GOVERNMENT OF INDIA

MINISTRY OF WATER RESOURCES,
RIVER DEVELOPMENT & GANGA REJUVENATION
CENTRAL GROUND WATER BOARD

GROUND WATER BROCHURE
BUNDI DISTRICT
RAJASTHAN

WESTERN REGION
JAIPUR
March, 2018

Ground Water Brochure
Bundi District

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EXECUTIVE SUMMARY

Bundi district is located in the south-eastern part of Rajasthan State having geographical area of 5550 sq km and extends between north latitudes $24^0$59' to 25^0 53' and east longitudes $75^0$15' to $76^0$15'. It comprises four blocks viz. Talera, Nenwa, Hindoli and Keshoraipatan. As per 2011 census, the population of district is 1113725.

Geomorphologically, the district can be divided into two units viz. (i) the high topographic relief towards the centre of the district (ii) plains flanking the south west- north east trending hill ranges.The district is characterised by five types of soils viz. (i) lithosol and regosols of hills (ii) yellowish – brown soils of foot hills (iii) recent alluvium (iv) brown soils-saline phase (v) black soils. Agriculture activity in 40.16 % part of the district is confined to the traditional kharif cultivation depending upon the monsoon rainfall. Out of total sown area i.e. 387266 hectare, 231753 hectare constituting 59.84 % area is irrigated. Rabi as well as kharif is prevalent in the area falling under Chambal canal command where irrigation facilities are available. The major crops grown are rice, wheat, oil seeds, sugarcane, gram, cotton etc.

The district experiences sub-humid type of climate. The average annual rainfall is 682.80 mm (1971-2000). The district as a whole is prone to droughts of mild to normal nature having frequency in the range from 30 to 55 %.

The district is drained by perennial Chambal River in the south eastern edge. The main tributary of Chambal is Mej whose catchment covers most of the district. The main tributaries of Mej in the northern part are Bajan and in the southern part is Kural or Mangli. There are a number of lakes and tanks in the district.

Water logging in the alluvial area covered under Chambal and general drought conditions are the main environmental hazards in the district. Immediately after the commissioning of canal system in the year 1960, the ground water level

started rising at an alarming rate causing water logging in low topographic areas. However, laying down of sub-surface drainage in the area under Canadian Project in 1995 has shown decrease in water logging scenario.

The gross area irrigated by various sources is 231753 hectare. Out of it, 62.27 % is irrigated by canals, 34.95 % by wells, and 1.24 % by tube wells, rest by ponds and other sources. The total area sown area is 387266 hec. In view of this, there is considerable scope for further development of ground water to bring much larger area in the district under irrigation command.

The northern undulating plain of the district is occupied by the formations of Bhilwara supergroup of Archaean age comprising slates, phyllites, quartzites, schists of Jahajpur group, Hindoli group and MangBundi Complex. The southern part of the district is covered by the formations of Vindhyan super group and Kaimur group. Quaternary alluvium overlies the hard rocks in the eastern part of the district.

Ground water occurs under water table condition in all the formations. Semi-confined to confined conditions have been noticed locally. Depth to water level varies from 1.85 to 26.25 mbgl and in general, it ranges from 1.85 to 20 mbgl in the area south of Bundi ridge whereas from 7.5 to 26 mbgl in the area north of it. Yield of wells tapping Archaean formation varies from 35 to 65 m^3/day, Vindhyan formations from 5 to 200 m^3/day and alluvium aquifer from 50 to 200 m^3/day.

In general, the chemical quality of ground water in shallow aquifers is potable having electrical conductivity in range of 500 and 3000 mmhos/cm at 25 C. Ground water is alkaline in nature. The fluoride content is also within permissible limit in greater part of the area having general range from traces to 2.0 mg/l. The quality of ground water in shallow and deeper aquifers is fresh having electrical conductivity value ranging from 300 to 2960 mmhos/cm at 25^0C. However in general, it lies between 500 and 2000 mmhos/cm at 25^0C.

The rainfall infiltration, return flow of irrigation water in canal command area and seepage from surface water bodies are the main sources of recharge to ground water body. The net dynamic ground water resource availability as on 01.01.2001 is 355.7014 mcm and existing gross ground water draft for all uses is 232.1179 mcm. The allocation for domestic and industrial requirements as on 2025 computed is 42.1148 mcm. The resulting net ground water availability for future irrigation development is 101.5456 mcm. The stage of ground water development of the district is 65.26 %. However out of total four blocks, two blocks (Keshoraipatan and Talera) fall in safe category and remaining two blocks (Hindoli and Nenwa) in critical category. The balance of net ground water resource available can create an additional irrigation potential of 48666 hectare through 16222 ground water abstraction structures at 100 % of stage of ground water development.

Field studies have indicated the following ground water vulnerable areas:

i) Water logging in Chambal command area as per Nov., 1999 data, the fully water logged area (dtw <1 mbgl) is 50 sq.km water logged (1-2 mbgl) 320 sq. km. and potentially water logged (2-3 mbgl) 136 sq. km. The implementation of sub-surface drainage in the area has resulted in alleviation of problem.

ii) Deep water table i.e. more than 20 m covers an area of about 595 sq km and lies mostly in the part north of Bundi ridge and in and around Bundi urban area.

Groundwater Brochure
Bundi District

1.0 INTRODUCTION

1.1 Location and extent:

Ground water management studies were carried out in Bundi district covering an area of 5550 sq.km (forming 1.62% of total area of Rajasthan State). Bundi district is located in the south-eastern part of Rajasthan State and extends between north latitudes 2459' to 2553' and east longitudes 7515' to 7615' (Fig.1). It encompasses an area of 5550 sq. km. and is spread in the survey of India degree sheet nos. 450 (0/6, 0/7, 0/8, 0/9, 0/10, 0/11, 0/12, 0/13, 0/14,0/15,0/16), 54C (C/1, C/2, C/3, C/4, C/6) and 45P (P/9). It is bounded on north by Tonk district,on the west by Bhilwara district and on the south by Kota district .Bundi district with its present area covers anent 1.6% of the total area of the State

1.2 Administrative set up:

A map of the district showing taluka boundaries, taluka headquarter and physical features is presented as Figure-1. Administratively, the district is divided into three sub-divisions viz. Bundi Lakheri and Nenwa. The details of administrative units are given below in table 1.

Table 1 - ADMINISTRATIVE UNITS OF BUNDI DISTRICT, RAJASTHAN

Sub-division	**Tehsil**	**Block**	**No. of town**	**No. of villages**		
				Habited	**Unhabited**	
Bundi	Bundi	Talera	Bundi	261	4	265
Nenwa	Keshoraipatan	Keshoraipatan	Lakheri Keshoraipatan Kapren Indergarh	216	8	224
Lakheri	Indergarh					
	Hindoli	Hindoli	-	174	-	174
	Nenwa	Nenwa	Nenwa	175	3	178
Total	**Five**	**Four**	**Six**	**826**	**15**	**841**

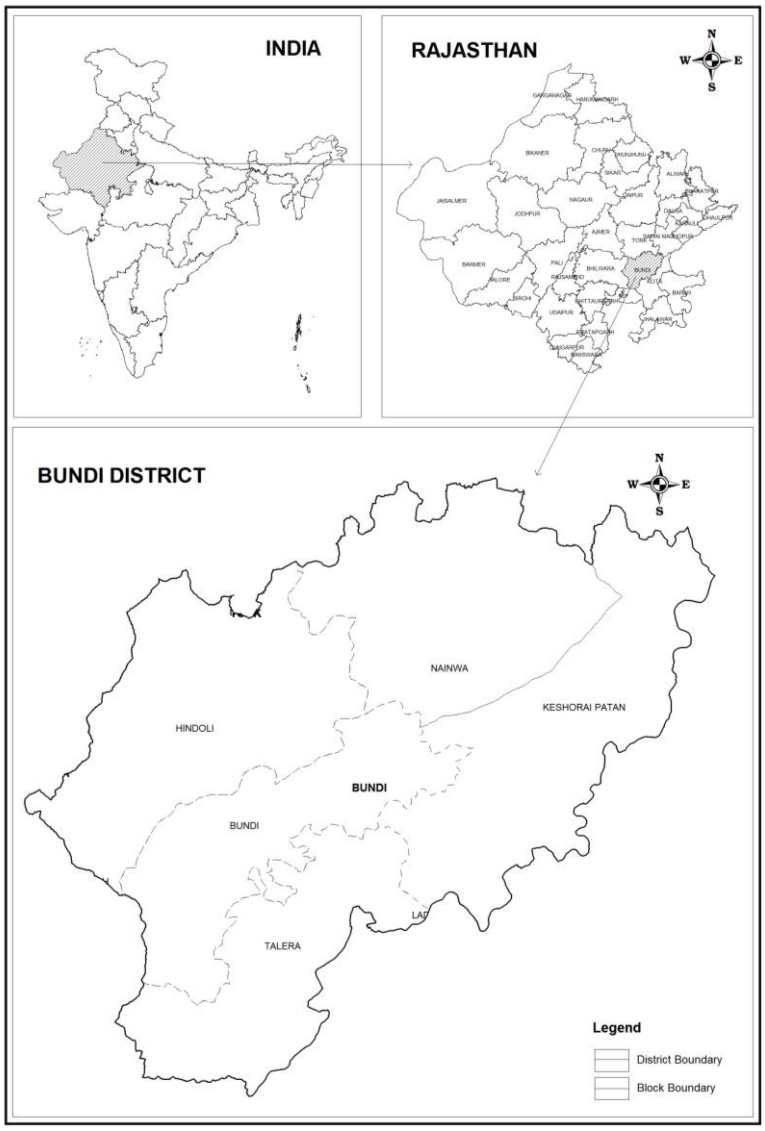

Fig. 1. Administrative map, Bundi district

1.3Soil Characteristics

The district is characterised by five types of soils given below.

a. **Lithosol and regosols of hills**
b. **Yellowish – brown soils of foot hills.**
c. **Recent alluvium**
d. **Brown soils-saline phase**
e. **Black soils**

Table-2 DISTRIBTION OF SOIL TYPES IN THE DISTRICT

Sl. No.	Type of soil	Area		Block
		Sq.km.	%	
A	Lithosol and regosols of hills	1206.64	21.74	In parts of Talera, Hindoli and Nenwa
B	Yellowish – brown soils of foot hills	895.55	16.14	In parts of Hindoli and Nenwa
C	Recent alluvium	1845.74	33.26	In parts of Talera, and Keshoraipatan
D	Brown soils-saline phase	776.73	13.99	In parts of Hindoli and Nenwa
E	Black soils	825.34	14.87	In parts of Talera

1.4Land use and cropping pattern

The district is very rich in forest wealth. Out of a total of 581938 hectare, forest covers an area of 139821 hectare consisting 24.03 % of the district area. Uncultivable land confines to mostly to the hill ranges constituting 15.33 % of total area. Culturable land but not cultivated apart from fallow land forms 9.81 % whereas waste land forms 6.24 % of the total area of the district

Actual cultivated area is 259479 hectare (Gross being 387266 hectare) constituting 66.54 % of total geographical area. Area sown more than once is 127787 hectare making 49.25 % of actual area sown.

Table 3 and 4 gives the land use pattern and status of ground water abstraction structures available in the district respectively.

Table-3 LAND USE IN BUNDI DISTRICT, (YEAR 2010) – AREA IN HECTARE

Block	Total geographical area as per village record	Uncultivable land (15.33 %)				Cultivable land but not cultivated apart from fallow land (9.81%)			
		Forest	Land used for other works besides agriculture	Barren and cultivable land	Total (5+6)	Pasture land	Trees,groves & garden	Barren land (cultivable land)	Total (8+10)
2	3	4	5	6	7	8	9	10	11
Talera	192227	61162	12864	20281	33145	8346	36	8565	16947
Keshoraipatan	136678	13486	12675	10873	23548	4728	71	4994	9793
Hindoli	134038	43434	7004	14901	21905	5373	61	11975	17409
Nenwa	118995	21739	5389	5224	10613	4880	41	8073	12944
Total	**581938**	**139821 (24.03%)**	**37932 (6.52%)**	**51279 (8.81%)**	**89211**	**23327 (4.01%)**	**209(0 .03%)**	**33607 (5.77%)**	**57143**

Block	Waste land (6.25 %)			Actual sown area (- double cropped)	Total sown area	Area sown more than once	Remarks
	Current waste land	Other waste land	Total of waste (12+13)				
	12	**13**	**14**	**15**	**16**	**17**	Total geographical area (column 4+5+6+8+9+10+12+13+15=100%
Talera	3364	6852	10216	70757	118367	47610	
Keshoraipatan	6921	6942	13863	75988	117576	41588	
Hindoli	2065	4026	6091	45199	66649	21450	
Nenwa	3331	2783	6114	67535	84674	17139	
Total	15681 (2.69%)	20603 (3.55%)	36284	259479 (44.59%)	387266 (66.54%)	127787 (49.25)	

Lithosol & regosol of hills (Red Grey valley Soil)

These are found in the Aravalli hills of south western part of the district. These soils are shallow with gravels found very near the surface, light textured, fairly drained, reddish brown to grayish brown in colour.

Older alluvium (Older Alluvial Soils)

These soils are derived from alluvium and found mainly in western parts of the district. These soils are non calcareous, semi-consolidated to unconsolidated

brown soils, loamy sand to sandy loam in texture. They are well drained and occupy gently sloping terrains.

Recent alluvium (Red Sandy Soils)

These soils are developed in alluvium and found mainly in the eastern part of the district. These soils are deep, well drained, sandy loam to loam in texture and non- calcareous.

Agriculture and Land Use

The socio-cultural and economic factors have significantly influenced over land use both in rural and urban areas in the district. Land forms, slope, soils and natural resources are some of the important which control the land use pattern of the district. Data are based on district statistics outline, 2013-14. The land use pattern of district is presented in Table 1.

Table 1: Land Use, Bundi District (2013-14)

Sl.No.	Land Use	Area in hectare	%
1	Total geographical area	581938	100
2	Forest	139821	24.03
3	Pasture land	23327	4.01
4	Land not cultivated including pasture land; barren land; trees, grooves & orchards; padat land	37932	6.52
5	Uncultivable land apart from padat land	51279	8.81
6	Padat land (current)	33607	5.77
7	Actual sown area (subtracting double)	259479	44.59
8	Gross sown area	387266	66.54
9	Area sown more than once	127787	49.25

Agriculture

Agriculture activity in the district is, by and large, confined to traditional kharif cultivation depending on monsoon rainfall and rabi cultivation is prevailing in areas where irrigation facilities are available. The major crops grown in the area are:

Food Grain	Jowar, Bajra,Wheat, Barley, Maize, Rice
Cereals	Gram, other kharif cereals,Tur, other rabi cereals
Oil seeds	Rai & Mustard,Til, Ground Nut,Arandi/Taramira
Non food grains	Cotton,Onion,Red chilli,Tobacco,Potato,Jute

Geomorphology

The district has distinct four types of geomorphological features (Fig. 12).

i) *Pediment / pediplain on Archaean rocks (undissected)*

It occurs in the north-western part of the district covering about 1785 sq. km. of geographical area.

ii) *Structural plain on upper Proterozoic rocks*

It occupies the area just south of pediplain and south-western part of the district and encompasses about 1695 sq. km. area.

iii) *Alluvial plain*

It lies in the south-eastern part between Chambal and Mej Rivers and covers about an area of 790sq.km.

iv*) Bad land (Ravines)*

Ravines are formed due to heavy flush of rain water passing over the alluvial sediments which are non- uniform in their distribution. It occurs just south of Bundi hill ranges and in extreme south –eastern fringe of district along Chambal river. It occupies an area of about 1280 sq.km.

Table 4 and 5 gives the land use pattern and status of ground water abstraction structures available in the district respectively.

Drainage

The district is drained by perennial Chambal River in the south eastern edge. The main tributary of Chambal is Mej whose catchment covers most of the district. Ephemeral Mej rises in Bhilwara district and enters Bundi district

near Negarh. It then proceeds in a north- eastern direction upto Dablana where it inclines due east for about 24 km and then turns abruptly southwards. It cuts its way through the central Bundi range near Khatgarh from where it takes a long sweep to the east till it joins Chambal in the north- eastern corner of the district. Maj River drains both the northern and southern plains of the district. Its main tributary in the northern part is Bajan and in the southern part is Kural or Mangli.

In the area between Bundi hill and Chambal River, Talera, Gorapachar and Mangli are the prominent tributaries of the Mej. This flow north- northeast and north-east and give rise to typical dendritic pattern. Talera River joins Gorpachar near Pipalda, Gorpachar joins Mangle at Sangawad and Mangle joins Mej near Bhain and Khera.

The drainage density in limited area to the east and north-east of Bundi town is between 0.30 to 0.50 km/km^2. In general, in the rest of the district, it is between 0.50 and 0.70 km/km^2.

The gross area irrigated by various sources is 231753 hectare. Out of it ,62.27 % is irrigated by canals,34.95 % by wells, 1.24 % by tube wells, rest by ponds and other sources.

Table-4 STATUS OF GROUND WATER ABSTRACTION STRUCTURES (YEAR 2010)

Block	**Total no. of wells**	**Total no. of wells in use**			**No. of wells unused**	**No. of wells fitted with pump sets**		**No. of wells operated by Persian wheels, bullock modes etc.**
		Domestic	**Irrigation**	**Total**		**Dug wells**	**Tube wells**	
Talera	5740	-	5708	5708	32	3784	1671	1924
Keshoraipatan	2954	-	2903	2903	51	1983	351	920
Hindoli	10056	-	9994	9994	62	4113	146	5881
Nenwa	7857	-	7803	7803	54	5743	200	2060

Table 5 provides block-wise details of area irrigated by different sources.

Table-5 GROSS AREA IRRIGATED BY DIFFERENT SOURCES IN BUNDI DISTRICT,RAJASTHAN (2010) (Area in hectare)

Block	Wells	Tubewells	Ponds	Canals	Other sources	Total
Nenwa	18826	51	1320	68134	1328	89661
Keshoraipatan	9589	1299	-	60136	497	71531
Hindoli	20196	-	162	14020	137	34515
Nenwa	32394	531	99	2022	-	36046
Total	81005	2881	1581	144312	1962	231753
% of total area irrigated area	34.95	1.24	0.6	62.27	0.86	100

Cropping pattern:-

Agriculture activity in 40.16 % part of the district is confined to the traditional kharif cultivation depending upon the monsoon rainfall. Out of total sown area i.e. 387266 hectare, 231753 hectare constituting 59.84 % area is irrigated. Rabi as well as kharif is prevalent in the area falling under Chambal canal command where irrigation facilities are available.

The major crops grown are :-

Main crops

Cereals: Wheat, Rice, Maize, Barley

Pluses: Gram, Masoor, Peas etc.

Spices: Coriander, Red chilli, Garlic etc.

Fruits: Guava, Water melon etc.

Vegetables: Potato, Sweat potato, Onion etc.

Oil seeds: Rai, Mustard, Soyabean, Alsi etc.

Others: Sugarcane, Fodder crops.

Canal irrigation by Chambal Left Main Canal (LMC) has brought green revolution in the Bundi district which constitutes the major source of irrigation i.e. 62.27% of total irrigated area.

CLIMATE

This chapter deals with the hydrometerological aspects of the district. Rainfall data of six raingauge stations of the district have been statistically analysed for a period of 30 years i.e. from 1971 o 2000. Discussions on other parameters such as temperature, humidity, potential evapotranspiration and wind speed are based on the data recorded at IMD observatory located at Kota. Climate of the district varies from semi-arid to sub-humid.

2.1 Rainfall

The district on an average (1971-2000) receives 695.20 mm of rainfall annually. The average normal annual rainfall (1971-70) is slightly higher at 715.80 mm. The percentile departure of annual rainfall from mean annual rainfall have been worked out .It is observed that rainfall during the period 1971 to 1979 was very good with the exception of the year 1972.

4. HYDROLOGY AND SURFACE WATER UTILISATION

4.1Irrigation projects:

There are two surface water irrigation projects in the district apart from conventional irrigation system from ground water.

I. Chambal Left Main Canal Bundi (Canal Area Development)

II. *Surface* ***Water Tanks (Irrigation Division Office)***

I. Chambal Left Main Canal Bundi (Canal Area Development)

Chambal canals were constructed in the year 1960. Under the aegis of Chambal river valley projects, the main water reservoirs viz.

Gandhi Sagar, Rana Pratap Sagar,Jawahar Sagar and Kota Barrage were constructed to provide production of electricity and irrigation facilities in the area. The irrigation facilities is being provided to farmers since 1960 and it has caused increase in food production and brought overall prosperity to farmers.The irrigated command area of Left Main Canal is 1.02 lac hectares.

Left Main Canal emerges from Kota Barrage and irrigates 290 villages of Bundi district and 10 villages of Kota district. The length of main canal is 2.59 km. The main two branches viz. Bundi and Kapren, divides at Nanta head. The water flow capacity of Left Main Canal (LMC) IS 1500 cubic feet per second

.

Bundi Branch:

Length of Bundi Branch ……..61.70 km

No of Distributaries……11

No of Minors…….60

Total length of Bundi canal system……..373 km

Kapren Branch:

Length of Kapren Branch ……..51.33 km

No of Distributaries……12

No of Minors……75

Total length of Kapren canal system…….438 km

Patan Branch:

This branch emerges at 320 chain of Kapren branch.

Length of Patan Branch ……..49 km

No of Distributaries……4

No of Minors……45

Total length of Patan canal system……264 km

The overall total length of canal system is 1075 km. The distribution of Chambal left main canal is depicted in Plate 19.

II. Surface **Water Tanks (Irrigation Division Office)**

There are a number of surface water tanks available in the district which is mostly seasonal except a few viz. Gudha dam, Bundi ka gothra, Abheypura, Mardia, Dabi, Hindoli, Jait sagar. Some of these tanks were constructed during State's times and others have been constructed subsequently. Dams are either earthen or masonary or earthen / masonary. The gross culturable command area of tanks is about 37670 hectares.

HYDROLOGY AND SURFACE WATER UTILISATION

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5.0GEOLOGY

5.1 General geology and structure

Geologically the district consists of diverse rock types belonging to oldest Archaean metamorphics of Bhilwara supergroup in the northern part and upper Proterozoic sedimentaries of Vindhyan supergroup in the southern part. Quaternary alluvium is observed along main river courses and in shallow depressions in the south-western belt of the district. (Fig. 12)

Archaeans

Archaeans are represented in the district by formations of Bhilwara supergroup comprising younger Jahazpur group and under Mangalwar complex. Rock belonging to Marwar supergroup is exposed in the northern half of the district adjoining Tonk and Bhilwara district.

The rocks belonging to Jahajpur group are located in the northern part of the district along a thin ENE-WSW trending belt and encompass mainly dolomite, dolomitic marble, banded ferruginous chert, phyllite, carbonaceous phyllite, quartzite and basic meta volcanics. These rocks are intruded by Pre-Aravalli intrusives like granite and dolerites which are exposed near village Basni, Deva ka Khera and Odhanda of Hindoli block of Bundi district. General trend of rocks is N 40^0 E with 60^0 NW dip.

Hindoli group of rocks covers the maximum area occupied by the Bhilwara Super Group. These comprise shale, slate, phyllite, metagraywacke,

limestone, dolomitic marble, Meta basic volcanics, and quartzite and mica schists. This group is intruded by sills and dykes of dolerites. The boundary between Hindoli group and Vindhyan supergroup is marked by a fundamental fracture (Bundi lineament) manifested in the Great Boundary Fault of Rajasthan.

Mangalwar Complex occupying the northern most tip of the district comprises migmatite, gneisses, felspathised mica-schist, garnetiferous mica-schist, quartzite, impure marble and amphibolite. The temporal relationship of Hindoli group with Mangalwar Complex is not clearly established. Hindoli group and Mangalwar Complex represent flysch type sedimentaries in geosynclinal trough (after GSI, Lithostratigraphic map of Aravalli Region, southern Rajasthan).

Vindhyans

Rocks belonging to Vindhyan supergroup are represented by younger Bhander group, Rewa group and the older Kaimur group. Bhander group mainly constitutes sandstone and limestone, Rewa group as sandstone and shale and Kaimur group constitutes sandstone, shale and conglomerates.

The formations belonging to Vindhyan supergroup occupy about 60% of the southern part of Bundi district. Most of this area is underlain by rocks of Bhander group, Rewa group is exposed S-W of Indergarh extending upto 5 km. and occur inbetween Taragarh fort of Bundi and Indergarh for about 72 km., whereas, the rocks belonging to Kaimur group occur along a thin ENE-WSW trending thin belt along the faulted contact of Vindhyans with Archaean.

Vindhyans sandstone belonging to Kaimur, Rewa and Bhander group are fine grained, grey to red in colour, very hard and compact. These are highly jointed and at places stand like high mounds and ridges giving rise to highly undulating topography. Sandstones are generally flat with low dip

towards north-east.

Rocks of Kaimur group occur as outlier on the N-W of Great Boundary Fault in between Bundi – Indergarh area.

Rewa group comprises Panna shale, Indergarh sandstone (lower Rewa), Jhiri shale and Ganurgarh sandstone formation (upper Rewa). Panna shale and Indergarh sandstone are exposed S-W of Indergarh extending upto 5km. Jhiri shale and Ganurgarh sandstone are persistent and both occur together in between Taragarh fort of Bundi and Indergarh for about 72 km.

Limestone of Bhander group are fine to medium grained and are grey ,red, yellowish, pink and buff in colour. Red and brick colour varieties are non-siliceous and hence are prone to weathering where as grey bands are siliceous and are very hard. At places (Ballop) the ruggy limestones are encountered. In general Bhander limestone is cavernous and at places it exhibit evidence of algal life in the form of arch shaped structures called ‘stromatolite’ developed mostly west of Bundi and east of Lakheri. Limestone connotes rolling dips towards north- east.

Lakheri limestone on which Lakheri cement factory is based, belongs to lower Bhander sub-group and occurs in between greenish grey Samaria shale above and reddish brown Ganurgarh shale below. It is marked by intraformational conglomerate and breccia at the base. It is exposed from east of Sarodara and runs to 5 km. north-east where appears in the form of anticline near village Satur and extends intermittently for 80 km. in 1 to 2 km. wide belt up to Indergarh.

Maihar sandstone occurs only in a hill on the east of Lakheri. Balwan limestone occurs conformably above the Maihar sandstone and is exposed near Kamleshwar Mahadev and in river Chaken. Its lower part is greyish, ferruginous, arenaceous and cherty in nature whereas upper horizon is pinkish

and stromatolitic in nature. Dholpura shale conformably overlies the Balwan limestone and exposed near Dholpura, Daulatpura, Narayanpura and Sandenala. It is pinkish, purple, reddish and brown in colour, thinly bedded and horizontally disposed.

The Vindhyan shale is grey light green and purple in colour. These shales are mostly splintery in nature and give rise to nearly horizontal landscape with very gentle slope. These are generally exposed in nallah cuttings and in unlined well section thinly bedded. Shales are least developed at Detunda at the foot of Mir Sale Ka Dungar and in the Neighbourhood of Khatkar, Talwara and Lakheri.

Vindhyans are covered with a covering of alluvium in the southern and south-eastern part of the district.

Quaternary alluvium

Quaternary sediments represent alluvium, aolian, scree & talus and are encountered mainly along the central, southern and south-eastern parts of the district. Thickness of alluvium ranges from a few metres to 40 metres. Thick alluvium is restricted to the banks of Chambal, Kural and Mej rivers i.e. 30 to 40 m. Alluvium is composed of unconsolidated to semi-consolidated, fine grained sand, silt, clay and occasionally kankar.

Sub-surface geology

The sub-surface geology of the area is revealed by the boreholes drilled in the district by CGWB and GWD, Rajasthan state. The salient data of boreholes drilled are given in Table 14, 15 and 15A and their locations have been depicted in Plate 2 and 2A. The lithological logs of represented boreholes are given in Appendix- I. In addition to it, salient data of tube wells constructed by GWD, Rajasthan state for PHED & other agencies is presented in Table 16. The statement exhibiting the depth at which borehole strike different formations in Bundi district is given in Table 17.

The deepest borehole in the alluvial part has been drilled by GWD, Rajasthan state, at Keshoraipatan down to a depth of 156 m at Beebanwa piercing through shale and limestone.

6.0HYDROGEOLOGY

The availability, occurrence and movement of groundwater is mainly controlled by the topographic features, physical characteristics and structural features present in the geological formations. The important water bearing formations besides alluvium are sandstone, limestone and shale of Vindhyan supergroup and phyllite & slate of Bhilwara supergroup. In hard rocks, the occurrence and movement of ground water is controlled through the bedding planes, fissures, joints, solution cavities and other structural weak planes. During the course of hydrogeological surveys, it has been observed that the weathered mantle of hard rocks form aquifer and yield good discharge. In alluvium, ground water occurs in the interstices of unconsolidated sand. Ground water occurs mainly under water table in all the formations. However at places, also occurs under semi- confined to confined conditions both in alluvium and hard rocks. It is reported that in one borehole at Keshoraipatan when limestone encountered at a depth of 74.6 m below ground level, the water rushes to such an extent that the piezometric head of water was 1.22 m above ground level. When the ground water in the dug well is just at ground level, the field area nearby is seen dry even if a pit is dug down to 0.50 mbgl.

6.1 Aquifer system and their parameters

Quaternary alluvium, rocks of Vindhyan supergroup and Bhilwara supergroup form the aquifer systems in the district (Plate 3) and described in the following paragraphs. Bundi district is mostly underlain by the rocks of Vindhyan Super Group with minor outcrops belonging to Bhilwara Super

Group and Post Delhi Intrusives at places overlain by Quaternary alluvium. The occurrence of groundwater in the area is mainly controlled by the topographic features, physical characteristics and structural features present in the geological formations. Ground water occurs under unconfined conditions in phreatic zones, semi-confined conditions in deeper zones and weathered & fractured portions of the hard rocks. Hydrogeological map of the area is depicted in Fig.5.

Alluvium

Alluvium covering about 1080 sq. km. form s the potential aquifer. It lies in the area south of Bundi ridge forming south- eastern part of the district (covering parts of Keshoraipatan and Talera blocks) and falling under Chambal canal command. Alluvium is composed of sand, silt, clay with kankar. The exploratory borehole and wells inventoried data reveals that the thickness of alluvium ranges from a few metres to 40 metres. It is more towards the Chambal River in the south – eastern part and is found maximum to 40 m around Laban.

The discharge of dug wells is generally poor and ranges from 50 to 200 m^3/day. The summarized data of pumping test conducted on dug wells are given in Table 19. The data indicate that the discharge of wells ranges from 19.2 to 55.8 m^3 /hour having drawdown from 2.96 to 4.92 m.

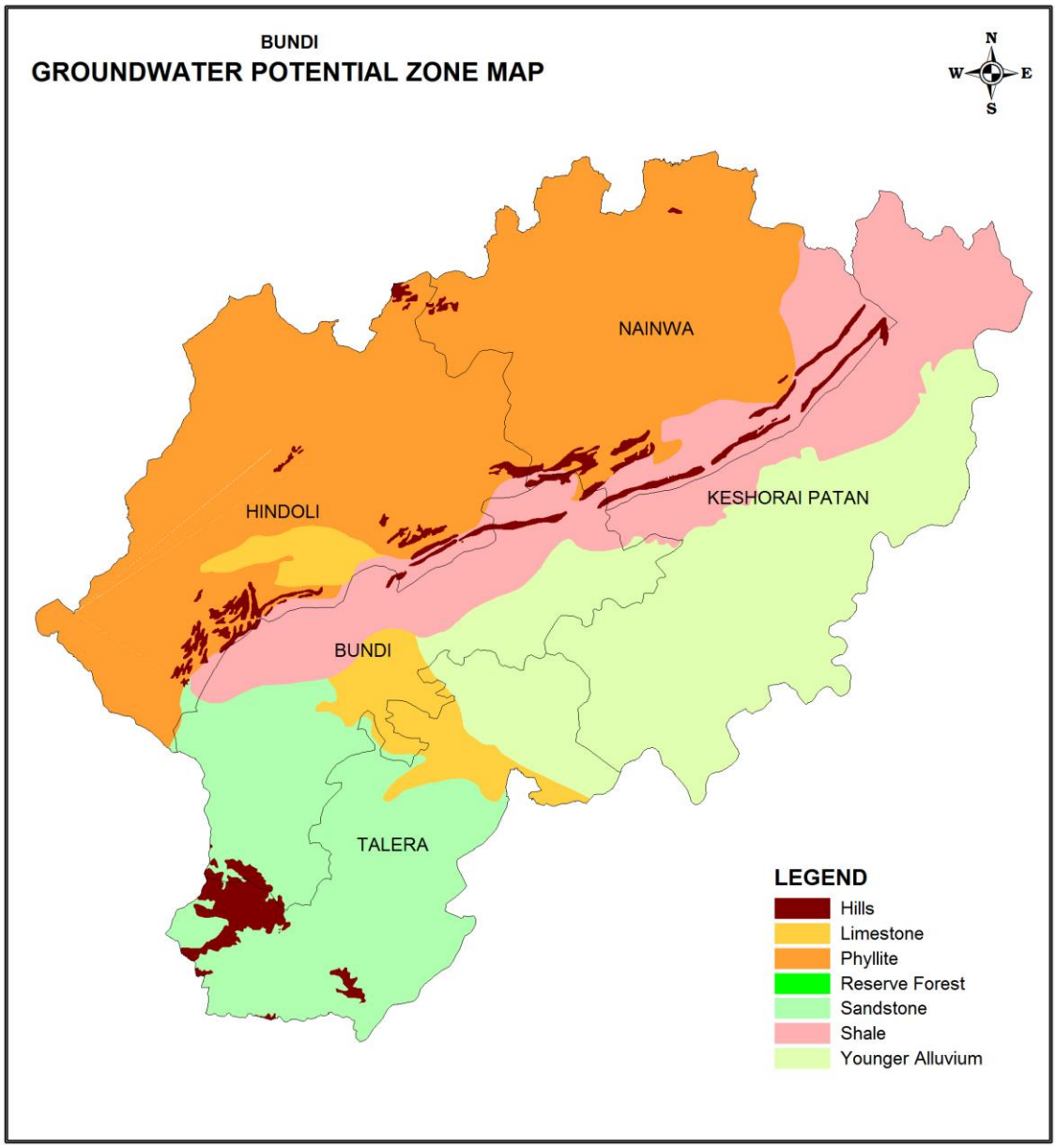

Fig.3: Groundwater Potential Map of Bundi district

GROUND WATER SCENARIO

A total of 61 exploratory wells, 9 observation wells and 41 piezometers have been constructed in the district. Summarized results of the same given in Table 7.

Table 7: Summarized results of ground water exploration, Bundi district

Type of well	No.	Depth drilled (m)	SWL (m)	T (m^2/day)	Discharge (lpm)	EC (micromhos/cm) at 25ºC
EW	61	12.8 – 202.7	1.92 – 45.12	27 – 662.4	10 - 1003	455 - 22240
OW	9	101.5 – 160.07	4.68 – 27.5	105	35 - 670	680 - 2710
PZ	41	30 – 159.42	2.55 – 62.94	35.66 – 362	15 - 880	540 - 15000

1.2 Depth to water level

Central Ground Water Board periodically monitors the National Hydrograph Network Stations (NHNS) stations in the Bundi district, four times a year i.e. in January, May (Premonsoon), August and November (Postmonsoon).

1.2.1 Depth to Water Level – Pre-monsoon (May-2017)

Depth to water level varies widely depending upon topography, drainage, bed rock, geology etc. Depth to water level ranges from 9mbgl(Rajgarh block) to 81.20mbgl(Behror block). Shallow water level less than 20m has been noticed in parts of Rajgarh, Umren and Thanagazi blocks only, water level between 20 and 40 mbgl observed in major part of district and more than 40 on north western part of district covering major parts of Behror, Neemrana blocks and little parts of Mandawar and Bansur blocks (Fig. 8).

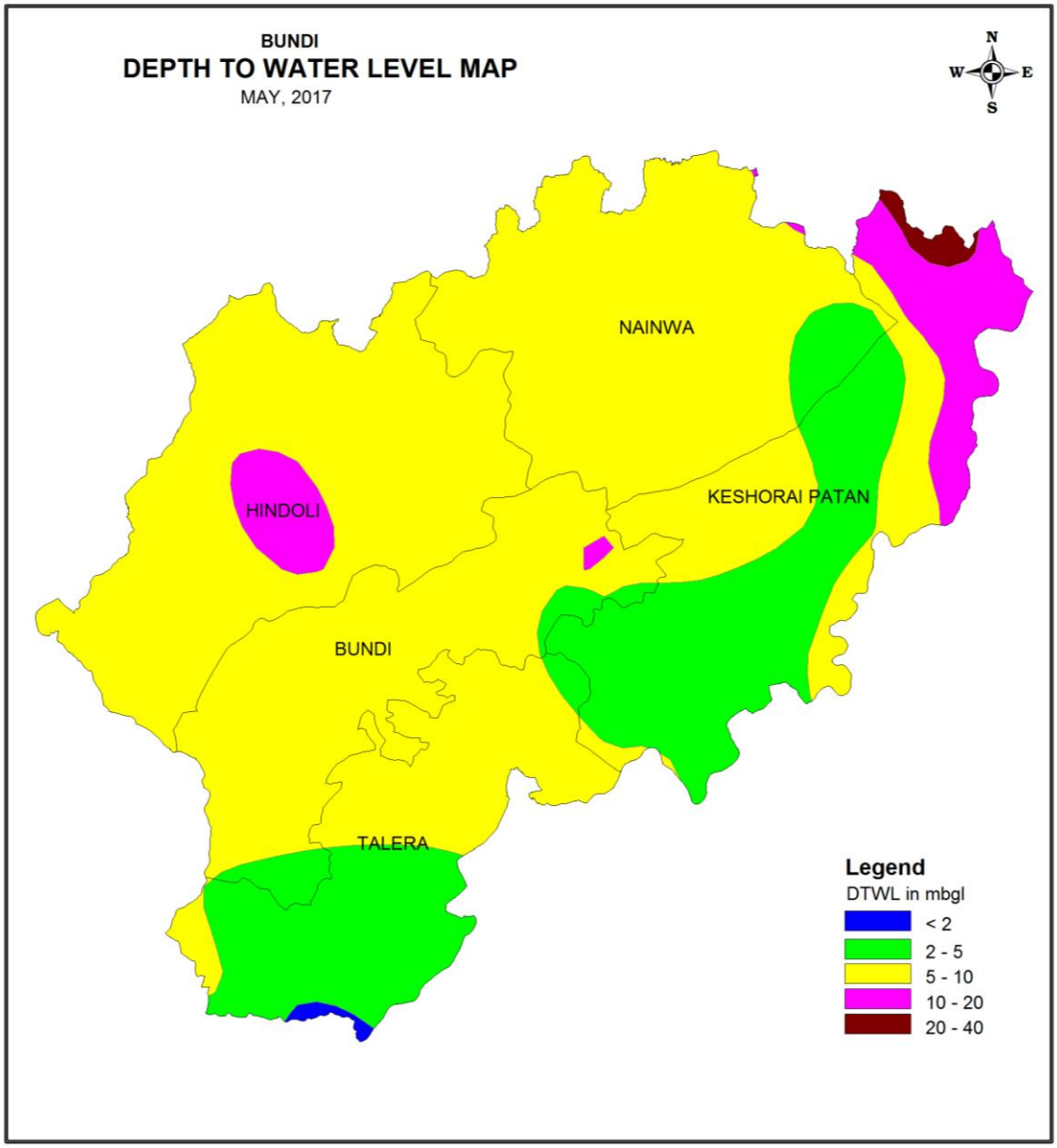

Fig.8: Depth to Water Level during pre-monsoon, 2017, Bundi district

1.2.2 Depth to Water Level – Post monsoon (Nov-2017)

During November, 2016, shallow water level less than 10m is observed in major parts of Rajgarh block and little parts of Thanagazi and Umrain blocks. Water level between 10 and 20 mbgl has been noticed in parts of Rajgarh, Thanagazi, Umrain Ramgarh, Reni and Tijara blocks , whereas deeper water level i.e. between 20 and 40 mbgl is observed in major p[art of district covering entire north western and south easten parts of district(Fig.9).

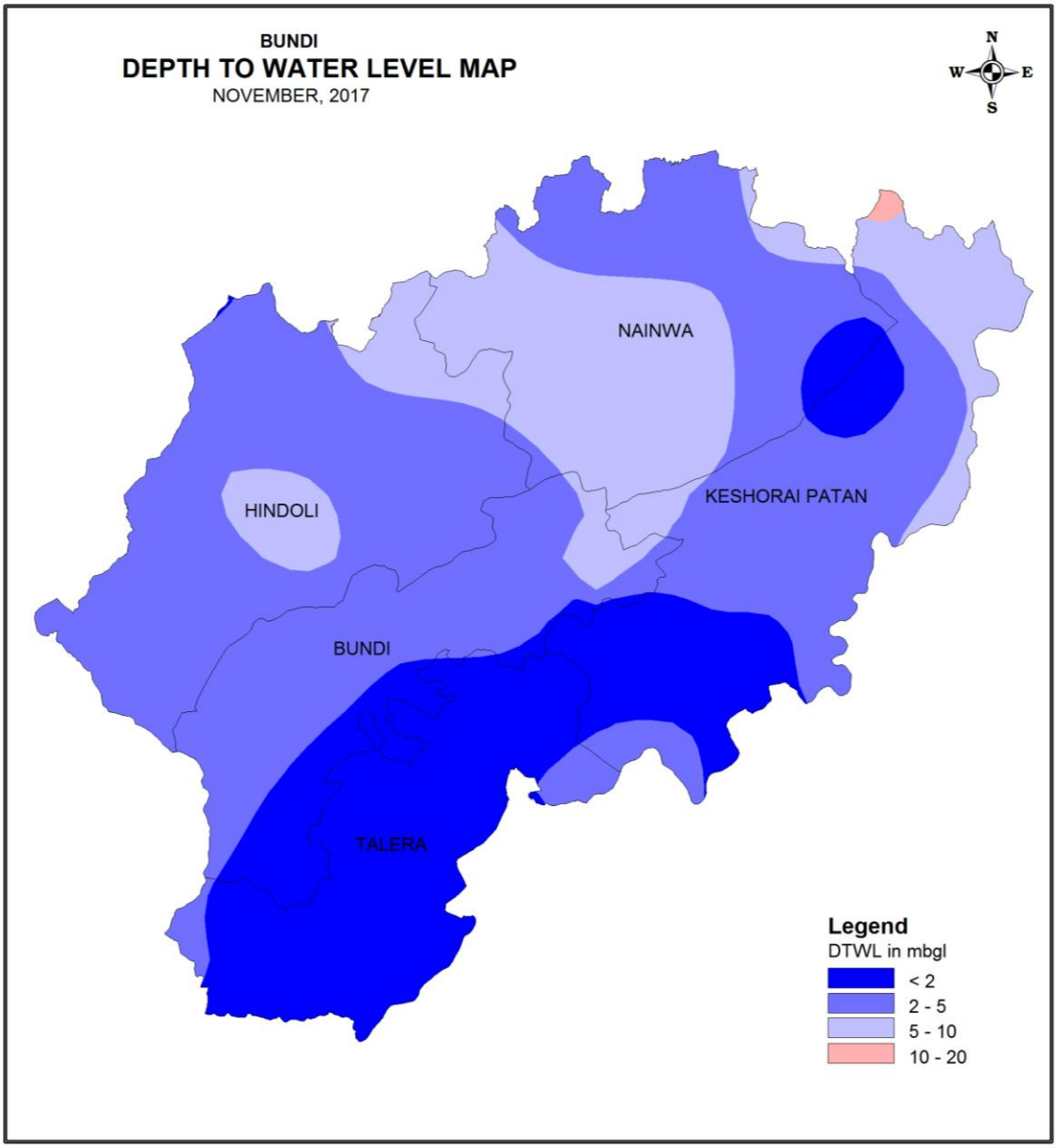

Fig. 9. Depth to Water Level during post-monsoon, 2017, Bundi district

1.2.3 Seasonal Water Level Fluctuation (May-Nov. 2017)

Seasonal fluctuation in water level based on Pre (May)- and Post (November)-Monsoon, 2016 indicates that both rise as well as fall in water levels during post-monsoon period have been recorded in the district (Fig. 10). Perusal of the fluctuation map also indicates that complete parts of Behror, Mandawar, Bansur, Kotkasin; major parts of Kathumar, Umrain and little parts of Kishangarh Bas have recorded fall in water level in the range of less than 2 m to more than 4 m. Remaining part of district shows rise in water level (from <2m to >4m) covering complete blocks of Tijara, Rajgarh, Ramgarh, Reni; major parts of Kishangarh Bas, Thanagazi, Laxmangarh and Kotkasim blocks .

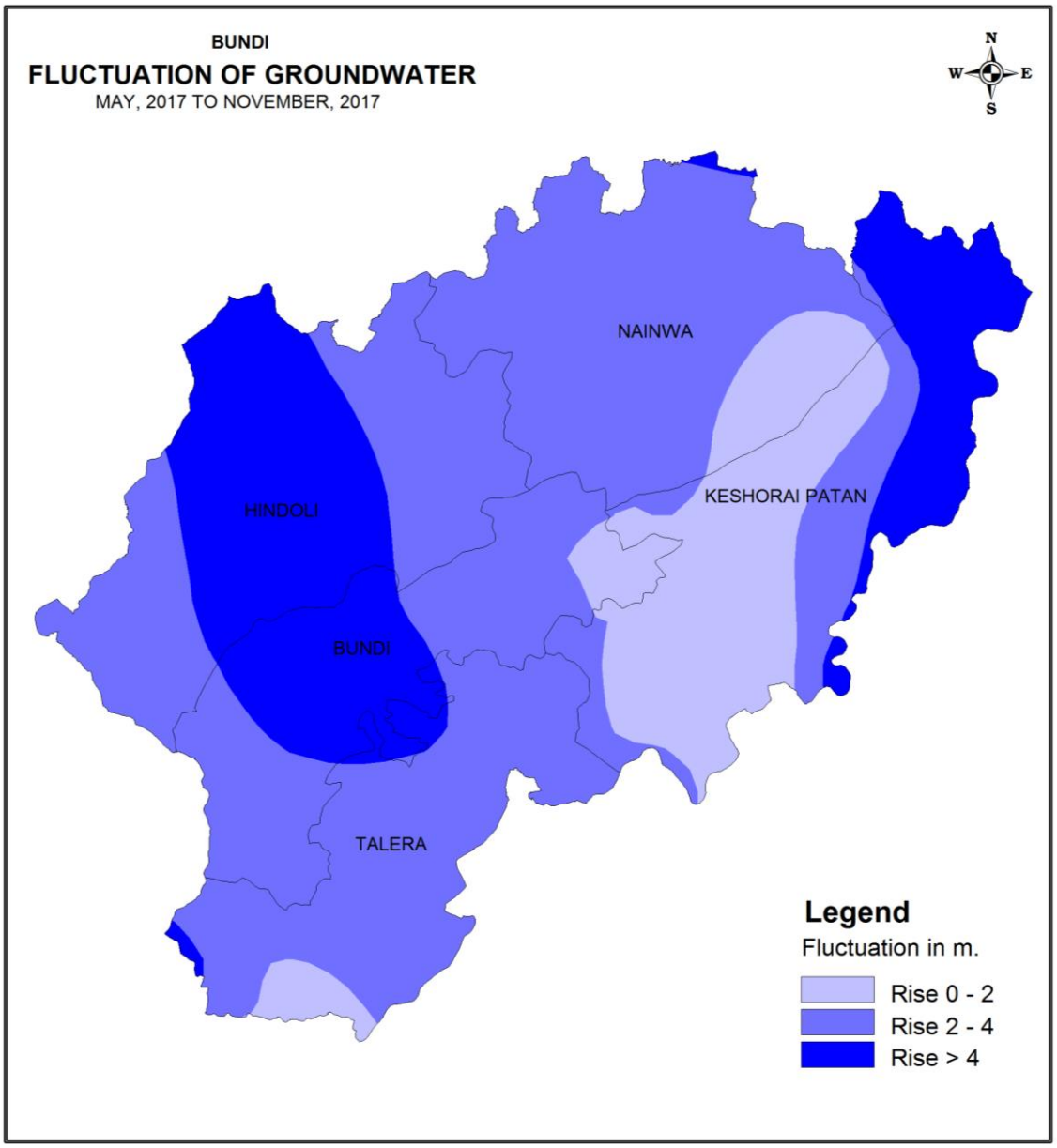

Fig. 10. Water level fluctuation map (May 2017 - November 2017), Bundi district

2.2.4 Decadal Water level Fluctuation (2007-16 and May,2017)

Decadal water level fluctuation map(2006-15 versus May,2016) has been prepared**(Fig.11)**. Perusal of map indicate that almost part of district indicates decline in water level ranging from less than 2m to 4 m. Marginal rise of amplitude of less than 2 m is observed in isolated pockets of Umrain and Reni blocks.

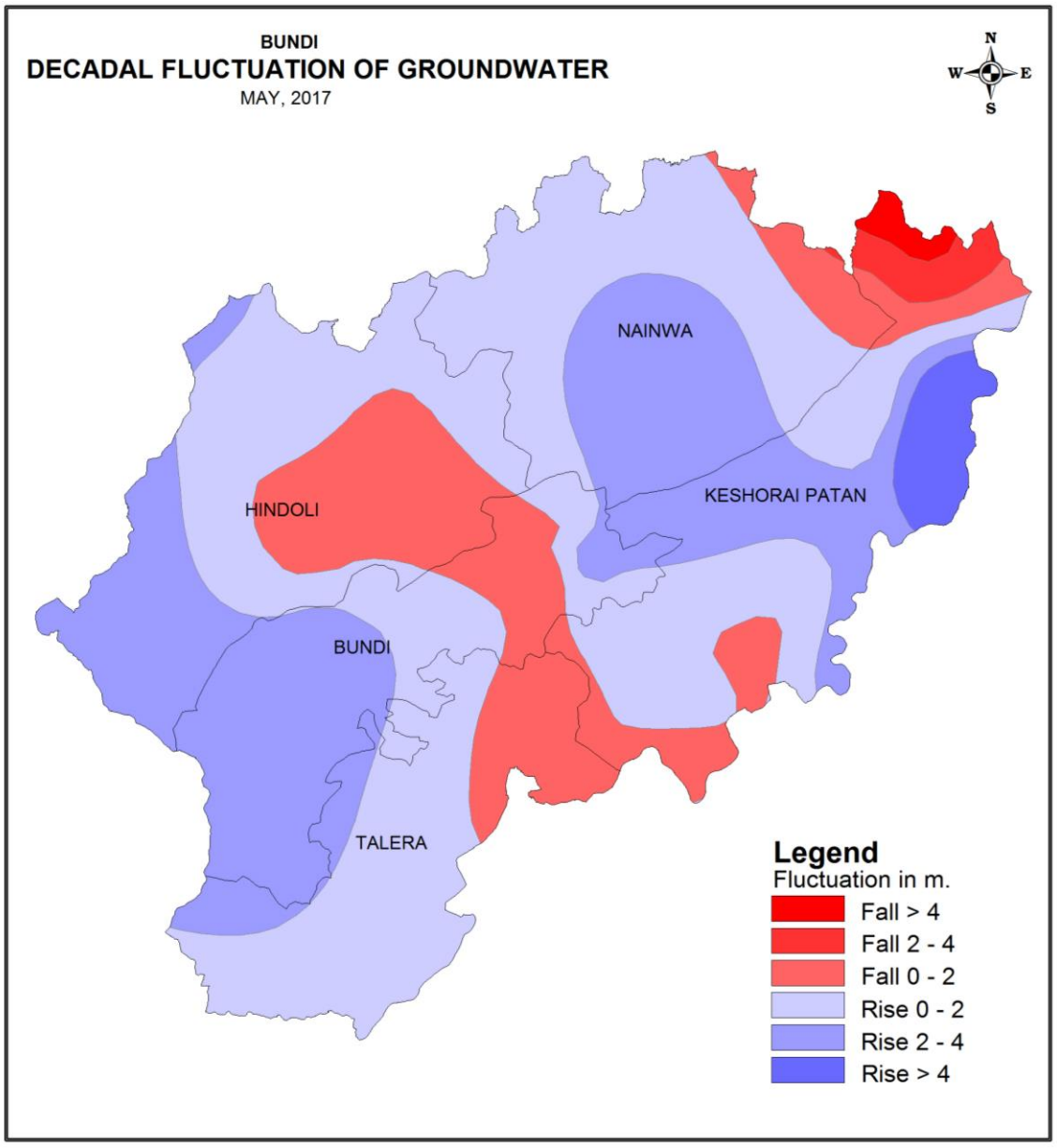

Fig. 11. Decadal pre-monsoon ground water level trend map (2006-15 vs May, 2016), Bundi district

- Transmissivity of alluvial aquifer varies from 27 to 662 m^2/day and storativity value from $5.0x10^{-5}$ to $2.6x10^{-2}$.

3. GROUND WATER QUALITY

In general, quality of ground water is suitable for irrigation and domestic uses. Shallow ground water in the district is alkaline in nature with pH varying from 7.2 to8.4.

3.1 Electrical conductivity

Electrical Conductivity varies from 485 ms/ cm at 25°C at Chatarpura in Bansur block to 15230 ms/ cm at 25°C at Mazri Khurd in Behror block. Electrical Conductivity in major part of the district is below 3000 microsiemens/ cm at 25°C and is represented by 84% of samples (Fig. 15). EC value of more than 3000ms/cm at 25°C has been observed in 16% of samples falling in south eastern parts (covering parts of Laxmangarh, Kathumar, Ramgarh blocks), and extreme north western parts (covering parts of Neemrana and little part of Behror blocks) of district.

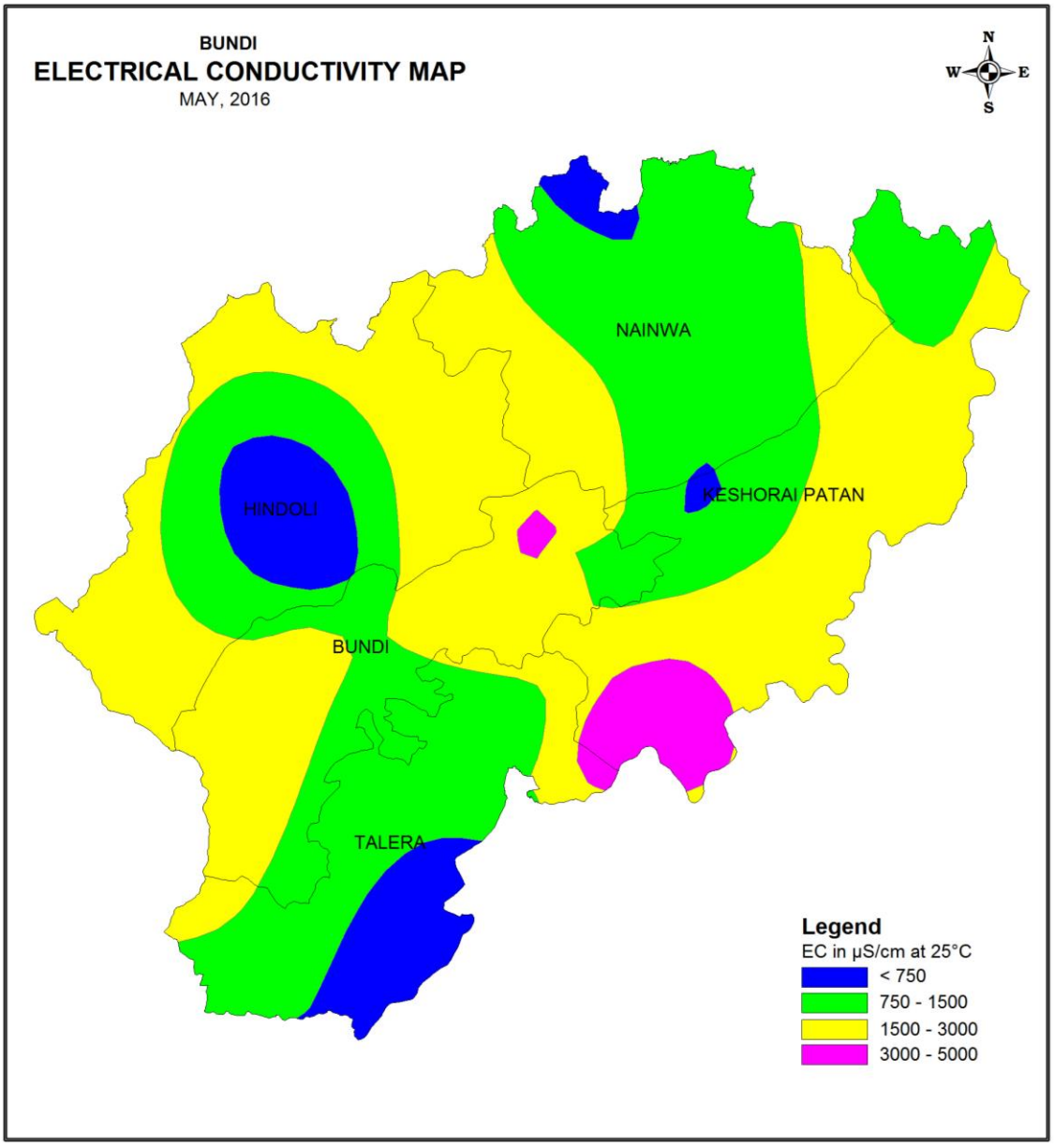

Fig. 15 Distribution of electrical conductivity in groundwater, Bundi District (May, 2016)

3.2 Fluoride

Concentration of fluoride in ground water varies from 0.02mg/l at Janak Singh Pura in Neemrana block to 2.40mg/l at Mazri Khurd in Behror block. 86% of samples have been found with fluoride concentration within the permissible limit of drinking water standards(2012) i.e. 1.5mg/l covering major part of the district and only 14% of samples beyond permissible limit(Fig.16).

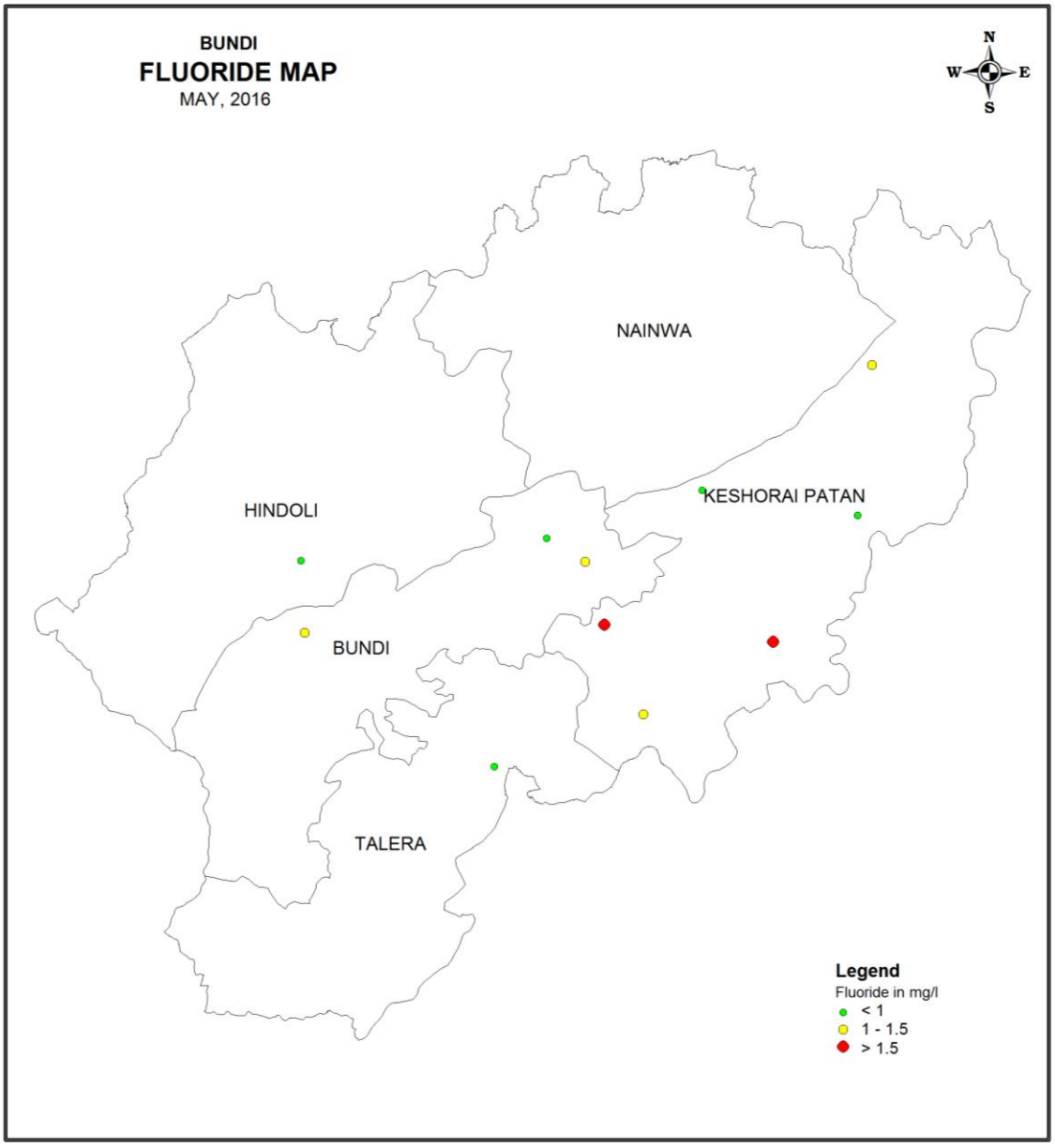

Fig. 16: Distribution of fluoride in groundwater, Bundi District (May, 2016)

3.3 Nitrate

Nitrate concentration in groundwater varies from 0 at Doroli in Reni block to 190 at Ramgarh in Ramgarh block and has been found within the permissible limit of 45 mg/litre in major part of the district constituted by 88% of samples (Fig. 17). However, higher values of nitrate more than 45mg/l has been observed 12% of samples.

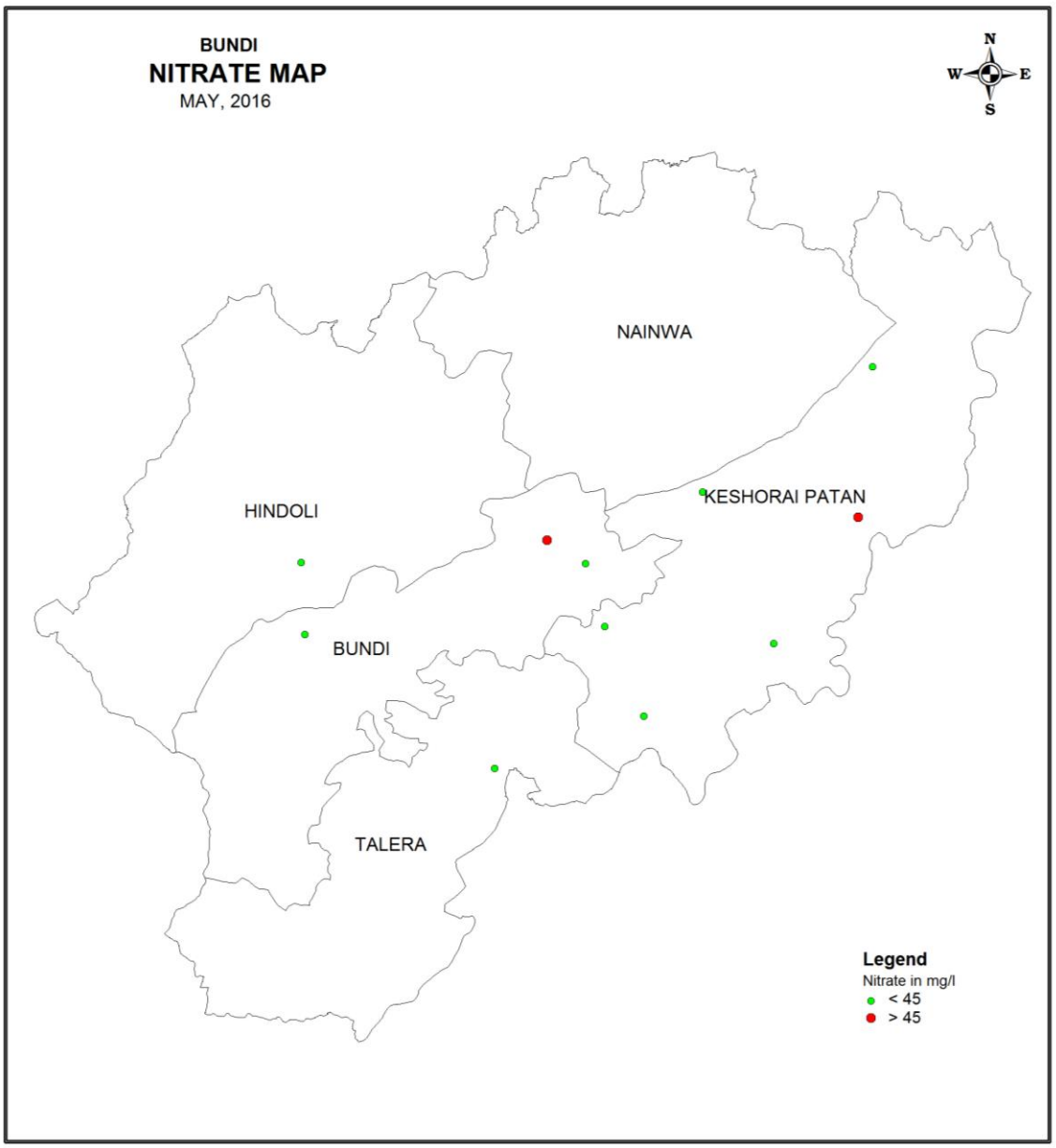

Fig.17. Distribution of nitrate in groundwater, Bundi district (May, 2016)

3.4 Iron

Iron concentration in ground water ranges from 0 to 6.93mg/l at Holawas in Bansur block. Ground water has high iron content more than acceptable limit i.e. 0.30mg/l of drinking water standard (2012) and is represented by 51% of samples (Fig.18).

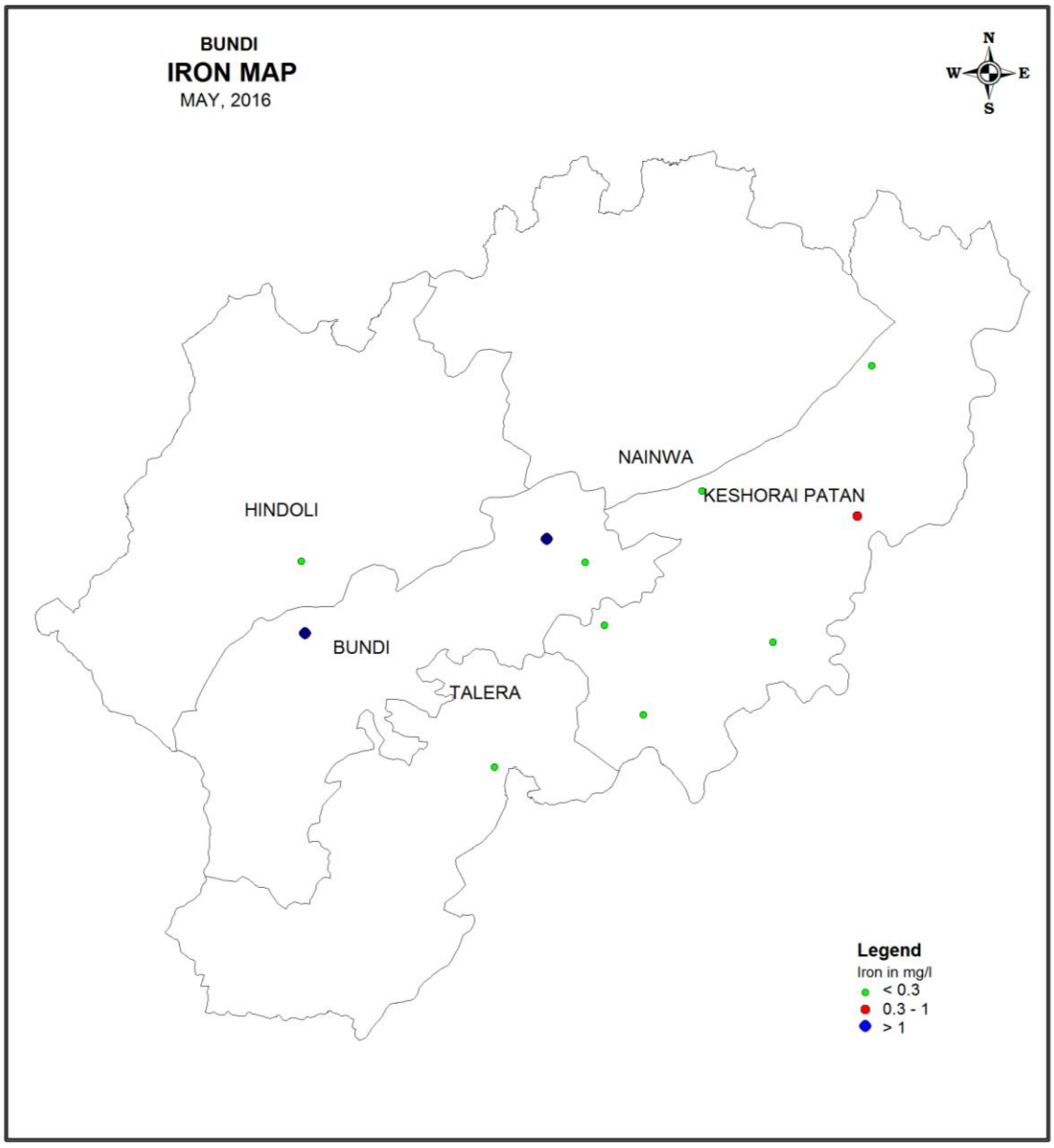

Fig. 18 Distribution of iron in groundwater, Bundi district (May, 2016)

3. GROUND WATER RESOURCES

Central Ground Water Board and Ground Water Department, Government of Rajasthan have jointly estimated the ground water resources of Bundi district based on GEC-97 methodology. The same are presented in Table 8. Net annual ground water availability in the district has been estimated as 349.3267mcm. Annual ground water draft for all uses in the district has been assessed to be 331.9884 mcm with overall stage of ground water development at 95.04%.

GROUND WATER POTENTIAL OF DISTRICT BUNDI AS ON 31.03.2013

Block	Area of Block (sq.km)	Potential zone area	Total Annual ground water Recharge	Net Annual Ground Water Availability	Existing Gross Ground Water Draft for Irrigation	Existing Gross G.W. Draft for Dom. & Ind. Use	Existing Gross Ground Water Draft for all uses	Net G.W. Availability for future Irr. Dev.	Stage of G.W. Develop-ment.	Category
		(Sq.kms)	(mcm)	(mcm)	(mcm)	(mcm)	(mcm)	(mcm)	(%)	
1	2	5	6	8	9	10	11	13	14	17
BUNDI	1175.13	178.65	30.8396	23.1297	11.9472	0.7855	12.7327	10.4807	55.05	
		93.75	13.8885	10.4164	9.0955	0.5943	9.6898	0.0814	93.02	
		233.12	13.2452	11.9207	13.8092	1.4220	15.2312	0.0000	127.77	
		113.47	14.3266	12.8939	11.0120	1.2979	12.3099	0.0000	95.47	
		154.12	9.1298	8.2168	9.5820	0.6461	10.2281	0.0000	124.48	
TOTAL OF BLOCK		**773.11**	**81.4297**	**66.5775**	**55.4459**	**4.7457**	**60.1916**	**10.5621**	**90.41**	**SEMICRITICAL**
HINDOLI	1275.3	88.00	13.5684	9.4979	5.4024	0.7742	6.1766	2.9320	65.03	
		714.44	55.3158	49.7842	54.0150	5.0116	59.0266	0.0000	118.56	
		82.37	8.0695	7.2625	11.0034	0.5439	11.5473	0.0000	159	
TOTAL OF BLOCK		**884.81**	**76.9537**	**66.5446**	**70.4208**	**6.3297**	**76.7505**	**2.9320**	**115.34**	**OVER EXPLO.**
K.PATAN	1243.51	819.41	119.2282	107.3054	78.7620	3.8121	82.5741	18.1601	76.95	
		206.79	4.5534	4.0981	8.9806	1.1760	10.1566	0.0000	247.84	
		126.68	3.8560	3.4704	5.5020	0.8132	6.3152	0.0000	181.97	
TOTAL OF BLOCK		**1152.88**	**127.6376**	**114.8739**	**93.2446**	**5.8013**	**99.0459**	**18.1601**	**86.22**	**SAFE**
NAINWA	1095.19	101.78	7.1808	6.4627	12.2514	1.3957	13.6471	0.0000	211.17	
		865.07	54.0048	48.6043	43.1970	6.9252	50.1222	0.0000	103.12	
TOTAL OF BLOCK		**966.85**	**61.1856**	**55.0670**	**55.4484**	**8.3209**	**63.7693**	**0.0000**	**115.8**	**OVER EXPLO.**
TALERA	710.87	160.28	34.7637	26.0728	7.7042	0.6352	8.3394	17.7390	31.99	
		51.99	6.2535	5.6281	2.4990	0.4225	2.9215	0.0000	51.91	
		250.26	16.1810	14.5629	19.9260	1.0440	20.9700	0.0000	144	
TOTAL OF BLOCK		**462.53**	**57.1982**	**46.2638**	**30.1292**	**2.1018**	**32.2310**	**17.7390**	**69.67**	**SAFE**
	C	1505.55	232.8684	194.9441	126.4223	8.3217	134.7441	49.3932	69.12	
	NC	2734.63	171.5363	154.3826	178.2666	18.9777	197.2443	0.0000	127.76	
Grand Total		**4240.18**	**404.4047**	**349.3267**	**304.6889**	**27.2994**	**331.9884**	**49.3932**	**95.04**	**CRITICAL**

5.0 STATUS OF GROUND WATER DEVELOPMENT

The stage of ground water development for the district is 174.11% as on 31.03.2013. All blocks have stage of ground water development more than 100% ranging from 102% (minimum in Thanagazi block) to 293.81% (maximum in Behror block) and these have been categorized as over exploited, thereby leaving hardly any scope of further ground water development.

Availability of groundwater in the district is estimated to be 855.0386 mcm. Draft for all uses is 1488.7001mcm. Out of which 1362.0542 mcm is used for irrigation and 126.6459mcm is used for industrial/domestic needs. There are 90614 wells including 50085 utilizable and 40529 un-utilizable wells used for irrigation, drinking and industrial uses. Rainfall in the district is the main source of ground water recharge. Due to less rainfall and increased ground water withdrawal the groundwater levels are declining As a result quality of ground water is also deteriorating. High salinity has been observed in south eastern parts(covering parts of Laxmangarh, Kathumar, Ramgarh blocks), and extreme north western parts(covering parts of Neemrana and little part of Behror blocks) of the district.

6.0 GROUND WATER RELATED ISSUES AND PROBLEMS

6.1 Decline in ground water level and depletion of alluvial aquifer

Long term water level data (pre monsoon 2001-12) have indicated declining water level trend in all the blocks except Rajgarh where marginal rising trend of 0.014m/year has been observed. Declining trend ranges from 0.0183m/year(Thanagazi Block) to 2.55m/year(Behror Block). Over draft of ground water resources for various uses than its natural replenishment, has resulted incessant declining trend in the most part of the district. Marginal rising trend may be due to the less withdrawal of ground water in the area being hilly and less availability of cultivable area. All the blocks fall under over exploited category.

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6.2 Deep ground water level

Water level pof more than 40 mbgl has been found in north western part of district covering major parts of Behror, Neemrana blocks and little parts of Mandawar and Bansur blocks. Deep water level causes consumption of more energy.

6.3 Ground water salinity

Ground water salinity more than 3000ms/cm at 25^{o}C has been observed in 16% of samples falling in south eastern parts (covering parts of Laxmangarh, Kathumar, Ramgarh blocks), and extreme north western parts (covering parts of Neemrana and little part of Behror blocks) of district.

6.4 Iron hazard

High iron content more than acceptable limit i.e. 0.30mg/l of drinking water standard(2012) has been found almost half of the district and is represented by 51% of samples.

6.5 Ground water pollution in

Ground water pollution study have been carried out in Bhiwadi Industrial cluster during 2011-12 and 2015-16, has indicated ground water pollution from the disposal of industrial effluents. Ground water pollution has been further augmented when compared to the study carried out during 2011-12.

Higher concentration of effluents with heavy elements particularly nickel, cadmium, iron and lead as compared to 2011, in turn has also reflected in further contamination/pollution of ground water mainly with nickel, cadmium, iron and lead in the study area. The heavy metals concentration beyond no relaxation of acceptable limit has escalated from 36.84%(2011) of ground water samples to 100%(2016) for Cadmium, from 84.21%(2011) to 100%(2016) for lead, from 2.63%(2011) to 11.42%(2016) for nickel and from 39.47%(2011) of ground water samples increased to 42.86%(2016) for iron. These heavy elements are considered to be toxic for human health. The analytical data indicate maximum ground water pollution affected areas which lies in northern western part of Bhiwadi industrial area covering Alupur, Naglia, Old Bhiwadi, Sithal villages etc.

7.0 GROUND WATER MANAGEMENT STRATEGY

Due to pressure of population and improvement in the standard of living, the demand of fresh water for both agriculture and domestic uses has substantially increased. As surface flow is available only for a limited period, groundwater withdrawal has sharply increased. The top layer of fresh groundwater is also reducing every year. To combat/reduce the depleting ground water storage of water level, the following management strategies may be adopted:

7.1 As the district has 174.11% stage of ground water development (all the blocks are over-exploited having stage of ground water development ranging from 102% (minimum in Thanagazi block) to 293.81% (maximum in Behror block), thereby leaving little scope of further ground water development for irrigation except for drinking purpose which may be taken up only in very restricted and planned way to avoid further enhancement of degree of over-exploitation.

7.2 Area is underlain by unsaturated moderate thickness of alluvial which provides sufficient scope of artificially augmentation of the ground water body as alluvial formation has very good storage and transmission capacity in the district. In the district, usable surplus water is available in Behror, Mandawar and Neemrana blocks only and is computed to the tune of 3.83mcm/annum and effective recharge of 2.68mcm/annum may be made through construction of 72 recharge shaft in local pond and 9 percolation tanks.

7.3 Since the agriculture sector is the cardinal consumption of ground water, it should be used judiciously taking in to account of modern agriculture water management techniques including cultivating crops requiring less watering (change in cropping pattern) and use of sprinkler system & drip irrigation should be encouraged. A total of 288mcm/annum of water(including 192mcm/annum by using sprinkler irrigation practices and 96mcm/annum by change in cropping pattern) may be saved by the implementation of said practices of water saving/conservation.

Addition of 2.68mcm/annum from supply side management through artificial recharge to ground water and subtraction from demand side of 288mcm/annum through water conservation practices may brought the 118.78% present stage of ground water development down to 146.52%.

7.4 A modern agriculture management has to be taken into account for effective water management techniques involving economic distribution of water maintaining minimum pumping hours and also be selecting most suitable cost effective crop pattern i.e. for getting maximum agriculture production through minimum withdrawal. Adopting proper soil and water management even the ground water with somewhat dissolved solids (TDS) may also be suitable for irrigation for salt tolerant crops in the area having high salinity.High water requirement crops should be discouraged. Proper agricultural extension services should be provided to the farmers so that they can go for alternate low water requirement economical crops.

7.5 For providing the drinking water in the areas/villages facing ground water salinity and fluoride hazards, desalination and defluorosis plants may be installed.

7.6 The stage of ground water development of the district is 174.11% which reflects excessive withdrawal of ground water in comparison of recharge, resulting in depletion of ground water levels and reduction in yields of wells. In view of this, Behror block (having 293.81% of state of ground water development as on 31.03.2013) has been notified on 2/12/2006 for Ground Water Regulation and Development by Central Ground Water Authority. Further, blocks having stage of ground water development more than 200% viz. Reni and Kathumar may be brough under notification to regulate ground water and development in the area.

7.7 Mass awareness programmes should be arranged at local level to make common mass aware of importance of ground water resources, its better practices of use in domestic, irrigation and industrial fronts, present status of ground water scenario, its conservation etc. One such program of Mass Awareness has been organized in Behror during 2001-2002.

7.8 Training programmes on water management should be arranged at local level to teach the common mass of various techniques of artificial augmentation to ground water resources. Such three training on “Water Management”, have been organized by CGWB at Bundi, Behror and Neemrana during 2003-04, 2004-05 and 2011-12 respectively.