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

Moga District, Punjab

उत्तरी पश्चिम क्षेत्र, चंडीगढ़

North Western Region, Chandigarh

AQUIFER MAPPING

&

MANAGEMENT PLAN

MOGA DISTRICT

PUNJAB

Central Ground Water Board
Ministry of Water Resources, River Development and Ganga Rejuvenation
Government of India
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AQUIFER MAPPING AND GROUND WATER MANAGEMENT IN MOGA DISTRICT, PUNJAB

(2172 Sq. Km UNDER NAQUIFERUIM XII PLAN)

1.0 INTRODUCTION

There has been a paradigm shift from "groundwater development" to "groundwater management" in the past two decades in the country. An accurate and comprehensive micro-level picture of ground water through aquifer mapping in different hydrogeological settings would enable robust groundwater management plans in an appropriate scale. Aquifer mapping is a process wherein a combination of geologic, geophysical, hydrologic and chemical field and laboratory analyses are applied to characterize the quantity, quality and sustainability of ground water in aquifers. This would help achieving drinking water security, improved irrigation facility and sustainability in water resources development in large parts of rural India, and many parts of urban India.

Central Ground Water Board (CGWB) implemented the Aquifer Mapping Programme in Punjab in four phases (**Fig. 1**) with the broad objective of preparing an Aquifer-wise management plan for the region. Various multi–disciplinary geo-scientific activities were undertaken in the study partly through in-house capacity of CGWB, DWRS, PSCTC and Private agencies for generation of additional micro-level hydrogeological data. This report primarily deals with Moga district of Punjab State (**Fig. 1**), covered under Phase-II.

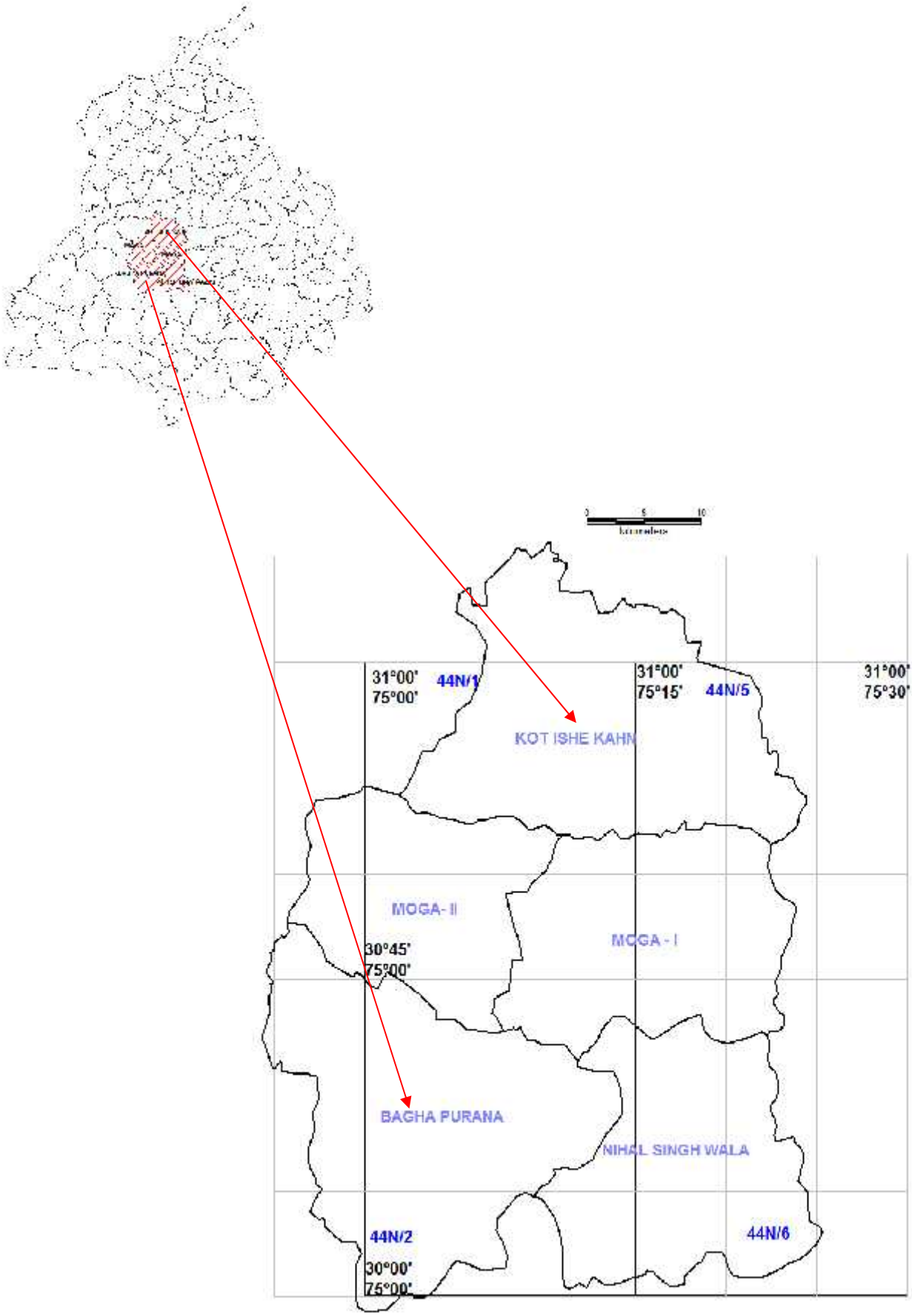
The district area forms a part of Indo-Gangetic plain and Sutlej sub-basin of Indus basin. The area as a whole is almost flat with a gentle slope towards the Western and Northwesterly direction. The Physiography of the district is broadly classified from south to north into four distinct features i.e. Upland plain, Sand dune tract, younger flood pain and active flood plain of Sutlej. The Sutlej is an important perennial river, which forms major drainage of the area and runs parallel to the Northern border of the district. There are two types of soils viz Sierozem and Desert soils in Moga District. The sierozem soils are found in major parts of the district and desert soils are comparatively found in a relatively smaller area towards western part

of the district.

Moga district is located in the Central part of Punjab state and lies between 30^0 35' to 31^0 15' north latitude & 75^0 15' to 75^0 25' east longitude. Total area of the district is 2172 sq km. Administratively, the district is under control of Ferozpur division and is divided into 3 sub-divisions/ tehsils namely Moga, Bhagapurana and Nihal Singhwala. Dharamkot and Bhadhani Kalan are 2 sub-tehsils of district Moga. Further, the district has been sub-divided into five development blocks i.e. Moga I, Moga - II, Dharamkot, Bhagapurana and Nihal Singhwala. Moga district has 4 towns and 329 villages with a total population of 9,92,289 as per 2011 census. As per 2011 census, 77.45 % population of Moga districts lives in rural areas of villages. The total Moga district population living in rural areas is 768,499 of which males and females are 405,793 and 362,706 respectively. In rural areas of Moga district, sex ratio is 894 females per 1000 males. Child population in the age 0-6 is 79,083 in rural areas of which males were 42,377 and females were 36,706. The child population comprises 10.44 % of total rural population of Moga district. Literacy rate in rural areas of Moga district is 69.04 % as per census data 2011. Gender wise, male and female literacy stood at 72.98 and 64.64 percent respectively. In total, 475,967 people were literate of which males and females were 265,239 and 210,728 respectively.

The district ranks at 11th place in the population size in the Punjab State. Density of population is 444 persons/ sq km which is second lowest in the state.

Fig 1: Base Map of Moga District



2. DATA COLLECTION AND GENERATION

2.1 Tube well Logs

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

Table-I Data availability of exploration wells in Moga district

MOGA DISTRICT

Sl.No	Source of data	Depth Range (m)			
		< 100	**100-200**	**200-300**	**>300**
1	CGWB	4	0	0	6
2	WR&ED	0	0	0	3
3	PRIVATE	1	24	4	2
Total		**5**	**24**	**4**	**11**

2.2 Ground Water Quality

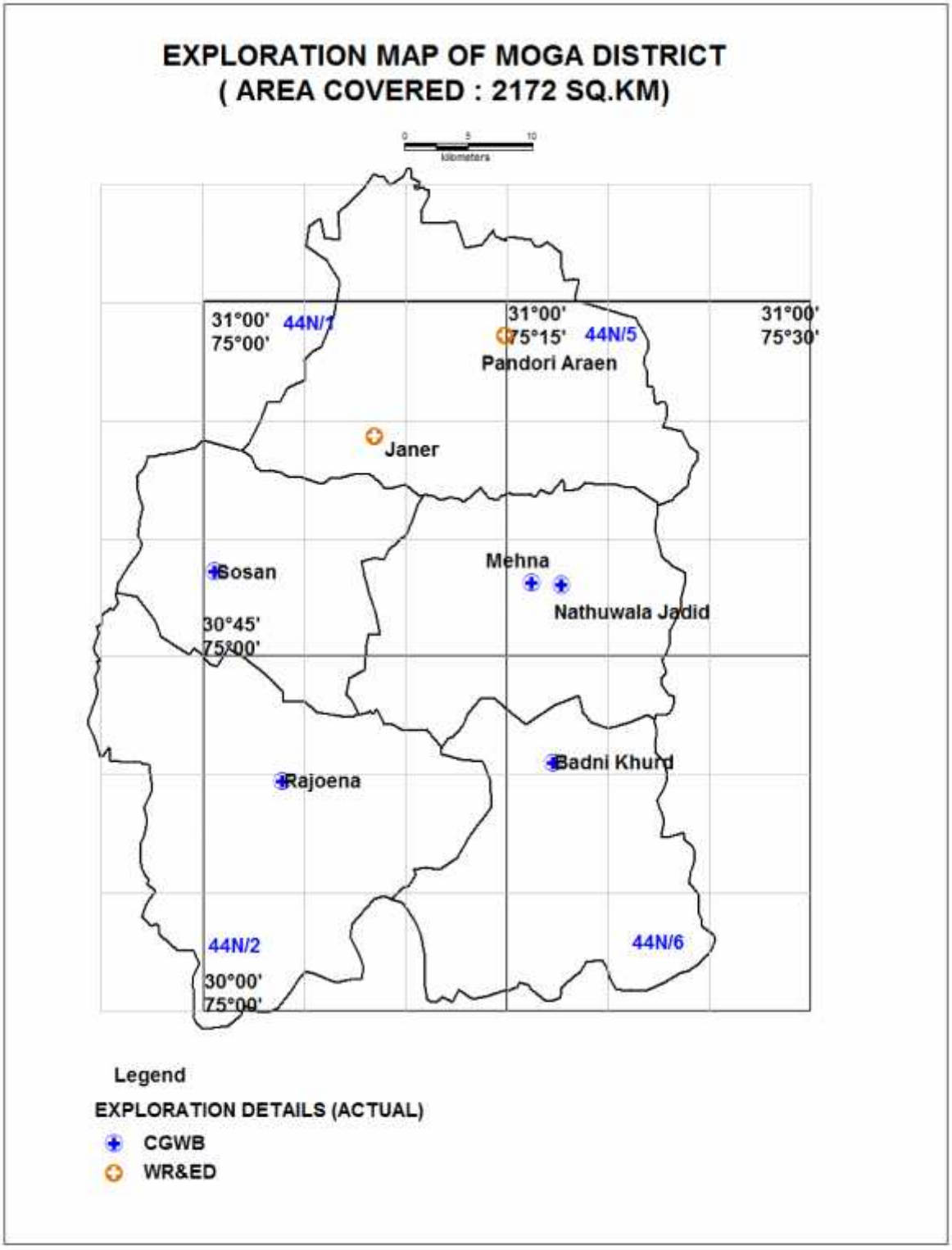
Chemical quality of groundwater of shallow aquifer shows that all parameters are within the permissible limits for drinking purpose set by the BIS, 2012. Electrical conductivity, Chloride, Nitrate and Fluoride are the important parameters that are normally considered for evaluating the suitability of ground water for drinking uses. Ground water occurs within desirable levels with respect to EC (less than 1000 micromohos/cm at 25^0C), Chloride (<250 mg/l), Nitrate (<45mg/l) and Fluoride (<1mg/l) in all samples. As per geo-chemical classification, the shallow ground water is Ca-Mg-HCO_3 type with few exception where water is Na-HCO_3 type.

2.3 SPATIAL DATA DISTRIBUTION

Data Distribution

The actual data of all the wells in the area are plotted on the map of 1:50000 scale with 5 min x 5 min grid (9km x 9km) and is shown in Fig: 2.The exploration data shows that majority of tube wells falls in the II^{nd} Aquifer. After data validation, only selected the deepest well in each quadrant is plotted on the map of 1.50000 scale with 5 min x 5 min grid (9km x 9km) and is shown in Fig: II. The grids/ formations devoid of SH/PZ/EW are identified as data gaps and these are to be filled by data generation.

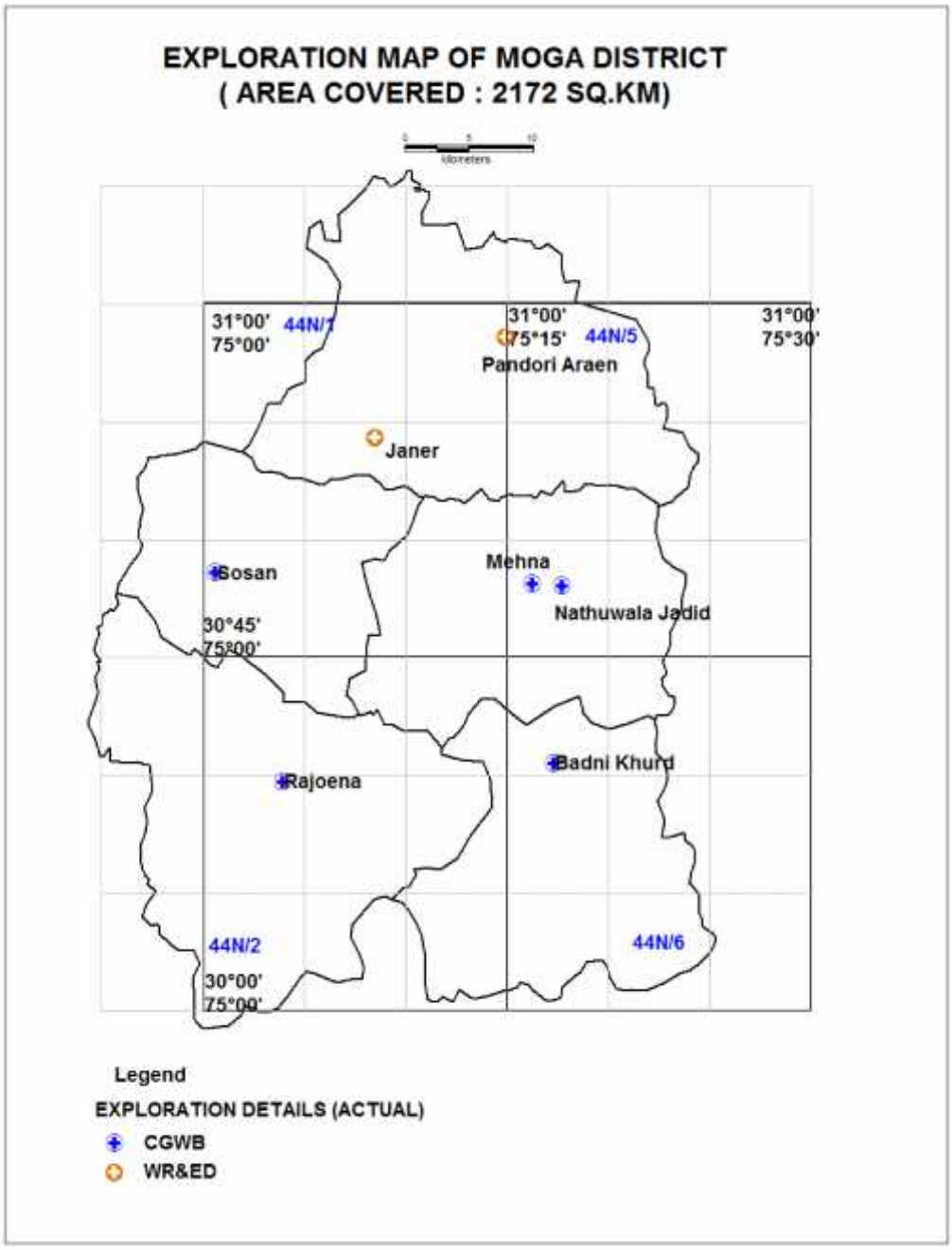
Fig-2 Location of Exploratory Bore Holes



2.4 DATA INTERPRETATION, INTEGRATION AND AQUIFER MAPPING

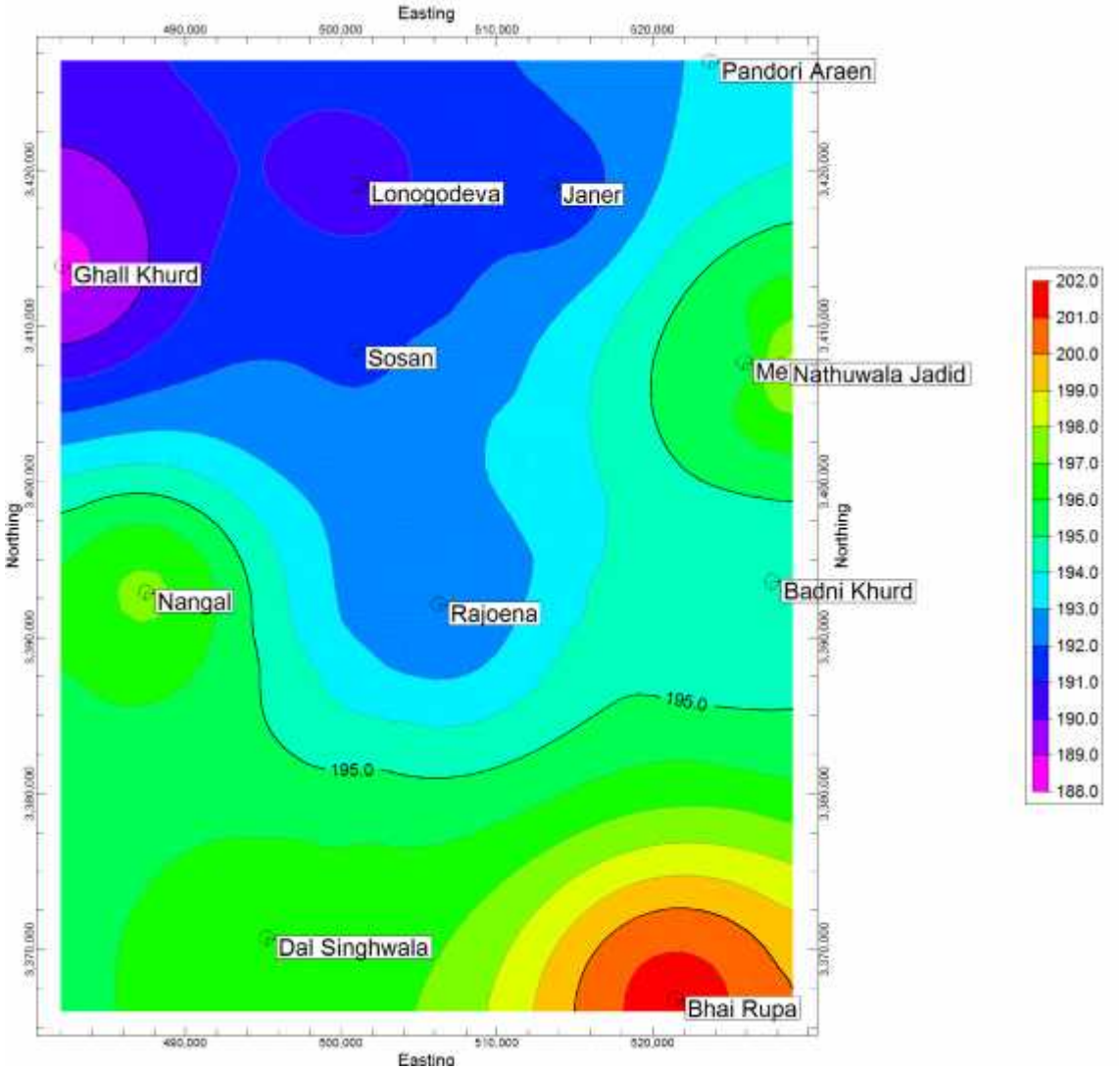
All the available data have been validated for consideration to generate aquifer map. The deepest well in each quadrant is selected and plotted on the map of 1.50000 scale with 5'X5'grid (9 x 9km) and is shown in Fig -3.

Fig 3: Validated Exploration Data of Moga District



The topographic elevation values have been plotted to prepare the elevation contour map and is in fig 4.

Fig 4: Elevation Contour Map-Moga District



The data is validated by selecting the deepest well in each quadrant with those supported electrical logs for preparation of aquifer map and is shown below

Table-3: Summery of Optimized Exploration Wells

Data Validated: The data is validated by selecting the deepest well in each quadrant with those supported electrical logs for preparation of aquifer map and is shown below;

Sl.No	Block	Toposheet and Grid number		Depth Range (m)								Elevation (m amsl)	Source of data
				Location	< 100	Location	100-200	Location	200-300	Location	>300		
1	Janer	44N/1	2B						300	Janer		**191**	WR&ED
2	Badni Khurd	44N/1	3A						285	Badni Khurd		**194**	CGWB
3	Nathuwala Jadid	44N/5	3A						300	Nathuwala Jadid		**199**	CGWB
4	Rajoena	44N/2	2A						300	Rajoena		**192**	CGWB
5	Sosan	44N/1	3A						247	Sosan		**192**	CGWB
6	Mehna	44N/5	3A						300	Mehna		**195**	CGWB
7	Pandori Araen	44N/5	1A						300	Pandori Araen		**193**	WR&ED

3. HYDROGEOLOGY

3.1 PREVIOUS WORK

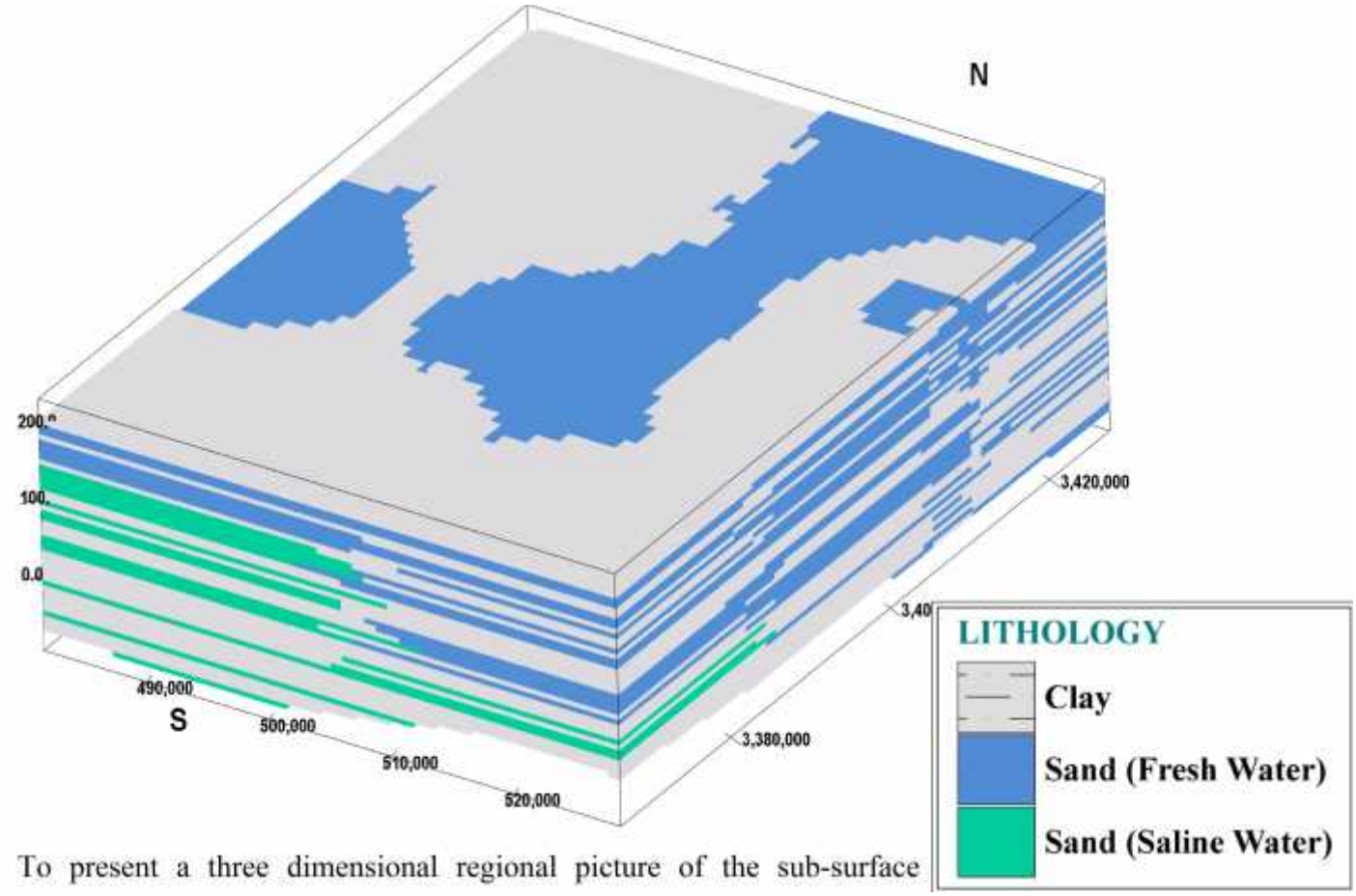
Geological formation encountered within the district comprises of unconsolidated alluvial deposits of Quaternary age. Aquifer material comprises chiefly of fine to medium grained sand. In general shallow aquifers in the area can be grouped into two classes; one unconfined/ semi confined aquifer down to depth of 80.0 m in the district and being in the depth range of 100.0 to 111.0m. These two aquifers are separated by a clay layer almost uniformly present in the district. The aquifer down to depth of 50.0 m is being tapped by shallow tubewells for purpose of irrigation and drinking. However, deeper tubewells down to depth of 125 m are being tapped by Government agencies for drinking purpose and by some farmers for irrigation purpose. Two ground water regime in the district can be identified which are separated by ground water divide running North of Northeast and South of Southwest direction. Elevation of ground water table varies from 191.0 to 199.0 m amsl. In the Northern part of the district ground water gradient is 0.30m/km in comparison to southern part of the district, where it is more than a meter per km. Most of the observation stations in Moga district show decline with varying degree of decline over last three decades .Rate of decline varies from 53 cm/year (Samal sari) to 79 cm/year (Damru Khurd). Depth to water level in the district varies from 15.78 mbgl to 21.17 mbgl during pre-monsoon and 17.13 to 22.15 mbgl in post-monsoon period.

Depth to water level in the district varies from 15.78 mbgl to 21.17 mbgl during pre-monsoon and 17.13 to 22.15 mbgl in post-monsoon period. Except Northern and Southwestern part of the district all other areas are reported to have deeper water levels. Water levels in the Nihal Singhwala block are deepest among all blocks.

3.2 Present NAQUIFERUIM study

To understand the sub surface lithology and its disposition, the lithological data of the optimized wells drilled by CGWB, PHED and Private Agencies is plotted using the RockWorks15 software and a lithological model has been prepared and is shown in fig. The 2D lithology map and 3D lithological fence diagram has been prepared using the lithology model and are shown in fig 5 & 6 respectively.

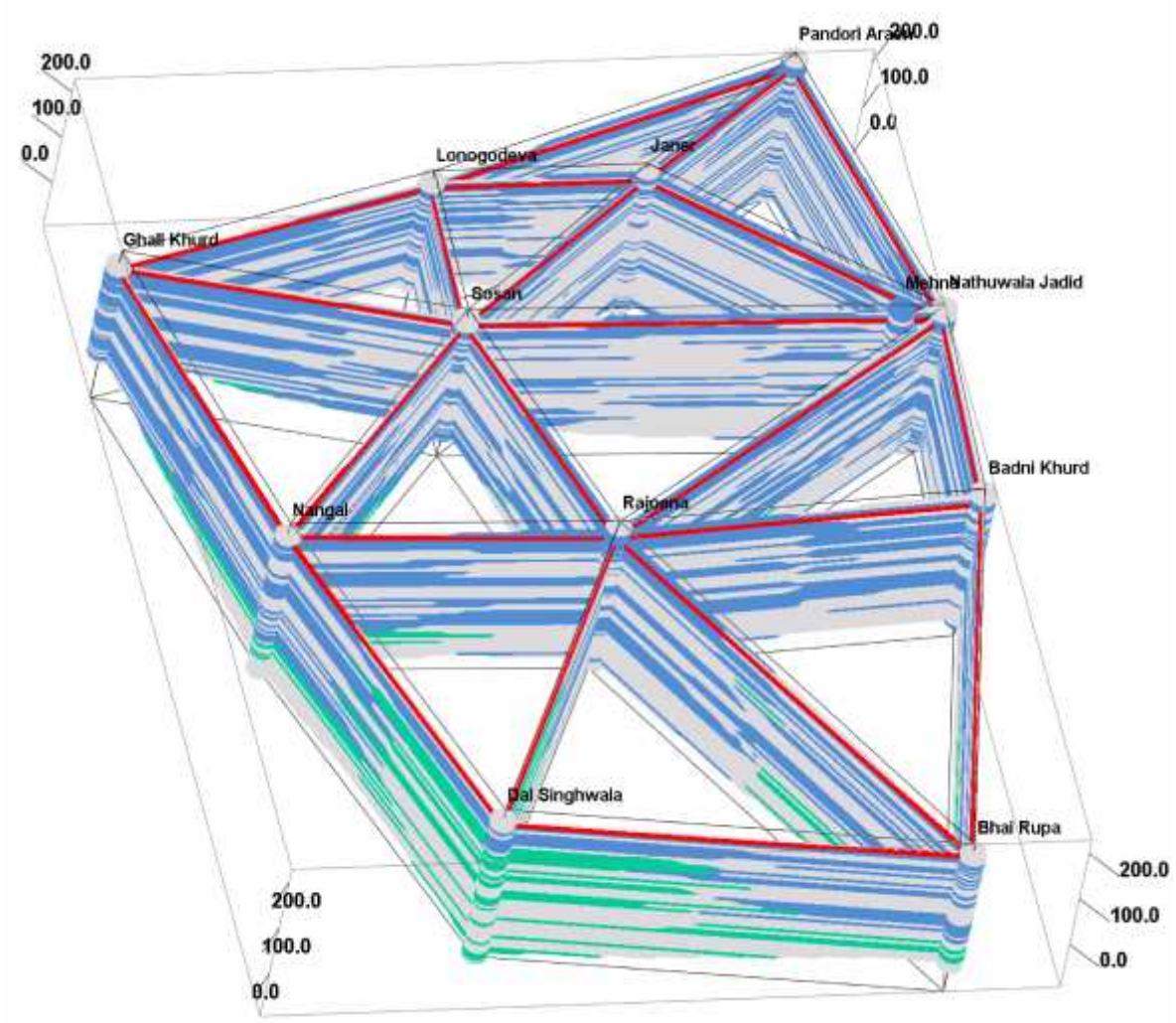
Fig 5: 3-Dimension Lithological Model of Moga District



To present a three dimensional regional picture of the sub-surface conditions in the two districts a fence diagram was prepared by synthesizing the various sub-surface sections. The fence diagram thus drawn reveals broad picture of disposition, inter relationship of granular zones, nature, geometry and extension of aquifers of the entire district. The aquifer group embodies a number of granular layers alternating with thick or thin clay lenses. A few clay layers intervening these aquifer groups pinch out against the sand zones at a few places. Sandy clay layer occurs at the surface covering the unconfined aquifer which is in turn underlain by prominent clay zone. It is composed of mainly of medium sand with thin beds of fine sand. The second and third aquifers are separated by a 8-10 m clay bed. Coarse sand beds occur as thin layers within medium sand. Fourth aquifer is again underlain

by a clay zone of unknown thickness. Striplogs showing lithologs of exploration wells and various block diagrams based on Lithology and Aquifer Group .

Fig 6: 3 Dimension Lithological Fence of Moga District

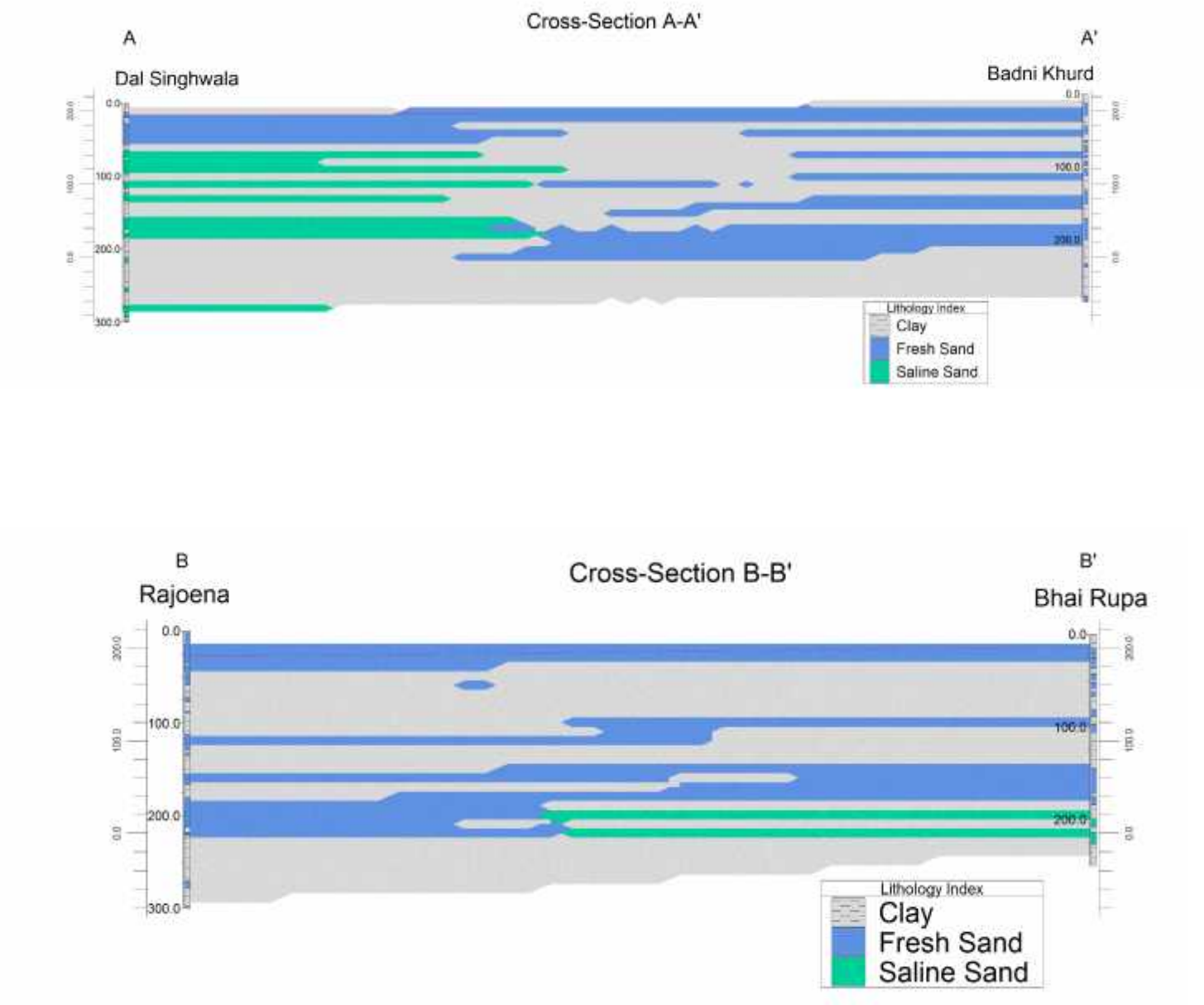


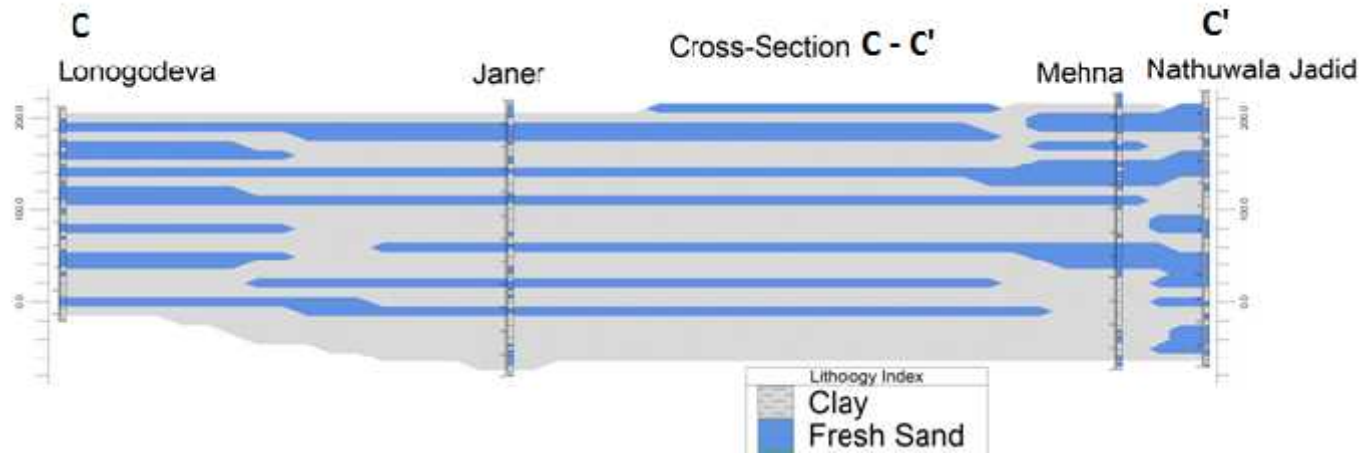
3.3 Aquifer Geometry

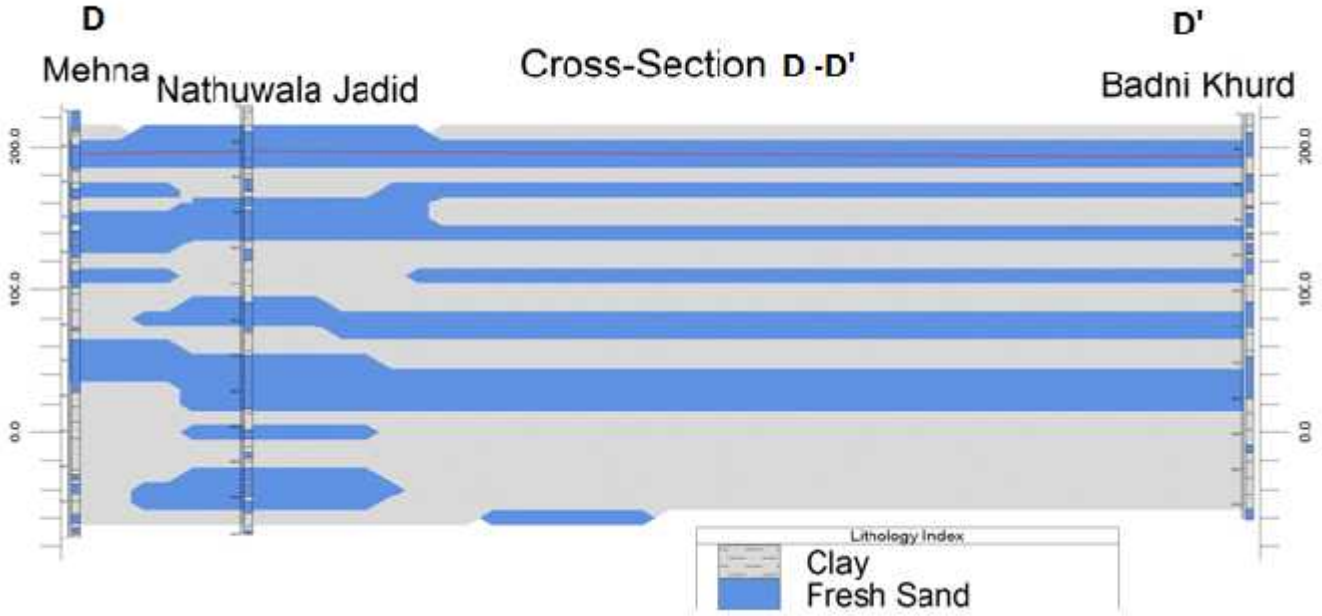
Moga District forms central part of sate and is underlain by formations of Quaternary age comprising of alluvium deposits belonging to vast Indus alluvial plains; therefore it belongs to a multiple aquifer system up to 300m depth with alternate bands of medium to coarse sand and clay. To know the broad picture of the aquifer disposition, inter-relationship of granular zones, nature, geometry and extension of aquifers in the Moga district, the aquifer grouping has been done using the sub-surface lithology and a three-

dimensional aquifer model has been prepared. The 2D aquifer map was also prepared using the aquifer model. The aquifer grouping is done and given in Table. The first aquifer is water table aquifer and extends all over the area. The aquifer is mainly composed of fine to medium grained sand. The Aquifer grouping cannot be done in the district as fresh and saline water exist. The grouping of Aquifer is done as Fresh and Saline. The resources are calculated separately which are included in next chapter. The Lithological cross-section of Moga district is given below:-

Fig 7: Cross Sections of Aquifer Map of Moga District




C
Lonogodeva
Janer
Cross-Section C - C'
Mehna
C'
Nathuwala Jadid
Lithology Index
Clay
Fresh Sand


D
Mehna
Nathuwala Jadid
Cross-Section D -D'
D'
Badni Khurd
200.0
100.0
0.0
Lithology Index
Clay
Fresh Sand

4. GROUND WATER RESOURCES

Ground water resource estimation of the area have been carried out by taking Dynamic and In-storage resources of unconfined aquifer and confined aquifers present up to 300m depth. The assessment of Dynamic and in storage Ground Water Resources of the study area have been carried out jointly by CGWB, Water Resources & Environment Directorate, Department of Irrigation, on the basis of Groundwater Estimation Committee (GEC) (1997) methodology based on data available and as per the revised methodology for the year 2013.

The occurrence of potential aquifers (productive granular zones) upto 300 m depth has been demarcated on basis of aquifer wise subsurface mapping. The total saturated thickness of granular zones was derived from the exploratory borehole data of a particular block. The granular zones occurring below the zone of water level fluctuation up to the first confining layer has been considered as static unconfined zone. The ground water resource of this zone has been calculated considering 12% specific yield of the formation. The specific yield value for the unconfined aquifer has been taken as 60% of 0.12 which comes as 0.072 whereas for the confined aquifer, the Storativity value has been considered. Since the specific yield is likely to reduce with increase in depth due to compaction of overlying sediments.

Hence, the major data elements considered in this estimation are thickness of granular zones, specific yield, Storativity and area of fresh water. It has been observed that in some of the blocks sufficient data on probable occurrence of granular zones was not available. In those cases, the existing exploratory data of adjoining block/district has been either extrapolated or interpolated to derive such parameters required for estimation. This assessment of total groundwater resources has been computed based on the available data with CGWB Water Resources & Environment Directorate, Department of Agriculture, and Punjab Water Resource Management & Development Corporation, Punjab

4.1 Unconfined aquifers

Dynamic Resources

As per Groundwater Resources Estimation 2013, the ground water development in all 5 blocks has exceeded the available recharge, thus 5 blocks have been categorized as

over exploited. Stage of ground water development in the Moga district has been assessed to be 207%.

Table 4: Dynamic Ground Water Resource & Development Potential (as on 31.03.2013)

Assessment Unit/ Block	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	Provision for domestic, and industrial requirement supply to 2025	Net Ground Water Availability for future irrigation development	Stage of Ground Water Development (%)
BAGHA PURANA	37924	60722	420	61142	534	-23332	161
DHARAMKOT (KOT ISA KHAN)	26313	56999	338	57337	431	-31116	218
MOGA I	19686	45301	632	45933	805	-26420	233
MOGA II	14932	33999	203	34202	259	-19325	229
NIHAL SINGH WALA	17714	42488	261	42749	332	-25106	241
Total (ham)	**116570**	**239509**	**1855**	**241363**	**2360**	**-125299**	**207**

Instorage Ground Water Resources

As per revised guidelines recommended by the Central Level Expert Group on ground water 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

4.2 Confined Aquifer

The availability of ground water resources in confined aquifer have two components: Storage under pressure (using Storativity concept) and Storage under desaturated (gravity drainage) condition (using Specific Yield concept) (source: Assessment of Ground Water Resources; A Review of International Practices, 2014) and is shown in Fig 9. However, since ground water withdrawals from confined aquifer are known to have serious environmental degradation effects, the preliminary assessment of ground water resources in confined aquifer is restricted to the estimation of ground water storage under pressure conditions only but here the storage under de-saturation is also computed.

Storativity Concept:

ii)	In-storage Ground Water resources (within the Peizometer)	=	Thickness of the water column in Peizometer of particular confined aquifer up to the top layer of same confined aquifer	×	Storativity of the confined aquifer	×	Areal extent of the confined aquifer group

Specific Yield Concept:

ii)	In-storage Ground Water resources (within the aquifer thickness)	=	Thickness of the confined aquifer (granular/ productive zone) down to the bottom layer of confined aquifer or exploitable depth of 300 m	×	Sp. Yield of the aquifer	×	Areal extent of the confined aquifer group

Preliminary assessment of the ground water resources in confined aquifer does not imply that the assessed resource is available for exploitation. The objective of this exercise is to have an overview of the ground water regime in the particular confined aquifer. It should be kept in mind that any significant ground water withdrawal from confined aquifer may invoke serious environmental degradation problem. Therefore, in case the preliminary assessment reveals that ground water is being withdrawn in significant quantity for any confined aquifer, that particular aquifer should be identified for detailed assessment using numerical modelling approach.

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

Fig 8: Concept for Resource Estimation in Unconfined and Confined Aquifer System

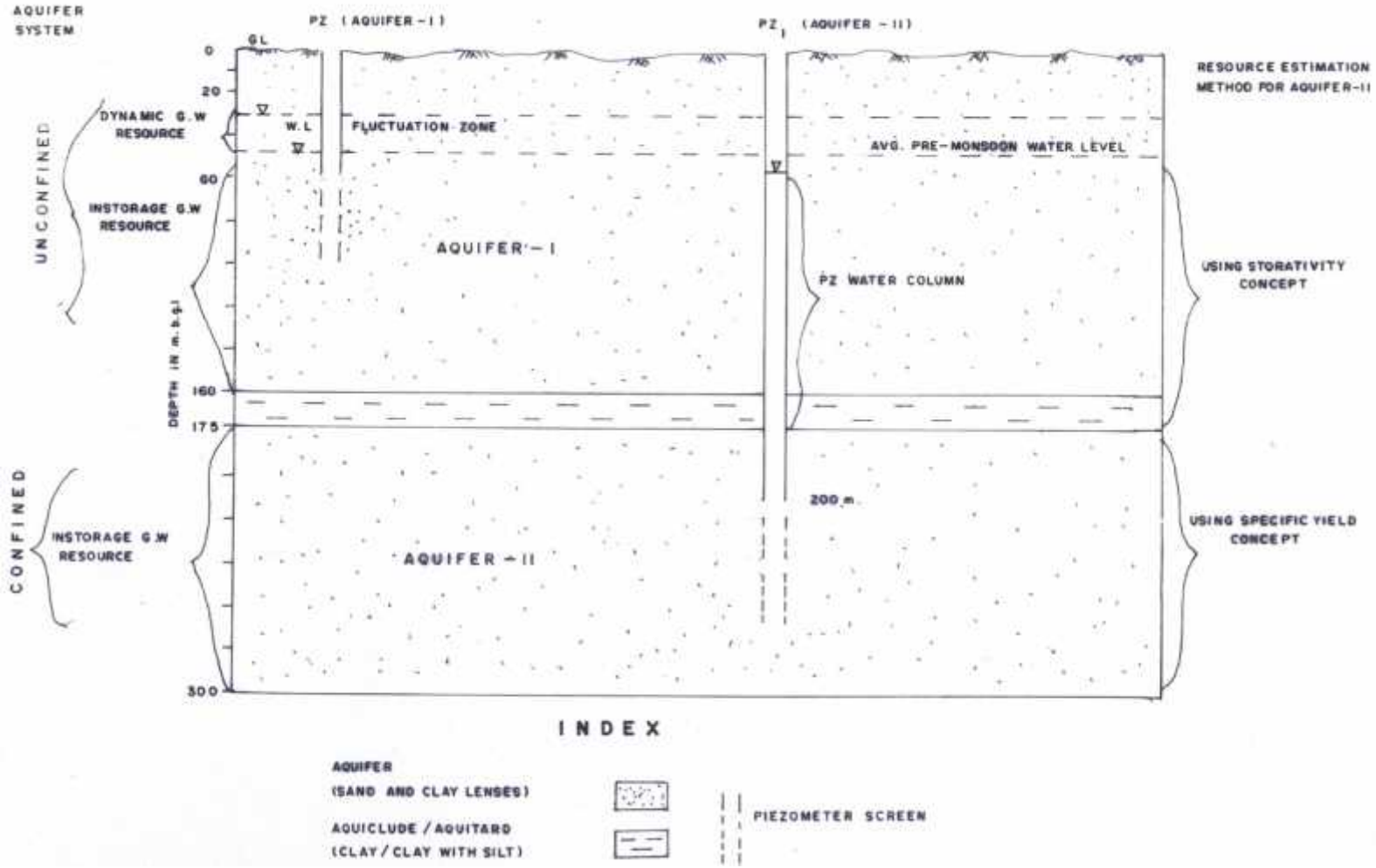


Table 5: BLOCK WISE AVAILABILITY OF TOTAL GROUNDWATER RESOURCES IN MOGA DISTRICT UP TO DEPTH OF 300M

S. N.	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 & Bore logging (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 (ham) 5*13*14
			Total Geographical Area	Assessment Area										
				Total	Fresh Water	Brackish/Saline Water								
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	BHAGA PURANA	Alluvium	46580	46580	46580	0	22	300	278	133	16	117	0.072	392390
2	KOT ISHA KHAN	Alluvium	54900	54900	54900	0	26.46	300	273.54	187	16	171	0.072	675929
3	MOGA-I	Alluvium	44500	44500	44500	0	30.84	300	269.16	147	17	130	0.072	416520
4	MOGA-II	Alluvium	33460	33460	33460	0	26.08	247	220.92	99	11	88	0.072	212003
5	NIHAL SINGHWALA	Alluvium	37780	37780	37780	0	28.4	285	256.6	119	14	105	0.072	285617
	Dist. Total(ham)		217220	217220	217220									1982458
	Dist. Total(MCM)													19825

Table 6: BLOCK WISE TOTAL AVAILABLE GROUND WATER RESOURCES IN AQUIFERS UP TO 300m DEPTH

AVAILABILITY OF TOTAL FRESH GROUNDWATER RESOURCES IN MOGA DISTRICT						
Sl.No	**BLOCK**	*Dynamic Groundwater Resources (2013) AQUIFER-I*	*In-storage Groundwater Resources UPTO FRESHWATER*	**Groundwater Resources upto FRESH WATER [(3)+(4)] (HAM)**	**Total Availabilty of Fresh Groundwater Resources [(5)+(6)+(7)]**	
					ham	**mcm**
1	*2*	*3*	*4*	*5*	*8*	*9*
1	Bagha purana	37924	*392390*	*430314*	*430314*	*4303*
2	Kot Isha Khan	26313	*675929*	*702242*	*702242*	*7022*
3	Moga I	19686	*416520*	*436206*	*436206*	*4362*
4	Moga II	14932	*212003*	*226935*	*226935*	*2269*
5	Nihal Singhwala	17714	*285617*	*303331*	*303331*	*3033*
Dist.Total (ham)		**116570**	**1982458**	**2099028**	**2099028**	**20990**
Dist.Total (mcm)		**1166**	**19825**	**20990**		

ham : hectare metre

mcm: million cubic metre

5. GROUND WATER RELATED ISSUES

Moga is famous for its paddy cultivation and is also known as 'Rice Bowl' of Punjab. The quality of ground water in the district is potable for both the drinking and irrigation purposes therefore, the ground water is constantly being pumped for the irrigation due to its easy access through tube wells and they are the main source of irrigation.

This will lead to its major ground water issue which is deepening of ground water level as the recharge of the groundwater through rainfall and other sources are less than the overall extraction.

5.1 GROUND WATER IRRIGATION SCENARIO

As per the data available from minor irrigation census 2006-07, the number of shallow and deep, tube wells, lined, unlined water distribution system, land holdings of wells are given in Table 7,8 and 9

Fig 9: Irrigation tube wells as per depth.

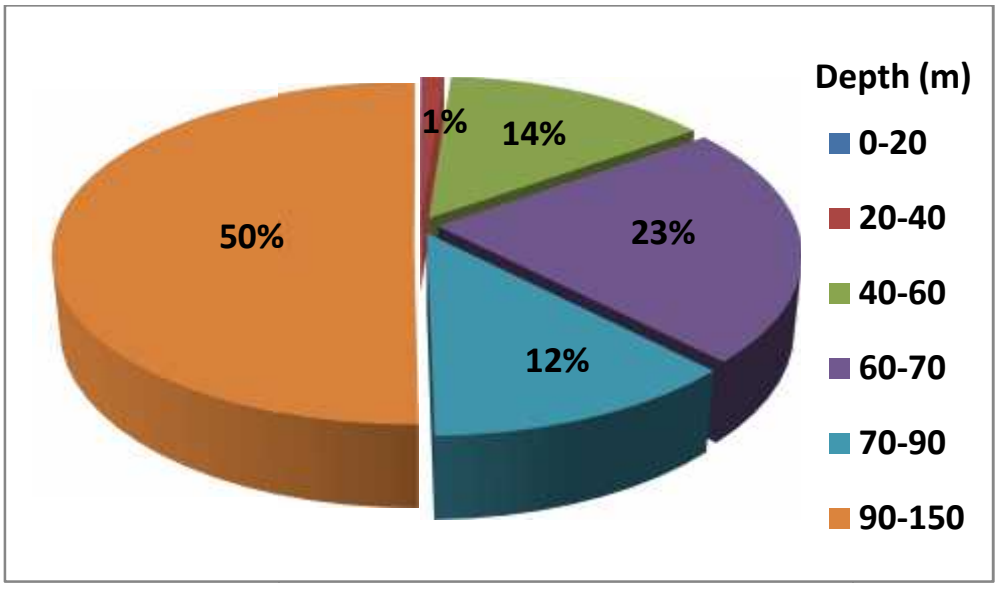


Table 7-Distribution of Tube wells According to Owner's holding Size

No. of shallow tube wells by size class of individual owner							
Sr.no	district	Marginal (0-1 ha)	Small (1-2 ha)	Semi-Medium (2-4 ha)	Medium (4-10ha)	Big (>=10 ha)	Total
1	**Moga**	**423**	**1858**	**7721**	**9671**	**2680**	**22353**

Table 8 -Distribution of Shallow Tube wells According to Depth of tube well

No. by the depth of shallow Tube well							
Sr.no	district	(0-20 mts)	(20-40 mts)	(40-60 mts)	(60-70 mts)	(>70 mts)	Total
1	**Moga**	**35**	**690**	**8259**	**13369**	**36914**	**59267**

Table 9- Type of Ground water distribution device

Open Water Channel		
Lined/pucca	**Unlined/kutcha**	Total
45	**64136**	**64181**

6. AQUIFER MANAGEMENT PLAN

A summery outline of the artificial recharge plan for the entire district of each OE block is given at the beginning in tabular forms. This is followed by the salient features of each block along with the detailed structure-wise recharge plan and cost estimates. Details of the block wise type of suitable recharge structures and volume of water assured for annual recharge for each block in rural area, urban area and artificial recharge in agricultural farm are given in table and design of recharge structures are annexed at annexure I, II. More than 5 meter Mean decadal water level with falling trend is considered for block wise artificial recharge calculation.

Another focus has been given to minimize the gross draft by enhancing ground water use efficiency in irrigation system after replacing the water distribution system from unlined/kutcha channel to Under Ground Pipeline System in the whole district.

6.1 SCOPE OF IMPLEMENTATION

This plan is focusing on the technical aspects of the ground water recharge through various means so that various implementing agencies may get the appropriate technical guidelines. The existing/ongoing schemes of the Central or State Govt. like MANERGA, IWSP, PMKSY (Prime Minister Krishi Sinchai Yojna), NABARD funded schemes, Urban Development schemes, departmentally funded projects etc. may be benefitted from the recharge plan by incorporating the input in the operational guidelines/ design and for locating the specific sites.

Agriculture University, Engineering Collages, Academic and Research Institution and NGO may also take up the pilot or demonstrative projects in the blocks suitable to them to plan at local level as per local conditions.

6.2 POTENTIAL OF ENHANCING THE GROUND WATER USE EFFICIENCY

The micro level transformation in the ground water management have vast impact potential to counter extensive ground water depletion faced by the state of Punjab, particularly in overexploited blocks. There are around 64232 tubewells operated by farmers for irrigation through unlined/Katcha (99.84%) open channel system in Moga district where water from the tube-well is discharge to the agricultural field. In this process huge quantity of ground water is wasted in soil moisture and evaporation losses.

Dynamic ground water resources (2011) indicate that Gross ground water draft for irrigation in Moga district is estimated at 2421.48 MCM. It is expected that around 50.20% of over draft can be brought down by switching over to underground/surface pipeline based distribution from the prevailing unlined open channels. Thereby gross draft will be reduced to the tune of 609.24 MCM assuming there is no crop diversification by the farmers.

The benefit will lead to saving of precious ground water resources in overexploited blocks of Moga Districts. The measure if implemented will bring down the ground water overdraft from 202% to 151.80 %. The category of the blocks will also improve drastically resulting in boosting of agriculture and industrial development otherwise not sustainable in majority of the blocks in the state.

The tubewells also consume enormous electricity which is subsidized and government incurs significant revenue on this account. The measures therefore will result in saving of energy and

money. Pollution impact will be reduced whenever diesel engines are used by the farmers. The environmental and ecological condition in the irrigated land will improve. Unwanted weed growth will also be controlled inside the farm land. This will also be useful in the waterlogged/ shallow water table areas as the seepage losses in these areas also aggravate the water logging. **Government should make/launch a mission mode program for installing the underground pipe lines instead of having *katcha* channel in the entire Punjab**. Heavy ground water overdraft can be reduced by these efforts. This will ensure **more crop per drop**.

6.3 Water Saving Potential from Crop Diversification-Change Paddy to Maize/Pulses:

As the requirement of water for paddy is much high therefore by changing paddy to maize/Pulses will help in saving of water. For estimating the water saving by crop diversification it is assumed that one mcm of water will be saved in case of maize or pulses planted in one sq km of land. In case of pulses even higher amount of ground water can be saved

Table 10: Scope of Quantitative Impact on Stage of Development after applying various management strategies

Block	Net Ground Water Availability (mcm)	Total Draft (mcm)	esent Stage of aft (SOD) (%) As per 2013	Reduction in draft by different water saving method				SOD afterwards (%)	Change of paddy ltivation area (% of existing)
				eplace water urses by UG Pipes (mcm)	t Artificial echarge (mcm)	ge Paddy to Maize (mcm)	Total (mcm) (2+3+4)		
			1	2	3	4	5		
Bagha purana	379.2	611.4	161	152.9	3.67	75.6	232.17	100	17
Kot Isha Khan	263.1	573.4	218	143.3	4.69	162.2	310.19	100	38
Moga I	196.9	459.3	233	114.8	2.98	144.7	262.48	100	47
Moga II	149.3	342.0	229	85.5	2.46	104.7	192.66	100	40
Nihal Singhwala	177.1	427.5	241	106.9	2.72	140.80	250.42	100	49
Total	1165.7	2413.6	207	603.4	16.52	628.00	1247.92		

7. BLOCK WISE AQUIFER MAPS AND MANAGEMENT PLAN

(I) BAGHA PURANA BLOCK (465.80 SQ KM)

1. Salient Information

Population (2011) Rural-1,94,727
Urban-0
Total-1,94,727

Rainfall 2014 (Moga District) Average annual rainfall -391 mm

Average Annual Rainfall (Bagha Purana block) 415 mm

Agriculture and Irrigation Major Crops- Rice, Wheat
Other crops-Sugarcane, Potatoes, Pulses,
Net Area Sown- 494.68 sq.km
Total Irrigated Area-499.49 sq.km

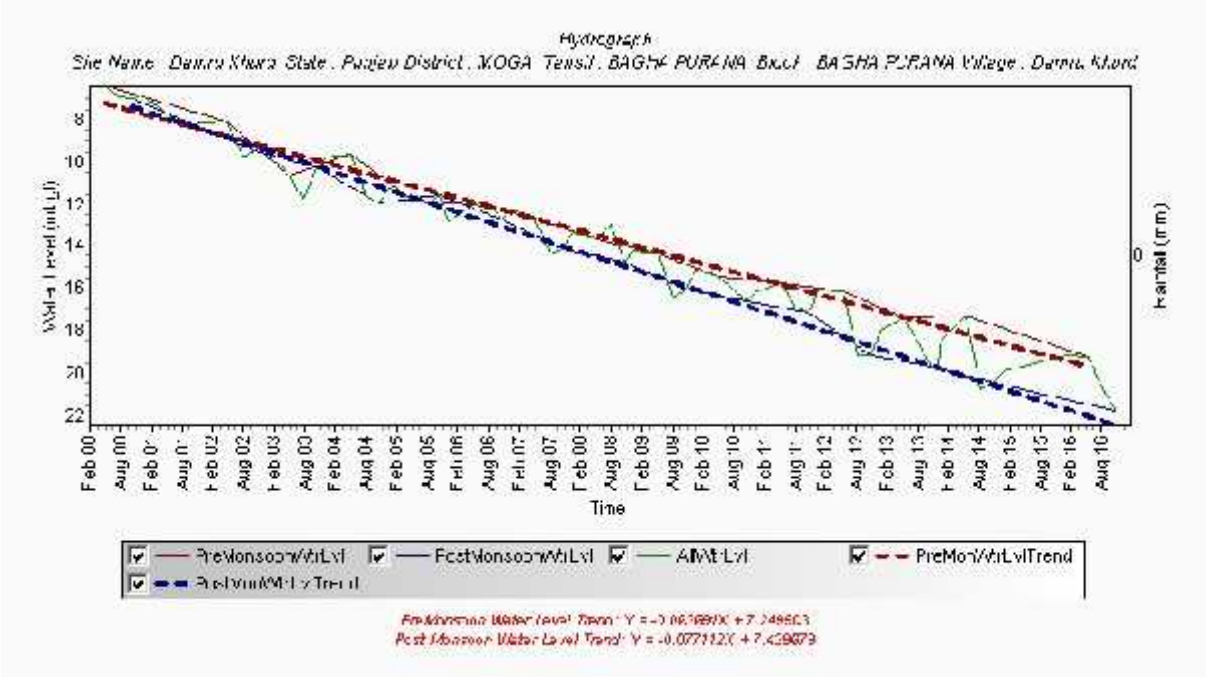
Water Bodies & Canal Irrigation

Water bodies available in the villages for the storm water and untreated waste water of villagers, that can be used for irrigation after treatment. The canal irrigation is available in the Bagha Purana block.

Ground Water Resource Availability: Ground Water Resources available in the combined group of aquifers. The resources are calculated as per Dynamic ground water resources (2013) and In-storage ground water resources up-to fresh water. Block is categorized as Over-Exploited as per Ground Water Assessment 2013.

Ground water Extraction: Information regarding the abstraction from different Aquifers is not available, but there are drinking water supplies from tubewells tapping combined aquifer and separate aquifer could not be assessed separately.

Water level Behavior (2015): Pre Monsoon-*~16.00—20.45 (mbgl)* &Post Monsoon-*~17.50—21.19(mbgl)*



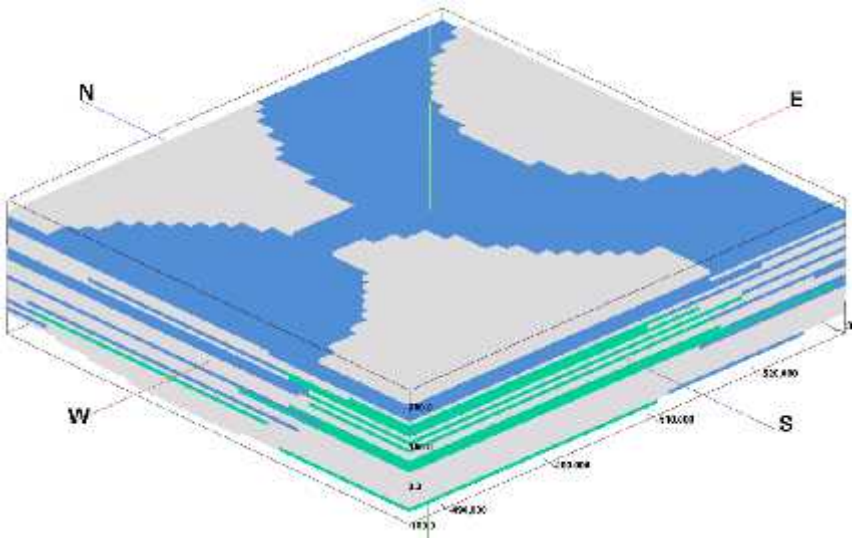
Aquifer Disposition: Combined Aquifer System

Aquifer	Geology	Type of Aquifer	Thickness of Granular Zones (m)	Transmissivity (m^2/day)	Specific Yield %	Storativity
Combined Aquifer (22-300m)	Quaternary Alluvial deposits	Unconfined	117	*5750*	0.072	$6.0*10^{-3}$

Aquifer comprises of freshwater only and the main aquifer material is sand.

The non-aquifer material comprise of clay.

3D Lithology model



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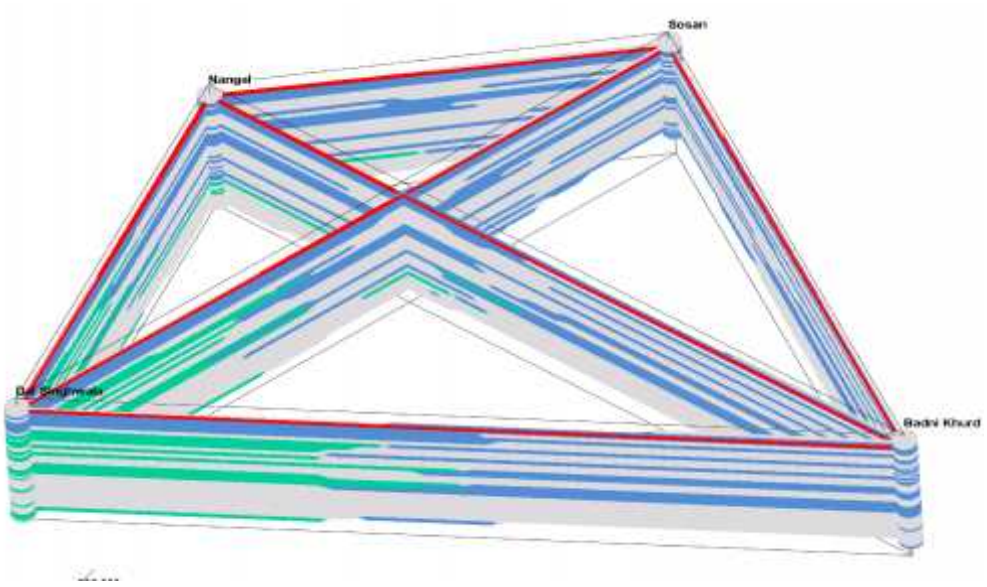
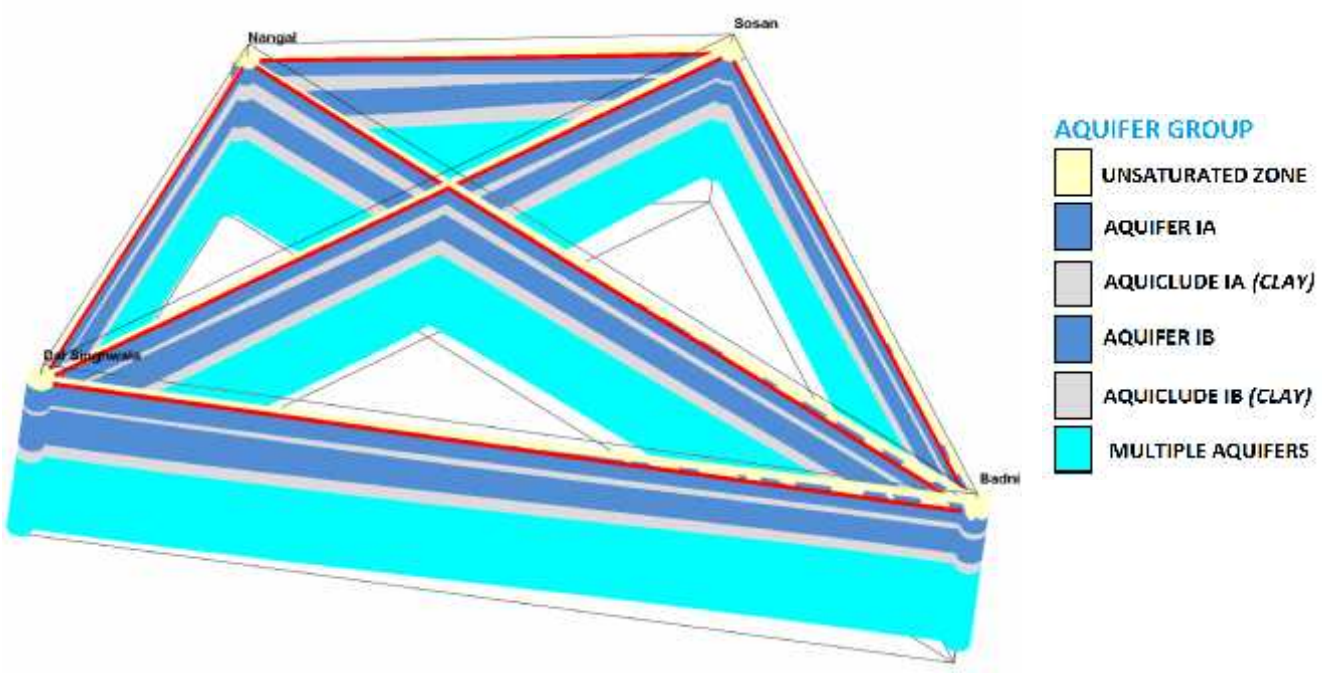
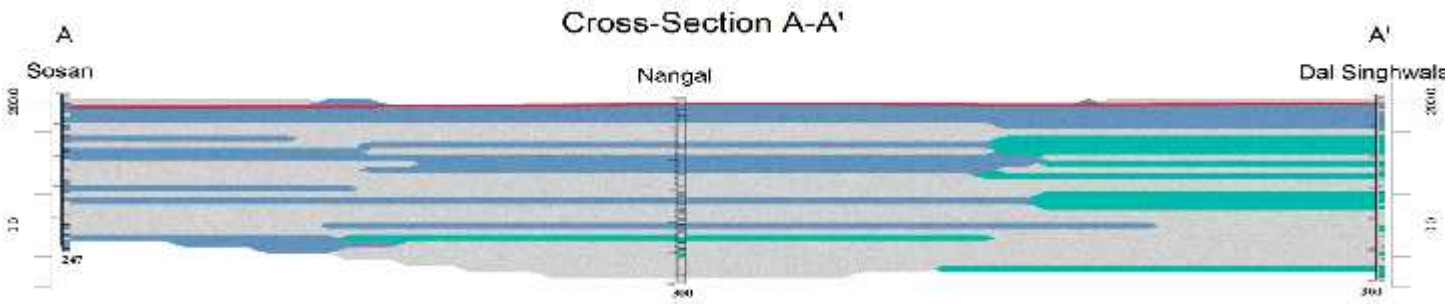






2. Ground Water Resource, Extraction, Contamination and Other Issues

Combined Aquifer wise Resource available (mcm)	Dynamic Aquifer	*379.24*
	In-storage Ground Water Resources	*3923.90*
	Total	4303.14
Ground Water Extraction (in mcm)	Irrigation	607.22
	Domestic & Industrial	4.20
Provision for domestic & Industrial requirement upto 2025 (in mcm)		5.34
Chemical Quality of ground water & contamination		Suitable for drinking and irrigation purposes
Other issues		Declining water level trend

3. Ground Water Resource Enhancement

Aquifer wise space available for recharge and proposed interventions	Volume of unsaturated zone upto the average depth to water level (16m).
Other interventions proposed	Artificial Recharge, Roof top Rainwater Harvesting, Farm recharge by constructing pits will save 3.672 mcm volume of water

4. Demand Side Interventions

Advanced Irrigation Practices	Lining of underground pipelines (Kutcha channel) will save 154.43mcm volume of water wastage
Change in cropping pattern	Proposed change in cropping pattern from Paddy to maize/soyabean 17 % of the total area needs to change the crop from paddy to maize/soyabean Anticipated volume of water to be saved by

	maize/soyabean is 75.60 mcm
Alternate water sources	Tanks, ponds and canals
Regulation and Control	-
Other interventions proposed, if any	-

(II) KOT ISHA KHAN (DHARAMKOT) BLOCK (545 SQ KM)

1. Salient Information

Population (2011) Rural-1,76,511
Urban-12800
Total-1,89,511

Rainfall 2014 (Moga District) Average annual rainfall -391 mm

Average Annual Rainfall (Kot Ishe Khan block) 545 mm

Agriculture and Irrigation Major Crops- Rice, Wheat
Other crops-Sugarcane, Potatoes, Pulses,
Net Area Sown- 459.91 sq.km
Total Irrigated Area-464.45 sq.km

Water Bodies & Canal Irrigation

Water bodies available in the villages for the storm water and untreated waste water of villagers, that can be used for irrigation after treatment. The canal irrigation is available in the Kot Ishe Khan block.

Ground Water Resource Availability: Ground Water Resources available in the combined group of aquifers. The resources are calculated as per Dynamic ground water resources (2013) and In-storage ground water resources up-to fresh water. Block is categorized as Over-Exploited as per Ground Water Assessment 2013.

Ground water Extraction: Information regarding the abstraction from different Aquifers is not available, but there are drinking water supplies from tubewells tapping combined aquifer and separate aquifer could not be assessed separately.

Water level Behavior (2015): Pre Monsoon-~10.00 – 40.00 (mbgl)

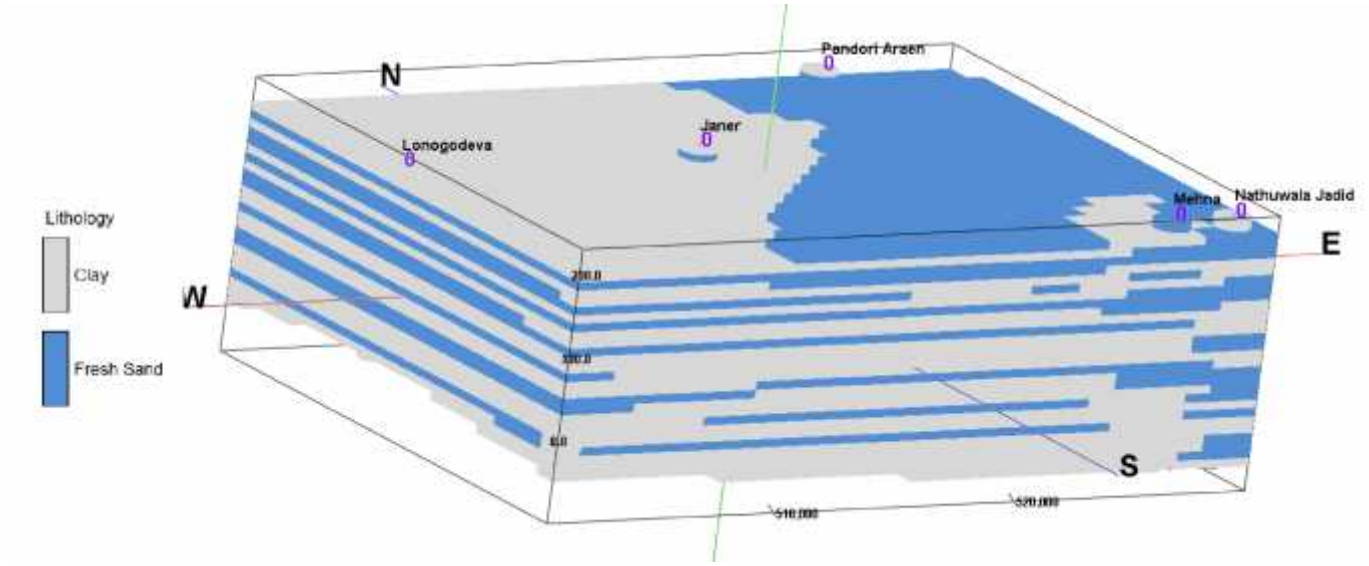
Aquifer Disposition: Combined Aquifer System

Aquifer	Geology	Type of Aquifer	Thickness of Granular Zones (m)	Transmissivity (m^2/day)	Specific Yield %	Storativity
Combined Aquifer (26-300m)	Quaternary Alluvial deposits	Unconfined	171	*5750*	0.072	$6.0*10^{-3}$

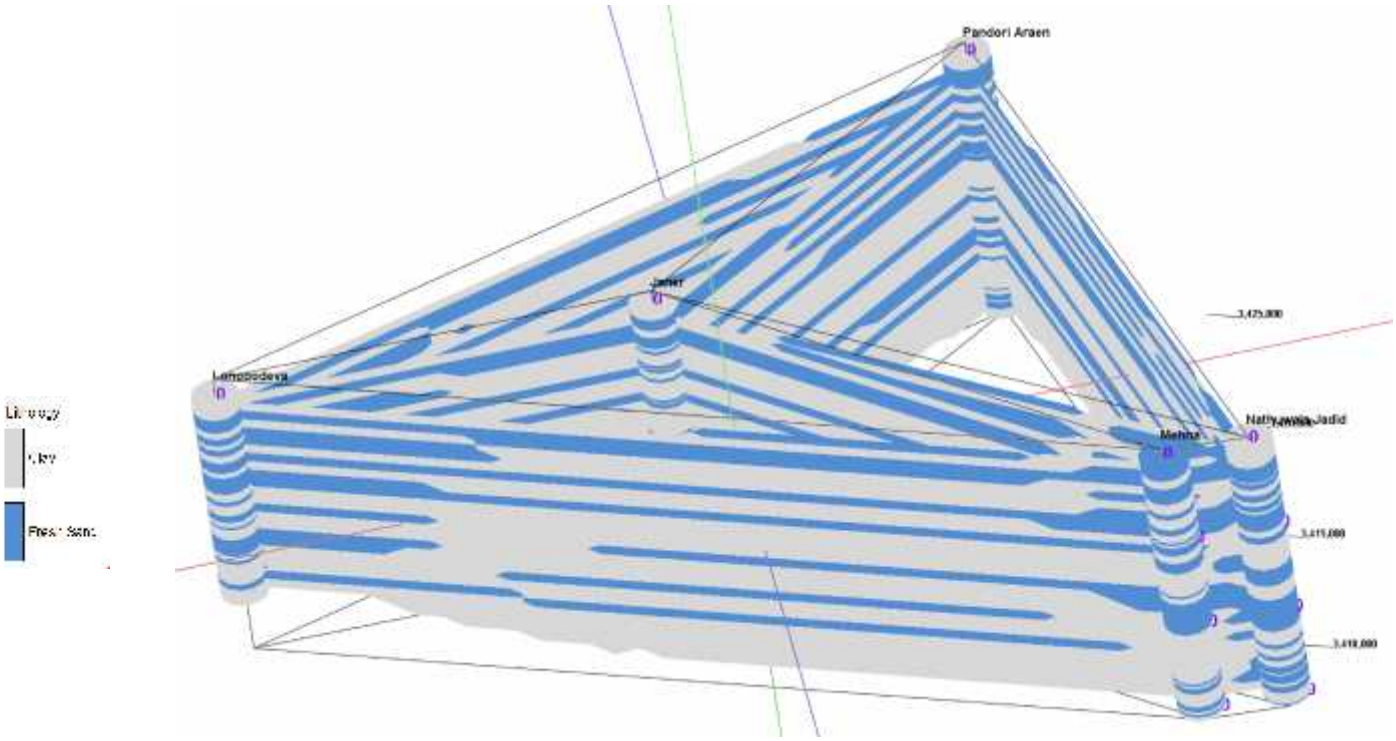
Aquifer comprises of freshwater only and the main aquifer material is sand.

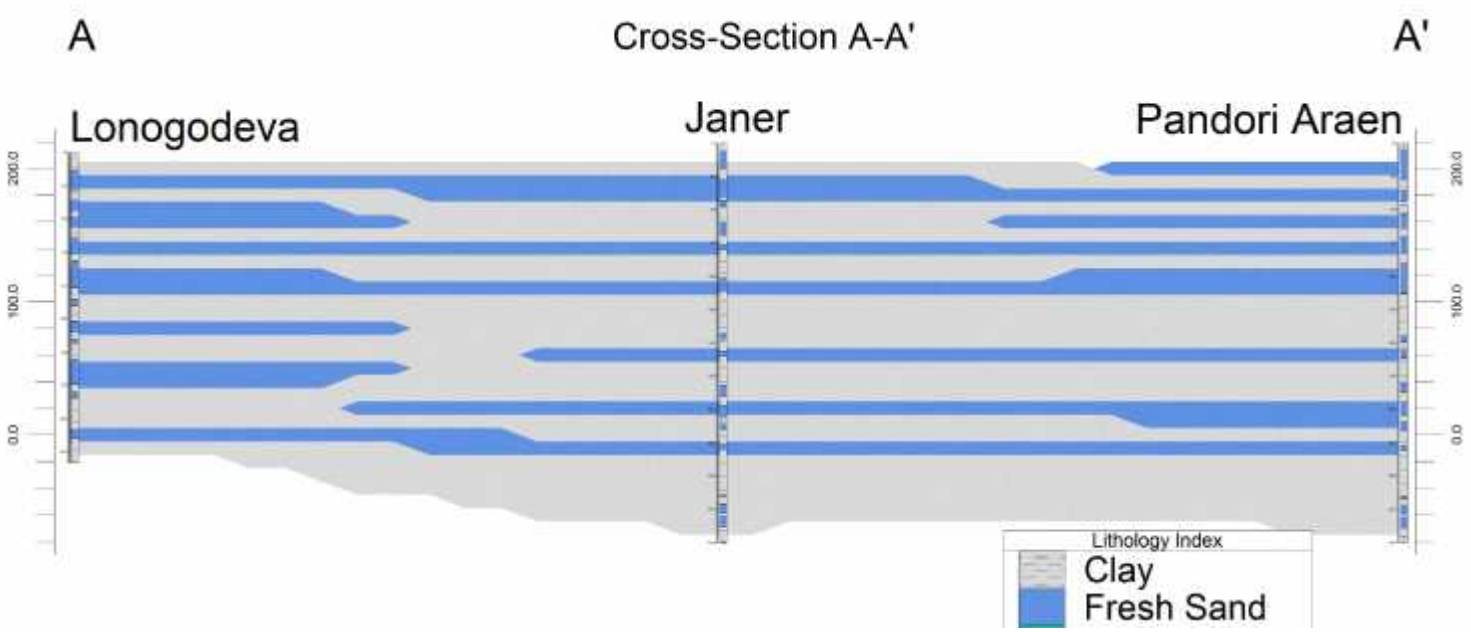
The non-aquifer material comprise of clay.

3D Lithology model



3D Lithology Fence

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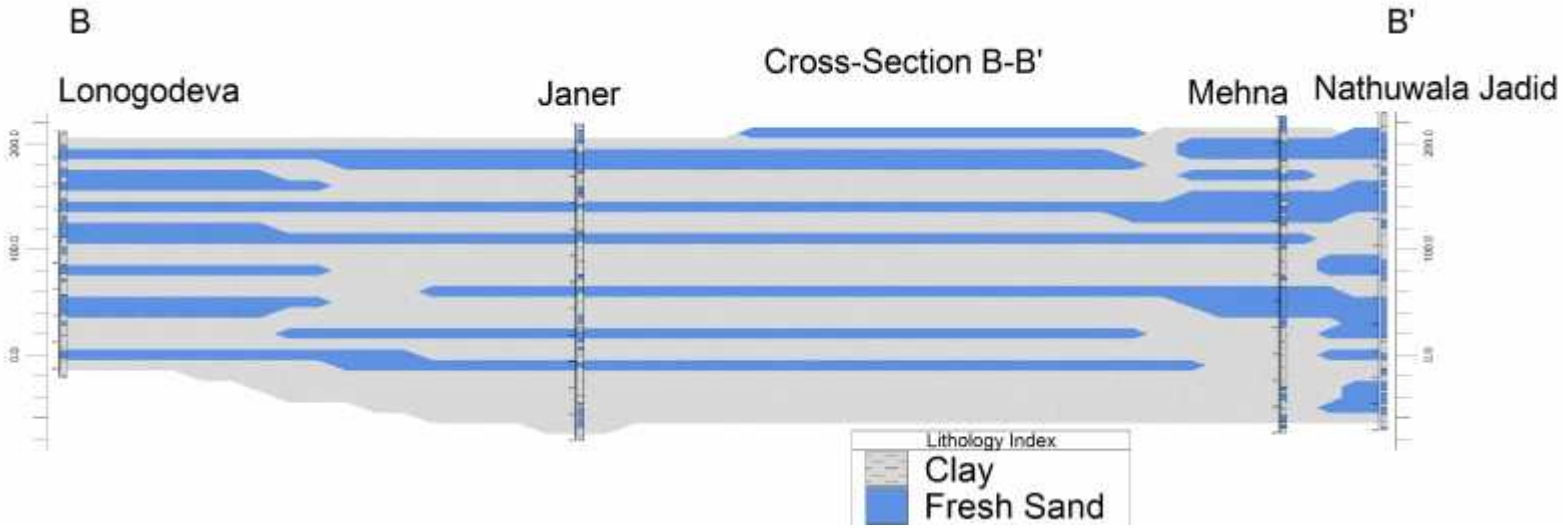
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Lithology Index
Clay
Fresh Sand

5. Ground Water Resource, Extraction, Contamination and Other Issues

Combined Aquifer wise Resource available (mcm)	Dynamic Aquifer	*263.13*
	In-storage Ground Water Resources	*6759.29*
	Total	7022.42
Ground Water Extraction (in mcm)	Irrigation	569.99
	Domestic & Industrial	3.38
Provision for domestic & Industrial requirement upto 2025 (in mcm)		4.31
Chemical Quality of ground water & contamination		Suitable for drinking and irrigation purposes
Other issues		Declining water level trend

6. Ground Water Resource Enhancement

Aquifer wise space available for recharge and proposed interventions	Volume of unsaturated zone upto the average depth to water level (16m).
Other interventions proposed	Artificial Recharge, Roof top Rainwater Harvesting, Farm recharge by constructing pits will save 4.688 mcm volume of water

7. Demand Side Interventions

Advanced Irrigation Practices	Lining of underground pipelines (Kutcha channel) will save 144.96mcm volume of water wastage
Change in cropping pattern	Proposed change in cropping pattern from Paddy to maize/soyabean 38 % of the total area needs to change the crop from paddy to maize/soyabean Anticipated volume of water to be saved by maize/soyabean is 162 mcm
Alternate water sources	Tanks, ponds and canals
Regulation and Control	-
Other interventions proposed, if any	-

3. MOGA-I BLOCK (445 SQ KM)

1. Salient Information

Population (2011)	Rural-1,41,124 Urban-4519 Total-1,45,643
Rainfall 2014 (Moga District)	Average annual rainfall -391 mm
Average Annual Rainfall (Moga -I block)	472 mm
Agriculture and Irrigation	Major Crops- Rice, Wheat Other crops-Sugarcane, Potatoes, Pulses, Net Area Sown- 324.39 sq.km Total Irrigated Area-327.51 sq.km

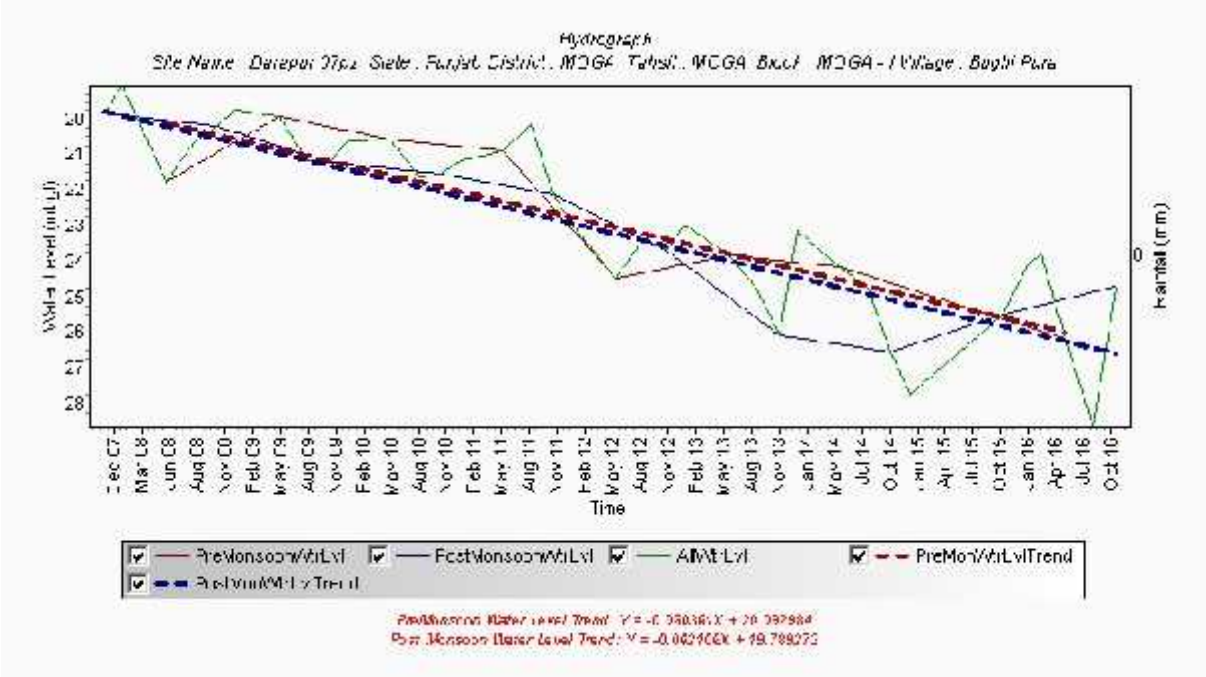
Water Bodies & Canal Irrigation

Water bodies available in the villages for the storm water and untreated waste water of villagers, that can be used for irrigation after treatment. The canal irrigation is available in the Moga-I block.

Ground Water Resource Availability: Ground Water Resources available in the combined group of aquifers. The resources are calculated as per Dynamic ground water resources (2013) and In-storage ground water resources up-to fresh water. Block is categorized as Over-Exploited as per Ground Water Assessment 2013.

Ground water Extraction: Information regarding the abstraction from different Aquifers is not available, but there are drinking water supplies from tubewells tapping combined aquifer and separate aquifer could not be assessed separately.

Water level Behavior (2015): Pre Monsoon-~20.80-30.10 (mbgl) &Post Monsoon-~22.50-31.35(mbgl)



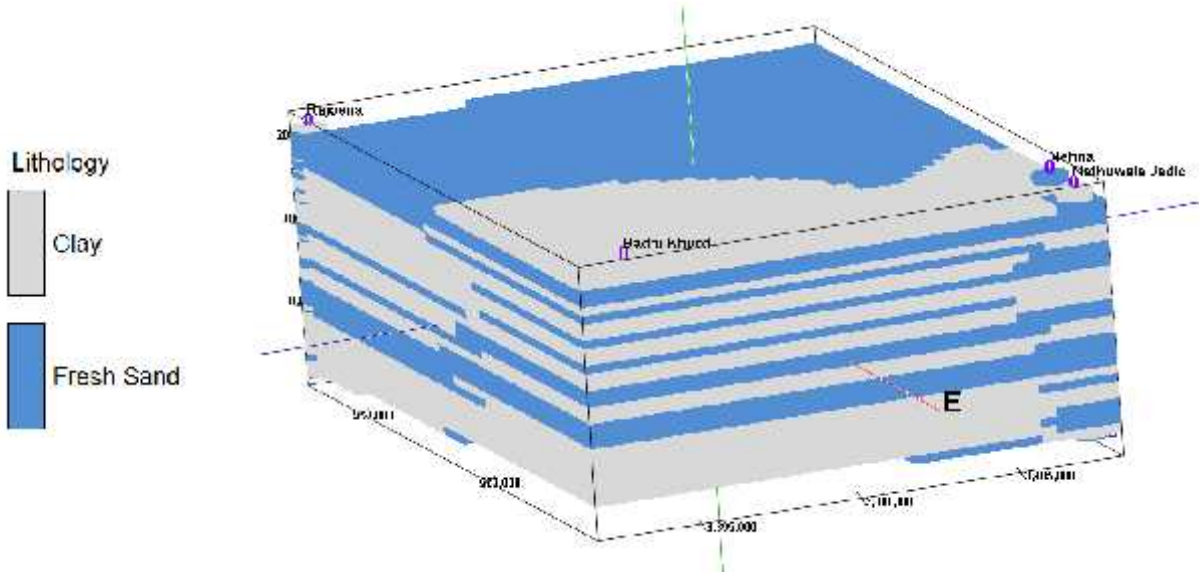
Aquifer Disposition: Combined Aquifer System

Aquifer	Geology	Type of Aquifer	Thickness of Granular Zones (m)	Transmissivity (m^2/day)	Specific Yield %	Storativity
Combined Aquifer (31-300m)	Quaternary Alluvial deposits	Unconfined	147	*5750*	0.072	$6.0*10^{-3}$

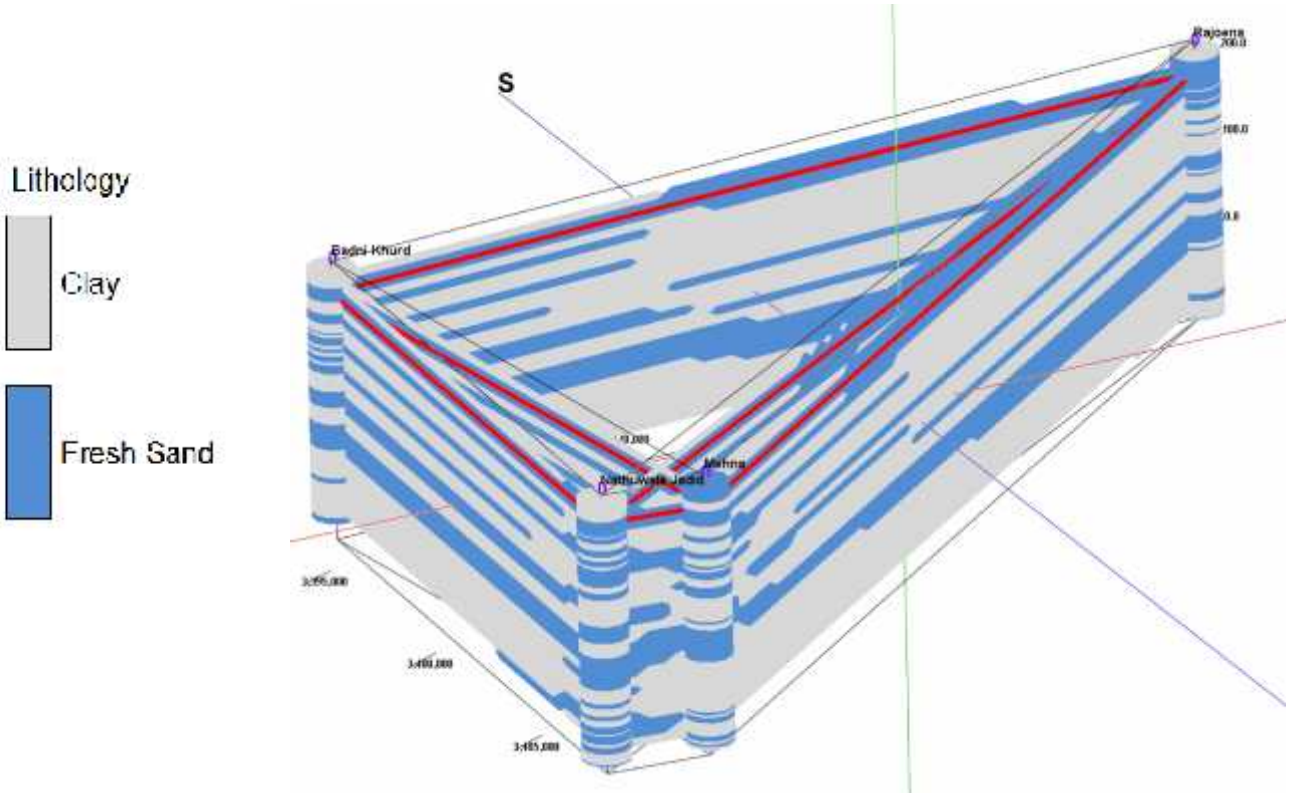
Aquifer comprises of freshwater only and the main aquifer material is sand.

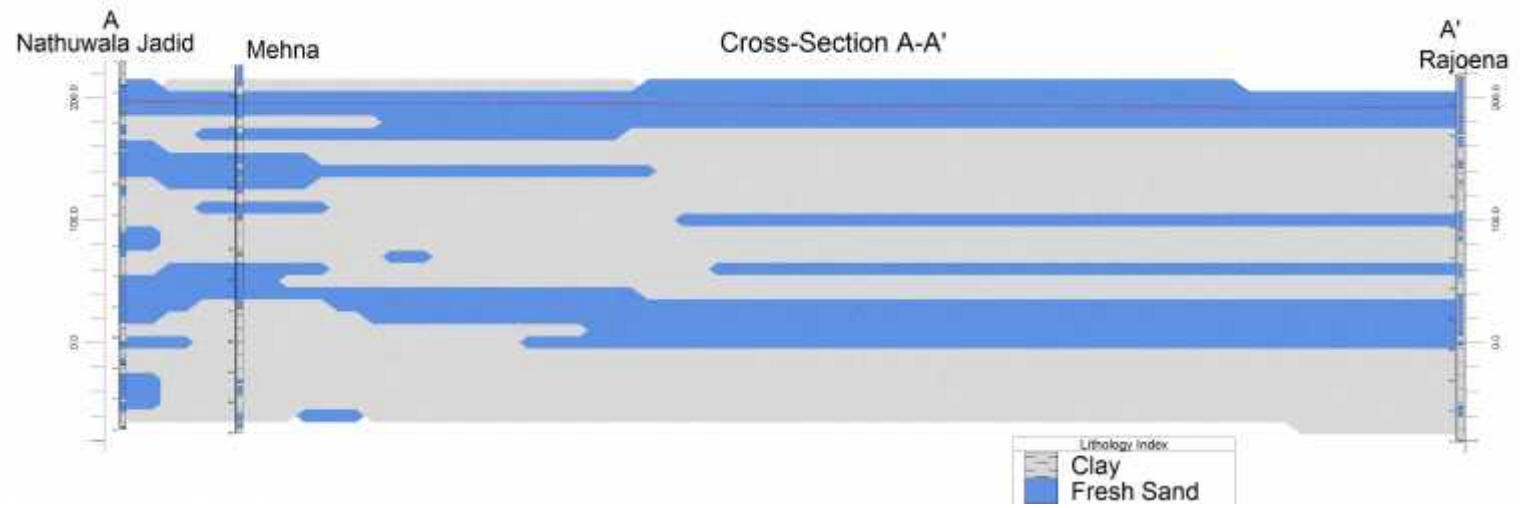
The non-aquifer material comprise of clay.

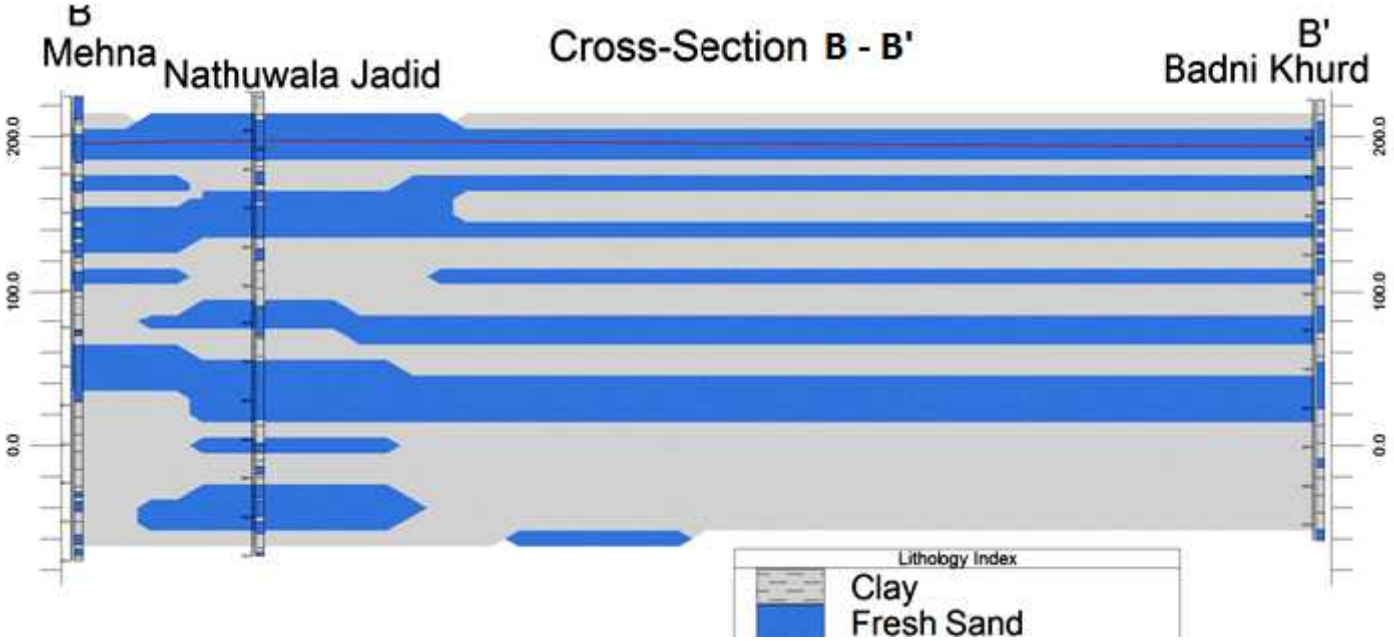
3D Lithology model



3D Lithology Fence







2. Ground Water Resource, Extraction, Contamination and Other Issues

Combined Aquifer wise Resource available (mcm)	Dynamic Aquifer	*196.86*
	In-storage Ground Water Resources	*4165.20*
	Total	4362.06
Ground Water Extraction (in mcm)	Irrigation	607.22
	Domestic & Industrial	6.32
Provision for domestic & Industrial requirement upto 2025 (in mcm)		8.05
Chemical Quality of ground water & contamination		Suitable for drinking and irrigation purposes
Other issues		Declining water level trend

3. Ground Water Resource Enhancement

Aquifer wise space available for recharge and proposed interventions	Volume of unsaturated zone upto the average depth to water level (17m).
Other interventions proposed	Artificial Recharge, Roof top Rainwater Harvesting, Farm recharge by constructing pits will save 2.984 mcm volume of water

4. Demand Side Interventions

Advanced Irrigation Practices	Lining of underground pipelines (Kutcha channel) will save 115.33mcm volume of water wastage
Change in cropping pattern	Proposed change in cropping pattern from Paddy to maize/soyabean 47 % of the total area needs to change the crop from paddy to maize/soyabean Anticipated volume of water to be saved by maize/soyabean is 145.70 mcm
Alternate water sources	Tanks, ponds and canals
Regulation and Control	-
Other interventions proposed, if any	-

4. MOGA-II BLOCK (465.80 SQ KM)

1. Salient Information

Population (2011) Rural-1,04,996
Urban-8467
Total-1,13,467

Rainfall 2014 (Moga District) Average annual rainfall -391 mm

Average Annual Rainfall (Moga –II block) 477 mm

Agriculture and Irrigation Major Crops- Rice, Wheat
Other crops-Sugarcane, Potatoes, Pulses,
Net Area Sown- 274.16 sq.km
Total Irrigated Area- 277.30 sq.km

Water Bodies & Canal Irrigation

Water bodies available in the villages for the storm water and untreated waste water of villagers, that can be used for irrigation after treatment. The canal irrigation is available in the Moga - II block.

Ground Water Resource Availability: Ground Water Resources available in the combined group of aquifers. The resources are calculated as per Dynamic ground water resources (2013) and In-storage ground water resources up-to fresh water. Block is categorized as Over-Exploited as per Ground Water Assessment 2013.

Ground water Extraction: Information regarding the abstraction from different Aquifers is not available, but there are drinking water supplies from tubewells tapping combined aquifer and separate aquifer could not be assessed separately.

Water level Behavior (2015): Pre Monsoon-~21.10-30.52(mbgl) & Post Monsoon-~23.30-32.10(mbgl)

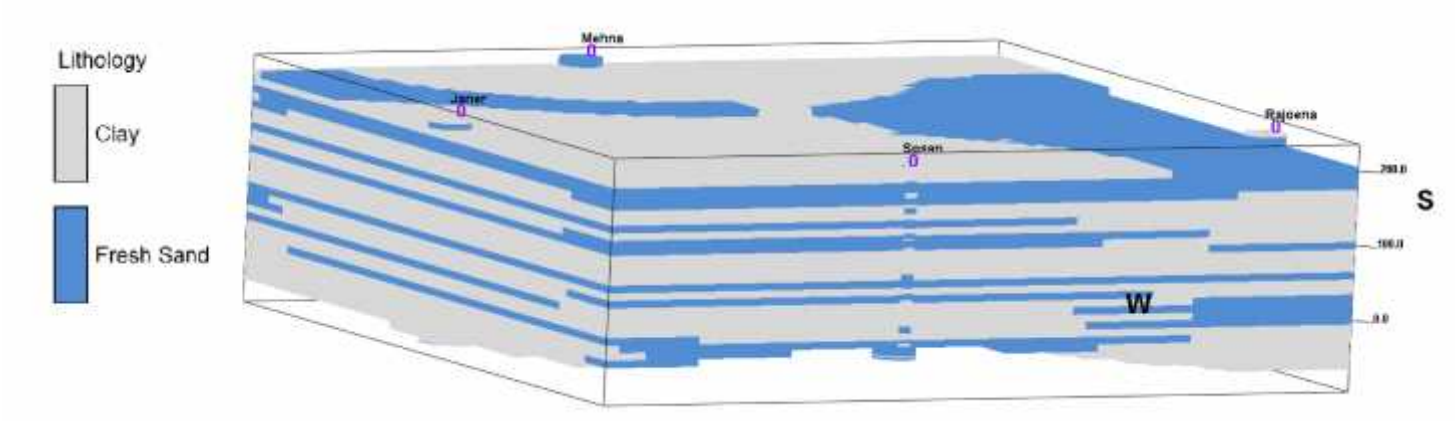
Aquifer Disposition: Combined Aquifer System

Aquifer	Geology	Type of Aquifer	Thickness of Granular Zones (m)	Transmissivity (m^2/day)	Specific Yield %	Storativity
Combined Aquifer (26-300m)	Quaternary Alluvial deposits	Unconfined	88	*5750*	0.072	$6.0*10^{-3}$

Aquifer comprises of freshwater only and the main aquifer material is sand.

The non-aquifer material comprise of clay.

3D Lithology model



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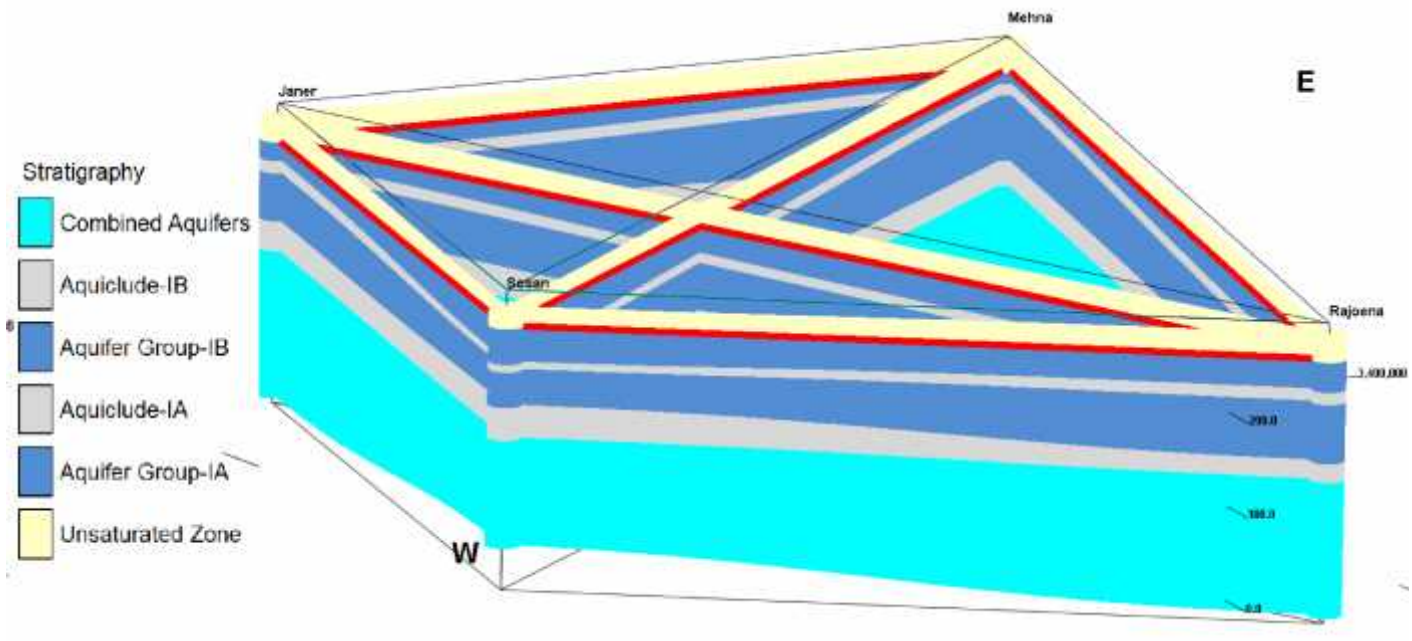

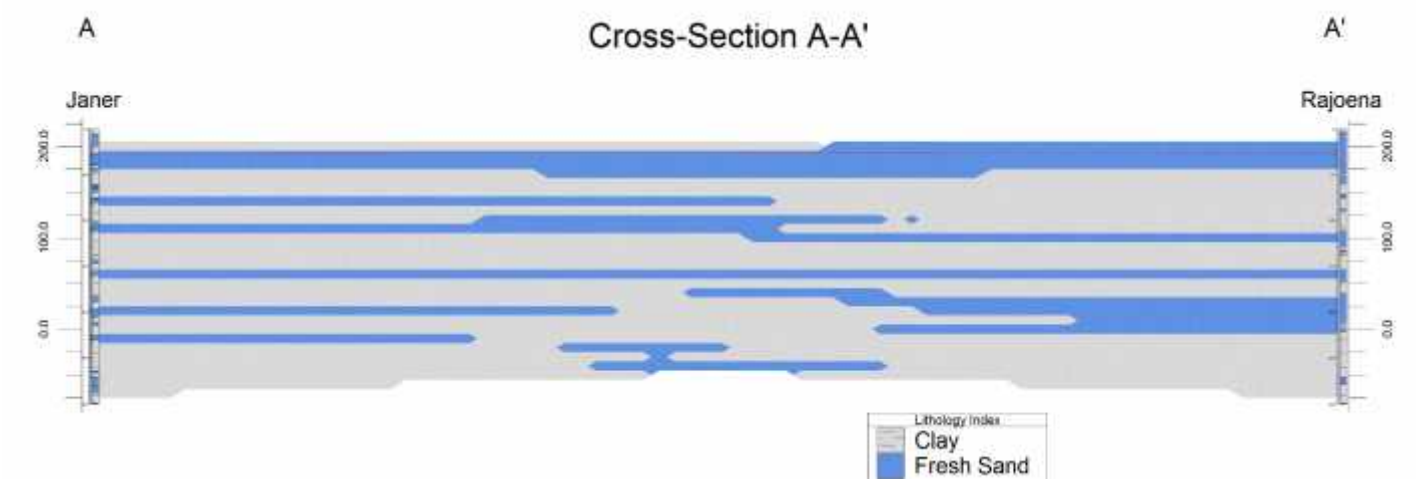
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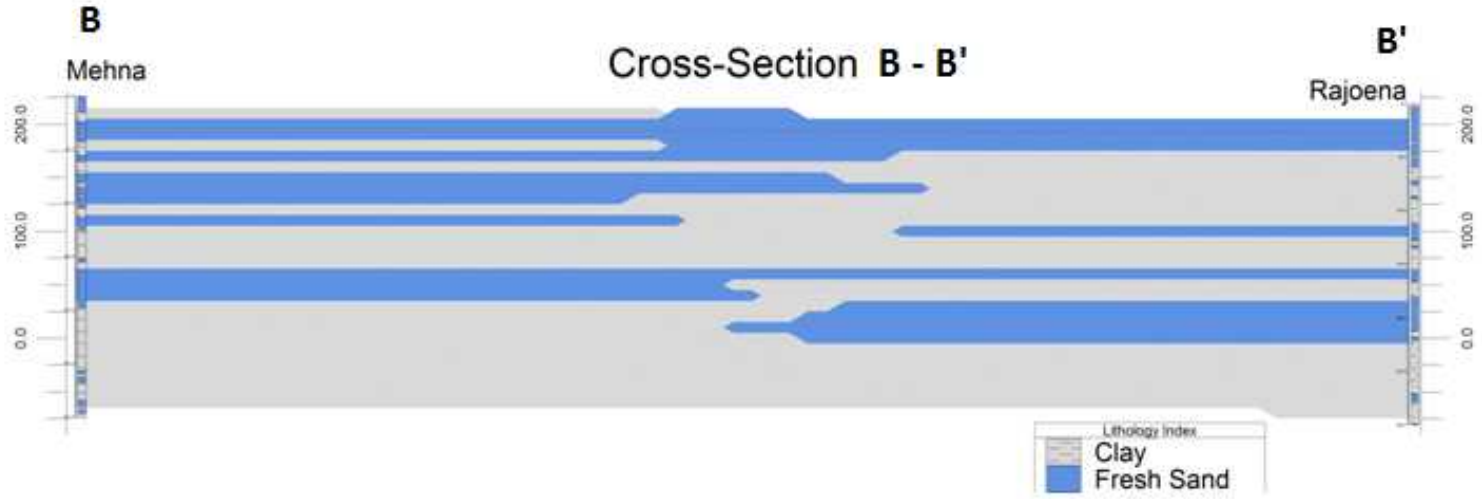
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2. Ground Water Resource, Extraction, Contamination and Other Issues

Combined Aquifer wise Resource available (mcm)	Dynamic Aquifer	*149.32*
	In-storage Ground Water Resources	*2120.03*
	Total	2269.35
Ground Water Extraction (in mcm)	Irrigation	339.99
	Domestic & Industrial	2.03
Provision for domestic & Industrial requirement upto 2025 (in mcm)		2.59
Chemical Quality of ground water & contamination		Suitable for drinking and irrigation purposes
Other issues		Declining water level trend

3. Ground Water Resource Enhancement

Aquifer wise space available for recharge and proposed interventions	Volume of unsaturated zone upto the average depth to water level (11 m).
Other interventions proposed	Artificial Recharge, Roof top Rainwater Harvesting, Farm recharge by constructing pits will save 2.73 mcm volume of water

4. Demand Side Interventions

Advanced Irrigation Practices	Lining of underground pipelines (Kutcha channel) will save 86.58 mcm volume of water wastage
Change in cropping pattern	Proposed change in cropping pattern from Paddy to maize/soyabean 40 % of the total area needs to change the crop from paddy to maize/soyabean Anticipated volume of water to be saved by maize/soyabean is 104 mcm
Alternate water sources	Tanks, ponds and canals
Regulation and Control	-
Other interventions proposed, if any	-

5. NIHAL SINGH WALA BLOCK (377.80 SQ KM)

1. Salient Information

Population (2011) Rural-1,51,044
Urban-0
Total-1,51,044

Rainfall 2014 (Moga District) Average annual rainfall -391 mm

Average Annual Rainfall (Nihal Singh Wala block) 439mm

Agriculture and Irrigation Major Crops- Rice, Wheat
Other crops-Sugarcane, Potatoes, Pulses,
Net Area Sown- 214.99 sq.km
Total Irrigated Area- 318.00 sq.km

Water Bodies & Canal Irrigation

Water bodies available in the villages for the storm water and untreated waste water of villagers, that can be used for irrigation after treatment. The canal irrigation is available in the Nihal Singh Wala block.

Ground Water Resource Availability: Ground Water Resources available in the combined group of aquifers. The resources are calculated as per Dynamic ground water resources (2013) and In-storage ground water resources up-to fresh water. Block is categorized as Over-Exploited as per Ground Water Assessment 2013.

Ground water Extraction: Information regarding the abstraction from different Aquifers is not available, but there are drinking water supplies from tubewells tapping combined aquifer and separate aquifer could not be assessed separately.

Water level Behavior (2015): Pre Monsoon-~17.60-30.50 (mbgl) &Post Monsoon-~28.20-31.21(mbgl)

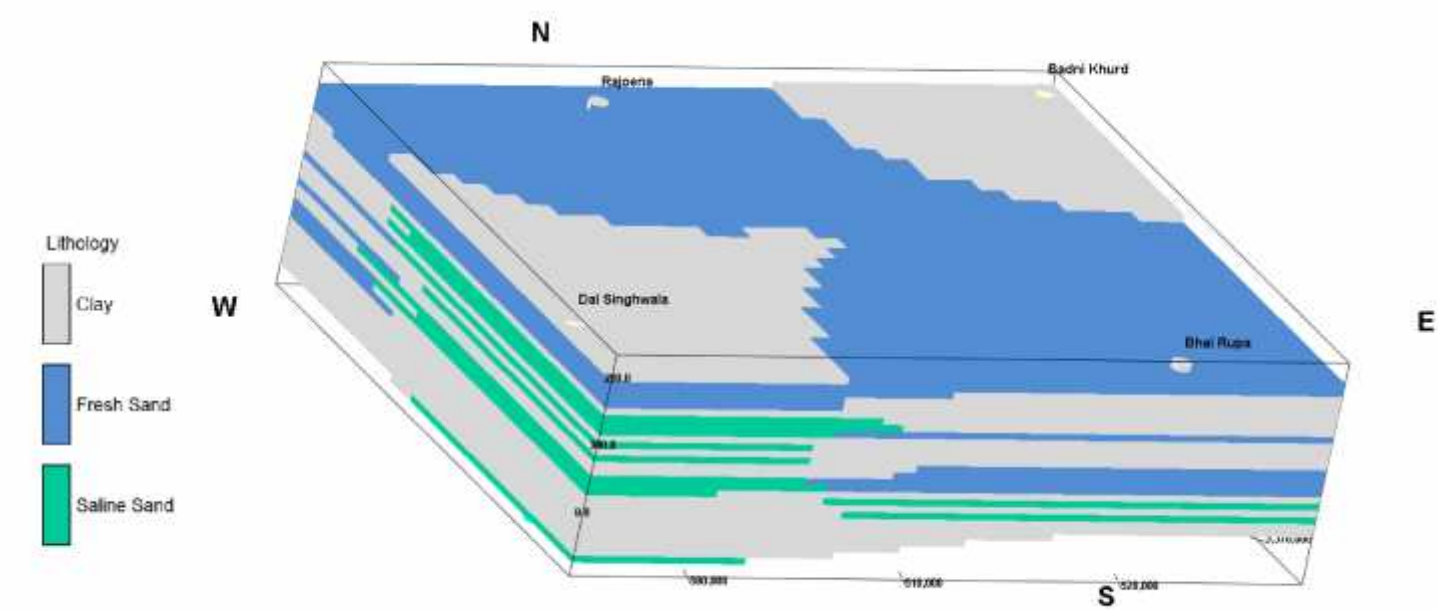
Aquifer Disposition: Combined Aquifer System

Aquifer	Geology	Type of Aquifer	Thickness of Granular Zones (m)	Transmissivity (m^2/day)	Specific Yield %	Storativity
Combined Aquifer (28-300m)	Quaternary Alluvial deposits	Unconfined	105	*5750*	0.072	$6.0*10^{-3}$

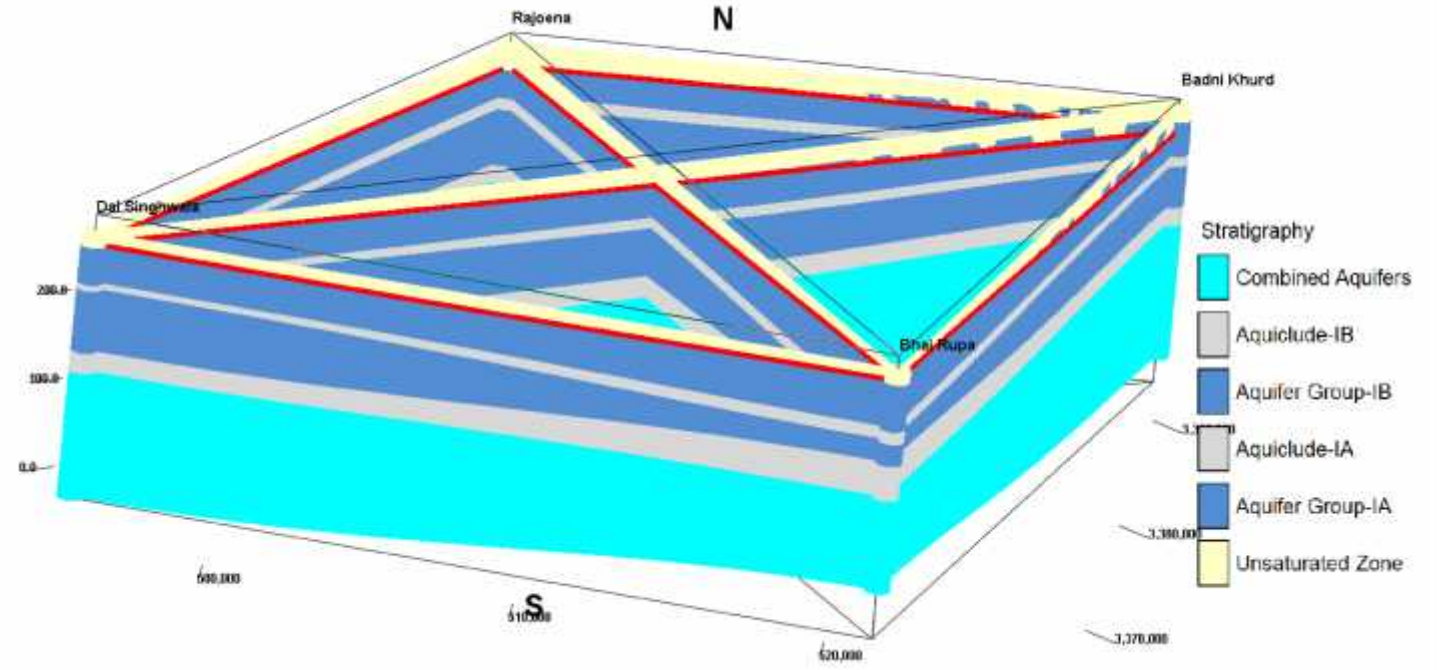
Aquifer comprises of freshwater only and the main aquifer material is sand.

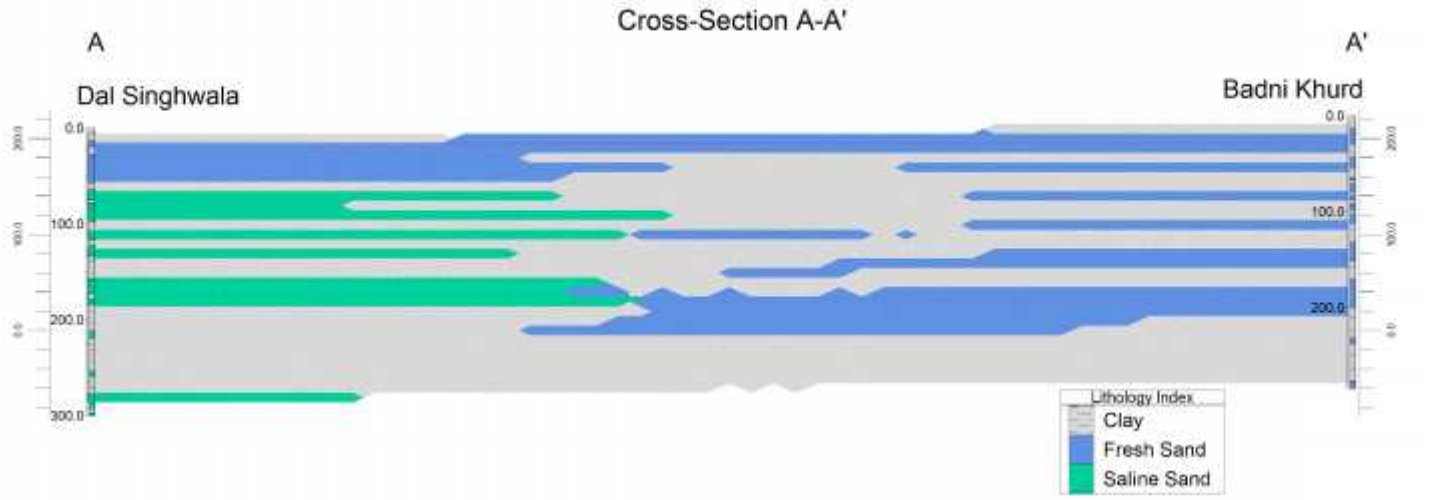
The non-aquifer material comprise of clay.

3D Lithology model



3D Stratigraphy Fence

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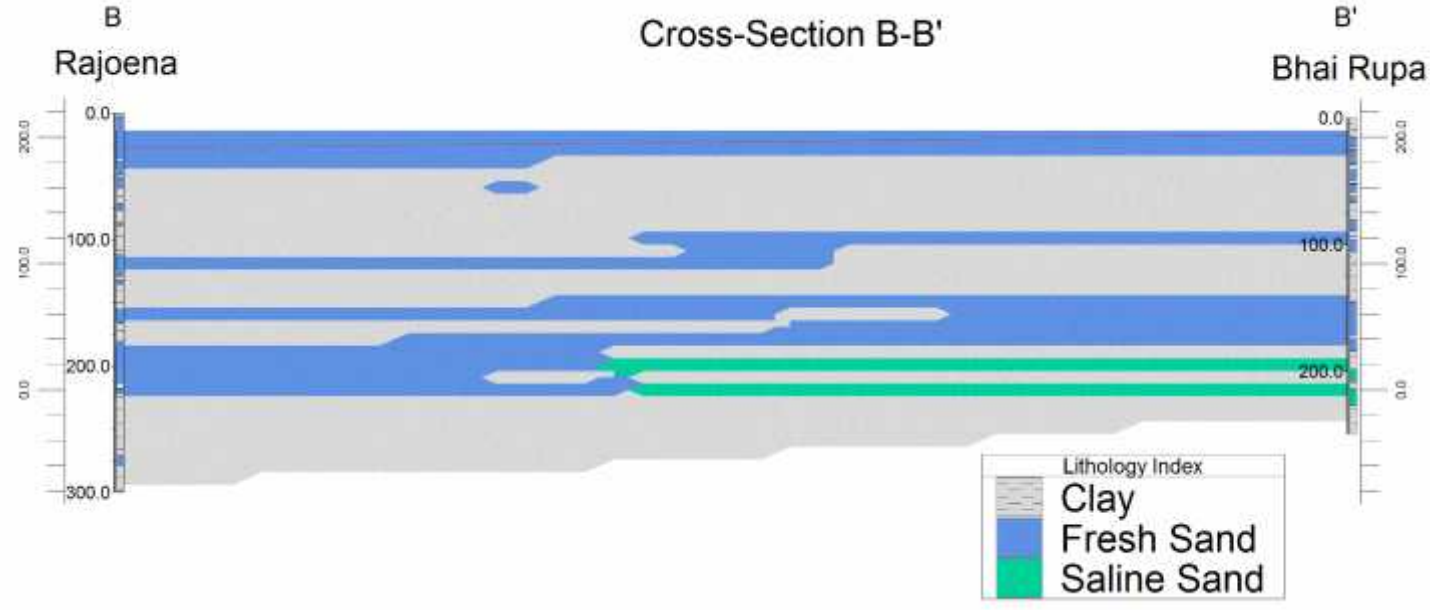
300.0
Lithology Index
Clay
Fresh Sand
Saline Sand


B
B'
Cross-Section B-B'
Rajoena
Bhai Rupa
0.0
100.0
200.0
300.0
Lithology Index
Clay
Fresh Sand
Saline Sand

2. Ground Water Resource, Extraction, Contamination and Other Issues

Combined Aquifer wise Resource available (mcm)	Dynamic Aquifer	*177.14*
	In-storage Ground Water Resources	*2856.17*
	Total	3033.31
Ground Water Extraction (in mcm)	Irrigation	424.88
	Domestic & Industrial	2.61
Provision for domestic & Industrial requirement upto 2025 (in mcm)		3.32
Chemical Quality of ground water & contamination		Suitable for drinking and irrigation purposes
Other issues		Declining water level trend

3. Ground Water Resource Enhancement

Aquifer wise space available for recharge and proposed interventions	Volume of unsaturated zone upto the average depth to water level (14 m).
Other interventions proposed	Artificial Recharge, Roof top Rainwater Harvesting, Farm recharge by constructing pits will save 2.72 mcm volume of water

4. Demand Side Interventions

Advanced Irrigation Practices	Lining of underground pipelines (Kutcha channel) will save 108.06 mcm volume of water wastage
Change in cropping pattern	Proposed change in cropping pattern from Paddy to maize/soyabean 49 % of the total area needs to change the crop from paddy to maize/soyabean Anticipated volume of water to be saved by maize/soyabean is 141.00 mcm
Alternate water sources	Tanks, ponds and canals
Regulation and Control	-
Other interventions proposed, if any	-