Technical series:E

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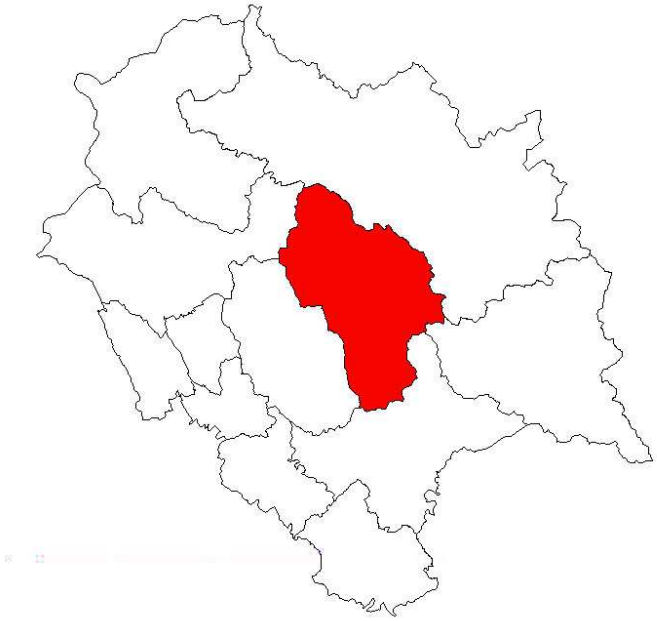
Government of India
Ministry of Water Resources
CENTRAL GROUND WATER BOARD

GROUND WATER INFORMATION BOOKLET
KULLU DISTRICT, HIMACHAL PRADESH



NORTHERN HIMALAYAN REGION
DHARMSALA
MARCH 2013

Contributors

Anukaran Kujur
Assistant Hydrogeologist

Prepared under the supervision of

Shri J.S. Sharma
Head of Office
&
DALEL SINGH
Supdt.Hyd.

Our Vision

Water security through sound groundwater management

Ground Water Information Booklet
Kullu District, Himachal Pradesh

CONTENTS

DISTRICT AT A GLANCE

KULU DISTRICT AT A GLANCE

Sl. No	*ITEMS*	*Statistics*
1.	GENERAL INFORMATION	
	i) Geographical area (sq km)	5503
	ii) Administrative Divisions (2001)	
	• Number of Tehsil & sub-tehsils	4 & 2
	• Number of CD Blocks	5
	• Number of Panchayats	204
	• Number of Villages	172
	iii) Population (2011 Census) • Total population • Population Density (pers/sq km) • Rural & Urban Population • Sex Ratio (F/M)	 4,37,903 80 3,96,512 & 41,391 942 /1000
	iv) Average Annual Rainfall (mm)	1405.7
2.	GEOMORPHOLOGY	
	Major Physiographic units	• Mountainous area • (Elevation 4200–5000m amsl) • Valley/ alluvial plain (elevation 914-2100m amsl)
	Major Drainages • Beas basin	Beas River and its Tributaries
3.	LAND USE (2008-09) (Hectare)	
	• Forest area	900
	• Total Cropped Area	64300
4.	MAJOR SOIL TYPES	• Alluvial soil • Non-calcic soil
5.	AREA UNDER PRINCIPAL CROPS (2008-09) in hectare	
	• Rice	1,443
	• Wheat	24,160
	• Maize	16,683
	• Barley	3,343
	• Pulses	2,899
6.	IRRIGATION BY DIFFERENT SOURCES(2008-09) in hectare	
	• Net area irrigated through different sources	2,553
7.	NUMBER OF GROUND WATER MONITORING WELLS OF CGWB (As on 31.3.2013)	
	• Number of Dug Wells	3
	• Number of Piezometers	Nil

8.	PREDOMINANT GEOLOGICAL FORMATIONS	• Alluvium/valley-fill (Quaternary) • Proterozoic
9.	HYDROGEOLOGY	
	Major Water Bearing Formations	
	1. *Semi consolidated & Consolidated sediments (Proterozoic)*	Covers major part as hilly terrain
	• Yield prospects	Low to moderate (1-5 lps)
	• GW structures	Springs, open wells
	2. *Unconsolidated porous sediments (River & Glacial Deposits)*	In Kulu valley & other small valleys along major rivers
	• Yield prospects	High (10-25 lps)
	• GW structures feasible	Open wells & tube wells
10	GROUND WATER EXPLORATION BY CGWB (as on 31.3.2013)	
	• No of wells drilled	9
	• Depth Range (m)	18 – 101
	• Discharge (lpm)	299 – 1079 lpm
	• Static Water Level	1.62 to 31.45 m bgl
11.	GROUND WATER QUALITY	
	Presence of Chemical constituents more than permissible limits (e.g. EC, F, As, Fe)	Nil
	Quality of Ground Water (EC Range in µS/cm)	Good (32– 805)
12.	AWARENESS AND TRAINING ACTIVITY	Nil
13.	EFFORTS OF ARTIFICIAL RECHARGE & RAINWATER HARVESTING	Nil
14.	GROUND WATER CONTROL AND REGULATION	
	• Number of OE & Critical Blocks	Nil
	• No of blocks notified	Nil
15.	MAJOR GROUND WATER PROBLEMS AND ISSUES	
	• Depletion of water table	Nil
	• Water scarcity & Deep water levels	Nil
	• Water logging	Nil

DISTRICT GROUND WATER BOOKLET
KULLU DISTRICT, HIMACHAL PRADESH

1.0 INTRODUCTION

Kullu was made a separate district on 30th July 1963 when it was a part of composite Punjab. Prior to it, it was a tehsil of district Kangra. Kullu is a sparsely populated, centrally located hilly district of the State. The district lies between $31^0$20'25" and 32^0 25'00" north latitude and 76°56'30" and $77^0$52'20" east longitude. It is bounded on the north and east by Lahul and Spiti district, on the south-east by Kinnaur district, on the south by Shimla district, on the south- west and west by Mandi district and on the north-west by Kangra district. The district has a total area of 5,503 Sq. km. As per 2001 census the Kullu district comprises of 4 Sub-Divisions, 4 tehsils and 2 sub-tehsils. The four tehsils are Kullu, Manali, Banjar and Nirmand and two sub-tehsils namely Anni, and Sainj. There are five community development blocks in the district. They are Nagar, Kullu, Banjar, Anni and Nirmand.

The district is approachable by all-weather roads, such as, National Highway No. 21 and other State Highways. Small valleys located in various parts of the district are

1. Kullu valley : - located along the Beas river
2. Lug valley :- located along Sarvary khad
3. Garsa valley :- located in the eastern part of Kullu district
4. Manikaran valley :- located along the Parvati river

District is not having any large or medium scale industrial units. However, the district is known for Tourism and Hotel units as the district is known for its rich Art and Cultural Heritage, lush green deep meadows, dazzling rivers, white-capped snowy peaks and high mountains. Some of the important places are Bijli-Mahadev, Bajaura, Nagar, Manali, Hadimba, Rohtang-Pass, Malana, Vasisht, Manikaran etc.

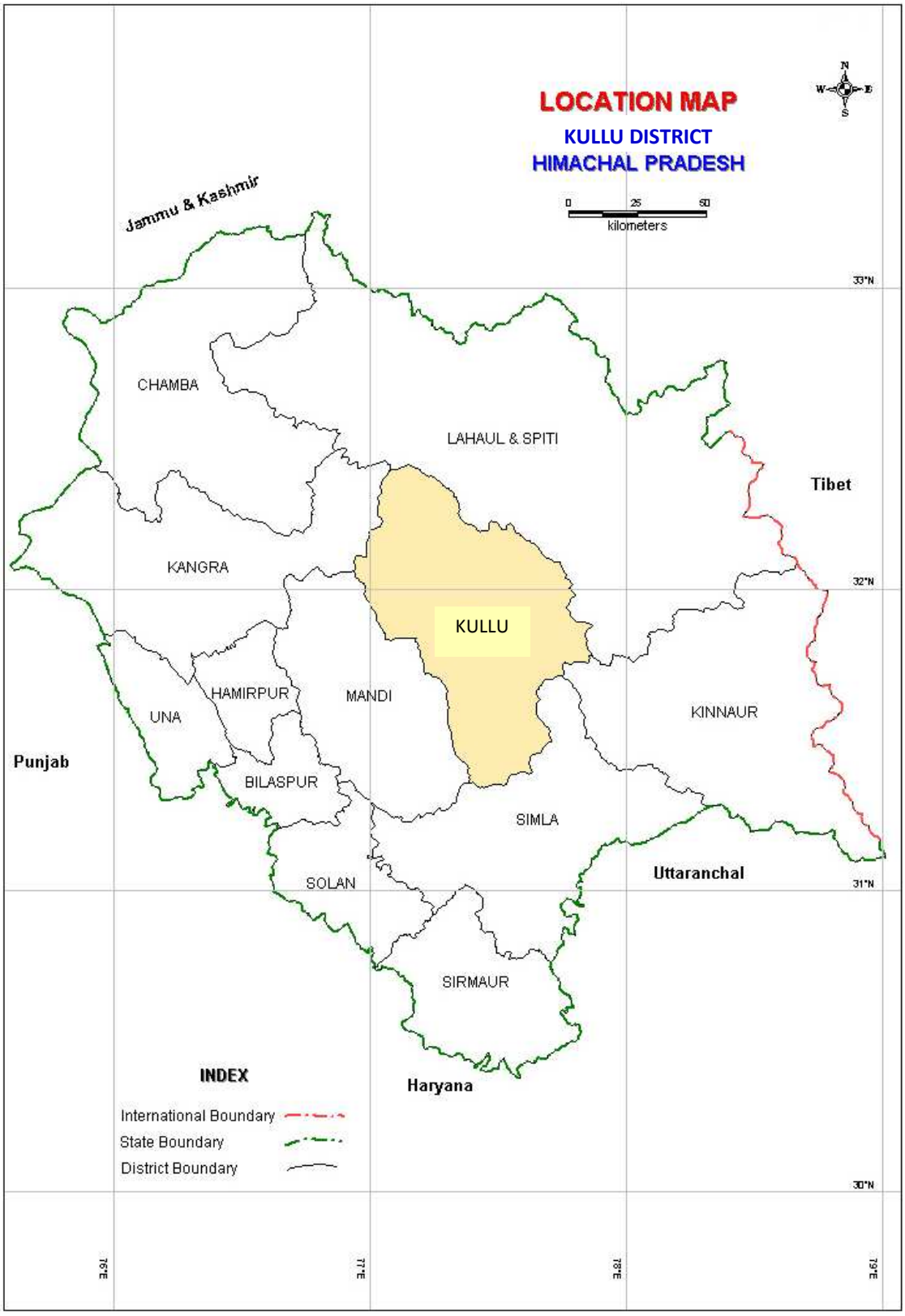

LOCATION MAP
KULLU DISTRICT
HIMACHAL PRADESH
0 25 50
kilometers
Jammu & Kashmir
CHAMBA
LAHAUL & SPITI
Tibet
KANGRA
KULLU
HAMIRPUR
MANDI
UNA
KINNAUR
Punjab
BILASPUR
SIMLA
Uttaranchal
SOLAN
SIRMAUR
Haryana
INDEX
International Boundary
State Boundary
District Boundary
33°N
32°N
31°N
30°N
76°E
77°E
78°E
79°E

Figure: 1

Hydroelectric power stations are under construction, namely Parvati project and Larji project. After the completion of these power projects the state will be in a position to earn revenue after selling electricity to the neighboring States.

In mineral wealth only slate mining is carried out for roofing materials and transported to near by districts, which earns a fair amount of money for the people of district.

As per 2011 census, total population of the district is 4,37,903 persons with a sex ratio of 942 females per 1000 males.

Central Ground Water Board under Exploratory Drilling Programme has drilled nine wells including observation wells up to March 2013 to know the sub-surface geology and aquifer parameters. State Government has also drilled shallow hand pumps in valley areas. For monitoring ground water levels and chemical quality in Kullu valley, the CGWB has established 3 observation wells.

2.0 CLIMATE & RAINFALL

Climate of the district is cool and dry and the year unfolds three broad seasons viz. cold season from October to February, hot season from March to June and rainy season from July to September. Snowfall generally occurs in December and January at higher elevations and most of the areas are cut off from the district headquarter since the mountain passes are closed. The district receives moderate rainfall and bulk of it is generally received during June to September and January-February. August is the wettest month through out the district. The average annual rainfall of the district is 1405.7 mm, out of which 57% occurs during June to September.

3.0 GEOMORPHOLOGY & SOILS

Geomorphology of the area plays an important role in deciphering the sub-surface and surface hydrogeological conditions. On the basis of hydro geomorphological and geological set up, the study area can be divided into the following geomorphic units.

I) Mountainous area- Dhauladhar and Pir-Panjal ranges trend NW-SE and peaks ranging in height between 4200-5000m above mean sea level.

II) Snow covered area- Northern and northeastern parts of Kullu district are covered with snow and snow line exists in this area.

III) Denuded hills- The presence of residual ridges along the intermontane valleys suggest that these ridges are the remnants of high relief mountains and formed active erosion.

IV) Valley area - Fluvial processes and structural disturbances in the area form intermontane valleys. Kullu valley is elongated and broadly v-shaped in cross-section and denuded hills along the sides.

V) Terrace area- Number of terraces are formed along the river valleys in Kullu district. Terraces are generally noticed on the western bank of the Beas River. Two levels of terraces are demarcated near Bhunter, which are covered with thick vegetation.

The elevation of Kullu district ranges from 914m to 4084m above mean sea level with varied agro-climatic conditions. The texture of soil ranges from sandy loam to clay loam and the colour of the soil also vary from brown to dark brown. Generally the soil is acidic in nature. Depth of the soil varies from 50 to 100 cms. But despite this, all the agro climatic conditions provide a range of potentialities for growing cash crops like, off season vegetables, seed potatoes, pulses and temperate fruits.

4.0 Drainage

The river Beas and its tributaries mainly drain more than 80% of the district. This river originates in the Pir-Panjal range near Rohtang, at an elevation of about 4000m and is joined by number of tributaries viz. Parbati, Hurla, Sainj etc. All the tributaries are perennial in nature.

The Beas river flow towards south-southwest direction under steep gradient up to Larji and thereafter, it becomes gentler. Besides Beas, Sutlej river forms a boarder between Shimla and Kullu district and flows in south easterly direction. Both the rivers are flowing in their youth stages as indicated by ‘V’ shaped river profile and deeper river channels.

The Beas river maintains a longitudinal and consequent relationship in its upper course and after Larji it takes a knee-bend type turn towards west. The river is joined by subsequent rivers i.e. Parbati, Hurla, Sainj on its left and right banks. Several streams on their southern side in Kullu district join these subsequent rivers.

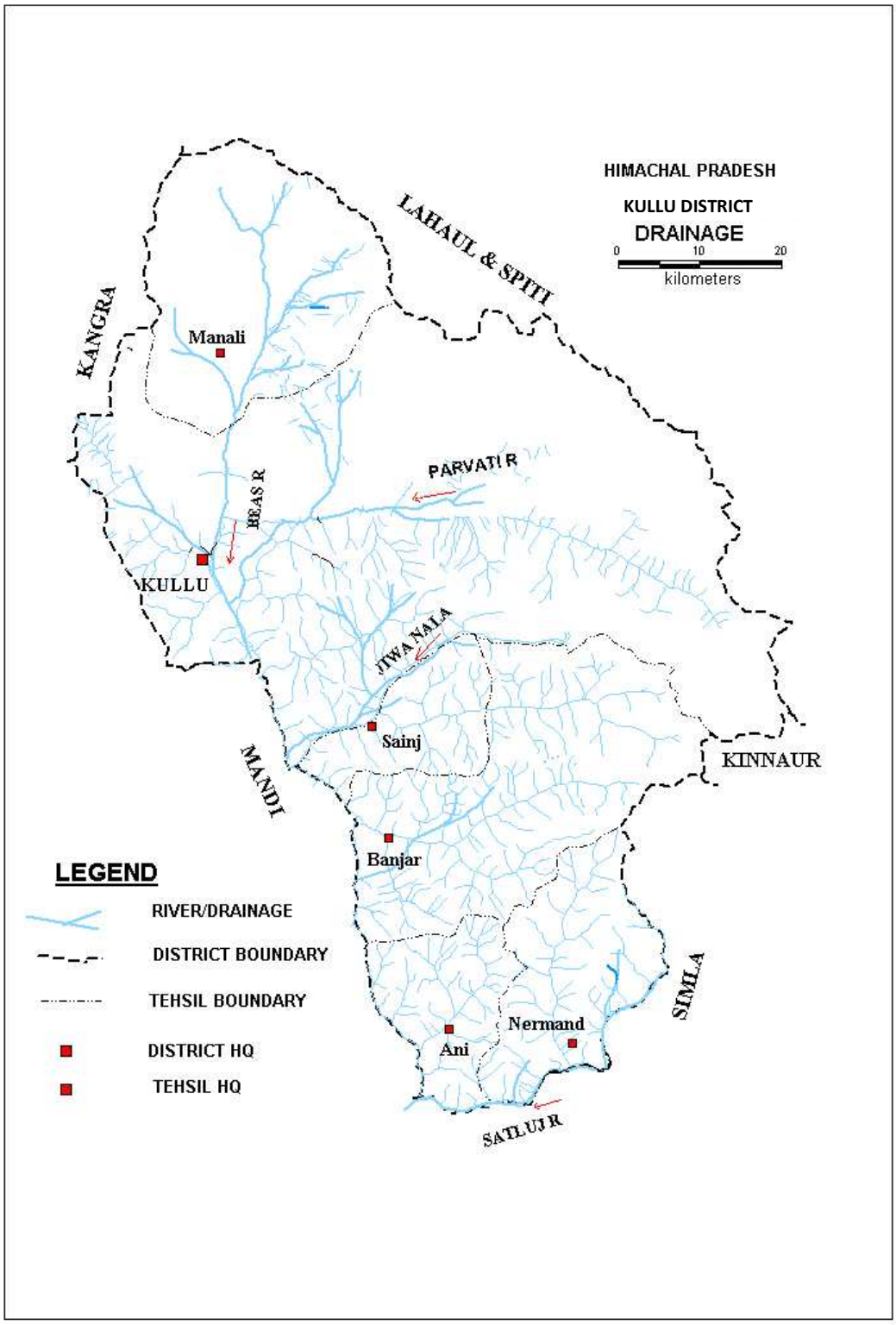

HIMACHAL PRADESH
KULLU DISTRICT
DRAINAGE
0 10 20
kilometers
LAHAUL & SPITI
KANGRA
Manali
PARVATI R
BEAS R
KULLU
JIWA NALA
Sainj
KINNAUR
MANDI
Banjar
SIMLA
Nermand
Ani
SATLUJ R
LEGEND
RIVER/DRAINAGE
DISTRICT BOUNDARY
TEHSIL BOUNDARY
DISTRICT HQ
TEHSIL HQ

Figure: 2

5.0 GROUND WATER SCENARIO

5.1 Hydrogeology

Broadly, the following geological sequence, which includes rocks of Precambrian to Quaternary age, is noticed in the district.

Geological succession in Kullu district

ERA	*PERIOD*	*FORMATION*	*DESCRIPTION*
Quaternary	Recent to sub-Recent	Alluvium; fluvial, terrace, piedmont	Sand, silt, clay, boulders, pebble and cobble etc.
Proterozoic	Neoproterozoic	Batal formation	Dark gray carbonaceous slates and phyllites with quartzites
		Chamba formation	Slate, phyllites, siltstones and Greywacke
	Mesoproterozoic	Kullu Group	Slate, Phyllites , Quartzites and Schist
	Precambrian	Largi formation	Slate, Phyllites and Quartzite with dolomites and conglomerates
		Vaikrita Group	Slate, Phyllites and Quartzites
		Granite & Gneiss	Granite, schist and gneisses

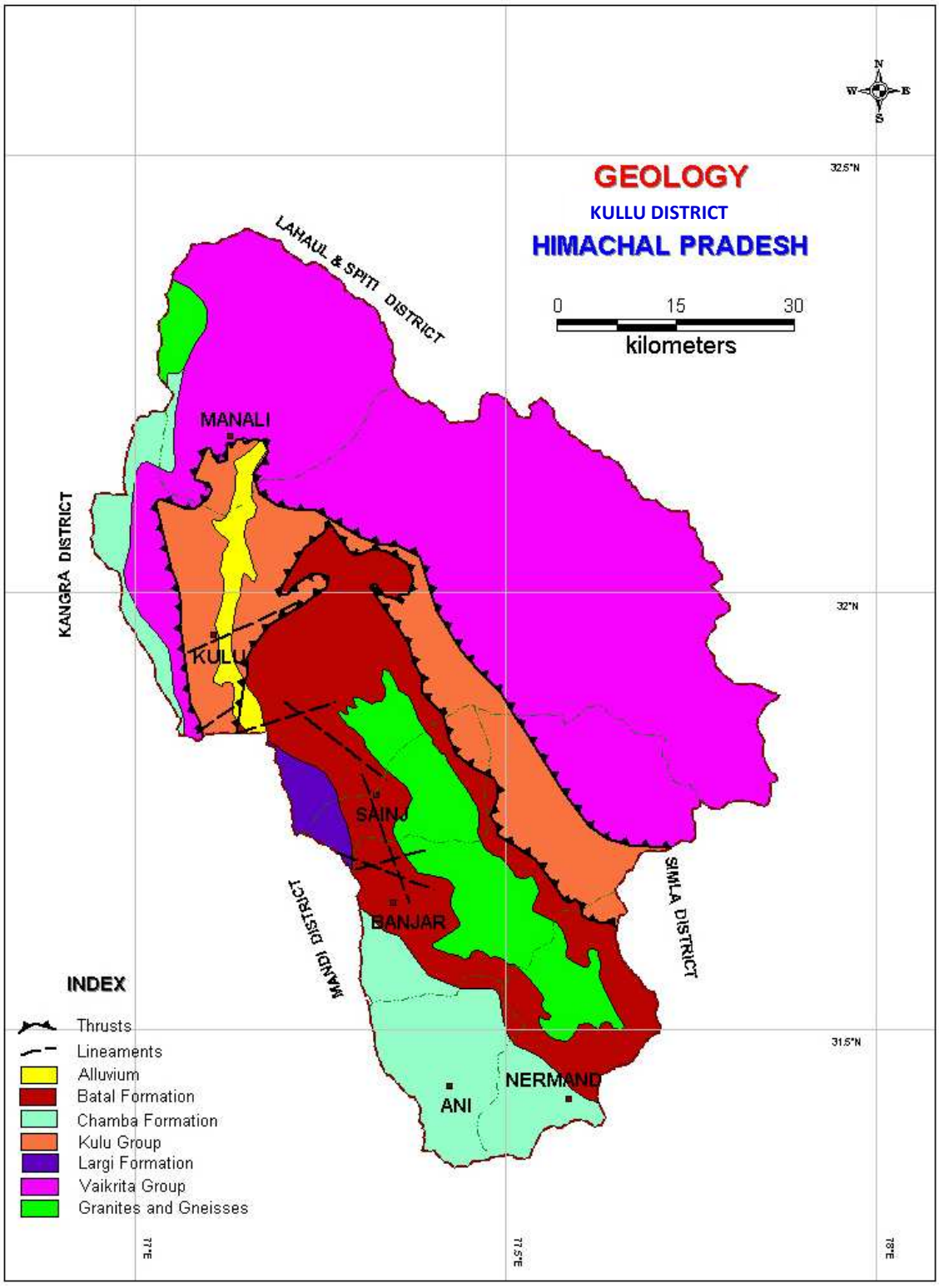


Figure: 3

Hydro geologically the entire area of Kullu district can be divided into porous and fissured formations. Porous formation includes the unconsolidated sediments. These sediments include fluvial channel

deposits, valley fill deposits, terrace deposits and alluvial fans. These sediments form the potential aquifers. Unconsolidated sediments underlie Kullu valley, Garsa valley, Manikaran valley, Lag valley and longitudinal valley all along the major rivers and khads.

Fissured formation includes the semi-consolidated to consolidated sediments exposed in the district and are of sedimentary, metamorphic and igneous in origin. These form low to high hill ranges throughout the district.

In Kullu valley, ground water generally occurs under confined to semi-confined conditions. Phreatic aquifers are tapped mainly by open wells and form major source of domestic and irrigation water supply in the valley area. The aquifer zone mainly comprises of sand and silt in association with pebbles and boulders in low plains and predominantly boulders, cobbles, pebbles mixed with little clay in terraces. Static water level varies from 1.62m to 31.45m below ground level.

Central Ground Water Board has drilled 9 wells including observation wells in the district to know the aquifer parameters and sub-surface geology. The discharge of these wells varies from 299 lpm to 1079 lpm.

The source of major water supply schemes are based on springs in the district. The discharge of the springs varies from 0.5 lps to 25 lps. Majority of the springs are gravity springs. In gravity springs, the most common are the contact springs, which are formed by permeable water bearing formations overlying less permeable formations the contact of these formations intersects the ground surface.

There are lots of hot springs in Kullu and Parbati valleys. Along Beas river valley hot springs vary in temperature from 29^0C to 59^0C and in Parbati river valley the thermal springs vary in temperature from 35^0C to 96^0C. In Beas river valley, all the rocks belong to Pre-Cambrian age and are represented by gneisses, phylites, quartzite and limestones. A major fault extending in north- south direction from Bashist to Katrain for a distance of 25 kms, appears to control the emergence of thermal activity.

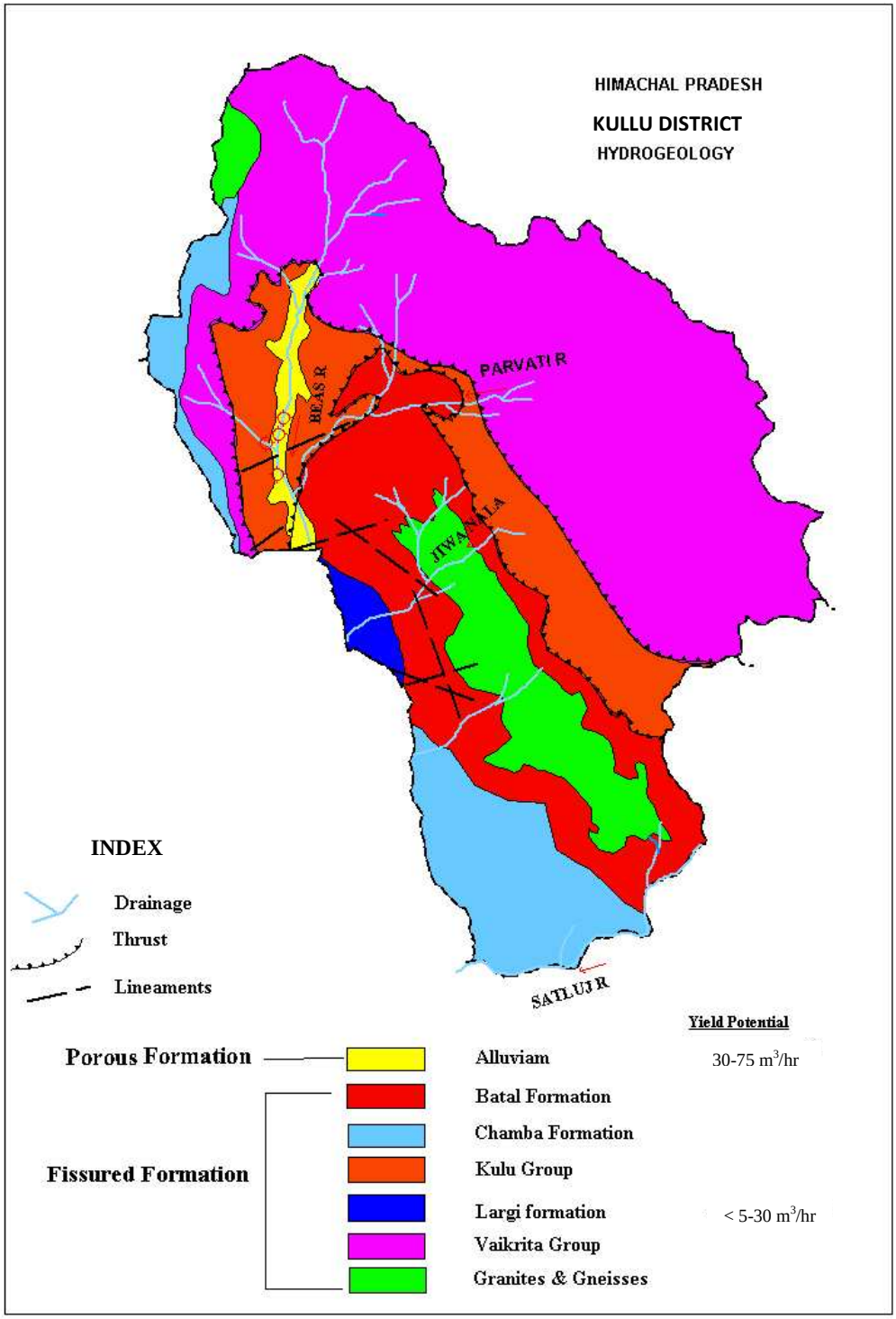


Figure: 4

Thermal springs are non-existent along the thrust zone. Geo- thermal activity is confined to valley-fill on either side of the valley-fill, except at Basisht located close to gneissic rocks.

In Parbati river valley, crystalline rocks of early to middle proterozoic age are thrust over younger middle proterozoic rocks. Thermal springs at Jan, Kasol and Manikaran emerge through quartzites at Balargarh through carbonaceous phillites/limestones, at Pulga through quartz-mica schists/gneisses and granite. Maximum temperature of 96^0 C is recorded at Manikaran.

5.2 Ground Water Resources

Ground water resources and irrigation potential for Kullu valley of the district has not been computed as per the GEC-97 methodology due to hilly terrain and localized aquifers. Snow fall in the higher reaches and rain fall in the lower areas, recharge the ground water. Springs are the other main sources for the irrigation and water supply schemes.

5.3 Ground Water Quality

Water samples collected from shallow as well as deep aquifers and springs for chemical analysis indicate that the chemical parameters are within the permissible limit of safe drinking water set by Bureau of Indian Standard (BIS), except hot water springs. All the parameters of hot water springs are more than permissible limit and not fit for drinking purposes.

Chemical results of 2012

S. No.	*Parameter*	*Range (spring/ dug wells)*		*Range (Hot spring)*	
		Min	*Max*	*Min*	*Max*
1.	pH	7.69	8.65	8.05	8.21
2.	EC µS/cm	34	1040	560	2400
3.	HCO_3 (mg/l)	21	350	171	720
4.	Cl (mg/l)	3.5	202	96	561
5.	F(mg/l)	0.10	0.79	.88	8.20
6.	Ca(mg/l)	6	156	10	46
7.	Mg(mg/l)	0.75	34	1.2	4.2
8.	Na(mg/l)	0.4	134	70	600
9.	K(mg/l)	0.1	48	13	41
10.	TH as CaCO3(mg/l)	18	530	30	133

The overall quality of ground water is potable and safe for drinking purpose except hot water springs.

5.4 Status of Ground Water Development

In Kullu valley, ground water occurs under water-table to semi-confined conditions. Phreatic aquifers are tapped mainly by open wells and form the major source of domestic and irrigation water supply in the valley. The aquifer zone mainly comprises of sand in association with pebbles and boulders in low plains and predominantly boulders, cobbles, pebbles mixed with little clay in terraces. Depth to water level varies from 1.62m to 31.45 m below ground level.

State Ground Water Organization has constructed shallow hand pumps down to a depth of 30 to 50m. bgl. Some of them have been energized for water supply schemes. Most of the hand pumps are along the Beas and other tributaries of the valley.

Under exploration work in Kullu valley, seven exploratory and two observation wells have been drilled with a depth ranging from 18m to 101m. The discharge of these wells varies from 299 lpm to 1079 lpm depending upon the lithology encountered in the area. In Sangribag hot-water artesian spring (34^0C) with a discharge of more than 5 lps encountered. To identify the contact of fresh and hot water spring another bore hole was drilled down to a depth of 21.00m. The ground water is fresh and potable.

6.0 GROUND WATER MANAGEMENT STRATEGY

6.1 Ground Water Development

Kullu valley is partly explored and only shallow aquifers are tapped for water supply schemes. All these wells are drilled all along the Beas river and its tributaries in the district. There is a lot of scope for the future ground water development in the district.

In Kullu valley, ground water occurs under water-table to semi-confined conditions. The aquifer zone mainly comprises of sand and fine silt in association with pebbles and boulders in low plains and predominantly boulders, cobbles, pebbles mixed with little clay in terraces.

Fissured formation includes the semi-consolidated to consolidated sediments exposed in the district and are of sedimentary, metamorphic and igneous in origin.

Metamorphic and igneous rocks exposed in northeastern parts of the district include quartzites, gneisses, phyllites slates and dolomites.

Phyllites interlayer with thin quartzite bands and slates with dolomites form the exposed metamorphic rocks. Springs are reported to exist in the low topography areas along the lineaments and contact of various formations.

Most of the part of Kullu district having Metamorphic and Igneous rocks (consolidated and semi-consolidated) have not been explored due to mountainous terrain and difficulty in approachability as such, their yield potentials are unknown.

6.2 Water Conservation and Artificial Recharge

Average annual rainfall of the district is 1,405.7 mm, out of which 57% occurs during June to Sept. Due to hilly terrain most of the rainfall goes as runoff and a very small quantity enters as ground water. The ground water condition becomes particularly severe in hard rock formations, where scope for recharging the aquifer is low. Only the area, sufficiently traversed by faults/joints/weak zones/ weathered zones get recharged during the monsoon period. Due to high relief, most of the surface water goes as runoff, and hence, there exists a scope for recharging such aquifers.

Taking into consideration the physiography of the area, the following methods for artificial recharge are suggested.

Gabion Structure: - In hard rock areas, marked with fractures/weak zones; such less costly structures can be useful for recharging the surface water.

Contour Bunding: - This practice can be followed efficiently in hilly terrain, tapping the stream water. Here, the ditches are excavated following the ground surface contour of the area.

Subsurface dykes: - These types of structures are very useful in arresting the sub-surface flow in a stream and store the water below ground surface, to meet the demands during the period of needs.

Check dams: - Check dams can be constructed across small streams, having gentle slope and are feasible both i.e. hard rock areas as well as alluvial formations. The design of the structure is based on the characteristics of the stream course.

Recharge Shafts: -These are most efficient and cost effective structures to recharge the aquifer directly. In the areas, where source of water is intermittent or perennial e.g. base flow, springs etc., the recharge shaft can be constructed.

Roof top rain water harvesting: - During the monsoon period , the rain water from roof tops can be collected and put into recharge structure for recharging the shallow aquifer. This will help in raising the water level in the area, to some extent. The water can also be used for domestic purposes by collecting it into tanks.

7.0 GROUND WATER RELATED ISSUES & PROBLEMS

In Kullu district, major water supply schemes are based on springs and surface water. The excess of silt in major rivers, create problems for water supply schemes. Ground water in Kullu district has not been explored fully for its development. Kullu valley, located along the Beas river, Lag valley-located along Sarvary khad, Garsa valley-located in the eastern part of Kullu district, Manikaran valley- located along Parbati River and small valleys in Sainj, Banjar, Ani can be explored for the development of ground water for round the year and fresh water supplies to the public and for irrigation purpose.

8.0 AWARENESS AND TRAINING ACTIVITY

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

Central Ground Water Board has not conducted any Mass Awareness and Training Programme in the district on Water Management and Rainwater Harvesting.

9.0 AREAS NOTIFIED BY CGWA / SGWA

The stage of ground water development in Kullu district has not been calculated. Hence, no area or block in the district has been notified from the groundwater development point of view.

10.0 RECOMMENDATIONS

- Ground water development in the district, has not been fully explored and falls in *safe category*, Hence, there is a scope for developing the ground water resource in the district.

- Groundwater development by constructing shallow and deep boreholes can be carried out, in the valleys and the river terraces.

- Rooftop rainwater harvesting structures are mandatory in municipal areas, but there is a need to create awareness about these structures in rural areas also as well.

- Traditional resources like springs and *bowries* need to be revived, developed and protected for future use. Public participation in water resource management should be encouraged.

*****

For Technical Assistance Relating to Rainwater Harvesting & Artificial Recharge to Ground Water

Contact:

CENTRAL GROUND WATER BOARD
NORTHERN HIMALAYAN REGION
Dove Cottage, Near Ram Nagar Post Office, Dharamshala (H.P)

Phone: 01892- 227160
Telefax: 01892-223535

e-mail: rdnhr-cgwb@nic.in
tsnhr-cgwb@nic.in

SAVE WATER SERVE HUMANITY