DYNAMIC GROUND WATER RESOURCES OF HIMACHAL PRADESH (March 2020)

MINISTRY OF JAL SHAKTI
DEPARTMEMT OF WATER RESOURCES, RIVER DEVELOPMENT & GANGA REJUVENATION
CENTRAL GROUND WATER BOARD
NORTHERN HIMALAYAN REGION
DHARAMSALA (H.P.)

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GROUND WATER ORGANISATION
JAL SHAKTI VIBHAG
UNA (H.P.)

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A Report by:

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Secretary

हिमाचल प्रदेश सरकार

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FOREWORD

Ground water is a major source of water in India & globally. In India, more than 85 % of water supplies for domestic use in rural area, 50% of water for urban areas and 55% of irrigation water requirement are being met through ground water. In Himachal Pradesh, situation is little different. Most of the drinking water schemes and irrigation schemes are based on spring sources and river water in hilly areas and tubewells and dugwells in valley areas of Himachal Pradesh. However ground water remains an important source of water for Himachal as it forms critical part of overall aquatic system.

Ground water resources, although replenishable, but are not inexhaustible. The increasing demand on this resource over the years has led to water scarcity in many parts of the world. During the past two decades, the water level in many parts of the county has been falling rapidly due to increase in extraction & resulted into over-exploitation of this resource. There is a continuous growth in demand, especially in critical and over-exploited regions of the country. In the state of Himachal Pradesh, story is a little different. All of the ten valleys assessed for Dynamic Ground Water Resource in Himachal Pradesh statefall under Safe category. It is time to stimulate investigations oriented towards quantitative and qualitative assessment of groundwater which is basic to formulation of plans for its exploitation, management & conservation.

The joint study conducted by Central Ground Water Board & Ground Water Organization under Jal Shakti Vibhag, Una is aimed at having database of ground water resources of the state, and would prove to be helpful for future planning under groundwater domain. Being a hilly state, only 6.2 percent of its total area that comprises of intermountain valleys is used for groundwater resource development. This area is very small compared to adjacent states and needs scientific inputs from all geoscientists for its sustainable management and smooth development in state. Himachal Pradesh Government is very keen to improve its water resources; as a result the state has implemented National Hydrology Project and formulated Himachal Pradesh Ground Water (Regulation and control of development and management.) Act 2005.

This study will be very helpful and supportive for water management, conservation and sustainable development of this precious resource for all the user agencies in the state.

(Vikas Labroo),IAS
Secretary (JSV)

PREFACE

The efficient management and development of ground water resources is dependent on a reliable database on ground water resources. Estimation of ground water resource on the administrative basis as recommended in GEC-15 is not applicable to the state of Himachal Pradesh, as the terrain is hilly with intermountain valleys. Keeping this in view, the resource estimation has been carried out for the major valleys onlybased on watershed. During the Ground Water Resource Estimation 2017 the estimation was made for eight valleys. In the present report also ten major valleys are taken for assessment.

This report presents the ground water resources database prepared on the basis of rainfall and water level fluctuation from year the 2009 to 2019, whereas ground water draft data was taken as on March 2020. The report is a valley wise compilation of annual replenishable ground water resources, natural losses, available ground water resources, gross ground water draft, allocation for domestic and industrial uses, balance ground water resource for domestic use and thus the stage of development was arrived at, based on watershed area having slope less than 20%.

In all the ten valley areas assessed, stage of ground water development of five valleys is <70. The overall stage of ground water development in the state of Himachal Pradesh is 36.25%. The report specifies that at present there is sufficient scope for future development of ground water resources in Himachal Pradesh.

The report is the outcome of efforts made by all the hydrogeologists and other officers of Ground Water Organisation under overall supervision of Shri Bhavnesh Shamra, Senior Hydrogeologist, Jal Shakti Vibhag, Govt. of Himachal Pradesh. The efforts made by Sh. Vipin Kumar, Scientist 'B' and all others officers of Central Ground Water Board, Northern Himalayan Region in bringing out this report are highly appreciated.

This report contains very useful data for all planners and user agencies dealing with the development of ground water resources and it is hoped that it would be utilized fully for real time management of ground water resources.

(J.N. Bhagat)
Regional Director (i/c)

CHAPTER 1
INTRODUCTION

I. BACKGROUND FOR RE-ESTIMATING THE GROUND WATER RESOURCES OF THE STATE:

The first attempt to estimate the ground water resources of the country was made in the year 1979. The committee known as 'Ground Water Over-exploitation committee' was constituted by the Agriculture Refinance and Development Corporation (ARDC) of Govt. of India. Based on the methodology and norms recommended by the above committee, the ground water resources were assessed. Subsequently, the necessity was felt to refine the methodologies and the "Ground Water Estimation Committee (GEC)" headed by the Chairman, CGWB came into existence. Based on the detailed surveys and the studies by the various offices and projects of CGWB, the committee recommended the revised methodology in 1984 (GEC-84) for estimation of ground water resources and the resources of the state was estimated accordingly. In 1997, the Ground Water Estimation Committee reviewed the previous studies and work done in various states and suggested a modified methodology in 1997 (GEC-97) for computation of groundwater resources. The need to revise the GEC was felt again with changing groundwater use pattern. The revised and latest methodology GEC 2015 recommends aquifer wise ground water resource assessment. Ground water resources have two components – Replenishable ground water resources or Dynamic ground water resources and In-storage resources or Static resources. GEC 2015 recommends estimation of Replenishable and in-storage ground water resources for both unconfined and confined aquifers. Wherever the aquifer geometry has not been firmly established for the unconfined aquifer, the in-storage ground water resources have to be assessed in the alluvial areas up to the depth of bed rock or 300m whichever is less. In case of hard rock aquifers, the depth of assessment would be limited to 100m

Most of the area of Himachal Pradesh is hilly having slopes more than 20% and underlain by hard rocks except a few small intermountain valleys. These valleys are underlain by alluvium, fluvial and fluvio-glacial deposits. The groundwater resources for Himachal Pradesh are therefore calculated only for these valleys. Administrative map, base map along with assessment unit demarcation is given in **Plate 1.**

II. CONSTITUTION OF STATE-LEVEL COMMITTEE FOR GROUND WATER RESOURCES ESTIMATION

The State Level Committee for Ground Water Resource Estimation has been constituted vide Government of Himachal Pradesh Notification No.IPH-B(A)3-1/2019 dated 17th December 2020 **(Annexure-I).** The Secretary, Jal Shakti Vibhag, Govt. of Himachal Pradesh is the Chairman of this committee. List of the committee members are as follows:

1.	Principal Secretary, JSV	Chairman
2.	Engineer-in Chief, JSV	Member
3.	Director Industries	Member
4.	Director Urban Development	Member
5.	Director, Agriculture	Member
6.	Director, RD	Member
7.	All Chief Engineers, JSV	Member
8.	Superintending Engineer (Hydrology) , JSV	Member
9.	Superintending Engineer (GSWSSC) , JSV	Member
10.	Superintending Engineer (P&I) II, JSV	Member
11.	Nominee from H.P. Water Management Board	Member
12.	The Chief General Manager, NABARD	Member
13.	Sr. Hydrogeologist, GWO, Una	Member
14.	Regional Director, CGWB	Member Secretary

III. BRIEF OUTLINE OF THE PROCEEDINGS OF THE RESOURCES ESTIMATION INCLUDING OUTCOME OF VARIOUS MEETINGS

The State Level Committee for Ground Water Resource Estimation has been constituted vide Government of Himachal Pradesh Notification No.IPH-B(A)3-1/2019 dated 17th December 2020, The Member Secretary of the committee requested input data for various variable for computation of ground water resources on 10.12.2020. Subsequently, the data was received under letter No. JSV-GWO- Resource Estimation/2020-21:2606 dated 01.03.2021 from GWO office, Una. **(ANNEXURE-A-2)**

For the first time all the computations were done online through IN-GRES portal which has been jointly developed by Central ground Water Board and IIT Hyderabad. All the data variables were fed into the IN-GRES portal and valley-wise assessment has been carried out.

CHAPTER 2

HYDROGEOLOGICAL CONDITION OF HIMACHAL PRADESH

DESCRIPTION OF ROCK TYPES WITH AREA COVERAGE

The area of Himachal Pradesh can be subdivided into following four stratigraphical zones and valley areas.

I. Outer Himalayan Zone

This zone is also known as the Siwalik hill ranges predominantly of low lying hills extending from NW to SE. The Siwalik are further sub-divided into upper. Middle and Lower. The Eocenes are represented by Kasauli, Dagshai and some other formations. The Siwaliks are separated from Eocenes by the Main Boundary Thrust.

II. Lower Himalayan Zone

This lies between main boundary thrust and central Himalayan thrust. This is composed of granites and other sediments of Krol belt.

III. Higher Himalayan Zone

This occupies the eastern part of the state covering Southern part of the Spiti region. The granites and granites-gneisses are well out cropped intermittently within the metamorphics of Spiti region and along Satluj river. This region is highly disturbed by tectonic activity.

IV. Tethys Himalayan Zone

Towards the north of higher Himalayan zone in Spiti valley, a nearly complete sequence of fossiliferous Paleozoic strata is exposed.

V. Valley areas

In addition to above zones, valleys fill deposits occur within the older formations. Valley fills mainly constitute boulders, cobbles, pebbles, gravels, sands interbedded with clays and sometimes associated with moronic deposits. Valley fills in the state whereas major moraine deposits occur in Kangra, Palampur, Lahaul and Spiti districts. The recent morainic formations occur in higher elevations.

Ten major valleys of Himachal Pradesh have been assessed as compared to eight valleys in previous assessment. The details of the valleys are as below:

Sr No	Assessment Unit	District	Area of Assessment unit (Sq Km.)
1	Nurpur-Indora Valley	Kangra	1024
2	Dharamshala-Palampur Valley	Kangra	452
3	Balh Valley	Mandi	107
4	Chauntra Valley	Mandi	52
5	Paonta Valley	Sirmour	276
6	Kala Amb Valley	Sirmour	82
7	Nalagarh Valley	Solan	336
8	Una Valley (Satluj Catchment)	Una	1045
9	Una Valley (Beas Catchment)	Una	65
10	Hum Valley	Una	29
	Total Area		3468

The number and area of old assessment units has been revised compared to previous study. In the present assessment study, boundaries of all the assessment units have been drawn using Digital Elevation profile data acquired through Shuttle Radar Topography Mission (SRTM) satellite data having 30m resolution and the boundaries of assessment units have been taken considering slopes worked out using SRTM data, hydrogeological & watershed boundaries, lithological boundaries of the assessment unit areas taken from Groundwater Prospect Maps, prepared by NRSA, Deptt. of Space, Govt. of India, using GIS software. Accordingly the slope map created for the present study is attached as Annexure-C & Aquifer wise detail of assessment units is shown in Annexure-II A 1 Page 6. Hydrogeological formation wise maps of assessment units are shown in Annexure-E to Annexure-M **under Annexure II A-1.**

HYDROMETEOROLOGY

I. Climate

In Himachal Pradesh, climatic conditions are highly diversified due to variation in elevation (450 – 6500m). In general the climate of this area is distinct from the Punjab plains due to shorter and less severe summer, higher precipitation and colder and more prolonged winter. The two main climatic characteristics of the region are the seasonal rhythm of weather and the vertical zoning. The climatic conditions vary from hot sub-humid tropical in the southern low tracts to temperate, cold alpine and glacial in the northern and eastern high mountains. Lahaul and Spiti experience drier conditions as they are almost cut off by the high mountain ranges.

Popularly the year is divided into three seasons. These are monsoon season (June-September), winter season (October to February) and summer season (March to May). In the Himachal Pradesh, there is much diversity in climatic condition due to variation in elevation (450-6,500m amsl). In general, the various climatic zones ranges from sub-tropical (450-900 m amsl) to warm temperate.

II. Rainfall

Generally rainfall increases from south to north. Beyond Kulu, the rainfall again decreases due to rain-shadow effect towards Lahaul & Spiti and Kinnaur. Spiti is the driest (below 50 cm). About 70% of annual rainfall is received during June to September, 20% from October to March and 10% from April to May. In Lahaul and Spiti, winter and spring precipitation is greater than the summer and the autumn. Pre monsoon showers occur in June and Post monsoon showers continue till the first week of October but the total amount of both is low. Highest normal monthly rainfall may take place in July or August. Dharamsala gets maximum (1055.3mm) in July while Dalhousie (620mm) in August. Dharamsala receives the Maximum rainfall (3200mm). Simla and Nurpur falls in rainfall zone of 1500-2000mm and Dalhousie, Dharamsala, Kangra, Palampur and Jogindernagar lie in a zone exceeding 2000mm but beyond this zone of maximum rainfall there is a gradual decrease towards Mandi, Rampur, Kulu, Kalpa and Keylong. Most of Lahaul and Spiti receive less then 500mm of rainfall. The number of rainy days varies from 48 at Keylong to 99 at Dharamsala. Precipitation is also received in the form of snow. The average snowfall above 3000m amsl is about 4m lasting for more than 4 months.

The annual rainfall of the valley areas for the assessment year is given in the **Annexure III B-2.** Spatial distribution of Normal Rainfall is shown in **Plate - 2.**

III. HYDROGEOLOGICAL UNITS

Most of the formations form the ground water horizons depending upon their tendency towards weathering, structural setup, depositional sequence and their topographic location. These formations are having either primary or secondary porosities.

i). Valley Fills

Valley fills occur either as major/minor valley/piedmont deposits. The major valley fills are Nurpur and Indora in Kangra district, Balh valley in Mandi district, Paonta valley and Kala Amb valley in Sirmaur district, Nalagarh valley in Solan district and Una valley & Hum

valley in Una district Chauntra valley in Mandi district, Dharamshala Palampur valley in Kangra district and covers an area of 346800 hectares. Apart from this there are numerous valley fill deposits occurring locally and their areas are so small in size that these have not been considered for Ground Water resource estimation. The valley fills forms a potential aquifer in Kangra, Mandi, Sirmaur, Solan and Una district. Ground water occurs under phreatic to confined conditions in these districts.

The discharge of wells generally ranges between 15 to 25 lps with transmissivity value ranging up to 2000m^2/day.

ii). Hard Rocks

In the Himachal Pradesh, Himalayan region is divisible into two geotectonic zones separated from each other by a tectonic line. The Paleocene rocks of lesser Himalayas trending NW-SE bounded in the north by Krol Thrust and in the south by main Boundary Thrust. North of this tectonic line there is a thick pile of more or less continuous sequences of sedimentary rocks ranging in age from Precambrian to Cretaceous. South of Middle Himalayan Suture, there is sequence of formations from Precambrian to Recent. These fracture or fault zones are forming potential ground water zones in low topographic areas. Ground water in the hard rock area is either developed through bore wells or springs. The Exploratory well drilled in Shimla yielded about 30lps with a Transmissivity of 626 m^2/day. Springs are yielding sometimes more than 40 lps and are utilized for both drinking and irrigation purposes. Springs exist in many places where favorable conditions exist mainly along structurally weak zones. These are major source of water supply in the State.

IV. GROUND WATER LEVEL CONDITIONS

V. Pre monsoon water levels May 2019

The depth to water level, recorded during May 2019, ranged between 0.62m (Kangra district) and 28.72 m bgl (Una district). Out of 101 stations monitored, the majority of 80 NHS (79.20%) recorded DTWL, in the range between 2 - 20 m |bgl. 15 stations (14.85%), recorded shallow water levels, less than 2 m bgl and 6 stations (5.94%), recorded deep water levels, more than 20 m bgl in the state.

2.1

Depth to Water Table
Distribution of Percentage of Observation Wells
2019/May

State : Himachal Pradesh

District	No. of Wells Analysed	Depth to Water Table (mbgl)		No. / Percentage of Wells Showing Depth to Water Table (mbgl) in the Range of					
		Min.	Max	0.0 - 2.0	2.0 - 5.0	5.0 - 10.0	10.0 - 20.0	20.0 - 40.0	> 40.0
HAMIRPUR	4	1.96	7.39	1 25.00%	1 25.00%	2 50.00%	0	0	0
KANGRA	34	0.62	12.48	6 17.65%	21 61.76%	4 11.76%	3 8.82 %	0	0
KULLU	3	0.85	8.47	1 33.33%	0	2 66.67%	0	0	0
MANDI	8	0.74	8.94	3 37.50%	3 37.50%	2 25.00%	0	0	0
SIRMAUR	12	2.11	28.52	0	1 8.33%	2 16.67%	8 66.67 %	1 8.33%	0
SOLAN	10	5.41	24.61	0	0	3 30.00%	5 50.00 %	2 20.00%	0
UNA	30	1.07	28.72	4 13.33%	13 43.33%	6 20.00%	4 13.33 %	3 10.00%	0
Total	101	0.62	28.72	15	39	21	20	6	0

Table: District wise number & % of NHS distribution, in different DWL of May 2019

ii) **Decadal average of May (2009-2018) to May 2019**

Decadal water level fluctuation has been worked out by comparing water level data of May 2019 with the average mean of 10 years water level data of May (2009-2018) and is presented in Annexure-IV and frequency distribution in various ranges is presented in Table - 13.

A perusal of Tableon the next page shows that out of 101 stations analysed, 82 stations (81.18%) have shown rise and 19 stations (18.81%), have shown fall in water level. 68 stations (82.92%) are showing rise in water level between 0 to 2m, 9 stations (10.97%) between 2 to 4m. and 5 stations (6.09%), more than 4m.

Out of 19 stations, 13 stations (68.42%) show fall in water level between 0 to 2m, 5 stations (26.31 %) between 2 to 4 m and 1stations (5.26%) more than 4m.

A minimum rise in water level of 0.01 m was noticed in Sirmour districts and the maximum rise of 7.83m is noticed in Solan district. Similarly, the minimum and maximum fall of 0.11 m is noticed in Mandi district & maximum fall of 4.08 m is noticed in Solan district.

A perusal of map of Decadal Variation - Average of May (2009 - 2018) with May 2019 reveals fall less than 2m, in all the valleys of Kullu district ,Mandi district, Sirmaur district, Solan district & Una district except at some places in Indaura valley, Balh valley and Paonta & Kangra-Palampur valley and Nurpur valley, which is showing rise. A fall is 2-4m and >4 m is shwon in Paonta valley, Kullu valley and Nallagarh valley.

2.1

District Wise - Fluctuation of Water Level with Mean and Selected Period

10 Years Mean (2009 May - 2018 May) - 2019/May

State : Himachal Pradesh

District Name	No. of Wells	Range of Fluctuation				No. of Wells /Percentage Showing Fluctuation						Total No. of Wells	
		Rise (m)		Fall (m)		Rise (m)			Fall (m)			Rise	Fall
		Min	Max	Min	Max	0 to 2	2 to 4	>4	0 to 2	2 to 4	>4		
HAMIRPUR	4	0.26	3.05	-	-	3 75.00 %	1 25.00%	0	0	0	0	4	0
KANGRA	34	0.20	4.73	0.67	0.67	27 79.41 %	4 11.76%	2 5.88%	1 2.94%	0	0	33	1
KULLU	3	0.31	0.31	0.57	3.05	1 33.33 %	0	0	1 33.33%	1 33.33 %	0	1	2
MANDI	8	0.29	1.11	0.11	2.31	5 62.50 %	0	0	2 25.00%	1 12.50 %	0	5	3
SIRMAUR	12	0.01	6.85	0.06	0.51	6 50.00 %	0	2 16.67%	4 33.33%	0	0	8	4
SOLAN	10	0.58	7.83	0.03	4.08	3 30.00 %	1 10.00%	1 10.00%	4 40.00%	0	1 10.00%	5	5
UNA	30	0.14	2.30	0.43	3.06	23 76.67 %	3 10.00%	0	1 3.33%	3 10.00 %	0	26	4
Total	101	0.31	0.58	0.00	4.08	68	9	5	13	5	1	82	19

Table: District wise number & % NHS distribution in different Decadal W/L Fluctuation Range (May (2009 - 2018) with May 2019

iii) Depth to Water Level – November 2019

The depth to water level recorded during November 2019 (Annexure - I) ranged between 0.38 m bgl in (Mandi district) to 30.43 m bgl in (Solan district) (Table-6). Out of 103 stations monitored, the majority of 71 NHS (68.93%) recorded DTWL, in the range between 2 - 20 m bgl. 29 stations (28.15%), recorded shallow water levels, less than 2 m bgl and 3 stations (2.91%), recorded deep water levels, more than 20 m bgl in the State.

A perusal of the DTWL map for November 2019 shows that the shallow water level areas of less than 2 m observed in eastern part of Kangra Palampur valley and in pockets of all the valleys, except Paonta valleys and Nalagarh valleys. Water level of 2-5m & 5-10 m bgl is observed in major part of Kangra Palampur valley, Indaura-Nurpur valley, Balh valley, southern part of Una Valley, Nalagargh valley Paonta valley respectively. 10-20 m bgl water level is shown in Una, Nalagah and Paonta valley only. Deeper water level more than 20m is confined mainly in eastern part of Paonta valley in Sirmaur district, southern part of Nalagarh valley of Solan district and small part of Una valley.

2.1

Depth to Water Table
Distribution of Percentage of Observation Wells
2019/Nov

State : Himachal Pradesh

District	No. of Wells Analysed	Depth to Water Table (mbgl)		No. / Percentage of Wells Showing Depth to Water Table (mbgl) in the Range of					
		Min.	Max.	0.0 - 2.0	2.0 - 5.0	5.0 - 10.0	10.0 - 20.0	20.0 - 40.0	> 40.0
HAMIRPUR	4	1.83	5.42	1 25.00%	2 50.00%	1 25.00%	0	0	0
KANGRA	36	0.48	10.31	11 30.56%	18 50.00%	6 16.67%	1 2.78 %	0	0
KULLU	2	1.17	6.06	1 50.00%	0	1 50.00%	0	0	0
MANDI	8	0.38	6.44	3 37.50%	4 50.00%	1 12.50%	0	0	0
SIRMAUR	11	1.59	25.66	1 9.09%	2 18.18%	5 45.45%	2 18.18 %	1 9.09%	0
SOLAN	11	4.34	30.43	0	1 9.09%	2 18.18%	7 63.64 %	1 9.09%	0
UNA	31	0.85	27.22	12 38.71%	8 25.81%	6 19.35%	4 12.90 %	1 3.23%	0
Total	103	0.38	30.43	29	35	22	14	3	0

Table: Depth to Water Level – November 2019

iv) Decadal average of November (2009-2018) to November 2019

Decadal water level fluctuation has been worked out by comparing water level data of November 2019 with the average water level data of November for 10 years (2009-2018) and is presented in Annexure - IV and frequency distribution in various ranges in Table on page 10.

A perusal of Table on page 10 shows that out of 105 stations analyzed, 69 stations (65.71%) have shown rise and 36 stations (34.28%), have shown fall in water level. 57 stations (82.60%) are showing rise in water level between 0 to 2m, 7stations (10.14 %) between 2 to 4m. and 5 stations (7.24%), more than 4m.

Out of 36 stations, 33 stations (91.66%) show fall in water level between 0 to 2m, 2 stations (5.55%) between 2 to 4 m and 1 stations (2.77 %) more than 4m.

A minimum rise in water level of 0.02 m was noticed in Una district and the maximum rise of 5.86 m is noticed in Una district. Similarly, the minimum and maximum fall of 0.01 m is noticed in Kangra district & maximum fall of 8.96 m is also noticed in Una district.

A perusal of map of Decadal average of November (2009-2018) to November 2019 reveals fall in water level less than 2m.is shown in eastern part of Kangra - Palampur valley & Indaura valley of Kangra district, major part of Nalagarh valley, Balh valley, a couple of places in Paonta valley. The fall between 2 to 4 m was noticed in, Una and Paonta valley. Similarly, rise is noticed in all the valleys from 0-2 m and 2- 4m except in major part of Nallagah valley.

District Wise - Fluctuation of Water Level with Mean and Selected Period

10 Years Mean (2009 Nov - 2018 Nov) - 2019/Nov

State : Himachal Pradesh

District Name	No. of Wells	Range of Fluctuation				No. of Wells /Percentage Showing Fluctuation						Total No. of Wells	
		Rise (m)		Fall (m)		Rise (m)			Fall (m)			Rise	Fall
		Min.	Max	Min.	Max	0 to 2	2 to 4	>4	0 to 2	2 to 4	>4		
HAMIRPUR	4	0.16	1.45	-	-	4 100.00 %	0	0	0	0	0	4	0
KANGRA	36	0.11	2.70	0.01	1.12	23 63.89 %	1 2.78%	0	12 33.33%	0	0	24	12
KULLU	3	4.27	4.27	0.03	0.29	0	0	1 33.33%	2 66.67%	0	0	1	2
MANDI	8	0.06	1.05	0.09	0.83	4 50.00 %	0	0	4 50.00%	0	0	4	4
SIRMAUR	11	0.20	7.03	0.05	2.80	3 27.27 %	0	1 9.09%	5 45.45%	2 18.18 %	0	4	7
SOLAN	11	1.30	5.19	0.00	1.99	2 18.18 %	1 9.09%	1 9.09%	7 63.64%	0	0	4	7
UNA	32	0.02	5.06	0.08	0.96	21 65.63 %	5 15.63%	2 6.25%	3 9.38%	0	1 3.13%	28	4
Total	105	1.05	4.27	0.00	0.96	57	7	5	33	2	1	69	36

Table: Decadal Fluctuation November (2009-2018) to November 2019

GROUND WATER QUALITY

The study of chemical characteristics of 105 water samples of ground water collected from ground Water Monitoring Stations of Una, Kangra, Nalagarh, Mandi, Sirmour and Solan districts reveal that ground water is fresh with electrical conductance and major ions within permissible limits as set down by BIS 2001 Standards.

The Ranges (Minimum and Maximum) of various parameters in different districts of H.P. are given in **Table below.** A perusal of Table-2 shows that in the entire state, the Nitrate concentration ranges from Tracers to 98 mg/l, except at Hathitan in Kullu district which is 229 mg/l.

S. No.	District (No of Samples)		pH	EC µS/cm at 25°C	HCO_3	Cl	So_4	NO_3	F	Ca	Mg	Na	K	Total Hardness as $CaCO_3$
					(in mg/l)									
1.	KANGRA (27)	Min	7.72	150	61	6.7	5	0.2	0.10	12	5	12	1	50
		Max	8.80	795	268	97	98	58	0.48	56	36	86	75	290
2.	UNA (38)	Min	7.48	220	58	14	5	0.2	0.07	8	5	10	1	30
		Max	8.79	1100	363	120	159	155	0.38	56	46	175	20	273
3.	MANDI (8)	Min	8.04	234	87	21	29	0.5	0.08	29	5	13	1.7	95
		Max	8.45	1052	189	156	167	72	0.48	76	38	107	18	347
4.	KULLU (2)	Min	8.18	378	102	35	BDL	48	0.07	38	8.4	11	5	158
		Max	8.53	470	175	35	BDL	61	0.12	63	15	36	12	177
5.	HAMIRPUR (4)	Min	8.04	312	87	21	BDL	1.7	0.09	34	10	10	1	126
		Max	8.46	367	218	50	BDL	16	0.18	55	13	22	6.1	189
6.	SOLAN (10)	Min	7.69	270	87	14	34	2.7	0.10	10	5	23	1	84
		Max	8.60	1145	243	248	141	52	0.26	86	38	118	23	305
7.	SIRMOUR (16)	Min	7.93	142	87	7	35	0.2	0.06	13	5	2.2	1	42
		Max	8.55	933	305	92	155	90	0.33	63	46	214	42	252
HIMACHAL PRADESH (105)		Min	7.72	150	58	6.7	5	0.2	0.07	8	5	10	1	30
		Max	8.80	1100	363	248	159	155	0.48	86	46	214	42	347

Table: Range of Chemical Quality in Shallow Aquifers of Himachal Pradesh (May 2019)

CHPTER-3

GROUND WATER RESOURCE ESTIMATION METHODOLOGY- GEC-15

a) INTRODUCTION

The previous ground water resources assessment of the state was done based on the recommendation of Ground Water Estimation Committee- 1997 (GEC-97). The GEC'84 methodology was subsequently modified in the light of enhanced database and new findings of experimental studies in the field of hydrogeology. The present methodology used for resources assessment is known as Ground Water Resource Estimation Methodology – 2015 (GEC-15). The revised methodology GEC 2015 recommends aquifer wise ground water resource assessment. Ground water resources have two components – Replenishable ground water resources or Dynamic ground water resources and In-storage resources or Static resources.GEC 2015 recommends estimation of Replenishable and in-storage ground water resources for both unconfined and confined aquifers. Wherever the aquifer geometry has not been firmly established for the unconfined aquifer, the in-storage ground water resources have to be assessed in the alluvial areas up to the depth of bed rock or 300m whichever is less. In case of hard rock aquifers, the depth of assessment would be limited to 100m. In case of confined aquifers, if it is known that ground water extraction is being taken place from this aquifer, the dynamic as well as in-storage resources are to be estimated. If it is firmly established that there is no ground water extraction from this confined aquifer, then only in-storage resources of that aquifer has to be estimated. The present report deals with replenish able or dynamic ground water resources of Himachal Pradesh. Thus the ground water resources assessment unit is in general watershed particularly in hard rock areas. In case of alluvium areas, administrative block can also be the assessment unit. In each assessment unit, hilly areas having slope more than 20% are deleted from the total area to get the area suitable for recharge. Further, areas where the quality of ground water is beyond the usable limits should be identified and handled separately. The remaining area after deleting the hilly area and separating the area with poor ground water quality is to be delineated into command and non-command areas are done separately for monsoon and non-monsoon seasons.

b) GROUND WATER RECHARGE

i). Monsoon Season

The resource assessment during monsoon season is estimated as the sum of the change in storage and gross draft. The change in storage is computed by multiplying water level

fluctuation between pre and post monsoon periods with the area of assessment and specific yield. Monsoon recharge can be expressed as

$$\mathbf{Rrf = h \; X \; Sy \; X \; A + D_G - R_C - R_{SW} - R_T - R_{GW} - R_{WC}}$$

Where,

h = rise in water level in the monsoon season

A = area for computation of recharge

Sy = specific yield

$\mathbf{D_G}$ = Gross Ground Water draft for monsoon season

$\mathbf{R_C}$ = Recharge due to seepage from canals during monsoon season

$\mathbf{R_{SW}}$ = Recharge from surface water irrigation during monsoon season

$\mathbf{R_T}$ = Recharge from tanks & ponds during monsoon season

$\mathbf{R_{GW}}$ = Recharge from ground water irrigation during monsoon season

$\mathbf{R_{WC}}$ = Recharge from water conservation structures during monsoon season

The rainfall recharge thus calculated is normalized for the normal monsoon season.

The monsoon ground water recharge has two components – rainfall recharge and recharge from other sources. Mathematically **total recharge during monsoon season** can be represented as –

R (Normal) = Rrf (normal) + Rc+Rsw+Rt+Rgw+Rwc

Where, **Rrf** is the normal monsoon rainfall recharge. The other sources of ground water recharge during monsoon season include **Rc, Rsw, Rt, Rgw, Rwc** which are seepage from canals, surface water irrigation, tanks & ponds, ground water irrigation and water conservation structures respectively.

The rainfall recharge during monsoon season computed by Water Level Fluctuation (WLF) method is compared with recharge figure from Rainfall Infiltration Factor (RIF) method. In case the difference between the two sets of data is more than 20% then RIF figure is considered, otherwise monsoon recharge from WLF method is adopted. While adopting the rainfall recharge figures, weightage is to be given to WLF method over adhoc norms method of RIF. Hence, wherever the difference between RIF method & WLF method is more than 20%, data have to be scrutinized and corrected accordingly.

ii). NON- MONSOON SEASON

During non – monsoon season, rainfall recharge is computed by using Rainfall Infiltration Factor (RIF) method. Recharge from other sources is then added to get total non-monsoon recharge. In case of areas receiving less than 10 % of the annual rainfall during non-monsoon season, the rainfall recharge is ignored.

iii). TOTAL ANNUAL GROUND WATER RECHARGE

The total annual ground water recharge of the area is the sum of monsoon and non-monsoon recharge. An allowance is kept for natural discharge in the non-monsoon season by deducting 5 % of total annual ground water recharge, if WLF method is employed to compute rainfall recharge during monsoon season and 10 % of total annual ground water recharge if RIF method is employed. The balance ground water available accounts for existing ground water withdrawal for various uses and potential for future development. This quantity is termed as Net Ground Water availability.

Net Ground Water Availability = Annual Ground Water Recharge - Natural Discharge during Non-monsoon season

iv). NORMS FOR ESTIMATION OF RECHARGE

GEC-15 methodology has recommended norms for various parameters being used in ground water recharge estimation. These norms vary depending upon water bearing formation and agro climatic condition. While norms for specific yield and recharge form rainfall values are to be adopted within the guidelines of GEC-15, in case of other parameters like seepage from canals, return flow from irrigation, recharge from tanks and ponds, water conservation structures, results of specific case studies may replace the adhoc norms.

c) GROUND WATER DRAFT

The gross yearly ground water draft is to be calculated for irrigation, domestic and industrial uses. The gross ground water draft would include the ground water extraction from all existing ground water structures during monsoon as well as during non-monsoon period. While the number of ground water structures should preferably be based on the latest well census, the average unit draft from different types of structures should be based on specific studies or ad-hoc norms given in GEC-15 report.

d) STAGE OF GROUND WATER DEVELOPMENT & CATEGORIZATION OF UNITS

The Stage of ground water development is defined by

$$\text{Stage of Ground Water Development (\%)} = \frac{\text{Gross ground water draft for all uses(Dg)*100}}{\text{Annual available ground water resources}}$$

The units of assessment are categorized for ground water development based on two criteria – a. stage of ground water development, and b. long – term trend of pre and post monsoon water levels. Four categories are – **Safe** areas which have ground water potential for development; **Semi-critical** areas where cautious ground water development is recommended;

Critical areas; and **Over-exploited** areas where there should be intensive monitoring & evaluation and future ground water development be linked with water conservation measures. The criteria for categorization of assessment units are as under:

Safe areas with potential for development

(a) Areas where ground water resource assessment shows stage of ground water development at 70% or lower, and there is no significant long term decline of pre or post monsoon ground water levels.

(b) Areas where ground water resource assessment shows stage of ground water development more than 70%, but less than 90%, and both pre monsoon and post monsoon ground water levels do not show a significant long term decline.

However, in these areas, caution may be exercised in planning future development, with regard to quantum of additional ground water withdrawal.

Semi critical areas for cautious ground water development

Areas where ground water resource assessment shows stage of ground water development more than 70%, but less than 90%, and either pre monsoon or post monsoon ground water level shows a significant long term decline.

Critical areas

(a) Areas where ground water resource assessment shows stage of ground water development more than 90%, but less than 100%, and either pre monsoon or post monsoon ground water level shows a significant long term decline.

(b) Areas where ground water resource assessment shows stage of ground water development less than 100%, but both pre monsoon and post monsoon ground water levels show a significant long term decline.

(c) Areas where ground water resource assessment shows stage of ground water development more than 100%, but either pre monsoon or post monsoon ground water level does not show a significant long term decline.

Over - exploited areas

Areas where ground water resource assessment shows stage of ground water development more than 100% and both pre and post monsoon ground water levels show a significant long term decline. In over-exploited areas, there should be intensive monitoring and evaluation and future ground water development be linked with water conservation measures. In fact, more widespread adoption of water conservation measures based on watershed management techniques will be beneficial even in semi critical and critical areas. The criteria for categorization of Assessment units are given in **Table on page 16.**

S. No.	Stage of Ground Water Development	Significant Long Term Decline		Categorization
		Pre-monsoon	Post monsoon	
1.	< = 70%	No	No	SAFE
		Yes/N	No/Yes	To be re-assessed
		Yes	Yes	To be re-assessed
2.	> 70% and <= 90%	No	No	SAFE
		Yes/No	No/Yes	SEMI-CRITICAL
		Yes	Yes	To be re-assessed
3.	>90% and <=100%	No	No	To be re-assessed
		Yes/No	No/Yes	SEMI-CRITICAL
		Yes	Yes	CRITICAL
4.	> 100%	No	No	To be re-assessed
		Yes/No	No/Yes	OVER-EXPLOITED
		Yes	Yes	OVER - EXPLOITED

Table: Criteria for categorization of Assessment units

The long term ground water level data should be minimum 10 years data for non-command areas. The significant rate of water level decline may be taken between 10 to 20 cm per year depending upon the local hydrogeological conditions.

e) ALLOCATION OF GROUND WATER RESOURCES FOR FUTURE UTILIZATION

The net annual ground water availability is to be apportioned between domestic, industrial and irrigation uses. Among these, as per the National Water Policy, 2002, requirement for domestic water supply is to be accorded priority. The requirement for domestic and industrial water supply is to be kept based on population as projected to the year 2025. The water available for irrigation use is obtained by deducting the allocation for domestic and industrial use, from the net annual ground water availability.

f) POOR QUALITY GROUND WATER

Computation of ground water recharge in poor quality ground water is to be done on the same line as described above. However, in saline areas, there may be practical difficulty due to non availability of data, as there will usually be no observation wells in such areas. Recharge assessment in such areas may be done based on rainfall infiltration factor method.

g) APPORTIONING OF GROUND WATER ASSESSMENT FROM WATERSHED TO DEVELOPMENT UNIT

Where the assessment unit is a watershed, the ground water assessment is converted in terms of an administrative unit such as block / taluka / mandal. This is done by converting the volumetric resource into depth unit and then multiplying this depth with the corresponding area of the block.

h) ADDITIONAL POTENTIAL RECHARGE

In shallow water table areas, particularly in discharge areas, rejected recharge would be considerable and water level fluctuation are subdued resulting in under-estimation of recharge component. In the area where the ground water level is less than 5 m below ground level or in waterlogged area, ground water resources have to be estimated upto 5 m bgl only based on the following equation-

Potential ground water recharge = (5 – D) x A x Sp. Yield

Where,

D = depth to water table below ground surface in pre-monsoon season in shallow aquifers;

A = area of shallow water table zone

CHAPTER 4

PROCEDURE FOLLOWED IN THE PRESENT ASSESSMENT INCLUDING ASSUMPTIONS

a) METHODOLOGY

Estimation of Ground Water resources has been carried out based on the methodology recommended by the Ground Water Estimation Committee (GEC-15). Salient features of the methodology and norms adopted in this report are given below.

i) Ground Water Computations:

The rainfall recharge computation presented in this report is for the year 2019-20, whereas draft calculations have been done up to March 2020. Himachal Pradesh experiences rainfall caused by SW monsoon, which generally commences by second week of June. The monsoon period has been taken as 4 months i. e. from June to September and 8 months (October to May) have been considered as non-monsoon period. Data for ground water draft has been collected by the Ground Water Organisation, Department of Irrigation and Public Health and rainfall data from Indian Meteorological Deptt.

ii) Unit of Computation:

The unit of computation proposed in the methodology is 'watershed'. But in Himachal Pradesh due to hilly terrain and local watersheds, it is not possible to compute water resources by taking complete watershed as a unit. Only valley & surrounding areas with slope less than 20% have been taken for computation of water resources **(Plate-1)**. The details of the Ground water Administrative units and Assessment units of Himachal Pradesh are given in **Annexure III A-4** and **Annexure III A-5** respectively.

iii) Gross Ground Water Draft:

Ground Water draft for various uses in valley areas have been estimated according to the methodology. Data variables used in dynamic ground water resources of Himachal Pradesh are rainfall, water level fluctuations and number of ground water abstraction structures and are given in **Annexure III A-2: Page 2.** Parameters used in the assessment of dynamic ground water resources of the state indicating the value of Specific yield, rainfall infiltration factor and season wise unit draft is given in **Annexure III C**. The details of ground water draft are given as below.

iii a). Domestic Draft: Ground Water draft for domestic use has been estimated based on the water supply schemes of Jal Shakti Vibahg for the year 2019-20. Minor irrigation census data of dugwells has also been incorporated in domestic draft.

iii b). Irrigation Draft:

The main structure constructed for irrigation are tubewells, percolation wells and dugwells constructed by private individuals, Jal Shakti Vibahg- Himachal Pradesh and CGWB. The valley wise data for these structures was made available by GWO, Jal Shakti Vibhag for the year 2019-20.

iii c). Industrial Draft:

Ground water in the state is mostly used for domestic and irrigation purposes. However ground water draft for industrial use for Indora valley, Paonta valley, Kala Amb valley, Nalagarh valley, Una valley and Hum valley has been included while assessing the ground water draft.

iii d). Allocation for Domestic and Industrial Requirement for the Year 2025

Ground Water draft for domestic use has been estimated based on the population of valley areas only. The population figures of the 2011 census have been projected to the year of assessment considering the decadal growth rate up to the year 2025 as given in **Annexure-III D1 Page 2.** Domestic draft has been calculated by taking consumption of 70 lpd per head as per Govt. of Himachal Pradesh norms.

CHAPTER 5.

COMPUTATION OF GROUND WATER RESOURCES ESTIMATION IN HIMACHAL PRADESH

a) SALIENT FEATURES OF THE DYNAMIC GROUND WATER RESOURCE ASSESSMENT

- Estimation of Ground Water resources has been carried out based on the methodology recommended by the Ground Water Estimation Committee (GEC-2015) through IN-GRES portal.
- Type of assessment unit is valley.
- There are ten assessment units in the state.
- Rainfall data used for the computation of the recharge of the year 2019-20 *(Source: IMD).*
- Water level data used for the year 2009 to 2019 of Ground Water Monitoring Stations of CGWB & shallow piezometers of Jal Shakti Vibhag, Govt. of Himachal Pradesh.
- Census 2011 data is used for the computation of allocation for domestic and industrial requirement.
- Year of projection for allocation for domestic water supply is up to 2025.

b) ASSESSMENT UNIT-WISE METHOD ADOPTED FOR COMPUTING RAINFALL RECHARGE DURING MONSOON SEASON (WLF/RIF)

i) Recharge from other Sources:

The main irrigation structures in the state are dugwells, tubewells, percolation wells and ponds. As the average water levels in all the major valley areas ranges from 0 to 10 m and considering the type of crop as non paddy, the recharge has been taken as 25% of the irrigation draft. In Hum valley the water levels are deeper (>100m), therefore considering the type of crop as non paddy the recharge has been taken as 5% of irrigation draft as per GEC 2015. Recharge from ground water irrigation, surface water bodies and surface water irrigation is given in **Annexure-III D-1**.

Recharge from various sources during monsoon and non monsoon season has been given in **Annexure III D-1.**

ii). Recharge from Monsoon Rainfall:

Recharge has been computed using both water level fluctuation method as well as rainfall infiltration factor method. The Annual rainfall is given in **Annexure III B-2.**

Recharge computation by water level fluctuation method:-

Recharge from rainfall using water level fluctuation method has been estimated using the following relation

$$\mathbf{Rwtf = h\ X\ Sy\ X\ A + D_G - R_C - R_{SW} - R_T - R_{GW} - R_{WC}}$$

Whereas **Rwtf** = possible recharge by water table fluctuation method,

h = rise in water level in the monsoon season

A = area for computation of recharge

Sy = specific yield

$\mathbf{D_G}$ = Gross Ground Water draft for monsoon season

$\mathbf{R_C}$ = Recharge due to seepage from canals during monsoon season

$\mathbf{R_{SW}}$ = Recharge from surface water irrigation during monsoon season

$\mathbf{R_T}$ = Recharge from tanks & ponds during monsoon season

$\mathbf{R_{GW}}$ = Recharge from ground water irrigation during monsoon season

$\mathbf{R_{WC}}$ = Recharge from water conservation structures during monsoon season

The specific yield value in case of valley fill deposits which includes boulders, cobbles, gravels, sand etc. has been taken as **0.16.**

Rainfall recharge computed by this method has been normalized on the normal monsoon rainfall using the procedure recommended by GEC-15 using the relation:

$$\mathbf{Rrf\ (Normal\ wtfm) = NMR\ X\ Rwtf\ /\ AMR}$$

Where,

Rrf (Normal wtfm) = Normalised rainfall recharge

NMR = Normal Monsoon Rainfall

Rwtf =Computed Rainfall Recharge

AMR = Actual Monsoon Rainfall in the year of assessment

For computation of recharge by WTF method, the water level data of Ground Water Monitoring Stations of CGWB & shallow piezometers of Jal Shakti Vibhag, Himachal Pradesh of 2019-20 has been considered.

iii) Recharge from Non Monsoon Rainfall:

Recharge from rainfall during non-monsoon period has been computed by Rainfall Infiltration Factor Method described above.

Recharge from sources other than rainfall: The other sources which contribute towards recharge of ground water resources are seepage from canal, return flow from surface water irrigation, recharge from tanks and ponds, recharge from water conservation structures. Recharge from rainfall during monsoon and non monsoon season has been given in **Annexure III D- 1**

iv). Recharge Computation by Rainfall Infiltration Factor Method during Monsoon:

Rainfall recharge during monsoon period have been computed using, normal monsoon rainfall (Indian Meteorological Deptt.). The rainfall infiltration factor for valley fill have been taken as **0.22** as recommended by GEC 2015.

The equation used for computation of recharge is

$$\mathbf{R_{rf}\,(Normal\ rifm) = NMR\ X\ A\ X\ RIF}$$

Whereas $\mathbf{R_{rf}}$ (Normal rifm)= recharge from rainfall by rainfall infiltration factor method, **NMR** = Normal Monsoon Rainfall, **A** = Area of valley in hectare, **RIF** = Rainfall Infiltration Factor

v). Percent Deviation

The results from the two methods (water level fluctuation and rainfall infiltration method) have been compared using percent deviation using the following relation:

$$\mathbf{P.\ D. = 100x\ \{R_{rf}\,(Normal\ wtfm) - R_{rf}\,(Normal\ rifm)\}/\ R_{rf}\,(Normal\ rifm)}$$

Where, **P. D.** = Percent deviation, $\mathbf{R_{rf}}$ **(Normal wtfm)** = Recharge from (Normalised rainfall as computed by water table fluctuation method), $\mathbf{R_{rf}}$ **(Normal rifm)** = Recharge from (Normalised rainfall as computed by Rainfall infiltration factor method).

After computation of the percent deviation the following criteria as recommended by the methodology (GEC 2015) has been adopted to compute the recharge from rainfall:

i) if P. D ≥ -20 & $\leq +20$ then R_{rf} (Normal) = R_{rf} (Normal wtfm)

ii)if P. D.< -20 then R_{rf} (Normal) = 0.8 X R_{rf} (Normal rifm)

iii)if P. D. > 20 then R_{rf} (Normal) = 1.2 X R_{rf} (Normal rifm)

The following **Table-10** gives the value of Percent Deviation along with the Normalized Monsoon recharge from the rainfall.

vi). Total Annual Recharge:

Total annual recharge was computed as arithmetic sum of recharge from Monsoon, Non-Monsoon Rainfall & recharge from other sources during monsoon and non monsoon season and is given in **Annexure III D-1**

c). TOTAL GROUND WATER RESOURCES OF HIMACHAL PRADESH

i). Net Annual Ground Water Availability:

Net annual ground water availability has been computed by deducting the unaccounted natural discharge. As per GEC '15 methodology, an allowance is kept for natural discharge during non-monsoon season by deducting 5% of annual replenishable ground water resource and adding the Additional potential recharge. Total Annual Ground Water Recharge, provision for Natural Discharges and Net Annual Ground Water Availability is given in **Annexure III D-1, (column 8, 9 &10 respectively)**.

ii). Stage of Ground Water Development:

Stage of ground water development has been computed using the relation:

$$\text{Stage of ground water Development} = \frac{\text{100x Gross ground water draft for all uses}(D_G)}{\text{Annual available ground water resources}}$$

The stage of ground water development and pre and post monsoon water level trend of all assessment units is given in **Annexure III E & F**.

As per the current assessment, all the ten assessment unti in Hiamchal Pradesh falls under safe category. Valleywise stage of Ground water extraction and categorsation is given in **ANNEXURE-III E**

iii). Net annual ground water availability for future use:

Net ground water availability for future use has been computed using the relation

$$R = A - (B + C)$$

Where, R = Net annual ground water available for future irrigation use

A = Net available ground water resource

B = Gross ground water draft for domestic and irrigation

C = Allocation for domestic and industrial water supply

Net Ground Water availability, existing Gross Ground Water Draft for Irrigation and existing ground water draft for domestic and industrial water supply is given in **Annexure III D-1**. Existing Ground Water Draft for all uses, Provision for domestic and Industrial

requirement supply up to 2025 and Net Ground Water Availability for Future irrigation development is given in column **09, 10 & 11 respectively of Annexure III D-1.** Stage of Ground Water Development of all Assessment units is given in **column 12 of Annexure III D-1.**

e) COMPARISON WITH EARLIER GROUND WATER RESOURCE ESTIMATION

Ground Water Resource Estimation of Himachal Pradesh was carried out earlier as per GEC-97 Methodology as on March 2004, March 2009, March 2011, March 2013, March 2017 and now as on March 2020.

Estimation of ground water resources on watershed basis as recommended in GEC-97 was not applicable to the state of Himachal Pradesh due to hilly terrain with intermountain valleys. In Ground Water Resource estimation as on March, 2013, eight valleys were considered as the Ground Water Resource Assessment units. The valley wise Area, Net Ground Water availability, Existing Gross Ground Water Draft, Net Ground Water Availability for Future Irrigation Development and Stage of Ground Water Development is given in **Table below**

S. No.	Name of Valley	Area (ha)	Net Ground Water Availability (ham)	Existing Gross Ground Water Draft for all uses (ham)	Net Ground Water Availability for future Irrigation Development (ham)	Stage of Ground Water Development (%)
1	Indora	26545	10038.64	5263.72	4774.92	**52.43**
2	Nurpur	23775	7035.39	3021.53	4013.86	**42.95**
3	Balh	9500	2825.59	912.77	1912.82	**32.30**
4	Paonta	15627	7702.97	2174.46	5528.51	**28.23**
5	Kala Amb	250	96.58	545.32	-448.74	**564.63**
6	Nalagarh	23849	7941.86	4332.31	3609.55	**54.55**
7	Una	49300	16903.11	20966.28	-4063.17	**124.04**
8	Hum	2200	563.45	561.04	-16.05	**99.57**
Total		**151046**	**53107.59**	**37777.43**	**15311.70**	**71.13**

In Ground water resource estimation as on March, 2013, actual draft data as on March 2013 was used for estimation. Resource estimation is carried out for all the eight valleys. For the calculation of Ground water recharge from other sources in Una valley, the surface water irrigation from Babhohr Sahib lift irrigation scheme, ponds & water conservation structures and ponds in Hum valley are added with the recharge from ground water irrigation. The water conservation structures constructed in Una valley by Swan project has also been considered for ground water recharge. Stage of Ground Water Development as on March 2013 is given in **Table below.**

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S. No.	Name of Valley	Area (ha)	Net Ground Water Availability (ham)	Existing Gross Ground Water Draft for all uses (ham)	Net Ground Water Availability for future Irrigation Development (ham)	Stage of Ground Water Development (%)
1	Indora	26545	10892.94	7523.32	4942.65	**69.07**
2	Nurpur	23775	11958.75	3537.92	9505.56	**29.58**
3	Balh	9500	2605.08	898.87	1557.34	**34.50**
4	Paonta	15627	6219.27	887.14	4691.10	**14.26**
5	Kala Amb	250	82.01	336.95	-8.05	**410.86**
6	Nalagarh	23849	8189.74	3899.04	4661.07	**47.61**
7	Una	49300	12844.41	9559.66	4503.63	**74.43**
8	Hum	2200	597.45	539.46	-33.01	**90.29**
Total		**151046**	**53389.65**	**27182.36**	**29820.29**	**50.91**

Table: Stage of Ground Water Development as on March 2013

S. No.	Name of Valley	Area (ha)	Net Ground Water Availability (ham)	Existing Gross Ground Water Draft for all uses (ham)	Net Ground Water Availability for future Irrigation Development (ham)	Stage of Ground Water Development (%)
1	Indora	26545	11198.502	13223.66	0	118%
2	Nurpur	23775	12089.592	4068.23	7150.58	34%
3	Balh	9500	2482.2	889.83	5074.1	36%
4	Paonta	15627	6123.258	1323.95	1143.51	22%
5	Kala Amb	250	117.576	411.61	0	350%
6	Nalagarh	23849	7683.858	8515.07	0	111%
7	Una	49300	7100.937	10480.11	0	148%
8	Hum	2200	582.012	411.09	0	70.6%
Total		**151046**	**47377.935**	**39323.55**	**13368.19**	**13368.19**

Table: Stage of Ground Water Development as on March 2017

Table-15:
Comparison of Net Ground Water Availability for future irrigation and Stage of Ground Water Development

Name of Valley	Area (ha)	Net Ground Water Availability for future Irrigation Development (ham) (2011)	Stage of Ground Water Development (%) (2011)	Net Ground water Availability for future Irrigation Development (ham) (2013)	Stage of Ground Water Development (%) (2013)	Net Ground Water Availability for future Irrigation Development (ham) (2017)	Stage of Ground Water Development (%) (2017)	Stage of Ground Water Development (%) (2020)
Indora	26545	4774.92	52.43	4942.65	69.07	00	119.61	29.27
Nurpur	23775	4013.86	42.95	9505.56	29.58	7150.58	33.65	
Balh	9500	1912.82	32.30	1557.34	34.50	5074.10	15.89	41.39
Paonta	15627	5528.51	28.23	4691.10	14.26	1143.51	20.72	22.44
Kala Amb	250	-448.74	564.63	-8.05	410.86	00	385.11	27.51
Nalagarh	23849	3609.55	54.55	4661.07	47.61	00	110.67	58.43
Una valley Sutlej Basin	49300	-4063.17	124.04	4503.63	74.43	00	108.37	62.81
Hum	2200	-16.05	99.57	-33.01	90.29	00	75.50	58.12
Chauntra Valley	--	--	--	--	--	--	--	17.12
Dharmshala Palampur Valley	--	--	--	--	--	--	--	13.76
Una Valley (Beas Basin)	--	--	--	--	--	--	--	31.35
Total	151046	15311.70	71.13	29820.29	50.91	00	73.99	36.25

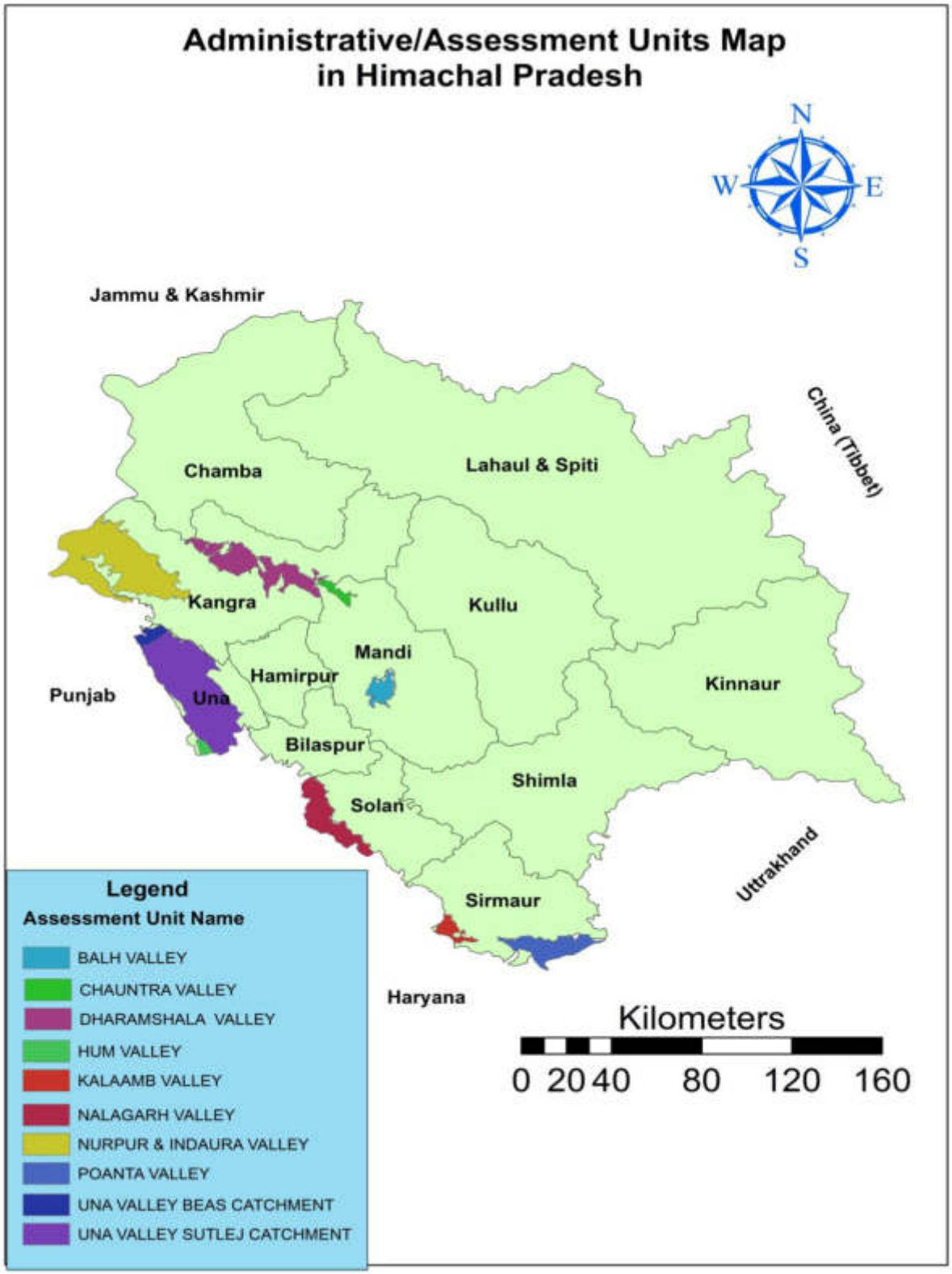
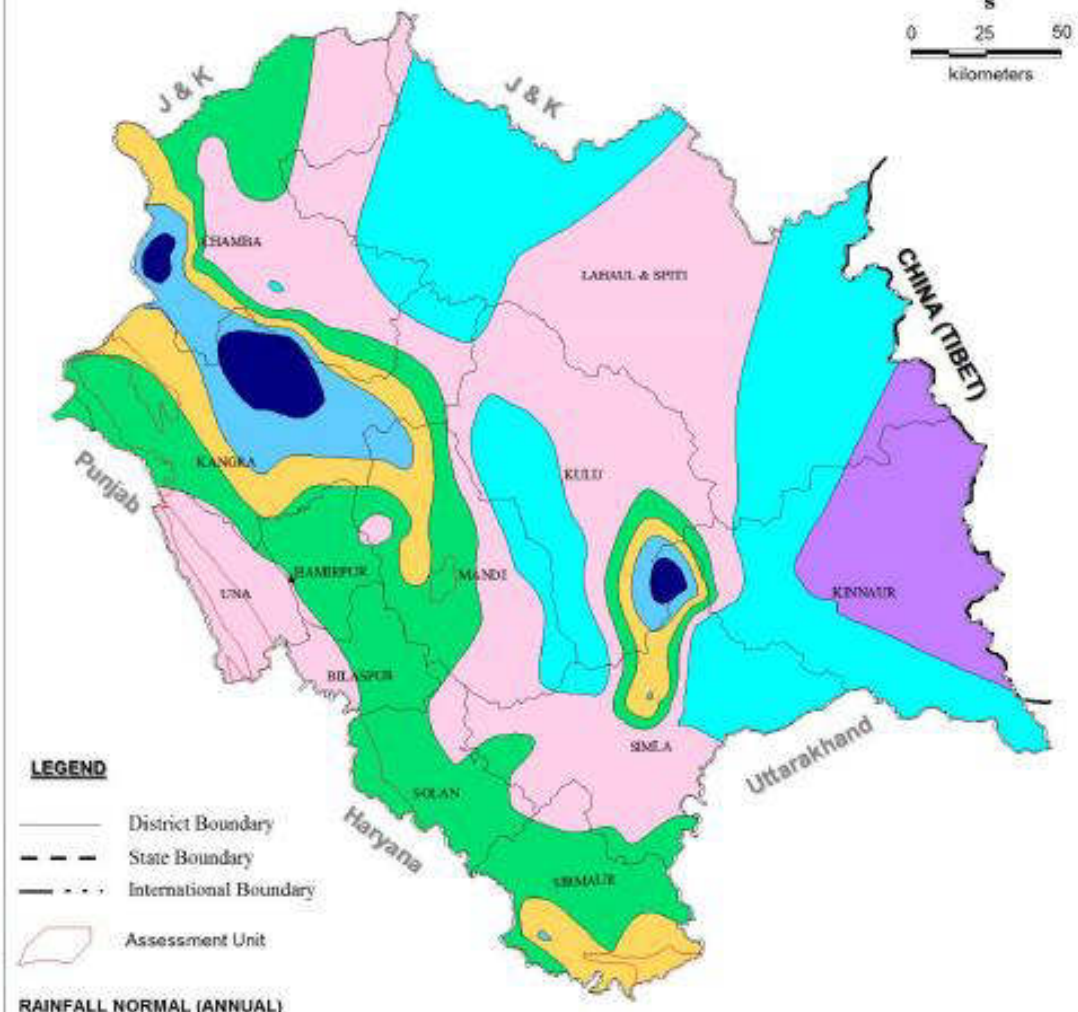

Administrative/Assessment Units Map
in Himachal Pradesh
N
W
E
S
Jammu & Kashmir
China (Tibbet)
Chamba
Lahaul & Spiti
Kangra
Kullu
Mandi
Hamirpur
Punjab
Una
Kinnaur
Bilaspur
Shimla
Solan
Sirmaur
Uttrakhand
Haryana
Legend
Assessment Unit Name
BALH VALLEY
CHAUNTRA VALLEY
DHARAMSHALA VALLEY
HUM VALLEY
KALAAMB VALLEY
NALAGARH VALLEY
NURPUR & INDAURA VALLEY
POANTA VALLEY
UNA VALLEY BEAS CATCHMENT
UNA VALLEY SUTLEJ CATCHMENT
Kilometers
0 20 40 80 120 160

Plate-1

Plate - 2

RAINFALL MAP
(NORMAL)
HIMACHAL PRADESH



Data Source: IMD

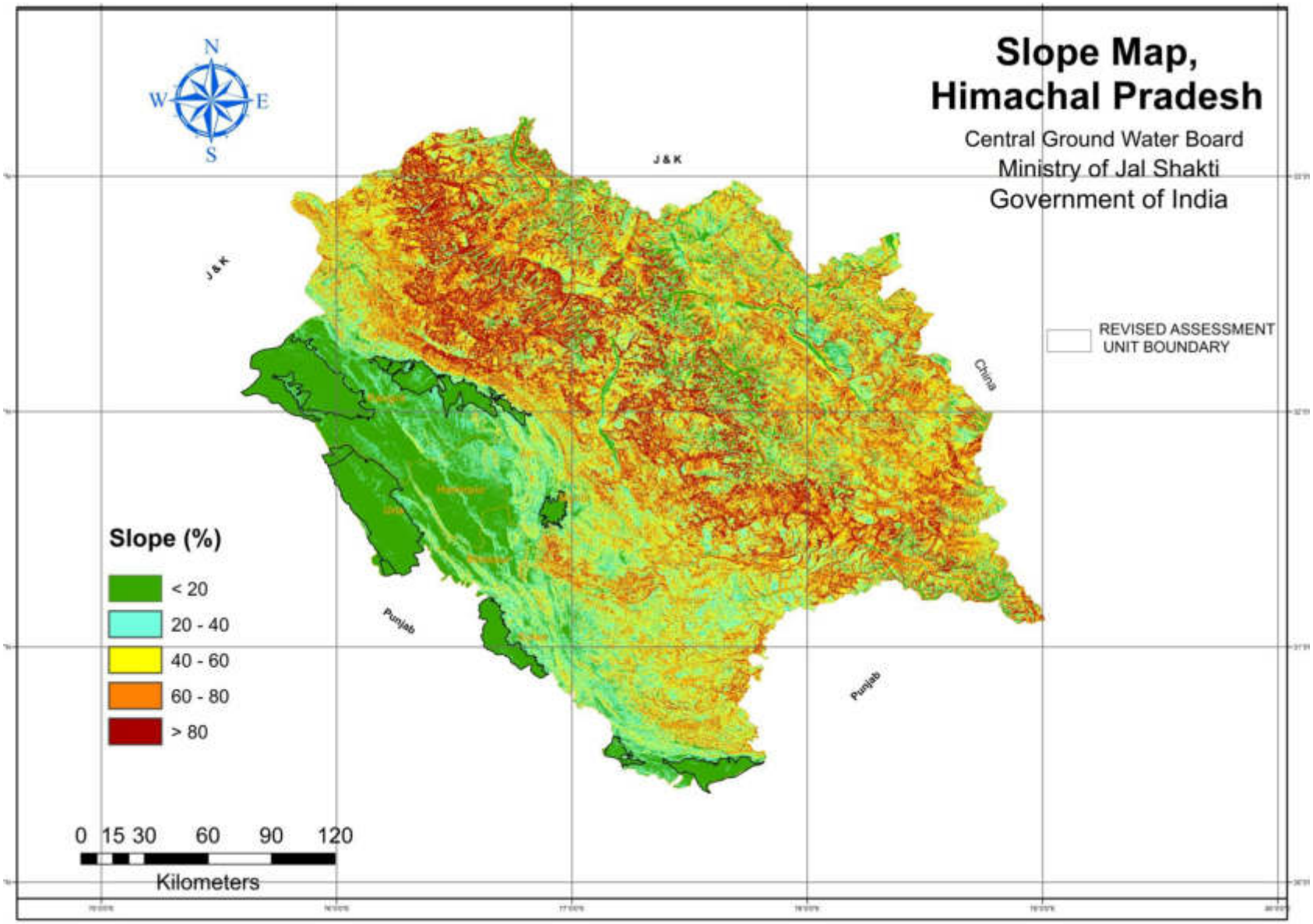

Slope Map,
Himachal Pradesh
Central Ground Water Board
Ministry of Jal Shakti
Government of India
N
W
E
S
J&K
J&K
China
Punjab
Punjab
REVISED ASSESSMENT
UNIT BOUNDARY
Slope (%)
< 20
20 - 40
40 - 60
60 - 80
> 80
0 15 30 60 90 120
Kilometers

Plate 3

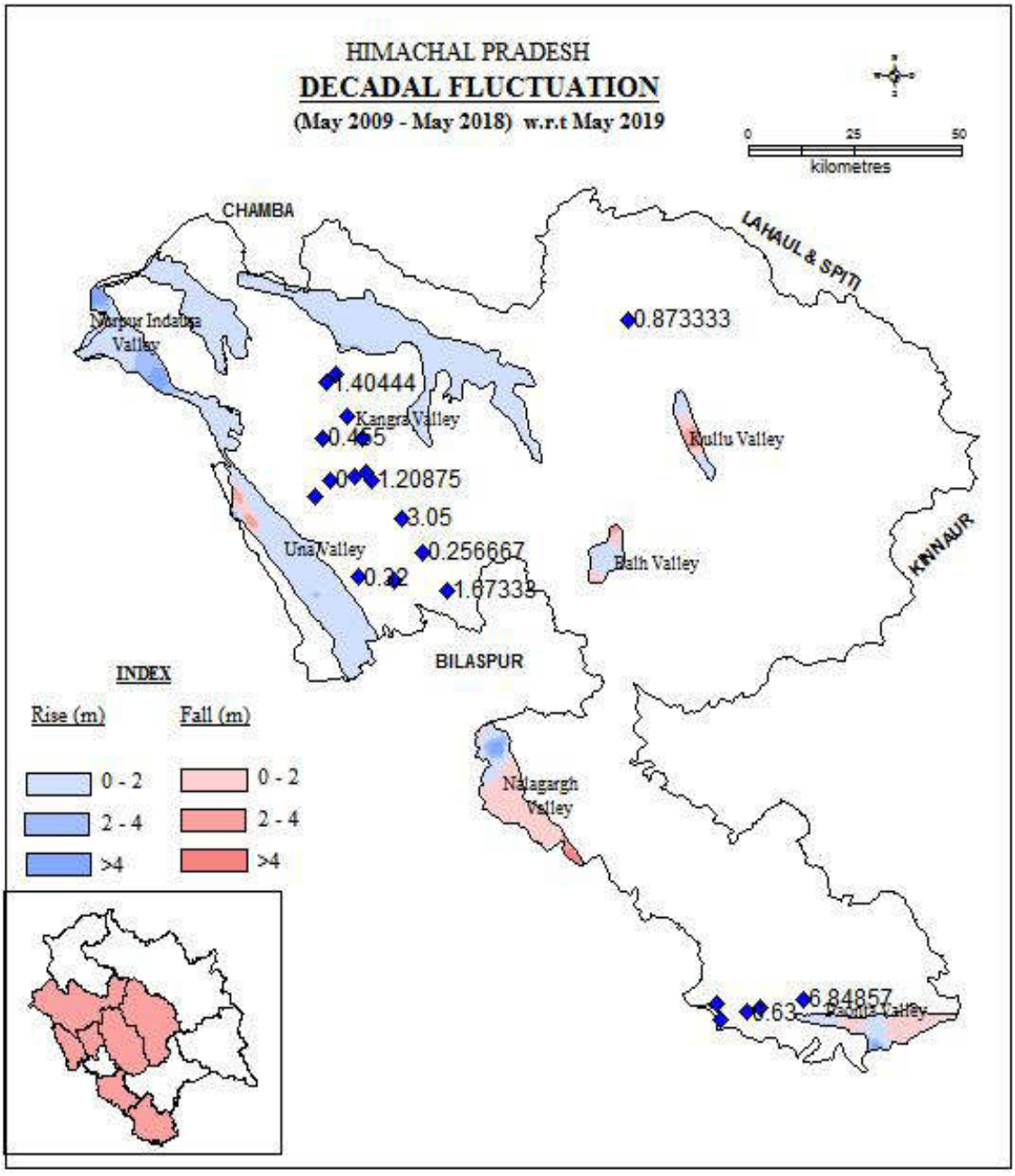

HIMACHAL PRADESH
DECADAL FLUCTUATION
(May 2009 - May 2018) w.r.t May 2019
0
25
50
kilometres
CHAMBA
LAHAUL & SPITI
KINNAUR
BILASPUR
Nurpur Indaura Valley
Kangra Valley
Kullu Valley
Una Valley
Balh Valley
Nalagargh Valley
Pachhad Valley
0.873333
1.40444
0.465
1.20875
3.05
0.256667
0.32
1.67333
6.84857
0.63
INDEX
Rise (m)
Fall (m)
0 - 2
2 - 4
>4
0 - 2
2 - 4
>4

Plate-4

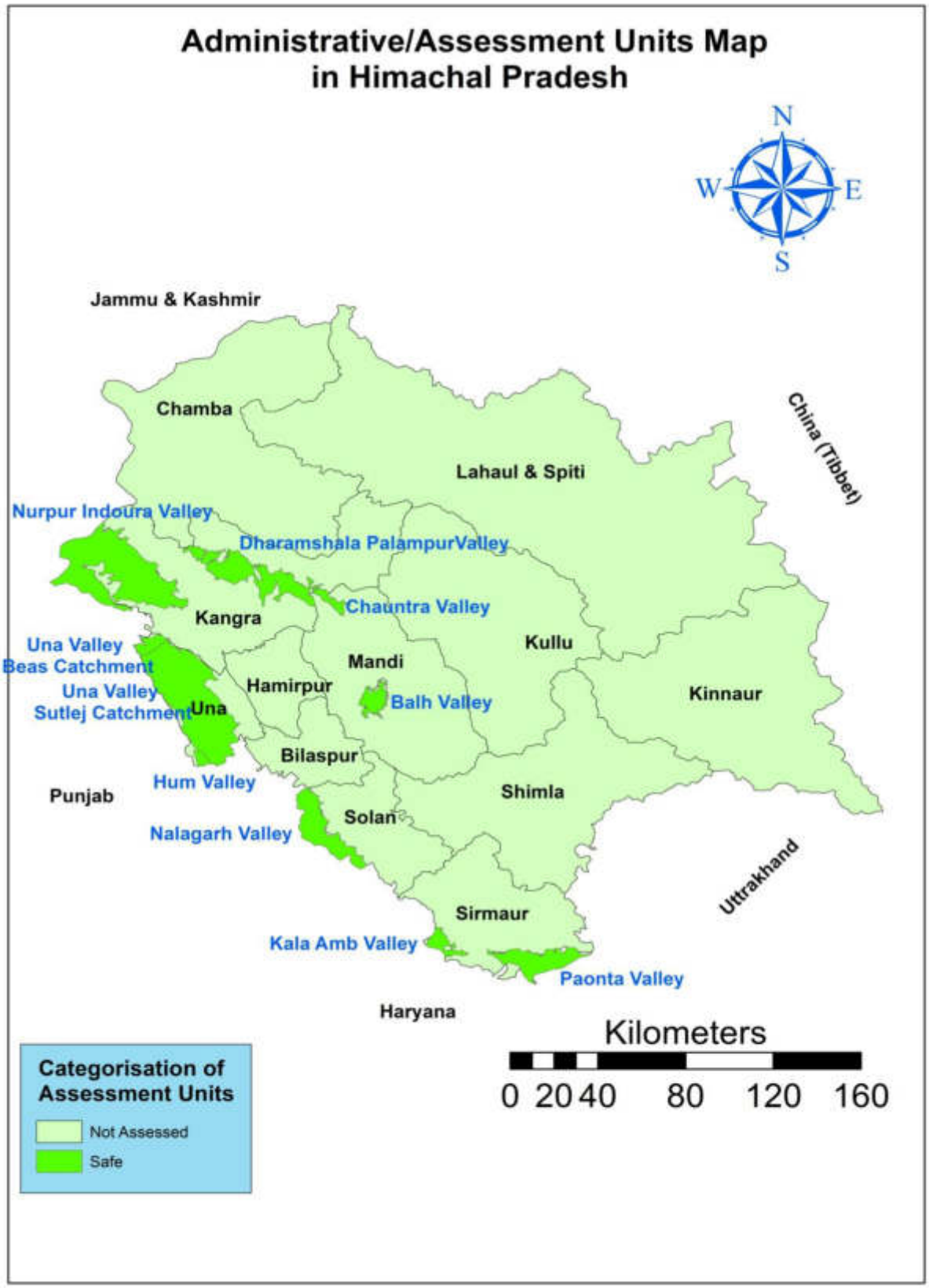

Administrative/Assessment Units Map
in Himachal Pradesh
N
W
E
S
Jammu & Kashmir
Chamba
Lahaul & Spiti
China (Tibbet)
Nurpur Indoura Valley
Dharamshala PalampurValley
Chauntra Valley
Kangra
Una Valley
Beas Catchment
Una Valley
Sutlej Catchment
Una
Mandi
Hamirpur
Balh Valley
Kullu
Kinnaur
Bilaspur
Hum Valley
Punjab
Shimla
Solan
Nalagarh Valley
Uttrakhand
Sirmaur
Kala Amb Valley
Paonta Valley
Haryana
Kilometers
0 20 40 80 120 160
Categorisation of
Assessment Units
Not Assessed
Safe

Plate 5

Annexure-1

Government of Himachal Pradesh
Jal Shakti Vibhag

No. IPH-B(A)3-1/2019-II Dated 17/12/2020

NOTIFICATION

The last assessment of state-wise annual ground water recharge for the entire country was carried out for the water year 2016-17 based on the methodology adopted by the Ground Water Resources Estimation Committee-2015. Since then changes in ground water scenario in many parts of the country has been observed. The National Water Policy, 2012 has also recommended that the ground water resources of the country should be re-assessed periodically. With a view to re-assess ground water resources for the water year 2019-20, the Governor, Himachal Pradesh is pleased to order to constitute a State Level Committee with the following composition:-

(i) The Secretary (JSV)	-Chairman
(ii) The Engineer-in-Chief (JSV)	-Member
(iii) The Director (Industries)	-Member
(iv) The Director (UD)	-Member
(v) The Director (Agriculture)	-Member
(vi) The Director (RD)	-Member
(Vii) All the Chief Engineers (JSV)	-Member
(Viii) The Superintending Engineer, GSWSSC	-Member
(iX) The Superintending Engiener (P&I)-II	-Member
(X) The Superintending Engineer (Hydrology)	-Member
(Xi) HP Water Management Board, Chief Engineer (D&M)	-Member
(Xii) The Chief General Manager, NABARD	-Member
(Xiii) Sr. Hydrologist, Ground Water Organization, Una	-Member
(Xiv) The Regional Director, Central Ground Water Board	-Member Secretary

The committee may co-opt any other Member(s) /special invitee(s), if necessary.

2. **Terms of Reference:** The broad terms of reference of the Committee would be as follows:-

i. To re-assess annual ground water recharge of the state in accordance with the Ground Water Resources Estimation Methodology-2015.

ii. To estimate the status of utilization of the annual extractable ground water resource.

3. **Time Frame:** The Committee will submit its report on or before 28-2-2021.

4. **Expenditure:** Expenditure on account of TA/DA to official Members of the Committee will be met from the source from which they draw their salaries and that of non-official Members, will be borne by the Department of Jal Shakti Vibhag.

5. This notification has already been uploaded on e-Gazette of H.P. Government website.

BY ORDER

Amitabh Awasthi
Secretary(JSV) to the
Government of Himachal Pradesh

Endst. No. As above Dated: Shimla-2 the 17 /12/2020
Copy to:

1. The Secretary, Government of India, Ministry of Jal Shakti, Department of Water Resources, River Development & Ganga Rejuvenation, Shram Shakti Bhawan, Rafi Marg, New Delhi-110001.
2. The Joint Secretary, Government of India, Ministry of Jal Shakti, Department of Water Resources, River Development & Ganga Rejuvenation, Shram Shakti Bhawan, Rafi Marg, New Delhi-110001.
3. All Heads of Departments in Himachal Pradesh.
4. All Divisional Commissioners in Himachal Pradesh.
5. All Deputy Commissioners in Himachal Pradesh.
6. All Members of H.P. Water Management Board.
7. All Members of State Level Committee.
8. The Engineer-in-Chief, JSV, Jal Shakti Bhawan, Tutikandi, Shimla-5.
9. The Director, Government of India, M&A Directorate, SDA Complex, Shimla-9.
10. The Regional Director, Central Ground Water Board, NHR, Dove Cottage, Ramnagar, P.O. Ramnagar, Dharamshala, Himachal Pradesh-176215.

(D.D. Sharma)
Special Secretary (JSV) to the
Government of Himachal Pradesh

Proceedings of the online meeting held on 01.03.2021 under the chairmanship of Secretary, Jal Shakti Vibhag, to the Govt. of Himachal Pradesh regarding-

1. **State Level Committee on Ground Water Resource Estimation of Himachal Pradesh as on March 2020.**
2. **5th meeting of State Ground Water Co-ordination Committee (SGWCC) for presentation of reports 2748 Sq. km under National Aquifer Mapping Program.**

At the outset, Shri J. N. Bhagat, Regional Director, CGWB, NHR welcomed Sh. Vikas Labroo, Secretary (Jal Shakti Vibhag) Chairman & other Members of State Ground Water Co-ordination Committee (SGWCC). He apprised the members that the Committee was constituted to re-assess annual ground water recharge of the State in accordance with the Ground Water Resource Estimation Methodology-2015 (GEC 2015) and estimate the status of utilization of the annual extractable ground water resource. The list of participants is attached as **Annexure-A.**

The meeting started with the following agenda, circulated to all Members, through e-mail:-

Agenda No. 1:- Approval of report on Dynamic Ground Water Resource of Himachal Pradesh as on March 2020, compiled on the basis of GEC (Ground Water Resource Estimation Committee) , 2015 jointly by Jal Shakti Vibhag, H.P. and Central Ground Water Board, Dharamshala.

- The outcome of the report was shared in the form of Power Point Presentation (PPT) by Sh. Vipin Kumar, Scientist-B, CGWB, Dharamshala.
- The committee was informed that as per **Ground Water Resource Estimation Committee** (GEC) 2015 recommendations, ground water recharge may be estimated for the entire assessment unit, however, out of the total geographical area of the unit, hilly areas wherever slope is greater than 20% are to be identified and subtracted as these areas have more runoff than infiltration. The hilly areas where slope is more than 20% may be demarcated using DEM (Digital Elevation Model) data and geomorphological maps.

  However in the earlier studies, assessment units were mapped manually on topographic-sheets and the categorization of slopes could not be

done precisely. Also in the earlier studies, only the areas having high yielding tubewells (alluvial formations) were taken into consideration and areas having semi-consolidated formation were not taken into account.

The committee was also apprised that groundwater exploration work carried out in the state since 2004 has resulted into expansion of the extent of valleys in the State; however, in the earlier studies carried out from the Year 2004 to 2009 there has been marginal increase in the areas of assessment units; but in the studies carried out after 2009, no changes have been incorporated in the assessment unit areas. Assessment units areas taken in the previous Groundwater Assessment Studies is attached as **Annexure-B**.

It was also informed that estimation study for new areas explored in the past years also need to done.

The committee was further apprised that in view of the GEC 2015 recommendations the boundaries of the assessment units taken in the previous studies required changes.

- It was apprised that in the present assessment study, boundaries of all the assessment units have been drawn using Digital Elevation profile data acquired through Shuttle Radar Topography Mission (**SRTM)** satellite data having 30m resolution and the boundaries of assessment units have been taken considering slopes worked out using SRTM data, hydrogeological & watershed boundaries, lithological boundaries of the assessment unit areas taken from Groundwater Prospect Maps, prepared by NRSA, Deptt. of Space, Govt. of India, using GIS software. Accordingly the slope map created for the present study is attached as **Annexure-C** & Aquifer wise detail of assessment units is shown in **Annexure-D**. Hydrogeological formation wise maps of assessment units are shown in **Annexure-E** to **Annexure-M.**

  A comparison of assessment unit areas taken for the Groundwater Assessment Studies conducted in March 2017 and the assessment unit areas to be taken for the present study is given hereunder:-

Sl. No.	Assessment Unit/Valley	District	Assessment unit area taken in 2017 assessment Study (Sq.km)	Assessment unit area worked out for the present study (Sq.km)	Remarks
1	Nurpur-Indora Valley	Kangra	503.20	1024.00	Indora & Nurpur Valleys were taken as 2 different units with area 265.45 Sq. km & 237.75 Sq. km respectively in 2017 whereas in the present study Indora & Nurpur valleys have been taken as single unit.
2	Dharamshala-Palampur Valley	Kangra	--	452.00	Assessment for this valley is being carried out for first time in 2020.
3	Balh Valley	Mandi	95.00	107.00	
4	Chauntra Valley	Mandi	--	52.00	Assessment for this valley is being carried out for first time in 2020.
5	Paonta Valley	Sirmour	156.77	276.00	
6	Kala Amb Valley	Sirmour	2.50	82.00	
7	Nalagarh Valley	Solan	238.49 493.00	336.00	Previously Una Valley was assessed as a single unit. In the present study, basin wise areas have been taken.
8	Una Valley (Satluj Basin)	Una		1045.00	
9	Una Valley (Beas Basin)	Una		65.00	
10	Hum Valley	Una	22.00	29.00	
		Total	**1510.96**	**3468.00**	

Detailed discussions were held on the revision of assessment unit area for the present study and after detailed deliberations the committee agreed to revise the boundaries of the assessment unit areas and addition of new assessment units and adopt the same for the Ground Water Resource Estimation (GWRE) as on March 2020.

- It was also apprised to the committee that Central Ground Water Board, Department of Water Resources, RD & GR, Ministry of Jal Shakti, Govt. of India in collaboration with Indian Institute of Technology Hyderabad and Vassar Labs

have automated the Estimation of Dynamic Ground Water Resources using GEC-2015 methodology and have created an online India-Ground Water Resource Estimation System (IN-GRES). IN-GRES is the common portal to input, estimate, analyze, and access static and dynamic groundwater resources of the Country. Recharge (in-fluxes) and Extraction (out-fluxes) of groundwater resources are automated. The ground water recharge is estimated by the system using ground water level fluctuation and specific yield approach as well as rainfall infiltration factor method.

The present study has been carried out through IN-GRES and the extraction data from April 2019 to March 2020 has been used. The data variables used for computing the Ground Water Resource Estimation through IN-GRES are attached in **Annexure-N, Annexure-O & Annexure-P.**

- As per GWRE as on March 2020 carried out using the new assessment unit areas of the valleys (3468 sq km) as mentioned above and through IN-GRES, stage of Groundwater extraction and categorization in different valleys of the State is as under:-

Stage of Ground Water Extractions in Himachal Pradesh as on March 2020				
Sl. No.	Assessment Unit	District	Stage of Development (%)	Categorization
1	Nurpur - Indora Valley	Kangra	29.27	Safe
2	Dharamshala-Palampur Valley	Kangra	13.76	Safe
3	Balh Valley	Mandi	41.39	Safe
4	Chauntra Valley	Mandi	17.12	Safe
5	Paonta Valley	Sirmour	22.44	Safe
6	Kala Amb Valley	Sirmour	27.51	Safe
7	Nalagarh Valley	Solan	58.43	Safe
8	Una Valley (Satluj Basin)	Una	60.99	Safe
9	Una Valley (Beas Basin)	Una	31.35	Safe
10	Hum Valley	Una	58.12	Safe

- The Chairman cum Secretary (Jal Shakti Vibhag) asked about the reasons for the major change in the stage of Groundwater Development of all the assessment units. In response to this, Sh. Bhavnesh Sharma, Senior Hydrogeologist, GWO

and Sh. Vipin Kumar, CGWB jointly explained that the change in stage of Groundwater extraction is mainly due to two factors:-

- Revision in the extent of hydrogeological boundaries. As the area of all the units has increased, resultantly recharge due to rainfall also increased in the units. The major change in water availability is due to the increase in recharge area of the assessment unit.
- During previous assessments, data variables used in calculating recharge from other sources e.g. Surface Irrigation Schemes, Canals, Water Conservation Structures; Tanks and Ponds were not taken. As the recharge from these structures has been taken into account in the present study, it has resulted also into change in the ground water availability.

In view of the above discussions & deliberations, the report on Dynamic Groundwater Resources of Himachal Pradesh as on March 2020 was approved by the committee.

Agenda No. 2:- Sharing of reports generated under National Aquifer Mapping for 2748 Sq. Km. of Himachal Pradesh.

Study Area	Area (Km^2)
NAQUIM & Management Plan in Parts of Bilaspur, Hamirpur & Solan (HP).	1488
NAQUIM & Management Plan in Parts of Kangra-Chamba area (HP).	859
NAQUIM & Management Plan in Kala Amb Valley, District Sirmour (HP).	81
NAQUIM & Management Plan in Indora Valley, District Kangra (HP).	320

- NAQUIM & Management Plan in Parts of Bilaspur, Hamirpur & Solan District was presented by Sh. Vipin Kumar, Scientist-B, CGWB as a type area. Sh. Vipin Kumar described about the need of study, area taken up for study and its hydrogeology.
- Various thematic map prepared for the study area were shared.
- Discussion was held regarding major ground water challenges in study and possible solution thereof.

- Sh. Vipin Kumar shared the Aquifer maps, 2D and 3D cross section of the area and current stage of ground water extraction.
- Management plan for the areas was shared, in which following solution were suggested:-
    - As the stage of groundwater extraction is low, irrigation though tubewells/borewells must be promoted through PMKSY.
    - Suitable structures for conservation of surface runoff must be done.
    - Details about the management pan are attached as **Annexure-H.**
    - Due to constraints of time other presentation were considered as shared.
    - Sh. J. N. Bhagat, Regional Director, CGWB said that the report of all the areas covered under NAQUIM will be submitted to Engineer-in-Chief, Jal Shakti Vibhag & concerned DM/DC for implementation of management plan.

In view of the above discussions, reports generated under National Aquifer Mapping for 2748 Sq. Km. of Himachal Pradesh were shared with the committee.

Meeting ended with the vote of thanks to the chair.

Annexure-A

List of Participants.

1. Sh. Vikas Labroo, Secretary (JSV), Govt. of HP, Shimla-2 (HP).
2. Er. Naveen Puri, Engineer-in-Chief, Jal Shakti Vibhag, Tutikandi Shimla-5. (HP).
3. Er. Dharmender Gill, Chief Engineer, Jal Shakti Vibhag, Mandi Zone, Mandi (H.P.)
4. Er. Sushil Justa, Chief Engineer, Jal Shakti Vibhag, Shimla Zone, Shimla (H.P.)
5. Er. S.K.Sharma, Chief Engineer, Jal Shakti Vibhag, Hamirpur Zone, Hamirpur (H.P.)
6. Er. Sunil Kanotra, Chief Engineer, JSV, Dharamshala Zone, Dharamshala (H.P.)
7. Er.. Hemant Tanwar, Superintending Engineer (P&I - II) cum Superintending Engineer (Hydrology) JSV, Jal Shakti Bhawan, Tutikandi Shimla-5 (HP).
8. Representative of Forest Department O/o Principal Chief Conservator of Forests (HP)
9. Sh. Bhavnesh Sharma, Senior Hydrogeologist, GWO, Jal Shakti Vibhag, Una (HP).
10. Sh. J.N.Bhagat, Regional Director cum Member Secretary, CGWB, Dharamshala (HP).
11. Sh. Vipin Kumar, Scientist-B, CGWB, Dharamshala (HP).
12. Mrs. Rachna Bhatti, Scientist-C, CGWB, Dharamshala (HP)
13. Mrs. Dharamshila Singh, Scientist-B, CGWB, Dharamshala (HP).
14. Sh. Vidya Bhooshan, STA(Hg), CGWB, Dharamshala (HP).

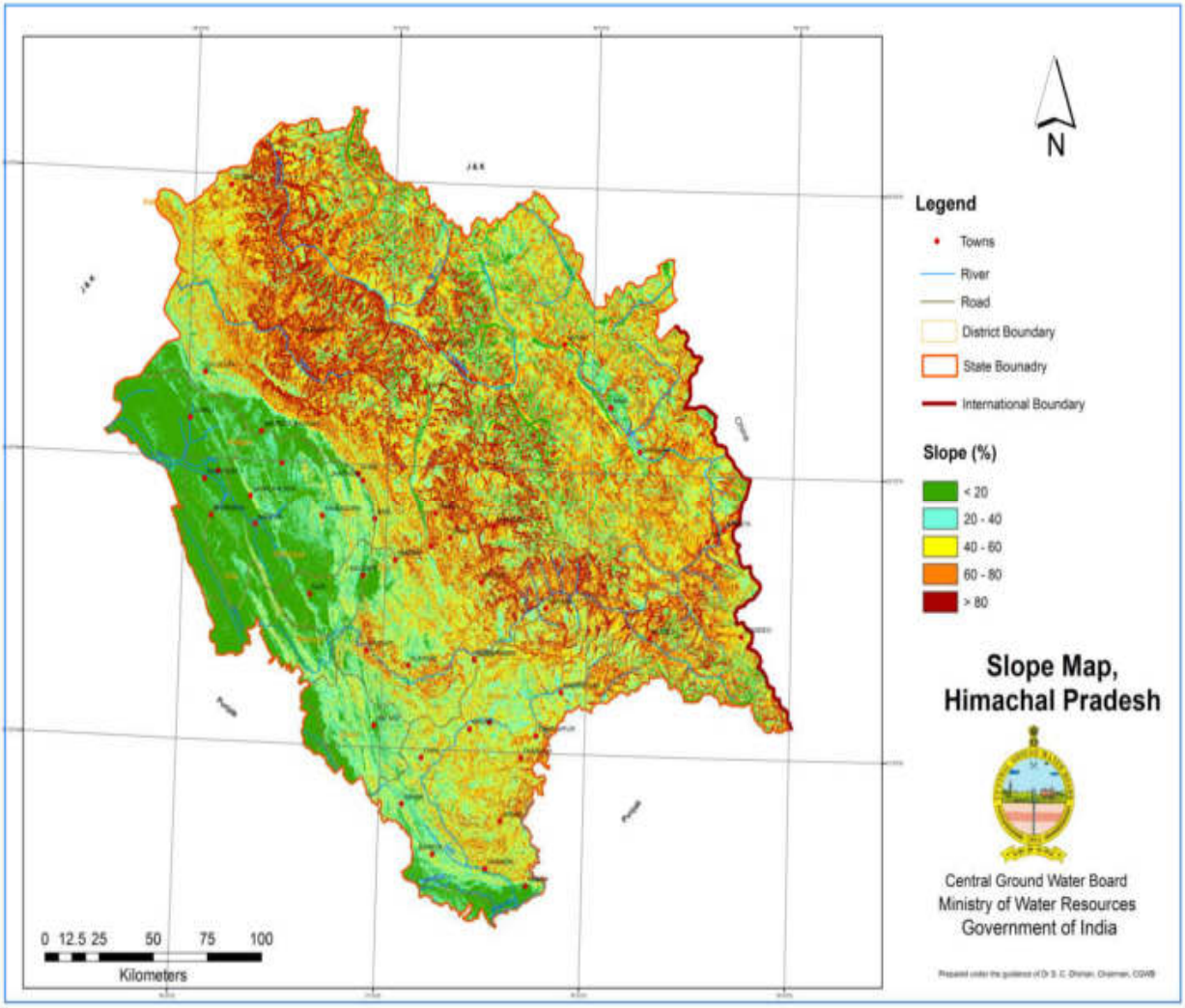
List of the officers who did not attend online Meeting on 01.03.2021

1. The Director, Directorate of Industries, Udyog Bhawan, Bemloe, Shimla-1 (H.P)
2. The Director, Urban Development, Palika Bhawan, Talland, Shimla-2 (H.P)
3. The Director, Directorate of Agriculture, Krishi Bhawan, Boileauganj, Shimla-5 (H.P.)
4. Chief General Manager (NABARD).

Assessment Unit Areas in GWRE Assessment in 2004, 2009, 2011, 2013 **(Annexure-B).**

Sr. No.	Assessment Unit	District	Area (Sq. Km) in 2004 assessment	Area (Sq. Km) in 2009 assessment	Area (Sq. Km) in 2011 assessment	Area (Sq. Km) in 2013 assessment
1	Nurpur - Indora Valley	Kangra	270	503.20 Indora and Nurpur Valley were taken as two units previously with area 265.45 & 237.75 sq km respectively	503.20 Indora and Nurpur Valley were taken as two units previously with area 265.45 & 237.75 sq km respectively	Nurpur - Indora Valley 503.20
2	Dharamshala-Palampur Valley	Kangra	The assessment for this valley is being carried out for first time in 2020	The assessment for this valley is being carried out for first time in 2020	The assessment for this valley is being carried out for first time in 2020	The assessment for this valley is being carried out for first time in 2020
3	Balh Valley	Mandi	95	95	95	95
4	Chauntra Valley	Mandi	The assessment for this valley is being carried for first time in 2020	The assessment for this valley is being carried for first time in 2020	The assessment for this valley is being carried for first time in 2020	The assessment for this valley is being carried for first time in 2020
5	Paonta Valley	Sirmour	150	156.27	156.27	Paonta Valley
6	Kala Amb Valley	Sirmour	The assessment for this valley was carried for first time in 2009	2.5	2.5	Kala Amb Valley
7	Nalagarh Valley	Solan	230	238.49	238.49	Nalagarh Valley
8	Una Valley (Satluj Basin)	Una	453	493	493	Una Valley (Satluj Basin)
9	Una Valley (Beas Basin)	Una	Previously Una Valley was assessed as a single unit with total area of 453 Sq km	Previously Una Valley was assessed as a single unit with total area of 493 Sq km	Previously Una Valley was assessed as a single unit with total area of 493 Sq km	Una Valley (Beas Basin)
10	Hum Valley	Una	The assessment for this valley was carried for first time in 2009	22	22	22
	Total		**1198**	**1510.46**	**1510.46**	**1510.46**

Slope Map Himachal Pradesh **(Annexure-C).**

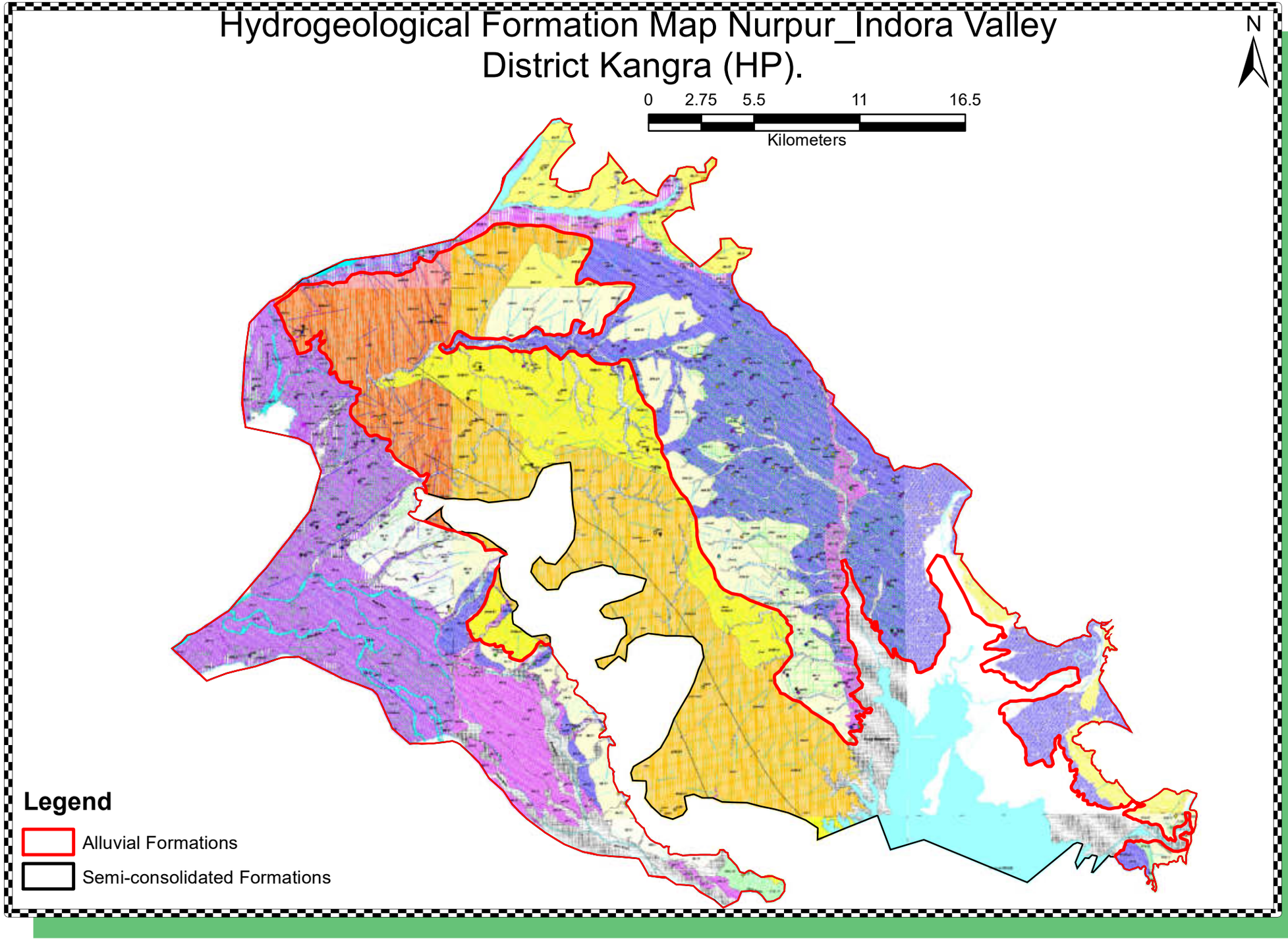


Aquifer wise Assessment Unit Areas in GWRE Study 2020 **(Annexure-D).**

Sr No	Assessment Unit	District	Area of Assessment unit (Sq Km.)	Valley fill	Sandstone/Conglomerate/ Shale
1	Nurpur-Indora Valley	Kangra	1024	578	446
2	Dharamshala-Palampur Valley	Kangra	452	452	0
3	Balh Valley	Mandi	107	107	0
4	Chauntra Valley	Mandi	52	52	0
5	Paonta Valley	Sirmour	276	221	55
6	Kala Amb Valley	Sirmour	82	35	47
7	Nalagarh Valley	Solan	336	280	56
8	Una Valley (Satluj Basin)	Una	1045	535	510
9	Una Valley (Beas Basin)	Una	65	20	45
10	Hum Valley	Una	29	29	0
	Total Area		**3468**	**2309**	**1159**

Annexure E

Hydrogeological Formation Map Nurpur_Indora Valley District Kangra (HP).



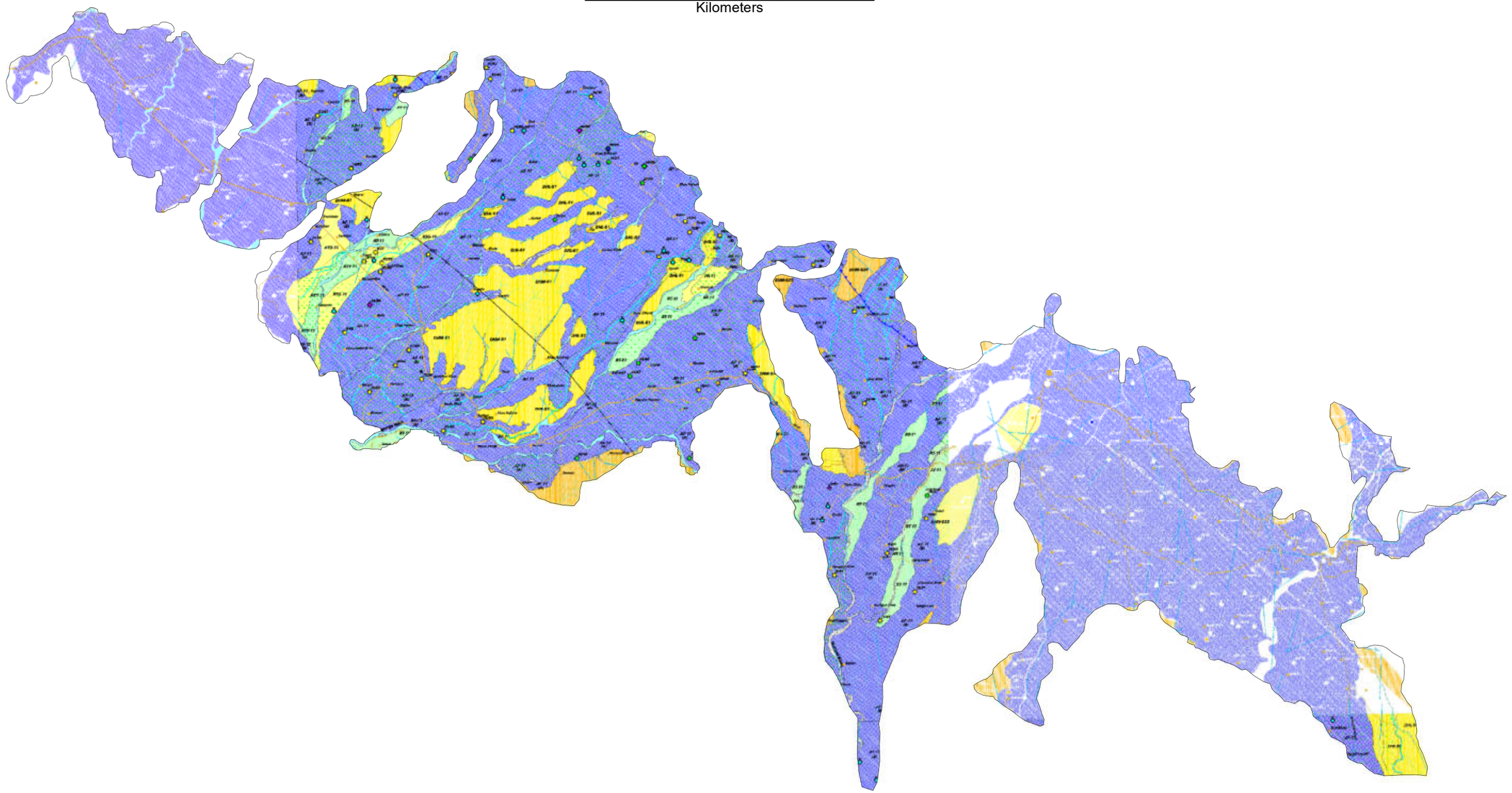
Annexure F

Hydrogeological Formation Map Dharamshalla_Palampur Valley
District Kangra (HP).

N

0 1.75 3.5 7 10.5

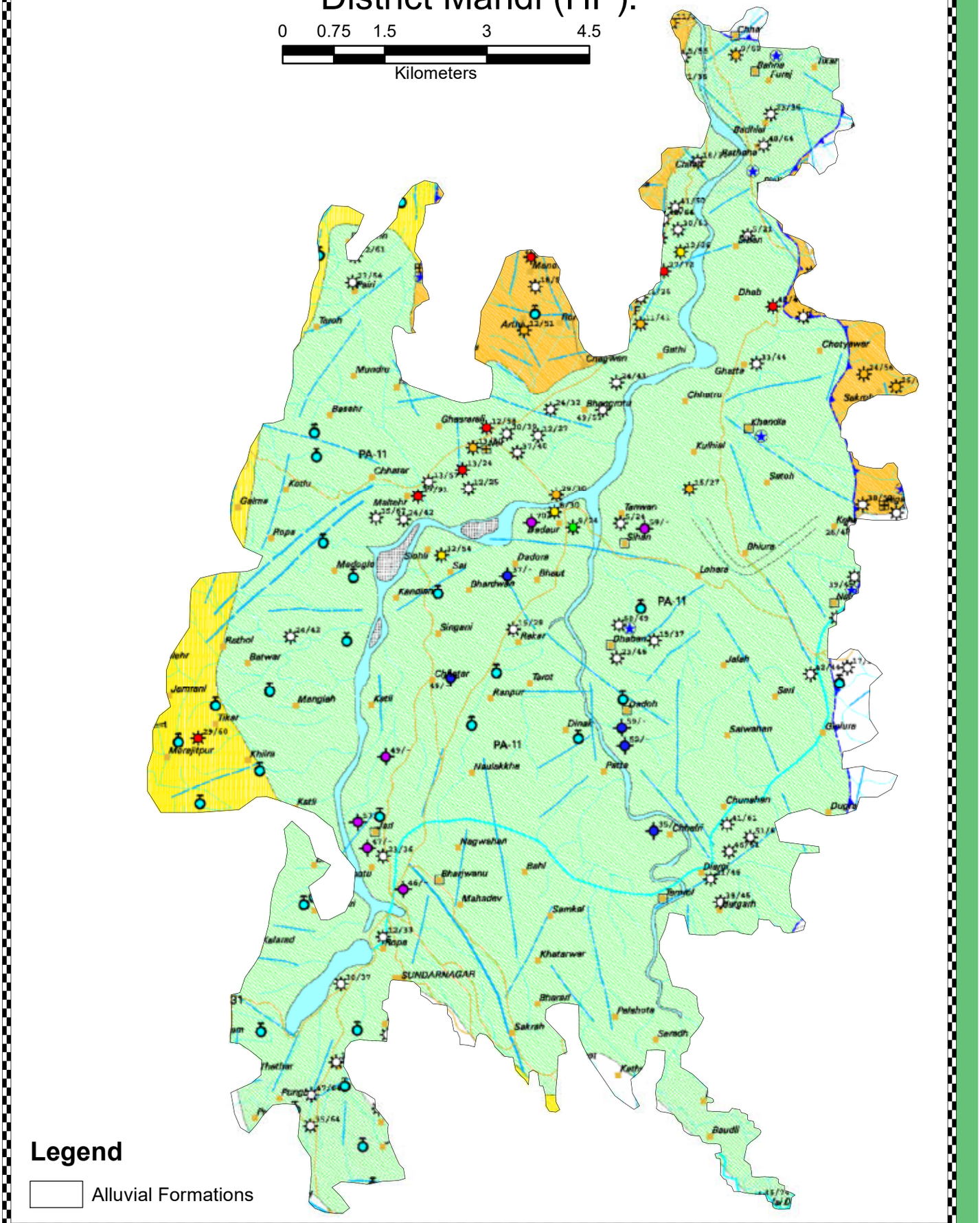
Kilometers



Legend

Alluvial Formations

Hydrogeological Formation Map Balh Valley District Mandi (HP).



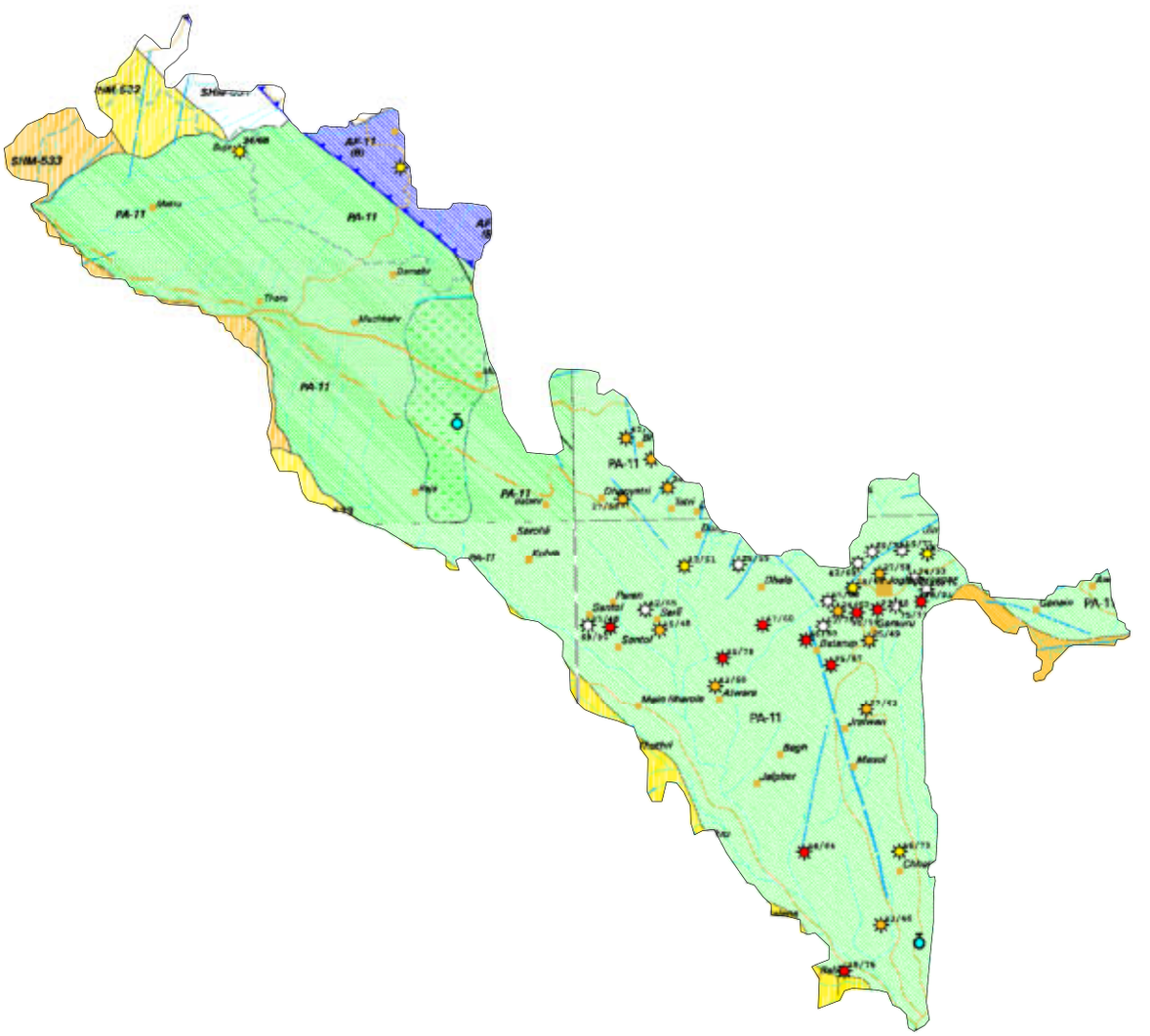
Annexure H

Hydrogeological Formationl Map Chauntra Valley District Mandi (HP).

N

0 1 2 4 6

Kilometers

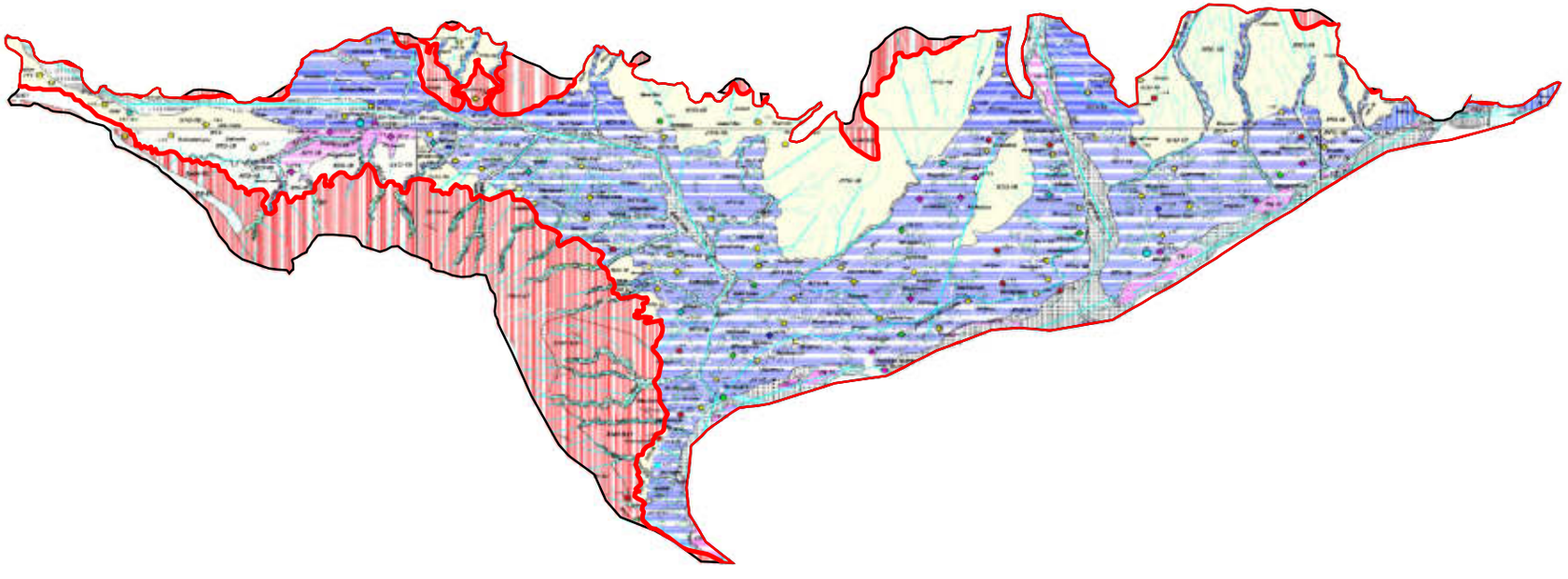


Legend

Alluvial Formations

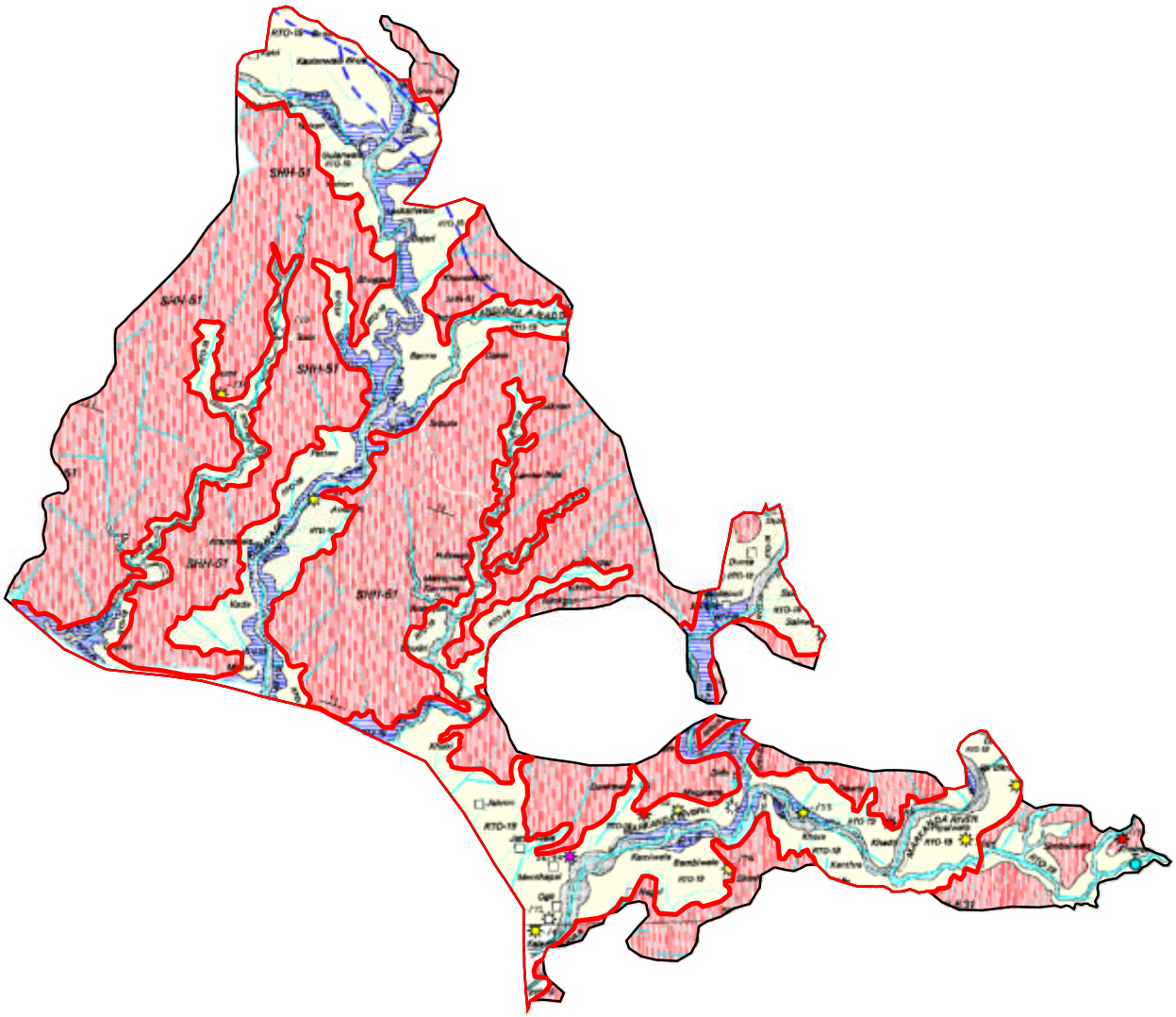
Annexure I

Hydrogeological Formation Map Paonta Valley District Sirmour (HP).



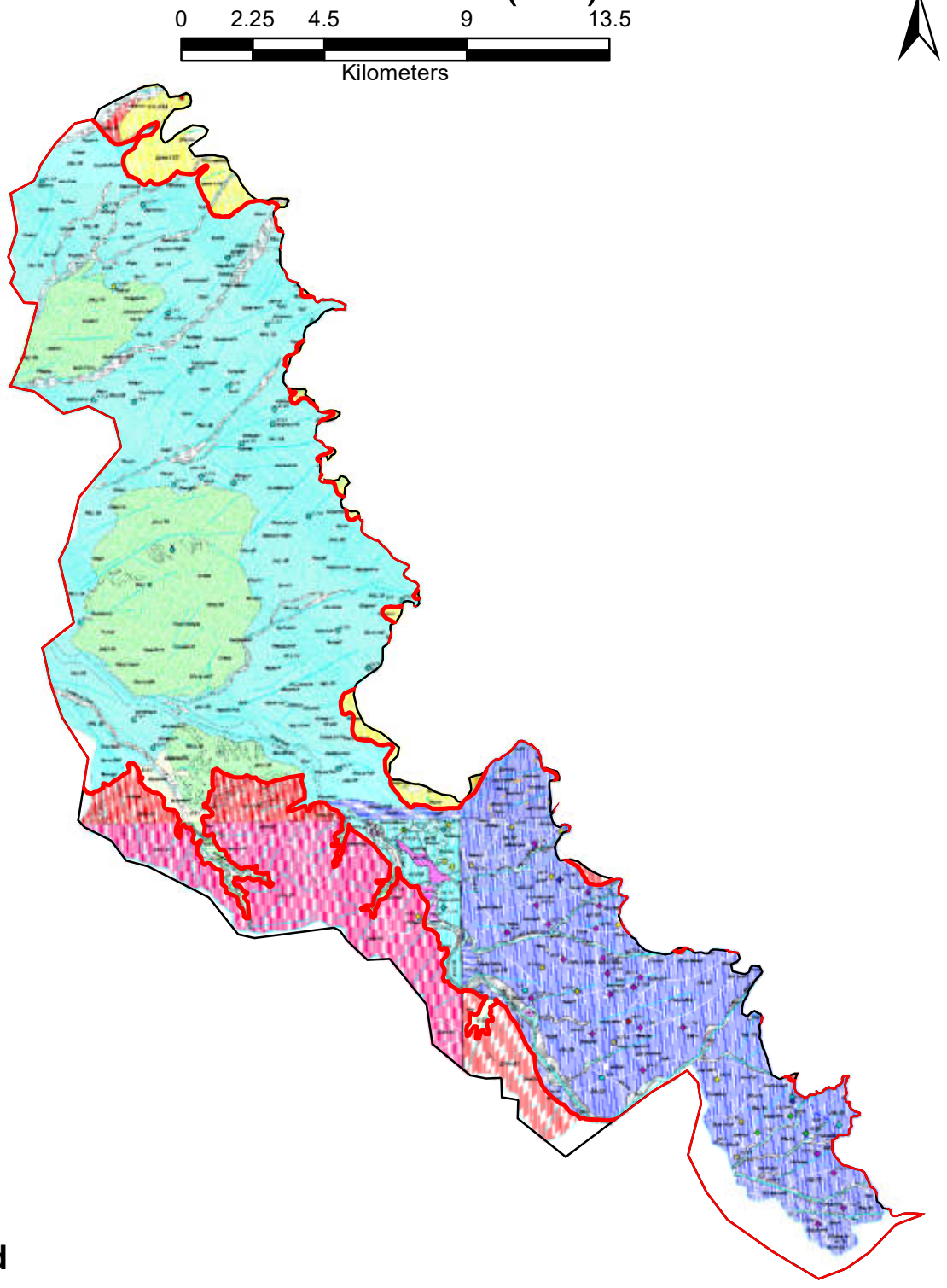
Annexure J

Hydrogeological Formation Map Kala Amb Valley District Sirmour (HP).

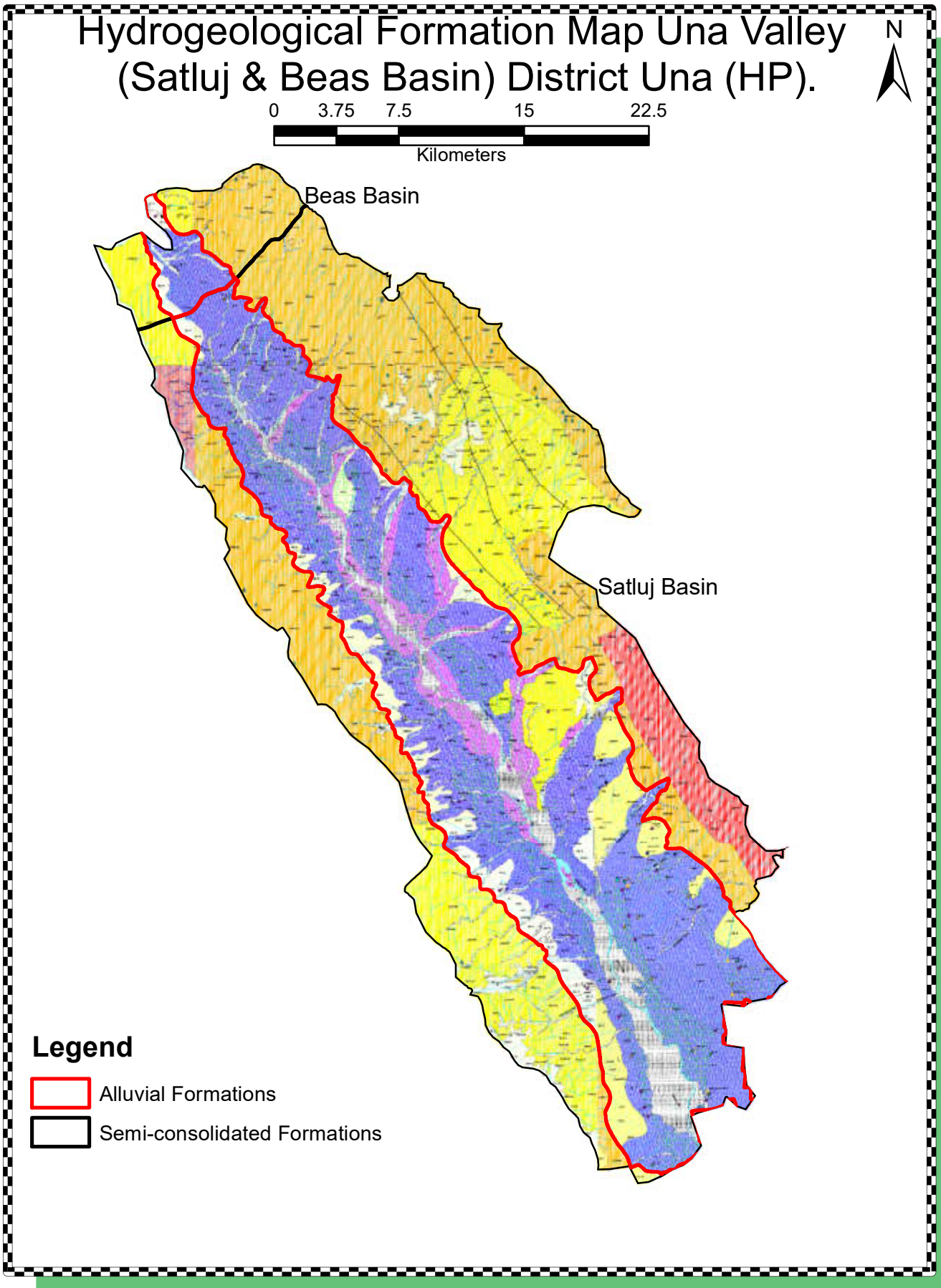


Annexure K

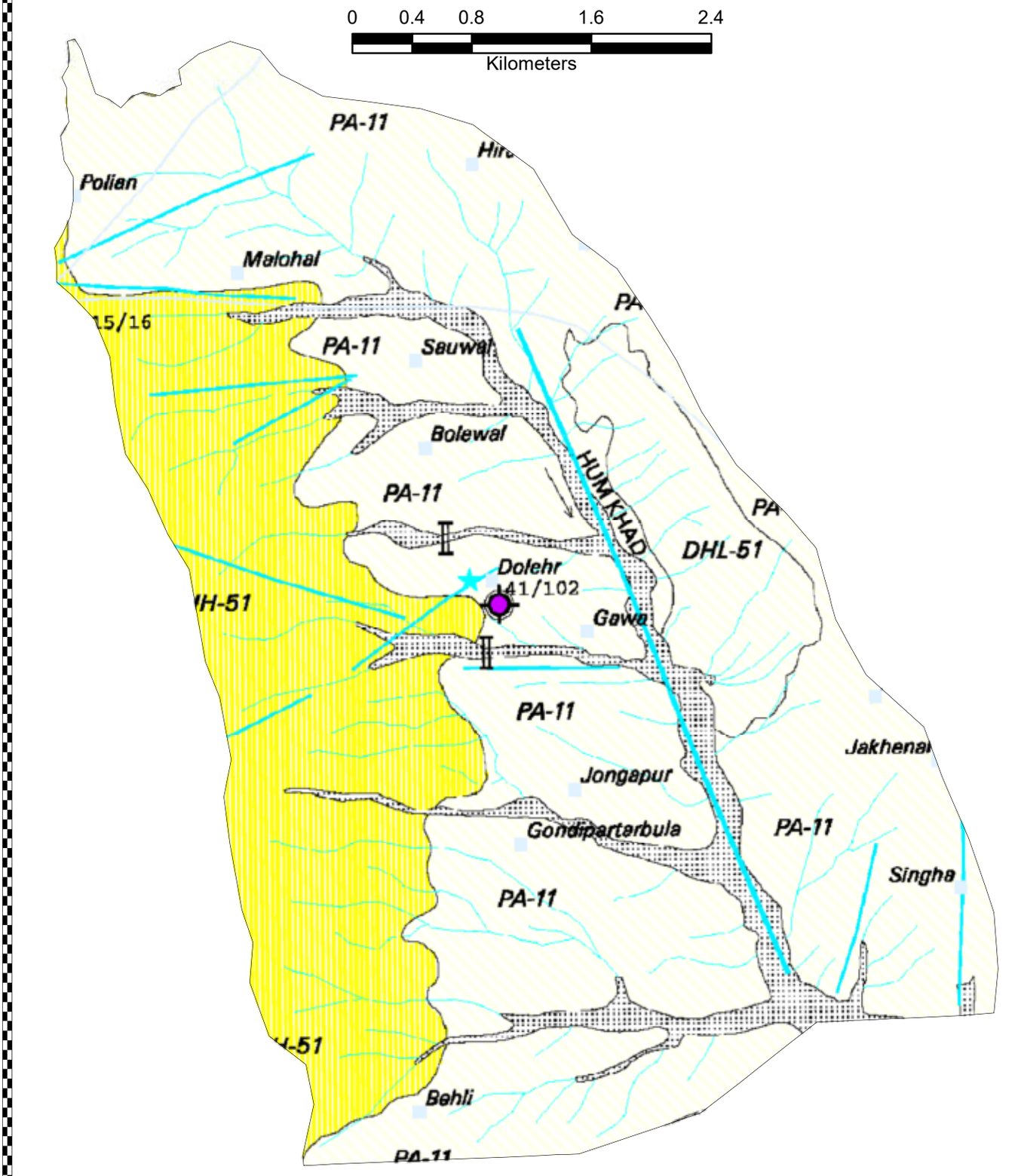
Hydrogeological Formation Map Nalagarh Valley District Solan (HP).



Annexure L


Hydrogeological Formation Map Una Valley
(Satluj & Beas Basin) District Una (HP).
N
0 3.75 7.5 15 22.5
Kilometers
Beas Basin
Satluj Basin
Legend
Alluvial Formations
Semi-consolidated Formations

Hydrogeological Formation Map Hum Valley District Una (HP).



Legend

Alluvial Formations

(Annexure-N).

DATA VARIABLES USED IN DYNAMIC GROUND WATER RESOURCES OF HIMACHAL PRADESH
(As on March-2020)

Sl. No.	Assessment Unit	Command/ Non command/Poor GW Quality	Rainfall (Average annual Normal) (mm)* *After subtracting 10% of NMR		Average Pre monsoon Water Level 2019 (mbgl)	Average Post monsoon Water Level 2019 (mbgl)	Average Fluctuation (mbgl)
			Monsoon	Non-Monsoon			
1	Nurpur-Indora Valley (Kangra District)	Non-Command	1556.04	412.64	3.96	2.98	0.98
2	Dharamshala Palampur Valley(Kangra District)	Non-Command	1556.04	412.64	20.72	19.77	0.95
3	Balh Valley Mandi District	Non-Command	934.4	496.1	3.91	3.22	0.69
4	Chauntra Valley Mandi District	Non-Command	934.4	496.1	29.50	24.80	4.70
5	Paonta Valley (Sirmour District	Non-Command	1090.49	335.59	13.18	10.11	3.07
6	Kala Amb Valley (Sirmour District)	Non-Command	1090.49	335.59	5.37	5.57	-0.20
7	Nalagarh Valley (Solan District)	Non-Command	900.09	366.1	12.79	12.18	0.61
8	Una Valley Satluj Basin (Una District)	Non-Command	751.63	248.00	6.22	5.02	1.2
9	Una Valley Beas Basin (Una District)	Non-Command	751.63	248.00	26.10	19.75	6.35
10	Hum Valley (Una District)	Non-Command	751.63	248.00	_	_	_

(Annexure-O).

DATA VARIABLES USED IN DYNAMIC GROUND WATER RESOURCES OF HIMACHAL PRADESH

(As on March-2020)

Sl No	Name of Valley	Domestic Use		Irrigation Use		Industrial draft		Water Conservation Structures	
		No of Structures	GW Draft (ham)	No of Structures	GW Draft (ham)	No of Structures	GW Draft (ham)	No of Structures	Pondage
1	Indora Nurpur Valley	518	2314.82	2186	7708.53	26	109.99	10	4.36
2	Dharamshala Palampur Valley	2612	2282.21	2	1.25	_	_	_	_
3	Balh Valley	454	632.73	88	262.92	_	_	_	_
4	Chauntra Valley	170	130.305	–	–	_	_	_	_
5	Paonta Valley	75	751.19	522	628.87	64	168.67	_	_
6	Kala Amb valley	27	202.85	37	101.76	77	118.92	_	_
7	Nalagarh Valley	119	1197.2	188	2436.76	215	4914.71	78	9600.45
8	Una Valley (Satluj Basin)	4233	2637.38	5482	8204.73	211	159.85	189	342.01
9	Una Valley (Beas Basin)	62	125.25	32	131.94	_	_	_	_
10	Hum Valley	4	103.94	14	291.26	6	6.14	41	49.12

(Annexure-P).

DATA VARIABLES USED IN DYNAMIC GROUND WATER RESOURCES OF HIMACHAL PRADESH
(As on March-2020)

Sr No	Name of Valley	Surface Irrigation		
		No of Schemes	CCA hectares	Average Discharge (ham /day)
1	Indora Nurpur Valley	2	14483.68	89.93
2	Dharamshala Palampur Valley	_	_	_
3	Balh Valley	_	_	_
4	Chauntra Valley	–	–	–
5	Paonta Valley	4	3608.77	32.4496659
6	Kala Amb valley	–	–	–
7	Nalagarh Valley	21	2158.00	12.2314032
8	Una Valley (Satluj Basin)	1	3563.00	6.455753956
9	Una Valley (Beas Basin)	–	–	–
10	Hum Valley	1	1122.00	0.835780822

(Annexure-Q).

Demand Side Management	Supply Side Management
Increasing Area Under Assured Irrigation through: 1. Construction of Shallow Depth TW: 3787 Nos. with 3-4LPs discharge @5.5 Lacs under PMKSY 2. Putting Fallow Land/ Cultivable Waste land to Agriculture Use: 20333 Hectare Cultivable land Available (Fallow + Cultivable Waste Land) through strengthening the network of Kuhls *(Irrigation Requirement 10166 Ham)* 3. *Increased grain production of 30122 MT of Maize (Approx Rs 55.7 crore per year)*	Run Off Conservation by Surface Storage Type Conservation Method: 1. Construction of Gabion Structures : 13824 G.S. (0.5 Ham) @50 Thousands 2. Construction of Check Dam/Subsurface Dykes/ Nala Bunding etc. (965 Check Dams of 02 Ham Capacity) @ 15 lac 3. Contour Trenching & Percolation ponds for enhancement of Spring discharge: 446 km Trenchwork for storing 249 Ham @ Rs 357 per trench 4. Modification of Village Tanks/Ponds: 259Ponds of 02 Ham @6.50 Lac 5. *68% GB, 19% CD, 7.7 CT, 5.1*
Total Cost: 208.2 Crore	Total Cost: 6912+14475+1672+1683=74742 Cr. Cost Benefit Ratio: 0.12 Rupees for 1 litre

Annexure A-2

Himachal Pradesh
Jal Shakti Vibhag

No.JSV-GWO/ Resource Estimation/2020-21: 2606 Dated: 01-03-2021

To

The Regional Director,
Central Ground Water Board,
Northern Himalayan Region,
Dharamshala (HP)

Subject: - Collection of data for assessment of "Dynamic Ground Water Resources Estimation in Himachal Pradesh " for the assessment year 2020-reg.

Enclosed please find here with the data for assessment of "Dynamic Ground Water Resources Estimation in Himachal Pradesh " for the assessment year 2020 for favour of further necessary action at your end please.

Senior Hydrogeologist,
Ground Water Organisation,
Jal Shakti Vibhag, Una - 174303

Draft Data Variables Used in GWRE 2020									
Sr No	Name of Valley	Domestic Use		Irrigation Use		Industrial draft		Water Storage	
		No of Structures	Gw Draft in ham	No of Struc	Gw Draft in ham	No of Structures	Gw Draft in ham	No of Structures	Pondage
1	Indora Nurpur Valley	518	2314.82	2186	7708.53	26	109.99	10	4.363037
2	Dharamshala Palampur Valley	2612	2282.21	2	1.25	–	–	–	–
3	Balh Valley	454	632.73	88	262.92	–	–	–	–
4	Chauntra Valley	170	130.305			–	–	–	–
5	Paonta Valley	75	751.19	522	628.87	64	168.67	–	–
6	Kala Amb valley	27	202.85	37	101.76	77	118.92	–	–
7	Nalagarh Valley	119	1197.2	188	2436.76	215	4914.71	78	960.0448
8	Una Valley (Satluj Basin)	4233	2637.38	5482	8204.73	211	159.85	189	342.01
9	Una Valley (Beas Basin)	62	125.25	32	131.94				
10	Hum Valley	4	103.94	14	291.26	6	6.14	41	49.12
	Total	8274	10377.875	8551	19768.02	599	5478.28	318	1355.538

Senior Hydrogeologist
GWO, JSV Una.

Draft Data Variables Used in GWRE 2020				
Sr No	Name of Valley	Surface Irrigation		
		No of Structures	CCA	Discharge (ham)
1	Indora Nurpur Valley	2	14483.68	89.93
2	Dharamshala Palampur Valley	–	–	–
3	Balh Valley	–	–	–
4	Chauntra Valley	–	–	–
5	Paonta Valley	4	3608.77	36.05
6	Kala Amb valley			
7	Nalagarh Valley	21	2158	11.79
8	Una Valley (Satluj Basin)	1	3563	2017.99
9	Una Valley (Beas Basin)	–	–	–
10	Hum Valley	1	1122	305.06
	Total	29	24935.45	2460.82

Senior Hydrogeologist
GWO, JSV Una.

Annexure II A-4

GENERAL DESCRIPTION OF THE GROUND WATER ASSESSMENT UNIT OF THE HIMACHAL PRADESH
(As on March, 2020)

Type of Assessment Unit: Valley area of the District

Sl. No.	Name of Assessment Unit	Type of rock formation							
			Total Geographical Area (Sq. KM)	Hilly Area	Ground Water Recharge Worthy Area			Flood Prone Area	Bottom of the unconfined aquifer in soft rock areas and depth of weathered zone and/or maximum depth of fractures under unconfined zone
					Command area	Non-command area (Valley area)	Poor ground water quality area		
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	
1.	**A. Nurpur & Indora valley (Kangra District)**	Valley fill	1024	**Nil**	**Nil**	1024	**Nil**	**Nil**	
2.	**B Dharamshala Palampur Valley**	Valley fill	452	**Nil**	**Nil**	452	**Nil**	**Nil**	
3.	**A. Balh valley Mandi District**	Valley fill	107	**Nil**	**Nil**	107	**Nil**	**Nil**	
4.	**A. Paonta Valley Sirmour District**	Valley fill	276	**Nil**	**Nil**	276	**Nil**	**Nil**	
5.	**B. Kala Amb Valley Sirmour District**	Valley fill	82	**Nil**	**Nil**	82	**Nil**	**Nil**	
6	**A. Nalagarh valley Solan District**	Valley fill	336	**Nil**	**Nil**	336	**Nil**	**Nil**	
7	**A. Una valley (Sutlej Catchment) Una Dist**	Valley fill	1045	**Nil**	**Nil**	1045	**Nil**	**Nil**	
8	**B. Hum valley Una District**	Valley fill	29	**Nil**	**Nil**	29	**Nil**	**Nil**	
9	**Una Valley Beas Catchment**	**Valley fill**	65	**Nil**	**Nil**	65	**Nil**	**Nil**	
10	**Chauntra Valley Mandi District**	**Valley fill**	52	**Nil**	**Nil**	52	**Nil**	**Nil**	

Annexure II A -5

GENERAL DESCRIPTION OF THE ADMINISTRATIVE UNIT OF THE HIMACHAL PRADESH
(As on March, 2020)

Type of Administrative Unit: Valley

S.No	DISTRICT	ASSESSMENT UNIT	Total Geographical Area(ha)					
			Recharge Worthy				Hilly Area	**Total**
			C	NC	PQ	**Total**		
1	MANDI	BALH VALLEY	0	10,700	0	10,700	28,800	39,500
2		CHAUNTRA VALLEY	0	5,200	0	5,200	0	5,200
3	KANGRA	DHARAMSHALA PALAMPUR VALLEY	0	45,200	0	45,200	0	45,200
4	UNA	HUM VALLEY	0	2,900	0	2,900	3,679	6,579
5	SIRMOUR	KALA AMB VALLEY	0	8,200	0	8,200	0	8,200
6	SOLAN	NALAGARH VALLEY	0	33,600	0	33,600	0	33,600
7	KANGRA	NURPUR & INDAURA VALLEY	0	1,02,400	0	1,02,400	0	1,02,400
8	SIRMOUR	POANTA VALLEY	0	27,600	0	27,600	0	27,600
9	UNA	UNA VALLEY BEAS CATCHMENT	0	6,500	0	6,500	0	6,500
10		UNA VALLEY SUTLEJ CATCHMENT	0	1,04,500	0	1,04,500	0	1,04,500
		TOTAL	0	3,46,800	0	3,46,800	32,479	3,79,279

Annexure III B-1

DATA VARIABLES USED IN DYNAMIC GROUND WATER RESOURCES OF HIMACHAL PRADESH
(As on March, 2020)

Sl.No.	Assessment Unit	Command/ Non command/Poor GW Quality	Rainfall (Average annual Normal) (mm)* *After subtracting 10% of NMR		Average Pre monsoon Water Level (mbgl)	Average Post monsoon Water Level (mbgl)	Average Fluctuation (mbgl)
			Monsoon	Non- Monsoon			
1.	**Nurpur-Indora Valley** (Kangra District)	**Non-Command**	1556.04	412.64	3.96	2.98	0.98
2.	**Dharamshala Palampur Valley** (Kangra District)	**Non-Command**	1556.04	412.64	20.72	19.77	0.95
3.	**Balh Valley** (Mandi District**)**	**Non-Command**	934.4	496.1	3.91	3.22	0.69
4.	**Chauntra Valley** (Mandi District**)**	**Non-Command**	934.4	496.1	29.50	24.80	4.70
5.	**Paonta Valley** (Sirmour District)	**Non-Command**	1090.49	335.59	13.18	10.11	3.07
6.	**Kala Amb Valley** (Sirmour District)	**Non-Command**	1090.49	335.59	5.37	5.57	-0.20
7.	**Nalagarh Valley** (Solan District)	**Non-Command**	900.09	366.1	12.79	12.18	0.61
8.	**Una Valley Satluj Basin** (Una District)	**Non-Command**	751.63	248.00	6.22	5.02	1.2
9.	**Una Valley Beas Basin** (Una District)	**Non-Command**	751.63	248.00	26.10	19.75	6.35
10.	**Hum Valley** (Una District)	**Non-Command**	751.63	248.00	_	_	_

SOURCE: RAINFALL DAT; IMD, WATER LEVEL DATA; CGWB & JSV

Annexure III B-1 (contd…) DATA VARIABLES USED IN DYNAMIC GROUND WATER RESOURCES OF THE HIMACHAL PRADESH (As on March 2017)

Sr.No.	Assessment Unit	Assessment Sub-Unit	Type of Structures	Irrigation	Domestic	Industrial
1	**Nurpur Indora Valley** (Kangra District)	Non Command	DW (Manual Lift)	2186	518	26
			DW with electric/diesel pump			
			STW			
			Others (Percolation well)			
2	**(Dharamshala Palampur Valley)**(Kangra District)	Non Command	DW (Manual Lift)			
			DW with electric/diesel pump			
			STW			
			Others (Percolation well)	2	2612	0
3	**Balh Valley** Mandi District	Non Command	DW (Manual Lift)			
			DW with electric/diesel pump			
			STW			
			Others (Percolation well)	88	454	0
4	**Chauntra Valley** Mandi District	Non Command	DW (Manual Lift)			
			DW with electric/diesel pump			
			STW			
			Others (Percolation well)	0	170	0
5	**Paonta Valley** (Sirmour District	Non Command	DW (Manual Lift)			
			DW with electric/diesel pump			
			STW			
			Others (Percolation well)	522	75	64
6	**Kala Amb Valley** (Sirmour District)	Non Command	DW (Manual Lift)			
			DW with electric/diesel pump			
			STW			
			Others (Percolation well)	37	27	77
7	A. Nalagarh Valley (Solan District	Non Command	DW (Manual Lift)			
			DW with electric/diesel pump			
			STW			
			Others (Percolation well)	188	119	215
8	**Una Valley Satluj Basin**	Non Command	DW (Manual Lift)	5482	4233	211

Sr.No.	Assessment Unit (Una District)	Assessment Sub-Unit	Type of Structures	Irrigation	Domestic	Industrial
			DW with electric/diesel pump			
			STW			
			Others (Percolation well)			
9	**Una Valley Beas Basin** (Una District)	Non Command	DW (Manual Lift)			
			DW with electric/diesel pump			
			STW			
			Others (Percolation well)	32	62	0
10	**Hum Valley** (Una District)	Non Command	DW (Manual Lift)			
			DW with electric/diesel pump			
			STW			
			Others (Percolation well)	14	4	6

SOURCE: JAL SHAKTI VIBHAG, GOVT. OF HP

Annexure III B-2

The Annual rainfall of the valley areas (in mm)
2019

Name of Assessment Unit	Jan	Feb	Mar	April	May	June	July	Aug	Sep	Oct	Nov	Dec	Monsoon	Non-Monsoon
Nurpur Indora Valley, Dharmshala Palampur valley District Kangra	97.2	219.8	38.4	45.3	39.6	37.5	447.2	575.9	249.6	25.6	45.8	95	1310.2	606.70
Balh Valley, Chauntra Valley District Mandi	79.1	198.5	61.1	36.4	33.6	82.6	297	427.8	127	22.1	27.6	37.7	934.4	496.10
Paonta/ Kala Amb Valley District Sirmaur	63.1	138.4	29.6	54.6	27.6	55	391.5	447.4	250.7	39.8	25.1	49.2	1144.6	427.40
Nalagarh Valley District Solan	68.7	138	39.8	25.1	45.3	81.3	304.1	338.3	118	6	31.3	33.1	841.7	387.30
Hum/Una Valley District Una	74.9	182.4	34.2	27.4	21.9	29.2	284.8	436.5	121.2	29	16.6	49.5	871.7	435.90

Source: Indian Meteorological Department (www.weathershimla.nic.in.in)

Annexure III C

PARAMETERS USED IN THE ASSESSMENT OF DYNAMIC GROUND WATER RESOURCES OF HIMACHAL PRADESH (As on March, 2020)

Sl. No.	Assessment Unit	Specific Yield (in fraction)		Rainfall Infiltration Factor (in fraction)		Area Wise Draft (ham)					
						Irrigation		Domestic		Industrial	
		Formation	Value	Formation	Value	Com	Non-Com	Com	Non-Com	Com	Non-Com
1.	Balh Valley	Valley Fill	0.16	Valley Fill	0.22	--	262.9	--	638.27	--	00
2.	Chauntra Valley	Valley Fill	0.16	Valley Fill	0.22	--	0	--	217.18	--	00
3.	Dharamshala Palampur Valley	Valley Fill	0.16	Valley Fill	0.22	--	1.26	--	2272.44	--	00
4.	Hum Valley	Valley Fill	0.16	Valley Fill	0.22	--	291.26	--	103.94	--	6.14
5.	Kala Amb Valley	Valley Fill	0.16 & 0.03	Valley Fill	0.22 & 0.12	--	101.77	--	202.85	--	118.92
6.	Nalagarh Valley	Valley Fill	0.16 & 0.03	Valley Fill	0.22 & 0.12	--	2436.77	--	1197.2	--	4914.7
7.	Nurpur & Indaura Valley	Valley Fill	0.16 & 0.03	Valley Fill	0.22 & 0.12	--	7708.53	--	2314.82	--	109.99
8.	Poanta Valley	Valley Fill	0.16 & 0.03	Valley Fill	0.22 & 0.12	--	628.27	--	759.20	--	168.68
9.	Una Valley Beas Catchment	Valley Fill	0.16 & 0.03	Valley Fill	0.22 & 0.12	--	131.94	--	125.26	--	00
10	Una Valley Sutlej Catchment	Valley Fill	0.16 & 0.03	Valley Fill	0.22 & 0.12	--	8204.73	--	2637.38	--	159.85
					TOTAL	--	19768.05	--	10462.9	--	5478.29

Annexure III D -1

ASSESSMENT OF DYNAMIC GROUND WATER RESOURCES OF HIMACHAL PRADESH (As on March, 2020) (in ham)

Sr. No.	Assessment Unit/District	Area (ha)	Command/ non Command /Total	Rainfall Recharge	Recharge from other sources	Ground Water Recharge (ham)	Enviormental Flows (10% of GW recharge in RIF method & 5 % of GW recharge in WTF)	Net Annual Ground Water Availability	Existing Grosss ground water draft for Irrigation	Existing Gross Ground Water Draft for domestic water supply	Existing Gross Ground Water Draft for Industrial Purpose	Existing gross ground water draft for All uses (11+12+13)
									11	12	13	14
1	Nurpur Indora Valley (Kangra District)	102400	Command	–	12346.09	12346.09	1234.61	34498.55	–	–		10133.34
			Non-Command	23544.59	2441.04	25985.63	2598.56		7708.53	2314.82	109.99	
			Total	23544.59	14787.13	38331.72	3833.17		7708.53	2314.82	109.99	
2	Dharmshala Palampur Valley (Kangra District)	45200	Command	–	–	–	–	16527.93				2283.47
			Non-Command	18364.37	–	18364.37	1836.44		1.26	2282.21	0.00	
			Total	18364.37		18364.37	1836.44		1.26	2282.21	0.00	
3	Balh Valley Mandi District	10700	Command	–	–	–	–	2163.93				895.65
			Non-Command	2321.35	83.02	2404.37	240.44		262.92	632.73	0.00	
			Total	2321.35	83.02	2404.37	240.44		262.92	632.73	0.00	
4	Chauntra Valley (Mandi District)	5200	Command	–	–	–	–	1268.76				130.21
			Non-Command	1409.73	–	1409.73	140.97		0.00	130.21	0.00	
			Total	1409.73	–	1409.73	140.97		0.00	130.21	0.00	
5	Paonta Valley (Sirmour District)	27600	Command	–	166.46	166.46	16.65	6937.82				1548.74
			Non-Command	7346.65	195.58	7542.23	754.22		628.87	751.19	168.68	
			Total	7346.65	362.04	7708.69	770.87		628.87	751.19	168.68	
6	Kala Amb Valley (Sirmour District)	8200	Command	–	–	–	–	1539.48				423.54
			Non-Command	1609.51	25.44	1634.95	95.47		101.77	202.85	118.92	
			Total	1609.51	25.44	1634.95	95.47		101.77	202.85	118.92	
7	Nalagarh Valley (Solan District)	33600	Command	–	7508.50	7508.50	750.85	14629.61				8548.68
			Non-Command	7977.35	769.27	769.27	76.93		2436.77	1197.20	4914.71	
			Total	7977.35	8277.77	16255.12	1625.51		2436.77	1197.20	4914.71	

Sr. No.	Assessment Unit/District	Area (ha)	Command/ non Command /Total	Rainfall Recharge	Recharge from other sources	Ground Water Recharge (ham)	Enviormental Flows (10% of GW recharge in RIF method & 5 % of GW recharge in WTF)	Net Annual Ground Water Availability	Existing Grosss ground water draft for Irrigation	Existing Gross Ground Water Draft for domestic water supply	Existing Gross Ground Water Draft for Industrial Purpose	Existing gross ground water draft for All uses (11+12+13)
8	Una Valley (Satluj Basin) (Una District)	104500	Command	_	861.85	861.85	86.19	18037.76	8204.73	2637.38	159.85	11001.96
			Non-Command	15290.95	2879.68	18170.63	908.53					
			Total	12717.18	3741.53	19032.48	994.72		8204.73	2637.38	159.85	
9	Una Valley (Beas Basin) (Una District)	6500	Command	_	_	_	_	820.30	131.94	125.26	0.00	257.20
			Non-Command	911.44	_	911.44	91.14					
			Total	911.44	_	911.44	91.14		131.94	125.26	0.00	
10	Hum Valley (Una District)	2900	Command	_	80.08	80.08	8.01	690.49	291.26	103.94	6.14	401.34
			Non-Command	593.37	93.76	687.13	68.71					
			Total	593.37	173.84	767.21	76.72		291.26	103.94	6.14	

Annexure III D-1(contd…)

ASSESSMENT OF DYNAMIC GROUND WATER RESOURCES OF HIMACHAL PRADESH (As on March, 2020) (in ha m)

S.N.	Assessment Unit/District	Area (ha)	Rainfall Recharge	Recharge from other sources	Ground Water Recharge (ham) Col(4+5)	Environ-mental Flows	Annual Extractable Ground Water Resource (ham) Col(7-6)	Ground Water Extraction for all Uses	Provision for domestic supply upto 2025	Net Ground Water Availability for future use (ham)	Stage of Ground Water Development
1	2	3	4	5	6	7	8	9	10	11	12
1	Nurpur Indora Valley	102400	23544.59	14787.13	38331.72	3833.172	34498.55	10133.34	2314.82	24365.21	29.37
2	Dharmshala Palampur Valley	45200	18364.37	0	18364.37	1836.437	16527.94	2273.70	2272.44	14254.24	13.76
3	Balh Valley	10700	2321.35	83.02	2404.37	240.437	2163.93	895.65	623.73	1268.28	41.39
4	Chauntra Valley	5200	1409.73	0	1409.73	140.973	1268.76	217.18	217.18	1051.57	17.12
5	Paonta Valley	27600	7346.65	362.04	7708.69	770.869	6937.82	1556.75	759.20	5381.07	22.44
6	Kala Amb Valley	8200	1609.51	25.44	1634.95	95.47	1539.48	423.54	202.85	1115.94	27.51
7	Nalagarh Valley	33600	7977.35	8277.78	16255.13	1625.513	14629.62	8548.68	1197.20	6757.66	58.43
8	Una Valley (Satluj Basin)	104500	15290.95	3741.53	19032.48	994.71	18037.77	11001.96	2637.38	5543.11	60.99
9	Una Valley (Beas Basin)	6500	911.44	0	911.44	91.144	820.29	257.19	125.26	563.10	31.35
10	Hum Valley	2900	593.37	173.84	767.21	76.721	690.48	401.34	103.94	289.14	58.12
	TOTAL	346800	79369.31	27450.78	106820.09	10682.009	97114.64	35709.33	10454.00	60589.32	36.77

Annexure III E

ASSESSMENT OF DYNAMIC GROUND WATER RESOURCES OF HIMACHAL PRADESH
ASSESSMENT UNIT-WISE CATEGORIZATION (As on March, 2020)

Sl. No.	Assessment Unit/Sub Unit*	Stage of Ground Water Development (%)	Pre-monsoon		Post-monsoon		Category (Safe/ Semi-critical/ Critical/ Over-exploited)
			Water level Trend	Is there a significant decline (Yes/ No)	Water level Trend	Is there a significant decline (Yes/ No)	
1	**A. Nurpur & Indora valley**(Kangra District)	**29.27**	Falling	**No**	Falling	**No**	**Safe**
2.	**B Dharamshala Palampur Valley**	**13.76**	Falling	**No**	Falling	**No**	**Safe**
3.	**A. Balh valley** Mandi District	**41.39**	Falling	**No**	Falling	**No**	**Safe**
4.	**A. Paonta Valley** Sirmour District	**22.44**	Falling	**No**	Falling	**No**	**Safe**
5.	**B. Kala Amb Valley** Sirmour District	**27.51**	Falling	**No**	Falling	**Yes**	**Safe**
6.	**A. Nalagarh valley** Solan District	**58.43**	Falling	**No**	Falling	**Yes**	**Safe**
7.	**A. Una valley (Sutlej Catchment)** Una Dist	**62.81**	Falling	**No**	Falling	**No**	**Safe**
8.	**B. Hum valley** Una District	**58.12**		**Long Term Data Not Available**			**Safe**
9.	**Una Valley** Beas Catchment	**31.35**	Falling	**No**	Falling	**No**	**Safe**
10.	**Chauntra Valley** Mandi District	**17.12**	Falling	**No**	Falling	**No**	**Safe**

Annexure III F

ASSESSMENT OF DYNAMIC GROUND WATER RESOURCES OF HIMACHAL PRADESH
ADMINISTRATIVE UNIT-WISE CATEGORIZATION (As on March, 2020)

Sl. No.	Assessment Unit/Sub Unit*	C. D. BLOCK	Stage of Ground Water Development (%)	Pre-monsoon		Post-monsoon		Category (Safe/ Semi-critical/ Critical/ Over-exploited)
				Water level Trend	Is there a significant decline (Yes/ No)	Water level Trend	Is there a significant decline (Yes/ No)	
1	**A. Nurpur & Indora valley**(Kangra District)	**Nurpur, Indaura, Fatehpur, Jwali, Dehra Gopipur, Jaswan**	**29.27**	Falling	**No**	Falling	**No**	**Safe**
2.	**B Dharamshala Palampur Valley**	**Kangra, palampur, Dharamshala, Baijanth**	**13.76**	Falling	**No**	Falling	**No**	**Safe**
3.	**A. Balh valley** Mandi District	**Mandi Sundernagar**	**41.39**	Falling	**No**	Falling	**No**	**Safe**
4.	**A. Paonta Valley** Sirmour District	**Paonta Sahib, Nahan**	**22.44**	Falling	**No**	Falling	**No**	**Safe**
5.	**B. Kala Amb Valley** Sirmour District	**Nahan**	**27.51**	Falling	**No**	Falling	**Yes**	**Safe**
6.	**A. Nalagarh valley** Solan District	**Nalagarh, Baddi**	**58.43**	Falling	**No**	Falling	**Yes**	**Safe**
7.	**A. Una valley (Sutlej Catchment)** Una Dist	**Amb, Una, Bangana, Haroli**	**62.81**	Falling	**No**	Falling	**No**	**Safe**
8.	**B. Hum valley** Una District	**Haroli**	**58.12**		**No observation Wells**			**Safe**
9.	**Una Valley** Beas Catchment	**Amb**	**31.35**	Falling	**No**	Falling	**No**	**Safe**
10.	**Chauntra Valley** Mandi District	**Jogindernaga, Baijnath**	**17.12**	Falling	**No**	Falling	**No**	**Safe**

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