केंद्रीय भूमि जल बोर्ड

जल संसाधन, नदी विकास और गंगा संरक्षण मंत्रालय

भारत सरकार

Central Ground Water Board

Ministry of Water Resources, River Development and Ganga Rejuvenation

Government of India

Report

on

AQUIFER MAPPING AND MANAGEMENT PLAN

Mansa District, Punjab

उत्तरी पश्चिम क्षेत्र, चंडीगढ़

North Western Region, Chandigarh

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MANSA DISTRICT, PUNJAB

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INTRODUCTION

Mansa District is located in the southern part of Punjab State and covers an area of 2,198 sq. km and lies between North latitude 29°30' to 30°15' and East longitude 75°10' to 75°46' it lies in topographic sheet 44 N/08,12 and 44 O/01,02,05,06,09 . It is bounded by Sangrur district in the east, Bathinda District in the west, Barnala District in the North and Haryana State in the South. The district has total Population of 7,68,808 as per census 2011, with a population density of 350 persons/km^2 and the decennial growth of 11.2%. 70.40 % population of Mansa districts lives in rural areas of villages.. This district is a newly created district of Punjab by reorienting parts of adjoining Bathinda District in 1992, and is divided into five development blocks for the purpose of administrative control

Administratively Mansa district falls under Bhathinda Constituency. The district has three sub-divisions viz-Mansa , Budhlada , Sardulgarh and five development blocks viz.- Mansa , Bhikhi , Budhlada , Sardulgarh , Jhunir

1.1 Objective

The primary objective of the Aquifer Mapping Programme is to delineation of lateral and vertical disposition of aquifers and their characterization on 1: 50,000 scale in general or larger scale aquifer map. Quantification of ground water availability and assessment of its quality to formulate aquifer management plans to facilitate sustainable management of ground water resources at appropriate scales through participatory management approach with active involvement of stakeholders.

1.2 Scope of the study

Systematic mapping of an aquifer encompasses a host of activities such as collection and compilation of available information on aquifer systems, demarcation of their extents and their characterization, analysis of data gaps, generation of additional data for filling the identified data gaps and finally, preparation of aquifer maps at the desired scale. This manual attempts to evolve uniform protocols for these activities to facilitate their easy integration for the district as whole.

1.0 CLIMATE & RAINFALL

The climate in the area is typical semi-arid type with distinct wet and dry seasons. The climate of district is classified as sub- tropical steppe, semi-arid and hot which is mainly dry except in rainy months Mansa and characterized by intensely hot summer and cold winter. The normal average annual rainfall of the district is 378.2 mm. The rainfall occurs due to southwest monsoon which sets in the last week of June and withdraws towards end of September. During three months of monsoon season from July to September the district experiences high humidity, cloudiness and good monsoon rainfall. The period from October to November Constitutes post monsoon season. The cold weather season prevails from December to February followed by hot weather season or Pre monsoon season which ends up to the last week of June

Rainfall The normal annual rainfall of Mansa District is 378 mm in 23 days which is unevenly distributed over the district. The southwest monsoon sets in last week of June and withdraws towards end of September and contributes about 83% of annual rainfall. July and August are rainiest month. Rest 17% of the annual rainfall occurs during Non-monsoon months of the year in the district increases from southwest to northeast

Normal Annual Rainfall : 378mm

Normal Monsoon Rainfall : 320 mm

Table2.0 : Last five year rainfall data of Mansa District.

Table :1 Rainfall data

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC	TOTAL
2010	0	0	0	0	0	13.6	60.6	10	52.3	0	0	5	141.5
2011	1.2	43	0	15.8	8.2	19.5	25.1	30.5	42.2	0	0	0.5	186
2012	1.4	0	0	3	0	3.7	12.4	26.5	42.8	2.7	0	2	94.5
2013	3.2	24.5	5	0	0	81.7	42.3	79	21.8	0	2.5	0	260
2014	16.5	9.6	23.4	19.5	11.4	22.8	20.6	3	50.3	0	2	4.4	183.5

Temperature

Mean Maximum: 48° c (May June)
Mean Minimum: 3.5°C(January)

2.0 GEOMORPHOLOGY & SOILS

The monotony of the plain surface is broken by presence of sand ridges which are residuals of sand dunes in different parts of the district. These sand dune features were quite apparent few decades ago but due to development of agriculture many of these were levelled down but the residuals of these dunes break the monotony of the landscape. The sand dune is a ridge of sand which can assume various forms. Here, in this district linear sand ridges can be observed here and there. According to concentration of sand dunes two types of areas may be demarcated i.e.

(i) Areas with concentration of sand ridges

(ii)Areas without sand ridges

(i) **Area with Concentration of Sand Dunes**.- Sand dunes are more conspicuous in three parts of the district. The first concentration of these sand dunes is quite apparent in northwestern part of the district. Many of these sand dunes form linear chains, some of the ridges have a length of about 1km, and most of these ridges are about few hundred meters long. The second concentration is between Uddat branch and Boha distributory of Sirhind canal. Unlike the sand dunes of above mentioned concentration, these run in different directions, indicating shifting wind direction. Most of these sand ridges are small in size. The third cluster of sand dunes is discernible in villages north of Ghaggar River passing through southern part of the district.

(ii) **(ii) Areas without Sand Dunes.-** In the intervening tracts between above mentioned three micro regions, either there is complete absence of sand dunes or there are scattered sand ridges here and there.

Apart from the presence of sand dunes, which break monotony of landscape, the Ghaggar River also plays a role in forming low-lying flood plain which differs from the upland plain in terms of alluvial morphology.

3.0 GEOLOGY

The area forms a part of the Indo-Gangetic Alluvial plains consisting of quaternary sediments. These sediments can be broadly classified into three subdivisions viz. older alluvium formed by the depositional processes of older stream, newer alluvium formed by the present day streams and aeolian deposits in the form of sand dunes and sheets representing the depositional

feature of the wind action. The older alluvium and the aeolian deposits are extensive whereas the newer alluvium has limited distribution. Although a number of remnants of sand dunes are present throughout the area, these are more conspicuous towards the western and southern parts of the district.

The older alluvium comprises interbanded clay, sandy clay, silt and sand with horizons of k*ankar.* On the surface, it is chiefly represented by massive, pale reddish brown, clayey silt to fine sand with disseminated k*ankar.* A horizon of sticky clay usually a meter or so thick, locally called *pandoo*, occurs 1.5 to 3.0 metre below the surface. *Kankar* bearing levels are usually found over this pandoo zone. The *pandoo* zone not only traps water under artesian conditions but also causes water logging and consequent formation of *kankar* and sodium and magnesium salts, thereby rendering the soil infertile. At places the grains are cemented together by infiltrating silica and lime to form impervious layers. The older alluvium soils are rich in alkalies and lime although there proportion is variable. The newer alluvium is lighter in colour and more fresh looking as compared to older alluvium and aeolian deposits. It occupies a very small stretch along the course of the Ghaggar River. From the Aeolian deposits it can be distinguished by its bluish

grey colour. Aeolian deposits are widespread in the western and southern parts of the area and thin out in the eastern side. These are common in the following areas:-

1. Piplian-Mandhali-Bareh Malsinghwala
2. Budhlada-Kulana-Rangrial-Daska
3. Boha-Sher Khanwala-Kishangarh

In Kotli Khurd and Piplian-Malsinghwala area the highest dune is 8 m high with average being 3-5 m.

5.0 HYDROGEOLOGY

The area falls under the Indo-Gangetic alluvial plains. The geological formations met within the district comprise Alluvium of Quaternary age. It consists of alternating beds of sand, silt and clay. In the southwestern part, the alluvium is overlain by thin layer unstratified loam.

The pre monsoon depth to water level ranges from 5.56 to 15.01 m bgl, and post monsoon value ranges from 2.18 to 10.33 m bgl .In most of the area depth to water level occurs within 10m b.g.l. The area experiences a rise in water level from pre-monsoon to post monsoon periods due to recharge from rainfall occurred in the area. The long-term water level fluctuation over the past shows the rising trend in the northeastern part up to 5m.

The rise in water table is due to less withdrawal of ground water owing to its bad quality and / or the intensive irrigation by network of canals. The decline in water level at few places may be attributed to withdrawal of ground water due to its fresh and marginal quality and/ or non-availability of canal water to meet the requirement for agricultural purposes. The water table elevation ranges from 186 m to 209 m above mean sea level.

The general ground water flow is from northeast to southwest direction. The yield of the shallow tube wells varies from 870 to3000 liters per minute for 4 to 13 m drawdown. The long term trend of water level ranges in the district from -0.14 to -0.82 m/yr .

5.1 AQUIFER SYSTEMS

Based on the hydrogeological characteristics, the area has been classified in to 1 principal aquifer system i.e. alluvium and 2 major aquifers i.e. younger alluvium, older alluvium.

Table-2 : Major Aquifer Systems of Phase-I

S. No	Principal Aquifers Code	Principal Aquifers	Area	Major Aquifer Code	Major Aquifer	Area	% of Total Area	Age (As per Geological Time Scale)
1	**AL**	**Alluvium**	2189	AL03	Older Alluvium	1861.5	85.04	Quaternary
2				AL06	Valley fills	327.5	14.96	Quaternary
Total			**2189**			**2189**	**100**	

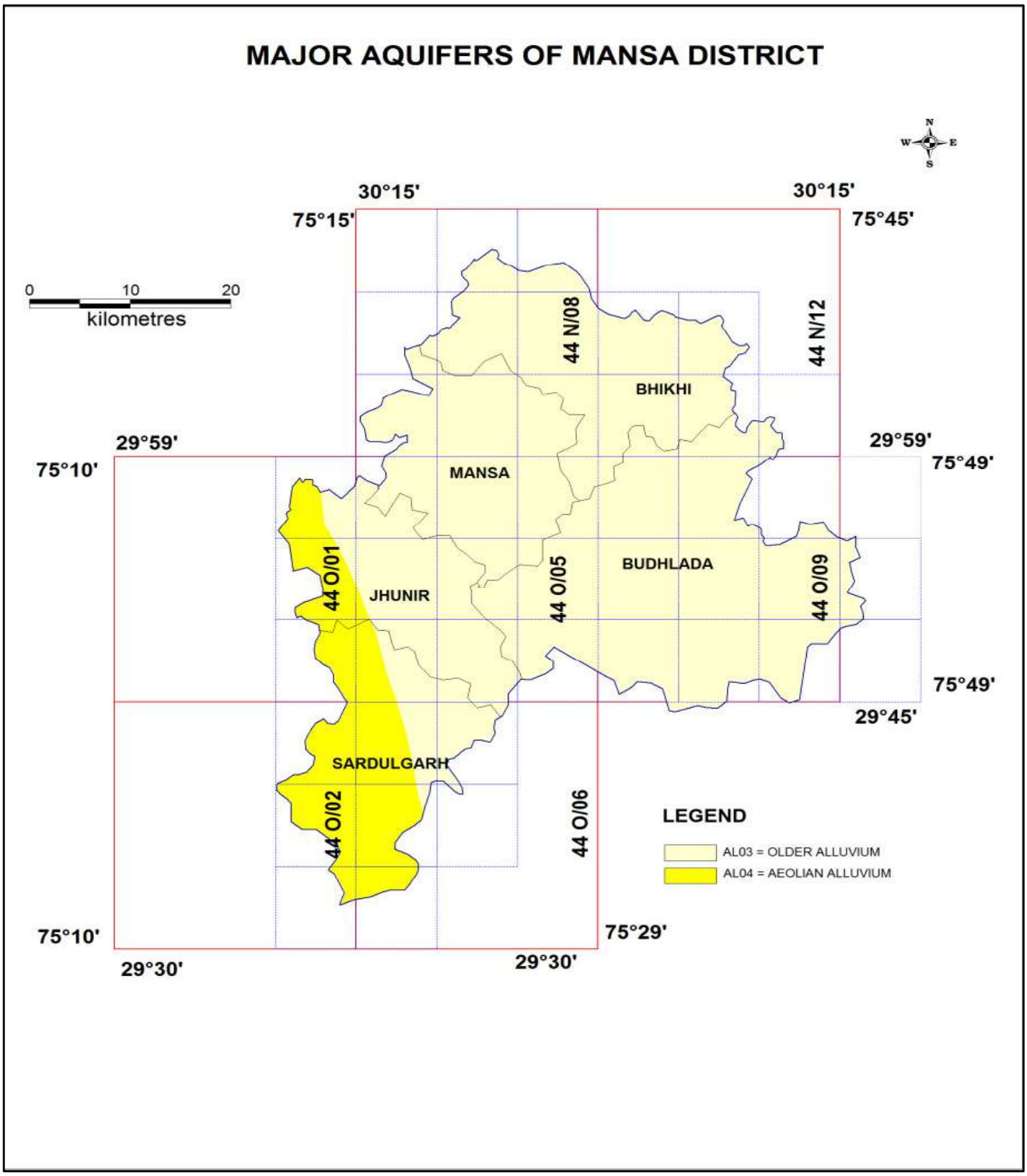


Fig. 1; Major Aquifers

5.2 Water Level Behavior

The depth to water in most of the area lies between 10-22 m bgl. within 10 m bgl. Depth to water level in the area varies from 4.5 to 26.5m bgl in pre-monsoon period, 2015 (Fig. 2). In north-eastern part, it is shallow to medium and becomes deeper towards south-western parts. In major part of the area, water level rest between 10-22 m.

5.3 Water Table Elevation

The highest elevation is in the middle part in the mansa and budhlada and the lowest in the southeastern part and reflects the topographic gradients . The hydraulic gradient in the middle part is steep, nature of formations in northeastern part and occurrence of finer sediments in southeastern part. The flow of ground water, in general, is from NE to SE direction

Fig.2

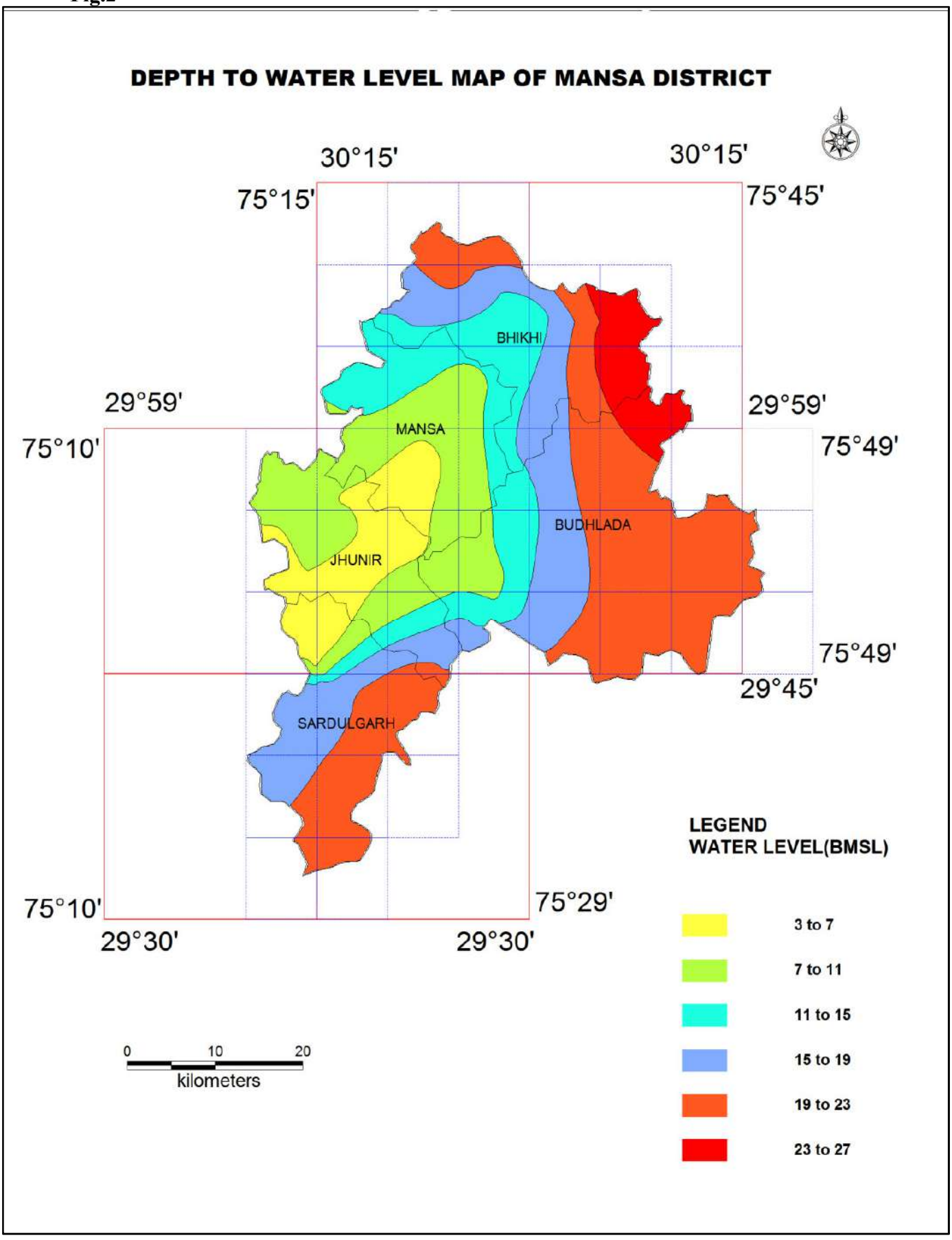
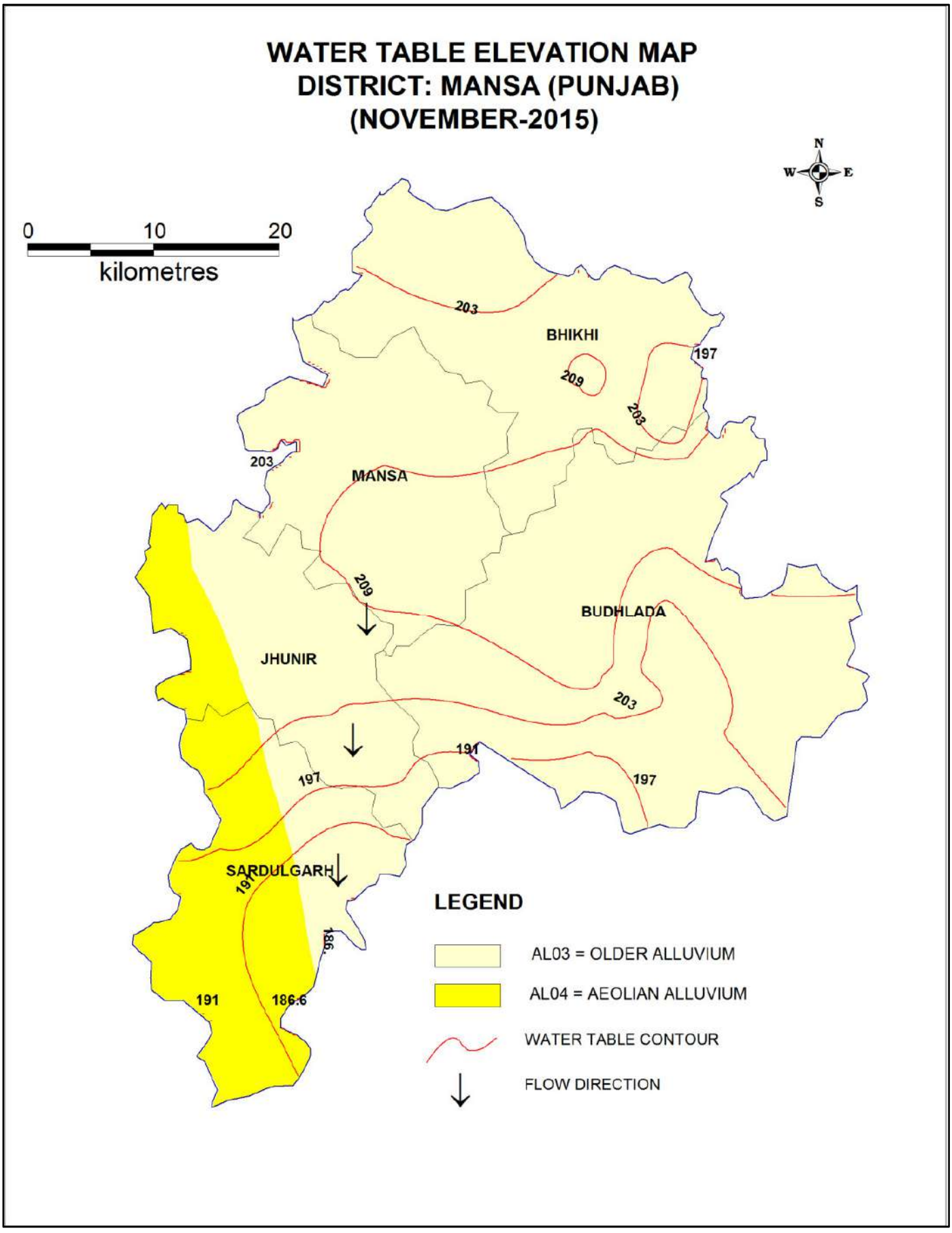

DEPTH TO WATER LEVEL MAP OF MANSA DISTRICT
30°15'
30°15'
75°15'
75°45'
BHIKHI
29°59'
29°59'
MANSA
75°10'
75°49'
BUDHLADA
JHUNIR
75°49'
29°45'
SARDULGARH
LEGEND
WATER LEVEL(BMSL)
75°10'
75°29'
29°30'
29°30'
3 to 7
7 to 11
11 to 15
15 to 19
19 to 23
23 to 27
0
10
20
kilometers

Fig.3


WATER TABLE ELEVATION MAP
DISTRICT: MANSA (PUNJAB)
(NOVEMBER-2015)
N
W
E
S
0
10
20
kilometres
203
BHIKHI
197
209
203
203
MANSA
209
BUDHLADA
JHUNIR
203
191
197
197
SARDULGARH
197
186.6
191
186.6
LEGEND
AL03 = OLDER ALLUVIUM
AL04 = AEOLIAN ALLUVIUM
WATER TABLE CONTOUR
FLOW DIRECTION

6.0 AQUIFER GEOMETRY AND CHARACTERISATION

The widespread Ground Water exploration carried out to bring a broad picture of the aquifer disposition, which is of great importance for Ground Water development. The nature of sediments, their lateral and vertical extent and aquifer systems have been studied with the help of litho logs of the boreholes drilled. A large number of sub surface geological cross section and fence diagrams have been drawn and correlated and their characterizations are described district wise along with figures

6.1 Mansa District

The nature and character of sediments, their lateral and vertical extent and aquifer system have been studied with the help of sub-surface geological sections prepared from the litho logs of the boreholes drilled in the Mansa district. The quality of ground water in the district is fresh and saline.

Central Ground Water Board has carried out 16 ground water exploratory wells up to a depth range from 248 m to 300 m , WAPCOS carried out 1 well exploration with depth range of 256.1 m and PRIVATE 12 well drilled upto a depth range of 201m to 300 m. . The depth of exploratory boreholes Transmissivity of the aquifers ranged from m^2/day 43 to 1590 m^2/day. The hydraulic conductivity values varied from 3 to 42 m/day.

6.2 Data Availability

The Lithologs of Exploratory Well/ Observation well/ Piezometer/ productive wells of CGWB, WAPCOS, and private wells have been collected and those supported electrical logs have been validate for aquifer map preparation. The details are shown

Table 6.2a Data Availability of Exploration Wells of Mansa district

Data Availability

Sl.No	Source of data	Depth Range (m)		
		< 100	100-200	200-300
1	CGWB	0	0	17
2	WAPCOS	0	0	1
3	PRIVATE	0	0	12
Total		**0**	**0**	**30**

6.3 Data Distribution

The actual data of all the wells in the area are plotted on the map of 1:50000 scale with 5 min by 5 min grid (9 x 9km) and is shown in Fig: 6.2a. The exploration data shows that majority of tube wells falls in the Ist Aquifer and IInd Aquifer. After data validation, only selected the deepest well in each quadrant is plotted on the map of 1.50000 scale with 5 min by 5 min grid (9 x 9km) and is shown in Fig: 6.2b. The grids/ formations devoid of SH/PZ/EW are identified as data gaps and these are to be filled by data generation.

Table 6.2b Data Availability of Exploration Wells of Mansa district

Data Availability

Sl.No	Source of data	Depth Range (m)		
		< 100	100-200	200-300
1	CGWB	0	0	16
2	WAPCOS	0	0	1
3	PRIVATE	0	0	12
Total		**0**	**0**	**30**

Fig 6.2a

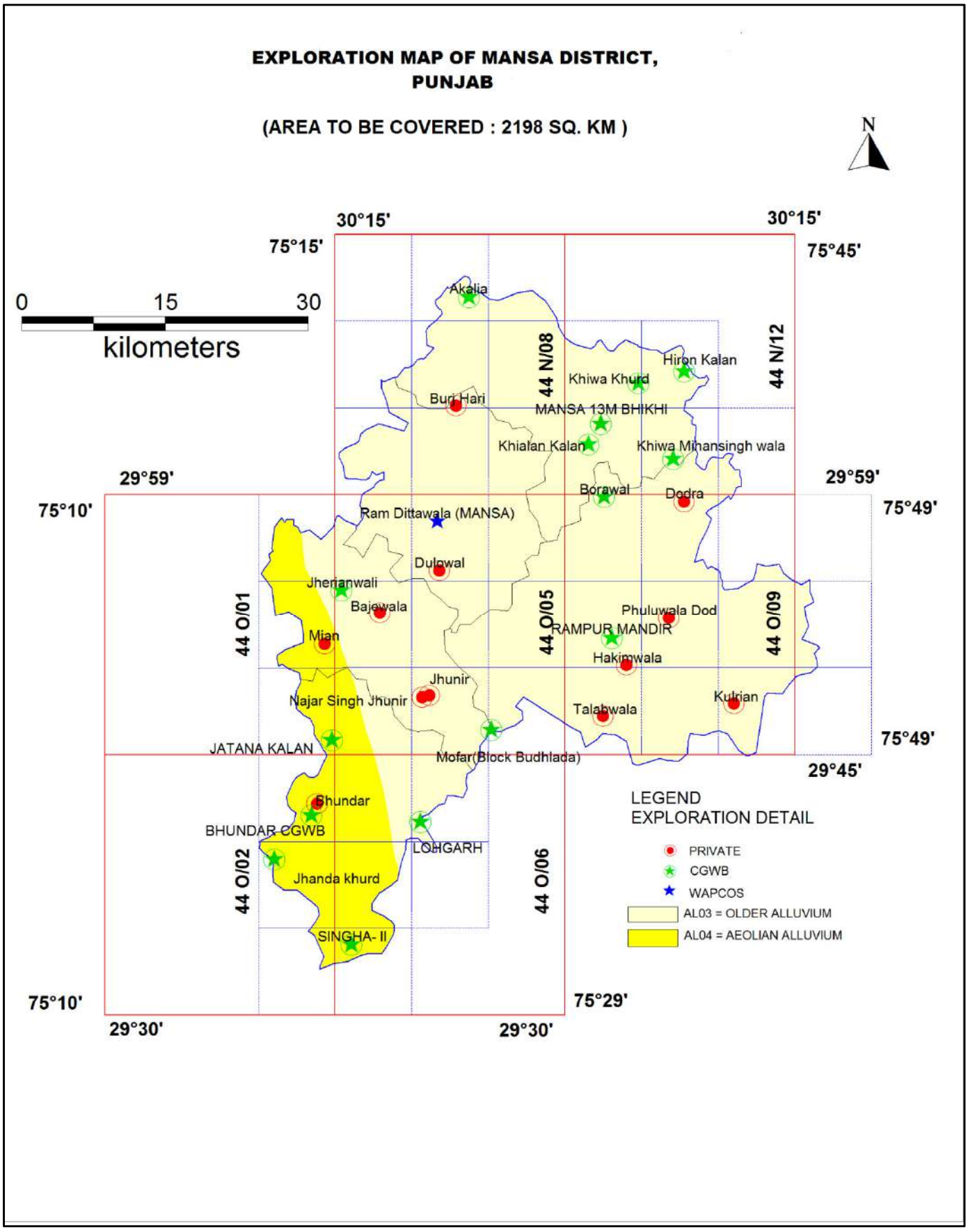
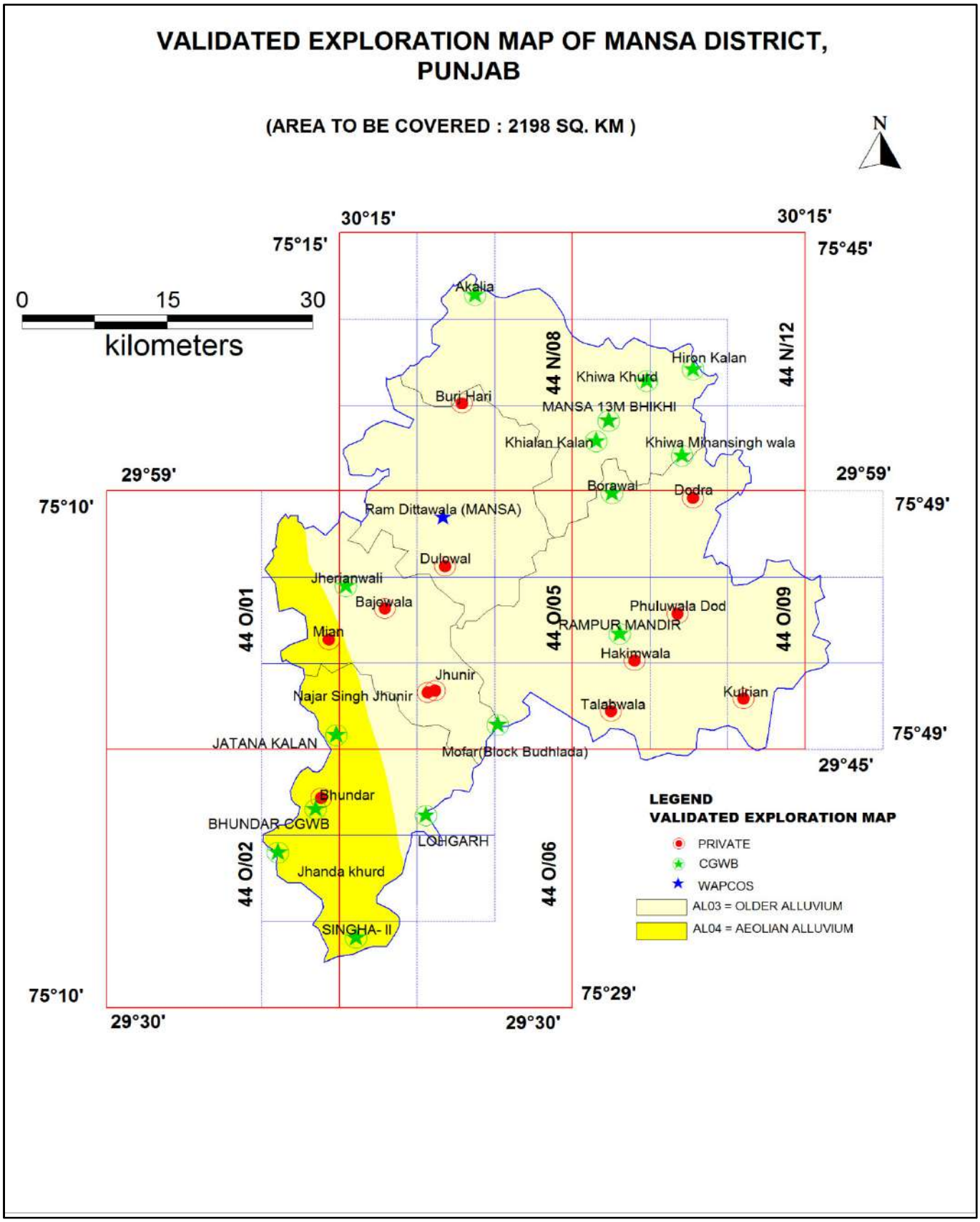

EXPLORATION MAP OF MANSA DISTRICT,
PUNJAB
(AREA TO BE COVERED : 2198 SQ. KM)
N
30°15'
75°15'
30°15'
75°45'
0
15
30
kilometers
Akalia
44 N/08
44 N/12
Hiron Kalan
Khiwa Khurd
Buri Hari
MANSA 13M BHIKHI
Khialan Kalan
Khiwa Mihansingh wala
29°59'
75°10'
29°59'
75°49'
Borawal
Dodra
Ram Dittawala (MANSA)
Dulowal
Jherianwali
Bajewala
Phuluwala Dod
RAMPUR MANDIR
Hakimwala
44 O/01
44 O/05
44 O/09
Mian
Jhunir
Najar Singh Jhunir
Talabwala
Kulrian
JATANA KALAN
Mofar(Block Budhlada)
75°49'
29°45'
Bhundar
BHUNDAR CGWB
LOHGARH
Jhanda khurd
44 O/02
44 O/06
SINGHA- II
LEGEND
EXPLORATION DETAIL
PRIVATE
CGWB
WAPCOS
AL03 = OLDER ALLUVIUM
AL04 = AEOLIAN ALLUVIUM
75°10'
75°29'
29°30'
29°30'

Fig 6.2b


VALIDATED EXPLORATION MAP OF MANSA DISTRICT, PUNJAB
(AREA TO BE COVERED : 2198 SQ. KM)
N
0
15
30
kilometers
30°15'
75°15'
30°15'
75°45'
29°59'
75°10'
29°59'
75°49'
75°49'
29°45'
75°10'
75°29'
29°30'
29°30'
44 N/08
44 N/12
44 O/01
44 O/05
44 O/09
44 O/02
44 O/06
Akalia
Hiron Kalan
Khiwa Khurd
Buri Hari
MANSA 13M BHIKHI
Khialan Kalan
Khiwa Mihansingh wala
Borawal
Dodra
Ram Dittawala (MANSA)
Dulowal
Jherianwali
Bajewala
Phuluwala Dod
RAMPUR MANDIR
Mian
Hakimwala
Jhunir
Najar Singh Jhunir
Talabwala
Kulrian
JATANA KALAN
Mofar(Block Budhlada)
Bhundar
BHUNDAR CGWB
LOHGARH
Jhanda khurd
SINGHA- II
LEGEND
VALIDATED EXPLORATION MAP
PRIVATE
CGWB
WAPCOS
AL03 = OLDER ALLUVIUM
AL04 = AEOLIAN ALLUVIUM

6.4 Physical record of Well data:

Physical record of existing data of CGWB, State Govt. and Private agency with supported electrical logs is shown below;

Table3

Bore	Longitude	Latitude	Elevation	Collar Elevation	Depth	Water level	Block	Deptt
Bajewala	75.298	29.885	213	237	300	6.5	JHUNIR	Prvt
Bhundar	75.225	29.699	209	209	300	16.2	Sardulgarh	Prvt
Burj Hari	75.381	30.084	221	221	285	14.5	Mansa	Prvt
Dodra	75.629	29.992	226	226	251	11.49	Budhlada	Prvt
Dulowal	75.363	29.926	218	218	300	8.6	Mansa	Prvt
Hakimwala	75.566	29.835	221	279	285.9	16.9	Budhlada	Prvt
Jhunir	75.350	29.805	214	214	210.4	12.2	JHUNIR	Prvt
Kulrian	75.683	29.798	222	222	292.68	18.8	Budhlada	Prvt
Mian	75.238	29.855	215	215	275	6.3	JHUNIR	Prvt
Najar Singh Jhunir	75.344	29.804	213	213	201	11.8	JHUNIR	Prvt
Phuluwala Dod	75.612	29.880	221	221	228.65	19.7	Budhlada	Prvt
Ram Dittawala (MANSA)	75.360	29.974	218	219	256.1	8.4	Mansa	WAPCOS
Talabwala	75.541	29.786	213	213	300	16.7	Budhlada	Prvt
Akalia	75.395	30.189	222	222	248	23.9	BHIKHI	CGWB
BHUNDAR CGWB	75.223	29.696	209	209	300	16.1	Sardulgarh	CGWB
Borawal	75.542	29.997	222	232	252	8.68	Budhlada	CGWB
DODHRA	75.395	30.189	221	221	251	23.9	Mansa	CGWB
Hiron Kalan	75.629	30.117	229	229	250.2	25.1	BHIKHI	CGWB
JATANA KALAN	75.246	29.763	211	211	300	8.8	Sardulgarh	CGWB
Jhanda khurd	75.183	29.649	208	208	300	15	Sardulgarh	CGWB
Jherianwali	75.256	29.907	215	215	300	6.9	Jhunir	CGWB
Khialan Kalan	75.525	30.047	221	221	258.85	17.6	BHIKHI	CGWB
Khiwa Khurd	75.579	30.106	226	226	300	22.3	BHIKHI	CGWB

Khiwa Mihansingh wala	75.617	30.033	224	224	250.25	23.6	BHIKHI	CGWB
LOHGARH	75.342	29.685	212	212	300	25.4	Sardulgarh	CGWB
MANSA 13M BHIKHI	75.538	30.067	229	229	275	18.7	BHIKHI	CGWB
Mofar(Block Budhlada)	75.419	29.769	215	215	300	20.1	Budladha	CGWB
RAMPUR MANDIR	75.550	29.861	225	225	282	14.7	Budladha	CGWB
SINGHA- II	75.267	29.567	209	209	250.5	17.1	Sardulgarh	CGWB
Bajewala	75.298	29.885	213	237	300	6.5	JHUNIR	Prvt

6.6 Sub Surface Disposition:

The study of lithologs of boreholes drilled in Mansa district indicates that the alluvium is fine to coarse sand clays. In the alluvial areas,. The top aquifer, which is unconfined occurs down and generally consists of fine to medium sand whereas the, Lower aquifers consist of mostly medium to coarse sand.

Lithological map (2D) of Mansa District along with cross Sections A-A' (N-S) , B-B' (S-NE), Section C-C' (NE-SW) , Section D-D' (W-SE), Section E-E' (S-N),Section F-F' (NE-SW) . Clay lenses which pinch out at short distances occur within the sand zones. The aquifers are thick and extensive in nature. The granular material consists of fine to coarse sand. The lithological maps (2D) and Lithological section line map with sections (2D) of Mansa districts (Fig.6.5a and Fig 6.5.b, c, d)

Fig.6.5a:Lithological map (2D) of Mansa District

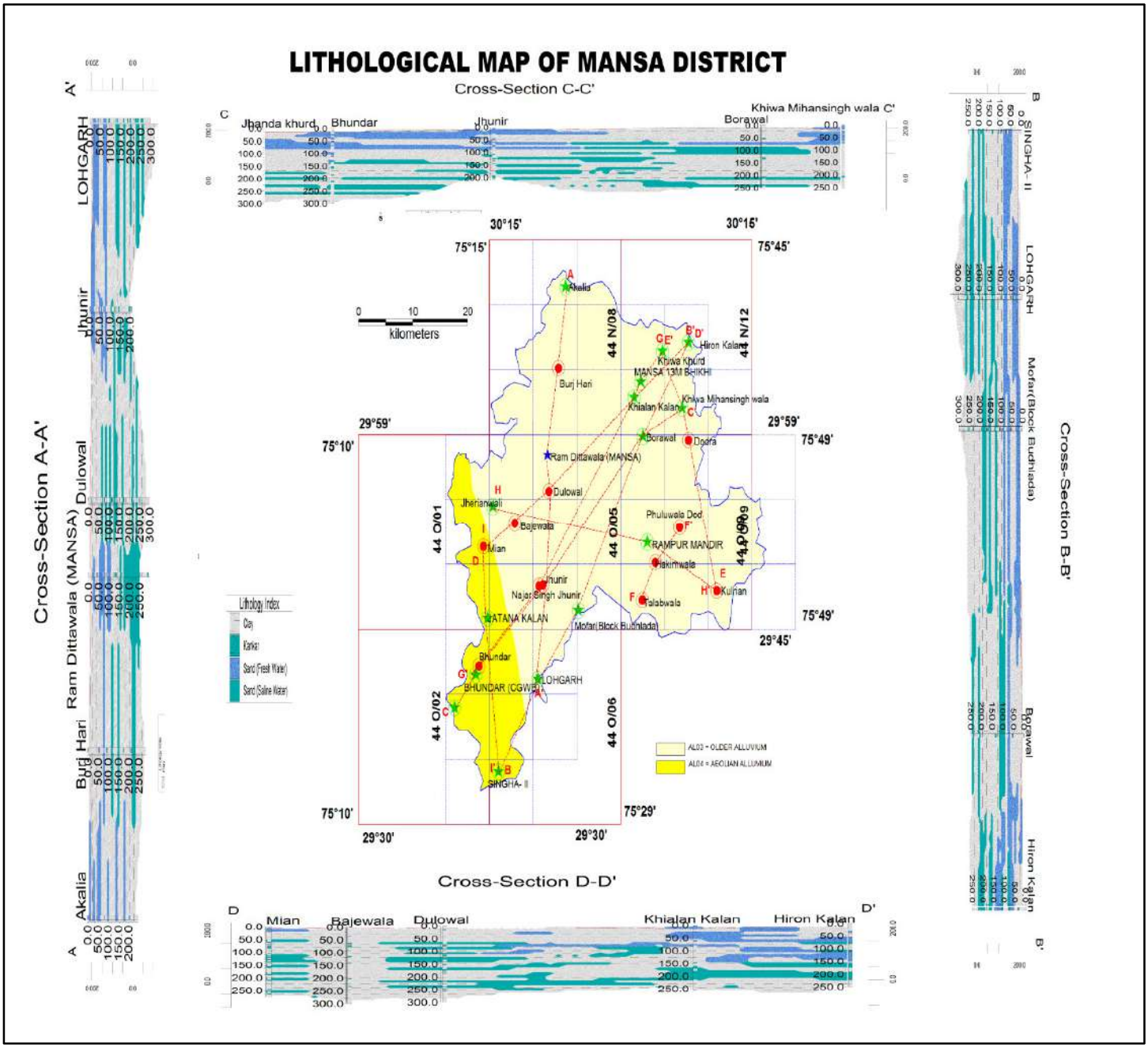


Fig.6.5b: Lithological section line map (2D) of Mansa district

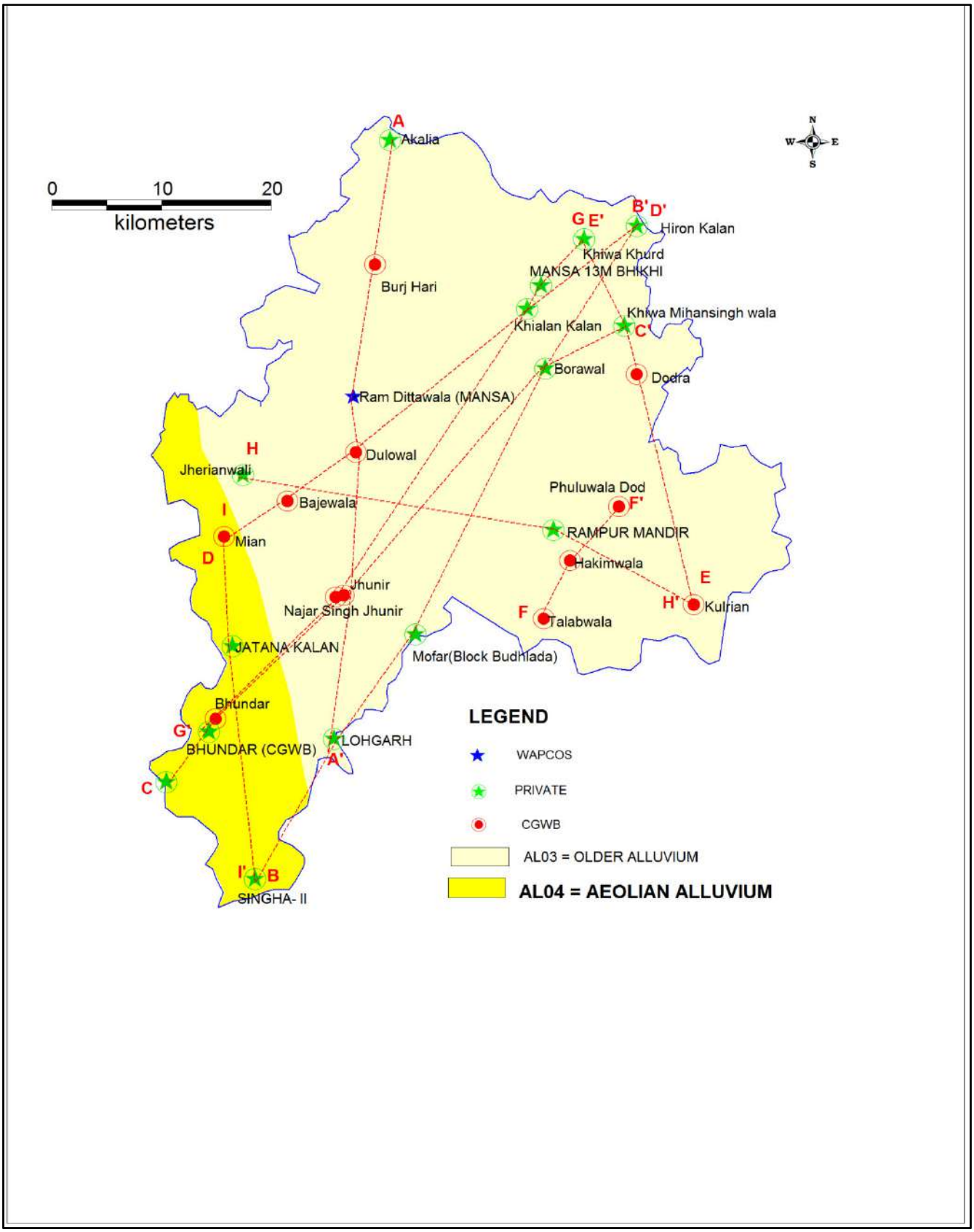
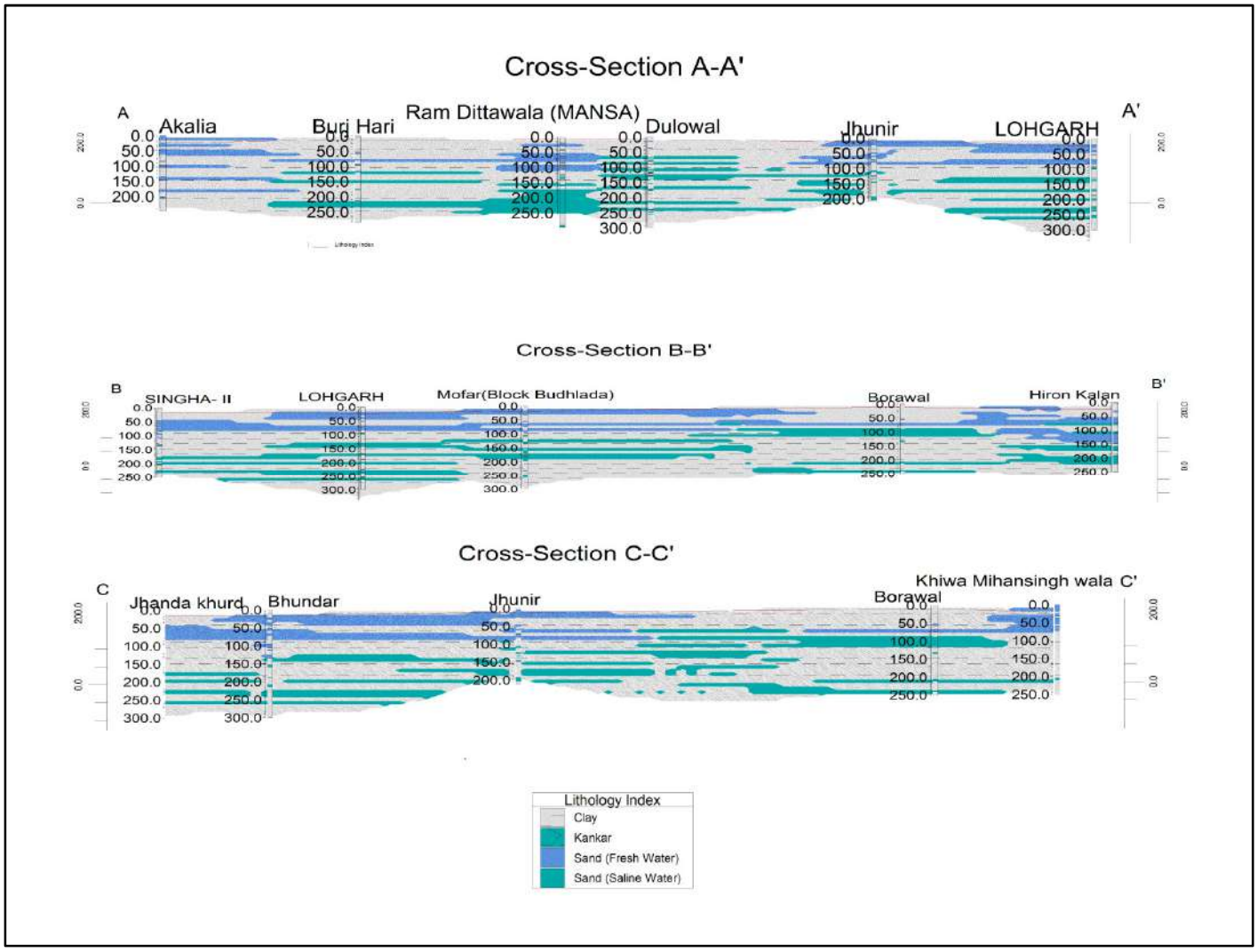


Fig.6.5c: Lithological section along Akalia-Lohgrh (A-A') , Singha-II-Hiron kalan (B-B'), Jhanda khud-Khiwa mihansingh wala(C-C').



Cross sections from Mian to Hiron Kalan (D-D'), Kulrian to Khiwa Khurd (E-E'),Talabwala to Phuluwal Dod (F-F').

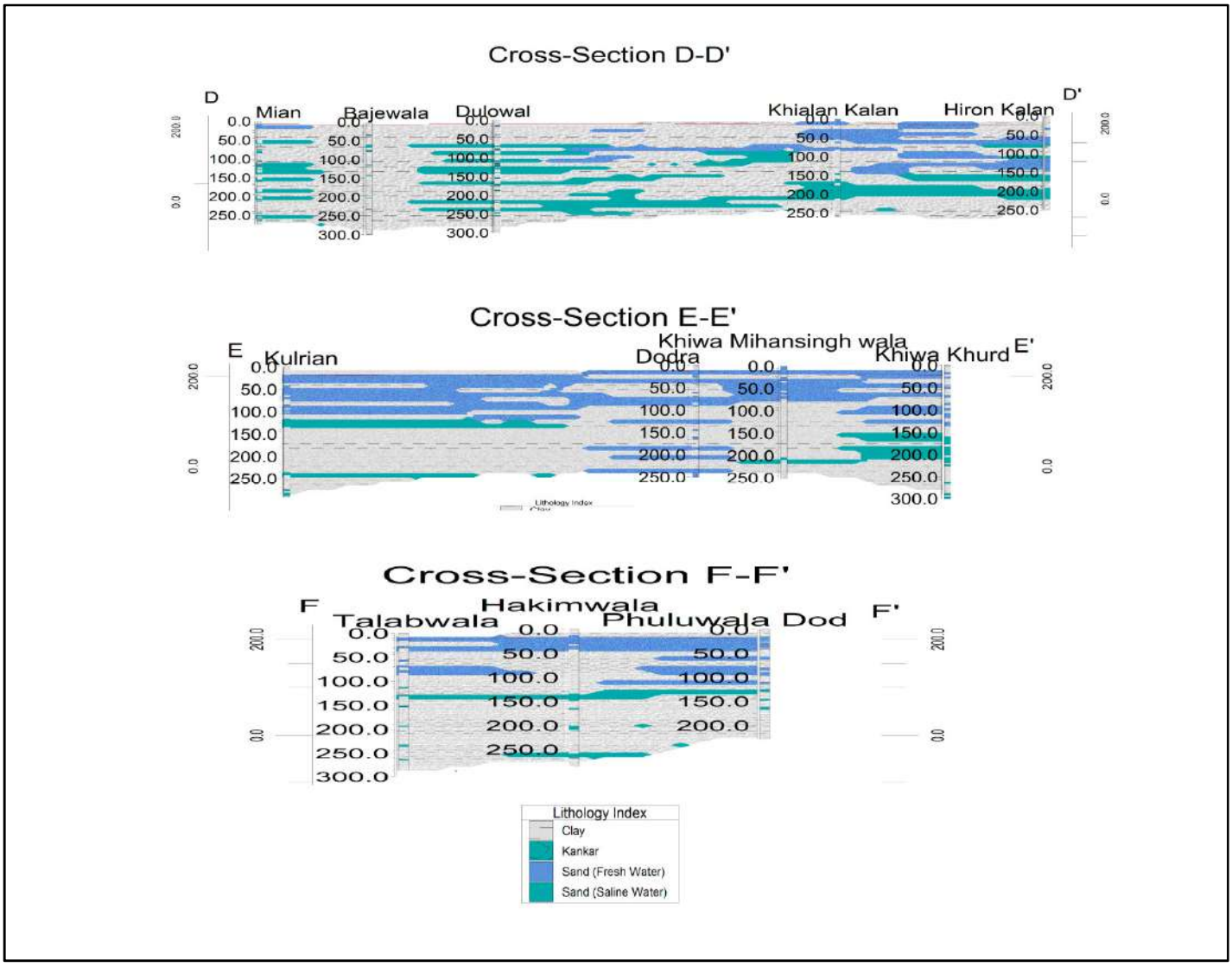
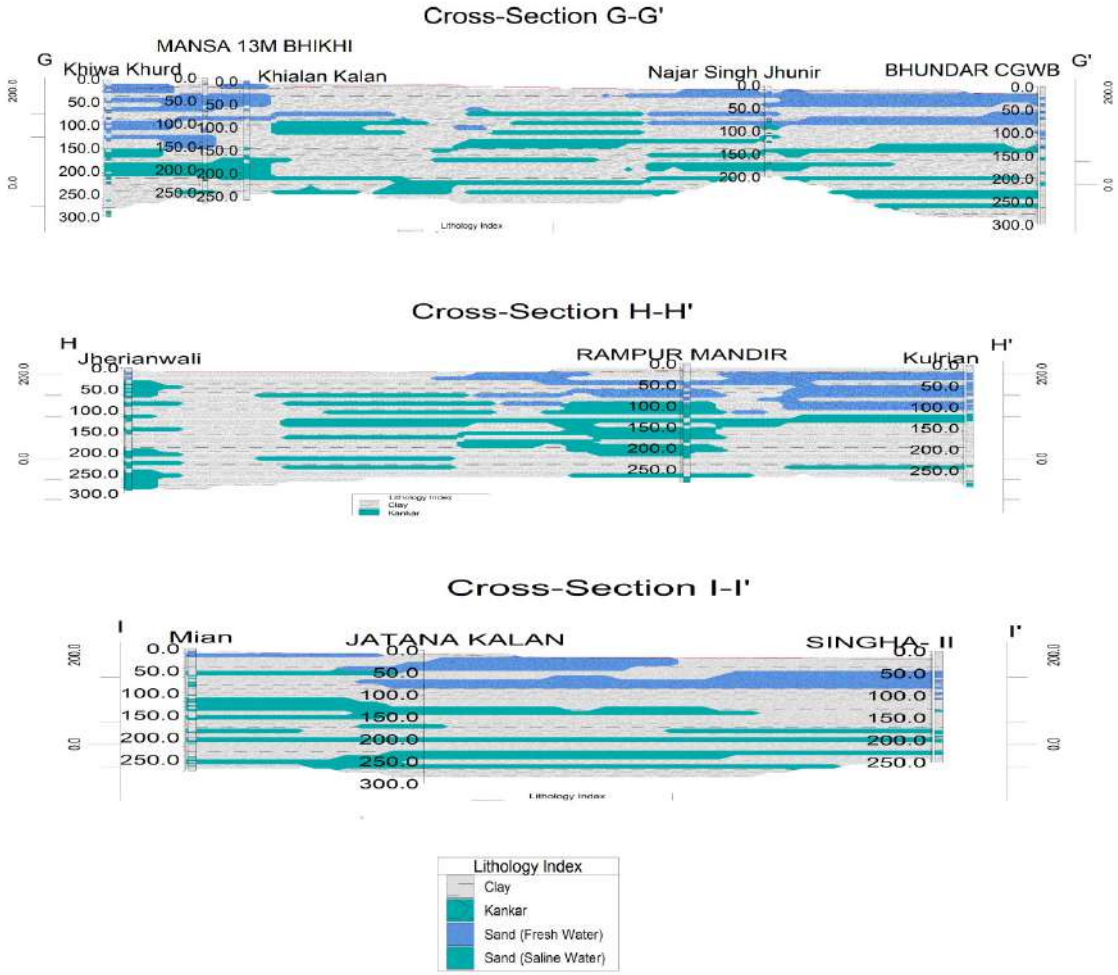


Fig.6.5d: Lithological section along Khiwa khurd – BHUNDAR CGWB (G-G') and Jherianwali - kulrian (H-H') Mian – Singha II (I-I').



6.7 Aquifer Geometry (3D)

To know the broad picture of the disposition, inter-relationship of granular zones, nature, geometry and extension of aquifers in the Mansa district, three-dimensional fence diagram (Fig 6.6a & 6.6b) have prepared by synthesizing the various sub-surface sections.

In Mansa district, aquifer group embodies a number of granular zones alternating with thick or thin clay lenses. The major clay zones intervening aquifer groups pinch out against the aquifer groups at a few places and within these clay zones the sand beds also occur. The marker horizons are traced all over the area by connecting their tops and bottoms.

Table-4: Aquifer Grouping in MANSA District

Aquifer Group	Range		Thickness	
	From	To	Min	Max
Aquifer I	6.3	131	55	122
Aquifer II	83	252	14	113
Aquifer III	207	300	39.9	78

BLOCK DIAGRAM OF AQUIFER:

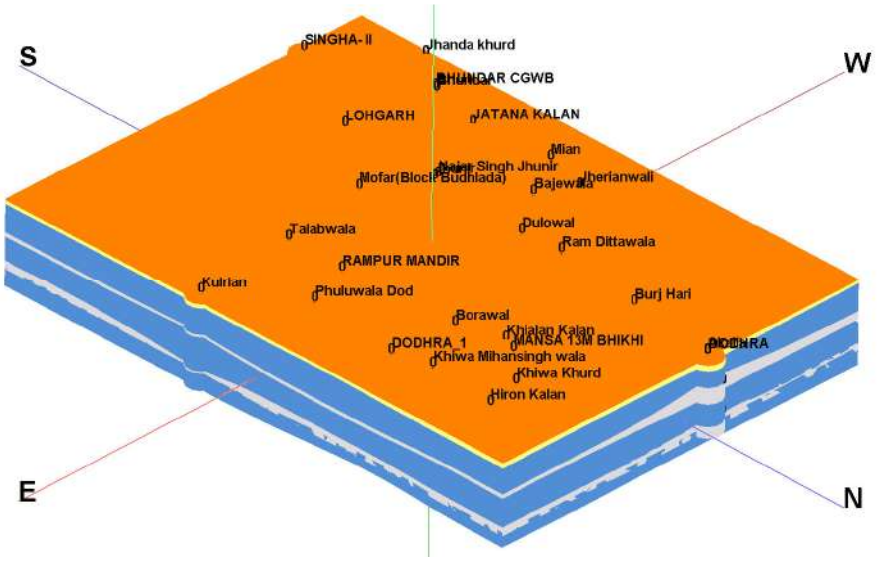


Fig.6.6a: Lithology Disposition (3D) of Mansa District

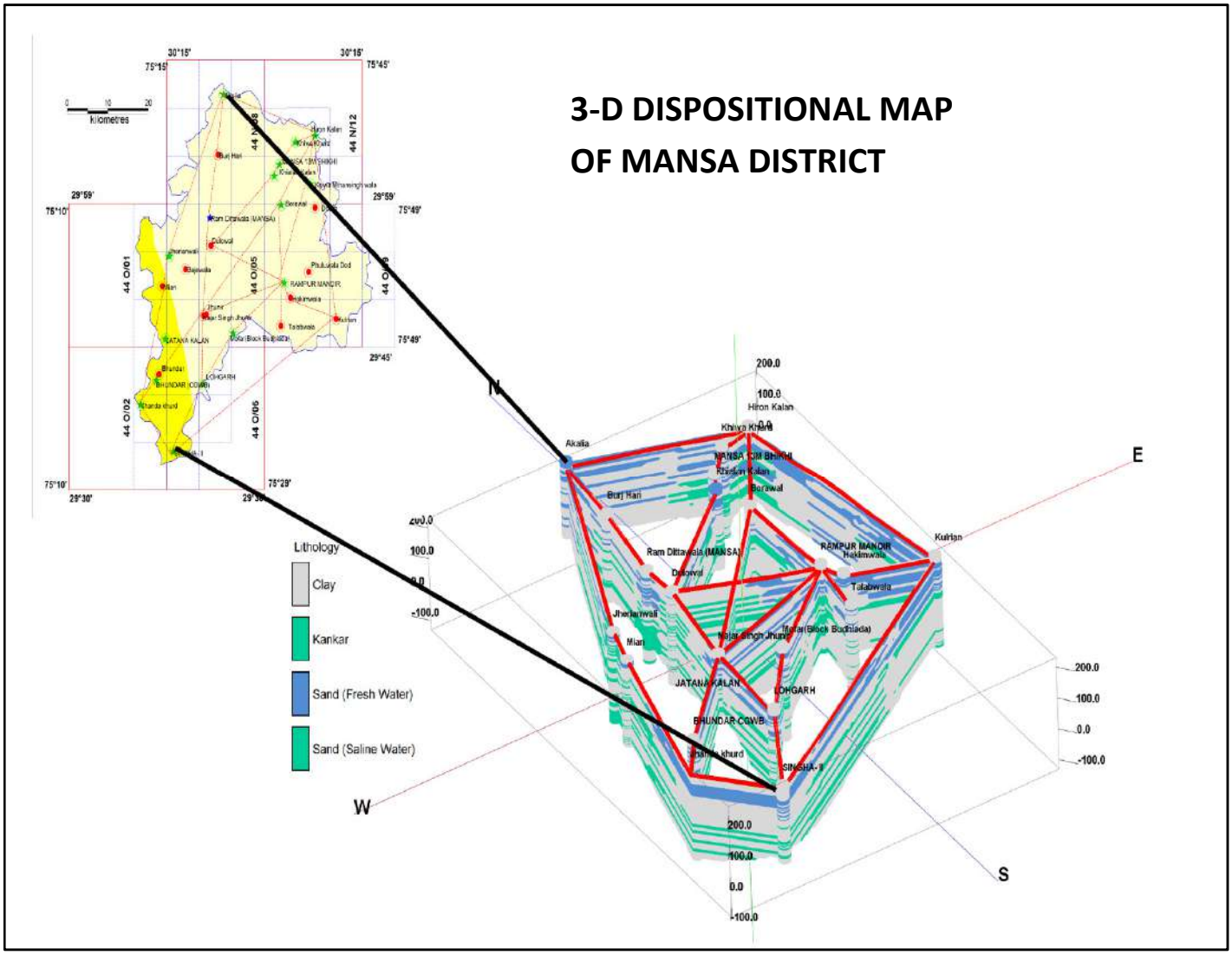
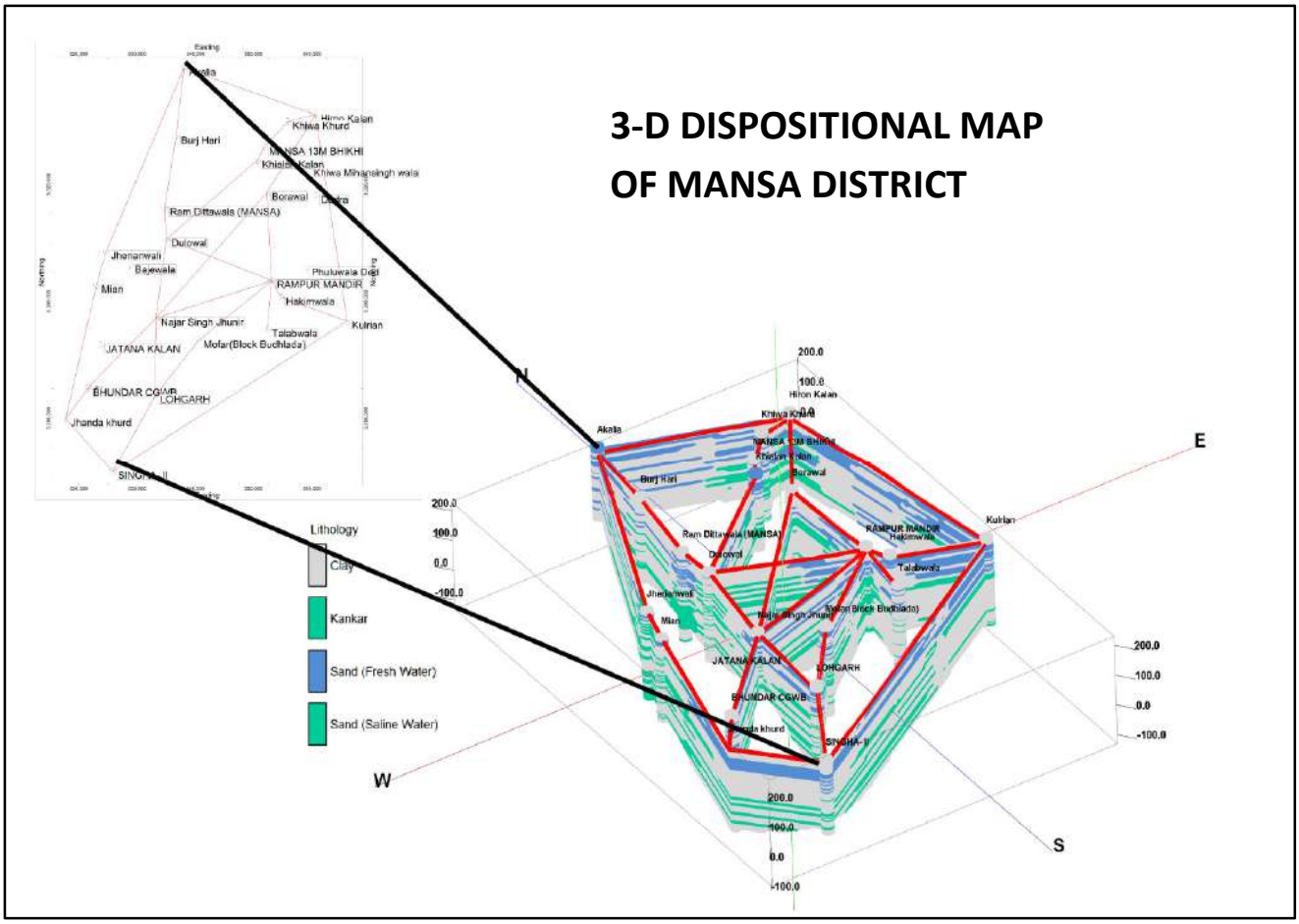


Fig.6.6b: Lithology Disposition (3D) of Mansa District



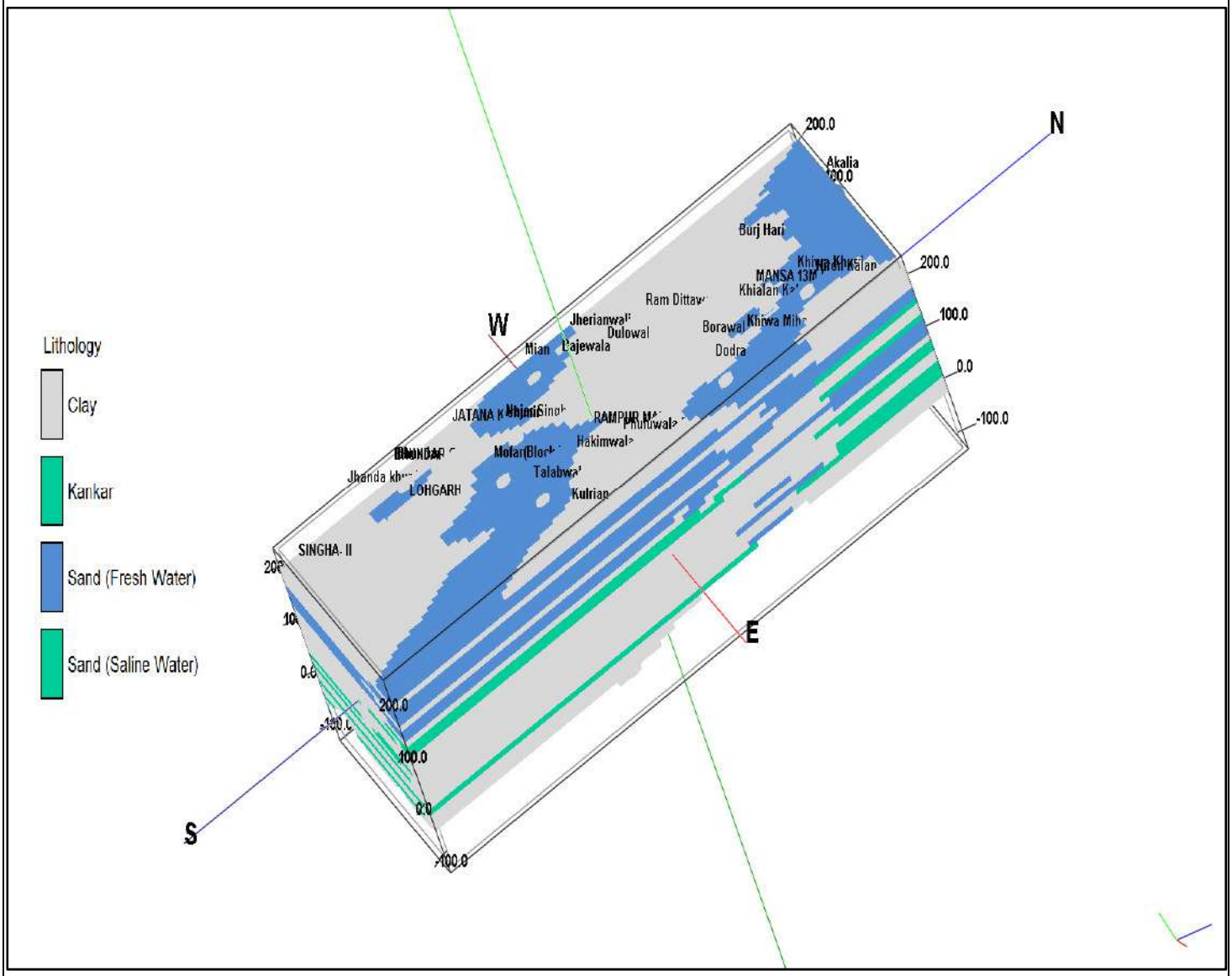


Fig.6.6c. (3D) Litho block diagram of Mansa District

8.0 Ground Water Resources

The Ground Water resources of the district were done for each individual block as per GEC 1997 norms. Perusal of the estimates reveals overall stage of ground water development in the district is of the order of 138 %. The ground water development in all the blocks of the district have been categorized as over exploited. Bhikhi ,Budhlada ,Jhunir ,Mansa ,Sardulgarh blocks are showing 125%,175%,98%,125% and 182 % respectively. Net ground water availability of the district is 1034.20 mcm.

The blocks wise resource potential in the district has been assessed are given below.

GROUND WATER RESOURCE AND DEVELOPMENT POTENTIAL OF MANSA DISTRICT, PUNJAB AS ON 31ST MARCH, 2013 in mcm

Block	Net annual ground water availability (mcm)	Existing gross ground water draft for irrigation (mcm)	Existing gross ground water draft for all uses (mcm)	Provision for domestic & industrial requirement supply to 2025 (mcm)	Net annual ground water availability for future irrigation development (mcm)	Stage of ground water development (%)	Catagory
BHIKHI	214.55	268.76	268.76	0	-54.21	125	OVER-EXPLOITED
BUDHLADA	251.92	441.38	441.43	5	-189.51	175	OVER-EXPLOITED
JHUNIR	212.60	208.26	208.26	0	4.35	98	OVER-EXPLOITED
MANSA	236.67	295.79	295.84	5	-59.16	125	OVER-EXPLOITED
SARDULGARH	118.46	217.78	217.82	4	-99.36	184	OVER-EXPLOITED
TOTAL	**1034.20**	**1431.97**	**1432.10**	**13**	**-397.91**	**138**	OVER-EXPLOITED

b. In-storage Ground Water Resources

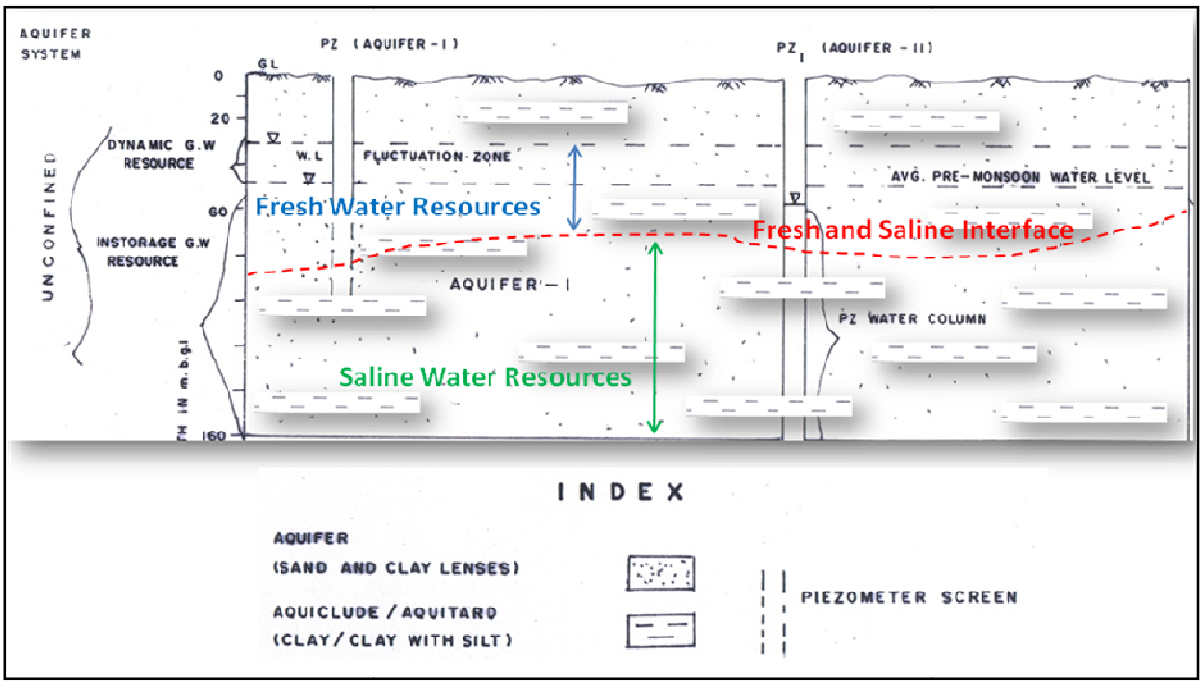
As per revised guidelines recommended by the Central Level Expert Group on groundwater resources assessment, the resources are separately considered as dynamic and in-storage unconfined. In case of alluvial area, the in-storage resources of unconfined aquifer have been computed based on specific yield of the aquifer as detailed below.

In-storage Ground Water resources (Unconfined Aquifer)	=	Thickness of the aquifer (granular/productive zone) below the zone of water level fluctuation down to the bottom layer of unconfined aquifer	x	Sp. Yield of the aquifer	x	Areal extent of the aquifer

The dynamic and in-storage ground water resources estimations have been calculated for single aquifer group upto 300m of each block of Ferozpur and Fazilka districts. In-storage ground water resources are estimated for fresh water and saline water resources based on the geophysical interpretations of depth of fresh and saline water interface for each block wise. The fresh and saline calculations are made based on the assumptions on aquifer is considered as unconfined aquifer so that the specific yield concept is used for resources estimations (Fig.19). The detailed resources estimations are calculated in detailed table for fresh and saline water resources in the below Table-7, 8& 9.

Total Availability of Ground Water Resources = Dynamic Resources + In-storage Resources.

Fig.19: Conceptual figure to understand the fresh and saline water resources in the aquifer up to 300 m for Resource Estimation in Unconfined and Confined Aquifer System.



(The clay lenses are more dominant in the aquifer and sometimes huge thickness of clay deposits are also observed in the lithologs)

Table-5. Block Wise In-Storage Ground Water Resources of Fresh Water Aquifers Upto Average Depth

GENERAL DESCRIPTION OF THE GROUND WATER ASSESSMENT UNIT OF DISTRICT MANSA, PUNJAB STATE (2013)

Type of Ground Water Assessment Unit (Block): MANSA Blocks

Sr. No.	Name of Assessment Unit	Type of rock formation	Areal extent (ha)		Average Pre-monsoon Water Level (m bgl)	Depth to bottom of Aquifer based on Geophysical Interface & Boreloggi ng (m bgl)	Total Thickness of formation below Pre-monsoon Water Level (m) (9-8)	Total thickness of the Granular Zones up to the depth of Fresh Water Zones (m)	Thickness of the unsaturated granular Zones up to Pre-monsoon WL (m)	Thickness of the saturated granular Zones up to the depth of Fresh water aquifer below (m) (11-12)	Average Specific Yield	In-Storage Ground Water Resources up to the depth of Fresh Water Aquifer (mcm) 5*13*14
			Total Geographical Area	Assessment Area Fresh Water								
1	2	3	4	5	8	9	10	11	12	13	14	15
	MANSA											
1	BHIKHI	Alluvium	221.2	221.2	8.65	55	46.35	30	2	28	0.072	446
2	BUDHLADA	Alluvium	67540	675.4	11.45	117	105.55	54	7	47	0.072	2286
3	JHUNIR	Alluvium	58330	583.3	9.75	204	194.25	118	2	116	0.072	4872
4	MANSA	Alluvium	35810	358.1	11.2	163	151.8	75	8	67	0.072	1727

5	SARDULGARH	Alluvium	23290	232.9	9.56	155	145.44	99	6	93	0.072	1559
Dist. Total(ham)			**185191**	1851.912								**10890**
Dist. Total(MCM)												**109**

Table6. Block Wise In-Storage Ground Water Resources of Saline Aquifers Upto 300 m Depth

GENERAL DESCRIPTION OF THE GROUND WATER ASSESSMENT UNIT OF DISTRICT Mansa, PUNJAB STATE (2013)										
Type of Ground Water Assessment Unit (Block): Mansa BLOCKS										
Sr. No.	**Name of Assessment Unit**	**Type of rock formation**	**Areal extent (ha)**		**Depth to bottom of Fresh Water Aquifer based on Geophysical Interface & Borelogging (m bgl)**	**Depth to bottom of Saline Water Aquifer based on Geophysical Interface & Borelogging (m bgl)**	**Total thickness of the Saline Water up to the max depth (m)**	**Total thickness of the Granular Zones up to the depth ofSaline Water Zones (m)**	**Average Specific Yield**	**In-Storage Ground Water Resources up to the depth of Saline Water Aquifer (ham) 5*13*14**
			Total Geographical Area	**Assessment Area**						
				Saline Water						
1	**2**	**3**	**4**	**5**	**9**	**10**	**11**	**12**	**14**	**15**
	Fazilka									
1	BHIKHI	Alluvium	221.2	221.2	18	**300**	282	135	0.072	2150
2	BUDHLADA	Alluvium	675.4	675.4	117	250	133	57	0.072	2772
3	JHUNIR	Alluvium	583.3	583.3	204	275	71	39	0.072	1638
4	MANSA	Alluvium	358.1	358.1	163	250	87	47	0.072	1212
5	SARDULGARH	Alluvium	232.9	232.9	155	300	145	73	0.072	1224
Dist. Total(ham)			**2071**	**2071**						**8996**
Dist. Total(MCM)										**90**

Table-8. Block Wise Total Availability of Fresh and Saline Groundwater Resources upto 300 m Depth and Volume of unsaturated granular zone in the District

GENERAL DESCRIPTION OF THE GROUND WATER ASSESSMENT UNIT OF DISTRICT MANSA, PUNJAB STATE (2013)								
Type of Ground Water Assessment Unit (Block): MANSA Blocks								
Sr. No.	**Name of Assessment Unit**	**Type of rock formation**	**Areal extent (ha)**		**Average Pre-monsoon Water Level (m bgl)**	**Thickness of the unsaturated granular Zones up to Pre-monsoon WL (m)**	**Specific Yield**	**Volume of Unsaturated Zone up to Pre-monsoon WL (ham) 5*7*8**
			Total Geographical Area	**Assessment Area Total Area Fresh and Saline**				
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
	MANSA							
1	BHIKHI	Alluvium	221.2	221	8.65	3	0.12	80
2	BUDHLADA	Alluvium	675.4	675	11.45	7	0.12	567
3	JHUNIR	Alluvium	583.3	583	9.75	2	0.12	140
4	MANSA	Alluvium	358.1	358	11.2	8	0.12	344
5	SARDULGARH	Alluvium	232.9	233	9.56	6	0.12	168
Dist. Total(ham)			**2071**	**2071**				**1298**
Dist. Total(MCM)								**13**

AVAILABILITY OF TOTAL FRESH GROUNDWATER RESOURCES IN MANSA DISTRICT							
Sl.No	**BLOCK**	*Dynamic Groundwater Resources (2013) AQUIFER-I*	*In-storage Groundwater Resources UPTO FRESHWATER*	**Groundwater Resources upto FRESH WATER [(3)+(4)] (HAM)**	**Groundwater Resources upto Saline**	**Total Availabilty of Fresh Groundwater Resources [(5)+(6)+(7)]**	
						ham	**mcm**
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*
1	BHIKHI	221	*446*	*667*	*2150*	*2817*	*28*
2	BUDHLADA	675	*2286*	*2961*	*2772*	*5733*	*57*
3	JHUNIR	583	*4872*	*5455*	*1638*	*7093*	*71*
4	MANSA	358	*1727*	*2086*	*1212*	*3297*	*33*
5	SARDULGARH	233	*1559*	*1792*	*1224*	*3017*	*30*
Dist.Total (ham)		**2071**	**10890**	**12961**	**8996**	**21957**	**220**
Dist.Total (mcm)		**21**	**109**	**130**			

ham : hectare metre

mcm: million cubic metre

9.0 Ground Water Quality

The ground water is alkaline in nature with pH values ranging from 7.77 to 8.78 with a mean pH value of 8.31. It is moderately to highly saline with EC values ranging from S/cm at 25°C at Fattamaluka with mean EC value ofμS/cm at Budhlada to 5350μ635 S/cm. The ground water is soft to hard in nature as total hardness values show aμ2576 wide variation and ranges from 4mg/l at Bhikhi to 612mg/l with a mean value of 315mg/l. The calcium and magnesium concentrations are mostly less than 100mg/l. Calcium ranges from 12mg/l at Doda to 82mg/l at Jhand Khurd whereas magnesium content varies from 2.4mg/l at Bhikhi to 119mg/l at Burj Bhalaike with mean of 37 and 54 mg/l respectively. Sodium varies widely from 23mg/l at Budhlada to 1028mg/l at Fattamaluka with an average of 435mg/l. The concentration of potassium ranges from 2.0mg/l at Doda to 375mg/l at Burj Bhalaike with an average of 98mg/l. In majority of the samples, the potassium content is less than 100mg/l.

Among anions, carbonate ranges from nil at several places to 120mg/l at Junir with an average value of 33mg/l. The bicarbonate concentration ranges from 302mg/l at Ralla to 905mg/l at Kot Dhamru with an average of 557mg/l. The chloride concentration in ground water varies from 30mg/l at Budhlada to 728mg/l at Burj Bhalaike and its average concentration is 250mg/l. The sulphate content in the district ranges from trace at Ralla to 4 433mg/l at Fattamaluka with an average concentration of 459mg/l. The nitrate values are less than 45mg/l in nearly 60% wells and it ranges from 1mg/l at Doda to 161mg/l at Mansa with a mean value of 59mg/l. High concentration of nitrate in ground water may be due to indiscriminate use of fertilizers. The fluoride content of the district ranges from 0.16mg/l at Budhlada to 4.58mg/l at Junir. However, exceptionally high concentration of 7.84mg/l of fluoride is recorded at Bhikhi II. It is within the permissible limit of 1.5mg/l in about 70% samples.

Among cations, Na is the predominant cation in most water samples. Among anions, bicarbonate is dominant in 23.5% samples and in the remaining samples; none of the anion is dominant. Ground water is by and large Na-mixed anion type. Ground water at Fatta Maluka is of Na-SO4 type.

On comparison with drinking water standards given by BIS, it is found that most of the waters have concentration of one or more chemical constituents above the permissible limit and thus are not suitable for drinking use. Only 40% ground waters are potable as these have all the chemical constituents within the permissible levels. The constituents that make them unfit for drinking are mainly NO3, F, EC, or combination of these.

Plot in the USSL staff (1954) diagram indicates that waters fall under C2S1, C3S2, C3S3, C3S4, C4S1, C4S3 and C4S4 classes of irrigation rating. Such waters may create medium to very high salinity hazards and low to very high sodium hazards when used for irrigation under customary irrigation. However, these waters can be used for irrigating salt tolerant crops grown on soils with adequate permeability, only after addition of appropriate amounts of gypsum. Classification based on RSC indicates that only 35% of waters are safe and the remaining 65% of the waters are unsafe for irrigation use. Arsenic contamination in ground water in district Mansa, Punjab, has been found in samples from 6 location, more than the prescribed limits by BIS, IS:10500

10.0 Status of Ground Water Development

Ground water development in the district has taken place through private and public agencies for both irrigation and drinking purposes and can be summarized as below: -

The water supply to the district is mainly based on ground water through tube wells. The water supply to the villagers is met out with the installation of hand pumps as spot & convenient source of water. The canal irrigation covers a very sound area of 90 sq. km out of 3060 sq. km area of total irrigated area. The remaining area is irrigated by ground water. The shallow tube wells in the district ranges from 25-90 m deep. Tapping the aquifer from 10-90m, With a discharge of 200 to 1500 lpm. Most of the shallow tube wells are either run by diesel engines or electric motors. 117352 no. of motors are working in district. The ground water discharge is between 600 1000 lpm in south east and is between 1300-300 lpm in the northern part of the district.

11.0 GROUND WATER MANAGEMENT STRATEGY

11.1 Water Conservation and Artificial Recharge

Rain water harvesting and Artificial recharge to ground water should be adopted to check further decline in ground water level since natural recharge to aquifer system is not adequate to support heavy withdrawal of ground water. Farmers have adopted paddy cultivation due to its profitability and incentives from Govt. Paddy requires much more water in comparison to other crops Thus, a change in cropping pattern is required. Paddy sown in the month of May requires more evapo transpiration than paddy sown after 15thJune. Thus, a lot of water can be saved by timely plantation of paddy. Effective irrigation practices like sprinkler, laser leveling should be adopted.

12.0 GROUND WATER RELATED ISSUES & PROBLEMS

12.1 Ground Water Depletion

Water levels are declining in the district. Rate of decline is quite considerable in all parts of the district. In general ground water is potable in the district. Awareness was provided to local administration and other agencies by providing guidance for various recharge projects in the district.

13.0 RECOMMENDATIONS

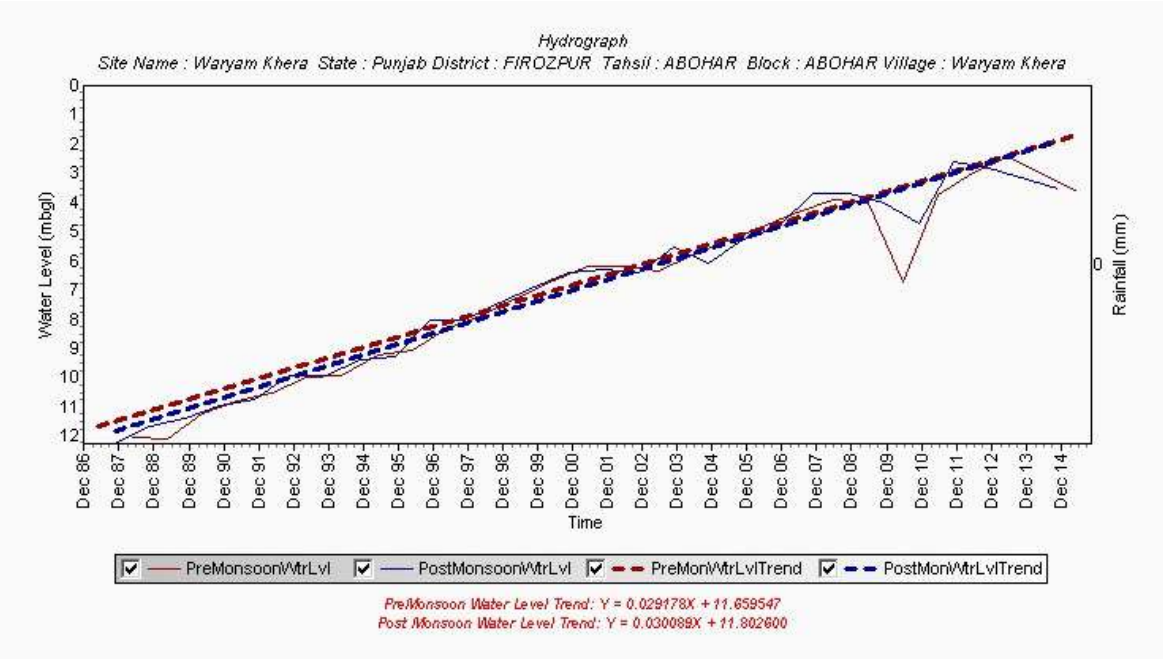
1. In order to arrest the declining trend of water levels in North western and south western part of the district, the rooftop rainwater harvesting technology should be adopted and recharge structures may also be constructed.
2. Planned use of surface and ground water (conjunctive use) has to be done to overcome both over exploitation and Ground water quality problems.
3. The construction of roof top rainwater harvesting structures should be made mandatory in building which will help in checking the falling water level trend in the towns of water level depleting areas.
4. The abandoned dug wells may be cleaned and should be used for recharging the ground water by utilizing the surface monsoon runoff.
5. The crops consuming less quantity of water may be grown in place of crops requiring more water in the Over exploited blocks.

1.0 Salient Information

Name of the Block and Area (in Km^2)	**Bhikhi 221.20 sq km**
District/ State	Mansa, Punjab
Population	Urban Population: 0 Rural Population: 19032 Total population: 19032
Rainfall	Normal Monsoon: 338 mm Non-monsoon Rainfall : 303.29 mm Annual Average Rainfall: 389 mm
Irrigation	Irrigation practices: Canal and Tube well Irrigation Cropping intensity: 101% Number and types of abstraction structures: 8439 nos., Tubewells
Ground Water Resource Availability and Extraction	**Ground water Resources Availability** Ground Water Resources are available in 2672 mcm (fresh and saline water resources) up to the depth of 300 m. The fresh water resources are estimated up to the depth of 106 m based on geophysical interpretations interface. The potential granular zones are available for fresh water is 81 m. Saline water resources are estimated based on the available depth of wells existed up to 300 m and the granular zones are counted after the depth of 152 m and available zones are 76 m. Block is categorized as Over-Exploited as aper Dynamic Groundwater Resources, 2013 assessment. **Ground water Resources Extraction** Deeper aquifers are marginal to highly saline and it is not suitable for irrigation purpose so that all users are tapping at shallow aquifers only. State government drinking water supply wells tapped at shallow aquifers and canal supply water are used for domestic and Irrigation purpose. So that the ground water draft could not be addressed for deeper aquifer.
Existing and future water demands	*Existing Gross Ground water Draft as on 2013* Irrigation: 268.76 mcm Domestic and industrial water supply: 0.0010 mcm *Future water demands* Irrigation development potential : -54.21 mcm Domestic and industrial water supply up to 2025 years : 0.001 mcm

Water level behavior	*Aquifer wise water level* **Aquifer-I** Pre Monsoon: 2.35 – 16.00 m bgl Post Monsoon: 1.55 – 18.20 m bgl Mean (10 yrs) : 1.58 – (-)0.86 m/yr *Trends* Pre Monsoon: 0.16 – (-)0.26 m/yr Post Monsoon: 0.15 – (-)0.29 m/yr

HYDROGRAPHS



2. 0 Aquifer Disposition

Number of aquifers	1
Principal aquifer	Alluvium
Major Aquifer	Older Alluvium

Aquifer wise Characteristics

Aquifer Group *	*Geology*	*Type of Aquifer*	*Thickness of Granular zones (m)*	*Transmissivity (m^2/day)*	*Yield (m^3/day)*	*Specific Yield %*	*Storativity*
Aquifer -I	Quaternary Alluvial deposits	Unconfined to confined	106	547		12	

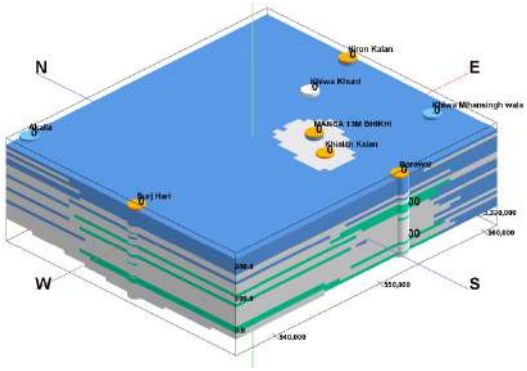
The Aquifer comprises of both fresh and saline water and the main aquifer material is sand. The non-aquifer material comprise of clay, clay with silt.

Data Availability

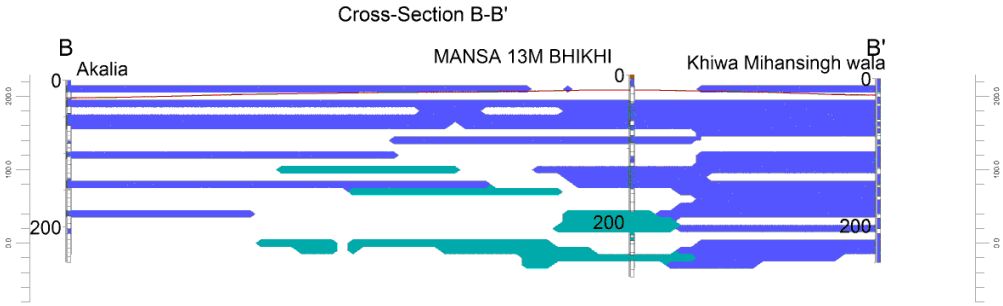
Sl.No	Source of data	Depth Range (m)		
		< 100	**100-200**	**200-300**
1	CGWB	0	0	6
2	WAPCOS	0	0	0
3	PRIVATE	0	0	0
Total		**0**	**0**	**6**

The data is validated by selecting the deepest well in each quadrant and used for preparation of 3-D Litho models, 2-D geological cross sections, Fence diagrams and aquifer maps.

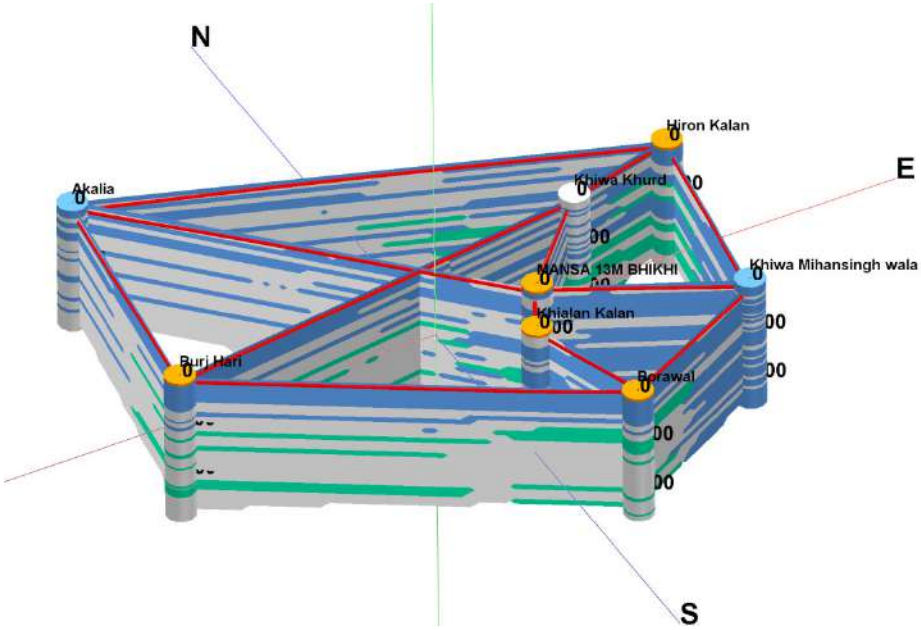
3-D Lithological model of Bhikhi Block



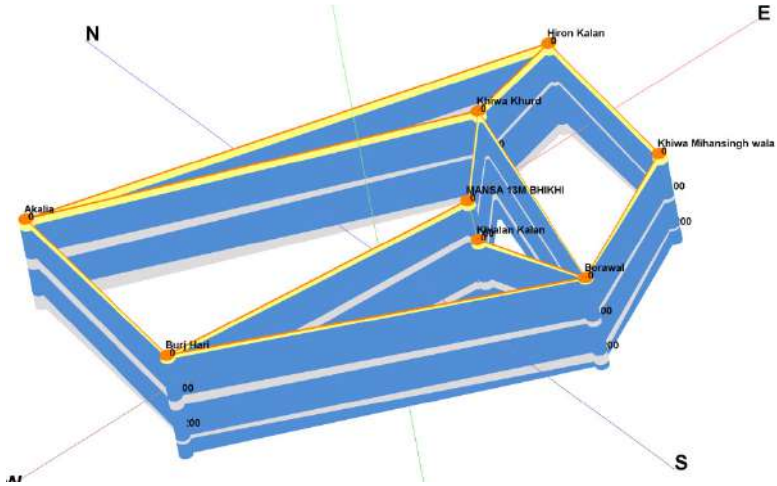
Lithological Cross section from Akalia to Khiwa MihanSingh wala



3-D Lithological Fence Diagram



3-D Aquifer Disposition Fence Diagram



Ground water Resource, Extraction, Contamination and other issues

Ground Water Resources upto the depth of 300m	Dynamic Fresh water resources	214.54 mcm
	In-storage Fresh water resources	6.67 mcm
	In-storage Saline water resources	21.5 mcm
	Total	544 mcm
Ground Water Extraction (as per 2013)	Irrigation	268.76 mcm
	Domestic & Industrial	0.001mcm
Future Demand for domestic & Industrial sector (2025) (as per 2013)		-54.21 mcm
Stage of Groundwater Development		125 %
Chemical Quality of ground water		Ground water in the area is alkaline and pH near to 9.06. Ground water in the area is fresh to marginal saline. EC value of the ground water show wide up to 1480 µS/cm at 25^0C.
Ground water Contamination Issues		*Nitrate (mg/l):* Kotra (104)
Other issues		Water level decline has been observed in major parts of the block due to in discriminate development of ground water resources.

4. Ground water Resource enhancement

Aquifer wise space available for recharge and proposed interventions (Supply Side Measures)

Aquifer-I:

Volumes of unsaturated zone after 3m upto a desirable depth: 8 mcm
Source water requirement/availability for recharge: *Rain, Canal, Irrigation return flow*
Types and number of structures: --
Other interventions proposed*: Artificial Recharge, Roof top Rainwater harvesting will save 0.0 mcm volume of water*

5. Demand side interventions

Advanced Irrigation Practices
Area proposed to be covered: 221.2 sq km
Volume of Water expected to be conserved under advanced irrigation practices such as lining of underground pipelines (Kutcha channel) etc.: 17.72 mcm

Change in cropping pattern Not Required

Proposed change in cropping pattern: Not Required
Area coverage: Not Required
Anticipated volume of water to be saved: Not Required

Alternate Water sources
Groundwater/surface water sources: *Tanks, Ponds*
Location, details and availability from such sources outside the area: --

Regulation and Control: Punjab Subsoil Act, 2009 for delay in paddy plantation should continue in the area.

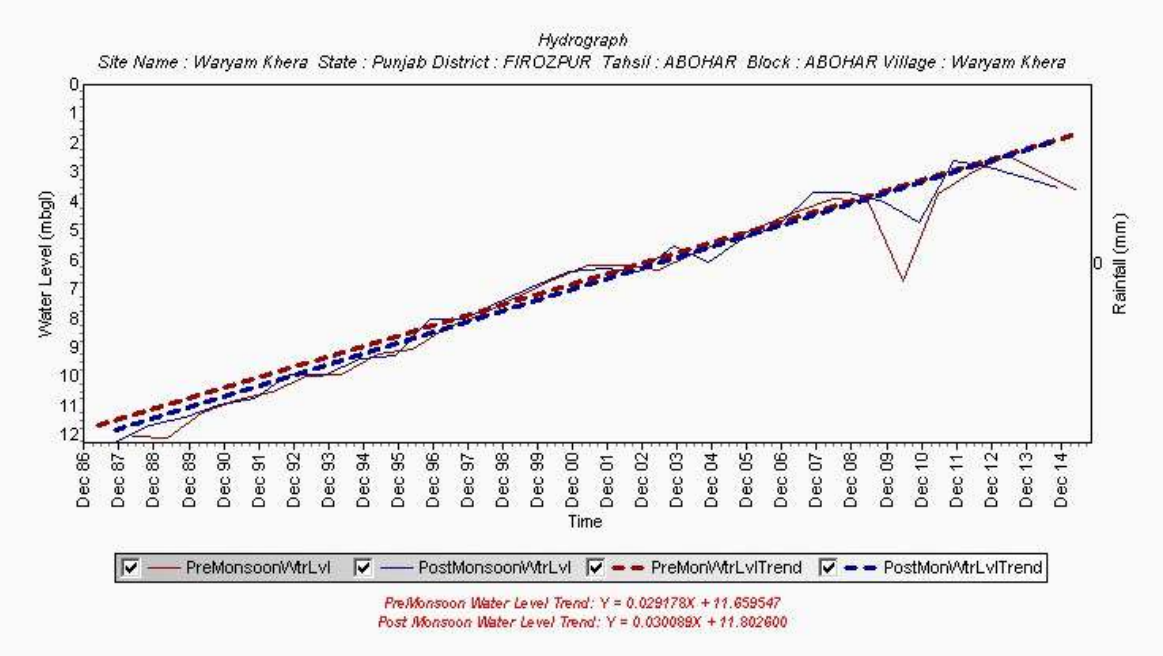
Other interventions proposed, if any
Modern Irrigation Practices be adopted for Rabi crops. Some of the techniques are given in the table below (PAU, Ludhiana).

2.0 Salient Information

Name of the Block and Area (in Km^2)	**Bhudhlada 675.4 sq km**
District/ State	Mansa, Punjab

Population	Urban Population: 0 Rural Population: 40218 Total population: 40218
Rainfall	Normal Monsoon: 328 mm Non-monsoon Rainfall : 93 mm Annual Average Rainfall: 429 mm
Irrigation	Irrigation practices: Canal and Tube well Irrigation Cropping intensity: 101% Number and types of abstraction structures: 40218 nos., Tubewells
Ground Water Resource Availability and Extraction	**Ground water Resources Availability** Ground Water Resources are available in 2672 mcm (fresh and saline water resources) up to the depth of 300 m. The fresh water resources are estimated up to the depth of 106 m based on geophysical interpretations interface. The potential granular zones are available for fresh water is 81 m. Saline water resources are estimated based on the available depth of wells existed up to 300 m and the granular zones are counted after the depth of 152 m and available zones are 76 m. Block is categorized as Over-Exploited as aper Dynamic Groundwater Resources, 2013 assessment. **Ground water Resources Extraction** Deeper aquifers are marginal to highly saline and it is not suitable for irrigation purpose so that all users are tapping at shallow aquifers only. State government drinking water supply wells tapped at shallow aquifers and canal supply water are used for domestic and Irrigation purpose. So that the ground water draft could not be addressed for deeper aquifer.
Existing and future water demands	*Existing Gross Ground water Draft as on 2013* Irrigation: 441.38 mcm Domestic and industrial water supply: 0.045 mcm *Future water demands* Irrigation development potential : -189 mcm Domestic and industrial water supply up to 2025 years : 0.045 mcm
Water level behavior	*Aquifer wise water level* **Aquifer-I** Pre Monsoon: 2.35 – 16.00 m bgl Post Monsoon: 1.55 – 18.20 m bgl Mean (10 yrs) : 1.58 – (-)0.86 m/yr *Trends* Pre Monsoon: 0.16 – (-)0.26 m/yr Post Monsoon: 0.15 – (-)0.29 m/yr

HYDROGRAPHS



2. 0 Aquifer Disposition

Number of aquifers	1
Principal aquifer	Alluvium
Major Aquifer	Older Alluvium

Aquifer wise Characteristics

Aquifer Group *	*Geology*	*Type of Aquifer*	*Thickness of Granular zones (m)*	*Transmissivity (m^2/day)*	*Yield (m^3/day)*	*Specific Yield %*	*Storativity*
Aquifer -I	Quaternary Alluvial deposits	Unconfined to confined	106	547		12	

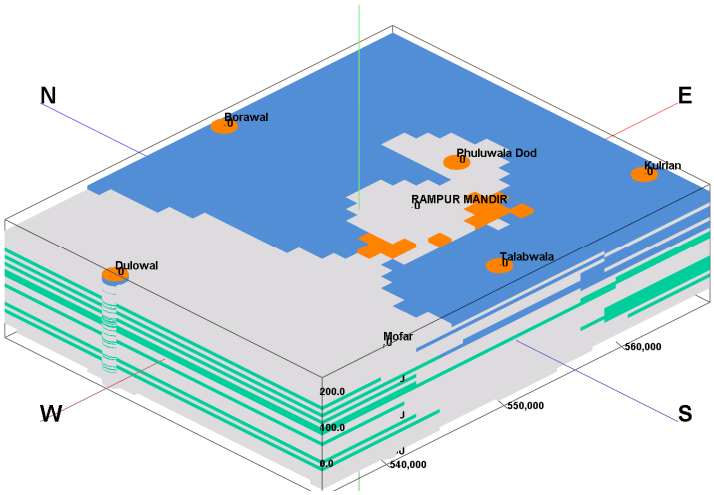
The Aquifer comprises of both fresh and saline water and the main aquifer material is sand. The non-aquifer material comprise of clay, clay with silt.

Data Availability

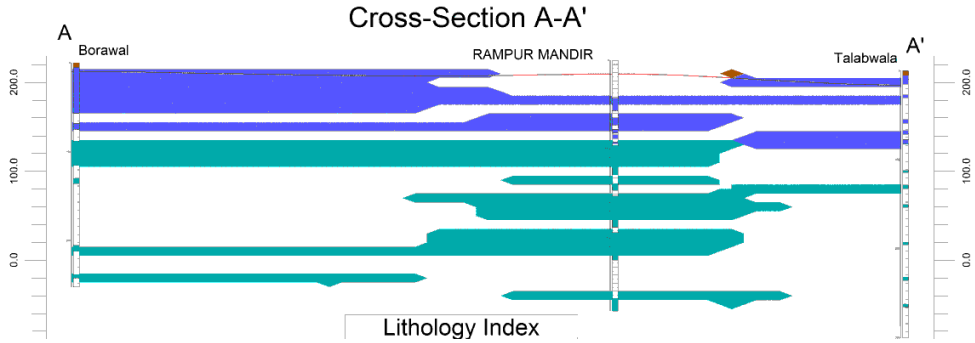
Sl.No	Source of data	Depth Range (m)		
		< 100	**100-200**	**200-300**
1	CGWB	0	0	2
2	WAPCOS	0	0	0
3	PRIVATE	0	0	5
Total		**0**	**0**	**7**

The data is validated by selecting the deepest well in each quadrant and used for preparation of 3-D Litho models, 2-D geological cross sections, Fence diagrams and aquifer maps.

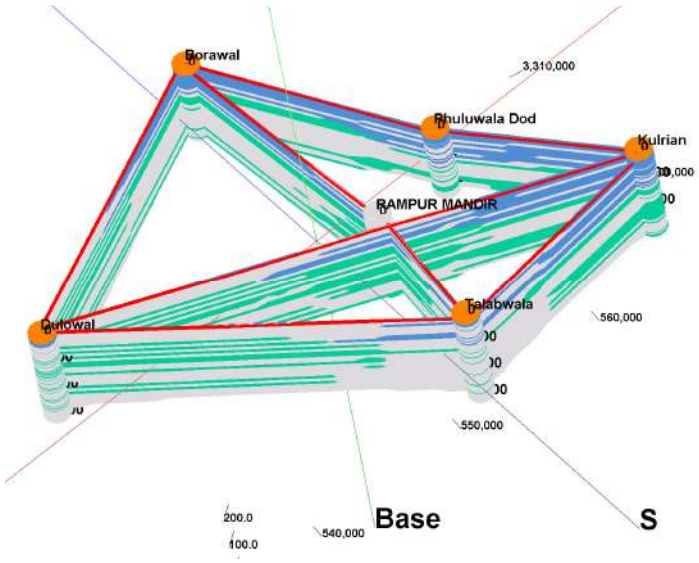
3-D Lithological model of Bhudhlada Block



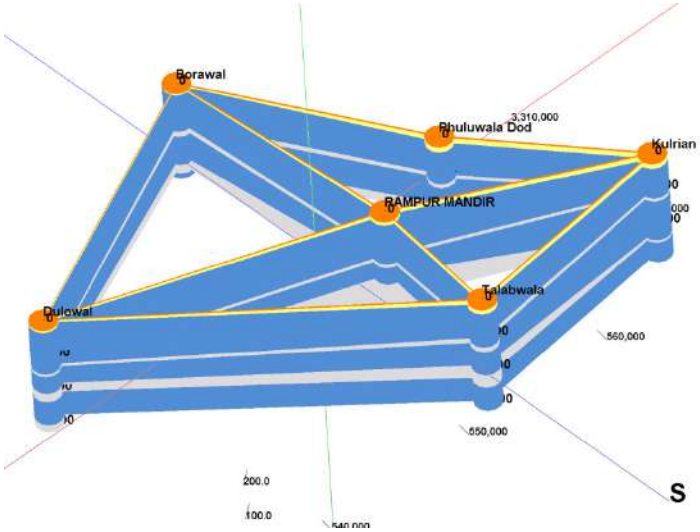
Lithological Cross section from Borawal to Talabwala



3-D Lithological Fence Diagram



3-D Aquifer Disposition Fence Diagram



Ground water Resource, Extraction, Contamination and other issues

Ground Water Resources upto the depth of 300m	Dynamic Fresh water resources	214.54 mcm
	In-storage Fresh water resources	6.67 mcm
	In-storage Saline water resources	21.5 mcm
	Total	544 mcm
Ground Water Extraction (as per 2013)	Irrigation	441.38 mcm
	Domestic & Industrial	0.0mcm
Future Demand for domestic & Industrial sector (2025) (as per 2013)		4.34 mcm
Stage of Groundwater Development		175%
Chemical Quality of ground water		Ground water in the area is alkaline and pH near to 9.09. Ground water in the area is fresh to marginal saline. EC value of the ground water show wide up to 680 µS/cm at 25^0C.
Ground water Contamination Issues		*Nitrate (mg/l):* Kotra (104)
Other issues		Water level decline has been observed in major parts of the block due to in discriminate development of ground water

	resources.

4. Ground water Resource enhancement

Aquifer wise space available for recharge and proposed interventions (Supply Side Measures)

Aquifer-I:

Volumes of unsaturated zone after 3m upto a desirable depth: 8 mcm
Source water requirement/availability for recharge: *Rain, Canal, Irrigation return flow*
Types and number of structures: --
Other interventions proposed*: Artificial Recharge, Roof top Rainwater harvesting will save 0.0 mcm volume of water*

5. Demand side interventions

Advanced Irrigation Practices

Area proposed to be covered: 675.4 sq km
Volume of Water expected to be conserved under advanced irrigation practices such as lining of underground pipelines (Kutcha channel) etc.: 17.72 mcm

Change in cropping pattern Not Required

Proposed change in cropping pattern: Not Required
Area coverage: Not Required
Anticipated volume of water to be saved: Not Required

Alternate Water sources
Groundwater/surface water sources: *Tanks, Ponds*
Location, details and availability from such sources outside the area: --

Regulation and Control: Punjab Subsoil Act, 2009 for delay in paddy plantation should continue in the area.

Other interventions proposed, if any

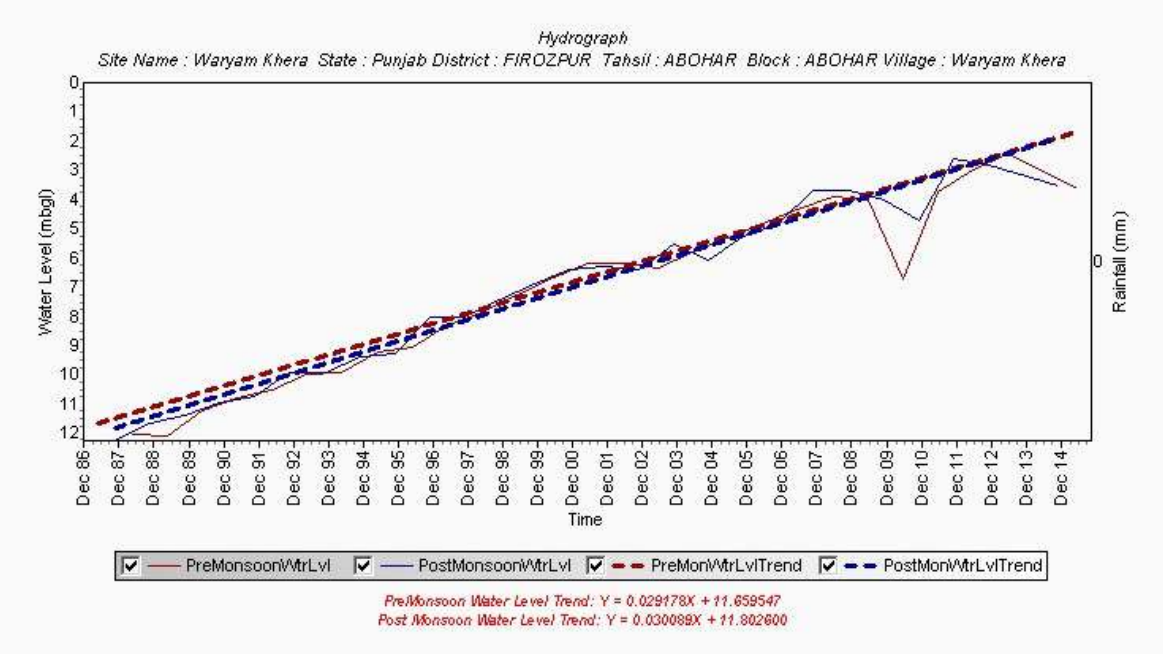
Modern Irrigation Practices be adopted for Rabi crops. Some of the techniques are given in the table below (PAU, Ludhiana).

3.0 Salient Information

Name of the Block and Area (in Km^2)	**JHUNIR 308.45 sq km**
District/ State	Mansa, Punjab
Population	Urban Population: 0

	Rural Population: 18104 Total population: 18104
Rainfall	Normal Monsoon: 318 mm Non-monsoon Rainfall : 63 mm Annual Average Rainfall: 387 mm
Irrigation	Irrigation practices: Canal and Tube well Irrigation Cropping intensity: 101% Number and types of abstraction structures: 40218 nos., Tubewells
Ground Water Resource Availability and Extraction	**Ground water Resources Availability** Ground Water Resources are available in 2672 mcm (fresh and saline water resources) up to the depth of 300 m. The fresh water resources are estimated up to the depth of 106 m based on geophysical interpretations interface. The potential granular zones are available for fresh water is 81 m. Saline water resources are estimated based on the available depth of wells existed up to 300 m and the granular zones are counted after the depth of 152 m and available zones are 76 m. Block is categorized as Over-Exploited as aper Dynamic Groundwater Resources, 2013 assessment. **Ground water Resources Extraction** Deeper aquifers are marginal to highly saline and it is not suitable for irrigation purpose so that all users are tapping at shallow aquifers only. State government drinking water supply wells tapped at shallow aquifers and canal supply water are used for domestic and Irrigation purpose. So that the ground water draft could not be addressed for deeper aquifer.
Existing and future water demands	*Existing Gross Ground water Draft as on 2013* Irrigation: 208.26 mcm Domestic and industrial water supply: 0.0 mcm *Future water demands* Irrigation development potential : 4.34 mcm Domestic and industrial water supply up to 2025 years : 0.0 mcm
Water level behavior	*Aquifer wise water level* **Aquifer-I** Pre Monsoon: 2.35 – 16.00 m bgl Post Monsoon: 1.55 – 18.20 m bgl Mean (10 yrs) : 1.58 – (-)0.86 m/yr *Trends* Pre Monsoon: 0.16 – (-)0.26 m/yr Post Monsoon: 0.15 – (-)0.29 m/yr

HYDROGRAPHS



2. 0 Aquifer Disposition

Number of aquifers	1
Principal aquifer	Alluvium
Major Aquifer	Aeolian Alluvium,Older Alluvium

Aquifer wise Characteristics

*Aquifer Group **	*Geology*	*Type of Aquifer*	*Thickness of Granular zones (m)*	*Transmissivity (m^2/day)*	*Yield (m^3/day)*	*Specific Yield %*	*Storativity*
Aquifer -I	Quaternary Alluvial deposits	Unconfined to confined	106	547		12	

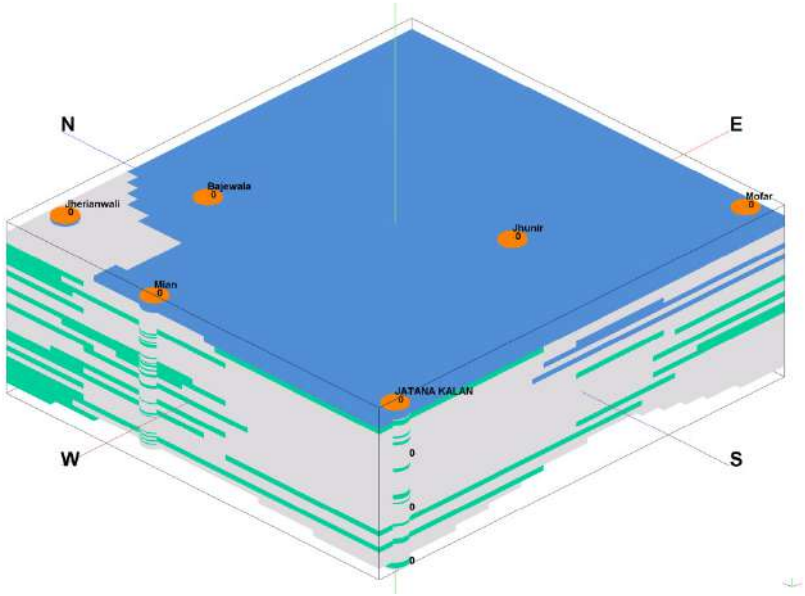
The Aquifer comprises of both fresh and saline water and the main aquifer material is sand. The non-aquifer material comprise of clay, clay with silt.

Exploratory Data Validated

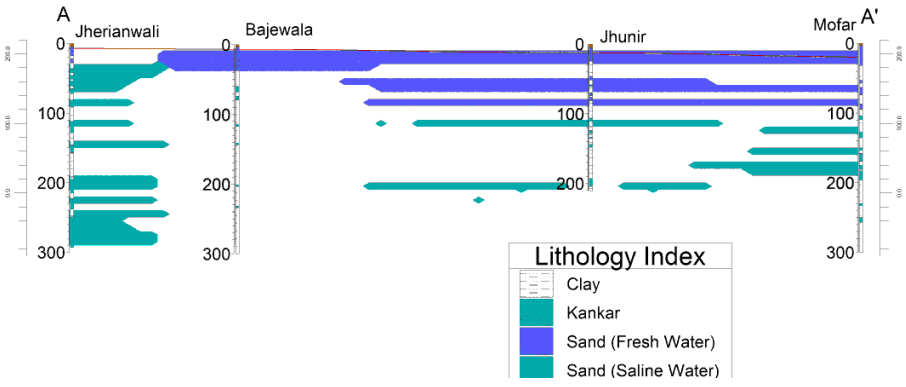
Source of Data	*No. of exploration wells as per depth range (m)*				*Total*
	<100	*100-200*	*200-300*	*>300*	
CGWB			1		
WRED/PSTC/WSS					
PRIVATE					
TOTAL					**1**

The data is validated by selecting the deepest well in each quadrant and used for preparation of 3-D Litho models, 2-D geological cross sections, Fence diagrams and aquifer maps.

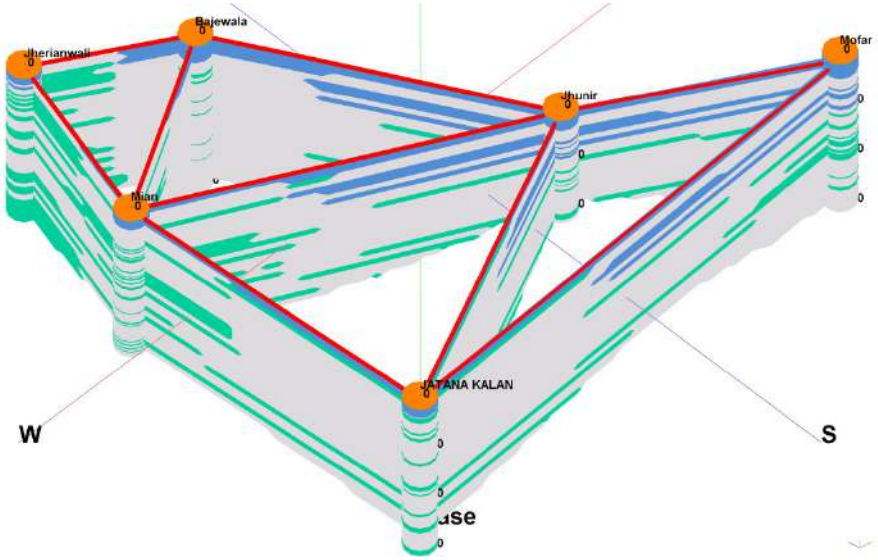
3-D Lithological model of Jhunir Block



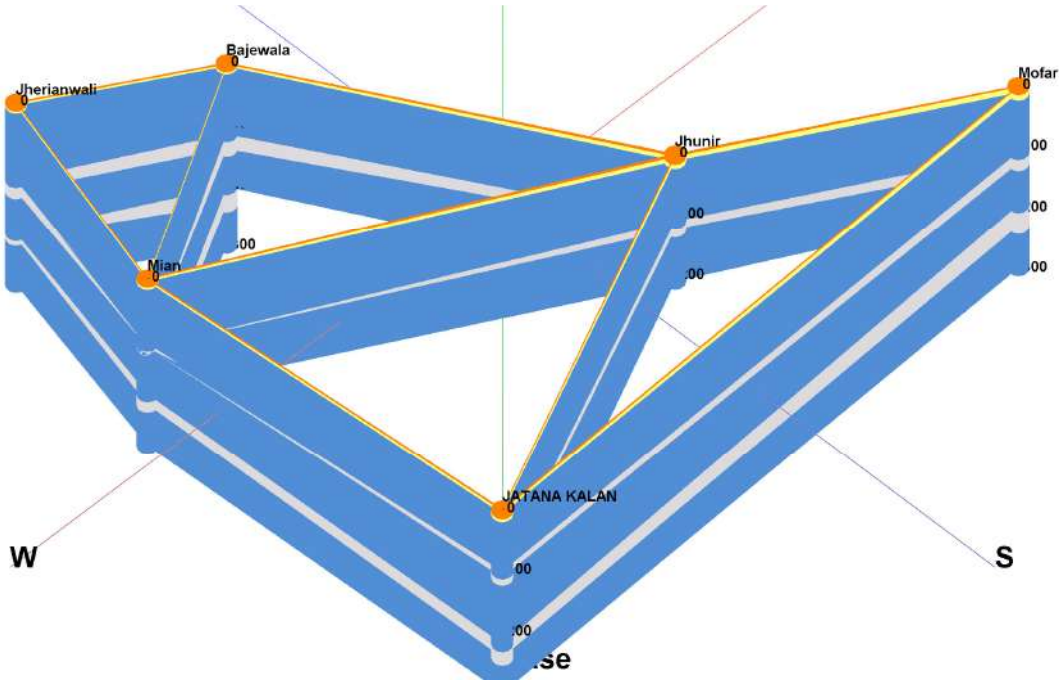
Lithological Cross section from Jherianwali to Mofar



3-D Lithological Fence Diagram



3-D Aquifer Disposition Fence Diagram



Ground water Resource, Extraction, Contamination and other issues

Ground Water Resources upto the depth of 300m	Dynamic Fresh water resources	214.54 mcm
	In-storage Fresh water resources	6.67 mcm

	In-storage Saline water resources	21.5 mcm
	Total	544 mcm
Ground Water Extraction (as per 2013)	Irrigation	208.26 mcm
	Domestic & Industrial	0.0mcm
Future Demand for domestic & Industrial sector (2025) (as per 2013)		0.0 mcm
Stage of Groundwater Development		98%
Chemical Quality of ground water		Ground water in the area is alkaline and pH range 8.63 to 9.51. Ground water in the area is fresh to marginal saline. EC value of the ground water show wide range from 240 to 5235 μS/cm at 25^0C.
Ground water Contamination Issues		*Nitrate (mg/l):* Fatta maluka(104), burj Bhaike(299) *Fluride (mg/l):mofar(2.32)*
Other issues		Water level decline has been observed in major parts of the block due to in discriminate development of ground water resources.

4. Ground water Resource enhancement

Aquifer wise space available for recharge and proposed interventions (Supply Side Measures)

Aquifer-I:

Volumes of unsaturated zone after 3m upto a desirable depth: 8 mcm

Source water requirement/availability for recharge: *Rain, Canal, Irrigation return flow*

Types and number of structures: --

Other interventions proposed*: Artificial Recharge, Roof top Rainwater harvesting will save 0.0 mcm volume of water*

5. Demand side interventions

Advanced Irrigation Practices

Area proposed to be covered: 675.4 sq km

Volume of Water expected to be conserved under advanced irrigation practices such as lining of underground pipelines (Kutcha channel) etc.: 17.72 mcm

Change in cropping pattern Not Required

Proposed change in cropping pattern: Not Required
Area coverage: Not Required
Anticipated volume of water to be saved: Not Required

Alternate Water sources
Groundwater/surface water sources: *Tanks, Ponds*
Location, details and availability from such sources outside the area: --

Regulation and Control: Punjab Subsoil Act, 2009 for delay in paddy plantation should continue in the area.

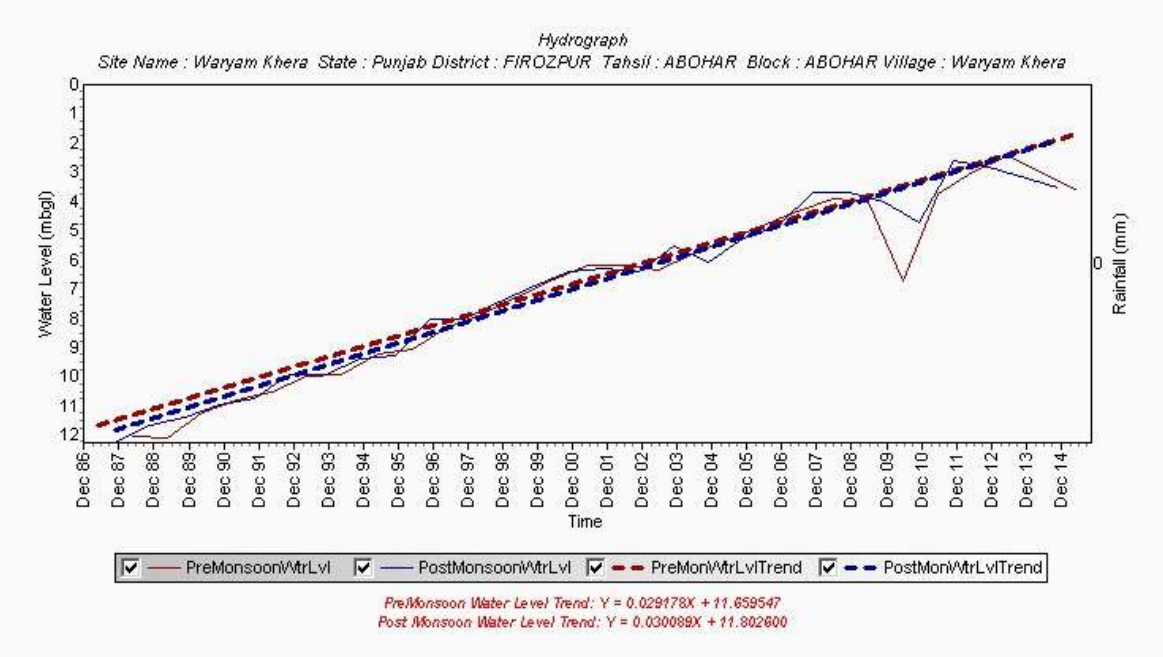
Other interventions proposed, if any
Modern Irrigation Practices be adopted for Rabi crops. Some of the techniques are given in the table below (PAU, Ludhiana).

4.0 Salient Information

Name of the Block and Area (in Km^2)	**Sardulgarh 232.90sq km**
District/ State	Mansa, Punjab
Population	Urban Population: 0 Rural Population: 17675 Total population: 17675
Rainfall	Normal Monsoon: 265 mm Non-monsoon Rainfall : 120 mm Annual Average Rainfall: 414 mm
Irrigation	Irrigation practices: Canal and Tube well Irrigation Cropping intensity: 101% Number and types of abstraction structures: 17665 nos., Tubewells
Ground Water Resource Availability and Extraction	**Ground water Resources Availability** Ground Water Resources are available in 2672 mcm (fresh and saline water resources) up to the depth of 300 m. The fresh water resources are estimated up to the depth of 106 m based on geophysical interpretations interface. The potential granular zones are available for fresh water is 81 m. Saline water resources are estimated based on the available depth of wells existed up to 300 m and the granular zones are counted after the depth of 152 m and available zones are 76 m. Block is categorized as Over-Exploited as aper Dynamic Groundwater Resources, 2013 assessment.

	Ground water Resources Extraction Deeper aquifers are marginal to highly saline and it is not suitable for irrigation purpose so that all users are tapping at shallow aquifers only. State government drinking water supply wells tapped at shallow aquifers and canal supply water are used for domestic and Irrigation purpose. So that the ground water draft could not be addressed for deeper aquifer.
Existing and future water demands	*Existing Gross Ground water Draft as on 2013* Irrigation: 217.78 mcm Domestic and industrial water supply: 3.8 mcm *Future water demands* Irrigation development potential : -99.36 mcm Domestic and industrial water supply up to 2025 years : 3.8 mcm
Water level behavior	*Aquifer wise water level* **Aquifer-I** Pre Monsoon: 2.35 – 16.00 m bgl Post Monsoon: 1.55 – 18.20 m bgl Mean (10 yrs) : 1.58 – (-)0.86 m/yr *Trends* Pre Monsoon: 0.16 – (-)0.26 m/yr Post Monsoon: 0.15 – (-)0.29 m/yr

HYDROGRAPHS



2. 0 Aquifer Disposition

Number of aquifers	1
Principal aquifer	Alluvium
Major Aquifer	Aeolian Alluvium,Older Alluvium

Aquifer wise Characteristics

Aquifer Group *	*Geology*	*Type of Aquifer*	*Thickness of Granular zones (m)*	*Transmissivity (m^2/day)*	*Yield (m^3/day)*	*Specific Yield %*	*Storativity*
Aquifer -I	Quaternary Alluvial deposits	Unconfined to confined	106	547		12	

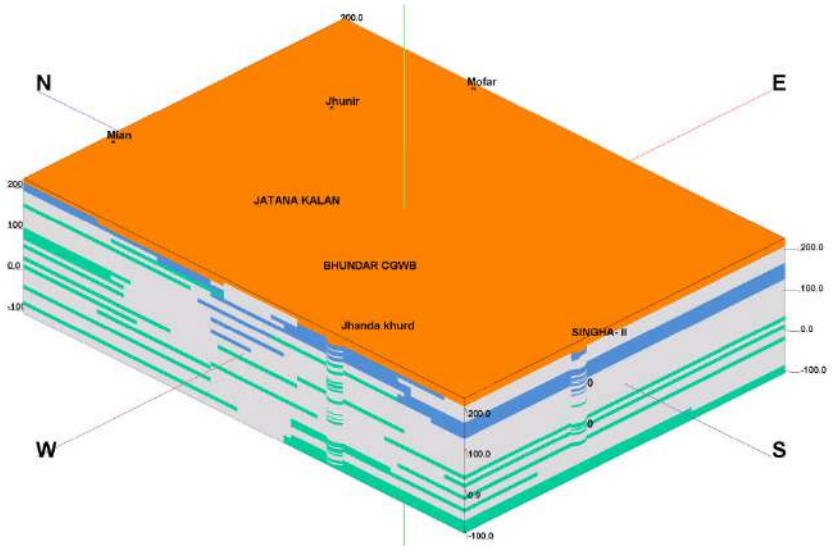
The Aquifer comprises of both fresh and saline water and the main aquifer material is sand. The non-aquifer material comprise of clay, clay with silt.

Data Availability

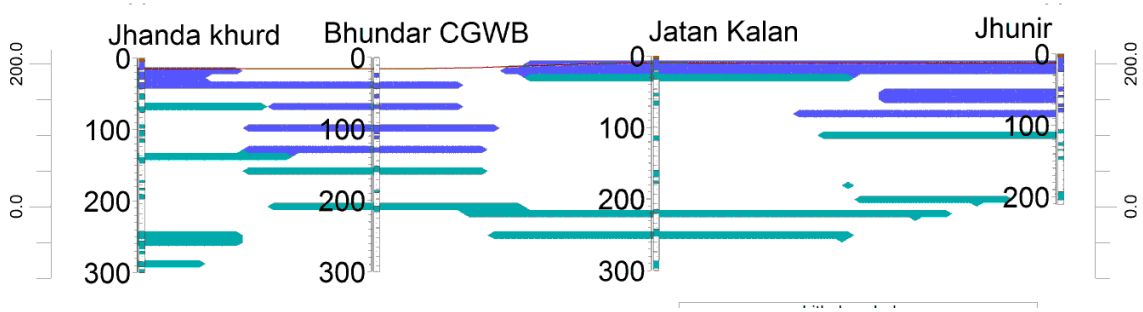
Sl.No	Source of data	Depth Range (m)		
		< 100	**100-200**	**200-300**
1	CGWB	0	0	5
2	WAPCOS	0	0	0
3	PRIVATE	0	0	1
Total		**0**	**0**	**6**

The data is validated by selecting the deepest well in each quadrant and used for preparation of 3-D Litho models, 2-D geological cross sections, Fence diagrams and aquifer maps.

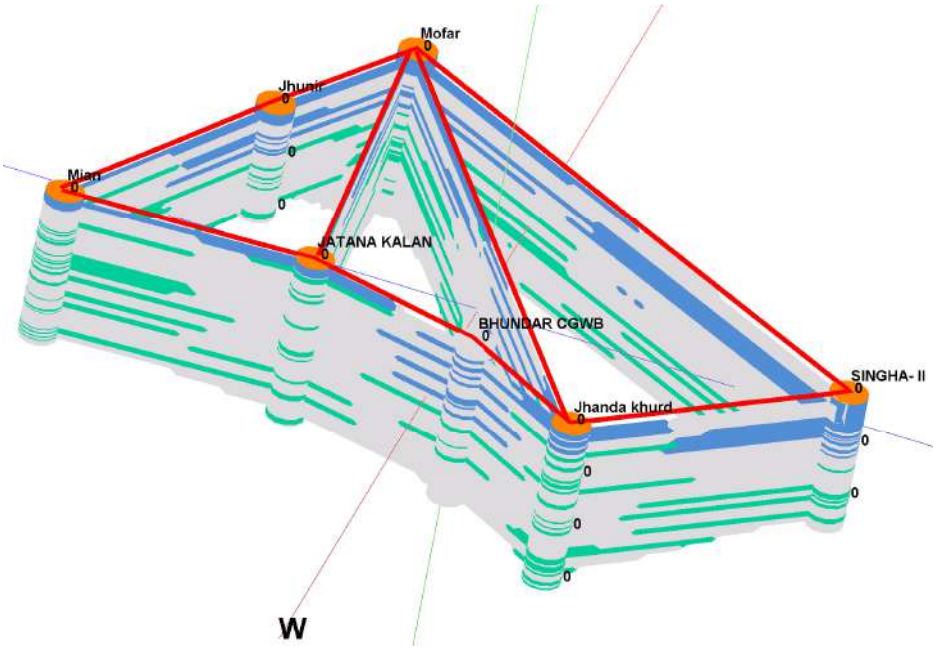
3-D Lithological model of SardulgarhBlock



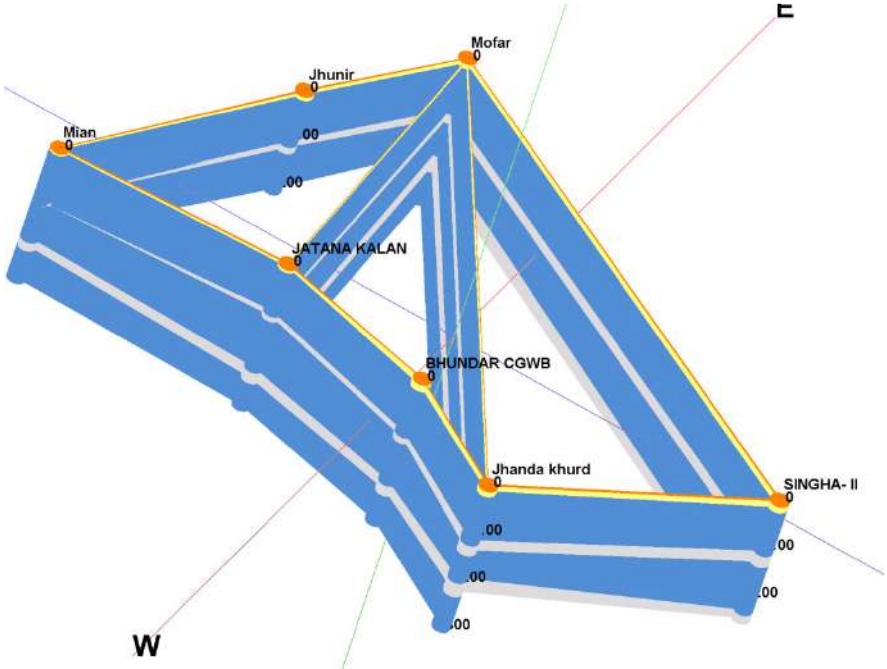
Lithological Cross section from Jhand Khurd to Jhunir



3-D Lithological Fence Diagram



3-D Aquifer Disposition Fence Diagram



Ground water Resource, Extraction, Contamination and other issues

Ground Water Resources upto the depth of 300m	Dynamic Fresh water resources	214.54 mcm
	In-storage Fresh water resources	6.67 mcm
	In-storage Saline water resources	21.5 mcm
	Total	544 mcm
Ground Water Extraction (as per 2013)	Irrigation	217.78 mcm
	Domestic & Industrial	5.0mcm
Future Demand for domestic & Industrial sector (2025) (as per 2013)		5.0 mcm
Stage of Groundwater Development		184%
Chemical Quality of ground water		NA
Ground water Contamination Issues		NA
Other issues		Water level decline has been observed in major parts of the block due to in discriminate development of ground water resources.

4. Ground water Resource enhancement

Aquifer wise space available for recharge and proposed interventions (Supply Side Measures)

Aquifer-I:

Volumes of unsaturated zone after 3m upto a desirable depth: 8 mcm

Source water requirement/availability for recharge: *Rain, Canal, Irrigation return flow*

Types and number of structures: --

Other interventions proposed*: Artificial Recharge, Roof top Rainwater harvesting will save 0.0 mcm volume of water*

5. Demand side interventions

Advanced Irrigation Practices

Area proposed to be covered: 675.4 sq km

Volume of Water expected to be conserved under advanced irrigation practices such as lining of underground pipelines (Kutcha channel) etc.: 17.72 mcm

Change in cropping pattern Not Required

Proposed change in cropping pattern: Not Required
Area coverage: Not Required
Anticipated volume of water to be saved: Not Required

Alternate Water sources
Groundwater/surface water sources: *Tanks, Ponds*
Location, details and availability from such sources outside the area: --

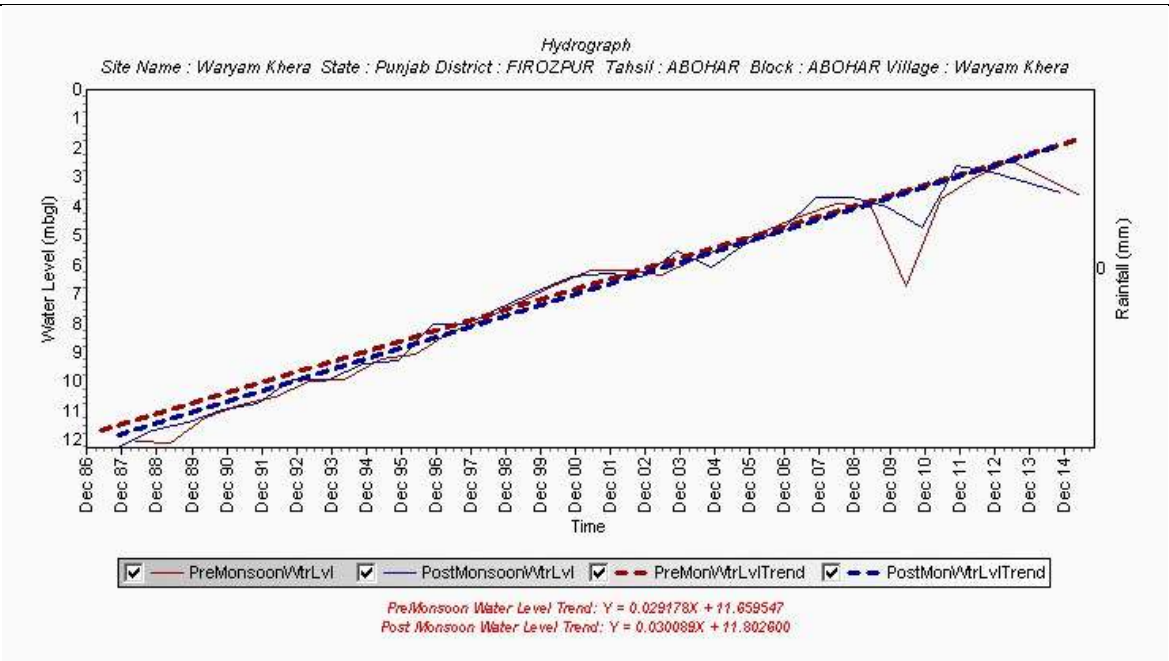
Regulation and Control: Punjab Subsoil Act, 2009 for delay in paddy plantation should continue in the area.

Other interventions proposed, if any
Modern Irrigation Practices be adopted for Rabi crops. Some of the techniques are given in the table below (PAU, Ludhiana).

5.0 Salient Information

Name of the Block and Area (in Km^2)	**Mansa 358.14 sq km**
District/ State	Mansa, Punjab
Population	Urban Population: 0 Rural Population: 22203 Total population: 22203
Rainfall	Normal Monsoon: 335 mm Non-monsoon Rainfall :78 mm Annual Average Rainfall: 408 mm
Irrigation	Irrigation practices: Canal and Tube well Irrigation Cropping intensity: 101% Number and types of abstraction structures: 22203 nos., Tubewells
Ground Water Resource Availability and Extraction	**Ground water Resources Availability** Ground Water Resources are available in 2672 mcm (fresh and saline water resources) up to the depth of 300 m. The fresh water resources are estimated up to the depth of 106 m based on geophysical interpretations interface. The potential granular zones are available for fresh water is 81 m. Saline water resources are estimated based on the available depth of wells existed up to 300 m and the granular zones are counted after the depth of 152 m and

	available zones are 76 m. Block is categorized as Over-Exploited as aper Dynamic Groundwater Resources, 2013 assessment. **<u>Ground water Resources Extraction</u>** Deeper aquifers are marginal to highly saline and it is not suitable for irrigation purpose so that all users are tapping at shallow aquifers only. State government drinking water supply wells tapped at shallow aquifers and canal supply water are used for domestic and Irrigation purpose. So that the ground water draft could not be addressed for deeper aquifer.
Existing and future water demands	*<u>Existing Gross Ground water Draft as on 2013</u>* Irrigation: 295.79 mcm Domestic and industrial water supply: 5.00 mcm *<u>Future water demands</u>* Irrigation development potential : -59.16 mcm Domestic and industrial water supply up to 2025 years : 5 mcm
Water level behavior	*<u>Aquifer wise water level</u>* **Aquifer-I** Pre Monsoon: 2.35 – 16.00 m bgl Post Monsoon: 1.55 – 18.20 m bgl Mean (10 yrs) : 1.58 – (-)0.86 m/yr *Trends* Pre Monsoon: 0.16 – (-)0.26 m/yr Post Monsoon: 0.15 – (-)0.29 m/yr
HYDROGRAPHS	



2. 0 Aquifer Disposition

Number of aquifers	1
Principal aquifer	Alluvium
Major Aquifer	Older Alluvium

Aquifer wise Characteristics

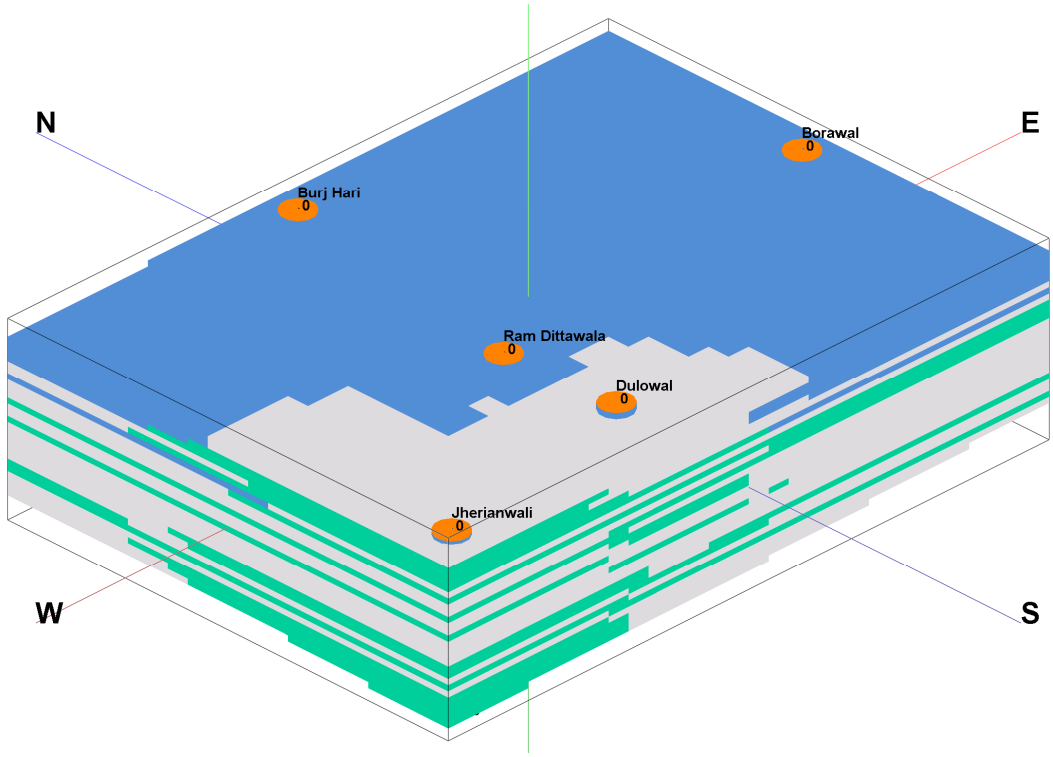
Aquifer Group *	*Geology*	*Type of Aquifer*	*Thickness of Granular zones (m)*	*Transmissivity (m^2/day)*	*Yield (m^3/day)*	*Specific Yield %*	*Storativity*
Aquifer -I	Quaternary Alluvial deposits	Unconfined to confined	106	547		12	

The Aquifer comprises of both fresh and saline water and the main aquifer material is sand. The non-aquifer material comprise of clay, clay with silt.

Data Availability

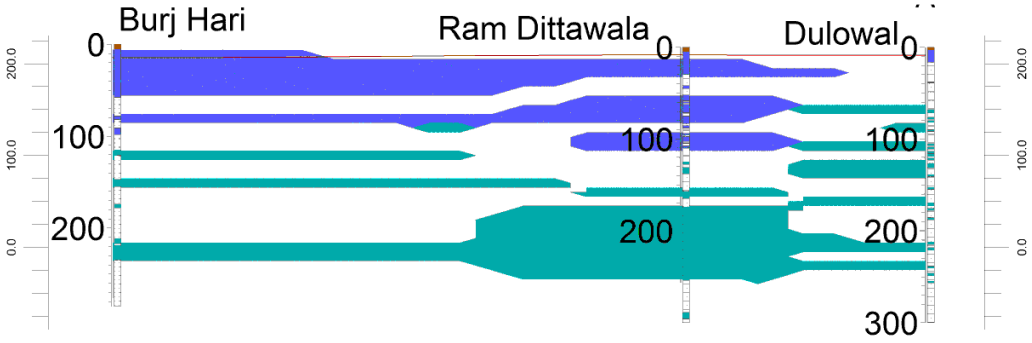
Sl.No	Source of data	Depth Range (m)		
		< 100	100-200	200-300
1	CGWB	0	0	o
2	WAPCOS	0	0	1
3	PRIVATE	0	0	2
Total		**0**	**0**	**3**

The data is validated by selecting the deepest well in each quadrant and used for preparation of 3-D Litho models, 2-D geological cross sections, Fence diagrams and aquifer maps.

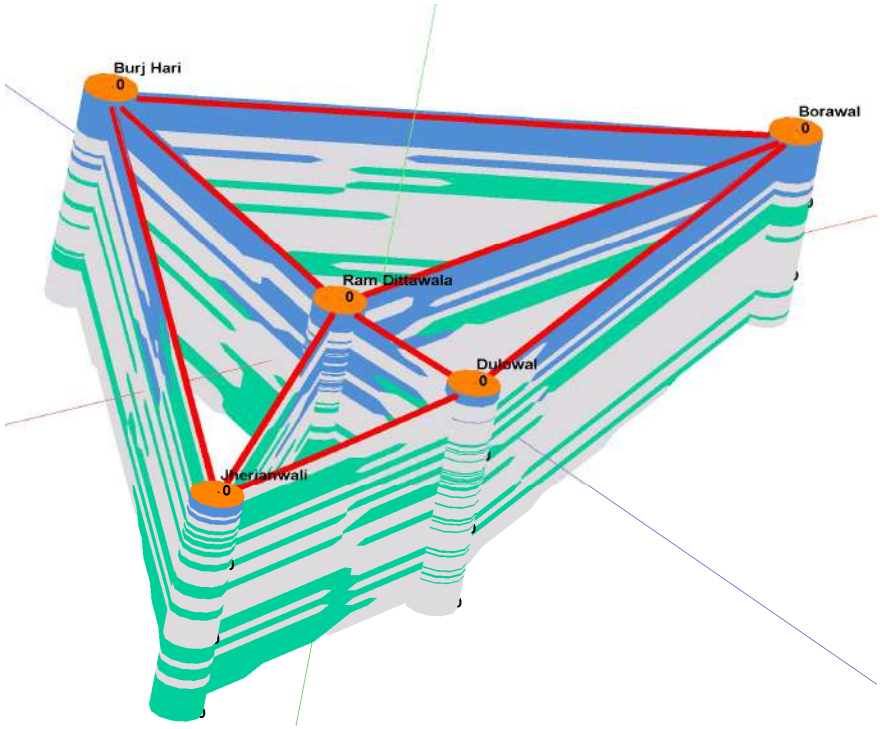


3-D Lithological model of Mansa Block

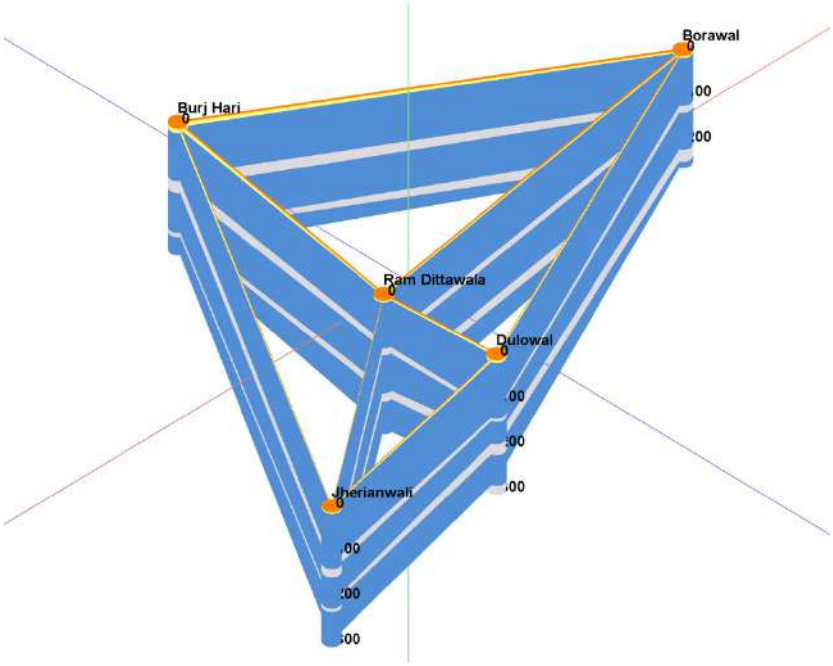
Lithological Cross section from Burj Hari to Dulowal



3-D Lithological Fence Diagram



3-D Aquifer Disposition Fence Diagram



Ground water Resource, Extraction, Contamination and other issues

Ground Water Resources upto the depth of 300m	Dynamic Fresh water resources	214.54 mcm
	In-storage Fresh water resources	6.67 mcm
	In-storage Saline water resources	21.5 mcm
	Total	544 mcm
Ground Water Extraction (as per 2013)	Irrigation	295.7 mcm
	Domestic & Industrial	5.0mcm
Future Demand for domestic & Industrial sector (2025) (as per 2013)		5.0 mcm
Stage of Groundwater Development		125%
Chemical Quality of ground water		Ground water in the area is alkaline and pH range 8.76 to 9.31. Ground water in the area is fresh to marginal saline. EC value of the ground water show wide range from

	305to 1340 µS/cm at 25^0C.
Ground water Contamination Issues	*Nitrate (mg/l):* ralla(47), *Fluride (mg/l):Bhikhi(2.32),* ralla(1.83),
Other issues	Water level decline has been observed in major parts of the block due to in discriminate development of ground water resources.

4. Ground water Resource enhancement

Aquifer wise space available for recharge and proposed interventions (Supply Side Measures)

Aquifer-I:

Volumes of unsaturated zone after 3m upto a desirable depth: 8 mcm
Source water requirement/availability for recharge: *Rain, Canal, Irrigation return flow*
Types and number of structures: --
Other interventions proposed*: Artificial Recharge, Roof top Rainwater harvesting will save 0.0 mcm volume of water*

5. Demand side interventions

Advanced Irrigation Practices
Area proposed to be covered: 675.4 sq km
Volume of Water expected to be conserved under advanced irrigation practices such as lining of underground pipelines (Kutcha channel) etc.: 17.72 mcm

Change in cropping pattern Not Required

Proposed change in cropping pattern: Not Required
Area coverage: Not Required
Anticipated volume of water to be saved: Not Required

Alternate Water sources
Groundwater/surface water sources: *Tanks, Ponds*
Location, details and availability from such sources outside the area: --

Regulation and Control: Punjab Subsoil Act, 2009 for delay in paddy plantation should continue in the area.

Other interventions proposed, if any

Modern Irrigation Practices be adopted for Rabi crops. Some of the techniques are given in the table below (PAU, Ludhiana).