपाल

North Central Region, Bhopal

AQUIFER MAPPING AND GROUND WATER MANAGEMENT PLAN OF SEHORE DISTRICT, MADHYA PRADESH



By

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PREFACE

Aquifer mapping can be defined as a scientific process, wherein a combination of geologic, geophysical, hydrologic, and chemical field and laboratory analyses are applied to characterize the quantity, quality, and sustainability of groundwater in aquifers. Systematic aquifer mapping is expected to improve our understanding of the geologic framework of aquifers, their hydrologic characteristics, water levels in the aquifers and how they change over time, and the occurrence of natural and anthropogenic contaminants that affect the portability of groundwater. Results of these studies will contribute significantly to resource management tools such as long-term aquifer monitoring networks and conceptual and quantitative regional ground-water-flow models used by planners, policymakers, and other stakeholders.

Under the project on National Aquifer Mapping (NAQUIM), Central Ground Water Board (CGWB) North Central Region, Bhopal has taken up Sehore district to prepare the Aquifer Maps for the entire district and formulate Aquifer Management Plan. Sehore district occupies an area of 6578 sq km, out of which the groundwater recharge worthy area is 4639.7 sq. km. and hilly area is 1938.28 sq. km. Most of the district is drained by the Narmada drainage system. The Major drainage system of this district is of Chambal. Narmada, and Betwa rivers and their tributaries. 85% of the district is mainly occupied by Deccan trap; rest by Alluvium and Vindhyan. The water level in shallow aquifer during pre-monsoon ranges from 2.7 to 18.4 mbgl and during post monsoon ranges from 1.6-11.3 mbgl. As per the Dynamic Ground Water Resource Assessment Report (2020), the annual extractable ground water resource 65187.81 ham and groundwater draft for all uses is 40400.72 ham which results in the stage of groundwater extraction being 61.98 % as a whole for the district. After successful implementation of the supply-side and demand-side management plan the stage of extraction in Sehore district is expected to improve condition of the district in terms of ground water. The interventions suggested in the report will not only have a positive impact on the groundwater regime but would also play a key role in augmenting the net cropping area and would ultimately enhance the agricultural productivity and economy of the district.

I would like to place on record my appreciation of the untiring efforts **Sh. S.K. Shrivastava, Scientist-D** for preparing the Aquifer maps and Management plan and compiling this informative report. I fondly hope that this report will serve as a valuable guide for the sustainable development of Ground Water in the Sehore block, Bhopal District, Madhya Pradesh.

Rana Chatterjee
(Regional Director)

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Chapter-1
INTRODUCTION

Central Ground Water Board has pioneered extensive groundwater studies, in all the hydrogeological terrain of the country. It has remarkably brought out comprehensive regional picture of the aquifers in terms of their water quality and yield potential. To meet the challenges of growing groundwater demand and sustainability of the resource, an effective aquifer based groundwater management in the country, through adequate and precise information on aquifers in time and space at a scale as large as possible, is the most imperative and earnestly desired. The aquifer-mapping programme demands for a multi-disciplinary, multi-institutional, innovative and modern approach to arrive at a comprehensive aquifer data base under National Aquifer Mapping Programmer.

1.1 Background of Aquifer Mapping

'Aquifer mapping' is a holistic approach for aquifer-based groundwater management. It may not be construed as aquifer geometry mapping only. In a broader perspective it can be defined as understanding the aquifers, ascertaining and establishing their quantity and quality sustainability through multi-disciplinary scientific approach integrating the techniques of geology, remote sensing, hydrogeology, geophysics, borehole drilling, hydrochemistry, hydrology, hydrometeorology, mathematical modelling, agriculture and soil science, water treatment and remediation, economics and social and environmental sciences. Out of these the Geophysical technique will help as a strong tool to identify the aquifer geometry precisely.

1.2 Scope of Study

At present a generalized picture of aquifer-dispositions and their characteristics are known from the existing hydrogeological and surface geophysical data, the borehole lithological and geophysical logs and the aquifer performance tests conducted by CGWB and other central and state agencies. But it is not enough to prepare aquifer maps because of the inadequate density of data vis-à-vis geological heterogeneities. The extrapolation and interpolation within the existing boreholes may not yield accurate information on aquifer disposition unless they are tied up further by close-grid geophysical measurements conducted in between. This has necessitated in a systematic mapping of aquifers. Further hydro-geological investigation either by geophysical technique or by exploration is proposed for the aquifer mapping. It is to provide adequate and precise subsurface information in terms of aquifer lithology and geometry leading to 3-dimensional aquifer dispositions. Also it is to establish the most appropriate technique or combination of techniques for identifying the aquifers in different hydrogeological terrains.

1.3 Objectives

The objective of applying the hydrogeological and geophysical techniques is to provide more adequate and more precise (reduced uncertainty and ambiguity) information on aquifers – shallow and deep including dry and saturated zones with their geometry at reasonable scale (1: 50,000) in the area.

The tentative depth of the hydrogeological and geophysical exploration will be 200 m in hard rock area. However, the depth of exploration may vary depending on the geological conditions and requirements. Additional exploratory wells shall be drilled for validations of aquifer parameter estimations where borehole data are not available.

The information thus generated through additional drilling of boreholes shall be used for refinement of hydrogeological data base in terms of aquifer characterization, yield capacity, chemical quality, selecting areas for artificial recharge and sustainability under varied future demand scenario leading to preparations of aquifer-management plans and recommendations to mitigate mining of aquifer.

1.4 Approach and Methodology

National Aquifer Mapping Programme basically aims at characterizing the geometry, parameters, behaviour of ground water levels and status of ground water development in various aquifer systems to facilitate Major Aquifers planning of their sustainable management. The major activities involved in this process include compilation of existing data, identification of data gaps and generation of data for filling data gaps and preparation of aquifer maps. The overall methodology of aquifer mapping is presented once the maps are prepared, plans for sustainable management of ground water resources in the aquifers mapped shall be formulated and implemented through participatory approach involving all stakeholders.

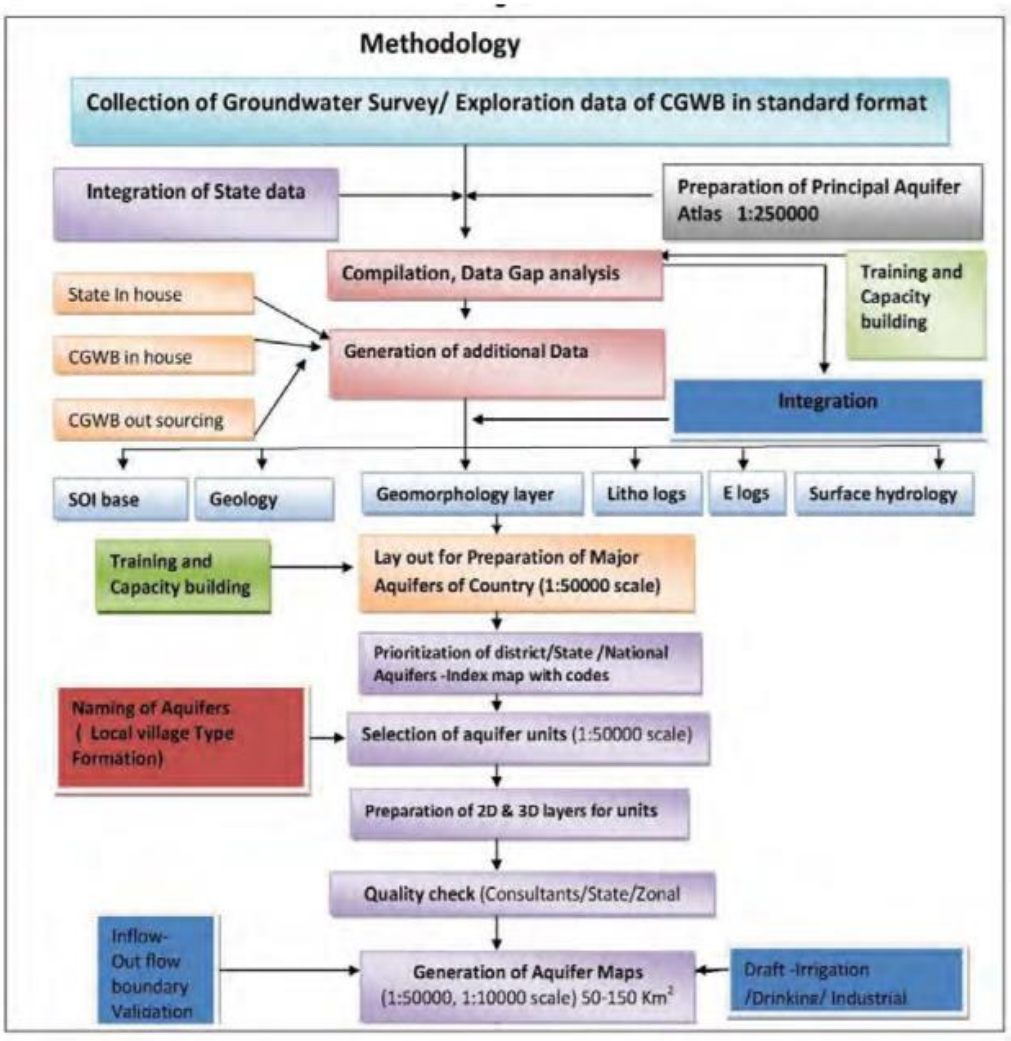

Fig:1.1: Flow Chart of Methodology

1.5 Study Area

Sehore district is lying in the central part of Madhya Pradesh. It is in Bhopal commissioner's division and is well connected by roads and railway. National Highway 67, connecting Bhopal and Dewas passes through the district. Sehore district with an area of 6578 km^2 lying between the North Latitudes 22^0 33' 30" and 23^0 40' 25" and East Longitudes 78^0 26' 00" and 78^0 02' 00" and falls under the Survey of India toposheet No. 55A, 55B and 55F. The district is encircled by Guna district in the North, Vidisha and Raisen in the east, Hoshangabad and Dewas in the South and Shajapur and Rajgarh in the west (Fig 1.2).

There are 8 tehsils and 5 blocks in the district. The block headquarters are Ashta, Sehore, Ichhawar, Budhni and Nasrullaganj. There are 1031 inhabited villages in the district (Table 1.1). As per census 2011, the total population of the district is 13,11,332.

Table1.1: Administrative Units of Sehore district

Total Blocks	Area (sq km)
Total Geographical Area (sq. km)	6578
Recharge worthy Area (sq. km)	4639.7 (70.52%)
Hilly/Forest (sq. km)	1938.2 (29.4%)

Block	Geographical Area (Sq. Km)	Recharge Area (Sq. Km)
Ashta	1442.57	1181.91
Budhni	1075.11	597.73
Ichawar	1110.85	525.05
Nasrullaganj	1365.22	888.42
Sehore	1584.25	1446.61
DISTRICT TOTAL	**6578**	**4639.72**

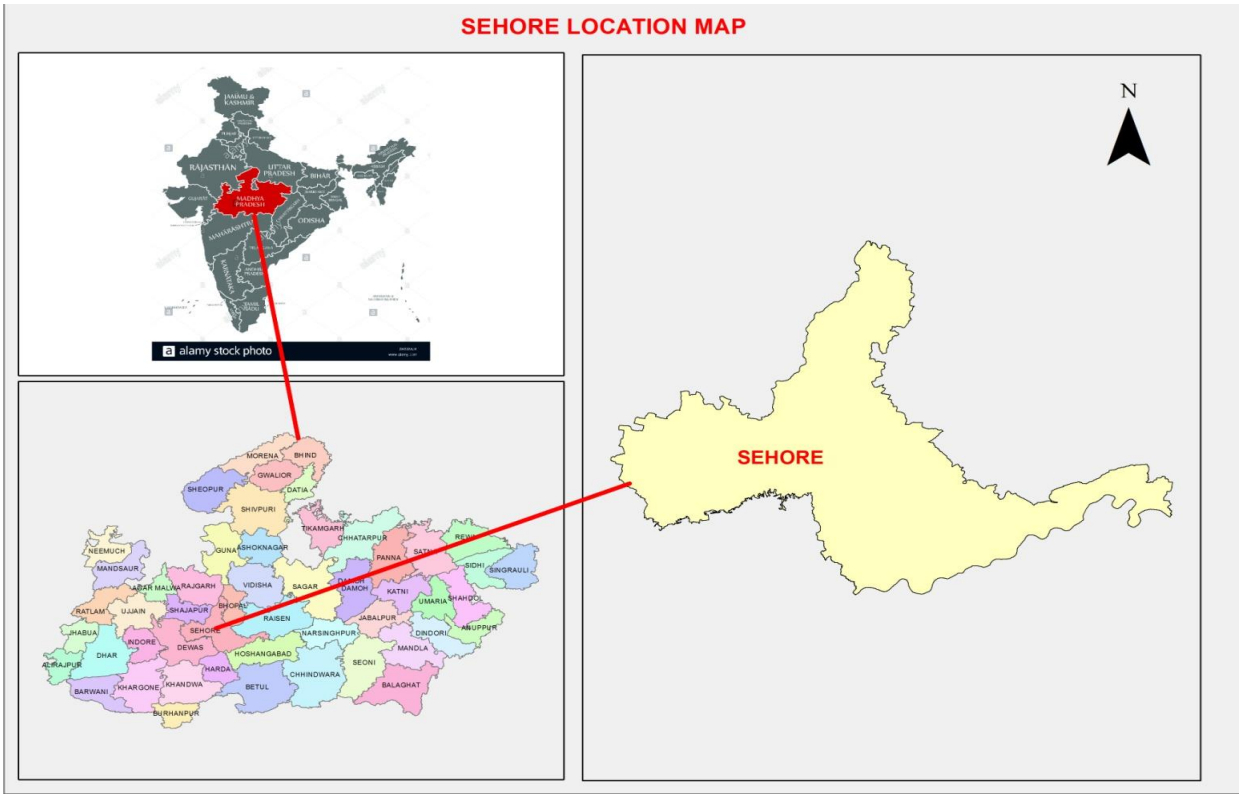

Fig 1.2: Location map of Sehore district

1.6 Rainfall and Climate

Rainfall

About 92.4% of the annual rainfall takes place during the southwest monsoon period i.e. between June to September. About 6.2% and 1.4% rainfall received during winter and summer season respectively. Hence only 7.6% of the annual rainfall takes place from October to May months. The frequency and timing of winter rains is uncertain and they are undependable under normal rainfall situation. The normal annual rainfall of the district is about 1217.7 mm, which is mostly concentrated during the month of July and August some time it extends up to end September. Average no. of rainy days is 36. Maximum rainfall intensity is found in the month of July & August. The lowest annual rainfall was recorded in the year 2018 (860.18 mm) and the highest average rainfall was recorded in the year 2019 (1753.12 mm).
The 10 year average annual rainfall is as given below in Table 1.2:

Table 1.2: Annual rainfall

S no.	Year	Annual rainfall (mm)
1	2011	1161.13
2	2012	1353.47
3	2013	1551.17
4	2014	941.59
5	2015	1217.43
6	2016	1459.85
7	2017	929.62
8	2018	860.18
9	2019	1753.12
10	2020	1363.32

Temperature

The Climate of Sehore district can be divided into four seasons. The winter season commences from end of November and lasts till the end of Feb. The period from March to about the middle of June is the hot season. The south west monsoon season from middle of June to end of September, October & end of November constitute the post monsoon or retreating monsoon season.

The January is the coldest month of the year. The average normal minimum temperature during the month is about 10.4ºC. The individual day temperature comes as low as 1 or 2ºC. From March onwards, the temperature starts rising and maximum temperature is observed during the month of May.

The average normal maximum temperature is 40.7^{0}C. The individual day temperature is as high as 45 or 46ºC. On the arrival of monsoon the weather became pleasant. In October, on the retreating of monsoon the temperature rises slightly during the day time and nights become pleasant. The average annual normal temperature of Sehore district is 31.4ºC.

Humidity

During the southwest monsoon the relative humidity are generally high exceeding about 88% in August. Humidity decreases in the post monsoon season. In the cold season it is fairly good over the district. The driest part of the year is the summer season with the humidity going down to

26% or less. The annual normal relative humidity of the district is 57%.

Wind Velocity

Winds are generally light to moderate in the district with some slight strengthening in force during the monsoon season. The wind velocity in the post monsoon or during the winter season is, in general, low as compared to Pre-monsoon or summer season. The normal average wind velocity of the district is about 8.3 Km/hr.

1.7 Physiography/DEM

Physiographically the district has been divided into three units based on the valleys formed by the major rivers i.e. Narmada basin, Chambal basin and Betwa basin.

Narmada Basin Valley

In the district the Narmada basin valley comprises an area of about 3295 sq. km. The surface water divide running between Ichhawar and Bilkishganj roughly marks the northern boundary of the basin. The northern boundary is marked by low-lying hills and or high grounds. The basin area is highly undulating with isolated hills and plains. The ground elevation ranges between 300 m and 667 m. above m.s.l. The ground slopes from north to south and east to west.

Chambal Basin Valley

The Chambal basin valley constituents an area of about 3108 sq. km. falling in the entire Ashta block and the area north of Ichhawar in the district. The hilly area high grounds occupying the eastern boundary of the district forms the surface water divide. The area along the western boundary of district, along which Parbati river flows, forms a valley. The southern boundary is also bounded by semi hilly area, high ground that forms the surface water divide. The interior area of the basin is undulating with isolated hills and elevated plains. The ground elevation in the basin varies between a minimum elevation in the basin vary between a minimum of about 455 m in the North/North west to about 545 m above m.s.l. in the South/Southwest. The land in the basin slopes from south to north in Ashta area, and from north to west in the remaining area.

Betwa Basin

A small part of the district, measuring about 175 sq. km is located in the east central part of the district forming the Betwa river basin, drained by its tributary the Kolinos nadi. The presence of elevated ground on all the three sides of the basin marks the surface water divide. The interior area of the basin is marked by undulating topography with elevated plains with very few low altitude isolated hills. The ground elevations in the area vary between about 545/550 m in the south and west and about 520 m in the east.

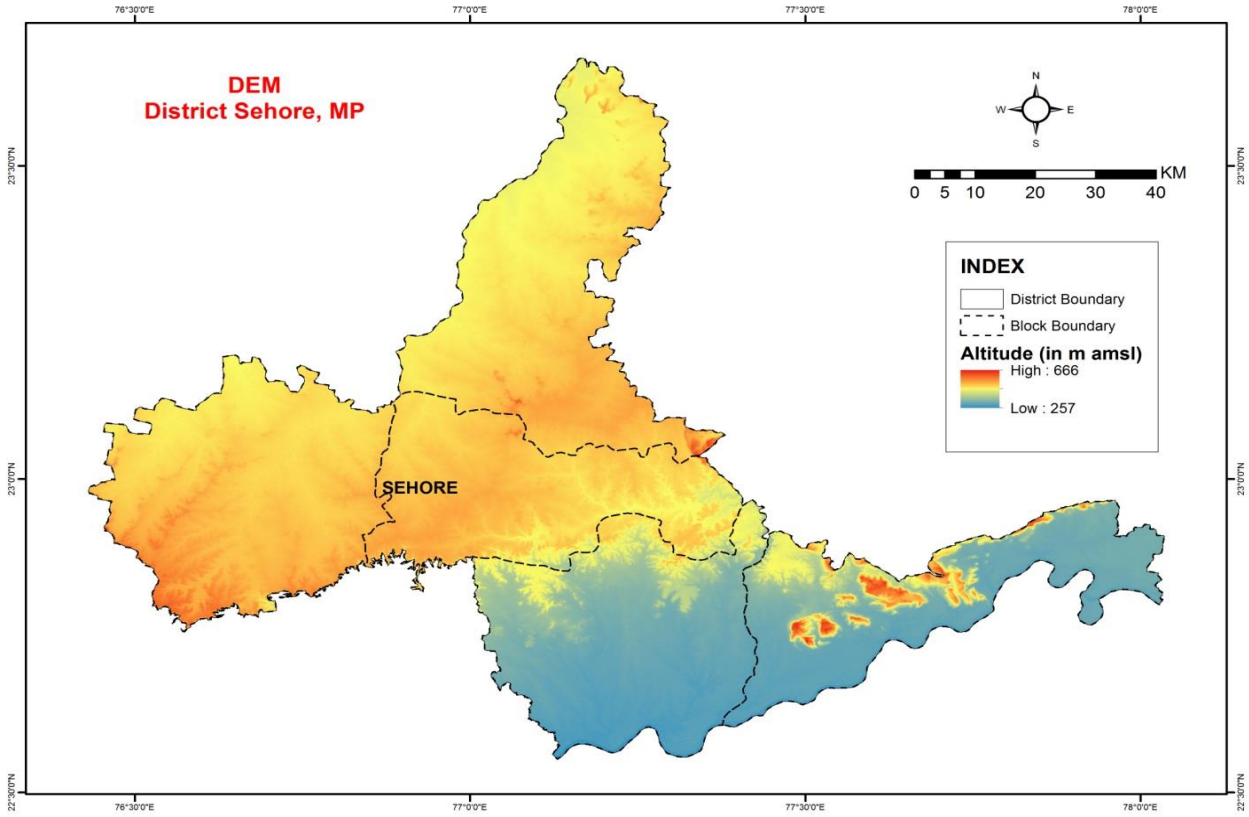

Fig 1.3: DEM map of Sehore district

1.8 Geomorphology

A hydrogeomorphic map has been prepared by M. P. Council of Science & Technology on 1:250000 scale by using visual interpretation and field checks.

Geomorphic units are classified on the basis of differential erosion and deposition of rock material. In Sehore district, 7 group of geomorphic units are distinguished which are given below:

Table 1.3: Geomorphic units of Sehore

S. No.	Map annotation	Geomorphic unit	Lithology
1	YAP	Younger Alluvial plain	Unconsolidated material consists of gravel, sand, silt & clay
2	AP	Alluvial plain	Unconsolidated material consists of gravel, sand, silt & clay
3	VF	Valley fills	Constitutes boulders, cobbles, pebbles sized sand, silt, clay sized grains
4	DBU	Basaltic upland	Composed of basalts of deccan traps
5	DPT	Dissected Deccan plateau	Composed of basalts of deccan traps
6	DP	Deccan plateau	Composed of basalts of deccan traps
7	SH (VC)	Structural hills (Vindhyan sediments)	Composed of sandstones & shales

Alluvial plain (YAP, AP & VF). The river Narmada, Chambal, Betwa& their tributaries form alluvium of recent origin over a flat to undulating surface. The constituents consists of unconsolidated materials consist of gravel, sand, silt and clay. These are good in ground water potential zones.

Deccan plateau (DP, DPT, DBU)

Deccan plateau is formed due to eruption of basaltic lava flows. Groundwater occurs in the plateau mainly in the weathered and decomposed zones and in the open spaces formed along the joints and fractures. Ground water potential in plateau is moderate.

Vindhyan Hills (VC)

These hills are composed of Vindhyan sandstone and shale of Vindhyan Super Group. Vindhyan sediments are fractured and jointed with no soil cover with moderate to steep slope. In these hills, groundwater structures are less in number and groundwater potential is moderate to poor.

1.9 Soil Cover

The district is generally covered with black cotton soils covering almost three fourths of the area. This part is occupied by Deccan Basalts. The rest part has red-yellow mixed soils derived from sandstone, shale, gneiss. The alluvial soils are found along the river courses. The higher elevations i.e. the hilly regions have a cover of murum, which is made up of small rounded pieces of weathered trap. The Vindhyans and Bijawars have a thin cover of sandy loams. The soils in granitic area are clayey. The schist has a thin capping of loam with lot of quartz grains. The alluvium is derived from hill slopes by numerous streams and watercourses.

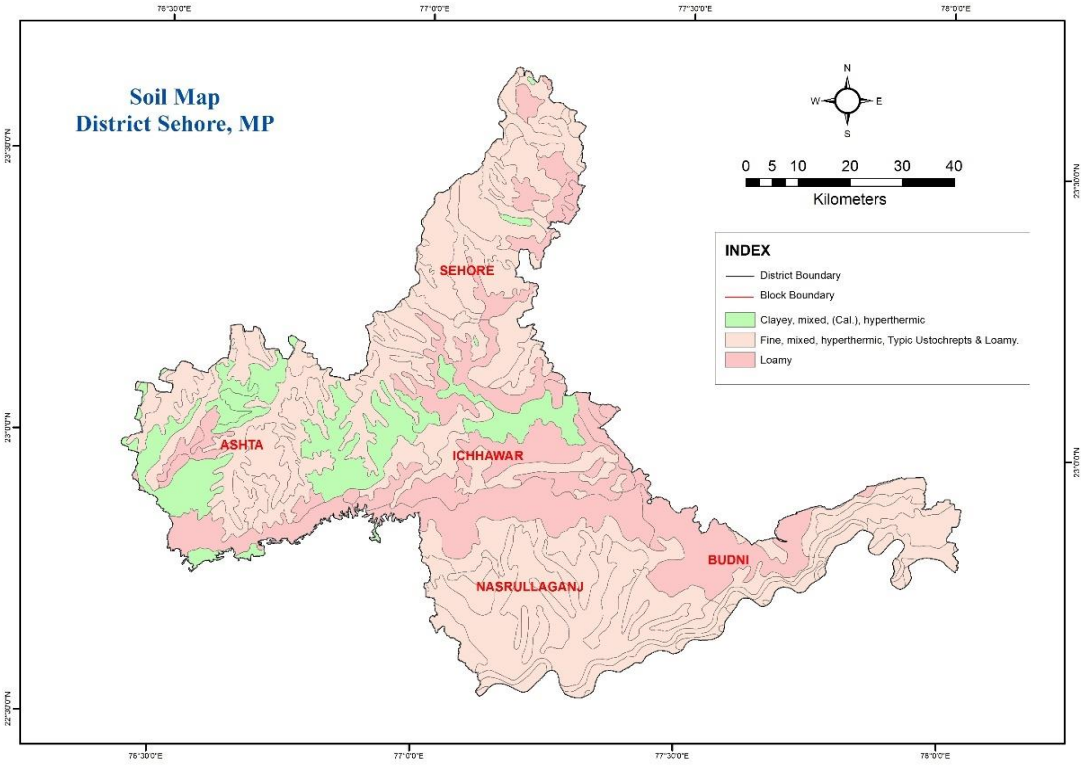

Fig.1.4: Soil map of Sehore District

1.10 Geology

Over 85% of the area is occupied by Deccan trap, about 10% by alluvium and about 5% of the area by Vindhyan formations. The generalized geological succession is given below in table 1.4 and the geological map of district is shown in Fig 1.5.

Table 1.4: General Geological succession of Sehore district

Age	Formation	Lithology
Quaternary	Alluvium	Clay, Sand, Silt, Gravel
	Laterite	Soil
Lower Eocene to Upper Creatceous	Deccan Trap	Lava flows of basalt
Pre-Cambrian	Vindhyans	Quartzitic sandstone with intercalated shales.

Vindhyan Formations

Upper Vindhyan formations comprising of sandstone shales and breccias are exposed in the northern and eastern part of the district. The small patch of the area falling in the northern part is exposed in the form of hills. It occupies an area of about 50 Sq.km and comprises of sandstones. A major part of Budhni block, except east and western parts, is occupied by Vindhyan formation and comprises of sandstone and shales. The sandstones are normally hard, Quartzitic, massive and compact. However, they are jointed at the surface level.

Deccan trap formations

Deccan trap formations occupy over 85% of the total area of the district. The general flow is characteristic of lava flows in the area are the most of the flows are of 'Aa' type in nature being disposed in a three-fold system along a vertical column. Each flow normally consists of an upper fragmentary zone, a middle massive part and an impersistent thin layer of basalt clinkers. The fragmentary top zone presents a brecciated look. It is very often highly vesicular and amygdaloidal. The vesicles are generally sub- rounded to irregular in shape. The middle part comprises of massive basalt, which is aphanitic to highly porphyritic.

Basalt clinker & horizon is impersistent and often absent. The thickness of this horizon where ever present varies between a few centimeters to about 0.50 m. This zone is analogous to top vesicular/ amygdaloidal horizons in physical characters. Variation in thickness of different flows is also evident in the area. Most of the flow contacts can be demarcated by the presence of a red bole horizon. About 12 flows of Deccan trap can be identified in the district between the altitudes 435 and 533 m above msl. In general the thickness of the individual flows range between 5 and 10m. However, the older flows seem to have more thickness compared to the younger ones as indicated by flow numbers, 0 and 1.

Alluvium

Recent to sub-recent alluvial formations of significant extension occur in the southeastern part of the district falling in Budhni block. The alluvial formation in this part occurs along the Narmada River. The other patches of alluvial formation, though insignificant in both aerial extension and thickness occur along the major rivers and streams flowing in the area. The alluvial formations comprise of Silt, Clay, Sand, Gravel and Pebbles Cobbles etc. with kankar. The district is covered mostly with Deccan trap formation deposited over the rocks of Vindhyan system. The alluvial area in the district occurs mainly along Narmada and Parbati rivers.

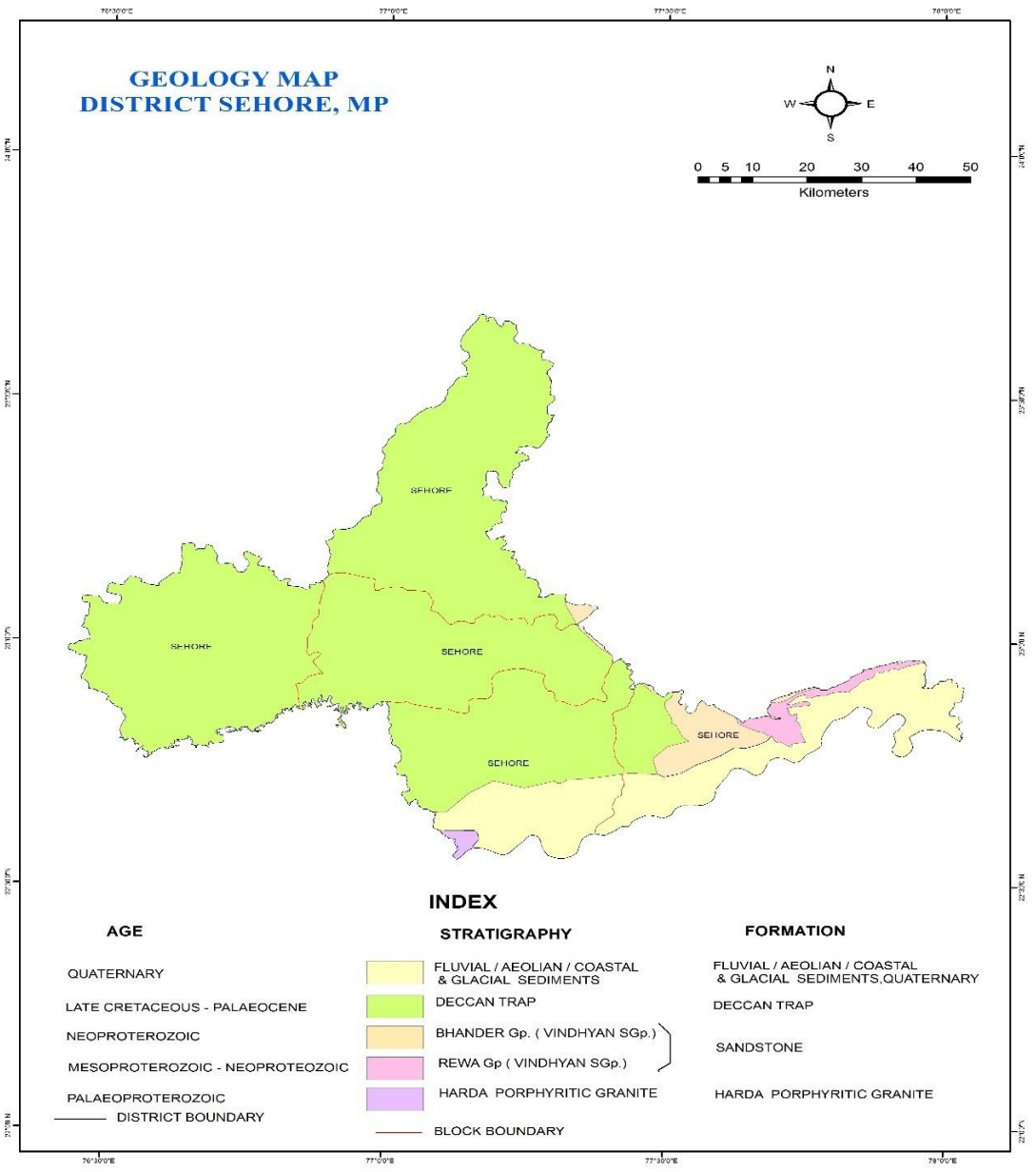

Fig 1.5: Geological map of Sehore district

1.11 Hydrology and drainage

Three major rivers in their respective basins drain the area of the district:- (i) Narmada (ii) Chambal and (iii) Betwa. The main rivers themselves though do not flow through the area, their main tributaries drain the area. The main tributaries, their length and their catchment areas are given below in Table 1.5:

Table 1.5: Major rivers & their tributaries

Basin	Name of the river	Catchment area (sq km)	Total length (km)
Chambal	Anjal	410	30
	Newaj	410	28
	Paru	392	46
	Papnas	250	35
	Parva	205	32
	Sewan	164	26
	Utooli	174	34
	Independent	1270	N.A.
	Total	3285	-
Narmada	Babbar	287	38
	Dobi	152	25
	Kolar	960	103
	Sip	796	72
	Independent	908	-
	Total	3103	-
Betwa	Independent		-
	Catchment	175.7	
	Grand total	6563.7	-

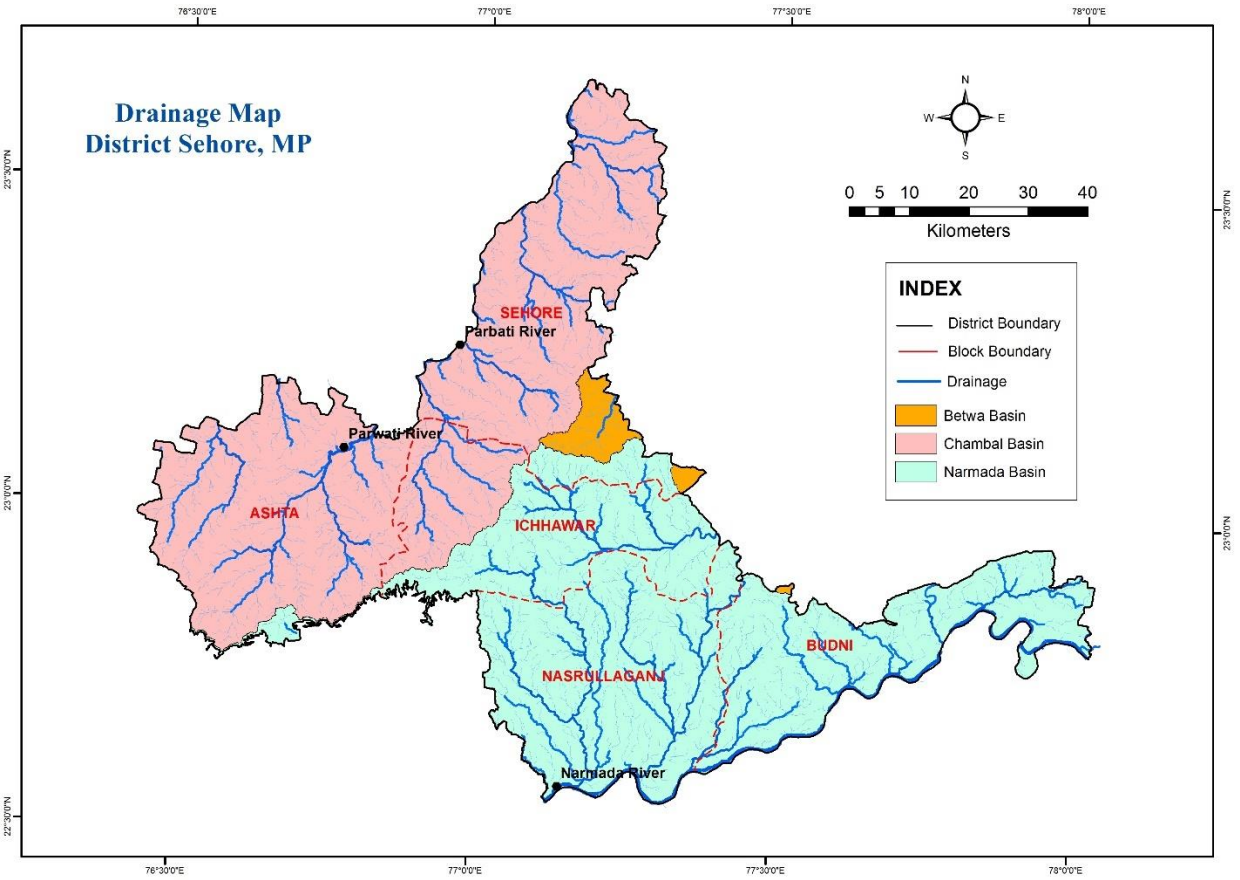

Fig 1.6: Drainage map of Sehore district

1.12 Land use, Irrigation, and Cropping pattern

The total area of Sehore district was 656368 hectares (ha). Out of which, agricultural area is 398894 ha (61%), 164111ha (25%) is under forests. 9605 ha (1%) is under waste land and 83830 ha (13%) is under other uses.

Table 1.6: Land use pattern

S. no.	Name of the block	No. of village covered	Total Geographical Area (ha)	Area under agriculture			Area under forest (ha)	Area under waste land (ha)	Area under other uses (ha)
				Gross cropped area (ha)	Net sown area (ha)	Area sown more than once (ha)			
1	**Ashta**	288	147201	184509	101312	83197	24608	4824	16529
2	**Budhni**	90	53821	50848	29328	21520	18260	-	6233
3	**Icchawar**	152	104085	89395	52141	37254	36076	-	15868
4	**Nasrullaganj**	223	193053	214281	98557	115724	74854	-	19642
5	**Sehore**	305	158208	222905	117556	105349	10313	4781	25558
	Total	1058	656368	761938	398894	363044	164111	9605	83830
Cover (%)					61		25	01	13

Source: DIP, Sehore

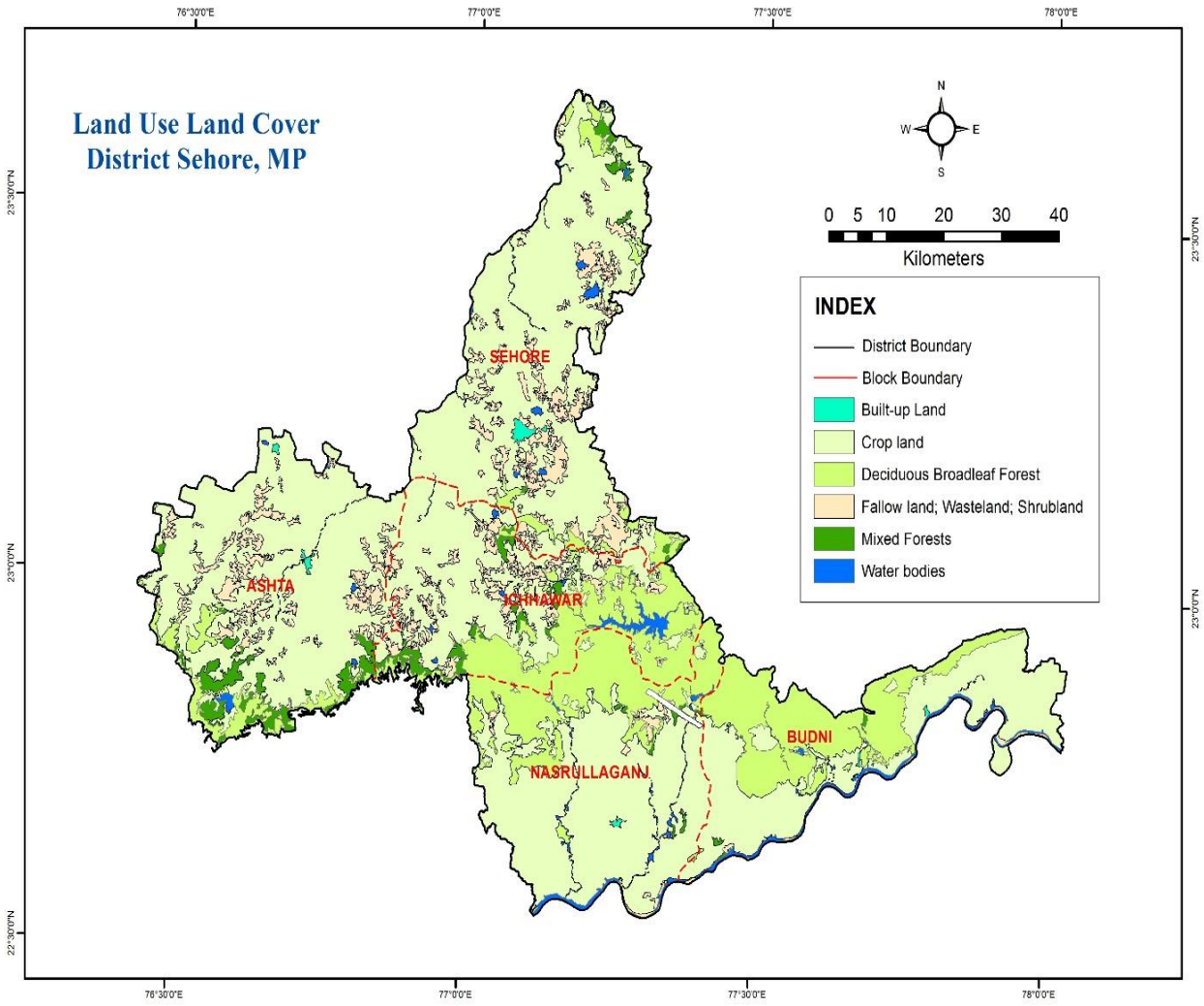

Fig 1.7: Landuse map of Sehore district

The area irrigated by tubewells was 91520 ha (31.06% of the total irrigated area), by open-wells 103744 ha (35.2%), irrigated by canals was 74995 ha (25.4% of the total irrigated area) and by tanks 24355 ha (8.26%). The total area under assured irrigation from various sources was only 294614 ha. This was 73.85% of the net sown area and 19.33% of the total sown area. Around 26.1% of the sown area in the district is dependent on rain-fed irrigation.

Table 1.7: Sources of irrigation

Distt/Block	Canals		Tanks		Open well		Tube/ Bore wells	
	No.	Area (ha)	No.	Area (ha)	No.	Area (ha)	No.	Area (ha)
Ashta	3	311	14	947	9001	20211	10200	37238
Budni	46	13354	3	1510	2504	8016	704	16223
Ichhawar	9	288	24	1322	7358	15173	1798	3000
Nasrullaganj	29	58027	6	2607	6314	28651	943	6118
Sehore	9	3015	17	17969	13781	31693	10674	28941
Total	96	74995	64	24355	38958	103744	24319	91520

Table 1.8: Area under irrigation

S no.	Name of block	Irrigated area (ha)	Rainfed area (ha)	
		Gross irrigated	Partially irrigated	Unirrigated/ Totally rainfed
1	**Ashta**	67858	53337	21771
2	**Budhni**	88360	3063	3114
3	**Icchawar**	33408	26488	5733
4	**Nasrullaganj**	79933	25156	8752
5	**Sehore**	89480	53437	43247
Total		269559	108044	39370

Source: DIP, Sehore

The principal crop grown during Rabi season is Wheat. It is sown in an area of 230000ha, shown in the Table 1.9:

Table 1.9: Major crops

Year	Soybean			Paddy			Pigeon pea			Wheat			Chickpea		
	A	P	Y	A	P	Y	A	P	Y	A	P	Y	A	P	Y
2011-12	289.8	262.5	906	11.39	12.06	1059	14.7	8.82	600	223.9	778.6	3477	100.27	80.28	680
2012-13	308.7	266.3	863	17.3	68.85	3980	9.33	5.88	630	237.5	681.65	2870	97.56	139.6	1396
2013-14	291.2	127.6	438	21.2	84.8	4000	10.4	6.24	599	238	714	3000	120	87.02	892
2014-15	272	366.7	1348	35	176.5	5042	10.7	64.8	606	241.6	850.9	3522	97	122.5	1263
2015-16	296	438	1297	23.6	8256	3500	9.76	87.84	900	230.1	805.3	3500	91.84	116.6	1270

A=Area (000,Ha), P=Production (000,Mt), Y=Yield (kg/ha) **Source: DPO & DDA, Sehore**

Chapter-2
DATA COLLECTION AND GENERATION

2.1 Hydrogeology

Description of rocks and their water bearing properties

Vindhyan System

A major portion of Budhni block falling in the southeastern part of the district is covered with Vindhyan formations comprising sandstones, shales, quartzite and breccia. The Vindhyans are, in general, poor aquifers, however, these formations when subjected to weathering or jointing and fracturing gives rise to moderately yielding aquifers. The depth to water level in this formation varies from 4.86 m to 9.50 mbgl. and season water level fluctuation ranges from 0.85 to 3.00 metres. The yield of wells in this formation varies from 1 to 3 lps.

Deccan trap formations

The Deccan trap formation occupies about 85% of the total area of the district. The main aquifer systems in the formation are the weathered, vesicular flow contacts jointed, fractured zones etc. The ground water occurs mainly under phreatic conditions the red bole horizon generally confined conditions the red bole horizon generally act as semi-confining and confining layers in the deep aquifers. The yield of wells in this formation varies from 1 to 5 lps.

Alluvium

Alluvial area in the district occurs mainly along Narmada and Parbati River. A major pertain of alluvial patch occurs along Narmada river falling in Budhni block small linear patches of alluvium also occur along Parbati river in the western side of the district. The alluvium consists of clay, silt, sand, gravels and pebbles. The sandy gravelling zones when saturated form very good aquifers. The yield of the formation depends upon the ranges from 5 to 10 lps.

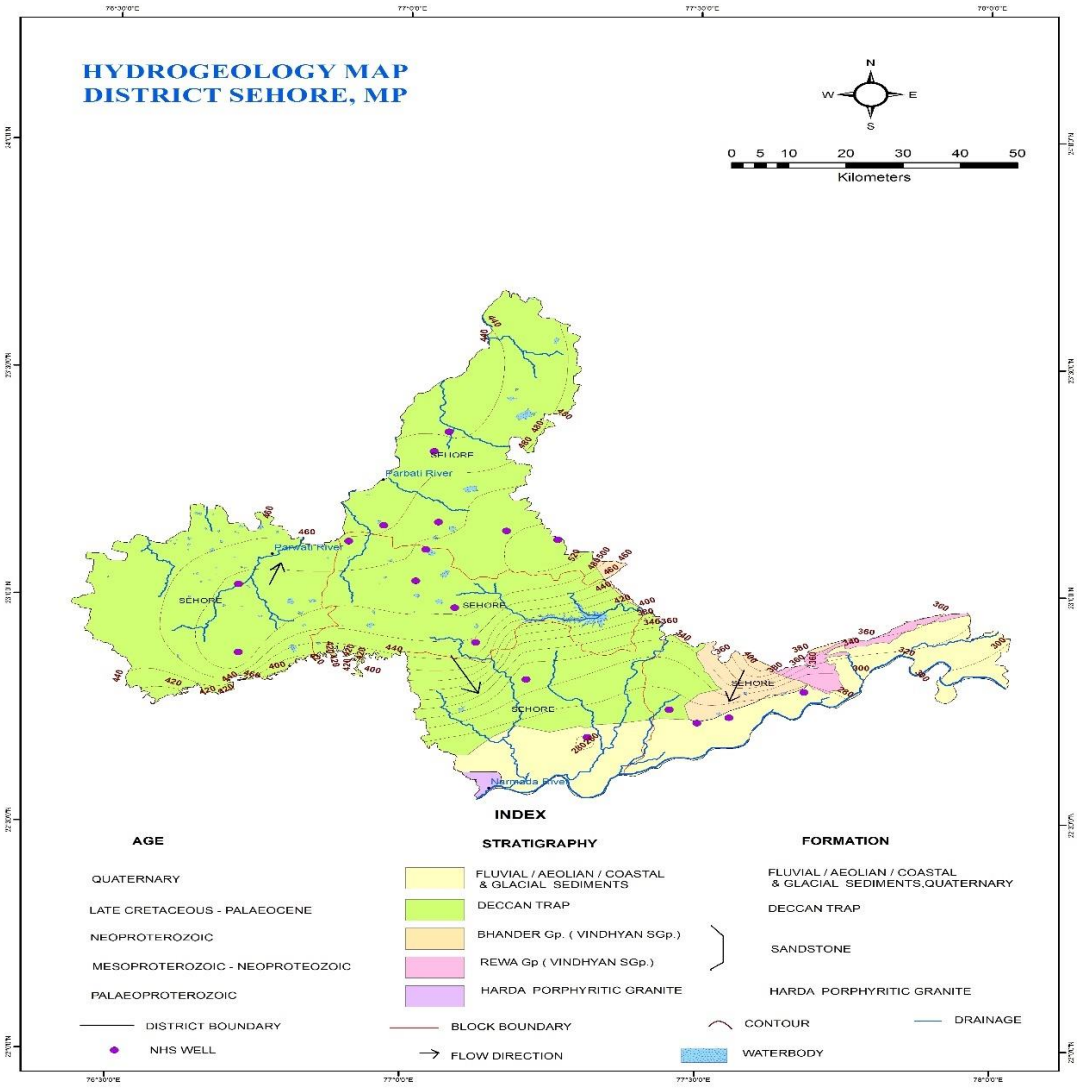

Fig 2.1: Hydrogeology Map of Sehore district

2.2. Ground water scenario

Water Levels

Water level data, including historical data are essential for not only to know the present ground water conditions but also for forecasting future trends in response to ground water reservoir operations. Using the water level data of 19 NHS monitoring wells of Sehore district as shown in Fig 2.2, Pre and post monsoon depth to water level maps are reproduced.

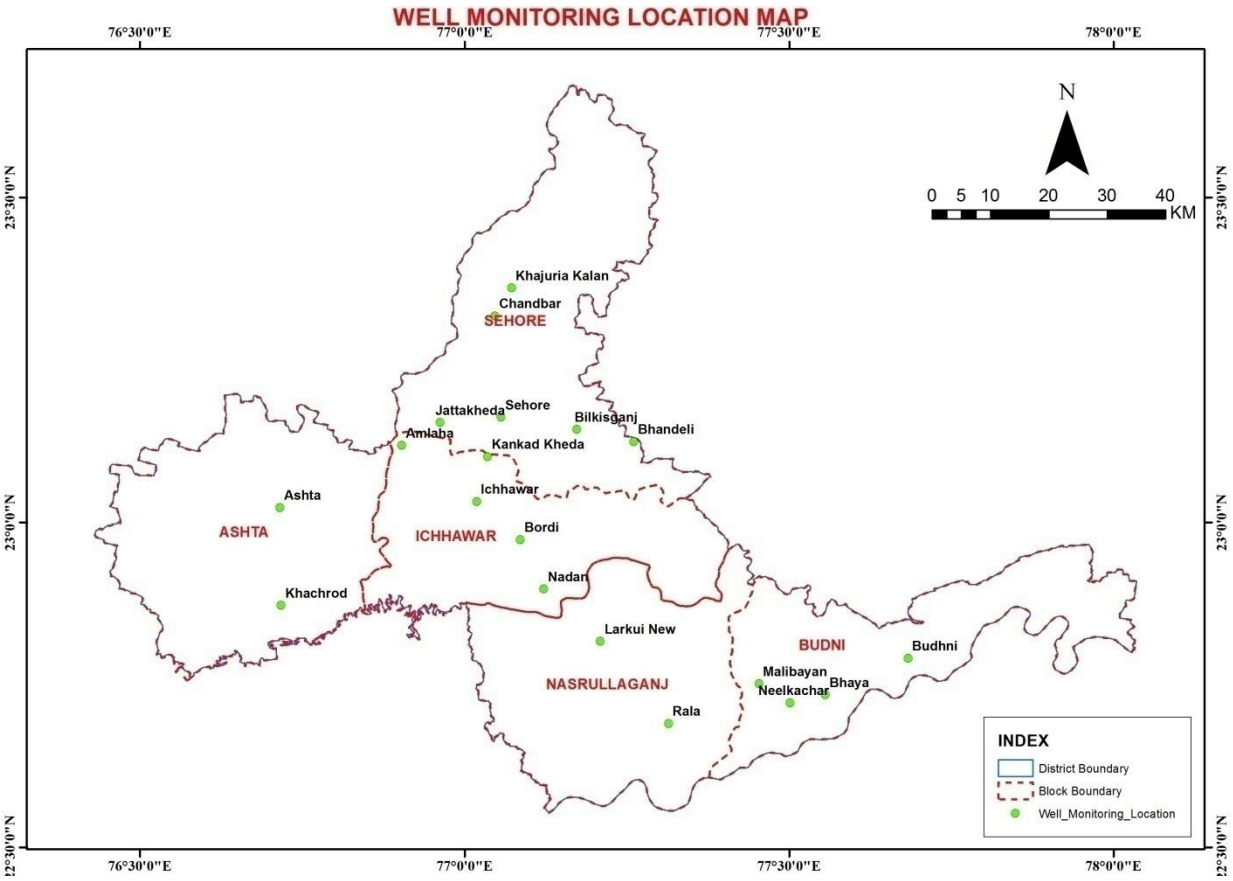

Fig 2.2: Monitoring well locations map

Pre- Monsoon (May 2020)

Pre-Monsoon depth to water level in the year 2020 range from 2.7 to 18.4 mbgl. Shallow water level (<3.00 m) occurs in the central part of the district (Fig.2.3).

The long- term water level trend (2011-2020) shows declining trend ranges from 0.1515 to 0.6735 m/year. Water level fall is noticed in all blocks where a large scale withdrawal of ground water for irrigation purpose is observed (Fig 2.5).

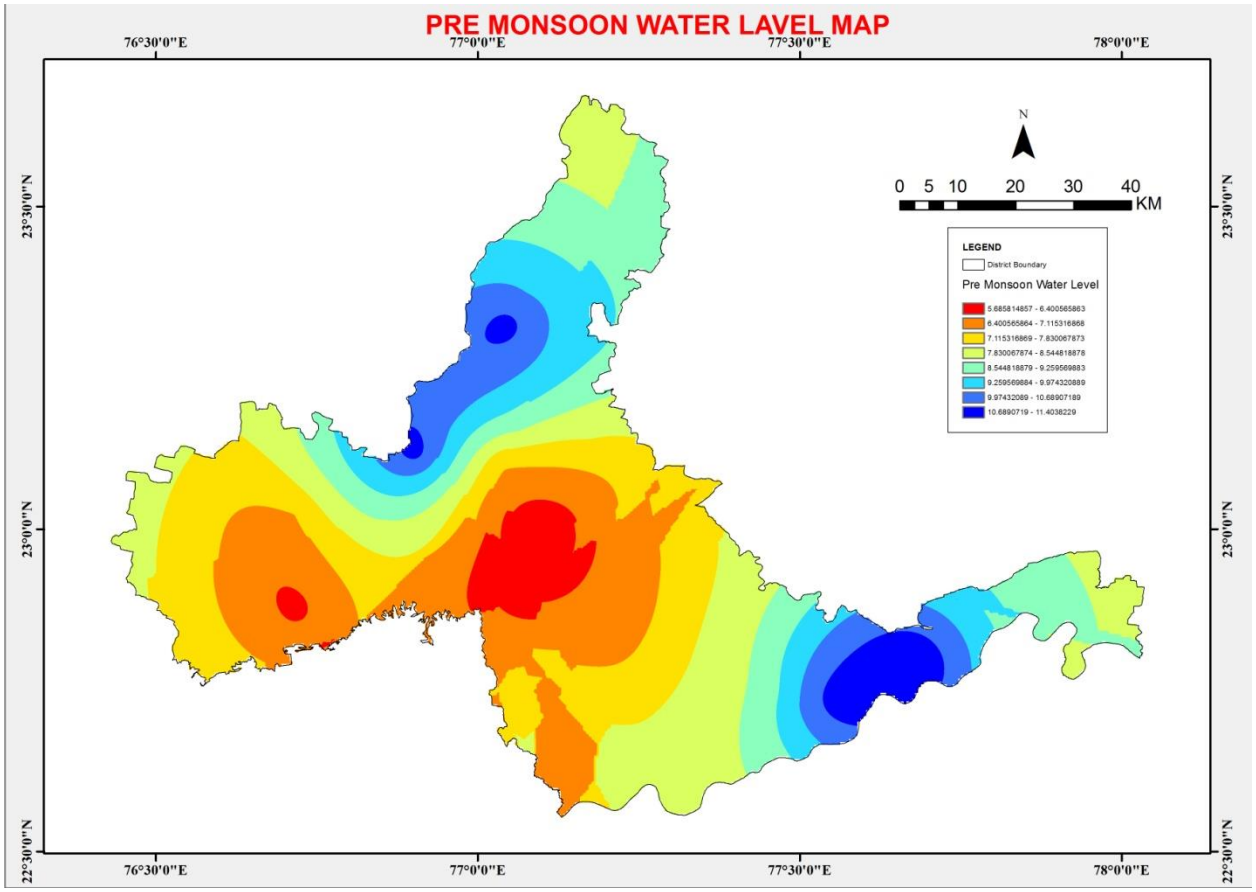

Fig 2.3: Pre-monsoon depth to water level map 2020

Post Monsoon November 2020.

During post monsoon period, water level ranges from 1.6 to 11.3 mbgl. Shallow. Water level (< 5 mbgl) occurs in central & western parts while deep water levels (12.8 mgl) observed in south eastern part (Fig 2.4).

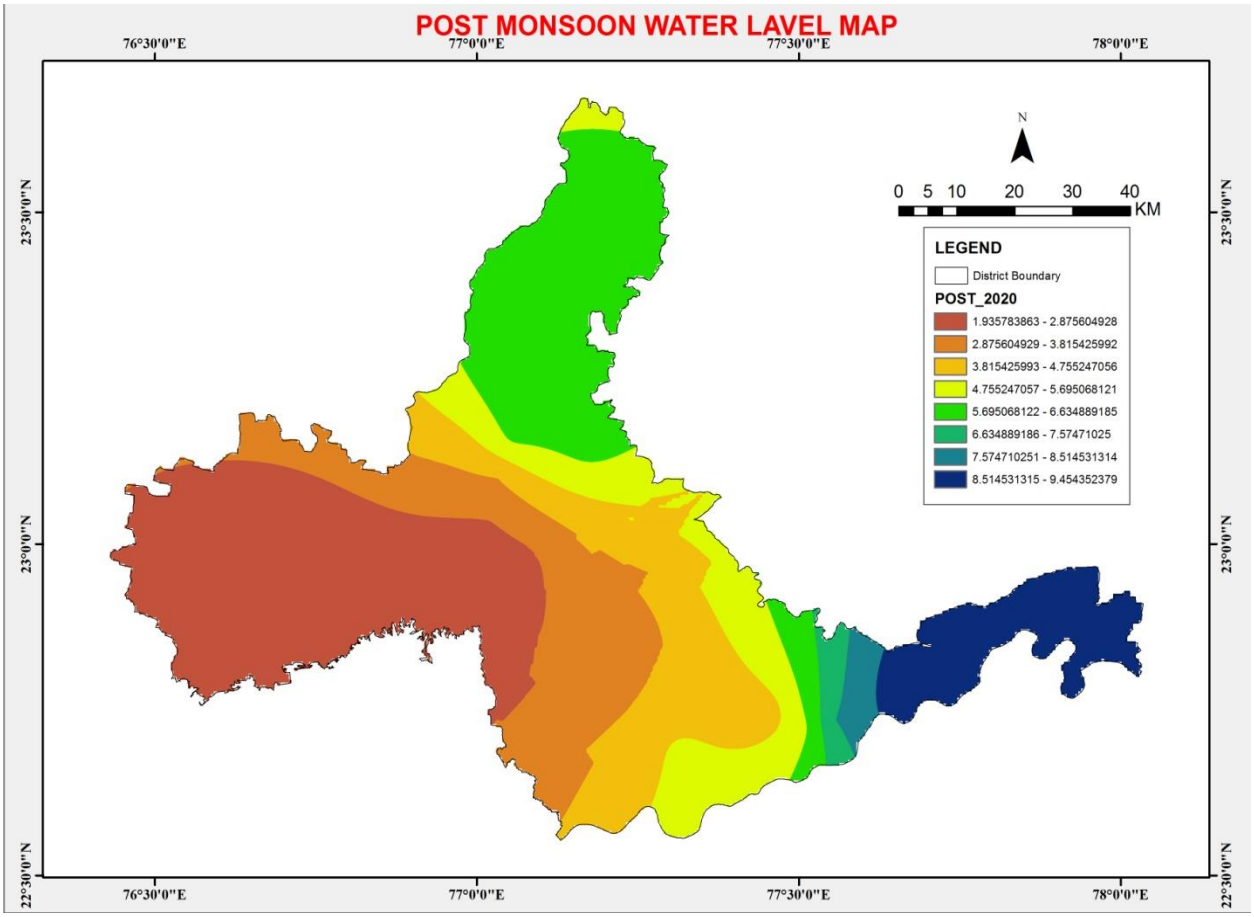

Fig 2.4: Post-monsoon depth to water level map 2020

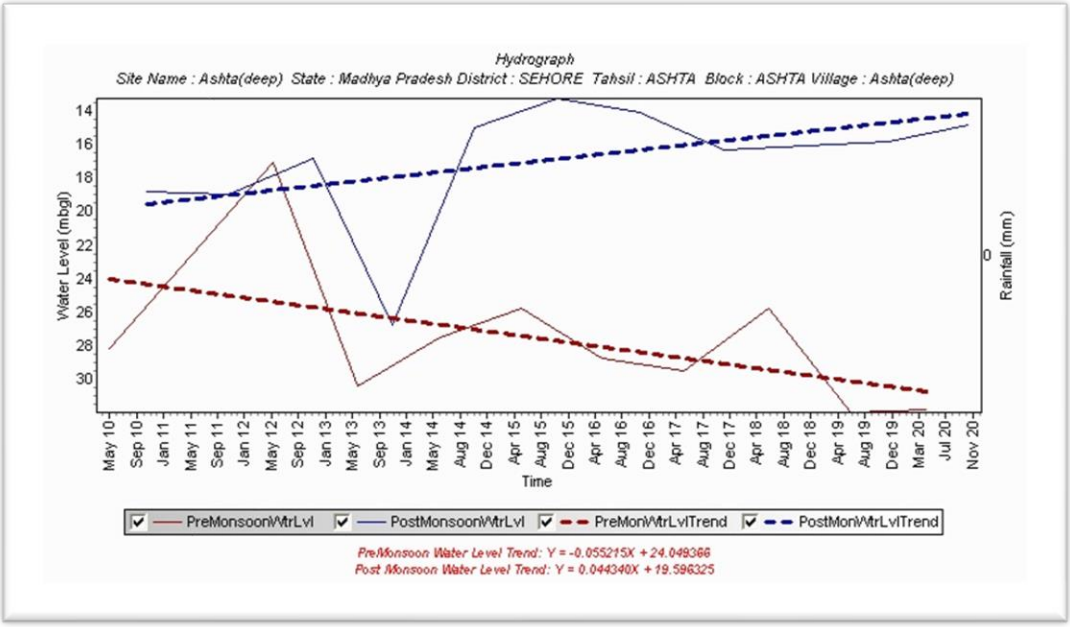

Fig 2.5(a): Ashta, Block Ashta (Deep piezometer)

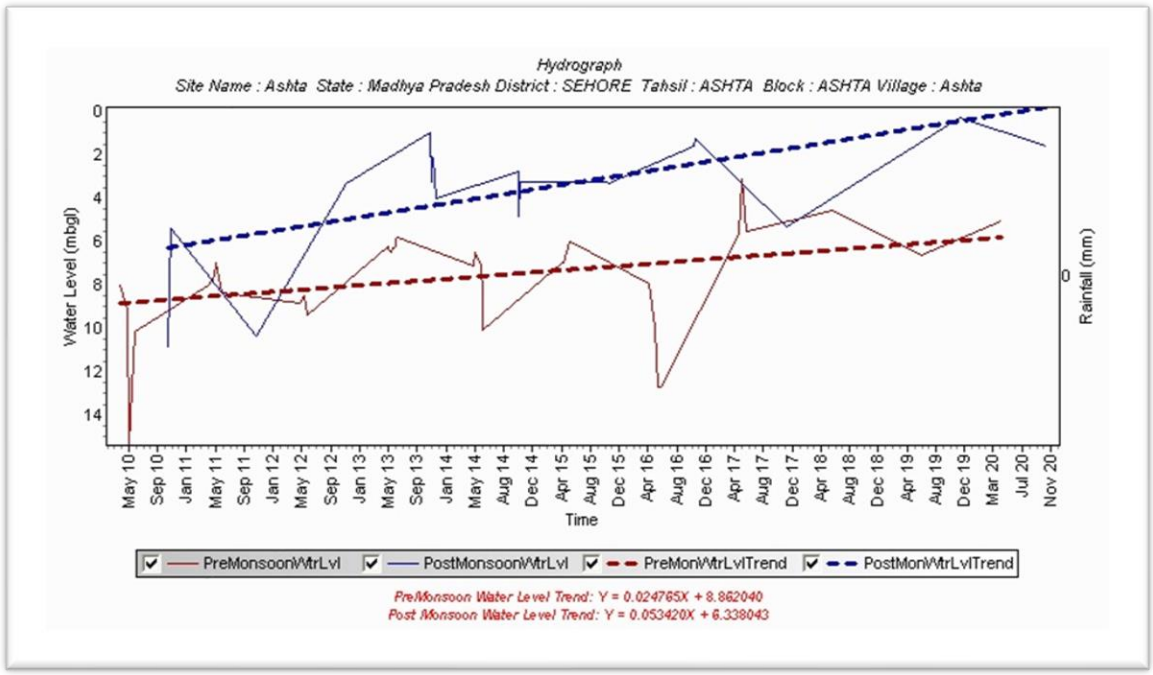

Fig 2.5 (b): Ashta, Block Ashta (Shallow piezometer)

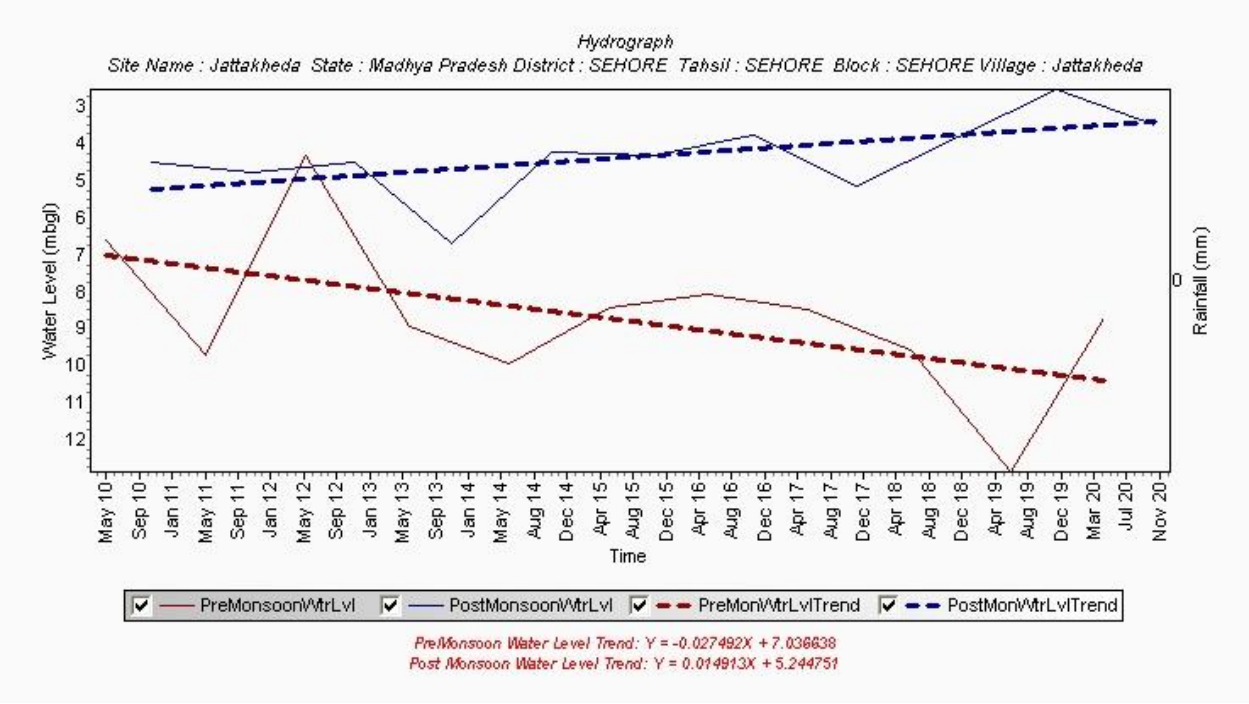

Fig 2.5(c): Village Jattakheda, Block Sehore

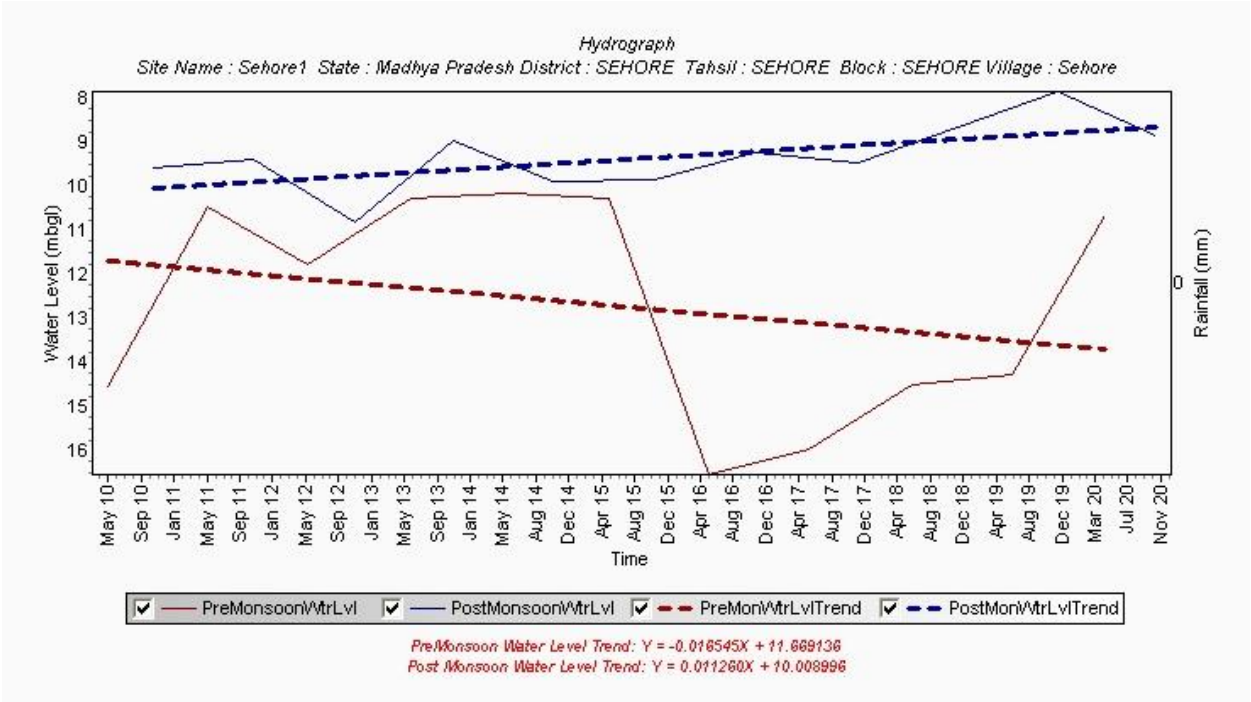

Fig 2.5(d): Sehore, Block Sehore

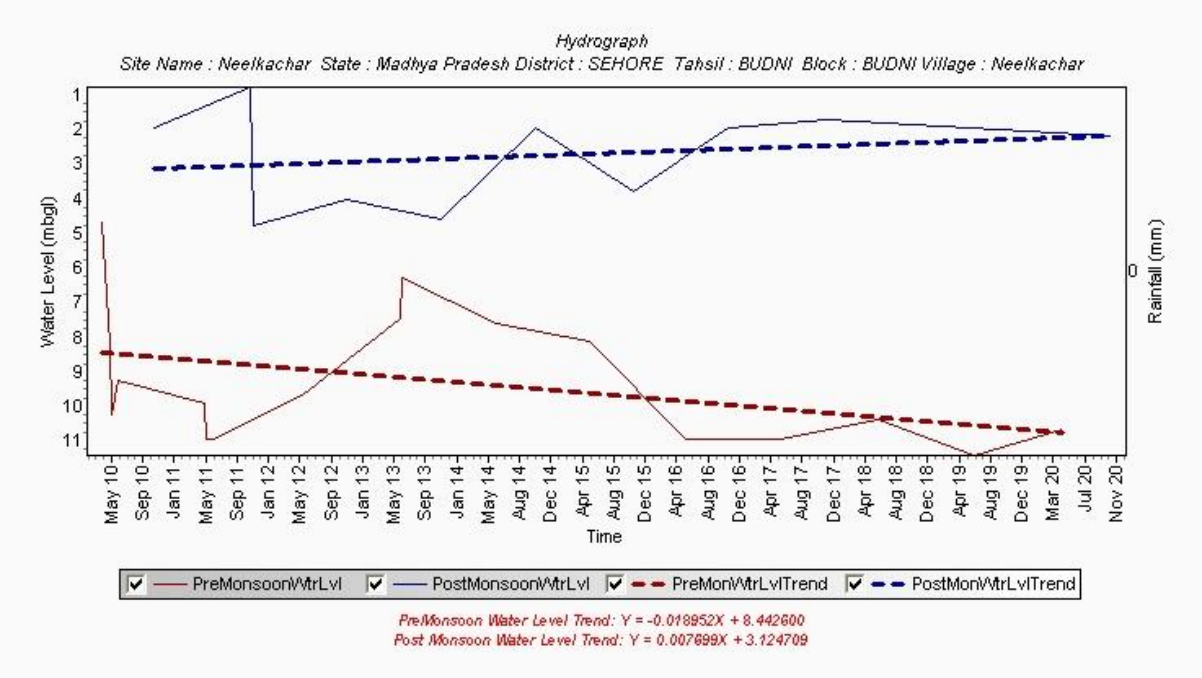

Fig 2.5(e): Village Neelkachar, Block Budhni

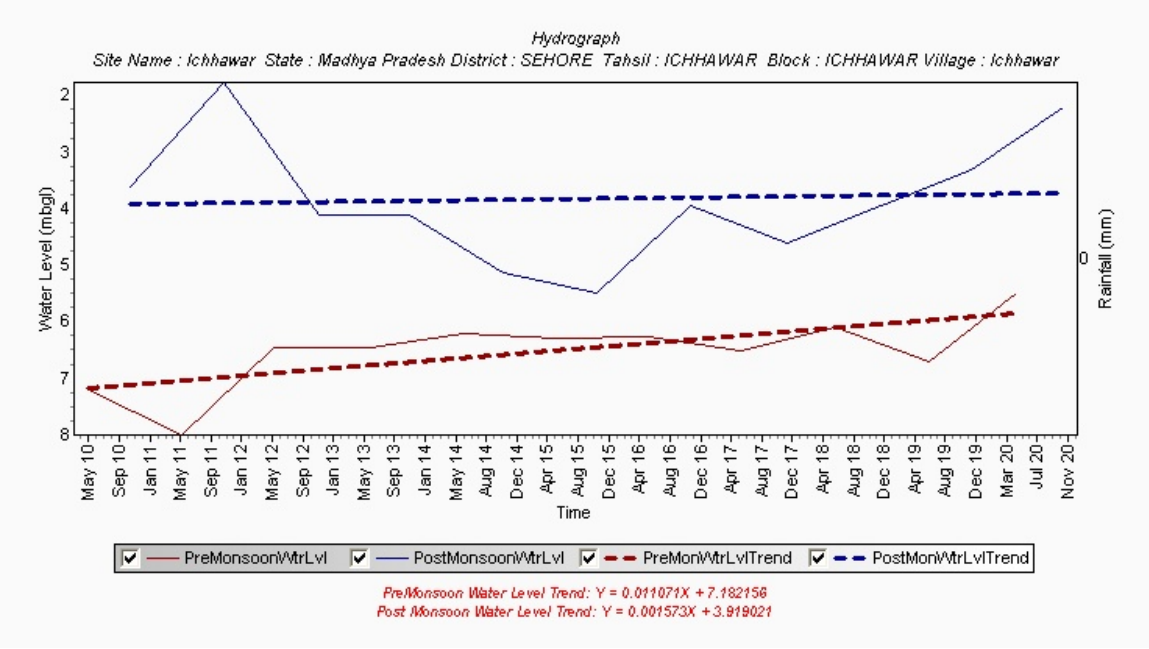

Fig 2.5(f): Ichhawar, Block Ichhwar

Fig 2.5: Hydrographs showing water level trend during pre-monsoon & post-monsoon at sites Ashta, Jattakheda, Sehore, Neelkachar, Ichhawar

2.3 Ground water Exploration

CGWB has drilled 07 exploration borewells and 6 Piezometers. On the basis of samples collected during drilling, litholog have been prepared. The aquifer parameters are calculated on the basis of pumping tests.

2.4 Geophysical studies

Surface and sub-surface geophysical investigations are the vital component in groundwater resources exploration, exploitation and management. As far as geophysical studies are concerned, no surface geophysical investigation has been done while the sub-surface geophysical logging of boreholes have been conducted in different parts of Sehore district.

Borehole Geophysical logging

In Sehore district, during the Acclerated exploratory drilling programme under drought, 23numbers of exploratory boreholes have been drilled to explore the sub-surface hydrogeological conditions of the district. Out of these exploratory boreholes 15 boreholes have been logged geophysically.

The natural gama log parameters of every logged borehole have been recorded, while the SP, Normal resistivity and caliper parameters of same of the exploratory boreholes have also been recorded. The geophysical logs are shown in figures given below. Because of geophysical logs capabilities in synthesizing the lithology, the logs have been used in assessing the hydrogeological characteristics of the aquifers and delineation of its regional geometry.

As the Sehore district is covered by basaltic rocks, the natural gamma logs indicate that the massive part of basaltic flows have low natural gamma counts of the order of 5 to 15 cps. The inter trappean beds show high natural gamma counts of the order of 20 to 60 ohm m. It is significant observation that the natural gamma logs are very much effective in delineating different lava flows because it provides better correlation among different lava flows.

The caliper logging of same borehole has been conducted to measure the variation in borehole diameter. The caliper logs helped in understanding the collapsible nature of intertrappean formation and solving the problem of borehole caving by placing adequate pipe against this formation, the electrical parameters of geophysical log could not be recorded properly.

2.5 Hydrochemical scenario of Sehore District

The water samples were collected from National Hydrograph Stations in clean double stoppered poly ethylene bottles from 19 different locations of Sehore district during May 2019.

Quality of Ground Water for Drinking Purpose:

The ground water samples from Sehore district have varied range of pH from 7.12 to 7.84. As per BIS(IS 10500 : 2012) recommendation, all the water samples have pH recorded within the permissible limits of 6.5 to 8.5, the maximum pH recorded in the water sample of Sehore (7.84). The ground water of the study area can be assessed as neutral to slightly alkaline. The electrical conductivity of ground water samples in Sehore district varies from 386 to 4875 µS/cm at 25°C. The electrical conductivity from Sehore district shows variability, Two samples from Ashta and Heerapur villages shows EC more than 3000 EC i.e. 3229 and 4875 µS/cm respectively, while 4 samples shows EC in between 2000-3000 µS/cm; 6 samples EC in between 1000-2000 µS/cm and the EC of remaining 7 samples is below 1000 µS/cm. So, overall ground water quality in Sehore district is good.

The fluoride concentration in Sehore district lies in between 0.1 to 1.49 mg/l, which represent that all the samples are within the permissible limit i.e. 1.5 mg/l as per BIS (IS 10500: 2012). Nitrate in ground water samples of Sehore district fall within limits of 1 to 141 mg/l. It is observed that 42% samples have Nitrate concentration more than the acceptable limit i.e. 45 mg/l, while rest 58% samples have concentration less than acceptable limit. There is no permissible limit for Nitrate as per BIS (IS 10500: 2012). Highest nitrate is reported in the water sample collected from Larkui (141mg/l). High nitrate in ground water samples may be due to anthropogenic activities or excessive use of fertilizers. The range of Total Hardness (as $CaCO_3$) in ground water samples of study area is 20 to 1035 mg/l. Except the water sample from one location i.e. Heerapur (1035mg/l). It is observed that 32% samples have total hardness concentration more than the permissible limit of 600 mg/l, while rest 68% samples have concentration less than permissible limit.

Piper diagram has three parts: a Cation triangle, an Anion triangle, and a Central diamond-shaped field. In Cation triangle, the relative percentages of the major cations (Ca^{2+}, Mg^{2+}, Na^{+}, K^{+}) are plotted. In Anion triangle the major anions ($HCO_3^{-}+CO_3^{2-}$, SO_4^{2-}, Cl^{-}) are plotted. These points are then projected to the central diamond shaped field.

Out of the total ground water samples analyzed from Sehore district, 42 % of samples are Mixed type, 47 samples show nature of water as Calcium-Bicarbonate type, hence show temporary hardness while 11% samples fall in the region of Sodium-Chloride type, so have permanent hardness features.

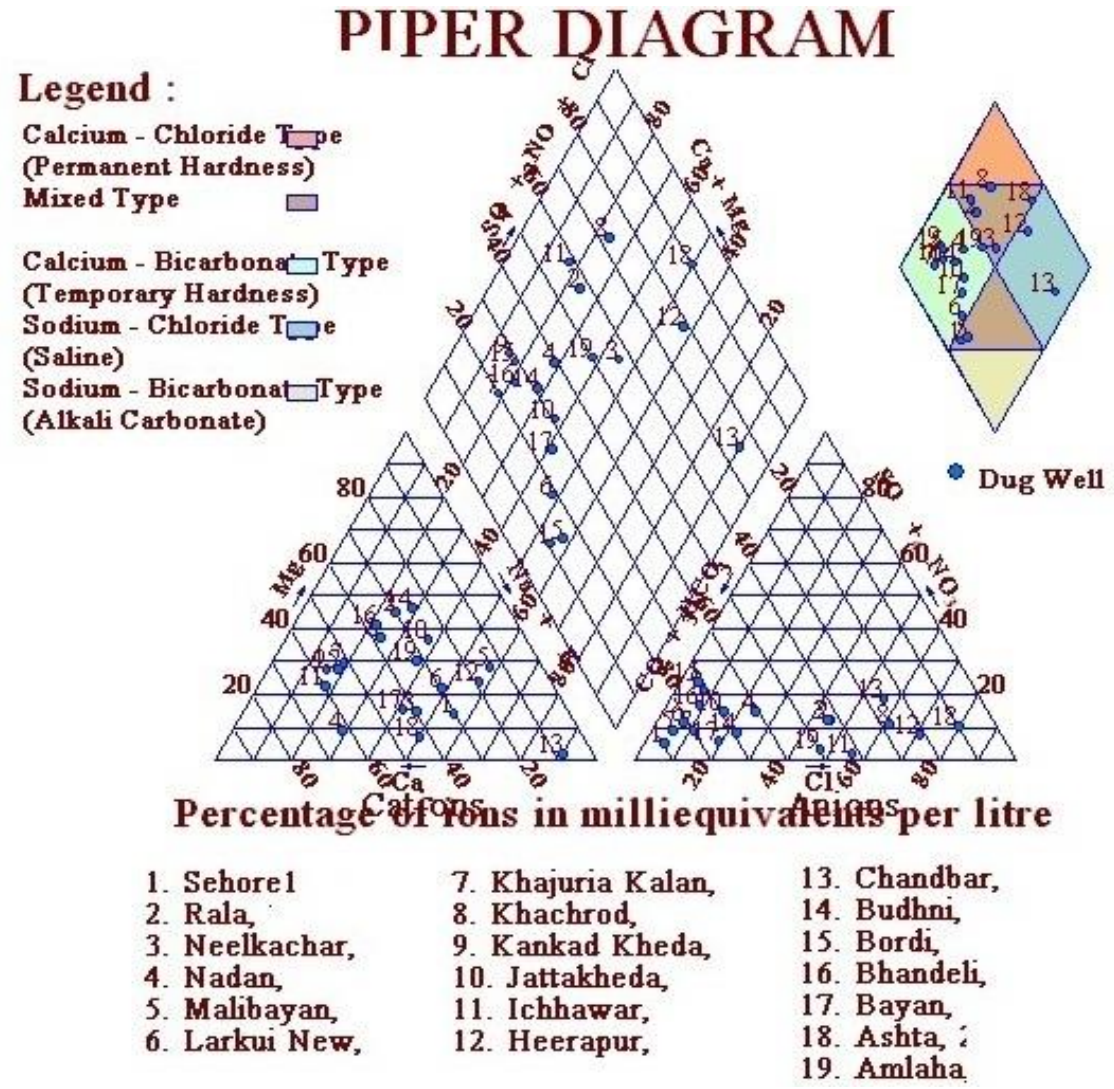

Fig 2.6: Hill Piper Diagram representing classification of water samples collected from National Hydrograph Stations, Sehore District, Madhya Pradesh

Quality of Ground Water for Irrigation Purpose:

In classification of water for irrigation purpose, it is assumed that the water will be used for irrigation purpose based upon its soil texture, infiltration rate, drainage and climate. The chemical data of all the water samples from Sehore district is plotted on U.S. Salinity Laboratory diagram.

It is clear that approx. 21% wells of study area are observed under C_2-S_1 Class (Medium Salinity & Low Sodium) which means that these waters can be used for irrigation purpose for most of the crops, 53% of total ground water samples fall under C_3-S_1 class (High Salinity & Low Sodium). The remaining samples falls under C_4S_1 Class (Very High Salinity & Low Sodium); C_2-S_2 class

(Medium Salinity & Sodium); C_3-S_3 class (High Salinity & Medium Sodium); C_4-S_2 class (Very High Salinity & Medium Sodium); C_4-S_3 class (Very High Salinity & High Sodium). Water from these areas can be used for irrigation, considering the salinity content of the ground water.

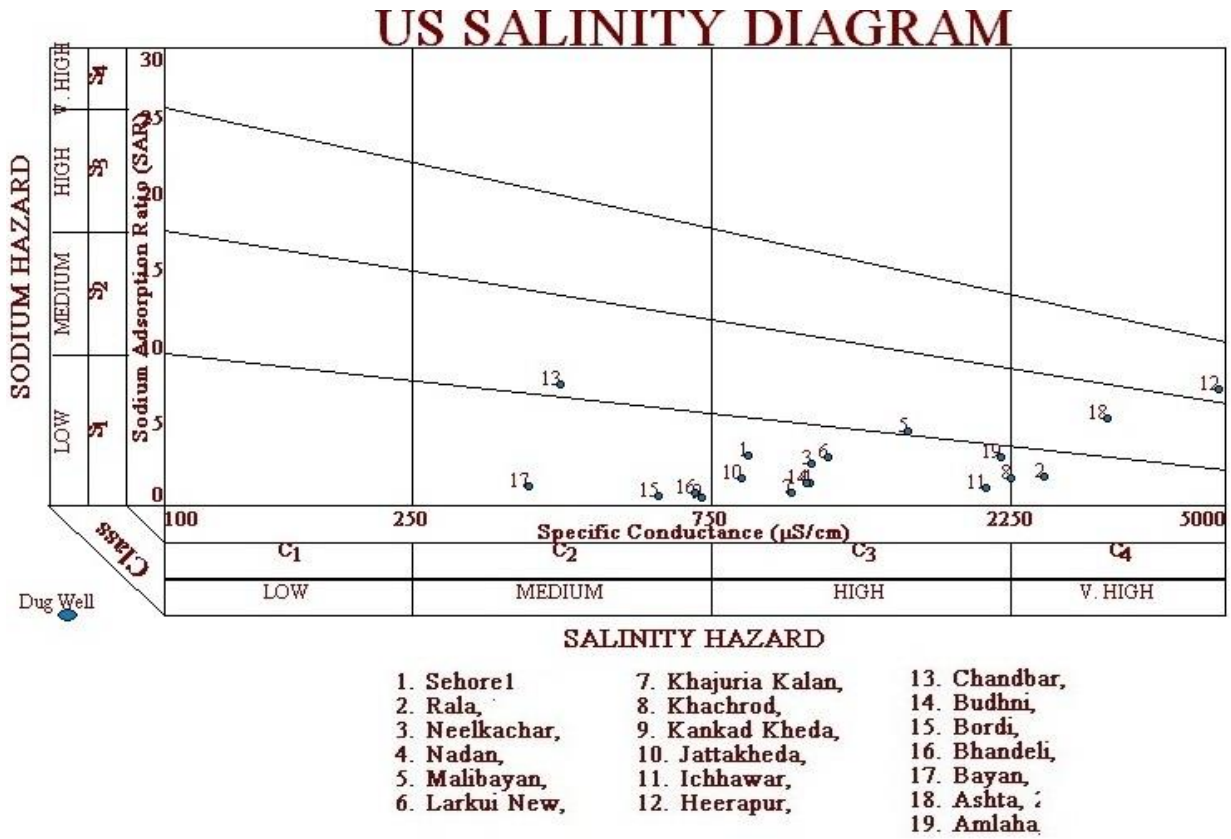

Fig 2.7: US Salinity Diagram for water samples collected from National Hydrograph Stations of Sehore District, Madhya Pradesh

Table 2.1: Chemical quality of Ground water in Sehore district

S. No.	District	Block	Location	pH	EC	CO_3	HCO_3	Cl	SO_4	NO_3	F	TH	Ca	Mg	Na	K	PO_4	SiO_2
					µS cm^{-1} at 25°C	mg/l												
1	Sehore	Ashta	Ashta	7.42	3229	0	172	901	140	26	0.58	797	273	28	365	10.1	0.9	65
2	Sehore	Ashta	Khachrod	7.4	2265	0	350	468	77	52	0.34	846	170	102	120	10.1	0.55	49
3	Sehore	Budni	Bayan	7.27	386	0	160	25	10	1	0.24	109	32	7	30	10.2	0.07	24
4	Sehore	Budni	Budhni	7.43	1068	0	424	84	11	39	0.48	376	53	59	63	10.2	0.12	61
5	Sehore	Budni	Malibayan	7.76	1554	0	756	32	55	14	0.31	322	42	53	198	10.3	0.09	55
6	Sehore	Budni	Neelkachar	7.13	1089	0	271	166	18	58	0.29	292	85	19	108	7	0.17	48
7	Sehore	Ichhawar	Amlaha	7.12	2184	0	633	354	22	16	0.39	668	137	79	184	10	0.8	38
8	Sehore	Ichhawar	Bordi	7.58	621	0	258	12	31	49	0.19	248	65	20	20	10.2	0.1	51
9	Sehore	Ichhawar	Ichhawar	7.31	2069	0	504	406	13	9	0.36	842	244	57	77	10.1	0.12	52
10	Sehore	Ichhawar	KankadKheda	7.49	729	0	301	20	22	64	0.46	302	81	24	20	10.2	0.07	38
11	Sehore	Ichhawar	Nadan	7.41	1084	0	381	92	11	82	0.47	376	131	12	66	8	0.11	61
12	Sehore	Nasrullaganj	Larkui New	7.49	1158	0	529	30	14	59	1.49	292	67	30	121	10.2	0.13	53
13	Sehore	Nasrullaganj	Rala	7.45	2555	0	615	386	33	141	0.32	955	152	140	134	14.2	0.23	59
14	Sehore	Sehore	Bhandeli	7.75	708	0	301	22	19	47	0.52	272	51	35	29	10.1	0.09	47
15	Sehore	Sehore	Chandbar	7.81	433	0	61	82	37	1	0.89	20	6	1	81	10	0.04	25
16	Sehore	Sehore	Heerapur	7.71	4875	0	578	1151	165	9	0.65	1035	182	141	560	134	0.98	66
17	Sehore	Sehore	Jattakheda	7.59	841	0	332	47	39	24	0.88	257	42	37	66	10.2	0.08	40
18	Sehore	Sehore	KhajuriaKalan	7.6	1008	0	480	40	11	41	0.28	401	101	36	37	10.2	0.15	45
19	Sehore	Sehore	Sehore1	7.84	860	0	430	17	17	4	0.1	188	51	14	103	7.9	0.14	44

Chapter-3
DATA INTERPRETATION, INTEGRATION AND AQUIFER MAPPING

The lithological data collected from 07 Exploratory Borewells& 6 piezometers of CGWB were studied, compiled and integrated as per Rockworks software format to prepare the 3-Dimensional Stratigraphic model and 2-Dimensional Cross section. From the 3-D Model, Fence diagram and 2-D Section is presented in the fig 3.1, 3.2, 3.3 & 3.4. It has been interpreted that the major water bearing zones has been encountered in weathered and fractured basalts.

3.1 3-D Lithological & 3-D Stratigraphic model

A 3-Dimensional Lithological & Stratigraphic model was prepared for the Sehore district, Madhya Pradesh after detailed analysis of the pre-existing and available bore-log data collected from the Basic Data Reports of CGWB. A comprehensive analysis was made as per lithology and stratigraphy of the area. The location details with RL values and their corresponding stratigraphic details as per the Rockworks format is provided in the Annexure.

The 3-D Model results showed that the region is dominantly occupied by deccan trap flows. The sub-surface hydrogeology has been broadly classified into Top soil/Unsaturated zone, underlain by Weathered Basalt which has been considered as shallow aquifer (upto a depth of 30 mts) and Fractured/ jointed basalt which has been considered as Deeper Aquifer (30-200) mts.

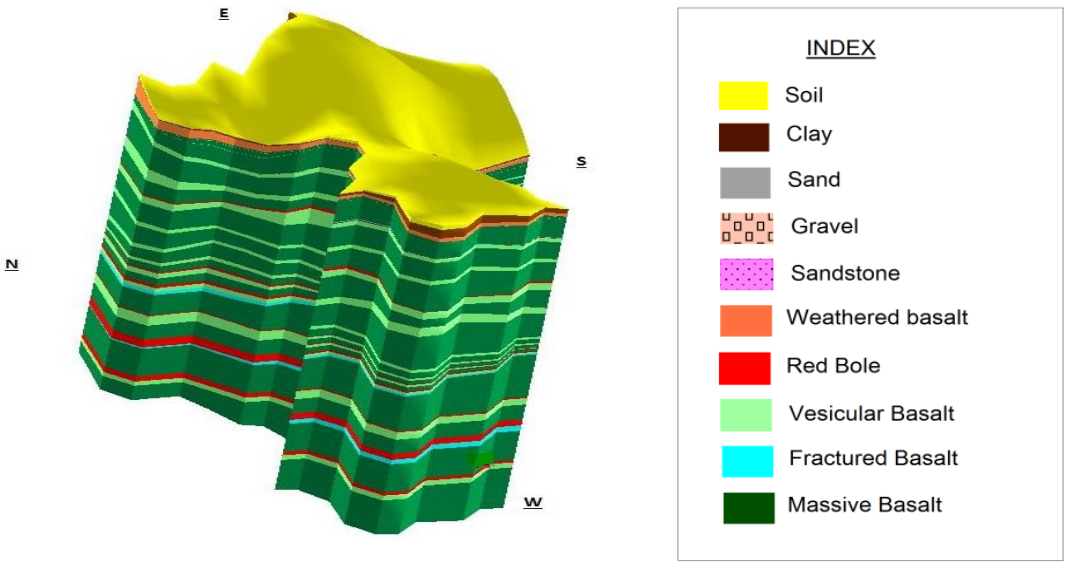

Fig 3.1: 3-D Lithological Model of Sehore District, Madhya Pradesh

3.2 Fence Diagram

The Fence diagram was also prepared using the Rockworks software. The pattern for the Fence was chosen as such to cover the maximum portion of the region to represent the enhanced picture of the sub-surface as deciphered from the 3-D stratigraphic model. It has also been interpreted from the diagram that the shallow and deeper aquifers are not in connection to each other.

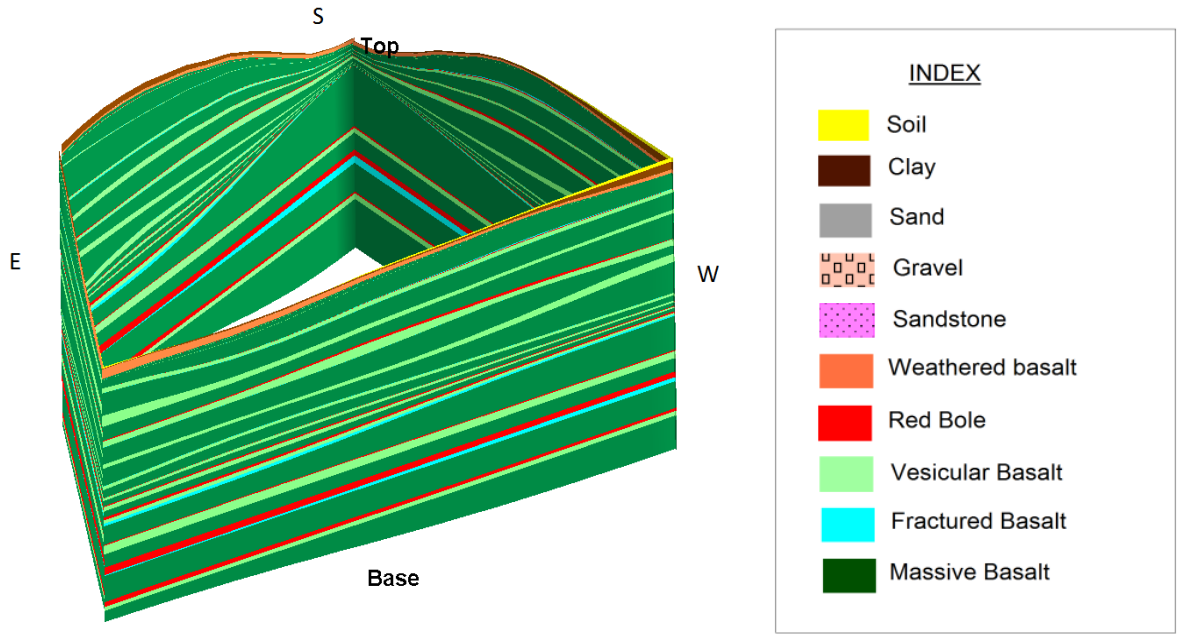

Fig 3.2: Fence Diagram, District Sehore, Madhya Pradesh

3.3 2-D Cross Section of Sehore District

2-Dimensional cross-sections along the section line A-A'(Shyampur-Jawar) NE-SW and B-B' (Shyampur-Machwas) N-Sdirection covering the wells has been prepared using Rockworks. The cross-section shows that the shallow aquifer is not continuing for the whole region and occurs as narrow pinches in the northern & western portion of Sehore. The potential deeper aquifers whereas, occurs throughout the section line as vesicular basalt and can be encountered at depth where fractures are present.

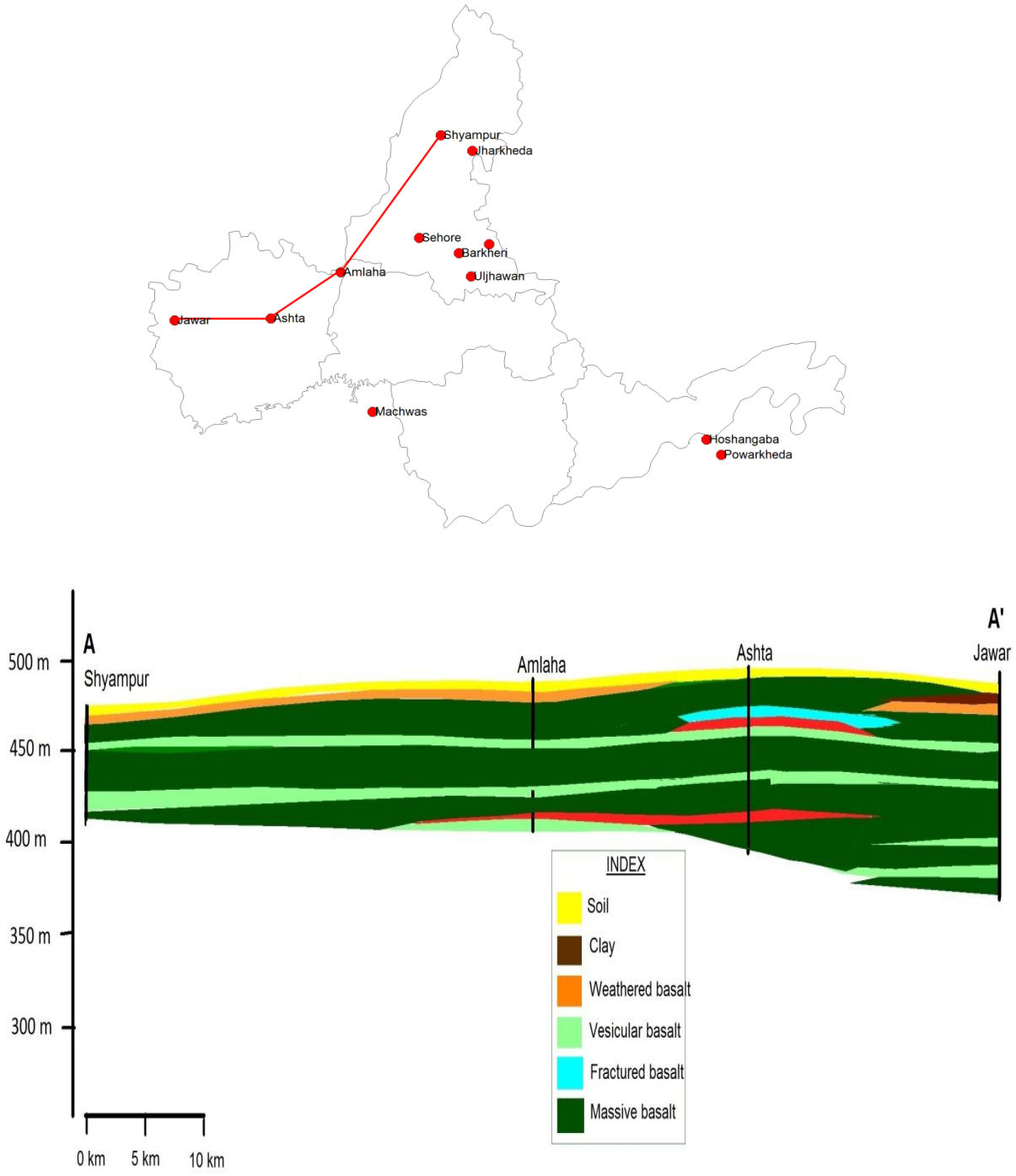

Fig 3.3: 2-D Cross sections A-A'(Shyampur-Jawar)

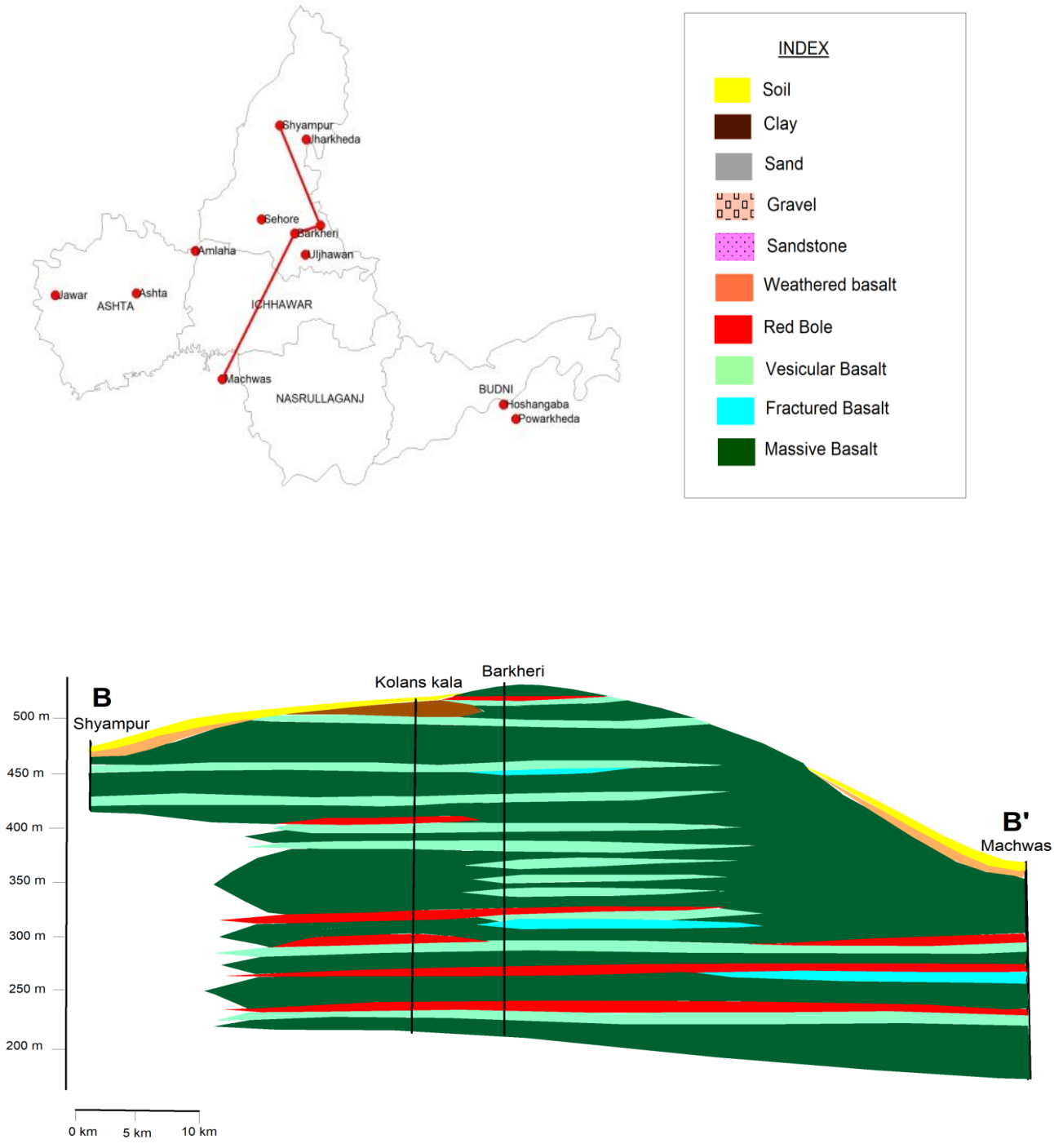

Fig 3.4: 2-D Cross sections B-B' (Shyampur-Machwas)

Chapter-4
GROUND WATER RESOURCES

4.1 Dynamic Ground water resources

Sehore district is underlain by Basaltic lava flows of Deccan trap, Vindhyan Sandstone and Alluvium. Dynamic ground water resources of the district have been estimated for base year -2019-20 on block-wise basis. Out of 6,57,800 ha of geographical area, 463972 ha (71%) is ground water recharge worthy area and 193828 ha (29%) is hilly area.

There are five number of assessment units (block) in the district which fall under non-command (80%) and command (20% Ashta, Budhni, Ichawar, Nasrullahganj & Sehore) sub units. Ashta block of the district are categorized as critical and rest of the blocks are safe. The highest stage of ground water development is computed as 99.67% in Ashta block.

The Annual Extractable Groundwater Resource in the district 65187.81 ham and Total Extraction of Groundwater for all uses is 40400.72 ham, making Stage of Groundwater Extraction 61.98% as a whole for district. After making allocation for future domestic and industrial supply for year 2025, balance available ground water for future irrigation would be 24992.51 ham. Table 4.1 shows the Dynamic Ground Water Resource Assessment estimated by CGWB for the year 2020.

4.2 Ground water Draft:

The draft of dug well and tube well has been calculated separately to assess the ground water draft for irrigation. The block-wise ground water resources and draft as an outcome of NAQUIM is presented in the Table no. 4.2 and 4.3.

Table 4.1: Dynamic Ground Water Resources (as on March 2020)

Assessment Unit / District	Recharge worthy area (ha)	Annual Extractable Ground Water Resource (Ham)	Ground Water Extraction for Irrigation use (Ham)	Ground Water Extraction for Domestic use (Ham)	Total Extraction (Ham)	Annual GW Allocation for Domestic Use as on 2025 (Ham)	Net Ground Water Availability for Future use in Ham	Stage of Ground Water Extraction in %
Ashta	118191	11674.6	11081.00	554.61	11635.63	625.44	413.74	99.67
Budhni	59773	9576.53	3317.75	201.00	3518.76	217.18	6041.59	36.74
Ichawar	52505	7766.85	4836.06	393.03	5229.1	424.66	2506.13	67.33
NasrullaGanj	88842	13425.5	5291.94	435.00	5726.93	486.13	7647.44	42.66
Sehore	144661	22744.33	13508.35	781.94	14290.3	852.37	8383.61	62.83
District total	463972	65187.81	38035.12	2365.6	40400.72	2605.78	24992.51	61.98

Table 4.2: Total Ground Water Recharge

S. No.	Assessment Unit Name	Recharge from Canals (Ham)	Recharge from Surface Water Irrigation (Ham)	Recharge from Ground Water Irrigation (Ham)	Recharge due to Tanks and Ponds (Ham)	Recharge due to Water Conservation Structures (Ham)	Total Recharge from Other Sources (Ham)
1.	ASHTA	45.6	399.96	2783.88	198.29	10.2	3437.93
2.	BUDHNI	735.6	1233.36	883.23	256.87	14.4	3123.46
3.	ICHAWAR	22.8	111.96	1223.46	114.41	11.64	1484.27
4.	NASRULLA GANJ	280.8	939.49	1361.68	623.95	23.04	3228.96
5.	SEHORE	31.2	439.56	3392.85	310.85	13.92	4188.38
	DISTRICT TOTAL	**1116**	**3124.33**	**9645.1**	**1504.37**	**73.2**	**15463.00**

Table 4.3: Total Groundwater extraction

S. No.	Assessment Unit Name	Ground Water Extraction for Irrigation Use (Ham)	Ground Water Extraction for Domestic Use (Ham)	Total Extraction (Ham)	Stage of Ground Water Extraction (%)	Categorization
1.	Sehore	13508.35	781.94	14290.3	62.83	safe
2.	Nasrulla ganj	5291.94	435.00	5726.93	42.66	safe
3.	Ashta	11081.016	554.61	11635.63	99.67	critical
4.	Ichawar	4836.06	393.03	5229.1	67.33	safe
5.	Budhni	3317.75	201.00	3518.76	36.74	safe
	DISTRICT TOTAL	**38035.12**	**2365.6**	**40400.72**	**61.98**	Safe

Chapter-5
GROUND WATER RELATED ISSUES

5.1 Declining of ground water level

The long-term water level trend analysis indicates mixed results. During pre-monsoon season, out of 38 Hydrograph Stations, 11stations are showing declining trend (Fig. 5.1).

Similarly, during post-monsoon season, out of 38 stations 6 stations are showing falling trend in the district.

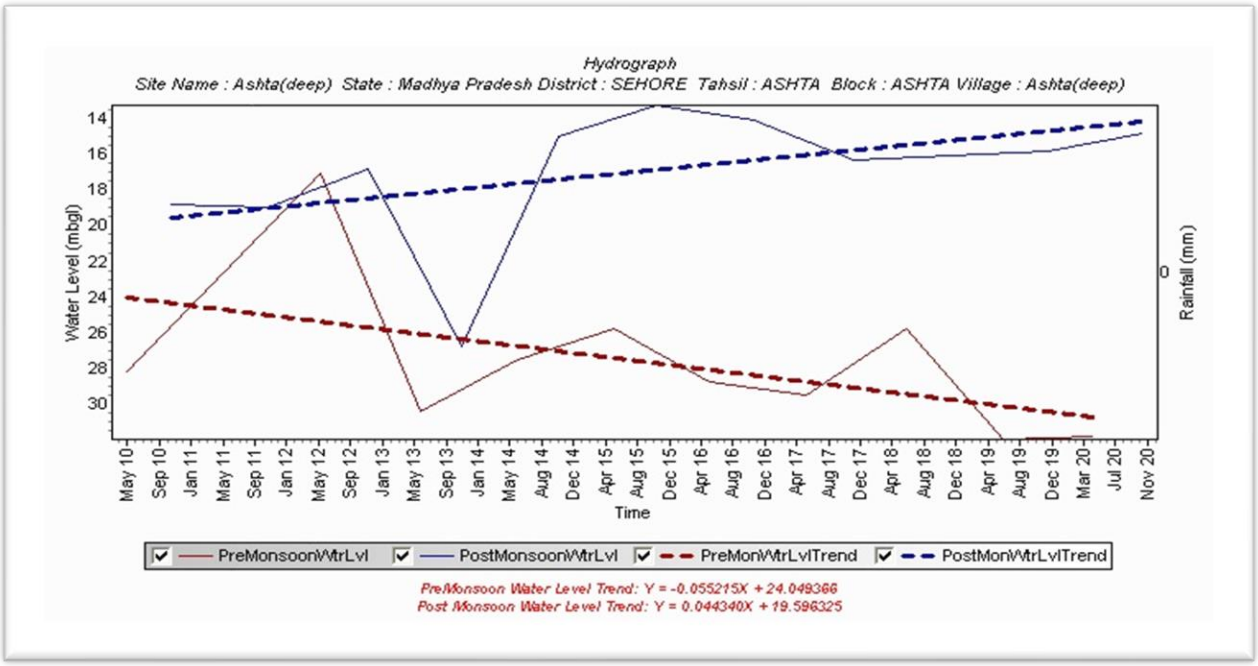

Fig 5.1(a): Ashta, Block Ashta (Deep)

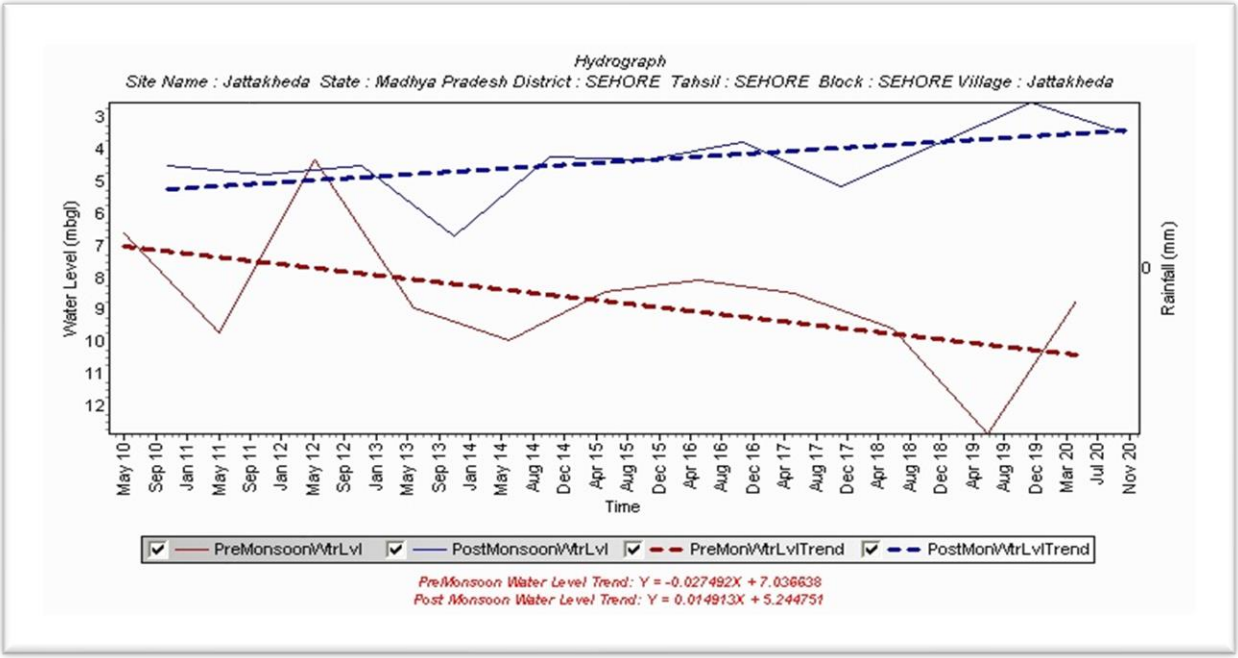

Fig 5.1(b): Village Jattakheda, Block Sehore

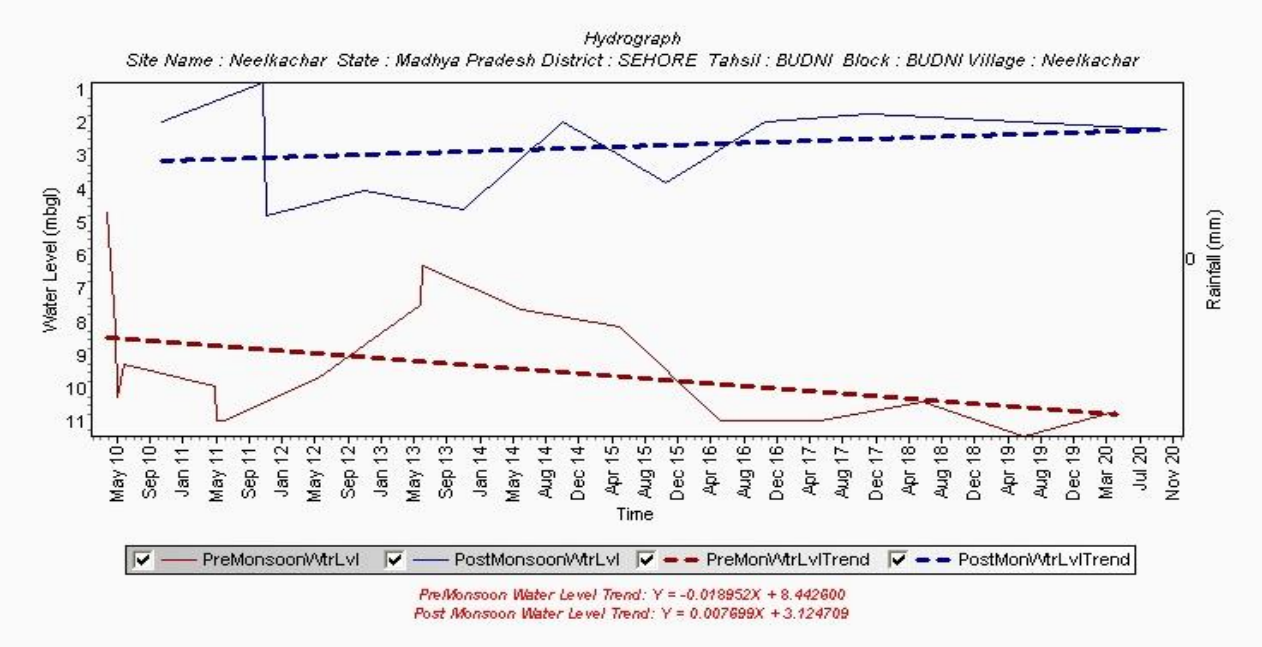

Fig 5.1(c): Village Neelkachar, Block Budhni

Fig 5.1: Hydrographs showing declining water level trend during Pre-monsoon at sites Ashta, Neelkachar & Jattakheda, Sehore District, Madhya Pradesh

5.2 Stage of Ground Water Extraction

Ground Water Resource Estimation reveals that out of 5 blocks of the district 1 block (Ashta) has crossed 90% stage of ground water development and it is falling under critical category.

Over all stage of ground water development of the district is computed as 61.98%, which cautions for further uncontrolled withdrawal of ground water.

5.3 Ground water quality

Excessive nitrate content is reported in the district at Khachrod, Neelkachar, Kankadkheda, Nadan, Larki new, Rala, Bhandeli. Highest concentration is at Rala village, Block Sehore (141 mg/l). High nitrate content in ground water of these areas is perhaps from seepage of sewerage into ground water system of the area, causing local pollution and contamination of ground water.

The EC values higher than 1000 µS/cm has also been found at places in Sehore district. Although the district does not face salinity problems but the higher value of more than 3229 µS/cm has been found at Ashta.

Chapter-6
GROUND WATER MANAGEMENT STRATEGIES

Groundwater has been contributing more to agricultural wealth than surface irrigation since ages. Tube wells are now the largest source of irrigation in the country. Since this sector has almost no dependence on the government, it is growing at a rapid rate and it is estimated that one million wells are added every year (Shah and Deb, 2004). Being an individually managed source, ground water irrigation is also a more efficient form of irrigation, with crop yields per cubic meter of water being 1.2 to 3 times higher than surface irrigation. However, since this sector has grown through investment by individual farmers, with little state involvement compared to canal irrigation, government support for understanding this sector and improving its performance is negligible. The major issues for the future growth of groundwater irrigation are declining resource base, demand driven growth, and a lack of policy and regulatory framework. Since groundwater extraction is primarily driven by the needs of the population and the density of farmer population and not the quality of resource, groundwater irrigation is scaling up even in such hard rock areas causing irreversible depletion of the resource base (Shah and Deb, 2004). To warrant the current situation effective groundwater management strategies needs to be evolved.

6.1 District Ground Water Management Plan (Outcome of NAQUIM)

There is a need of sustainable water conservation and management practices through an integrated approach for the optimal utilization of ground water resources in the district. The ground water management plan for Sehore district has been made keeping in view the area specific details and includes the strategies like enhancing the ground water resources through construction of artificial recharge structures such as percolation tanks, check dams/nala bunds, recharge shafts, etc. and ensuring water use efficiency through maintenance/ renovation of existing water bodies/water conservation structures. Also, adoption of micro-irrigation techniques such as sprinkler irrigation has been proposed, that would not only conserve ground water resources by reducing the draft, but would also increase the net cropping area thereby augmenting the agricultural economy of the district.

6.1.1 Supply Side Management

Artificial recharge to ground water is one of the most efficient, scientifically proven and cost effective technology to mitigate the problems of over exploitation of ground water resources. The artificial recharge techniques simultaneously rejuvenates the depleted ground water storage, reduces the ground water quality problems and also improves the sustainability of wells in the affected areas.

The supply side management plan for Sehore district has been formulated using the basic concepts of hydrogeology. Sub-surface storage is calculated by multiplying the total area with the

respective specific yield (considering the variable lithology) and the unsaturated zone thickness obtained by subtracting 3 mts from the post-monsoon water level. The volume of ground water recharge generated through pre-existing rain water harvesting/water conservation structures is subtracted from the sub-surface storage to assess the available storage potential. Thus, the surface water requirement to completely saturate the sub-surface storage is obtained by multiplying a factor of 1.33 to available storage potential.

A runoff coefficient factor of 0.23 has been considered for Sehore district to calculate the total surface water runoff, 30% of which accounts to the non-committed runoff which is available to sustain the proposed artificial recharge structures. Further, the number of structures has been calculated by allotting 35%, 20% and 35% of non-committed runoff to Percolation tanks, Recharge shafts/Tube wells and Nala bunds/Check dams/Cement Plugs respectively.

The remaining runoff is considered to restore the pre-existing village tanks, ponds and water conservation structures. A detailed calculation of the proposed artificial recharge structures is presented in the Table no. 6.1.

A financial outlay plan has also been chalked out, assuming the cost for the artificial recharge structures to be Rs. 20 lakhs each for percolation tanks, Rs. 4 lakhs each for Nala bunds/Check Dams/Cement Plugs, Rs. 1 lakh each for Recharge shafts and Rs. 2.5 lakhs each for renovation of Village tanks/ponds/WCS. This accounts to a total of Rs. 443.72Crores to successfully implement the supply side management strategy. Table no. 6.2 represents the complete financial outlay plan for the district.

6.1.2 Demand Side Management

Micro irrigation technologies such as drip and sprinkler systems are being increasingly promoted as technological solutions for achieving water conservation. Micro-irrigation comprises two technologies—drip and sprinkler irrigation. Both saves conveyance losses and improve water application efficiency by applying water near the root-zone of the plant. Some benefits of the micro-irrigation have been listed below:

1. The increase in yield for different crops ranges from 27 per cent to 88 per cent and water saving ranges from 36 per cent to 68 per cent vis-à-vis conventional flow irrigation systems (Phansalker and Verma, 2005).

2. It enables farmers to grow crops which would not be possible under conventional systems since it can irrigate adequately with lower water quantities.

3. It saves costs of hired labour and other inputs like fertilizer.

4. It reduces the energy needs for pumping, thus reducing energy per ha of irrigation because of its reduced water needs. However, overall energy needs of the agriculture sector may not get reduced because most farmers use the increased water efficiency to bring more area under irrigation.

Adoption of Sprinkler irrigation techniques would save 20% of gross ground water draft for irrigation. Also, the 60% of additional recharge created by construction of artificial recharge structures can be utilized to increase the total cropping area, thereby enhancing the productivity and economy of the district.

Table 6.1: Ground Water Management– Supply Side, Sehore District, Madhya Pradesh

Block	Rainfall (m)	Area (Sq Km)	Area suitable for recharge (Sq Km)	Average post-monsoon water level (m)	Unsaturated zone (m)	Average SP Yield (%)	Sub-surface storage (mcm)	Surface water required (mcm)	Surface water (Run-off) available (mcm)	Non-committed Run-off (mcm)	Percolation tank proposed	Recharge shaft proposed	Nala bund/ Cement plug	No of Village ponds
Ashta	1.15	1442.57	1181.91	6.31	3.31	0.02	78.24	104.06	331.8	99.54	132	1068	468	455
Budhni	1.15	1075.11	597.73	6.56	3.56	0.02	42.56	56.60	247.3	74.18	95	815	271	280
Ichawar	1.15	1110.85	525.05	4.91	1.91	0.02	20.06	26.68	255.5	76.65	46	220	123	115
Nasrullaganj	1.15	1365.22	888.42	7.38	4.38	0.02	77.83	103.51	314.0	94.20	162	1125	448	464
Sehore	1.15	1584.25	1446.61	4.78	1.78	0.02	51.50	68.49	364.4	109.31	108	739	333	326
Total	**0.95**	6578	4639.72	29.94	14.94	0.1	270.18	359.34	1512.94	453.88	543	3967	1643	1640

Table 6.2: Financial Outlay Plan- Supply Side Management, Sehore District, Madhya Pradesh

Block Name	Proportionate Surface water for planning AR (MCM)	Percolation Tanks structure (Nos)	cost (crores)	NB// CP structure (Nos)	cost (crores)	Recharge shaft (Nos)	cost (crores)	Renovation of Village Ponds structure (Nos)	cost (crores)	Total Cost of Rs. in crores
Ashta	99.54	132	26.4	468	4.68	1068	10.68	455	11.375	53.135
Budhni	56.60	95	19	271	2.71	815	8.15	280	7	36.86
Ichawar	26.68	46	9.2	123	1.23	220	2.2	115	2.875	15.505
Nasrullaganj	94.20	162	32.4	448	4.48	1125	11.25	464	11.6	59.73
Sehore	68.49	108	21.6	333	3.33	739	7.39	326	8.15	40.47
TOTAL	345.5099	543	108.6	1643	16.43	3967	39.67	1640	41	205.7

6.2 Post-Intervention Impact

The expected outcome of the proposed interventions from both supply side and demand side has been described. It can be envisaged that the Stage of ground water development for the Ashta block of Sehore district, would reduce to 87.23% as compared to the present stage of ground water development of 99.67% after implying and successful implementation of proposed interventions.

6.3 Block-wise Ground Water Management Plan (Outcome of NAQUIM)

As per directions of Ministry of Water Resources, River Development and Ganga Rejuvenation, Government of India, Aquifer Management Plan for Sehore district has been prepared block-wise. The plan for each block discusses the broad framework of ground water situation in the block, status of water availability (both surface and ground water), feasibility of artificial recharge and other water conservation structures and their numbers and cost estimates.

Table 6.3: Post-Intervention Impact, Sehore District, Madhya Pradesh

Block	Annual Extractable Groundwater Resource	Total Extraction	Stage of Ground water Extraction	Saving by Sprinkler	Additional recharge created by AR	After intervention of AR Structure Net extractable GW	After intervention of AR Structure & utilization of additional GW created	Extraction after sprinkler	Additional area irrigated by GW after intervention	Stage of Extraction
	MCM	**MCM**	**%**	**MCM**	**MCM**	**MCM**	**MCM**	**MCM**	**Sq.Km**	**%**
Ashta	116.75	116.35	99.67	8.86	78.24	194.99	62.59	170.09	156.48	87.23
Budhni	95.77	35.18	36.74	2.65	42.56	138.33	42.56	75.09	425.58	54.29
Ichawar	77.66	52.29	67.33	3.87	20.06	97.72	16.05	64.47	160.46	66
Nasrullaganj	134.26	57.27	42.66	4.23	77.83	212.09	62.26	115.30	155.65	54.36
Sehore	227.44	142.90	62.83	10.81	51.50	278.94	41.20	173.29	103.00	62.13
TOTAL	651.88	404.00	61.98	30.43	270.18	922.06	224.66	598.23	1001.17	64.88

6.4 Block wise Groundwater Management Plan

MANAGEMENT PLAN ASHTA BLOCK

Area (sq km)	**1442.57**
Rainfall (m)	1.15
Area suitable for recharge (sq km)	1181.91
Unsaturated zone (m)	3.31
Average specific yield (%)	0.02
Sub Surface Storage available (MCM)	78.24
Surface water required (MCM)	104.06
Runoff available (MCM)	331.8
Non Committed Runoff available (MCM)	99.54
No. of Percolation tanks	132

No. of Recharge shaft	1068
No. of NB/CD/CP	468
No. of Village Ponds	455

MANAGEMENT PLAN ASHTA BLOCK

Type of structure	**Number**	**Cost INR (Crore)**
Percolation Tanks	132	26.4
Recharge Shaft/ Tube Wells	1068	10.68
NB/CD/CP	468	4.68
Renovation of Village Ponds	455	11.37
Total Cost		53.13

Block	Annual Extractable Groundwater Resource	Total Extraction	Stage of Groundwater Extraction	Saving by Sprinkler	Additional Recharge created by AR	After Intervention of AR structure Net Extractable GW	After Intervention of AR structure & utilization of additional GW created	Extraction after sprinkler	Additional area irrigated by GW after intervention	Stage of Extraction
	MCM	MCM	%	MCM	MCM	MCM	MCM	MCM	Sq km	%
Ashta	116.75	116.35	99.67	8.86	78.24	194.99	62.59	175.09	156.48	87.23

MANAGEMENT PLAN BUDHNI BLOCK

Area (sq km)	**1075.11**
Rainfall (m)	1.15
Area suitable for recharge (sq km)	597.73
Unsaturated zone (m)	3.56

Average specific yield (%)	0.02
Sub Surface Storage available (MCM)	42.56
Surface water required (MCM)	56.60
Runoff available (MCM)	247.3
Non Committed Runoff available (MCM)	74.18
No. of Percolation tanks	95
No. of Recharge Shaft	815
No. of NB/CD/CP	271
No. of Village Ponds	280

MANAGEMENT PLAN BUDHNI BLOCK

Type of structure	Number	Cost INR (Crore)
Percolation Tanks	95	19
Recharge Shaft/ Tube Wells	815	8.15
NB/CD/CP	271	2.71
Renovation of Village Ponds	280	7
Total Cost		36.86

Block	Annual Extractable Groundwater Resource	Total Extraction	Stage of Groundwater Extraction	Saving by Sprinkler	Additional Recharge created by AR	After Intervention of AR structure Net Extractable GW	After Intervention of AR structure & utilization additional GW created	Extraction after sprinkler	Additional area irrigated by GW after intervention	Stage of Extraction
	MCM	MCM	%	MCM	MCM	MCM	MCM	MCM	Sq km	%
Budhni	95.77	35.18	36.74	2.65	42.56	138.33	42.56	75.09	425.58	54.29

MANAGEMENT PLAN ICHHAWAR BLOCK

Area (sq km)	**1110.85**
Rainfall (m)	1.15
Area suitable for recharge (sq km)	525.05
Unsaturated zone (m)	1.91
Average specific yield (%)	0.02
Sub Surface Storage available (MCM)	20.06
Surface water required (MCM)	26.68
Runoff available (MCM)	255.5
Non Committed Runoff available (MCM)	76.65
No. of Percolation tanks	46
No. of Recharge Shaft	220
No. of NB/CD/CP	123
No. of Village Ponds	115

MANAGEMENT PLAN ICHHAWAR BLOCK

Type of structure	Number	Cost INR (Crore)
Percolation Tanks	46	9.2
Recharge Shaft/ Tube Wells	220	2.2
NB/CD/CP	123	1.23
Renovation of Village Ponds	115	2.87
Total Cost		15.50

Block	Annual Extractable Groundwater Resource	Total Extraction	Stage of Groundwater Extraction	Saving by Sprinkler	Additional Recharge created by AR	After Intervention of AR structure Net Extractable GW	After Intervention of AR structure & utilization of additional GW created	Extraction after sprinkler	Additional area irrigated by GW after intervention	Stage of Extraction
	MCM	MCM	%	MCM	MCM	MCM	MCM	MCM	Sq km	%
Ichhawar	77.66	52.29	67.33	3.87	20.06	97.72	16.05	64.47	160.46	66

MANAGEMENT PLAN NASRULLAGANJ BLOCK

Area (sq km)	**1365.22**
Rainfall (m)	1.15
Area suitable for recharge (sq km)	888.42
Unsaturated zone (m)	4.38
Average specific yield (%)	0.02
Sub Surface Storage available (MCM)	77.83
Surface water required (MCM)	103.51
Runoff available (MCM)	314
Non Committed Runoff available (MCM)	94.20
No. of Percolation tanks	162
No. of Recharge Shaft	1125
No. of NB/CD/CP	448
No. of Village Ponds	464

MANAGEMENT PLAN NASRULLAGANJ BLOCK

Type of structure	Number	Cost INR (Crore)
Percolation Tanks	162	32.4
Recharge Shaft/ Tube Wells	1125	11.25
NB/CD/CP	448	4.48
Renovation of Village Ponds	464	11.6
Total Cost		59.73

Block	Annual Extractable Groundwater Resource	Total Extraction	Stage of Groundwater Extraction	Saving by Sprinkler	Additional Recharge created by AR	After Intervention of AR structure Net Extractable GW	After Intervention of AR structure & utilization of additional GW created	Extraction after sprinkler	Additional area irrigated by GW after intervention	Stage of Extraction
	MCM	MCM	%	MCM	MCM	MCM	MCM	MCM	Sq km	%
Nasrullaganj	134.26	57.27	42.66	4.23	77.83	212.09	62.26	115.30	155.65	54.36

MANAGEMENT PLAN SEHORE BLOCK

Area (sq km)	**1584.25**
Rainfall (m)	1.15
Area suitable for recharge (sq km)	1446.61
Unsaturated zone (m)	1.78
Average specific yield (%)	0.02
Sub Surface Storage available (MCM)	51.50
Surface water required (MCM)	68.49
Runoff available (MCM)	364.4

Non Committed Runoff available (MCM)	109.31
No. of Percolation tanks	108
No. of Recharge Shaft	739
No. of NB/CD/CP	333
No. of Village Ponds	326

MANAGEMENT PLAN SEHORE BLOCK

Type of structure	Number	Cost INR (Crore)
Percolation Tanks	108	21.6
Recharge Shaft/ Tube Wells	739	7.39
NB/CD/CP	333	3.33
Renovation of Village Ponds	326	8.15
Total Cost		40.47

Block	Annual Extractable Groundwater Resource	Total Extraction	Stage of Groundwater Extraction	Saving by Sprinkler	Additional Recharge created by AR	After Intervention of AR structure Net Extractable GW	After Intervention of AR structure & utilization of additional GW created	Extraction after sprinkler	Additional area irrigated by GW after intervention	Stage of Extraction
	MCM	MCM	%	MCM	MCM	MCM	MCM	MCM	Sq km	%
Sehore	227.44	142.90	62.83	10.81	51.50	278.94	41.20	173.29	103.00	62.13

Chapter-7
CONCLUSIONS AND RECOMMENDATIONS

- Sehore district occupies an area of 6578sq km out of which the ground water recharge worthy area is 4639sq. km. and the rest is covered by hilly and forest area. The major rivers draining the area includes the rivers Narmada, Chambal & Betwa.

- The major part of the district is covered by Deccan traps and in the southern part, alluvium overlies Deccan trap along the Narmada river.

- Sehore district comprises of five blocks, namely Ashta, Budhni, Ichhawar, Nasrullaganj & Sehore.

- The phreatic aquifer is recharged during monsoon and sustains for 3 to 4 months.

- More stress on Groundwater, 85% of irrigation carried out by Ground water and 15% of irrigation by surface water.

- Groundwater decline range is 0.03 to 0.0.67 m/year. More decline in Ashta & Sehore Blocks. Pre-Monsoon: 0.15-0.6735 m/yr, Post-Monsoon 0.03-0.5895 m/yr.

- Isolated pockets TDS- ranges from >500 to4875 mg/l. Isolated pockets Nitrate ranges from >45 to 141 mg/l.

- As per the Dynamic Ground Water Resource Assessment Report (2020), the net ground water availability in the district is 651.87 MCM and ground water draft for all uses is 404.00 MCM, resulting the stage of ground water development to be 61.98 % as a whole for district. The Sehore district falls under safe category.

- There is 1 critical block named Ashta block out of 5 blocks and its stage of extraction is 99.67%.

- After the implemention of project interventions in the report, additional area for the irrigation will be created 100117 Ha. for Sehore District.

- As per the Management plan prepared under NAQUIM of all the Block of Sehore District, a total number of 543 Percolation Tanks, 1068 Recharge Shafts, 1643 Nala Bunds/Cement Plugs and 1640 Renovation of village ponds have been proposed and

financial expenditure is expected to be Rs 443.72Crores in Sehore District for sustainable development and management of ground water resources.

- The number of artificial recharge structure and financial estimation has been proposed based on the CGWB Master plan 2020. It may differ from the field condition as well as changes in dynamic Ground water resources.

- It is also recommended implementation intervention would be two phased, first phase should be in above 70 % Stage of Extraction of the Blocks.

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Annexure I
Rockwork software Format

Bore	File	Easting	Northing	Elevation	Total Depth
Ashta	Ashta	676785	2545790	499	90
Amlaha	Amlaha	692959	2557004	490	80
Barkheri	Barkheri	720409	2561923	530	239
Jawar	Jawar	654325	2545050	493	120
Jharkheda	Jharkheda	723227	2586414	492	66
Sehore	Sehore	711111	2565465	406	80
Shyampur	Shyampur	715789	2589996	475	60
Machwas	Machwas	700859	2523742	366	200
Kolans Kala	Kolans Kala	727461	2564155	515	295
Ulijhawan	Ulijhawan	723380	2556446	531	161

Bore	File	Easting	Northing	Elevation	Total Depth
Hoshangabad	Hoshangabad	778992	2518404	303	81
Powarkheda	Powarkheda	782486	2514775	318	48

Borehole	Depth 1	Depth 2	Lithology
Ashta	0	1	s
Ashta	1	1	c
Ashta	1	1	sand
Ashta	1	1	gravel
Ashta	1	1	sst
Ashta	1	1	wb
Ashta	1	1	mb1
Ashta	1	1	rb2
Ashta	1	1	vb2
Ashta	1	1	mb2
Ashta	1	1	fb2
Ashta	1	1	vb3
Ashta	1	25	mb3
Ashta	25	27	fb3
Ashta	27	29	rb4
Ashta	29	34	vb4
Ashta	34	34	fb4
Ashta	34	58	mb4
Ashta	58	58	rb5
Ashta	58	60	vb5
Ashta	60	80	mb5
Ashta	80	85	rb6
Ashta	85	85	vb6
Ashta	85	85	fb6
Ashta	85	90	mb6
Amlaha	0	5	s
Amlaha	5	5	c
Amlaha	5	5	sand

Amlaha	5	5	gravel
Amlaha	5	5	sst
Amlaha	5	9	wb
Amlaha	9	9	mb1
Amlaha	9	9	rb2
Amlaha	9	9	vb2
Amlaha	9	9	mb2
Amlaha	9	9	fb2
Amlaha	9	9	vb3
Amlaha	9	31	mb3
Amlaha	31	31	fb3
Amlaha	31	31	rb4
Amlaha	31	37	vb4
Amlaha	37	37	fb4
Amlaha	37	58	mb4
Amlaha	58	58	rb5
Amlaha	58	64	vb5
Amlaha	64	71	mb5
Amlaha	71	74	rb6
Amlaha	74	80	vb6
Barkheri	0	0	s
Barkheri	0	0	c
Barkheri	0	0	sand
Barkheri	0	0	gravel
Barkheri	0	0	sst
Barkheri	0	0	wb
Barkheri	0	11	mb1
Barkheri	11	12	rb2
Barkheri	12	14	vb2
Barkheri	14	36	mb2

Barkheri	36	36	fb2
Barkheri	36	37	vb3
Barkheri	37	77	mb3
Barkheri	77	77	fb3
Barkheri	77	77	rb4
Barkheri	77	78	vb4
Barkheri	78	81	fb4
Barkheri	81	100	mb4
Barkheri	100	100	rb5
Barkheri	100	106	vb5
Barkheri	106	130	mb5
Barkheri	130	130	rb6
Barkheri	130	133	vb6
Barkheri	133	133	fb6
Barkheri	133	145	mb6
Barkheri	145	153	vb7
Barkheri	153	153	mb7
Barkheri	153	153	fb7
Barkheri	153	167	vb8
Barkheri	167	173	mb8
Barkheri	173	174	rb9
Barkheri	174	179	vb9
Barkheri	179	188	mb9
Barkheri	188	188	rb10
Barkheri	188	191	vb10
Barkheri	191	206	mb10
Barkheri	206	207	rb11
Barkheri	207	215	vb11
Barkheri	215	222	fb11
Barkheri	222	234	mb11

Barkheri	234	234	rb12
Barkheri	234	239	vb12
Jawar	0	5	s
Jawar	5	14	c
Jawar	14	14	sand
Jawar	14	14	gravel
Jawar	14	14	sst
Jawar	14	18	wb
Jawar	18	18	mb1
Jawar	18	18	rb2
Jawar	18	18	vb2
Jawar	18	18	mb2
Jawar	18	18	fb2
Jawar	18	18	vb3
Jawar	18	34	mb3
Jawar	34	34	fb3
Jawar	34	34	rb4
Jawar	34	37	vb4
Jawar	37	37	fb4
Jawar	37	55	mb4
Jawar	55	55	rb5
Jawar	55	59	vb5
Jawar	59	87	mb5
Jawar	87	87	rb6
Jawar	87	94	vb6
Jawar	94	94	fb6
Jawar	94	101	mb6
Jawar	101	110	vb7
Jawar	110	120	mb7
Jharkheda	0	5	s

Jharkheda	5	5	c
Jharkheda	5	5	sand
Jharkheda	5	5	gravel
Jharkheda	5	5	sst
Jharkheda	5	27	wb
Jharkheda	27	27	mb1
Jharkheda	27	27	rb2
Jharkheda	27	27	vb2
Jharkheda	27	27	mb2
Jharkheda	27	27	fb2
Jharkheda	27	27	vb3
Jharkheda	27	27	mb3
Jharkheda	27	27	fb3
Jharkheda	27	27	rb4
Jharkheda	27	36	vb4
Jharkheda	36	36	fb4
Jharkheda	36	63	mb4
Jharkheda	63	66	rb5
Sehore	0	2	s
Sehore	2	2	c
Sehore	2	2	sand
Sehore	2	2	gravel
Sehore	2	2	sst
Sehore	2	9	wb
Sehore	9	9	mb1
Sehore	9	9	rb2
Sehore	9	9	vb2
Sehore	9	9	mb2
Sehore	9	9	fb2
Sehore	9	9	vb3

Sehore	9	9	mb3
Sehore	9	9	fb3
Sehore	9	9	rb4
Sehore	9	9	vb4
Sehore	9	9	fb4
Sehore	9	9	mb4
Sehore	9	9	rb5
Sehore	9	9	vb5
Sehore	9	9	mb5
Sehore	9	9	rb6
Sehore	9	9	vb6
Sehore	9	9	fb6
Sehore	9	29	mb6
Sehore	29	29	vb7
Sehore	29	35	mb7
Sehore	35	35	fb7
Sehore	35	35	vb8
Sehore	35	54	mb8
Sehore	54	54	rb9
Sehore	54	57	vb9
Sehore	57	65	mb9
Sehore	65	68	rb10
Sehore	68	80	vb10
Shyampur	0	2	s
Shyampur	2	2	c
Shyampur	2	2	sand
Shyampur	2	2	gravel
Shyampur	2	2	sst
Shyampur	2	9	wb
Shyampur	9	9	mb1

Shyampur	9	9	rb2
Shyampur	9	9	vb2
Shyampur	9	9	mb2
Shyampur	9	9	fb2
Shyampur	9	9	vb3
Shyampur	9	18	mb3
Shyampur	18	18	fb3
Shyampur	18	18	rb4
Shyampur	18	22	vb4
Shyampur	22	22	fb4
Shyampur	22	45	mb4
Shyampur	45	58	vb5
Shyampur	58	60	mb5
Machwas	0	1	s
Machwas	1	1	c
Machwas	1	1	sand
Machwas	1	1	gravel
Machwas	1	1	sst
Machwas	1	5	wb
Machwas	5	5	mb1
Machwas	5	5	rb2
Machwas	5	5	vb2
Machwas	5	5	mb2
Machwas	5	5	fb2
Machwas	5	5	vb3
Machwas	5	5	mb3
Machwas	5	5	fb3
Machwas	5	5	rb4
Machwas	5	5	vb4
Machwas	5	5	fb4

Machwas	5	5	mb4
Machwas	5	5	rb5
Machwas	5	5	vb5
Machwas	5	5	mb5
Machwas	5	5	rb6
Machwas	5	5	vb6
Machwas	5	5	fb6
Machwas	5	5	mb6
Machwas	5	5	vb7
Machwas	5	5	mb7
Machwas	5	5	fb7
Machwas	5	5	vb8
Machwas	5	5	mb8
Machwas	5	5	rb9
Machwas	5	5	vb9
Machwas	5	5	mb9
Machwas	5	5	rb10
Machwas	5	5	vb10
Machwas	5	5	mb10
Machwas	5	5	rb11
Machwas	5	5	vb11
Machwas	5	5	fb11
Machwas	5	71	mb11
Machwas	71	73	rb12
Machwas	73	78	vb12
Machwas	78	96	mb12
Machwas	96	102	rb13
Machwas	102	110	fb13
Machwas	110	140	mb13
Machwas	140	142	rb14

Machwas	142	148	vb14
Machwas	148	200	mb14
Kolanskala	0	2	s
Kolanskala	2	14	c
Kolanskala	14	14	sand
Kolanskala	14	14	gravel
Kolanskala	14	14	sst
Kolanskala	14	14	wb
Kolanskala	14	14	mb1
Kolanskala	14	14	rb2
Kolanskala	14	14	vb2
Kolanskala	14	14	mb2
Kolanskala	14	14	fb2
Kolanskala	14	17	vb3
Kolanskala	17	63	mb3
Kolanskala	63	63	fb3
Kolanskala	63	63	rb4
Kolanskala	63	66	vb4
Kolanskala	66	66	fb4
Kolanskala	66	90	mb4
Kolanskala	90	90	rb5
Kolanskala	90	93	vb5
Kolanskala	93	108	mb5
Kolanskala	108	111	rb6
Kolanskala	111	114	vb6
Kolanskala	114	114	fb6
Kolanskala	114	126	mb6
Kolanskala	126	133	vb7
Kolanskala	133	192	mb7
Kolanskala	192	192	fb7

Kolanskala	192	192	vb8
Kolanskala	192	192	mb8
Kolanskala	192	192	rb9
Kolanskala	192	192	vb9
Kolanskala	192	192	mb9
Kolanskala	192	192	rb10
Kolanskala	192	192	vb10
Kolanskala	192	192	mb10
Kolanskala	192	197	rb11
Kolanskala	197	197	vb11
Kolanskala	197	197	fb11
Kolanskala	197	218	mb11
Kolanskala	218	221	rb12
Kolanskala	221	228	vb12
Kolanskala	228	243	mb12
Kolanskala	243	252	rb13
Kolanskala	252	252	fb13
Kolanskala	252	280	mb13
Kolanskala	280	286	rb14
Kolanskala	286	290	vb14
Kolanskala	290	295	mb14
Ulijhawan	0	12	c
Ulijhawan	12	12	sand
Ulijhawan	12	12	gravel
Ulijhawan	12	12	sst
Ulijhawan	12	14	wb
Ulijhawan	14	14	mb1
Ulijhawan	14	14	rb2
Ulijhawan	14	14	vb2
Ulijhawan	14	45	mb2

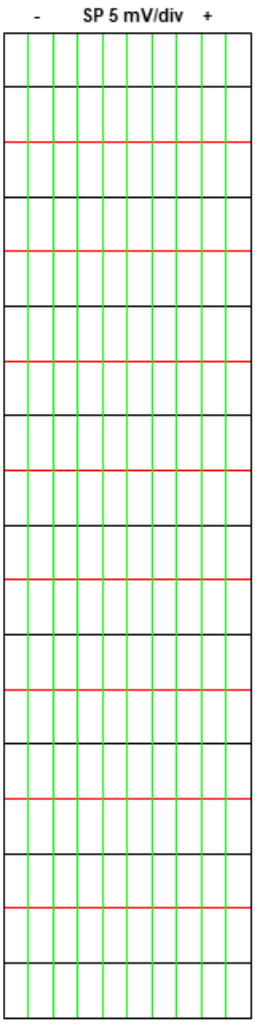
Ulijhawan	45	45	fb2
Ulijhawan	45	45	vb3
Ulijhawan	45	78	mb3
Ulijhawan	78	78	fb3
Ulijhawan	78	78	rb4
Ulijhawan	78	81	vb4
Ulijhawan	81	81	fb4
Ulijhawan	81	93	mb4
Ulijhawan	93	93	rb5
Ulijhawan	93	103	vb5
Ulijhawan	103	129	mb5
Ulijhawan	129	129	rb6
Ulijhawan	129	132	vb6
Ulijhawan	132	133	fb6
Ulijhawan	133	161	mb6
Hoshangabad	0	10	c
Hoshangabad	10	23	sand
Hoshangabad	23	65	gravel
Hoshangabad	65	70	sst
Hoshangabad	70	70	wb
Hoshangabad	70	70	mb1
Hoshangabad	70	70	rb2
Hoshangabad	70	70	vb2
Hoshangabad	70	70	mb2
Hoshangabad	70	70	fb2
Hoshangabad	70	70	vb3
Hoshangabad	70	70	mb3
Hoshangabad	70	70	fb3
Hoshangabad	70	70	rb4
Hoshangabad	70	70	vb4

Hoshangabad	70	70	fb4
Hoshangabad	70	70	mb4
Hoshangabad	70	70	rb5
Hoshangabad	70	70	vb5
Hoshangabad	70	70	mb5
Hoshangabad	70	70	rb6
Hoshangabad	70	70	vb6
Hoshangabad	70	70	fb6
Hoshangabad	70	70	mb6
Hoshangabad	70	70	vb7
Hoshangabad	70	70	mb7
Hoshangabad	70	70	fb7
Hoshangabad	70	70	vb8
Hoshangabad	70	70	mb8
Hoshangabad	70	70	rb9
Hoshangabad	70	70	vb9
Hoshangabad	70	70	mb9
Hoshangabad	70	70	rb10
Hoshangabad	70	70	vb10
Hoshangabad	70	70	mb10
Hoshangabad	70	70	rb11
Hoshangabad	70	70	vb11
Hoshangabad	70	70	fb11
Hoshangabad	70	70	mb11
Hoshangabad	70	70	rb12
Hoshangabad	70	70	vb12
Hoshangabad	70	70	mb12
Hoshangabad	70	70	rb13
Hoshangabad	70	70	fb13
Hoshangabad	70	70	mb13

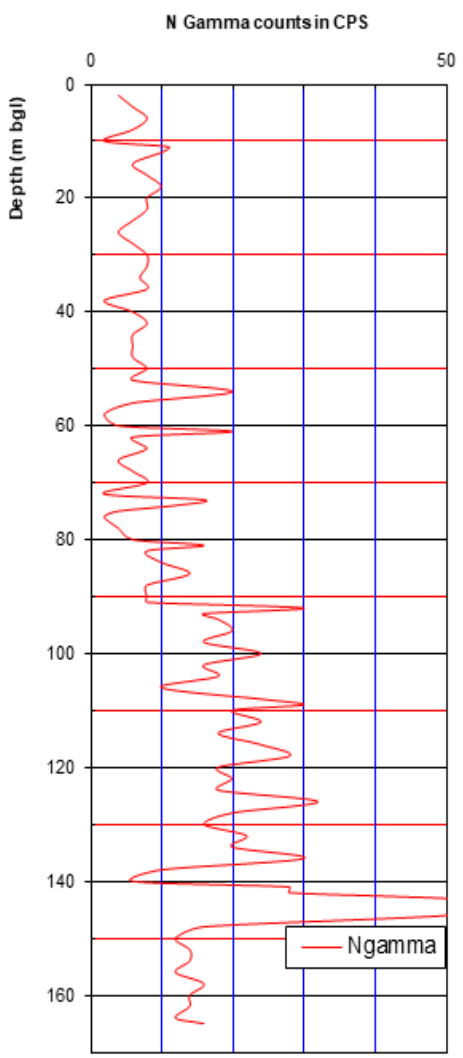
Hoshangabad	70	70	rb14
Hoshangabad	70	70	vb14
Hoshangabad	70	81	mb14
Powarkheda	0	3	s
Powarkheda	3	13	c
Powarkheda	13	36	sand
Powarkheda	36	36	gravel
Powarkheda	36	36	sst
Powarkheda	36	46	wb
Powarkheda	46	46	mb1
Powarkheda	46	46	rb2
Powarkheda	46	46	vb2
Powarkheda	46	46	mb2
Powarkheda	46	46	fb2
Powarkheda	46	46	vb3
Powarkheda	46	46	mb3
Powarkheda	46	46	fb3
Powarkheda	46	46	rb4
Powarkheda	46	46	vb4
Powarkheda	46	46	fb4
Powarkheda	46	46	mb4
Powarkheda	46	46	rb5
Powarkheda	46	46	vb5
Powarkheda	46	46	mb5
Powarkheda	46	46	rb6
Powarkheda	46	46	vb6
Powarkheda	46	46	fb6
Powarkheda	46	46	mb6
Powarkheda	46	46	vb7
Powarkheda	46	46	mb7

Powarkheda	46	46	fb7
Powarkheda	46	46	vb8
Powarkheda	46	46	mb8
Powarkheda	46	46	rb9
Powarkheda	46	46	vb9
Powarkheda	46	46	mb9
Powarkheda	46	46	rb10
Powarkheda	46	46	vb10
Powarkheda	46	46	mb10
Powarkheda	46	46	rb11
Powarkheda	46	46	vb11
Powarkheda	46	46	fb11
Powarkheda	46	46	mb11
Powarkheda	46	46	rb12
Powarkheda	46	46	vb12
Powarkheda	46	46	mb12
Powarkheda	46	46	rb13
Powarkheda	46	46	fb13
Powarkheda	46	48	mb13

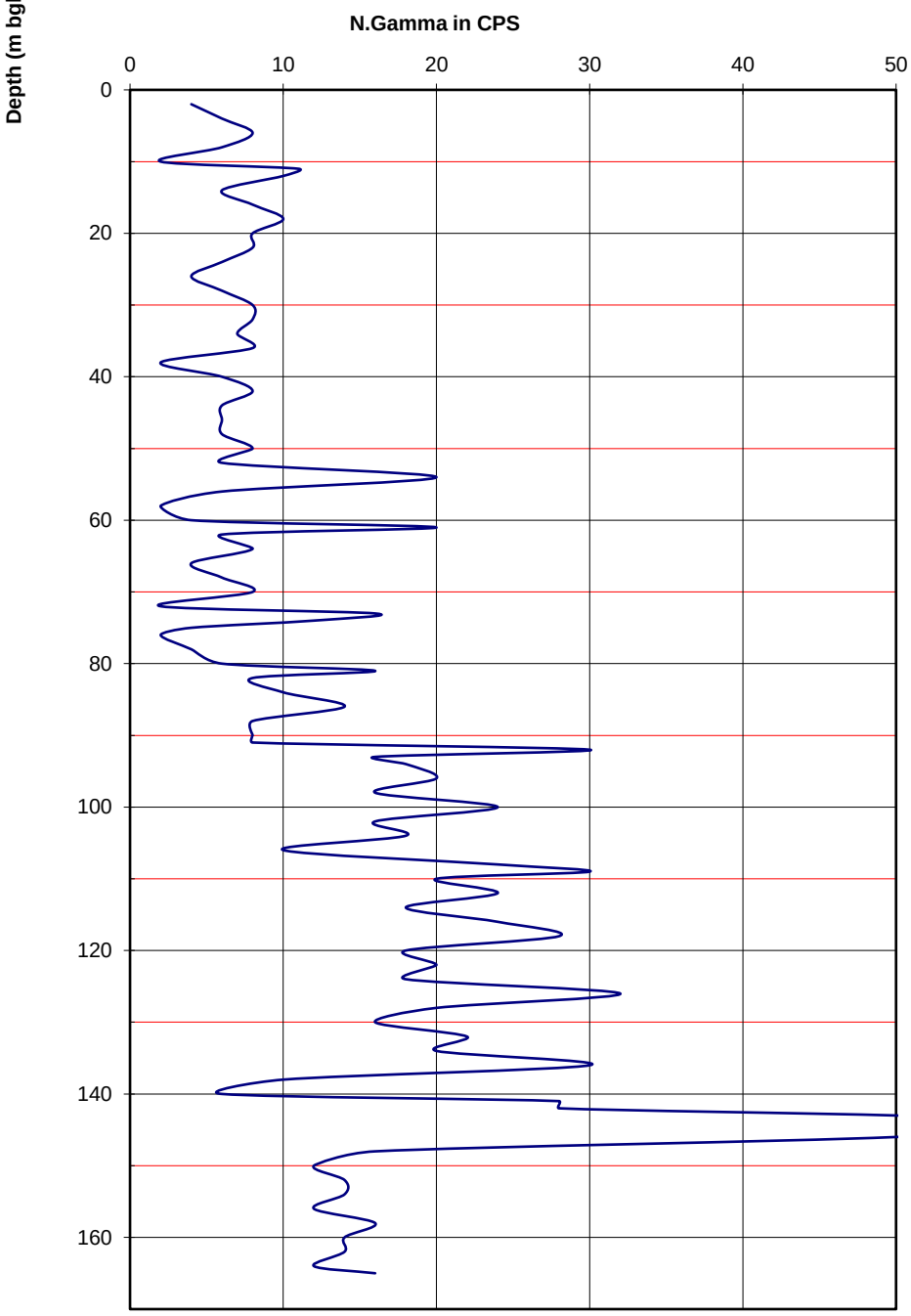
Location : SeriCulture.Sehore
Logging Date : 02.10.01
Llogged Depth :165 m.b.g.l.
Drilled Depth :168.7 m.b.g.l.



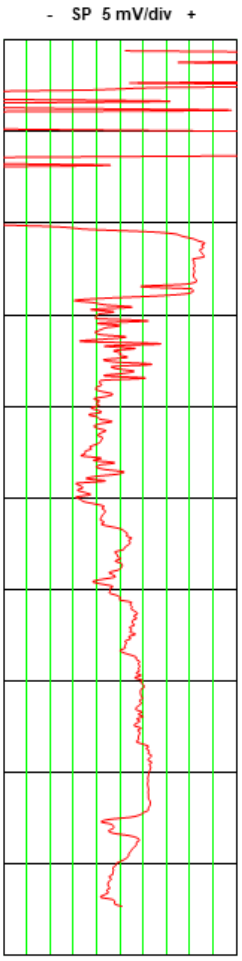
Logger :Geologger3030, Logged by :H. S.Namdeo
Exploratory Borehole,
Geology:**Deccan Trap**



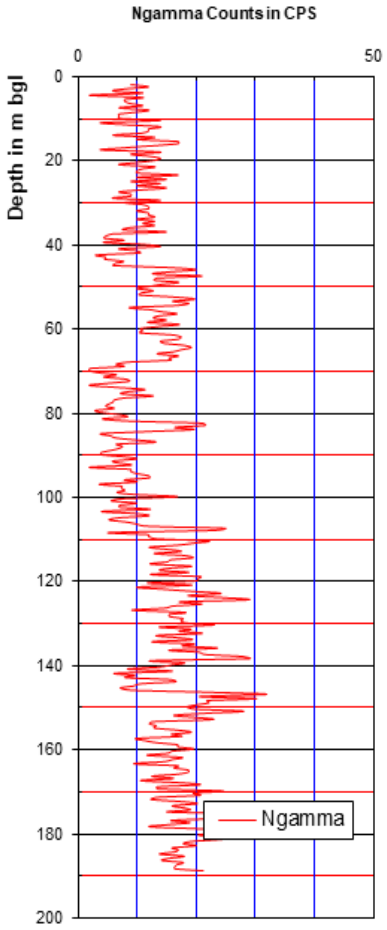
Logger :Geologger3030 Logged by : HS Namdeo
Exploratory Borehole at SeriCulture, Sehore
Geology: **Deccan Trap**



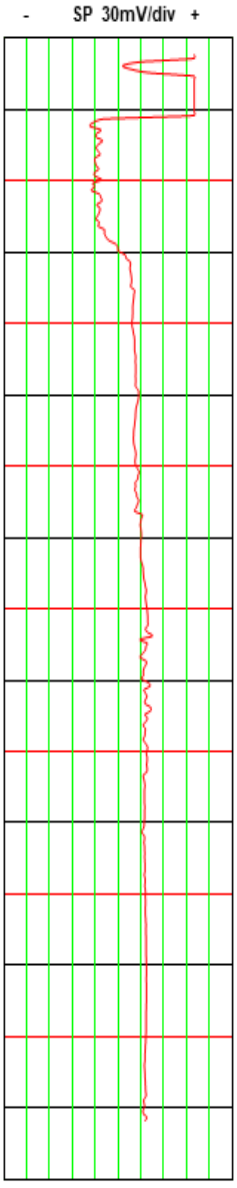
LOCATION :**Gurbhela**, Sehore
Log. Date: 5.10.01
loged depth: 190 m.b.g.l.
Drilled Depth: 200 m.b.g.l.



Logger:geologger3030, logged by :H.S.Namdeo
BH Dia:216 mm
Geology:**Deccan Trap**

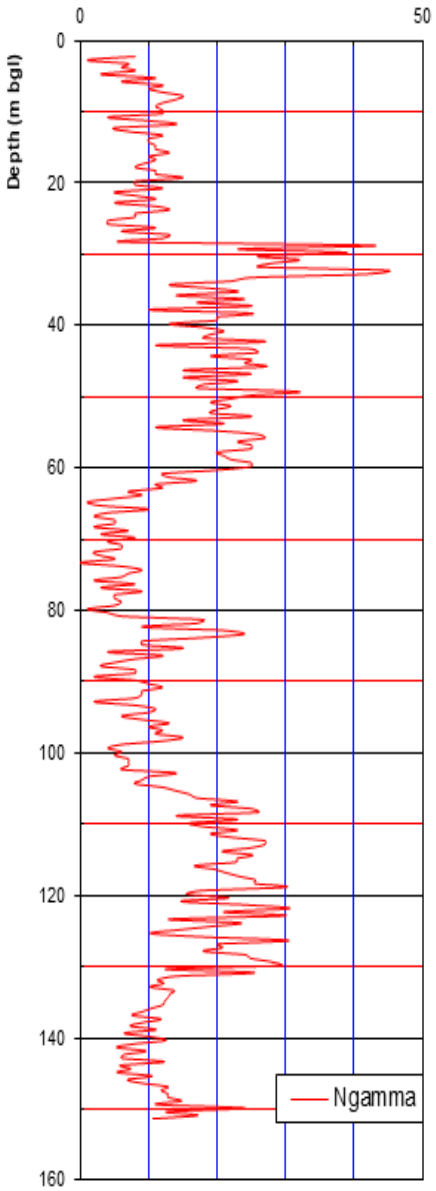


Location:**Dhamunda,Sehore**
Log Date:7.10.01
Logged depth : 149 m.b.g.l.
Drilled Depth : 200 m.b.g.l.

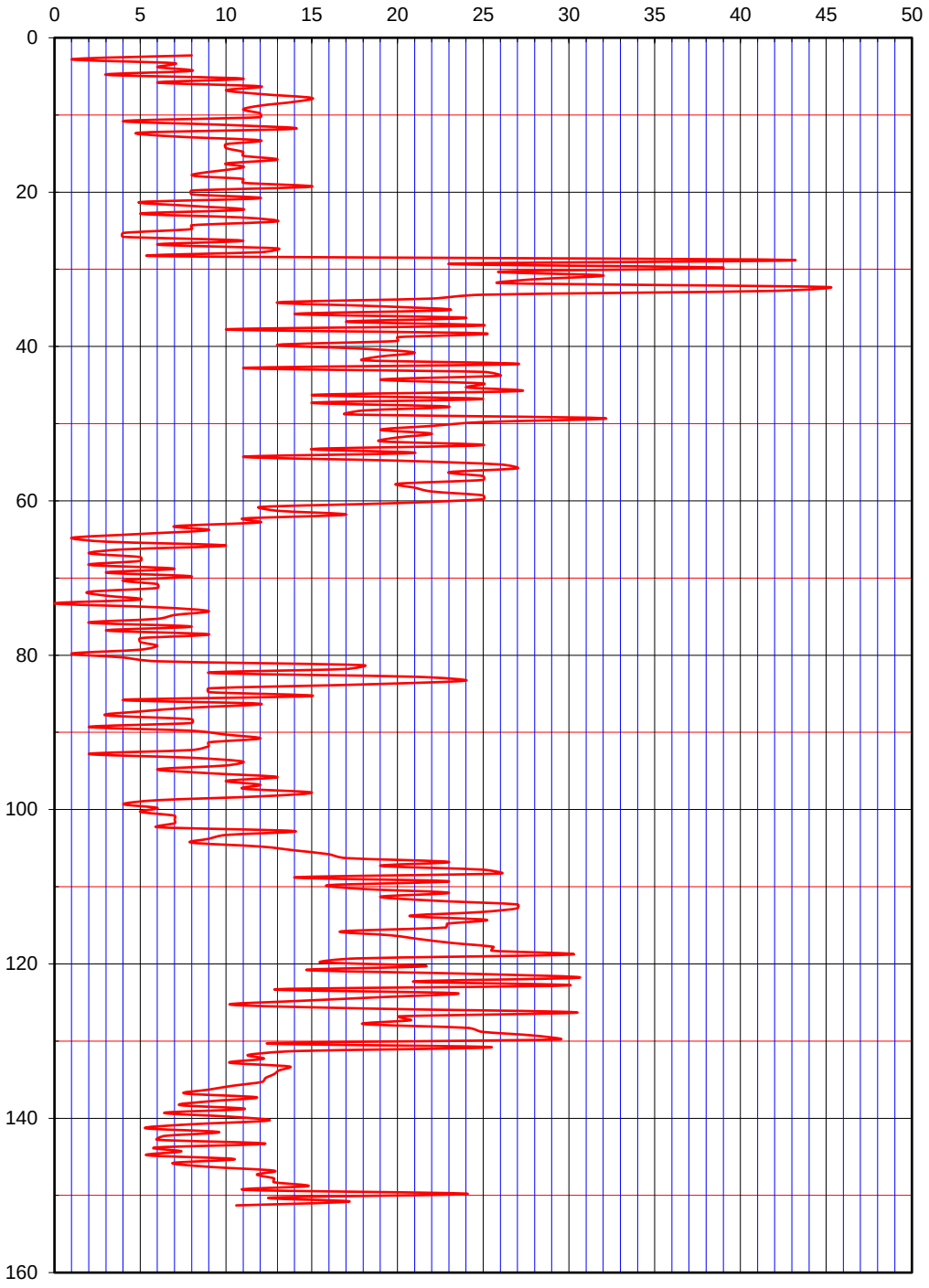


Logger :Geologger3030, Logged by :H.S.Namdeo
Exploratory Borehole,
Geology:**DeccanTrap**

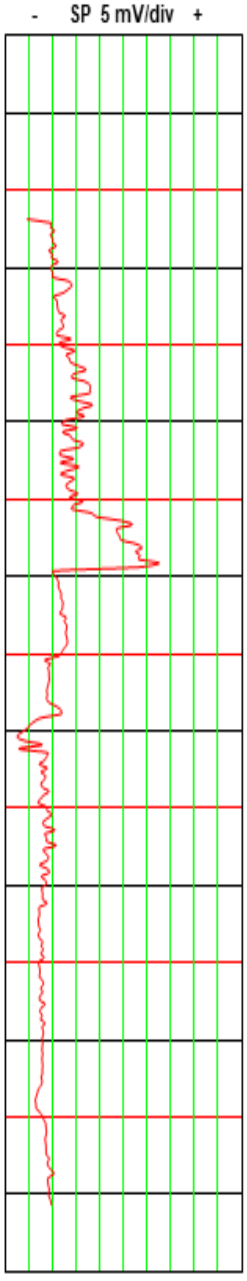
Ngamma CountsinCPS



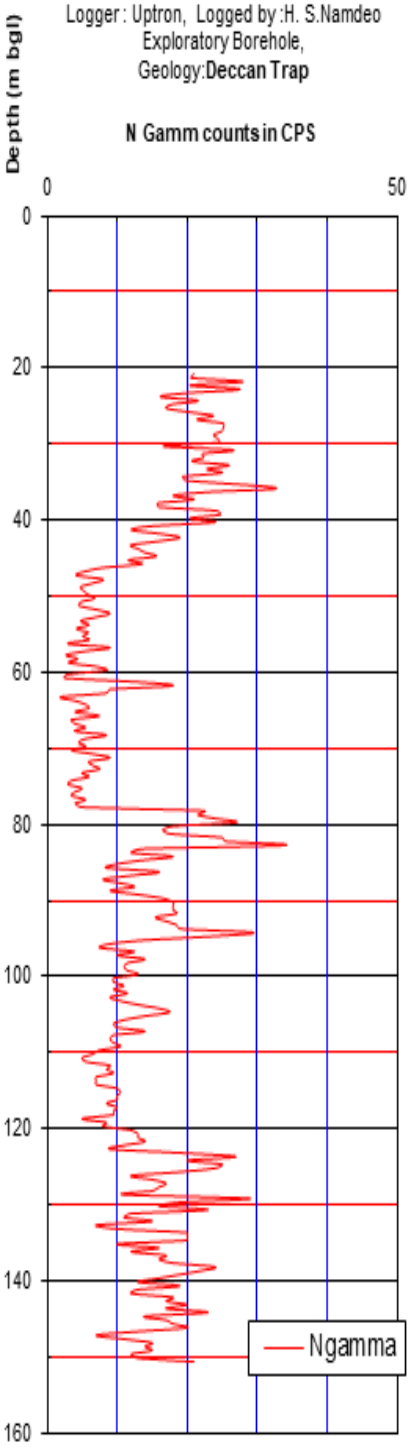
Logger :Geologger3030, Logged by :H.S.Namdeo
Exploratory Borehole,at **Dhamunda**,Sehore
Geology**:DeccanTrap**



Location : **Kothari**,Sehore
Log Date: 8.10.01
Logged depth : 152 m.b.g.l.
Drilled Depth : 158 m.b.g.l.

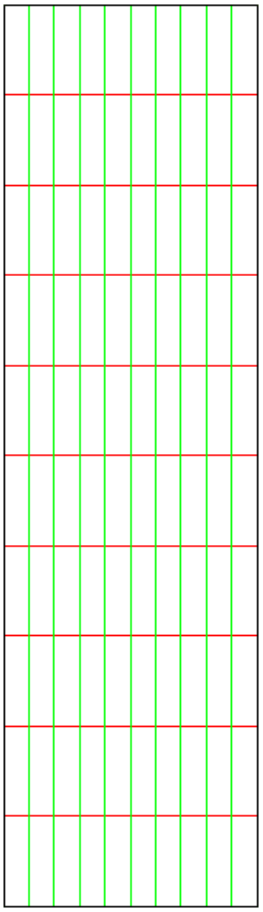


Logger : Uptron, Logged by :H. S.Namdeo
Exploratory Borehole,
Geology:**Deccan Trap**



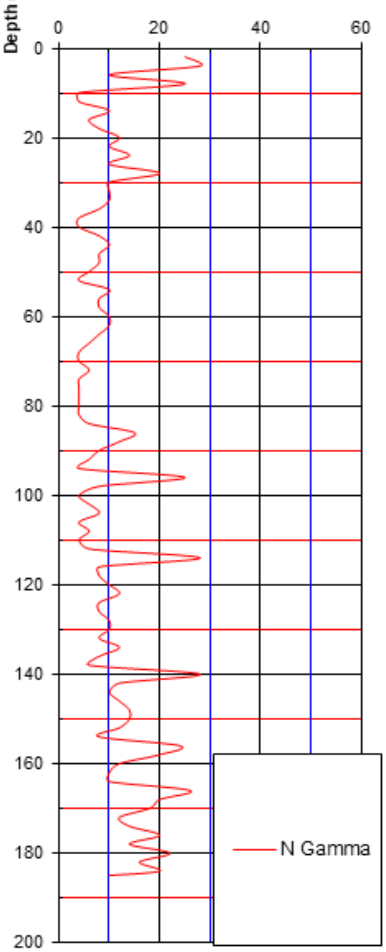
Location : **Bamulia,Sehore**
Log Date:15.10.01
Logged depth : 185.04m.b.g.l.
Drilled Depth :186.32m.b.g.l.

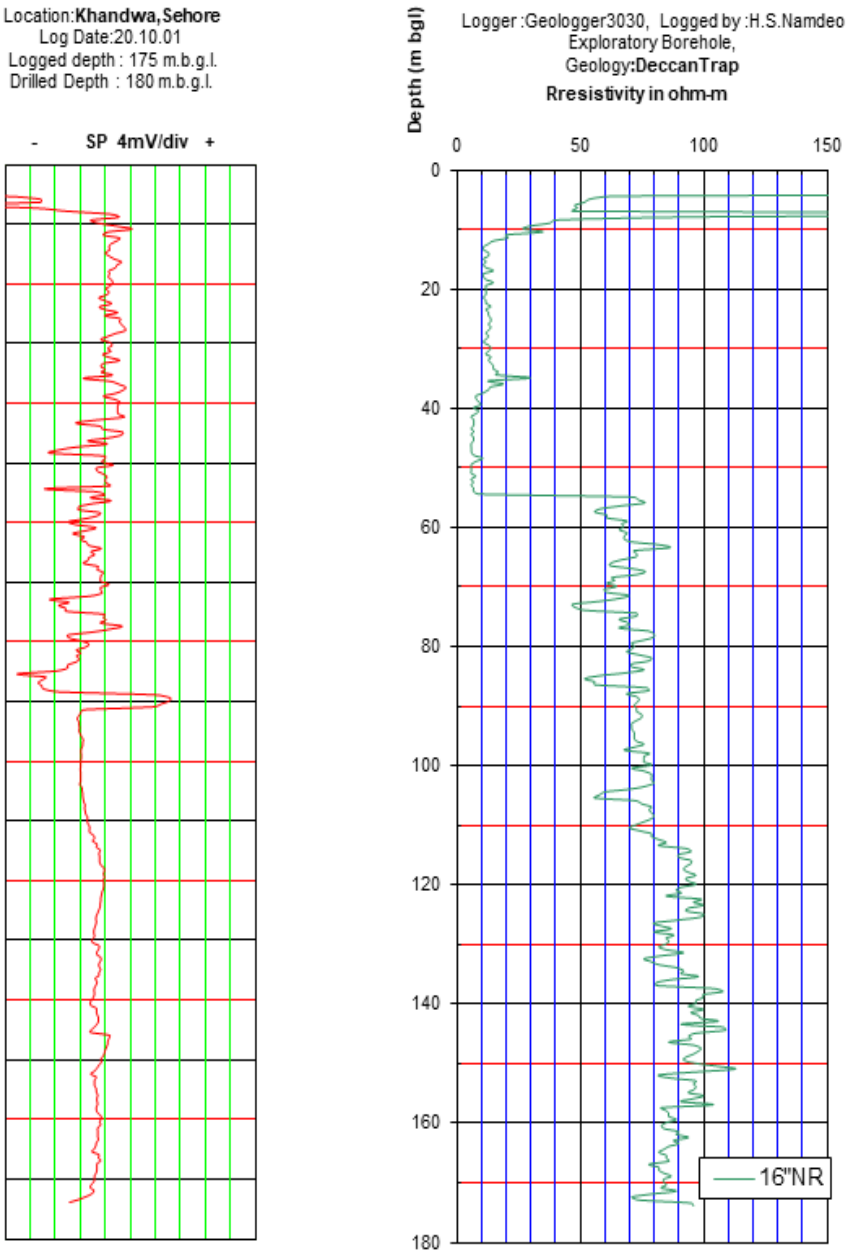
SP 5 mV/div



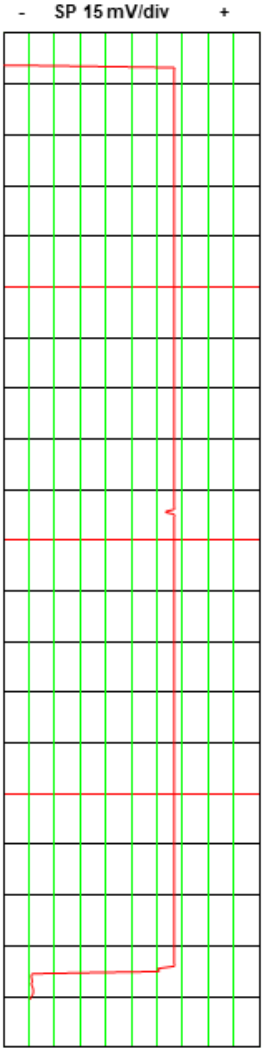
Logger :Geologger3030 Logged by : HS Namdeo
Exploratory Borehole, Bamulia
Geology: **Deccan Trap**

N.Gamma counts in cps

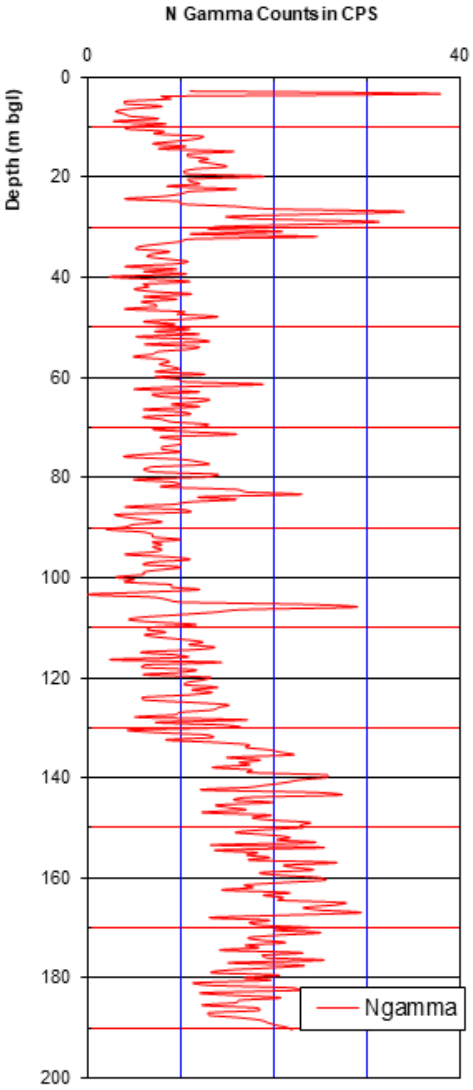



Location:Khandwa,Sehore
Log Date:20.10.01
Logged depth : 175 m.b.g.l.
Drilled Depth : 180 m.b.g.l.
- SP 4mV/div +
Logger :Geologger3030, Logged by :H.S.Namdeo
Exploratory Borehole,
Geology:DeccanTrap
Rresistivity in ohm-m
Depth (m bgl)
0
50
100
150
0
20
40
60
80
100
120
140
160
180
16"NR

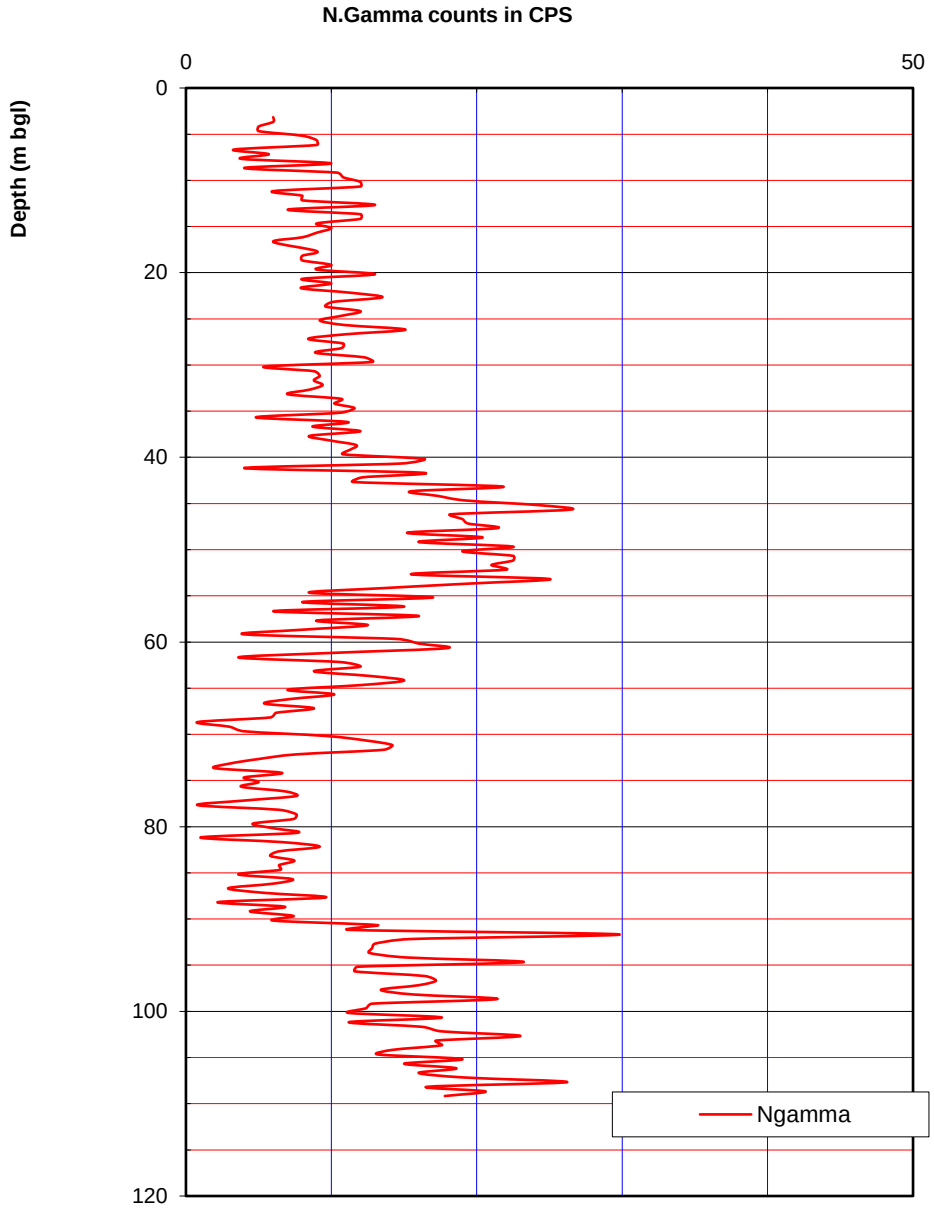
Location :**Bilkisgunj Sehore**
Log Date: 17.10.01
Logged depth : 192.31m.b.g.l.
Drilled Depth : 200 m.b.g.l.



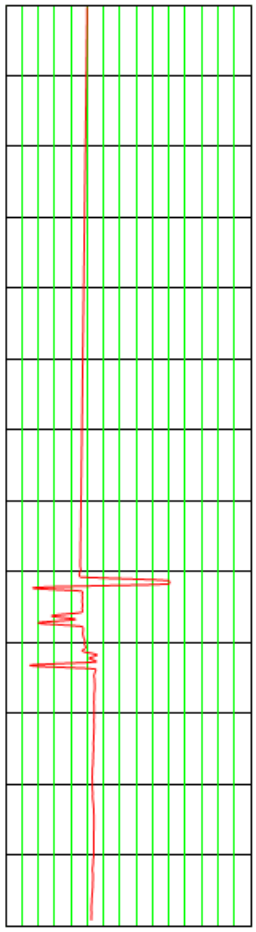
Logger : Geologger Logged by : H.S.Namdeo
Exploratory Borehole,
Gelogy:**Deccan Trap**



Logger : Geologger Logged by :H. S.Namdeo
Exploratory Borehole**Bijauri,** BH. Dia. : 216 mm
Rm: 12 Ohm-m at 25^{o} C

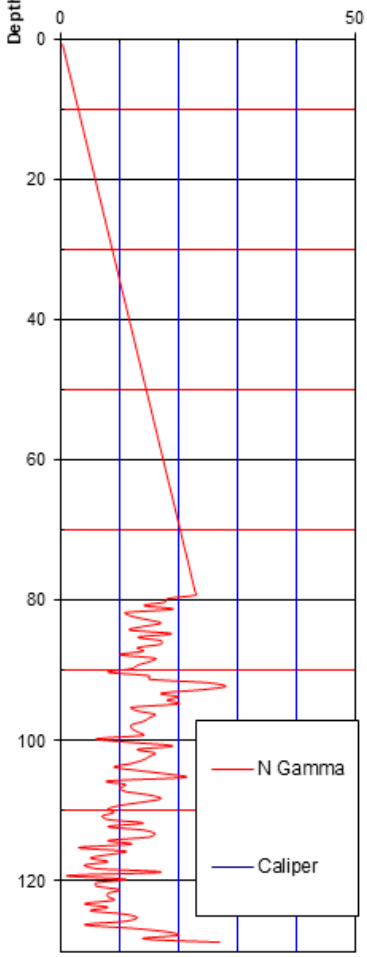


Location : **Ashtha,Sehore**
Log Date: 25.10.01
Logged depth : 194m.b.g.l.
Drilled Depth : 200.06m.b.g.l.



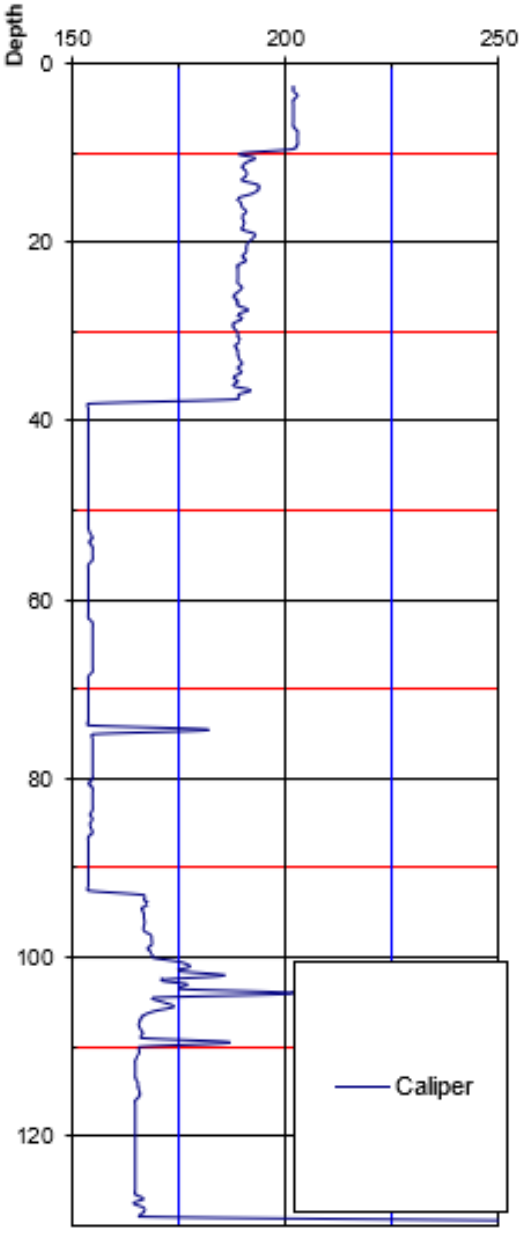
Logger :Geologger3030 Logged by : HS Namdeo
Exploratory Borehole,
Geology: **Deccan Trap**

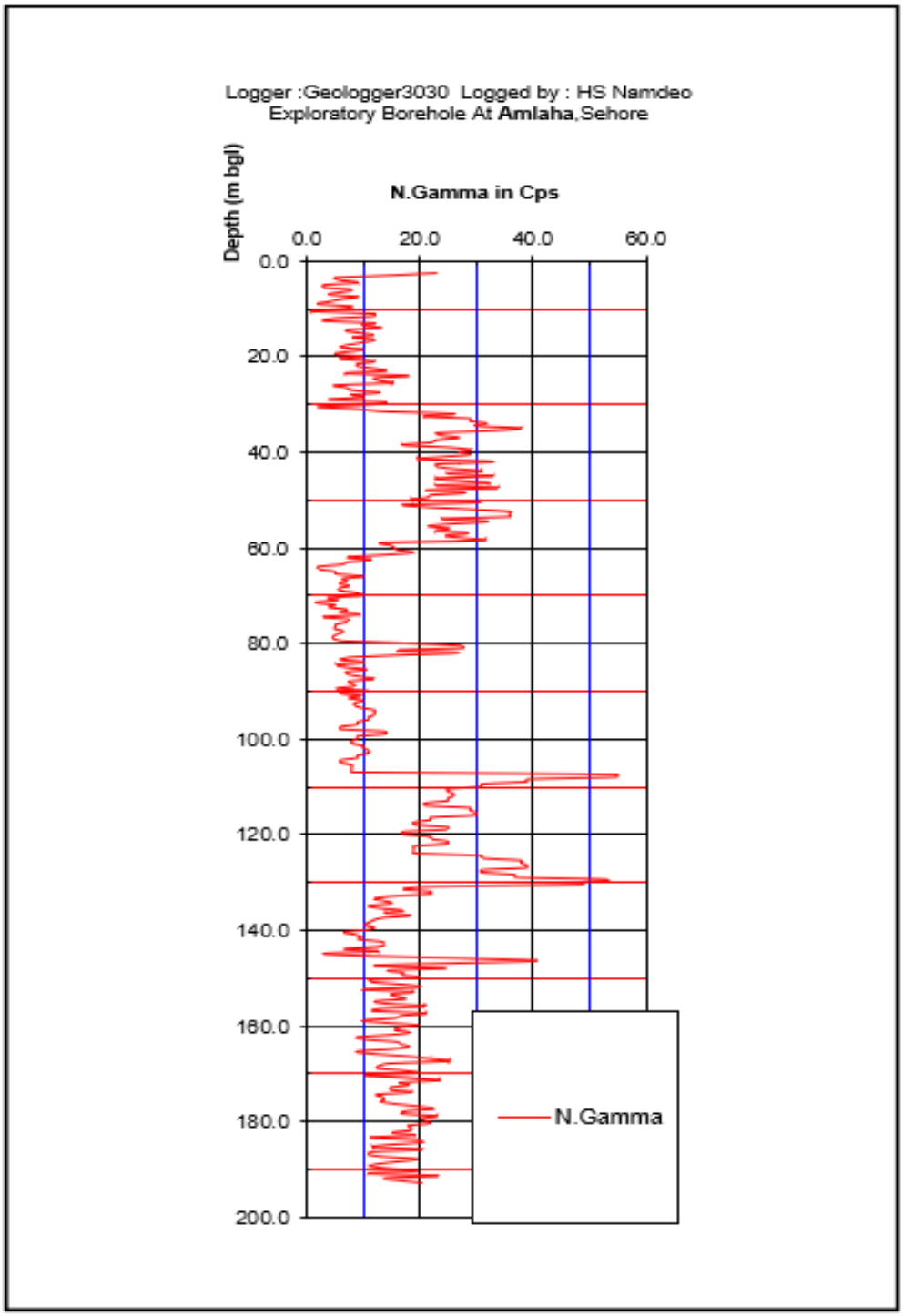
N.Gamma counts in cps & Caliper in mm.

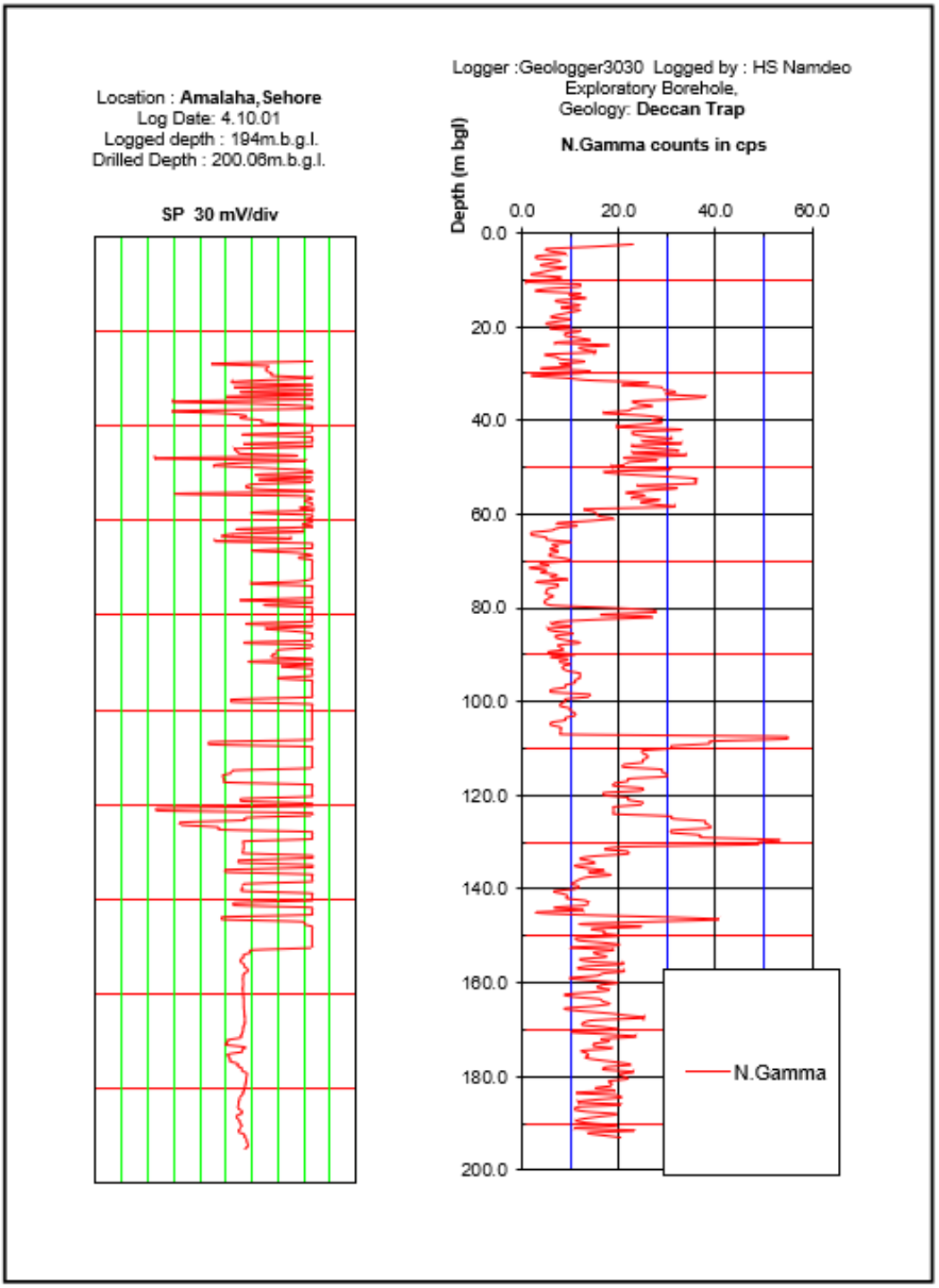


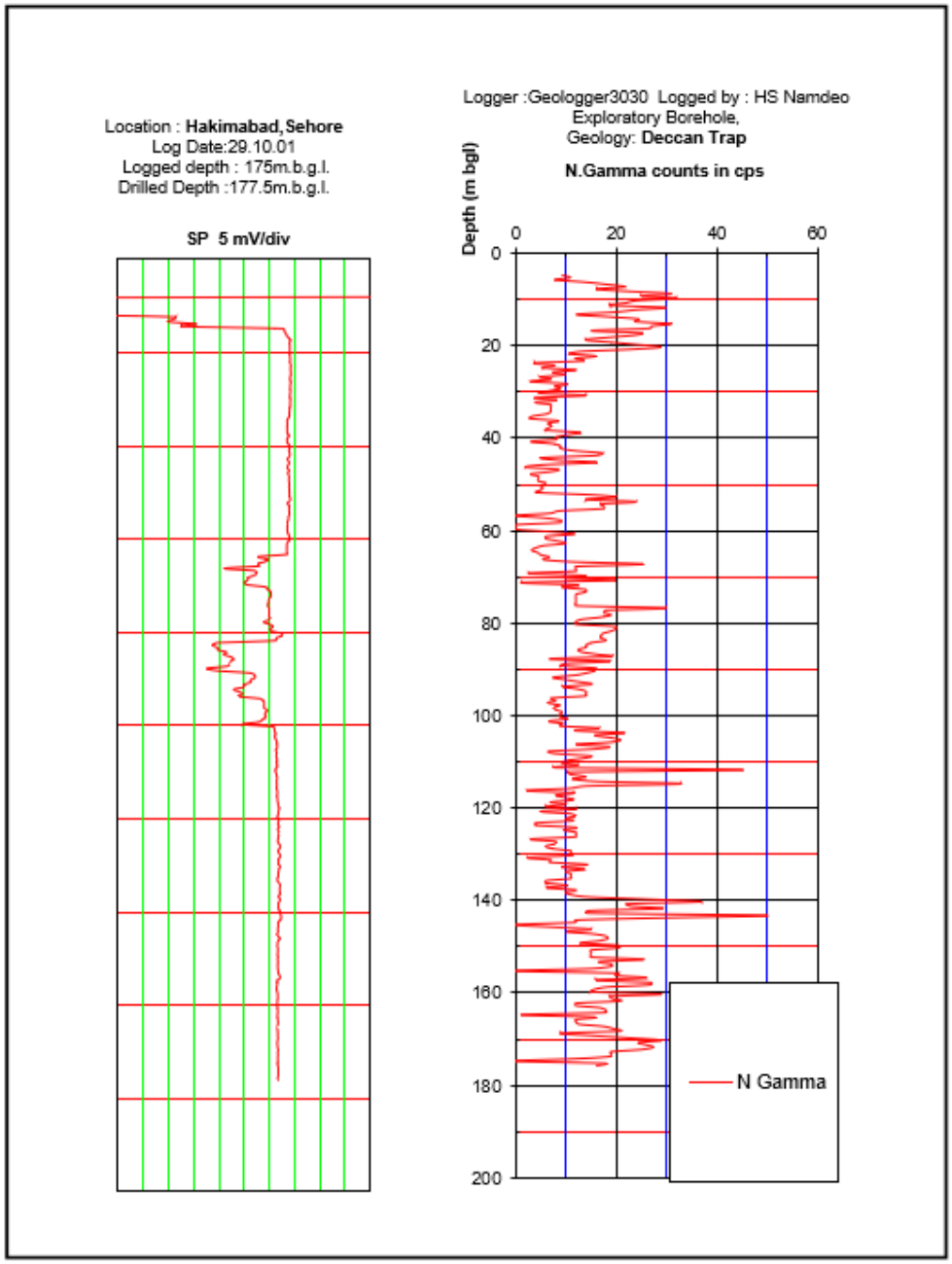
Logger :Geologger3030 Logged by : HS Namdeo
Exploratory Borehole at **Astha**, Sehore
Geology: **Deccan Trap**

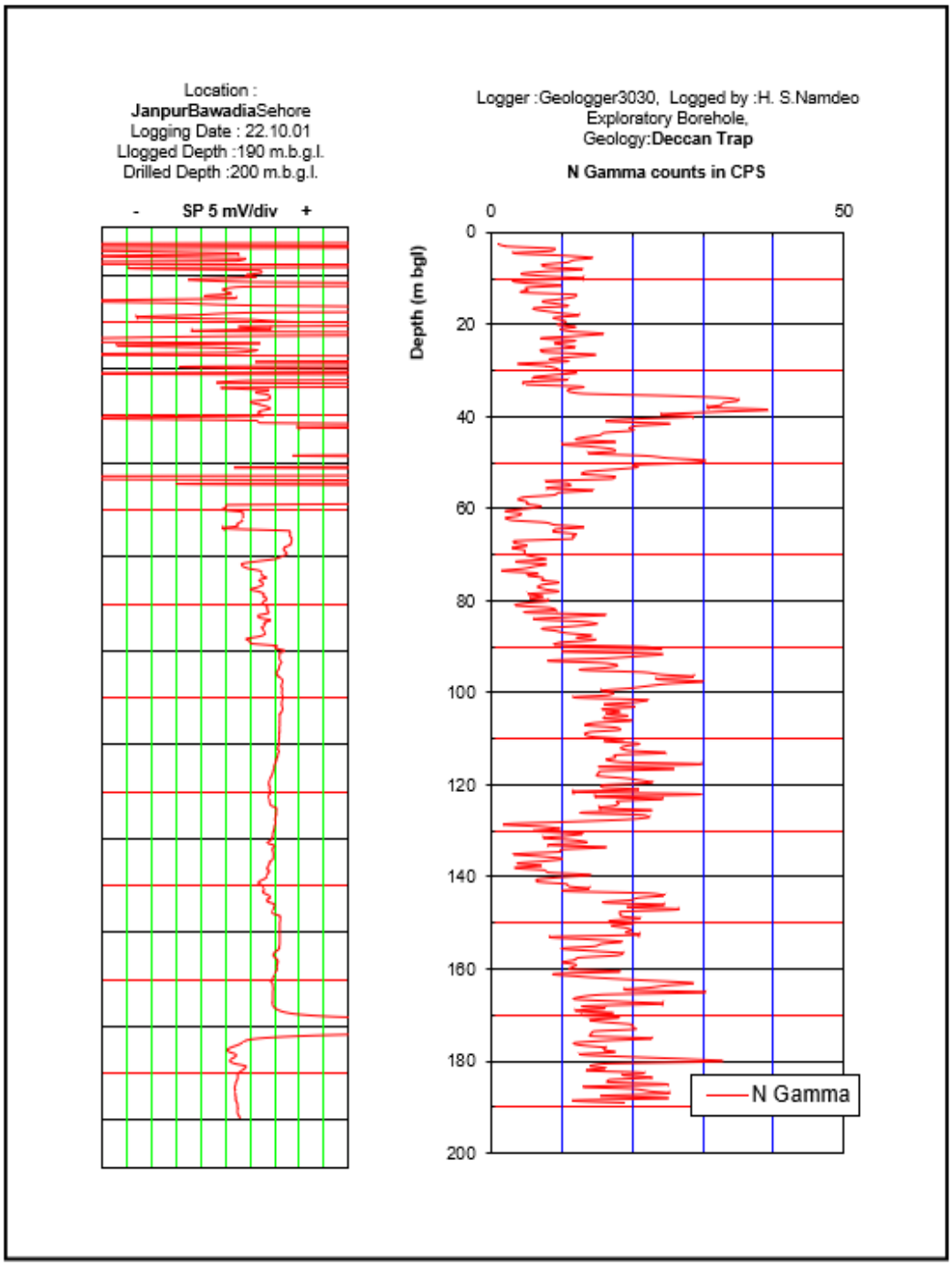
Caliper in mm.




Logger :Geologger3030 Logged by : HS Namdeo
Exploratory Borehole At Amlaha,Sehore
N.Gamma in Cps
Depth (m bgl)
0.0
20.0
40.0
60.0
0.0
20.0
40.0
60.0
80.0
100.0
120.0
140.0
160.0
180.0
200.0
N.Gamma


Location : Amalaha, Sehore
Log Date: 4.10.01
Logged depth : 194m.b.g.l.
Drilled Depth : 200.06m.b.g.l.
SP 30 mV/div
Logger :Geologger3030 Logged by : HS Namdeo
Exploratory Borehole,
Geology: Deccan Trap
N.Gamma counts in cps
Depth (m bgl)
0.0
20.0
40.0
60.0
80.0
100.0
120.0
140.0
160.0
180.0
200.0
N.Gamma


Location : Hakimabad, Sehore
Log Date:29.10.01
Logged depth : 175m.b.g.l.
Drilled Depth :177.5m.b.g.l.
SP 5 mV/div
Logger :Geologger3030 Logged by : HS Namdeo
Exploratory Borehole,
Geology: Deccan Trap
N.Gamma counts in cps
Depth (m bgl)
0
20
40
60
0
20
40
60
80
100
120
140
160
180
200
N Gamma


Location :
JanpurBawadiaSehore
Logging Date : 22.10.01
Llogged Depth :190 m.b.g.l.
Drilled Depth :200 m.b.g.l.
- SP 5 mV/div +
Logger :Geologger3030, Logged by :H. S.Namdeo
Exploratory Borehole,
Geology:Deccan Trap
N Gamma counts in CPS
0
50
Depth (m bgl)
0
20
40
60
80
100
120
140
160
180
200
N Gamma