GROUND WATER RESOURCES OF PUNJAB STATE

(As on 31st March, 2017)

CENTRAL GROUND WATER BOARD
NORTH WESTERN REGION
CHANDIGARH

WATER RESOURCES & ENVIRONMENT
DIRECTORATE, PUNJAB
WATER RESOURCES DEPARTMENT
MOHALI

OCTOBER, 2018

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Prepared by

WATER RESOURCES & ENVIRONMENT DIRECTORATE,
WATER RESOURCES DEPARTMENT, PUNJAB,
MOHALI

and

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FOREWORD

One of the prime requisites for self-reliance and development of any state is the optimal development of its Water Resources. Ground Water being easily accessible, less expensive, more dependable and comparatively low in pollution has its merits. In order to develop this precious natural resource in a judicious and equitable manner, it is essential to have knowledge of its availability, present withdrawal and future scope of its development.

The present ground water assessment report has been computed by the officers & officials of the Water Resources & Environment Directorate, Water Resources Department Punjab, along with Department of Agriculture & Farmer's Welfare and Punjab Water Resources Management and Development Corporation Limited on the basis of latest guidelines by the Ground Water Resource Estimation Committee (GEC 2015), Government of India,. The report gives details on total annual recharge to ground water, its present draft and scope for future block-wise development.

The present ground water development in the state is 165% as on March 2017. Out of 138 blocks of the state taken for study, 109 blocks are "Over-exploited", 2 blocks are "Critical", 5 blocks are "Semi-critical" and 22 blocks are in "Safe" category. There is an urgent need to recharge ground water in the over-exploited blocks and develop available shallow ground water in the safe blocks to avoid water logging in the foreseeable future. The irrigation policy also needs review vis-a-vis prevailing hydrogeological scenario.

I would like to appreciate the efforts regarding excellent data collection by the officers/officials of Water Resources and Environment Directorate, Mohali through their superb network and skilled manpower, which is the main support for this whole exercise especially Shri Atul Kumar Sood, Senior Geophysicist, Sh. Suresh Narang, Senior Hydrologist, Sh. Vasu Sachdeva, Junior Hydrologist, Sh. Ashish Swaroop, Junior Geologist, Sh. Sanjeev Bansal, STA and Sh. Karamjeet Singh, Draftsman under the able guidance of Sh. Narinder Kumar Jain, Director, to complete the task in the most comprehensive and logical manner in a very short span of time.

I would like to place on record the commendable efforts of Shri S.K. Mohiddin, Senior Hydrogeologist and Sh. M.L. Angurala, Senior Hydrogeologist of the Central Ground Water Board for their contribution in preparation of this report.

I personally feel that this report will be of immense use to the planners, administrators and agencies engaged in the development and regulation of ground water resources of the state.

Chandigarh
September, 2018

(Er. H.S.Arora)
Chief Engineer/WR,
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क्षेत्रीय निदेशक
जल संसाधन, नदी विकास
और गंगा संरक्षण मंत्रालय
भारत सरकार

केन्द्रीय भूमि जल बोर्ड
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Regional Director
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Government of India

Central Ground Water Board
North Western Region

No. :

Dated :

PREFACE

Punjab is a granary state of India, comprising 1.5 per of the geographical area of the country, has been contributing around two third of wheat and half of the rice to the central pool. Groundwater is being used for irrigating 71% of total area irrigated in the state. This has led to over exploitation of groundwater resources, as the surface water fall short of the irrigation needs of the State. Punjab model of irrigation is characterized by excess demand of water for irrigation coupled with unconstrained mining of groundwater for meeting the food bowl requirements of the country.

Ground water being a replenishable resources, its proper and economic development on sustainable basis requires its realistic assessment. The complexities of the process governing occurrence and movement of ground water make the problem of ground water assessment somewhat difficult not only because of enormous data is to be collected and analysed but also multidisciplinary approach is to be adopted. The computation of resources for the state like Punjab is highly complicated as it involves analysis of enormous data not only on recharge front but also on ground water pumping side. This needs to be done in highly precision manner. Moreover, the presence of saline aquifers in southwestern part of the state makes the estimation more complicated.

The estimation of ground water resources based on the recent methodology i.e. GEC, 2015 has been done with all precessions by the Water Resources & Environment Directorate, Punjab in collaboration with Central Ground Water Board is highly praiseworthy. The estimation has brought out clearly the grim situation regarding ground water resources scenario in Punjab state which needs to be developed in more scientific and sustainable development model. The large scale ground water recharge measures like onfarm water management techniques, village pond revival for recharging to ground water, construction of check dams in Siwaliks and water harvesting in urban areas is also required to be promoted and encouraged in the state to arrest the over-exploitation of precious ground water resources.

I would like to appreciate the sincere efforts made by the officers of CGWB and WRED, Punjab in preparing this report at a very short span of time.

(Anoop Nagar)
Regional Director, CGWB

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CHAPTER-1
INTRODUCTION

1.1 BACKGROUND

Punjab State, one of the smallest states of India having geographical area of 50,362 sq km (Only 1.5 percent of the geographical area of the country), is pre-dominantly an agrarian state contributing around two third of the food grains procured annually in the country and is devoid of any other mineral or natural resource except water. Agriculture in the State is highly intensive which needs heavy requirement of water. The economy of the State and well being of the farmers depend to a large extent on the availability of water. The hard work of the farmers has proudly earned the State the name of "Food Basket of Country".

In Punjab State, surface water resources are being fully utilized through well-organized canal irrigation system. The available surface water resources of the State are unable to meet the demand of agriculture as such there is an increasing pressure on ground water resources. The ground water is being over-exploited to meet ever increasing demands of water for diverse purposes i.e. for intensive irrigation, drinking, industry, power generation etc. With the introduction of Green Revolution in the State in mid-sixties, the number of tube-wells increased from a meager 50,000 in the early sixties to above 70,000 in early eighties, to about 10.70 lakhs in year 2001 to 11.80 lakhs in the year 2005-06 and to approx. 12.0 lakhs in the year 2012-13 as per the 5th Minor Irrigation Census Report.

The share of State's surface water resources is limited and decreasing with the effect of global warming and in ground water resources, the State is facing the dual phenomenon of rising water table (mostly in south-western parts, where water extraction is limited due to brackish/saline quality) and falling water table in north-western, central, southern and south-eastern parts of the state, where ground water is generally fresh and fit for irrigation.

To assess the irrigation potential from the ground water, an estimate of ground water resources was made in the year 1973 by the Ministry of Agriculture in consultation with State ground water and minor irrigation organization. Subsequently in early eighties, the ground water resource was re-estimated on the basis of Methodology proposed by the Ground Water Over Exploitation Committee-1977. In 1982, the Government of India had constituted a Ground Water Estimation Committee to improve the quantitative assessment of ground water and to suggest a methodology after considering all aspects of ground water estimation. This Committee recommended a methodology namely: Ground Water Estimation Committee Methodology–1984 (GEC-84). Since then, the Central Ground Water Board and State Ground Water Organization

have adopted this GEC–1984 methodology and estimated the ground water resource in the Punjab State in the years 1984, 1986, 1989, 1992 and 1999.

However, some limitations were encountered in the estimation and this necessitated revision of methodology for more accurate assessment. Therefore, with a view to review GEC–84 and to look into all the related issues, a Committee on Ground Water Estimation was constituted vide GOI, MOWR Notification No. 3/9/93-GWII/2333 dated 13.11.1995, which had recommended a revised methodology namely: Ground Water Resource Estimation Methodology–1997 (GEC-97) for estimating the ground water resource for all the States in future. The Government of India also desired that a Working Group on the Estimation of Ground Water Resource and Irrigation potential from Ground Water should be constituted in each State for furnishing the relevant information to the Planning Commission and to review the GEC-97 and to suggest suitable modification, if any.

However, R and D Advisory Committee on Ground Water Estimation, Government of India, thought of refining the existing Methodology i.e. GEC-1997 and strengthening the norms for various parameters for resource estimation like specific yield, canal seepage factor, rainfall recharge factor, irrigation return flow factor etc. It was decided in the 11th Meeting of R and D Advisory Committee on Ground Water Estimation, held on 13.11.2009, to carry out the Ground Water Estimation in the alluvial areas as per the norms mentioned in the Methodology GEC-1997 with refinement of data. The Dynamic Study of Ground Water Estimation in the Punjab State in 2004, 2009, 2011 and in 2013 has been carried out on the basis of GEC-97 Methodology.

In 2010, Ministry of Water Resources constituted a Central Level Expert Group (CLEG) for over all supervision of the reassessment of ground water resources in the entire country. The group finalized its report and the draft report was circulated to all the members of the Committee for their views. During the fourth meeting of the committee, held on 03-12-2015, the draft report of “Ground Water Resource Estimation Committee - 2015 (GEC 2015) was discussed in detail. The views expressed by the members for revised methodology were considered and necessary modifications were made and report of the Committee was finalized. As decided in the meeting held on 09.02.2016 at New Delhi on Revision of Ground water estimation Methodology-97, a workshop on “Ground Water Resource Estimation Methodology - 2015” was held on 24th January 2017 at CWPRS, Khadakwasla, Pune involving stakeholders and experts. The major changes proposed in the workshop were (i) to change the criteria for categorization of

assessment units and (ii) to remove the potentiality tag.

The Ministry of Water Resources also requested all the State Governments to constitute State Level Committees for over all supervision of assessment of ground water resources at the state level. As per guidelines of Central Ground Water Board, Punjab Government, vide Punjab Govt. Notification No. 1 / 5 / 2003 / IPJ (3) 24378-89 dated 11th Dec. 2004 **(Appendix –1.1),** has notified a committee namely: "***State Level Committee on Ground Water Resource Estimation***" for proper monitoring and Finalization of the Report. Also, vide Notification No. 1/5/2003/PJ (3)/3419 dated 9/10/2009 **(Appendix –1.2)**, Govt. of Punjab constituted a "***Sub-Committee for Ground Water Balance***" for Ground Water Resource Estimation as a standing forum for the purpose of finalization of Ground Water Assessment Report before putting up to State Level Committee .

Accordingly steps were taken to carry out the ground water resource assessment with data for the period 2004-08 for 2009, 2006-10 for 2011, 2008-12 for 2013, and the data for 2012-16 for the present study. The recommendations of GEC-2015 have been suitably incorporated in the present report.

Hydrological data observed from network created under HP-II (Aided by World Bank) has been used in this study. Under this Project a network of about 750 Ground Water observation Wells (GWOW) have been established recently in the state covering each block and this reliable data has been very useful to estimate the Ground Water Resources of each block of the state.

CHAPTER 2
HYDROGEOLOGICAL CONDITIONS OF PUNJAB

2.1 GENERAL FEATURES

Punjab is one of the North Western States of India and covers an area of 50,362 sq km falling between latitude 29º30' N to 32º32' N and longitude 73º55' E to 76º50'E. There are 22 Districts and 145 Blocks in the State. It is one of the most developed State of India where all villages are approachable by metalled roads and all the houses in villages have electricity.

The Punjab State is a flat alluvial plain except a thin belt along north eastern border, where it is mountainous and in the south western parts, where stable sand dunes are seen dotting the landscape. The slope of the plain is towards South and South West which seldom exceeds 0.4 m/km.

There are 3 perennial rivers namely Sutlej, Beas and Ravi and one non- perennial river Ghaggar in the State. These rivers feed a vast network of canal system in the State and even provide water to Haryana, Rajasthan and Jammu and Kashmir.

2.2 GEOLOGY

The alluvial deposits in the state comprise of sand, silt and clays often mixed with kankar. Sandy zones of varying grade constitute a vast ground water reservoir. The alluvial plain towards the hills is bordered by the piedmont deposits comprising Kandi and Sirowal. Immediately south-west of the hills, Kandi belt is 10 to 15 km wide followed by Sirowal which imperceptibly merges with the alluvial plain. Kandi deposit explored almost down to 450 m bgl show a gradation from boulders to clays, at places an admixture of various grades in different proportions. The Sirowal is essentially composed of finer sediments but occasional gravel beds are also encountered. The saturated sand, gravel or boulder beds constitute the aquifers. **(PLATE 1)**

2.3 HYDROMETEOROLOGY

2.3.1. Climate

The climate of the State is semi-humid to semi-arid in the North, arid in the South and southwest and semi-arid in the remaining part of the State. The state experiences four seasons in the year namely, cold season from November to March, hot season from April to June, southwest monsoon season from last week of June to mid of September and post monsoon season from September to beginning of November. During cold weather season, seasons of western disturbances affect the climate of the state and bring rainfall of light intensity.

The State has well-defined rainy period from July to September. There is about 80% rainfall during this period due to South-West Monsoon. Long dry spells are often experienced

necessitating irrigation from man-made systems for agriculture.

2.3.2 Rainfall Distribution

There are two periods of rainfall in the state. The southwest monsoon season, the principal source of ground water sets in last week of June and withdraws towards end of September and constitutes about 80% of annual average rainfall. Another period of rainfall is winter rain from December to March is about 20% of total rainfall which is mostly absorbed into the soil.

The rainfall distribution in Punjab State is erratic both in time and space. The annual rainfall in the state varies from about 1000 mm in the northeast to less than 300 mm in the southwest. The areas to the north of Gurdaspur and near the Shivalik hills receive maximum amount of rainfall while the areas situated in the southwestern side of Punjab (Fazilka) receive minimum amount of rainfall. In the central part of the state, average long term rainfall varies from 400 mm to 600 mm. The highest and the lowest annual average rainfall in the state for the year 2016 are recorded in Pathankot and Fazilka districts which are 1110 mm and 82 mm respectively. Isohyets for the year 2016 are attached as **FIG- 1.**

Average annual rainfall in recent past has been quite low as compared to that in the earlier years as is clear from data given below :-

YEAR	AVERAGE ANNUAL RAINFALL (in mm)
1970	672 mm
1980	739 mm
1990	754 mm
1997	710 mm
1998	477 mm
1999	392 mm
2000	392 mm
2001	463 mm
2002	315 mm
2003	460 mm
2004	375 mm
2005	448 mm
2006	418 mm
2007	438 mm
2008	529 mm
2009	385 mm
2010	472 mm
2011	480 mm
2012	366 mm

2013	620 mm
2014	385 mm
2015	547 mm
2016	427 mm

2.4 HYDROGEOLOGY

Ground water levels in Punjab State vary from almost near surface to about 60 m bgl. The deep water levels are recorded in Kandi belt. Water logging conditions exist in some parts of south-western districts. In the remaining part of Punjab the water table varies from 3 to 40 m bgl approximately. The master ground water slope is towards southwest. Most of the shallow tubewells have ground water draft per year varying from 0.22 to 3.04 Ham (electric) and 0.221 to 1.95 Ham (diesel) and are capable of commanding 1 to 3 Hectare of land per tube-well. There is significant variation in quality of ground water with depth, especially in the south western parts.

2.5 GROUND WATER LEVEL FLUCTUATIONS/ TRENDS

2.5.1 Depth to Ground Water Level – June 2016

The depth to ground water level during June 2016 varies from 0.83 m in Fazilka block of Fazilka district to 60.50 m in Hoshiarpur –II block of Hoshiarpur district. Water level up to 1.50 mbgl has been observed in about 1% area of the State, mainly in district Fazilka and Sri Muktsar Sahib. Shallow water level in range from 1.50 to 5.00 mbgl has been encountered in an estimated area of about 14% of the State, mainly in districts Faridkot, Fazilka, Gurdaspur, Pathankot, Sri Muktsar Sahib and Ropar. Water levels in the range of 5-10 mbgl has been encountered in an estimated area of about 19% area of the State, mainly in districts, Bathinda, Faridkot, Ferozepur, Gurdaspur, Hoshiarpur, Kapurthala, Mansa, Mohali and Ropar. Moderate water levels in the range 10 to 20m depth have been observed in an estimated area of about 29% falling mainly in the districts of Amritsar, Bathinda, Fatehgarh Sahib, Gurdaspur, Hoshiarpur, Jalandhar, Kapurthala, Ludhiana, Mansa , S.B.S.Nagar (Nawan Shahr), and Tarn-Taran. Water level in the range of 20-30 m depth has been observed in about 24% estimated area mainly in districts Barnala, Bathinda, Fatehgarh Sahib, Hoshiarpur, Jalandhar, Ludhiana, Kapurthala, Moga, Patiala and Sangrur. Deeper water level of more than 30 m has been noticed in about 13% estimated area, mainly in districts Barnala, Jalandhar, Patiala and Sangrur. (**Refer Fig. 2 for Depth to Water Level- June 2016 and Fig. 3 for Water Table Elevation, June-2016**).

2.5.2 Depth to Ground Water Level – October 2016

The depth to ground water level during October 2016 varies from 0.79 m in Fazilka block of Fazilka district to 60.10 m in Hoshiarpur –II block of Hoshiarpur district. Data for this period reveals that water level upto 1.50 mbgl has been observed in about 2% estimated area of the states, mainly in districts Sri Muktsar Sahib and Fazilka, and in some pockets of districts Faridkot, Gurdaspur, Mansa and Mohali. Shallow water level in range from 1.50 to 5.00 mbgl has been encountered in about 14% estimated area mainly in districts Faridkot, Fazilka, Gurdaspur, Pathankot, and Sri Muktsar Sahib and in some pockets of districts Ferozepur, Hoshiarpur,Ludhiana Mohali , Patiala and Ropar.

Ground Water Level Depth in the range of 5-10 mbgl has been encountered in about 19% estimated area, mainly in districts Bathinda, Faridkot, Ferozepur, Gurdaspur, Kapurthala, Mansa and Ropar. Ground Water Level Depth in the range of 10-20 mbgl has been encountered in about 26% estimated area, mainly in districts Amritsar, Bathinda, Fatehgarh Sahib , Ferozepur, Hoshiarpur,Ludhiana, Mansa, S.B.S.Nagar (Nawan Shahr), Ropar and Tarn-Taran.

Deep water level of 20-30 mbgl been observed in about 25% estimated area of State mainly in parts of districts Barnala, Bathinda, Fatehgarh Sahib, Hoshiarpur, Jalandhar, Kapurthala, Ludhiana, Moga, Patiala and Sangrur. Deeper water level of 30m or more has been estimated in about 14% estimated area of the state comprising parts of districts Barnala, Jalandhar, Moga and Patiala. (**Refer Fig. 4 for Depth to Water Level- October 2016 and Fig. 5 for Water Table Elevation, October -2016**).

2.5.3 Long-Term Fluctuation – June 1984 to June 2016

Analysis of the data pertaining to this period reveals that ground water level has gone down in about 85% area of the state, while in the remaining about 15% area of the state it has risen during this period. The magnitude of fall / rise in ground water level varies from area to area.

It is observed that fall of water level of more than 15m occurs in about 31% estimated area, mainly in parts of districts, Barnala, Bathinda, Hoshiarpur, Jalandhar, Ludhiana, Moga, Patiala and Sangrur,. Fall of water level between 10 m-15 m is noticed in about 17% estimated area mainly in parts of districts, Amritsar, Fatehgarh Sahib, Jalandhar, Kapurthala, Ludhiana, Moga, Nawan Shahr and Tarn-Taran. Fall of water level between 5m-10m is encountered in about 16% estimated area, mainly in parts of districts, Amritsar, Faridkot, Ferozepur, Gurdaspur, Jalandhar, Kapurthala, Mansa, Nawan Shahr and Tarn-Taran. In about 21% estimated area of the state fall of water level upto 5m is encountered, in parts of districts except

Barnala, Fatehgarh Sahib Moga and Sangrur.

Rise of water level between 5 m-10 m is encountered in about 4% estimated area, mainly in parts of districts Bathinda, Fazilka, Sri Muktsar Sahib Gurdaspur and Mansa. Rise of water level between 10 m-15 m is encountered in about 3% area, mainly in parts of districts Fazilka, Bathinda, Muktsar and Pathankot. Rise of water level of more than 15 m is encountered in about 1% area, mainly in parts of districts Hoshiarpur and Sri Muktsar Sahib. However, Rise of water level upto 5 m is encountered in about 7% estimated area in parts of many districts.

It has been observed that water level has gone down in most of the area of the state. The average yearly rate of fall of water level, in the area of significant fall of water level (fall of more than 5 m during this period) worked out to be apprx. 0.49 m / year, and districts Baranala, Bathinda, Fatehgarh Sahib, Hoshiarpur, Jalandhar, Moga, Mohali, Pathankot, Patiala and Sangrur are mainly affected. Moreover, taking the entire area of fall of water level into consideration, average yearly rate of fall is worked out to be apprx. 0.37 m / year for this area.

On the other hand, the average yearly rate of rise of water level, in the area of significant rise of water level (rise of more than 5 m during this period) worked out to be apprx. 0.32 m / year, and districts Bathinda, Fazilka, Hoshiarpur, Sri Muktsar Sahib and Pathankot are mainly affected. Moreover, taking the entire area of rise of water level into consideration, average yearly rate of rise is worked out to be apprx 0.19 m / year for the state. (**Refer Fig. 6 for Long-Term Fluctuation – June 1984 to June 2016**)

2.6 GROUND WATER QUALITY

Increasing water pollution due to urbanization, industrialization and increased use of fertilizers and pesticides is causing water quality deterioration of surface and groundwater resources. Groundwater at Shallow depth is largely contaminated caused by surface water pollution. The physico-chemical characteristics of shallow groundwater in the State indicate wide variations in mineral contents. The quality of groundwater is classified as Fit, Marginal and Unfit on the basis of Electrical Conductivity (E.C.) and Residual Sodium Carbonate (R.S.C.) which is indicative of salinity and alkalinity effect. Nearly 50-60% of the groundwater up to 60 meters depth in the State is fresh and fit and generally found in North, Northeastern and Central parts of the State comprising of districts of Amritsar, Gurdaspur, Hoshiarpur, Jalandhar, Kapurthala, Nawanshahar, Ropar, Ludhiana, Fatehgarh Sahib and SAS Nagar. Nearly 20-30% of the groundwater generally found in Northwestern and Central parts of the State comprising of districts of Tarn Taran, Patiala, Sangrur, Barnala and Moga is moderately saline and of marginal quality. About 15-25% of the groundwater is saline/alkaline and not fit for irrigation use and

generally found in isolated patches in South and Southwestern parts of the State in districts of Muktsar, Bathinda, Mansa and Sangrur. Groundwater in South and Southwestern districts of the State namely Faridkot, Ferozepur, Muktsar, Bathinda, Mansa, Barnala and Sangrur contain varying concentration of soluble salts and its use for irrigation adversely effects agricultural production. Depth-wise study in South and Southwestern part of the State reveals that quality of native groundwater is largely fresh/fit at shallower depths and generally deteriorates with depth. The study shows that groundwater quality is fresh and fit in 60% of area at 10 metres depth which decreases to nearly 30% and 18% at 35 metres and 60 metres depth respectively. Similarly, groundwater quality is saline/ alkaline in nearly 17% of the area at depth of 10 metres which increases to 50% and 52% at the depth of 35 and 60 metres respectively. Ground water quality problem is more severe in terms of salinity in the districts of Muktsar, Mansa and Bathinda. Contaminations notably of Nitrate, Fluoride, heavy metals and radio-active element such as uranium in groundwater has been reported in significant proportion beyond the permissible limit in South and Southwestern part of the State by various agencies.

In general about 60% of ground water is fresh and of good quality mostly in districts of Amritsar, Fatehgarh Sahib, Nawan Shahr, Gurdaspur, Ropar, Hoshiarpur, Jalandhar, Ludhiana and Kapurthala, nearly 30% is saline/alkaline (marginal to moderate) in districts of Patiala, Moga, Ferozepur and Mansa and nearly 10% is saline/alkaline which is unsafe for all purposes mostly in districts of Faridkot, Muktsar, Bathinda and Sangrur.

CHAPTER 3

GROUND WATER RESOURCES ESTIMATION METHODOLOGY

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 aquifer. 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 300 m whichever is less. In case of hard rock aquifers, the depth of assessment would be limited to 100 m. 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 instorage resources of that aquifer has to be estimated

3.1 PERIODICITY OF ASSESSMENT

Keeping in view of the rapid change in Ground Water Extraction, the committee recommends more frequent estimation of Ground Water Resources. The committee observes that the comprehensive assessment of Ground Water Resources is a time intensive exercise. Hence as a tradeoff, it recommends that the resources should be assessed once in every three years. As per the present practice, there is a considerable time lag between assessment and publication of the results. Hence the committee recommends to make all out efforts to reduce the time lag and the results may be reported with in the successive water year.

3.2 GROUND WATER ASSESSMENT UNIT

This methodology recommends aquifer wise ground water resource assessment. An essential requirement for this is to demarcate lateral as well as vertical extent and disposition of different aquifers. A watershed with well-defined hydrological boundaries is an appropriate unit for ground water resource estimation if the principal aquifer is other than alluvium. Ground water resources worked out on watershed as a unit, may be apportioned and presented on administrative units (block/ taluka/ mandal/ firka). This would facilitate local administration in planning of ground water management programmes. Areas occupied by unconsolidated sediments (alluvial deposits, aeolian deposits, coastal deposits etc.) usually have flat topography and demarcation of watershed boundaries may not be possible in such areas. Until Aquifer

Geometry is established on appropriate scale, the existing practice of using watershed in hard rock areas and blocks/ mandals/ firkas in soft rock areas may be continued.

The ground water resources assessment were carried out based on the guidelines of Ministry of Water Resources, RD & GR which broadly follows the methodology recommended by Ground Water Resources Estimation Committee, 2015. The salient features of the methodology are enumerated in the following paragraphs.

The ground water recharge is estimated season-wise both for monsoon season and non-monsoon season separately. The following recharge and discharge components are assessed in the resource assessment - recharge from rainfall, recharge from canal, return flow from irrigation, recharge from tanks and ponds and recharge from water conservation structures and discharge through ground water draft.

The ground water resources of any assessment unit is the sum of the total ground water availability in the principal aquifer (mostly unconfined aquifer) and the total ground water availability of semi-confined and confined aquifers existing in that assessment unit. The total ground water availability of any aquifer is the sum of Dynamic ground water resources and the In-storage or Static resources of the aquifer.

3.3 GROUND WATER ASSESSMENT OF UNCONFINED AQUIFER

As mentioned earlier, assessment of ground water includes assessment of dynamic and in-storage ground water resources. The development planning should mainly depend on dynamic resource only as it gets replenished every year. Changes in static or in-storage resources reflect impacts of ground water mining. Such resources may not be replenishable annually and may be allowed to be extracted only during exigencies with proper recharge planning in the succeeding excess rainfall years..

3.3.1 Dynamic Ground Water Resources

The methodology for ground water resources estimation is based on the principle of water balance as given below –

$$\textbf{Inflow} - \textbf{Outflow} = \textbf{Change in Storage (of an aquifer)} \qquad \textbf{1}$$

Equation 1 can be further elaborated as -

$$\Delta S = R_{RF} + R_{STR} + R_C + R_{SWI} + R_{GWI} + R_{TP} + R_{WCS} \pm VF \pm LF - GE - T - E - B \qquad 2$$

Where,

ΔS – Change in storage

R_{RF} – Rainfall recharge

R_{STR}- Recharge from stream channels

Rc – Recharge from canals

R_{SWI} – Recharge from surface water irrigation

R_{GWI}- Recharge from ground water irrigation

R_{TP}- Recharge from Tanks and Ponds

R_{WCS} – Recharge from water conservation structures

VF – Vertical flow across the aquifer system

LF- Lateral flow along the aquifer system (through flow)

GE-Ground Water Extraction

T- Transpiration

E- Evaporation

B-Base flow

It is preferred that all the components of water balance equation should be estimated in an assessment unit. The present status of database available with Government and non-government agencies is not adequate to carry out detailed ground water budgeting in most of the assessment units. Therefore, it is proposed that at present the water budget may be restricted to the major components only taking into consideration certain reasonable assumptions. The estimation is to be carried out using lumped parameter estimation approach keeping in mind that data from many more sources if available may be used for refining the assessment.

3.3.2 Rainfall Recharge

It is recommended that ground water recharge should be estimated on ground water level fluctuation and specific yield approach since this method takes into account the response of ground water levels to ground water input and output components. This, however, requires adequately spaced representative water level measurement for a sufficiently long period. It is proposed that there should be at least three spatially well distributed observation wells in the assessment unit, or one observation well per 100 sq. Km. Water level data should also be available for a minimum period of 5 years (preferably 10years), along with corresponding rainfall data. Regarding frequency of water level data, three water level readings during pre and post monsoon seasons and in the month of January/ May preferably in successive years, are the minimum requirements. It would be ideal to have monthly water level measurements to record the peak rise and maximum fall in the ground water levels. In units or subareas where adequate data on ground water level fluctuations are not available as specified above, ground water recharge may be estimated using rainfall infiltration factor method only. The rainfall recharge during non-monsoon season may be estimated using rainfall infiltration factor method only.

3.3.3 Ground water level fluctuation method

The ground water level fluctuation method is to be used for assessment of rainfall recharge in the monsoon season. The ground water balance equation in non-command areas is given by

$$\Delta S = R_{RF}+R_{STR}+R_{SWI}+R_{GWI}+R_{TP}+R_{WCS} \pm VF \pm LF - GE - T - E - B \quad (3)$$

Where,

ΔS – Change in storage

R_{RF} – Rainfall recharge

R_{STR}- Recharge from stream channels

R_{SWI} – Recharge from surface water irrigation (Lift Irrigation)

R_{GWI}- Recharge from ground water irrigation

R_{TP}- Recharge from tank and ponds

R_{WCS} – Recharge from water conservation structures

VF – Vertical flow across the aquifer system

LF- Lateral flow along the aquifer system (through flow)

GE-Ground water Extraction

T- Transpiration

E- Evaporation

B-Base flow

Whereas the water balance equation in command area will have another term Recharge due to canals (R_C) and the equation will be as follows:

$$\Delta S = R_{RF}+R_{STR}+R_C+R_{SWI}+R_{GWI}+R_T+R_{WCS} \pm VF \pm LF - GE - T - E - B \quad (4)$$

A couple of important observations in the context of water level measurement must be followed. It is important to bear in mind that while estimating the quantum of ground water extraction, the depth from which ground water is being extracted should be considered, and certain limit should be fixed. First, by estimating recharge by Water Level Fluctuation method, rise in water level (pre to post monsoon Water Level observed in a dug well) is considered and in estimating the draft from dug wells and bore wells (shallow and deep) drop in water level is considered. One should consider only the draft from the same aquifer for which the resource is being estimated.

The change in storage can be estimated using the following equation:

$$\Delta S = \Delta h * A * S_Y \quad (5)$$

Where

ΔS – Change in storage

Δh - rise in water level in the monsoon season

A - area for computation of recharge

Sy - Specific Yield

Substituting the expression in equation 5 for storage increase ΔS in terms of water level fluctuation and specific yield, the equations 3 and 4 becomes,

$$\mathbf{R_{RF} = h \times Sy \times A - R_{STR} - R_{SWI} - R_{GWI} - R_{TP} - R_{WCS} \pm VF \pm LF + GE + T + E + B} \quad \mathbf{6}$$

$$\mathbf{R_{RF} = h \times Sy \times A - R_{C} - R_{STR} - R_{SWI} - R_{GWI} - R_{TP} - R_{WCS} \pm VF \pm LF + GE + T + E + B} \quad \mathbf{7}$$

The recharge calculated from equation 6 in case of non-command sub units and equation 7 in case of command sub units and poor ground water quality sub units gives the rainfall recharge for the particular monsoon season. However, it may be noted that in case base flow/ recharge from stream and through flow have not been estimated, the same may be assumed to be zero.

The rainfall recharge obtained by using equation 6 and equation 7 provides the recharge in any particular monsoon season for the associated monsoon season rainfall. This estimate is to be normalised for the normal monsoon season rainfall as per the procedure indicated below.

Normalization of Rainfall Recharge

Let Ri be the rainfall recharge and ri be the associated rainfall. The subscript i takes values 1 to N where N is number of years data is available which is at least 5. The rainfall recharge, Ri is obtained as per equation 6 and equation 7 depending on the sub unit for which the normalization is being done.

$$\mathbf{R_{i} = h \times Sy \times A - R_{STR} - R_{SWI} - R_{GWI} - R_{TP} - R_{WCS} \pm VF \pm LF + GE + T + E + B} \quad \mathbf{8}$$

$$\mathbf{R_{i} = h \times Sy \times A - R_{C} - R_{STR} - R_{SWI} - R_{GWI} - R_{TP} - R_{WCS} \pm VF \pm LF + GE + T + E + B} \quad \mathbf{9}$$

where,

Ri = Rainfall recharge estimated in the monsoon season for the i^{th} particular year

h = Rise in ground water level in the monsoon season for the i^{th} particular year

Sy =Specific yield

A = Area for computation of recharge

GE = Ground water extraction in monsoon season for the i^{th} particular year

B = Base flow the monsoon season for the i^{th} particular year

R_C = Recharge from canals in the monsoon season for i^{th} particular year

R_{STR} = Recharge from stream channels in the monsoon season for i^{th} particular year

R_{SWI} = Recharge from surface water irrigation including lift irrigation in the monsoon season for the i^{th} particular year

R_{GWI} = Recharge from groundwater irrigation in the monsoon season for the i^{th} particular year

R_{WCS} =Recharge from water conservation structures in the monsoon season for the i^{th} particular year

R_{TP} = Recharge from tanks and ponds in the monsoon season for the i^{th} particular year

LF = Recharge through Lateral flow/ Through flow across assessment unit boundary in the monsoon season for the i^{th} particular year

VF – Vertical flow across the aquifer system in the monsoon season for the i^{th} particular year

T- Transpiration in the monsoon season for the i^{th} particular year

E- Evaporation in the monsoon season for the i^{th} particular year

After the pairs of data on Ri and ri have been obtained as described above, a normalisation procedure is to be carried out for obtaining the rainfall recharge corresponding to the normal monsoon season rainfall. Let r(normal) be the normal monsoon season rainfall obtained on the basis of recent 30 to 50 years of monsoon season rainfall data. Two methods are possible for the normalisation procedure.

The first method is based on a linear relationship between recharge and rainfall of the form

$$\mathbf{R = ar} \qquad \mathbf{10}$$

where,

R = Rainfall recharge during monsoon season

r = Monsoon season rainfall

a = a constant

The computational procedure to be followed in the first method is as given below:

$$R_{rf}(normal) = \frac{\sum_{i=1}^{N}\left[R_i \times \frac{r(normal)}{r_i}\right]}{N} \qquad \mathbf{11}$$

Where,

$R_{rf}(normal)$ - Normalized Rainfall Recharge in the monsoon season.

R_i - Rainfall Recharge in the monsoon season for the i^{th} year.

r(normal) - Normal monsoon Season rainfall.

r_i - Rain fall in the monsoon season for the i^{th} year.

N - No, of years data is available.

The second method is also based on a linear relation between recharge and rainfall. However, this linear relationship is of the form,

$$\mathbf{R = ar+b} \qquad \mathbf{12}$$

where,

R = Rainfall recharge during monsoon season

r = Monsoon season rainfall

a and b = constants.

The two constants 'a' and 'b' in the above equation are obtained through a linear regression analysis. The computational procedure to be followed in the second method is as given below:

$$a = \frac{NS_4 - S_1S_2}{NS_3 - S_1^2} \qquad \mathbf{13}$$

$$b = \frac{S_2 - aS_1}{N} \qquad \mathbf{14}$$

Where

$$S_1 = \sum_{i=1}^{N} r_i \qquad S_2 = \sum_{i=1}^{N} R_i \qquad S_3 = \sum_{i=1}^{N} r_i^2 \qquad S_4 = \sum_{i=1}^{N} r_i R_i$$

The rainfall recharge during monsoon season for normal monsoon rainfall condition is computed as below:

$$\mathbf{R_{rf}\ (normal) = a\ x\ r(normal)\ +\ b} \qquad \mathbf{15}$$

3.3.4 Rainfall Infiltration Factor method

The rainfall recharge estimation based on Water level fluctuation method reflects actual field conditions since it takes into account the response of ground water level. However the ground water extraction estimation included in the computation of rainfall recharge using Water Level Fluctuation approach is often subject to uncertainties. Therefore, it is recommended to compare the rainfall recharge obtained from Water Level Fluctuation approach with that estimated using Rainfall Infiltration Factor Method.

Recharge from rainfall is estimated by using the following relationship -

$$\mathbf{R_{rf} = RFIF * A*\ (R - a)/1000} \qquad \mathbf{16}$$

Where,

R_{rf} = Rainfall recharge in ham

A = Area in Hectares

RFIF = Rainfall Infiltration Factor

R = Rainfall in mm

a = Minimum threshold value above which rainfall induces ground water recharge in mm

The relationship between rainfall and ground water recharge is a complex phenomenon depending on several factors like runoff coefficient, moisture balance, hydraulic conductivity and Storativity/ Specific yield of the aquifer etc. In this report, certain assumptions have been adopted for computation of Rainfall recharge factor. These assumptions may be replaced with actual data in case such area specific studies are available. At the same time, it is important to bring in elements of rainfall distribution and variability into sharpening the estimates of precipitation. Average rainfall data from nearby rain gauge stations may be considered for the Ground water assessment unit and the average rainfall may be estimated by the Theisen polygon or isohyet methods. Alternatively other advanced methods may also be used.

The threshold limit of minimum and maximum rainfall event which can induce recharge to the aquifer is to be considered while estimating ground water recharge using rainfall infiltration factor. The minimum threshold limit is in accordance with the relation shown in equation 16 and the maximum threshold limit is based on the premise that after a certain limit, the rate of storm rains are too high to infiltrate the ground and they will only contribute to surface runoff. It is suggested that 10% of Normal annual rainfall be taken as Minimum Rainfall Threshold and 3000 mm as Maximum Rainfall limit. While computing the rainfall recharge, 10% of the normal annual rainfall is to be deducted from the monsoon rainfall and balance rainfall would be considered for computation of rainfall recharge. The same recharge factor may be used for both monsoon and non-monsoon rainfall, with the condition that the recharge due to non-monsoon rainfall may be taken as zero, if the normal rainfall during the non-monsoon season is less than 10% of normal annual rainfall. In using the method based on the specified norms, recharge due to both monsoon and non-monsoon rainfall may be estimated for normal rainfall, based on recent 30 to 50 years of data.

3.3.5 Percent Deviation

After computing the rainfall recharge for normal monsoon season rainfall using the water table fluctuation method and Rainfall Infiltration Factor method these two estimates have to be compared with each other. A term, Percent Deviation (PD) which is the difference between the two expressed as a percentage of the former is computed as

$$PD = \frac{R_{rf}(normal, wtfm) - R_{rf}(normal, rifm)}{R_{rf}(normal, wtfm)} \times 100 \qquad \textbf{17}$$

where,

Rrf (normal, wlfm) = Rainfall recharge for normal monsoon season rainfall estimated by the water level fluctuation method

Rrf (normal, rifm) = Rainfall recharge for normal monsoon season rainfall estimated by the rainfall infiltration factor method

The rainfall recharge for normal monsoon season rainfall is finally adopted as per the criteria given below:

- If PD is greater than or equal to -20%, and less than or equal to +20%,Rrf (normal) is taken as the value estimated by the water level fluctuation method.
- If PD is less than -20%, Rrf (normal) is taken as equal to 0.8 times the value estimated by the rainfall infiltration factor method.
- If PD is greater than +20%, Rrf (normal) is taken as equal to 1.2 times the value estimated by the rainfall infiltration factor method.

3.3.6 Recharge from other Sources

Recharge from other sources constitute recharges from canals, surface water irrigation, ground water irrigation, tanks and ponds and water conservation structures in command areas where as in non-command areas the recharge due to surface water irrigation, ground water irrigation, tanks and ponds and water conservation structures are possible.

3.3.7 Recharge from Canals: Recharge due to canals is to be estimated based on the following formula:

$$\mathbf{R_C = WA * SF * Days} \qquad \mathbf{18}$$

Where:

R_C= Recharge from Canals

WA=Wetted Area

SF= Seepage Factor

Days= Number of Canal Running Days.

3.3.8 Recharge from Surface Water Irrigation: Recharge due to applied surface water irrigation, either by means of canal outlets or by lift irrigation schemes is to be estimated based on the following formula:

$$\mathbf{R_{SWI} = AD*Days*RFF} \qquad \mathbf{19}$$

Where:

R_{SWI} = Recharge due to applied surface water irrigation

AD= Average Discharge

Days=Number of days water is discharged to the Fields

RFF= Return Flow Factor

3.3.9 Recharge from Ground Water Irrigation: Recharge due to applied ground water irrigation is to be estimated based on the following formula:

$$\mathbf{R_{GWI} = GE_{IRR}*RFF} \qquad \mathbf{20}$$

Where:

R_{GWI} = Recharge due to applied ground water irrigation

GE_{IRR}= Ground Water Extraction for Irrigation

RFF= Return Flow Factor

3.3.10 Recharge due to Tanks and Ponds: Recharge due to Tanks and Ponds is to be estimated based on the following formula:

$$\mathbf{R_{TP} = AWSA * RF} \qquad \mathbf{21}$$

Where:

R_{TP} = Recharge due to Tanks and Ponds

AWSA= Average Water Spread Area

RF= Recharge Factor

3.3.11 Recharge due to Water Conservation Structures: Recharge due to Water Conservation Structures is to be estimated based on the following formula:

$$\mathbf{R_{WCS} = GS * RF} \qquad \mathbf{22}$$

Where:

R_{WCS} = Recharge due to Water Conservation Structures

GS= Gross Storage = Storage Capacity multiplied by number of fillings.

RF= Recharge Factor

3.4 Lateral flow along the aquifer system (Through flow)

In equations 6 and 7, if the area under consideration is a watershed, the lateral flow across boundaries can be considered as zero in case such estimates are not available. If there is inflow and outflow across the boundary, theoretically, the net inflow may be calculated using Darcy law, by delineating the inflow and outflow sections of the boundary. Besides such delineation, the calculation also requires estimate of transmissivity and hydraulic gradient across the inflow and outflow sections. These calculations are most conveniently done in a computer model. It is recommended to initiate regional scale modelling with well-defined flow boundaries. Once the modelling is complete, the lateral through flows (LF) across boundaries for any assessment unit can be obtained from the model. In case Lateral Flow is calculated using computer model, the same should be included in the water balance equation.

3.5 Base flow and Stream Recharge

If stream gauge stations are located in the assessment unit, the base flow and recharge from streams can be computed using Stream Hydrograph Separation method, Numerical

Modelling and Analytical solutions. If the assessment unit is a watershed, a single stream monitoring station at the mouth of the watershed can provide the required data for the calculation of base flow. Any other information on local-level base flows such as those collected by research centres, educational institutes or NGOs may also be used to improve the estimates on base flows.

Base flow separation methods can be divided into two main types: non-tracer-based and tracer-based separation methods. Non-tracer methods include Stream hydrograph analysis, water balance method and numerical ground water modelling techniques. Digital filters are available for separating base flow component of the stream hydrograph.

Hydro-chemical tracers and environmental isotope methods also use hydrograph separation techniques based on mass balance approach. Stream recharge can also be estimated using the above techniques.

Base flow assessment and Stream recharge should be carried out in consultation with Central Water Commission in order to avoid any duplicity in the estimation of total water availability in a river basin.

3.6 Vertical Flow from Hydraulically Connected Aquifers

This can be estimated provided aquifer geometry and aquifer parameters are known. This can be calculated using the Darcy's law if the hydraulic heads in both aquifers and the hydraulic conductivity and thickness of the aquitard separating both the aquifers are known. Ground water flow modelling is an important tool to estimate such flows. As envisaged in this report regional scale modelling studies will help in refining vertical flow estimates.

3.7 Evaporation and Transpiration

Evaporation can be estimated for the aquifer in the assessment unit if water levels in the aquifer are within the capillary zone. It is recommended to compute the evaporation through field studies. If field studies are not possible, for areas with water levels within 1.0 mbgl, evaporation can be estimated using the evaporation rates available for other adjoining areas. If depth to water level is more than 1.0m bgl, the evaporation losses from the aquifer should be taken as zero.

Transpiration through vegetation can be estimated if water levels in the aquifer are within the maximum root zone of the local vegetation. It is recommended to compute the transpiration through field studies. Even though it varies from place to place depending on type of soil and vegetation, in the absence of field studies the following estimation can be followed. If water levels are within 3.5m bgl, transpiration can be estimated using the transpiration rates available for other areas. If it is greater than 3.5m bgl, the transpiration should be taken as zero.

For estimating evapotranspiration, field tools like Lysimeters can be used to estimate actual evapotranspiration. Usually agricultural universities and IMD carry out lysimeter experiments and archive the evapotranspiration data. Remote sensing based techniques like SEBAL (Surface Energy Balance Algorithm for Land) can be used for estimation of actual evapotranspiration. Assessing offices may apply available lysimeter data or other techniques for estimation of evapotranspiration. In case where such data is not available, evapotranspiration losses can be empirically estimated from PET data provided by IMD.

3.8 Recharge during Monsoon Season

The sum of normalized monsoon rainfall recharge and the recharge from other sources and lateral and vertical flows into the sub unit and stream inflows during monsoon season is the total recharge during monsoon season for the sub unit. Similarly this is to be computed for all the sub units available in the assessment unit.

3.9 Recharge during Non-Monsoon Season

The rainfall recharge during non-monsoon season is estimated using Rainfall Infiltration factor Method only when the non-monsoon season rainfall is more than 10% of normal annual rainfall. The sum of non-monsoon rainfall recharge and the recharge from other sources and lateral and vertical flows into the sub unit and stream inflows during non-monsoon season is the total recharge during non-monsoon season for the sub unit. Similarly this is to be computed for all the sub units available in the assessment unit.

3.10 Total Annual Ground Water Recharge

The sum of the recharge during monsoon and non-monsoon seasons is the total annual ground water recharge for the sub unit. Similarly this is to be computed for all the sub units available in the assessment unit.

3.11 Annual Extractable Ground Water Recharge (EGR)

The Total Annual Ground Water Recharge cannot be utilised for human consumption, since ecological commitments need to be fulfilled, before the extractable resources is defined. The National Water Policy, 2012 stresses that the ecological flow of rivers should be maintained. Therefore Ground water base flow contribution limited to the ecological flow of the river should be determined which will be deducted from Annual Ground Water Recharge to determine Annual Extractable Ground Water Resources (EGR). The ecological flows of the rivers are to be determined in consultation with Central Water Commission and other concerned river basin agencies.

In case base flow contribution to the ecological flow of rivers is not determined then following assumption is to be followed. In the water level fluctuation method, a significant

portion of base flow is already accounted for by taking the post monsoon water level one month after the end of rainfall. The base flow in the remaining non-monsoon period is likely to be small, especially in hard rock areas. In the assessment units, where river stage data are not available and neither the detailed data for quantitative assessment of the natural discharge are available, present practice (GEC 1997) of allocation of unaccountable natural discharges to 5% or 10% of annual recharge may be retained. If the rainfall recharge is assessed using water level fluctuation method this will be 5% of the annual recharge and if it is assessed using rainfall infiltration factor method, it will be 10% of the annual recharge. The balance will account for Annual Extractable Ground Water Resources (EGR).

3.12 Estimation of Ground Water Extraction

Groundwater draft or extraction is to be assessed as follows.

$$GE_{ALL} = GE_{IRR} + GE_{DOM} + GE_{IND} \quad (23)$$

Where,

GE_{ALL}=Ground water extraction for all uses

GE_{IRR}=Ground water extraction for irrigation

GE_{DOM} =Ground water extraction for domestic uses

GE_{IND} = Ground water extraction for industrial uses

3.12.1 Ground Water Extraction for Irrigation (GE_{IRR}): The single largest component of the groundwater balance equation in large regions of India is the groundwater extraction and, the precise estimation of ground water extraction is riddled with uncertainties. Therefore it is recommended that at least two of the three methods for estimation of ground water extraction may be employed in each assessment sub unit. The methods for estimation of ground water extraction are as follows.

Unit Draft Method: – In this method, season-wise unit draft of each type of well in an assessment unit is estimated. The unit draft of different types (eg. Dug well, Dug cum bore well, shallow tube well, deep tube well, bore well etc.) is multiplied with the number of wells of that particular type to obtain season-wise ground water extraction by that particular structure. This method is being widely practiced in the country. There are several sources which maintain records on well census. These include Minor Irrigation Census conducted by MoWR, RD, GR, Government of India, and data maintained at the Tehsil level. It is recommended that a single source of well census should be maintained for resources computation at all India level. Minor Irrigation Census of MoWR, RD, GR would be the preferred option.

Crop Water Requirement Method: – For each crop, the season-wise net irrigation water requirement is determined. This is then multiplied with the area irrigated by ground water

abstraction structures. The database on crop area is obtained from Revenue records in Tehsil office, Agriculture Census and also by using Remote Sensing techniques.

Power Consumption Method: **–** Ground water extraction for unit power consumption (electric) is determined. Extraction per unit power consumption is then multiplied with number of units of power consumed for agricultural pump sets to obtain total ground water extraction for irrigation. Direct metering of ground water draft in select irrigation and domestic wells and in all wells established for industrial purpose may be initiated. Enforcing fitting of water meters and recording draft in all govt. funded wells could also be a feasible option. The unit drafts obtained from these sample surveys can be used to assess ground water extraction. In addition to metering, dedicated field sample surveys (instantaneous discharge measurements) can also be taken up.

3.12.2 Ground Water Extraction for Domestic Use (GE_{DOM}): There are several methods for estimation of extraction for domestic use (GE_{DOM}). Some of the commonly adopted methods are described here.

Unit Draft Method: **–** In this method, unit draft of each type of well is multiplied by the number of wells used for domestic purpose to obtain the domestic ground water draft.

Consumptive Use Method: **–** In this method, population is multiplied with per capita consumption usually expressed in litre per capita per day (lpcd). It can be expressed using following equation.

$$GE_{DOM} = \text{Population} \times \text{Consumptive Requirement} \times Lg \qquad 24$$

Where,

Lg = Fractional Load on Ground Water for Domestic Water Supply

The Load on Ground water can be obtained from the Information based on Civic water supply agencies in urban areas.

3.12.3 Ground water Extraction for Industrial use (GE_{IND}): The commonly adopted methods for estimating the extraction for industrial use are as below:

Unit Draft Method: - In this method, unit draft of each type of well is multiplied by the number of wells used for industrial purpose to obtain the industrial ground water extraction.

Consumptive Use Pattern Method: **–** In this method, water consumption of different industrial units are determined. Number of Industrial units which are dependent on ground water are multiplied with unit water consumption to obtain ground water draft for industrial use.

$$GE_{IND} = \text{Number of industrial units} \times \text{Unit Water Consumption} \times Lg \qquad 25$$

Where,

Lg = Fractional load on ground water for industrial water supply

The load on Ground water for Industrial water supply can be obtained from water supply agencies in the Industrial belt. Other important sources of data on ground water extraction for industrial uses are - Central Ground Water Authority, State Ground Water Authority, National Green Tribunal and other Environmental Regulatory Authorities.

Ground water extraction obtained from different methods need to be compared and based on field checks, the seemingly best value may be adopted. At times, ground water extraction obtained by different methods may vary widely. In such cases, the value matching the field situation should be considered. The storage depletion during a season where other recharges are negligible can be taken as ground water extraction during that particular period.

3.13 Stage of Ground Water Extraction

The stage of ground water extraction is defined by,

$$Stage\ of\ Ground\ Water\ Extraction(\%) = \frac{\text{Existing gross ground water extraction for all uses}}{\text{Annual Extractable Ground water Resources}} \times 100 \quad \textbf{26}$$

The existing gross ground water extraction for all uses refers to the total of existing gross ground water extraction for irrigation and all other purposes. The stage of ground water extraction should be obtained separately for command areas, non-command areas and poor ground water quality areas.

3.14 Validation of Stage of Ground Water Extraction

The assessment based on the stage of ground water extraction has inherent uncertainties. The estimation of ground water extraction is likely to be associated with considerable uncertainties as it is based on indirect assessment using factors such as electricity consumption, well census and area irrigated from ground water. The denominator in equation 26, namely Annual Extractable Ground Water Resources also has uncertainties due to limitations in the assessment methodology, as well as uncertainties in the data. In view of this, it is desirable to validate the 'Stage of Ground Water Extraction' with long term trend of ground water levels.

Long term Water Level trends are to be prepared for a minimum period of 10 years for both pre-monsoon and post-monsoon period. The Water level Trend would be average water level trend as obtained from the different observation wells in the area.

In interpreting the long term trend of ground water levels, the following points may be kept in view. If the pre and post monsoon water levels show a fairly stable trend, it does not necessarily mean that there is no scope for further ground water development. Such a trend

indicates that there is a balance between recharge, extraction and natural discharge in the unit. However, further ground water development may be possible, which may result in a new stable trend at a lower ground water level with associated reduced natural discharge.

If the ground water resource assessment and the trend of long term water levels contradict each other, this anomalous situation requires a review of the ground water resource computation, as well as the reliability of water level data. The mismatch conditions are enumerated below.

SOGWE	Ground Water level trend	Remarks
≤70%	Decline trend in both pre-monsoon and post-monsoon	Not acceptable and needs reassessment
>100%	No significant decline in both pre-monsoon and post-monsoon long term trend	Not acceptable and needs reassessment

In case, the category does not match with the water level trend given above, a 'reassessment' should be attempted. If the mismatch persists even after reassessment, the sub unit may be categorized based on Stage of Ground Water Extraction of the reassessment. However, the sub unit should be flagged for strengthening of observation well network and parameter estimation.

3.15 Categorisation of Assessment Units

As emphasised in the National Water Policy, 2012, a convergence of Quantity and Quality of ground water resources is required while assessing the ground water status in an assessment unit. Therefore, it is recommended to separate estimation of resources where water quality is beyond permissible limits for the parameter salinity.

3.15.1 Categorization of Assessment Units Based on Quantity: The categorization based on status of ground water quantity is defined by Stage of Ground Water extraction as given below:

Stage of Ground Water Extraction	Category
≤70%	Safe
> 70%and ≤90%	Semi-Critical
> 90%and ≤100%	Critical
> 100%	Over Exploited

In addition to this Category every assessment sub unit should be tagged with potentiality tag indicating its ground water potentiality viz. Poor Potential (Unit Recharge <0.025m), Moderately Potential (Unit Recharge in between 0.025 and 0.15m) and Highly Potential (Unit Recharge > 0.15m)

3.15.2 Categorization of Assessment Units Based on Quality

GEC 1997 proposed categorization of assessment units based on ground water extraction only.

To adequately inform management decisions, quality of ground water is also an essential criterion. The Committee deliberated upon the possible ways of categorizing the assessment units based on ground water quality in the assessment units. It was realized that based on the available water quality monitoring mechanism and available database on ground water quality it may not be possible to categorize the assessment units in terms of the extent of quality hazard. As a trade-off, the Committee recommends that each assessment unit, in addition to the Quantity based categorization (safe, semi-critical, critical and over-exploited) should bear a quality hazard identifier. Such quality hazards are to be based on available ground water monitoring data of State Ground Water Departments and/or Central Ground Water Board. If any of the three quality hazards in terms of Arsenic, Fluoride and Salinity are encountered in the assessment sub unit in mappable units, the assessment sub unit may be tagged with the particular Quality hazard.

3.16 Allocation of Ground Water Resource for Utilisation

The Annual Extractable Ground Water Resources are to be apportioned between domestic, industrial and irrigation uses. Among these, as per the National Water Policy, requirement for domestic water supply is to be accorded priority. This requirement has to be based on population as projected to the year 2025, per capita requirement of water for domestic use, and relative load on ground water for urban and rural water supply. The estimate of allocation for domestic water requirement may vary for one sub unit to the other in different states. In situations where adequate data is not available to make this estimate, the following empirical relation is recommended.

$$\textbf{Alloc} = 22 \times N \times L_g \ \textbf{mm per year} \qquad 27$$

Where

Alloc= Allocation for domestic water requirement

N = population density in the unit in thousands per sq. km.

L_g = fractional load on ground water for domestic and industrial water supply (≤ 1.0)

In deriving equation 27, it is assumed that the requirement of water for domestic use is 60 lpd per head. The equation can be suitably modified in case per capita requirement is different. If by chance, the estimation of projected allocation for future domestic needs is less than the current domestic extraction due to any reason, the allocation must be equal to the present day extraction. It can never be less than the present day extraction as it is unrealistic.

3.17 Net Annual Ground Water Availability for Future Use

The water available for future use is obtained by deducting the allocation for domestic use and current extraction for Irrigation and Industrial uses from the Annual extractable Ground

Water Recharge. The resulting ground water potential is termed as the net annual ground water availability for future use. The Net annual ground water availability for future use should be calculated separately for non-command areas and command areas. As per the recommendations of the R&D Advisory committee, the ground water available for future use can never be negative. If it becomes negative, the future allocation of Domestic needs can be reduced to current extraction for domestic use. Even then if it is still negative, then the ground water available for future uses will be zero.

3.18 Additional Potential Resources under Specific Conditions

3.18.1 Potential Resource Due to Spring Discharge: Spring discharge constitutes an additional source of ground water in hilly areas which emerges at the places where ground water level cuts the surface topography. The spring discharge is equal to the ground water recharge minus the outflow through evaporation and evapotranspiration and vertical and lateral sub-surface flow. Thus Spring Discharge is a form of 'Annual Extractable Ground Water Recharge'. It is a renewable resource, though not to be used for Categorisation. Spring discharge measurement is to be carried out by volumetric measurement of discharge of the springs. Spring discharges multiplied with time in days of each season will give the quantum of spring resources available during that season. The committee recommends that in hilly areas with substantial potential of spring discharges, the discharge measurement should be made at least 4 times a year in parity with the existing water level monitoring schedule.

Potential ground water resource due to springs = Q x No of days **28**

Where

Q = Spring Discharge

No of days= No of days spring yields.

3.18.2 Potential Resource in Waterlogged and Shallow Water Table Areas: The quantum of water available for development is usually restricted to long term average recharge or in other words "Dynamic Resources". But the resource calculated by water level fluctuation approach is likely to lead to under-estimation of recharge in areas with shallow water table, particularly in discharge areas of sub-basin/ watershed/ block/ taluka and waterlogged areas. In such cases rejected recharge may be substantial and water level fluctuations are subdued resulting in under-estimation of recharge component. It is therefore, desirable that the ground water reservoir should be drawn to optimum limit before the onset of monsoon, to provide adequate scope for its recharge during the following monsoon period.

In the area where the ground water level is less than 5m below ground level or in waterlogged areas, the resources up to 5m below ground level are potential and would be

available for development in addition to the annual recharge in the area. It is therefore recommended that in such areas, ground water resources may be estimated up to 5m bgl only assuming that where water level is less than 5m bgl, the same could be depressed by pumping to create space to receive recharge from natural resources. It is further evident that these potential recharge would be available mostly in the shallow water table areas which would have to be demarcated in each sub-basin/ watershed/ block/ taluka/ mandal.

The computation of potential resource to ground water reservoir can be done by adopting the following equation:

Potential ground water resource in shallow water table areas = (5-D) x A x S_Y 29

Where

D = Depth to water table below ground surface in pre-monsoon period in shallow aquifers.

A = Area of shallow water table zone.

S_Y = Specific Yield

The planning of future minor irrigation works in the waterlogged and shallow water table areas as indicated above should be done in such a way that there should be no long term adverse effects of lowering of water table up to 5m and the water level does not decline much below 5m in such areas. The behaviour of water table in the adjoining area which is not water logged should be taken as a bench mark for development purposes.

This potential recharge to ground water is available only after depression of water level up to 5m bgl. This is not an annual resource and should be recommended for development on a very cautious approach so that it does not adversely affect the ground water potentials in the overall area.

3.18.3 Potential Resource in Flood Prone Areas: Ground water recharge from a flood plain is mainly the function of the following parameters-

- Areal extent of flood plain
- Retention period of flood
- Type of sub-soil strata and silt charge in the river water which gets deposited and controls seepage

Since collection of data on all these factors is time taking and difficult, in the meantime, the potential recharge from flood plain may be estimated on the same norms as for ponds, tanks and lakes. This has to be calculated over the water spread area and only for the retention period using the following formula.

Potential ground water resource in Flood Prone Areas = 1.4 x N x A/1000 30

Where

N = No of Days Water is Retained in the Area

A = Flood Prone Area

3.19 Apportioning of Ground Water Assessment from Watershed to Development Unit:

Where the assessment unit is a watershed, there is a need to convert the ground water assessment in terms of an administrative unit such as block/ taluka/ mandal. This may be done as follows.

A block may comprise of one or more watersheds, in part or full. First, the ground water assessment in the subareas, command, non-command and poor ground water quality areas of the watershed may be converted into depth unit (mm), by dividing the annual recharge by the respective area. The contribution of this subarea of the watershed to the block, is now calculated by multiplying this depth with the area in the block occupied by this sub-area. This procedure must be followed to calculate the contribution from the sub-areas of all watersheds occurring in the block, to work out the total ground water resource of the block.

The total ground water resource of the block should be presented separately for each type of sub-area, namely for command areas, non-command areas and poor ground water quality areas, as in the case of the individual watersheds.

3.20 Assessment of In-Storage Ground Water Resources or Static Ground Water Resources

The quantum of ground water available for development is usually restricted to long term average recharge or dynamic resources. Presently there is no fine demarcation to distinguish the dynamic resources from the static resources. While water table hydrograph could be an indicator to distinguish dynamic resources, at times it is difficult when water tables are deep. For sustainable ground water development, it is necessary to restrict it to the dynamic resources. Static or in-storage ground water resources could be considered for development during exigencies that also for drinking water purposes. It is also recommended that no irrigation development schemes based on static or in-storage ground water resources be taken up at this stage.

Assessment of In-storage ground water resources has assumed greater significance in the present context, when an estimation of Storage Depletion needs to be carried out in Over-exploited areas. Recently Remote Sensing techniques have been used in GRACE studies, to estimate the depletion of Ground Water Resources in North West India. Such estimation presents larger scale scenario. More precise estimation of ground water depletion in the over-

exploited area based on actual field data can be obtained by estimating the Change in In-storage during successive assessments. Thus In-storage computation is necessary not only for estimation of emergency storage available for utilisation in case of natural extremities (like drought) but also for an assessment of storage depletion in over-exploited areas for sensitising stakeholders about the damage done to the environment.

The computation of the static or in-storage ground water resources may be done after delineating the aquifer thickness and specific yield of the aquifer material. The computations can be done as follows:-

$$SGWR = A *(Z_2 - Z_1) * S_Y \quad 31$$

Where,

SGWR = Static or in-storage Ground Water Resources

A = Area of the Assessment Unit

Z_2 = Bottom of Unconfined Aquifer

Z_1 = Pre-monsoon water level

S_Y = Specific Yield in the In storage Zone

3.21 Assessment of Total Ground Water Availability in Unconfined Aquifer

The sum of Annual Exploitable Ground Water Recharge and the In storage ground water resources of an unconfined aquifer is the Total Ground Water Availability of that aquifer.

3.22 GROUND WATER ASSESSMENT OF CONFINED AQUIFER SYSTEM

Assessment of ground water resources of confined aquifers assumes crucial importance, since over-exploitation of these aquifers may lead to far more detrimental consequences than to those of shallow unconfined aquifers. If the piezometric surface of the confined aquifer is lowered below the upper confining layer so that desaturation of the aquifer occurs, the coefficient of storage is no longer related to the elasticity of the aquifer but to its specific yield. In view of the small amounts of water released from storage in the confined aquifers, large scale pumpage from confined aquifers may cause decline in piezometric levels amounting to over a hundred metre and subsidence of land surface posing serious geotectonical problems.

It is recommended to use ground water storage approach to assess the ground water resources of the confined aquifers. The co-efficient of storage or storativity of an aquifer is defined as the volume of water it releases or takes into storage per unit surface area of the aquifer per unit change in head. Hence the quantity of water added to or released from the aquifer (ΔV) can be calculated as follows

$$\Delta V = S \Delta h \quad 32$$

If the areal extent of the confined aquifer is A then the total quantity of water added to or

released from the entire aquifer is

$$Q = A\,\Delta V = SA\,\Delta h \qquad 33$$

Where

Q = Quantity of water confined aquifer can release (m^3)

S = Storativity

A = Areal extent of the confined aquifer (m^2)

Δh= Change in Piezometric head (m)

Most of the storage in confined aquifer is associated with compressibility of the aquifer matrix and compressibility of water. Once the piezometric head reaches below the top confining bed, it behaves like an unconfined aquifer and directly dewaters the aquifer and there is a possibility of damage to the aquifer as well as topography. Hence ground water potential of a confined aquifer is nothing but the water available for use without damaging the aquifer. Hence the resources available under pressure are only considered as the ground water potential. The quantity of water released in confined aquifer due to change in pressure can be computed between piezometric head (h_t) at any given time 't' and the bottom of the top confining layer (h_o) by using the following equation.

$$Q_p = SA\Delta h = SA\,(h_t - h_0) \qquad 34$$

If any development activity is started in the confined aquifer, then there is a need to assess the dynamic as well as in storage resources of the confined aquifer. To assess the ground water resources of the confined aquifer, there is a need to have sufficient number of observation wells tapping exclusively that particular aquifer and proper monitoring of the piezometric heads is also needed.

3.22.1 Dynamic Ground Water Resources of Confined Aquifer

To assess the dynamic ground water resources the following equation can be used with the pre and post monsoon piezometric heads of the particular aquifer.

$$Q_D = SA\Delta h = SA\,(h_{POST} - h_{PRE}) \qquad 35$$

Where

Q_D = Dynamic Ground Water Resource of Confined Aquifer (m^3)

S = Storativity

A = Areal extent of the confined aquifer (m^2)

Δh = Change in Piezometric head (m)

h_{post} =Piezometric head during post-monsoon period(m amsl)

h_{PRE} = Piezometric head during pre-monsoon period(m amsl)

3.22.2 In storage Ground Water Resources of Confined Aquifer

For assessing the in storage ground water potential of a confined aquifer, one has to

compute the resources between the pre monsoon piezometric head and bottom of the top confining layer. That can be assessed using the following formula:

$$Q_I = SA\Delta h = SA\,(h_{PRE} - h_0) \qquad 36$$

Where

Q_I =In storage Ground Water Resource of Confined Aquifer (m^3)

S = Storativity

A = Areal extent of the confined aquifer (m^2)

Δh = Change in Piezometric head (m)

h_0 = Bottom level of the top confining layer (m amsl)

h_{PRE} = Piezometric head during pre-monsoon period(m amsl)

If the confined aquifer is not being exploited for any purpose, the dynamic and static resources of the confined aquifer need not be estimated separately. Instead the in storage of the aquifer can be computed using the following formula.

$$Q_p = SA\Delta h = SA\,(h_{POST} - h_0) \qquad 37$$

Where

Q_p = In storage Ground Water Resource of the confined aquifer or the Quantity of water under pressure (m^3)

S = Storativity

A = Areal extent of the confined aquifer (m^2)

Δh = Change in Piezometric head (m)

H_{POST} =Piezometric head during post-monsoon period (m amsl)

h_0 = Bottom of the Top Confining Layer (m amsl)

The calculated resource includes small amount of dynamic resource of the confined aquifer also, which replenishes every year. But to make it simpler this was also computed as part of the static or in-storage resource of the confined aquifer.

3.22.3 Assessment of Total Ground Water Availability of Confined Aquifer

If the confined aquifer is being exploited, the Total Ground Water Availability of the confined aquifer is the sum of Dynamic Ground Water Resources and the In storage ground water resources of that confined aquifer whereas if it is not being exploited, the Total Ground Water Availability of the confined aquifer comprises of only one component i.e. the In storage of the confined aquifer.

3.23 GROUND WATER ASSESSMENT OF SEMI-CONFINED AQUIFER SYSTEM

The Assessment of Ground Water Resources of a semi-confined aquifer has some more complications. Unless and until, it is well studied that the recharge to this is not computed either

in the over lying unconfined aquifer or underlying/overlying semi confined aquifers, it should not be assessed separately. If it is assessed separately, there is a possibility of duplication of estimating the same resource by direct computation in one aquifer and as leakage in the other aquifer. As it is advisable to under estimate rather than to overestimate the resources, it is recommended not to assess these resources separately as long as there is no study indicating its non-estimation. If it is found through field studies that the resources are not assessed in any of the aquifers in the area, these resources are to be assessed following the methodology similar to that used in assessing the resources of Confined aquifers.

3.24 TOTAL GROUND WATER AVAILABILITY OF AN AREA

The Total Ground water availability in any area is the Sum of Dynamic Ground Water Resources, the total static/ in-storage ground water resources in the unconfined aquifer and the dynamic and In-storage resources of the Confined aquifers and semi confined aquifers in the area.

CHAPTER – 4

PROCEDURE FOLLOWED IN THE PRESENT ASSESSMENT INCLUDING ASSUMPTIONS

4.1 DYNAMIC GROUND WATER RESOURCES ESTIMATION

The Dynamic Ground Water Resource of Punjab State has been assessed as per GEC-2015 Methodology by taking Block as a Unit of Assessment. At present, there are total 149 Blocks in Punjab State, however in the present study 138 blocks have been considered which represents the entire geographical area of the state. The block boundaries and other technical details in respect of newly carved out blocks are not available. The Minor Irrigation Census for Tube wells for the year 2006-07 has been carried out by the Agriculture Department for 136 Blocks only. As such, 138 Blocks has been considered (Refer **PLATE–2** for Administrative Base Map) for this study, by incorporating the data of 2 Blocks on pro-rata basis, for making assessment of Dynamic Ground Water Resource for which the multidisciplinary data have been provided by the following Agencies:

1. Irrigation Department, Punjab.
2. Agriculture Department Punjab.
3. Public Health Department, Punjab.
4. Central Ground Water Board, North Western Region, Chandigarh.
5. Department of Industries, Punjab.
6. Indian Meteorological Department.
7. Census Department, Govt. of India, Sector 19, Chandigarh.

The water level data for the year 2012-16 has been used for calculation of average monsoon recharge which has been normalized as per GEC-2015 guidelines. The unit draft figures for the year 2009-10 on pro rata basis have been made available by Agriculture Department. The block wise figures of population provided by the Census Department GOI, has been used as per census 2011. The per capita consumption of water is taken as 100 lpd for assessing the domestic use requirement of ground water as per detailed deliberations held during various meetings. The percentage increase in district-wise population w.r.t. 2011 census has been applied for calculating the present and future domestic requirements. The block-wise water use requirement figures for Industry as supplied by Department of Industries, Punjab for the year 2003 have been used by projecting the data on pro-rata basis of population growth rate i.e. 1.5% per annum. As many new changes/modifications have been incorporated in the network of canals in the Punjab State,

so the canal data has been procured from the various Canal Divisional Offices and has been updated and used in the calculations.

The value of Specific Yield for calculating the Dynamic Ground Water Resource of the State has been taken as 12% which is within the norms provided in the guidelines of GEC-2015 issued by Ministry of Water Resources, Govt. of India.

While calculating the ground water resources of the State, GEC -2015 methodology along with its amendments has been used with the following parameters/assumptions:-

1. In the primarily agrarian State of Punjab, it is not possible to differentiate between Command Area and Non-Command Area, so no separate computation of Command Area and Non-Command Area has been taken.
2. Even in the saline areas, there is canal and tube-well network and judicious mixing of the two sources of water is being done to raise different crops in these areas. No separate canal and Tubewell Irrigation data and its draft data figures are available for these areas. As such, these areas cannot be differentiated and has been clubbed for calculating the dynamic ground water recharge.
3. The various dependency factors for calculation of domestic ground water consumption have been taken from the GEC-2015 Methodology of CGWB.
4. The various modifications have been incorporated on the basis of the various inputs made available from CGWB, Agriculture Department of Punjab, Punjab Agricultural University, Ludhiana and other agencies associated with this estimation. The extracts of minutes of "*Meeting of Technical Sub Committee on Water balance of Punjab State*" **(Appendix 2.1, 2.2 and 2.3)** concerning with present estimation are as follows:-
    i. A uniform value of Specific Yield has been adopted instead of soil related value. The value of Sp. Yield, as adopted has been taken as 12% for the Punjab State.
    ii. The canal seepage factor for un-lined canals may be taken as 17.5 ha m/day/million sq. mts. and 3.5 ha m/day/million sq. mts. for lined canals as recommended by GEC-2015.
    iii. For this Report, the Agriculture Department has supplied the block wise areas under Paddy/Non-Paddy crops and unit draft figures on pro-rata basis. The representatives of Agriculture Department intimated in the meeting of Sub-Committee on Ground Water balance held on 05.06.2018 to take the unit draft figures on pro-rata basis over unit Draft of 2009. Data for Number of Tube wells

was supplied by Agriculture Department on the basis of 4th Minor Census held in 2006-07 and it was decided in the meeting of Sub Committee to adopt these figures in this estimation.

iv. The Block-wise industrial draft figures (period 2004 -07), supplied by the Department of Industry, for the 2009 report has been used in this report as new data not supplied by Department of Industry. It was decided that the Ground Water Extraction by industries may be calculated as per the growth rate of 1.5% per annum on pro-rata basis of population growth rate i.e. 1.5% per annum.

v. Domestic draft has been calculated on population basis @ 100 lpd and also includes demand for next 25 years. The ground water dependency factor of 0.8 is taken into consideration for estimation of future requirement.

vi. G.E.C- 1997 requires that the average value of water level at 5 different points in a block be considered for calculation of seasonal fluctuation. The same condition has also been applied in the present study.

vii. Whole of the geographical area of block, including saline area, has been taken as ground water worthy area in the Ground Water Estimation as surface water irrigation is being supplemented by the ground water in the State of Punjab even in the saline areas.

viii. Updated Canal data, as received from the Canal Circle / Division Offices during 2013-14 has been used in the estimation.

ix. Blocks where more than 50% of its geographical area is having groundwater level less than 5 m (below ground level) have been considered as “Safe”.

x. Keeping in view the high ground water draft figures for agriculture and increasing domestic needs due to urbanization, the small size of the blocks and the agrarian character of the State, it is difficult to differentiate between command and non-command areas in the State as 97% of cultivated area is under irrigation either by tubewells or canal water or both and even in the saline areas, surface water irrigation is being supplemented by the ground water. Keeping this in view, it is decided to compute the ground water estimation by clubbing both command and non-command areas.

CHAPTER – 5

COMPUTATION OF GROUND WATER RESOURCES ESTIMATION IN PUNJAB

5.1 SALIENT FEATURES OF DYNAMIC GROUND WATER RESOURCES ASSESSMENT

Type of Assessment Units	Blocks
No. of Assessment Units (Blocks) taken for Study	138
Years of Collection of Data (5 years)	2012-16
Year of Projection of Report	2017
No. of Over-Exploited Blocks	109
No. of Critical Blocks	02
No. of Semi-Critical Blocks	05
No. of Safe Blocks	22

Out of total 138 Blocks taken for study, 109 Blocks (79%) are "Over-Exploited", 2 Blocks (1%) are "Critical", 5 Blocks (4%) are "Semi-Critical" and 22 Blocks (16%) are in "Safe" category. (**PLATE 3**) The percentage of blocks under different categories is represented as Pie Chart in **FIG-7.** The water level trends have been computed for last 10 years from 2006-2016 data.

5.2 METHOD ADOPTED FOR COMPUTING RAIN FALL RECHARGE DURING MONSOON SEASON

The administrative block has been taken as assessment unit and for computing the block-wise rainfall recharge during monsoon season. Rainfall Infiltration Factor (RIF) Method has been mostly applied as the difference of computing this with Water Level Fluctuations (WLF) Method is more than 20%. WLF Method has been applied only on 4 blocks out of total 138 blocks taken for study. The block-wise details of the method applied for rainfall recharge during monsoon season is shown in **Annexure III D-2**.

5.3 GROUND WATER RESOURCE ASSESSMENT

The ground water resource assessment of Punjab State has been computed as per GEC-97 Methodology and the computations and its various details have been attached as **Annexure III A-1 to Annexure III-J**. The abstract of Dynamic Ground Water Assessment is as follows:-

Net Annual Ground Water Availability	21, 58,498 Ham	17.49 MAF
Existing GW Draft for Irrigation	34, 56,464 Ham	28.00 MAF
Existing GW Draft for Domestic and Industrial Use	121,772 Ham	0.99 MAF
Existing GW Draft for All Uses	35, 78,236 Ham	28.99 MAF
Net GW Availability for Future Irrigation Development in Safe, Semi-critical, critical and Potential Resources in water logged areas	117000 Ham	0.948 MAF
Average Stage of GW Extraction of State	166%	

- The Net Annual Ground Water Availability for the period 2012-16 works out to be 21, 58,498 Ham (17.49 MAF). The Average Normal Recharge figures for all the districts from rainfall and other sources have been calculated and indicated in **Table- I and FIG-8**.
- The gross ground water draft for all uses has been worked out to be 35, 78,236 Ham (28.99 MAF). The existing gross ground water draft for all Uses has been observed to be maximum in Sangrur district as 3,68,502 Ham and minimum in Pathankot district as 18,742 Ham. The district-wise ground water draft for irrigation and for other uses (domestic and industrial use) is given in **Table- II and FIG- 9.** Domestic and Industrial water use demand for next 25 years have been taken in this estimation.
- The district-wise ground water availability of Punjab State vis-a-vis the ground water draft and net ground water availability for future irrigation Development have been depicted in **Table-II** and **FIG-10**. It has been observed that the net ground water availability for future irrigation development in the state is 'NIL' in over-exploited blocks of the State but in Safe, Semi-critical, critical and in water logged areas it has been assessed as 1,17,000 Ham (0.948 MAF) .
- The block-wise stage of ground water development varies from 24 % in Dhar Kalan Block of Pathankot district to maximum of 368 % in Pattran block of Sangrur district respectively (**Annexure III D-2 contd**.).
- The district wise stage of ground water extraction has been computed and given in **Table II** and shown in **FIG-11**. It varies from 74% in Muktsar district to 260 % in Sangrur district.
- Shallow water level area having depth to water table less than 5 m bgl in the State is about 5477 km^2 depicted in **Annexure III A-I** which is lying mainly in the south-western districts of the Punjab State. Blockwise Annual Additional Potential Ground Water Recharge has been worked out to be 8705 Ham for water logged and shallow

water table areas of the State and has been depicted in **Annexure III J.** The district-wise details have been given in **Table-III.** The maximum potential has been observed in Muktsar District.

5.4 GROUND WATER ASSESSMENT COMPARISON OF VARIOUS STUDIES

The number of Over-Exploited Blocks has increased with time as per various Ground Water Estimation Studies carried out from time to time, as shown below:

Study Year → / **Category of Blocks ↓**	**1984**	**1986**	**1989**	**1992**	**1999**	**2004**	**2009**	**2011**	**2013**	**2017**
Dark / Over-exploited	53	55	62	63	73	103	110	110	105	109
Dark /Critical	7	9	7	7	11	5	3	4	4	2
Grey / Semi Critical	22	18	20	15	16	4	2	2	3	5
White/ Safe	36	36	29	33	38	25	23	22	26	22
Total	**118**	**118**	**118**	**118**	**138**	**137**	**138**	**138**	**138**	**138**

Net Annual Ground Water Availability for Irrigation Development comparison of various studies

Year	**Net Annual Ground Water Availability for Future Irrigation Development**	
	Ham	**MAF**
1984	301929	2.44
1989	67914	0.55
1992	103177	0.84
1999	27101	0.22
2004	(-) 988926	(-) 8.01
2009	(-) 1457475	(-) 11.81
2011	(-) 1483189	(-) 12.02
2013	(-) 1162414	(-) 9.42
2017	0	0

5.5 SPATIAL VARIATION OF GROUND WATER RECHARGE AND DEVELOPMENT SCENARIO

The annual ground water recharge and the method adopted for computing monsoon recharge for previous 2013 study and for present 2017 study has been compared in **Table-IV.** Similarly, Categorization for Future Ground Water Development and the Stage of Ground Water development for each block and district of this study as a whole has also been compared with previous 2013 study as shown in **Table-V.**

5.6 COMPARISON WITH EARLIER GROUND WATER RESOURCE ESTIMATE

It has been observed that out of the total area of the State (50, 36,200 Ha) the area where ground water table is more than 10m deep has been continuously increasing. It was 7, 49,600 Ha (14.9%) in June 1989, 10, 23,400 Ha (20%) in June 1992, 14,15,100 Ha (28%) in June 1997, and 22,07,300 Ha (44%) in June 2002 and 30,41,800 Ha (61%) in June 2008, 32,36,100 Ha (64%) in June 2010, 33,10,400 Ha (65%) in June 2012 and 33,177,00 Ha (65%) in June 2016. Water level as observed in June 2012 and June 2016 has gone down in general thereby showing decline of water levels. This ground water estimation shows deterioration in ground water scenario in comparison to previous report as number of Over exploited Blocks has increased from 105 (GWRE-2013) to 109 (GWRE-2017) and overall Stage of ground water extraction has gone up to 165 % from 149 % (GWRE -2013).

5.7 INSTORAGE GROUND WATER RESOURCES

GEC-2015 recommends estimation of instorage Ground Water Resources of aquifers upto the explored depths. As per the NAQUIM scheme the aquifer maps have been prepared upto 300 mts. and aquifers have been identified and as such, the resources of aquifers present upto the depth of 300 mts have been estimated which are given in **Table VII.** The abstract of instorage Ground Water Resources is as follows:

Aquifer I	138.97 MAF (171.53 BCM)
Aquifer II	61.43 MAF (75.83 BCM)
Aquifer III	41.93 MAF (51.76 BCM)

Thus the total instorage Ground water Resources of all the aquifers upto the depth of 300 mts. works out to be 242.33 MAF (299.12BCM)

5.8 SALINE GROUND WATER RESOURCES

GEC 2015 also recommends estimation of saline Ground Water Resources in areas where salinity is more than 3000 micromhos/cm. As such, the ground water resources in poor quality areas have been calculated as 903692 Ham (7.32 MAF, 9.04 BCM) and given in **Annexure III-I.**

5.9 TOTAL GROUND WATER AVAILABILITY

The Total Ground water availability (Dynamic and Static) in Punjab State is works out to be 329700949 Ham (267.12 MAF). Total availability of Groundwater Resources figures for all the districts have been calculated and indicated in Table- VII and FIG-12.

5.10 CHARACTERIZATION OF BLOCKS BASED ON POTENTIALITY

Block wise unit recharge has been calculated by using **Annexure-III A-I and Annexure**

III D-2 i.e. Total Annual Ground Water Recharge (Col. 8 of Annexure-III D 2) divided by the Area of Assessment (Col. 6 of Annexure-III A).

$$= \frac{\text{Total Annual Ground Water Recharge (Col. 8 of Annexure-III D-2)}}{\text{Area of Assessment (Col. 6 of Annexure-III A-I).}}$$

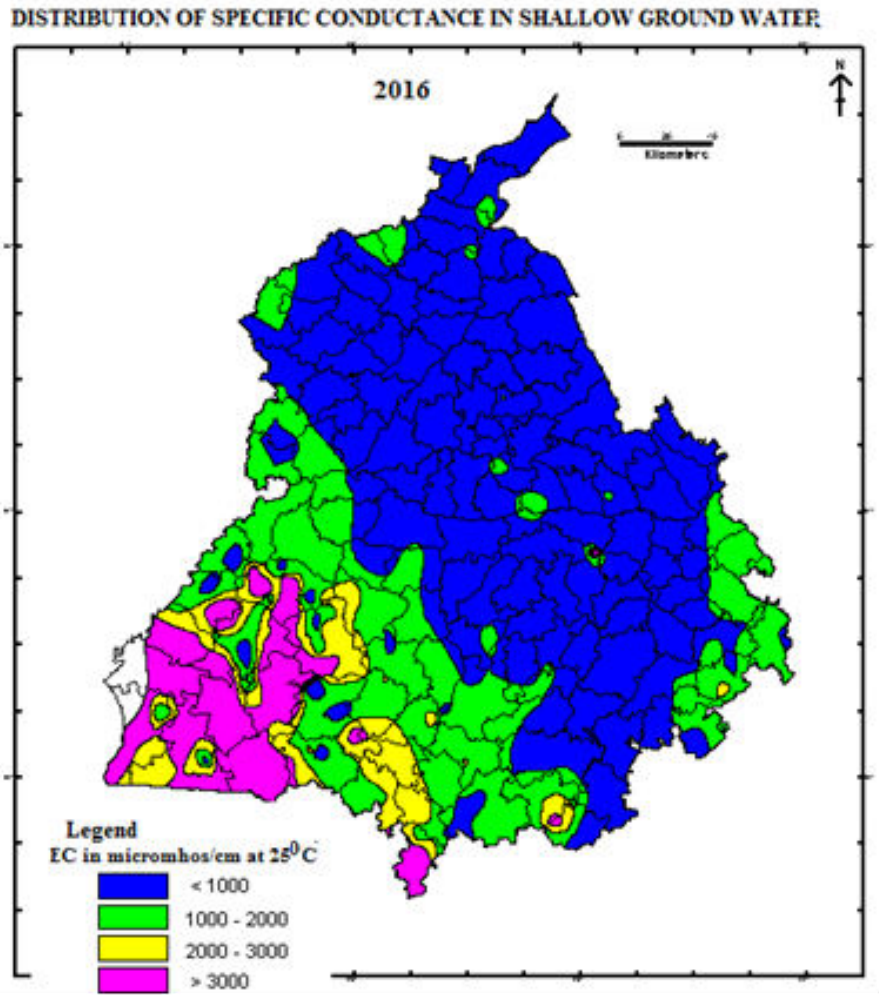
The block wise calculations have been done on the above formula and the blocks have been categorized as Highly Potential and Moderately Potential. The same has been shown in **Table- VIII**.

CHAPTER – 6
WATER QUALITY TAG

GEC, 2015 recommends that each assessment unit, in addition t the quantity based categorization should bear a quality hazard identifier. If any of the quality hazards in terms of Arsenic, Fluoride and Salinity are encountered in the assessment sub unit in mappable units, the assessment unit may be tagged with the particular hazard.

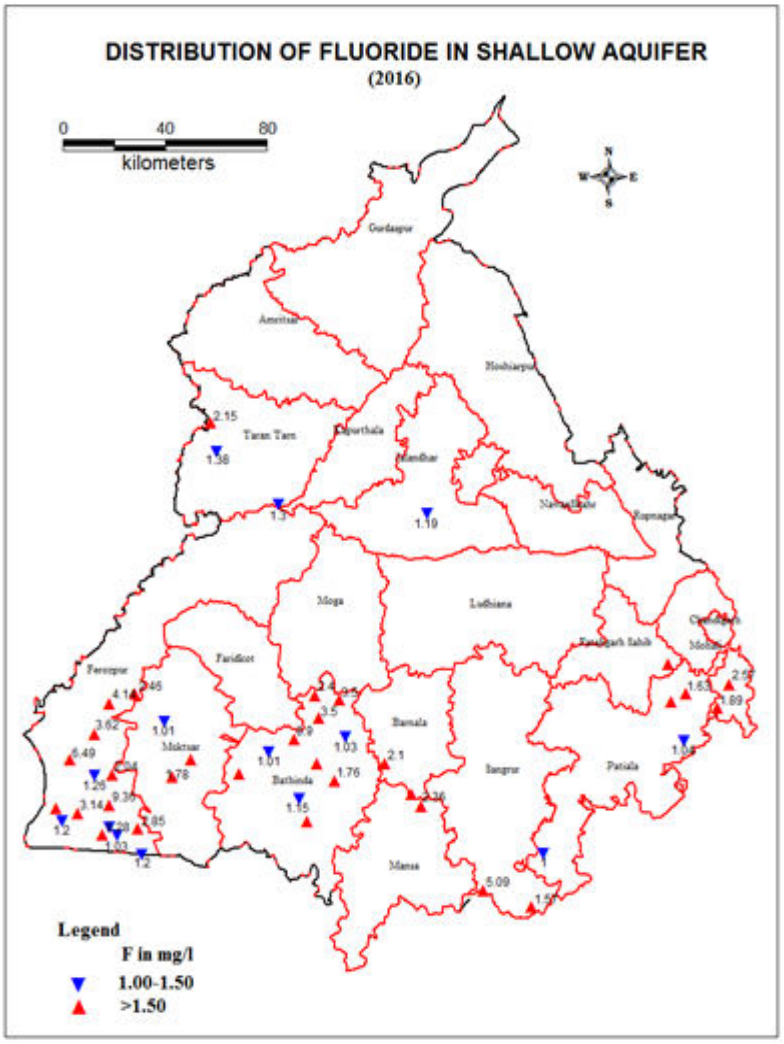
6.1 DISTRIBUTION OF ELECTRICAL CONDUCTANCE (E.C)

Grouping water samples based on EC values, it is found that 43.3 % of them have EC less than 750, 49.1% have between 750 and 3000 and the remaining 7.6% of the samples have EC above 3000µS/cm. The Plate showing aerial distribution of EC with intervals corresponding to limits assigned for desirable, permissible and unsuitable classes of waters indicates that desirable class of waters occur in northern and central area of the State. The ground water occurring in the southern and southwestern parts comprising of Bhatinda, Faridkot, Ferozepur, Ludhiana, Muktsar and Sangrur districts is mostly saline and not suitable for drinking uses.



6.2 DISTRIBUTION OF FLUORIDE (F)

It is found that 84.4% samples have fluoride in desirable range, 4.8% in the permissible and the remaining 10.7% have fluoride above 1.5 mg/L. Map showing spatial distribution of fluoride contents in ground water indicates that ground water in most parts of the State has desirable concentration of fluoride. Ground waters with fluoride above 1.5 mg/L are found mainly in Bathinda, Faridkot, Fatehgarh Sahib, Ferozepur, Mansa, Muktsar, Patiala, Sangrur, SAS Nagar and Tarn Taran districts of the State. It is worth mentioning that high fluoride waters are encountered in areas where agriculture activities are predominant. It indicates the possibility that fluoride has come from the phosphatic fertilizers, which have fluoride as impurity.



6.3 DISTRIBUTION OF ARSENIC (As)

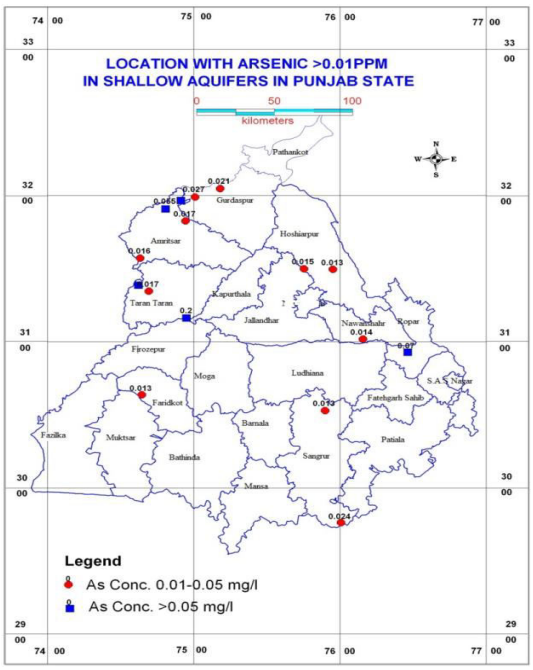
As per the analytical data generated the arsenic concentration varies from below detection limit at several places to 0.200 mg/l at village Harike (HP), block Patti in Taran Taran district. Isolated cases from eight districts namely, Amritsar, Faridkot, Gurdaspur, Hoshiarpur, Nawanshahr, Ropar, Sangrur and Taran Taran have Arsenic concentration more than the permissible limit of 0.01mg/l. The locations with arsenic concentration >0.01 mg/l alongwith block details, well depth, water level during May 2015 are tabulated below.

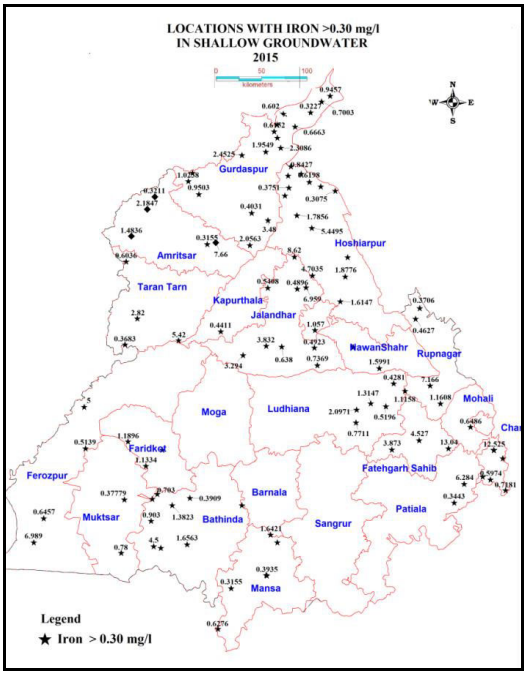
Table showing Ground Water Monitoring Stations with Arsenic concentration above 0.01 mg/l (2015)

S.N.	District	Block	Location	Well Depth in mt	Water Level mbgl	Aquifer	As >0.01 mg/l
1	Amritsar	Ajnala	Goaggomahal	69.00	5.35	Alluvium	0.055
2	Amritsar	Ajnala	Ramdas	9.50	8.35	Alluvium	0.06
3	Faridkot	Faridkot	Sukhanwala	30.00	3.79	Alluvium	0.013
4	Gurdaspur	Fatehgarh Chudian	Madipur	11.80	9.56	Alluvium	0.017
5	Gurdaspur	Kalanaur	Salehchak	40.00	3.40	Alluvium	0.021
6	Gurdaspur	Dere Baba Nanak	Mullowali	10.00	3.24	Alluvium	0.027
7	Hoshiarpur	Hoshiarpur-II	Rampur Colony	20.00	21.35	Alluvium	0.013
8	Hoshiarpur	Hoshiarpur-I	Sham Chourasi	14.90	12.05	Alluvium	0.015
9	Nawashahar	Nawanshahr	Bahlore Kalan	62.41	5.01	Alluvium	0.014
10	Ropar	Ropar	Bada Chaunta	5.60	4.05	Alluvium	0.070
11	Sangrur	Maler Kotla	Maler Kotla	40.00	34.63	Alluvium	0.013
12	Sangrur	Andana	Bulan	13.50	-	Alluvium	0.024
13	Tarn Taran	Chogawan	Mohawa	23.00	13.08	Alluvium	0.016
14	Tarn Taran	Bhikhiwind	Bhikhiwind	54.00	15.03	Alluvium	0.017
15	Tarn Taran	Bhikhiwind	Khalra	13.00	13.08	Alluvium	0.070
16	Tarn Taran	Patti	Harike	13.10	11.35	Alluvium	0.200

6.4 DISTRIBUTION OF ARSENIC AND IRON

The following table shows the distribution of Arsenic and Iron in Punjab state. The samples in which Arsenic and Iron are more than the permissible limits are highlighted in this table and shown in the maps below.





Results of Arsenic and Iron of water samples from GWMS in Punjab (2015)

S. No	District	Block	Location	As (mg/l)	Fe (mg/l)
1	Amritsar	Raiya	Beas	BDL	0.003
2	Amritsar	Jandiala	Jandiala Gurn	0.001	0.0317
3	Amritsar	Verka	Amritsar	0.006	0.0858
4	Amritsar	Chogawan	Chogawan	0.001	1.4836
5	Amritsar	Ajnala	Ajnala	BDL	2.1847
6	Amritsar	Ajnala	Goaggomahal	0.055	0.3211
7	Amritsar	Ajnala	Ramdas	0.06	BDL
8	Amritsar	Tarike	Tanel	0.001	7.66
9	Barnala	Barnala	Barnala	0.002	0.0193
10	Barnala	Mehal Kalan	Gehl Iind	0.003	0.0016
11	Barnala	Mehal Kalan	Mahal Kalan	0.001	BDL
12	Barnala	Sehna	Bhadaur	0.002	0.3838
13	Bathinda	Bathinda	Nahianwala	0.001	1.3823
14	Bathinda	Bathinda	Dera Tappa	BDL	0.186
15	Bathinda	Bathinda	Ablu	BDL	0.703
16	Bathinda	Sangat	Rai Ke Kalan	0.001	0.0654
17	Bathinda	Sangat	Jassi Bhag Wali	0.001	0.0663

S. No	District	Block	Location	As (mg/l)	Fe (mg/l)
18	Bathinda	Bathinda	Balluana	0.001	0.903
19	Bathinda	Sangat	Ghudda	BDL	4.5
20	Bathinda	Phul	Dial Pur Bhlaike	BDL	0.0832
21	Bathinda	Phul	Rampura Phull	BDL	0.0211
22	Bathinda	Nathana	Phulla	BDL	BDL
23	Bathinda	Nathana	Dial Pur Mirja	BDL	0.0016
24	Bathinda	Phul	Phul	BDL	BDL
25	Bathinda	Bathinda	Kot Shamir	BDL	1.6563
26	Bathinda	Talwandi Sabo	Maiser Khanna	BDL	1.6421
27	Bathinda	Talwandi Sabo	Bhagi Bandar	BDL	0.1169
28	Bathinda	Rampura	Kaila Bander	BDL	0.014
29	Bathinda	Rampura	Jhanduke	0.002	0.0131
30	Bathinda	Talwandi Sabo	Jajjal	0.001	0.0388
31	Bathinda	Bathinda	Khialiwala	0.001	0.3909
32	Bathinda	Bathinda	Gulabgarh	0.001	0.0504
33	Bathinda	Sangat	Sangat Kalan	BDL	0.3962
34	Bathinda	Phul	Gurusar	0.002	0.0131
35	Bathinda	Phul	Dhapali	0.004	0.0379
36	Bathinda	Bathinda	Ganga	BDL	2.9953
37	Bathinda	Rampura	Badiala	BDL	0.1089
38	Bathinda	Rampura	Kotho Guru	0.002	0.0034
39	Faridkot	Kotkapura	Baja Khana	0.001	BDL
40	Faridkot	Kotkapura	Beed Sikhanwala	0.001	BDL
41	Faridkot	Faridkot	Chahd Baja	BDL	BDL
42	Faridkot	Faridkot	Dalsinghwala	0.005	BDL
43	Faridkot	Faridkot	Devi Wala	0.001	1.7697
44	Faridkot	Kotkapura	Dhilwan Kalan	BDL	BDL
45	Faridkot	Faridkot	Dipsinghwala	0.003	0.2797
46	Faridkot	Kotkapura	Karirwali	0.001	0.1236
47	Faridkot	Kotkapura	Kot Kapura	0.001	0.1118
48	Faridkot	Kotkapura	Matta	BDL	0.0271
49	Faridkot	Faridkot	Mehmuana	0.002	BDL
50	Faridkot	Faridkot	Sher Singh Wala	BDL	0.174
51	Faridkot	Kotkapura	Wara Dharaka	BDL	1.1334
52	Faridkot	Faridkot	Sukhanwala	0.013	1.1896
53	Faridkot	Faridkot	Jand Sahib	0.003	0.2319
54	Faridkot	Faridkot	Nangal	0.001	BDL
55	Faridkot	Faridkot	Tehna	0.007	BDL
56	Faridkot	Faridkot	Sadiqe	0.001	BDL
57	Faridkot	Momdot	Killi	0.004	BDL
58	Faridkot	Faridkot	Nathuwala	BDL	BDL
59	Faridkot	Faridkot	Mumara	BDL	0.1681
60	Faridkot	Faridkot	Arianwala	BDL	0.1496

S. No	District	Block	Location	As (mg/l)	Fe (mg/l)
61	Faridkot	Faridkot	Kilanau	0.001	0.1236
62	Faridkot	Kotkapura	Moharewala	0.005	BDL
63	Fatehgarh Sahib	Bassi Pathana	Bassi Pathana	0.001	0.0731
64	Fatehgarh Sahib	Fatehgarh Sahib	Fatehgarh Sahib	0.003	4.527
65	Fatehgarh Sahib	Amloh	Amloh	BDL	3.873
66	Fatehgarh Sahib	Khera	Badliala Singh	0.001	0.1654
67	Fatehgarh Sahib	Bassi Pathana	Bhatria	0.001	0.1081
68	Fatehgarh Sahib	Khera	Chunni Kalan	0.001	0.0453
69	Fatehgarh Sahib	Sirhand	Bir Bhramarsi	0.001	0.0596
70	Fatehgarh Sahib	Khera	Bhgrana	0.002	13.04
71	Fatehgarh Sahib	Khera	Pawala	BDL	0.2968
72	Fatehgarh Sahib	Sirhand	Nalini	0.001	0.0363
73	Firozpur	Abohar	Abohar	0.001	0.017
74	Firozpur	Khuian Sarwar	Alamgarh	0.001	0.2084
75	Firozpur	Guru Harsahai	Banna Wala	BDL	BDL
76	Firozpur	Abohar	Bazidpurabhoma	0.003	BDL
77	Firozpur	Khuian Sarwar	Danewal Satkosi	0.001	0.289
78	Firozpur	Fazilka	Dipulana	0.001	0.0758
79	Firozpur	Khuian Sarwar	Khuiansarwar	0.003	6.989
80	Firozpur	Abohar	Kundal	0.002	0.0758
81	Firozpur	Jalalabad	Ladhuwala	0.001	0.2168
82	Firozpur	Makhu	Lauhke Kalan	0.001	0.0178
83	Firozpur	Mamdot	Malsian	BDL	5.000
84	Firozpur	Khuian Sarwar	Nihalkhera	0.001	0.6457
85	Firozpur	Gahll Kurd	Piyarana	BDL	0.0716
86	Firozpur	Fazilka	Sham Singhwala	0.008	BDL
87	Firozpur	Abohar	Sitoganno	0.001	0.1597
88	Firozpur	Guru Harsahai	Sohangarh Ratte	0.001	0.5139
89	Firozpur	Guru Harsahai	Swah Wala	0.009	BDL
90	Firozpur	Guru Harsahai	Nureke Uttar	BDL	BDL
91	Firozpur	Guru Harsahai	Motiwala	0.001	BDL
92	Firozpur	Makhu	Jamwal Singhwala	0.001	Leaked
93	Gurdaspur	Fatehgarh Chudian	Madipur	0.017	0.1988
94	Gurdaspur	Dere Baba Nanak	Mullowali	0.027	1.0238
95	Gurdaspur	Dere Baba Nanak	Dera Baba Nanak	0.001	2.9022
96	Gurdaspur	Kalanam	Salehchak	0.021	0.1539
97	Gurdaspur	Kalanam	Kalanam	0.004	0.0247
98	Gurdaspur	Dhariwal	Bhagowal	0.005	0.0348
99	Gurdaspur	Dere Baba Nanak	Dhianpur	0.003	0.9503
100	Gurdaspur	Fatehgarh Chudian	Ghaniyake Banger	0.002	0.0882
101	Gurdaspur	Sree Hargobindpur	Dakoha	0.001	2.0563
102	Gurdaspur	Sree Hargobindpur	Sri Hargobindpur	0.001	0.0301
103	Gurdaspur	Sree Hargobindpur	Bham	0.001	BDL

S. No	District	Block	Location	As (mg/l)	Fe (mg/l)
104	Gurdaspur	Qaddian	Aulakhkalan	0.001	3.48
105	Gurdaspur	Qaddian	Qaddian	BDL	0.4031
106	Gurdaspur	Kahnuwan	Sathiali	BDL	0.003
107	Gurdaspur	Dhariwal	Naushera	0.001	0.0526
108	Gurdaspur	Gurdaspur	Gurdaspur	0.002	0.2731
109	Gurdaspur	Dina Nagar	Pandori Dham	0.008	0.219
110	Gurdaspur	Dina Nagar	Galri	0.008	2.4525
111	Gurdaspur	Dina Nagar	Dina Nagar	0.001	1.9549
112	Hoshiarpur	Hazipur	Hazipur	0.001	0.088
113	Hoshiarpur	Hazipur	Nangal Bihala	0.001	0.0308
114	Hoshiarpur	Talwara	Talwara	0.001	0.3075
115	Hoshiarpur	Talwara	Bhamnaur	0.001	0.0299
116	Hoshiarpur	Dasua	Dulmiwal	0.002	0.0342
117	Hoshiarpur	Hoshiarpur-I	Sham Chourasi	0.015	4.7035
118	Hoshiarpur	Hoshiarpur-Ii	Chohal	0.003	0.5408
119	Hoshiarpur	Mahilpur	Thakkarwala	0.001	1.6147
120	Hoshiarpur	Mukerian	Mukerian	0.001	0.3751
121	Hoshiarpur	Dasua	Haler Rampur	BDL	0.121
122	Hoshiarpur	Hazipur	Sibochak	0.001	0.6198
123	Hoshiarpur	Mukerian	Pankhuh	BDL	0.8427
124	Hoshiarpur	Mukerian	Chak Sheru	0.010	10.645
125	Hoshiarpur	Mukerian	Bangala	0.003	0.9327
126	Hoshiarpur	Mukerian	Samraj Tanda	0.001	0.8132
127	Hoshiarpur	Talwara	Zhir Da Khuh	BDL	0.5512
128	Hoshiarpur	Hazipur	Dagan	0.001	0.1982
129	Hoshiarpur	Dasua	Dassuya	0.001	1.7856
130	Hoshiarpur	Hoshiarpur-II	Rampur Colony	0.013	1.8776
131	Hoshiarpur	Garh Shankar	Garh Shankar S	0.001	0.2719
132	Hoshiarpur	Bhunga	Adhowal Garhi	0.002	0.0117
133	Hoshiarpur	Bhunga	Gardhiwala	0.003	5.4495
134	Hoshiarpur	Hoshiarpur-Ii	Phuglana	BDL	0.2407
135	Hoshiarpur	Mahilpur	Mahilpur	0.001	0.0724
136	Hoshiarpur	Garh Shankar	Simbli	0.001	0.0143
137	Jalandhar	Jalandhar West	Kartarpur	0.007	0.5408
138	Jalandhar	Jalandhar City	Jalandhar	0.002	0.1028
139	Jalandhar	Adampur	Adampur	0.001	6.959
140	Jalandhar	Shahkot	Shahkot	BDL	3.294
141	Jalandhar	Nakodar	Nakodar	BDL	3.832
142	Jalandhar	Phillaur	Phillour	BDL	0.7369
143	Jalandhar	Nakodar	Gohiran	0.001	0.0577
144	Jalandhar	Rurka Kalan	Goraya	0.001	0.4923
145	Jalandhar	Nurmahal	Sarih	0.001	0.638
146	Jalandhar	Bhogpur	Kharal Kalan	0.002	8.62

S. No	District	Block	Location	As (mg/l)	Fe (mg/l)
147	Jalandhar	Rurka Kalan	Lallian Kalan	0.001	0.1574
148	Jalandhar	Jalandhar West	Jandiala	BDL	0.0464
149	Jalandhar	Shahkot	Malsian	0.007	0.1583
150	Jalandhar	Adampur	Allawalpur	0.002	0.4896
151	Jalandhar	Jalandhar East	Udhopur	0.001	0.0906
152	Kapurthala	Sultanpur Lodhi	Sultanpur Lodhi	0.005	0.4411
153	Kapurthala	Nadala	Bholath	0.003	0.2164
154	Kapurthala	Kapurthala	Kapurthala	0.002	0.0195
155	Kapurthala	Phagwara	Phagwara	0.001	1.057
156	Kapurthala	Nadala	Bhatnura Khurd	0.003	0.2771
157	Kapurthala	Sultanpur Lodhi	Talwandi Choudri	0.007	0.1236
158	Kapurthala	Kapurthala	Hussainpur	Leaked	Leaked
159	Kapurthala	Sultanpur Lodhi	Dalla	0.002	0.0013
160	Ludhiana	Khanna	Ikloha	0.001	0.0644
161	Ludhiana	Doraha	Maksudra	BDL	0.7711
162	Ludhiana	Doraha	Doraha	BDL	2.0971
163	Ludhiana	Doraha	Kaddon	0.002	0.2235
164	Ludhiana	Smrala	Begowal	Leaked	Leaked
165	Ludhiana	Macchiwara	Lalan	BDL	1.3147
166	Ludhiana	Smrala	Smrala	BDL	0.0771
167	Ludhiana	Smrala	Utlan	BDL	0.5196
168	Ludhiana	Macchiwara	Mushkabad	BDL	0.1328
169	Ludhiana	Macchiwara	Bhahlolpur	BDL	1.1158
170	Ludhiana	Macchiwara	Sherian	0.001	0.4281
171	Ludhiana	Smrala	Punjeta	0.001	0.179
172	Ludhiana	Dehlon	Dehlon (Gopalpur)	0.001	0.0644
173	Ludhiana	Pakhowal	Lil	0.001	0.1057
174	Ludhiana	Ludhiana	Pau	0.001	0.0771
175	Ludhiana	Jagraon	Jagaon	Leaked	Leaked
176	Ludhiana	Sidwabet	Sidwabet	BDL	0.0787
177	Mansa	Mansa	Ralla	0.002	0.2765
178	Mansa	Bhikhi	Kotra	0.001	0.2188
179	Mansa	Jhunir	Burj Bahlaike	0.001	0.3155
180	Mansa	Jhunir	Fatta Maluka	0.004	0.0211
181	Mansa	Budhlada	Budhlada	0.001	0.1727
182	Mansa	Mansa	Kot Dharmu	0.001	0.3935
183	Mansa	Mansa	Bikhi	0.008	0.4787
184	Mansa	Jhunir	Jhanda Khurd	0.002	0.6276
185	Mansa	Jhunir	Mofar	0.006	0.9132
186	Mansa	Jhunir	Raipur	0.001	0.0051
187	Moga	Bagha Purana	Dameru	BDL	0.0433
188	Moga	Moga I	Darapur	0.009	0.0362
189	Moga	Moga I	Chaugawan	0.001	0.3155

S. No	District	Block	Location	As (mg/l)	Fe (mg/l)
190	Moga	Moga Ii	Dagru	0.004	0.0255
191	Moga	Bagha Purana	Budh Singh Wala	BDL	BDL
192	Moga	Nihal Singh Wala	Nihal Singh Wala	0.002	0.03
193	Moga	Kot Ishe Khan	Bajeke	BDL	0.0938
194	Muktsar	Muktsar	Balocha Khera	BDL	0.0984
195	Muktsar	Muktsar	Bhaliana	0.001	0.0321
196	Muktsar	Muktsar	Doda	BDL	0.3779
197	Muktsar	Malout	Kabar Wala	0.006	0.1547
198	Muktsar	Malout	Khunde Halal	0.001	0.085
199	Muktsar	Lambi	Kuttianwali	0.001	0.0623
200	Muktsar	Muktsar	Labanianwali	0.001	0.0573
201	Muktsar	Lambi	Lambi	BDL	0.7800
202	Muktsar	Muktsar	Muktsar	0.001	BDL
203	Nawashahar	Nawanshahr	Rahon	0.001	0.1357
204	Nawashahar	Balachaur	Balachaur	0.002	0.1652
205	Nawashahar	Saroya	Mehandpur	0.007	0.1522
206	Nawashahar	Aur	Raipur Dhabba	0.001	0.5885
207	Nawashahar	Nawanshahr	Bahlore Kalan	0.014	1.5991
208	Nawashahar	Balachaur	Mauhar	0.001	0.023
209	Pathankot	Pathankot	Pathankot	0.002	0.6663
210	Pathankot	Dharkalan	Kiari	0.003	0.7003
211	Pathankot	Dharkalan	Kui	0.003	0.9457
212	Pathankot	Dharkalan	Barmota	0.001	0.3227
213	Pathankot	Pathankot	Ghoh	0.002	BDL
214	Pathankot	Pathankot	Nawan Pind	0.001	0.602
215	Pathankot	Pathankot	Sarna	0.001	BDL
216	Pathankot	Narot Jaimal Singh	Bhoa	0.001	0.6152
217	Pathankot	Narot Jaimal Singh	Jhakolari	0.002	0.3877
218	Pathankot	Narot Jaimal Singh	Khani Khui	0.002	2.3086
219	Pathankot	Narot Jaimal Singh	Gharota Kalan	0.002	0.0154
220	Pathankot	Bamiyal	Bamial	0.002	0.4031
221	Patiala	Patran	Patran	BDL	BDL
222	Patiala	Smana	Smana	0.001	0.0216
223	Patiala	Smana	Dhakraba	BDL	0.0796
224	Patiala	Nabha	Kalyan	0.001	0.0154
225	Patiala	Nabha	Sangatpura	0.001	0.0154
226	Patiala	Nabha	Bhojomajri	0.001	0.0162
227	Patiala	Nabha	Chehal	0.001	0.0649
228	Patiala	Patiala	Lacnkani	BDL	0.0773
229	Patiala	Rajpura	Thuas	0.003	0.0255
230	Patiala	Rajpura	Rajpura (Tti)	BDL	BDL
231	Patiala	Patiala	Birkali	0.001	0.1532
232	Patiala	Bhunerheri	Devigarh	0.002	0.0665

S. No	District	Block	Location	As (mg/l)	Fe (mg/l)
233	Patiala	Bhunerheri	Mirpur	0.001	0.5974
234	Patiala	Ganaur	Lachrru Kalan	0.002	0.2476
235	Patiala	Ganaur	Hari Majra	0.001	0.3443
236	Patiala	Ganaur	Kami Kalan	0.001	0.2747
237	Patiala	Rajpura	Hulka	0.001	BDL
238	Patiala	Rajpura	Chatt	BDL	0.1578
239	Patiala	Rajpura	Banur	0.001	BDL
240	Ropar	Anandpur Sahib	Ahmedpur	BDL	0.0379
241	Ropar	Ropar	Hardoh Namoh	0.010	BDL
242	Ropar	Anandpur Sahib	Dhair	0.004	0.0585
243	Ropar	Anandpur Sahib	Brahampur	0.001	0.3706
244	Ropar	Anandpur Sahib	Bhallan	0.001	0.4627
245	Ropar	Nurpur Bedi	Dumewal	BDL	BDL
246	Ropar	Nurpur Bedi	Nurpur Bedi	0.001	0.2476
247	Ropar	Ropar	Bada Chautta	0.07	7.166
248	Ropar	Chamkaur Sahib	Roorkee Heeran	0.001	Leaked
249	Ropar	Morinda	Chatamali	0.001	0.1493
250	Ropar	Morinda	Kakrali	BDL	1.1608
251	Sangrur	Dhuri	Ghanauri Kalan	0.001	0.0269
252	Sangrur	Dhuri	Bugra	0.003	0.1678
253	Sangrur	Dhuri	Ladda	BDL	0.0763
254	Sangrur	Dhuri	Bhujowali	0.001	0.0936
255	Sangrur	Maler Kotla	Maler Kotla	0.013	0.2196
256	Sangrur	Maler Kotla - Ii	Manvi	Leaked	Leaked
257	Sangrur	Maler Kotla - Ii	Bhagarian	0.001	0.1575
258	Sangrur	Amargarh	Chhinton	0.001	0.0763
259	Sangrur	Bhwanigarh	Mesampur	0.001	0.1065
260	Sangrur	Sangrur	Longowal	BDL	0.0341
261	Sangrur	Sunam	Sunam	BDL	0.0572
262	Sangrur	Andana	Haryao	0.003	0.0445
263	Sangrur	Lehraggaga	Chural Kalan	0.001	0.1933
264	Sangrur	Sangrur	Badrukha	0.001	0.0715
265	Sangrur	Mehal Kalan	Sherpur	0.001	0.6486
266	Sangrur	Andana	Bulan	0.024	0.0691
267	Sas Nagar	Dera Bassi	Dera Bassi	0.001	0.027
268	Sas Nagar	Dera Bassi	Isarpur	0.005	BDL
269	Sas Nagar	Dera Bassi	Isarpur	BDL	12.525
270	Sas Nagar	Dera Bassi	Isarpur	BDL	25.825
271	Sas Nagar	Dera Bassi	Gholu Majra	BDL	0.1864
272	Sas Nagar	Dera Bassi	Sarsini	0.001	4.233
273	Sas Nagar	Dera Bassi	Joli	BDL	0.8087
274	Sas Nagar	Dera Bassi	Handesra	0.001	6.284
275	Sas Nagar	Dera Bassi	Antala	BDL	0.7181

S. No	District	Block	Location	As (mg/l)	Fe (mg/l)
276	Sas Nagar	Kharar	Dheri	BDL	0.0015
277	Sas Nagar	Kharar	Landran	BDL	0.0588
278	Sas Nagar	Kharar	Soara	0.001	0.1725
279	Sas Nagar	Kharar	Ghoga	0.002	BDL
280	Tarn Taran	Khadur Sahib	Khodun Sahib	0.002	0.0023
281	Tarn Taran	Khadur Sahib	Goindwal Sahib	0.004	BDL
282	Tarn Taran	Tarn Taran	Sahabpur	0.001	BDL
283	Tarn Taran	Naushehra Pannian	Dhotian	0.008	0.0317
284	Tarn Taran	Chohla Sahib	Chohla Sahib	BDL	BDL
285	Tarn Taran	Patti	Harike	0.2	5.42
286	Tarn Taran	Valtoha	Rattoke	0.007	0.3683
287	Tarn Taran	Bhikhiwind	Kalsian Kalan	0.006	2.82
288	Tarn Taran	Bhikhiwind	Bhikhiwind	0.017	0.0572
289	Tarn Taran	Bhikhiwind	Khalra	0.07	0.2847
290	Tarn Taran	Chogawan	Mahawa	0.016	0.6036
291	Tarn Taran	Gandiwind	Gandiwind	0.003	0.0379
292	Tarn Taran	Gandiwind	Chhabal	0.005	BDL

Note: BDL-Below Detection Level

CHAPTER – 7

CONCLUSIONS

1. The Dynamic Ground Water Estimation has been done as per GEC-2015 Methodology adopted by CGWB and based on data observed in the field for the last five years i.e. 2012-16.
2. There is overexploitation of Ground Water to meet the agriculture requirement of the state as surface water is limited and due to more draft of ground water the overall stage of ground water extraction of the state is 165 % as estimated in this report. As per this report about 79% area of the state is over-exploited. Out of 138 blocks, 109 blocks are “over-exploited” 02 blocks are “critical “ 05 blocks are “semi-critical” and 22 blocks are in “safe” category.
3. In this report, Ground Water scenario has considerably deteriorated in comparison to previous report. The number of Over exploited Blocks has increased from 105 (Report-2013) to 109 (Report-2015). The Overall Stage of Ground water extraction has increased from 149% (Report-2013) to 166%, due to the various modifications which have been incorporated on the basis of the various inputs made available from CGWB, Agriculture Department of Punjab, Punjab Agricultural University, Ludhiana and other agencies associated with this estimation.

CHAPTER 8

GROUNDWATER RESOURCES vs. DOMESTIC WATER DEMAND AND SUPPLY FOR SELECTED CITIES IN PUNJAB

INTRODUCTION

In NITI Aayog report entitled "Composite Water management Index – A Tool for water management" it has been mentioned that 21 cities across India are expected to run out of water by 2020. In this connection, CGWB was entrusted to study the ground water situation in 24 cities (Anenxure-1) and a committee was constituted vide L.No.95/TC/Chmn/CGWB/2016-17-4533 dated 27.07.2018 to study the ground water situation and submit a report (Annexure-2).

The committee obtained information from the Regional Offices on ground water situations along with demand vis-à-vis supply in 2018 and projected demand and supply for 2021, 2031 & 2041. The data on water demand and supply was collected by CGWB Regional Offices from respective State Agencies and the methodology adopted for the analysis of the same has been enumerated below:

1. The demand & supply from surface water & ground water sources in 2018 and projected demand & supply from surface water & ground water sources for 2021, 2031 & 2041 were obtained from the concerned State Agencies. In the absence of data on projected supply for the subsequent years, data for the year 2018 has also been considered for subsequent years.
2. The demand & supply data obtained for 2018, 2021, 2031 & 2041 have been linearly distributed for arriving at the demand and supply figures for the intervening years.
3. The ground water resources as in 2017 were worked out for each city, using GEC-2015 methodology for determination of annual replenishable and in-storage resources in the aquifer. As the NITI Aayog report mentions about drying up of cities, an exercise has been made by CGWB to assess the in-storage resources of the aquifer (if de-watered) to find about the total availability. However, for any policy decision, annual replenishable resources are only to be considered. Use of in-storage resources, which means mining of ground water, may lead to serious, undesirable consequences and hence, it is advocated not to use the in-storage resources.
4. The ground water resources as assessed in 2017 have been considered as annual ground water availability for subsequent years of projected demand.

5. The gap between demand and total supply for domestic purpose has been worked out for each year.
6. An attempt was initially made to find out the availability of ground water to meet the proposed water supply from the annual replenishable resources and if found inadequate, the available in-storage resource has been considered. In case, the total in-storage resource is also found inadequate, the balance available replenishable resources are shown as only available resources every year for the subsequent years.
7. Subsequently, an attempt was made to find out the possibility of ground water meeting the gap between demand and supply. In this attempt, initially only annual replenishable resources were considered and if found inadequate, the available in-storage resource has been considered. In case, the total in-storage resource is also found inadequate, the balance available replenishable resources will be the only available ground water resources every year.

8.0 CITY WISE DEMAND VIS-À-VIS SUPPLY

8.1 AMRITSAR

Amritsar city is the administrative headquarter of Amritsar district in the state of Punjab, covering an area of 170.88 sq. km.

8.1.1 Vital Statistics

The vital statistics of the city as obtained from the State Agency is summarised below:

Area (sq.km)	Population (2011)	Growth rate per year (%)	Population (2018)	Population (2021)	Population (2031)	Population (2041)	Normal Annual Rainfall (mm)
170.88	1132761	1.54	1254873	1340000	1600000	1860000	546.1

8.1.2 Groundwater System

The city forms part of Upper Bari Doab and is underlain by formations of Quaternary age comprising of alluvium deposits belonging to vast Indus alluvial plains. Sub surface geological formations comprise of fine to coarse grained sand, silt, clay and kankar. Gravel associated with sand beds occurs along left bank of Ravi. The beds of thin clay exists alternating with thick sand beds and pinches out at short distances against sand beds. Based on the available data, three aquifer systems have been delineated in the area. The aquifer group I occur under unconfined condition and found between the depth of 17m bgl and 114m bgl with a thickness 79m. The specific yield of the aquifer is 7.2%. The

Transmissivity values ranges from 1450 m^2/day to 2424 m^2/day. Aquifer is fresh and comprises of sand.

The aquifer group II and III occurs at a depth varying from 125m bgl to 179m bgl and 185m bgl to 300m bgl, with the thickness of 29m and 89m, respectively. Depth of ground water level in the Amritsar city is 25.56mbgl (Verka) and 26.6 mbgl (Jandiala Guru Pz). Ground water level is shallow in western part of the city. Deeper ground water levels ranging from 21m bgl to 25m bgl occurs in the central part of the city covering Golden Temple Complex, Ram Bagh and Bus Stand areas.

The ground water resources have been assessed down to a depth of 300m bgl. The annual replenishable resources has been assessed as in 2017 as 28.92 M.Cu.m and in-storage resources as 2385.57 M.Cu.m and total resources as 2414.49 M.Cu.m.

The mean (pre-monsoon, 2008 to 2017) water level is of the order of 24.04m bgl. The water level fluctuation with respect to mean is given below:

No. of wells Analysed	Rise						Fall						Rise		Fall	
	0-2 m		2-4 m		>4 m		0-2 m		2-4 m		>4 m					
	No	%	No	%	No	%	No	%	No	%	No	%	No	%	No	%
1	-	-	-	-	-	-	1	100	-	-	-	-	-	-	1	**100**

8.1.3 Demand vis-à-vis Supply

The information on demand vis-à-vis supply has been obtained from State Agencies and a summary is furnished below:

Year	Demand (M.Cum)	Supply from SW (M.Cum)	Supply from GW (M.Cum)	Total supply (M.Cum)	% of GW Share in Water Supply	Gap (M.Cum)
2018	79.60	0.00	104.80	104.80	100%	0.00
2021	94.10	0.00	104.80	104.80	100%	0.00
2031	100.70	0.00	104.80	104.80	100%	0.00
2041	117.10	0.00	104.80	104.80	100%	12.30

The demand vs. supply for the period from 2018 to 2041 has been provided as **Fig 2.10.1**.

8.1.4 Analysis and Discussion

As per the data supplied by the State Agencies, the demand would increase from 79.60 M.Cu.m in 2018 to 117.10 M.Cum in 2041. There is no surface water supply & ground water supply to meet the demand from 2018 to 2041 is 104.80 M.Cu.m (Fig.2.10.1). The share of ground water in water supply has been provided by State Government Agency 100% from 2018 to 2041. Overall, the total supply to meet the demand is constant i.e. 104.80

M.Cu.m from 2018 to 2041, there by resulting in no gap between demand and supply from 2018 to 2031. However, there is a gap of 12.30 M.Cu.m in 2041.

An attempt was made to find out the availability of ground water to meet the proposed water supply from ground water sources by the State Agencies. The annual replenishable resources are not sufficient to meet the proposed water supply. However available in-storage would be able to meet the envisaged supply. Subsequently, an attempt was also made to find out whether the gap in the water supply can be met from available ground water resources. It is seen that the available ground water resources including the in-storage will be able to meet the gap.

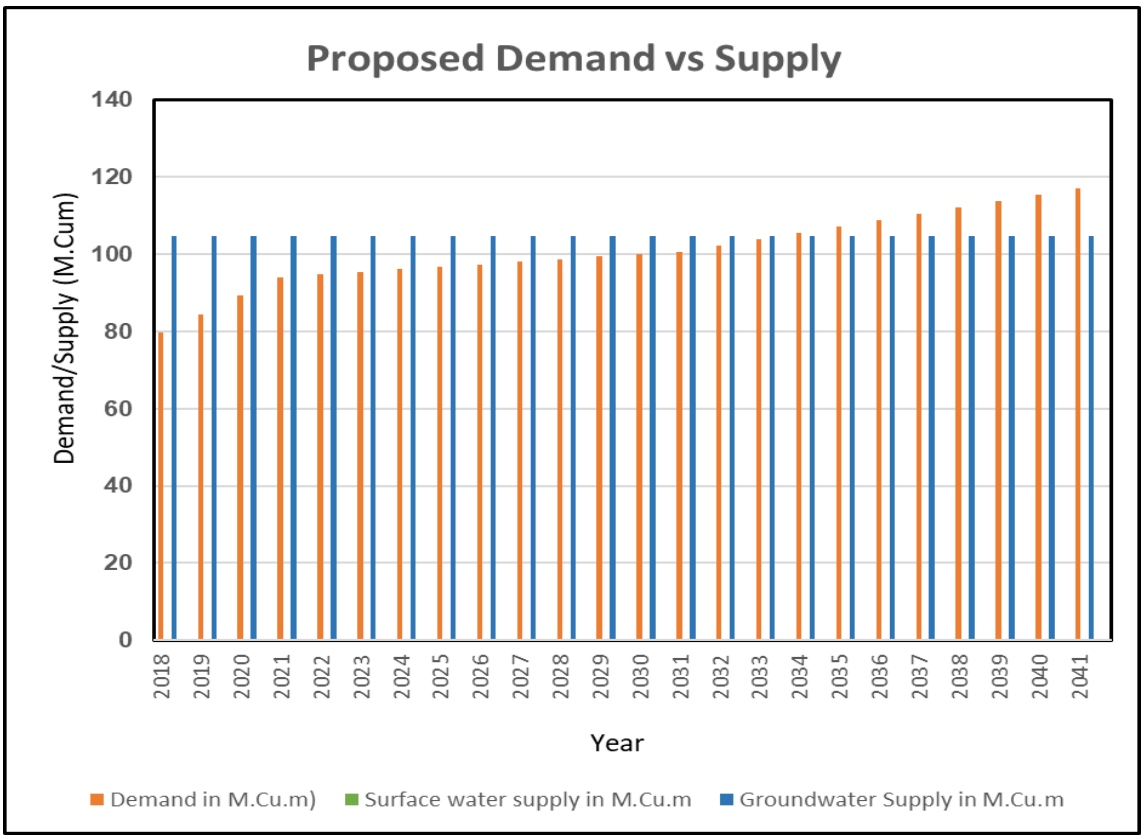


Fig.2.10.1

8.1.5 Conclusion

Demand: Demand has been assessed as 79.60 M.cu.m in 2018, 94.10 M.cu.m in 2021, 100.70 M.cu.m in 2031 & 117.10 M.cu.m in 2041.

Total Supply: Total supply has been assessed as 104.80 M.cu.m from 2018 to 2041 and the share of ground water in water supply is 100% from 2018 to 2041.

Gap: There is no gap in 2018, 2021 and 2031; however, it increases to 12.30 M.cu.m in 2041.

Groundwater Availability: The annual replenishable ground water resources (dynamic) as in 2017 is 28.92 M.cu.m and in-storage is 2385.57 M.cu.m with a total of 2414.49 M.cu.m

As per the water supply plan of state agencies, the share of ground water in water supply is 100% and it cannot be met from the annual replenishable resources. However available in-storage would be able to meet the envisaged supply.

The groundwater resources including the in-storage will be able to meet the envisaged gap between demand and supply in 2041.

8.1.6 Recommendations:

It is advocated that ground water use should be restricted to the annual replenishable resources so that any adverse impact on the ground water repository, quantity or quality wise can be avoided.

8.2 JALANDHAR

The city, with has major road and rail connections, is a market for agricultural products. Manufacturing units include textiles, leather goods, wood products, and sporting goods. Jalandhar is situated at a distance of 146 km from state capital Chandigarh. It is at a distance of 350 Km from Delhi on Delhi-Amritsar Highway. It is surrounded by Ludhiana district in East, Kapurthala in West, Hoshiarpur in North and Ferozepur in South. Total geographical area of Jalandhar Municipal Corporation and out growth is 101 km^2. Jalandhar city is spread over in parts of Tehsils, Jalandhar-I and Jalandhar-II and parts of Blocks Jalandhar west and Jalandhar East.

8.2.1 Vital Statistics

The vital statistics of the city as obtained from the State agency is summarised below:

Area (sq.km)	2011 Population	Growth rate per year (%)	population 2018	population 2021	population 2031	population 2041	Normal Annual Rainfall (mm)
101.43	874412	2.05	999890	1053666	1232921	1412175	586.8

8.2.2 Groundwater System

The Jalandhar city is a part of Indo-Gangetic plain and Sutlej sub-basin of main Indus basin. The alluvial deposits comprise of sand, silt, clay and often associated with Kankar. Fine to medium grained sand horizon forms the potential aquifer in the area. The ground water from unconfined aquifer is abstracted through hand pumps and shallow tube wells up to the depth of 65 meters. Generally, the granular zones occurring between 29-35 m, 40-48 m and 56-68 m are tapped by shallow irrigation tube wells. However medium depth tube wells

for the purpose of irrigation and drinking are being drilled up to the depth of 200m. Three Piezometers tapping different aquifer groups have also been constructed up to a depth of 300m in Jalandhar city. The exploratory drilling data have revealed the existence of about 16 to 18 granular zones down to the maximum depth of 350m. The Mean [Pre monsoon) (2008 to 2017)] water level is of the order of 31.26m bgl**.** The water level fluctuation with respect to mean is given below.

No. of wells Analysed	Rise						Fall						Rise		Fall	
	0-2 m		2-4 m		>4 m		0-2 m		2-4 m		>4 m					
	No	%	No	%	No	%	No	%	No	%	No	%	No	%	No	%
1	-	-	-	-	-	-	-	-	-	-	1	100	-	-	1	100

The ground water resources have been assessed down to a depth of 300m bgl. The annual replenishable resources has been assessed as in 2017 as 26.41M.Cu.m and in-storage as 1174.43 M.Cu.m and total storage as 1200.84 M.Cu.m.

8.2.3 Demand vis-à-vis Supply

The information on demand vis-à-vis supply has been obtained from State agencies and a summary is furnished below:

Year	Demand (M.Cum)	Supply from SW (M.Cum)	Supply from GW (M.Cum)	Total supply (M.Cum)	% of GW Share in Water Supply	Gap (M.Cum)
2018	62.39	0.00	126.00	126.00	100%	0.00
2021	65.38	0.00	126.00	126.00	100%	0.00
2031	76.50	0.00	126.00	126.00	100%	0.00
2041	87.63	0.00	126.00	126.00	100%	0.00

The demand vs. supply for the period from 2018 to 2041 has been provided as **Fig 2.11.1**

8.2.4 Analysis and Discussion

As per the data supplied by the State Agencies, the demand would increase from 62.39 M.Cu.m in 2018 to 87.63 M.Cu.m in 2041. There is no surface water supply to meet the demand from 2018 to 2041. However, the ground water supply will be 126 M.Cu.m from 2018 to 2041(Fig 2.11.1) which is more than the demand. The share of ground water in water supply has been provided by State Government Agency 100% as in 2018. Overall, the total supply to meet the demand will be 126 M.Cu.m from 2018 to 2041, for all the years and the gap is nil. The supply is 200% of demand in 2018, 193% in 2021, 165% I 2031 & 126 % 2041, thereby indicating that groundwater development is more than the requirement. However it has been informed that due to losses during water supply, supply is kept more than demand.

An attempt was made to find out the availability of ground water to meet the proposed water supply from ground water sources by the State Agencies. The annual replenishable resources are not sufficient to meet the proposed water supply. Subsequently, an attempt was also made to find out whether the gap in the water supply can be met from available ground water resources. It is seen that even the in-storage ground water resources are likely to be used up by the year 2029 and thereafter only annual replenishable resources would be available every year.

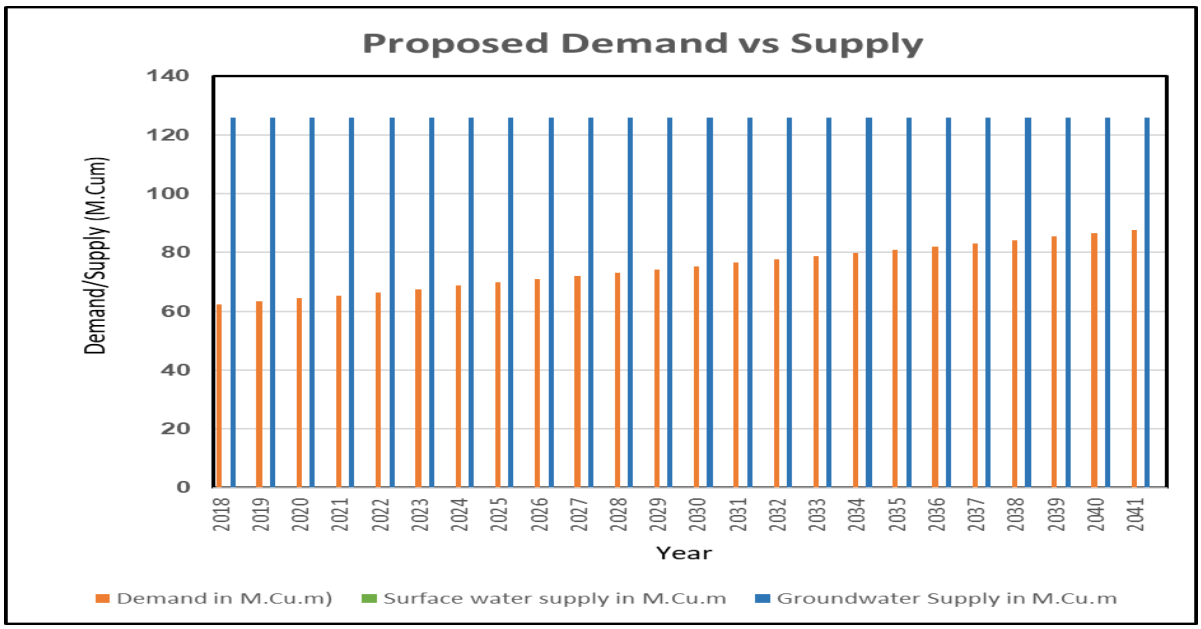


Fig 2.11.1

8.2.5 Conclusion

Demand: Demand has been assessed as 62.39 M.Cu.m in 2018, 65.38 M.Cu.m in 2021, 76.50 M.Cu.m in 2031 & 87.63 M.Cu.m in 2041.

Total Supply: Total Supply has been assessed as 126 M.Cu.m from 2018 to 2041, and the share of ground water in water supply is 100%. Due to losses during water supply, supply is envisaged to be more than demand.

Gap: There will be no gap between demand and supply from 2021 to 2041 as per data received from State agencies.

Groundwater Availability: The annual replenishable ground water resources (Dynamic) as in 2017 is 26.41 M.Cu.m and in-storage is 1174.43 M.Cu.m with a total of 1200.84 M.Cu.m

As per the water supply plan of State Agencies, the share of ground water in water supply is 100% and it cannot be met from the annual replenishable resources.

If the ground water resources are to be used for meeting the envisaged water supply, the in-storage ground water resources are likely to be used up by the year 2029 and thereafter only annual replenishable resources would be available every year. However, depleting water

level may trigger increased lateral flow from the surrounding areas. Hence, the ground water resources are likely to last more than the estimated period.

8.2.6 Recommendations

It is advocated that ground water use should be restricted to the annual replenishable resources so that any adverse impact on the ground water repository, quantity or quality wise can be avoided**.**

8.3 LUDHIANA CITY

Ludhiana city located in Ludhiana District of state of Punjab covers an area of 159.37 sq.km. The city stands on the old bank of the Sutlej river about 13 km south of its present course. The city is 107 km west to the state capital Chandigarh.

8.3.1 Vital Statistics

The vital statistics of the city as obtained from the State Agency is summarised below:

Area (sq.km)	2011 Population	Growth rate per year (%)	population 2018	population 2021	population 2031	population 2041	Normal Annual Rainfall (mm)
159.37	1618858	1.54	1793371	1949460	2285062	2620664	681

8.3.2 Groundwater System

The area is underlain by the Indo-Gangetic alluvium of Quaternary age. The alluvium is underlain by Pre-Cambrian basement rocks. The exploratory drilling carried out within Ludhiana City reveals that the thickness of unconsolidated alluvium is likely to be more than 373 m (Guruam Nagar). The alluvium is mainly of fluvial type and comprises of thick beds of fine to coarse grained unconsolidated sand, silt, clay, kankar etc., in various proportions. In the southern and eastern part, thick clay beds alternating with sand beds occur beyond 160 m. The lithological data of the area indicates the presence of many sand beds forming the principal aquifers separated by clay beds at various depths. The sand content in the aquifer in the area varies from 50 to 80%. Clay beds though thick at places occur mostly as lenses and pinch out laterally. The granular material becomes coarser with depth. In the shallow aquifer down to a depth of 50m, ground water occurs under unconfined/ semi-confined conditions, whereas in deeper aquifer, semi-confined/ confined conditions exist. This aquifer is tapped for domestic purpose by shallow tube wells and hand-pumps with a depth range of 40-60m. The tube wells constructed by Municipal Corporation and other agencies have tapped deeper

aquifer down to depth of 200m. The deep tube wells constructed by CGWB tapped deeper aquifers below 150m, which are semi confined/ confined in nature. In the city area four aquifers groups have been delineated with thick clay layers separating each group. The thickness of these impervious horizons varies from 10m to 40m. In Ludhiana city, granular zone or potential aquifer of about 135 m thickness has been encountered up to the depth of 360m. In western part, three to four thick aquifers exist down to the depth of 300m. These aquifers are extensive in nature and are separated by 5-10m thick clay beds. In northern part four granular zones ranging in thickness from 5-15m are present which are interspersed by clay beds of 3-7m thick. There are two monitoring stations in the city and the average water level during May 2018 was 35.70m bgl. The Mean (pre-monsoon, 2008 to 2017) water level is of the order of 38.06m bgl**.** The water level fluctuation with respect to mean is given below.

No. of wells Analysed	Rise						Fall						Rise		Fall	
	0-2 m		2-4 m		>4 m		0-2 m		2-4 m		>4 m					
	No	%	No	%	No	%	No	%	No	%	No	%	No	%	No	%
1	-	-	-	-	-	-	1	100	-	-	-	-	-	**-**	1	**100**

The ground water resources have been assessed down to a depth of 258m bgl. The annual replenishable resources has been assessed as in 2017 as 41.66 M.Cu.m and in-storage as 1447.44 M.Cu.m and total storage as 1489.10 M.Cu.m.

8.3.3 Demand vis-à-vis Supply

The information on demand vis-à-vis supply has been obtained from State agencies and a summary is furnished below:

Year	Demand (M.Cum)	Supply from SW (M.Cum)	Supply from GW (M.Cum)	Total supply (M.Cum)	% of GW Share in Water Supply	Gap (M.Cum)
2018	167.17	0.00	231.41	231.41	100%	0.00
2021	178.49	0.00	231.41	231.41	100%	0.00
2031	206.59	0.00	231.41	231.41	100%	0.00
2041	234.69	0.00	231.41	231.41	100%	3.28

The demand vs. supply for the period from 2018 to 2041 has been provided as **Fig 2.12.1.**

8.3.4 Analysis and Discussion

As per the data supplied by the State agencies, the demand would increase from 167.17 M.C.um in 2018 to 234.69 M.C.um in 2041. There is no surface water supply to meet the demand from 2018 to 2041. However, the ground water supply remains 231.41 M.Cu.m from 2018 to 2041 (Fig 2.12.1). The share of groundwater in water supply has been provided by State Government Agency as 100%. The gap is nil, except for the year 2041, which is 3.28

M.Cu.m. The supply is more than the demand by 138% in 2018, 130% in 2021, 112% in 2031 and only 98% in 2041, resulting in gap only in 2041.The groundwater development is more than the requirement as it has been informed that supply has been kept higher than the demand due to losses during water supply.

An attempt was made to find out the availability of ground water to meet the proposed water supply from ground water sources by the State Agencies. The annual replenishable resources are not sufficient to meet the proposed water supply. Subsequently, an attempt was also made to find out whether the gap in the water supply can be met from available ground water resources. It is seen that the in-storage ground water resources are likely to be used up by the year 2025 and thereafter only annual replenishable resources would be available every year.

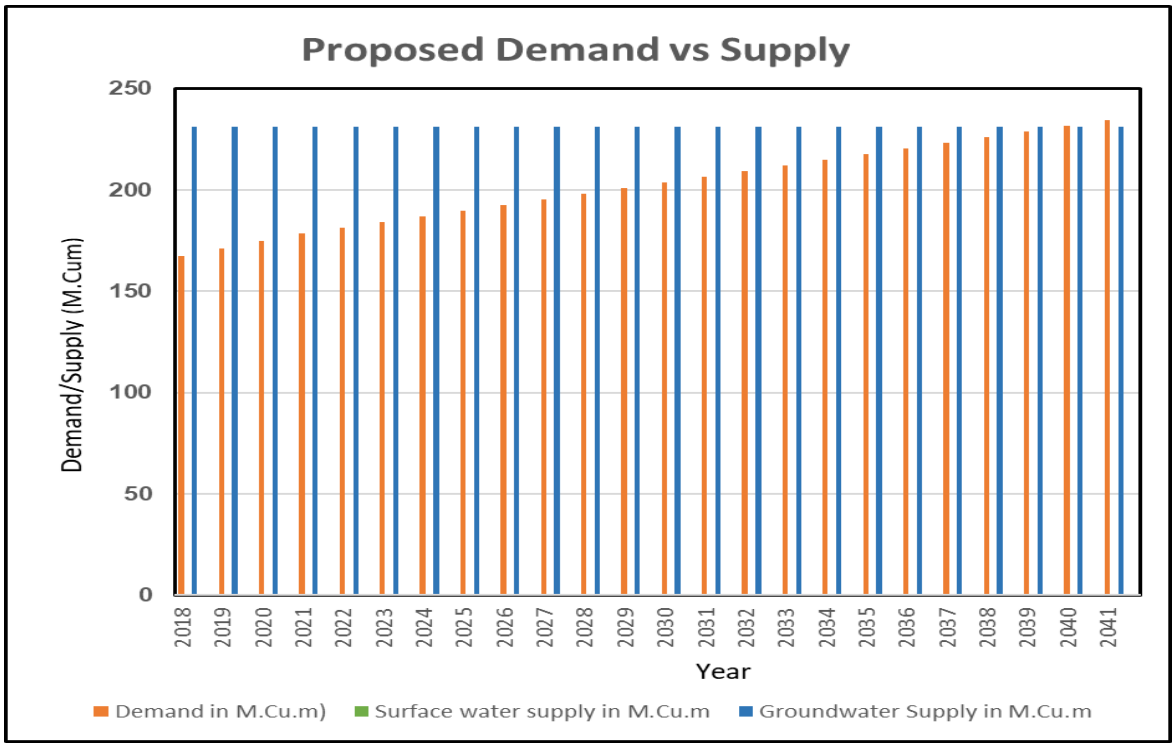


Fig 2.12.1

8.3.5 Conclusion

Demand: Demand has been assessed as 167.17 M.Cu.m in 2018, 178.49 M.Cu.m in 2021, 206.59 M.Cu.m in 2031 & 234.69 M.Cu.m in 2041.

Total Supply: Total supply has been assessed as 231.41 M.Cu.m from 2018 to 2041 and the share of ground water in water supply is 100% .The supply has been kept higher than the demand due to losses during water supply.

Gap: There is no gap between demand & supply except in 2041 which is 3.28 M.Cu.m.

Groundwater Availability: The annual replenishable ground water resources (Dynamic) as in 2017 is 41.66 M.Cu.m and in-storage is 1447.44 M.Cu.m with a total of 1489.10 M.Cu.m

As per the water supply plan of State Agencies, the share of ground water in water supply is 100% from 2018 to 2041 and it cannot be met from the annual replenishable resources.

If the ground water resources are to be used for meeting the envisaged water supply, the in-storage ground water resources are likely to be used up by the year 2025 and thereafter only annual replenishable resources would be available every year. However, depleting water level may trigger increased lateral flow from the surrounding areas. Hence, the ground water resources are likely to last more than the estimated period.

8.3.6 Recommendations:

It is advocated that ground water use should be restricted to the annual replenishable resources so that any adverse impact on the ground water repository, quantity or quality wise can be avoided.

8.4 MOHALI CITY

Mohali, also known as Ajitgarh or Sahibzada Ajit Singh Nagar, is a city in Sahibzada Ajit Singh Nagar district (SAS Nagar) in Punjab, India, which is a commercial hub lying south-west to the Union Territory of Chandigarh.

8.4.1 Vital Statistics

The vital statistics of the city as obtained from the State Agency is summarised below:

Area (sq.km)	2011 Population	Growth rate per year (%)	population 2021	population 2031	population 2041	Normal Annual Rainfall (mm)
23.86	146000	1.84	146000	164000	200000	1027.7

8.4.2 Groundwater System

The S.A.S Nagar district is occupied by Quaternary Alluvial deposits belonging to the vast Indo-Gangetic alluvial plains, which forms the main aquifer system. Ground water occurs under phreatic conditions in the shallow aquifers while leaky confined to confined conditions occur along the deeper aquifers of Quaternary alluvial deposits. CGWB has delineated three aquifer groups in the area. The aquifer group I occur under unconfined to confined extending down to a depth of 9.89m bgl to 108m bgl and the thickness of granular zones is 34m. The aquifer group II, occurs at a depth of 130m bgl to 201m bgl and the thickness of granular zones is 24m. The aquifer group III occurs at a depth of 220m bgl to

300m bgl with a thickness of 19m for the granular zones. The transmissivity varies from 687 m^2/day to 1395 m^2/day and a discharge rate of 2857 m^3/day to 3466 m^3/day for aquifers underlying the area. Presently, there are 6 monitoring stations in the city. The average depth of water level during May 2018 in the city is of the order of 12.16 mbgl. The water level fluctuation with respect to decadal mean is given below:

No. of wells Analysed	Rise						Fall						Rise		Fall	
	0-2 m		2-4 m		>4 m		0-2 m		2-4 m		>4 m					
	No	%	No	%	No	%	No	%	No	%	No	%	No	%	No	%
2	-	-	-	-	-	-	2	100	-	-	-	-	-	-	2	100

The ground water resources have been assessed down to a depth of 300 mbgl. The annual replenishable resources has been assessed as in 2017 as 7.51 M.Cu.m and in-storage as 140.69 M.Cu.m and total storage as 148.20 M.Cu.m.

8.4.3 Demand vis-à-vis Supply

The information on demand vis-à-vis supply has been obtained from State is furnished below:

Year	Demand (M.Cum)	Supply from SW (M.Cum)	Supply from GW (M.Cum)	Total supply (M.Cum)	% of GW Share in Water Supply	Gap (M.Cum)
2018	25.77	15.46	10.31	25.77	40%	0.00
2021	26.75	15.46	10.31	25.77	40%	0.98
2031	29.69	15.46	10.31	25.77	40%	3.91
2041	32.63	15.46	10.31	25.77	40%	6.86

The demand vs. supply for the period from 2018 to 2041 has been provided as **Fig 2.13.1.**

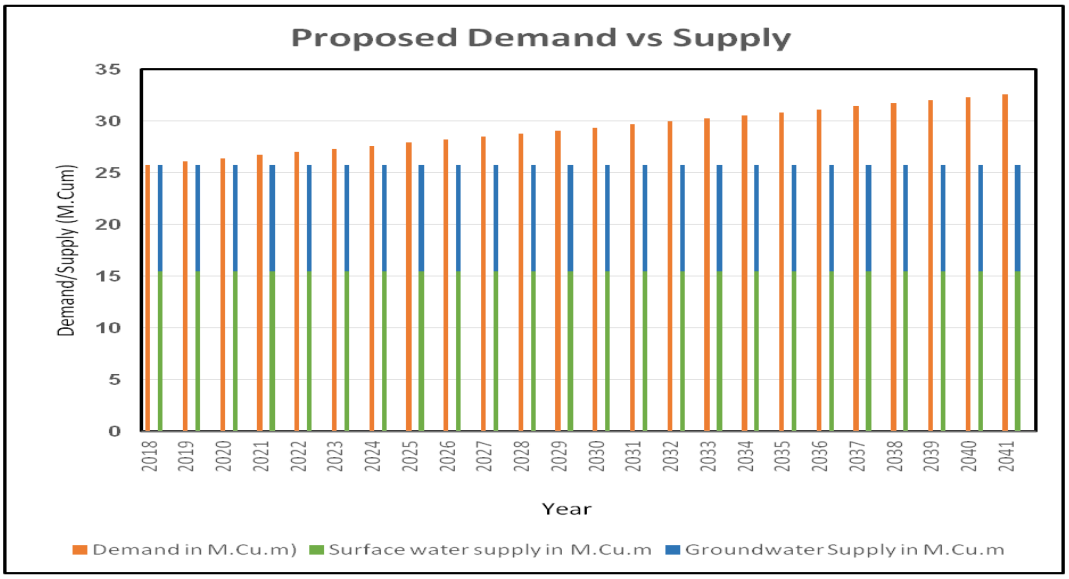


Fig 2.13.1

8.4.4 Analysis and Discussion

As per the data supplied by the State Agencies, the demand would increase from 25.77M.Cum in 2018 to 32.63 M.Cum in 2041 and the supply is 15.46 M.Cum from surface water and 10.31 M.Cum from ground water resulting in a total supply of 25.77 M.Cum in 2018. There is no change in surface water supply & groundwater supply to meet the demand from 2018 to 2041(Fig 2.13.1). As a result the demand supply gap has been increased from nil in 2018 to 6.86 M.Cum in 2041. The share of ground water in water supply has been provided by State Government agency, as 40%.

An attempt was made to find out the availability of ground water to meet the proposed water supply from ground water sources by the State Agencies. The annual replenishable resource is not sufficient to meet the proposed water supply. However, the available in-storage will be able to cater to the proposed supply. Subsequently, an attempt was also made to find out whether the gap in the water supply can be met from available ground water resources. It is seen that the in-storage ground water resources are likely to be used up by the year 2039 and thereafter only annual replenishable resources would be available every year.

8.4.5 Conclusion

Demand: Demand has been assessed as 25.77 M.Cu.m in 2018, 26.75M.Cu.m in 2021, 29.69 M.Cu.m in 2031 & 32.63M.Cu.m in 2041

Total Supply: Total Supply has been assessed as 25.77 M.Cu.m from 2018 and the same is considered for the subsequent years. The share of ground water in water supply is 40%.

Gap: The Gap has been assessed as nil in 2018, 0.98 M.Cu.m in 2021, 3.91 M.Cu.m in 2031 & 6.86M.Cu.m in 2041

Groundwater Availability: The annual replenishable groundwater resources (Dynamic) as in 2017 is 7.51 M.Cu.m and in-storage is 140.69M.Cu.m with a total of 148.20M.Cu.m

As per the water supply plan of State Agencies, the share of ground water in water supply is 40% and it cannot be met from the annual replenishable resources. However the available in-storage will be able to meet the envisaged supply.

If the ground water resources are to be used for meeting the envisaged gap between demand and water supply, the in-storage ground water resources are likely to be used up by the year 2039 and thereafter only annual replenishable resources would be available every year. However, depleting water level may trigger increased lateral flow from the surrounding areas. Hence the ground water resource is likely to last more than the estimated period.

8.4.6 Recommendations

It is advocated that ground water use should be restricted to the annual replenishable resources so that any adverse impact on the ground water repository, quantity or quality wise can be avoided.

8.5 PATIALA CITY

Patiala is a city in south eastern Punjab. It is the fourth largest city in the state and is the administrative capital of Patiala district.

8.5.1 Vital Statistics

The vital statistics of the city as obtained from the State Agency is summarised below:

Area (sq.km)	2011 Population	Growth rate per year (%)	population 2018	population 2021	population 2031	population 2041	Normal Annual Rainfall (mm)
65	445000	1.15	480823	560500	676000	800000	632

8.5.2 Groundwater System

The city is occupied by Indo-Gangetic alluvial plain of Quaternary age, and falls in the Ghaggar basin. The groundwater occurs in alluvium formations comprising fine to coarse sand, which forms the potential aquifers. In the shallow aquifer, ground water occurs under unconfined/water table conditions, where as in deeper aquifer, semi-confined/confined conditions exist. Three aquifers have been demarcated down to 300 meter depth (Aquifer I from 20.48m bgl to 103m bgl, Aquifer II from 130m bgl to 185m bgl, Aquifer III from 232m bgl to 300m bgl). The average water level during May 2018 in the city is of the order of 30.88mbgl and the water level fluctuation with respect to decadal mean is given below:

No. of wells Analysed	Rise						Fall						Rise		Fall	
	0-2 m		2-4 m		>4 m		0-2 m		2-4 m		>4 m					
	No	%	No	%	No	%	No	%	No	%	No	%	No	%	No	%
2	-	-	-	-	-	-	-	-	1	50	1	50	-	-	2	100

The ground water resources have been assessed down to a depth of 300mbgl. The annual replenishable resources has been assessed as in 2017 as 8.08 M.Cu.m and in-storage as 445.33 M.Cu.m and total storage as 453.41 M.Cu.m.

8.5.3 Demand vis-à-vis Supply

The information on demand vis-à-vis supply has been obtained from State agencies and a summary is furnished below:

Year	Demand (M.Cum)	Supply from SW (M.Cum)	Supply from GW (M.Cum)	Total supply (M.Cum)	% of GW Share in Water Supply	Gap (M.Cum)
2018	29.20	0.00	25.19	25.19	100%	4.01
2021	31.39	6.21	25.19	31.40	80%	0.00
2031	38.33	13.14	25.19	38.33	66%	0.00
2041	45.63	20.44	25.19	45.63	55%	0.00

The demand vs. supply for the period from 2018 to 2041 has been provided as **Fig. 2.14.1.**

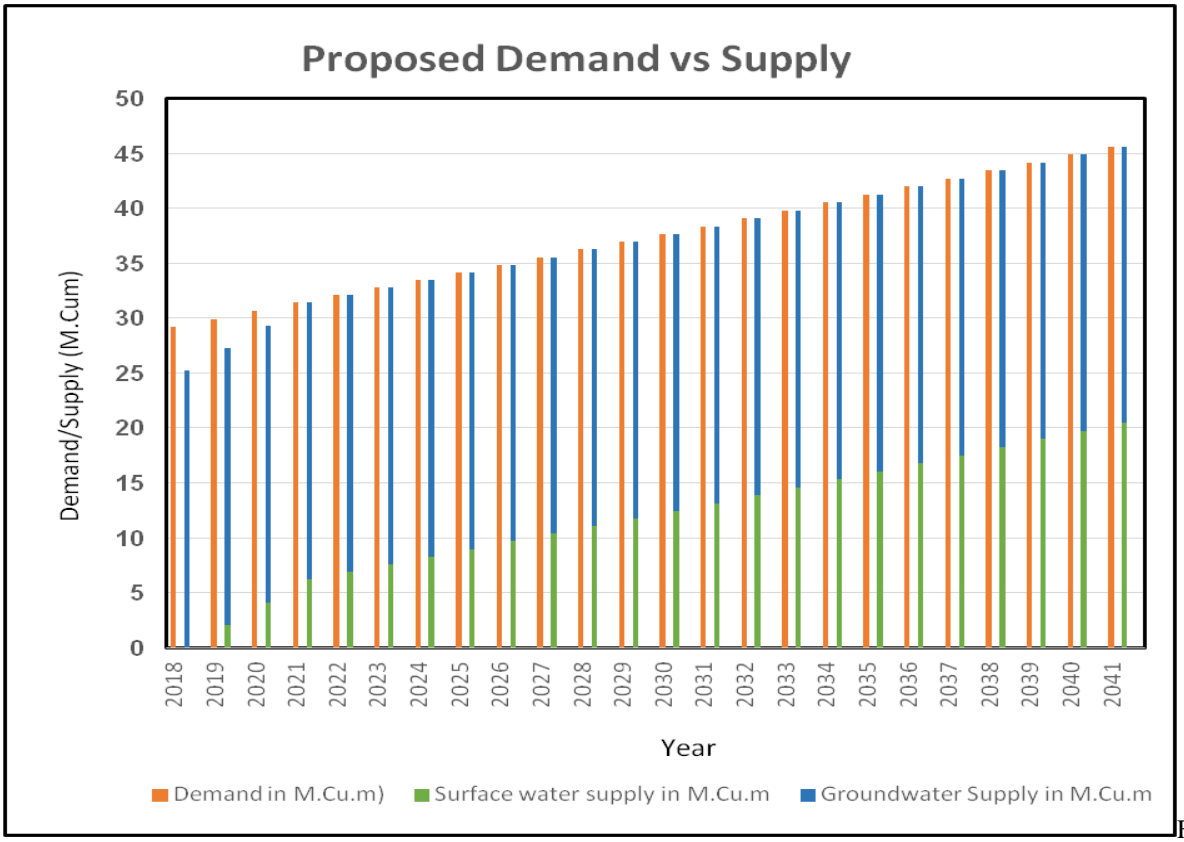


Fig. 2.14.1

8.5.4 Analysis and Discussion

As per the data supplied by the State Agencies, the demand would increase from 29.20 M.Cum in 2018 to 45.63 M.Cum in 2041, while there is a significant increase in surface water supply from NIL to 20.44 M.Cum, respectively from 2018 to 2041 while the ground water supply is 25.19 M.Cum in 2018 & is retained till 2041 (Fig 2.14.1). The share of ground water in water supply has been provided by State Government Agency is decreasing from 100% in 2018 to 55% in 2041. The total supply to meet the demand has

increased from 25.19 to 45.63 M.Cum from 2018 to 2041, there by resulting in a gap of 4.01M.Cum in 2018 and no gap in subsequent years.

An attempt was made to find out the availability of ground water to meet the proposed water supply from ground water sources by the State Agencies. The annual replenishable resource is not sufficient to meet the proposed water supply. However, the available in-storage would be able to meet the envisaged supply. Subsequently, an attempt was also made to find out whether the gap in the water supply can be met from available ground water resources. It is seen that the ground water resources including the in-storage will be able to meet the demand in the projected years till 2041.

8.5.5 Conclusion

Demand: Demand has been assessed as 29.2 M.Cu.m in 2018, 31.39 M.Cu.m in 2021, 38.33 M.Cu.m in 2031, and 45.63 M.Cu.m in 2041

Total Supply: Total Supply has been assessed as 25.19 M.Cu.m in 2018, 31.4 M.Cu.m in 2021, 38.33 M.Cu.m in 2031 & 45.63 M.Cu.m in 2041 and the share of ground water in water supply is 100% in 2018, 80% in 2021, 66% in 2031 & 55% in 2041.

Gap: The Gap has been assessed as 4.01 M.Cu.m in 2018 and there is no gap in subsequent years.

Groundwater Availability: The annual replenishable groundwater resources (Dynamic) as in 2017 is 8.08 M.Cu.m and in-storage resources is 445.33 M.Cu.m with a total of 453.41M.Cu.m

As per the water supply plan of State Agencies, the share of ground water in water supply is 100% in 2018 and it cannot be met from the annual replenishable resources alone. However, the available in-storage would be able to meet the envisaged supply.

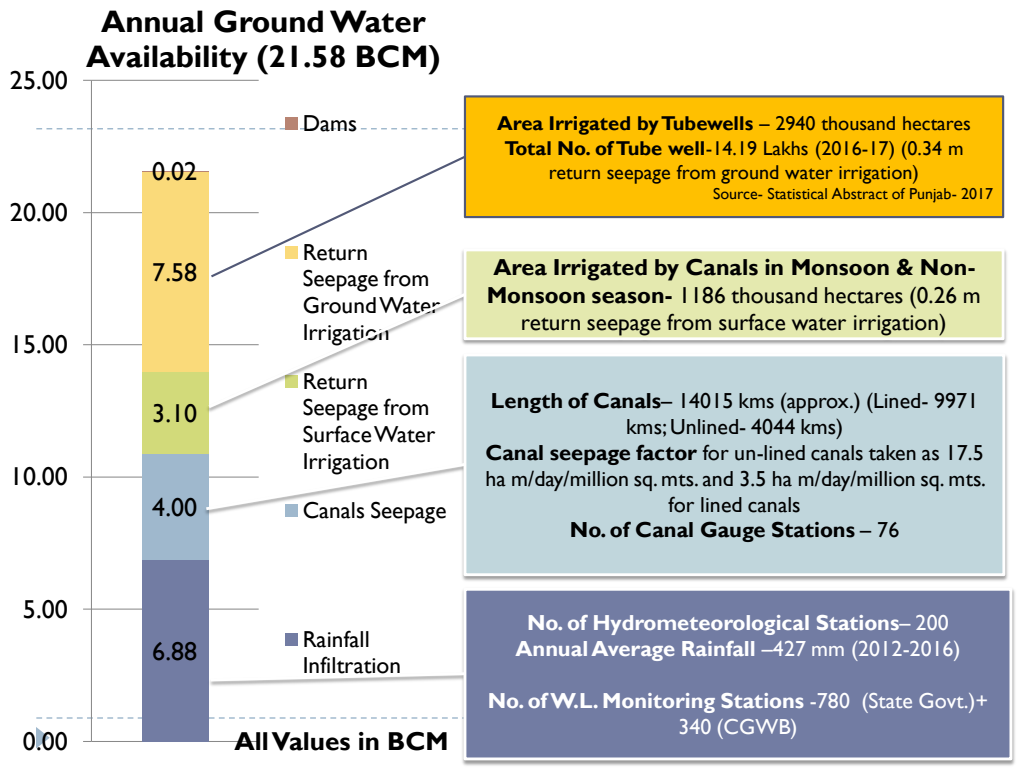
The ground water resources including the in-storage will be able to meet the demand in the projected years till 2041 .However there will be a huge depletion in in-storage ground water resource which may trigger lateral inflow from surrounding areas.

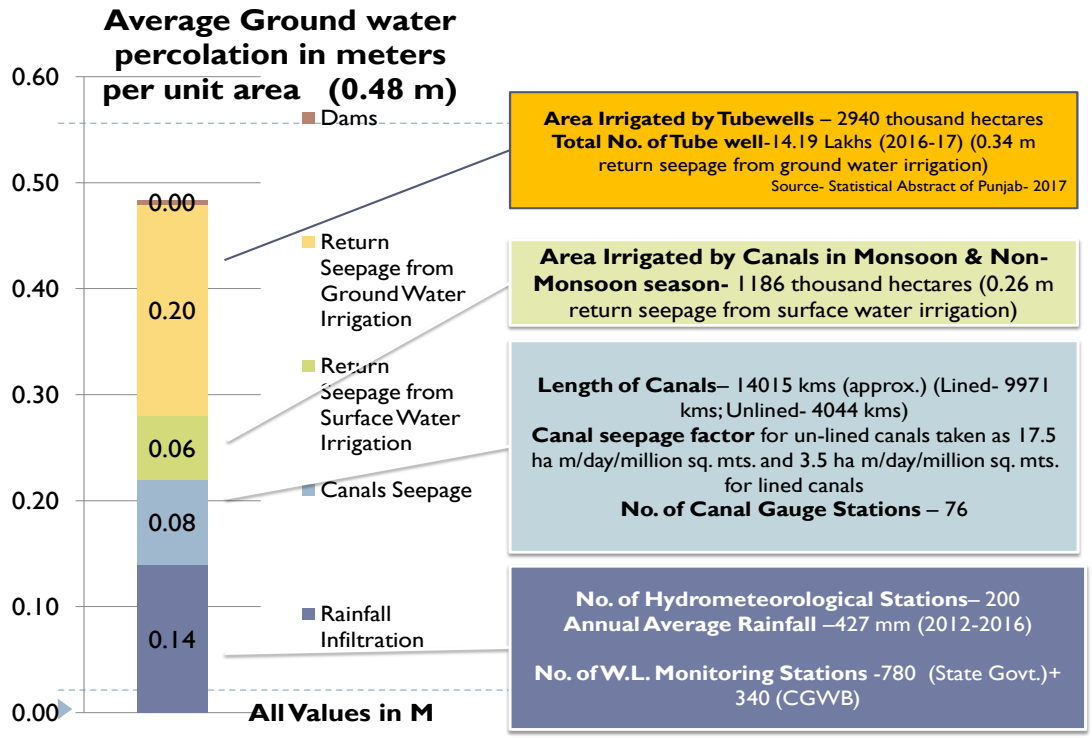
8.5.6 Recommendations

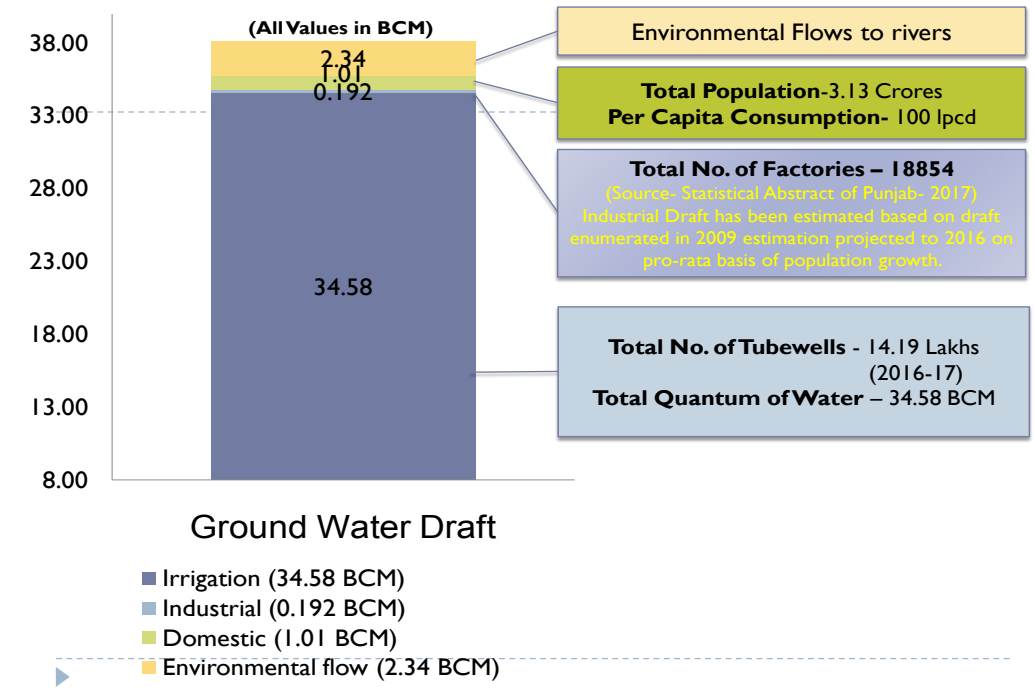
It is advocated that ground water use should be restricted to the annual replenishable resources so that any adverse impact on the ground water repository, quantity or quality wise can be avoided.

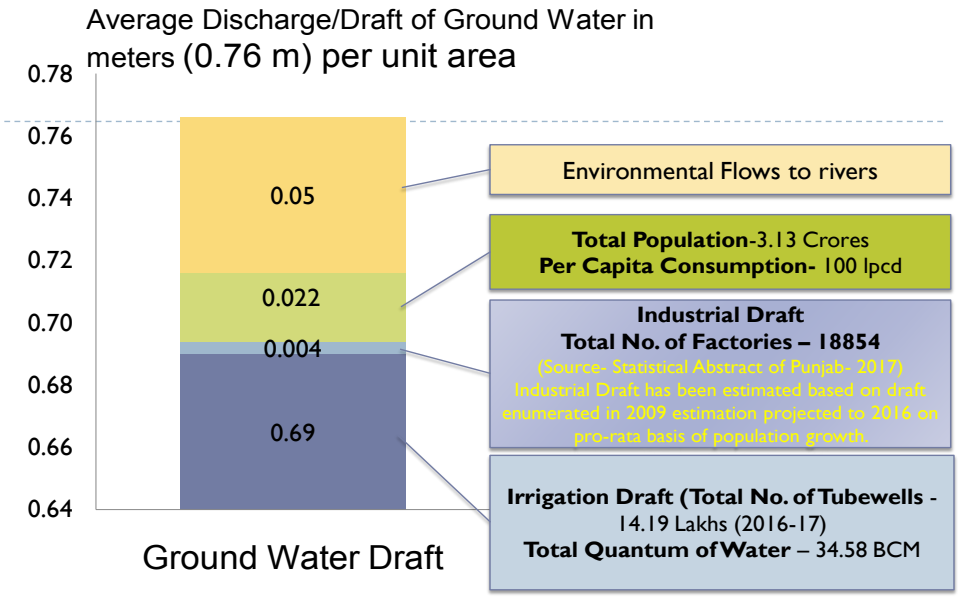
Summary of the Report

Particulars	Year of GWR estimation -2017
Net Ground Water Availability/Percolation (BCM)	21.58
Gross Ground Water Draft/withdrawal (BCM)	35.78
Net GW Availability for Future Irrigation Development in Safe, Semi-critical, critical and potential resources in water logged areas (BCM)	1.17
Stage of Ground water Extraction as percentage of total percolation	166%
No. of Blocks	138
No. of OE Blocks	109
No. of Critical Blocks	02
No. of Semi-Critical Blocks	05
No. of Safe blocks	22

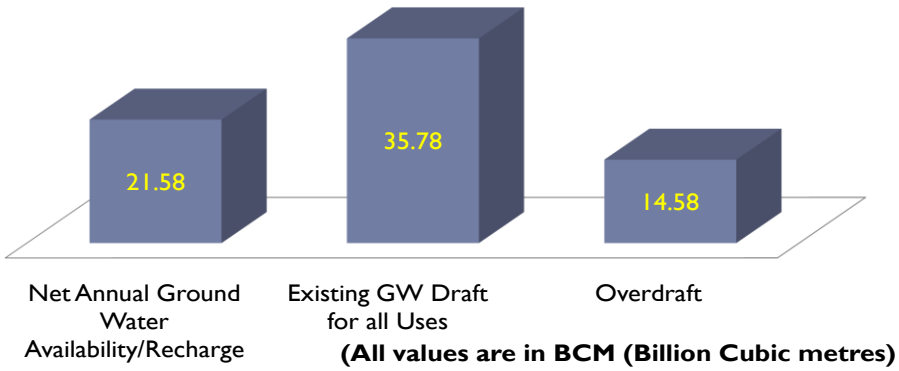



Average Ground water percolation in meters per unit area (0.48 m)
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0.00
0.20
0.06
0.08
0.14
Dams
Return Seepage from Ground Water Irrigation
Return Seepage from Surface Water Irrigation
Canals Seepage
Rainfall Infiltration
All Values in M
Area Irrigated by Tubewells – 2940 thousand hectares
Total No. of Tube well-14.19 Lakhs (2016-17) (0.34 m return seepage from ground water irrigation)
Source- Statistical Abstract of Punjab- 2017
Area Irrigated by Canals in Monsoon & Non-Monsoon season- 1186 thousand hectares (0.26 m return seepage from surface water irrigation)
Length of Canals– 14015 kms (approx.) (Lined- 9971 kms; Unlined- 4044 kms)
Canal seepage factor for un-lined canals taken as 17.5 ha m/day/million sq. mts. and 3.5 ha m/day/million sq. mts. for lined canals
No. of Canal Gauge Stations – 76
No. of Hydrometeorological Stations– 200
Annual Average Rainfall –427 mm (2012-2016)
No. of W.L. Monitoring Stations -780 (State Govt.)+ 340 (CGWB)


(All Values in BCM)
38.00
33.00
28.00
23.00
18.00
13.00
8.00
2.34
1.01
0.192
34.58
Environmental Flows to rivers
Total Population-3.13 Crores
Per Capita Consumption- 100 lpcd
Total No. of Factories – 18854
(Source- Statistical Abstract of Punjab- 2017)
Industrial Draft has been estimated based on draft enumerated in 2009 estimation projected to 2016 on pro-rata basis of population growth.
Total No. of Tubewells - 14.19 Lakhs (2016-17)
Total Quantum of Water – 34.58 BCM
Ground Water Draft
Irrigation (34.58 BCM)
Industrial (0.192 BCM)
Domestic (1.01 BCM)
Environmental flow (2.34 BCM)



DYNAMIC GROUND WATER RESOURCES & Draft OF PUNJAB STATE as on 31.3.2017



(All values are in BCM (Billion Cubic metres)

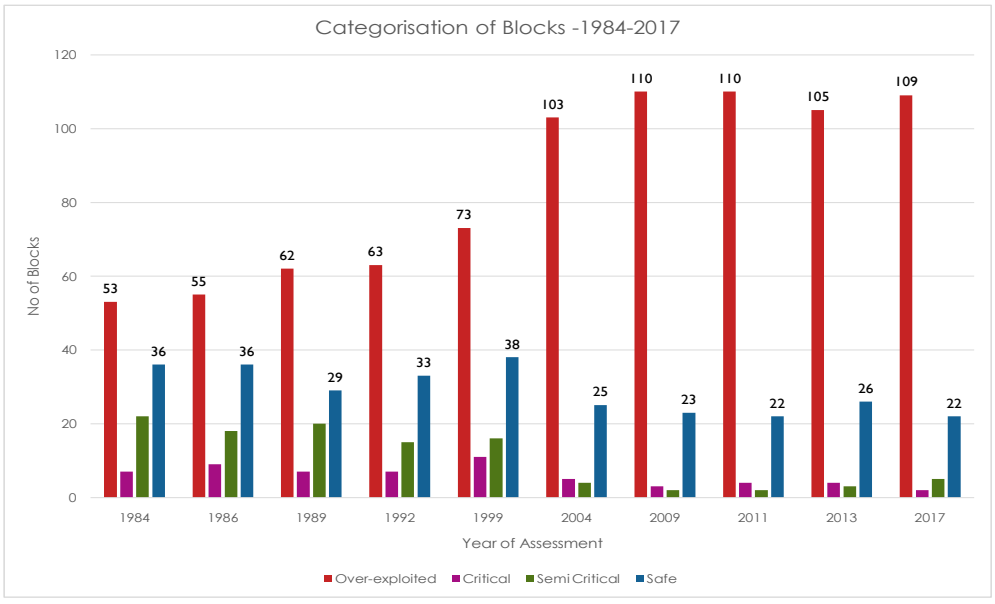
Net GW Availability for Future Irrigation Development in Safe, Semi-critical, critical and potential resources in water logged areas is 1.17 BCM which can be developed in future for creation of additional irrigation from ground water source.

INSTORAGE (Static) GROUND WATER RESOURCES		
1.	Aquifer I (Unconfined) Upto 100 m approx depth	171.53 BCM
2.	Aquifer II (Semic-confined) from 100 to 200 m approx depth	75.83 BCM
3.	Aquifer III (Confined) from 200 to 300 m approx depth	51.76 BCM
4.	Total Annual Replenishable Ground water Resources	21.58 BCM
	Total Ground Water Resources upto 300 m depth	320.70 BCM

If the present rate of extraction continues, the available ground water resources may exhaust in 20 to 25 years

Additional potential Resources in water logged and shallow water level area is 0.09 BCM

The GW Resources in poor quality (Saline water) areas = 9.043 BCM



Comparison GW Resources Estimation

Item	Year of GWR estimation				
	2004	2009	2011	2013	2017
Net Ground Water Availability(MCM)	21443	20349	20321	23390	21650
Gross Ground Water Draft(MCM)	31162	34661	34881	34810	35812
Net GW Availability for Future Irrigation Development (MCM)	--	--	--	--	1167
Stage of Ground water development in %	145	170	172	149	165
No. of Blocks	137	138	138	138	138
No. of OE Blocks	103	110	110	105	109
No. of Critical Blocks	05	03	04	04	02
No. of Semi-Critical Blocks	04	02	02	03	05
No. of Safe blocks	25	23	22	26	22

APPENDIX – 1.1

Copy of Government of Punjab, Department of Irrigation (Project Branch) Notification No. 1 / 5 / 2003 / IPJ (3) 24378-89, Dated 11th Dec. 2004

The Governor of Punjab is pleased to constitute "State Level Committee on Ground Water Resource Estimation" with the following members:

1.	Principal Secretary, Government of Punjab, Irrigation Department Chandigarh.	Chairman
2.	Chief Engineer/Water Resources, Irrigation Works, Punjab, Chandigarh.	Member
3.	Chief Engineer/Canals, Irrigation Works, Punjab, Chandigarh.	Member
4.	Chief Engineer P.W.D (Public Health Branch), Punjab, Patiala.	Member
5.	Managing Director, Punjab Water Supply and Sewerage Board, Chandigarh.	Member
6	Director, Industries, Punjab, Chandigarh	Member
7.	Director Research, Punjab Agriculture University, Ludhiana	Member
8.	Director, Punjab Remote Sensing Center, (PAU Campus), Ludhiana.	Member
9.	Director of Agriculture, Punjab, Chandigarh.	Member
10.	Executive Director, Punjab State Council for Science and Technology, Chandigarh.	Member
11.	General Manager, NABARD, Chandigarh.	Member
12.	Regional Director, (North Western Region) Central Ground Water Board, Chd.	Member Secretary

The following shall be the Terms of Reference:-

i. To estimate ground water potential and Irrigation potential of Punjab State in accordance with the methodology recommended by Ground Water Estimation Committee set up by Government of India.

ii. To estimate the present level of development and utilisation of this resource in State of Punjab.

iii. To estimate ground water recharge from rainfall and other resources separately in the State of Punjab.

iv. To assess the present and future requirement of ground water for Agriculture, Public Health, Industrial uses and other diverse purposes.

The headquarters of the Committee shall be at Chandigarh.

The Committee shall meet as often as may be considered necessary by the Chairman, but at least once every year. The Chairman may invite such persons and officers as he may considered necessary to be present at any meeting and participate in the deliberations.

The members shall draw TA/DA from their respective organizations.

Dated, Chandigarh
11th December, 2004

K.R. Lakhanpal
Principal Secretary to Govt. of Punjab
Department of Irrigation

APPENDIX- 1.2

Copy of Government of Punjab, Department of Irrigation (Project Branch)
Notification No. 1 / 5 / 2003 / IPJ (3) 3419, Dated 9th October, 2009

The Governor of Punjab is pleased to constitute the Sub-Committee for Ground Water Balance of the State Level Committee on Ground Water Resources Estimation for the purpose of certification of finalization of Ground Water Assessment Report before putting up to State Level Committee and for the purpose of issuing Ground Water Assessment Certificate for any area of the State for installation of Tube-wells, both shallow and deep. The constitution of Sub-Committee is as follows:-

1.	Director, Water Resources and Environment, Punjab, Chandigarh	Chairman
2.	Director, Central Ground Water Board, Chandigarh	Member
3.	Representative of MD, PDWRDC Ltd., Chandigarh.	Member
4	Geologist/ Hydrologist, Ground Water Cell, Agriculture Department, Punjab, Chandigarh	Member Secretary

The Ground Water Assessment Certificate will be issued and signed by the Member Secretary, of Sub-Committee for Ground Water Balance. All the correspondence in the connection by various Departments /Agencies will be addressed to Geologist/ Hydrologist, Ground Water Cell, Agriculture Department, Punjab, Chandigarh.

Dated, Chandigarh the 4 Nov., 2009

Suresh Kumar,
Principal Secretary to Govt. of Punjab
Department of Irrigation

APPENDIX -2.1

Minutes of 1st Meeting of Technical Sub Committee on Water balance of Punjab State for the preparation of Dynamic Ground Water Estimation Report 2017 held under the Chairmanship of Director, Water Resources and Environment Directorate, Punjab in his office on 05-06-2018 at 3:00 PM.

1.0 A meeting to discuss the modalities and time schedules for the preparation of Dynamic Ground Water Estimation 2017 was held on 05-06-2018 under the Chairmanship of Sh. N.K. Jain. Director, Water Resources and Environment Directorate (WRED), Punjab.

2.0 The following attended the meeting:

1	Sh. Tejdeep Singh	Scientist 'D', Central Ground Water Board (CGWB), NWR, Chandigarh
2	Sh. Atul Kumar Sood	Sr. Geophysicist, WRED, Punjab, SAS Nagar
3	Sh. Jaswant Singh	Geologist/Hydrologist, GWC, Division No 1, Department of Agriculture and Farmers Welfare (DoA and FW) Punjab, SAS Nagar-Member Secretary
4	Sh. Neeraj Pandit	Geologist/Hydrologist, GWC, Division No 2, DoA and FW, Punjab, SAS Nagar
5	Sh. Suresh Narang	Sr. Hydrologist, WRED, Punjab, SAS Nagar
6	Sh. Sandeep Singh Walia	Assistant Geologist, DoA and FW, Punjab
7	Sh. J.K. Arya	Executive Engineer, Punjab Water Resource Management and Development Corporation (PWRMDC), Punjab
8	Sh. Vasu Sachdeva	Jr. Hydrologist, WRED, Punjab, SAS Nagar

3.0 At the outset, the Chairman welcomed all the participants and briefed the members about the modalities and time schedules for the preparation of Dynamic Ground Water Estimation 2017. He stressed that the time line given by ministry of Water Resources, GoI, New Delhi was 15th July, 2018 for the completion of the said task. He further asked Sh. Jaswant Singh, Members Secretary, Technical Sub Committee on Water Balance of Punjab State to brief the members about the Water balance study. Sh. Jaswant Singh informed the Chair that the member departments are to supply the required data of their respective department and the work of compilation of report is to be carried out by WRED, Punjab. Thereafter, he requested all the present members to deliberate upon the status of data

to be incorporated and also the new guidelines for preparation of Ground Water Estimation Report, 2017. Sh. Atul Kumar Sood was requested to brief the Chair about new methodology. He informed that the block wise lateral/horizontal flow is to be taken as per new methodology and there is a need for 2-3 days training to be imparted by CGWB to the member officers.

4.0 After detailed deliberation, the following decisions were taken:

(i) The deadline for the supply of data to be incorporated in the Ground Water Estimation Report 2017 be 15th June, 2018. Since this is a short notice for preparation of report, all the departments should work accordingly and supply the available data within stipulated time period.

(ii) The work for Dynamic Water Estimation 2017 be carried out by the technical Sub Committee and the Static part be worked/calculated by CGWB. For this, PWRMDC would supply data of deep tubewells directly to CGWB. Also, data of deeper tubewells having depth of more than 200 m shall not be considered in Dynamic Water Estimation.

(iii) At present, the demarcation (geographical area/villages boundary) of 146 blocks of State of Punjab is not properly available/computed. Therefore, 138 blocks as considered in previous report would be considered in the present report.

(iv) The specific yield (@15%) and rainfall infiltration rate (22%) as per previous ground water report is to be followed in the present report.

(v) Same Canal water data to be used which was used in previous report.

(vi) The latest Minor Irrigation Census Report is still awaited. Therefore, it was decided that the number of tubewells and draft to be supplied by DoA and FW, Punjab be considered on prorata basis.

(vii) CGWB would get printedand supply the adequate number of hard copies to 22 district offices/State HQ of DoAand FW, Punjab.

(viii) Due consideration of all the officers of Technical Sub Committee especially DoA and FW, Punjab be given in the published report of Dynamic Water Estimation 2017.

The Chairman concluded the meeting with the remark that the second meeting be held on 25th June, 2018 at the same venue and time to discuss the progress and prepare the further course of action for timely submission of Ground Water Balance Report, 2017.

The meeting ended with a vote of thanks to the Chair.

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APPENDIX -2.2

Minutes of 2nd Meeting of Technical Sub Committee on Water balance of Punjab State for the preparation of Dynamic Ground Water Estimation Report 2017 held under the Chairmanship of Director, Water Resources and Environment Directorate, Punjab in his office on 26-06-2018 at 3:00 PM.

1.0 A meeting to discuss the progress and prepare the further course of action for timely submission of Ground Water Report, 2017 was held on 26-06-2018 under the Chairmanship of Sh. N.K. Jain. Director, Water Resources and Environment Directorate (WRED), Punjab.

2.0 The following attended the meeting:

1	Sh. Atul Sood	Sr. Geophysicist, WRED, Punjab, SAS Nagar
2	Sh. Jaswant Singh	Geologist/Hydrologist, GWC, Div No 1, Department of Agriculture and Farmers Welfare (DoA and FW) Punjab, SAS Nagar-Member Secretary
3	Sh. Suresh Narang	Sr. Hydrologist(XEN), WRED, Punjab, SAS Nagar
4	Sh. Anil Kumar Bhutani	Sr. Hydrologist, Punjab Water Resource Management and Development Corporation (PWRMDC), Punjab
5	Sh. Jagdish Singh	Executive Engineer, Punjab Water Resource Management and Development Corporation (PWRMDC), Punjab
6	Sh. Sandeep Singh Walia	Assistant Geologist, DoA and FW, Punjab
7	Sh. Vasu Sachdeva	Jr. Hydrologist, WRED, Punjab, SAS Nagar
8	Sh. Sanjeev Bansal	S.T.A,WRED, Punjab, SAS Nagar

3.0 At the outset, the Chairman welcomed all the participants and enquired about the progress of data compilation for the preparation of Dynamic Ground Water Estimation 2017. Geologist/Hydrologist, GWC, Division No 1, Department of Agriculture and Farmers Welfare (DoA and FW) Punjab, SAS Nagar-Member Secretary informed that Minor irrigation census data 2012-13 has been received only on 25-06-2108. As such, if the actual tube-well data is to be incorporated then it would take minimum 3 months' time to process the data and if discrepancy arises then it would take some more time.

4.0 After detailed deliberation, it was unanimously decided that:

(i) As Minor Irrigation Census Data of 2012-13 was received on 25-06-2018, it may not be used for preparation of the report as it is likely to take time for validation.

(ii) The draft figures would be worked on prorata basis and submitted to GOI within stipulated time frame for the time being and revised subsequently at later stage, if required.

The meeting ended with a vote of thanks to the Chair.

****

APPENDIX -2.3

Minutes of 3rd Meeting of Technical Sub Committee on Water Balance of Punjab State for the preparation of Dynamic Ground Water Estimation Report 2017 held under the Chairmanship of Director, Water Resources and Environment Directorate, Punjab in his office on 27-08-2018 at 3:00 PM.

1.0 A meeting to discuss and finalize the Ground Water Balance Report, 2017 was held on 27-08-2018 under the Chairmanship of Sh N.K. Jain. Director, Water Resources and Environment Directorate (WRED), Punjab.

2.0 The following attended the meeting:-

1	Sh. S.K. Mohiddin	Sr. Hydrogeologist, Central Ground Water Board (CGWB), NWR, Chandigarh
2	Sh. M.L. Angurala	Sr. Hydrogeologist, Central Ground Water Board (CGWB), NWR, Chandigarh
3	Sh. Rakesh Rana	Scientist D, Central Ground Water Board (CGWB), NWR, Chandigarh
4	Sh. Atul Sood	Sr. Geophysicist, WRED, Punjab, SAS Nagar
5	Sh. Jaswant Singh	Geologist/Hydrologist, GWC, Div. No 1, Department of Agriculture and Farmers Welfare (DoA and FW) Punjab, SAS Nagar-Member Secretary
6	Sh. Neeraj Pandit	Geologist/Hydrologist, GWC, Div. No 2, DoA and FW, Punjab, SAS Nagar
7	Sh. Suresh Narang	Sr. Hydrologist, WRED, Punjab, SAS Nagar
8	Sh. Sandeep Singh Walia	Assistant Geologist, DoA and FW, Punjab
9	Sh. R.S. Gupta	Jr. Hydrogeologist, Punjab Water Resource Management and Development Corporation (PWRMDC), Punjab
10	Sh. Vasu Sachdeva	Jr. Hydrologist, WRED, Punjab, SAS Nagar
11	Sh. Ashish Swaroop	Jr. Geologist, WRED, Punjab, SAS Nagar
12	Sh. Sanjeev Bansal	S.T.A,WRED, Punjab, SAS Nagar

3.0 At the outset, the Chairman welcomed all the participants and asked Sh. Atul Sood, Sr. Geophysicist, WRED, Punjab to initiate the proceeding. Sh. Atul Sood presented the draft report on GEC 2017.

After presentation, the following points were deliberated:

(i) The modified values of unit draft of 4 blocks namely Bhunga, Hoshiarpur-2, Mahilpur and Mukerian, was provided by Agriculture Department, which will be duly incorporated in the report.

(ii) It was discussed that as per newly constructed boundaries of blocks, total no of blocks increased to 149 from 138, so the data should be updated as per new blocks. But since the proper data of new blocks is not available i.e. block boundaries, list of villages and population, it was decided to consider only 138 blocks in the present study

(iii) Officers from Department of Agriculture and Farmer's Welfare, Punjab informed that more than 50% area of 5 blocks have less than 5 m ground water level and should be placed in safe category. The areas of 5 blocks have been calculated based upon post monsoon 2016 map. Officers from CGWB were of the opinion that as per GEC 2015 methodology areas should be based upon pre monsoon ground water levels and the same was agreed upon by all.

(iv) CGWB said that Dynamic Ground Water Estimation Report 2017 should have one chapter on ground water quality of Punjab as per GEC 2015 methodology.

(v) CGWB suggested to include lateral Ground water flow calculated as per GEC 2015 methodology and should be included in the report. WRED clarified that no such studies are being carried out by their department and same should be provided by CGWB.

(vi) The data of Static Water Resources has been received from Central Ground Water Board and the same is being processed.

The meeting ended with a vote of thanks to the Chair.

****

A meeting to discuss and finalize the Draft Ground Water Balance Report-2017 was held today i.e. on 15-10-2018 under the Chairmanship of Sh. N.K. Jain. Director, Water Resources & Environment Directorate (WRED), Punjab.

The list of participants is attached.

At the outset, the Chairman welcomed all the participants. After presentation and deliberations the Draft Ground Water Balance Report- 2017 was **approved** by the members of "Technical Sub Committee on Water Balance of Punjab State for the preparation of Dynamic Ground Water Estimation Report".

The meeting ended with a vote of thanks to the Chair.

Narinder Kumar Jain
15/10/18.

Chairman
(Director, Water Resources and Environment, Punjab, Mohali)

15/10/18
CANOOP MACOB

Member
(Director, Central Ground Water Board, NWR, Chandigarh)

15/10/18
(ANIL KR. BHUTANI)

Member
Representative of MD, PDWRDC Ltd., Chandigarh.

15/10/18
JASWANT SINGH

Member Secretary
Geologist/ Hydrologist, Ground Water Cell, Department of Agriculture and Farmer Welfare, Punjab, Mohali.

APPENDIX -2.4

Minutes of Meeting of State Level Committee for approval of Dynamic Ground Water Resource Estimation Report-2017 held under the Chairmanship of Principal Secretary, Irrigation, Government of Punjab on 13.3.2019 at Punjab Civil Secretariat II, Sector-9, Chandigarh

1.0 Second meeting for approval of Dynamic Ground Water Resource Estimation Report-2017 prepared jointly by Water Resources Department, WRED, SAS Nagar, Punjab and Central Ground Water Board, NWR, Chandigarh was held under the Chairmanship of Sh. Sarvjit Singh, Principal Secretary, Irrigation, Government of Punjab on 13.3.2019 at Punjab Civil Secretariat II, Sector-9, Chandigarh. The list of Participants is enclosed as Annexure I.

2.0 At the outset, the Chairman welcomed all the participants. Sh. Anoop Nagar, Regional Director, CGWB, NWR explained the summary of the report prepared and modified as per the suggestions given in the first meeting of the committee held on 7-12-2018 presented as Annexure-II. The summary of the report was thoroughly deliberated by the members. Sh. Sarvjit Singh Principal Secretary, Chairman of the Committee while discussing the details of the of the report and advised for incorporating the following recommendations in the report.

1. The terminology used as Stage of Ground Water Development should be changed to Stage of Ground water extraction as percentage of total ground water percolation.

2. Ground water availability per unit area may be termed as Average Ground Water percolation in meters per unit area. Accordingly, the draft per unit area may be written as Average draft/discharge from unit area.

3. In the slide where total ground water resources which include both In-storage and Dynamic ground water resources have been mentioned, it was opined by Sh. Harminder Singh, Chief Engineer, WRED, Punjab to mention total ground water availability for different aquifers along with depth detail which was agreed by the chairman.

4. It was explained during the deliberations that the approximate extensions of the three aquifers i.e. Aquifer-I the depth of which is approximately available upto 100m, Aquifer -II which extends from approximately from 100 to 200 m depth and Aquifer -III which extends from 200 m to 300 m depths. It was advised by the chairman that the same details should also be mentioned.

5. The high level of ground water extraction was also deliberated and it is opined that the report should also incorporate that if the present rate of extraction continues, the

ground water resources may exhaust in 20 to 25 years period. Ground water resources available in saline areas should also be mentioned prominently so that the proper planning may be done to utilize these resources also. to mention total ground water availability

6. As the Resource Estimation is based on norms and certain assumptions, it was deliberated that same is mismatching in some blocks where ground water extraction computed is more than the ground water recharge/percolation which is basically due to the real different situation on the ground. It was opined that the detailed studies shall be takenup jointly by WRED, Government of Punjab, Agriculture Department, Government of Punjab and CGWB, Government of India to ascertain the representative field values for the adopted parameters in the present computation.

7. In some blocks, the ground water resources have been estimated as Over-exploited, but the 50% of these blocks have shallow water levels where water levels are less than 5m, these blocks have been categorized as 'Safe' Block. The recommendation of the Technical Sub-committee in this matter is accepted and it is decided to keep these blocks as "Safe, Category.

The Report was approved and accepted by the State Level Committee for Ground Water Resources estimation in Punjab State.

The meeting ended with a vote of thanks to the Chair.

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Annexure I

In the Chair, Sh. Sarvjit Singh, Principal Secretary, Irrigation, Government of Punjab.
The List of other officers present in the meeting:-

S. N.	Name	Designation
1	Sh. Anoop Nagar	Regional Director, CGWB, NWR, Chandigarh and Member Secretary, State Level Committee on GWRE
2	Sh. Harminder Singh	Chief Engineer Water Resources, Punjab
3	Sh.Jagmohan S. Mann	Chief Engineer, Canals, Water Resources, Punjab
4	P.K. Litoria	Head (GWG & IT), Punjab Remote Sensing Centre, Ludhiana
5	Sh.Bharat Bhushan Singla,	Director, (WRED) Water Resources & Env. Dte., Punjab
6	Sh. Atul Sood	Sr. Geophysicist, WRED, Punjab, SAS Nagar
7	Sh. Jaswant Singh	Geologist/Hydrologist, GWC, Div No 1, Department of Agriculture & Farmers Welfare (DoA&FW) Punjab, SAS Nagar-Member Secretary
8	Sh. Rajan Aggrawal,	Head of the Department SWE, PAU, Ludhiana
9	Sh.A.K. Sood	Asst. Director (Tech), Department of Industries and Commerce
10	Sh. Vikas Mittal	NABARD, Chandigarh
11	Sh. Neeraj Pandit	Department of Agriculture and Farmers Welfare
12	Sh. Rajesh Vashist	Department of Agriculture and Farmers Welfare
13	Er. S.N. Bhagat	Water Resources Department
14	Dr. Satnam S. Ladhar	Additional Director, Punjab state council for Science and Technology
15	Sh. S.K. Mohiddin	Sr. Hydro-geologist, Central Ground Water Board (CGWB), NWR, Chandigarh
16	Sh. Aditya Sharma	Sr. Technical Assistant, Central Ground Water Board (CGWB), NWR, Chandigarh

ਜਲ ਸਰੋਤ ਵਿਭਾਗ
(ਪ੍ਰੋਜੈਕਟ ਸ਼ਾਖਾ)

ਸੇਵਾ ਵਿਖੇ,

Sh. Anoop Nagar,
Regional Director & Member Secretary,
Central Ground Water Board,
North Western Region,
Bhujal Bhawan, Plot-3-B,
Sector-27-A, Madhya Marg,
Chandigarh.

ਮੀਮੋ ਨੰ:1/5/2002-ਪੀਸੈ(3)/14438-1/1

ਮਿਤੀ, ਚੰਡੀਗੜ੍ਹ 2-4-19

Subject:- **Draft Minutes of Meeting of State Level Committee for approval of Total Dynamic Ground water Resources Estimation Report 2017 of Punjab State**

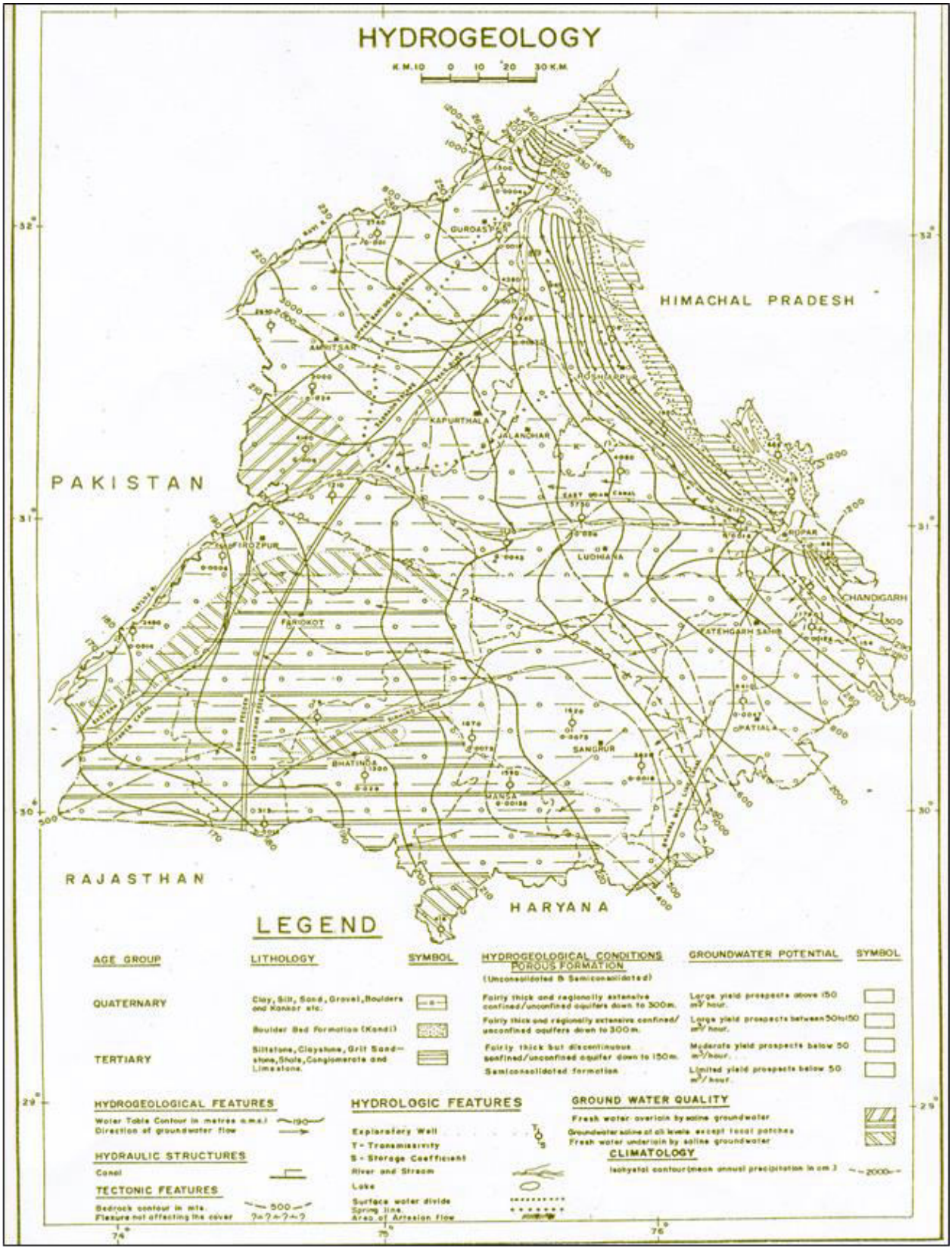
ਉਪਰੋਕਤ ਵਿਸ਼ੇ ਤੇ ਆਪ ਦੀ ਈਮੇਲ ਮਿਤੀ 15/3/2019 ਦੇ ਹਵਾਲੇ ਵਿੱਚ।

2. ਵਿਸ਼ਾ ਅੰਕਿਤ ਮਾਮਲੇ ਸਬੰਧੀ ਹਵਾਲੇ ਅਧੀਨ ਈਮੇਲ ਰਾਹੀਂ ਆਪ ਵਲੋਂ ਪ੍ਰਾਪਤ **Draft Minutes** ਅਤੇ **Dynamic Ground water Resources Estimation Report 2017 of Punjab State** ਪ੍ਰਮੁੱਖ ਸਕੱਤਰ, ਜਲ ਸਰੋਤ ਜੀ ਵਲੋਂ ਪ੍ਰਵਾਨ ਕਰ ਦਿੱਤੀ ਗਈ ਹੈ।

ਇਹ ਆਪ ਦੀ ਸੂਚਨਾ/ਅਗਲੇਰੀ ਲੋੜੀਂਦੀ ਕਾਰਵਾਈ ਹਿੱਤ ਹੈ।

ਸੁਪਰਡੰਟ

PLATE 1



Source: CGWB, NWR, Chandigarh

PLATE - 2

ADMINISTRATIVE BASE MAP

PLATE 3

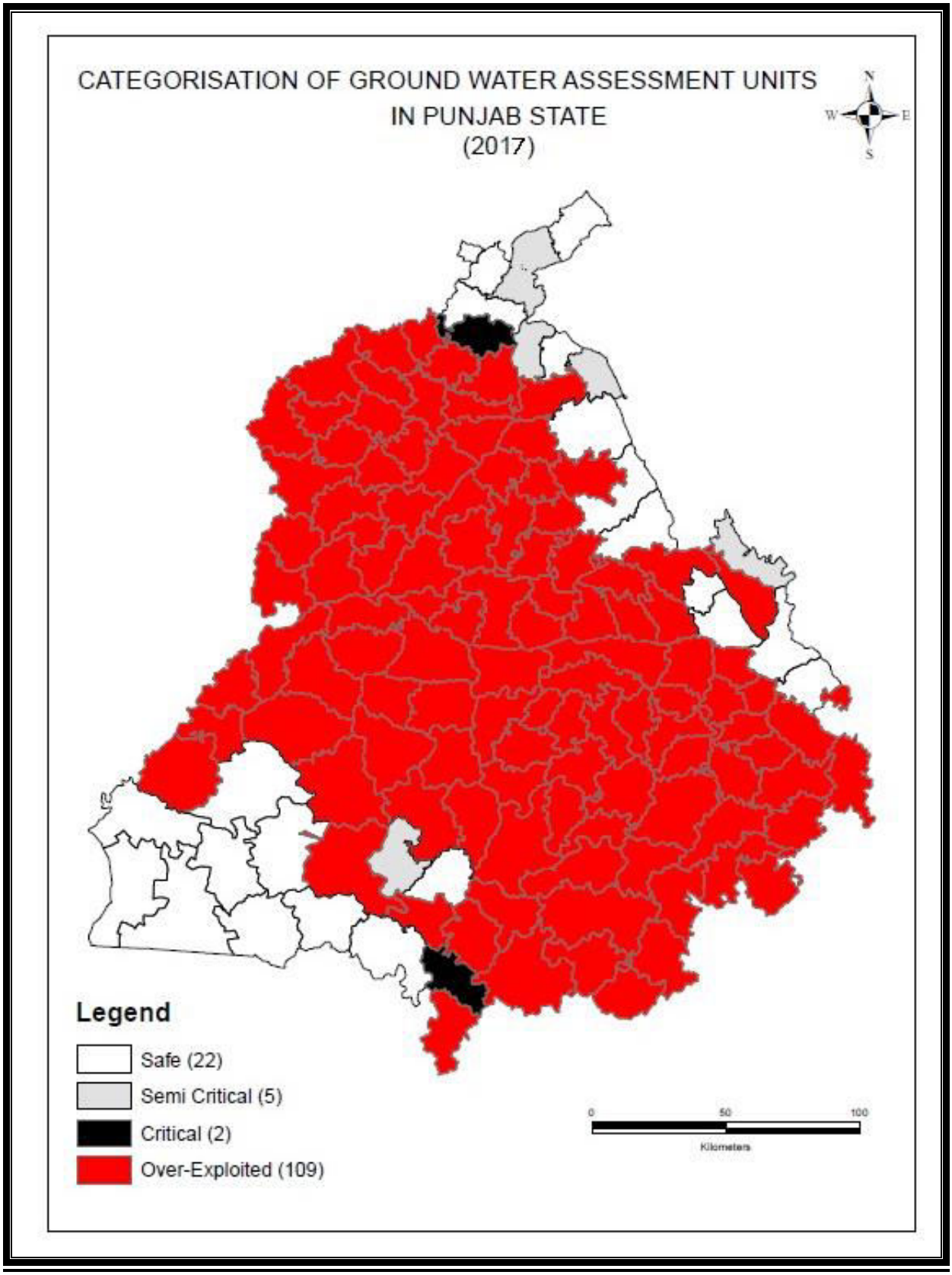

CATEGORISATION OF GROUND WATER ASSESSMENT UNITS
IN PUNJAB STATE
(2017)
N
W
E
S
Legend
Safe (22)
Semi Critical (5)
Critical (2)
Over-Exploited (109)
0
50
100
Kilometers

FIGURE 1

ISOHYETS FOR THE YEAR 2016

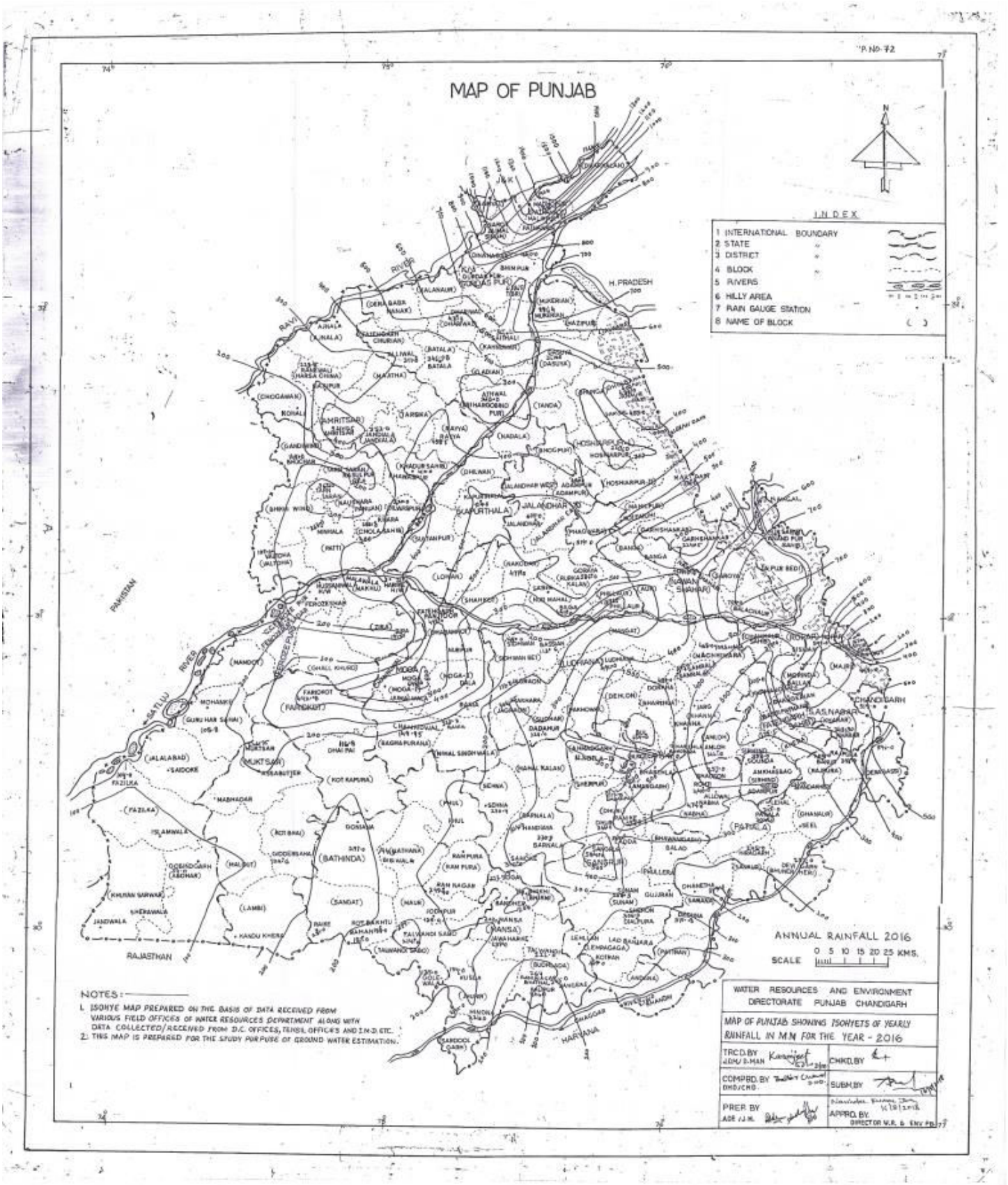


FIGURE 2

DEPTH TO WATER LEVEL, JUNE-2016

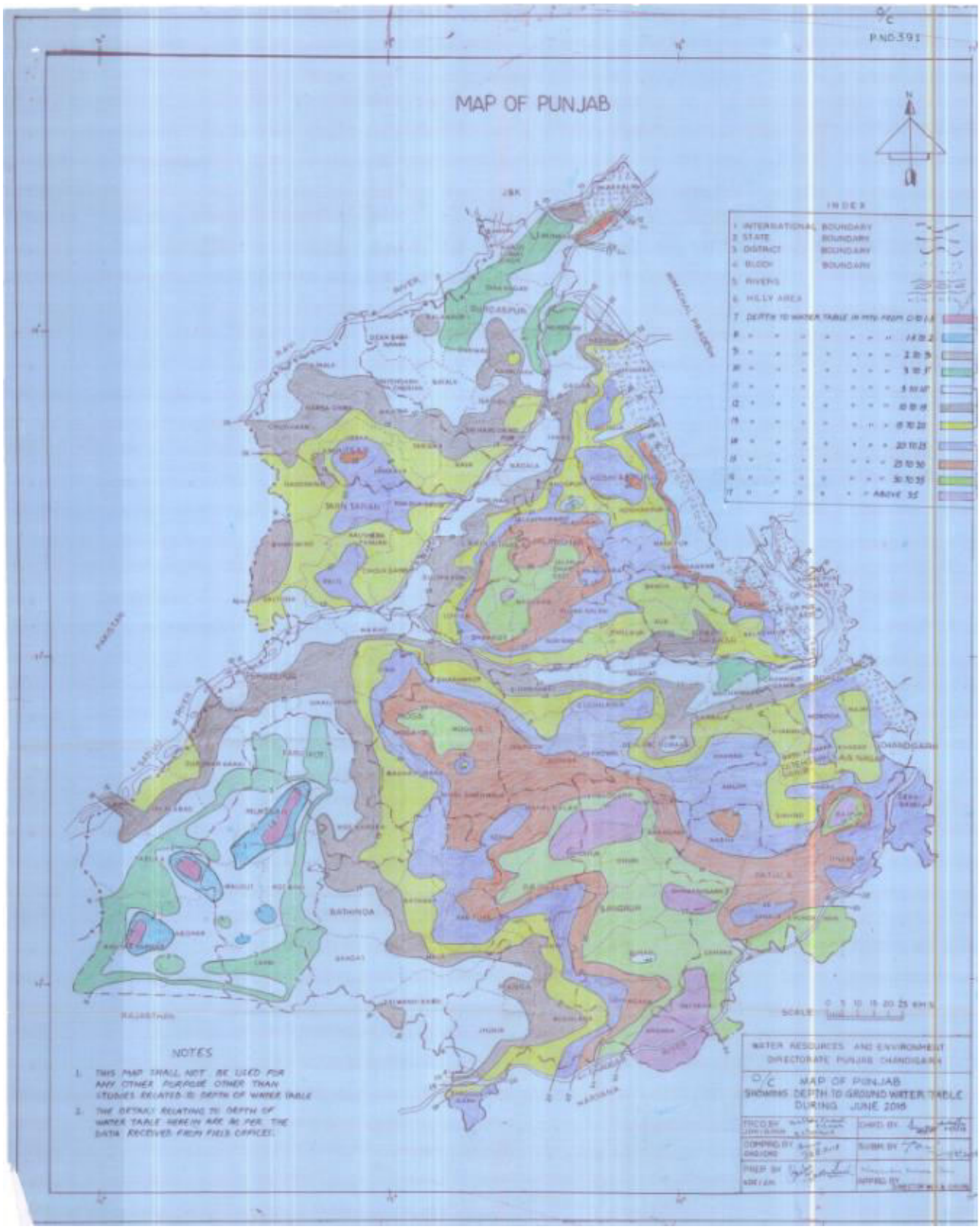


FIGURE 3

WATER TABLE CONTOURS, JUNE-2016

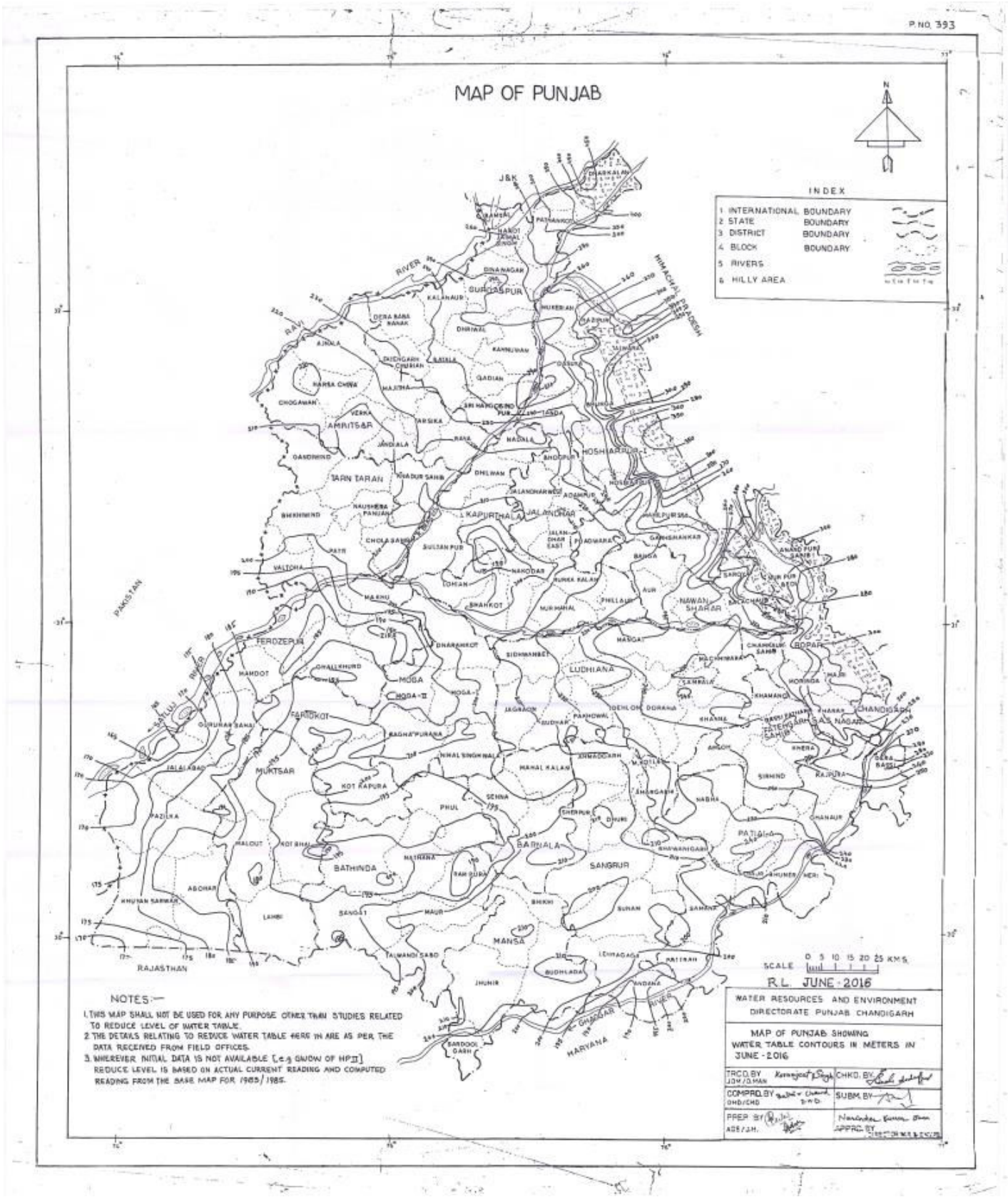


FIGURE 4

DEPTH TO WATER LEVEL, OCTOBER - 2016

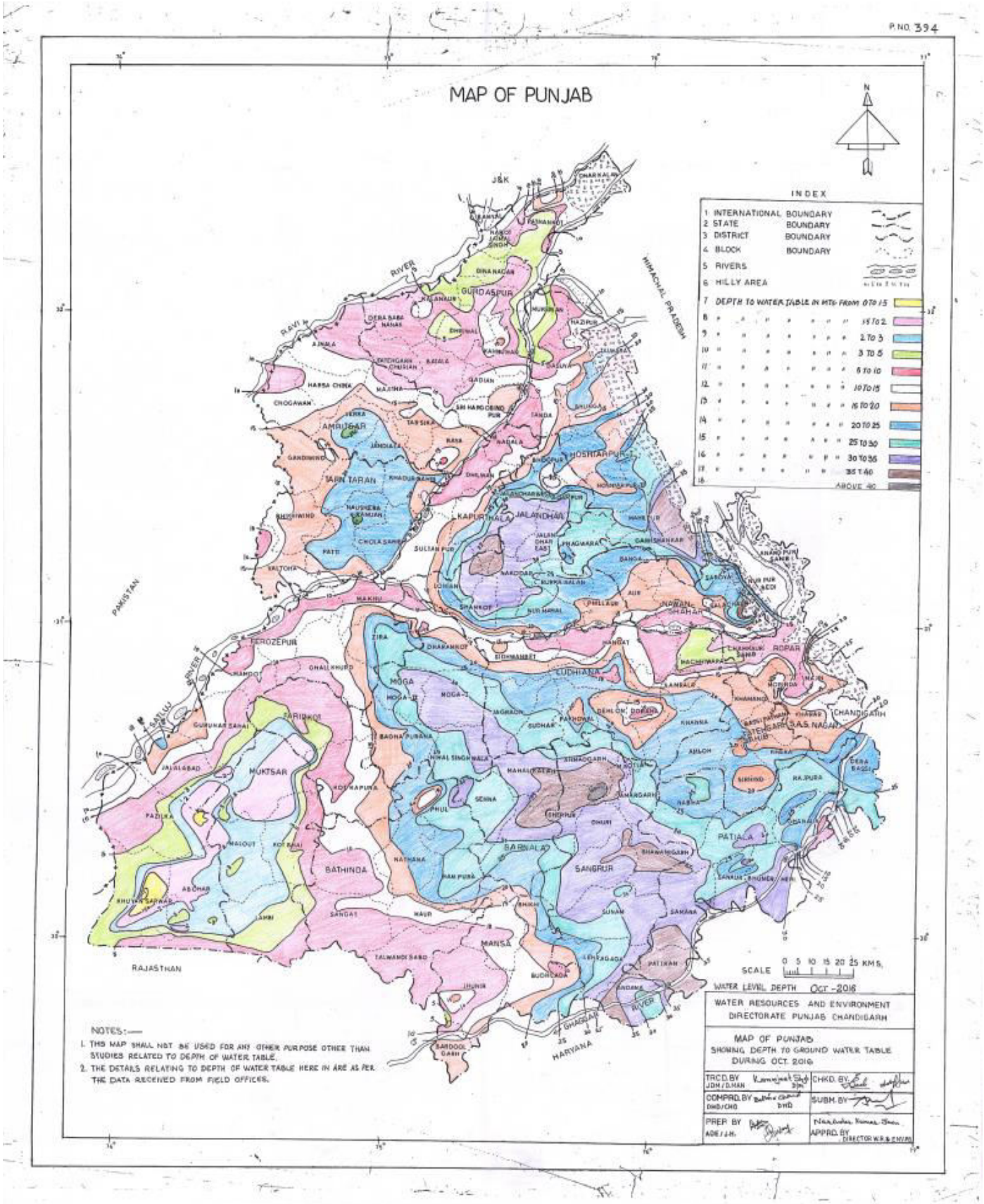


FIGURE 5

WATER TABLE CONTOURS, OCTOBER -2016

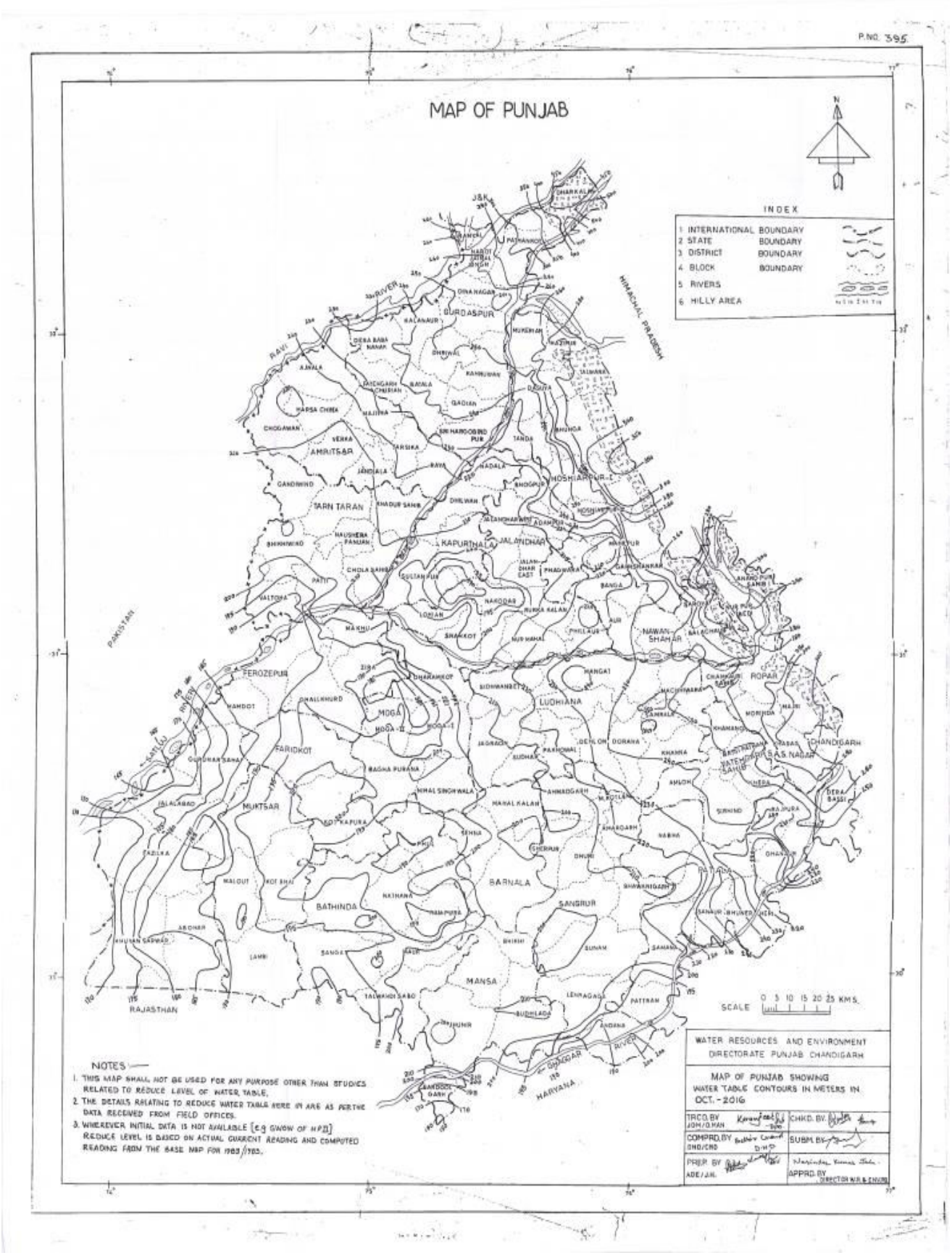


FIGURE 6

RISE and FALL OF WATER TABLE, JUNE 1984- JUNE 2016

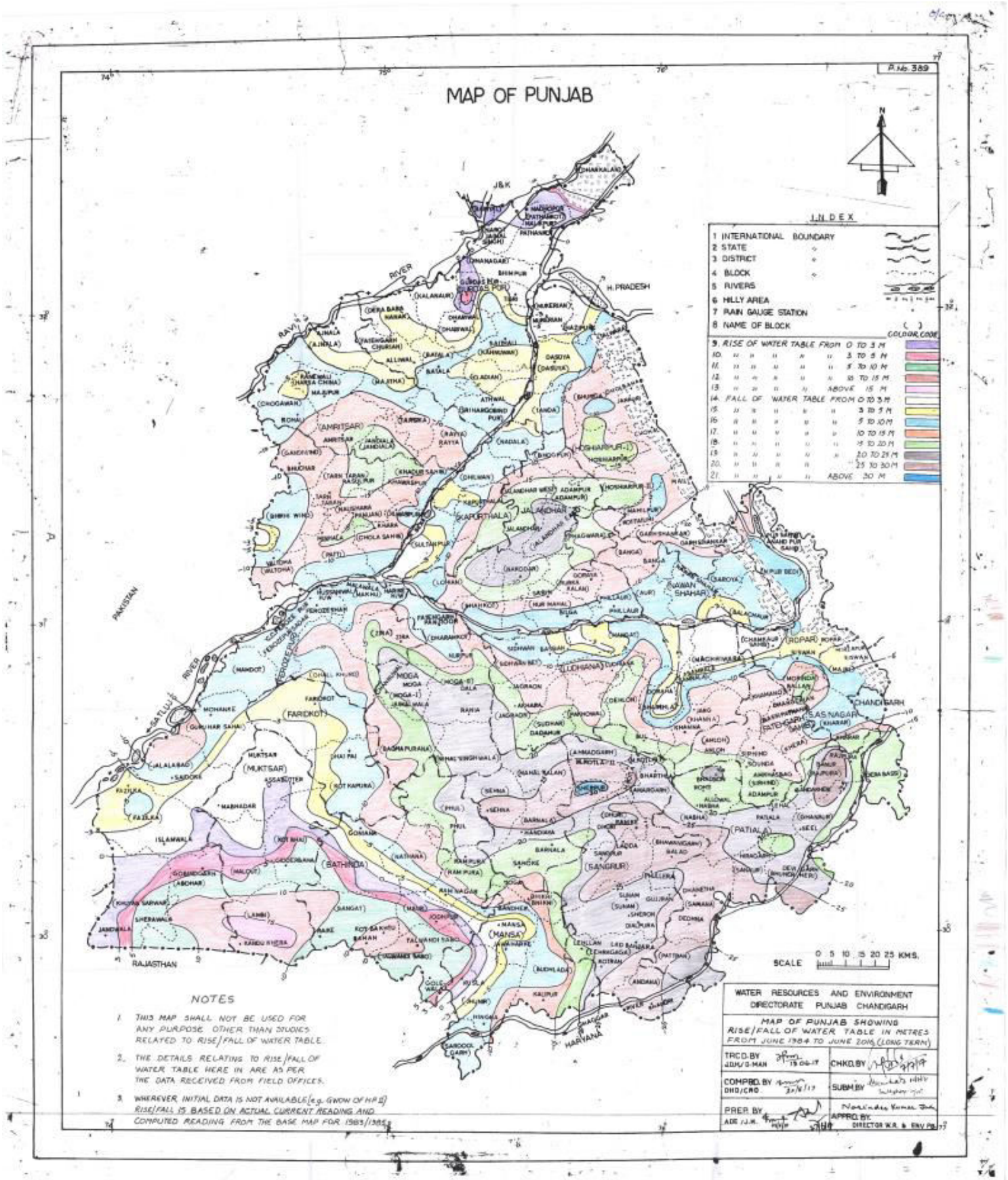


FIG. 7 PERCENTAGE OF BLOCKS UNDER DIFFERENT CATEGORIES

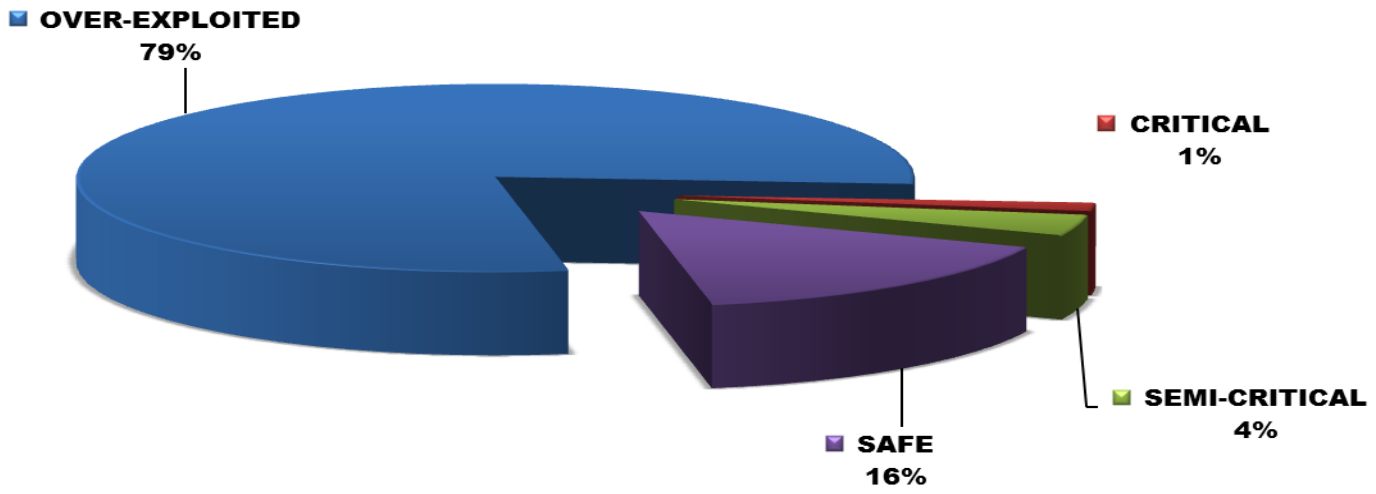


FIG. 8 DISTRICT-WISE RECHARGE FROM RAINFALL AND OTHER SOURCES,PUNJAB

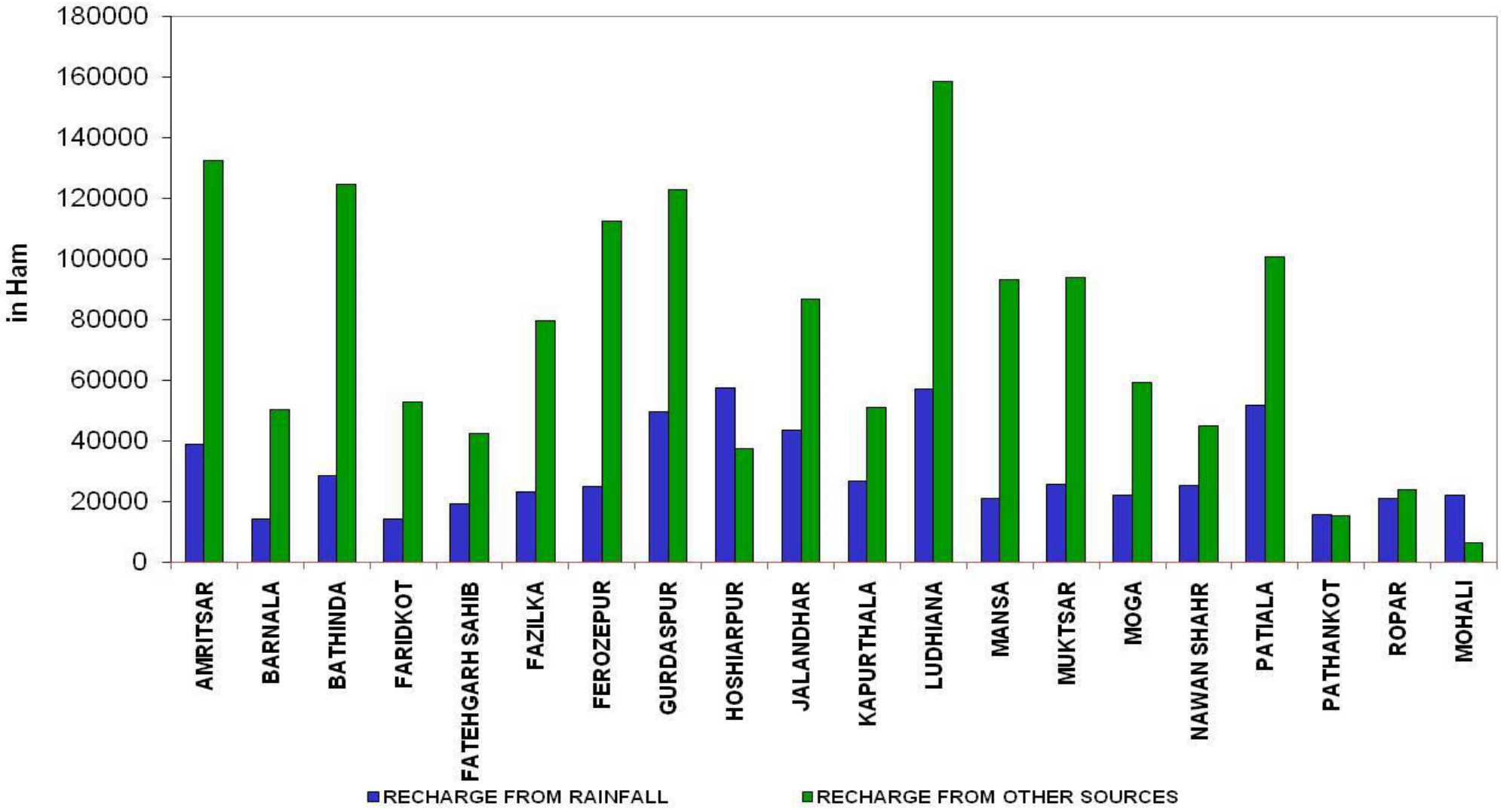


FIG. 9 DISTRICT-WISE GROUND WATER DRAFT, PUNJAB

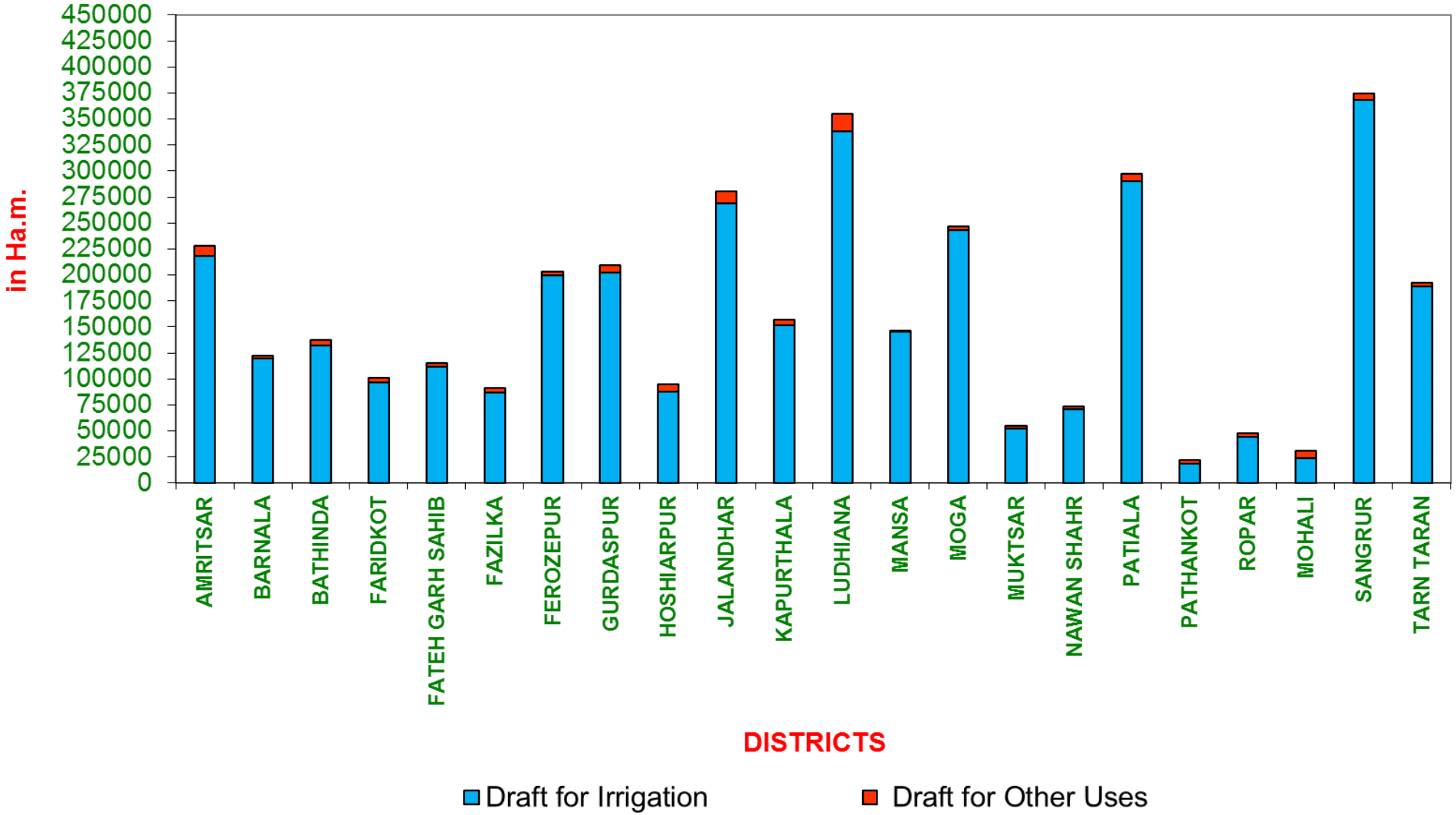


FIG.10 DISTRICT-WISE GROUND WATER AVAILABILITY, GROUND WATER DRAFT, NET GROUND WATER AVAILABILITY FOR FUTURE IRRIGATION PUNJAB

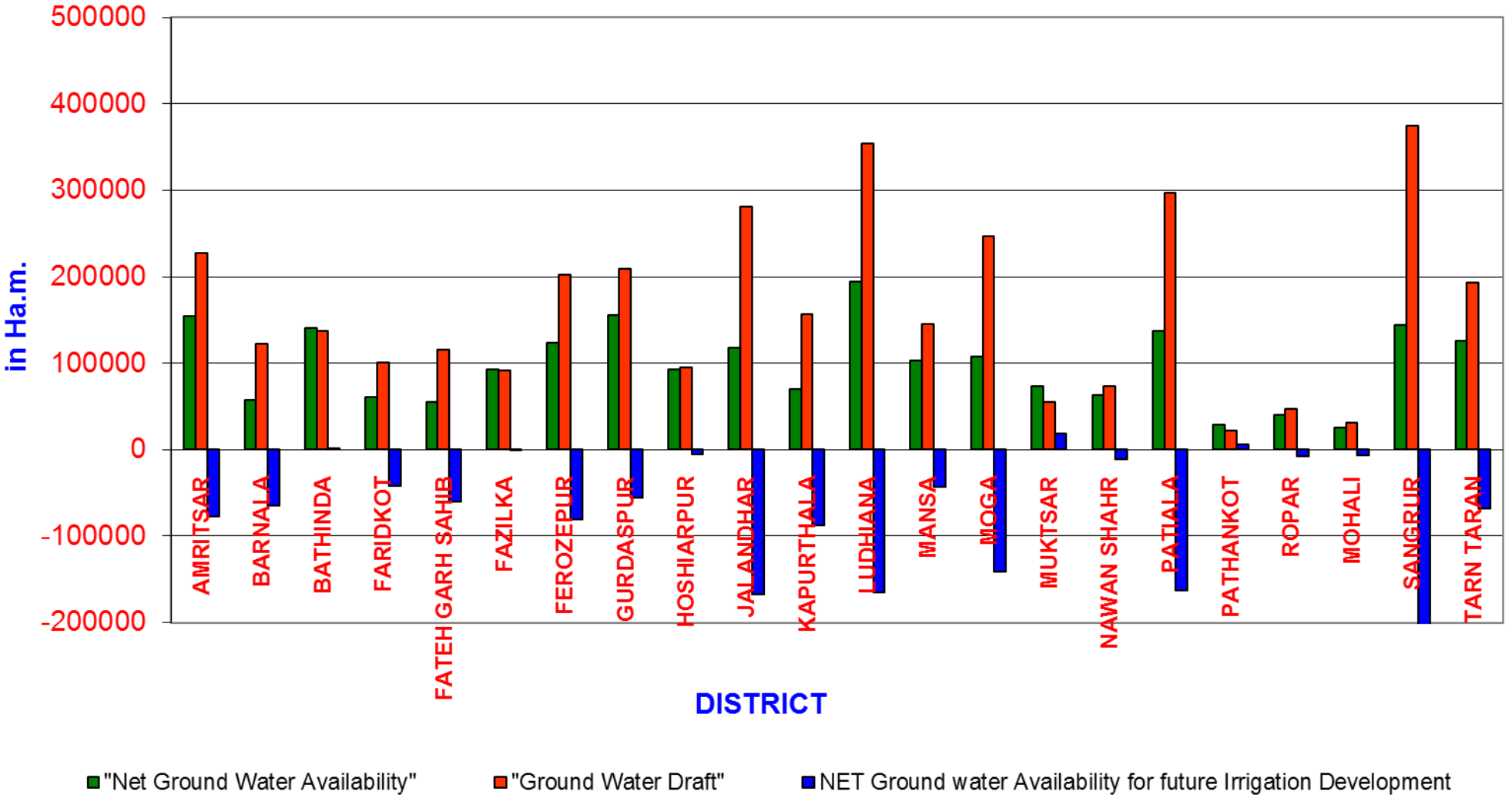


FIG.11 DISTRICT-WISE STAGE OF GROUND WATER DEVELOPMENT, PUNJAB

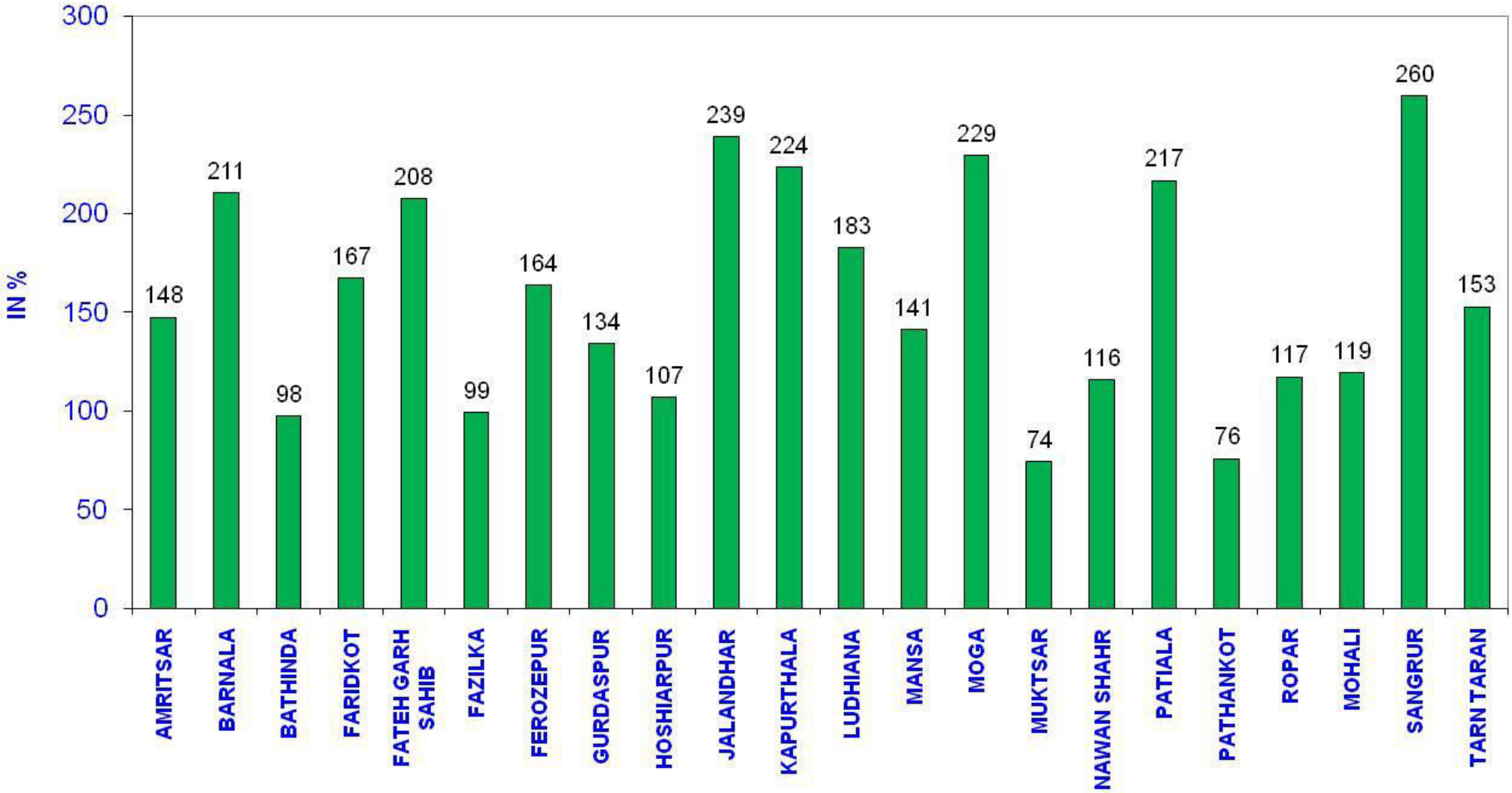
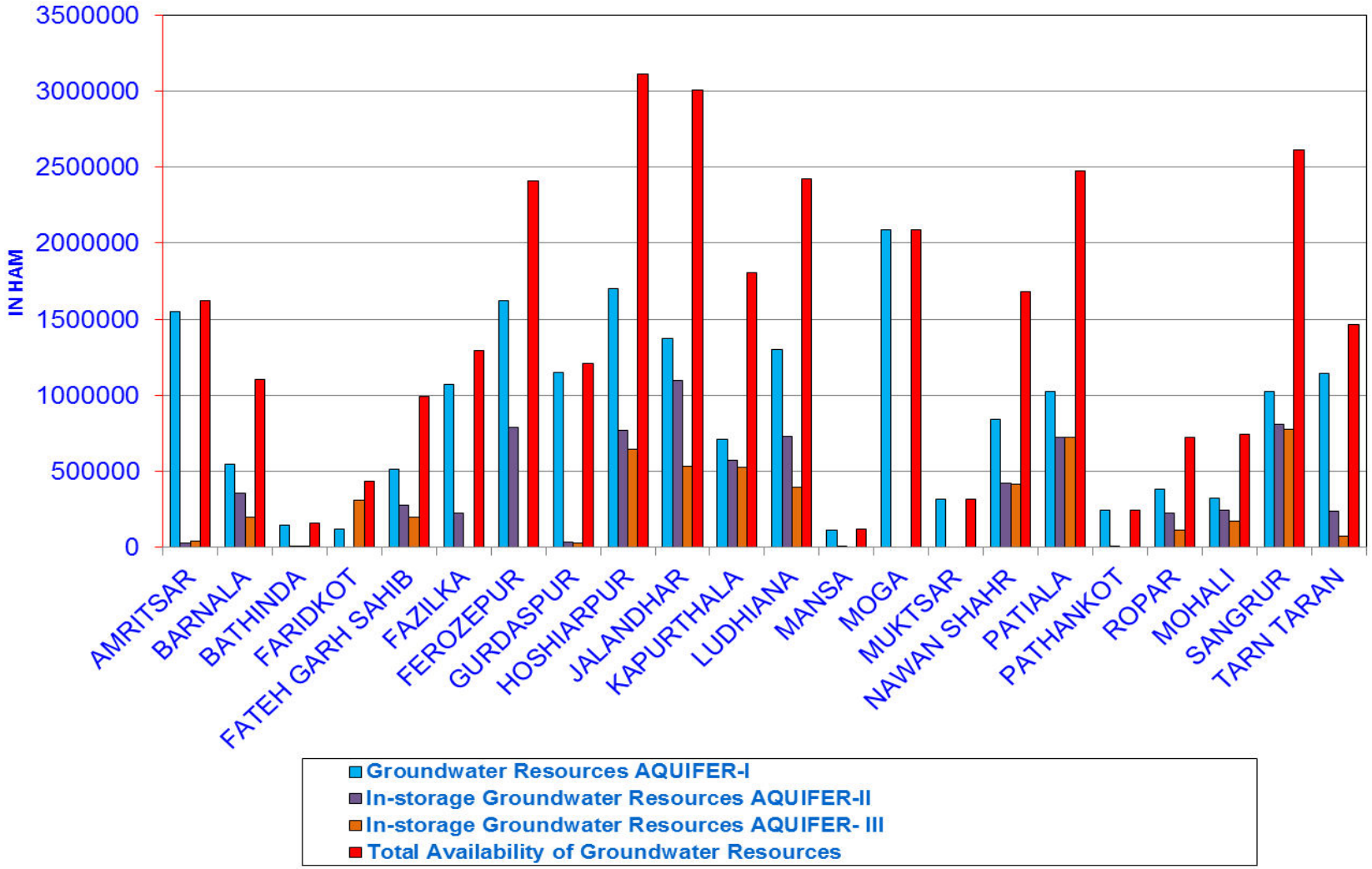


FIG.12 TOTAL AVAILABLE GROUND WATER RESOURCES IN PUNJAB (UP TO 300m DEPTH)



LIST OF CONTRIBUTORS

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4. Sh. Ashish Swaroop, Junior Geologist (SDO)
5. Sh. Sanjeev Bansal, STA.
6. Sh. Karamjeet Singh, Draftsman.
7. Sh. Balbir Chand, Draftsman.
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4. Sh. Sandeep Singh Walia, Assistant Geologist.

PWRMDC

1. Sh. Anil Kumar Bhutani, Senior Hydrogeologist.
2. Sh. R.S.Gupta, Junior Hydrogeologist.

Under the Supervision of:

1. Sh. Narinder Kumar Jain, Director, Water Resources and Environment Directorate, Punjab, Chandigarh.
2. Sh. Anoop Nagar, Regional Director, Central Ground Water Board, MoWR and GR, NWR, Chandigarh.

ANNEXURE III A-1

GENERAL DESCRIPTION OF THE ADMINISTRATIVE UNIT OF THE PUNJAB STATE as on 31.3.2017

S. No.	Name of Assessment Unit (i.e. Block)	Type of rock formation	Areal Extent (in Hectares)						
					Ground Water Recharge Worthy		Shallow Water Table Area	Flood Prone Area	Bottom of the uncofined aquifer in soft rock areas and depth of weathered zone and/or maximum depth of fractures under unconfined zone(m)
			Total Geographical Area	Hilly Area	Command Area/Non-Command Area	Poor Ground Water Quality Area			
1	2	3	4	5	6	8	9	10	
	District:	AMRITSAR							
1	AJNALA	Alluvial Soil	37550	0	37550	0	0		90
2	CHOGAWAN	Alluvial Soil	39600	0	39600	0	0		100
3	HARSHA CHINA	Alluvial Soil	25740	0	25740	0	0		110
4	JANDIALA	Alluvial Soil	20620	0	20620	0	0		155
5	MAJITHA	Alluvial Soil	27190	0	27190	0	0		120
6	RAYYA	Alluvial Soil	32640	0	32640	0	0		76
7	TARSIKA	Alluvial Soil	23650	0	23650	0	0		100
8	VERKA	Alluvial Soil	33340	0	33340	0	0		100
	TOTAL		240330	0	240330	0	0		
	District:	BARNALA							
1	BARNALA	Alluvial Soil	61390	0	61390	30600	0		85
2	MAHAL KALAN	Alluvial Soil	34760	0	34760	0	0		80
3	SEHNA	Alluvial Soil	39020	0	39020	12500	0		76
	TOTAL		135170	0	135170	43100	0		
	District:	BATHINDA							
1	PHUL	Alluvial Soil	52230	0	52230	33000	0		60
2	NATHANA	Alluvial Soil	44550	0	44550	11600	0		58
3	MAUR	Alluvial Soil	35610	0	35610	33000	0		55
4	BATHINDA	Alluvial Soil	73950	0	73950	46700	740		60
5	TALWANDI SABOO	Alluvial Soil	52240	0	52240	31600	0		58
6	SANGAT	Alluvial Soil	63040	0	63040	60600	5674		65
7	RAMPURA	Alluvial Soil	33100	0	33100	24700	0		67
	TOTAL		354720	0	354720	241200	6413		
	District:	FARIDKOT							
1	FARIDKOT	Alluvial Soil	75210	0	75210	38500	30084		52
2	KOT KAPURA	Alluvial Soil	66650	0	66650	5000	3333		68
	TOTAL		141860	0	141860	43500	33417		
	District:	FAZILKA							
1	ABOHAR	Alluvial Soil	67290	0	67290	10200	53832		81
2	FAZILKA	Alluvial Soil	85920	0	85920	5200	44678		93
3	JALALABAD	Alluvial Soil	52440	0	52440	5000	14683		88
4	KHUYIAN SARWAR	Alluvial Soil	84540	0	84540	17300	60869		78
	TOTAL		290190	0	290190	37700	174062		
	District:	FATEHGARH SAHIB							
1	KHERA	Alluvial Soil	18080	0	18080	0	0		60
2	SIRHIND	Alluvial Soil	37240	0	37240	0	0		75
3	AMLOH	Alluvial Soil	22200	0	22200	0	0		75
4	BASSI PATHANA	Alluvial Soil	18650	0	18650	0	0		67
5	KHAMANON	Alluvial Soil	15500	0	15500	0	0		65
	TOTAL		111670	0	111670	0	0		

	District:	FEROZPUR							
1	FEROZPUR	Alluvial Soil	46950	0	46950	0	0		90
2	GHALL KHURD	Alluvial Soil	53210	0	53210	0	0		90
3	GURU HAR SAHAI	Alluvial Soil	49060	0	49060	25600	9321		90
4	MAKHU	Alluvial Soil	28860	0	28860	0	0		75
5	MAMDOT	Alluvial Soil	37580	0	37580	0	376		80
6	ZIRA	Alluvial Soil	38340	0	38340	0	0		78
	TOTAL		254000	0	254000	25600	9697		
	District:	GURDASPUR							
1	BATALA	Alluvial Soil	27830	0	27830	0	0		67
2	DINA NAGAR	Alluvial Soil	23630	0	23630	0	13233		128
3	FATEHGARH CHURIAN	Alluvial Soil	21330	0	21330	0	0		188
4	GURDASPUR	Alluvial Soil	25130	0	25130	0	9298		117
5	KAHNUWAN	Alluvial Soil	32370	0	32370	0	5503		100
6	KALANAUR	Alluvial Soil	22640	0	22640	0	11320		98
7	QADIAN	Alluvial Soil	18060	0	18060	0	0		82
8	SRI HARGOBINDPUR	Alluvial Soil	28330	0	28330	0	0		99
9	DERA BABA NANAK	Alluvial Soil	29450	0	29450	0	5300		173
10	DHARIWAL	Alluvial Soil	25680	0	25680	0	4879		89
	TOTAL		254450	0	254450	0	49533		
	District:	HOSHIARPUR							
1	HOSHIARPUR-II	Alluvial Soil	46260	7500	38760	0	0		65
2	BHUNGA	Alluvial Soil	54910	12600	42310	0	0		75
3	DASUYA	Alluvial Soil	37450	0	37450	0	0		45
4	GARHSAHNKAR	Alluvial Soil	41210	9975	31235	0	0		100
5	HAZIPUR	Alluvial Soil	12590	0	12590	0	0		77
6	HOSHIARPUR-1	Alluvial Soil	31120	0	31120	0	0		85
7	MAHILPUR	Alluvial Soil	37990	7500	30490	0	0		83
8	MUKERIAN	Alluvial Soil	25600	0	25600	0	11008		89
9	TALWARA	Alluvial Soil	22640	16875	5765	0	0		69
10	TANDA	Alluvial Soil	23370	0	23370	0	0		58
	TOTAL		333140	54450	278690	0	11008		
	District:	JALANDHAR							
1	ADAMPUR	Alluvial Soil	20420	0	20420	0	0		85
2	BHOGPUR	Alluvial Soil	17800	0	17800	0	890		55
3	RURKA KALAN	Alluvial Soil	19180	0	19180	0	0		47
4	JALANDHAR-EAST	Alluvial Soil	25620	0	25620	0	0		75
5	JALANDHAR-WEST	Alluvial Soil	33890	0	33890	0	0		90
6	LOHIAN	Alluvial Soil	28030	0	28030	0	0		85
7	NAKODAR	Alluvial Soil	35330	0	35330	0	0		95
8	NUR MAHAL	Alluvial Soil	31980	0	31980	0	0		89
9	PHILLAUR	Alluvial Soil	27030	0	27030	0	0		47
10	SHAHKOT	Alluvial Soil	24070	0	24070	0	0		77
	TOTAL		263350	0	263350	0	890		
	District:	KAPURTHALA							
1	NADALA	Alluvial Soil	22440	0	22440	0	0		78
2	DHILWAN	Alluvial Soil	25650	0	25650	0	0		80
3	KAPURTHALA	Alluvial Soil	39210	0	39210	0	0		75
4	PHAGWARA	Alluvial Soil	30040	0	30040	0	0		89
5	SULTANPUR LODHI	Alluvial Soil	44470	0	44470	0	0		104
	TOTAL		161810	0	161810	0	0		

	District:	LUDHIANA							
1	DEHLON	Alluvial Soil	28560	0	28560	0	0		120
2	DORAHA	Alluvial Soil	22480	0	22480	0	0		120
3	JAGRAON	Alluvial Soil	34430	0	34430	0	0		90
4	KHANNA	Alluvial Soil	36570	0	36570	0	0		100
5	LUDHIANA	Alluvial Soil	31680	0	31680	0	0		116
6	MACHHIWARA	Alluvial Soil	36570	0	36570	0	9143		94
7	MANGAT	Alluvial Soil	50730	0	50730	0	0		98
8	PAKHOWAL	Alluvial Soil	21083	0	21083	0	0		104
9	RAIKOT	Alluvial Soil	26620	0	26620	0	0		88
10	SAMRALA	Alluvial Soil	15350	0	15350	0	0		94
11	SIDHWAN BET	Alluvial Soil	40170	0	40170	0	0		135
12	SUDHAR	Alluvial Soil	14447	0	14447	0	0		116
	TOTAL		358690	0	358690	0	9143		
	District:	MANSA							
1	BHIKHI	Alluvial Soil	22120	0	22120	18800	0		62
2	BUDHLADA	Alluvial Soil	67540	0	67540	62000	0		65
3	JHUNIR	Alluvial Soil	58330	0	58330	52600	3500		69
4	MANSA	Alluvial Soil	35810	0	35810	7500	0		45
5	SARDULGARH	Alluvial Soil	23290	0	23290	7500	0		58
	TOTAL		207090	0	207090	148400	3500		
	District:	MOGA							
1	BAGHA PURANA	Alluvial Soil	46580	0	46580	43900	0		65
2	DHARAMKOT (KOT ISA KHAN)	Alluvial Soil	54900	0	54900	0	0		80
3	MOGA I	Alluvial Soil	44500	0	44500	0	0		79
4	MOGA II	Alluvial Soil	33460	0	33460	29600	0		79
5	NIHAL SINGH WALA	Alluvial Soil	37780	0	37780	35500	0		80
	TOTAL		217220	0	217220	109000	0		
	District:	MUKTSAR							
1	GIDDERBAHA/ (KOT BHAI)	Alluvial Soil	58360	0	58360	50000	34432		52
2	LAMBI	Alluvial Soil	65200	0	65200	0	49552		41
3	MALOUT	Alluvial Soil	62770	0	62770	31900	62770		65
4	MUKTSAR	Alluvial Soil	79280	0	79280	30800	79280		68
	TOTAL		265610	0	265610	112700	226034		
	District:	NAWAN SHAHR							
1	AUR	Alluvial Soil	21850	0	21850	0	0		77
2	BALACHAUR	Alluvial Soil	37850	0	37850	0	0		89
3	BANGA	Alluvial Soil	23240	0	23240	0	0		82
4	NAWAN SHAHR	Alluvial Soil	33020	0	33020	0	0		59
5	SAROYA	Alluvial Soil	16580	3125	13455	0	0		77
	TOTAL		132540	3125	129415	0	0		
	District:	PATHANKOT							
1	BAMYAL	Alluvial Soil	4780	0	4780	0	0		60
2	DHAR KALAN	Alluvial Soil	39840	24017	15823	0	1992		96
3	PATHANKOT	Alluvial Soil	35150	0	35150	0	10897		82
4	NAROT JAIMAL SINGH	Alluvial Soil	17090	0	17090	0	9058		90
	TOTAL		96860	24017	72843	0	21946		

	District:	PATIALA							
1	BHUNER HERI	Alluvial Soil	38020	0	38020	0	0		53
2	GHANAUR	Alluvial Soil	44320	0	44320	0	0		56
3	NABHA	Alluvial Soil	54820	0	54820	0	0		80
4	PATIALA	Alluvial Soil	42310	0	42310	0	0		86
5	RAJPURA	Alluvial Soil	39940	0	39940	0	0		48
6	SAMANA	Alluvial Soil	39650	0	39650	0	0		90
7	SANAUR	Alluvial Soil	33980	0	33980	0	0		86
8	PATRAN	Alluvial Soil	37230	0	37230	0	0		59
	TOTAL		330270	0	330270	0	0		
	District:	ROPAR							
1	ANANDPUR SAHIB	Alluvial Soil	31140	6700	24440	0	0		73
2	CHAMKAUR SAHIB	Alluvial Soil	15160	0	15160	0	2122		52
3	MORINDA	Alluvial Soil	16950	0	16950	0	0		60
4	NURPUR BEDI	Alluvial Soil	31980	14500	17480	0	0		45
5	ROPAR	Alluvial Soil	41810	5200	36610	0	0		61
	TOTAL		137040	26400	110640	0	2122		
	District:	S.A.S.NAGAR							
1	DERA BASSI	Alluvial Soil	47990	0	47990	0	0		43
2	KHARAR	Alluvial Soil	41620	0	41620	0	0		65
3	SIALBA MAJRI	Alluvial Soil	29290	0	29290	0	0		62
	TOTAL		118900	0	118900	0	0		
	District:	SANGRUR							
1	AHMEDGARH	Alluvial Soil	35050	0	35050	0	0		72
2	ANDANA	Alluvial Soil	41150	0	41150	0	0		65
3	BHIWANIGARH	Alluvial Soil	35170	0	35170	0	0		66
4	DHURI	Alluvial Soil	24810	0	24810	3700	0		61
5	LEHRAGHAGA	Alluvial Soil	46920	0	46920	23000	0		72
6	MALER KOTLA	Alluvial Soil	46440	0	46440	0	0		90
7	SANGRUR	Alluvial Soil	55770	0	55770	7500	0		77
8	SHERPUR	Alluvial Soil	22040	0	22040	4000	0		61
9	SUNAM	Alluvial Soil	66380	0	66380	3700	0		72
	TOTAL		373730	0	373730	41900	0		
	District:	TARN TARAN							
1	BHIKHIWIND	Alluvial Soil	33300	0	33300	0	0		120
2	CHOLA SAHIB	Alluvial Soil	34980	0	34980	0	0		100
3	GANDIWIND	Alluvial Soil	33690	0	33690	0	0		100
4	KHADUR SAHIB	Alluvial Soil	34150	0	34150	0	0		110
5	NAUSHEHRA PANUAN	Alluvial Soil	19920	0	19920	0	0		90
6	PATTI	Alluvial Soil	37550	0	37550	0	0		77
7	TARN TARAN	Alluvial Soil	32000	0	32000	0	0		85
8	VALTOHA	Alluvial Soil	32750	0	32750	0	0		120
	TOTAL		258340	0	258340	0	0		

Annexure III B-1

DATA VARIABLES USED IN DYNAMIC GROUND WATER RESOURCES OF THE PUNJAB STATE , as on 31.3.2017

Sr. No	Assessment Unit	Poor GW Quality	Rainfall (mm)	Average Pre-Monsoon Water Level (mbgl)	Average Post-Monsoon Water Level (mbgl)	Average Fluctuation (m)
1	2	3	4	5	6	7
	District:	**AMRITSAR**				
1	AJNALA	0	583	9.09	9.27	-0.18
2	CHOGAWAN	0	594	11.74	11.91	-0.18
3	HARSHA CHINA	0	596	12.47	12.42	0.05
4	JANDIALA	0	640	17.49	17.53	-0.04
5	MAJITHA	0	673	11.24	10.97	0.27
6	RAYYA	0	731	14.97	15.10	-0.13
7	TARSIKA	0	732	14.04	14.16	-0.13
8	VERKA	0	619	19.27	19.22	0.05
	District:	**BARNALA**				
1	BARNALA	30600	433	28.72	29.53	-0.82
2	MAHAL KALAN	0	494	28.08	30.07	-1.99
3	SEHNA	12500	419	22.87	24.35	-1.49
	District:	**BATHINDA**				
1	PHUL	33000	352	21.11	22.90	-1.78
2	NATHANA	11600	356	16.86	18.13	-1.27
3	MAUR	33000	390	10.54	11.11	-0.57
4	BATHINDA	46700	372	8.82	9.09	-0.27
5	TALWANDI SABOO	31600	390	6.97	7.02	-0.05
6	SANGAT	60600	385	6.43	6.52	-0.09
7	RAMPURA	24700	377	20.44	22.04	-1.61
	District:	**FARIDKOT**				
1	FARIDKOT	38500	411	5.86	5.71	0.15
2	KOT KAPURA	5000	382	9.95	10.01	-0.06
	District:	**FAZILKA**				
1	ABOHAR	10200	322	4.01	3.90	0.12
2	FAZILKA	5200	315	5.27	5.29	-0.02
3	JALALABAD	5000	323	9.03	9.77	-0.74
4	KHUYIAN SARWAR	17300	292	3.29	3.11	0.18
	District:	**FATEHGARH SAHIB**				
1	KHERA	0	707	18.24	17.62	0.62
2	SIRHIND	0	639	20.02	20.62	-0.60
3	AMLOH	0	647	21.47	22.00	-0.53
4	BASSI PATHANA	0	733	21.43	22.11	-0.68
5	KHAMANON	0	732	17.24	17.84	-0.60

	District:	**FEROZEPUR**				
1	FEROZPUR	0	336	9.22	9.42	-0.20
2	GHALL KHURD	0	412	10.95	11.10	-0.15
3	GURU HAR SAHAI	25600	370	8.47	7.78	0.69
4	MAKHU	0	429	11.23	13.97	-2.74
5	MAMDOT	0	385	8.49	8.51	-0.03
6	ZIRA	0	424	23.24	24.35	-1.11
	District:	**GURDASPUR**				
1	BATALA	0	745	7.81	7.67	0.14
2	DINA NAGAR	0	941	5.06	4.65	0.42
3	FATEHGARH CHURIAN	0	677	6.54	6.50	0.03
4	GURDASPUR	0	912	6.04	5.62	0.42
5	KAHNUWAN	0	863	8.86	8.39	0.47
6	KALANAUR	0	785	6.47	6.24	0.23
7	QADIAN	0	850	10.57	9.53	1.04
8	SRI HARGOBINDPUR	0	777	12.62	12.44	0.18
9	DERA BABA NANAK	0	688	7.03	6.90	0.13
10	DHARIWAL	0	798	8.56	8.39	0.17
	District:	**HOSHIARPUR**				
1	HOSHIARPUR-II	0	872	12.62	12.59	0.03
2	BHUNGA	0	916	12.55	12.91	-0.38
3	DASUYA	0	880	13.78	12.82	0.96
4	GARHSAHNKAR	0	772	19.78	19.81	-0.04
5	HAZIPUR	0	987	15.54	14.27	1.27
6	HOSHIARPUR-1	0	887	21.89	21.91	-0.02
7	MAHILPUR	0	776	23.20	23.41	-0.21
8	MUKERIAN	0	975	3.62	3.16	0.46
9	TALWARA	0	972	11.62	11.39	0.23
10	TANDA	0	833	11.22	11.05	0.18
	District:	**JALANDHAR**				
1	ADAMPUR	0	769	8.22	7.48	0.74
2	BHOGPUR	0	805	16.88	18.04	-1.16
3	RURKA KALAN	0	634	17.52	17.55	-0.02
4	JALANDHAR-EAST	0	679	30.10	30.78	-0.68
5	JALANDHAR-WEST	0	727	15.08	13.89	1.18
6	LOHIAN	0	550	19.92	20.69	-0.77
7	NAKODAR	0	609	27.40	27.92	-0.52
8	NUR MAHAL	0	616	21.92	23.69	-1.78
9	PHILLAUR	0	618	17.63	18.21	-0.58
10	SHAHKOT	0	564	24.06	25.29	-1.23

	District:	**KAPURTHALA**				
1	NADALA	0	764	8.06	8.08	-0.02
2	DHILWAN	0	687	8.04	8.13	-0.09
3	KAPURTHALA	0	672	18.64	19.24	-0.60
4	PHAGWARA	0	704	23.46	25.49	-2.03
5	SULTANPUR LODHI	0	543	13.11	13.23	-0.12
	District:	**LUDHIANA**				
1	DEHLON	0	653	18.76	19.51	-0.75
2	DORAHA	0	670	13.99	14.10	-0.11
3	JAGRAON	0	532	23.12	25.22	-2.10
4	KHANNA	0	636	19.97	20.30	-0.33
5	LUDHIANA	0	651	22.21	22.34	-0.14
6	MACHHIWARA	0	735	6.75	6.71	0.04
7	MANGAT	0	626	8.93	8.98	-0.05
8	PAKHOWAL	0	598	19.66	20.00	-0.34
9	RAIKOT	0	550	24.93	26.37	-1.44
10	SAMRALA	0	702	14.88	15.76	-0.88
11	SIDHWAN BET	0	575	15.08	15.27	-0.19
12	SUDHAR	0	541	20.22	21.22	-0.99
	District:	**MANSA**				
1	BHIKHI	18800	391	16.80	17.97	-1.17
2	BUDHLADA	62000	414	14.11	14.78	-0.67
3	JHUNIR	52600	377	7.08	7.18	-0.10
4	MANSA	7500	408	8.44	8.74	-0.30
5	SARDULGARH	7500	396	13.48	13.71	-0.24
	District:	**MOGA**				
1	BAGHA PURANA	43900	406	18.74	19.90	-1.16
2	DHARAMKOT (KOT ISA KHAN)	0	527	18.15	18.87	-0.72
3	MOGA I	0	466	26.48	28.13	-1.64
4	MOGA II	29600	469	27.52	28.88	-1.35
5	NIHAL SINGH WALA	35500	426	26.17	27.73	-1.56
	District:	**MUKTSAR**				
1	GIDDERBAHA/ (KOT BHAI)	50000	364	4.04	3.91	0.13
2	LAMBI	0	341	2.97	2.78	0.19
3	MALOUT	31900	342	2.20	1.85	0.35
4	MUKTSAR	30800	361	2.26	1.78	0.49
	District:	**NAWANSHAHAR**				
1	AUR	0	673	15.28	16.07	-0.79
2	BALACHAUR	0	839	16.32	16.24	0.08
3	BANGA	0	681	17.86	18.91	-1.05
4	NAWAN SHAHR	0	793	14.08	14.09	-0.02
5	SAROYA	0	839	29.11	30.19	-1.09

	District:	**PATHANKOT**				
1	BAMYAL	0	1152	4.25	3.80	0.45
2	DHAR KALAN	0	1269	9.51	8.56	0.95
3	PATHANKOT	0	1117	6.99	6.22	0.76
4	NAROT JAIMAL SINGH	0	1099	4.41	4.07	0.34
	District:	**PATIALA**				
1	BHUNER HERI	0	633	30.74	31.69	-0.95
2	GHANAUR	0	720	17.62	18.51	-0.89
3	NABHA	0	592	24.25	24.46	-0.21
4	PATIALA	0	620	24.50	25.61	-1.10
5	RAJPURA	0	716	24.58	25.03	-0.45
6	SAMANA	0	530	30.04	30.96	-0.93
7	SANAUR	0	594	24.40	24.59	-0.20
8	PATRAN	0	486	35.83	36.12	-0.30
	District:	**ROPAR**				
1	ANANDPUR SAHIB	0	890	8.58	7.75	0.82
2	CHAMKAUR SAHIB	0	772	7.16	7.29	-0.13
3	MORINDA	0	772	15.16	14.67	0.49
4	NURPUR BEDI	0	877	8.89	8.39	0.50
5	ROPAR	0	814	8.42	8.01	0.41
	District:	**MOHALI**				
	DERA BASSI	0	764	15.07	15.26	-0.19
	KHARAR	0	760	12.46	12.75	-0.29
	SIALBA MAJRI	0	796	18.03	17.84	0.19
	District:	**SANGRUR**				
1	AHMEDGARH	0	552	30.35	31.13	-0.77
2	ANDANA	0	463	27.05	27.63	-0.58
3	BHIWANIGARH	0	525	30.42	31.08	-0.65
4	DHURI	3700	499	28.99	29.54	-0.55
5	LEHRAGHAGA	23000	467	23.81	24.01	-0.20
6	MALER KOTLA	0	583	25.39	26.01	-0.62
7	SANGRUR	7500	496	28.98	29.62	-0.64
8	SHERPUR	4000	484	35.01	35.49	-0.48
9	SUNAM	3700	486	27.12	27.58	-0.46
	District:	**TARN TARAN**				
1	BHIKHIWIND	0	490	13.54	13.41	0.13
2	CHOLA SAHIB	0	511	18.44	18.43	0.02
3	GANDIWIND	0	602	14.30	13.97	0.33
4	KHADUR SAHIB	0	609	18.75	18.60	0.16
5	NAUSHEHRA PANUAN	0	521	18.89	18.72	0.17
6	PATTI	0	434	18.07	17.98	0.10
7	TARN TARAN	0	540	18.86	18.69	0.17
8	VALTOHA	0	397	10.10	10.06	0.04

Annexure III B-1(Cont.)

DATA VARIABLES USED IN DYNAMIC GROUND WATER RESOURCES OF THE THE PUNJAB STATE , as on 31.3.2017

S. N.	Assessment Unit	Assessment Sub-Unit	Type of Structures	Irrigation	Domestic	Industrial
	DISTRICT : AMRITSAR					
	AJNALA	Command/Non-Command	STW (ELECTRIC & DIESEL)	15729		
			DEEP (ELECTRIC & DIESEL)	180		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
	CHOGAWAN	Command/Non-Command	STW (ELECTRIC & DIESEL)	10718		
			DEEP (ELECTRIC & DIESEL)	861		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
	HARSHA CHINNA	Command/Non-Command	STW (ELECTRIC & DIESEL)	7287		
			DEEP (ELECTRIC & DIESEL)	23		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
	JANDIALA	Command/Non-Command	STW (ELECTRIC & DIESEL)	8382		
			DEEP (ELECTRIC & DIESEL)	87		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
	MAJITHA	Command/Non-Command	STW (ELECTRIC & DIESEL)	11092		
			DEEP (ELECTRIC & DIESEL)	12		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
	BABA BAKALA	Command/Non-Command	STW (ELECTRIC & DIESEL)	10540		
			DEEP (ELECTRIC & DIESEL)	2		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
	TARSIKA	Command/Non-Command	STW (ELECTRIC & DIESEL)	9347		
			DEEP (ELECTRIC & DIESEL)	3		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
	VERKA	Command/Non-Command	STW (ELECTRIC & DIESEL)	7105		
			DEEP (ELECTRIC & DIESEL)	121		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
	DISTRICT : BARNALA					
	BARNALA	Command/Non-Command	STW (ELECTRIC & DIESEL)	555		
			DEEP (ELECTRIC & DIESEL)	15164		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
	SEHNA	Command/Non-Command	STW (ELECTRIC & DIESEL)	7500		
			DEEP (ELECTRIC & DIESEL)	4382		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
	MEHAL KALAN	Command/Non-Command	STW (ELECTRIC & DIESEL)	16		
			DEEP (ELECTRIC & DIESEL)	7052		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			

	DISTRICT : BATHINDA					
	BATHINDA	Command/Non-Command	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)	9769		
			DEEP (ELECTRIC & DIESEL)	19		
	MAUR	Command/Non-Command	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)	4780		
			DEEP (ELECTRIC & DIESEL)	3		
	NATHANA	Command/Non-Command	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)	4239		
			DEEP (ELECTRIC & DIESEL)	972		
	PHUL	Command/Non-Command	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)	10206		
			DEEP (ELECTRIC & DIESEL)	1953		
	RAMPURA	Command/Non-Command	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)	3027		
			DEEP (ELECTRIC & DIESEL)	2608		
	SANGAT	Command/Non-Command	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)	3287		
			DEEP (ELECTRIC & DIESEL)	7		
	TALWANDI SABOO	Command/Non-Command	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)	6184		
			DEEP (ELECTRIC & DIESEL)	27		
	DISTRICT : FARIDKOT					
	FARIDKOT	Command/Non-Command	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)	19906		
			DEEP (ELECTRIC & DIESEL)	1160		
	KOT KAPURA	Command/Non-Command	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)	15414		
			DEEP (ELECTRIC & DIESEL)	1335		
	DISTRICT : FAZILKA					
	ABOHAR	Command/Non-Command	STW (ELECTRIC & DIESEL)	4763		
			DEEP (ELECTRIC & DIESEL)			
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
	FAZILKA	Command/Non-Command	STW (ELECTRIC & DIESEL)	13846		
			DEEP (ELECTRIC & DIESEL)	16		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
	JALALABAD	Command/Non-Command	STW (ELECTRIC & DIESEL)	10296		
			DEEP (ELECTRIC & DIESEL)			
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
	KHUYAN SARWAR	Command/Non-Command	STW (ELECTRIC & DIESEL)	3349		
			DEEP (ELECTRIC & DIESEL)			
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			

	DISTRICT : FATEHGARH SAHIB					
	AMLOH	Command/Non-Command	STW (ELECTRIC & DIESEL)	7402		
			DEEP (ELECTRIC & DIESEL)	2		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
	BASSI PATHANA	Command/Non-Command	STW (ELECTRIC & DIESEL)	5568		
			DEEP (ELECTRIC & DIESEL)	196		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
	KHAMANO	Command/Non-Command	STW (ELECTRIC & DIESEL)	6787		
			DEEP (ELECTRIC & DIESEL)			
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
	KHERA	Command/Non-Command	STW (ELECTRIC & DIESEL)	6002		
			DEEP (ELECTRIC & DIESEL)	212		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
	SIRHIND	Command/Non-Command	STW (ELECTRIC & DIESEL)	9828		
			DEEP (ELECTRIC & DIESEL)	24		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
	DISTRICT : FEROZEPUR					
	FEROZEPUR	Command/Non-Command	STW (ELECTRIC & DIESEL)	10034		
			DEEP (ELECTRIC & DIESEL)	7		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
	GHAL KHURAD	Command/Non-Command	STW (ELECTRIC & DIESEL)	13963		
			DEEP (ELECTRIC & DIESEL)	1947		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
	GURU HAR SAHAI	Command/Non-Command	STW (ELECTRIC & DIESEL)	9733		
			DEEP (ELECTRIC & DIESEL)	160		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
	MAKHU	Command/Non-Command	STW (ELECTRIC & DIESEL)	6966		
			DEEP (ELECTRIC & DIESEL)	7		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
	MAMDOT	Command/Non-Command	STW (ELECTRIC & DIESEL)	10148		
			DEEP (ELECTRIC & DIESEL)			
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
	ZIRA	Command/Non-Command	STW (ELECTRIC & DIESEL)	81		
			DEEP (ELECTRIC & DIESEL)	11591		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			

	DISTRICT : GURDASPUR					
	BATALA	Command/Non-Command	STW (ELECTRIC & DIESEL)	9942		
			DEEP (ELECTRIC & DIESEL)	1		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
	DERA BABA NANAK	Command/Non-Command	STW (ELECTRIC & DIESEL)	9640		
			DEEP (ELECTRIC & DIESEL)	11		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
	DHARIWAL	Command/Non-Command	STW (ELECTRIC & DIESEL)	8097		
			DEEP (ELECTRIC & DIESEL)	56		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
	DINANAGAR	Command/Non-Command	STW (ELECTRIC & DIESEL)	4773		
			DEEP (ELECTRIC & DIESEL)	1		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
	FATEHGARH CHURIAN	Command/Non-Command	STW (ELECTRIC & DIESEL)	8655		
			DEEP (ELECTRIC & DIESEL)	962		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
	GURDASPUR	Command/Non-Command	STW (ELECTRIC & DIESEL)	7837		
			DEEP (ELECTRIC & DIESEL)	2		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
	KAHNUWAN	Command/Non-Command	STW (ELECTRIC & DIESEL)	9625		
			DEEP (ELECTRIC & DIESEL)	2		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
	KALANOUR	Command/Non-Command	STW (ELECTRIC & DIESEL)	6195		
			DEEP (ELECTRIC & DIESEL)	1		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
	QUADIAN	Command/Non-Command	STW (ELECTRIC & DIESEL)	5314		
			DEEP (ELECTRIC & DIESEL)	29		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
	SHRI HARGOBIND PUR	Command/Non-Command	STW (ELECTRIC & DIESEL)	5763		
			DEEP (ELECTRIC & DIESEL)	383		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			

	DISTRICT : HOSHIARPUR					
	BHUNGA	Command/Non-Command	STW (ELECTRIC & DIESEL)	3823		
			DEEP (ELECTRIC & DIESEL)	2982		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
	GARH SHANKAR	Command/Non-Command	STW (ELECTRIC & DIESEL)	1917		
			DEEP (ELECTRIC & DIESEL)	4852		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
	HAZIPUR	Command/Non-Command	STW (ELECTRIC & DIESEL)	3216		
			DEEP (ELECTRIC & DIESEL)	108		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
	HOSHIARPUR-I	Command/Non-Command	STW (ELECTRIC & DIESEL)	1639		
			DEEP (ELECTRIC & DIESEL)	3564		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
	HOSHIARPUR 2	Command/Non-Command	STW (ELECTRIC & DIESEL)	616		
			DEEP (ELECTRIC & DIESEL)	4743		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
	MAHILPUR	Command/Non-Command	STW (ELECTRIC & DIESEL)	1550		
			DEEP (ELECTRIC & DIESEL)	3781		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
	MUKERIAN	Command/Non-Command	STW (ELECTRIC & DIESEL)	7611		
			DEEP (ELECTRIC & DIESEL)	2		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
	TALWARA	Command/Non-Command	STW (ELECTRIC & DIESEL)	737		
			DEEP (ELECTRIC & DIESEL)	23		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
	TANDA	Command/Non-Command	STW (ELECTRIC & DIESEL)	10119		
			DEEP (ELECTRIC & DIESEL)	735		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			

	DISTRICT : JALANDHAR					
	ADAMPUR	Command/Non-Command	STW (ELECTRIC & DIESEL)	1023		
			DEEP (ELECTRIC & DIESEL)	5139		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
	BHOGPUR	Command/Non-Command	STW (ELECTRIC & DIESEL)	1359		
			DEEP (ELECTRIC & DIESEL)	6689		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
	JALANDHAR EAST	Command/Non-Command	STW (ELECTRIC & DIESEL)	6238		
			DEEP (ELECTRIC & DIESEL)	72		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
	JALANDHAR WEST	Command/Non-Command	STW (ELECTRIC & DIESEL)	7358		
			DEEP (ELECTRIC & DIESEL)	2310		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
	LOHIAN	Command/Non-Command	STW (ELECTRIC & DIESEL)	3613		
			DEEP (ELECTRIC & DIESEL)	3313		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
	NAKODER	Command/Non-Command	STW (ELECTRIC & DIESEL)	9666		
			DEEP (ELECTRIC & DIESEL)	4230		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
	NURMEHAL	Command/Non-Command	STW (ELECTRIC & DIESEL)	7347		
			DEEP (ELECTRIC & DIESEL)	13		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
	PHILLOR	Command/Non-Command	STW (ELECTRIC & DIESEL)	6597		
			DEEP (ELECTRIC & DIESEL)	1292		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
	RURKA KALAN	Command/Non-Command	STW (ELECTRIC & DIESEL)	771		
			DEEP (ELECTRIC & DIESEL)	4615		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
	SHAHKOT	Command/Non-Command	STW (ELECTRIC & DIESEL)	4337		
			DEEP (ELECTRIC & DIESEL)	2846		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
	DISTRICT : KAPURTHALA					
	DHILLWAN	Command/Non-Command	STW (ELECTRIC & DIESEL)	9307		
			DEEP (ELECTRIC & DIESEL)	1399		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
	KAPURTHALA	Command/Non-Command	STW (ELECTRIC & DIESEL)	10021		
			DEEP (ELECTRIC & DIESEL)	124		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
	NADALA	Command/Non-Command	STW (ELECTRIC & DIESEL)	11048		
			DEEP (ELECTRIC & DIESEL)	10		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
	PHAGWARA	Command/Non-Command	STW (ELECTRIC & DIESEL)	8216		
			DEEP (ELECTRIC & DIESEL)	572		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
	SULTANPUR	Command/Non-Command	STW (ELECTRIC & DIESEL)	13330		
			DEEP (ELECTRIC & DIESEL)	496		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			

	DISTRICT : LUDHIANA					
	DEHLON	Command/Non-Command	STW (ELECTRIC & DIESEL)	11059		
			DEEP (ELECTRIC & DIESEL)	1354		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
	DORAHA	Command/Non-Command	STW (ELECTRIC & DIESEL)	10279		
			DEEP (ELECTRIC & DIESEL)	428		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
	JAGRAON	Command/Non-Command	STW (ELECTRIC & DIESEL)	3842		
			DEEP (ELECTRIC & DIESEL)	6950		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
	KHANNA	Command/Non-Command	STW (ELECTRIC & DIESEL)	9789		
			DEEP (ELECTRIC & DIESEL)	1		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
	LUDHIANA	Command/Non-Command	STW (ELECTRIC & DIESEL)	5631		
			DEEP (ELECTRIC & DIESEL)	2160		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
	MACHHIWARA	Command/Non-Command	STW (ELECTRIC & DIESEL)	11314		
			DEEP (ELECTRIC & DIESEL)	13		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
	MANGAT	Command/Non-Command	STW (ELECTRIC & DIESEL)	13311		
			DEEP (ELECTRIC & DIESEL)	59		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
	PAKHOWAL	Command/Non-Command	STW (ELECTRIC & DIESEL)	1566		
			DEEP (ELECTRIC & DIESEL)	7098		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
	RAIKOT	Command/Non-Command	STW (ELECTRIC & DIESEL)	2650		
			DEEP (ELECTRIC & DIESEL)	6901		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
	SAMRALA	Command/Non-Command	STW (ELECTRIC & DIESEL)	6578		
			DEEP (ELECTRIC & DIESEL)	0		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
	SIDHWAN BET	Command/Non-Command	STW (ELECTRIC & DIESEL)	14265		
			DEEP (ELECTRIC & DIESEL)	11		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
	SUDHAR	Command/Non-Command	STW (ELECTRIC & DIESEL)	1518		
			DEEP (ELECTRIC & DIESEL)	3533		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			

	DISTRICT : MANSA					
	BHIKHI	Command/Non-Command	STW (ELECTRIC & DIESEL)	7206		
			DEEP (ELECTRIC & DIESEL)	1389		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
	BUDHLADA	Command/Non-Command	STW (ELECTRIC & DIESEL)	12786		
			DEEP (ELECTRIC & DIESEL)	2202		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
	JHUNIR	Command/Non-Command	STW (ELECTRIC & DIESEL)	5805		
			DEEP (ELECTRIC & DIESEL)	0		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
	MANSA	Command/Non-Command	STW (ELECTRIC & DIESEL)	9592		
			DEEP (ELECTRIC & DIESEL)	10		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
	SARDOOLGARH	Command/Non-Command	STW (ELECTRIC & DIESEL)	4922		
			DEEP (ELECTRIC & DIESEL)	1024		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
	DISTRICT : MOGA					
	BAGHA PURANA	Command/Non-Command	STW (ELECTRIC & DIESEL)	13028		
			DEEP (ELECTRIC & DIESEL)	3598		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
	KOT ISE KHAN (DHARAMKOT)	Command/Non-Command	STW (ELECTRIC & DIESEL)	6408		
			DEEP (ELECTRIC & DIESEL)	8904		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
	MOGA-1	Command/Non-Command	STW (ELECTRIC & DIESEL)	1629		
			DEEP (ELECTRIC & DIESEL)	10537		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
	MOGA II	Command/Non-Command	STW (ELECTRIC & DIESEL)	913		
			DEEP (ELECTRIC & DIESEL)	8230		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
	NIHAL SINGH WALA	Command/Non-Command	STW (ELECTRIC & DIESEL)	523		
			DEEP (ELECTRIC & DIESEL)	10885		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
	DISTRICT : MUKATSAR					
	GIDARBAHA	Command/Non-Command	STW (ELECTRIC & DIESEL)	9222		
			DEEP (ELECTRIC & DIESEL)	67		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
	LAMBI	Command/Non-Command	STW (ELECTRIC & DIESEL)	4517		
			DEEP (ELECTRIC & DIESEL)	144		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
	MALOUT	Command/Non-Command	STW (ELECTRIC & DIESEL)	5729		
			DEEP (ELECTRIC & DIESEL)	3		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
	MUKATSAR	Command/Non-Command	STW (ELECTRIC & DIESEL)	9631		
			DEEP (ELECTRIC & DIESEL)	7		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			

	DISTRICT : NAWAN SHAHAR					
	AUR	Command/Non-Command	STW (ELECTRIC & DIESEL)	5040		
			DEEP (ELECTRIC & DIESEL)	1781		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
	BALACHOR	Command/Non-Command	STW (ELECTRIC & DIESEL)	3921		
			DEEP (ELECTRIC & DIESEL)	1415		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
	BANGA	Command/Non-Command	STW (ELECTRIC & DIESEL)	2916		
			DEEP (ELECTRIC & DIESEL)	3633		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
	NAWAN SHAHR	Command/Non-Command	STW (ELECTRIC & DIESEL)	5263		
			DEEP (ELECTRIC & DIESEL)	1356		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
	SAROYA	Command/Non-Command	STW (ELECTRIC & DIESEL)	11		
			DEEP (ELECTRIC & DIESEL)	1129		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
	DISTRICT :PATHANKOT					
	BAMIAL	Command/Non-Command	STW (ELECTRIC & DIESEL)	707		
			DEEP (ELECTRIC & DIESEL)	25		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
	DHAR KALAN	Command/Non-Command	STW (ELECTRIC & DIESEL)	240		
			DEEP (ELECTRIC & DIESEL)	166		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
	NAROT JAIMAL SINGH	Command/Non-Command	STW (ELECTRIC & DIESEL)	2732		
			DEEP (ELECTRIC & DIESEL)	0		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
	PATHANKOT	Command/Non-Command	STW (ELECTRIC & DIESEL)	3547		
			DEEP (ELECTRIC & DIESEL)	882		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			

	DISTRICT : PATIALA					
	BHUNAR HERI	Command/Non-Command	STW (ELECTRIC & DIESEL)	9967		
			DEEP (ELECTRIC & DIESEL)	180		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
	GHANOUR	Command/Non-Command	STW (ELECTRIC & DIESEL)	6171		
			DEEP (ELECTRIC & DIESEL)	1110		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
	NABHA	Command/Non-Command	STW (ELECTRIC & DIESEL)	17814		
			DEEP (ELECTRIC & DIESEL)	10		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
	PATIALA	Command/Non-Command	STW (ELECTRIC & DIESEL)	9870		
			DEEP (ELECTRIC & DIESEL)	249		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
	PATRAN	Command/Non-Command	STW (ELECTRIC & DIESEL)	11141		
			DEEP (ELECTRIC & DIESEL)	470		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
	RAJPURA	Command/Non-Command	STW (ELECTRIC & DIESEL)	4677		
			DEEP (ELECTRIC & DIESEL)	3181		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
	SAMANA	Command/Non-Command	STW (ELECTRIC & DIESEL)	6565		
			DEEP (ELECTRIC & DIESEL)	69		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
	SANAUR	Command/Non-Command	STW (ELECTRIC & DIESEL)	5216		
			DEEP (ELECTRIC & DIESEL)	42		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
	DISTRICT : ROPAR					
	ANANDPUR SAHIB	Command/Non-Command	STW (ELECTRIC & DIESEL)	6518		
			DEEP (ELECTRIC & DIESEL)	26		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
	CHAMKAUR SAHIB	Command/Non-Command	STW (ELECTRIC & DIESEL)	5267		
			DEEP (ELECTRIC & DIESEL)	395		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
	MORINDA	Command/Non-Command	STW (ELECTRIC & DIESEL)	3367		
			DEEP (ELECTRIC & DIESEL)	87		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
	NURPUR BEDI	Command/Non-Command	STW (ELECTRIC & DIESEL)	4999		
			DEEP (ELECTRIC & DIESEL)	23		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
	ROPAR	Command/Non-Command	STW (ELECTRIC & DIESEL)	4533		
			DEEP (ELECTRIC & DIESEL)	113		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			

	DISTRICT : SANGRUR					
	AHMEDGARH	Command/Non-Command	STW (ELECTRIC & DIESEL)	470		
			DEEP (ELECTRIC & DIESEL)	11517		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
	ANDANA	Command/Non-Command	STW (ELECTRIC & DIESEL)	31		
			DEEP (ELECTRIC & DIESEL)	7458		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
	BHIWANIGARH	Command/Non-Command	STW (ELECTRIC & DIESEL)	282		
			DEEP (ELECTRIC & DIESEL)	11360		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
	DHURI	Command/Non-Command	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)	165		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)	8658		
			DEEP (ELECTRIC & DIESEL)			
	LEHRAGAGA	Command/Non-Command	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)	1475		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)	7359		
			DEEP (ELECTRIC & DIESEL)			
	MALERKOTLA	Command/Non-Command	STW (ELECTRIC & DIESEL)	589		
			DEEP (ELECTRIC & DIESEL)	13828		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
	SANGRUR	Command/Non-Command	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)	41		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)	12200		
			DEEP (ELECTRIC & DIESEL)			
	SHERPUR	Command/Non-Command	STW (ELECTRIC & DIESEL)	133		
			DEEP (ELECTRIC & DIESEL)	8570		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
	SUNAM	Command/Non-Command	STW (ELECTRIC & DIESEL)	1010		
			DEEP (ELECTRIC & DIESEL)	21080		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
	DISTRICT : S A S NAGAR					
	DERABASSI	Command/Non-Command	STW (ELECTRIC & DIESEL)	3372		
			DEEP (ELECTRIC & DIESEL)	1310		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
	KHARAR	Command/Non-Command	STW (ELECTRIC & DIESEL)	4217		
			DEEP (ELECTRIC & DIESEL)	37		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
	SIALBA MAJRI	Command/Non-Command	STW (ELECTRIC & DIESEL)	1521		
			DEEP (ELECTRIC & DIESEL)	1256		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			

	DISTRICT : TARN TARAN					
	BHIKHIWIND	Command/Non-Command	STW (ELECTRIC & DIESEL)	4846		
			DEEP (ELECTRIC & DIESEL)	2752		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
	CHOHLA SAHIB	Command/Non-Command	STW (ELECTRIC & DIESEL)	6529		
			DEEP (ELECTRIC & DIESEL)	4		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
	GANDIWIND	Command/Non-Command	STW (ELECTRIC & DIESEL)	1339		
			DEEP (ELECTRIC & DIESEL)	3821		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
	KHADOOR SAHIB	Command/Non-Command	STW (ELECTRIC & DIESEL)	8779		
			DEEP (ELECTRIC & DIESEL)	246		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
	NOUSHERA PANUAN	Command/Non-Command	STW (ELECTRIC & DIESEL)	5219		
			DEEP (ELECTRIC & DIESEL)	415		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
	PATTI	Command/Non-Command	STW (ELECTRIC & DIESEL)	8395		
			DEEP (ELECTRIC & DIESEL)	423		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
	TARN TARAN	Command/Non-Command	STW (ELECTRIC & DIESEL)	9609		
			DEEP (ELECTRIC & DIESEL)	25		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			
	VALTOHA	Command/Non-Command	STW (ELECTRIC & DIESEL)	3936		
			DEEP (ELECTRIC & DIESEL)	3637		
		Poor Ground Water Quality	STW (ELECTRIC & DIESEL)			
			DEEP (ELECTRIC & DIESEL)			

Annexure III C

PARAMETERS USED IN THE ASSESSMENT OF DYNAMIC GROUND WATER RESOURCES OF THE PUNJAB STATE , as on 31.3.2017

S. N.	Assessment unit	Sub-unit (Command/non-Command/poor quality)	Specific Yield (in Percentage	Rainfall Infiltration Factor (in Percentage)		Season-wise Unit draft (ham)						
							Irrigation		Domestic		Industrial	
			Formation Value	Formation Value	Structure	No.	Monsoon	Non-Monsoon	Monsoon	Non-Monsoon	Monsoon	Non-Monsoon
	District:	**AMRITSAR**										
1	AJNALA		12	22	Electric	10240	1.950	0.670	0	0	0	0
					Diesel	5565	1.260	0.520	0	0	0	0
2	CHOGAWAN		12	22	Electric	11501	2.060	0.890	0	0	0	0
					Diesel	2	1.260	0.520	0	0	0	0
3	HARSHA CHINA		12	22	Electric	7238	2.060	0.890	0	0	0	0
					Diesel	24	1.260	0.520	0	0	0	0
4	JANDIALA		12	22	Electric	8406	2.060	0.890	0	0	0	0
					Diesel	7	1.260	0.520	0	0	0	0
5	MAJITHA		12	22	Electric	10902	1.950	0.670	0	0	0	0
					Diesel	129	1.260	0.520	0	0	0	0
6	RAYYA		12	22	Electric	10465	1.950	0.670	0	0	0	0
					Diesel	8	1.260	0.520	0	0	0	0
7	TARSIKA		12	22	Electric	9261	1.950	0.670	0	0	0	0
					Diesel	28	1.260	0.520	0	0	0	0
8	VERKA		12	22	Electric	7176	2.060	0.890	0	0	0	0
					Diesel	2	1.260	0.520	0	0	0	0
	District:	**BARNALA**										
1	BARNALA		12	22	Electric	14717	2.870	0.940	0	0	0	0
					Diesel	898	0.450	0.390	0	0	0	0
2	MAHAL KALAN		12	22	Electric	7009	2.160	0.800	0	0	0	0
					Diesel	13	1.050	0.460	0	0	0	0
3	SEHNA		12	22	Electric	10857	2.870	0.940	0	0	0	0
					Diesel	947	0.450	0.390	0	0	0	0
	District:	**BATHINDA**										
1	PHUL		12	22	Electric	6659	2.130	0.820	0	0	0	0
					Diesel	5420	1.510	0.750	0	0	0	0
2	NATHANA		12	22	Electric	5068	2.130	0.820	0	0	0	0
					Diesel	109	1.510	0.750	0	0	0	0
3	MAUR		12	22	Electric	4711	2.370	1.280	0	0	0	0
					Diesel	41	1.540	0.870	0	0	0	0
4	BATHINDA		12	22	Electric	8483	2.220	1.540	0	0	0	0
					Diesel	1241	1.410	0.870	0	0	0	0
5	TALWANDI SABOO		12	22	Electric	739	1.360	1.000	0	0	0	0
					Diesel	5431	0.630	0.580	0	0	0	0
6	SANGAT		12	22	Electric	691	2.220	1.540	0	0	0	0
					Diesel	2581	1.410	0.870	0	0	0	0
7	RAMPURA		12	22	Electric	5207	2.130	0.820	0	0	0	0
					Diesel	391	1.500	0.750	0	0	0	0
	District:	**FARIDKOT**										
1	FARIDKOT		12	22	Electric	19570	2.010	0.650	0	0	0	0
					Diesel	1357	0.840	0.390	0	0	0	0
2	KOT KAPURA		12	22	Electric	15553	2.010	0.650	0	0	0	0
	District:	**FAZILKA**			Diesel	1086	0.840	0.390	0	0	0	0
1	ABOHAR		12	22	Electric	469	1.910	1.670	0	0	0	0
					Diesel	4263	1.110	0.840	0	0	0	0
2	FAZILKA		12	22	Electric	9602	2.310	0.850	0	0	0	0
					Diesel	4169	1.110	0.840	0	0	0	0
3	JALALABAD		12	22	Electric	9064	2.310	0.850	0	0	0	0
					Diesel	1164	1.110	0.840	0	0	0	0
4	KHUYIAN SARWAR		12	22	Electric	744	1.910	1.670	0	0	0	0
					Diesel	2583	1.110	0.840	0	0	0	0

	District:	**FATEHGARH SAHIB**										
1	KHERA		12	22	Electric	5664	2.430	0.890	0	0	0	0
					Diesel	540	1.010	0.440	0	0	0	0
2	SIRHIND		12	22	Electric	8999	2.430	0.890	0	0	0	0
					Diesel	788	1.010	0.440	0	0	0	0
3	AMLOH		12	22	Electric	7336	2.430	0.890	0	0	0	0
					Diesel	19	1.010	0.440	0	0	0	0
4	BASSI PATHANA		12	22	Electric	5228	2.430	0.890	0	0	0	0
					Diesel	498	1.010	0.440	0	0	0	0
5	KHAMANON		12	22	Electric	6638	2.120	0.720	0	0	0	0
					Diesel	104	1.110	0.490	0	0	0	0
	District:	**FEROZEPUR**										
1	FEROZPUR		12	22	Electric	9951	2.260	0.980	0	0	0	0
					Diesel	24	1.740	0.840	0	0	0	0
2	GHALL KHURD		12	22	Electric	15770	2.260	0.980	0	0	0	0
					Diesel	35	1.740	0.840	0	0	0	0
3	GURU HAR SAHAI		12	22	Electric	9412	2.010	0.650	0	0	0	0
					Diesel	416	0.840	0.390	0	0	0	0
4	MAKHU		12	22	Electric	5786	2.260	0.980	0	0	0	0
					Diesel	1141	1.740	0.840	0	0	0	0
5	MAMDOT		12	22	Electric	9431	2.610	0.540	0	0	0	0
					Diesel	650	1.740	0.840	0	0	0	0
6	ZIRA		12	22	Electric	11551	2.260	0.980	0	0	0	0
					Diesel	44	1.740	0.840	0	0	0	0
	District:	**GURDASPUR**										
1	BATALA		12	22	Electric	9847	1.950	0.670	0	0	0	0
					Diesel	31	1.260	0.510	0	0	0	0
2	DINA NAGAR		12	22	Electric	3444	1.970	0.630	0	0	0	0
					Diesel	1299	1.340	0.570	0	0	0	0
3	FATEHGARH CHURIAN		12	22	Electric	9428	1.950	0.670	0	0	0	0
					Diesel	126	1.260	0.510	0	0	0	0
4	GURDASPUR		12	22	Electric	6671	1.610	0.510	0	0	0	0
					Diesel	1117	0.680	0.240	0	0	0	0
5	KAHNUWAN		12	22	Electric	7984	2.220	0.700	0	0	0	0
					Diesel	1578	1.050	0.440	0	0	0	0
6	KALANAUR		12	22	Electric	5947	2.220	0.700	0	0	0	0
					Diesel	208	1.050	0.440	0	0	0	0
7	QADIAN		12	22	Electric	5265	2.220	0.700	0	0	0	0
					Diesel	43	1.050	0.440	0	0	0	0
8	SRI HARGOBINDPUR		12	22	Electric	6084	2.220	0.700	0	0	0	0
					Diesel	21	1.050	0.440	0	0	0	0
9	DERA BABA NANAK		12	22	Electric	9300	1.950	0.670	0	0	0	0
					Diesel	288	1.260	0.510	0	0	0	0
10	DHARIWAL		12	22	Electric	8094	2.220	0.700	0	0	0	0
					Diesel	6	1.050	0.440	0	0	0	0
	District:	**HOSHIARPUR**										
1	HOSHIARPUR-II		12	22	Electric	4463	0.550	0.441	0	0	0	0
					Diesel	861	0.300	0.271	0	0	0	0
2	BHUNGA		12	22	Electric	4371	0.550	0.450	0	0	0	0
					Diesel	2389	0.300	0.270	0	0	0	0
3	DASUYA		12	22	Electric	4114	2.030	0.550	0	0	0	0
					Diesel	2655	1.120	0.270	0	0	0	0
4	GARHSAHNKAR		12	22	Electric	5896	1.790	0.440	0	0	0	0
					Diesel	828	1.120	0.270	0	0	0	0
5	HAZIPUR		12	22	Electric	1401	1.500	0.440	0	0	0	0
					Diesel	1901	1.090	0.270	0	0	0	0
6	HOSHIARPUR-1		12	22	Electric	4474	1.790	0.440	0	0	0	0
					Diesel	695	1.120	0.270	0	0	0	0
7	MAHILPUR		12	22	Electric	4033	0.656	0.441	0	0	0	0
					Diesel	1263	0.328	0.271	0	0	0	0
8	MUKERIAN		12	22	Electric	2837	0.656	0.551	0	0	0	0
					Diesel	4726	0.441	0.271	0	0	0	0
9	TALWARA		12	22	Electric	222	1.790	0.440	0	0	0	0
					Diesel	533	1.120	0.270	0	0	0	0
10	TANDA		12	22	Electric	7472	1.290	0.380	0	0	0	0
					Diesel	3311	0.900	0.220	0	0	0	0

	District:	**JALANDHAR**										
1	ADAMPUR		12	22	Electric	6084	2.100	1.230	0	0	0	0
					Diesel	37	0.370	0.430	0	0	0	0
2	BHOGPUR		12	22	Electric	7943	2.100	1.230	0	0	0	0
					Diesel	52	0.370	0.430	0	0	0	0
3	RURKA KALAN		15	22	Electric	2	2.340	1.600	0	0	0	0
					Diesel	0	0.360	0.430	0	0	0	0
4	JALANDHAR-EAST		12	22	Electric	6207	2.100	1.230	0	0	0	0
					Diesel	62	0.370	0.430	0	0	0	0
5	JALANDHAR-WEST		15	22	Electric	2	2.040	1.230	0	0	0	0
					Diesel	0	0.360	0.430	0	0	0	0
6	LOHIAN		12	22	Electric	6457	2.100	1.230	0	0	0	0
					Diesel	423	0.370	0.430	0	0	0	0
7	NAKODAR		12	22	Electric	13759	2.100	1.230	0	0	0	0
					Diesel	46	0.370	0.430	0	0	0	0
8	NUR MAHAL		12	22	Electric	7309	2.400	1.600	0	0	0	0
					Diesel	3	0.370	0.430	0	0	0	0
9	PHILLAUR		12	22	Electric	7731	2.400	1.600	0	0	0	0
					Diesel	107	0.370	0.430	0	0	0	0
10	SHAHKOT		12	22	Electric	7016	1.700	1.100	0	0	0	0
					Diesel	120	0.450	0.660	0	0	0	0
	District:	**KAPURTHALA**										
1	DHILWAN		12	22	Electric	8963	2.220	0.680	0	0	0	0
					Diesel	1673	1.090	0.400	0	0	0	0
2	DHILWAN		12	22	Electric	8963	2.220	0.680	0	0	0	0
					Diesel	1673	1.090	0.400	0	0	0	0
3	KAPURTHALA		12	22	Electric	9880	2.040	0.650	0	0	0	0
					Diesel	198	1.230	0.470	0	0	0	0
4	PHAGWARA		12	22	Electric	8130	2.400	1.600	0	0	0	0
					Diesel	600	0.370	0.430	0	0	0	0
5	SULTANPUR LODHI		12	22	Electric	11754	2.530	0.690	0	0	0	0
					Diesel	1981	1.150	0.520	0	0	0	0
	District:	**LUDHIANA**										
1	DEHLON		12	22	Electric	9301	2.560	0.660	0	0	0	0
					Diesel	3030	0.650	0.490	0	0	0	0
2	DORAHA		12	22	Electric	8594	2.560	0.660	0	0	0	0
					Diesel	2042	0.650	0.490	0	0	0	0
3	JAGRAON		12	22	Electric	9957	2.160	0.800	0	0	0	0
					Diesel	764	1.050	0.460	0	0	0	0
4	KHANNA		12	22	Electric	9528	2.510	0.960	0	0	0	0
					Diesel	198	1.630	0.550	0	0	0	0
5	LUDHIANA		12	22	Electric	8638	2.160	0.800	0	0	0	0
					Diesel	851	1.050	0.460	0	0	0	0
6	MACHHIWARA		12	22	Electric	7891	2.110	0.720	0	0	0	0
					Diesel	3362	1.110	0.490	0	0	0	0
7	MANGAT		12	22	Electric	10345	2.160	0.800	0	0	0	0
					Diesel	2938	1.050	0.460	0	0	0	0
8	PAKHOWAL		12	22	Electric	7859	2.160	0.800	0	0	0	0
					Diesel	748	1.050	0.460	0	0	0	0
9	RAIKOT		12	22	Electric	8638	2.160	0.800	0	0	0	0
					Diesel	851	1.050	0.460	0	0	0	0
10	SAMRALA		12	22	Electric	6132	2.560	0.660	0	0	0	0
					Diesel	403	0.650	0.490	0	0	0	0
11	SIDHWAN BET		12	22	Electric	10473	2.050	0.740	0	0	0	0
					Diesel	3709	1.220	0.500	0	0	0	0
12	SUDHAR		12	22	Electric	4555	2.160	0.800	0	0	0	0
					Diesel	463	1.050	0.460	0	0	0	0
	District:	**MANSA**										
1	BHIKHI		12	22	Electric	6155	2.400	0.970	0	0	0	0
					Diesel	2384	1.950	0.800	0	0	0	0
2	BUDHLADA		12	22	Electric	6270	2.400	0.970	0	0	0	0
					Diesel	8620	1.950	0.800	0	0	0	0
3	JHUNIR		12	22	Electric	3691	2.510	1.820	0	0	0	0
					Diesel	2114	1.230	1.200	0	0	0	0
4	MANSA		12	22	Electric	6148	2.400	0.970	0	0	0	0
					Diesel	3391	1.950	0.800	0	0	0	0
5	SARDULGARH		12	22	Electric	4069	2.510	1.820	0	0	0	0
					Diesel	1838	1.230	1.200	0	0	0	0

	District:	**MOGA**										
1	BAGHA PURANA		12	22	Electric	15750	2.940	0.870	0	0	0	0
					Diesel	766	1.620	0.600	0	0	0	0
2	DHARAMKOT (KOT ISA		12	22	Electric	15192	2.940	0.870	0	0	0	0
	KHAN)				Diesel	20	1.620	0.600	0	0	0	0
3	MOGA I		12	22	Electric	12080	2.940	0.870	0	0	0	0
					Diesel	6	1.620	0.600	0	0	0	0
4	MOGA II		12	22	Electric	9078	2.940	0.870	0	0	0	0
					Diesel	5	1.620	0.600	0	0	0	0
5	NIHAL SINGH WALA		12	22	Electric	11332	2.940	0.870	0	0	0	0
					Diesel	2	1.620	0.600	0	0	0	0
	District:	**MUKTSAR**										
1	GIDDERBAHA/ (KOT		12	22	Electric	2769	1.660	0.550	0	0	0	0
					Diesel	6459	1.050	0.430	0	0	0	0
2	LAMBI		12	22	Electric	1972	1.660	0.550	0	0	0	0
					Diesel	2658	1.050	0.430	0	0	0	0
3	MALOUT		12	22	Electric	1438	1.660	0.550	0	0	0	0
					Diesel	4256	1.050	0.430	0	0	0	0
4	MUKTSAR		15	22	Electric	5925	1.660	0.550	0	0	0	0
					Diesel	3650	1.050	0.430	0	0	0	0
	District:	**NAWAN SHAHR**										
1	AUR		15	22	Electric	5833	2.400	1.600	0	0	0	0
					Diesel	943	0.370	0.430	0	0	0	0
2	BALACHAUR		12	22	Electric	2458	1.790	0.440	0	0	0	0
					Diesel	2843	1.120	0.270	0	0	0	0
3	BANGA		12	22	Electric	5966	1.790	0.440	0	0	0	0
					Diesel	540	1.120	0.270	0	0	0	0
4	NAWAN SHAHR		15	22	Electric	5188	2.400	1.600	0	0	0	0
					Diesel	1387	0.370	0.430	0	0	0	0
5	SAROYA		12	22	Electric	1229	0.660	0.320	0	0	0	0
					Diesel	522	0.400	0.390	0	0	0	0
	District:	**PATHANKOT**										
1	BAMYAL		12	22	Electric	335	1.400	0.600	0	0	0	0
					Diesel	367	1.280	0.500	0	0	0	0
2	DHAR KALAN		12	22	Electric	337	1.720	0.670	0	0	0	0
					Diesel	66	0.990	0.360	0	0	0	0
3	PATHANKOT		12	22	Electric	2649	1.910	0.980	0	0	0	0
					Diesel	1751	1.580	0.540	0	0	0	0
4	NAROT JAIMAL SINGH		12	22	Electric	1332	1.400	0.600	0	0	0	0
					Diesel	1400	1.280	0.500	0	0	0	0
	District:	**PATIALA**										
1	BHUNER HERI		12	22	Electric	10014	2.840	0.970	0	0	0	0
					Diesel	67	1.890	0.580	0	0	0	0
2	GHANAUR		12	22	Electric	6588	2.420	0.890	0	0	0	0
					Diesel	645	1.000	0.440	0	0	0	0
3	NABHA		12	22	Electric	17693	2.700	0.790	0	0	0	0
					Diesel	14	1.890	0.580	0	0	0	0
4	PATIALA		12	22	Electric	10009	2.700	0.790	0	0	0	0
					Diesel	43	1.890	0.580	0	0	0	0
5	RAJPURA		12	22	Electric	7248	2.420	0.890	0	0	0	0
					Diesel	558	1.000	0.440	0	0	0	0
6	SAMANA		12	22	Electric	6591	3.010	1.110	0	0	0	0
					Diesel	0	1.890	0.580	0	0	0	0
7	SANAUR		12	22	Electric	8996	2.840	0.970	0	0	0	0
					Diesel	33	1.890	0.580	0	0	0	0
8	PATRAN		12	22	Electric	11534	3.040	0.960	0	0	0	0
					Diesel	1	1.890	0.580	0	0	0	0
	District:	**ROPAR**									0	0
1	ANANDPUR SAHIB		12	22	Electric	1604	0.660	0.320	0	0	0	0
					Diesel	4897	0.400	0.390	0	0	0	0
2	CHAMKAUR SAHIB		12	22	Electric	4326	2.620	1.320	0	0	0	0
					Diesel	1298	1.020	0.580	0	0	0	0
3	MORINDA		12	22	Electric	3417	2.060	0.990	0	0	0	0
					Diesel	14	0.820	0.490	0	0	0	0
4	NURPUR BEDI		12	22	Electric	3831	0.660	0.320	0	0	0	0
					Diesel	1158	0.400	0.390	0	0	0	0
5	ROPAR		12	22	Electric	3596	0.660	0.320	0	0	0	0
					Diesel	1019	0.400	0.390	0	0	0	0

	District:	**SANGRUR**										
1	AHMEDGARH		12	22	Electric	11536	2.510	0.960	0	0	0	0
					Diesel	372	1.630	0.550	0	0	0	0
2	ANDANA		12	22	Electric	7307	2.580	0.860	0	0	0	0
					Diesel	133	1.340	0.440	0	0	0	0
3	BHIWANIGARH		12	22	Electric	10512	2.700	0.790	0	0	0	0
					Diesel	1053	1.890	0.580	0	0	0	0
4	DHURI		12	22	Electric	8494	2.850	0.910	0	0	0	0
					Diesel	271	0.460	0.330	0	0	0	0
5	LEHRAGHAGA		12	22	Electric	8366	2.580	0.860	0	0	0	0
					Diesel	410	1.340	0.440	0	0	0	0
6	MALER KOTLA		12	22	Electric	14311	2.510	0.960	0	0	0	0
					Diesel	11	1.630	0.550	0	0	0	0
7	SANGRUR		12	22	Electric	11950	2.960	0.960	0	0	0	0
					Diesel	211	1.340	0.440	0	0	0	0
8	SHERPUR		12	22	Electric	8206	2.870	0.940	0	0	0	0
					Diesel	440	0.450	0.390	0	0	0	0
9	SUNAM		12	22	Electric	20326	2.580	0.860	0	0	0	0
					Diesel	1619	1.340	0.440	0	0	0	0
	District:	**MOHALI**										
1	DERA BASSI		12	22	Electric	3919	2.430	0.890	0	0	0	0
					Diesel	732	1.010	0.440	0	0	0	0
2	KHARAR		12	22	Electric	3815	0.720	1.000	0	0	0	0
					Diesel	411	0.510	0.440	0	0	0	0
3	SIALBA MAJRI		12	22	Electric	2685	0.660	0.320	0	0	0	0
					Diesel	74	0.400	0.390	0	0	0	0
	District:	**TARN TARAN**										
1	BHIKHIWIND		12	22	Electric	7546	2.060	0.890	0	0	0	0
					Diesel	2	1.260	0.520	0	0	0	0
2	CHOLA SAHIB		12	22	Electric	6301	2.060	0.890	0	0	0	0
					Diesel	189	1.260	0.520	0	0	0	0
3	GANDIWIND		12	22	Electric	9836	2.060	0.890	0	0	0	0
					Diesel	7	1.260	0.520	0	0	0	0
4	KHADUR SAHIB		12	22	Electric	8643	2.060	0.890	0	0	0	0
					Diesel	322	1.260	0.520	0	0	0	0
5	NAUSHEHRA PANUAN		12	22	Electric	5593	2.060	0.890	0	0	0	0
					Diesel	4	1.260	0.520	0	0	0	0
6	PATTI		12	22	Electric	8759	2.060	0.890	0	0	0	0
					Diesel	1	1.260	0.520	0	0	0	0
7	TARN TARAN		12	22	Electric	9570	2.060	0.890	0	0	0	0
					Diesel	1	1.260	0.520	0	0	0	0
8	VALTOHA		12	22	Electric	7521	2.000	0.890	0	0	0	0
					Diesel	2	1.260	0.520	0	0	0	0

ANNEXURE - III D-2

ASSESSMENT OF DYNAMIC GROUND WATER RESOURCES OF THE PUNJAB STATE , as on 31.3.2017

S. No.	Assessment Unit (Block)/District	Command/non-Command/Total (Hac.)	Recharge from rainfall during monsoon season (ham)	Recharge from other sources during monsoon season (ham)	Recharge from rainfall during non-monsoon season (ham)	Recharge from other sources during non-monsoon season (ham)	Total annual Ground Water Recharge (ham) (4+5+6+7)	Provision for Natural Discharges (ham)	Net Annual Ground Water Availability (ham) (8-9)	Method Adopted for Computing Rainfall Recharge during Monsoon
1	2	3	4	5	6	7	8	9	10	11
	District:	**AMRITSAR**								
1	AJNALA	37550	4451	14592	1107	3207	23358	2336	21022	RIF METHOD
2	CHOGAWAN	39600	4882	12937	1106	9482	28408	2841	25567	RIF METHOD
3	HARSHA CHINA	25740	3031	10049	849	5604	19534	1953	17580	RIF METHOD
4	JANDIALA	20620	2662	8083	685	2915	14346	1435	12911	RIF METHOD
5	MAJITHA	27190	3690	15258	951	11622	31521	3152	28369	RIF METHOD
6	RAYYA	32640	4722	9721	1314	3010	18767	1877	16891	RIF METHOD
7	TARSIKA	23650	3215	8941	1129	2631	15916	1592	14324	RIF METHOD
8	VERKA	33340	4260	8800	990	5693	19743	1974	17769	RIF METHOD
	TOTAL	**240330**	**30913**	**88382**	**8132**	**44165**	**171592**	**17159**	**154433**	
	District:	**BARNALA**								
1	BARNALA	61390	5689	15470	1107	3060	25325	2533	22793	RIF METHOD
2	MAHAL KALAN	34760	2514	6301	635	3936	13386	1339	12048	RIF METHOD
3	SEHNA	39020	3657	14669	549	6768	25643	2564	23078	RIF METHOD
	TOTAL	**135170**	**11860**	**36439**	**2292**	**13764**	**64354**	**6435**	**57919**	
	District:	**BATHINDA**								
1	PHUL	52230	2675	11167	701	4968	19511	1951	17560	RIF METHOD
2	NATHANA	44550	3293	9908	745	8691	22637	1132	21505	RIF METHOD
3	MAUR	35610	3065	6563	501	5280	15408	1541	13868	RIF METHOD
4	BATHINDA	73950	5375	15708	960	15827	37870	1893	35976	WTF METHOD
5	TALWANDI SABOO	52240	2859	5462	908	6556	15785	1578	14206	RIF METHOD
6	SANGAT	63040	3795	4678	596	5935	15004	1500	13503	RIF METHOD
7	RAMPURA	33100	2464	11727	692	12316	27199	2720	24479	RIF METHOD
	TOTAL	**354720**	**23526**	**65212**	**5103**	**59573**	**153414**	**12316**	**141098**	
	District:	**FARIDKOT**								
1	FARIDKOT	75210	6592	20426	1307	8822	37148	3715	33433	RIF METHOD
2	KOT KAPURA	66650	5648	17953	894	5576	30072	3007	27065	RIF METHOD
	TOTAL	**141860**	**12240**	**38380**	**2202**	**14399**	**67220**	**6722**	**60498**	
	District:	**FATEHGARH SAHIB**								
1	KHERA	18080	2511	5902	720	1374	10506	1051	9455	RIF METHOD
2	SIRHIND	37240	5102	7899	983	2476	16460	1646	14814	RIF METHOD
3	AMLOH	22200	2930	7663	718	2727	14038	1404	12634	RIF METHOD
4	BASSI PATHANA	18650	2841	5074	640	1297	9853	985	8868	RIF METHOD
5	KHAMANON	15500	2361	6284	529	1669	10843	1084	9758	RIF METHOD
	TOTAL	**111670**	**15746**	**32822**	**3590**	**9543**	**61700**	**6170**	**55530**	
	District:	**FAZILKA**								
1	ABOHAR	67290	4850	11030	725	17259	33864	3386	30478	RIF METHOD
2	FAZILKA	85920	6011	15133	945	6527	28616	2862	25755	RIF METHOD
3	JALALABAD	52440	3683	15857	658	3558	23755	2376	21380	RIF METHOD
4	KHUYIAN SARWAR	84540	5401	3792	930	6330	16453	1645	14808	RIF METHOD
	TOTAL	**290190**	**19944**	**45812**	**3258**	**33674**	**102689**	**10269**	**92420**	

	District:	**FEROZEPUR**								
1	FEROZPUR	46950	3471	17790	578	6417	28255	2826	25430	RIF METHOD
2	GHALL KHURD	53210	4158	18607	1358	4841	28964	2896	26068	RIF METHOD
3	GURU HAR SAHAI	49060	3575	16456	1015	3634	24679	2468	22211	RIF METHOD
4	MAKHU	28860	2499	9165	641	3993	16298	1630	14668	RIF METHOD
5	MAMDOT	37580	2837	16286	818	2930	22872	2287	20584	RIF METHOD
6	ZIRA	38340	3279	10310	843	1935	16368	1637	14731	RIF METHOD
	TOTAL	**254000**	**19819**	**88613**	**5254**	**23749**	**137436**	**13744**	**123692**	
	District:	**GURDASPUR**								
1	BATALA	27830	4100	10368	1145	2257	17870	1787	16083	RIF METHOD
2	DINA NAGAR	23630	4114	5613	1087	1572	12385	619	11766	RIF METHOD
3	FATEHGARH CHURIAN	21330	2900	11846	760	4081	19587	1959	17629	RIF METHOD
4	GURDASPUR	25130	3123	11845	1139	3968	20074	2007	18067	RIF METHOD
5	KAHNUWAN	32370	5452	10541	1602	3664	21259	2126	19133	RIF METHOD
6	KALANAUR	22640	3616	7762	897	1879	14153	1415	12738	RIF METHOD
7	QADIAN	18060	3099	6267	795	2142	12303	1230	11073	RIF METHOD
8	SRI HARGOBINDPUR	28330	4465	7490	1122	2685	15762	1576	14186	RIF METHOD
9	DERA BABA NANAK	29450	4074	11386	1063	2136	18658	1866	16792	RIF METHOD
10	DHARIWAL	25680	4095	12221	1096	3287	20699	2070	18629	RIF METHOD
	TOTAL	**254450**	**39037**	**95339**	**10704**	**27671**	**172752**	**16656**	**156096**	
	District:	**HOSHIARPUR**								
1	HOSHIARPUR-II	46260	6917	483	1535	375	9310	931	8379	RIF METHOD
2	BHUNGA	54910	5384	1334	1796	1377	9891	989	8902	RIF METHOD
3	DASUYA	37450	6674	3806	1689	1372	13540	1354	12186	RIF METHOD
4	GARHSAHNKAR	41210	4906	5262	1216	1876	13261	1326	11935	RIF METHOD
5	HAZIPUR	12590	2506	3193	645	2676	9021	902	8119	RIF METHOD
6	HOSHIARPUR-1	31120	5784	1889	1253	654	9579	958	8622	RIF METHOD
7	MAHILPUR	37990	3200	2900	1500	1450	9050	905	8145	RIF METHOD
8	MUKERIAN	25600	4680	1915	1278	1283	9156	458	8698	RIF METHOD
9	TALWARA	22640	1123	404	297	285	2109	211	1898	RIF METHOD
10	TANDA	23370	4023	4283	931	817	10053	1005	9048	RIF METHOD
	TOTAL	**333140**	**45197**	**25468**	**12141**	**12164**	**94970**	**9039**	**85931**	
	District:	**JALANDHAR**								
1	ADAMPUR	20420	3240	5583	755	2521	12099	1210	10889	RIF METHOD
2	BHOGPUR	17800	2970	5139	677	1869	10655	1066	9590	RIF METHOD
3	RURKA KALAN	19180	2410	5832	667	2489	11398	1140	10258	RIF METHOD
4	JALANDHAR-EAST	25620	3537	3335	879	1234	8986	899	8087	RIF METHOD
5	JALANDHAR-WEST	33890	4966	7917	1282	3379	17544	1754	15790	RIF METHOD
6	LOHIAN	28030	3308	3928	635	1364	9235	924	8312	RIF METHOD
7	NAKODAR	35330	4421	10332	1049	3090	18893	1889	17004	RIF METHOD
8	NUR MAHAL	31980	4162	6962	865	3091	15081	1508	13572	RIF METHOD
9	PHILLAUR	27030	3418	9421	827	4191	17857	1786	16071	RIF METHOD
10	SHAHKOT	24070	2917	3864	556	1323	8660	866	7794	RIF METHOD
	TOTAL	**263350**	**35349**	**62313**	**8193**	**24553**	**130408**	**13041**	**117367**	
	District:	**KAPURTHALA**								
1	NADALA	22440	3483	6921	869	1334	12607	1261	11346	RIF METHOD
2	DHILWAN	25650	3589	8733	886	1691	14899	1490	13409	RIF METHOD
3	KAPURTHALA	39210	5486	7492	1225	1736	15939	1594	14345	RIF METHOD
4	PHAGWARA	30040	3608	6067	1646	2388	13709	1371	12338	RIF METHOD
5	SULTANPUR LODHI	44470	4990	12361	1154	2265	20770	2077	18693	RIF METHOD
	TOTAL	**161810**	**21157**	**41574**	**5780**	**9414**	**77924**	**7792**	**70131**	

	District:	LUDHIANA								
1	DEHLON	28560	3747	10597	980	2959	18283	1828	16455	RIF METHOD
2	DORAHA	22480	3062	14895	762	9493	28213	2821	25391	RIF METHOD
3	JAGRAON	34430	3809	13109	856	4922	22696	2270	20426	RIF METHOD
4	KHANNA	36570	5001	7358	949	2087	15395	1540	13856	RIF METHOD
5	LUDHIANA	31680	4148	6411	1080	2187	13826	1383	12443	RIF METHOD
6	MACHHIWARA	36570	5764	11773	1110	7714	26362	2636	23726	RIF METHOD
7	MANGAT	50730	7192	11627	993	3643	23455	2346	21110	RIF METHOD
8	PAKHOWAL	21083	2666	7811	552	2104	13134	1313	11820	RIF METHOD
9	RAIKOT	26620	3071	6561	662	1577	11872	1187	10684	RIF METHOD
10	SAMRALA	15350	2273	6446	476	1170	10365	1037	9329	RIF METHOD
11	SIDHWAN BET	40170	4687	12308	1175	3619	21789	2179	19610	RIF METHOD
12	SUDHAR	14447	1625	5626	366	2431	10048	1005	9043	RIF METHOD
	TOTAL	**358690**	**47046**	**114523**	**9962**	**43907**	**215438**	**21544**	**193894**	
	District:	**MANSA**								
1	BHIKHI	22120	1939	14544	287	7534	24305	2430	21874	RIF METHOD
2	BUDHLADA	67540	5759	12961	1352	6370	26443	2644	23799	RIF METHOD
3	JHUNIR	58330	4820	8484	821	9502	23627	2363	21265	RIF METHOD
4	MANSA	35810	3120	14189	614	9232	27155	2715	24439	RIF METHOD
5	SARDULGARH	23290	1881	6111	461	4232	12686	1269	11418	RIF METHOD
	TOTAL	**207090**	**17519**	**56290**	**3536**	**36871**	**114216**	**11422**	**102794**	
	District:	**MOGA**								
1	BAGHA PURANA	46580	4009	25414	820	8800	39043	3904	35139	RIF METHOD
2	DHARAMKOT (KOT ISA KHAN)	54900	6319	19833	1099	3634	30886	3089	27797	RIF METHOD
3	MOGA I	44500	4312	11341	969	1926	18548	1855	16693	RIF METHOD
4	MOGA II	33460	3295	8551	707	1065	13618	1362	12256	RIF METHOD
5	NIHAL SINGH WALA	37780	3461	11618	657	1819	17555	1755	15799	RIF METHOD
	TOTAL	**217220**	**21395**	**76758**	**4251**	**17244**	**119648**	**11965**	**107683**	
	District:	**MUKTSAR**								
1	GIDDERBAHA/ (KOT BHAI)	58360	4761	7264	706	4423	17154	1715	15438	RIF METHOD
2	LAMBI	65200	3293	6924	775	10127	21119	2112	19007	RIF METHOD
3	MALOUT	62770	4773	5321	746	6826	17666	1767	15899	RIF METHOD
4	MUKTSAR	79280	5651	9922	1587	8567	25727	2573	23155	RIF METHOD
	TOTAL	**265610**	**18478**	**29432**	**3814**	**29943**	**81666**	**8167**	**73499**	
	District:	**NAWAN SHAHR**								
1	AUR	21850	3080	8021	668	3557	15327	1533	13794	RIF METHOD
2	BALACHAUR	37850	6565	5964	1516	3694	17738	1774	15964	RIF METHOD
3	BANGA	23240	3135	5448	869	1355	10807	1081	9727	RIF METHOD
4	NAWAN SHAHR	33020	5361	10297	1293	6385	23337	2334	21003	RIF METHOD
5	SAROYA	16580	2327	156	545	71	3098	310	2788	RIF METHOD
	TOTAL	**132540**	**20468**	**29886**	**4891**	**15062**	**70307**	**7031**	**63276**	
	District:	**PATIALA**								
1	BHUNER HERI	38020	5119	9454	1029	3036	18638	1864	16774	RIF METHOD
2	GHANAUR	44320	6669	5834	1463	2187	16153	1615	14537	RIF METHOD
3	NABHA	54820	6802	21415	1471	14171	43860	4386	39474	RIF METHOD
4	PATIALA	42310	5831	8680	912	2728	18150	1815	16335	RIF METHOD
5	RAJPURA	39940	6105	4672	1204	1601	13582	1358	12224	RIF METHOD
6	SAMANA	39650	4229	5645	1099	1469	12442	1244	11198	RIF METHOD
7	SANAUR	33980	4207	8250	934	2104	15495	1550	13946	RIF METHOD
8	PATRAN	37230	3538	8525	1032	1022	14117	1412	12706	RIF METHOD
	TOTAL	**330270**	**42501**	**72475**	**9144**	**28317**	**152437**	**15244**	**137193**	

	District:	**PATAHANKOT**								
1	BAMYAL	4780	749	353	298	96	1495	75	1420	WTF METHOD
2	DHAR KALAN	39840	2618	1380	1145	804	5947	595	5352	RIF METHOD
3	PATHANKOT	35150	5419	5733	1864	5277	18293	1829	16464	RIF METHOD
4	NAROT JAIMAL SINGH	17090	2790	1326	978	411	5504	275	5229	WTF METHOD
	TOTAL	**96860**	**11576**	**8792**	**4284**	**6588**	**31239**	**2774**	**28465**	
	District:	**ROPAR**								
1	ANANDPUR SAHIB	31140	4491	1391	1043	1550	8475	847	7627	RIF METHOD
2	CHAMKAUR SAHIB	15160	2445	5477	537	1810	10269	1027	9242	RIF METHOD
3	MORINDA	16950	2663	2434	660	1020	6776	678	6099	RIF METHOD
4	NURPUR BEDI	31980	3147	821	750	419	5137	514	4624	RIF METHOD
5	ROPAR	41810	4220	3686	1281	5234	14421	1442	12979	RIF METHOD
	TOTAL	**137040**	**16966**	**13808**	**4271**	**10034**	**45079**	**4508**	**40571**	
	District:	**MOHALI**								
1	DERA BASSI	47990	7716	2803	1636	987	13142	1314	11828	RIF METHOD
2	KHARAR	41620	6615	834	1447	868	9764	976	8787	RIF METHOD
3	SIALBA MAJRI	29290	3544	495	1173	280	5492	275	5217	WTF METHOD
	TOTAL	**118900**	**17874**	**4133**	**4256**	**2135**	**28397**	**2565**	**25832**	
	District:	**SANGRUR**								
1	AHMEDGARH	35050	4192	8559	763	3230	16744	1674	15070	RIF METHOD
2	ANDANA	41150	3824	4804	1005	965	10598	1060	9538	RIF METHOD
3	BHIWANIGARH	35170	3863	9380	843	3519	17605	1761	15845	RIF METHOD
4	DHURI	24810	2646	7031	519	1163	11359	1136	10223	RIF METHOD
5	LEHRAGHAGA	46920	4199	6970	1321	2551	15041	1504	13537	RIF METHOD
6	MALER KOTLA	46440	5517	12236	1359	9434	28546	2855	25691	RIF METHOD
7	SANGRUR	55770	5683	9468	1350	2304	18805	1880	16924	RIF METHOD
8	SHERPUR	22040	2426	8172	325	3117	14040	1404	12636	RIF METHOD
9	SUNAM	66380	6870	14536	1373	4583	27361	2736	24625	RIF METHOD
	TOTAL	**373730**	**39220**	**81155**	**8858**	**30866**	**160098**	**16010**	**144088**	
	District:	**TARN TARAN**								
1	BHIKHIWIND	33300	3174	10084	945	3936	18139	1814	16325	RIF METHOD
2	CHOLA SAHIB	34980	3537	7055	985	3664	15240	1524	13716	RIF METHOD
3	GANDIWIND	33690	4162	11323	993	7809	24288	2429	21859	RIF METHOD
4	KHADUR SAHIB	34150	4129	9475	1134	3250	17989	1799	16190	RIF METHOD
5	NAUSHEHRA PANUAN	19920	1977	6138	635	1857	10608	1061	9547	RIF METHOD
6	PATTI	37550	3024	9884	1066	2772	16745	1675	15071	RIF METHOD
7	TARN TARAN	32000	3497	12318	887	5333	22036	2204	19832	RIF METHOD
8	VALTOHA	32750	2888	8972	454	2739	15053	1505	13548	RIF METHOD
	TOTAL	**258340**	**26388**	**75249**	**7100**	**31360**	**140097**	**14010**	**126087**	

ANNEXURE - III D-2 Contd.)

ASSESSMENT OF DYNAMIC GROUND WATER RESOURCES OF THE PUNJAB STATE , as on 31.3.2017
(in ham)

S. No.	Assessment Unit/Distict	Command/non-Command/Total (Hac.)	Net Annual Ground Water Availability	Existing Gross Ground Water Draft for irrigation	Existing Gross Ground Water Draft for domestic and industrial water supply	Existing Gross Ground Water Draft for all uses (5+6)	Provision for domestic, and industrial requirement supply to 2025 years	Net Annual Ground Water Availability for future irrigation development (4-5-8)	Stage of Ground Water Development 7/4*100 (%)	Existing Gross Ground Water Draft for domestic and industrial water supply	
1	2	3	4	5	6	7	8	9	10	Industrial use	domestic
	District:	**AMRITSAR**									
1	AJNALA		21022	36735	785	37520	1077	-16789	178	8	777
2	CHOGAWAN		25567	33299	779	34078	1072	-8804	133	0	779
3	HARSHA CHINA		17580	21395	381	21776	524	-4339	124	0	381
4	JANDIALA		12911	24810	462	25272	629	-12528	196	17	445
5	MAJITHA		28369	28793	5298	34090	7284	-7708	120	1	5297
6	RAYYA		16891	27433	1002	28434	1371	-11913	168	17	984
7	TARSIKA		14324	24314	552	24866	759	-10749	174	0	552
8	VERKA		17769	21173	755	21927	939	-4343	123	262	492
	TOTAL		**154433**	**217950**	**10014**	**227964**	**13655**	**-77172**	**148**		
	District:	**BARNALA**									
1	BARNALA		22793	56826	1329	58155	1827	-35860	255	0	1329
2	MAHAL KALAN		12048	20766	548	21314	754	-9472	177	0	548
3	SEHNA		23078	42161	463	42624	637	-19719	185	0	463
	TOTAL		**57919**	**119753**	**2340**	**122093**	**3217**	**-65051**	**211**		
	District:	**BATHINDA**									
1	PHUL		17560	31893	431	32324	589	-14923	184	8	423
2	NATHANA		21505	15197	584	15781	802	5506	73	2	582
3	MAUR		13868	17294	328	17622	452	-3878	127	0	328
4	BATHINDA		35976	34726	2201	36927	3023	-1772	103	10	2192
5	TALWANDI SABOO		14206	8316	862	9177	1183	4708	65	4	858
6	SANGAT		13503	8483	497	8980	683	4338	67	2	495
7	RAMPURA		24479	16240	581	16821	796	7443	69	8	573
	TOTAL		**141098**	**132149**	**5484**	**137633**	**7528**	**1422**	**98**		
	District:	**FARIDKOT**									
1	FARIDKOT		33433	53725	2866	56591	3539	-23831	169	1073	1793
2	KOT KAPURA		27065	42707	1880	44587	2117	-17759	165	1249	631
	TOTAL		**60498**	**96432**	**4746**	**101179**	**5656**	**-41590**	**167**		
	District:	**FATEHGARH SAHIB**									
1	KHERA		9455	19587	282	19869	388	-10520	210	0	282
2	SIRHIND		14814	31019	583	31602	797	-17002	213	13	570
3	AMLOH		12634	24383	1604	25987	1903	-13652	206	805	798
4	BASSI PATHANA		8868	18079	311	18390	427	-9639	207	0	311
5	KHAMANON		9758	19018	383	19401	518	-9778	199	24	359
	TOTAL		**55530**	**112087**	**3162**	**115250**	**4032**	**-60590**	**208**		

	District:	**FAZILKA**									
1	ABOHAR		30478	9992	1581	11573	2166	18320	38	19	1562
2	FAZILKA		25755	38472	1326	39798	1788	-14505	155	94	1232
3	JALALABAD		21380	30912	1135	32047	1547	-11079	150	36	1098
4	KHUYIAN SARWAR		14808	7700	569	8270	780	6328	56	9	561
	TOTAL		**92420**	**87076**	**4611**	**91687**	**6280**	**-937**	**99**		
	District:	**FEROZEPUR**									
1	FEROZPUR		25430	32303	1173	33476	1612	-8486	132	0	1173
2	GHALL KHURD		26068	51185	495	51680	662	-25780	198	47	448
3	GURU HAR SAHAI		22211	25548	361	25909	489	-3825	117	21	340
4	MAKHU		14668	21690	206	21897	284	-7306	149	0	206
5	MAMDOT		20584	31385	308	31692	284	-11084	154	6	301
6	ZIRA		14731	37539	633	38172	854	-23662	259	45	589
	TOTAL		**123692**	**199650**	**3176**	**202825**	**4185**	**-80143**	**164**		
	District:	**GURDASPUR**									
1	BATALA		16083	25854	1676	27530	2172	-11943	171	352	1324
2	DINA NAGAR		11766	11435	438	11874	589	-258	101	37	401
3	FATEHGARH CHURIAN		17629	24924	503	25427	655	-7950	144	97	405
4	GURDASPUR		18067	15170	1660	16830	2159	738	93	329	1330
5	KAHNUWAN		19133	25665	503	26168	687	-7218	137	13	490
6	KALANAUR		12738	17675	308	17983	418	-5356	141	12	296
7	QADIAN		11073	15438	392	15830	529	-4894	143	28	365
8	SRI HARGOBINDPUR		14186	17797	528	18325	693	-4303	129	90	438
9	DERA BABA NANAK		16792	24876	543	25419	725	-8808	151	58	485
10	DHARIWAL		18629	23643	513	24156	694	-5709	130	30	484
	TOTAL		**156096**	**202477**	**7064**	**209541**	**9321**	**-55702**	**134**		
	District:	**HOSHIARPUR**									
1	BHUNGA		8902	5733	504	6237	693	2477	70	0	504
2	DASUYA		12186	14305	645	14949	884	-3002	123	7	638
3	GARHSAHNKAR		11935	14299	1327	15626	1585	-3949	131	639	688
4	HAZIPUR		8119	5303	308	5611	424	2392	69	0	308
5	HOSHIARPUR-1		8622	10943	1732	12675	2213	-4534	147	449	1283
6	HOSHIARPUR-II		8379	4914	799	5714	1020	2444	68	209	590
7	MAHILPUR		8145	5181	522	5703	718	2246	70	0	522
8	MUKERIAN		8698	6789	687	7476	934	975	86	27	660
9	TALWARA		1898	1236	295	1531	405	257	81	0	295
10	TANDA		9048	16187	412	16599	566	-7705	183	2	411
	TOTAL		**85931**	**84890**	**7231**	**92120**	**9442**	**-8401**	**107**		
	District:	**JALANDHAR**									
1	ADAMPUR		10889	20289	395	20684	530	-9930	190	34	361
2	BHOGPUR		9590	26492	288	26780	385	-17287	279	30	258
3	RURKA KALAN		10258	21263	340	21603	460	-11465	211	21	319
4	JALANDHAR-EAST		8087	20719	4848	25567	6640	-19272	316	70	4779
5	JALANDHAR-WEST		15790	31949	1617	33566	2212	-18372	213	30	1587
6	LOHIAN		8312	21840	236	22077	317	-13846	266	21	216
7	NAKODAR		17004	45854	1231	47085	1674	-30525	277	47	1183
8	NUR MAHAL		13572	29238	321	29560	436	-16102	218	17	305
9	PHILLAUR		16071	31010	2061	33071	2793	-17732	206	111	1951
10	SHAHKOT		7794	19778	926	20704	1267	-13250	266	18	908
	TOTAL		**117367**	**268433**	**12264**	**280697**	**16714**	**-167780**	**239**		

	District:	**KAPURTHALA**									
1	NADALA		11346	21945	566	22511	688	-11287	198	240	326
2	DHILWAN		13409	28485	650	29136	805	-15881	217	239	411
3	KAPURTHALA		14345	26914	1936	28849	2286	-14855	201	1000	936
4	PHAGWARA		12338	33000	1675	34675	2013	-22675	281	773	902
5	SULTANPUR LODHI		18693	41156	592	41748	762	-23226	223	137	455
	TOTAL		**70131**	**151500**	**5419**	**156919**	**6555**	**-87924**	**224**		
	District:	**LUDHIANA**									
1	DEHLON		16455	33403	786	34189	976	-17924	208	280	506
2	DORAHA		25391	30001	685	30686	866	-5475	121	203	482
3	JAGRAON		20426	30626	1215	31841	1537	-11737	156	356	859
4	KHANNA		13856	33494	1250	34744	1577	-21215	251	380	871
5	LUDHIANA		12443	26853	7338	34192	9905	-24315	275	495	6843
6	MACHHIWARA		23726	27711	510	28220	623	-4608	119	208	302
7	MANGAT		21110	35058	1698	36756	2108	-16056	174	605	1093
8	PAKHOWAL		11820	24392	411	24803	530	-13102	210	93	318
9	RAIKOT		10684	26853	478	27331	657	-16826	256	0	478
10	SAMRALA		9329	20204	772	20977	941	-11817	225	323	450
11	SIDHWAN BET		19610	35599	647	36246	743	-16732	185	390	257
12	SUDHAR		9043	14182	540	14722	714	-5853	163	77	463
	TOTAL		**193894**	**338377**	**16330**	**354707**	**21176**	**-165659**	**183**		
	District:	**MANSA**									
1	BHIKHI		21874	27298	0	27298	0	-5424	125	0	0
2	BUDHLADA		23799	44835	5	44840	5	-21042	188	5	0
3	JHUNIR		21265	21119	0	21119	0	146	99	0	0
4	MANSA		24439	30044	6	30050	6	-5611	123	6	0
5	SARDULGARH		11418	22085	5	22090	5	-10672	193	5	0
	TOTAL		**102794**	**145381**	**16**	**145397**	**16**	**-42603**	**141**		
	District:	**MOGA**									
1	BAGHA PURANA		35139	61708	826	62534	1136	-27706	178	0	826
2	DHARAMKOT (KOT ISA KHAN)		27797	57926	666	58592	916	-31045	211	0	666
3	MOGA I		16693	46038	1245	47283	1712	-31057	283	0	1245
4	MOGA II		12256	34598	401	34999	551	-22893	286	0	401
5	NIHAL SINGH WALA		15799	43179	513	43692	705	-28086	277	0	513
	TOTAL		**107683**	**243450**	**3651**	**247101**	**5020**	**-140787**	**229**		
	District:	**MUKTSAR**									
1	GIDDERBAHA/ (KOT BHAI)		15438	15679	555	16234	555	-795	105	555	0
2	LAMBI		19007	8292	255	8547	255	10461	45	255	0
3	MALOUT		15899	9477	690	10167	690	5732	64	690	0
4	MUKTSAR		23155	18496	1205	19701	1205	3453	85	1205	0
	TOTAL		**73499**	**51944**	**2705**	**54649**	**2705**	**18851**	**74**		
	District:	**NAWAN SHAHR**									
1	AUR		13794	24086	337	24424	464	-10756	177	0	337
2	BALACHAUR		15964	9433	590	10023	764	5767	63	125	465
3	BANGA		9727	14055	495	14550	680	-5009	150	1	494
4	NAWAN SHAHR		21003	21862	746	22607	1025	-1884	108	0	746
5	SAROYA		2788	1617	234	1851	322	850	66	0	234
	TOTAL		**63276**	**71053**	**2402**	**73455**	**3256**	**-11032**	**116**		

	District:	**PATIALA**									
1	BHUNER HERI		16774	38319	452	38771	621	-22166	231	0	452
2	GHANAUR		14537	22735	502	23237	690	-8888	160	0	502
3	NABHA		39474	61783	1180	62964	1575	-23884	160	129	1052
4	PATIALA		16335	35038	2251	37288	3094	-21797	228	0	2251
5	RAJPURA		12224	24794	952	25746	1308	-13879	211	0	952
6	SAMANA		11198	27155	663	27818	911	-16869	248	0	663
7	SANAUR		13946	34356	489	34845	672	-21083	250	0	489
8	PATRAN		12706	46138	651	46790	895	-34328	368	0	651
	TOTAL		**137193**	**290319**	**7139**	**297458**	**9768**	**-162894**	**217**		
	District:	**PATHANKOT**									
1	BAMYAL		1420	1323	165	1488	225	-128	105	4	161
2	DHAR KALAN		5352	895	407	1301	554	3904	24	14	392
3	PATHANKOT		16464	11368	1908	13275	2481	2615	81	379	1529
4	NAROT JAIMAL SINGH		5229	5156	421	5577	578	-505	107	4	418
	TOTAL		**28465**	**18742**	**2900**	**21642**	**3838**	**5886**	**76**		
	District:	**ROPAR**									
1	ANANDPUR SAHIB		7627	5441	643	6083	882	1305	80	5	638
2	CHAMKAUR SAHIB		9242	19121	445	19566	609	-10488	212	7	438
3	MORINDA		6099	10440	421	10861	512	-4853	178	179	242
4	NURPUR BEDI		4624	4669	375	5045	514	-560	109	6	370
5	ROPAR		12979	4329	1741	6070	2058	6592	47	897	844
	TOTAL		**40571**	**44000**	**3625**	**47626**	**4575**	**-8004**	**117**		
	District:	**MOHALI**									
1	DERA BASSI		11828	14051	3309	17359	3906	-6129	147	1715	1594
2	KHARAR		8787	6952	3518	10470	4161	-2326	119	1802	1715
3	SIALBA MAJRI		5217	2690	350	3040	479	2048	58	6	344
	TOTAL		**25832**	**23693**	**7177**	**30869**	**8547**	**-6407**	**119**		
	District:	**SANGRUR**									
1	AHMEDGARH		15070	40841	553	41394	760	-26531	275	0	553
2	ANDANA		9538	25373	475	25848	654	-16488	271	0	475
3	BHIWANIGARH		15845	39288	431	39719	593	-24036	251	0	431
4	DHURI		10223	32152	555	32707	764	-22692	320	0	555
5	LEHRAGHAGA		13537	29509	572	30080	786	-16758	222	0	572
6	MALER KOTLA		25691	49683	1202	50885	1653	-25645	198	0	1202
7	SANGRUR		16924	47220	1004	48224	1381	-31676	285	0	1004
8	SHERPUR		12636	31634	418	32052	575	-19573	254	0	418
9	SUNAM		24625	72803	919	73722	1263	-49442	299	0	919
	TOTAL		**144088**	**368502**	**6129**	**374631**	**8427**	**-232842**	**260**		
	District:	**TARN TARAN**									
1	BHIKHIWIND		16325	22264	454	22718	623	-6563	139	2	452
2	CHOLA SAHIB		13716	18924	440	19364	605	-5813	141	0	440
3	GANDIWIND		21859	29029	275	29303	378	-7548	134	0	275
4	KHADUR SAHIB		16190	26070	501	26571	688	-10568	164	1	500
5	NAUSHEHRA PANUAN		9547	16506	347	16853	477	-7436	177	0	346
6	PATTI		15071	25841	815	26656	1117	-11887	177	11	804
7	TARN TARAN		19832	28233	986	29219	1347	-9748	147	23	963
8	VALTOHA		13548	21739	369	22108	508	-8699	163	0	369
	TOTAL		**126087**	**188607**	**4187**	**192794**	**5743**	**-68263**	**153**		

ANNEXURE III E

ASSESSMENT OF DYNAMIC GROUND WATER RESOURCES OF THE OF THE PUNJAB STATE
ASSESSMENT UNIT-WISE CATEGORIZATION
as on 31.3.2017

Sr. No	Assessment Unit (Block)/ District	Stage of Ground Water Development (%)	Pre-monsoon	Post-monsoon	Categorization for future ground water development (Safe/semi-critical /critcal/over-exploited	Pre-monsoon	Post-monsoon	Remarks
			Water level Trend Is there a significant decline (Yes/No)	Water level Trend Is there a significant decline (Yes/No)		Water level (cm/yr)	Water level (cm/yr)	
	District:	**AMRITSAR**						
1	AJNALA	178	NO	NO	OVER-EXPLOITED	1.2	7.8	
2	CHOGAWAN	133	NO	NO	OVER-EXPLOITED	0.4	7.2	
3	HARSHA CHINA	124	YES	YES	OVER-EXPLOITED	37.5	30.9	
4	JANDIALA	196	YES	YES	OVER-EXPLOITED	50.5	58	
5	MAJITHA	120	YES	YES	OVER-EXPLOITED	37.9	48.7	
6	RAYYA	168	YES	YES	OVER-EXPLOITED	23.1	32.7	
7	TARSIKA	174	YES	YES	OVER-EXPLOITED	24.1	26.6	
8	VERKA	123	YES	YES	OVER-EXPLOITED	24.1	30.9	
	District:	**BARNALA**						
1	BARNALA	255	YES	YES	OVER-EXPLOITED	71.6	73.3	
2	MAHAL KALAN	177	YES	YES	OVER-EXPLOITED	158.5	166.8	
3	SEHNA	185	YES	YES	OVER-EXPLOITED	106.6	103.8	
	District:	**BATHINDA**						
1	PHUL	184	YES	YES	OVER-EXPLOITED	76.7	92.7	
2	NATHANA	73	YES	YES	SEMI-CRITICAL	61	83.3	
3	MAUR	127	NO	YES	OVER-EXPLOITED	5.8	16.7	
4	BATHINDA	103	YES	YES	OVER-EXPLOITED	19.4	26.3	
5	TALWANDI SABOO	65	NO	NO	SAFE	-5	-2.1	
6	SANGAT	67	NO	NO	SAFE	-15.3	-15.1	
7	RAMPURA	69	YES	YES	SAFE	121.5	125.1	
	District:	**FARIDKOT**						
1	FARIDKOT	169	YES	YES	OVER-EXPLOITED	10.9	15.7	
2	KOT KAPURA	165	YES	YES	OVER-EXPLOITED	19.4	22.2	
	District:	**FATEHGARH SAHIB**						
1	KHERA	210	YES	YES	OVER-EXPLOITED	43.4	19.1	
2	SIRHIND	213	YES	YES	OVER-EXPLOITED	60.5	56	
3	AMLOH	206	YES	YES	OVER-EXPLOITED	35.2	32.8	
4	BASSI PATHANA	207	YES	YES	OVER-EXPLOITED	63.3	61.6	
5	KHAMANON	199	YES	YES	OVER-EXPLOITED	32.1	28.4	
	District:	**FAZILKA**						
1	ABOHAR	38	NO	NO	SAFE	-16.7	-15	
2	FAZILKA	155	NO	NO	SAFE	1.1	5.2	Water level (b.g.l) in > 50 % area of the block is < 5 mts.So considered Safe
3	JALALABAD	150	YES	YES	OVER-EXPLOITED	17.8	21.3	
4	KHUYIAN SARWAR	56	NO	NO	SAFE	-24.3	-17.2	

	District:	**FEROZEPUR**						
1	FEROZPUR	132	NO	YES	OVER-EXPLOITED	4.3	11	
2	GHALL KHURD	198	YES	YES	OVER-EXPLOITED	61.2	69.2	
3	GURU HAR SAHAI	117	YES	YES	OVER-EXPLOITED	32	46.1	
4	MAKHU	149	NO	NO	OVER-EXPLOITED	-0.6	4.2	
5	MAMDOT	154	YES	YES	OVER-EXPLOITED	30.8	48	
6	ZIRA	259	YES	YES	OVER-EXPLOITED	105.5	116.6	
	District:	**GURDASPUR**						
1	BATALA	171	NO	YES	OVER-EXPLOITED	4.5	16.6	
2	DINA NAGAR	101	NO	YES	SAFE	-0.6	13.50	Water level (b.g.l) in 50 % area of the block is < 5 mts.So considered Safe
3	FATEHGARH CHURIAN	144	NO	YES	OVER-EXPLOITED	9.1	22.2	
4	GURDASPUR	93	NO	YES	CRITICAL	8.9	18.7	
5	KAHNUWAN	137	NO	NO	OVER-EXPLOITED	-27.9	-16.7	
6	KALANAUR	141	NO	YES	OVER-EXPLOITED	8.7	20.8	
7	QADIAN	143	NO	NO	OVER-EXPLOITED	8.5	-7.2	
8	SRI HARGOBINDPUR	129	YES	YES	OVER-EXPLOITED	15.6	33.4	
9	DERA BABA NANAK	151	NO	NO	OVER-EXPLOITED	-14.5	-5.6	
10	DHARIWAL	130	NO	NO	OVER-EXPLOITED	-7.8	8.6	
	District:	**HOSHIARPUR**						
1	HOSHIARPUR-II	68	YES	YES	SAFE	134.7	130.1	
2	BHUNGA	70	YES	YES	SAFE	96	101.4	
3	DASUYA	123	YES	YES	OVER-EXPLOITED	58.6	65.8	
4	GARHSAHNKAR	131	YES	YES	OVER-EXPLOITED	52.3	56.4	
5	HAZIPUR	69	YES	YES	SAFE	22.2	36.4	
6	HOSHIARPUR-1	147	YES	YES	OVER-EXPLOITED	171.7	172.7	
7	MAHILPUR	70	YES	YES	SAFE	75.1	76.3	
8	MUKERIAN	86	NO	YES	SEMI-CRITICAL	2.1	16.8	
9	TALWARA	81	YES	YES	SEMI-CRITICAL	38.3	48	
10	TANDA	183	YES	YES	OVER-EXPLOITED	68.4	78.4	
	District:	**JALANDHAR**						
1	ADAMPUR	190	NO	YES	OVER-EXPLOITED	6.9	14.2	
2	BHOGPUR	279	YES	YES	OVER-EXPLOITED	93.7	124.1	
3	RURKA KALAN	211	YES	YES	OVER-EXPLOITED	46.6	46.5	
4	JALANDHAR-EAST	316	YES	YES	OVER-EXPLOITED	154	180.1	
5	JALANDHAR-WEST	213	YES	YES	OVER-EXPLOITED	112.3	153.2	
6	LOHIAN	266	YES	YES	OVER-EXPLOITED	96.9	124.8	
7	NAKODAR	277	YES	YES	OVER-EXPLOITED	43.7	63	
8	NUR MAHAL	218	YES	YES	OVER-EXPLOITED	78.7	110	
9	PHILLAUR	206	YES	YES	OVER-EXPLOITED	49.5	62.7	
10	SHAHKOT	266	NO	NO	OVER-EXPLOITED	-14.6	-5.9	
	District:	**KAPURTHALA**						
1	NADALA	198	NO	NO	OVER-EXPLOITED	-13	1.7	
2	DHILWAN	217	YES	YES	OVER-EXPLOITED	16.1	24.7	
3	KAPURTHALA	201	YES	YES	OVER-EXPLOITED	34.1	47.8	
4	PHAGWARA	281	YES	YES	OVER-EXPLOITED	68.1	95.2	
5	SULTANPUR LODHI	223	NO	YES	OVER-EXPLOITED	0.4	10.9	

	District:	**LUDHIANA**						
1	DEHLON	208	YES	YES	OVER-EXPLOITED	76	86.6	
2	DORAHA	121	NO	NO	OVER-EXPLOITED	1.1	6.8	
3	JAGRAON	156	YES	YES	OVER-EXPLOITED	67.4	89.9	
4	KHANNA	251	YES	YES	OVER-EXPLOITED	44.6	44.5	
5	LUDHIANA	275	NO	NO	OVER-EXPLOITED	-53.2	-51.8	
6	MACHHIWARA	119	YES	YES	OVER-EXPLOITED	30.3	31.3	
7	MANGAT	174	NO	NO	OVER-EXPLOITED	1.6	2	
8	PAKHOWAL	210	YES	YES	OVER-EXPLOITED	56.5	69.7	
9	RAIKOT	256	YES	YES	OVER-EXPLOITED	112	130	
10	SAMRALA	225	YES	YES	OVER-EXPLOITED	35.4	49.2	
11	SIDHWAN BET	185	YES	YES	OVER-EXPLOITED	48.7	53.3	
12	SUDHAR	163	YES	YES	OVER-EXPLOITED	62.4	76	
	District:	**MANSA**						
1	BHIKHI	125	YES	YES	OVER-EXPLOITED	65	76.5	
2	BUDHLADA	188	YES	YES	OVER-EXPLOITED	54.1	60.7	
3	JHUNIR	99	YES	YES	CRITICAL	20.9	26	
4	MANSA	123	YES	YES	OVER-EXPLOITED	29.7	35.7	
5	SARDULGARH	193	YES	YES	OVER-EXPLOITED	99.8	101.2	
	District:	**MOGA**						
1	BAGHA PURANA	178	YES	YES	OVER-EXPLOITED	72	77	
2	DHARAMKOT (KOT ISA KHAN)	211	NO	NO	OVER-EXPLOITED	-32.5	-35.8	
3	MOGA I	283	YES	YES	OVER-EXPLOITED	61.9	66.2	
4	MOGA II	286	YES	YES	OVER-EXPLOITED	87.4	81.5	
5	NIHAL SINGH WALA	277	YES	YES	OVER-EXPLOITED	89.4	98.7	
	District:	**MUKATSAR**						
1	GIDDERBAHA/ (KOT BHAI)	105	NO	NO	SAFE	5.2	8.4	Water level (b.g.l) in > 50 % area of the block is < 5 mts.So considered Safe
2	LAMBI	45	NO	NO	SAFE	-6.5	-4.2	
3	MALOUT	64	NO	NO	SAFE	-2.2	1.7	
4	MUKTSAR	85	NO	NO	SAFE	-0.4	-5.4	Water level (b.g.l) in whole of the block is < 5 mts.So considered Safe
	District:	**NAWAN SHAHR**						
1	AUR	177	YES	YES	OVER-EXPLOITED	33.2	50.2	
2	BALACHAUR	63	YES	YES	SAFE	30.3	42.2	
3	BANGA	150	YES	YES	OVER-EXPLOITED	66.6	89.7	
4	NAWAN SHAHR	108	YES	YES	OVER-EXPLOITED	22.6	18.7	
5	SAROYA	66	NO	YES	SAFE	-5.4	12.8	
	Disrtict:	**PATHANKOT**						
1	BAMYAL	105	NO	NO	SAFE	-4.5	7.9	Water level (b.g.l) in whole of the block is < 5 mts.So considered Safe
2	DHAR KALAN	24	YES	YES	SAFE	23.6	48.8	
3	PATHANKOT	81	YES	YES	SEMI-CRITICAL	14.9	23	
4	NAROT JAIMAL SINGH	107	NO	YES	SAFE	2.8	12	Water level (b.g.l) in > 50 % area of the block is < 5 mts.So considered Safe

	District:	**PATIALA**						
1	BHUNER HERI	231	YES	YES	OVER-EXPLOITED	90.6	103.6	
2	GHANAUR	160	YES	YES	OVER-EXPLOITED	60.5	80.1	
3	NABHA	160	YES	YES	OVER-EXPLOITED	75.9	72	
4	PATIALA	228	YES	YES	OVER-EXPLOITED	83.1	91.1	
5	RAJPURA	211	YES	YES	OVER-EXPLOITED	128.7	128.1	
6	SAMANA	248	YES	YES	OVER-EXPLOITED	133.6	125.6	
7	SANAUR	250	YES	YES	OVER-EXPLOITED	109.5	112	
8	PATRAN	368	YES	YES	OVER-EXPLOITED	143.5	119.6	
	District:	**ROPAR**						
1	ANANDPUR SAHIB	80	YES	YES	SEMI-CRITICAL	11.4	14.6	
2	CHAMKAUR SAHIB	212	NO	NO	OVER-EXPLOITED	-1.3	8.9	
3	MORINDA	178	YES	YES	OVER-EXPLOITED	58.8	53.2	
4	NURPUR BEDI	109	YES	YES	OVER-EXPLOITED	16	31.5	
5	ROPAR	47	YES	YES	SAFE	34.9	39.3	
	District:	**MOHALI**						
1	DERA BASSI	147	NO	YES	OVER-EXPLOITED	7.1	14.1	
2	KHARAR	119	YES	YES	OVER-EXPLOITED	66.4	69.2	
3	SIALBA MAJRI	58	YES	YES	SAFE	108.7	113.8	
	District:	**SANGRUR**						
1	AHMEDGARH	275	YES	YES	OVER-EXPLOITED	53.1	63.3	
2	ANDANA	271	YES	YES	OVER-EXPLOITED	156.3	154.8	
3	BHIWANIGARH	251	YES	YES	OVER-EXPLOITED	115.1	102.6	
4	DHURI	320	YES	YES	OVER-EXPLOITED	125.5	122.6	
5	LEHRAGHAGA	222	YES	YES	OVER-EXPLOITED	113.6	101.8	
6	MALER KOTLA	198	YES	YES	OVER-EXPLOITED	102.3	103.4	
7	SANGRUR	285	YES	YES	OVER-EXPLOITED	133.3	131.3	
8	SHERPUR	254	YES	YES	OVER-EXPLOITED	88.3	75.2	
9	SUNAM	299	YES	YES	OVER-EXPLOITED	90.3	77.5	
	District:	**TARN TARAN**						
1	BHIKHIWIND	139	YES	YES	OVER-EXPLOITED	41.9	57.5	
2	CHOLA SAHIB	141	YES	YES	OVER-EXPLOITED	65.5	85	
3	GANDIWIND	134	YES	YES	OVER-EXPLOITED	52.7	57.4	
4	KHADUR SAHIB	164	YES	YES	OVER-EXPLOITED	35.2	43	
5	NAUSHEHRA PANUAN	177	YES	YES	OVER-EXPLOITED	30	46.9	
6	PATTI	177	YES	YES	OVER-EXPLOITED	48.5	55.3	
7	TARN TARAN	147	YES	YES	OVER-EXPLOITED	43.3	50.2	
8	VALTOHA	163	YES	YES	OVER-EXPLOITED	19.3	27.5	

Annexure-III H

ASSESSMENT OF DYNAMIC GROUND WATER RESOURCES OF THE PUNJAB STATE
SUMMARY OF ASSESSMENT UNIT-WISE CATEGORIZATION
as on 31.3.2017

S. N.	District	Total Blocks	Over-Exploited	Critical	Semi-Critical	Safe	Poor Quality
1	AMRITSAR	8	8				0
2	BARNALA	3	3				2
3	BATHINDA	7	3		1	3	7
4	FARIDKOT	2	2				2
5	FATEH GARH SAHIB	5	5				0
6	FAZILKA	4	1			3	4
7	FEROZEPUR	6	6				1
8	GURDASPUR	10	8	1		1	0
9	HOSHIARPUR	10	4		2	4	0
10	JALANDHAR	10	10				0
11	KAPURTHALA	5	5				0
12	LUDHIANA	12	12				0
13	MANSA	5	4	1			5
14	MOGA	5	5				3
15	MUKTSAR	4				4	3
16	NAWAN SHAHR	5	3			2	0
17	PATHANKOT	4			1	3	0
18	PATIALA	8	8				0
19	ROPAR	5	3		1	1	0
20	MOHALI	3	2			1	0
21	SANGRUR	9	9				5
22	TARN TARAN	8	8				0
	Total	138	109	2	5	22	32

ANNEXURE - I

ANNUAL GROUND WATER RECHARGE IN POOR QUALITY ZONE OF THE PUNJAB STATE , as on 31.3.2017

S. No.	Assessment Unit (Block)/District	Recharge from rainfall during monsoon season (ham)	Recharge from other sources during monsoon season (ham)	Recharge from rainfall and other sources, if any during monsoon season (ham)	Recharge from rainfall during non-monsoon season (ham)	Recharge from other sources during non-monsoon season (ham)	Recharge from rainfall and other sources, if any during non-monsoon season (ham)	Total annual Ground Water Recharge (ham) (4+5+6+7)	Provision for Natural Discharges (ham)	Net Annual Ground Water Availability (ham) (8-9)
1	2	4	5		6	7		8	9	10
	District:	**BARNALA**								
1	BARNALA	5689	15470	21158	1107	3060	4167	25325	2533	22793
3	SEHNA	3657	14669	18326	549	6768	7317	25643	2564	23078
	TOTAL	**9346**	**30138**	**39484**	**1657**	**9827**	**11484**	**50968**	**5097**	**57919**
	District:	**BATHINDA**								
1	PHUL	2675	11167	13842	701	4968	5669	19511	1951	17560
2	NATHANA	3293	9908	13201	745	8691	9436	22637	1132	21505
3	MAUR	3065	6563	9628	501	5280	5781	15408	1541	13868
4	BATHINDA	5375	15708	21083	960	15827	16787	37870	1893	35976
5	TALWANDI SABOO	2859	5462	8321	908	6556	7464	15785	1578	14206
6	SANGAT	3795	4678	8472	596	5935	6531	15004	1500	13503
7	RAMPURA	2464	11727	14191	692	12316	13008	27199	2720	24479
	TOTAL	**23526**	**65212**	**88738**	**5103**	**59573**	**64676**	**153414**	**12316**	**141098**
	District:	**FARIDKOT**								
1	FARIDKOT	6592	20426	27018	1307	8822	10129	37148	3715	33433
2	KOT KAPURA	5648	17953	23602	894	5576	6471	30072	3007	27065
	TOTAL	**12240**	**38380**	**50620**	**2202**	**14399**	**16600**	**67220**	**6722**	**60498**
	District:	**FAZILKA**								
1	ABOHAR	4850	11030	15879	725	17259	17985	33864	3386	30478
2	FAZILKA	6011	15133	21144	945	6527	7472	28616	2862	25755
3	JALALABAD	3683	15857	19540	658	3558	4215	23755	2376	21380
4	KHUYIAN SARWAR	5401	3792	9193	930	6330	7260	16453	1645	14808
	TOTAL	**19944**	**45812**	**65757**	**3258**	**33674**	**36932**	**102689**	**10269**	**92420**
	District:	**FEROZEPUR**								
3	GURU HAR SAHAI	3575	16456	20030	1015	3634	4649	24679	2468	22211
	TOTAL	**3575**	**16456**	**20030**	**1015**	**3634**	**4649**	**24679**	**2468**	**123692**
	District:	**MANSA**								
1	BHIKHI	1939	14544	16483	287	7534	7821	24305	2430	21874
2	BUDHLADA	5759	12961	18721	1352	6370	7722	26443	2644	23799
3	JHUNIR	4820	8484	13304	821	9502	10324	23627	2363	21265
4	MANSA	3120	14189	17309	614	9232	9846	27155	2715	24439
5	SARDULGARH	1881	6111	7993	461	4232	4694	12686	1269	11418
	TOTAL	**17519**	**56290**	**73809**	**3536**	**36871**	**40407**	**114216**	**11422**	**102794**

	District:	**MOGA**								
1	BAGHA PURANA	4009	25414	29423	820	8800	9620	39043	3904	35139
4	MOGA II	3295	8551	11846	707	1065	1772	13618	1362	12256
5	NIHAL SINGH WALA	3461	11618	15079	657	1819	2476	17555	1755	15799
	TOTAL	**10765**	**45583**	**56348**	**2183**	**11684**	**13867**	**70215**	**7022**	**107683**
	District:	**MUKTSAR**								
1	GIDDERBAHA/ (KOT BHAI)	4761	7264	12025	706	4423	5129	17154	1715	15438
3	MALOUT	4773	5321	10094	746	6826	7572	17666	1767	15899
4	MUKTSAR	5651	9922	15573	1587	8567	10154	25727	2573	23155
	TOTAL	**15184**	**22508**	**37692**	**3039**	**19816**	**22855**	**60547**	**6055**	**73499**
	District:	**SANGRUR**								
4	DHURI	2646	7031	9677	519	1163	1681	11359	1136	10223
5	LEHRAGHAGA	4199	6970	11169	1321	2551	3872	15041	1504	13537
7	SANGRUR	5683	9468	15151	1350	2304	3654	18805	1880	16924
8	SHERPUR	2426	8172	10598	325	3117	3441	14040	1404	12636
9	SUNAM	6870	14536	21405	1373	4583	5955	27361	2736	24625
	TOTAL	**21824**	**46176**	**68001**	**4887**	**13717**	**18604**	**86605**	**8660**	**144088**
	STATE TOTAL	**133923**	**366555**	**500479**	**26880**	**203195**	**230074**	**730553**	**70030**	**903692**

ANNEXURE III J

ADDITIONAL POTENTIAL RECHARGE UNDER SPECIFIC CONDITIONS OF THE PUNJAB STATE , as on 31.3.2017 (in ha m)

S. No.	Assessment Unit / District	Potential Recharge in water logged and shallow water level area	Potential Recharge in flood prone area	Total Annual Additional Potential Ground Water Recharge (3+4)
1	2	3	4	5
	District:	**AMRITSAR**		
1	AJNALA	312		312
2	CHOGAWAN	0		0
3	HARSHA CHINA	0		0
4	JANDIALA	0		0
5	MAJITHA	0		0
6	RAYYA	0		0
7	TARSIKA	0		0
8	VERKA	0		0
	TOTAL	**312**		**312**
	District:	**BARNALA**		
1	BARNALA	0		0
2	MAHAL KALAN	0		0
3	SEHNA	0		0
	TOTAL	**0**		**0**
	District:	**BATHINDA**		
1	PHUL	0		0
2	NATHANA	0		0
3	MAUR	0		0
4	BATHINDA	0		0
5	TALWANDI SABOO	0		0
6	SANGAT	1		1
7	RAMPURA	0		0
	TOTAL	1		1
	District:	**FARIDKOT**		
1	FARIDKOT	41		41
2	KOT KAPURA	9		9
	TOTAL	51		51
	District:	**FATEHGARH SAHIB**		
1	KHERA	0		0
2	SIRHIND	0		0
3	AMLOH	0		0
4	BASSI PATHANA	0		0
5	KHAMANON	0		0
	TOTAL	0		0
	District:	**FAZILKA**		
1	ABOHAR	160		160
2	FAZILKA	109		109
3	JALALABAD	30		30
4	KHUYIAN SARWAR	143		143
	TOTAL	442		442

	District:	**FEROZEPUR**		
1	FEROZPUR	1		1
2	GHALL KHURD	6		6
3	GURU HAR SAHAI	15		15
4	MAKHU	0		0
5	MAMDOT	1		1
6	ZIRA	0		0
	TOTAL	23		23
	District:	**GURDASPUR**		
1	BATALA	0		0
2	DINA NAGAR	1429		1429
3	FATEHGARH CHURIAN	0		0
4	GURDASPUR	1372		1372
5	KAHNUWAN	9		9
6	KALANAUR	679		679
7	QADIAN	0		0
8	SRI HARGOBINDPUR	0		0
9	DERA BABA NANAK	127		127
10	DHARIWAL	1		1
	TOTAL	3619		3619
	District:	**HOSHIARPUR**		
1	HOSHIARPUR-II	0		0
2	BHUNGA	10		10
3	DASUYA	8		8
4	GARHSAHNKAR	0		0
5	HAZIPUR	1		1
6	HOSHIARPUR-1	0		0
7	MAHILPUR	0		0
8	MUKERIAN	13		13
9	TALWARA	0		0
10	TANDA	1		1
	TOTAL	32		32
	District:	**JALANDHAR**		
1	ADAMPUR	0		0
2	BHOGPUR	0		0
3	RURKA KALAN	0		0
4	JALANDHAR-EAST	0		0
5	JALANDHAR-WEST	0		0
6	LOHIAN	0		0
7	NAKODAR	0		0
8	NUR MAHAL	0		0
9	PHILLAUR	0		0
10	SHAHKOT	0		0
	TOTAL	0		0
	District:	**KAPURTHALA**		
1	NADALA	0		0
2	DHILWAN	0		0
3	KAPURTHALA	0		0
4	PHAGWARA	0		0
5	SULTANPUR LODHI	1		1
	TOTAL	1		1

	District:	LUDHIANA		
1	DEHLON	0		0
2	DORAHA	0		0
3	JAGRAON	0		0
4	KHANNA	0		0
5	LUDHIANA	0		0
6	MACHHIWARA	2		2
7	MANGAT	83		83
8	PAKHOWAL	0		0
9	RAIKOT	0		0
10	SAMRALA	0		0
11	SIDHWAN BET	0		0
12	SUDHAR	0		0
	TOTAL	84		84
	District:	MANSA		
1	BHIKHI	0		0
2	BUDHLADA	0		0
3	JHUNIR	294		294
4	MANSA	189		189
5	SARDULGARH	0		0
	TOTAL	483		483
	District:	MOGA		
1	BAGHA PURANA	0		0
2	DHARAMKOT (KOT ISA KHAN)	0		0
3	MOGA I	0		**0**
4	MOGA II	0		**0**
5	NIHAL SINGH WALA	0		0
	TOTAL	0		0
	District:	MUKTSAR		
1	GIDDERBAHA/ (KOT BHAI)	105		105
2	LAMBI	131		131
3	MALOUT	210		210
4	MUKTSAR	296		296
	TOTAL	742		742
	District:	NAWAN SHAHR		
1	AUR	0		0
2	BALACHAUR	0		0
3	BANGA	0		0
4	NAWAN SHAHR	0		0
5	SAROYA	0		0
	TOTAL	0		0
	District:	PATIALA		
1	BHUNER HERI	0		0
2	GHANAUR	4		4
3	NABHA	0		0
4	PATIALA	0		0
5	RAJPURA	0		0
6	SAMANA	0		0
7	SANAUR	0		0
8	PATRAN	0		0
	TOTAL	4		**4**

	District:	**PATHANKOT**		
1	BAMYAL	333		333
2	DHAR KALAN	339		339
3	PATHANKOT	850		850
4	NAROT JAIMAL SINGH	1304		1304
	TOTAL	2826		2826
	District:	**ROPAR**		
1	ANANDPUR SAHIB	55		55
2	CHAMKAUR SAHIB	1		1
3	MORINDA	0		0
4	NURPUR BEDI	2		2
5	ROPAR	16		16
	TOTAL	73		73
	District:	**MOHALI**		
1	DERA BASSI	10		10
2	KHARAR	0		0
3	SIALBA MAJRI	0		0
	TOTAL	**10**		**10**
	District:	**SANGRUR**		
1	AHMEDGARH	0		0
2	ANDANA	0		0
3	BHIWANIGARH	0		0
4	DHURI	0		0
5	LEHRAGHAGA	0		0
6	MALER KOTLA	0		0
7	SANGRUR	0		0
8	SHERPUR	0		0
9	SUNAM	0		0
	TOTAL	0		0
	District:	**TARN TARAN**		
1	BHIKHIWIND	0		0
2	CHOLA SAHIB	0		0
3	GANDIWIND	0		0
4	KHADUR SAHIB	0		0
5	NAUSHEHRA PANUAN	0		0
6	PATTI	0		0
7	TARN TARAN	0		0
8	VALTOHA	0		0
	TOTAL	0		0
		8705		**8705**

TABLE -I

GROUND WATER RESOURCE POTENTIAL OF PUNJAB STATE as on 31.3.2017

S. No.	Assessment Unit /District	Geographical Area (hac)	Recharge from rainfall during monsoon season (ham)	Recharge from other sources during monsoon season (ham)	Recharge from rainfall during non-monsoon season (ham)	Recharge from other sources during non-monsoon season (ham)	Total annual Ground Water Recharge (ham) (4+5+6+7)	Provision for Natural Discharges (ham)	Net Annual Ground Water Availability (ham) (8-9)
1	2	3	4	5	6	7	8	9	10
1	AMRITSAR	240330	30913	88382	8132	44165	171592	17159	154433
2	BARNALA	135170	11860	36439	2292	13764	64354	6435	57919
3	BATHINDA	354720	23526	65212	5103	59573	153414	12316	141098
4	FARIDKOT	141860	12240	38380	2202	14399	67220	6722	60498
5	FATEH GARH SAHIB	111670	15746	32822	3590	9543	61700	6170	55530
6	FAZILKA	290190	19944	45812	3258	33674	102689	10269	92420
7	FEROZEPUR	254000	19819	88613	5254	23749	137436	13744	123692
8	GURDASPUR	254450	39037	95339	10704	27671	172752	16656	156096
9	HOSHIARPUR	333140	45197	25468	12141	12164	94970	9039	85931
10	JALANDHAR	263350	35349	62313	8193	24553	130408	13041	117367
11	KAPURTHALA	161810	21157	41574	5780	9414	77924	7792	70131
12	LUDHIANA	358690	47046	114523	9962	43907	215438	21544	193894
13	MANSA	207090	17519	56290	3536	36871	114216	11422	102794
14	MOGA	217220	21395	76758	4251	17244	119648	11965	107683
15	MUKTSAR	265610	18478	29432	3814	29943	81666	8167	73499
16	NAWAN SHAHR	132540	20468	29886	4891	15062	70307	7031	63276
17	PATIALA	330270	42501	72475	9144	28317	152437	15244	137193
18	PATHANKOT	96860	11576	8792	4284	6588	31239	2774	28465
19	ROPAR	137040	16966	13808	4271	10034	45079	4508	40571
20	MOHALI	118900	17874	4133	4256	2135	28397	2565	25832
21	SANGRUR	373730	39220	81155	8858	30866	160098	16010	144088
22	TARN TARAN	258340	26388	75249	7100	31360	140097	14010	126087
	TOTAL	**5036980**	**554219**	**1182854**	**131014**	**524992**	**2393079**	**234581**	**2158498**

TABLE-II

ASSESSMENT OF DYNAMIC GROUND WATER RESOURCES OF THE PUNJAB STATE , as on 31.3.2017

S. No.	Assessment Unit/ Distict	Geographical Area (hac)	Net Annual Ground Water Availability (ham)	Existing Gross Ground Water Draft for irrigation (ham)	Existing Gross Ground Water Draft for domestic and industrial water supply (ham)	Existing Gross Ground Water Draft for all uses (5+6) (ham)	Provision for domestic, and industrial requirement supply to 25 years (ham)	Net Annual Ground Water Availability for future irrigation development (4-5-8) (ham)	Stage of Ground Water Development 7/4*100 (%)
1	2	3	4	5	6	7	8	9	10
1	AMRITSAR	240330	154433	217950	10014	227964	13655	-77172	148
2	BARNALA	135170	57919	119753	2340	122093	3217	-65051	211
3	BATHINDA	354720	141098	132149	5484	137633	7528	1422	98
4	FARIDKOT	141860	60498	96432	4746	101179	5656	-41590	167
5	FATEH GARH SAHIB	111670	55530	112087	3162	115250	4032	-60590	208
6	FAZILKA	290190	92420	87076	4611	91687	6280	-937	99
7	FEROZEPUR	254000	123692	199650	3176	202825	4185	-80143	164
8	GURDASPUR	254450	156096	202477	7064	209541	9321	-55702	134
9	HOSHIARPUR	333140	85931	84890	7231	92120	9442	-8401	107
10	JALANDHAR	263350	117367	268433	12264	280697	16714	-167780	239
11	KAPURTHALA	161810	70131	151500	5419	156919	6555	-87924	224
12	LUDHIANA	358690	193894	338377	16330	354707	21176	-165659	183
13	MANSA	207090	102794	145381	16	145397	16	-42603	141
14	MOGA	217220	107683	243450	3651	247101	5020	-140787	229
15	MUKTSAR	265610	73499	51944	2705	54649	2705	18851	74
16	NAWAN SHAHR	132540	63276	71053	2402	73455	3256	-11032	116
17	PATIALA	330270	137193	290319	7139	297458	9768	-162894	217
18	PATHANKOT	96860	28465	18742	2900	21642	3838	5886	76
19	ROPAR	137040	40571	44000	3625	47626	4575	-8004	117
20	MOHALI	118900	25832	23693	7177	30869	8547	-6407	119
21	SANGRUR	373730	144088	368502	6129	374631	8427	-232842	260
22	TARN TARAN	258340	126087	188607	4187	192794	5743	-68263	153
	TOTAL	**5036980**	**2158498**	**3456464**	**121772**	**3578236**	**159655**	**-1457621**	**166**
	FIG. IN MAF		**17.49**	**28.00**	**0.99**	**28.99**	**1.293**	**-11.81**	
	FIG IN BCM		**21.58**	**34.56**	**1.22**	**35.78**	**1.60**	**-14.58**	

TABLE III

ADDITIONAL POTENTIAL RECHARGE UNDER SPECIFIC CONDITIONS OF PUNJAB STATE , as on 31.3.2017

(in ha m)

S. No.	Assessment Unit/ Distict	Potential Recharge in water logged and shallow water level area	Potential Recharge in flood prone area	Total Annual Additional Potential Ground Water Recharge (3+4)
1	**2**	**3**	**4**	**5**
1	AMRITSAR	312	0	312
2	BARNALA	0	0	0
3	BATHINDA	1	0	1
4	FARIDKOT	51	0	51
5	FATEH GARH SAHIB	0	0	0
6	FAZILKA	442	0	442
7	FEROZEPUR	23	0	23
8	GURDASPUR	3619	0	3619
9	HOSHIARPUR	32	0	32
10	JALANDHAR	0	0	0
11	KAPURTHALA	1	0	1
12	LUDHIANA	84	0	84
13	MANSA	483	0	483
14	MOGA	0	0	0
15	MUKTSAR	742	0	742
16	NAWAN SHAHR	0	0	0
17	PATIALA	4	0	4
18	PATHANKOT	2826	0	2826
19	ROPAR	73	0	73
20	MOHALI	10	0	10
21	SANGRUR	0	0	0
22	TARN TARAN	0	0	0
	TOTAL	**8705**		**8705**

TABLE-IV

ASSESSMENT OF DYNAMIC GROUND WATER RESOURCES OF THE PUNJAB STATE , as on 31.3.2017

S. No.	Assessment Unit (Block)/District	Command/non-Command/Total (Hac.)	Net Annual Ground Water Availability (ham) OLD	Method Adopted for Computing Rainfall Recharge during Monsoon OLD	Net Annual Ground Water Availability (ham) NEW	Method Adopted for Computing Rainfall Recharge during Monsoon NEW
1	2	3	4	5	6	7
	District:	**AMRITSAR**				
1	AJNALA	37550	19682	RIF Method	21022	RIF Method
2	CHOGAWAN	39600	18472	RIF Method	25567	RIF Method
3	HARSHA CHINA	25740	11448	RIF Method	17580	RIF Method
4	JANDIALA	20620	12513	RIF Method	12911	RIF Method
5	MAJITHA	27190	16606	RIF Method	28369	RIF Method
6	RAYYA	32640	16788	RIF Method	16891	RIF Method
7	TARSIKA	23650	13705	RIF Method	14324	RIF Method
8	VERKA	33340	13811	RIF Method	17769	RIF Method
	District:	**BARNALA**				
1	BARNALA	61390	22135	RIF Method	22793	RIF Method
2	MAHAL KALAN	34760	19751	RIF Method	12048	RIF Method
3	SEHNA	39020	18755	RIF Method	23078	RIF Method
	District:	**BATHINDA**				
1	PHUL	52230	12374	RIF Method	17560	RIF Method
2	NATHANA	44550	17916	RIF Method	21505	RIF Method
3	MAUR	35610	8285	RIF Method	13868	RIF Method
4	BATHINDA	73950	24334	RIF Method	35976	WTF Method
5	TALWANDI SABOO	52240	10787	RIF Method	14206	RIF Method
6	SANGAT	63040	10391	WTF Method	13503	RIF Method
7	RAMPURA	33100	16880	RIF Method	24479	RIF Method
	District:	**FARIDKOT**				
1	FARIDKOT	75210	34070	RIF Method	33433	RIF Method
2	KOT KAPURA	66650	27156	RIF Method	27065	RIF Method
	District:	**FATEHGARH SAHIB**				
1	KHERA	18080	9005	RIF Method	9455	RIF Method
2	SIRHIND	37240	15724	RIF Method	14814	RIF Method
3	AMLOH	22200	11946	RIF Method	12634	RIF Method
4	BASSI PATHANA	18650	9039	RIF Method	8868	RIF Method
5	KHAMANON	15500	7791	RIF Method	9758	RIF Method
	District:	**FAZILKA**				
1	ABOHAR	67290	15563	RIF Method	30478	RIF Method
2	FAZILKA	85920	26038	RIF Method	25755	RIF Method
3	JALALABAD	52440	20987	RIF Method	21380	RIF Method
4	KHUYIAN SARWAR	84540	12547	RIF Method	14808	RIF Method

	District:	**FEROZEPUR**				
1	FEROZPUR	46950	24003	RIF Method	25430	RIF Method
2	GHALL KHURD	53210	27329	RIF Method	26068	RIF Method
3	GURU HAR SAHAI	49060	21642	RIF Method	22211	RIF Method
4	MAKHU	28860	12329	RIF Method	14668	RIF Method
5	MAMDOT	37580	19222	RIF Method	20584	RIF Method
6	ZIRA	38340	16893	RIF Method	14731	RIF Method
	District:	**GURDASPUR**				
1	BATALA	27830	17038	RIF Method	16083	RIF Method
2	DINA NAGAR	23630	10194	RIF Method	11766	RIF Method
3	FATEHGARH CHURIAN	21330	12917	RIF Method	17629	RIF Method
4	GURDASPUR	25130	16443	RIF Method	18067	RIF Method
5	KAHNUWAN	32370	17892	RIF Method	19133	RIF Method
6	KALANAUR	22640	10870	RIF Method	12738	RIF Method
7	QADIAN	18060	11827	RIF Method	11073	RIF Method
8	SRI HARGOBINDPUR	28330	13088	RIF Method	14186	RIF Method
9	DERA BABA NANAK	29450	15667	RIF Method	16792	RIF Method
10	DHARIWAL	25680	18545	RIF Method	18629	RIF Method
	District:	**HOSHIARPUR**				
1	BHUNGA	54910	13945	RIF Method	8902	RIF Method
2	DASUYA	37450	12704	RIF Method	12186	RIF Method
3	GARHSAHNKAR	41210	12472	RIF Method	11935	RIF Method
4	HAZIPUR	12590	5701	RIF Method	8119	RIF Method
5	HOSHIARPUR-1	31120	9777	RIF Method	8622	RIF Method
6	HOSHIARPUR-II	46260	9543	WTF Method	8379	RIF Method
7	MAHILPUR	37990	7740	RIF Method	8145	RIF Method
8	MUKERIAN	25600	12736	RIF Method	8698	RIF Method
9	TALWARA	22640	1724	RIF Method	1898	RIF Method
10	TANDA	23370	9336	RIF Method	9048	RIF Method
	District:	**JALANDHAR**				
1	ADAMPUR	20420	12513	RIF Method	10889	RIF Method
2	BHOGPUR	17800	10845	RIF Method	9590	RIF Method
3	RURKA KALAN	19180	10273	RIF Method	10258	RIF Method
4	JALANDHAR-EAST	25620	9436	RIF Method	8087	RIF Method
5	JALANDHAR-WEST	33890	17515	RIF Method	15790	RIF Method
6	LOHIAN	28030	8693	RIF Method	8312	RIF Method
7	NAKODAR	35330	13185	RIF Method	17004	RIF Method
8	NUR MAHAL	31980	14313	RIF Method	13572	RIF Method
9	PHILLAUR	27030	15501	RIF Method	16071	RIF Method
10	SHAHKOT	24070	5862	RIF Method	7794	RIF Method
	District:	**KAPURTHALA**				
1	NADALA	22440	11538	RIF Method	11346	RIF Method
2	DHILWAN	25650	13684	RIF Method	13409	RIF Method
3	KAPURTHALA	39210	14205	RIF Method	14345	RIF Method
4	PHAGWARA	30040	9258	RIF Method	12338	RIF Method
5	SULTANPUR LODHI	44470	16691	RIF Method	18693	RIF Method

	District:	**LUDHIANA**				
1	DEHLON	28560	15888	RIF Method	16455	RIF Method
2	DORAHA	22480	13051	RIF Method	25391	RIF Method
3	JAGRAON	34430	23199	RIF Method	20426	RIF Method
4	KHANNA	36570	11728	RIF Method	13856	RIF Method
5	LUDHIANA	31680	12167	RIF Method	12443	RIF Method
6	MACHHIWARA	36570	13489	RIF Method	23726	RIF Method
7	MANGAT	50730	27182	RIF Method	21110	RIF Method
8	PAKHOWAL	21083	10726	RIF Method	11820	RIF Method
9	RAIKOT	26620	11655	RIF Method	10684	RIF Method
10	SAMRALA	15350	7598	RIF Method	9329	RIF Method
11	SIDHWAN BET	40170	22382	RIF Method	19610	RIF Method
12	SUDHAR	14447	10114	RIF Method	9043	RIF Method
	District:	**MANSA**				
1	BHIKHI	22120	10825	RIF Method	21874	RIF Method
2	BUDHLADA	67540	19337	RIF Method	23799	RIF Method
3	JHUNIR	58330	13683	RIF Method	21265	RIF Method
4	MANSA	35810	14410	RIF Method	24439	RIF Method
5	SARDULGARH	23290	8991	RIF Method	11418	RIF Method
	District:	**MOGA**				
1	BAGHA PURANA	46580	36486	RIF Method	35139	RIF Method
2	DHARAMKOT (KOT ISA	54900	31389	RIF Method	27797	RIF Method
3	MOGA I	44500	19346	RIF Method	16693	RIF Method
4	MOGA II	33460	15572	RIF Method	12256	RIF Method
5	NIHAL SINGH WALA	37780	16618	RIF Method	15799	RIF Method
	District:	**MUKTSAR**				
1	GIDDERBAHA/ (KOT	58360	15449	RIF Method	15438	RIF Method
2	LAMBI	65200	20216	RIF Method	19007	RIF Method
3	MALOUT	62770	16190	RIF Method	15899	RIF Method
4	MUKTSAR	79280	24956	RIF Method	23155	RIF Method
	District:	**NAWAN SHAHR**				
1	AUR	21850	14172	RIF Method	13794	RIF Method
2	BALACHAUR	37850	15467	RIF Method	15964	RIF Method
3	BANGA	23240	9652	RIF Method	9727	RIF Method
4	NAWAN SHAHR	33020	22030	RIF Method	21003	RIF Method
5	SAROYA	16580	2693	WTF Method	2788	RIF Method
	District:	**PATIALA**				
1	BHUNER HERI	38020	19494	RIF Method	16774	RIF Method
2	GHANAUR	44320	15280	RIF Method	14537	RIF Method
3	NABHA	54820	41202	RIF Method	39474	RIF Method
4	PATIALA	42310	18723	RIF Method	16335	RIF Method
5	RAJPURA	39940	13781	RIF Method	12224	RIF Method
6	SAMANA	39650	13913	RIF Method	11198	RIF Method
7	SANAUR	33980	15450	RIF Method	13946	RIF Method
8	PATRAN	37230	11240	RIF Method	12706	RIF Method

	District:	**PATHANKOT**				
1	BAMYAL	4780	1679	RIF Method	1420	WTF Method
2	DHAR KALAN	39840	6170	RIF Method	5352	RIF Method
3	PATHANKOT	35150	19723	WTF Method	16464	RIF Method
4	NAROT JAIMAL SINGH	17090	5878	RIF Method	5229	WTF Method
	District:	**ROPAR**				
1	ANANDPUR SAHIB	31140	7685	RIF Method	7627	RIF Method
2	CHAMKAUR SAHIB	15160	9030	RIF Method	9242	RIF Method
3	MORINDA	16950	5656	RIF Method	6099	RIF Method
4	NURPUR BEDI	31980	4762	RIF Method	4624	RIF Method
5	ROPAR	41810	14385	WTF Method	12979	RIF Method
	District:	**MOHALI**				
1	DERA BASSI	47990	11907	RIF Method	11828	RIF Method
2	KHARAR	41620	9246	RIF Method	8787	RIF Method
3	SIALBA MAJRI	29290	6361	RIF Method	5217	WTF Method
	District:	**SANGRUR**				
1	AHMEDGARH	35050	14523	RIF Method	15070	RIF Method
2	ANDANA	41150	11633	RIF Method	9538	RIF Method
3	BHIWANIGARH	35170	18004	RIF Method	15845	RIF Method
4	DHURI	24810	11755	RIF Method	10223	RIF Method
5	LEHRAGHAGA	46920	14296	RIF Method	13537	RIF Method
6	MALER KOTLA	46440	18958	RIF Method	25691	RIF Method
7	SANGRUR	55770	19964	RIF Method	16924	RIF Method
8	SHERPUR	22040	9996	RIF Method	12636	RIF Method
9	SUNAM	66380	20193	RIF Method	24625	RIF Method
	District:	**TARN TARAN**				
1	BHIKHIWIND	33300	13209	RIF Method	16325	RIF Method
2	CHOLA SAHIB	34980	11160	RIF Method	13716	RIF Method
3	GANDIWIND	33690	16149	RIF Method	21859	RIF Method
4	KHADUR SAHIB	34150	15633	RIF Method	16190	RIF Method
5	NAUSHEHRA PANUAN	19920	7864	RIF Method	9547	RIF Method
6	PATTI	37550	12380	RIF Method	15071	RIF Method
7	TARN TARAN	32000	14704	RIF Method	19832	RIF Method
8	VALTOHA	32750	13268	RIF Method	13548	RIF Method

TABLE-V

Comparison of Stage of Ground Water Extraction & Categorization of Previous and Present Study

Sr. No	Assessment Unit (Block)/ District	2013 STUDY		2017 STUDY		Remarks
		Stage of Ground Water Development (%)	Categorization for future ground water development (Safe/semi-critical /critcal/over-exploited)	Stage of Ground Water Development (%)	Categorization for future ground water development (Safe/semi-critical /critcal/over-exploited	
	District:	**AMRITSAR**				
1	AJNALA	169	OVER-EXPLOITED	178	OVER-EXPLOITED	
2	CHOGAWAN	111	OVER-EXPLOITED	133	OVER-EXPLOITED	
3	HARSHA CHINA	110	OVER-EXPLOITED	124	OVER-EXPLOITED	
4	JANDIALA	155	OVER-EXPLOITED	196	OVER-EXPLOITED	
5	MAJITHA	96	CRITICAL	120	OVER-EXPLOITED	Stage of Development Increased
6	RAYYA	144	OVER-EXPLOITED	168	OVER-EXPLOITED	
7	TARSIKA	151	OVER-EXPLOITED	174	OVER-EXPLOITED	
8	VERKA	104	OVER-EXPLOITED	123	OVER-EXPLOITED	
	TOTAL	**126**		**148**		
	District:	**BARNALA**				
1	BARNALA	246	OVER-EXPLOITED	255	OVER-EXPLOITED	
2	MAHAL KALAN	140	OVER-EXPLOITED	177	OVER-EXPLOITED	
3	SEHNA	177	OVER-EXPLOITED	185	OVER-EXPLOITED	
	TOTAL	**194**		**211**		
	District:	**BATHINDA**				
1	PHUL	169	OVER-EXPLOITED	184	OVER-EXPLOITED	
2	NATHANA	70	SAFE	73	SEMI-CRITICAL	Stage of Development Increased
3	MAUR	124	OVER-EXPLOITED	127	OVER-EXPLOITED	
4	BATHINDA	104	OVER-EXPLOITED	103	OVER-EXPLOITED	
5	TALWANDI SABOO	59	SAFE	65	SAFE	
6	SANGAT	56	SAFE	67	SAFE	
7	RAMPURA	65	SAFE	69	SAFE	
	TOTAL	**93**		**98**		
	District:	**FARIDKOT**				
1	FARIDKOT	158	OVER-EXPLOITED	169	OVER-EXPLOITED	
2	KOT KAPURA	162	OVER-EXPLOITED	165	OVER-EXPLOITED	
	TOTAL	**160**		**167**		
	District:	**FATEHGARH SAHIB**				
1	KHERA	203	OVER-EXPLOITED	210	OVER-EXPLOITED	
2	SIRHIND	186	OVER-EXPLOITED	213	OVER-EXPLOITED	
3	AMLOH	193	OVER-EXPLOITED	206	OVER-EXPLOITED	
4	BASSI PATHANA	186	OVER-EXPLOITED	207	OVER-EXPLOITED	
5	KHAMANON	190	OVER-EXPLOITED	199	OVER-EXPLOITED	
	TOTAL	**191**		**208**		
	District:	**FAZILKA**				
1	ABOHAR	36	SAFE	38	SAFE	
2	FAZILKA	145	OVER-EXPLOITED	155	SAFE	> 50% area under 5 mts depth
3	JALALABAD	141	OVER-EXPLOITED	150	OVER-EXPLOITED	
4	KHUYIAN SARWAR	54	SAFE	56	SAFE	
	TOTAL	**95**		**99**		

	District:	**FEROZEPUR**				
1	FEROZPUR	121	OVER-EXPLOITED	132	OVER-EXPLOITED	
2	GHALL KHURD	180	OVER-EXPLOITED	198	OVER-EXPLOITED	
3	GURU HAR SAHAI	95	CRITICAL	117	OVER-EXPLOITED	Stage of Development Increased
4	MAKHU	146	OVER-EXPLOITED	149	OVER-EXPLOITED	
5	MAMDOT	125	OVER-EXPLOITED	154	OVER-EXPLOITED	
6	ZIRA	229	OVER-EXPLOITED	259	OVER-EXPLOITED	
	TOTAL	**144**		**164**		
	District:	**GURDASPUR**				
1	BATALA	151	OVER-EXPLOITED	171	OVER-EXPLOITED	
2	DINA NAGAR	103	SAFE	101	SAFE	
3	FATEHGARH CHURIAN	133	OVER-EXPLOITED	144	OVER-EXPLOITED	
4	GURDASPUR	85	SEMI-CRITICAL	93	CRITICAL	Stage of Development Increased
5	KAHNUWAN	124	OVER-EXPLOITED	137	OVER-EXPLOITED	
6	KALANAUR	131	OVER-EXPLOITED	141	OVER-EXPLOITED	
7	QADIAN	128	OVER-EXPLOITED	143	OVER-EXPLOITED	
8	SRI HARGOBINDPUR	116	OVER-EXPLOITED	129	OVER-EXPLOITED	
9	DERA BABA NANAK	140	OVER-EXPLOITED	151	OVER-EXPLOITED	
10	DHARIWAL	122	OVER-EXPLOITED	130	OVER-EXPLOITED	
	TOTAL	**124**		**134**		
	District:	**HOSHIARPUR**				
1	HOSHIARPUR-II	64	SAFE	68	SAFE	
2	BHUNGA	63	SAFE	70	SAFE	
3	DASUYA	113	OVER-EXPLOITED	123	OVER-EXPLOITED	
4	GARHSAHNKAR	114	OVER-EXPLOITED	131	OVER-EXPLOITED	
5	HAZIPUR	70	SAFE	69	SAFE	
6	HOSHIARPUR-1	120	OVER-EXPLOITED	147	OVER-EXPLOITED	
7	MAHILPUR	70	SAFE	70	SAFE	
8	MUKERIAN	90	SEMI-CRITICAL	86	SEMI-CRITICAL	
9	TALWARA	70	SAFE	81	SEMI-CRITICAL	Stage of Development Increased
10	TANDA	168	OVER-EXPLOITED	183	OVER-EXPLOITED	
	TOTAL	**99**		**111**		
	District:	**JALANDHAR**				
1	ADAMPUR	179	OVER-EXPLOITED	190	OVER-EXPLOITED	
2	BHOGPUR	248	OVER-EXPLOITED	279	OVER-EXPLOITED	
3	RURKA KALAN	201	OVER-EXPLOITED	211	OVER-EXPLOITED	
4	JALANDHAR-EAST	244	OVER-EXPLOITED	316	OVER-EXPLOITED	
5	JALANDHAR-WEST	183	OVER-EXPLOITED	213	OVER-EXPLOITED	
6	LOHIAN	213	OVER-EXPLOITED	266	OVER-EXPLOITED	
7	NAKODAR	241	OVER-EXPLOITED	277	OVER-EXPLOITED	
8	NUR MAHAL	185	OVER-EXPLOITED	218	OVER-EXPLOITED	
9	PHILLAUR	181	OVER-EXPLOITED	206	OVER-EXPLOITED	
10	SHAHKOT	246	OVER-EXPLOITED	266	OVER-EXPLOITED	
	TOTAL	**209**		**239**		
	District:	**KAPURTHALA**				
1	NADALA	188	OVER-EXPLOITED	198	OVER-EXPLOITED	
2	DHILWAN	203	OVER-EXPLOITED	217	OVER-EXPLOITED	
3	KAPURTHALA	180	OVER-EXPLOITED	201	OVER-EXPLOITED	
4	PHAGWARA	249	OVER-EXPLOITED	281	OVER-EXPLOITED	
5	SULTANPUR LODHI	204	OVER-EXPLOITED	223	OVER-EXPLOITED	
	TOTAL	**205**		**224**		

	District:	**LUDHIANA**				
1	DEHLON	178	OVER-EXPLOITED	208	OVER-EXPLOITED	
2	DORAHA	110	OVER-EXPLOITED	121	OVER-EXPLOITED	
3	JAGRAON	138	OVER-EXPLOITED	156	OVER-EXPLOITED	
4	KHANNA	208	OVER-EXPLOITED	251	OVER-EXPLOITED	
5	LUDHIANA	248	OVER-EXPLOITED	275	OVER-EXPLOITED	
6	MACHHIWARA	105	SAFE	119	OVER-EXPLOITED	Area under 5 mts depth decreased
7	MANGAT	154	OVER-EXPLOITED	174	OVER-EXPLOITED	
8	PAKHOWAL	193	OVER-EXPLOITED	210	OVER-EXPLOITED	
9	RAIKOT	223	OVER-EXPLOITED	256	OVER-EXPLOITED	
10	SAMRALA	201	OVER-EXPLOITED	225	OVER-EXPLOITED	
11	SIDHWAN BET	168	OVER-EXPLOITED	185	OVER-EXPLOITED	
12	SUDHAR	146	OVER-EXPLOITED	163	OVER-EXPLOITED	
	TOTAL	**162**		**183**		
	District:	**MANSA**				
1	BHIKHI	125	OVER-EXPLOITED	125	OVER-EXPLOITED	
2	BUDHLADA	175	OVER-EXPLOITED	188	OVER-EXPLOITED	
3	JHUNIR	98	CRITICAL	99	CRITICAL	
4	MANSA	125	OVER-EXPLOITED	123	OVER-EXPLOITED	
5	SARDULGARH	184	OVER-EXPLOITED	193	OVER-EXPLOITED	
	TOTAL	**138**		**141**		
	District:	**MOGA**				
1	BAGHA PURANA	161	OVER-EXPLOITED	178	OVER-EXPLOITED	
2	DHARAMKOT (KOT ISA KHAN)	218	OVER-EXPLOITED	210	OVER-EXPLOITED	
3	MOGA I	233	OVER-EXPLOITED	282	OVER-EXPLOITED	
4	MOGA II	229	OVER-EXPLOITED	285	OVER-EXPLOITED	
5	NIHAL SINGH WALA	241	OVER-EXPLOITED	276	OVER-EXPLOITED	
	TOTAL	**207**		**229**		
	District:	**MUKTSAR**				
1	GIDDERBAHA/ (KOT BHAI)	105	SAFE	105	SAFE	
2	LAMBI	40	SAFE	45	SAFE	
3	MALOUT	60	SAFE	64	SAFE	
4	MUKTSAR	82	SAFE	85	SAFE	
	TOTAL	**70**		**74**		
	District:	**NAWAN SHAHR**				
1	AUR	164	OVER-EXPLOITED	177	OVER-EXPLOITED	
2	BALACHAUR	61	SAFE	63	SAFE	
3	BANGA	139	OVER-EXPLOITED	150	OVER-EXPLOITED	
4	NAWAN SHAHR	94	CRITICAL	108	OVER-EXPLOITED	Stage of Development Increased
5	SAROYA	61	SAFE	66	SAFE	
	TOTAL	**107**		**116**		
	Disrtict:	**PATHANKOT**				
1	BAMYAL	82	SAFE	105	SAFE	
2	DHAR KALAN	19	SAFE	24	SAFE	
3	PATHANKOT	67	SAFE	81	SEMI-CRITICAL	Stage of Development Increased
4	NAROT JAIMAL SINGH	93	SAFE	107	SAFE	
	TOTAL	**64**		**76**		

	District:	**PATIALA**				
1	BHUNER HERI	210	OVER-EXPLOITED	231	OVER-EXPLOITED	
2	GHANAUR	148	OVER-EXPLOITED	160	OVER-EXPLOITED	
3	NABHA	152	OVER-EXPLOITED	160	OVER-EXPLOITED	
4	PATIALA	187	OVER-EXPLOITED	228	OVER-EXPLOITED	
5	RAJPURA	172	OVER-EXPLOITED	211	OVER-EXPLOITED	
6	SAMANA	198	OVER-EXPLOITED	248	OVER-EXPLOITED	
7	SANAUR	215	OVER-EXPLOITED	250	OVER-EXPLOITED	
8	PATRAN	287	OVER-EXPLOITED	368	OVER-EXPLOITED	
	TOTAL	**189**		**217**		
	District:	**ROPAR**				
1	ANANDPUR SAHIB	76	SEMI-CRITICAL	80	SEMI-CRITICAL	
2	CHAMKAUR SAHIB	202	SAFE	212	OVER-EXPLOITED	Area under 5 mts depth decreased
3	MORINDA	177	OVER-EXPLOITED	178	OVER-EXPLOITED	
4	NURPUR BEDI	102	OVER-EXPLOITED	109	OVER-EXPLOITED	
5	ROPAR	39	SAFE	47	SAFE	
	TOTAL	**109**		**117**		
	District:	**S.A.S. NAGAR**				
1	DERA BASSI	122	OVER-EXPLOITED	147	OVER-EXPLOITED	
2	KHARAR	100	OVER-EXPLOITED	117	OVER-EXPLOITED	
3	SIALBA MAJRI	44	SAFE	58	SAFE	
	TOTAL	**98**		**119**		
	District:	**SANGRUR**				
1	AHMEDGARH	219	OVER-EXPLOITED	275	OVER-EXPLOITED	
2	ANDANA	205	OVER-EXPLOITED	271	OVER-EXPLOITED	
3	BHIWANIGARH	212	OVER-EXPLOITED	251	OVER-EXPLOITED	
4	DHURI	270	OVER-EXPLOITED	320	OVER-EXPLOITED	
5	LEHRAGHAGA	194	OVER-EXPLOITED	222	OVER-EXPLOITED	
6	MALER KOTLA	153	OVER-EXPLOITED	198	OVER-EXPLOITED	
7	SANGRUR	226	OVER-EXPLOITED	285	OVER-EXPLOITED	
8	SHERPUR	240	OVER-EXPLOITED	254	OVER-EXPLOITED	
9	SUNAM	233	OVER-EXPLOITED	299	OVER-EXPLOITED	
	TOTAL	**211**		**260**		
	District:	**TARN TARAN**				
1	BHIKHIWIND	125	OVER-EXPLOITED	139	OVER-EXPLOITED	
2	CHOLA SAHIB	117	OVER-EXPLOITED	141	OVER-EXPLOITED	
3	GANDIWIND	107	OVER-EXPLOITED	134	OVER-EXPLOITED	
4	KHADUR SAHIB	148	OVER-EXPLOITED	164	OVER-EXPLOITED	
5	NAUSHEHRA PANUAN	165	OVER-EXPLOITED	177	OVER-EXPLOITED	
6	PATTI	161	OVER-EXPLOITED	177	OVER-EXPLOITED	
7	TARN TARAN	128	OVER-EXPLOITED	147	OVER-EXPLOITED	
8	VALTOHA	151	OVER-EXPLOITED	163	OVER-EXPLOITED	
	TOTAL	**133**		**153**		

TABLE VI

BLOCK WISE TOTAL AVAILABLE GROUND WATER RESOURCES IN AQUIFERS UP TO 300m DEPTH (HAM)

S. No.	Assessment Unit/Distict	Dynamic Groundwater Resources (2017) AQUIFER-I	In-storage Groundwater Resources AQUIFER-I	Groundwater Resources AQUIFER-I [(3)+(4)]	In-storage Groundwater Resources AQUIFER-II	In-storage Groundwater Resources AQUIFER- III	Total Availability of Groundwater Resources [(5)+(6)+(7)]	
							ham	bcm
1	2	3	4	5	6	7	8	9
	District:	**AMRITSAR**						
1	AJNALA	21022	262249	283271	4826	6435	294532	2.95
2	CHOGAWAN	25567	273715	299282	4901	8011	312194	3.12
3	HARSHA CHINA	17580	142703	160283	3431	3798	167512	1.68
4	JANDIALA	12911	117287	130198	1423	4368	135989	1.36
5	MAJITHA	28369	137038	165407	3624	4853	173884	1.74
6	RAYYA	16891	159805	176696	6681	3806	187183	1.87
7	TARSIKA	14324	122602	136926	2308	4334	143568	1.44
8	VERKA	17769	182436	200205	4682	4285	209172	2.09
	TOTAL	**154433**	**1397835**	**1552268**	**31876**	**39890**	**1624034**	**16.24**
	District:	**BARNALA**						
1	BARNALA	22793	154703	177496	180085	65520	423101	4.23
2	MAHAL KALAN	12048	145158	157206	94464	74639	326309	3.26
3	SEHNA	23078	191042	214120	80528	60696	355344	3.55
	TOTAL	**57919**	**490903**	**548822**	**355077**	**200855**	**1104754**	**11.05**
	District:	**BATHINDA**						
1	PHUL	17560	1094	18654	1281	523	20458	0.20
2	NATHANA	21505	1518	23023	1738	92	24853	0.25
3	MAUR	13868	103	13971	242	1449	15662	0.16
4	BATHINDA	35976	1903	37879	2244	504	40628	0.41
5	TALWANDI SABOO	14206	921	15128	1068	2252	18448	0.18
6	SANGAT	13503	158	13662	314	87	14063	0.14
7	RAMPURA	24479	254	24733	507	1049	26289	0.26
	TOTAL	**141098**	**5952**	**147050**	**7394**	**5957**	**160401**	**1.60**
	District:	**FARIDKOT**						
1	FARIDKOT	33433	182375	215808	0	285516	501324	5.01
2	KOT KAPURA	27065	213062	240127	0	27360	267487	2.67
	TOTAL	**60498**	**61453**	**121951**	**0**	**312876**	**768811**	**7.69**
	District:	**FATEHGARH SAHIB**						
1	KHERA	9455	62484	71939	56025	40827	168791	1.69
2	SIRHIND	14814	139427	154241	83097	75812	313150	3.13
3	AMLOH	12634	95904	108538	68316	51477	228331	2.28
4	BASSI PATHANA	8868	73854	82722	46908	34292	163922	1.64
5	KHAMANON	9758	84816	94574	26592	0	121166	1.21
	TOTAL	**55530**	**456485**	**512015**	**280938**	**202408**	**995361**	**9.95**
	District:	**FAZILKA**						
1	ABOHAR	30478	24663	55141	99144	0	154285	1.54
2	FAZILKA	25755	273156	298911	21341	0	320252	3.20
3	JALALABAD	21380	228851	250231	16920	0	267151	2.67
4	KHUYIAN SARWAR	14808	450239	465047	90929	0	555976	5.56

	TOTAL	**92420**	**976909**	**1069329**	**228334**	**0**	**1297663**	**12.98**
	District:	**FEROZEPUR**						
1	FEROZPUR	25430	229867	255297	232233	0	487530	4.88
2	GHALL KHURD	26068	340970	367038	245192	0	612230	6.12
3	GURU HAR SAHAI	22211	195938	218149	71885	0	290034	2.90
4	MAKHU	14668	301298	315966	114286	0	430252	4.30
5	MAMDOT	20584	359866	380450	0	0	380450	3.80
6	ZIRA	14731	267767	282498	195994	0	478492	4.78
	TOTAL	**123692**	**1499768**	**1623460**	**787705**	**0**	**2678988**	**26.79**
	District:	**GURDASPUR**						
1	BATALA	16083	94177	110260	4028	5636	119924	1.20
2	DINA NAGAR	11766	63612	75378	4771	2913	83062	0.83
3	FATEHGARH CHURIAN	17629	42526	60155	2663	0	62818	0.63
4	GURDASPUR	18067	125901	143967	0	0	143967	1.44
5	KAHNUWAN	19133	49144	68278	2211	0	70489	0.70
6	KALANAUR	12738	150177	162915	2388	4616	169919	1.70
7	QADIAN	11073	130516	141588	6572	4345	152505	1.53
8	SRI HARGOBINDPUR	14186	57053	71239	3325	4585	79149	0.79
9	DERA BABA NANAK	16792	123530	140323	2419	1786	144528	1.45
10	DHARIWAL	18629	157062	175691	4528	3669	183888	1.84
	TOTAL	**156096**	**993697**	**1149793**	**32905**	**27550**	**1210248**	**12.10**
	District:	**HOSHIARPUR**						
1	BHUNGA	8902	312328	321230	121600	113300	556130	5.56
2	DASUYA	12186	156391	168577	109600	42100	320277	3.20
3	GARHSAHNKAR	11935	192863	204798	128000	132200	464998	4.65
4	HAZIPUR	8119	45324	53443	39000	19600	112043	1.12
5	HOSHIARPUR-1	8622	134438	143060	49900	64100	257060	2.57
6	HOSHIARPUR-II	8379	216497	224876	85600	49000	359476	3.59
7	MAHILPUR	5143	175058	180201	97600	111100	388901	3.89
8	MUKERIAN	8907	114278	123185	74900	28700	226785	2.27
9	TALWARA	1898	141817	143715	32400	35200	211315	2.11
10	TANDA	9048	126198	135246	34200	48100	217546	2.18
	TOTAL	**83138**	**1615192**	**1698330**	**772800**	**643400**	**3114530**	**31.15**
	District:	**JALANDHAR**						
1	ADAMPUR	10889	116100	126989	51900	60800	239689	2.40
2	BHOGPUR	9590	74300	83890	51600	28800	164290	1.64
3	RURKA KALAN	10258	89800	100058	50000	43300	193358	1.93
4	JALANDHAR-EAST	8087	92200	100287	166600	32800	299687	3.00
5	JALANDHAR-WEST	15790	146400	162190	201000	47900	411090	4.11
6	LOHIAN	8312	131200	139512	62900	103100	305512	3.06
7	NAKODAR	17004	162800	179804	171400	45300	396504	3.97
8	NUR MAHAL	13572	142800	156372	60500	72100	288972	2.89
9	PHILLAUR	16071	169300	185371	163300	51900	400571	4.01
10	SHAHKOT	7794	130000	137794	122000	49500	309294	3.09
	TOTAL	**117367**	**1254900**	**1372267**	**1101200**	**535500**	**3008967**	**30.09**
	District:	**KAPURTHALA**						
1	NADALA	11346	85631	96977	97400	50600	244977	2.45
2	DHILWAN	13409	96034	109443	98400	76300	284143	2.84

3	KAPURTHALA	14345	169387	183732	136300	147700	467732	4.68
4	PHAGWARA	12338	101655	113993	184500	65700	364193	3.64
5	SULTANPUR LODHI	18693	185707	204400	54400	189300	448100	4.48
	TOTAL	**70131**	**638414**	**708545**	**571000**	**529600**	**1809145**	**18.09**
	District:	**LUDHIANA**						
1	DEHLON	16455	69401	85856	72314	61690	219860	2.20
2	DORAHA	25391	84019	109410	51059	0	160469	1.60
3	JAGRAON	20426	58057	78483	0	0	78483	0.78
4	KHANNA	13856	128808	142664	103127	0	245791	2.46
5	LUDHIANA	12443	139549	151992	75657	61586	289235	2.89
6	MACHHIWARA	23726	98923	122649	0	0	122649	1.23
7	MANGAT	21110	246036	267146	154412	0	421558	4.22
8	PAKHOWAL	11820	52552	64372	63274	37949	165595	1.66
9	RAIKOT	10684	46958	57642	0	0	57642	0.58
10	SAMRALA	9329	34924	44253	55504	78469	178226	1.78
11	SIDHWAN BET	19610	112797	132407	131266	147504	411177	4.11
12	SUDHAR	9043	33099	42142	22496	9362	74000	0.74
	TOTAL	**193894**	**1105123**	**1299017**	**729109**	**396560**	**2424686**	**24.25**
	District:	**MANSA**						
1	BHIKHI	21874	446	22320	2150	0	24470	0.24
2	BUDHLADA	23799	2286	26085	2772	0	28857	0.29
3	JHUNIR	21265	4872	26137	1638	0	27775	0.28
4	MANSA	24439	1727	26166	1212	0	27378	0.27
5	SARDULGARH	11418	1559	12977	1224	0	14201	0.14
	TOTAL	**102794**	**10890**	**113684**	**8996**	**0**	**122680**	**1.23**
	District:	**MOGA**						
1	BAGHA PURANA	35139	392390	427529	0	0	427529	4.28
2	DHARAMKOT (KOT ISA KHAN)	27797	675929	703726	0	0	703726	7.04
3	MOGA I	16693	416520	433213	0	0	433213	4.33
4	MOGA II	12256	212003	224259	0	0	224259	2.24
5	NIHAL SINGH WALA	15799	285617	301416	0	0	301416	3.01
	TOTAL	**107683**	**1982459**	**2090142**	**0**	**0**	**2090142**	**20.90**
	District:	**MUKTSAR**						
1	GIDDERBAHA/ (KOT BHAI)	15438	48322	63760	0	0	63760	0.64
2	LAMBI	19007	65722	84729	0	0	84729	0.85
3	MALOUT	15899	49714	65613	0	0	65613	0.66
4	MUKTSAR	23155	79914	103069	0	0	103069	1.03
	TOTAL	**73499**	**243672**	**317171**	**0**	**0**	**317171**	**3.17**
	District:	**NAWAN SHAHR**						
1	AUR	13794	152600	166394	59872	68538	294804	2.95
2	BALACHAUR	15964	234367	250331	111891	116001	478223	4.78
3	BANGA	9727	148922	158649	72952	74539	306140	3.06
4	NAWAN SHAHR	21003	166421	187424	126099	103560	417083	4.17
5	SAROYA	2788	75207	77995	52332	52019	182346	1.82
	TOTAL	**63276**	**777517**	**840793**	**423146**	**414657**	**1678596**	**16.79**
	District:	**PATIALA**						
1	BHUNER HERI	16774	76648	93422	85410	137162	315994	3.16
2	GHANAUR	14537	121260	135797	98342	112204	346343	3.46

3	NABHA	39474	209193	248667	129550	134028	512245	5.12
4	PATIALA	16335	121853	138188	84697	83322	306207	3.06
5	RAJPURA	12224	77643	89867	75333	74611	239811	2.40
6	SAMANA	11198	97063	108261	81446	71987	261694	2.62
7	SANAUR	13946	92969	106915	78996	71479	257390	2.57
8	PATRAN	12706	91139	103845	92927	38833	235605	2.36
	TOTAL	**137193**	**887768**	**1024961**	**726701**	**723626**	**2475288**	**24.75**
	District:	**PATHANKOT**						
1	BAMYAL	1420	9292	10712	0	0	10712	0.11
2	DHAR KALAN	5352	29621	34973	0	0	34973	0.35
3	PATHANKOT	16464	77520	93984	888	0	94872	0.95
4	NAROT JAIMAL SINGH	5229	98701	103930	163	0	104093	1.04
	TOTAL	**28465**	**215134**	**243599**	**1051**	**0**	**244650**	**2.45**
	District:	**ROPAR**						
1	ANANDPUR SAHIB	7627	59751	67378	59213	0	126591	1.27
2	CHAMKAUR SAHIB	9242	39360	48602	23217	16154	87973	0.88
3	MORINDA	6099	41494	47593	28740	28069	104402	1.04
4	NURPUR BEDI	4624	94405	99029	59867	17039	175935	1.76
5	ROPAR	12979	109365	122344	54968	52500	229812	2.30
	TOTAL	**40571**	**344375**	**384946**	**226005**	**113762**	**724713**	**7.25**
	District:	**MOHALI**						
1	DERA BASSI	11828	120935	132763	108245	79471	320479	3.20
2	KHARAR	8787	101886	110673	81098	56936	248707	2.49
3	SIALBA MAJRI	5217	73811	79028	57253	37960	174241	1.74
	TOTAL	**25832**	**296632**	**322464**	**246596**	**174367**	**743427**	**7.43**
	District:	**SANGRUR**						
1	AHMEDGARH	15070	70661	85731	83795	126447	295973	2.96
2	ANDANA	9538	112586	122124	96443	104178	322745	3.23
3	BHIWANIGARH	15845	134209	150054	88394	85986	324434	3.24
4	DHURI	10223	60797	71020	44523	41572	157115	1.57
5	LEHRAGHAGA	13537	46500	60037	48009	44684	152730	1.53
6	MALER KOTLA	25691	95325	121016	84848	70698	276562	2.77
7	SANGRUR	16924	152587	169511	137700	117316	424527	4.25
8	SHERPUR	12636	44162	56798	45525	18817	121140	1.21
9	SUNAM	24625	162467	187092	181261	168982	537335	5.37
	TOTAL	**144088**	**879294**	**1023382**	**810498**	**778680**	**2612560**	**26.13**
	District:	**TARN TARAN**						
1	BHIKHIWIND	16325	*96407*	112732	50334	0	163066	1.63
2	CHOLA SAHIB	13716	*155559*	169275	33046	6469	208789	2.09
3	GANDIWIND	21859	*151872*	173731	27087	14085	214903	2.15
4	KHADUR SAHIB	16190	*150380*	166570	20867	24162	211599	2.12
5	NAUSHEHRA PANUAN	9547	*87689*	97236	16496	5926	119658	1.20
6	PATTI	15071	*176315*	191386	39851	2415	233652	2.34
7	TARN TARAN	19832	*99164*	118996	24699	13379	157074	1.57
8	VALTOHA	13548	*101253*	114800	29227	9479	153507	1.54
	TOTAL	**126087**	**1018640**	**1144727**	**241607**	**75914**	**1462248**	**14.62**
	STATE TOTAL	**2155706**	**17153012**	**19308718**	**7582938**	**5175602**	**32067258**	**320.67**

TABLE VII

ASSESSMENT OF TOTAL AVAILABLE GROUND WATER RESOURCES IN PUNJAB (UP TO 300m DEPTH)

S. No.	Assessment Unit/Distict	Dynamic Groundwater Resources (2017) AQUIFER-I (ham)	In-storage Groundwater Resources AQUIFER-I (ham)	Groundwater Resources AQUIFER-I [(3)+(4)] (ham)	In-storage Groundwater Resources AQUIFER-II (ham)	In-storage Groundwater Resources AQUIFER-III (ham)	Annual Ground Water Availability in Poor Quality Area (ham)	Total Availability of Groundwater Resources [(5)+(6)+(7)+(8)] (ham)
1	2	3	4	5	6	7	8	9
1	AMRITSAR	154433	1397835	1552268	31876	39890	0	1624034
2	BARNALA	57919	490903	548822	355077	200855	57919	1104754
3	BATHINDA	141098	5952	147050	7394	5957	141098	160401
4	FARIDKOT	60498	61453	121951	0	312876	60498	768811
5	FATEH GARH SAHIB	55530	456485	512015	280938	202408	0	995361
6	FAZILKA	92420	976909	1069329	228334	0	92420	1297663
7	FEROZEPUR	123692	1499768	1623460	787705	0	123692	2678988
8	GURDASPUR	156096	993697	1149793	32905	27550	0	1210248
9	HOSHIARPUR	83138	1615192	1698330	772800	643400	0	3114530
10	JALANDHAR	117367	1254900	1372267	1101200	535500	0	3008967
11	KAPURTHALA	70131	638414	708545	571000	529600	0	1809145
12	LUDHIANA	193894	1105123	1299017	729109	396560	0	2424686
13	MANSA	102794	10890	113684	8996	0	102794	122680
14	MOGA	107683	1982459	2090142	0	0	107683	2090142
15	MUKTSAR	73499	243672	317171	0	0	73499	317171
16	NAWAN SHAHR	63276	777517	840793	423146	414657	0	1678596
17	PATIALA	137193	887768	1024961	726701	723626	0	2475288
18	PATHANKOT	28465	215134	243599	1051	0	0	244650
19	ROPAR	40571	344375	384946	226005	113762	0	724713
20	MOHALI	25832	296632	322464	246596	174367	0	743427
21	SANGRUR	144088	879294	1023382	810498	778680	144088	2612560
22	TARN TARAN	126087	1018640	1144727	241607	75914	0	1462248
	TOTAL	**2155706**	**17153012**	**19308718**	**7582938**	**5175602**	**903691**	**32970949**
	FIG IN MAF	**17.46**	**138.97**	**156.43**	**61.43**	**41.93**	**7.32**	**267.12**
	FIG IN BCM	**21.56**	**171.53**	**193.09**	**75.83**	**51.76**	**9.04**	**329.71**

CHARACTERIZATION OF BLOCKS BASED ON POTENTIALITY
as on 31.3.2017

S. No.	Assessment Unit / District	Unit Recharge (in Mts.)	Characterization of Blocks Based on Potentiality
1	2	3	4
	District:	**AMRITSAR**	
1	AJNALA	0.6220	HIGHLY POTENTIAL
2	CHOGAWAN	0.7174	HIGHLY POTENTIAL
3	HARSHA CHINA	0.7589	HIGHLY POTENTIAL
4	JANDIALA	0.6957	HIGHLY POTENTIAL
5	MAJITHA	1.1593	HIGHLY POTENTIAL
6	RAYYA	0.5750	HIGHLY POTENTIAL
7	TARSIKA	0.6730	HIGHLY POTENTIAL
8	VERKA	0.5922	HIGHLY POTENTIAL
	District:	**BARNALA**	
1	BARNALA	0.4125	HIGHLY POTENTIAL
2	MAHAL KALAN	0.3851	HIGHLY POTENTIAL
3	SEHNA	0.6572	HIGHLY POTENTIAL
	District:	**BATHINDA**	HIGHLY POTENTIAL
1	PHUL	0.3736	HIGHLY POTENTIAL
2	NATHANA	0.5081	HIGHLY POTENTIAL
3	MAUR	0.4327	HIGHLY POTENTIAL
4	BATHINDA	0.5121	HIGHLY POTENTIAL
5	TALWANDI SABOO	0.3022	HIGHLY POTENTIAL
6	SANGAT	0.2380	HIGHLY POTENTIAL
7	RAMPURA	0.8217	HIGHLY POTENTIAL
	District:	**FARIDKOT**	
1	FARIDKOT	0.4939	HIGHLY POTENTIAL
2	KOT KAPURA	0.4512	HIGHLY POTENTIAL
	District:	**FATEHGARH SAHIB**	
1	KHERA	0.5811	HIGHLY POTENTIAL
2	SIRHIND	0.4420	HIGHLY POTENTIAL
3	AMLOH	0.6323	HIGHLY POTENTIAL
4	BASSI PATHANA	0.5283	HIGHLY POTENTIAL
5	KHAMANON	0.6995	HIGHLY POTENTIAL
	District:	**FAZILKA**	
1	ABOHAR	0.5033	HIGHLY POTENTIAL
2	FAZILKA	0.3331	HIGHLY POTENTIAL
3	JALALABAD	0.4530	HIGHLY POTENTIAL
4	KHUYIAN SARWAR	0.1946	HIGHLY POTENTIAL

	District:	**FEROZEPUR**	
1	FEROZPUR	0.6018	HIGHLY POTENTIAL
2	GHALL KHURD	0.5443	HIGHLY POTENTIAL
3	GURU HAR SAHAI	0.5030	HIGHLY POTENTIAL
4	MAKHU	0.5647	HIGHLY POTENTIAL
5	MAMDOT	0.6086	HIGHLY POTENTIAL
6	ZIRA	0.4269	HIGHLY POTENTIAL
	District:	**GURDASPUR**	
1	BATALA	0.6421	HIGHLY POTENTIAL
2	DINA NAGAR	0.5241	HIGHLY POTENTIAL
3	FATEHGARH CHURIAN	0.9183	HIGHLY POTENTIAL
4	GURDASPUR	0.7988	HIGHLY POTENTIAL
5	KAHNUWAN	0.6568	HIGHLY POTENTIAL
6	KALANAUR	0.6251	HIGHLY POTENTIAL
7	QADIAN	0.6812	HIGHLY POTENTIAL
8	SRI HARGOBINDPUR	0.5564	HIGHLY POTENTIAL
9	DERA BABA NANAK	0.6336	HIGHLY POTENTIAL
10	DHARIWAL	0.8060	HIGHLY POTENTIAL
	District:	**HOSHIARPUR**	
1	HOSHIARPUR-II	0.2402	HIGHLY POTENTIAL
2	BHUNGA	0.2338	HIGHLY POTENTIAL
3	DASUYA	0.3616	HIGHLY POTENTIAL
4	GARHSAHNKAR	0.4245	HIGHLY POTENTIAL
5	HAZIPUR	0.7165	HIGHLY POTENTIAL
6	HOSHIARPUR-1	0.3078	HIGHLY POTENTIAL
7	MAHILPUR	0.2968	HIGHLY POTENTIAL
8	MUKERIAN	0.3577	HIGHLY POTENTIAL
9	TALWARA	0.3658	HIGHLY POTENTIAL
10	TANDA	0.4302	HIGHLY POTENTIAL
	District:	**JALANDHAR**	
1	ADAMPUR	0.5925	HIGHLY POTENTIAL
2	BHOGPUR	0.5986	HIGHLY POTENTIAL
3	RURKA KALAN	0.5942	HIGHLY POTENTIAL
4	JALANDHAR-EAST	0.3507	HIGHLY POTENTIAL
5	JALANDHAR-WEST	0.5177	HIGHLY POTENTIAL
6	LOHIAN	0.3295	HIGHLY POTENTIAL
7	NAKODAR	0.5348	HIGHLY POTENTIAL
8	NUR MAHAL	0.4716	HIGHLY POTENTIAL
9	PHILLAUR	0.6606	HIGHLY POTENTIAL
10	SHAHKOT	0.3598	HIGHLY POTENTIAL

	District:	**KAPURTHALA**	
1	NADALA	0.5618	HIGHLY POTENTIAL
2	DHILWAN	0.5809	HIGHLY POTENTIAL
3	KAPURTHALA	0.4065	HIGHLY POTENTIAL
4	PHAGWARA	0.4564	HIGHLY POTENTIAL
5	SULTANPUR LODHI	0.4671	HIGHLY POTENTIAL
	District:	**LUDHIANA**	
1	DEHLON	0.6402	HIGHLY POTENTIAL
2	DORAHA	1.2550	HIGHLY POTENTIAL
3	JAGRAON	0.6592	HIGHLY POTENTIAL
4	KHANNA	0.4210	HIGHLY POTENTIAL
5	LUDHIANA	0.4364	HIGHLY POTENTIAL
6	MACHHIWARA	0.7209	HIGHLY POTENTIAL
7	MANGAT	0.4624	HIGHLY POTENTIAL
8	PAKHOWAL	0.6229	HIGHLY POTENTIAL
9	RAIKOT	0.4460	HIGHLY POTENTIAL
10	SAMRALA	0.6753	HIGHLY POTENTIAL
11	SIDHWAN BET	0.5424	HIGHLY POTENTIAL
12	SUDHAR	0.6955	HIGHLY POTENTIAL
	District:	**MANSA**	
1	BHIKHI	1.0988	HIGHLY POTENTIAL
2	BUDHLADA	0.3915	HIGHLY POTENTIAL
3	JHUNIR	0.4051	HIGHLY POTENTIAL
4	MANSA	0.7583	HIGHLY POTENTIAL
5	SARDULGARH	0.5447	HIGHLY POTENTIAL
	District:	**MOGA**	
1	BAGHA PURANA	0.8382	HIGHLY POTENTIAL
2	DHARAMKOT (KOT ISA KHAN)	0.5626	HIGHLY POTENTIAL
3	MOGA I	0.4168	HIGHLY POTENTIAL
4	MOGA II	0.4070	HIGHLY POTENTIAL
5	NIHAL SINGH WALA	0.4647	HIGHLY POTENTIAL
	District:	**MUKTSAR**	
1	GIDDERBAHA/ (KOT BHAI)	0.2939	HIGHLY POTENTIAL
2	LAMBI	0.3239	HIGHLY POTENTIAL
3	MALOUT	0.2814	HIGHLY POTENTIAL
4	MUKTSAR	0.3245	HIGHLY POTENTIAL
	District:	**NAWANSHAHAR**	
1	AUR	0.7014	HIGHLY POTENTIAL
2	BALACHAUR	0.4686	HIGHLY POTENTIAL
3	BANGA	0.4650	HIGHLY POTENTIAL
4	NAWAN SHAHR	0.7067	HIGHLY POTENTIAL
5	SAROYA	0.2302	HIGHLY POTENTIAL

	District:	**PATIALA**	
1	BHUNER HERI	0.4902	HIGHLY POTENTIAL
2	GHANAUR	0.3645	HIGHLY POTENTIAL
3	NABHA	0.8001	HIGHLY POTENTIAL
4	PATIALA	0.4290	HIGHLY POTENTIAL
5	RAJPURA	0.3401	HIGHLY POTENTIAL
6	SAMANA	0.3138	HIGHLY POTENTIAL
7	SANAUR	0.4560	HIGHLY POTENTIAL
8	PATRAN	0.3792	HIGHLY POTENTIAL
	District:	**PATHANKOT**	
1	BAMYAL	0.3128	HIGHLY POTENTIAL
2	DHAR KALAN	0.3758	HIGHLY POTENTIAL
3	PATHANKOT	0.5204	HIGHLY POTENTIAL
4	NAROT JAIMAL SINGH	0.3221	HIGHLY POTENTIAL
	District:	**ROPAR**	
1	ANANDPUR SAHIB	0.3468	HIGHLY POTENTIAL
2	CHAMKAUR SAHIB	0.6774	HIGHLY POTENTIAL
3	MORINDA	0.3998	HIGHLY POTENTIAL
4	NURPUR BEDI	0.2939	HIGHLY POTENTIAL
5	ROPAR	0.3939	HIGHLY POTENTIAL
	District:	**MOHALI**	
1	DERA BASSI	0.2738	HIGHLY POTENTIAL
2	KHARAR	0.2346	HIGHLY POTENTIAL
3	SIALBA MAJRI	0.1875	HIGHLY POTENTIAL
	District:	**SANGRUR**	
1	AHMEDGARH	0.4777	HIGHLY POTENTIAL
2	ANDANA	0.2575	HIGHLY POTENTIAL
3	BHIWANIGARH	0.5006	HIGHLY POTENTIAL
4	DHURI	0.4578	HIGHLY POTENTIAL
5	LEHRAGHAGA	0.3206	HIGHLY POTENTIAL
6	MALER KOTLA	0.6147	HIGHLY POTENTIAL
7	SANGRUR	0.3372	HIGHLY POTENTIAL
8	SHERPUR	0.6370	HIGHLY POTENTIAL
9	SUNAM	0.4122	HIGHLY POTENTIAL
	District:	**TARN TARAN**	
1	BHIKHIWIND	0.5447	HIGHLY POTENTIAL
2	CHOLA SAHIB	0.4357	HIGHLY POTENTIAL
3	GANDIWIND	0.7209	HIGHLY POTENTIAL
4	KHADUR SAHIB	0.5268	HIGHLY POTENTIAL
5	NAUSHEHRA PANUAN	0.5325	HIGHLY POTENTIAL
6	PATTI	0.4459	HIGHLY POTENTIAL
7	TARN TARAN	0.6886	HIGHLY POTENTIAL
8	VALTOHA	0.4596	HIGHLY POTENTIAL