GOVERNMENT OF INDIA
MINISTRY OF WATER RESOURCES
CENTRAL GROUND WATER BOARD

DISTRICT GROUNDWATER BROCHURE OF NAINITAL DISTRICT, UTTARAKHAND

UTTARANCHAL REGION **NOVEMBER 2010** **DEHRADUN**

DISTRICT GROUNDWATER BROCHURE OF NAINITAL DISTRICT, UTTARAKHAND

By
Sh. D. Jamloki
Assistant Hydrogeologist

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NAINITAL DISTRICT AT A GLANCE

S.No.	Items	Statistics
1	GENERAL INFORMATION	
	(i) Geographical area (sq.km.)	4064.33 sq.km.
	(ii) Population (as on 2001 census)	7,62,909
	(iv) Average Annual Rainfall (mm)	1246
2	GEOMORPHOLOGY	
	Major physiographic units	Lesser Himalaya, Himalayan foothill zone and Piedmont alluvial zone
	Major drainage	Ramaganga, Gola , Kosi, Dabka, Baur and Bhakra
3	LAND USE (sq.km.)	
	(a) Forest (sq.km.)	2983.36
	(b) Net Sown area	465.84 } 798.91 sq. km
	(c) Area Sown more than once	333.07 }
	(d) Cultivable area	890.18 sq. km
4	MAJOR SOIL TYPES	Lithic/Typic Cryorthents, Lithic/Typic Udorthents and Dystric Eutrochrepts
5	AREA UNDER PRINCIPAL CROPS	Wheat-34.97%, Paddy-17.43%, Manduwa-28.95%
6	IRRIGATION BY DIFFERENT SOURCES (area and numbers of structures)	
	Dug wells	Nil
	Tube wells/bore wells	44.78 sq. km
	Tanks/Ponds	Nil
	Canals	241.30 sq. km
	Other sources	5.49 sq. km
	Net Irrigated area	293.37 sq. km.
	Gross Irrigated area	584.84
7	NOS. OF GROUND WATER MONITORING WELLS OF CGWB	
	No. of Dug wells	3
	No. of piezometers	Nil
	No. of Handpumps	10
	No. of Springs	4
8	PREDOMINANT GEOLOGICAL FORMATIONS	Lesser Himalaya, Siwaliks and Bhabar
9	HYDROGEOLOGY	
	Major water bearing formations	Bhabar

	(Pre-monsoon depth to water level Range	3.92 – 69.61 m bgl
	Long term water level trend in 10 yrs (1997 – 2006)	-
10	GROUND WATER E4XPLORATION BY CGWB (As on 31/03/2007)	-
	No. of wells drilled (EW,OW,PZ,SH, Total)	17
	Depth Range (m)	62.45 – 301.00
	Discharge Range (lpm)	1330 – 4526
	Storativity (S)	-
	Transmissivity (m^2/day)	27 – 23860
11	GROUND WATER QUALITY	Potable
	Presence of Chemical constituents more than permissible limit	Overall Ground water quality is good for domestic purpose except few locations
12	DYNAMIC GROUND WATER RESOURCES (2004) in Ha m	Calculated for only Two Blocks Ramnagar and Haldwani
	Annual replenishable Ground resources	9426.48
	Net annual ground water draft	2434.51
	Projected demand for domestic and industrial uses up to 2025	241.48
	Stage of Ground Water Development	<40% (Safe)
13	AWARENESS AND TRAINING ACTIVITY	
	Training programmes organized	One
	Date	19th March, 2007
	Place	Haldwani
	No. of participants	207 trainees from various State & Central Government department & NGO's attended the training.
14	EFFORTS OF ARTIFICIAL RECHARGE & RAINWATER HARVESTING	
	Projects completed by CGWB (No. & amount spent)	Nil
	Projects under technical guidance of CGWB (Numbers)	Nil
15	MAJOR GROUND WATER PROBLEMS AND ISSUES	-

DISTRICT GROUNDWATER BROCHURE
NAINITAL DISTRICT, UTTARAKHAND

1.0 INTRODUCTION

Nainital district forms part of Kumaon Division of Uttarakhand State. It lies between $29^0$0' and $29^0$36'21'' N latitudes and $78^0$50'53'' and $80^0$0' E longitudes. The district comprises of four tehsils namely, Nainital, Dhari, Haldwani and Kosya Kutoli and eight developmental blocks viz., Haldwani, Ramnagar, Kotabagh, Dhari, Betalghat, Ramgarh, Bhimtal and Okhalkanda. The total population of the district is 7,62,909 as per 2001 census. The density of population is 198 persons per sq. km. The geographical area of the district is 4064.33 km^2. The details of the blocks are given in **Table 1** and their spatial distribution is given in **Fig 1**.

Table 1. Details of the developmental blocks and tehsils, District Nainital.

Sl. No.	Name Block	Area (km^2)	Name of Tehsil	No. of Villages	No. of Towns
1	Haldwani	217.20	Haldwani	252	1
2	Ramnagar	209.22	Haldwani	187	1
3	Kotabagh	174.92	Nainital	115	1
4	Dhari	238.69	Dhari	46	1
5	Okhalkanda	294.96		107	1
6	Ramgarh	276.61	Kosya Kutoli/ Nainital	130	1
7	Betalghat	256.33	Nainital	133	1
8	Bhimtal	200.52	Nainital	112	1
Forest		2173.69			
Urban area		22.19			
Total		**4064.33**			

2.0 CLIMATE AND RAINFALL

The district enjoys sub-tropical to sub-humid climate. The maximum temperature in the plain areas ranges from 42ºC to 46ºC and the minimum between 1°C and 9°C. In the hilly areas the minimum temperature falls below freezing point up to 0.9°C during winter. The annual normal rainfall in the district varies from 1200 mm

to 2647 mm. The average annual rainfall is 1246 mm. The intensity of rainfall generally increases from north to South

3.0 GEOMORPHOLOGY AND SOIL TYPE

***3.1 Physiography*:** Nainital district comprises of three broad physiographic divisions, from north to south viz., the Lesser Himalayan Zone, the Himalayan Foot Hill Zone and the Piedmont Alluvial Tract corresponding to the major geo-tectonic sub-divisions of the Himalayas. The physiographic map of Nainital district is shown in **Fig. 2.**

3.1.1. Lesser Himalaya: This zone comprises of deep valleys and distinct terraces, both of alluvial and glacial origin. The terrain is overall rugged with sudden rise and/or fall in relief and slope with a maximum elevation of 2610 m above Mean Sea Level. The zone is extensively filled up by fluvial terrace deposits. The regional trend of major ridges is NNW-SSE.

3.1.2 The Himalayan Foothill Zone: This zone runs in NW-SE direction with a maximum elevation of 1677 m above Mean Sea Level. The lower Siwaliks are truncated towards south by major/minor structural discontinuities. The slopes are relatively moderate, with flat-topped hills.

***3.1.3. Piedmont Alluvial Zone*:** At the Himalayan foothills, extensive zone of Recent sediments were deposited by the streams running downhill which can broadly be classified as Bhabar and Tarai. These zones extend in the NW-SE direction along the Himalayan foothill and are separated with each other by spring line. The slope of this belt gradually decreases towards south and becomes almost flat beyond the spring line. The gradients vary from 9.5 to 17 m/km.

The soils are natural, dynamic, heterogeneous, non-renewable resource, which support plant and animal life. The tract of Nainital district consists of outward succession of ridges viz; Lesser Himalaya and Siwaliks of decreasing height. These hills posses very little leveled land. The soils have developed from rocks like granite, schist, gneiss, limestone, phyllites, shales, slate, sand stone etc. under cool and moist climate.

3.2. Soil: Very steep to steep hills and Glacio-fluvial valleys are dominantly occupied by very shallow to moderately shallow excessively drained, sandy-skeletal to loamy-skeletal, neutral to slightly acidic with low available water capacity soils. They have been classified as Lithic/Typic Cryorthents. These soils are in general under sparse vegetation.

The Lesser Himalayan range is mainly composed of highly compressed and altered rocks like granite, phyllites, quartzite etc. and a major part of it, is under forest. Intermittent sparse patchy terraced cultivation is also practiced on fairly steep hill slopes whereas dry and wet cultivation are prevalent on the uplands and low-lying valleys respectively. The broader valley slopes dominantly have deep, well drained, fine-loamy, moderately acidic and slightly stony.

4.0 GROUNDWATER SCENARIO

4.1. Geology: Nainital district can be classified into three broad geotectonic divisions namely, the Lesser Himalayas, the sub Himalayas and the Piedmont alluvial plains. Each of these divisions is characterised by distinct rock types of varied geological age, structural trends, tectonic setting and geomorphic features.

***4.1.1 Lesser Himalaya*:** The Lesser Himalayan formations occupy almost one third area of the district. These formations comprise dominantly of unfossiliferous meta-sedimentary sequences along with low to medium grade metamorphics ranging in age from Precambrian to Palaeogene. The main rock types are granite, granodiorite, phyllites, slates, quartzites, schists and gneiss. The Krol and Blaini formations comprise mainly of sandstones, limestones and quartzites.

***4.1.2 Outer Himalayan Foothill Zone*:** This zone can be classified into the Lower Siwaliks, Middle Siwaliks and the Upper Siwaliks.

***Lower Siwaliks*:** The lower Siwaliks are characterised by hard, massive, grey to brownish grey sandstones interbedded with grey to maroon clays. They form the outermost zone in the Nainital Himalayas and occasionally exhibit local structural discontinuities. The dip is usually northwards.

***Middle Siwaliks*:** The middle Siwaliks are characterised by massive light grey micaceous sandstones. They exhibit sporadic patterns of cementation at different stratigraphic intervals.

***Upper Siwaliks*:** The Upper Siwaliks are constituted of pebbles, cobbles, boulders, conglomerates and clay lenses. The pebbles and boulders are mostly quartzitic. Thin lenses of grey to light green colour clays are common. Outcrops of upper Siwaliks are exposed in the western part between Kaladhungi and Ramnagar.

***Intermontane Valleys*:** Small (~ 25 km long and 10 km wide) intermontane valleys locally known as "Kota Doon" occur within the Sub-Himalayan Siwaliks trending in NNW-SSE direction. The epispastics mainly comprise of boulders, pebbles, cobbles, granules, sands & clays of varied composition.

4.1.3 Piedmont Alluvial Plains: This zone is broadly classified into the Bhabar and Tarai formations, which are separated by the spring line.

***Bhabar Formation*:** The formation is mainly comprised of poorly sorted unconsolidated sediments viz, cobbles boulders, gravel, pebbles, sand and silt with intervening clay layers. The lithological constituents are of heterogeneous nature viz., basic, acid and intermediate along with epiclastics and metamorphiclasts. Clay lenses are of limited extent. The belt exhibits NW-SE elongation. Its northern boundary has an abrupt structural contact (Main Boundary Thrust) with lower Siwaliks. The width of the belt is quite variable. The maximum width (about 21km) is in Haldwani – Kichha (Udham Singh Nagar) section.

***Tarai Formation*:** Tarai formation consists of sand, clay, silt, sandy clays and occasionally gravel. Clay beds predominate over sand beds. The northern limit of the belts is the spring line, separating it from Bhabar. The Tarai deposits represent the finer wash out material brought by the streams from the hilly tracts and are evenly sorted.

4.2 Subsurface Geology: Central Ground Water Board, under its exploratory drilling programme, drilled a number of boreholes in the entire Bhabar – Tarai belt of Nainital district to explore the geometry and nature of granular zones occurring down to a

depth of 300 m bgl. A subsurface lithological correlation depicts the disposition of a number of granular zones forming the major aquifer system in the Bhabar belt. The granular material is essentially composed of cobbles, boulders, medium to coarse-grained sand with occasional gravels ranging in size from 4.0 to 8.0 mm. The thickness of these granular zones varies laterally and a great deal of facies variation and intercalations are prevalent in the area. Tarai aquifers have inter-tonguing relationship with those of the Bhabar tract and the thickness of the clay and sand – clay beds increases towards the Tarai belt.

4.3 Structure: The main Himalayan zone in the north of the area is one of the highly active domains of the Himalayan foreland belt and is delineated by a regional tectonic discontinuity known as the Main Boundary Thrust. The other tectonic discontinuities are the Krol thrust, the Ramnagar thrust and the South Almora thrust. Within these tectonic domains the rocks have under gone multiple episodes of folding and thrusting leading to a highly complex, poly deformed structural set up.

4.4 Hydrogeology

The geotectonic setup and physiography vary enormously within a limited geographical area controlling the occurrence, movement and behavior of ground water. On the basis of general morphology and geologic setting, the entire district can be broadly classified into two distinct parts viz.1 Hard Rock Terrain and 2.Piedmount Alluvial Tract with reference to occurrence and yield of groundwater.

4.4.1. Groundwater conditions in hard rock terrain: More than 55% of the geographical area of Nainital district is underlain by the Outer Himalayan foot hill zone and Lesser Himalayan formations comprising mainly of sand stone, mudstone, shale, clay lenses, quartizites, slates, phyllites and gneisses. These rock masses have poor primary porosity. These rocks store and yield adequate volume of water only when secondary inter granular porosity develops on account of weathering and disintegration along planes of weakness. The occurrence and movement of ground water is primarily controlled by the presence of structural disjunction, geometry and spacing, disposition in space, interconnectivity, and depths to which they pervade the host rocks. The primary source of recharge, in this region, is precipitation. Substantial

amount of rainwater percolates down the exposed fractures, fissures, discontinuity planes and weathered mantle cover by infiltration and is stored as ground water. The various rock formations of this region are broadly grouped into three hydrogeological units, which are described below.

***i. High Potential Unit*:** The unconsolidated and semi consolidated fluvial and colluvial valley fill deposits along the major and minor rivers such as Kosi, Gola, Bhakra and Dabka are highly permeable which are capable of holding significant quantities of groundwater in unconfined condition. Highly weathered rock masses further add to a profound increase in the ground water potential in the area. Cavernous limestones and dolomites in the vicinity of Nainital Township are well recognized as high potential aquifers. Groundwater oozes out of these formations in the form of springs. This spring water may be harnessed for supplying water to some of the water scarcity areas. The Upper Siwaliks are the most permeable in the entire Siwalik succession.

***ii. Moderate Potential Unit*:** Highly fractured and jointed rocks with overlying weathered mantle of rock waste that overlie gentle to moderate slopes come under this category. These rocks are mainly slates, phyllites, schists etc. of Almora group, Ramnagar group and Bhimtal volcanics lying around Bhimtal, Bhowali and northeastern parts of the district. Permeable sandstones of middle Siwaliks may also be grouped in this category.

***iii. Low Potential Unit*:** This unit primarily consists of massive granitoids, gneisses, quartzites and shales at higher reaches with almost nil or little secondary interstices. Springs are the main source of drinking water in this unit where discharges are variable. The Depth to Water (DTW) map of Nainital district is shown in **Fig. 3.**

4.1.2. Groundwater conditions in the Piedmont Alluvial tract: The sediments belonging to the Quaternary age mainly consist of loose, poorly sorted, unconsolidated boulders, cobbles, pebbles, gravels, coarse to medium sand and clay. Composition of these sediments is heterogeneous in nature and cover around 40 – 45% of the

geographical area of the Nainital district. The alluvial tract is divided into the Bhabar and Tarai zones.

***i. Bhabar zone*:** The Bhabar formation is essentially coalesced piedmont fans, which have resulted in the formation of piedmont alluvial plains. These are primarily the deposits from braided channel system. This highly permeable zone lies in an elongated trough in NW – SE direction with the width ranging from 4 to 20 km. This unit gradually merges with the Tarai zone towards south. The general gradient of the Bhabar tract varies between 10m/km to 20m/km.

Groundwater in this belt occurs under unconfined conditions. Depth to water levels generally varies between 40 and 75 m bgl during Pre-monsoon period 2007. The deepest water level, 173.71 m bgl, has been recorded in a tubewell at Bhotia Parao (Haldwani). In the wells tapping the perched aquifers, water levels generally rest within the depth of 10 m bgl. The depth to water table gradually decreases towards south. The elevation of water table varies from 250 to 300m above MSL. The hydraulic gradient is around 3m/km. The yield of the tube wells, 90 to 301 m deep, has been observed up to 3773 lpm at a draw down of 3 to 10 m. The hydraulic conductivity, as deciphered from pumping tests, ranges between 25 and 250 m/day.

***ii. Tarai zone*:** The Tarai belt consists predominantly of fine sediments comprising of clay and silts with well-sorted granular material such as sand, gravels and occasional boulders and cobbles. The sand and gravel associated with fine materials constitute the principal aquifers, which are normally under confined condition. These aquifers upto a great extent are connected with the thick aquifers of the Bhabar tract, which serves as the recharge area for this zone.

Groundwater occurs under unconfined to confined conditions. The depth to water in shallow unconfined aquifers ranges from 2 to 6 m bgl with average seasonal fluctuation of 2-4 m. The water table slopes towards south. The tubewells, tapping deeper confined aquifers occurring below 50 m depth generally exhibit auto flow conditions. These tubewells on pumping yield 25.0 to 55.0 lps for a drawdown of 2.0 to 8.0 m. In case of tubewells tapping confined aquifers with non-flowing conditions the

yield varies between 10 and 40 lps for a drawdown of 4 to 9.0 m. The coefficient of permeability ranges between 17 and 108 m/day.

Based on geology and geomorphology, the hydrogeological map of Nainital district has been prepared and shown in **Fig. 4**

4.5 Ground Water Resources

Groundwater resources, in Nainital district have been estimated for only two blocks (Ramnagar and Haldwani), which fall in the plain area. The Net Annual Ground Water available for Ramnagar and Haldwani blocks are 3481.2 and 5338.71 ha m, respectively and percentage of Ground Water Development in Ramnagar and Haldwani blocks are 29.17% and 23.53% respectively.

4.6 Ground Water Quality

Water quality monitoring is an important exercise for establishing its suitability for various uses. It is helpful in evaluating the nature and extent of pollution, if any. A perusal of the chemical analysis results of groundwater/spring water samples indicates that the groundwater in the entire district is fresh and all the constituents lie within the permissible limits. The variations of different chemical parameters pertaining to hand pumps and springs are given in **Table 2.** The water in the area is suitable for domestic and irrigation requirements.

Table 2. Variations of different chemical parameter, District Nainital

Parameter	Hand pumps	Springs
Electrical Conductivity	275-500 µmohos/cm	175-467 µmohos/cm
pH	8.10-8.20	8.10-8.20
Calcium	8-64 mg/l	16-32 mg/l
Magnesium	15-43 mg/l	12-44mg/l
Sodium	6.4-34 mg/l	3.5-21 mg/l
Potassium	1.1-4.5mg/l	0.9-3.8 mg/l
Bicarbonate	146-268 mg/l	98-195 mg/l
Chloride	7.1-21 mg/l	7.1-21 mg/l
Nitrate	Nil-17 mg/l	Nil-8.8 mg/l
Fluoride	Nd-0.17mg/l	Nd-0.30 mg/l
Total hardness as $CaCO_3$	150-260 mg/l	100-240 mg/l

4.7 Status of Ground Water Development (Block wise)

Groundwater resource evaluation for the year 2004 has been done for only two blocks (Ramnagar and Haldwani) in the district, which fall in the plain area. The sub-optimal utilization of groundwater in these blocks as reflected by profound low stage of development (29.17% in Ramnagar block and 23.53% in Haldwani block) leaving an enormous scope to harness the ground water resources to the extent of approximately 70%.

5.0 GROUNDWATER MANAGEMENT STRATEGY

5.1 Ground Water Development

The ground water development in the entire Nainital district is very low. The resource evaluation reflects that there is considerable balance of ground water resources available in the area lying south of Siwalik foothills, which can be developed scientifically in a phased manner in future through deep tubewells. The valley fills along the major rivers are potential zones, which need to be explored for further ground water development to cater the domestic and irrigational needs. In the hilly tract; structural disjunctions viz; faults, joints, lineaments and fracture systems along with deeply weathered zones hold promising prospects for future groundwater development.

5.2 Water Conservation and Artificial Recharge

Groundwater conservation needs to be implemented in right earnest, particularly in the hilly tract of the district. There is an immediate need to implement measures to prevent wasteful run-off allowing water to percolate to the phreatic/piezometric surface, channelize surface flow and establish some degree of connectivity between the natural sources of water. At places, especially in Ramnagar, Dhari and Okhalkanda block, there is a need for construction of groundwater storage and conservation structures since more than 60% of the geographical area of the district lies in the Sub-Himalayan/Lesser Himalayan/Outer-Himalayan foothill zone. The conservation structures need to be constructed at different topographic levels so as to utilize the water thus stored at all times during the year right from lean period to times when there is abundant replenishment from precipitation.

6.0 GROUNDWATER RELATED ISSUES AND PROBLEMS

In this hilly district water sources are not easily accessible hence water for drinking and irrigation is a problem for the local populace. Agriculture is mostly rainfed in higher reaches. Hence new sources need to be identified and existing sources need to be conserved and augmented.

7.0 AWARENESS AND TRAINING ACTIVITY

7.1 Mass Awareness Programme (MAP) & Water Management Training Programme (WMTP) by CGWB

Till date one Water Management Training Programmes has been organized by CGWB in Nainital district.

8.0 AREAS NOTIFIED BY CGWA/SGWA

No area has been notified in Nainital district by CGWA. Uttarakhand State does not have State Ground Water Authority.

9.0 RECOMMENDATIONS

On the basis of hydrogeological, geomorphological and geophysical studies, following recommendations are made:

(1) The Nainital district is mainly occupied by Himalayan ranges; therefore large-scale development of ground water is not possible in the hilly part of the district.

(2) Ground water can be developed through tube wells in the Bhabar area.

(3) Hand pumps and springs in the area occupied by Lesser Himalaya. Hand pumps can be installed at suitable areas in hilly region.

(4) Small surface water reservoir may be developed at suitable locations so as to increase the recharge of the aquifer and surface water availability in the district.

(5) The water of the high discharge springs may be channelzed for irrigation at lower altitude.

(6) Due to sufficient rainfall and more number of rainy days, roof top rainwater harvesting in urban as well as rural areas may be promoted to cater the domestic requirement.

(7) Mass Awareness Programme is required to aware the public regarding harvesting of Rainwater and water conservation.

For Technical Guidance Contact:

Regional Director
Ministry of Water Resources
Central Ground Water Board
Uttaranchal Region
419 – A, Kanwali Road, Balliwala
Dehradun – 248 001
Uttarakhand

Phone: (0135) – 2761675, 2769533
(0135) – 2769525 (Telefax)
www.cgwb.gov.in
e-mail: rdur-cgwb@nic.in
rodcur-cgwb@nic.in

CONTRIBUTORS

Prepared by
D. Jamloki, Assistant Hydrogeologist

Under the Supervision of
Dr. R. P. Singh, Scientist – 'D'

Under the guidance of
Mr. A. K. Bhatia, Regional Director

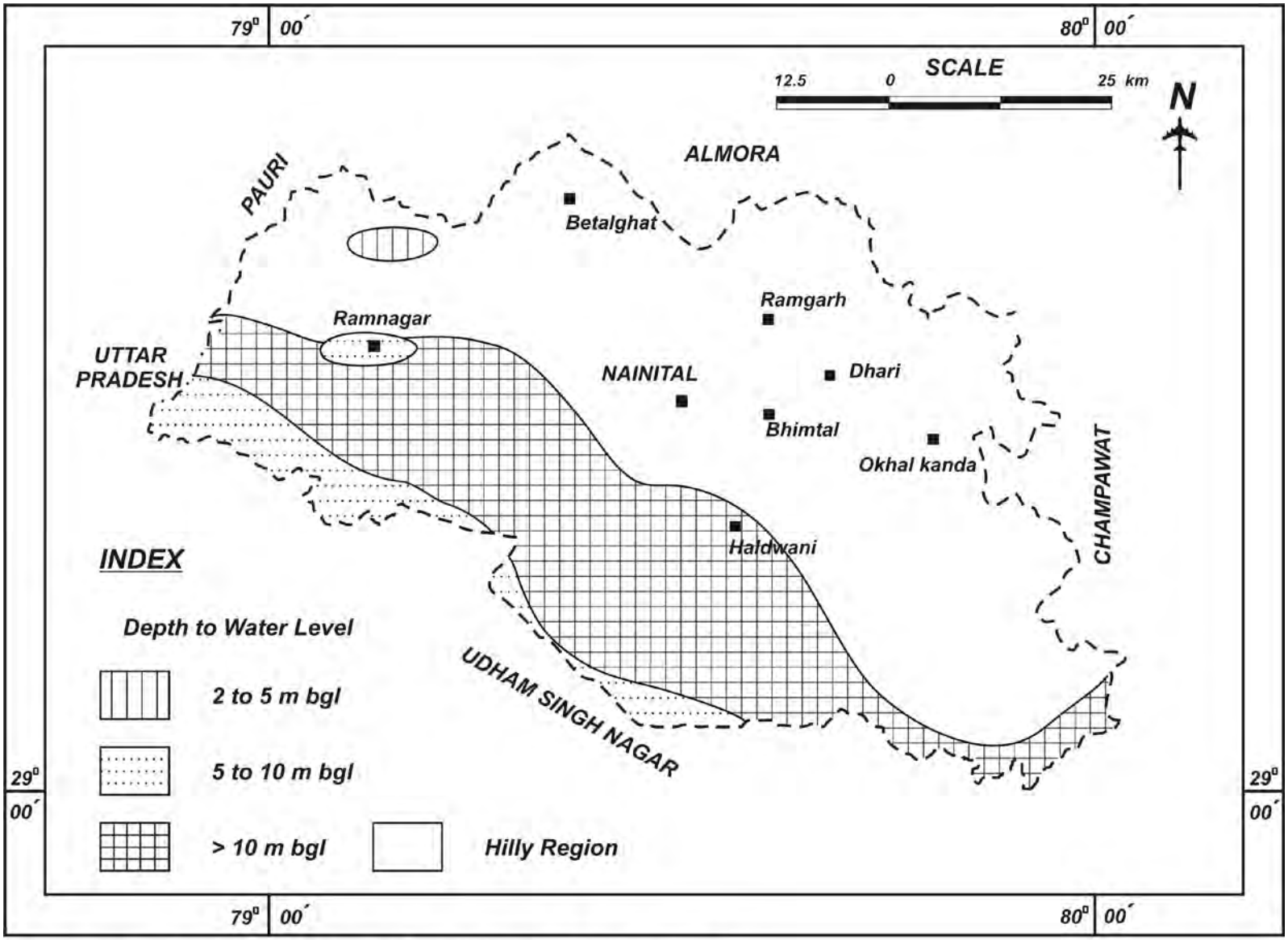
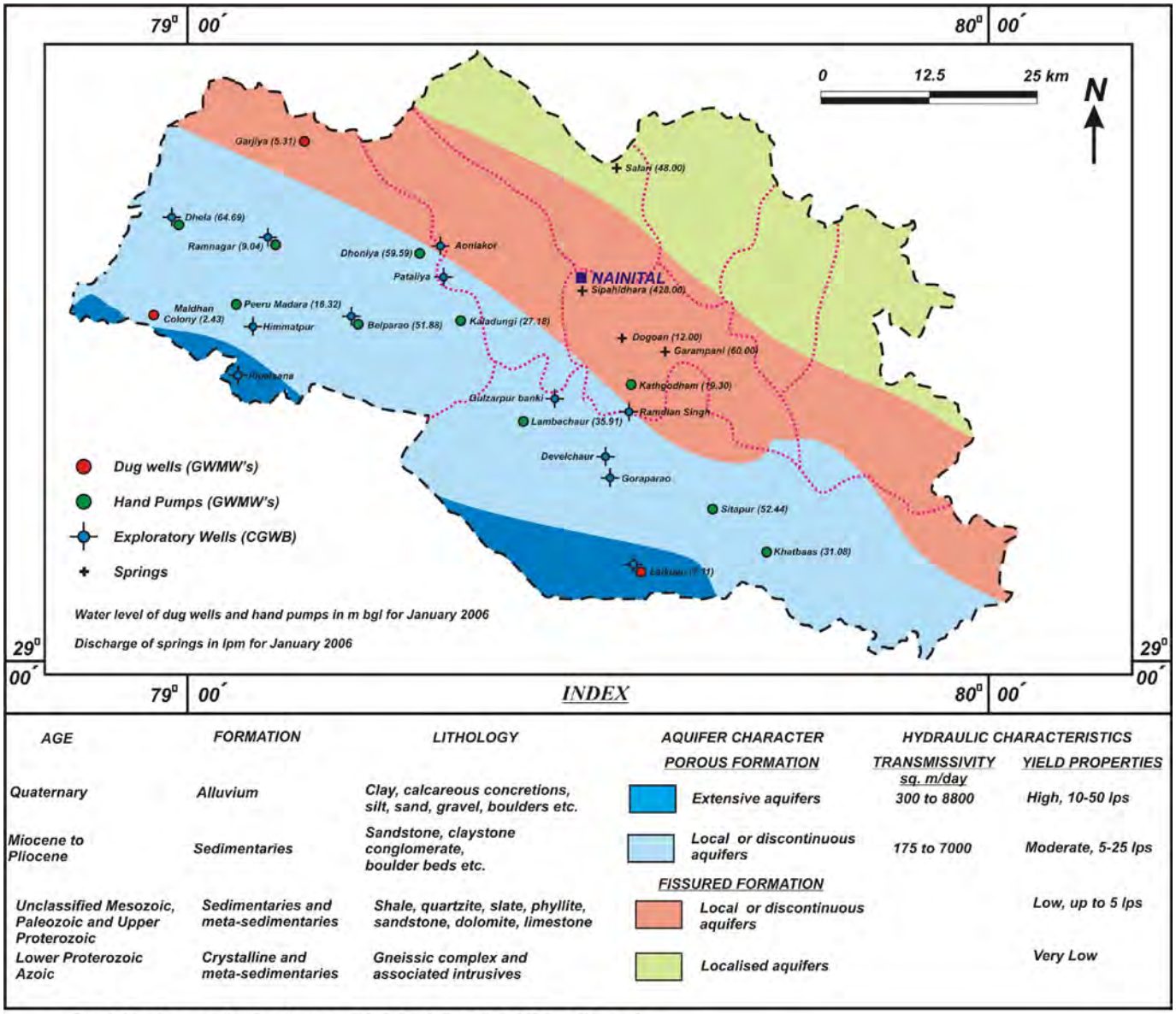


Fig. 3 Depth to water map, Nainital district, Uttarakhand



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AGE	FORMATION	LITHOLOGY	AQUIFER CHARACTER	HYDRAULIC CHARACTERISTICS	
			POROUS FORMATION	TRANSMISSIVITY sq. m/day	YIELD PROPERTIES
Quaternary	Alluvium	Clay, calcareous concretions, silt, sand, gravel, boulders etc.	Extensive aquifers	300 to 8800	High, 10-50 lps
Miocene to Pliocene	Sedimentaries	Sandstone, claystone conglomerate, boulder beds etc.	Local or discontinuous aquifers	175 to 7000	Moderate, 5-25 lps
			FISSURED FORMATION		
Unclassified Mesozoic, Paleozoic and Upper Proterozoic	Sedimentaries and meta-sedimentaries	Shale, quartzite, slate, phyllite, sandstone, dolomite, limestone	Local or discontinuous aquifers		Low, up to 5 lps
Lower Proterozoic Azoic	Crystalline and meta-sedimentaries	Gneissic complex and associated intrusives	Localised aquifers		Very Low

Fig 4. Hydrogeological map, Nainital district, Uttarakhand

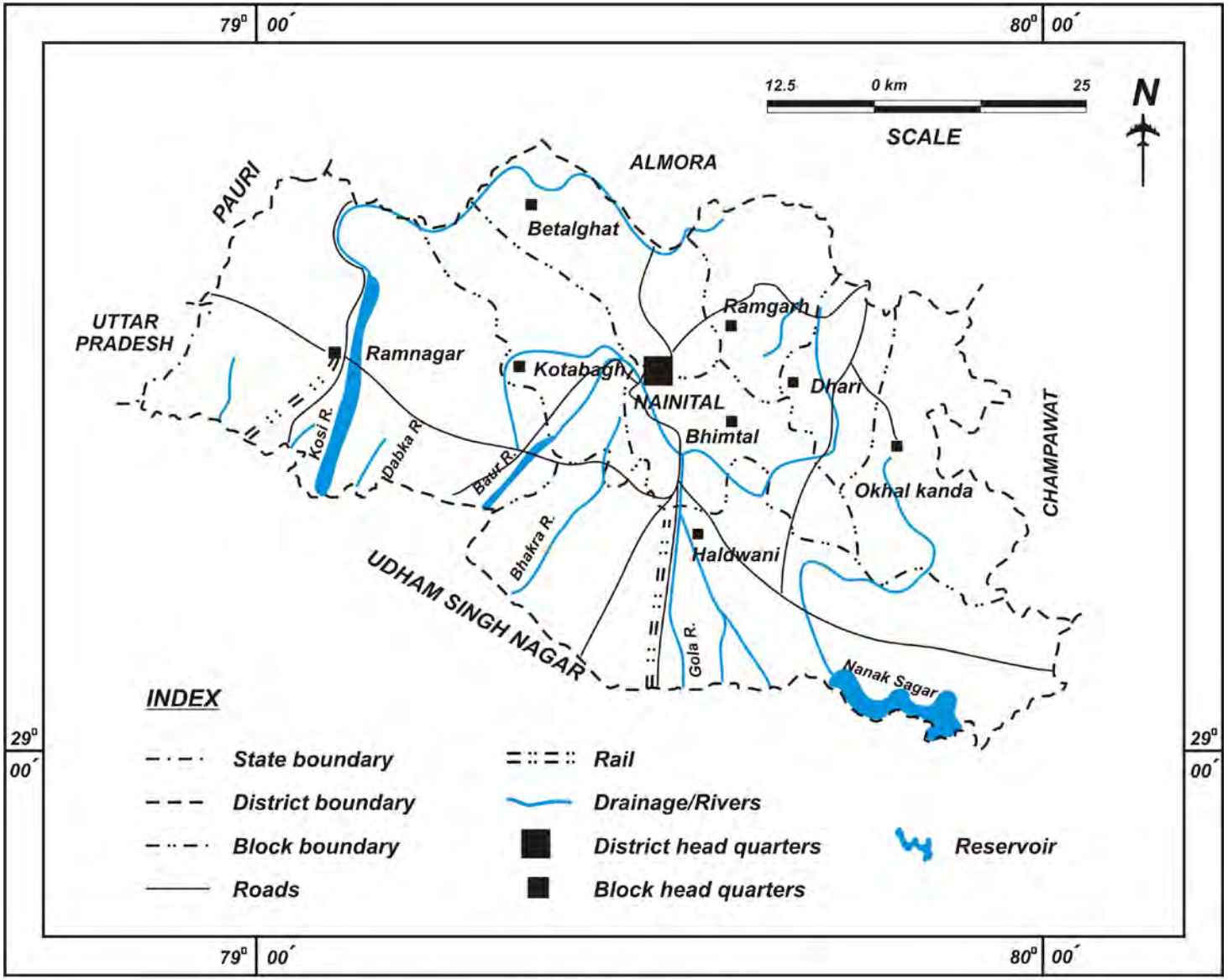

Fig 1. Administrative map, Nainital district, Uttarakhand

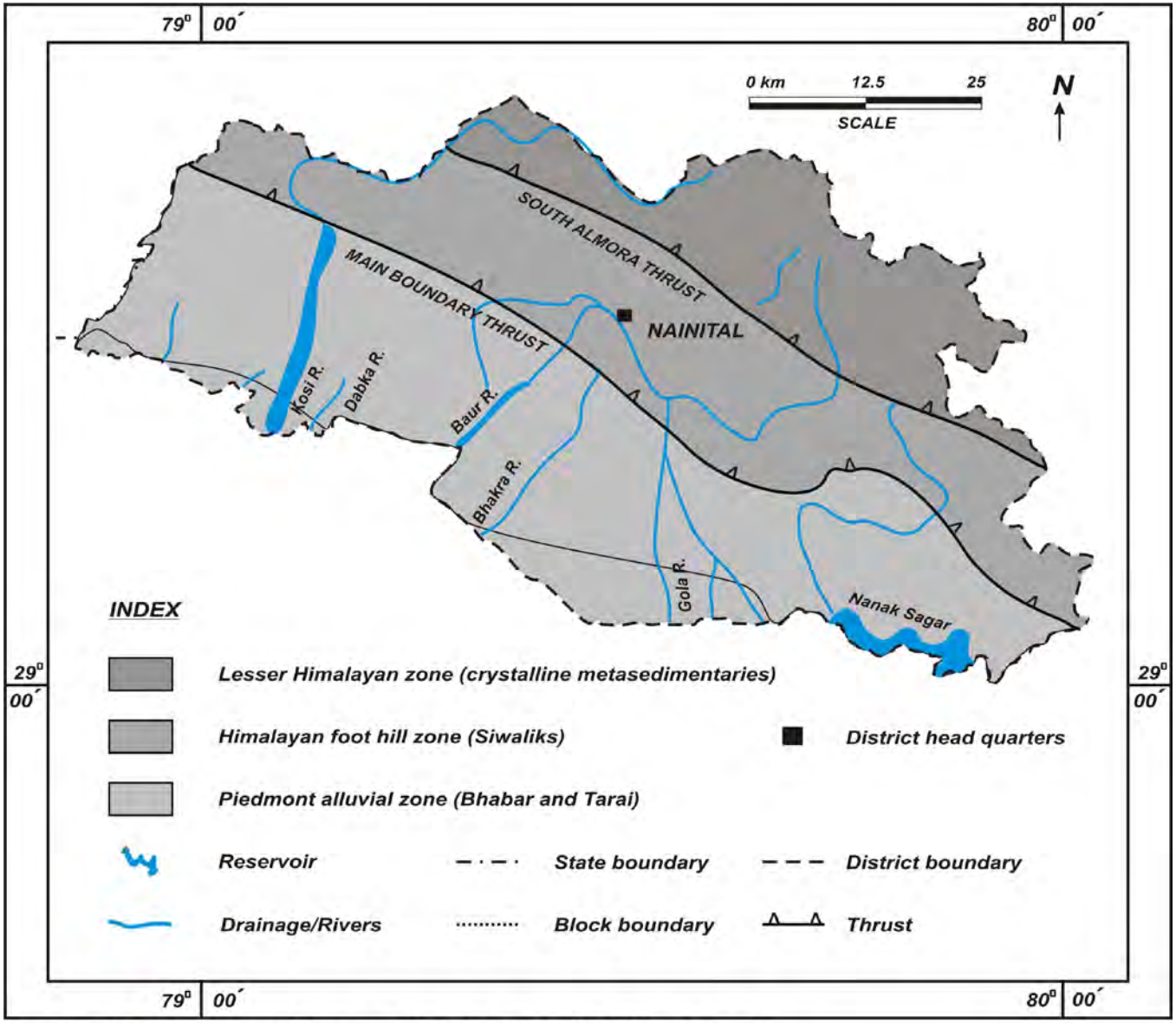

Fig 2. Physiographic map, Nainital district, Uttarakhand