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जलभृत मानचित्रण और प्रबंधन योजना

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AQUIFER MAPPING AND MANAGEMENT PLAN OF NURPUR VALLEY, DISTRICT KANGRA, HIMACHAL PRADESH

उत्तरी हिमालयन क्षेत्र, धर्मशाला

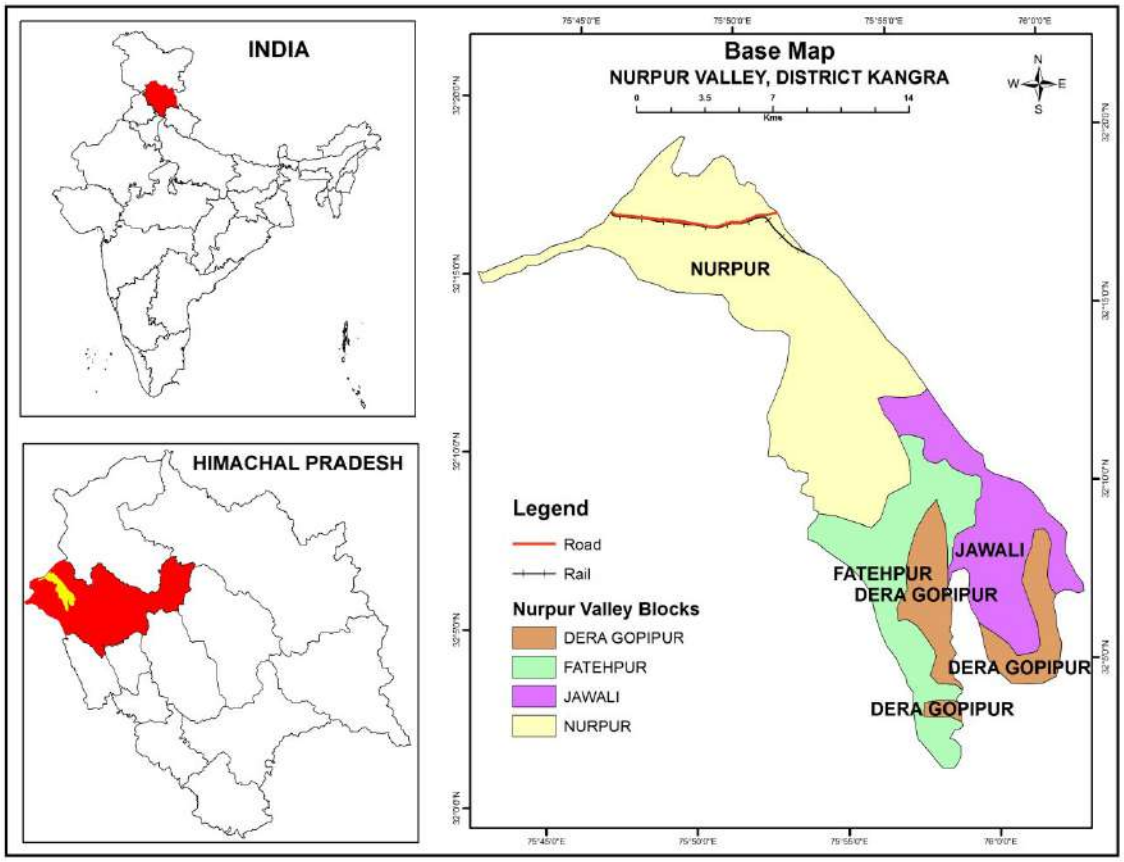
Northern Himalayan Region, Dharamshala

GOVERNMENT OF INDIA

MINISTRY OF WATER RESOURCES, RIVER DEVELOPMENT & GANGA REJUVENATION

CENTRAL GROUND WATER BOARD

AQUIFER MAPPING AND MANAGEMENT PLAN OF NURPUR VALLEY, DISTRICT KANGRA, HIMACHAL PRADESH



NORTHERN HIMALAYAN REGION

DHARAMSHALA

2018

AQUIFER MAPPING AND MANAGEMENT PLAN OF
NURPUR VALLEY, DISTRICT KANGRA, HIMACHAL PRADESH

CONTENTS

LIST OF FIGURES

LIST OF TABLES

AQUIFER MAPPING AND MANAGEMENT PLAN OF NURPUR VALLEY, DISTRICT KANGRA, HIMACHAL PRADESH

1. INTRODUCTION

Aquifer mapping is a process wherein a combination of geologic, geophysical, hydrologic and chemical field and laboratory analyses are applied to characterize the quantity, quality and sustainability of ground water in aquifers. There has been a paradigm shift from “groundwater development” to “groundwater management”. An accurate and comprehensive micro-level picture of groundwater in India through aquifer mapping in different hydrogeological settings will enable robust groundwater management plans at the appropriate scale to be devised and implemented for this common-pool resource. This will help achieving drinking water security, improved irrigation facility and sustainability in water resources development in large parts of rural India, and many parts of urban India as well. The aquifer mapping program is important for planning suitable adaptation strategies to meet climate change also. Thus the crux of NAQUIM is not merely mapping, but reaching the goal – that of ground water management through community participation.

1.1 Objectives

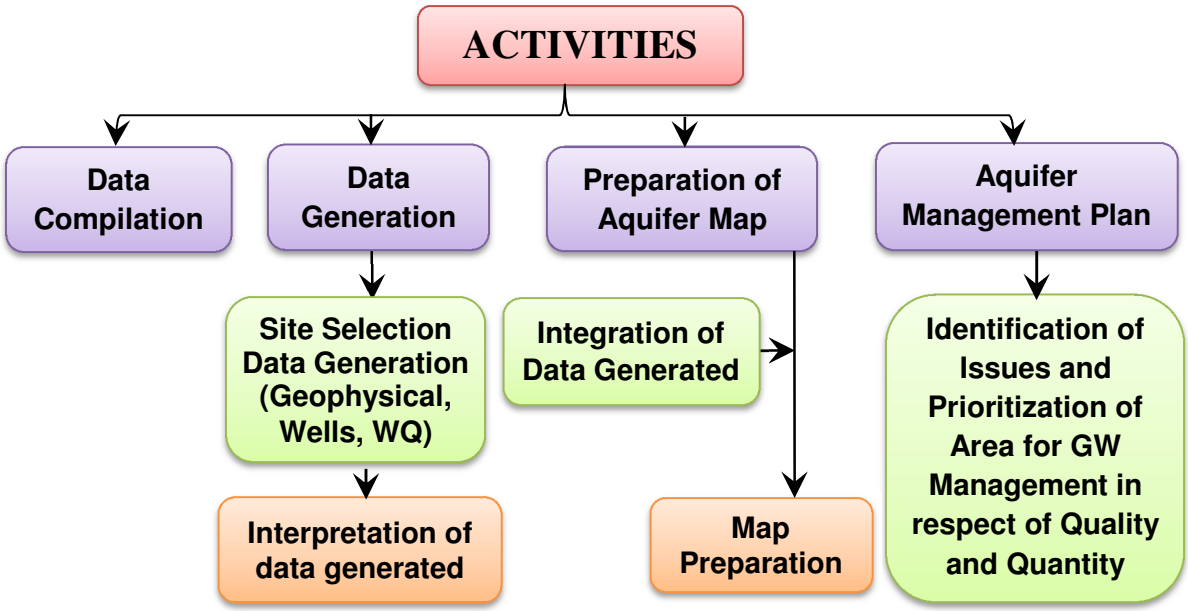
The primary objective of the Aquifer Mapping Exercise can be summed up as “Know your Aquifer, Manage your Aquifer”. Demystification of Science and thereby involvement of stake holders is the essence of the entire project. The involvement and participation of the community will infuse a sense of ownership amongst the stakeholders. This is an activity where the Government and the Community work in tandem. Greater the harmony between the two, greater will be the chances of successful implementation and achievement of the goals of the Project. As per the Report of the Working Group on Sustainable Ground Water Management, “It is imperative to design an aquifer mapping programme with a clear-cut groundwater management purpose. This will ensure that aquifer mapping does not remain an academic exercise and that it will seamlessly flow into a participatory groundwater management programme. The aquifer mapping approach can help integrate ground water availability with ground water accessibility and quality aspects.

With these aims, Aquifer Mapping Study is carried out in Nurpur valley of Kangra District of Himachal Pradesh under the Annual Action Programme 2015-16. These surveys are carried out to integrate the information on the scenario of groundwater occurrence, availability and utilization in terms of quality and quantity along with exploratory drilling, monitoring of water levels with quality, spring monitoring (discharge and quality), pumping tests, infiltration tests, geophysical surveys etc. Development of aquifer mapping at the appropriate scale and

formulation of sustainable management plan will help in achieving drinking water security, improving the sustainability of water resources development through springs. It will also result in better management of vulnerable areas. During this study, 11 key observation wells both Dugwells and borewells (Dugwells: 10 Nos. and springs: 1 Nos.) were established. Subsequently, all the available data on ground water from the earlier studies are compiled and integrated with these studies to bring out the ground water scenario, lateral and vertical characteristics of the aquifers and better management plan of ground water in a scientific manner.

1.2 Methodology

Various activities of NAQUIM are as follows:



1.3 Location, Extent and Accessibility

Nurpur is a city and a municipal council in Kangra district in the Indian state of Himachal Pradesh. It was formerly a Kingdom ruled by the Pathania clan of Tomara Rajputs, since the 11th century AD. The capital of the Kingdom was at Pathankot formerly known as Paithan, now in Punjab. It has an average elevation of 643 metres (2109 feet).

The study area Nurpur valley area of about 248 sq.km between northern latitudes of 32°01' to 32°17' and eastern longitudes of 75°40' to 76°04' which falls in the Survey of India Toposheet no. 43 P/11, P/15, P/16 and 52 D/4.

Nearest Airport is at Gaggal, Dharamshala (DHM) (in Kangra) - 45 km away. Jammu (J&K) Airport- 129 km away; and Amritsar Airport -134 km away.

Nearest Railhead is at [Pathankot and Pathankot Cantt.]- 24 km away, which is well connected by important trains from all the major cities, going to Jammu/Katra. Nurpur is blessed with narrow gaze train service (Pathankot/Jogindernagar) known as kangra valley rail. Travelling in Kangra Valley narrow gaze train is very charming and mesmerising passing through small mountains/bridges/villages.

Nurpur is well connected by road network from all sides and Pathankot/Kullu Manali highway passes through Nurpur.

1.4 Administrative Divisions and Demographic Particulars

Administratively, Nurpur town is the head quarter of the district. The study area comprises of 4 Blocks viz., Dera Gopipur, Fatehpur, Jawali and Nurpur Administrative divisions are shown in the Fig.1.1.

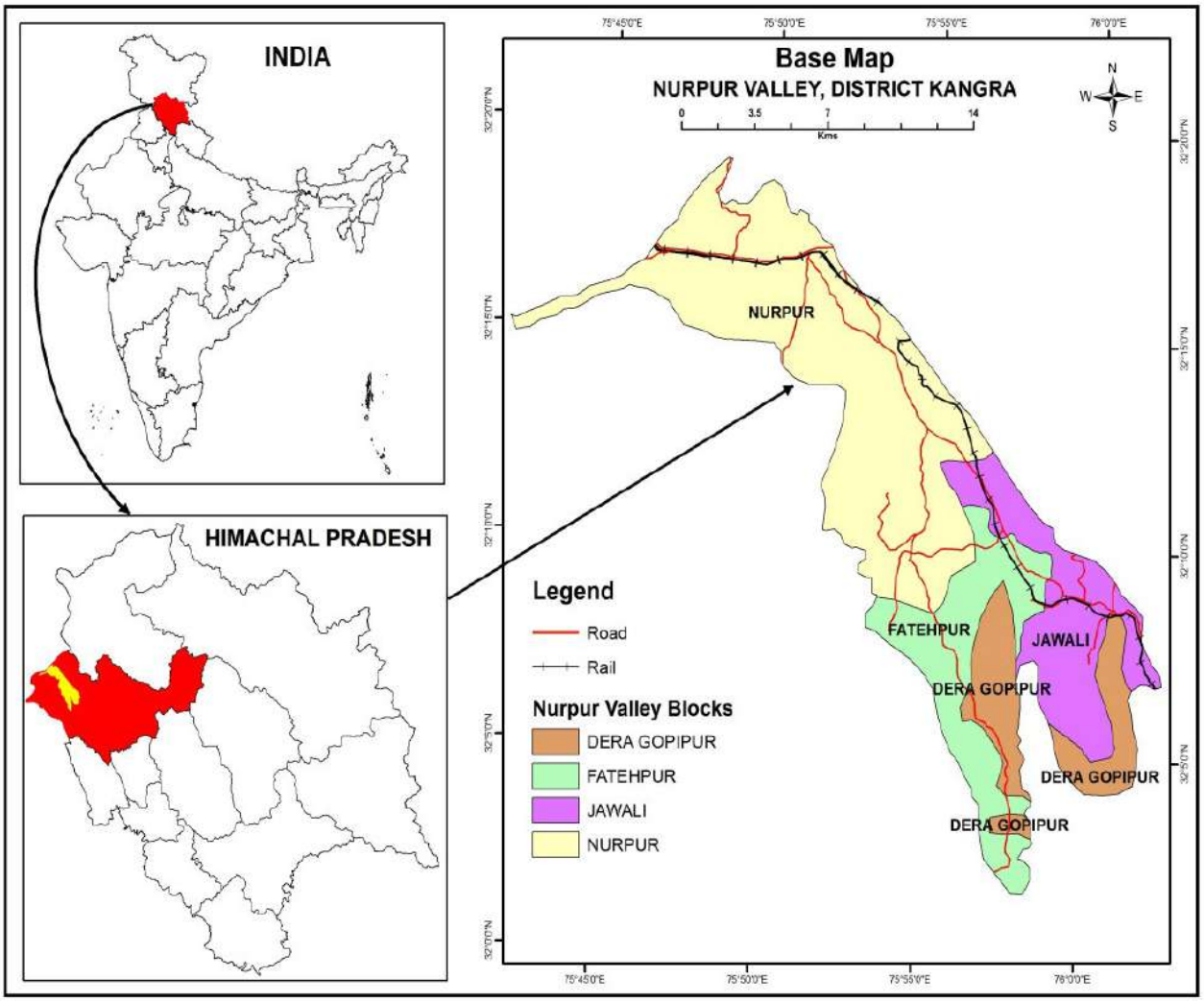


Fig 1.1: The administrative division of the study area

1.5 Data Gap Analysis

The Data gap analysis was done on the basis of NAQUIM & EFC guidelines in Aquifer Mapping Study area of 248 sq.kms in Nurpur Valley, District Kangra of Himachal Pradesh. The study area falls in Survey of India Toposheets No. 43P/11, 43P/15, 43P/16 and 52D/4 covering full or partial area of 11 quadrants (Figure -1.2 -Toposheet Index Map). The Data Gap analysis of all the attributes are given in Table 1.1.

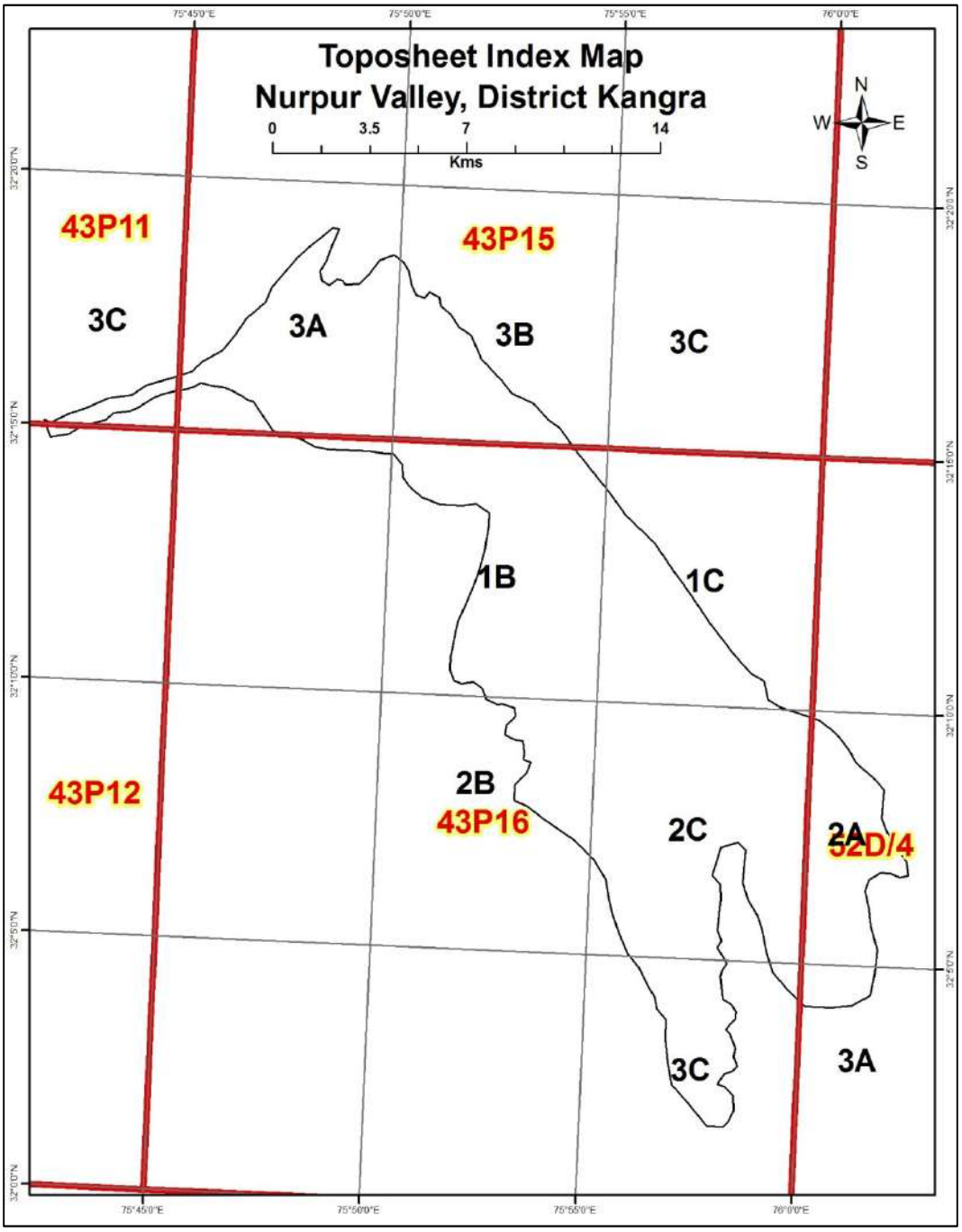
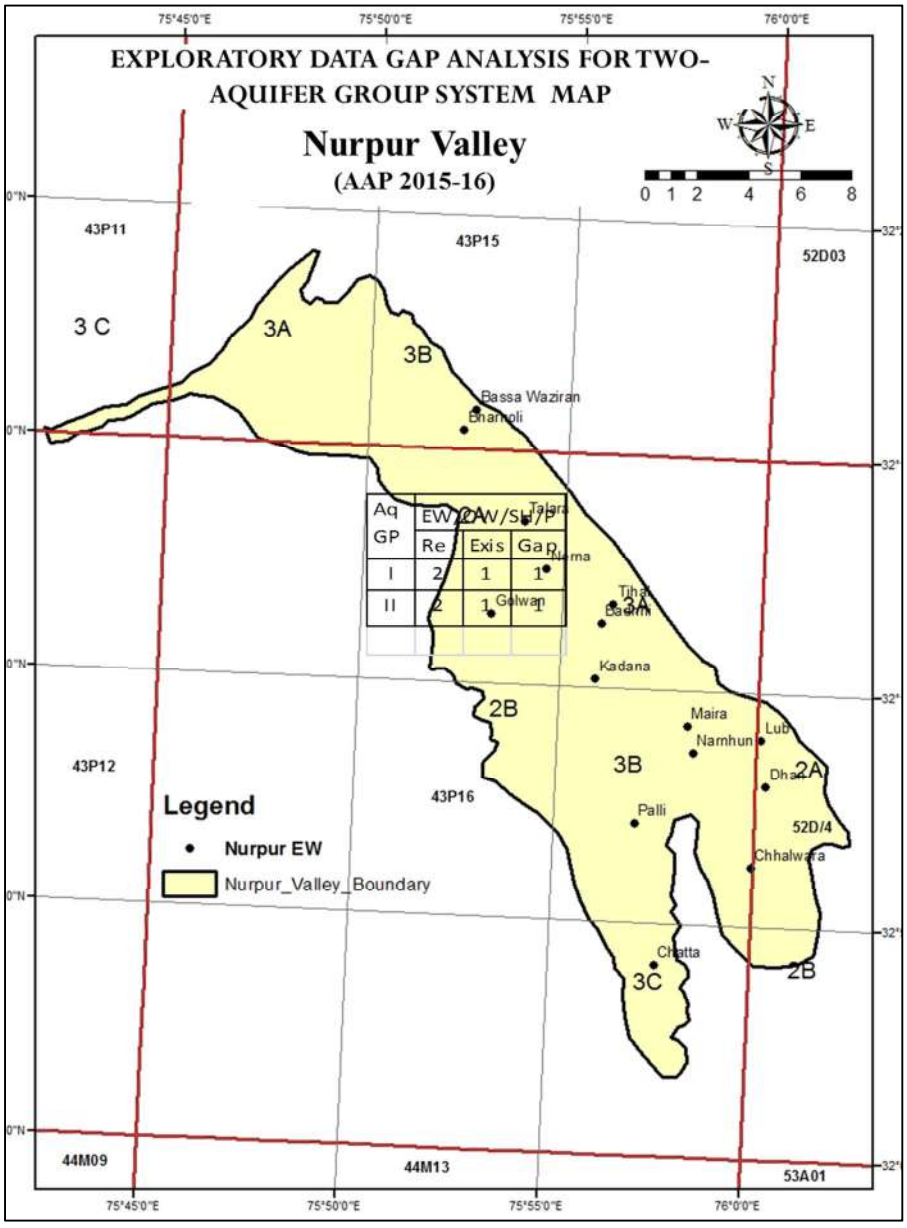


Fig.1.2 Toposheet Index Map - Nurpur Valley, Kangra District

1.5.1 Exploratory Data

The Data gap Analysis indicates the required Ground Water Exploration sites, sets of exploratory and observation wells to ascertain the aquifer parameters, in the area as per the EFC and the existing number of sites in the area and the Gap is indicated where ever the required number of sites is higher than the existing number of sites. If the number of existing exploratory wells is higher than the required exploration sites, the gap is considered as zero and the existing structures were taken as fulfilling the norms. On the basis of data gap analysis, quadrant-wise existing and recommended sites is presented and shown as square diagram in the figure-1.3 and Table No.1.1



Aq GP	EW/ZW/SW/P		
	Req	Exis	Gap
I	2	1	1
II	2	1	1

Fig.1.3 Exploratory Data Gap Analysis of Nurpur Valley, Kangra District

1.5.2 Geophysical Data

The Vertical Electrical Soundings (VES) is required for lithological interpretation to a depth of 300 m but due to hilly terrain the adequate spread may not be available, therefore, TEM is also recommended for lithological interpretation to a depth of about 100 m. But for the study area, no VES data is available with CGWB and state agencies. On the basis of data gap analysis, the required no. of VES are 09 Nos. The quadrant-wise existing and recommended VES sites is presented and shown as square diagram in the figure -1.4.

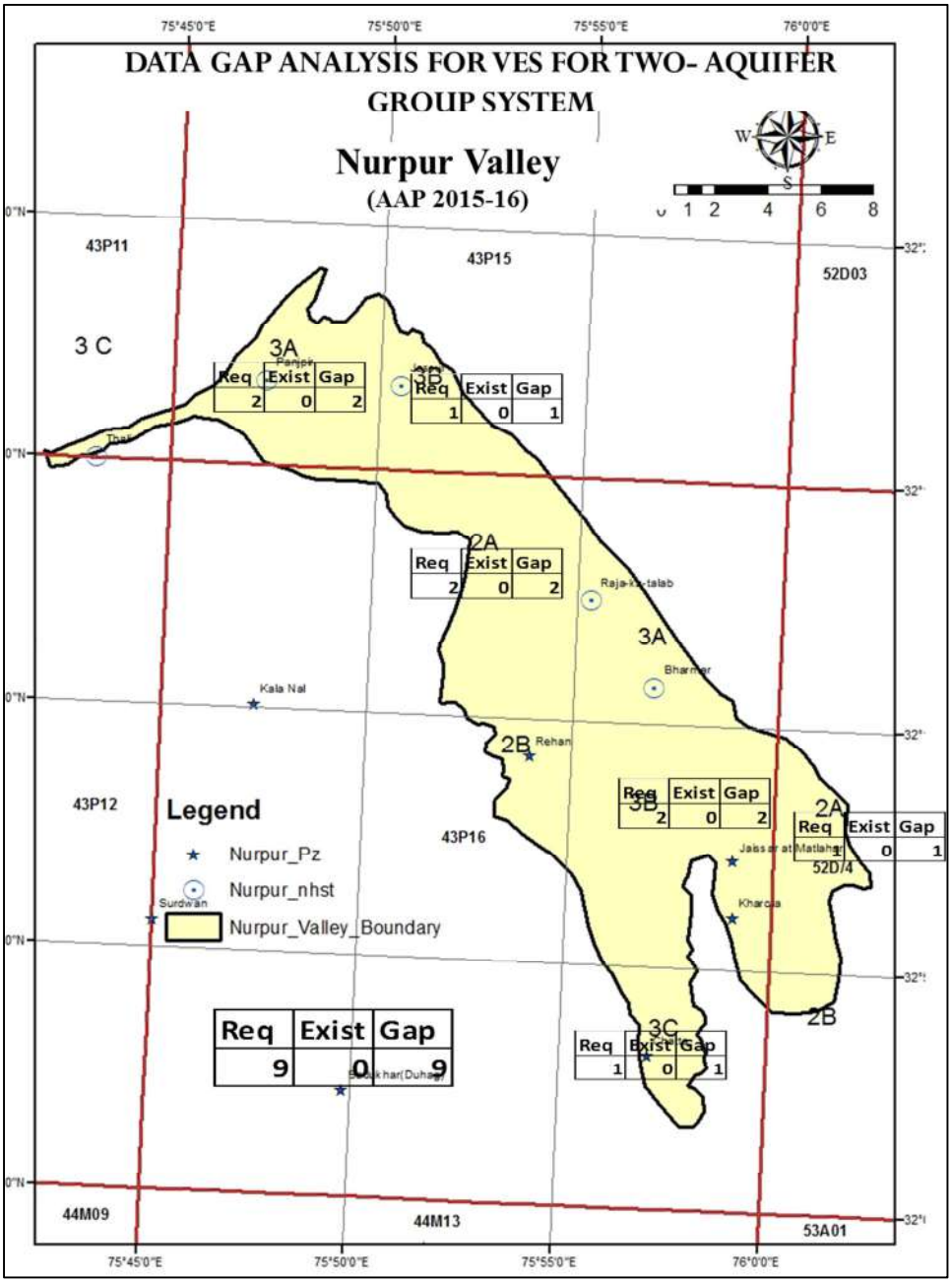


Fig.1.4 Data Gap Analysis of Surface Geophysical Surveys Nurpur Valley, Kangra District

1.5.3 Ground Water Monitoring Stations (GWMS)

The ground water monitoring NHS and Key well observation stations in the area tap the unconfined aquifer. Wells constructed by CGWB and hand pumps by State agencies which tap the deeper and shallow aquifers are utilised for drinking water supply instead of monitoring the piezometric head in the deeper and shallow aquifers. On the basis of data gap analysis, quadrant-wise and aquifer-wise existing and recommended ground water monitoring stations is presented and shown as square diagram in the figure -1.5.

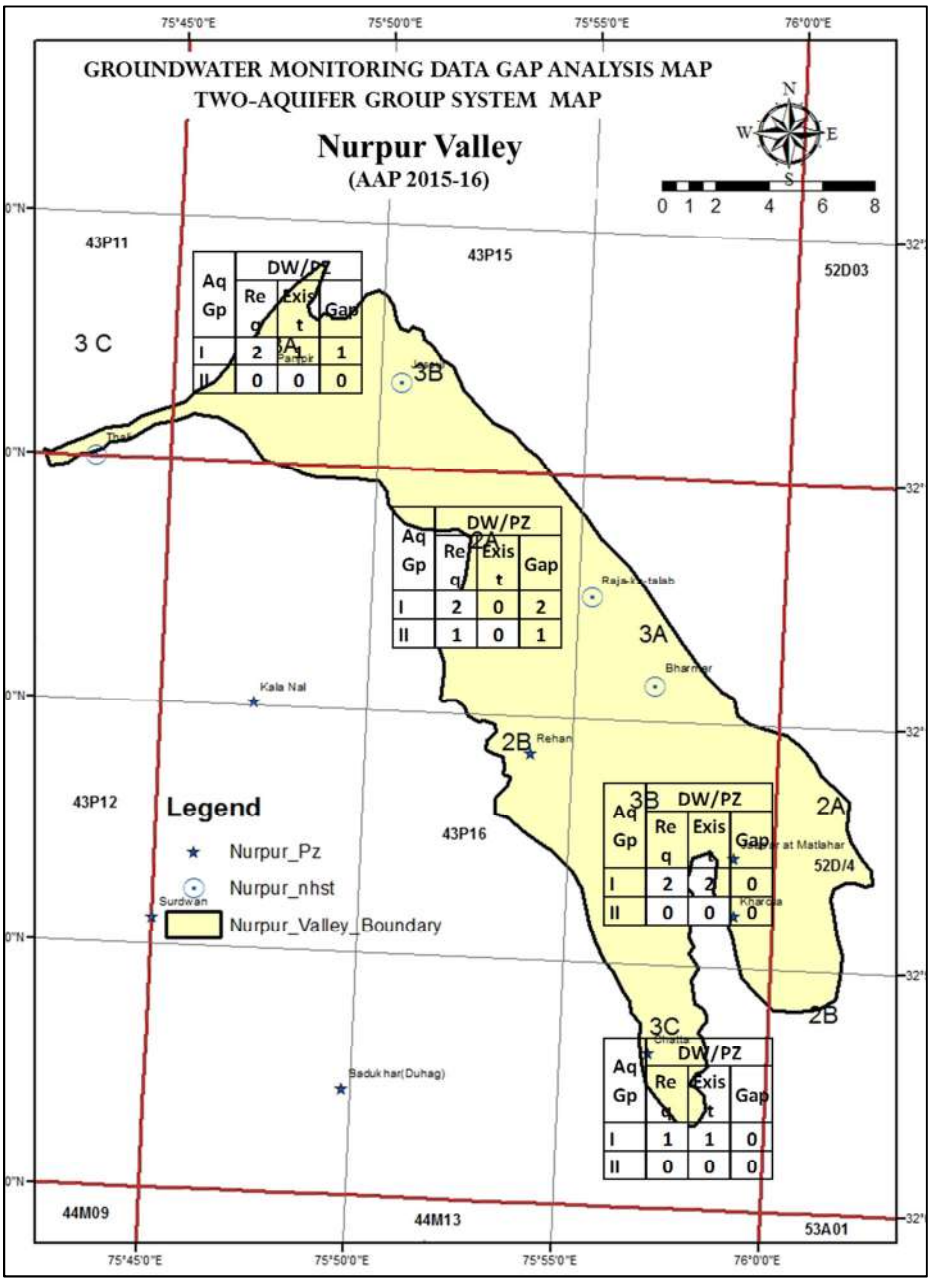
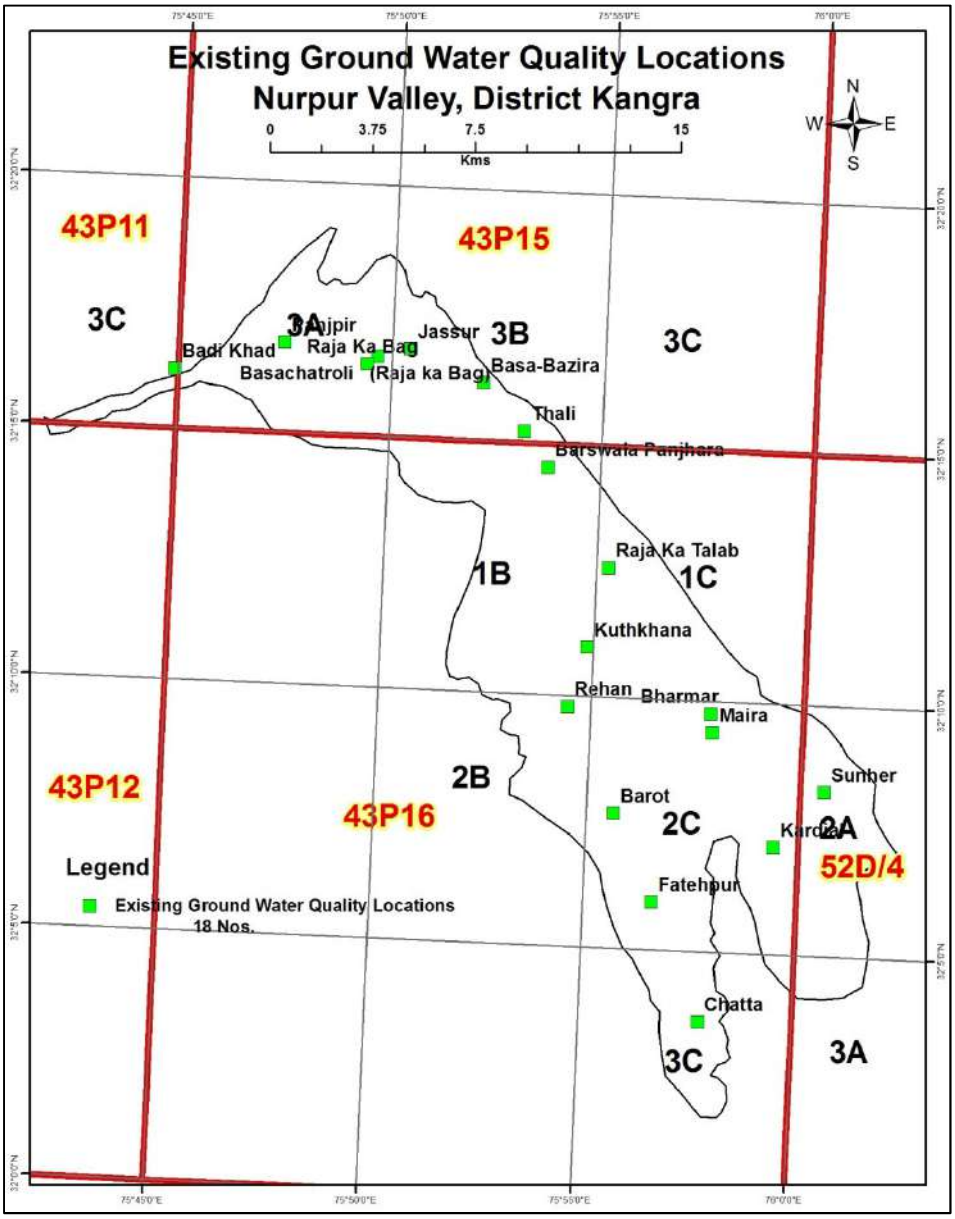


Fig.1.5 Data Gap Analysis for Ground Water Monitoring Nurpur Valley, Kangra District

1.5.4 Ground Water Quality Monitoring Stations (GWQMS)

Most of the ground water quality monitoring NHS and Key well observation stations in the area tap the unconfined aquifer. Wells constructed by CGWB and hand pumps by the state agencies tapping the deeper and shallow aquifers are utilised to monitor the quality of ground water in the deeper and shallow aquifers. On the basis of data gap analysis, no additional GWQMS are required, it will be monitored through NHS, Key well observation stations, hand pumps, existing and proposed E/Ws, and Pzs. The quadrant-wise and aquifer-wise existing and recommended ground water quality monitoring stations are shown as square diagram in the figure -1.6.



1.6 Existing Ground Water Quality Locations - Nurpur Valley, Kangra District

1.5.5 Rate of Infiltration

The amount of recharge to ground water depends on the infiltration rates of the soils. No infiltration tests have been conducted in previous surveys by CGWB and even this data is not available with state agencies. To know the infiltration characteristics of the soil in the study area, 12 nos. of infiltration tests are required. On the basis of data gap analysis, quadrant-wise existing and recommended infiltration tests are presented and shown as square diagram in the figure -1.7.

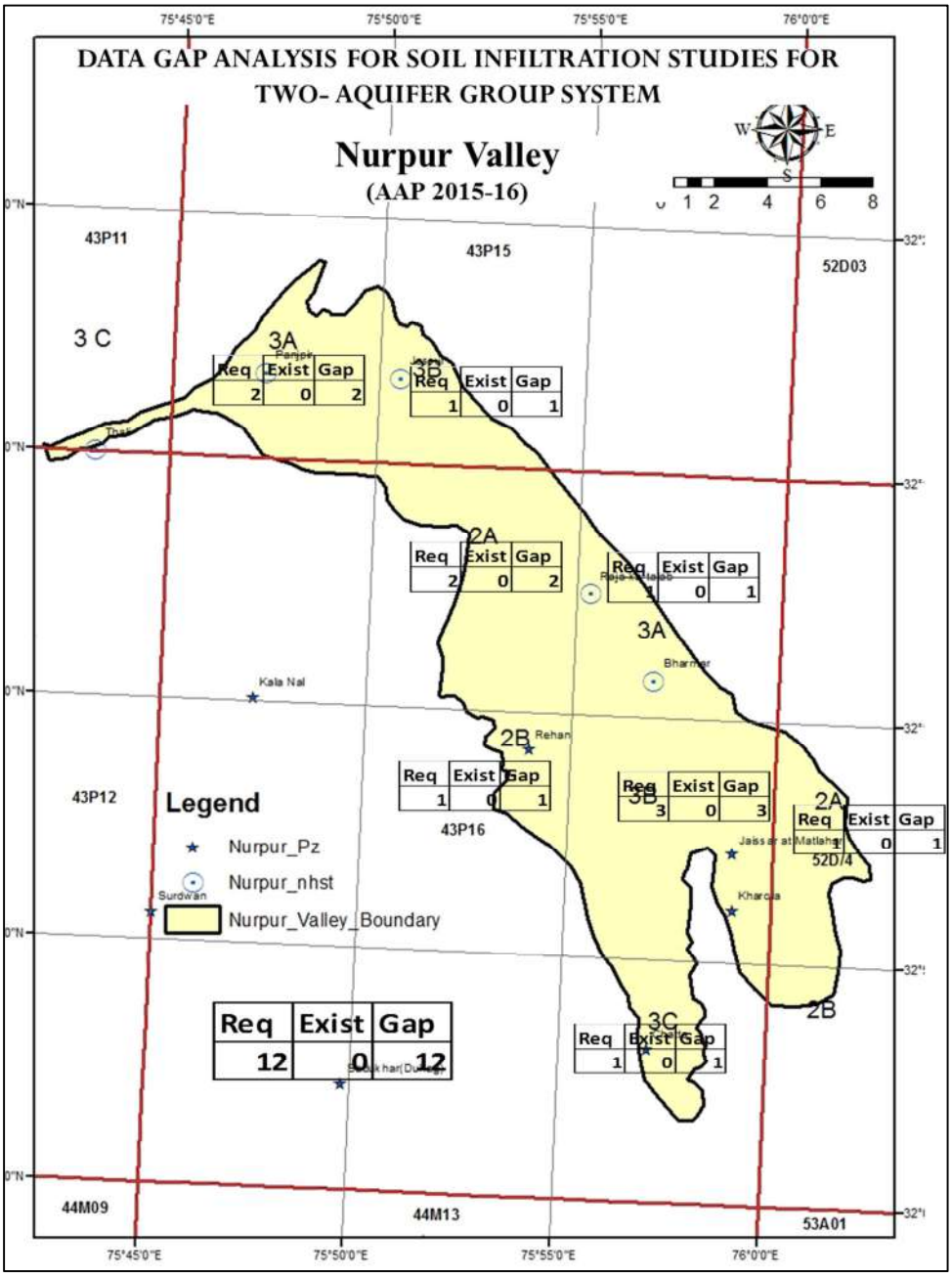


Fig.1.7 Data Gap Analysis for Soil Infiltration Studies - Nurpur Valley, Kangra District

Table 1.1 DATA GAP ANALYSIS - NURPUR VALLEY

Toposheet No: 43P/11, 43P/15, 43P/16 and 52D/4

Quadrant No.	No. of additional EWs Required		No. of additional OWs Required		No. of additional VES Required		No. of additional water level monitoring stations Required		No. of Infiltration studies Required
	Aq-I	Aq-II	Aq-I	Aq-II	Aq-I	Aq-II	Aq-I	Aq-II	
43P11 3C									
43P15 3A						2	1		2
43P15 3B						1			1
43P16 2A	1	1	1	1		2	1	0	2
43P16 2B									1
43P16 3A									1
43P16 3B						2			3
43P16 3C						1			1
52D4 2A						1			1
52D4 2B									
Total	**1**	**1**	**1**	**1**		**9**	**2**	**0**	**12**

1.6 Drainage

The Beas River, one of the perennial rivers of India, forms the southern border of the Kangra district. The Chakki River, tributary of Beas Rivers, forms the northwestern border of the district. It arises from the southern slopes of Dhauladhar range and join Beas near Pathankot. The Beas River is fed by Gaj, Neogal, Manjhi, Bhul, Ikka, Baner, Naker, Dehar khads. All these khads are perennial and snow fed. These khads have deep valleys in the hilly area. The valleys are wide in the Kangra valley region where the slope/gradient of the river is gentle. The courses of these rivers are structurally controlled. The gradient and flow are being utilized both of irrigation and power generations. A number of micro hydel projects are under construction on these khads. The water of these rivers are also being used for irrigation by diverting its flows through Kuhls/irrigational channels.

The northernly flowing tributaries are ephemeral and have flash floods during the monsoons. The width of these stream channel varies from less than a kilometer to more than 2 kms. The channel areas are generally devoid of vegetation. The Beas River has been bounded at Pong reservoir resulting in a vast body of water covering about 26,400 hectares of land at maximum storage level (Fig. 1.8).

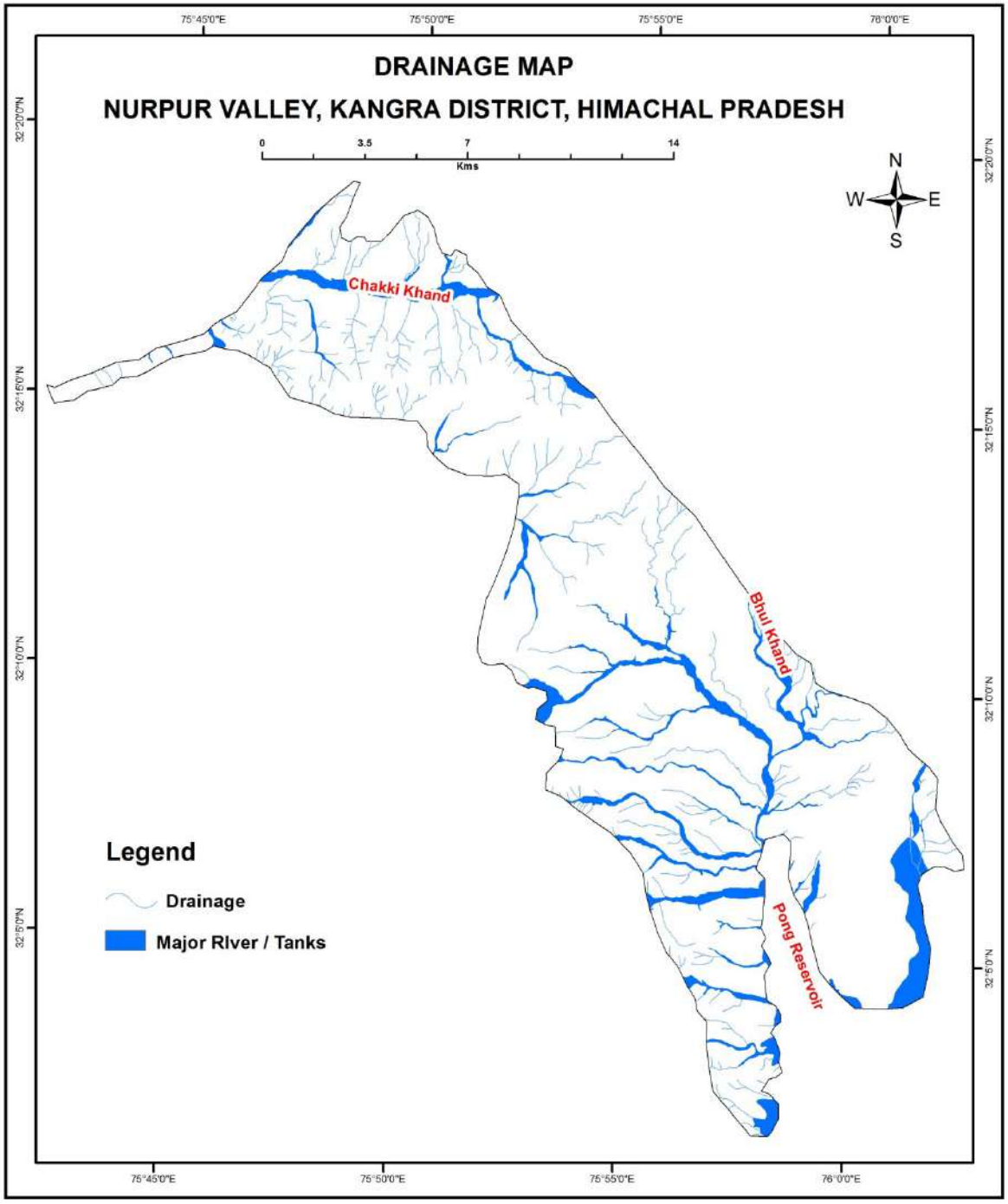


Fig 1.8 The Drainage Map - Nurpur Valley, Kangra District

1.7 Geology

The Shiwalik group mainly represents the rocks of the Kangra district. In addition to this at few places the newer alluvium of Quaternary age are also present. The Shiwalik deposits comprises of mudstones, sandstones and coarsely bedded conglomerates laid down when the region was a vast basin during middle Miocene, to upper Pleistocene times. The sediments

were deposited by rivers flowing southwards from the Greater Himalayas, resulting in extensive multiordered drainage systems. Following this deposition, the sediments were uplifted through intense tectonic regimes (commencing in Upper Miocene times), subsequently resulting in a unique topographical entity- the Shiwalik hills. The Shiwaliks are divided stratigraphically into three major sub-groups Lower, Middle, and Upper. These sub-groups are further divided into individual formations that are all laterally and vertically exposed today in varying linear and random patterns.

Ongoing erosion and tectonic activity has greatly affected the topography of the Shiwaliks. Their present–day morphology is comprised of hogback ridges, consequent, subsequent, obsequent and resquent valleys of various orders, gullies, choes (seasonal streams), earth pillars, rilled earth buttresses of conglomerate formation, semi-circular choe-divides, talus cones, colluvial cones, water gaps, and choe terraces. Associated badlands features include the lack of vegetation, steep slopes, high drainage density, and rapid erosion rates. In the advent of Neogene a depression was formed in front of the rising mountains (Proto-Himalaya). This depression becomes a repository of a thick sequence of molassic sediments of the Shiwalik. The Shiwalik group comprises of conglomerates friable micaceous sandstone, siltstone and claystone. The stray pebbles of granite, limestone, sandstone, braccia and lumps of claystone are also observed at places. Often the size of pebbles is large enough to be called as Boulder.

The Geological Map of the study area has been prepared with the help of G.S.I. Digital Geological Map (Fig.1.9). The details of formation as given below: -

Geological Succession of study Area

Period	Age	Formation	Description of Lithology
Quaternary	Recent	Alluvium	Grey to dark grey iron stained fine to coarse sand with pebble and clay
	Pleistocene	Older alluvium	Multiple fill cyclic sequence of medium to coarse grained grey sand and grit with pebble of sandstone and lenses of clay
Tertiary	Pliocene	Upper Siwalik	Boulder conglomerates, clay, sands, pebbly grit.
	Upper Miocene	Middle Siwalik	Micacous sandstone and shales.
	Middle Miocene	Lower Siwalik	Hard, compact, purple sandstone intercalated with brown clays / shales

Tertiary formation:

The Tertiary formations cover a major part of the district and represent a relatively lower topography. Lower Siwaliks are consisting of massive dark grey sandstones and purple shales. These are confirmably overlain by micaceous sandstone and grey clays/shales of middle siwaliks. Upper siwaliks are consisting of conglomerates, coarse grained sandstones interbedded with grey and pink clays silts and lenses of pebble beds.

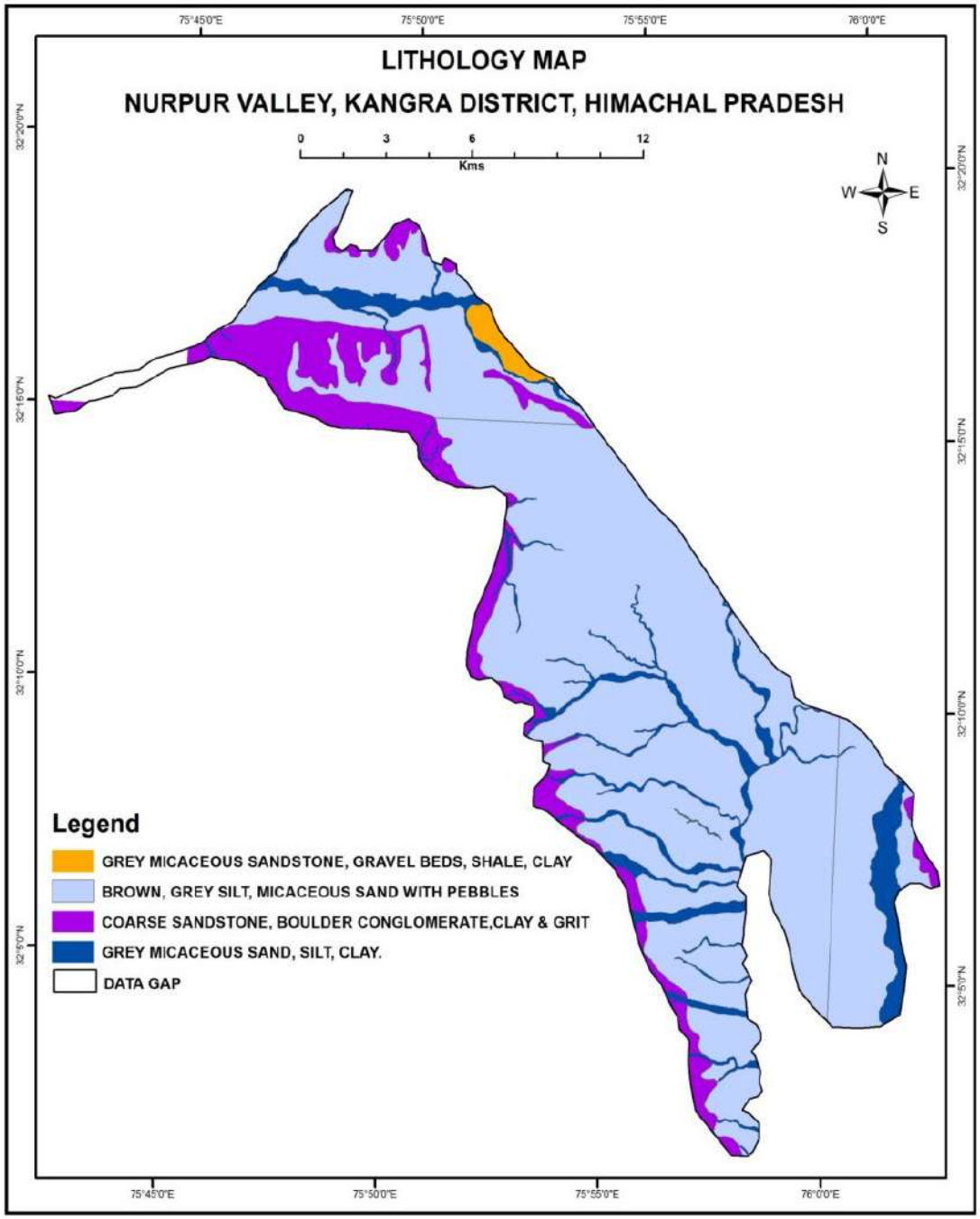


Fig 1.9 Lithology Map of Nurpur Valley, Kangra District

Source: Geological Survey of India Map

Post Tertiary Sediments (Quaternary Deposits)

Quaternary deposits, forming valley fill deposits represents fluvio-glacial, fluvial, lacustrine and loessic deposits. These deposits rest unconformable over the Siwaliks. The sediments are deposited in different glacial stages.

Riverine Deposits:

Riverine sediments are distributed in the lower topography areas in lower reaches of rive/khad systems. These sediments are composed of sand, gravel, pebble and boulders and are loose to semi-consolidated. These deposits can be divided into older and younger choe deposits.

1.8 Hydrogeology

Major part of this valley fill is submerged under the Pong reservoir and the area available for groundwater development is limited to northern and western sides. The thickness of the alluvial sediments ranges from 50 metres to more than 150 metres. Central Ground Water Board has constructed many exploratory tubewells are being utilized both for drinking and irrigation purposes.

Ground water occurs under both unconfined and confined conditions. Depth to water varies from 2.5 metres above ground level in Fatehpur to 65 metres in Jawali areas but generally ranges between 20 m and 40 m. Artesian flowing conditions are occurring in the southern part in Fatehpur area. On the north-western part of Pong dam a ground water divide is formed with flow direction towards both northwest and southeast. The artesian free flow of ground water is between 5 to 10 lps. In Fatehpur area whereas in Jassur-Kanduwal area it varies between 2 lps to 5 lps. The yield of the tubewells varies between 20 lps and 35 lps for drawdown varying between 8 to 12 metres.

Ground water regime is being affected by Pong reservoir. Ground water level is varying with reservoir level and yields of tubewells located in the vicinity of dam are increasing appreciably. This is due to the recharging of the aquifers both shallow and deep by the reservoir and khads. Impact of the reservoir is also reported on the springs existing in the south and west of Jassur. The alluvial deposit occurring between Jawali-Fatehpur and Raja Ka Talab-Jassur belong to a system deposited both by Beas River and Chakki/Jabbar khads. The westernly shift of Chakki/Jabber khad and southernly sift of Beas river has resulted in the formation of this deposit. The developments of artesian conditions in Fatehpur are controlled by NE-SW and north-south extending fault fracture zones. There exist wide scopes for the development of ground water resources by constructing tubewells in this area. Induced recharge both from the

dams and khads and can thus create additional water resources which will be available for the further development (Fig.1.10).

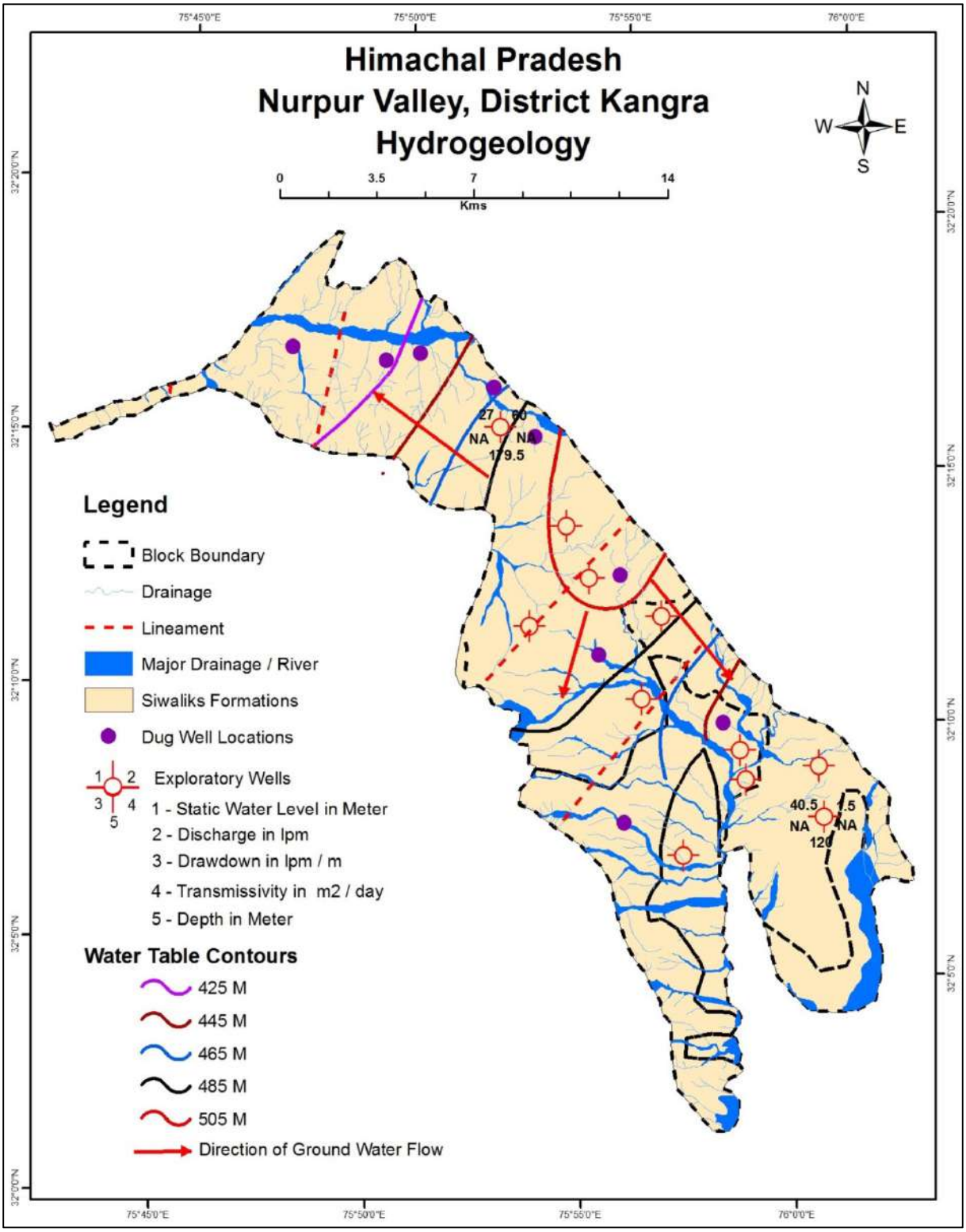


Fig 1.10 Hydrogeology Map of Nurpur Valley, Kangra District

1.10 Geomorphology

The geomorphological map was prepared with the help of survey of India topographic sheets and IRS P6 LISS - IV satellite imagery. The geomorphic units represented in the study area are Structural and Denudational hills, Pediment, River and River Alluvium shown in fig.1.11.

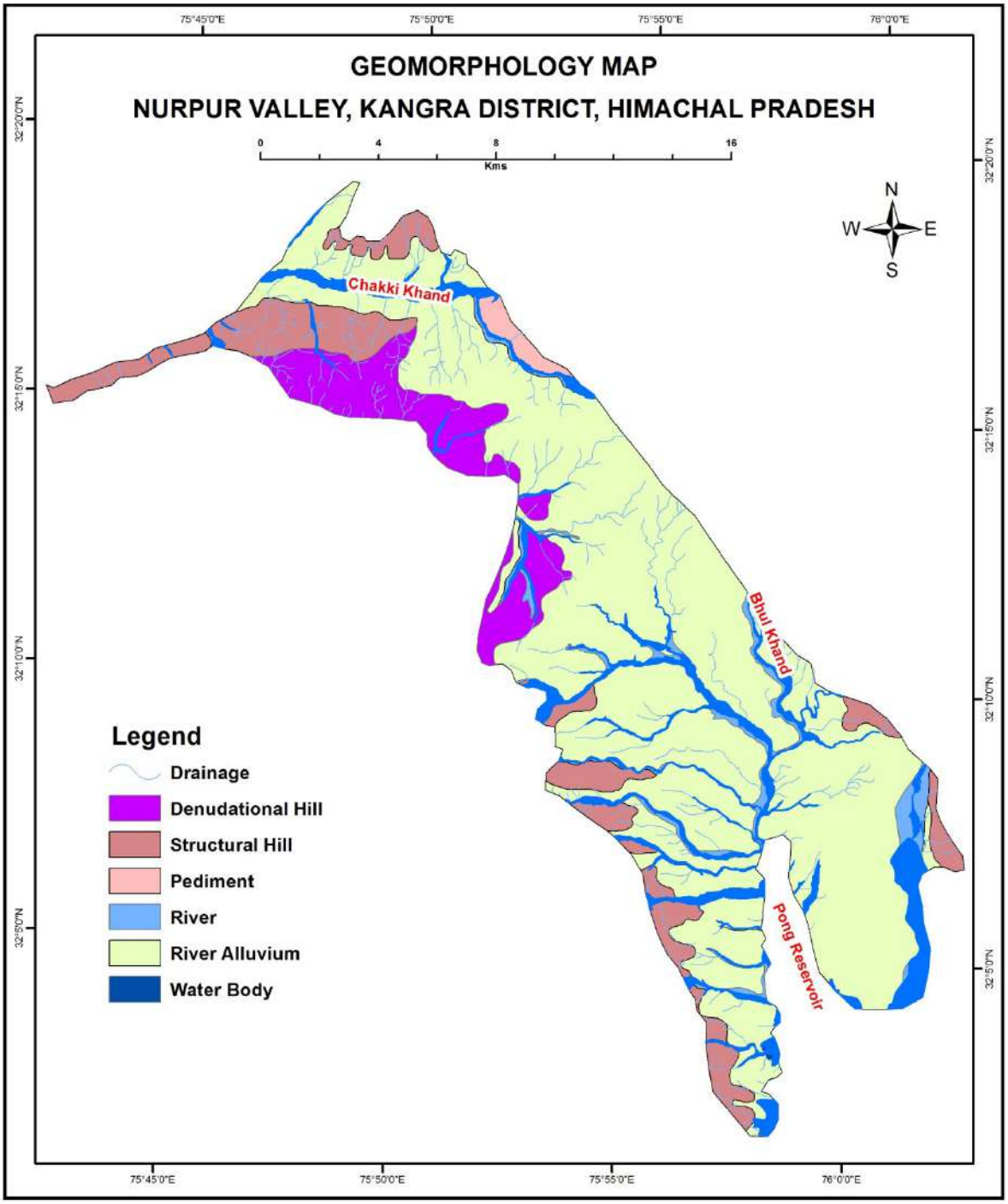


Fig. 1.11 Geomorphology Map of Nurpur Valley, Kangra District

1.11 Land use and Land Cover

The landuse / land cover map was prepared using Survey of India topographic sheets and IRS P6 LISS – III satellite imagery. The Landuse and land cover features in the study area Dense Forest, Land with scrub, River and Water Body (fig.1.12 (a)). Similarly Forest Area map was prepared with the help of processed satellite imagery, the same has been shown in fig. 1.12 (b).

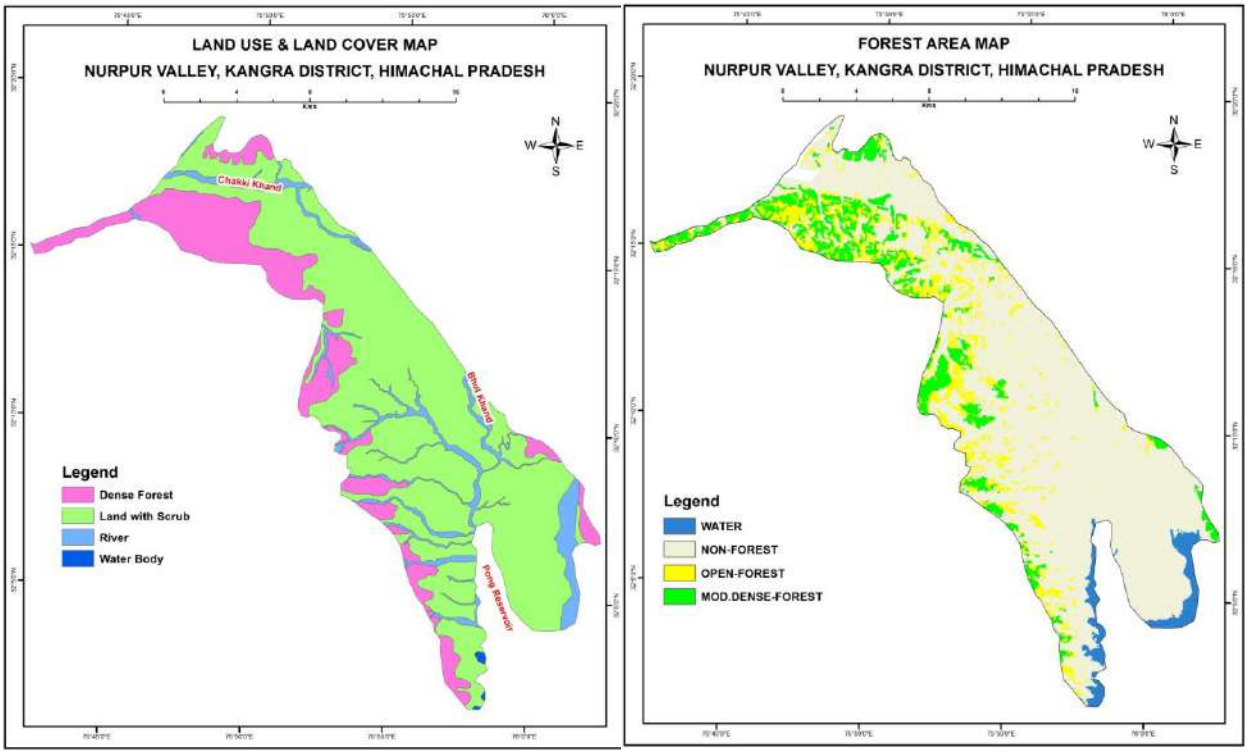


Fig. 1.12 (a) Land Use & Land Cover (b) Forest Area

1.12 Soil Types

The soil of Nurpur and Dehra tehsils have developed principally on sandstones and are sandy loam to loamy in texture. The pH ranges between 6 to 7. These soils are fond at lower altitudes upto 900 m amsl. The rainfall in this zone ranges from 1000 to 1500 mm. Climatically this zone falls under humid sub-tropical zone with a part of Nurpur tehsil near Pathankot falling in sub-humid sub-tropical zone. The organic carbon in these soils is medium to high and the available nitrogen is medium. The phosphorous and potassium contents are also medium.

For the preparation of the soil map, the soil atlas of the Himachal Pradesh, prepared by C.G.W.B. Northern Himalayan Region is used as the primary source and then updated with satellite imagery. The different soil types are shown in fig. 1.13.

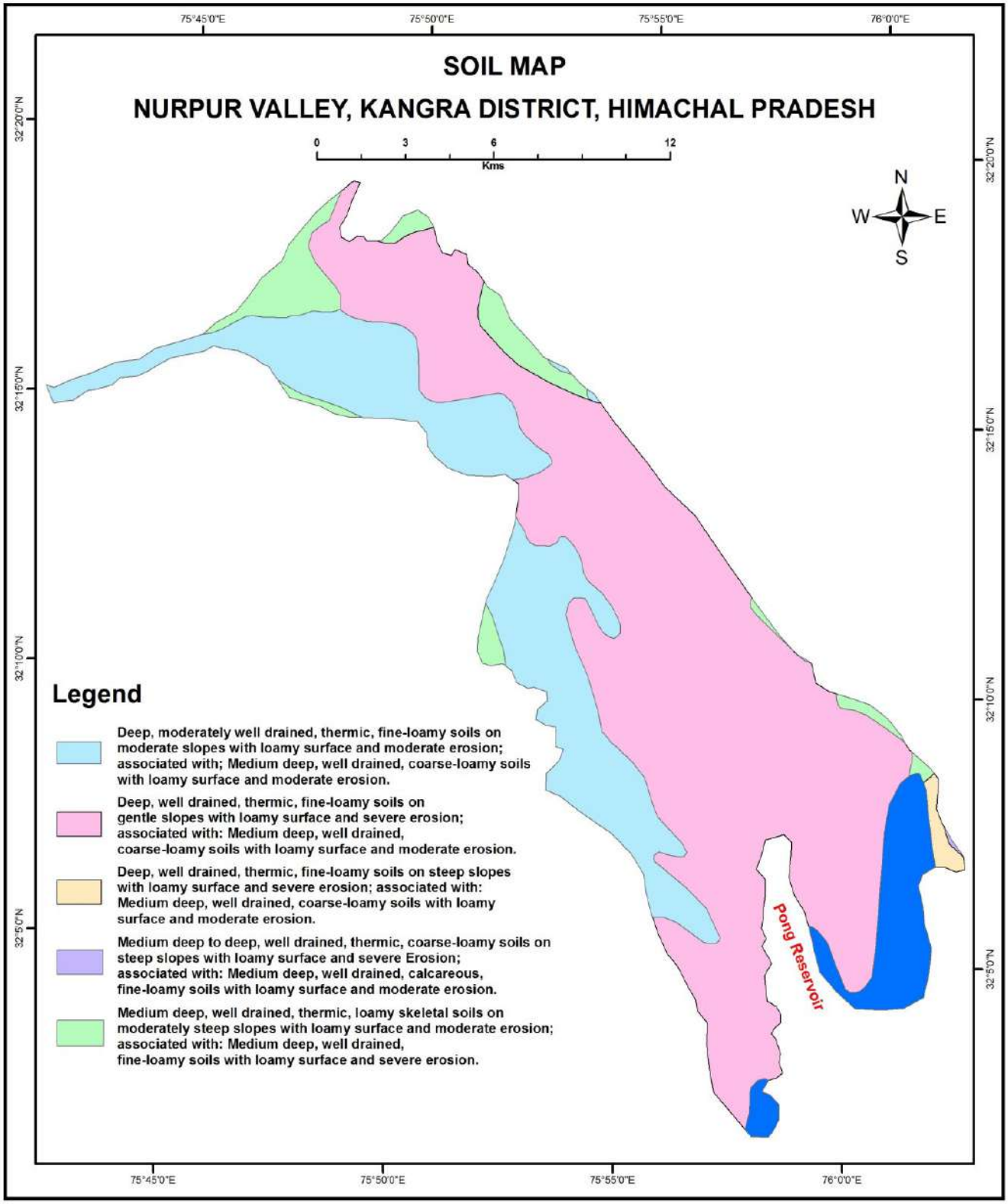


Fig. 1.13 Soil Map of Nurpur Valley, Kangra District

1.13 Previous Work and Present Status of Data

Nurpur tracks of Kangra district were covered under hydrogeological surveys by S/Shri D.L. Shah (1968-69) and R.L.Kaul (1970) of Geological Survey of India. Reappraisal hydrogeological surveys in these areas were carried out by S/Shri S.K. Tyagi in 1976-77, Sushil Gupta in 1984-85 and I.K. Sharma in 1996-97.

Exploratory drilling was taken up in Nurpur, Fatehpur, Jawali and Dehra area by Central Ground Water Board since 1988 and is continuing. A number of hydrogeological investigations for locating the source of water for various water supplies schemes in different parts of the district has also been carried out for different departments of Himachal Pradesh by Central Ground Water Board. For long term monitoring of water levels, first hydrograph network station at Kangra was established by G.S.I. during 1969 and increased in number in phased manner The water levels are being monitored by Central Ground Water Board four times in a year.

CGWB NHR, Dharamshala is monitoring ground water levels from National Hydrograph Network observations and aquifer mapping wells (Table 1.3) since 1977 in all valleys of Himachal Pradesh four times a year in the months of, May, August, November and January. The ground water quality is being studied by CGWB once in a year from the samples collected from those observation wells during the month of May.

Table 1.3 National Hydrograph Network observations and aquifer mapping wells of Nurpur Valley, Kangra District, Himachal Pradesh

Sl.No	Name of Village/site	Latitude	Longitude	Estt. Date	RL (mamsl)	Total Depth of DW (mbgl)	Type (DW/)	Measuring Point (magl)
1	Basachatroli	32.2768	75.8278	2/6/2015	428	18	DW	0.92
2	Kuthkhana	32.1831	75.9146	2/6/2015	502	28	DW	0.5
3	Barot	32.1284	75.9274	2/6/2015	487	15	DW	0.4
4	Panjpir	32.2800	75.7914	1/6/2015	408.88	5.35	DW	0.40
5	Jassur	32.2796	75.8408	1/6/2015	436.23	8.4	DW	0.74
6	Raja Ka Talab	32.2097	75.9216	1/6/2015	521.68	8.65	DW	0.9
7	Bharmar	32.1627	75.9638	1/6/2015	450.7	19.2	DW	0.45
8	Thali	32.2540	75.8865	1/6/2015	506		DW	0.45
9	Basa-Bazira	32.2694	75.8698	1/6/2015	471		DW	0.80

2.0 DATA COLLECTION AND GENERATION

2.1 Hydrogeological Data

Water Level Behavior: To know the water level and its behavior with respect to time and space, 9 dug wells have been inventoried for Ground Water Management Studies all over the area. The dug wells are located in and around Nurpur valley. The water levels were taken during the month of May and November, 2015 & 2016 and on the basis of these data, pre-monsoon, post monsoon and seasonal fluctuation map have been prepared for the Nurpur valley area. The hydrogeological data of the inventoried dug wells are given in Table 2.1.

In Nurpur valley depth to water level shows wide variation. During pre-monsoon period (May 2015) it ranges from 2.77 to 12.70 m bgl (Fig. 2.0) and post monsoon period (Nov.2015) ranges from 2.97 to 10.60 m bgl. (Fig. 2.1). In major parts of Nurpur valley, Seasonal Water Level Fluctuation ranges between less than (-0.2) to 5.30 m bgl (Fig.2.2). Whereas in pre-monsoon period of (May 2016) it ranges from 4.10 to 15.10 m bgl (Fig.2.3) and post monsoon period (Nov.2016) ranges from 2.55 to 9.80 m bgl (Fig.2.4) and Seasonal Water Level Fluctuation ranges between 0.84 to 5.30 m bgl (Fig. 2.5).

Table 2.1 Water level data (May & Nov.2015 and May & Nov.2016) GWMS and Aquifer Mapping Wells of Nurpur Valley, Kangra District, Himachal Pradesh

Location	Latitude	Longitude	Water Level, 2015		2015 Fluctuation	Water Level, 2016		2016 Fluctuation
			May 2015	Nov. 2015		May 2016	Nov.2016	
Basachatroli	32.2768	75.8278	6.1	5.43	0.67	6.18	4.68	1.5
Kuthkhana	32.1831	75.9146	10.9	9.7	1.2	11.57	8.75	2.82
Barot	32.1284	75.9274	3.9	3.7	0.2	4.3	2.85	1.45
Panjpir	32.2800	75.7914	4.3	4	0.3	4.81	3.8	1.01
Jassur	32.2796	75.8408	3.6	3.1	0.5	4.49	3.65	0.84
Raja Ka Talab	32.2097	75.9216	4.45	3.2	1.25	4.4	3.25	1.15
Bharmar	32.1627	75.9638	12.7	10.6	2.1	15.1	9.8	5.3
Thali	32.2540	75.8865	2.77	2.97	-0.2	4.1	2.55	1.55
Basa-Bazira	32.2694	75.8698	10.2	4.9	5.3	9.8	8.3	1.5

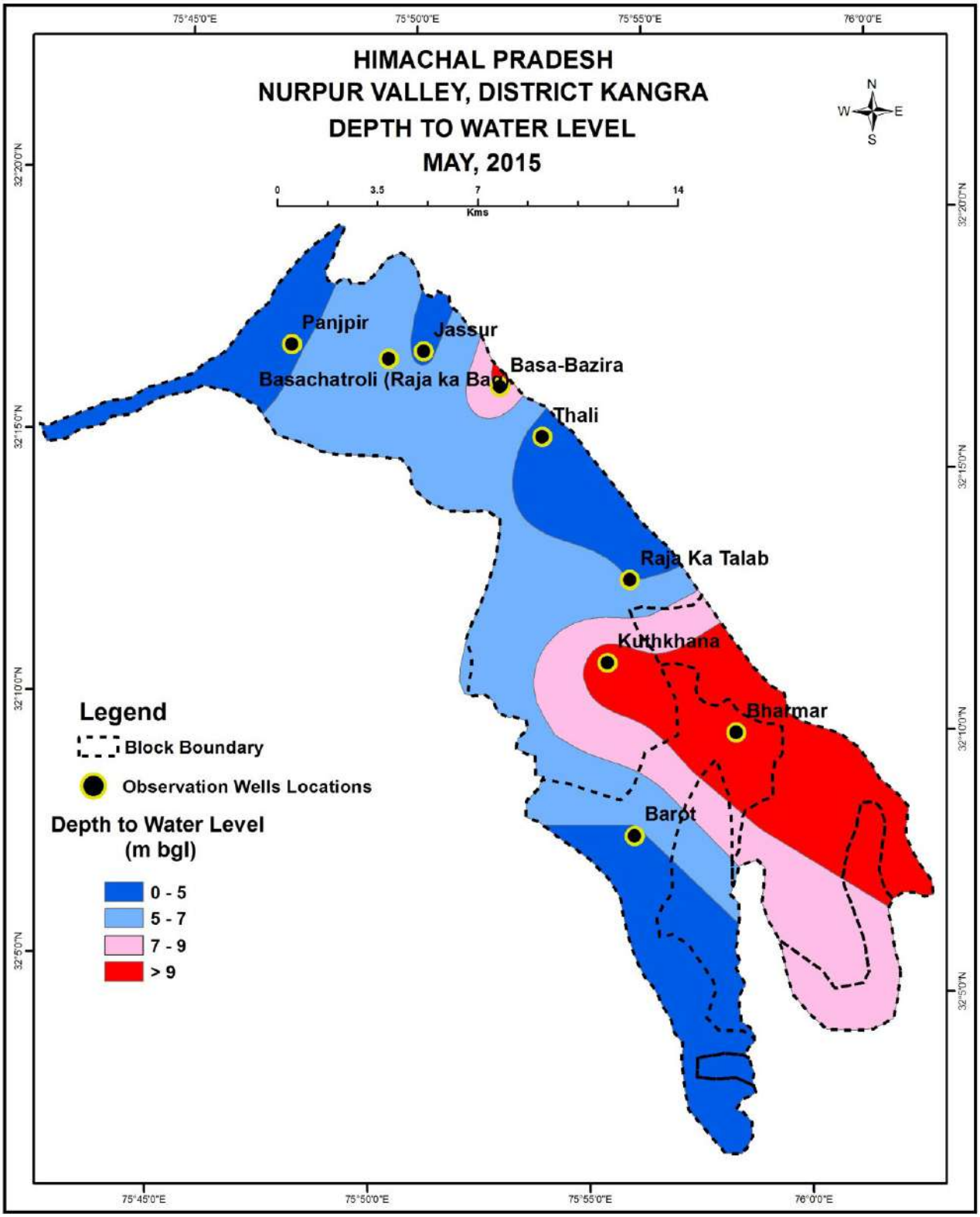


Fig. 2.0 Depth Water Level – May 2015, Nurpur Valley, Kangra District

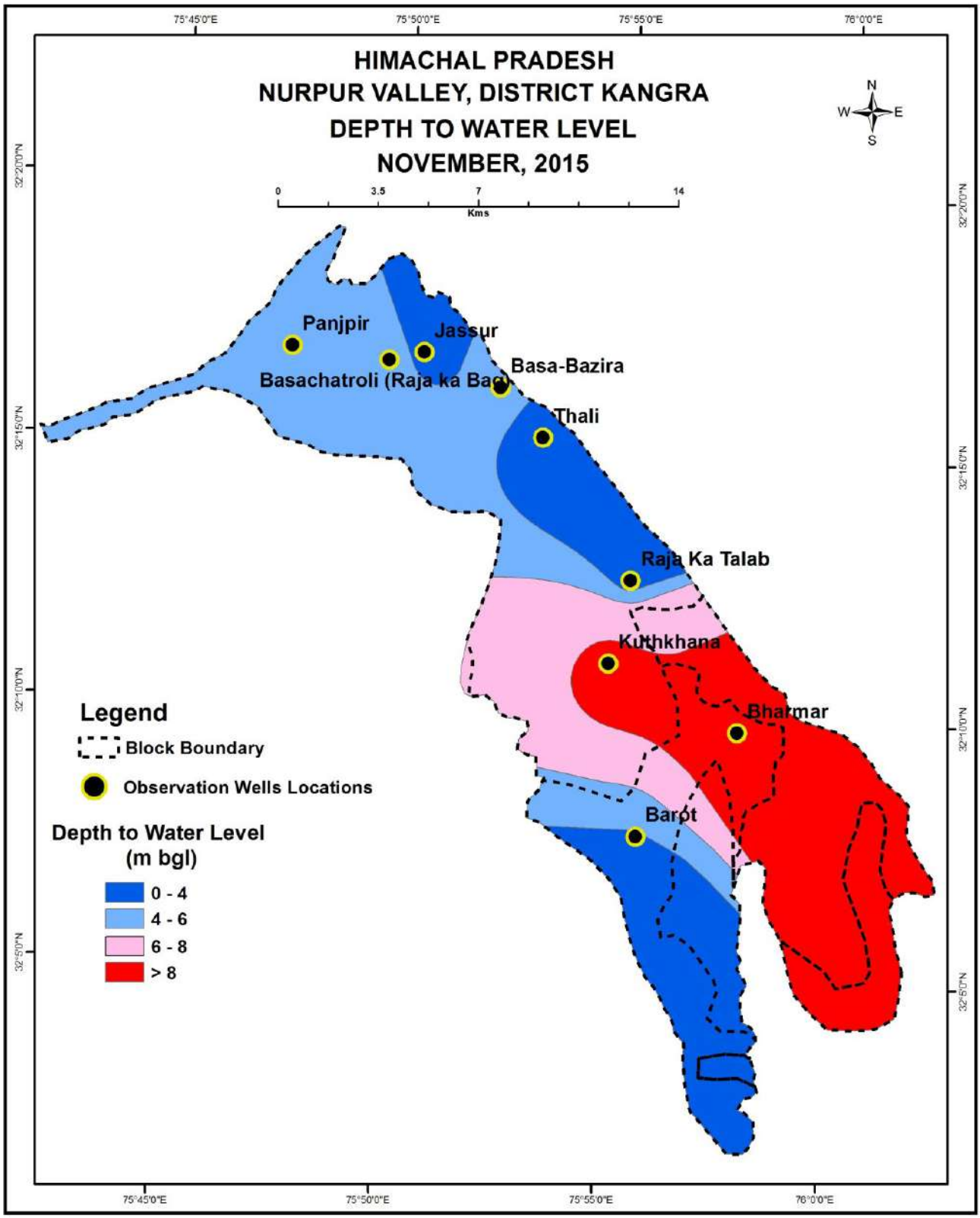


Fig. 2.1 Depth Water Level – November 2015, Nurpur Valley, Kangra District

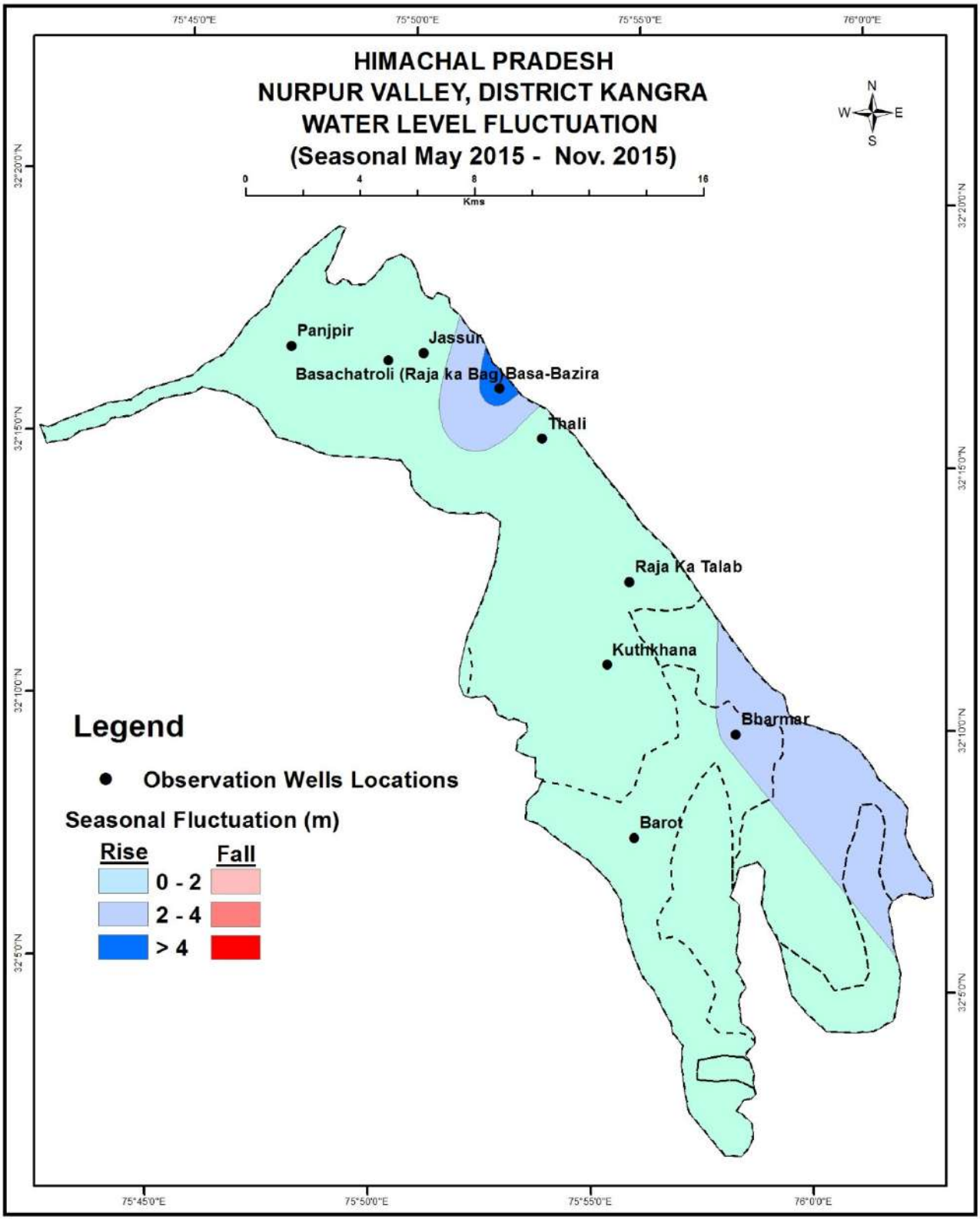


Fig. 2.2 Seasonal Water Level Fluctuation – May 2015 & November 2015, Nurpur Valley, Kangra District.

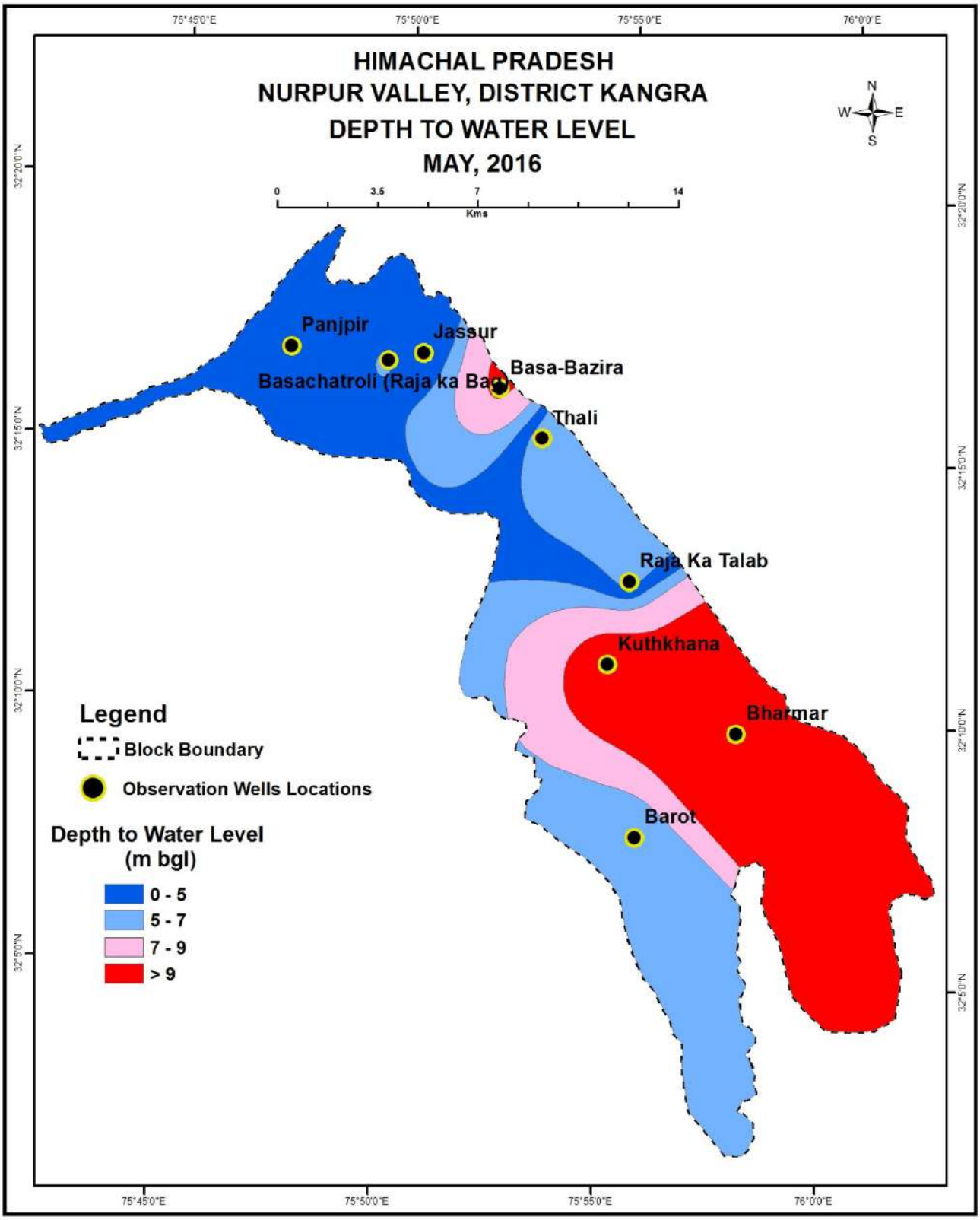


Fig. 2.3 Depth Water Level – May 2016, Nurpur Valley, Kangra District

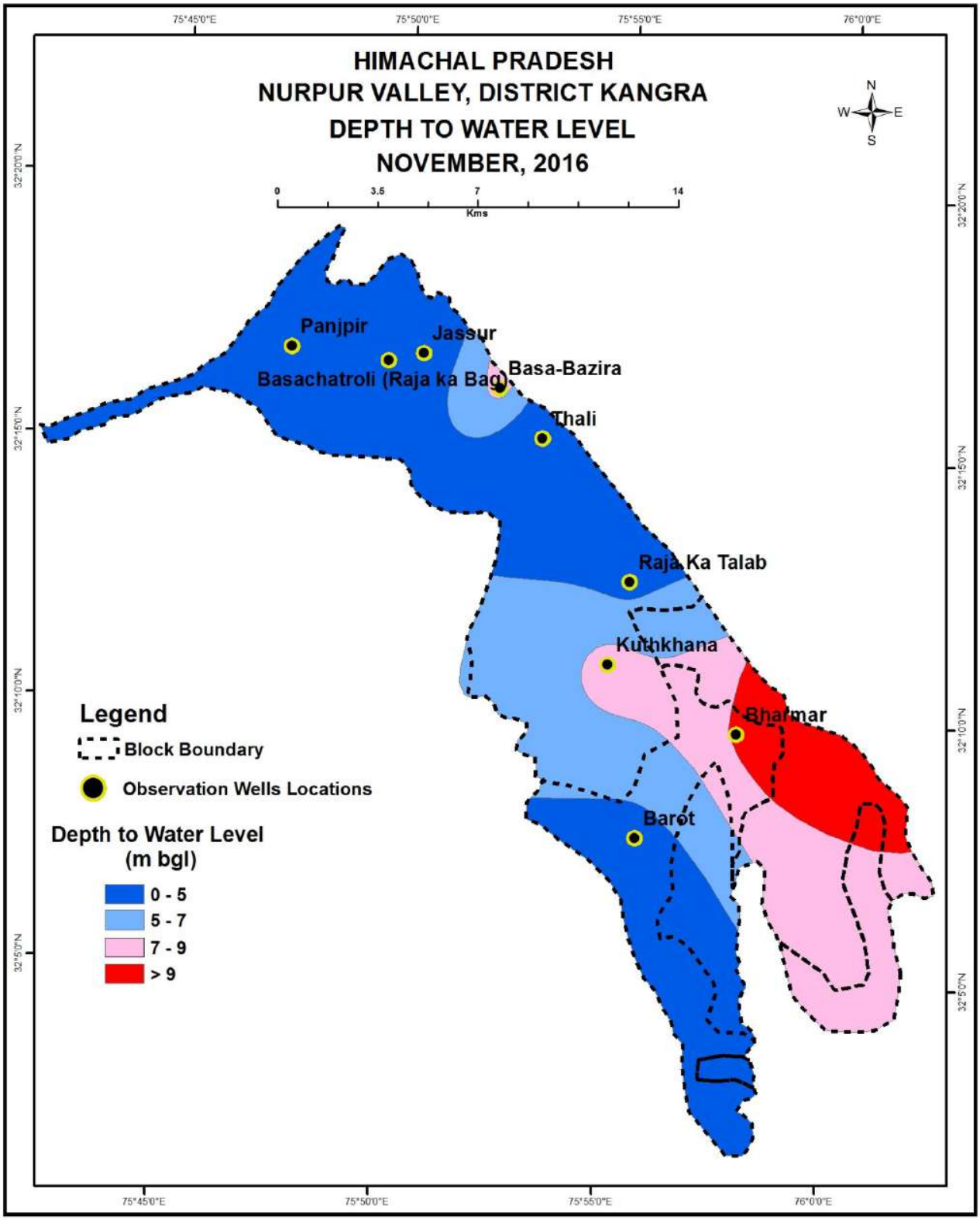


Fig. 2.4 Depth Water Level – November 2016, Nurpur Valley, Kangra District

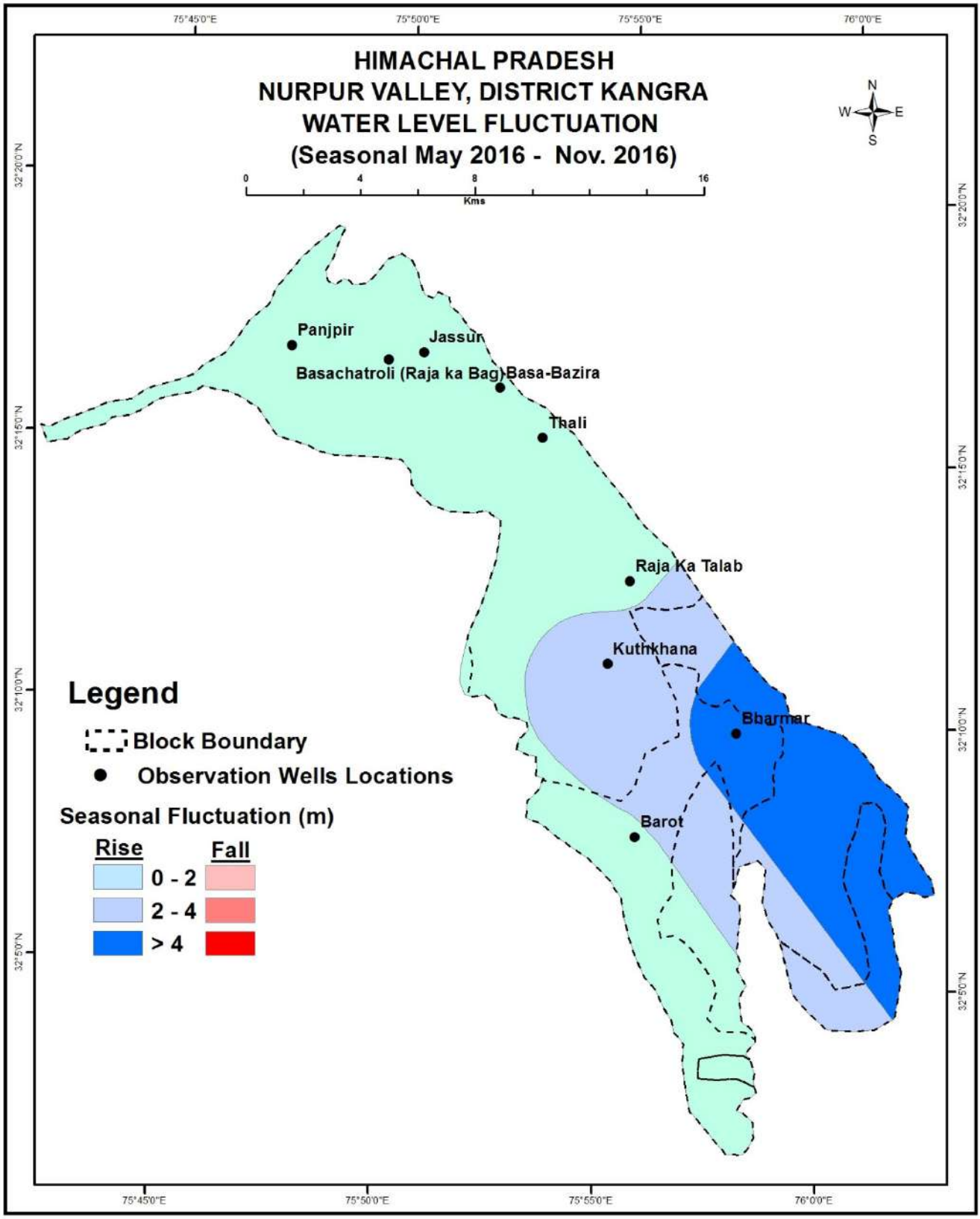


Fig. 2.5 Seasonal Water Level Fluctuation – May 2016 & November 2016, Nurpur Valley, Kangra District

Annual fluctuation in water level of GWMS and Aquifer Mapping Wells during different monitoring periods were analysed and discussed below.

November 2015 & November 2016

To know the annual water level fluctuation and its behavior with respect to time and space, 09 dug wells have been inventoried for Ground Water Management Studies all over the Nurpur Valley area. The water levels were taken during the month of November, 2015 & November 2016 and on the basis of these data, annual fluctuation map have been prepared for the Nurpur valley area. The hydrogeological data of the inventoried dug wells are given in Table 2.2.

Table 2.2 Water level data (Nov. 2015 and Nov. 2016) GWMS and Aquifer Mapping Wells of Nurpur Valley, Kangra District, Himachal Pradesh

Location	Latitude	Longitude	November 2015	November 2016	Annual Fluctuation
Basachatroli	32.2768	75.8278	5.43	4.68	0.75
Kuthkhana	32.1831	75.9146	9.7	8.75	0.95
Barot	32.1284	75.9274	3.7	2.85	0.85
Panjpir	32.2800	75.7914	4	3.8	0.2
Jassur	32.2796	75.8408	3.1	3.65	-0.55
Raja Ka Talab	32.2097	75.9216	3.2	3.25	-0.05
Bharmar	32.1627	75.9638	10.6	9.8	0.8
Thali	32.2540	75.8865	2.97	2.55	0.42
Basa-Bazira	32.2694	75.8698	4.9	8.3	-3.4

During the period of November 2015 water level ranges from 3.10 to 10.60 m bgl (Fig.2.6) and November 2016 water level ranges from 2.55 to 9.80 m bgl. (Fig.2.7) and Annual Water Level Fluctuation ranges between -3.4 to 0.95 m bgl (Fig. 2.8).

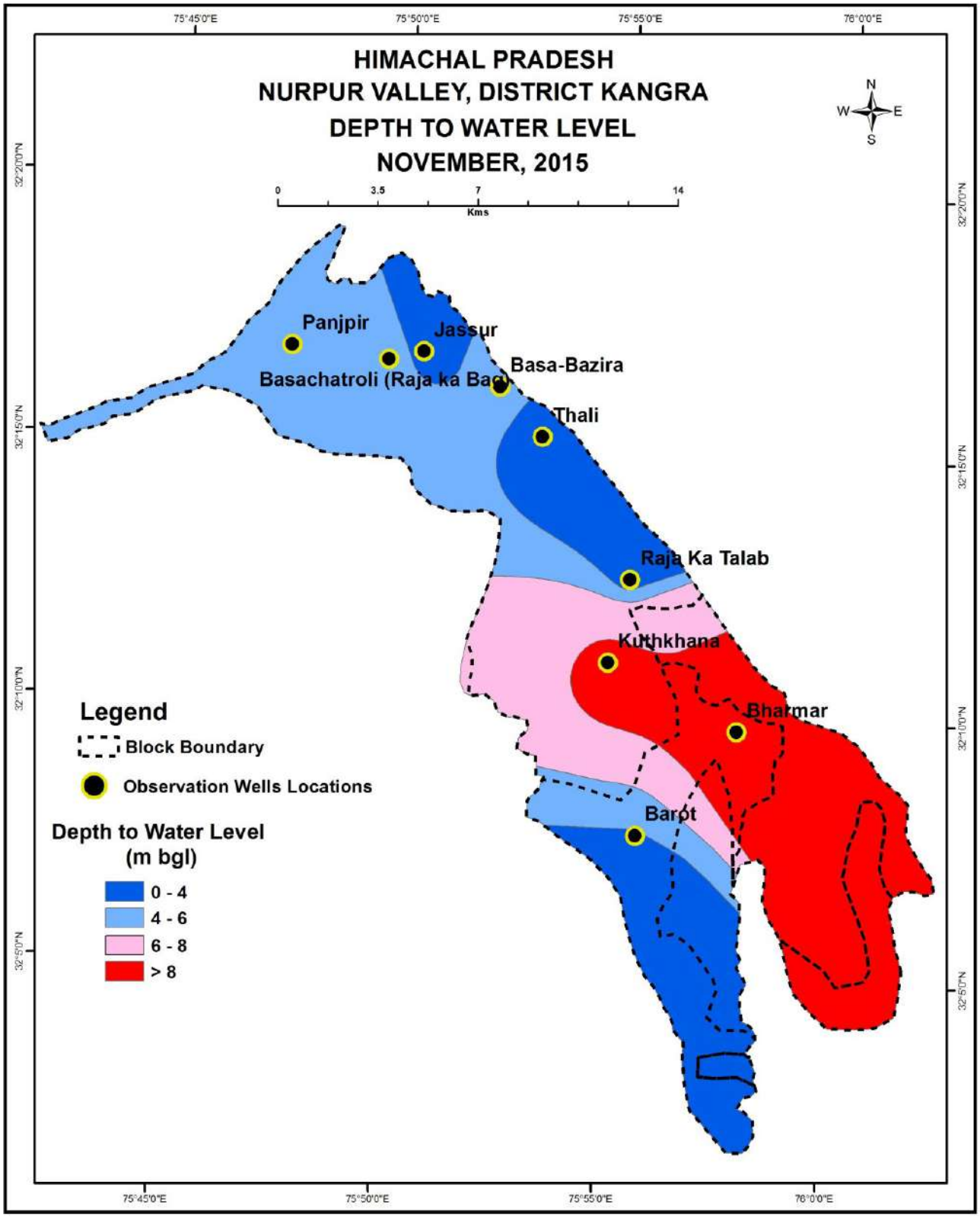


Fig. 2.6 Depth Water Level – November 2015, Nurpur Valley, Kangra District

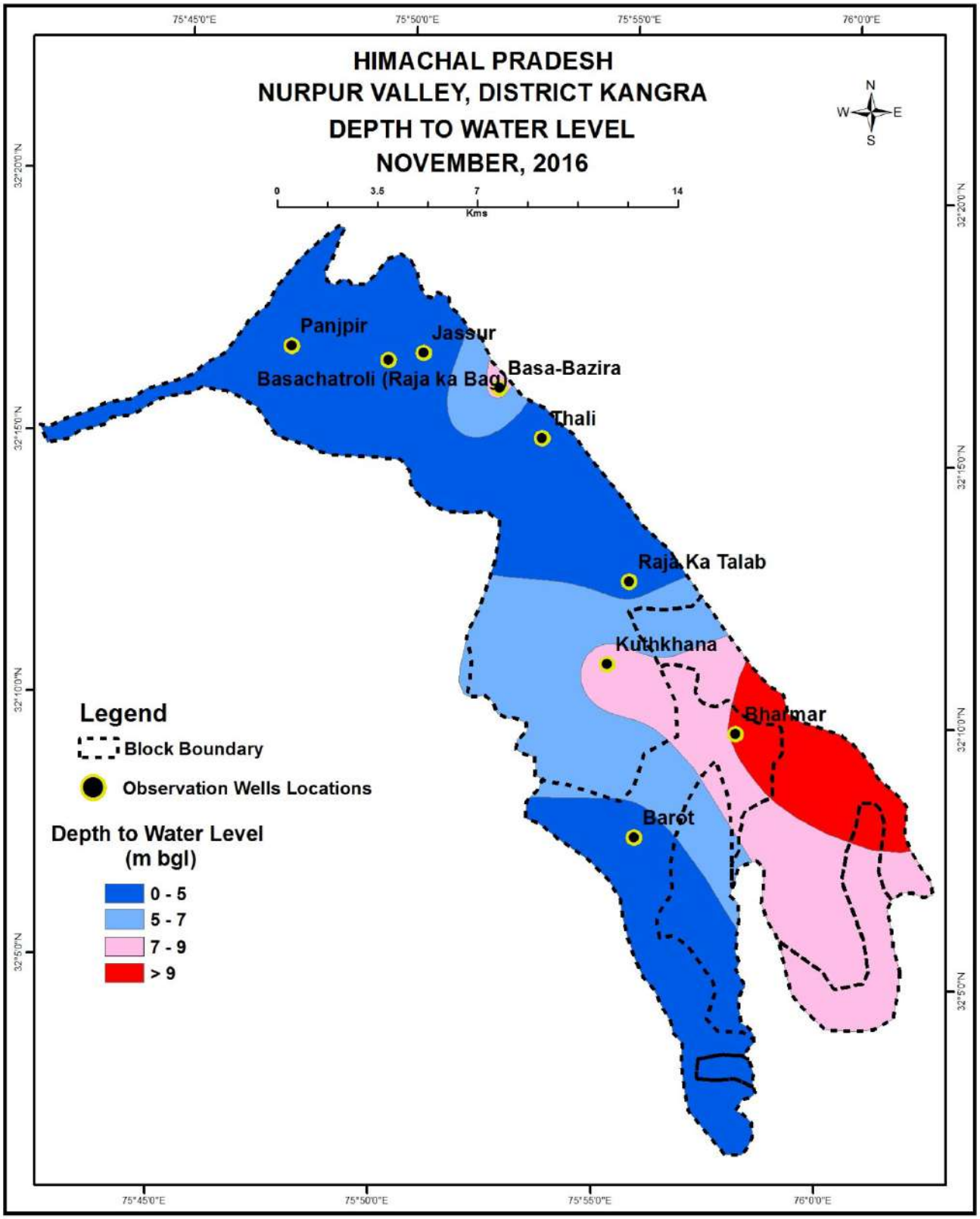


Fig. 2.7 Depth Water Level – November 2016, Nurpur Valley, Kangra District

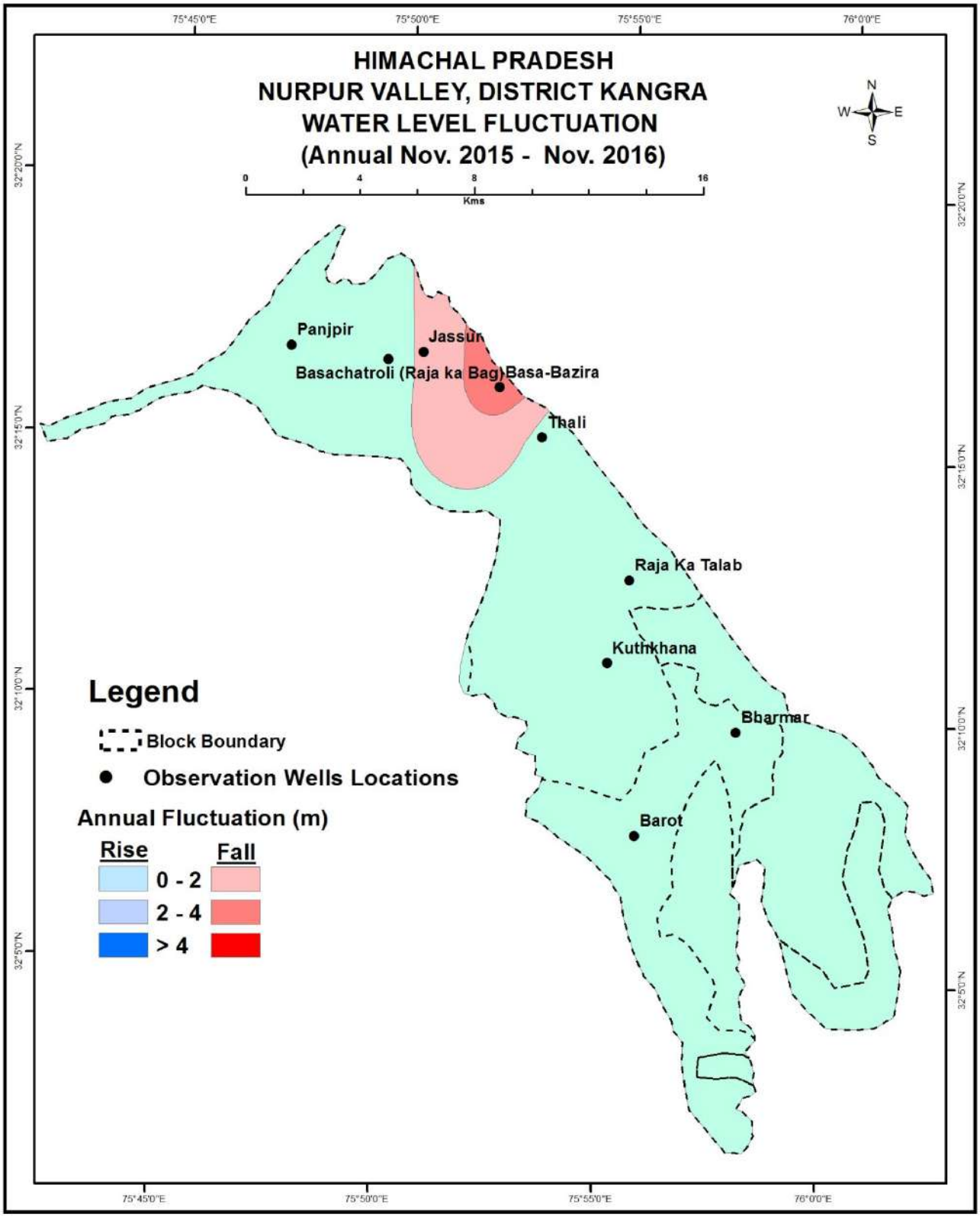


Fig. 2.8 Annual Water Level Fluctuation – November 2015 & November 2016, Nurpur Valley, Kangra District

January 2016 & January 2017

09 Nos. dug well water levels were taken during the month of January, 2016 & January 2017 on the basis of these data, annual fluctuation map have been prepared for the Nurpur valley area. The hydrogeological data of the inventoried dug wells are given in Table 2.3. During the period of January 2016 water level ranges from 2.55 to 12.35 m bgl (Fig.2.9) and January 2017 water level ranges from 2.60 to 11.95 m bgl. (Fig.2.10) and Annual Water Level Fluctuation ranges between – 0.52 to 1.80 m bgl (Fig. 2.11).

Table 2.3 Water level data (Jan. 2016 and Jan. 2017) GWMS and Aquifer Mapping Wells of Nurpur Valley, Kangra District, Himachal Pradesh

Location	Latitude	Longitude	January 2016	January 2017	Annual Fluctuation
Basachatroli	32.2768	75.8278	5.08	4.74	0.34
Kuthkhana	32.1831	75.9146	10.1	9.62	0.48
Barot	32.1284	75.9274	4.1	2.9	1.2
Panjpir	32.2800	75.7914	4.2	4.25	-0.05
Jassur	32.2796	75.8408	5.65	3.85	1.8
Raja Ka Talab	32.2097	75.9216	4.13	4.65	-0.52
Bharmar	32.1627	75.9638	12.35	11.95	0.4
Thali	32.2540	75.8865	2.55	2.6	-0.05
Basa-Bazira	32.2694	75.8698	8.3	8.75	-0.45

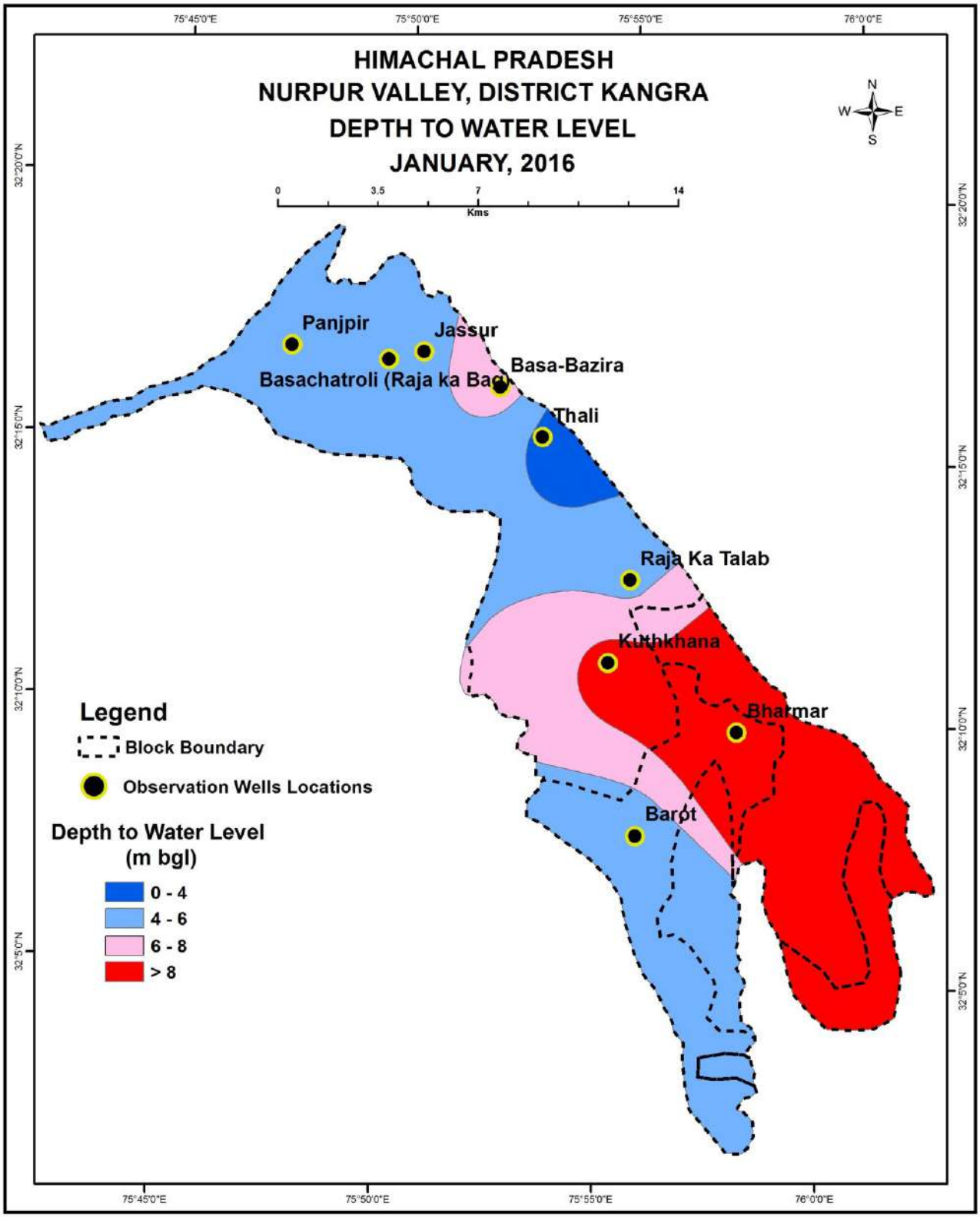


Fig. 2.9 Depth Water Level – January 2016, Nurpur Valley, Kangra District

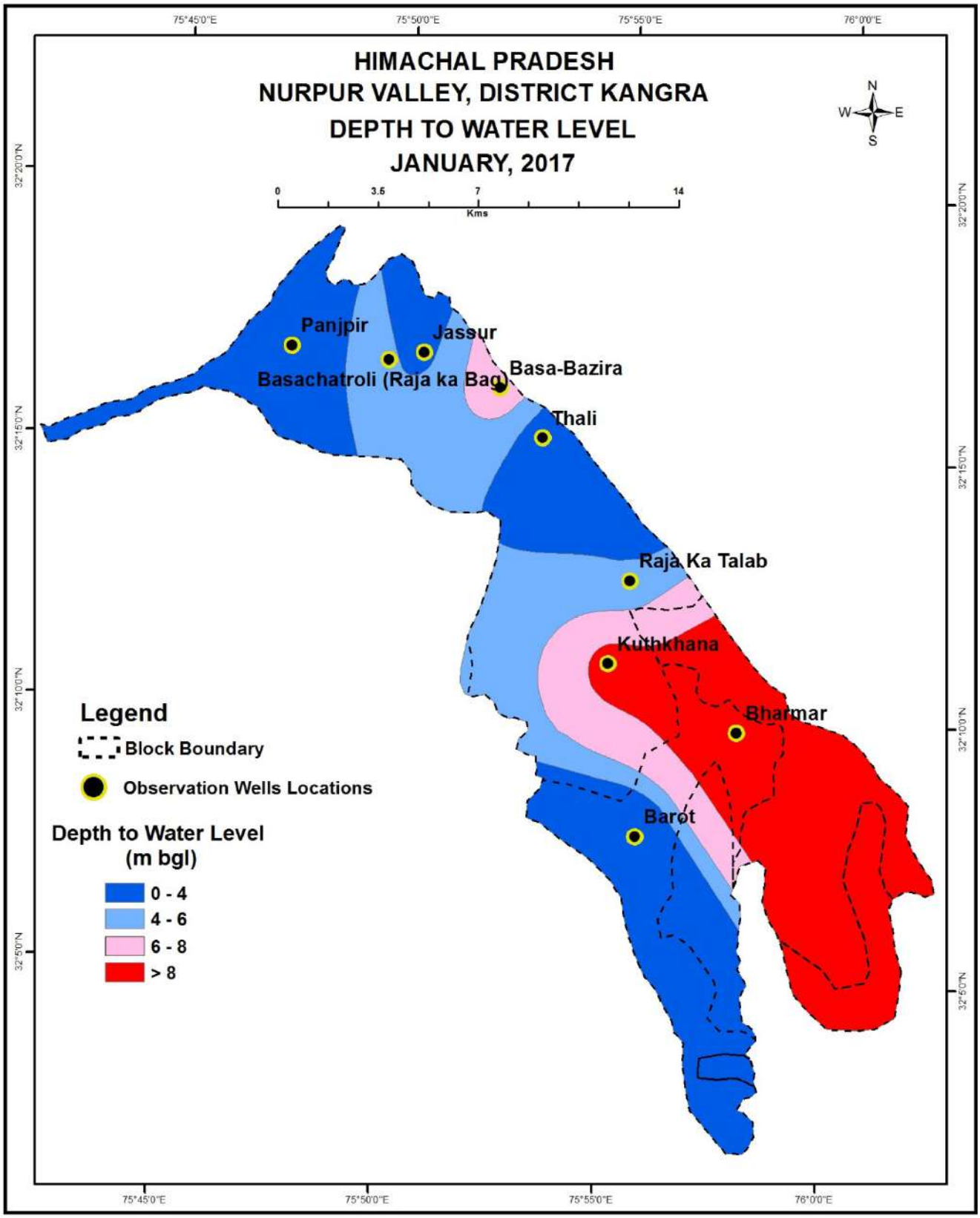


Fig. 2.10 Depth Water Level – January 2017, Nurpur Valley, Kangra District

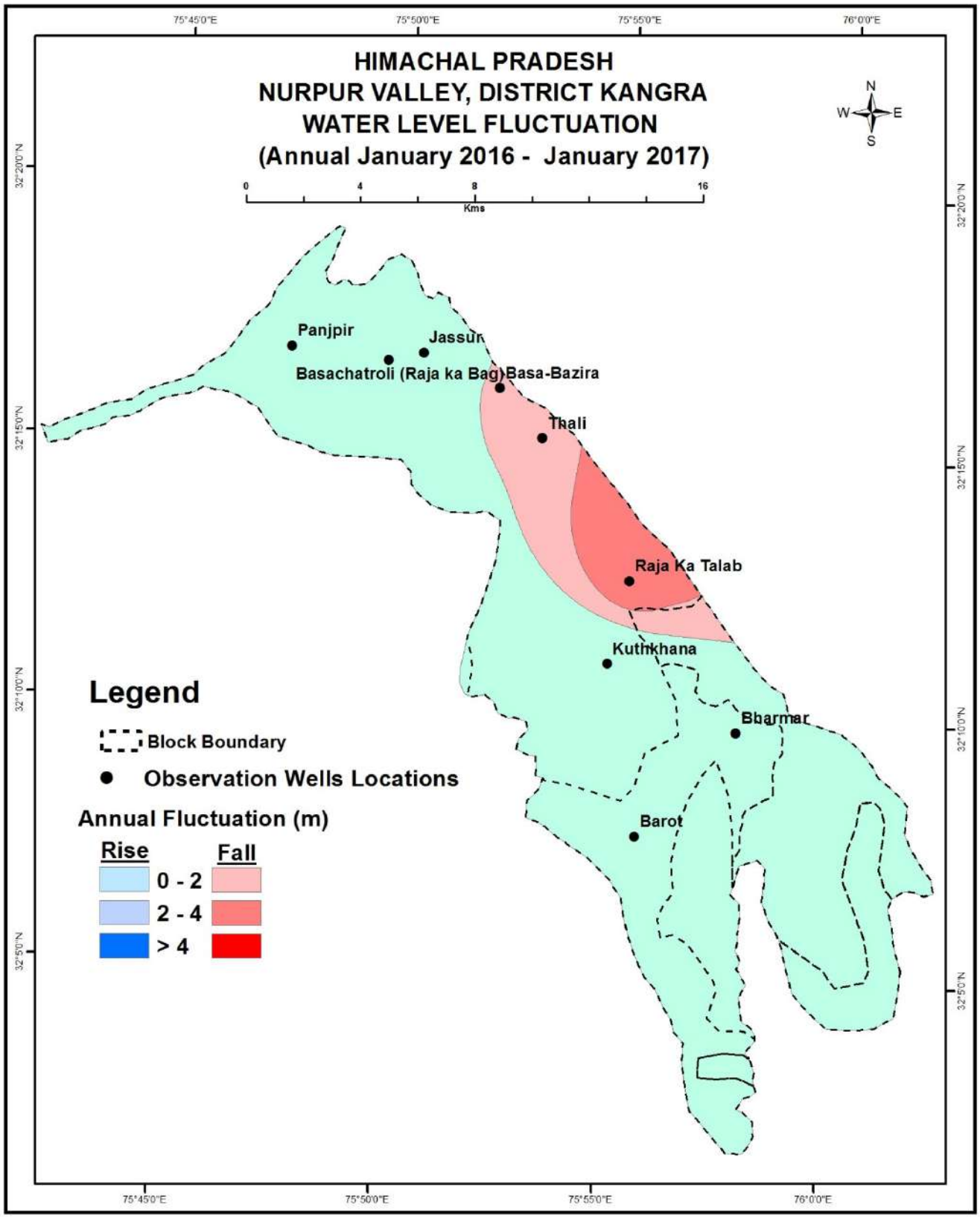


Fig. 2.11 Annual Water Level Fluctuation – January 2016 & January 2017, Nurpur Valley, Kangra District

May 2015 & May 2016

09 Nos. dug well water levels were taken during the month of May 2015 & May 2016 on the basis of these data, annual fluctuation map have been prepared for the Nurpur valley area. The hydrogeological data of the inventoried dug wells are given in Table 2.4. During the period of May 2015 water level ranges from 2.77 to 12.70 m bgl (Fig.2.12.) and May 2016 water level ranges from 4.10 to 15.10 m bgl. (Fig.2.13.) and Annual Water Level Fluctuation ranges between – 2.40 to 0.40 m bgl (Fig. 2.14).

Table 2.4 Water level data (May 2015 and May 2016) GWMS and Aquifer Mapping Wells of Nurpur Valley, Kangra District, Himachal Pradesh

Location	Latitude	Longitude	May 2015	May 2016	Annual Fluctuation
Basachatroli	32.2768	75.8278	6.1	6.18	-0.08
Kuthkhana	32.1831	75.9146	10.9	11.57	-0.67
Barot	32.1284	75.9274	3.9	4.3	-0.4
Panjpir	32.2800	75.7914	4.3	4.81	-0.51
Jassur	32.2796	75.8408	3.6	4.49	-0.89
Raja Ka Talab	32.2097	75.9216	4.45	4.4	0.05
Bharmar	32.1627	75.9638	12.7	15.1	-2.4
Thali	32.2540	75.8865	2.77	4.1	-1.33
Basa-Bazira	32.2694	75.8698	10.2	9.8	0.4

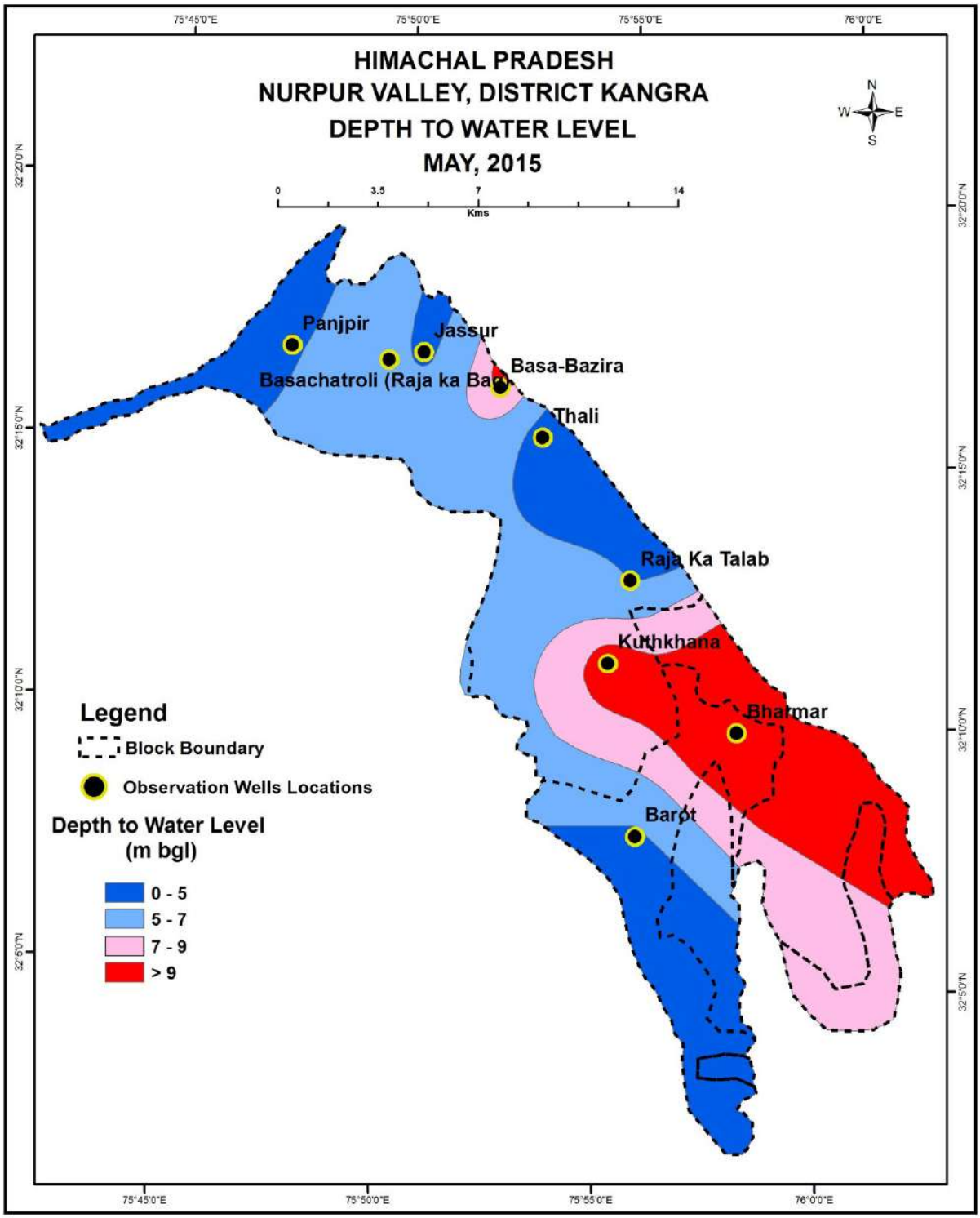


Fig. 2.12 Depth Water Level – May 2015, Nurpur Valley, Kangra District

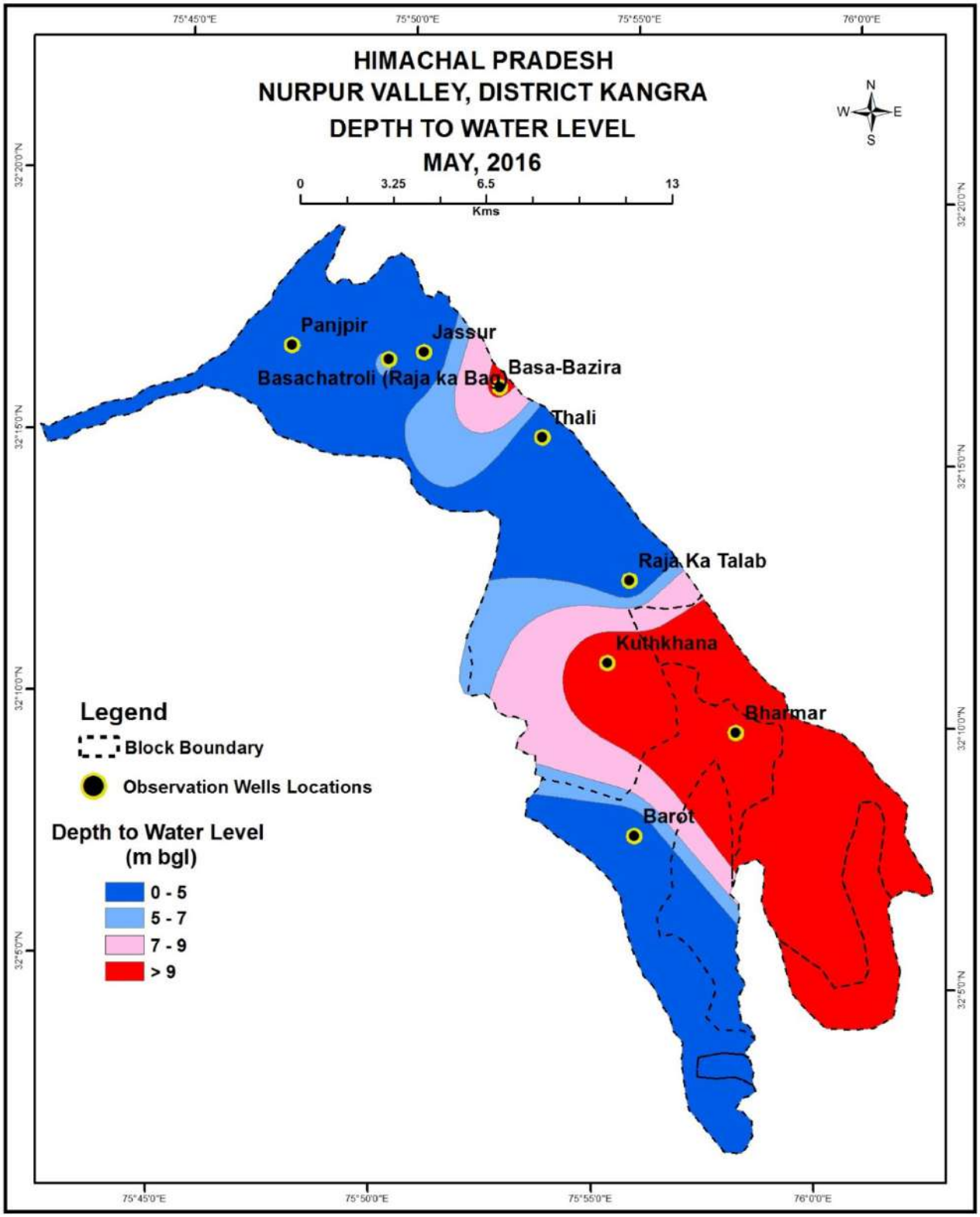


Fig. 2.13 Depth Water Level – May 2016, Nurpur Valley, Kangra District

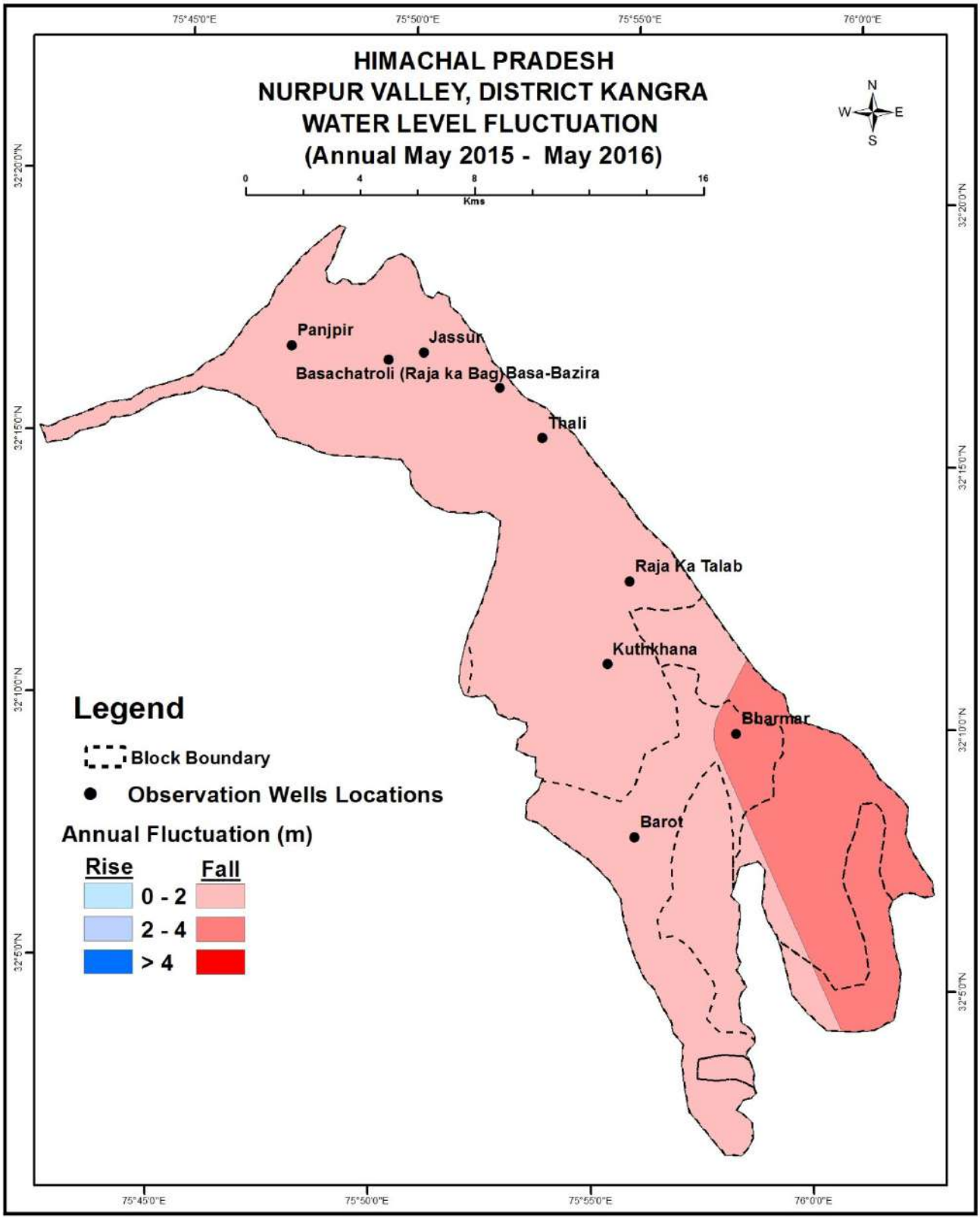


Fig. 2.14 Annual Water Level Fluctuation – May 2015 & May 2016, Nurpur Valley, Kangra District

August 2015 & August 2016

09 Nos. dug well water levels were taken during the month of August, 2015 & August 2016 on the basis of these data, annual fluctuation map have been prepared for the Nurpur valley area. The hydrogeological data of the inventoried dug wells are given in Table 2.5. During the period of August 2015 water level ranges from 1.20 to 8.20 m bgl (Fig.2.15.) and August 2016 water level ranges from 1.05 to 7.95 m bgl. (Fig.2.16.) and Annual Water Level Fluctuation ranges between – 0.75 to 1.10 m bgl (Fig. 2.17).

Table 2.5 Water level data (August 2015 and August 2016) GWMS and Aquifer Mapping Wells of Nurpur Valley, Kangra District, Himachal Pradesh

Location	Latitude	Longitude	August 2015	August 2016	Annual Fluctuation
Basachatroli	32.2768	75.8278	2.08	2.38	-0.3
Kuthkhana	32.1831	75.9146	8.2	7.95	0.25
Barot	32.1284	75.9274	1.3	1.05	0.25
Panjpir	32.2800	75.7914	1.85	2.1	-0.25
Jassur	32.2796	75.8408	4.5	3.75	0.75
Raja Ka Talab	32.2097	75.9216	1.2	1.9	-0.7
Bharmar	32.1627	75.9638	6.57	5.67	0.9
Thali	32.2540	75.8865	2.55	2.5	0.05
Basa-Bazira	32.2694	75.8698	7.8	6.7	1.1

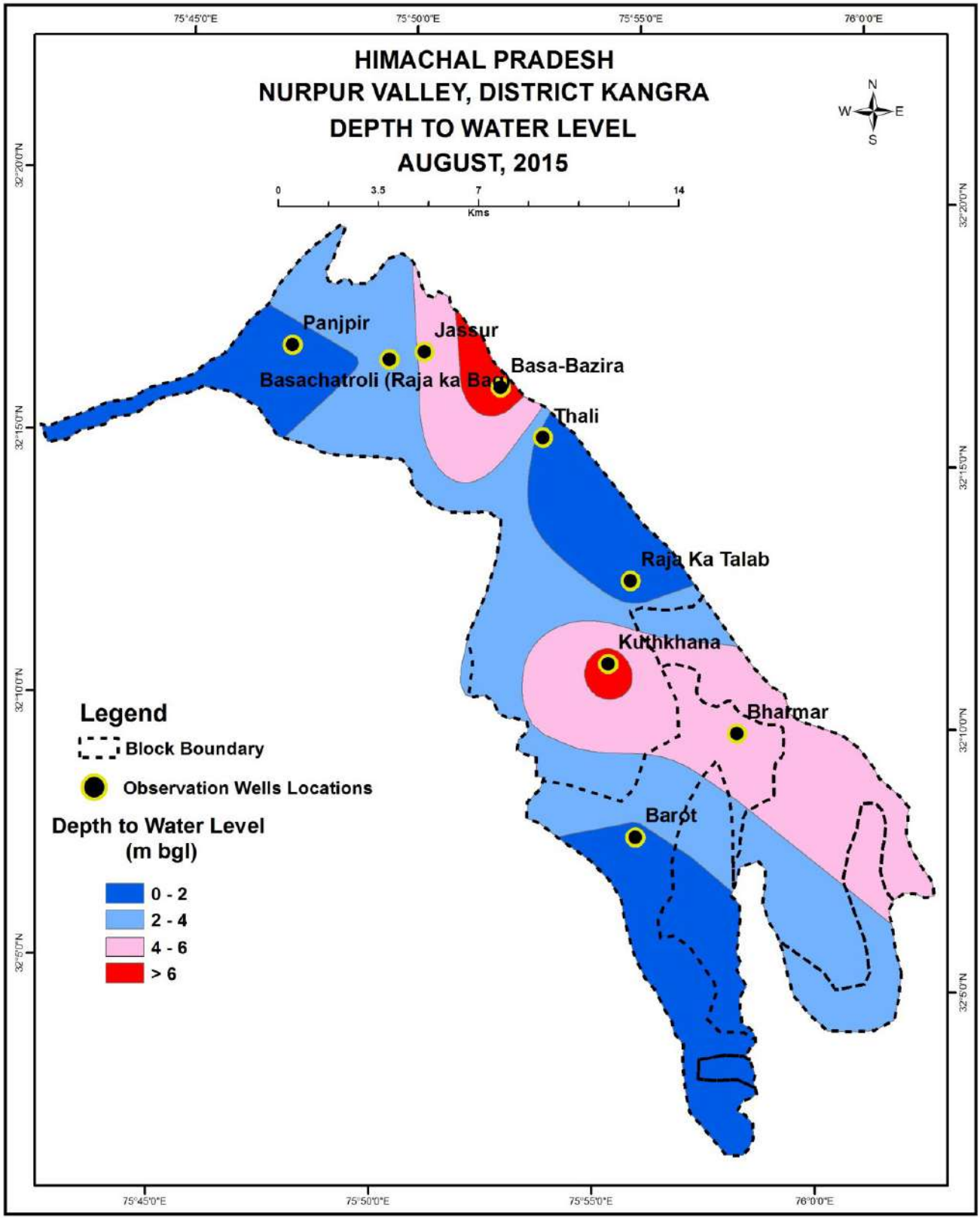


Fig. 2.15 Depth Water Level – August 2015, Nurpur Valley, Kangra District

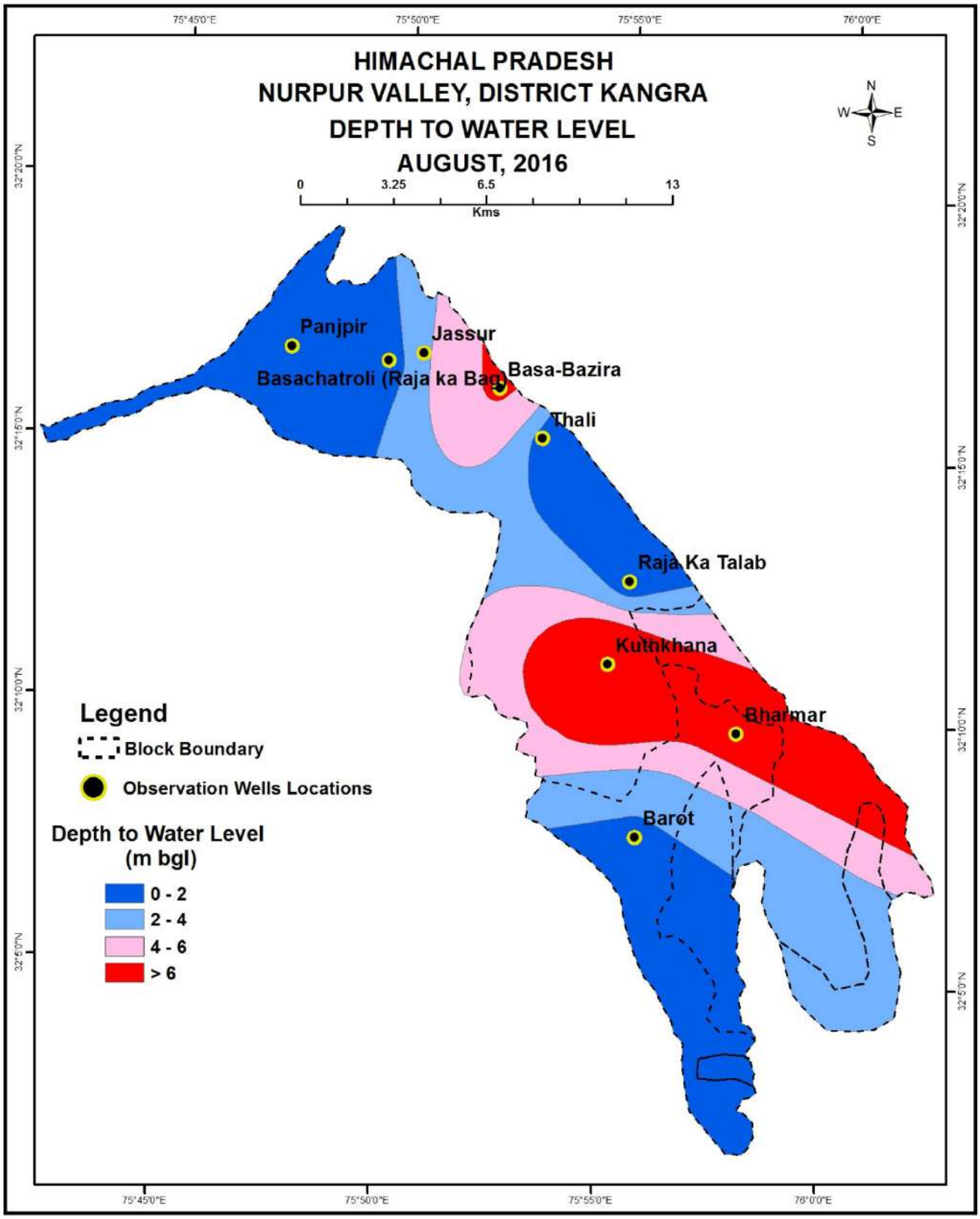


Fig. 2.16 Depth Water Level – August 2016, Nurpur Valley, Kangra District

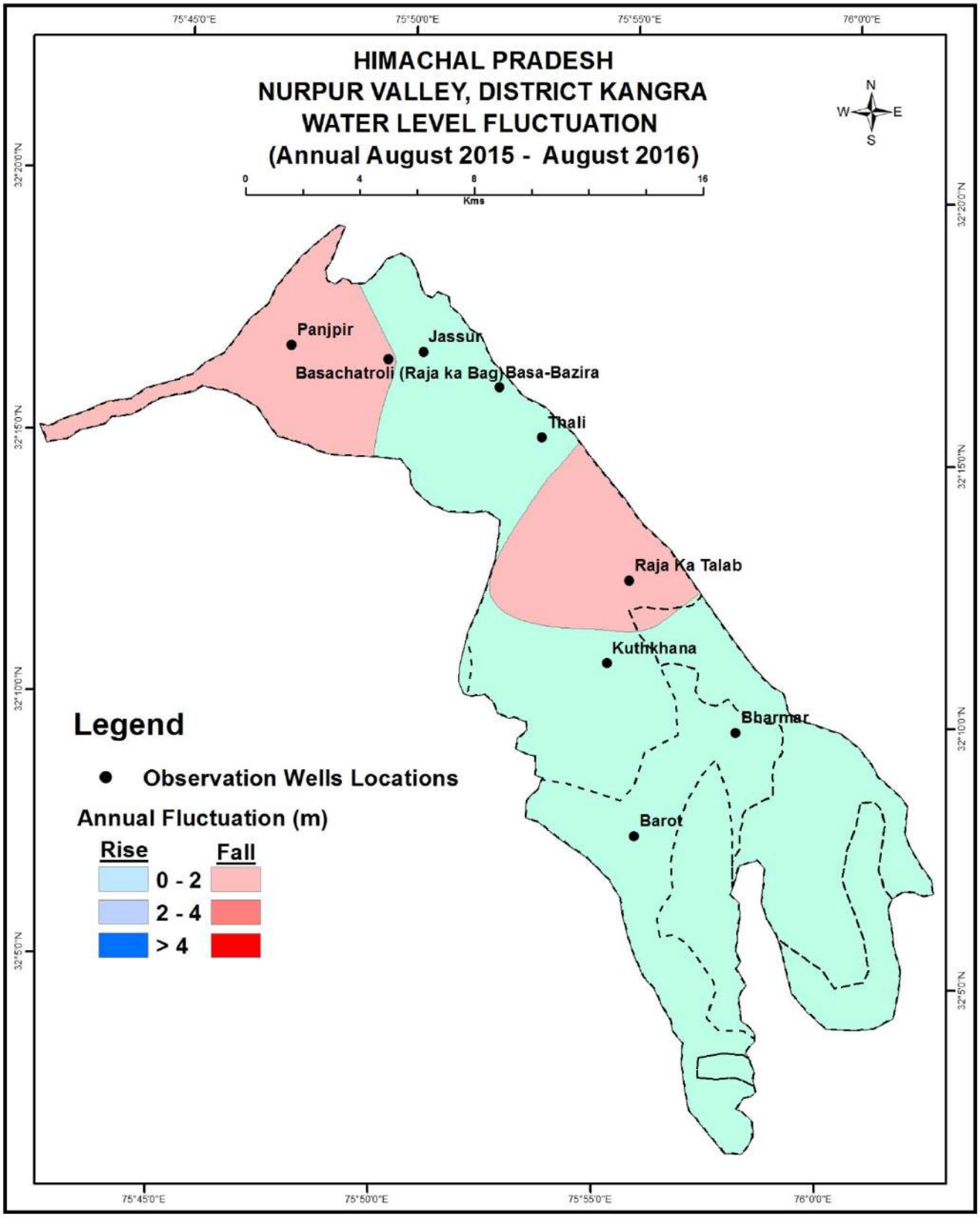


Fig. 2.17 Annual Water Level Fluctuation – August 2015 & August 2016, Nurpur Valley, Kangra District

2.2. Exploratory Drilling – CGWB & I& PH Wells

The Lithologs 26 Nos. of Exploratory Well productive wells of CGWB, Irrigation and Public Health Department (I &PH) have been collected and those supported electrical logs have been used to validation for preparation of aquifer maps. Deeper well data of CGWB is available. The details are shown in Table-2.6. The compromised logs derived from lithologs and geophysical well loggings have been taken as reliable data base.

Table 2.6 Data availability of exploration wells in Nurpur Valley, Kangra District.

Table of Wells, Nurpur Valley			
Agency	**Well Depth (meters)**		
	<100	**100-150**	**>150**
CGWB	1	0	0
I & PH	1	23	1
Total	**2**	**23**	**1**

2.3 Ground Water Quality

The water quality standards are laid down to evaluate suitability of water for intended uses and to safeguard water from degradation. These recommended limits form the basis of treatment needed for improvement in quality of water before use. In the formulation of water quality standards, the selection of parameters is considered depending upon its end use. Two types of standards are referred in India decipher the quality of water suitable for drinking purposes, namely Bureau of Indian Standards (BIS) and World Health Organisation (WHO) Standards.

2.4 Drinking Water

The BIS has laid down the standard specification for drinking water during 1983, which have been revised and updated from time to time. In order to enable the users to exercise their discretion, the maximum permissible limit has been prescribed especially where no alternative sources are available. It is medically established fact that water with concentration beyond permissible limits cause short term or permanent adverse health effects.

To assess the impact of ground water quality, 18 numbers of water samples (Fig. 2.18) were collected from the study area of Nurpur Valley of district Kangra as per the list below:

Sr.No	Type of Source	Total Nos.
1	Dug Well	09 Nos.
2	Hand Pump	08 Nos.
3	Spring	01 Nos.

All the collected samples are sent to chemical laboratory of CGWB, North Western Himalayan Region, Jammu, (J&K), by adopting Standard methods of analysis (APHA) and results are awaiting.

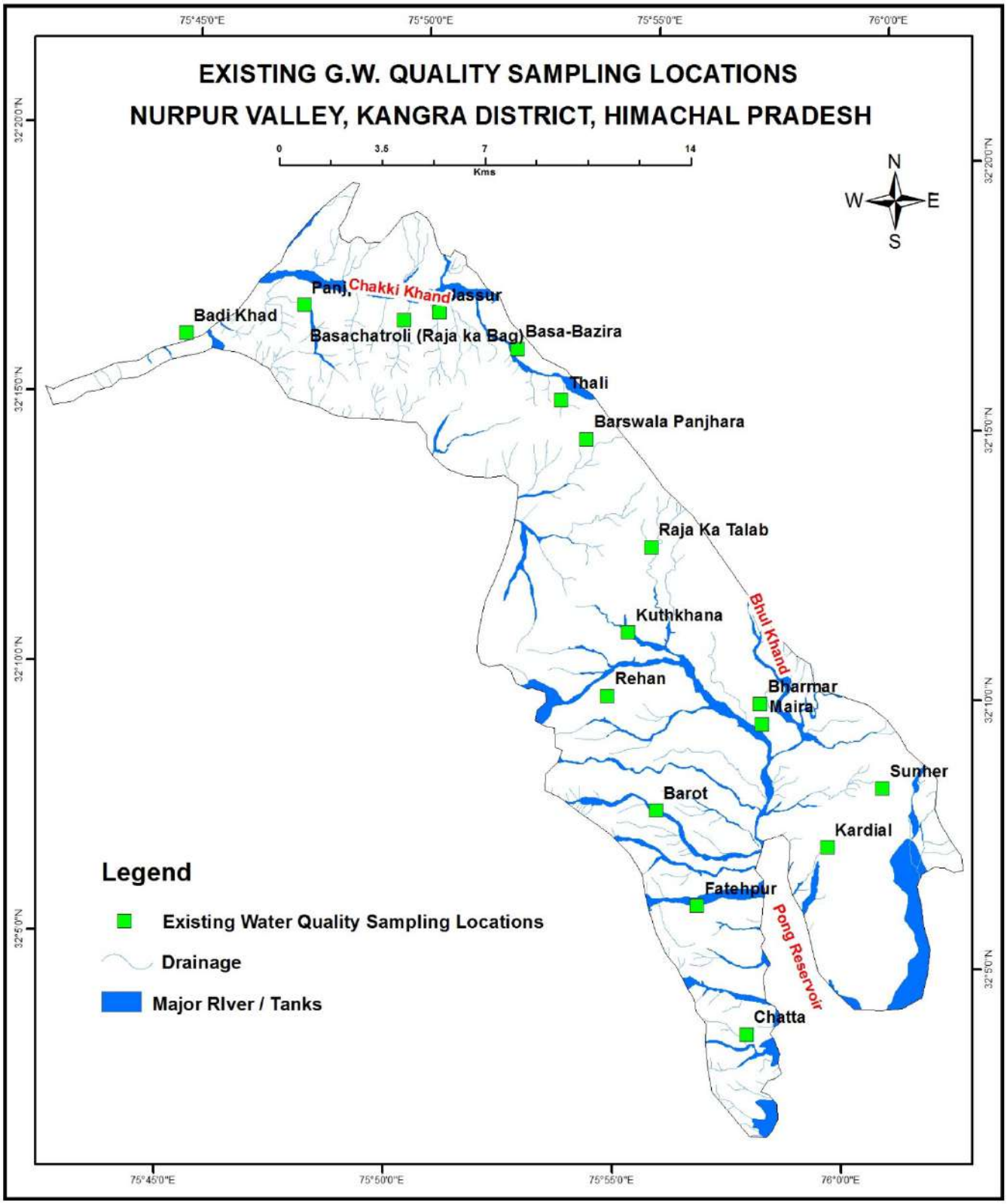


Fig-2.18 Locations of Water Samples for Ground Water Quality Nurpur Valley, Kangra District.

2.5 Spatial Data Distribution

The data of CGWB & I&PH wells in the area are plotted on the map of 1:50000 scale with 5'X5'grid (9km x 9km) and is shown in Fig-2.19 respectively. The exploration data shows that majority of tube wells falls in the Ist Aquifer and II nd Aquifer. The grids/ formations devoid of EW/ DW and PZ are identified as data gaps and these are to be filled by data generation.

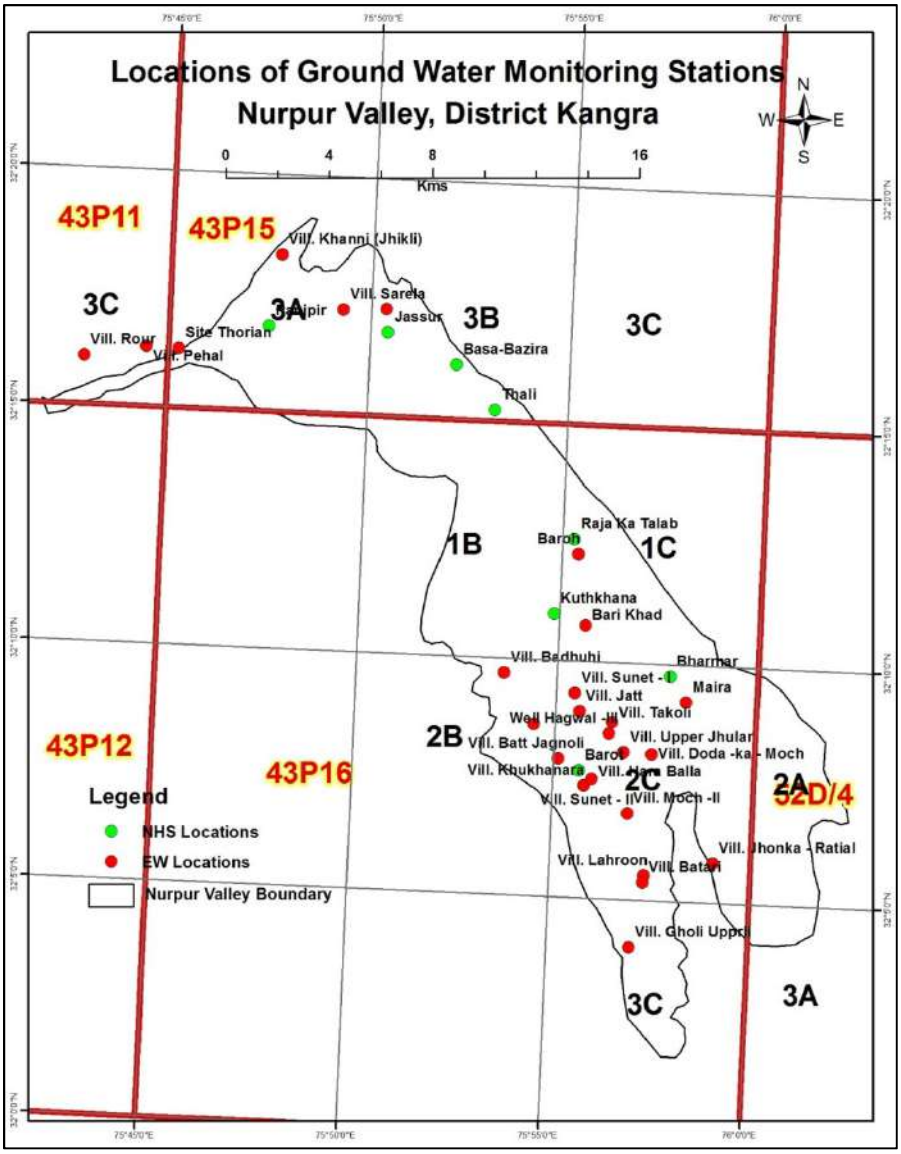


Fig. 2.19 Locations of GWMS in Nurpur Valley, Kangra District

3.0 DATA INTERPRETATION, INTEGRATION AND AQUIFER MAPPING

All the available data have been validated and optimised for consideration to generate the aquifer map in Nurpur Valley, Kangra District. The wells optimisation part is done based on the maximum depth & litholog The deepest well in each quadrant is selected and plotted on the map of 1.50000 scale with 5'X5'grid (9 x 9km) and is shown in Fig-3.0.

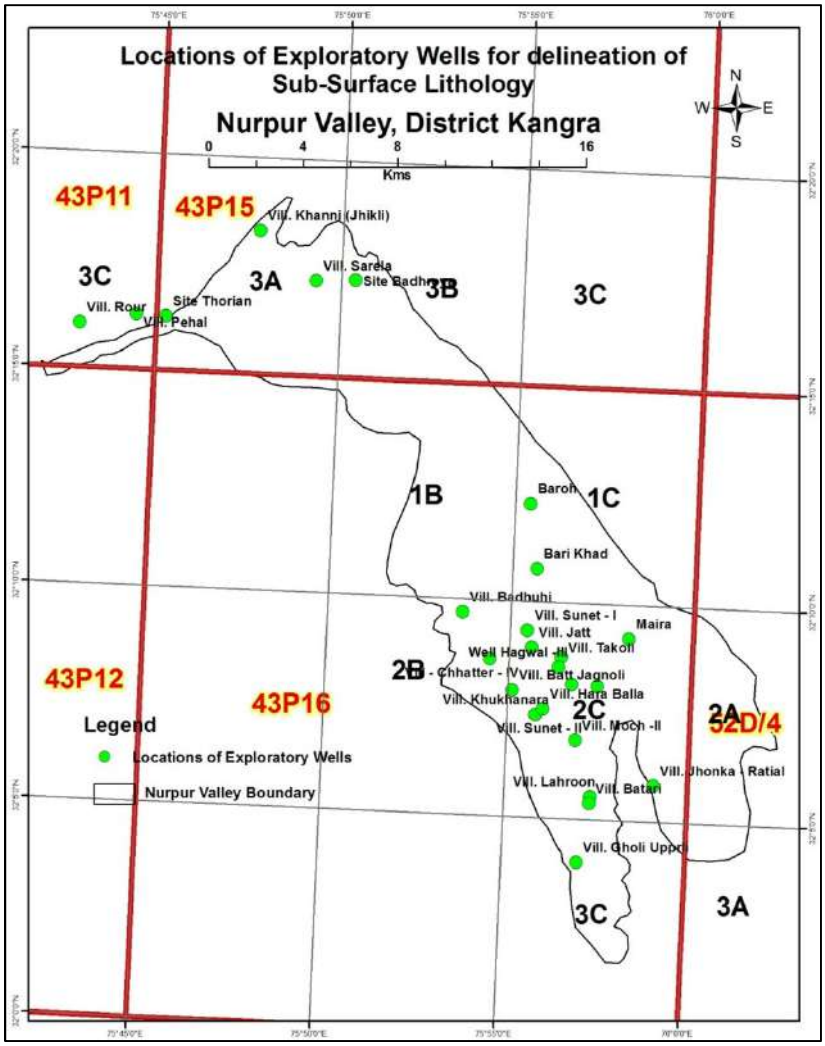


Fig. 3.0 Locations of Exploratory Wells for delineation of Sub-Surface Lithology Nurpur Valley, Kangra District.

3.1 Aquifer Parameter Ranges

In Nurpur Valley, District Kangra (H.P) the exploration drilling was carried out by CGWB, the aquifer parameters range extracted and given in below Table-2.7.

Table 2.7 Summary of exploration and hydraulic details in Nurpur Valley, Kangra District

Exploratory Well	T (m2/day)	Discharge (lpm)	Well Depth
Golwan	157.00	674	150.00
Kadana	547.00	2594	145.00
Narnhun	264.00	1700	150.00
Lub	557.00	1026	172.00
Palli	1971.00	3410	140.00
Bassa Waziran	31.00	304	103.00
Tihal	576.00	1248	134.00
Talara	229.00	530	150.00
Nerna	449.00	1222	103.00

3.2 Aquifer Geometry and Disposition

To understand the lithological frame work and aquifer disposition in the sub surface aquifers, the litholog data of wells drilled by CGWB are used to compile, optimized and modeled into 3D synoptic picture by using the Arc GIS and RockWorks15 software. The lithological model has been prepared along with distribution of wells are shown in Fig-3.1. The 3D lithological fence diagram has been prepared along with distribution of wells are shown in Fig-3.1.

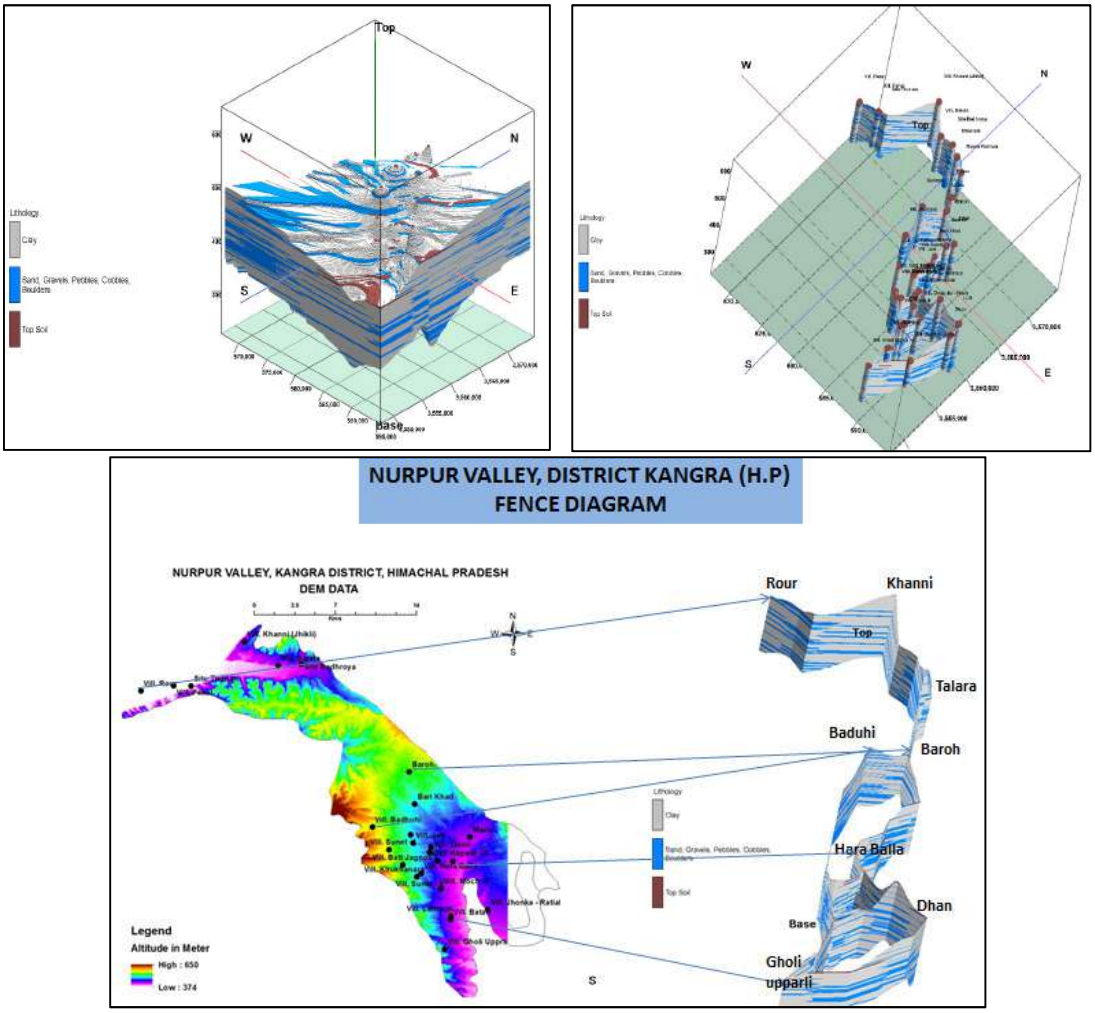
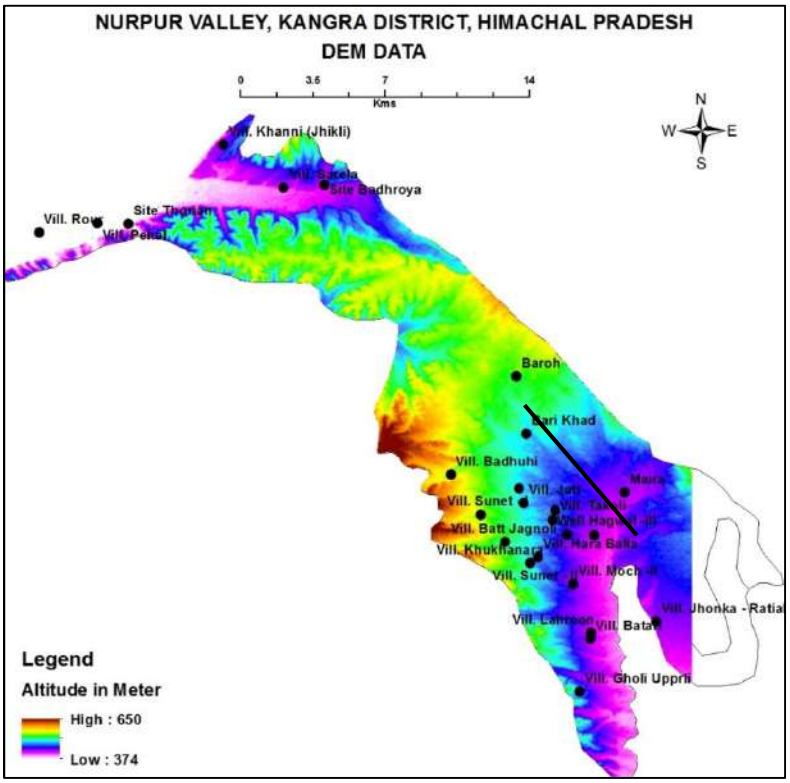


Fig.3.1 3-Dimension Lithological Model of Nurpur Valley, Kangra District

Majority of the Nurpur Valley, Kangra District falls under the Beas Rives Basin, therefore it belongs to a single aquifer system with thin layers of Sand, Gravels, Pebbles, Cobbles, Boulders and Clay. Based on the similar characteristics to know the broad picture of the aquifer disposition, inter-relationship of ground water zones, nature, geometry and extension of aquifers in the Nurpur Valley, Kangra District, the aquifer grouping has been done using the sub – surface lithology and a three – dimensional aquifer model has been prepared.



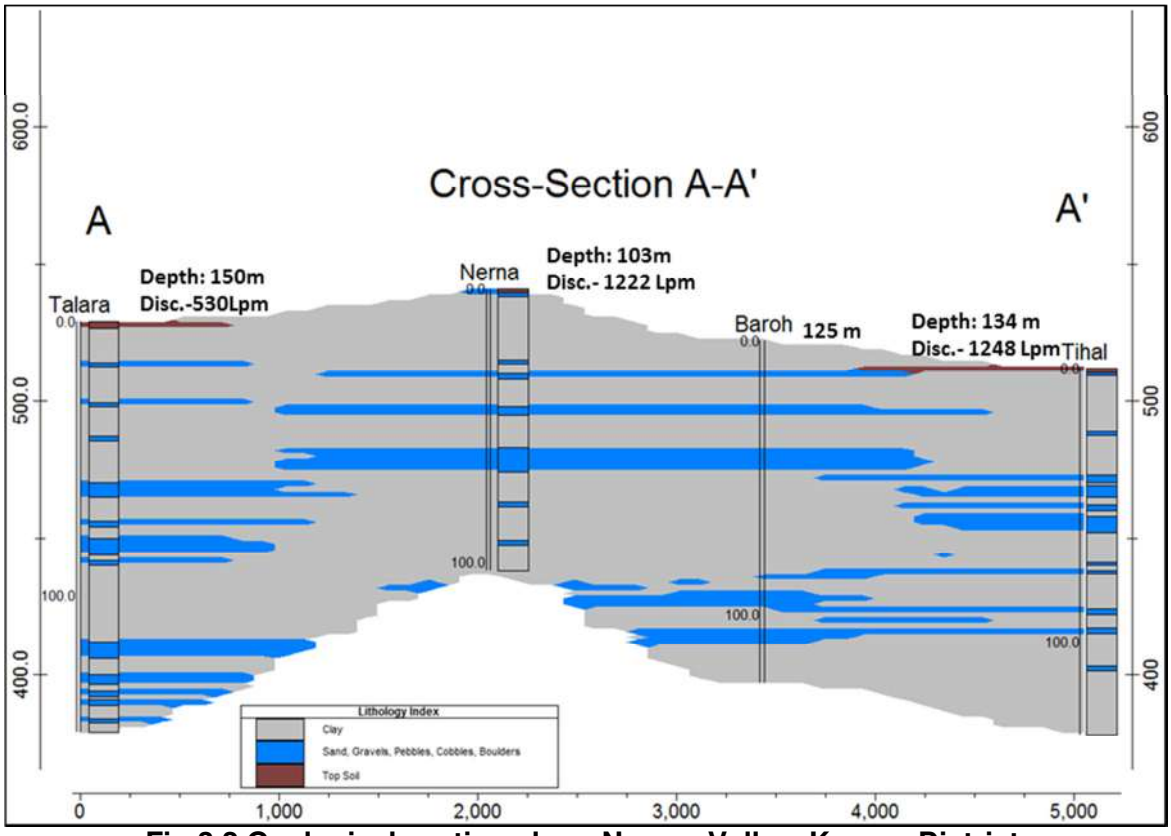


Fig.3.2 Geological section along Nurpur Valley, Kangra District.

4.0 GROUND WATER RESOURCES

Rainfall is the major source recharge to the groundwater body apart from the influent seepage from the rivers, irrigated fields and inflow from upland areas. The discharge from ground water mainly takes place from wells and tube wells; effluent seepages of ground water in the form of springs and base flow in streams.

Aquifer mapping area of Nurpur valley consists of valley areas with an area of 248 sq.km. Ground water resources and irrigation potential for Nurpur valley area of the Kangra district have been computed and details of the Dynamic ground water resource of Nurpur valley are as given below:

1.	Area of Nurpur valley considered for GW Assessment	248	Sq. km.
2.	Net Ground water Availability	11958.75	Ham
3.	Existing Gross Ground Water Draft for Irrigation	1476.75	-do-
4.	Existing Gross Ground Water Draft for Domestic & Industrial Supply	2061.17	-do-
5.	Existing Gross Ground Water Draft	3537.92	-do-
6.	Demand for Domestic and Industrial uses (Projected up to 2025)	976.44	-do-
7.	Net Ground Water Development for future Irrigation Development	9505.56	-do-
8.	Stage of Ground Water Development	29.58	%

The stage of ground water development of Nurpur valley is **29.58%** as on March, 2013 and falls under **"Safe Category".** This suggests that further ground water development can take place in the valley area.

5.0 GROUND WATER RELATED ISSUES

In Nurpur valley major cultivation is Rice, Wheat & Maize and fruits like oranges, Mango, oranges etc. The quality of ground water in the area is potable for both the drinking and irrigation purposes. Therefore, ground in valley area is constantly being pumped for the irrigation due to its easy occurs through tube wells which are the main source of irrigation.

This will lead to its major ground water issues which is deepening of ground water level if the recharge of ground water through rainfall and other sources are less than overall extraction.

In the hilly areas i.e. at the marginal areas of Nurpur Valley, ground water extractions are done through shallow bore wells fitted with hand pumps and spring water is being used as a source of water supply for domestic uses. The discharge of the spring water is also decreasing with the passage of time or during the non – monsoon period.

6.0 AQUIFER MANAGEMENT PLAN

An outline of the Aquifer Management Plan includes details regarding population, rainfall, average annual rainfall, agriculture and irrigation, water bodies, ground water resource

availability, ground water extraction and water level behavior. Aquifer disposition and various cross sections have also been given.

6.1 Plan for Sustainable Management of the Resource

Supply Management

- Since the Nurpur valley area falls in **Safe Category** as per Ground Water Resource Estimation. The Kangra district receives good rainfall (1751 mm), intensity and also having good recharge. So, in the present valley area the construction of 429 nos. of shallow tube wells also suggested for extracting the ground water.
- Augmentation of GW through Artificial Recharge structures
- **Roof top rainwater** harvesting practices can be adopted in in the study area and urban areas, since the district receives fair amount of rainfall. Construction of roof top rain water harvesting structures should be made mandatory in all new construction and rain water harvesting in rural areas should be promoted.
- Traditional water storage systems need to be revived. Recharge structures feasible in hilly areas are check dams and Gabion structures at suitable locations.
- **Flow Irrigation Scheme:** for Minor Irrigation, tapping of perennial streams, spring water and snows melt. If already taped - renovation modernization and lining of the existing systems / defunct.
- Ground Water Recharge Practices should be adopted in spring shed area.

Demand Management

Water Use Efficiency method

- To minimize transmission losses, evaporation losses constructing shallow tube wells, shallow dug wells, percolation wells etc. in the farmers field/community.
- **Irrigation Practices:** Sprinkler / Drip method has higher application and distribution efficiency, saves considerable water and provides complete control on timing and quality of irrigation water to be applied. The Water use efficiency can be much higher as compared to surface method of irrigation.

Annexure - I

Sl.No	Bore	Latitude	Longitude	Elevation	Total Depth
1	Maira	32.15388889	75.97083333	446	63.00
2	Baroh	32.20444444	75.92361111	522	125.00
3	Vill. Upper Jhular	32.13527778	75.94577778	455	125.00
4	Vill. Pehal	32.27122222	75.74097222	373	125.00
5	Vill. Takoli	32.14591667	75.9405	471	125.00
6	Vill. Doda -ka - Moch	32.13511111	75.95741667	434	125.00
7	Vill. Sunet - II	32.12316667	75.92975	482	125.00
8	Vill. Khukhanara	32.12316667	75.92976111	482	125.00
9	Vill. Sunet - I	32.15561111	75.92466667	488	125.00
10	Vill. Hara Balla	32.12555556	75.93313889	481	125.00
11	Vill. Batt Jagnoli	32.13230556	75.91880556	456	125.00
12	Vill. Gholi Upprli	32.06688889	75.95130556	418	125.00
13	Vill. Lahroon	32.09238889	75.95608333	429	127.44
14	Vill - Chhatter - IV	32.14402778	75.90811111	497	125.00
15	Vill. Badhuhi	32.16163889	75.89497222	537	150.00
16	Vill. Sarela	32.28686111	75.82205556	424	125.00
17	Well Hagwal -III	32.14186111	75.93927778	465	125.00
18	Vill. Rour	32.26708333	75.7155	362	140.24
19	Bari Khad	32.17947222	75.92777778	486	128.00
20	Site Thorian	32.27083333	75.75444444	391	148.00
21	Site Badhroya	32.28780556	75.83991667	430	126.52
22	Vill. Moch -II	32.11386111	75.94838889	440	125.00
23	Vill. Jatt	32.14911111	75.92686111	492	125.00
24	Vill. Jhonka - Ratial	32.09747222	75.98452778	435	91.46
25	Vill. Khanni (Jhikli)	32.30544444	75.79566667	446	160.06
26	Vill. Batari	32.08980556	75.95583333	437	125.40

Bore	From	To	Lithology
Vill. Maira	0	0.5	Top Soil
	0.5	1.5	Clay
	1.5	5	Sand, Gravels, Pebbles, Cobbles, Boulders
	5	7	Clay
	7	8	Sand, Gravels, Pebbles, Cobbles, Boulders
	8	13	Clay
	13	14	Sand, Gravels, Pebbles, Cobbles, Boulders
	14	16	Sand, Gravels, Pebbles, Cobbles, Boulders
	16	29	Clay

Vill. Maira	29	34	Clay
	34	38	Clay
	38	55	Clay
	55	56	Sand, Gravels, Pebbles, Cobbles, Boulders
	56	63	Sand, Gravels, Pebbles, Cobbles, Boulders
Baroh Kangra	0	10	Top Soil
	10	31	Clay
	31	41	Sand, Gravels, Pebbles, Cobbles, Boulders
	41	43	Clay
	43	63	Sand, Gravels, Pebbles, Cobbles, Boulders
	63	70	Clay
	70	79	Sand, Gravels, Pebbles, Cobbles, Boulders
	79	89.5	Clay
	89.5	96	Sand, Gravels, Pebbles, Cobbles, Boulders
	96	98.5	Clay
	98.5	103.5	Sand, Gravels, Pebbles, Cobbles, Boulders
	103.5	105	Clay
	105	108	Sand, Gravels, Pebbles, Cobbles, Boulders
	108	125	Clay
Vill. Upper Jhular	0	1.52	Top Soil
	1.52	25.91	Clay
	25.91	30.48	Sand, Gravels, Pebbles, Cobbles, Boulders
	30.48	36.58	Clay
	36.58	41.16	Sand, Gravels, Pebbles, Cobbles, Boulders
	41.16	48.78	Clay
	48.78	53.35	Sand, Gravels, Pebbles, Cobbles, Boulders
	53.35	62.5	Clay
	62.5	65.55	Sand, Gravels, Pebbles, Cobbles, Boulders
	65.55	71.65	Clay
	71.65	74.7	Sand, Gravels, Pebbles, Cobbles, Boulders
	74.7	83.84	Clay
	83.84	88.41	Sand, Gravels, Pebbles, Cobbles, Boulders
	88.41	103.66	Clay
	103.66	106.7	Sand, Gravels, Pebbles, Cobbles, Boulders
	106.7	117.38	Clay
	117.38	121.34	Sand, Gravels, Pebbles, Cobbles, Boulders
	121.34	125	Clay
Vill. Pehal	0	1.22	Top Soil
	1.22	7.62	Sand, Gravels, Pebbles, Cobbles, Boulders
	7.62	9.76	Sand, Gravels, Pebbles, Cobbles, Boulders
	9.76	14.33	Clay

	14.33	20.73	Sand, Gravels, Pebbles, Cobbles, Boulders
	20.73	27.44	Clay
	27.44	39.63	Clay
	39.63	45.73	Clay
	45.73	57.32	Sand, Gravels, Pebbles, Cobbles, Boulders
	57.32	59.45	Clay
	59.45	65.55	Clay
	65.55	70.12	Sand, Gravels, Pebbles, Cobbles, Boulders
	70.12	73.17	Clay
	73.17	76.22	Sand, Gravels, Pebbles, Cobbles, Boulders
	76.22	78.35	Clay
	78.35	81.71	Sand, Gravels, Pebbles, Cobbles, Boulders
	81.71	102.74	Clay
	102.74	107.32	Sand, Gravels, Pebbles, Cobbles, Boulders
	107.32	110.37	Clay
	110.37	115.85	Sand, Gravels, Pebbles, Cobbles, Boulders
	115.85	118.29	Clay
	118.29	121.34	Sand, Gravels, Pebbles, Cobbles, Boulders
	121.34	125	Clay
Vill. Takoli	0	1	Top Soil
	1	10.67	Clay
	10.67	32.01	Clay
	32.01	35.06	Sand, Gravels, Pebbles, Cobbles, Boulders
	35.06	42.68	Clay
	42.68	45.73	Sand, Gravels, Pebbles, Cobbles, Boulders
	45.73	50.3	Clay
	50.3	53.35	Sand, Gravels, Pebbles, Cobbles, Boulders
	53.35	59.45	Clay
	59.45	62.5	Sand, Gravels, Pebbles, Cobbles, Boulders
	62.5	74.69	Clay
	74.69	82.31	Sand, Gravels, Pebbles, Cobbles, Boulders
	82.31	85.36	Clay
	85.36	91.46	Sand, Gravels, Pebbles, Cobbles, Boulders
	91.46	103.65	Clay
	103.65	106.7	Sand, Gravels, Pebbles, Cobbles, Boulders
	106.7	111.28	Clay
	111.28	114.23	Sand, Gravels, Pebbles, Cobbles, Boulders
	114.33	119.51	Clay
	119.51	121.64	Sand, Gravels, Pebbles, Cobbles, Boulders
	121.64	125	Clay

Vill. Doda -ka - Moch	0	1.52	Top Soil
	1.52	10.67	Clay
	10.67	13.72	Sand, Gravels, Pebbles, Cobbles, Boulders
	13.72	38.11	Clay
	38.11	44.82	Sand, Gravels, Pebbles, Cobbles, Boulders
	44.82	53.35	Clay
	53.35	56.4	Sand, Gravels, Pebbles, Cobbles, Boulders
	56.4	71.65	Clay
	71.65	74.7	Sand, Gravels, Pebbles, Cobbles, Boulders
	74.7	94.51	Clay
	94.51	97.56	Sand, Gravels, Pebbles, Cobbles, Boulders
	97.56	106.71	Clay
	106.71	112.8	Sand, Gravels, Pebbles, Cobbles, Boulders
	112.8	116.46	Clay
	116.46	118.9	Sand, Gravels, Pebbles, Cobbles, Boulders
	118.9	125	Clay
Vill. Sunet - II	0	1.52	Top Soil
	1.52	21.34	Clay
	21.34	24.39	Clay
	24.39	33.54	Sand, Gravels, Pebbles, Cobbles, Boulders
	33.54	40.55	Clay
	40.55	44.21	Clay
	44.21	53.96	Sand, Gravels, Pebbles, Cobbles, Boulders
	53.96	56.4	Clay
	56.4	61.89	Sand, Gravels, Pebbles, Cobbles, Boulders
	61.89	76.22	Clay
	76.22	80.79	Sand, Gravels, Pebbles, Cobbles, Boulders
	80.79	82.32	Clay
	82.32	85.98	Sand, Gravels, Pebbles, Cobbles, Boulders
	85.98	91.77	Clay
	91.77	98.48	Sand, Gravels, Pebbles, Cobbles, Boulders
	98.48	108.84	Clay
	108.84	120.43	Sand, Gravels, Pebbles, Cobbles, Boulders
	120.43	125	Clay
Vill. Khukhanara	0	1.22	Top Soil
	1.22	19.51	Clay
	19.51	23.47	Clay
	23.47	28.05	Sand, Gravels, Pebbles, Cobbles, Boulders
	28.05	36.59	Clay
	36.59	61.59	Sand, Gravels, Pebbles, Cobbles, Boulders
	61.59	65.55	Clay

	65.55	77.13	Sand, Gravels, Pebbles, Cobbles, Boulders
	77.13	80.79	Clay
	80.79	100	Sand, Gravels, Pebbles, Cobbles, Boulders
	100	103.05	Clay
	103.05	111.89	Sand, Gravels, Pebbles, Cobbles, Boulders
	111.89	117.38	Clay
	117.38	120.43	Sand, Gravels, Pebbles, Cobbles, Boulders
	120.43	125	Clay
Vill. Sunet - I	0	1.52	Top Soil
	1.52	27.44	Clay
	27.44	53.35	Clay
	53.35	59.45	Sand, Gravels, Pebbles, Cobbles, Boulders
	59.45	67.07	Clay
	67.07	70.12	Sand, Gravels, Pebbles, Cobbles, Boulders
	70.12	73.17	Clay
	73.17	77.74	Sand, Gravels, Pebbles, Cobbles, Boulders
	77.74	89.94	Clay
	89.94	94.51	Sand, Gravels, Pebbles, Cobbles, Boulders
	94.51	103.66	Clay
	103.66	106.71	Sand, Gravels, Pebbles, Cobbles, Boulders
	106.71	114.33	Clay
	114.33	118.9	Sand, Gravels, Pebbles, Cobbles, Boulders
	118.9	125	Clay
Vill. Hara Balla	0	1.52	Top Soil
	1.52	5.49	Clay
	5.49	42.69	Clay
	42.69	45.73	Clay
	45.73	57.93	Clay
	57.93	60.98	Sand, Gravels, Pebbles, Cobbles, Boulders
	60.98	64.63	Clay
	64.63	67.07	Sand, Gravels, Pebbles, Cobbles, Boulders
	67.07	70.12	Clay
	70.12	74.7	Sand, Gravels, Pebbles, Cobbles, Boulders
	74.7	83.84	Clay
	83.84	86.89	Sand, Gravels, Pebbles, Cobbles, Boulders
	86.89	95.73	Clay
	95.73	98.17	Sand, Gravels, Pebbles, Cobbles, Boulders
	98.17	101.22	Clay
	101.22	104.27	Sand, Gravels, Pebbles, Cobbles, Boulders
	104.27	117.38	Clay
	117.38	120.45	Sand, Gravels, Pebbles, Cobbles, Boulders

	120.45	125	Clay
Vill. Batt Jagnoli	0	1	Top Soil
	1	9.15	Clay
	9.15	25.91	Clay
	25.91	30.49	Sand, Gravels, Pebbles, Cobbles, Boulders
	30.49	38.11	Clay
	38.11	45.73	Sand, Gravels, Pebbles, Cobbles, Boulders
	45.73	51.83	Clay
	51.83	60.98	Clay
	60.98	65.55	Sand, Gravels, Pebbles, Cobbles, Boulders
	65.55	79.27	Clay
	79.27	82.32	Sand, Gravels, Pebbles, Cobbles, Boulders
	82.32	97.56	Clay
	97.56	100.61	Sand, Gravels, Pebbles, Cobbles, Boulders
	100.61	108.23	Clay
	108.23	112.8	Sand, Gravels, Pebbles, Cobbles, Boulders
	112.8	117.38	Clay
	117.38	119.21	Sand, Gravels, Pebbles, Cobbles, Boulders
	119.21	125	Clay
	0	1.52	Top Soil
	1.52	12.2	Clay
	12.2	15.24	Sand, Gravels, Pebbles, Cobbles, Boulders
	15.24	25.91	Clay
	25.91	28.96	Sand, Gravels, Pebbles, Cobbles, Boulders
	28.96	37.8	Clay
	37.8	41.16	Sand, Gravels, Pebbles, Cobbles, Boulders
	41.16	74.7	Clay
	74.7	78.05	Sand, Gravels, Pebbles, Cobbles, Boulders
	78.05	106.1	Clay
	106.1	109.45	Sand, Gravels, Pebbles, Cobbles, Boulders
	109.45	119.51	Clay
	119.51	121.95	Sand, Gravels, Pebbles, Cobbles, Boulders
	121.95	125	Clay
Vill. Lahroon	0	1.52	Top Soil
	1.52	6.1	Clay
	6.1	27.44	Clay
	27.44	45.73	Clay
	45.73	64.02	Clay
	64.02	68.6	Sand, Gravels, Pebbles, Cobbles, Boulders
	68.6	73.17	Clay
	73.17	76.22	Sand, Gravels, Pebbles, Cobbles, Boulders

	76.22	83.84	Clay
	83.84	86.89	Sand, Gravels, Pebbles, Cobbles, Boulders
	86.89	89.94	Clay
	89.94	92.99	Sand, Gravels, Pebbles, Cobbles, Boulders
	92.99	101.83	Clay
	101.83	105.49	Sand, Gravels, Pebbles, Cobbles, Boulders
	105.49	115.85	Clay
	115.85	123.78	Sand, Gravels, Pebbles, Cobbles, Boulders
	123.78	127.44	Clay
Vill - Chhatter - IV	0	1.52	Top Soil
	1.52	28.96	Clay
	28.96	32.01	Clay
	32.01	38.11	Clay
	38.11	41.16	Sand, Gravels, Pebbles, Cobbles, Boulders
	41.16	50.3	Clay
	50.3	54.27	Clay
	54.27	59.45	Clay
	59.45	61.89	Sand, Gravels, Pebbles, Cobbles, Boulders
	61.89	73.78	Clay
	73.78	76.83	Sand, Gravels, Pebbles, Cobbles, Boulders
	76.83	80.79	Clay
	80.79	86.89	Sand, Gravels, Pebbles, Cobbles, Boulders
	86.89	94.51	Clay
	94.51	99.09	Sand, Gravels, Pebbles, Cobbles, Boulders
	99.09	102.13	Clay
	102.13	112.8	Clay
	112.8	114.33	Sand, Gravels, Pebbles, Cobbles, Boulders
	114.33	116.46	Clay
	116.46	121.34	Sand, Gravels, Pebbles, Cobbles, Boulders
	121.34	125	Clay
Vill. Badhuhi	0	1	Top Soil
	1	13	Clay
	13	17.4	Sand, Gravels, Pebbles, Cobbles, Boulders
	17.4	26.5	Clay
	26.5	34.4	Clay
	34.4	42.5	Sand, Gravels, Pebbles, Cobbles, Boulders
	42.5	47.2	Clay
	47.2	63	Sand, Gravels, Pebbles, Cobbles, Boulders
	63	72.5	Clay
	72.5	80.5	Sand, Gravels, Pebbles, Cobbles, Boulders
	80.5	85	Clay

	85	88	Clay
	88	90.8	Sand, Gravels, Pebbles, Cobbles, Boulders
	90.8	96	Clay
	96	99.6	Sand, Gravels, Pebbles, Cobbles, Boulders
	99.6	101.7	Clay
	101.7	105.6	Sand, Gravels, Pebbles, Cobbles, Boulders
	105.6	110.4	Clay
	110.4	116.2	Sand, Gravels, Pebbles, Cobbles, Boulders
	116.2	118	Clay
	118	124	Sand, Gravels, Pebbles, Cobbles, Boulders
	124	150	Sand, Gravels, Pebbles, Cobbles, Boulders
Vill. Sarela	0	1.52	Top Soil
	1.52	17.38	Clay
	17.38	19.82	Sand, Gravels, Pebbles, Cobbles, Boulders
	19.82	34.14	Clay
	34.14	35.67	Sand, Gravels, Pebbles, Cobbles, Boulders
	35.67	53.35	Clay
	53.35	57.93	Clay
	57.93	60.06	Sand, Gravels, Pebbles, Cobbles, Boulders
	60.06	71.65	Clay
	71.65	75.3	Sand, Gravels, Pebbles, Cobbles, Boulders
	75.3	83.84	Clay
	83.84	86.89	Sand, Gravels, Pebbles, Cobbles, Boulders
	86.89	99.09	Clay
	99.09	102.13	Sand, Gravels, Pebbles, Cobbles, Boulders
	102.13	105.79	Clay
	105.79	108.84	Sand, Gravels, Pebbles, Cobbles, Boulders
	108.84	115.85	Clay
	115.85	118.9	Sand, Gravels, Pebbles, Cobbles, Boulders
	118.9	125	Clay
Well Hagwal -III	0	3.05	Top Soil
	3.05	7.01	Clay
	7.01	10.67	Sand, Gravels, Pebbles, Cobbles, Boulders
	10.67	26.52	Clay
	26.52	30.18	Sand, Gravels, Pebbles, Cobbles, Boulders
	30.18	35.98	Clay
	35.98	45.73	Clay
	45.73	49.7	Sand, Gravels, Pebbles, Cobbles, Boulders
	49.7	57.32	Clay
	57.32	62.5	Sand, Gravels, Pebbles, Cobbles, Boulders
	62.5	68.29	Clay

	68.29	71.65	Sand, Gravels, Pebbles, Cobbles, Boulders
	71.65	74.7	Clay
	74.7	79.27	Sand, Gravels, Pebbles, Cobbles, Boulders
	79.27	80.79	Clay
	80.79	85.37	Sand, Gravels, Pebbles, Cobbles, Boulders
	85.37	87.2	Clay
	87.2	90.55	Sand, Gravels, Pebbles, Cobbles, Boulders
	90.55	96.04	Clay
	96.04	99.7	Sand, Gravels, Pebbles, Cobbles, Boulders
	99.7	102.13	Clay
	102.13	108.23	Sand, Gravels, Pebbles, Cobbles, Boulders
	108.23	111.28	Clay
	111.28	115.85	Sand, Gravels, Pebbles, Cobbles, Boulders
	115.85	117.38	Clay
	117.38	120.43	Sand, Gravels, Pebbles, Cobbles, Boulders
	120.43	125	Clay
Vill. Rour	0	1	Top Soil
	1	2.13	Clay
	2.13	6.1	Sand, Gravels, Pebbles, Cobbles, Boulders
	6.1	27.44	Clay
	27.44	30.49	Sand, Gravels, Pebbles, Cobbles, Boulders
	30.49	36.59	Clay
	36.59	41.16	Sand, Gravels, Pebbles, Cobbles, Boulders
	41.16	51.83	Clay
	51.83	54.88	Sand, Gravels, Pebbles, Cobbles, Boulders
	54.88	64.02	Clay
	64.02	68.6	Sand, Gravels, Pebbles, Cobbles, Boulders
	68.6	87.8	Clay
	87.8	89.94	Sand, Gravels, Pebbles, Cobbles, Boulders
	89.94	109.76	Clay
	109.76	114.33	Sand, Gravels, Pebbles, Cobbles, Boulders
	114.33	121.95	Clay
	121.95	126.52	Sand, Gravels, Pebbles, Cobbles, Boulders
	126.52	134.15	Clay
	134.15	136.28	Sand, Gravels, Pebbles, Cobbles, Boulders
	136.28	140.24	Clay
Bari Khad	0	1	Top Soil
	1	16	Clay
	16	24	Clay
	24	32	Sand, Gravels, Pebbles, Cobbles, Boulders
	32	36	Clay

	36	50	Sand, Gravels, Pebbles, Cobbles, Boulders
	50	56	Clay
	56	63	Sand, Gravels, Pebbles, Cobbles, Boulders
	63	66	Clay
	66	73	Sand, Gravels, Pebbles, Cobbles, Boulders
	73	100	Clay
	100	104	Sand, Gravels, Pebbles, Cobbles, Boulders
	104	108	Clay
	108	114	Sand, Gravels, Pebbles, Cobbles, Boulders
	114	121	Sand, Gravels, Pebbles, Cobbles, Boulders
	121	124	Clay
	124	128	Sand, Gravels, Pebbles, Cobbles, Boulders
Site Thorian	0	5	Top Soil
	5	51	Clay
	51	55	Sand, Gravels, Pebbles, Cobbles, Boulders
	55	56.7	Clay
	56.7	58.8	Sand, Gravels, Pebbles, Cobbles, Boulders
	58.8	61.2	Clay
	61.2	63.6	Sand, Gravels, Pebbles, Cobbles, Boulders
	63.6	67.4	Clay
	67.4	69.7	Sand, Gravels, Pebbles, Cobbles, Boulders
	69.7	72	Clay
	72	79.5	Sand, Gravels, Pebbles, Cobbles, Boulders
	79.5	82.4	Clay
	82.4	89	Sand, Gravels, Pebbles, Cobbles, Boulders
	89	95	Clay
	95	99.9	Sand, Gravels, Pebbles, Cobbles, Boulders
	99.9	111.2	Clay
	111.2	118.2	Sand, Gravels, Pebbles, Cobbles, Boulders
	118.2	130.5	Clay
	130.5	137	Sand, Gravels, Pebbles, Cobbles, Boulders
	137	145.6	Clay
	145.6	148	Sand, Gravels, Pebbles, Cobbles, Boulders
Site Badhroya	0	1	Top Soil
	1	13	Clay
	13	17.4	Sand, Gravels, Pebbles, Cobbles, Boulders
	17.4	26.5	Clay
	26.5	34.4	Clay
	34.4	42.5	Sand, Gravels, Pebbles, Cobbles, Boulders
	42.5	47.2	Clay
	47.2	63	Sand, Gravels, Pebbles, Cobbles, Boulders

	63	72.5	Clay
	72.5	80.5	Sand, Gravels, Pebbles, Cobbles, Boulders
	80.5	85	Clay
	85	88	Clay
	88	90.8	Sand, Gravels, Pebbles, Cobbles, Boulders
	90.8	96	Clay
	96	99.6	Sand, Gravels, Pebbles, Cobbles, Boulders
	99.6	101.7	Clay
	101.7	105.6	Sand, Gravels, Pebbles, Cobbles, Boulders
	105.6	110.4	Clay
	110.4	116.2	Sand, Gravels, Pebbles, Cobbles, Boulders
	116.2	118	Clay
	118	124	Sand, Gravels, Pebbles, Cobbles, Boulders
	124	150	Sand, Gravels, Pebbles, Cobbles, Boulders
Vill. Moch -II	0	1.52	Top Soil
	1.52	12.2	Clay
	12.2	14.63	Sand, Gravels, Pebbles, Cobbles, Boulders
	14.63	20.73	Clay
	20.73	22.87	Sand, Gravels, Pebbles, Cobbles, Boulders
	22.87	41.16	Clay
	41.16	47.26	Sand, Gravels, Pebbles, Cobbles, Boulders
	47.26	49.39	Clay
	49.39	51.83	Sand, Gravels, Pebbles, Cobbles, Boulders
	51.83	54.27	Clay
	54.27	57.93	Sand, Gravels, Pebbles, Cobbles, Boulders
	57.93	65.55	Clay
	65.55	84.76	Clay
	84.76	88.11	Sand, Gravels, Pebbles, Cobbles, Boulders
	88.11	92.07	Clay
	92.07	98.78	Sand, Gravels, Pebbles, Cobbles, Boulders
	98.78	114.02	Clay
	114.02	118.9	Sand, Gravels, Pebbles, Cobbles, Boulders
	118.9	122.56	Clay
	122.56	125	Clay
Vill. Jatt	0	1	Top Soil
	1	10.67	Clay
	10.67	42.68	Clay
	42.68	45.73	Sand, Gravels, Pebbles, Cobbles, Boulders
	45.73	53.35	Clay
	53.35	56.4	Sand, Gravels, Pebbles, Cobbles, Boulders
	56.4	68.6	Clay

	68.6	71.65	Sand, Gravels, Pebbles, Cobbles, Boulders
	71.65	77.74	Clay
	77.74	83.84	Sand, Gravels, Pebbles, Cobbles, Boulders
	83.84	103.66	Clay
	103.66	114.33	Sand, Gravels, Pebbles, Cobbles, Boulders
	114.33	119.82	Clay
	119.82	121.34	Sand, Gravels, Pebbles, Cobbles, Boulders
	121.34	125	Clay
Vill. Jhonka - Ratial	0	3.05	Top Soil
	3.05	10.67	Clay
	10.67	19.82	Clay
	19.82	25.91	Clay
	25.91	28.96	Clay
	28.96	32.01	Clay
	32.01	36.59	Clay
	36.59	41.16	Sand, Gravels, Pebbles, Cobbles, Boulders
	41.16	45.73	Clay
	45.73	54.88	Sand, Gravels, Pebbles, Cobbles, Boulders
	54.88	66.77	Clay
	66.77	69.51	Sand, Gravels, Pebbles, Cobbles, Boulders
	69.51	77.74	Sand, Gravels, Pebbles, Cobbles, Boulders
	77.74	91.46	Clay
Vill. Khanni (Jhikli)	0	1.22	Top Soil
	1.22	31.1	Clay
	31.1	35.06	Clay
	35.06	41.16	Clay
	41.16	44.21	Sand, Gravels, Pebbles, Cobbles, Boulders
	44.21	53.05	Clay
	53.05	56.71	Sand, Gravels, Pebbles, Cobbles, Boulders
	56.71	59.45	Clay
	59.45	70.73	Clay
	70.73	80.43	Clay
	80.43	83.23	Sand, Gravels, Pebbles, Cobbles, Boulders
	83.23	96.34	Clay
	96.34	100	Sand, Gravels, Pebbles, Cobbles, Boulders
	100	107.93	Clay
	107.93	110.98	Sand, Gravels, Pebbles, Cobbles, Boulders
	110.98	118.9	Clay
	118.9	124.7	Clay
	124.7	127.74	Sand, Gravels, Pebbles, Cobbles, Boulders
	127.74	144.82	Clay

	144.82	152.13	Sand, Gravels, Pebbles, Cobbles, Boulders
	152.13	160.06	Clay
Vill. Batari	0	1	Top Soil
	1	11	Clay
	11	33	Sand, Gravels, Pebbles, Cobbles, Boulders
	33	47.5	Clay
	47.5	49	Sand, Gravels, Pebbles, Cobbles, Boulders
	49	50.5	Clay
	50.5	56.5	Sand, Gravels, Pebbles, Cobbles, Boulders
	56.5	65.4	Clay
	65.4	67.8	Sand, Gravels, Pebbles, Cobbles, Boulders
	67.8	83.4	Clay
	83.4	104.5	Clay
	104.5	110	Sand, Gravels, Pebbles, Cobbles, Boulders
	110	121.4	Clay
	121.4	125.4	Sand, Gravels, Pebbles, Cobbles, Boulders

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