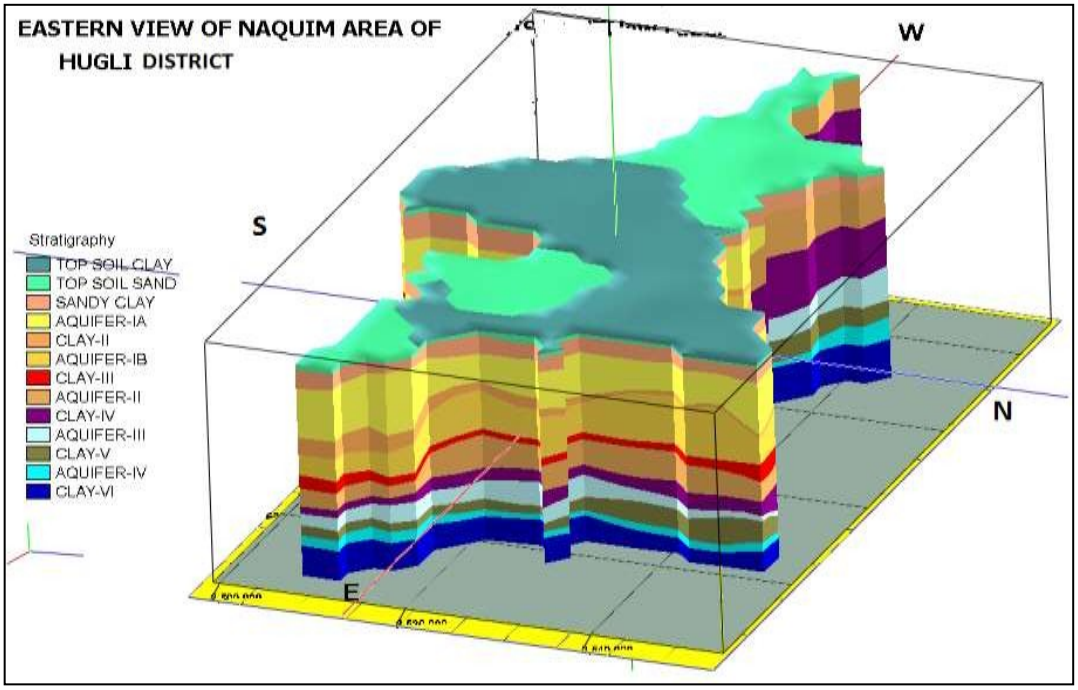
Government of India

MINISTRY OF JAL SHAKTI, DEPARTMENT OF WATER RESOURCES, RIVER DEVELOPMENT & GANGA REJUVENATION

REPORT ON

REPORT ON AQUIFER MAPPING STUDIES & MANAGEMENT PLAN IN PARTS OF HUGLI DISTRICT, WEST BENGAL



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CENTRAL GROUNDWATER BOARD
Eastern Region, Kolkata
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FOREWORD

To understand the nature and occurrences of groundwater, Aquifer geometry, dispositions & characteristics and management of groundwater resource, National Aquifer Mapping & Management Programme (NAQUIM) has been taken up by CGWB under XIIth Plan. During the Annual Action Plan 2019-2020, Aquifer Mapping studies & Management plan was taken up in Parts of Hugli District.

This report is presented in two parts, where Part-I embodies general report for the study area, Part-II include Block Management Plans for the district. Relevant data in respect of the said subjects have been collected from different departments and their publications, viz. Public Health Engineering Dept., State Water Investigation Dept., Agri.-Irrigation Dept., Bureau of economics & Statistics, Land & Land Reforms Dept., Data of Indian Meteorological Dept., National Bureau of Soil Survey & Land Use Planning, etc. of Govt. of India have also been used. Hydro-geological data is sourced from the scientific studies of CGWB pertaining to groundwater explorations, hydrogeological surveys, chemical analysis and outsourcing explorations being taken up for data generation.

Compilation of this report, evaluation of data and preparation of relevant maps, 2D cross-sections & 3D models of aquifers and their reproduction in the form of present report is outcome of the efforts given by **Ms Prachi Gupta, Scientist 'B' under the supervision of Dr. S. Brahma, Scientist-D (OIC/NAQUIM).** The section pertaining to Hydrochemistry has been prepared by Shri Atalanta Narayan Chowdhury, Assistant Chemist and his effort is thankfully acknowledged.

Effective method of dissemination of the existing technical information to different user agencies is an important aspect of NAQUIM which plays a very vital role in the safe and optimal development of groundwater resources in our country. In this regard, Central Ground Water Board has taken up a great initiative in incorporating NAQUIM project since 2012 to fulfill this directive. It is much anticipated that, this report will become an important tool not only for various user agencies, Engineers, Scientists, Administrators, Planners and others involved in groundwater planning, development and management but also to the common public to make them aware of local groundwater issues and its sustainable management.

(Dr S.K.Samanta)

Regional Director

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1.0 INTRODUCTION

Groundwater is one of the prime sources of fresh water contributing significantly for the survival of mankind. However, overexploitation, surface runoff, subsurface groundwater discharge has depleted the fresh groundwater availability considerably. Assessing the groundwater potential zone is extremely important for the protection of water quantity & quality, and the management of groundwater system. In this context, the National Aquifer Mapping & Management Programme (NAQUIM) has been taken up by CGWB under XIIth Plan. As per the Action Plan under NAQUIM, ground water management studies in 11 blocks, e.g., Dhaniakhali, Tarakeswar, Haripal, Jangipara, Chanditala II, Goghat I, Goghat II, Arambagh, Khanakul I, Khanakul II, and Pursurah and 2 municipalities, e.g., Tarakeswar Municipality and Arambagh Municipality, of Hugly district in West Bengal, covering an area of approximately 1890.92 sq. km. was taken up in this study. This report envisages the salient features of aquifer geometry, characteristics; ground water occurrences, availability, resource vis-a-vis quality, development & management scope of ground water etc. in present scenario.

1.1 Objective

The broad objective of the study is to establish the geometry of the underlying aquifer systems in horizontal and vertical domain, its resources potential in respect of quality & quantity, aquifer characterization, scope for development potential and prepare aquifer-wise management plan.

1.2 Scope of Study

The scope of the present study is broadly within the framework of National Aquifer Mapping & Management Programme (NAQUIM) being implemented by CGWB. There are four major activity components viz.: (i) data collection/compilation (ii) Data gap analysis (iii) Data generation and (vi) Preparation of aquifer maps and management plan to achieve the primary objective. Data compilation included collection, and wherever required procurement, of all maps from concerned Agencies, such as the Survey of India, Geological Survey of India, State Governments etc., computerization and analyses of all acquired data, and preparation of a knowledge base. Identification of Data Gap included ascertaining requirement for further data generation in respect of hydro-geological, geophysical, chemical, hydrological, hydro-

meteorological studies, etc. Data generation included those of hydrometeorology, chemical quality of ground water, litho-logs and aquifer parameters. Generation of ground water chemical quality data was accomplished by collection of water samples and their laboratory analyses for all routine parameters, and some data of contamination by geogenic contaminants during recent special studies. Additional data pertaining to sub-surface lithology and aquifer parameters were obtained through drilling of additional exploratory wells by outsourcing including pumping tests at sites.

1.3 Approach and Methodology

An approach and methodology adopted to achieve the major objective have been shown below stepwise.

i) Compilation of existing data

ii) Identification of data gaps

iii) Data generation based on data gaps

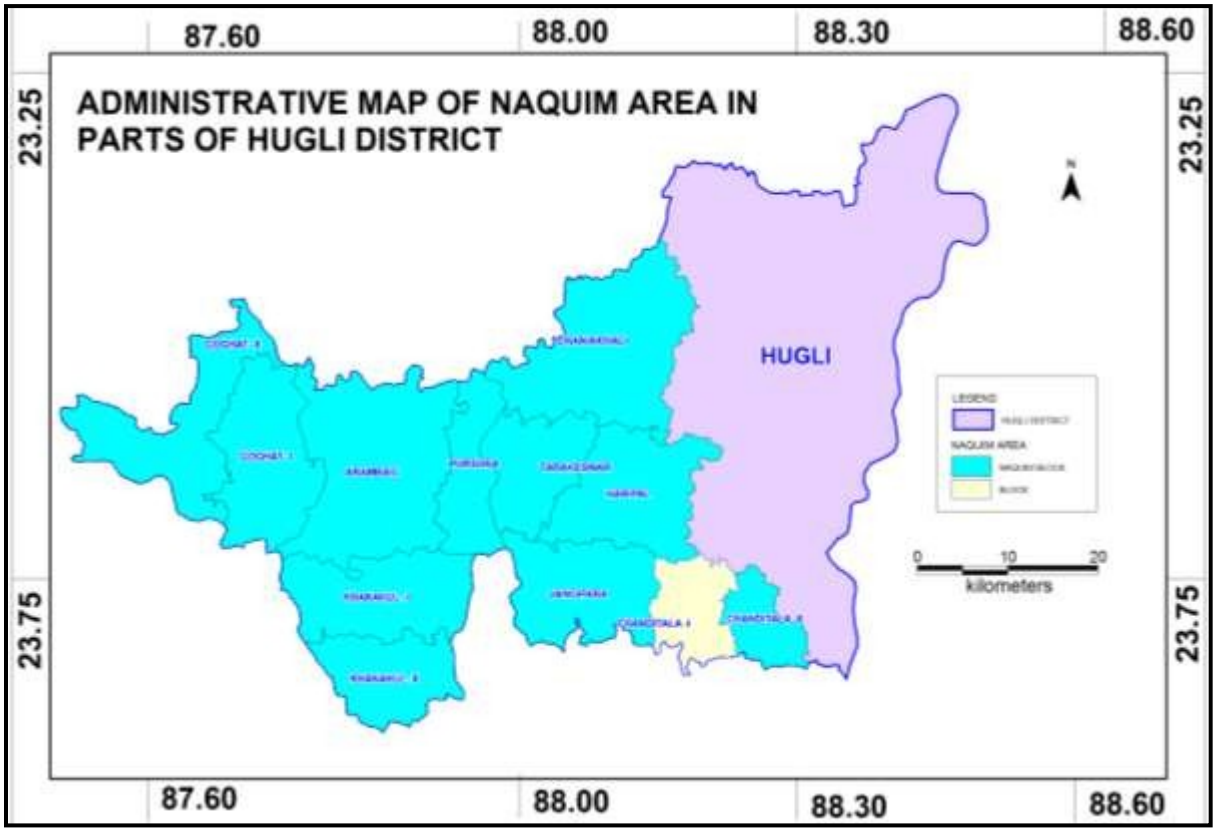
iv) Preparation of thematic maps on GIS platform

v) Preparation of 2D/3D aquifer disposition maps

vi) Compilation of Block-wise Aquifer Maps and Management Plan

1.4 Location, Extent and Accessibility of the study area

The study area (Plate 1.4) comprising 11 blocks and 2 municipalities of Hugly district in West Bengal. The blocks are Dhaniakhali, Tarakeswar, Haripal, Jangipara, Chanditala II, Goghat I, Goghat II, Arambagh, Khanakul I, Khanakul II, and Pursurah and 2 municipalities are Tarakeswar Municipality and Arambagh Municipality, covering a total area of approximately 1890.92 sq. km. was taken up in this study. This area is in the southern part of the State and mainly located in the upper deltaic region of Bengal Basin. The area extends between North latitudes 22°45' and 23004’ and East longitudes 87°30'15” and 88015’. The study area partly falls in the Survey of India Degree Sheet no.79B & 73N. This area is well connected by rail & roads with State Capital Kolkata.



1.5 Administrative Divisions and Population

This area covers 11 blocks and 2 municipalities in Hugly district in West Bengal for an area of 1890.92 sq km. Details of administrative divisions are summarized in *Table 1.1*

Table 1.1 Administrative Units of the Study Area

Sub-Division	C.D.Block/M.C./M	Panchayat		
		Samity	Gram	Gram Sansad
Sadar Sub-Div.	Dhaniakhali	1	18	264
Chandannagar Sub-Div.	Tarakeswar	1	10	144
	Tarakeswar(M)	-	-	-
	Haripal	1	15	208
Serampur Sub-Div.				
Serampur Sub-Div.	Jangipara	1	10	177
	Chanditala-II	1	9	132
Arambagh Sub-Div.	Goghat-I	1	7	107
	Goghat-II	1	9	121
	Arambagh	1	15	221
	Arambagh(M)	-	-	-
	Khanakul-I	1	13	192
	Khanakul-II	1	11	145
	Pursurah	1	8	138
District Total- 4		11	125	1849

(Source: District Statistical Handbook, 2014)

In study area covering 1890.92 sq km, there are 11 Panchayat Samity, 125 Gram Panchayat and 1849 Gram Sansad. The Total population of the Study area are presented in Table 1.2.

Table 1.2 : Population Distribution in Study Area

Sub-Division/ C.D.Block/M.C. /M	Rural Population			Urban Population			Total Population		
	Male	Female	Total	Male	Female	Total	Male	Female	Total
Sadar Sub-Division									
Dhaniakhali	160789	159745	320534	-	-	-	160789	159745	320534
Chandannagar Sub-Division									
Tarakeswar	91534	87614	179148	-	-	-	91534	87614	179148
Tarakeswar (M)	-	-	-	16049	14898	30947	16049	14898	30947
Tarakeswar	91534	87614	179148	16049	14898	30947	107583	102512	210095
Haripal	129407	127100	256507	2350	2216	4566	131757	129316	261073
Serampur Sub-Division									
Jangipara	103912	101187	205099	8405	8074	16479	112317	109261	221578
Chanditala-II	24559	24335	48894	55272	54230	109502	79831	78565	158396
Arambagh Sub-Division									
Goghat-I	71804	68226	140030	-	-	-	71804	68226	140030
Goghat-II	82262	78323	160585	-	-	-	82262	78323	160585
Arambagh	146041	139166	285207	-	-	-	146041	139166	285207
Arambagh (M)	-	-	-	33443	32732	66175	33443	32732	66175
Arambagh	146041	139166	285207	33443	32732	66175	179484	171898	351382
Khanakul-I	130712	123722	254434	-	-	-	130712	123722	254434
Khanakul-II	93979	90755	184734	-	-	-	93979	90755	184734
Pursurah	88908	84529	173437	-	-	-	88908	84529	173437
Total	1123907	1084702	2208609	115519	112150	227669	1239426	1196852	2436278

In Study Area total population is 2436278 of which Rural population is 2208609 and Urban is 227669.

1.6 Land Use, Irrigation and Cropping Pattern

Out of the total area concerned, more than 95 % area is occupied by cultivable land, about meager area is occupied by current waste land and the negligible area is under forest land. The details of land use pattern in each block is shown in Table 1.3

Table 1.3 Block-wise details of Land-use pattern (Source: West Bengal Land use and Land cover Department)

Block	Reporting area (Ha)	Area under non agriculture use (Ha)	Barren and uncultrable land(Ha)	Total agricultural land(Ha)	Pasture (Ha)	Orchard (Ha)	Cultivalble waste (Ha)	Fallow land other than Curent Fallow(Ha)	Curent Fallow(Ha)	Forest (Ha)	Net sown area(Ha)
Dhaniakhali	27568	5960	-	21001	43	160	160	11	650	-	20089
Tarakeswar	12118	2993	-	8279	3	35	47	35	-	-	8232
Haripal	18442	4473	5	14071	-	316	105	1	-	-	13799
Jangipara	16423	4873	-	11693	-	322	94	-	-	-	11496
Chanditala-II	7042	3147	2	2548.22	-	250	45	-	-	-	2421
Pursurah	10042	2980	-	7499	-	13	15	1	-	-	7405
Arambagh	30390	9052	-	20559	-	60	-	1	-	528	20455
Khanakul-I	17240	4000	-	13308	-	131	-	-	-	-	13184
Khanakul-II	12183	2406	-	10093.14	-	40	-	-	-	-	8631
Goghat	37644	8912	68	27684	11	109	-	378	-	2	27302
Total	189092	48796	75	136735.3	57	1436	466	427	650	530	133014

*1890.92 km^2 is reported area but mappable area is 1540 km^2

Irrigation plays an important role for crop production and intensity of crops. Out of the total CCA, 67 % irrigation for crop production is dependent on ground water irrigation systems and the rest is covered by surface water. Surface water is predominant in Khanakul II and Tarakeswar blocks. Ground water irrigation is created by deep tube well and shallow' tube wells. Irrigation by surface water is done through canal flow & River lift irrigation.

Rice forms the principal crop of the study area. Other crops with a substantial production include wheat, jute, oil seeds, vegetables including potato and sugar cane; Hugly district is known for record potato production in India. Land use map of the area has been shown in Figure 2.1.

1.7 Urban areas, Industries and Mining activities

Urban areas in the study area include 2 municipalities: viz. Tarakeswar Municipality in Tarakeswar Subdivision and Arambagh Municipality in Arambagh Subdivision in Hugly district. Small industries are set up in the study area, registered with the Directorate of Cottage and Small-Scale Industries. Mining activities are absent in this area.

2.0 CLIMATE

The climate of the area is characterized by hot and humid climate with adequate rainfall mainly derived from south-west monsoon, which starts from mid-June and continue up to September. Generally, 85 percent of the rainfall is received during the monsoon period. Pre-monsoon showers are occasionally received in the month of March, April, and May.

2.1 Rainfall

Month wise average rainfall for the year 2012 – 2016 in Hugly district in NAQUIM study area have been tabulated and presented in Table 2.2 below. Normal Annual Rainfall in the district is to the tune of 1362 mm.

2.2 Temperature

The winter season sets in around middle of November when both maximum and minimum temperature begin to drop steadily and attain their respective lowest values in the month of January. The temperature starts rising in the month of February. May is the hottest month of the year.

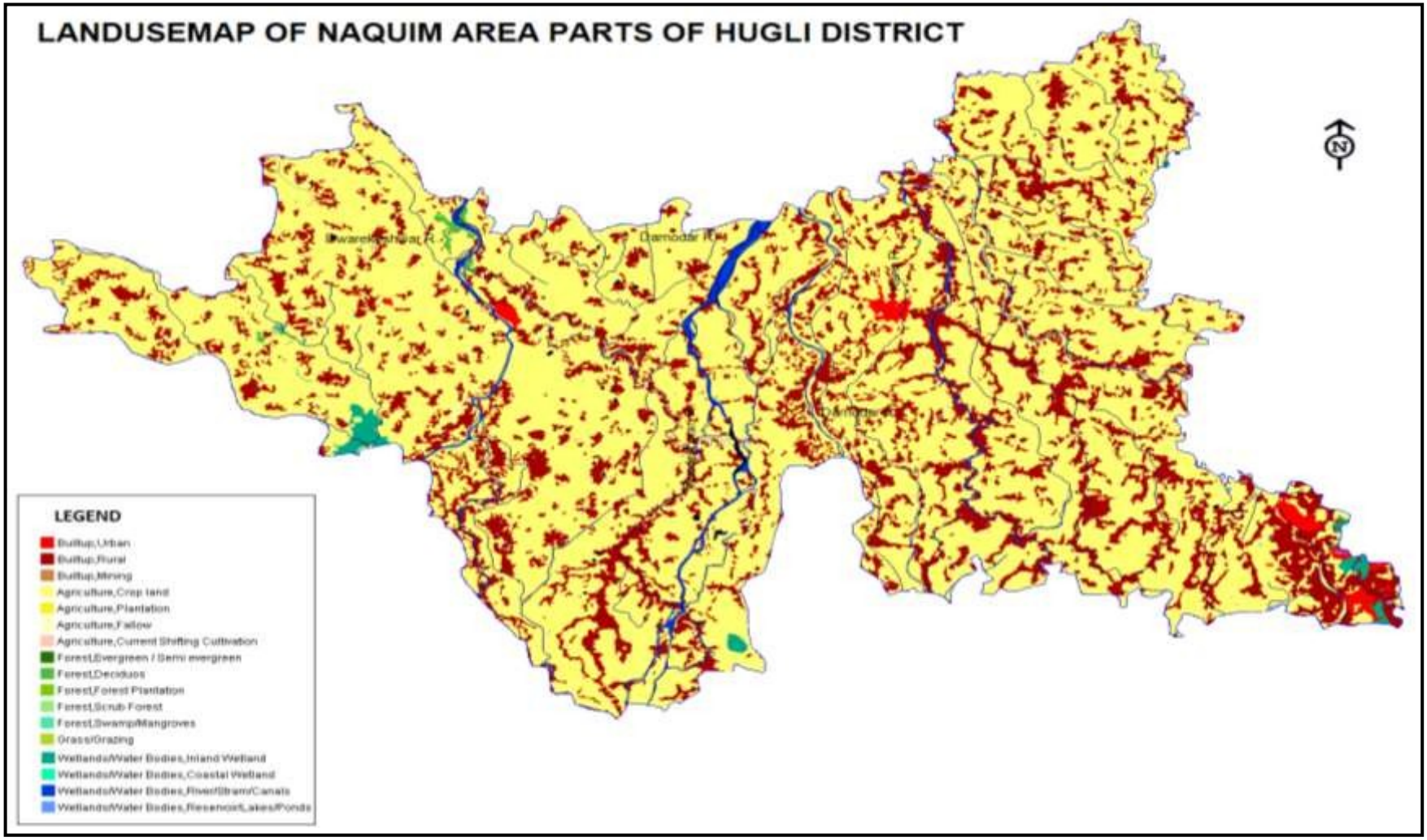


Figure 2.1 Land use map of study area

Table 2.1 Block wise details of structure for water extraction

Block Name	Dugwell		Shallow Tubewell		Deep Tubewell		Surface Flow		Surface Lift		CCA(ha.)		Total CCA(ha.)
	No.	CCA(ha.)	No.	CCA(ha.)	No.	CCA(ha.)	No.	CCA(ha.)	No.	CCA(ha.)	Ground Water	Surface Water	
ARAMBAGH	0	0	1935	7410.25	60	2388	0	0	41	1901.41	9798.25	1901.41	11699.66
CHANDITALA-II	0	0	83	654.23	14	797.51	0	0	229	1096.48	1451.74	1096.48	2548.22
DHANIAKHALI	1	0	1260	3760.99	27	910.68	0	0	602	2010.76	4671.67	2010.76	6682.43
GOGHAT-I	0	0	1091	4957.6	16	480	0	0	29	725.14	5437.6	725.14	6162.74
GOGHAT-II	0	0	1653	5662.12	16	490	0	0	32	365.5	6152.12	365.5	6517.62
HARIPAL	0	0	681	3934.49	23	788.79	0	0	338	982.6	4723.28	982.6	5705.88
JANGIPARA	0	0	712	3961.83	24	897.18	0	0	75	512	4859.01	512	5371.01
KHANAKUL-I	0	0	897	4267.84	30	1106.3	0	0	284	3802.58	5374.18	3802.58	9176.76
KHANAKUL-II	0	0	139	588.73	20	675	34	5201.6	145	3627.86	1263.73	8829.41	10093.14
PURSURAH	0	0	739	2727.22	29	1019.4	0	0	99	1673.96	3746.62	1673.96	5420.58
TARAKESWAR	0	0	523	2009.88	17	651.71	40	2247.8	89	540.76	2661.59	2788.59	5450.18
TOTAL:-	1	0	9713	39935.2	276	10205	74	7449.4	1963	17239.1	50139.79	24688.43	74828.22

(Source-4th MI Census)

Table 2.2 Average annual rainfall in parts of Hugli district for the period 2013 -17 (in mm)

year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2013	2.1	8.9	2.4	56.5	93.7	223.9	221.4	287	186.6	282.8	0	0
2014	0	44	19.5	0.1	78.6	218.3	239.9	289.1	190.5	34.4	0	0
2015	9.1	4.1	16	62.4	54	299.5	671.6	188	215.3	27.2	0.1	1.8
2016	1.3	14	20.3	0	85.3	166.2	253	347.1	242.8	75.9	12.7	0
2017	0	0	23.9	11.8	115.2	186.6	434.6	227	180.8	212.4	25.2	19.9
Avg yrs	2.5	14.2	16.42	26.16	85.36	218.9	364.1	267.64	203.2	126.5	7.6	4.34

3.0 PHYSIOGRAPHY

3.1 Geomorphology

Overall, the study area belongs to alluvial plain topography. The area under study is generally flat with surface elevation ranging from about 8 m above MSL to 27 m above MSL. The slope of land is 0.27 m per km from north to south/southeast. Digital elevation model has been shown in Figure 3.1 The Geomorphology Map of the study area is shown in Figure 3.2**.** The area is characterized by a part of alluvial tract of Lower Ganga Basin, which shows gentle southerly slope with some local elevations and depressions. This flat alluvial plain is drained by rivers and streams, viz. Dwarakeswar, Mundeswari, Damodar etc. with sub parallel drainage pattern. There are mainly two main geomorphic features: Older Alluvial Plain and Flood Plain; out of these the latter occupies a major part of study area.

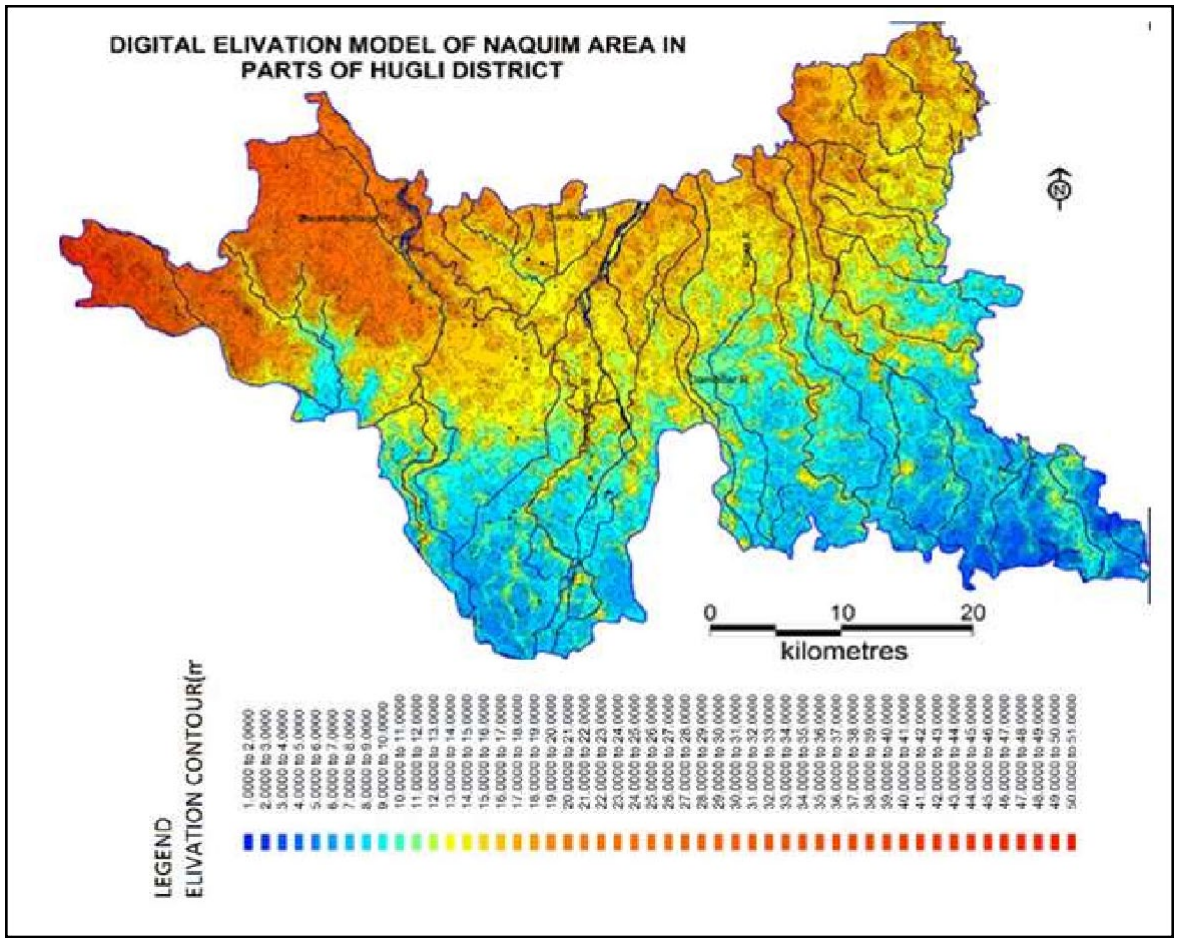


Figure 3.1 Digital Elevation Model

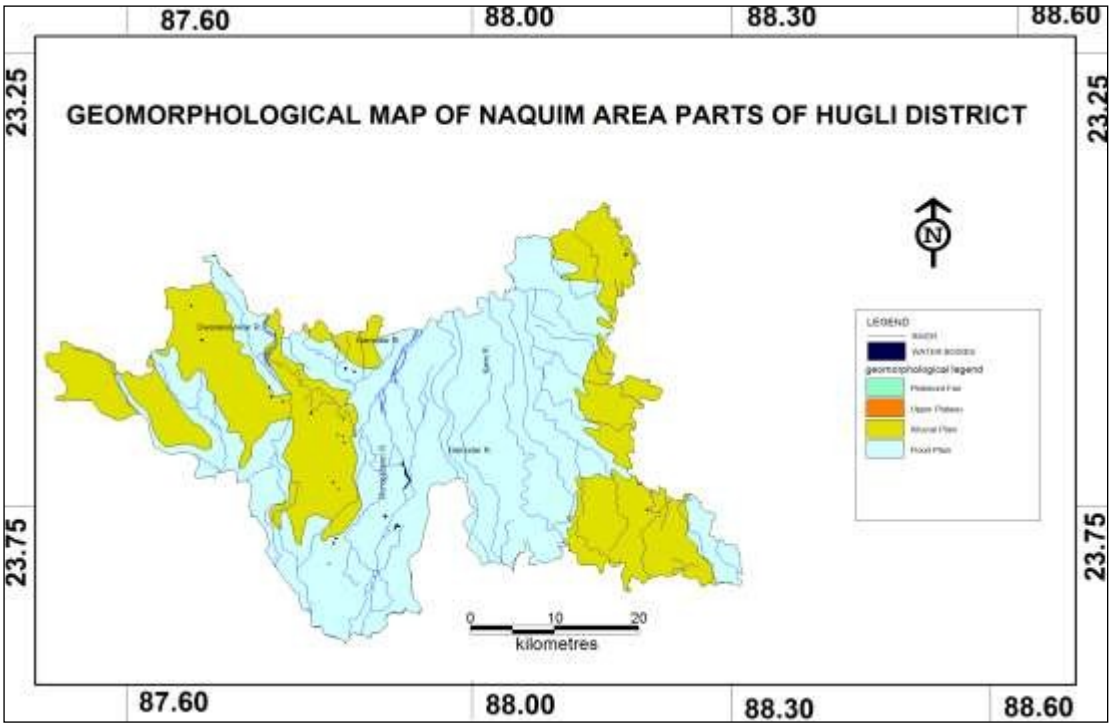


Figure 3.2 Geomorphological Map of NAQUIM Area In Parts Of Hugli District

3.2 Drainage

The whole area is drained by the rivers and tributaries of Hugly/Ganga drainage system. All rivers and tributaries are perennial in nature. The major tributaries are Hugly/Bhagirathi River System of study area are Dwarakeswar, Mundeswari, Damodar etc. flowing from north to south to join River Hugli outside present area. The Drainage Map of the study area is shown in Figure 3.3

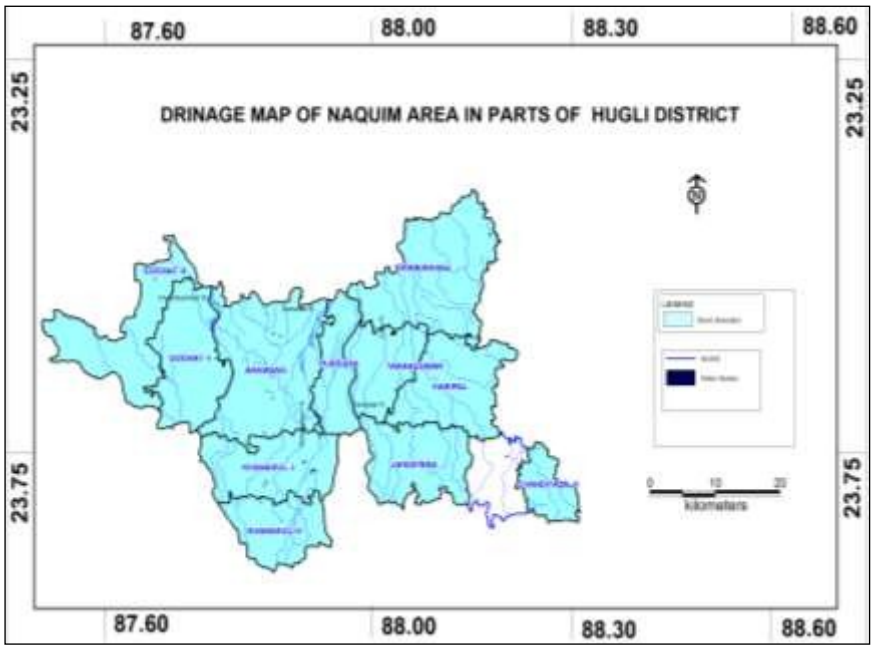


Figure 3.3 Drainage Map of NAQUIM Area In Parts of Hugli District

3.3 Soil Characteristics

Main types of soil in the study area are poorly drained, fine loamy soils (fine loam), moderately well drained, sandy soils (coarse loam) and imperfectly drained, fine loamy soils; the first two category occupy major part of the area. Block-wise major soil types are described in Table 3.3. However, the detailed Soil Map of this area is shown in Figure 3.4

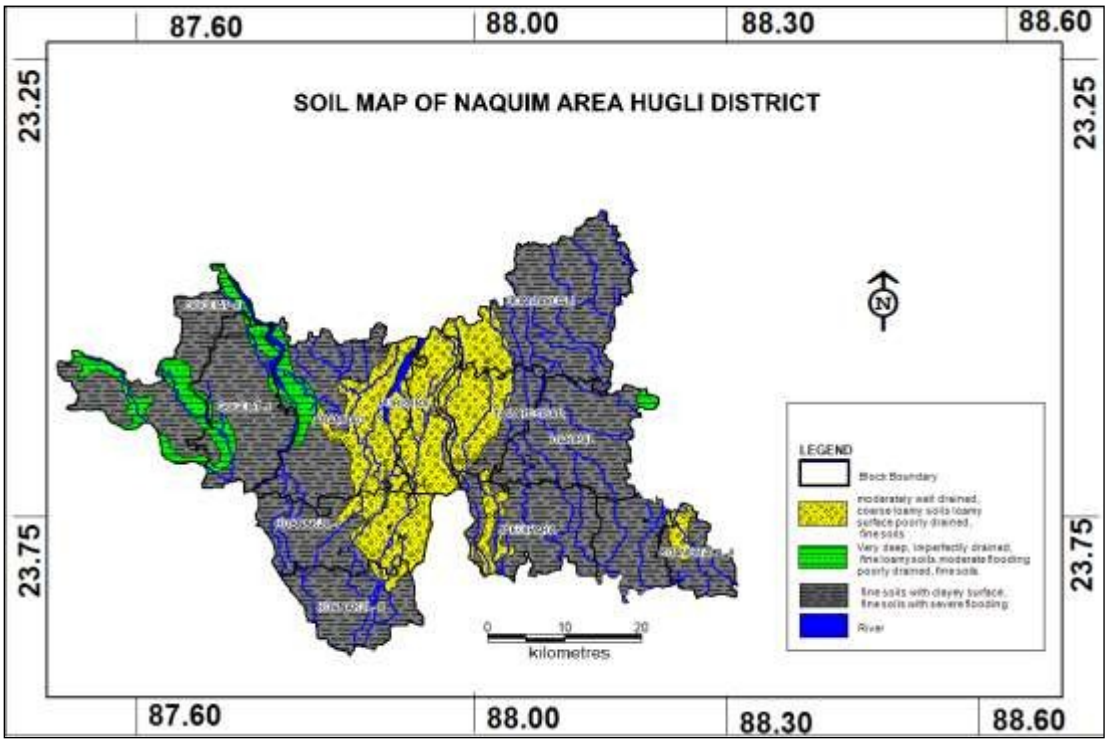


Figure 3.4 Soil map of 11 blocks in study area of Hugli District

Table 3.1 Major soil types in study area

Block	Block Area	Poorly drained, fine loamy soils (fine loam)		Imperfectly drained, fine loamy soils		Moderately well drained, sandy soils (coarse loam)		River	
		Sq.km	**%**	**Sq.km**	**%**	**Sq.km**	**%**	**Sq.km**	**%**
Dhaniakhali	275.68	233.4	84.66	0	0	41.52	15.06	0.76	0.28
Tarakeswar	123.83	43.5	35.13	0	0	77.11	62.27	3.22	2.6
Haripal	184.42	178.2	96.63	4.59	2.49	0	0	1.629	0.88
Jangipara	164.23	139.2	84.76	0	0	25.53	15.55	0	0
Chanditala-II	70.34	50.58	71.91	0	0	14.2	20.19	5.56	7.9
Pursurah	100.42	0	0	0	0	100.3	99.88	0.12	0.12
Arambagh	288.35	148.9	51.64	29.91	10.37	117.6	40.78	0	0
Khanakul-I	171.92	92.68	53.91	0	0	81.11	47.18	0	0
Khanakul-II	121.83	113.8	93.41	0	0	7.9	6.55	0.054	0.04
Goghat-I	186.32	147	78.9	31.87	17.1	0	0	7.45	4
Goghat-II	190.03	125.7	66.15	60.36	31.76	0	0	3.97	2.09

4.0 GEOLOGY

4.1 General Geology

The area under study is mostly covered by a huge thickness of Quaternary deposits, which overlies Tertiaries. Tertiaries, which are represented by finer fractions of sediments Quaternaries of Hugli-Bhagirathi River system are represented by Older Alluvium and Younger Alluvium. Older Alluvium are mainly sand, silt, clay, calcareous concretion and mostly developed in upland areas of parts of study area. Sometimes, these are reportedly capped by laterite deposits and are encountered just in the far west, outside study area. Recent to Sub-Recent Alluvium of the Ganga River system consists of clay, silt, sand and gravel; these deposits are characteristically grey to yellowish, fine to coarse. The geology of the whole study area has been shown in plate Figure 4.1

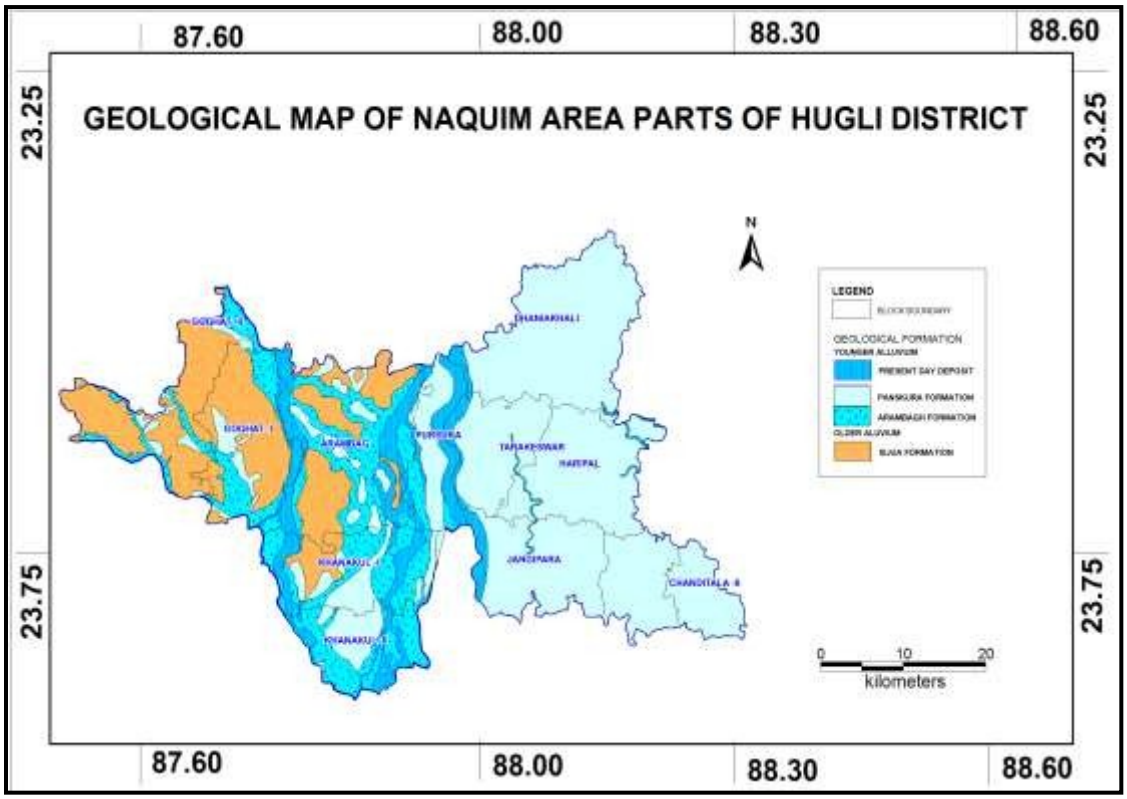


Figure 4.1 Geology in parts of Hugli district

4.2 Sub Surface Geology

Blocks under study area of Hugli district are Dhaniyakhali, Haripal, Jangipara, Chanditala-II, Tarkeswar, Pursura, Khanakul-I, Khanakul-II, Arambagh, Goghat-I and Goghat-II. From the drilling data, geophysical data and hydrogeological data of CGWB (through In-house and out-sourcing activity) and other central and state Govt. organizations exploration data, three prominent aquifers have found in Hugli District. Location of Exploratory well are shown in

Figure 4.2. Maximum wells are explored through outsourcing and some wells are already explored through in-house activities.

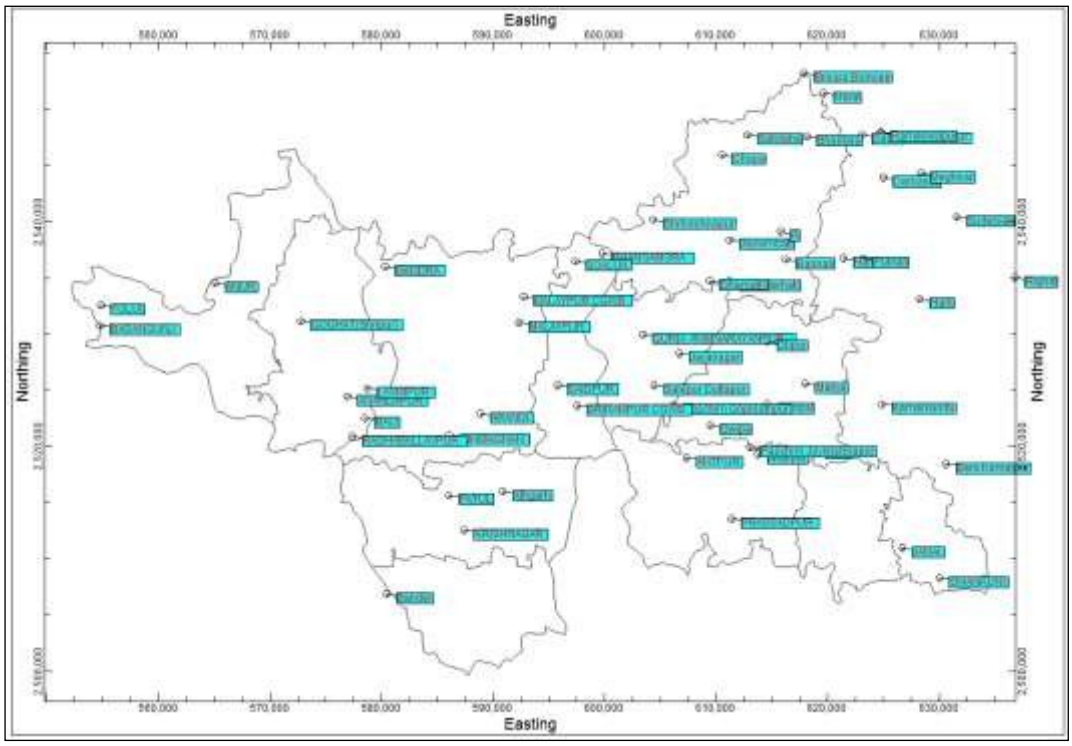


Figure 4.2 Location of Exploratory wells in Parts of NAQUIM Area in Hugli district (pts.)

In Figure 4.3 lithologs encountered in exploratory wells have shown in parts of NAQUIM Area of Hugli District.

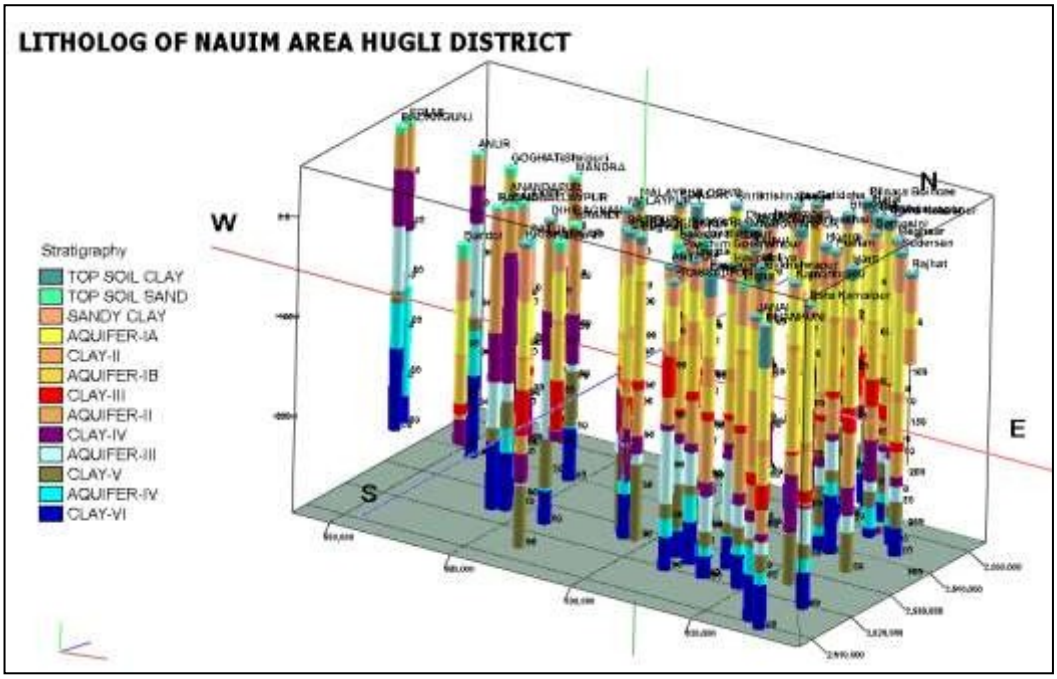


Figure 4.3 Lithologs of NAQUIM Area in Parts of Hugli district

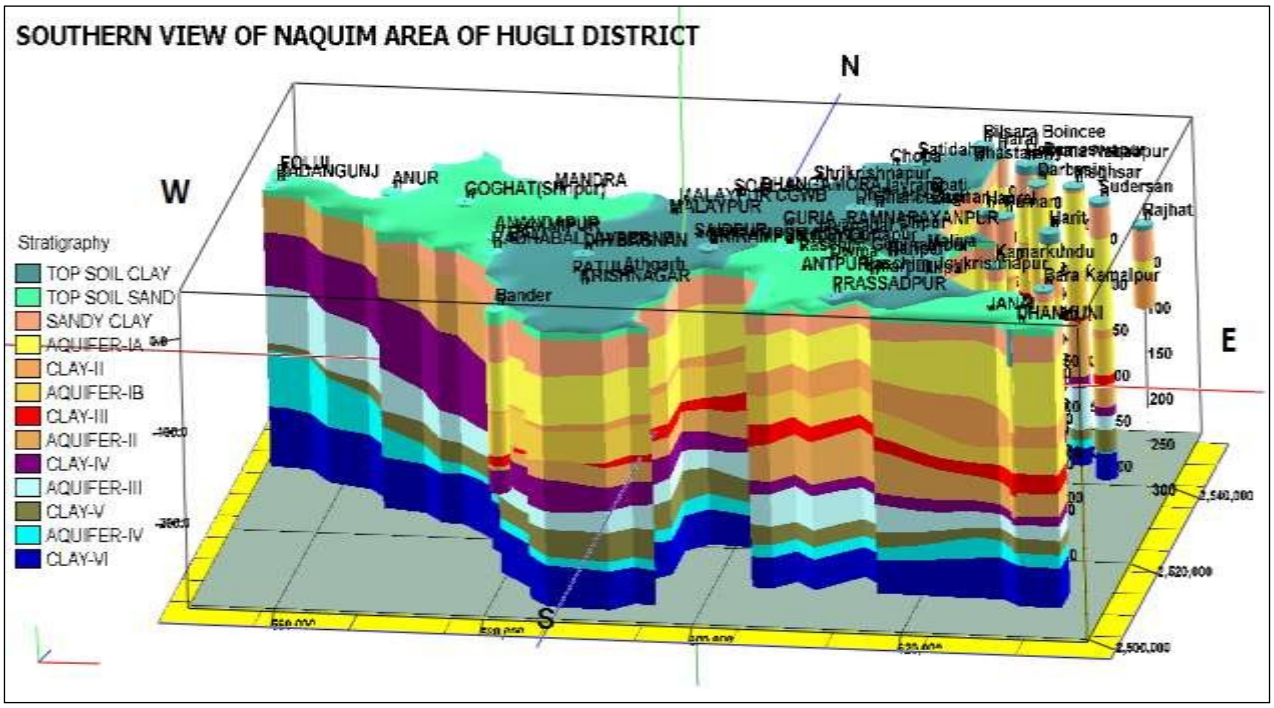


Figure 4.4 3D aquifer dispositions in parts of NAQUIM Area in Hugli District (pt.)

Table 4.1 General geology in and around study area

Age	Group	Formation	Lithology	Notation
Late Holocene	Newer Alluvium	Present day deposit	Sand, silt, clay	Q_2nap^2
Holocene	Newer Alluvium	Panskura formation	Yellowish brown fine sand, silt, clay	Q_2naps
Holocene	Newer Alluvium	Arambagh formation	Sand, silt & gravels	Q_2naa
Pleistocene-Holocene	Older Alluvium	Sijua formation	Sand, silt, clay, calcareous concretion	Q_2oasj

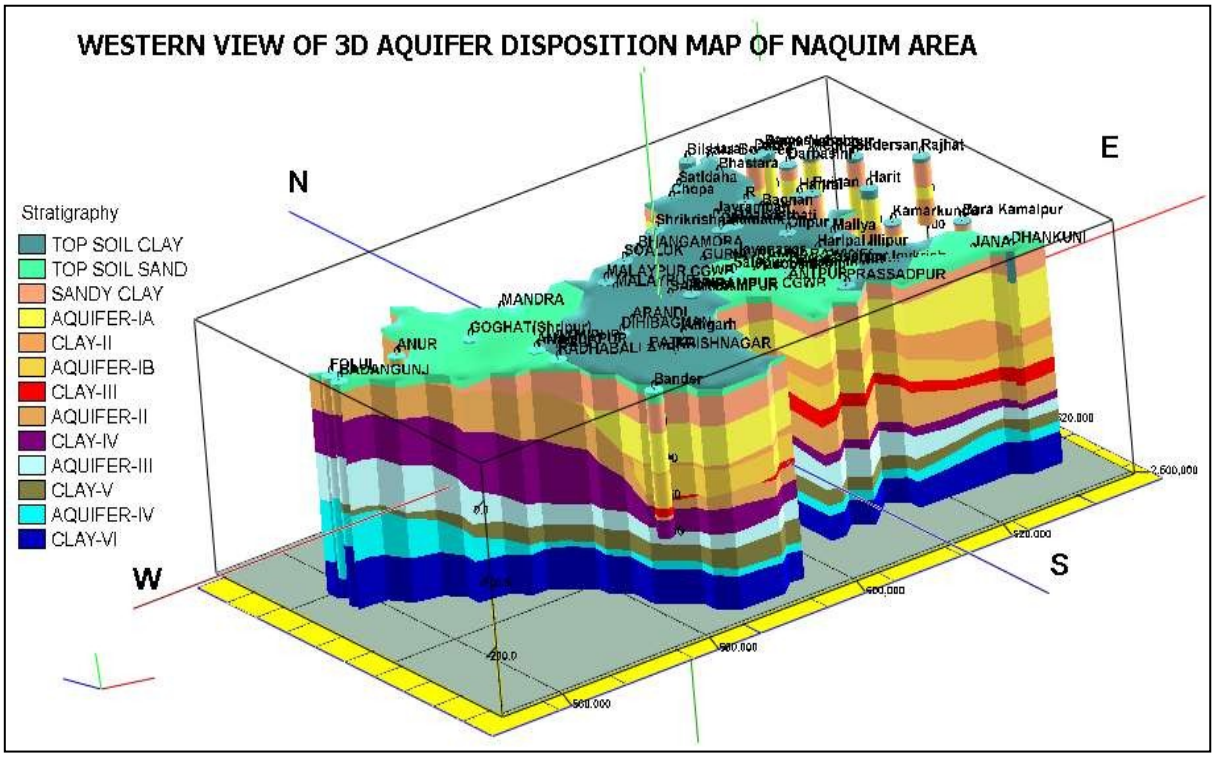


Figure 4.5 3D aquifer disposition in parts of NAQUIM Area in Hugli District (pt.)

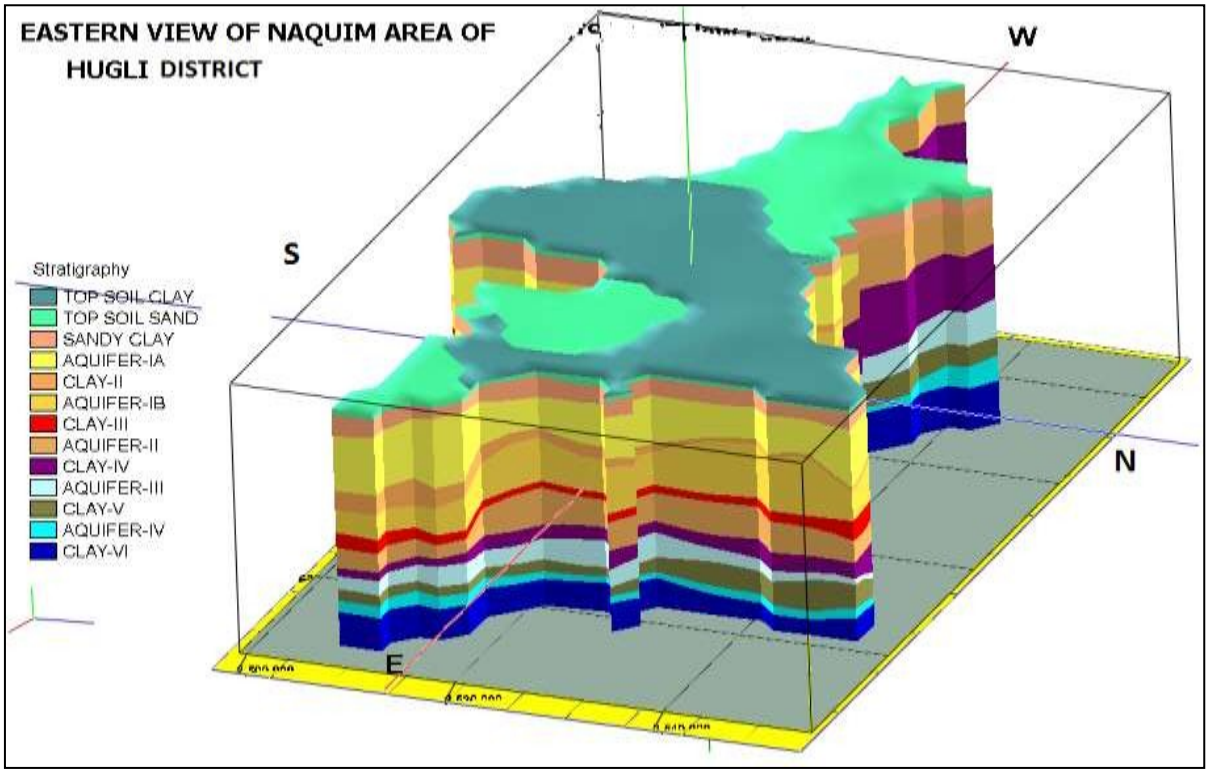


Figure 4.6 3D aquifer disposition in parts of NAQUIM Area in Hugli District (pt.)

After detail study of the lithologs, geophysical log and other hydrogeological parameters it was found that, Aquifer-IA is part of younger alluvium and aquifer-IB and Aquifer-II and

termed as 2nd aquifers, and Aquifer-III and Aquifer-IV are parts of Tertiary formation and termed as **3rd** aquifer. All the aquifers are regionally extensive, but their thickness varies from one place to another.

1st Aquifer Group is ranging from depth 5m-143.5 m and mainly overlain by a 0-5 m Sandy clay layer and in some places in patches by Sticky clay. It is fine grained, mainly yellow colour and it is not found in the western part of the area.

2nd Aquifer Group is encountered In Western part of the study area. It is subdivided into two sub aquifers Aquifer- IB and Aquifer-II. Range of IB Aquifer is 26 m to 169m and Aquifer- II is 84m to 251 m. Overall range of 2nd aquifer group is 26 m to 251m. This aquifer is basically part of Older Alluvium and is coarse in nature along with brownish, reddish colour. Towards west of study area, 1st and 2nd aquifers are merged, but due to their hydrogeological properties they are separated as two different aquifers. Thickness of **1st** and **2nd** aquifer is more towards Eastern side.

3rd Aquifer Group is subdivided into two sub aquifers: Aquifer-III and Aquifer-IV. Overall range of 3rd Aquifer Group is 164m to 295m. Range of Aquifer-III is between 164.58m to 293m and, Aquifer-IV is from 230m to 295 m. This aquifer is part of Tertiary formation. This Aquifer Group is separated from **2nd Aquifer Group** by thick grey sticky clay. 3rd aquifer group is intercalated with clay layers, so it is less potential. Thickness of 3rd Aquifer Group is more towards west. 2nd aquifer and 3rd aquifer groups are separated from each other by thick clay layer, which becomes thicker towards West. For better understanding of aquifer disposition, sections have been prepared in North-South and East-West direction.

Disposition of Stratigraphy in Cross sections

1. **Bilsara Boinchee- Haral-Bhastara- Dhaniyakhali-Bagnan-Olipur-Maliya-Haripal-Illipur-Janai-Dhankuni Section**

A section is drawn from Bilsara (in Dhaniyakahli block) in the north to Dankuni (Chanditala-II block) in south in eastern part of Study area (Figure 4.7 & Figure 4.8). Topsoil Clay aquitard is of limited thickness (1-2 m). Top clay is not uniform, and it is thickened in northern part in Dhaniyakhali-Bhartara area and behave like confining layer. Below topsoil 2-3 m sandy clay is present. Aquifer I Group is regionally extensive and though its thickness varies, maximum depth of its occurrence is found at 114.3 mbgl near Dankuni.

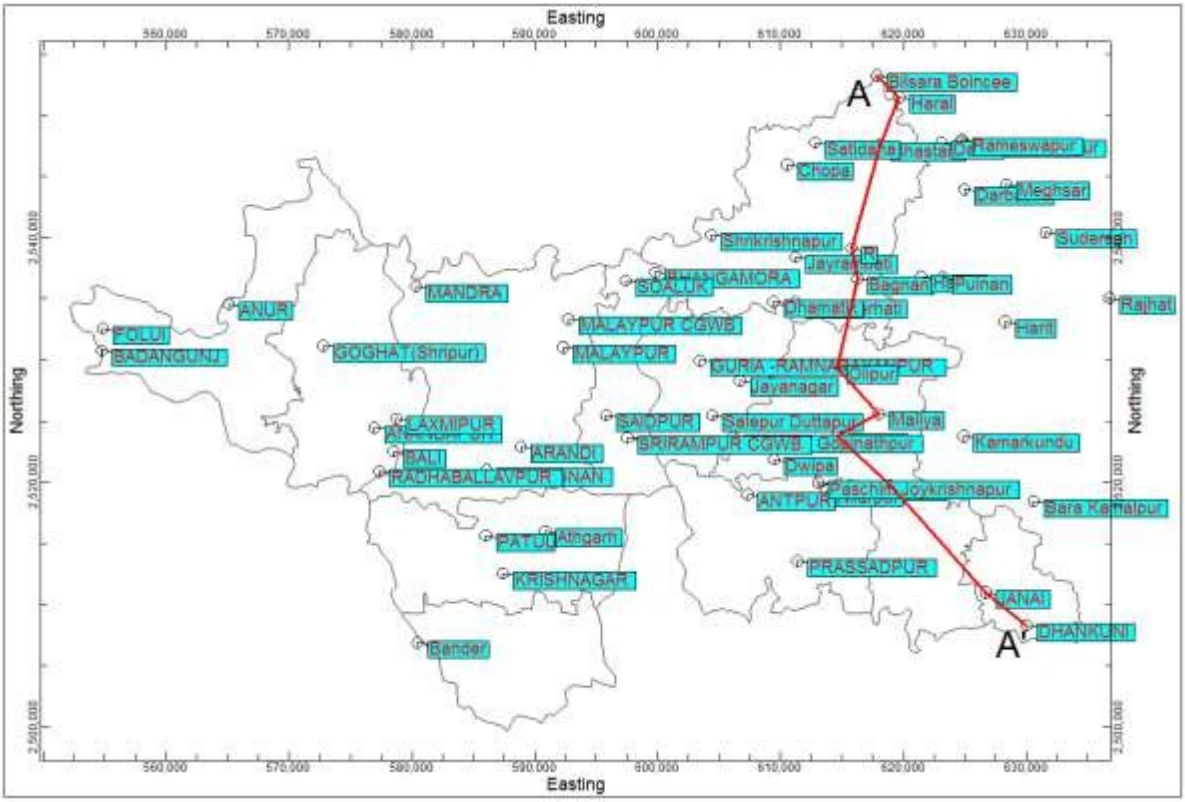


Figure 4.7 Index line of N-S Cross section (eastern part of area) - Bilsara to Dankuni, Hugli District

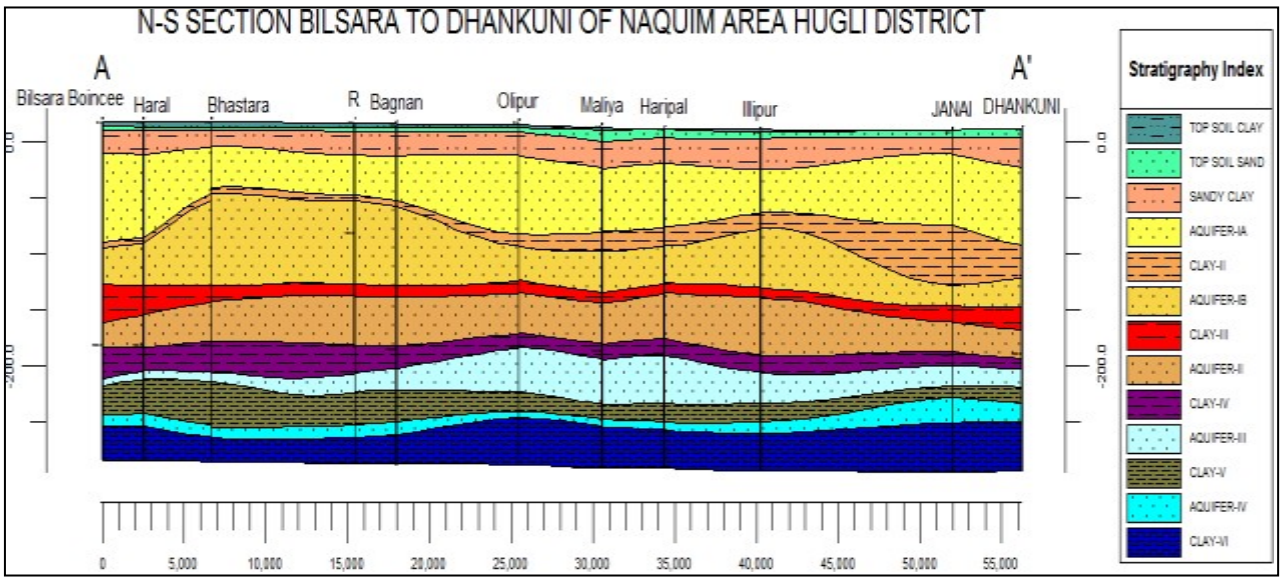


Figure 4.8 N-S Cross section (eastern part of area) - Bilsara to Dankuni, Hugli Dist. (pt.)

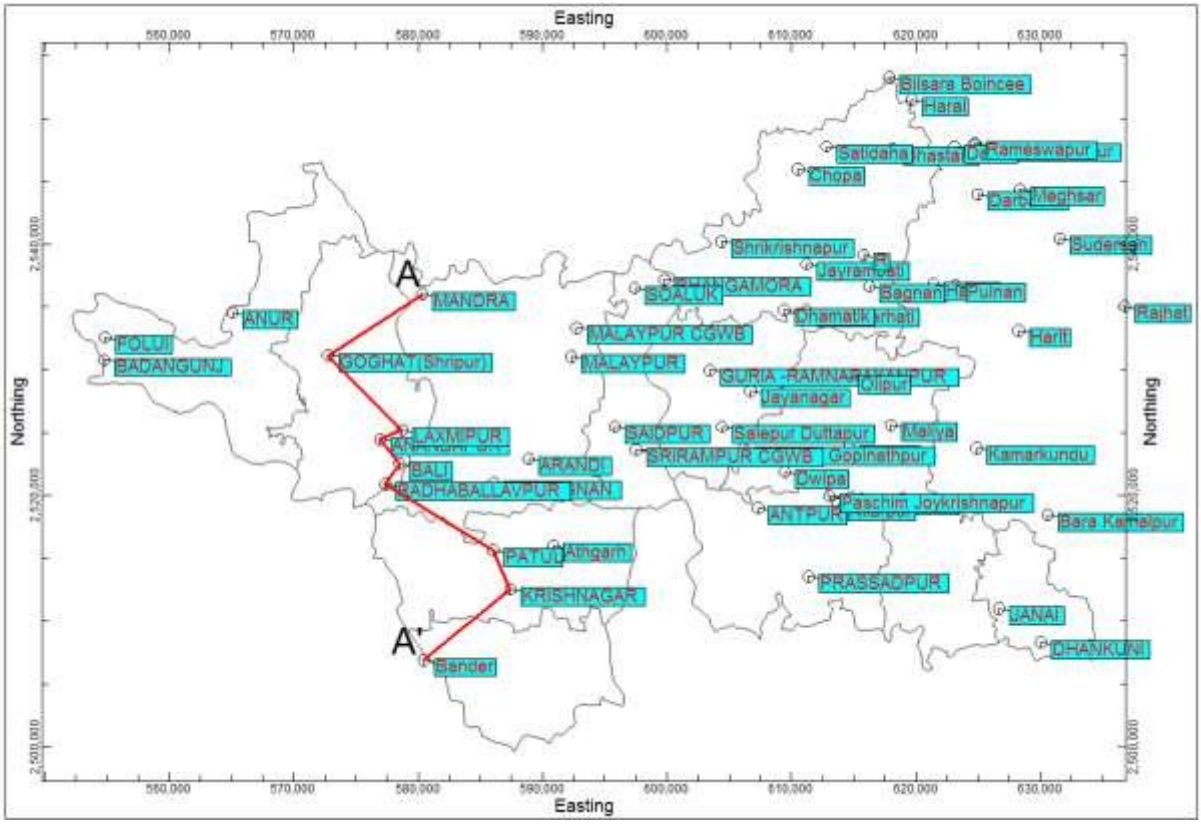


Figure 4.9 Index line of N-S Cross section (western part of area) - Mandra to Bander, Hugli Dist. (pt.)

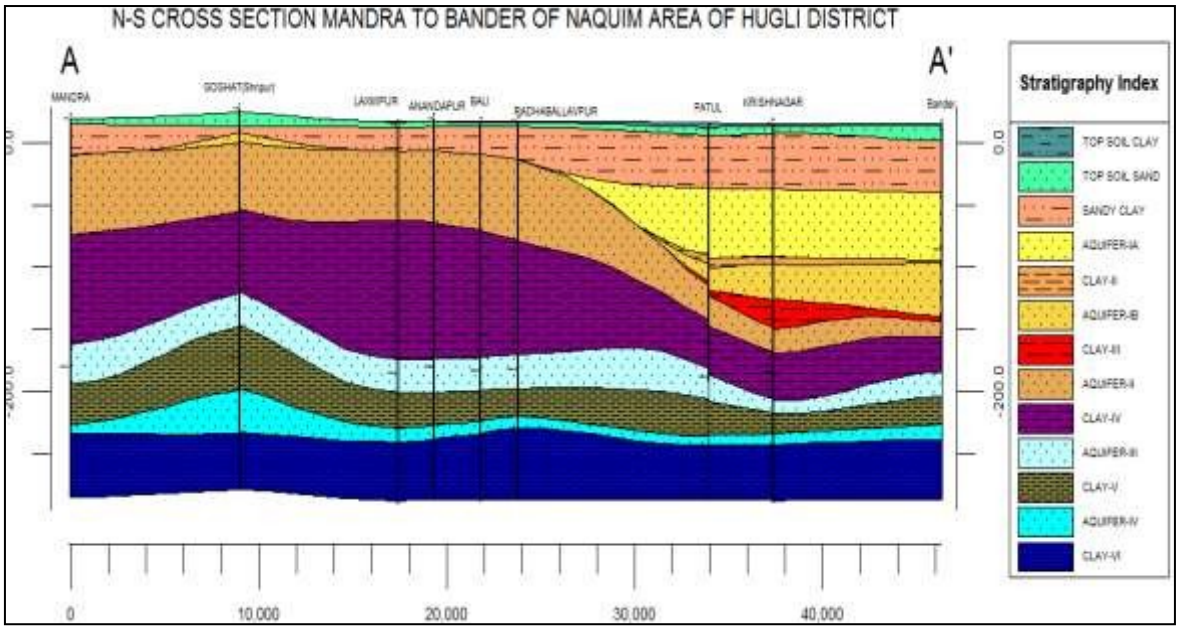


Figure 4.10 Index line of N-S Cross section (western part of area) - Mandra to Bander, Hugli Dist. (pt.)

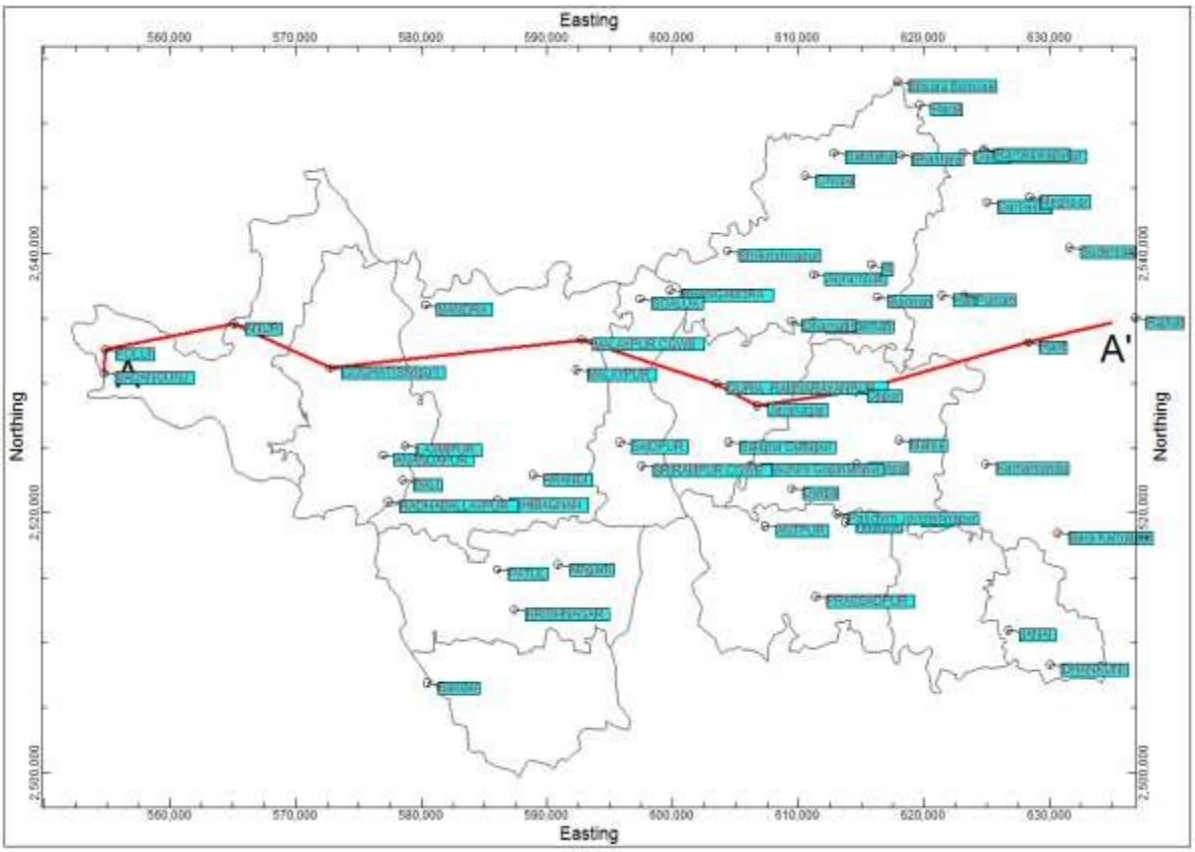


Figure 4.11 Index line of W-E Cross section (northern part of area) – Badanganj to Rajhat, Hugli Dist. (pt.)

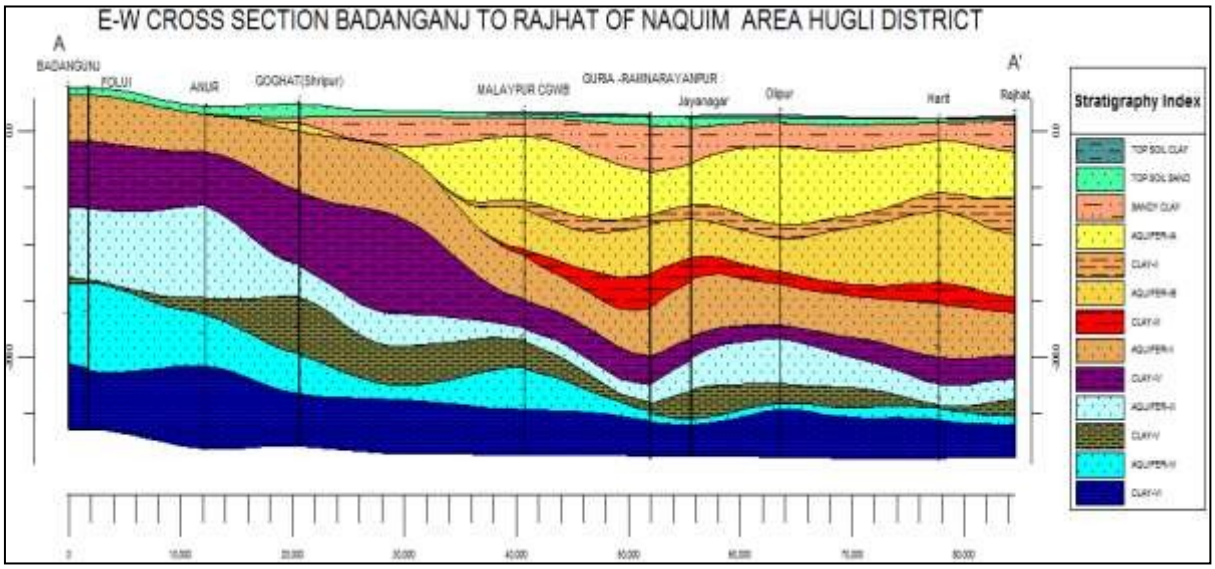


Figure 4.12 W-E Cross section (northern part of area) – Badanganj to Rajhat, Hugli Dist. (pt.)

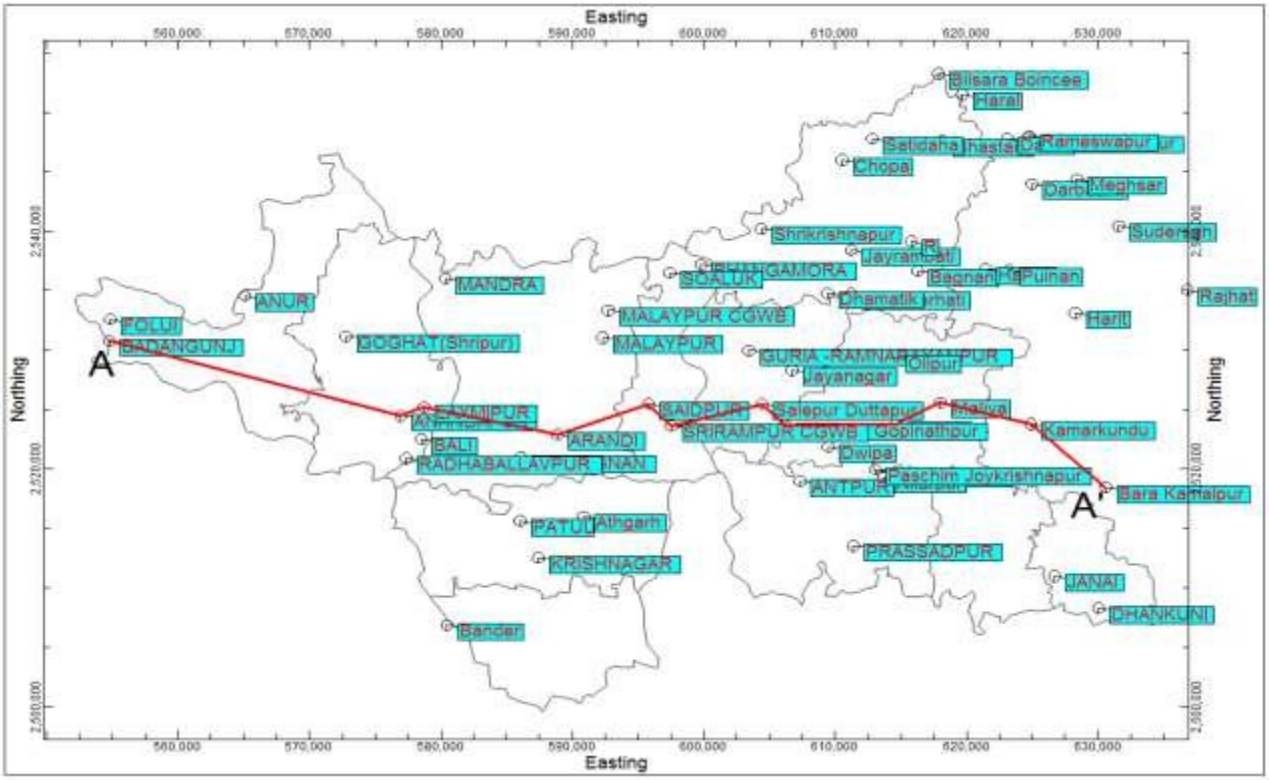


Figure 4.13 Index line of W-E Cross section (southern part of area) – Badanganj to Bara Kamalpur (outside of area), Hugli Dist. (pt.)

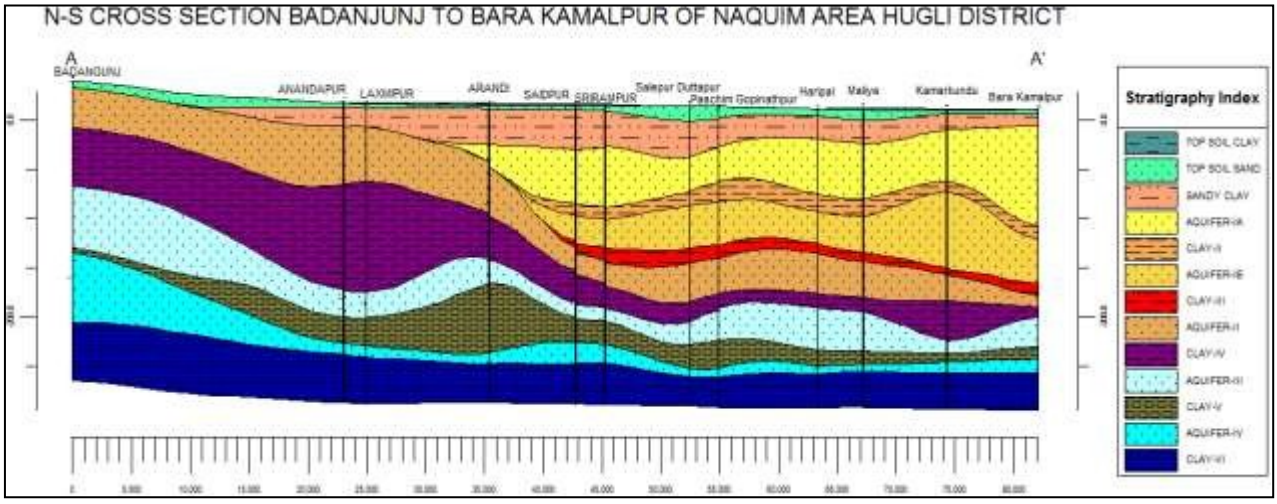


Figure 4.14 Index line of W-E Cross section (southern part of area) – Badanganj to Bara Kamalpur (outside of area), Hugli Dist. (pt.)

5.0 HYDROGEOLOGY

5.1 Water bearing formations:

Aquifer I Group ranges from 5m to 143.5 m and mainly overlain by 0-5 m thick sandy clay layer and in some places by sticky clay. It is fine grained mainly yellow in colour. This Aquiferis not found in the western part of the area; instead, Aquifer-II Group is exposed below the sandy clay layer. Towards western part, 1st aquifer is not found because of its location in the marginal part of Bengal Basin. According to PHED report, ground water in Aquifer- I, arsenic contamination more than 0.01mg/l has been encountered sporadically at places

Aquifer II Group is subdivided into two sub aquifers Aquifer- IB and Aquifer-II. Range of IB-Aquifer is 26 m to 169 m and Aquifer- II is 84 m to 251 m. Total range of Aquifer II Group is 26 m to 251m. Iron concentration is very high in this aquifer. Towards western Part of the study area, Aquifer I and Aquifer II get merged, but due to their hydrogeological properties they are identified as two different aquifers. Quality wise 2nd aquifer is potable for drinking purpose. Thickness of 2nd aquifer is more in Arambagh, Goghat-I and Goghat-II block.

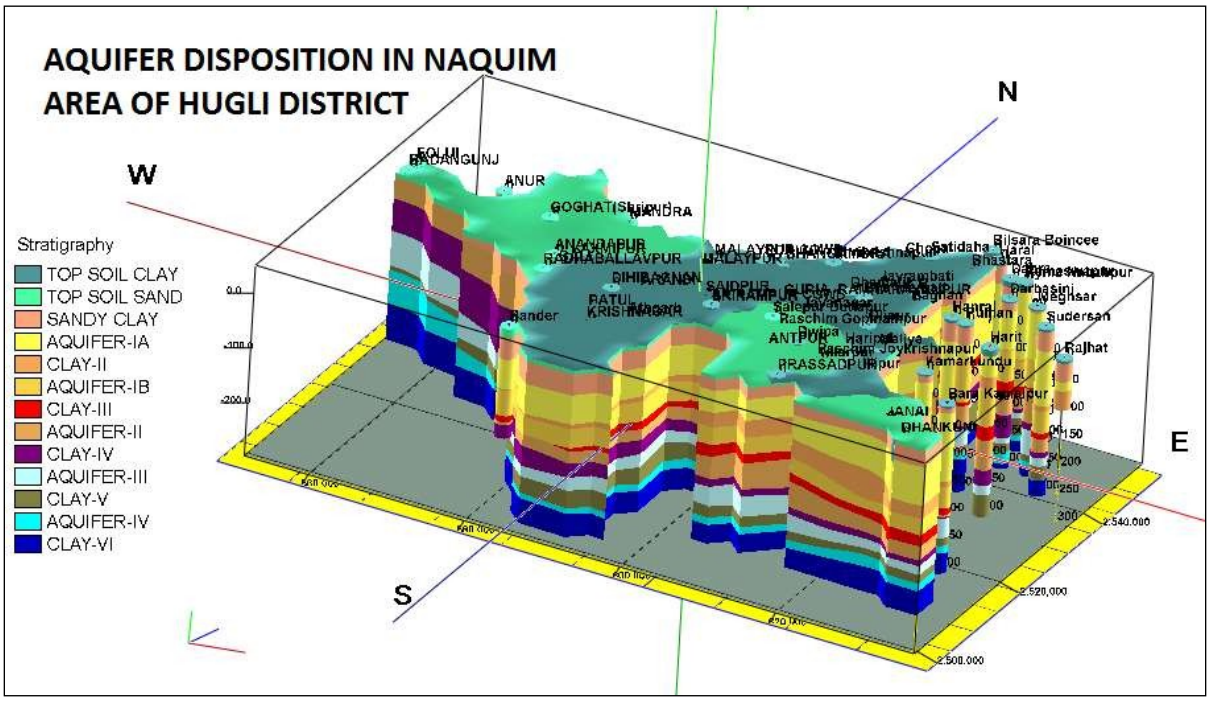


Figure 5.1 Occurrence of aquifers in Parts of Hugli district

Aquifer III is subdivided into two sub aquifers-Aquifer-III and Aquifer-IV. Overall range of 3rd aquifer is 164m to 295m.Range of Aquifer-III is 164.58m to 293m and Aquifer-IV is 230m to 295 m. Based on exploratory wells data through outsourcing activities it was found that

discharge of 3rd is very less as comparison to 1st and 2nd Aquifer. This aquifer is less productive in Western side and high productive in Eastern Side. It is separated from 2nd Aquifer by thick grey sticky clay. 3rd aquifer is divided is intercalated by multiple clay layers, so it is less productive in nature. Quality wise 3rd aquifer is good, so it is portable for drinking purpose. Some wells are drilled by CGWB in Goghat-I & II block having portable water and can be used for surplus supply for drinking purpose in that part of the block. But in other part of the area discharge of 3rd aquifer is not high. The dispositions of aquifers in Hugli district have been shown in Figure 4.4.

5.2 Aquifer wise groundwater regime, depth to water level:

A total of 86 key wells have been established in the study area for aquifer wise water level monitoring and sampling. These are mostly tube wells, submersibles, piezometers and some are dug wells (mainly in Tarkeswar). Out of these, 40 wells represent shallow Aquifer I and the depth range of these wells varies from 1.21 -97.54 mbgl, 38 wells represent Aquifer II, with depth range within 24.32 – 199 mbgl and 8 wells in deeper fresh water within Aquifer III,with depth range wells varying from 112.78 -365.76 mbgl.

5.2.1 First Aquifer Group (Aquifer IA)

The shallow first aquifer is underlain by thick clay layer, especially in the east. But in the west in Arambagh, Goghat-I and Goghat-II blocks, Aquifer IA is not encountered; in Figure 5.1, this aquifer truncating against Older Alluvium has been shown . Towards east, Aquifer-IA is overlain by sandy clay layer layer which acts as an aquitard. The results of pumping test conducted in Goghat-II block, confirms that Aquifer II is exposed in Western part of the area, and Aquifer I is not found. Both Aquifers I & II, combine towards west and appears to be single aquifer system but due to their different hydrogeological properties and chemical properties both are considered as separate aquifers, and maps of water level, watertable and subsurface geology are prepared separately.

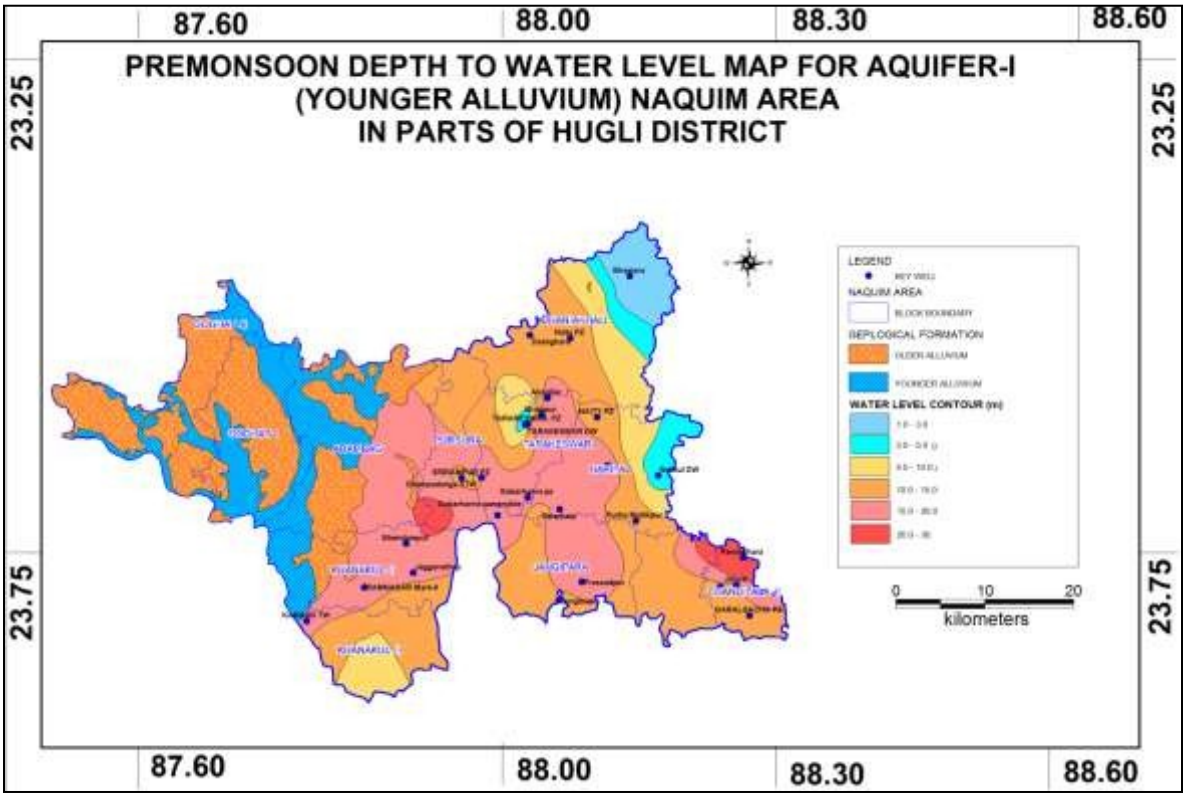


Figure 5.2 Pre-monsoon depth to water level map, Aquifer-I in parts of Hugli District

The pre monsoon depth to water level in Aquifer I in study area is represented in Figure 5.1, showing depth to water level ranging from 1mbgl to 30 mbgl. The depth to water level in east of block Chanditala-II, southern part of Pursura block is maximum within 20- 30 mbgl, which may be due to heavy withdrawal of ground water for irrigation, or domestic usage for huge population inhabiting the area. The minimum depth to water level ranging from 1.0- 3.00 mbgl has been encountered in the northern part of Dhaniyakhali block. In major part of the study area the depth to water level ranges from 10 – 15 mbgl. In Figure 5.2, post monsoon depth to water level (DTW) map of first aquifer has been depicted; overall DTW ranges from 0.0 – 12 mbgl. DTW is maximum in northern part of Dhaniyakhali block, southern parts of Jangipara and Chanditala-II blocks and it ranges from 10 -12 mbgl in average and with lowest range being from 0 to 3 mbgl in northern part of Tarkeswar block, eastern part of Haripal block. Block wise Average Pre and Post monsoon depth to water level range of Aquifer-I in parts of Hugli District is given in Table 5.1

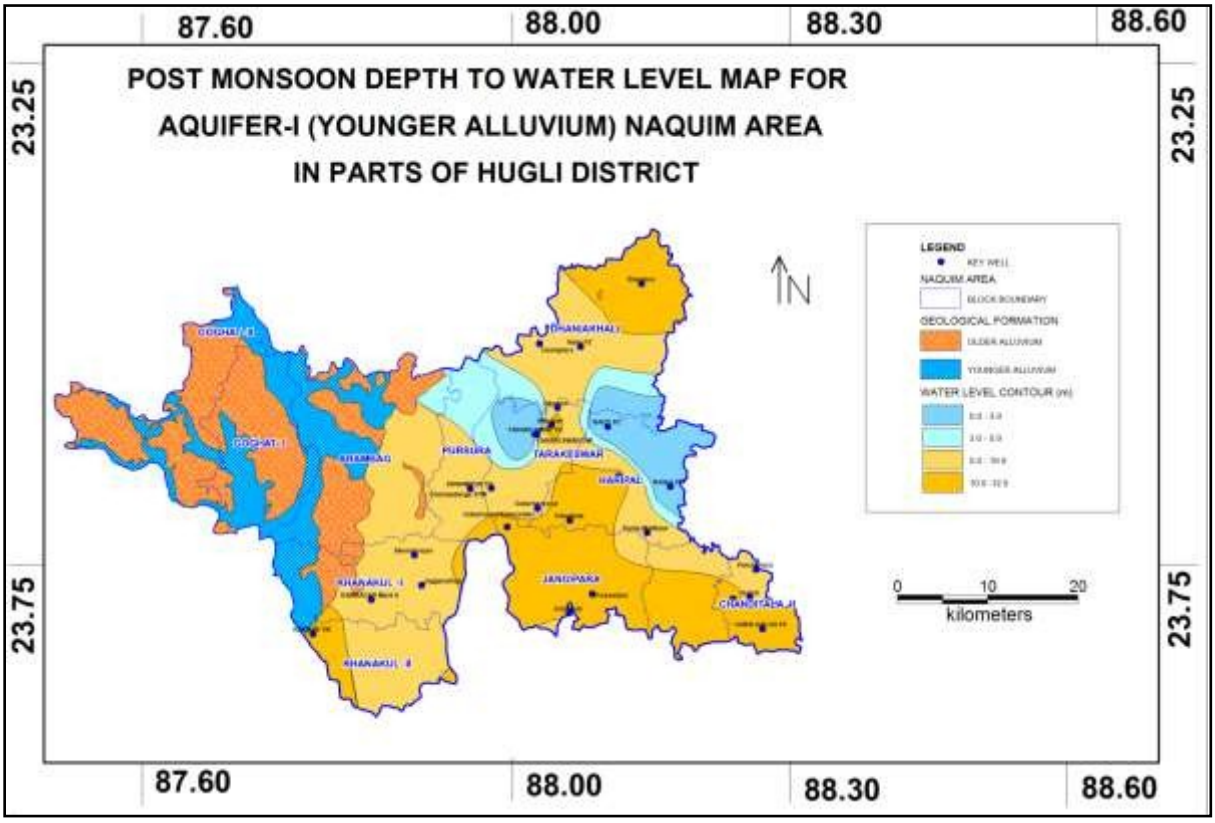


Figure 5.3 Post monsoon depth to water level, Aquifer-I in parts of Hugli District

Table 5.1. Block wise Average Pre and Post monsoon depth to water level range of Aquifer-I in parts of Hugli District

Aquifer Type	Block	Pre Monsoon water Level Range		Post Monsoon water Level Range	
		Minimum	**Maximum**	**Minimum**	**Maximum**
Aquifer-I	CHANDITALA -II	14.44	14.9	6.44	11.54
Aquifer-I	DHANIAKHALI	1.7	13.11	7.16	11.16
Aquifer-I	HARIPAL	3.81	16.9	1.06	11.69
Aquifer-I	JANGIPARA	13.75	17.47	8.99	10.84
Aquifer-I	KHANAKUL -I	15.29	16.86	7.92	8.81
Aquifer-I	KHANAKUL -II	9.32	15.98	9.7	10.1
Aquifer-I	PURSURA	14.49	21.85	7.5	9.8
Aquifer-I	TARAKESWAR	3.46	18.62	0.83	9.55

5.2.2 Second Aquifer (Aquifer II)

The deeper Aquifer II ranges from 26 mbgl to 251 mbgl having varied depth and thickness throughout study area. This aquifer is fresh water bearing except high Iron contentin Goghat-I block. Towards east in Dhaniyakhali, Haripal and Chanditala-II Blocks, clay layerin it thickens to the tune of about 30-35 m and separates Aquifer II in to two sub aquifers.

The pre monsoon depth to water level map (Figure 5.4)for Aquifer II shows a wide range varying from 7.0 -22.0 mbgl. Ground water trough has been developed in a huge area in Goghat-II block, and a smaller trough has developed in Aramabgh block too. Maximum depth of water level is about 20 to 22 mbgl. This is also due to heavy pumping in these areas. The depth range of water level varies between 15 to 20 mbgl in the rest part of study area. Block wise average Pre and Post monsoon depth to water level range in Aquifer-II in parts of Hugli District is given in Table 5.2

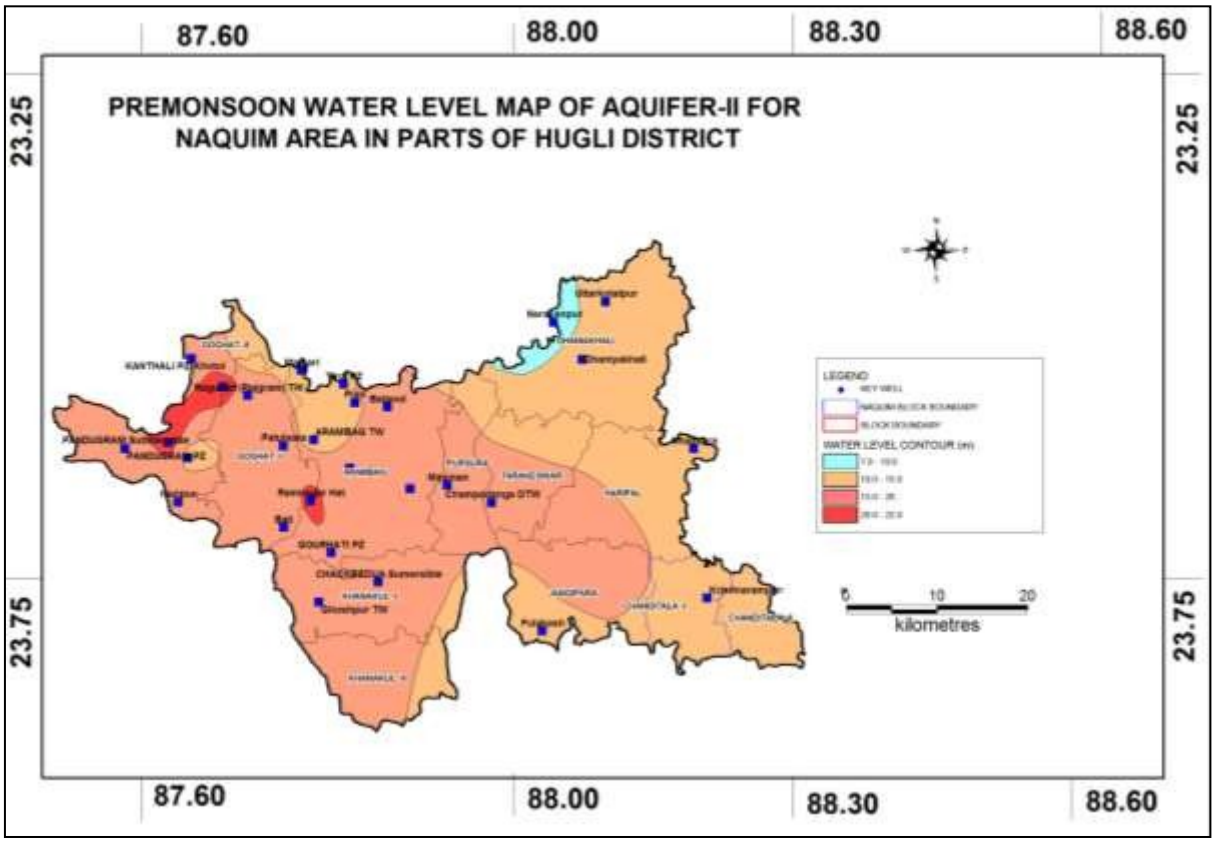


Figure 5.4 Pre monsoon Depth to water level, Aquifer-II

The post monsoon depth to water level map of Aquifer II has been shown in Figure 5.5 DTW ranges within 5.0 – 19.0 mbgl. DTW is very deep, within 15 – 19 m, in western part of Goghat-

I and Goghat-II blocks. In almost entire Dhaniyakhali, Haripal, Jangipara and Chanditala-II blocks of Hugli district, it ranges from 6 to 10 mbgl.

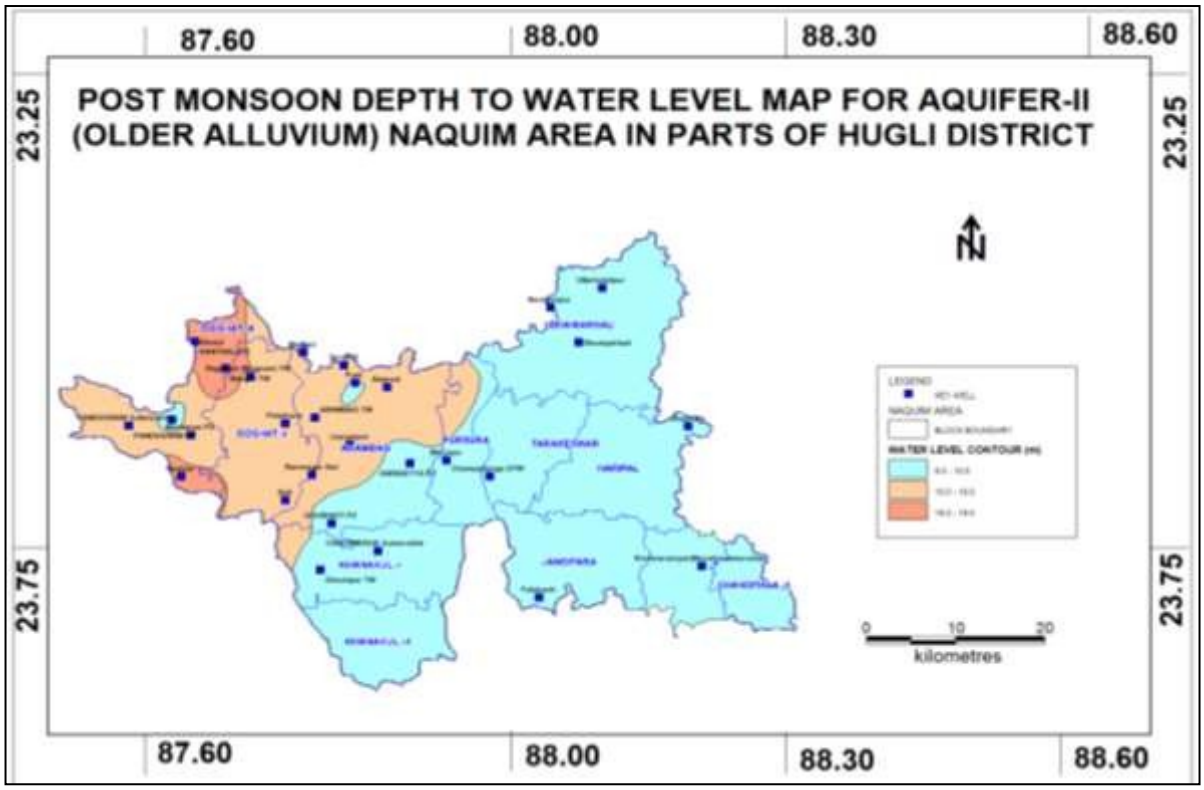


Figure 5.5 Post monsoon Depth to water level, Aquifer II

Table 5.2. Block wise Average Pre and Post monsoon depth to water level, Aquifer-II

Aquifer Type	Block	Pre Monsoon water level		Post Monsoon Water level	
		Minimum	**Maximum**	**Minimum**	**Maximum**
Aquifer-II	ARAMBAG	13.2	19.65	9.03	14.75
Aquifer-II	CHANDITALA -II	14.54	15.48	8.26	10.2
Aquifer-II	DHANIAKHALI	7.18	13.14	7.36	8.36
Aquifer-II	GOGHAT -I	16.73	20.6	12	14.75
Aquifer-II	GOGHAT -II	11.43	21.54	8.82	19.17
Aquifer-II	HARIPAL	13.84	14.23	5.9	6.44
Aquifer-II	JANGIPARA	11.43	16.34	10.3	10.98
Aquifer-II	KHANAKUL -I	16.92	18.11	7.8	9.1
Aquifer-II	KHANAKUL -II	16.92	18.11	7.8	9.1
Aquifer-II	PURSURA	16.1	18.08	9.65	11.2
Aquifer-II	TARAKESWAR	16.22	16.33	8.16	10.3

5.2.3 Third Aquifer (Aquifer III)

DTW in Aquifer III, is not available due to lack of deeper wells in all blocks. So, DTW maps could not be prepared. However, block wise average Pre and Post monsoon DTW in Aquifer III in parts of Hugli District is given in Table 5.3**.** Minimum Pre-monsoon DTW is 7.75 mbgl (Dhaniyakhali Block) and maximum pre-monsoon water level is 24 mbgl (Jangipara Block). Minimum Post-monsoon water level range is 8.04 mbgl (Dhaniyakhali Block) and maximum pre-monsoon water level is 19.65 mbgl (Goghat-II Block).

Table 5.3 Block wise average Pre and Post monsoon depth to water level, Aquifer-III

Block	Pre Monsoon water level		Post Monsoon water level	
	Minimum	**Maximum**	**Minimum**	**Maximum**
DHANIAKHALI	7.75	15	8.04	15.4
JANGIPARA	14.4	24	-	-
CHANDITALA-I	8.3	14.5	14.06	17.6
GOGHAT -I	8.25	19.21	14.2	19
GOGHAT -II	21.3	19.65	12.59	19.65
Haripal	8.3	13.52	13.9	18.85
Pursurah	9.4	11.4	13.55	14.17
TARAKESWAR	8.9	10.6	11.67	13.2
KHANAKUL	8.5	11.8	12.6	14.2

5.3 Water Level Fluctuation:

Water level fluctuation (pre-monsoon minus post monsoon) map for Aquifer-II is prepared and shown in Figure 5.6. This map is prepared with the interpolation of point values data. In Jangipara, Arambagh, Goghat-II and Khanakul-II block water level fluctuation is very high in the range of 9.0 to 12.0 m. Overall fluctuation of the area is in the range of 6.0 m to 9.0 m. In parts, fluctuation is negative, i.e., pre-monsoon water level is shallow as compared to that of post monsoon, e.g. In Goghat-II Block. In Table-5.3, block wise average fluctuation has been given. In Dhaniyakhali block water level fluctuation is minimum of 3.1 m and maximum fluctuation of 12.5 m is encountered in Jangipara block.

Table 5.4 Block wise average water level fluctuation in parts of Hugli district

Aquifer Type	Block name	Average fluctuation of block
Aquifer-II	ARAMBAG	6.2
Aquifer-II	CHANDITALA -II	6.28
Aquifer-II	DHANIAKHALI	3.1
Aquifer-II	GOGHAT -I	5.2
Aquifer-II	GOGHAT -II	5.9
Aquifer-II	HARIPAL	7.4
Aquifer-II	JANGIPARA	12.5
Aquifer-II	KHANAKUL -I	9.1
Aquifer-II	KHANAKUL -II	9.1
Aquifer-II	PURSURA	12.3
Aquifer-II	TARAKESWAR	12.2

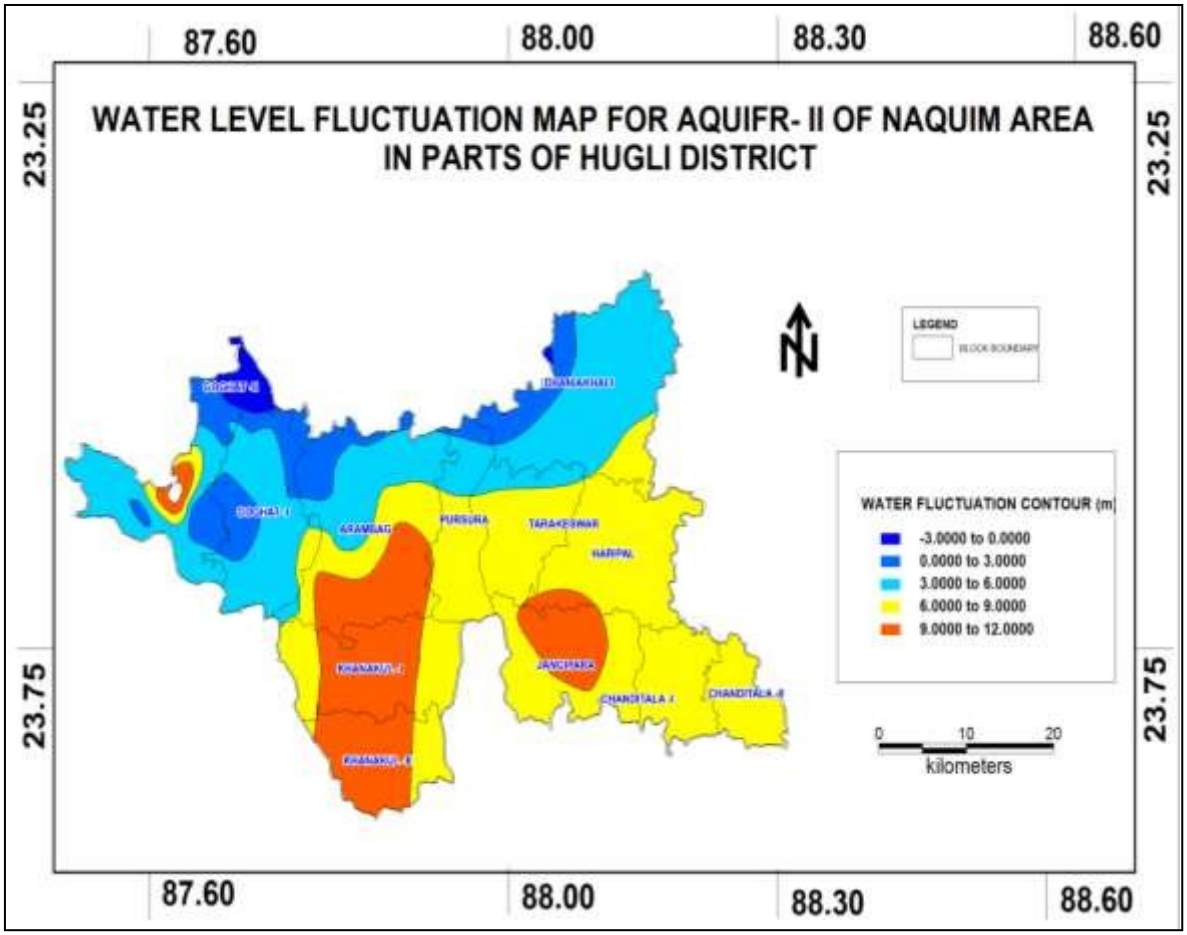


Figure 5.6 Water level fluctuation, Aquifer-II in parts of Hugli District

5.4 Occurrence, movement, and distribution of ground water:

First Aquifer Group is subdivided by thick clay layer in the east of study area and in the west in Arambagh ,Goghat-I and Goghat-II blocks, Aquifer IA is not deposited. In the east, Aquifer-IA is overlain by sandy clay layer, which acts as an aquitard.

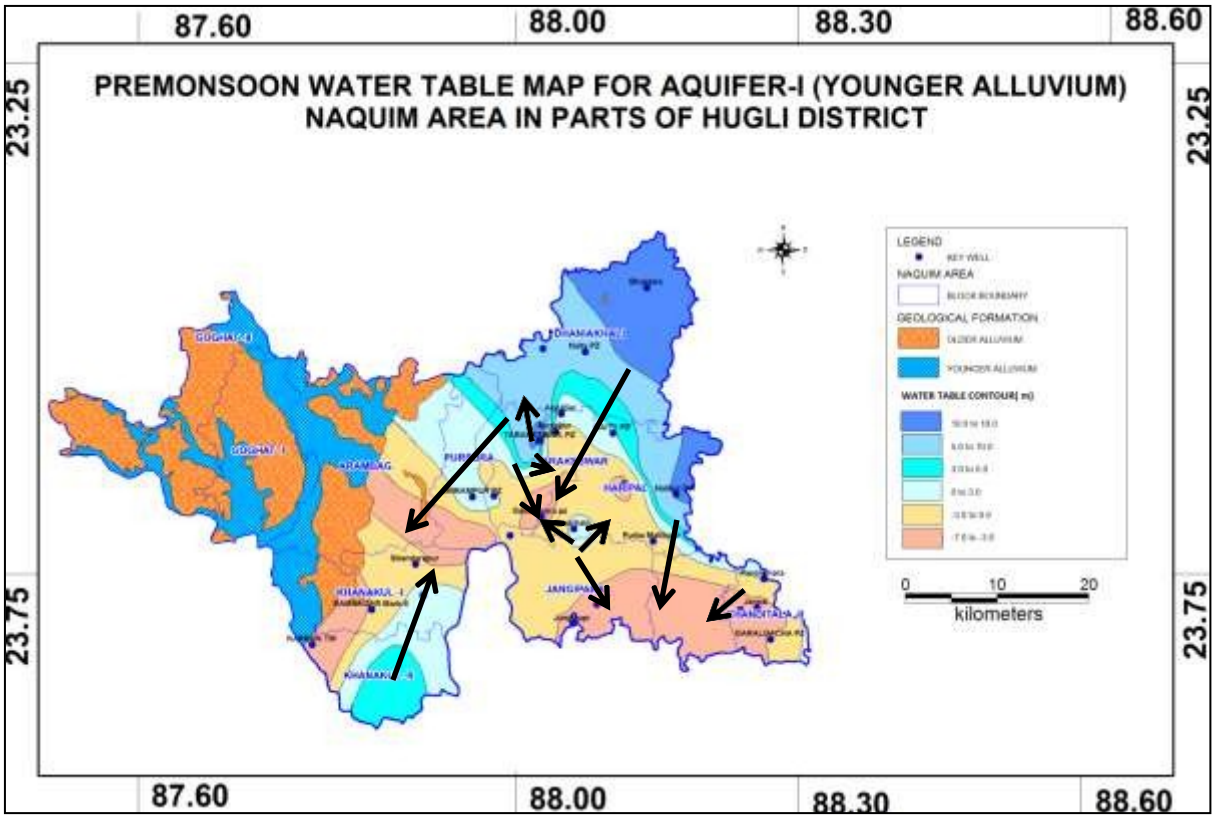


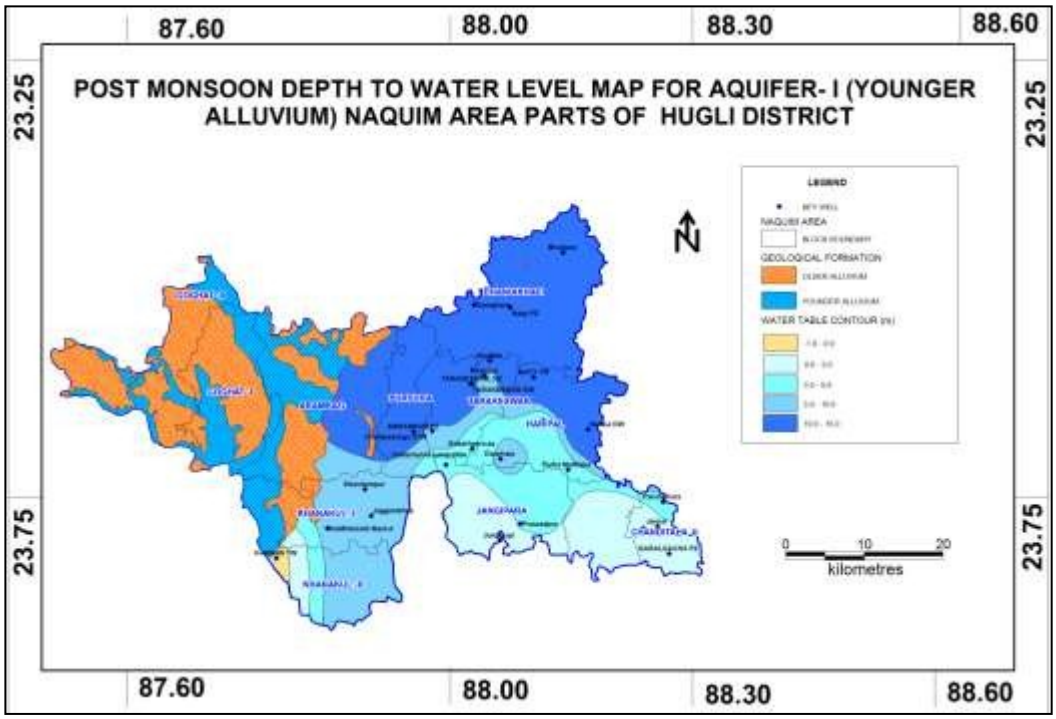
Figure 5.7 Pre monsoon Water Table Contour Map of Aquifer-I

Pre monsoon Water Table Contour Map is shown in Figure 5.7 water table contour ranges from (-) 7 m to 18.0 m (w.r.t msl). Water table is sloping towards south. In some places, troughs have been formed locally due to anthropogenic activities. A depression in water table has been formed adjacent to Pursura and Khanakul-II blocks, because of high draft in this populated zone. A smaller trough has been formed in the SW of Haripal block and W of Chanditala- II blocks due to heavy draft. Water table contour in the N of Tarkeswar block and Southern part of Haripal block is forming a dome structure, indicating recharge areas.

The hydrogeological map shown in Figure 5.8, represents post monsoon water table map of the shallow aquifer. The water table contour ranges from (-) 1m to 15.0 m (w.r.t msl). Again, the general water table flow is towards southern direction. But in some places, troughshave been formed locally due to anthropogenic activities, e.g., small troughs have been formed in the SW of Haripal block and in Dhaniyakhali and Haripal blocks. Another smaller

trough is formed in southern part of the Jangipara block. Pre-Monsoon Water Table Map of the Aquifer II has been shown in Figure 5.9

Figure 5.8 Post monsoon Water Table Contour Map for Aquifer-I



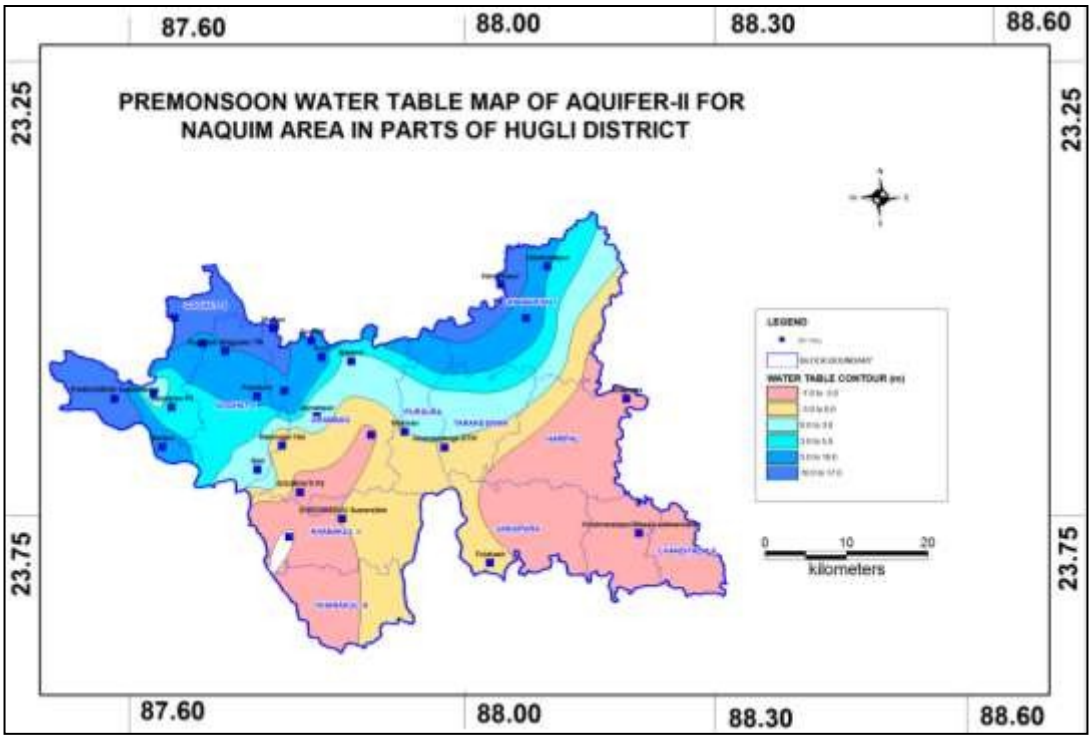


Figure 5.9 Pre monsoon Water Table Contour Map, Aquifer- II

The water table contour ranges from -7 m to 17.0 m (w.r.t msl). The general water table flow is towards south to southeast. At some places due to over pumping, flow direction has changed to southwest near Khanakul-I & Khaankul-II Blocks.

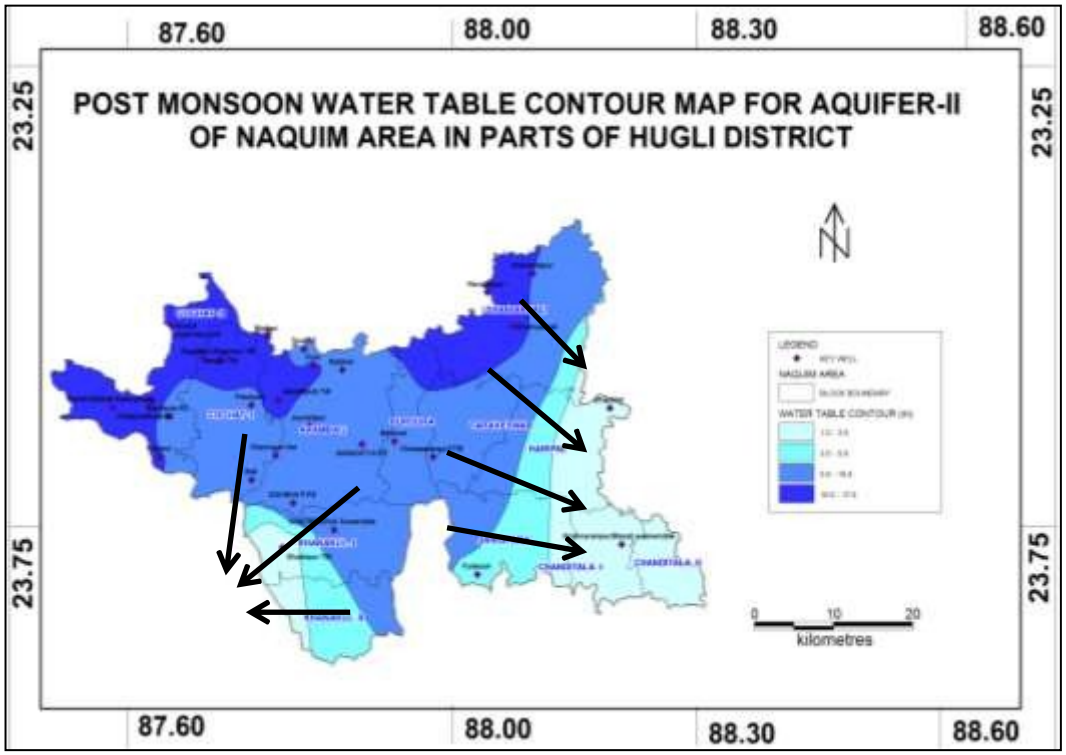


Figure 5.10 Post monsoon Water Table Contour Map, Aquifer-II

Post Monsoon Water Table map of Aquifer II has been shown in Figure 5.10. The water table contour ranges from 1 m to 16.0 m (w.r.t msl). The general water table flow varies from south to southeast.

5.5 Pre-monsoon & Post-monsoon long term trend in shallow aquifer, Aquifer I:

The long-term trend analysis for last 10 years (from 2008 - 2017) of National Hydrograph Network Station (NHNS) monitoring data have been taken for trend analysis. In Arambagh, Gogaht-I and Goghat-II, Aquifer I is not encountered; so, in these blocks Aquifer-II trend data is given.

The long-term trend analysis for last 10 years (from 2008-2017) of NHNS monitoring data, reveals an overall falling trend in maximum blocks of study area during pre-monsoon expect Haripal, Pursura and Tarkeswar blocks. Haripal block block shows the lowest rising trend in pre monsoon which is to the tune of 13.20 cm/yr and Tarkeswar block shows the highest rising trend to the tune of 20.62 cm/yr. Dhaniyakhali block block shows the

lowest falling trend to the tune of 27.31 cm/yr in pre monsoon and Arambagh block shows the highest falling trend to the tune of 33.69 cm/yr.

During Post-monsoon, excepting Haripal and Khanakul-II blocks, other blocks are showing falling trend. Haripal block block shows the lowest rising trend to the tune of 16.86 cm/yr in pre monsoon and Khanakul-II block shows highest rising trend to the tune of 18.16 cm/yr. Tarkeswar block shows the lowest falling trend in the tune of 26.45 cm/yr in pre monsoon and Goghat-I block shows the highest falling trend to the tune of 65.32 cm/yr. In Goghat I, Goghat II and Arambag, Aquifer-II is encountered. The block wise details of average water level trend during pre and post monsoon for Aquifer- I & II is given in Table-5.5

Table 5.5 Block wise details of Average pre and Post-monsoon long term water level trends (2008 to 2017) in Aquifer I & II Aquifer Wise Pre-monsoon

Block Name	Aquifer Type	water level trend (Yes/No) ('Yes ' denotes falling and 'No' denotes rising)			
		Trend (cm/year)	**Pre-monsoon**	**Trend (cm/year)**	**Post-monsoon**
CHANDITALA-II	Aquifer-I	28.27	Yes	29.10	Yes
DHANIAKHALI	Aquifer-I	27.31	Yes	29.27	Yes
HARIPAL	Aquifer-I	**13.20**	**No**	**16.86**	**No**
JANGIPARA	Aquifer-I	28.55	Yes	26.65	Yes
KHANAKUL-I	Aquifer-I	30.45	Yes	31.36	Yes
KHANAKUL-II	Aquifer-I	29.38	Yes	**18.16**	**No**
PURSHURA	Aquifer-I	**20.12**	**No**	27.52	Yes
TARAKESWAR	Aquifer-I	**20.62**	**No**	26.45	Yes
ARAMBAG	Aquifer-II	33.69	Yes	39.75	Yes
GOGHAT-I	Aquifer-II	32.88	Yes	65.32	Yes
GOGHAT-II	Aquifer-II	26.44	Yes	30.59	Yes

5.6 Aquifers with yield prospects-

From the In-house and outsourcing exploration of CGWB and other State-owned tube wells data , three Aquifer Groups have been delineated down to a depth of 301 mbgl in the

area under study. The Aquifer I exists within depth of 143.5 mbgl with yield potential to the tune of 6.29 m3/hr to 50.61 m3/hr; Transmissivity of the Aquifer I varies from 560 -1688.33 (CGWB pump test data) m^2/day. Aquifer II exists in the depth span of 26 - 251 mbgl, with yield potential to the tune of 52.04 m3/hr to 182.19 m3/hr; Transmissivity varies from 575.99 – 4768.59 m2/day. Aquifer III has been encountered at a depth of 164 - 295 mbgl with yield potential to the tune of 11.6 m3/hr to 73.8 m3/hr; Transmissivity of the third aquifer system varies from 205 -907.3 m2/day. Aquifer wise parameters in the study area aregiven in the following Table-5.6.

Table 5.6 Aquifer-wise depth, Discharge, Transmissivity, Storability and Specific Capacity in parts of Hugli Districts

Name of Block	1st Aquifer					2nd Aquifer							3rd Aquifer				
	Depth Range (mbgl)	**Discharge (m^3/hr) with DD**	**T (m^2/day)**	**S**	**Specific capacity m^3/day per m)**	**Sub Aquifer**	**Depth Range (mbgl)**	**Discharge (m^3/hr) with DD**	**T (m^2/day)**	**S**	**Specific capacity m^3/day per m)**	**Sub Aquifer**	**Depth Range (mbgl)**	**Discharge (m^3/hr) with DD**	**T (m^2/day)**	**S**	**Specific capacity (m^3/day per m)**
Dhaniyakhali	IA 5 - 110	22.64 (DD 1.07)	615.05 (J)/ 560.06 (T)	$1.139x10^{-4}$	21.16	IB	26- 169	93.99 (DD- 5.27)	1212.8	$1.20 X 10^{-4}$	24.98	III	185 - 293	45.68 (DD 6.58)	430.5	$9.6 X 10^{-10}$	7.47
						II	125 -224					IV	253.5 - 295				
Haripal	18.28-109.72	6.29 (DD 1.07)	615.05(J)/ 560.06(T)	$1.139x10^{-4}$	21.16	IB	82.29 - 155.4	73.8 (DD 6)	575.99	$1.20 X 10^{-4}$	12.3	III	188.97 - 255	90.4 (DD 6)	430.5	$9.6 X 10^{-10}$	15.06
						II	113 - 201.15					IV	234.68 - 278				
PURSURA	9.14 - 143.5	10.571 (DD 2.30)	1688.33	$4.16 X 10^{-1}$	28.39	IB	108.7 - 167.6	52.04 (DD 4.88)	2358	$3.17 X 10^{-4}$	11.82	III	201.15 - 231.63	50.24 (DD 15.21)	147.86	$5.5 X 10^{-10}$	3.31
						II	152.39 - 204.75					IV	240 - 262.11				
Tarkeswar	29 - 110	47.9 (DD 4.1)	1688.33	$4.16 X 10^{-1}$	11.68	IB	70 - 169	52.04 (DD 4.88)	2358	$3.17 X 10^{-4}$	11.82	III	171 - 283	39.6 (DD 6)	147.86	$5.5 X 10^{-10}$	6.6
						II	84 - 251					IV	260 - 278				
KHANAKUL -I	30 - 112.77	47.9 (DD 4.1)	1688.33	$4.16 X 10^{-1}$	11.68	IB	82 - 146.3	66 (DD- 6)	4768.59	$2.85 X 10^{-3}$	11	III	240 - 242	59.83 (DD- 6)	205	$5.5 X 10^{-10}$	9.972
						II	137 - 210.3										
KHANAKUL -II	56 - 110	47.9 (DD 4.1)	615.05(J)/560.06(T)	$1.139x10^{-4}$	11.68	IB	112 - 159	66 (DD- 6)	4768.59	$2.85 X 10^{-3}$	11	III	240 - 242	22.71 (DD 8.39)	907.3435	$3.13 X 10^{-7}$	3.2
						II	170 - 175										

JANGIPARA	15 - 80	30.6 (DD-1.52)	615.05(J)/ 560.06(T)	$1.139x10^{-4}$	20.13	IB	78.28 - 135	52.04 (DD 4.88)	2358	$3.17 X 10^{-4}$	11.82	III	164.58 - 255	22.71 (DD 8.39)	907.3435	$3.13 X 10^{-7}$	3.2
						II	131.06 - 206					IV	252.36 - 280				
CHANDITALA -II	12.18 - 114.3	50.61 (DD 2.69)	615.05(J)/ 560.06(T)	$1.139x10^{-4}$	18.75	IB	130 - 159	182.19 (DD 2.69)	575.99	$1.20 X 10^{-4}$	67.5	III	205 - 229	22.71 (DD 8.39)	907.3435	$3.13 X 10^{-7}$	3.2
						II	168- 208					IV	230 - 259				
Arambagh						II	19.5 - 91.43	137.79 (DD- 4.62)	4768.59	$2.85 X 10^{-3}$	29.85	III	140 - 220	59.83 (DD- 6)	205	$5.5 X 10^{-10}$	9.972
Goghat-I						II	9.14 - 126	59.52 (DD- 6)	4768.59	$2.85 X 10^{-3}$	19.2	III	135 - 237.25	23.4 (DD- 6.13)	205	$5.5 X 10^{-10}$	3.87
												IV	220.68 - 275				
Goghat-II						II	3.04 - 48.76	59.52 (DD- 6)	4768.59	2.85 X 10-3	19.2	III	100 - 165	23.4 (DD- 6.13)	205		3.87
												IV	176.78 - 301.73				

6.0 GROUND WATER RESOURCES

6.1 Aquifer I

Dynamic Ground water resources of the area under study have been estimated on the basis of GEC (1997) methodology by CGWB and State Water Investigation Department (SWID) for the year as on 31.03.2017. The block wise computed data of dynamic ground water resources is given in Table 6.1.

On the basis of ground water resource estimation (2017) and water level trend, out of 11 blocks of study area 6 blocks, e.g. Haripal, Khanakul I, Khanakul II, Tarakeshwar and Chanditala II, have been categorized as safe blocks, 2 blocks, e.g. Jangipara and Goghat I, have been categorized as Semi critical, and 3 blocks, e.g. Dhaniakhali, Arambag and Goghat II, are categorized as Critical blocks. The Category of blocks with quality problems is shown in Figure 6.1

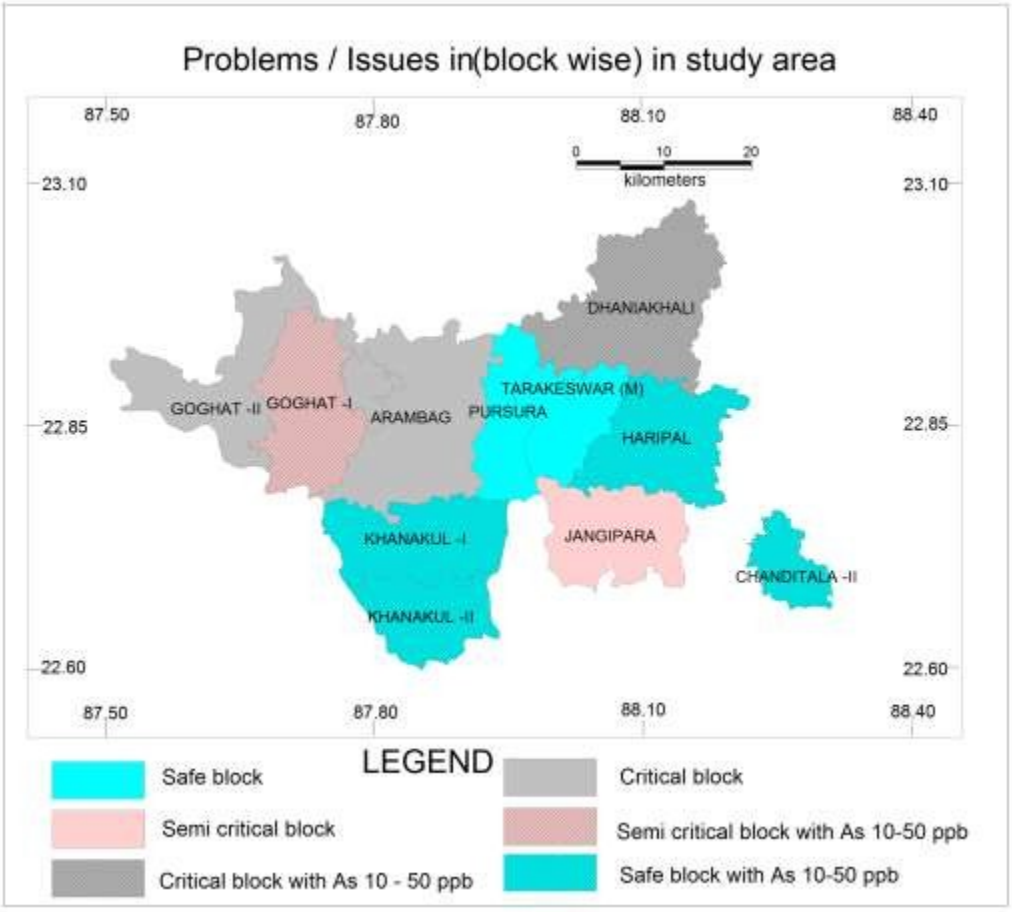


Figure 6.1 Categorization of blocks with quality problems in parts of Hugli Districts

Table 6.1 Block wise dynamic ground water resources, as par 31st March 2017 in Ham

Block Name	Annual Extractable Ground Water Availability	Existing Gross Ground Water Draft for All uses i	Stage of Ground Water Development in %	water level trend (Yes/No ('+' denotes falling and '-' denotes rising)				Category	Net Ground Water Availability for future use
				Trend in cm/year	**Pre-monsoon**	**Trend in cm/year**	**Post-monsoon**		
ARAMBAG	9586.13	9338.74	97.58	28.03	Yes	37.28	Yes	Critical	99.89
CHANDITALA-II	1676.44	1058.77	63.16	-	No	31	Yes	Safe	515.02
DHANIAKHALI	6774.28	6367.66	94	-	No	26.41	Yes	Critical	275.88
GOGHAT-I	5316.88	4362.59	82.05	34.12	Yes	60.32	Yes	Semi Critical	886.71
GOGHAT-II	7243.44	6926.80	95.64	27.83	Yes	45.10	Yes	Critical	251.2
HARIPAL	5608.62	3852.71	68.69	-	**No**	-	**No**	Safe	68.69
JANGIPARA	4750.26	3804.82	80.10	28.50	Yes	30.71	Yes	Semi Critical	80.10
KHANAKUL-I	7021.95	4644.76	66.15	27.93	Yes	29.11	Yes	Safe	66.15
KHANAKUL-II	6694.69	1286.82	19.22	-	No	-	**No**	Safe	19.22
PURSHURA	9773.94	4581.02	46.87	-	**No**	25.59	Yes	Safe	5123.16
TARAKESWAR	6754.72	3690.30	54.63	-	**No**	25.67	Yes	Safe	3015.46

Static Ground Water Resources (block wise) for top aquifer (Aquifer – I) has been presented in **Error! Reference source not found.**. Purshura block has maximum static resource of 51.2316 MCM and Goghat-II block has the lowest static resource of 0.1922 MCM. In Figure 6.2 & Figure 6.3, Water table Contour line map of unconfined aquifer during pre-monsoon and post monsoon respectively have been shown.

Table 6.2 In-Storage Ground Water Resources (ham) of unconfined in Hugli District

BLOCK	Area (m^2)	Specific yield	pre-monsoon WL(m)	bottom of first aquifer (m)	Thickness of saturated zone	Resource (m^3)	Static resource (MCM)
HARIPAL	1844200	0.16	3.81	109.72	105.91	31251075.52	31.25
JANGIPARA	1642300	0.16	13.75	80	66.25	17408380	17.41
KHANAKUL -I	1719200	0.16	15.29	112.77	97.48	26814018.56	26.81
KHANAKUL -II	1218300	0.16	9.32	110	100.68	19625351.04	19.63
PURSURA	1004200	0.16	14.49	143.5	129.01	20728294.72	20.73
TARAKESWAR	1238300	0.16	3.46	110	106.54	21108557.12	21.11
CHANDITALA -II	703400	0.16	14.44	114.3	99.86	11238643.84	11.24
DHANIAKHALI	2756800	0.16	1.7	110	108.3	47769830.4	47.77
ARAMBAG	2883500	0.16	13.2	91.43	78.23	36092192.8	36.09
GOGHAT -I	1863200	0.12	16.73	126	109.27	24431023.68	24.43
GOGHA-II	1900300	0.12	11.43	48.76	37.33	8512583.88	8.51

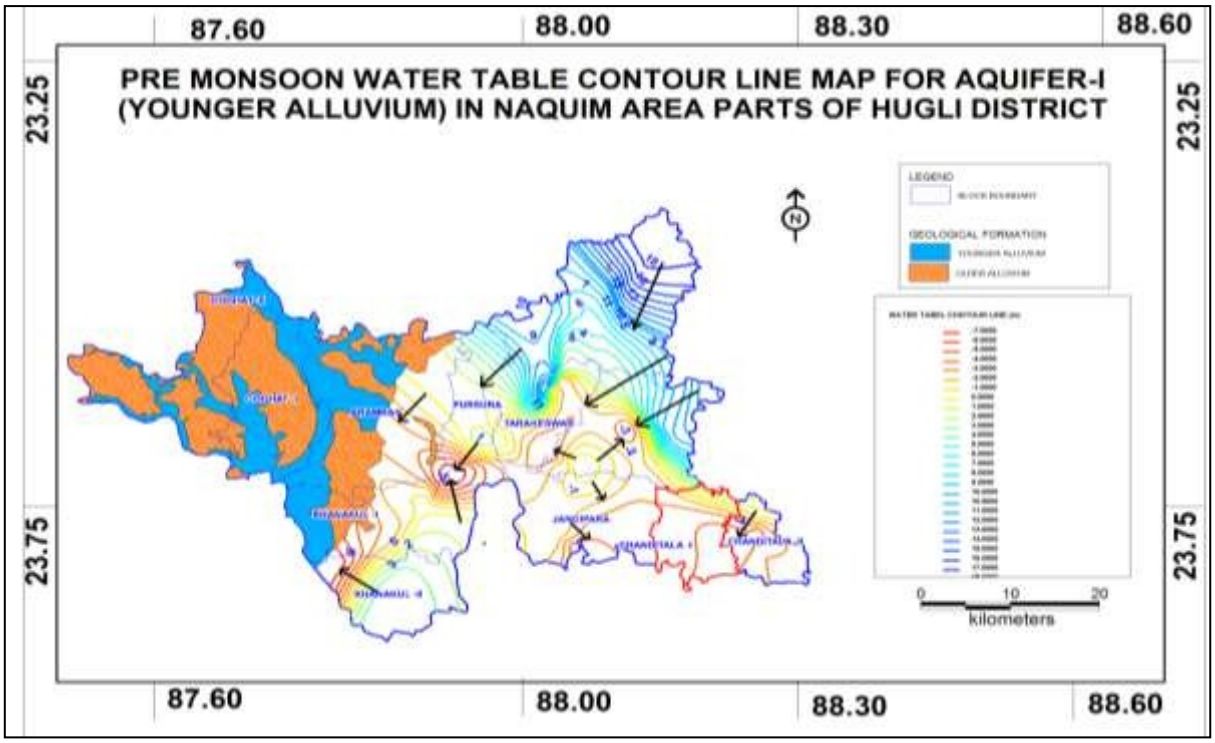


Figure 6.2 Pre monsoon water table contour line map for Aquifer-I

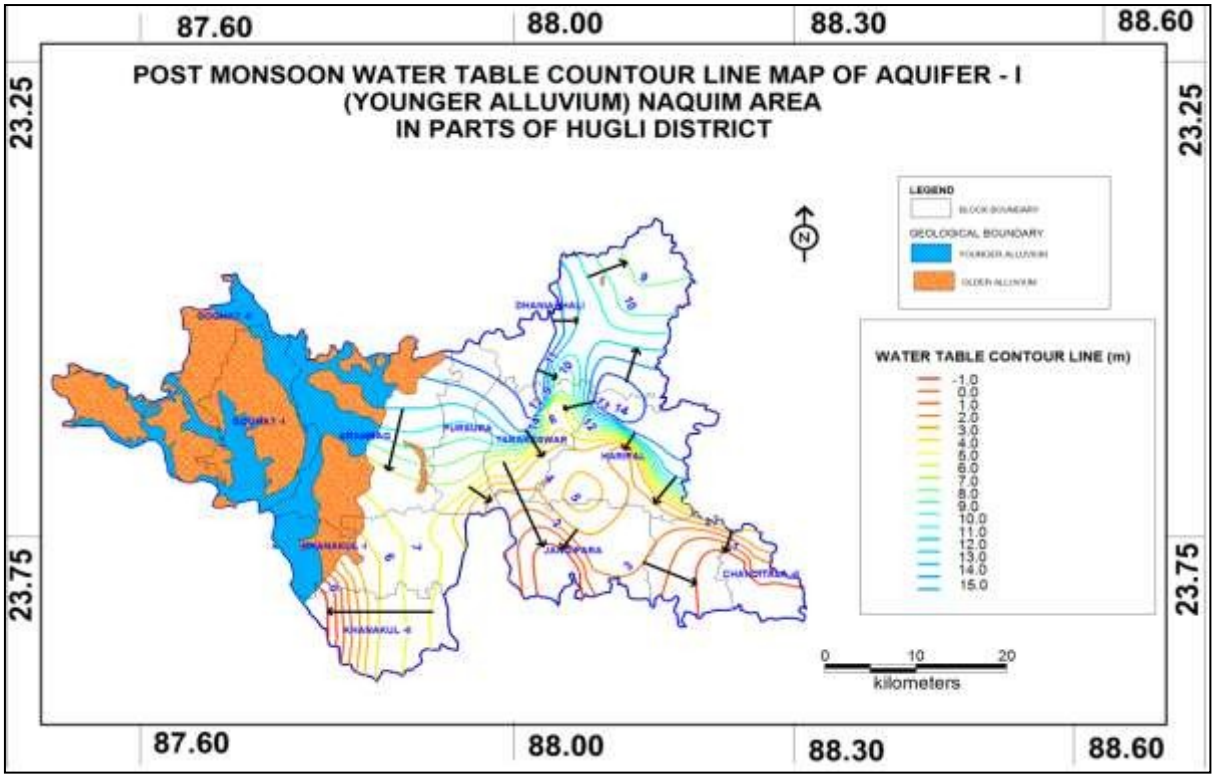


Figure 6.3 Post monsoon water table contour line map for Aquifer – I

6.2 Aquifer-II

Static Ground water resource for confined aquifer-II has been calculated based on water level fluctuation method. Static Ground resource has been shown in Table 6.3. Maximum and minimum dynamic Ground water resources are estimated in Jangipara block and Dhaniyakhali block respectively.

Table 6.3 Calculation of Change in storage in confined aquifer in Study area

Block	Aquifer Type	Area in ha	Fluctuation	Average fluctuation (pre to post)	Average Storability of confined aquifer	Change in storage(ham)
ARAMBAG	**Aq-II**	28835	2.46	6.99	0.000285	57.52
CHANDITALA -II	**Aq-II**	7034	6.28	6.28	0.00012	5.30
DHANIAKHALI	**Aq-II**	27568	4.78	3.13	0.00012	4.10
GOGHAT -I	**Aq-II**	18632	4.19	5.155	0.000285	26.58
GOGHAT -II	**Aq-II**	19003	2.8	5.93	0.000285	32.01
HARIPAL	**Aq-II**	18442	7.4	7.4	0.00012	16.23
JANGIPARA	**Aq-II**	16423	14.93	12.46	0.000317	65.04
KHANAKUL -I	**Aq-II**	17192	9.12	9.065	0.000285	44.90
KHANAKUL -II	**Aq-II**	12183	9.01	9.07	0.000285	31.47
PURSURA	**Aq-II**	10042	16.1	12.27	0.000317	39.23
TARAKESWAR	**Aq-II**	12383	8.17	12.20	0.000317	46.62

For confined aquifer, Ground water Flow has been calculated based on TIL Method. Pre-monsoon water table map of confined aquifer shown in Figure 6.5 has been used for calculation.

Figure 6.4 Block wise Ground water flow from confined aquifer-II during Pre-monsoon by TIL method

Block Name	T (M2/day)	Maximum length of block L(m)	Gradient (I=dh/dl)	Q (m^3/Day) Q=TIL	Direction
Haripal	**575.99**	21500	0.00055	1.36	SE direction
Dhaniyakhali	**1212.8**	22500	0.00067	3.66	SE direction
Pursura	**2358**	6500	0.001	3.07	SW DIRECTION
	2358	8000	0.00021	0.79	TOWARDS SOUTH
Tarkeswar	**2358**	16500	0.0002	1.56	SE direction
	2358	15000	0.00077	5.45	SE direction
Khanakul -I	**4768.59**	12000	0.00033	3.78	TOWARDS WEST
	4768.59	24500	0.001	23.37	SE direction
Khanakul -II	**4768.59**	12000	0.0004	4.58	TOWARDS WEST
Jangipara	**2358**	16000	0.00075	5.66	TOWARDS NE
Chanditala -II	**575.99**	10500	0.00017	0.21	TOWARDS SE
Arambagh	**4768.59**	28000	0.0008	21.36	TOWARDS SE
	4768.59	21500	0.00055	11.28	TOWARDS SE
Goghat-I	**4768.59**	16000	0.00082	12.51	TOWARDS SW
	4768.59	14000	0.00025	3.34	TOWARDS SE
Goghat-II	**4768.59**	5000	0.00075	3.58	TOWARDS SW
	4768.59	19000	0.001	18.12	TOWARDS SE

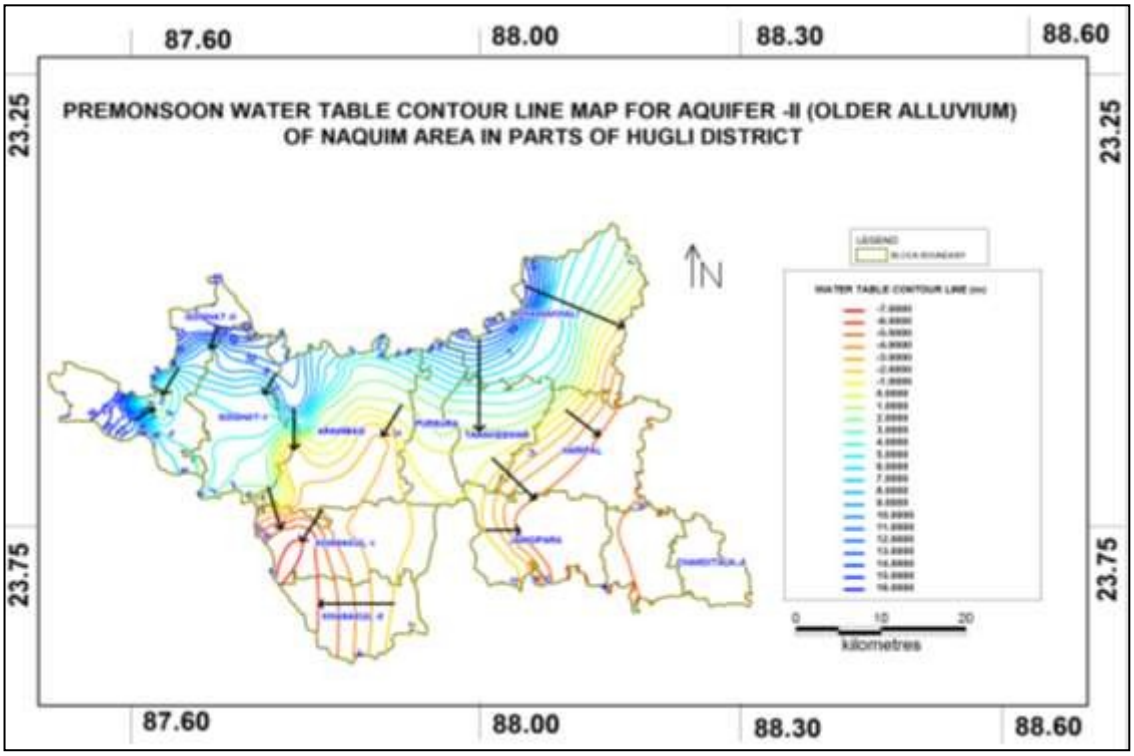


Figure 6.5 Pre monsoon water table/piezometric surface contour line map, Aquifer-II

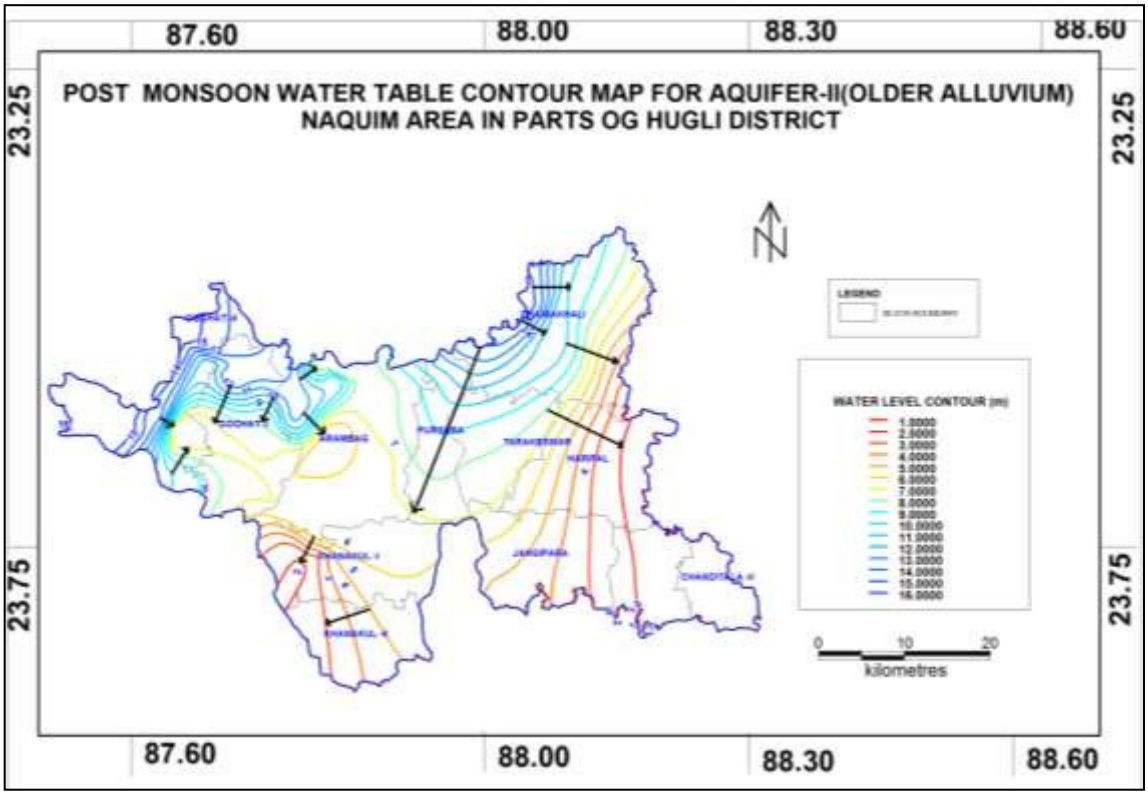


Figure 6.6 Post monsoon water table/piezometric surface contour lines map, Aquifer-II

7.0 HYDROCHEMISTRY

Ground water samples were collected during pre-monsoon from the National Hydrograph Stations falling in the study area and those have been analysed in the departmental Chemical Laboratory.

7.1 General range of chemical parameter

From the analytical results as available from the Laboratory of 86 samples, aquifer wise of quality is given below.

7.1.1 Aquifer IA

pH of ground water, in general, varies between 7.89 and 8.23, EC is within 400.75- 619.29 µS/cm (Table 7.1) TDS ranges from 251.68 to 370.24 mg/1. Concentrations of Na and K are ranging from 26.76 to 95.87 mg/l and from 1.48 to 3.88 mg/1, respectively. Mg is ranging within 17.88-26.73 mg/1. CO3 is found sporadically of 1mg/l. HCO_3 is present to the tune within range of 202.83 - 304.13 mg/1 and Cl is mostly in the range of 10.58 - 71.79mg/1. SO4 concentration varies within 1.66 -11.49 mg/l.

7.1.2 Aquifer II

pH of water, in general, varies within 7.45- 8.23 and, EC between 353.75 and 687 µS/cm (vide Table 7.2.). TDS ranges from 203.69 to 438.28 mg/1. Concentrations of Na and K range from 15.76 to 115.46 mg/1 and from 1.15 to 3.22 mg/1 respectively. Mg is available sporadically from less than 17.01 to 24.86 mg/1. HCO_3 is present in the range of 157.08-347.2 mg/1 and Cl is mostly in the range of 12.32- 92.17 mg/1. F ranges from 0.01- 0.5 mg/1. SO4 concentrations are varying from 2.85 to 0.96 mg/l.

7.1.3 Aquifer III

pH of water, in general, varies between 7.38 and 8.24 and, EC is within 396.5 - 1040 µS/cm (Table 7.3). TDS ranges from 223.17-520 mg/1. Concentrations of Na and K are ranging from 19.81-78.57mg/1 and from 1.4-4.35mg/1 respectively. Mg is occurring within 14.47 – 36 mg/1. CO3 is occurring sparsely of 1.5 mg/l. HCO_3 is present in the range of 183.05 - 400 mg/1 and Cl is mostly in the range of 17.55 - 57mg/1. SO4 concentrations are varying from 3.67 to 10.47mg/l.

Table 7.1 Aquifer wise chemical parameters in parts of Hugli District (aquifer-IA)

Block	Aquifer	pH	Conductivity (µs/cm)	TH	Ca	Mg	Na	K	HCO_3	Cl	NO_3	SO_4 (<5)	F (<1)	SiO_2 (<5)	TDS	SAR
Chanditala II	aquifer-IA	8.22	619.3	100.7	10.9	17.9	95.9	2.8	304.1	42.5	0.0	0.0	0.3	14.4	370.2	25.3
Dhaniakhali	aquifer I	8.20	446.5	147.5	18.5	24.6	32.0	3.4	202.8	40.8	0.0	1.7	0.1	19.9	264.5	6.9
Haripal	aquifer-IA	8.18	533.9	140.7	17.1	23.8	61.3	2.2	259.7	33.4	0.0	0.0	0.2	16.8	313.2	13.6
Jangipara	Aquifer-I	8.14	567.3	123.3	12.0	22.7	76.4	3.0	298.9	23.6	0.0	2.8	0.1	17.1	340.7	18.3
Khanakul I	Aquifer-I	8.13	400.8	125.0	17.5	19.7	36.4	2.0	224.2	16.0	0.0	0.0	0.4	23.0	251.7	8.4
Khanakul II	aquifer I	8.23	442.0	135.0	10.0	26.7	41.3	2.2	231.8	24.8	0.0	0.0	0.0	22.3	268.8	9.6
PURSURAH	Aquifer-I	7.89	438.0	150.3	27.7	19.5	26.8	1.5	234.1	10.6	0.4	0.0	0.1	27.0	256.0	5.5
Tarakeswar	Aquifer-I	8.20	592.1	177.5	27.5	26.4	46.8	3.9	214.3	71.8	1.6	11.5	0.2	16.7	337.0	9.0

Table 7.2 Aquifer wise chemical parameters in parts of Hugli District (aquifer-IB & II).

Block Name	Aquifer	pH	Conductivity (µs/cm)	TH	Ca	Mg	Na	K	HCO_3	Cl	NO_3	SO_4 (<5)	F (<1)	SiO_2 (<5)	TDS	SAR
Arambagh	aquifer-II	8.1	441.4	160.0	27.3	22.3	25.4	1.6	185.7	41.4	0.4	7.9	0.1	22.1	261.7	5.1
Chanditala II	aquifer-IB	8.1	572.0	120.0	16.0	19.4	74.7	3.1	280.6	28.4	0.0	4.1	0.0	19.3	336.1	17.7
Dhaniakhali	aquifer-II	8.1	437.3	146.7	18.0	24.7	33.1	2.5	213.5	22.5	0.0	9.0	0.0	16.3	256.2	7.2
Goghat I	aquifer-II	8.2	353.8	137.5	27.0	17.0	15.8	2.0	157.1	29.3	0.1	0.0	0.0	16.8	203.7	3.4
Goghat II	Aquifer-II	8.1	387.3	137.0	26.0	17.5	24.7	2.5	162.9	37.9	0.3	7.3	0.1	16.7	232.5	5.3
HARIPAL	Aquifer II	7.4	662.3	220.3	44.0	24.9	19.4	2.2	347.2	14.8	1.2	0.0	0.3	55.7	380.0	3.3
Jangipara	aquifer-II	8.2	502.0	112.5	13.0	19.4	67.3	2.7	292.8	17.7	0.0	0.0	0.0	15.3	314.1	16.7
Khanakul I	Aquifer II	7.7	425.0	196.0	37.5	24.6	42.3	2.2	246.1	12.4	0.5	2.9	0.5	25.9	265.6	7.6
Khanakul II	aquifer-II	8.2	687.0	115.0	14.0	19.4	115.5	1.2	280.6	92.2	0.0	4.6	0.5	19.8	438.3	28.2
PURSURAH	Aquifer II	7.8	565.3	127.0	23.8	21.4	26.1	3.2	286.8	19.3	0.7	0.0	0.3	19.7	323.4	5.5
Tarakeswar	aquifer-II	8.2	410.3	130.0	24.0	17.0	28.4	1.4	195.2	21.3	0.0	7.3	0.1	14.1	264.4	6.3

Table 7.3 Aquifer wise chemical parameters in parts of Hugli District (aquifer-III & IV)

Block Name	Aquifer	pH	Conductivity (µs/cm)	TH	Ca	Mg	Na	K	HCO_3	Cl	NO_3	SO_4(<5)	F (<1)	SiO_2 (<5)	TDS	SAR
Chanditala II	Aquifer-III	7.5	1040.0	259.0	55.0	23.0	36.0	1.8	400.0	57.0	2.3	BDL	0.5	39.9	520.0	3.7
DHANIAKHALI	Aquifer -III	7.4	611.8	237.3	49.5	29.0	39.1	4.0	332.5	17.8	1.4	10.5	0.3	56.2	363.0	4.6
DHANIAKHALI	Aquifer III	8.0	427.0	135.8	24.5	16.3	31.7	3.7	219.1	18.3	0.3	6.1	0.2	14.4	251.1	3.6
GOGHAT- I	Aquifer III	7.9	396.5	155.5	35.0	14.5	29.4	2.8	183.1	35.2	0.6	5.7	0.7	23.5	232.9	2.9
Goghat II	Aquifer III	7.8	414.0	151.2	31.7	17.8	19.8	2.3	185.1	17.5	1.0	3.7	0.2	16.7	223.2	3.6
HARIPAL	Aquifer III	7.6	747.5	213.5	44.5	28.5	43.2	4.4	372.0	31.0	1.7	0.0	0.3	34.6	440.0	4.7
Jangipara	aquifer-III	8.2	569.5	100.0	11.0	17.6	78.6	1.9	302.0	28.4	0.0	0.0	0.0	14.4	337.0	4.7
Tarakeswar	Aquifer III	7.4	600.0	194.0	30.0	36.0	43.0	1.4	277.0	22.0	1.6	BDL	0.3	15.5	368.0	6.3

7.2 Ground water pollution:

Generally, all chemical parameters in collected water samples show values within permissible limit. All the water samples analyzed in the laboratory show pH values within the permissible limit of 6.5 and 8.5.EC of these samples indicate that ground water is, in general, potable. Other parameters of routine analysis are also very much within their respective permissible limits including fluoride, which sometimes show lower values of concentration. As per Arsenic Task Force, Govt. of West Bengal, sporadic occurrence of arsenic within 0.01 – 0.05 mg/l in ground water in blocks of Goghat I, Dhaniakhali, Haripal, Chanditala II, Khanakul I and Khanakul II have been encountered. But, as per the random analysis of samples of Network Hydrograph Stations (NHS) in study area, ground water in top or the phreatic aquifer is free from aresenic and potable in nature. Arsenic concentration in ground water in tube wells of NHS of the area is given in Table 7.1

7.3 Ground Water Suitability for irrigation:

The Sodium Adsorption Ratio (SAR) of ground water of all the 3 Aquifer Groups in the study area mostly ranges less than 18, which that ground water is mostly well within the permissible suitability limit for irrigational use, excepting 2 samples, one each from Chanditala II (25.29) & Jangipara (18.34), from Aquifer IA, and 1 sample of Aquifer IB & II, from Khanakul II (28.24), show very high SAR. The ground water has low EC values which implies that salinity hazards is nil in the area. However, the water from deeper aquifer (>80 mbgl) is suitable for domestic, agriculture and industrial uses except in some pockets where a little higher concentration of Fe might be encountered which can be reduced by simple aeration and filtration method.

7.3.1 Ground Water Availability for future irrigation

After the estimation of Dynamic Ground water resources for West Bengal on the basis of GEC (2015) methodology by CGWB and State Water Investigation Department (SWID) for the year as on 31.03.2017, the block wise cultivable area, net irrigated area & ground water availability for future irrigation have been presented in Table 7.5. For future irrigation by available ground water resources, crops have been suggested as per the advice of scientistsand experts of V.C. K.V. Average crop water use in As infested area has been given in Table 7.4.

Table 7.3 Arsenic Concentration in ground water of top aquifer (NHS)

District	Block	Location	Well ID	Latitude	Longitude	Type of well	Arsenic (as As) mg/l
Hooghly	Arambagh	Arambag	WBHG12	22.88806	87.7852778	Tube Well	Nil
Hooghly	Arambagh	Batanol	WBHG96	22.92	87.8647222	Tube Well	Nil
Hooghly	Arambagh	Gourhati	WBHG36	22.77583	87.8038889	Tube Well	Nil
Hooghly	Arambagh	Haraditya	WBHG33	22.83917	87.8886111	Tube Well	Nil
Hooghly	Arambagh	Patulsara	WBHG81	22.88167	87.7525	Tube Well	Nil
Hooghly	Arambagh	Puin	WBHG86	22.88139	87.75	Tube Well	Nil
Hooghly	Arambagh	Tirol	WBHG69	22.96889	87.8169444	Tube Well	Nil
Hooghly	Chanditala II	Garalgacha	WBHG52	22.68611	88.2705556	Tube Well	0.001
Hooghly	Chanditala II	Krishnarampur	WBHG82	22.73056	88.2083333	Tube Well	0.001
Hooghly	Dhaniakhali	Dhaniakhali	WBHG25	22.96722	88.0722222	Tube Well	Nil
Hooghly	Goghat I	Bengai	WBHG76	22.93972	87.6994444	Tube Well	Nil
Hooghly	Goghat I	Goghat	WBHG34	22.8875	87.7016667	Tube Well	Nil
Hooghly	Goghat I	Kumarganj	WBHG75	22.98	87.7488889	Tube Well	Nil
Hooghly	Goghat I	Pandugram	WBHG62	22.87889	87.5822222	Tube Well	Nil
Hooghly	Goghat I	Ragubati rajgram)	WBHG91	22.93139	87.7141667	Tube Well	Nil
Hooghly	Goghat I	Shyambazar	WBHG63	22.88889	87.5697222	Tube Well	Nil
Hooghly	Goghat II	Hazipur	WBHG85	22.82611	87.6394444	Tube Well	Nil
Hooghly	Goghat II	Kamarpukur	WBHG32	22.91278	87.6491667	Tube Well	Nil
Hooghly	Goghat II	Kanthali	WBHG61	22.88722	87.6766667	Tube Well	Nil
Hooghly	Goghat II	Mandaran	WBHG70	22.83361	87.65	Tube Well	Nil
Hooghly	Haripal	Gobarhanra	WBHG83	22.80639	88.0272222	Tube Well	0.0002
Hooghly	Haripal	Gopalprasadpur	WBHG30	22.79528	88.0466667	Tube Well	0.0003
Hooghly	Haripal	Naity	WBHG31	22.8875	88.1033333	Tube Well	Nil
Hooghly	Jangipara	Jangipara	WBHG55	22.74972	88.0533333	Tube Well	0.0003
Hooghly	Khanakul I	Ghoshpur	WBHG77	22.73472	87.7844444	Tube Well	Nil
Hooghly	Pursura	Digruighat	WBHG19	22.78667	87.9238889	Tube Well	Nil
Hooghly	Pursura	Jangalpara	WBHG59	22.86139	87.9566667	Tube Well	0.0003
Hooghly	Pursura	Masinan	WBHG84	22.8425	87.9286111	Tube Well	Nil
Hooghly	Pursura	Pursura	WBHG60	22.83944	87.9566667	Tube Well	Nil
Hooghly	Pursura	Srirampur	WBHG26	22.82583	87.955	Tube Well	Nil
Hooghly	Tarakeshwar	Aknapur	WBHG97	22.90667	88.0488889	Tube Well	Nil
Hooghly	Tarakeshwar	Chapadanga	WBHG80	23.04944	88.32	Tube Well	0.0001
Hooghly	Tarakeshwar	Mirzapur	WBHG88	22.88889	88.0425	Tube Well	Nil
Hooghly	Tarakeshwar	Muktarpur	WBHG87	22.84333	87.9791667	Tube Well	Nil

Table 7.4 Block wise cultivable area, net irrigated area & ground water availability for future irrigation

Block	Geographical area	Cultivable area	Net irrigated Command area (GW)	Net irrigated Command area (SW)	Net irrigated Command area (GW +SW)	Net area available for Irrigation	GW available for Future irrigation (ham)
Dhaniakhali	27568	21001	4671.67	2010.76	6682.43	14318.57	275.88
Tarakeswar	12118	8279	2661.59	2788.59	5450.18	2828.82	3015.46
Haripal	18442	14071	4723.28	982.6	5705.88	8365.12	68.69
Jangipara	16423	11693	4859.01	521	5380.01	6312.99	80.10
Chanditala-II	7042	2548.22	1451.74	1096.48	2548.22	0	515.02
Pursurah	10042	7499	3746.62	1673.96	5420.58	2078.42	5123.16
Khanakul-I	17240	13308	5374.18	3802.58	9176.76	4131.24	66.15
Khanakul-II	12183	10093.14	1263.73	8829.41	10093.14	0	19.22
Arambagh	30390	20559	9798.25	1901.41	11699.66	8859.34	99.89
Goghat-I	18641	13273	5437.6	725.14	6162.74	7110.26	886.71
Goghat-II	19003	14411	6152.12	365.5	6517.62	7893.38	251.2

Area in hectares

Table 7.5 Management Plan for Irrigation in consultation with experts of Bidhan Chandra Krashi Vidhyalaya (BCKV) in as infested area

Major Crops currently in practice	**Rice, mustard, cabbage, Jute, wheat, cauliflower, brinjal, okra, lentil**
Water column depth(m)	Wheat (0.3-0.35), rice (1.2-1.4), Vegetable (0.15-0.2), pulse (0.1-0.12)
Crops suggested for better management	wheat, mustard, lentil, flowers, vegetables
Water column depth (m) recommended	Wheat (0.2-0.25), mustard (0.2), pulse (0.08-0.12), flowers (0.12-0.16)
Irrigation techniques etc	Conjunctive use of fresh and contaminated water in appropriate ratio/drip for vegetable, flowers

8.0 AQUIFER MANAGEMENT PLAN

8.1 Desirable Management Interventions

To formulate the proper Aquifer Management Plan, it is required to understand the ground water resources, its quality and proper scientific development. The study area is mostly under intensive irrigated agriculture by groundwater and partly by surface water. Paddy and Rabi vegetables are the important corps cultivated by farmers in the region. In major part of the area farmers depend only on groundwater for cultivation of these crops during all seasons. Any reduction in the yield of the tube wells due to decline in groundwater shall adversely impact the production of the food grain. Though the study area has multilayer aquifer system, viz. Aquifer Group I, Aquifer Group II and Aquifer Group III; all hold fresh ground water and generally potable; however, potentiality in top & intermediate aquifers are high and that of Aquifer III is comparatively low. However, there might be sporadic instances of arsenic contamination of ground water in Aquifer I at a few locations. Therefore, Aquifer II and Aquifer III are earmarked exclusively for drinking purpose only, whereas Aquifer I may be used for irrigation and industrial purposes. Tube wells in deeper aquifers (Aquifer II & Aquifer III Groups) for drinking purpose should be constructed using cement sealing techniques to avoid leaching, if any, of arsenic contaminated ground water from upper aquifer.

8.2 Ground Water Management Plan for Drinking Purposes:

The drinking water in 11 blocks (Rural) under study is being supplied by partially by PHED from ground water. Source. Sporadic occurrence of arsenic above permissible limit has been reported in top aquifer and experience shows that source of this arsenic contamination is Younger Alluvium. In study area, in 675 habitations a total population of 1210313 are at risk zone (As per 2011 Census). Block wise details of risk population and proposed interventions for PWSS of safe water are shown in Table 8.1.

Cost of construction of tube wells for PWSS as shown above is given in Block wise management Plan separately for individual block.

Table 8.1 Status of Implementation of Water Supply Schemes

Block	Number of Villages to be covered	Population in risk zone Census 2011) to	Proposed Interventions for PWSS of safe ground water to the risk population

	by water supply schemes	be covered by water supply schemes.	
Arambagh	95	182707	Aquifer-III is productive(59.83 m^3/hr) only in Northern part of the block and Aquifer-II is highly productive(137.79 m^3/hr).considering lower discharge of 60 m^3/hr of aquifer - III number of wells are selected
Chanditala - II	18	60380	In Chanditala-II block, Aquifer-III is less productive (73.8 m^3/has comparison to aquifer-II and Aquifer-II is highly productive (182.89 m^3/hr).considering lower discharge of 73.8 m^3/hr of aquifer - III number of wells are selected
Dhaniyakhali	129	164559	In Dhaniyakhali block, Aquifer-III is less productive (discharge 35.4 m^3/hr) compared to aquifer-II (discharge 93.99 m^3/hr).considering lower discharge of 50 m^3/hr of both aquifers number of wells are selected
Goghat-I	55	74664	In Goghat- I block, Aquifer-III is productive (11.6 m^3/hr) only in Northern part (Aprrox.-50% area) of the block and Aquifer-II is highly productive (59.52 m^3/hr) in whole part.considering lower discharge of 35.4 m^3/hr of both aquifers number of wells are selected
Goghat-II	83	112145	In Goghat- II block, Aquifer-III is productive (35.2 m^3/hr) only in Northern part (Aprrox.-50% area) of the block and Aquifer-II is highly productive (59.52 m^3/hr) in whole part.considering lower discharge of 47.36 m^3/hr of both Aquifers number of wells are selected
Haripal	61	82569	In Haripal block, Aquifer-III is less productive (73.8 $m^{3/hr}$) in comparison to Aquifer-II and Aquifer-II is highly productive (90.40 m^3/hr)considering lower discharge of 60 m^3/hr of both aquifers number of wells are selected
Jangipara	81	140767	In Jangipara block, Aquifer-III is less productive (56.7 m^3/hr)has comparison to aquifer-II (90.04 m^3/hr).considering average discharge of 56.70 m^3/hr of aquifer - III number of wells are selected
Khanakul - I	56	146539	In Khanakul-I block, Aquifer-III is less productive (59.83 m^3/hr) has comparison to aquifer-II (66 m^3/hr).considering lower discharge of 62.91 m^3/hr of both aquifers number of wells are selected
Khanakul - II	35	100293	In Khanakul-II block, Aquifer-III is less productive (59.83 m^3/hr) has comparison to aquifer-II (66 m^3/hr).considering lower discharge of 62.91 m^3/hr of both aquifers number of wells are selected
Pursura	24	75061	In Pursura block, Aquifer-III is less productive (39.6 m^3/hr) has comparison to aquifer-II (52.04 m^3/hr).considering average discharge of 45.82 m^3/hr of both aquifer's number of wells are selected
Tarkeswar	38	70629	In Tarkeswar block, Aquifer-III is less productive (39.6 m^3/hr)has comparison to aquifer-II (52.04 m^3/hr).considering average discharge of 45.82 m^3/hr of aquifer - III number of wells are selected

8.3 Block wise ground water management plan for irrigation

Table 8.2 Block wise ground water Resources, Draft, SOD and Category

Name of Block	Annual Extractable Ground Water Recharge in MCM	Gross GW Draft in MCM	SOD % in 2017	Category of Block
Arambagh	95.86	93.39	97.58	Critical
Chanditala - II	16.76	10.59	63.16	Safe
Dhaniyakhali	67.74	63.68	94	Critical
Goghat-I	53.17	43.63	82.05	Semi-Critical
Goghat-II	72.43	69.27	95.64	Critical
Haripal	56.09	38.53	68.69	Safe
Jangipara	47.50	38.05	80.10	Semi-Critical
Khanakul - I	70.22	46.45	66.15	Safe
Khanakul - II	66.95	12.87	19.22	Safe
Pursura	97.74	45.81	46.87	Safe
Tarkeswar	67.55	36.90	54.63	Safe

It is observed that in all the blocks, the stage of development is widely varying between 19.22 % and 97.58 % However, ground water data of 2008-2017 reveals that there is a remarkable falling trend in Aquifer I both during Pre-monsoon and Post-monsoon periods in Khanakul I, Jangipara, Arambag, Goghat I and Goghat II; in Aquifer I, Pre-monsoon trend varies from 27.83 cm/year (in Goghat II Block) to 34.12 cm/year (in Goghat I Block) and post-monsoon trend varies from 29.11 cm/year (in Khanakul I Block) to 60.32 cm/year (in Goghat I Block). But Haripal block does show falling trend in neither period; in 4 other blocks, e.g. Khanakul II, Tarakeswar, Dhaniakhali and Pursura, only in post monsoon period it shows falling trend within 25.99 (Pursura) and 31 (Chanditala II), but in pre-monsoon period it does not show falling trend. Based on the ground water resources estimation, it is not recommended to use of ground water resources for irrigation purposes in Dhaniakhali, Arambag and Goghat II, which have been declared as 'Critical' Blocks, in Haripal, Khanakul II, Tarakeshwar, Chanditala II, Khanakul I and Pursura, which are categorized as 'Safe', ground water of Aquifer I can be used for irrigation; however, in Jangipara and Goghat I, which are declared as Semi Critical, ground water can be used for irrigation with some caution and regular monitoring of ground water regime in these blocks is essential. It is also recommended to implement artificial recharge projects in a big way in all the blocks. Blockwise ground water management plan was presented in Table 8.3 below.

Table 8.3 Block wise ground water management plan for irrigation

Block	Geographical area	Cultivable area	Net irrigated Command area (GW)	Net irrigated Command area (SW)	Net irrigated Command area(GW +SW)	Net area available for Irrigation	GW available for Future irrigation (ham)	Pre monsoon WL Trend 2017 in cm/yr	Post monsoon WL Trend 2017 in cm/yr
Dhaniakhali	27568	21001	4671.67	2010.76	6682.43	14318.6	5467.16	F-27.31	F-29.27
Tarakeswar	12118	8279	2661.59	2788.59	5450.18	2828.82	2510.59	F-20.62	F-26.45
Haripal	18442	14071	4723.28	982.6	5705.88	8365.12	3658.82	R-13.2	R-16.86
Jangipara	16423	11693	4859.01	521	5380.01	6312.99	3046.52	F-28.55	F-26.65
Chanditala-II	7042	2548.22	1451.74	1096.48	2548.22	0	1910.63	F-28.27	F-29.1
Pursura	10042	7499	3746.62	1673.96	5420.58	2078.42	1173.8	F-20.12	F-27.52
Khanakul-I	17240	13308	5374.18	3802.58	9176.76	4131.24	3972.38	F-30.45	F-31.36
Khanakul-II	12183	10093.1	1263.73	8829.41	10093.1	0	6725.9	R-29.38	R-18.16
Arambagh	30390	20559	9798.25	1901.41	11699.7	8859.34	4016.94	F-33.69	F-39.75
Goghat-I	18641	13273	5437.6	725.14	6162.74	7110.26	2943.18	F-32.88	F-65.32
Goghat-II	19003	14411	6152.12	365.5	6517.62	7893.38	1298.15	F-26.44	F-30.59

Block	Remarks summary of Irrigation management plan
Dhaniakhali	SOD is high (94%) & block is Critical; To arrest the declining trend of water level, SW may be used & rainwater harvesting are suggested for cultivation in remaining area. Boro cultivation should be restricted.
Tarakeswar	To arrest the declining trend of water level, SW may be used more than Ground water.
Haripal	SOD is moderate & GW trend is rising so GW & SW both may be used. Boro cultivation may be done with caution.
Jangipara	SOD is alarmingly high (80%) and block is Semi Critical; GW trend is declining. Use of STW should be restricted & use of SW & rainwater harvesting may be encouraged for cultivation

Chanditala-II	SOD is low But GW trend is declining, and block is under semi critical condition. There is no area available for irrigation so Change in cropping pattern and use of SW are suggested.
Pursura	To arrest the declining trend of water level, more use of SW may be encouraged than Ground water.
Khanakul-I	To arrest the declining trend of water level, more use of SW may be encouraged than Ground water.
Khanakul-II	Trend of water level is Rising & SOD is low; GW may be used for Irrigation.
Arambagh	SOD is extremely high (97.58%) & to arrest the declining trend of water level, More use of SW than Ground water and rainwater harvesting are highly suggested.
Goghat-I	SOD is high (82.05%); To arrest the declining trend of water level, more use of SW than Ground water & rainwater harvesting are suggested.
Goghat-II	SOD is very high (95.64%); Block is Critical; so further irrigation could be suggested by SW and rainwater harvesting; chane in cropping pattern is also suggested.

It is observed that in some blocks, a sizeable part of the total cultivable area is yet to be brought to be under irrigation. Again, in the study area, the rate of declining in long term trend of ground water level in parts of present area is quite alarming. On the other hand, stage of Ground Water development in the area is generally very high excepting a few; it might be due to massive irrigation in the area. A close monitoring of water level as well as water quality is required to adopt time to time change in ground water management scenario of the area.

8.4 Scope for Artificial Recharge in Study Area:

Considering the administrative units (blocks or municipalities), average post monsoon water level, which is generally very high throughout the area and falling long term trend of ground water level, almost the whole study area is suitable for artificial recharge. Also, the area is suitable for water conservation too, for which land surface gradient is an important factor.

It is observed that in the total area 1890.92 sq km, a major part has been earmarked for artificial recharge to ground water aquifers, both Aquifer I and Aquifer II (Figure 8.1), and water conservation.

Water budgeting has been made block wise based on Normal Rainfall, soil type and land slope, followed by determination of co-efficient for estimation of run-off. The following steps have been followed:

i. Total volume of surface runoff available Annually 'Vt' (RnXAXC) Ham

ii. Determination of 75% of 'Vt' = V Ham

iii. Determination of 50% of V (Non committed)= Vnc Ham

iv. Determination of60% of Vnc(considering e-flow)= Vf Ham

V. Source water allocation for artificial recharge for percolation tank, REET with recharge shaft, injection well, conservation structure, viz. ponds, etc.

Finally, nos. of different structures possible in different blocks (vide Block wise Management Plan of this report) depending upon soil characteristics and other aspects, along with their size specifications and cost estimate have also been made.

Considering the higher ground water development, categorization of the block as per the Ground Water Resource Assessment, 2017 and block/municipal level suitable area for recharge, priority may be assessed for implementation of artificial recharge projects in the study area. Percolation Tanks and Re-excavation of Existing Tanks with Recharge Shafts in the rural area, and Injection Wells in the municipal and urban area may be constructed as per the feasibility study.

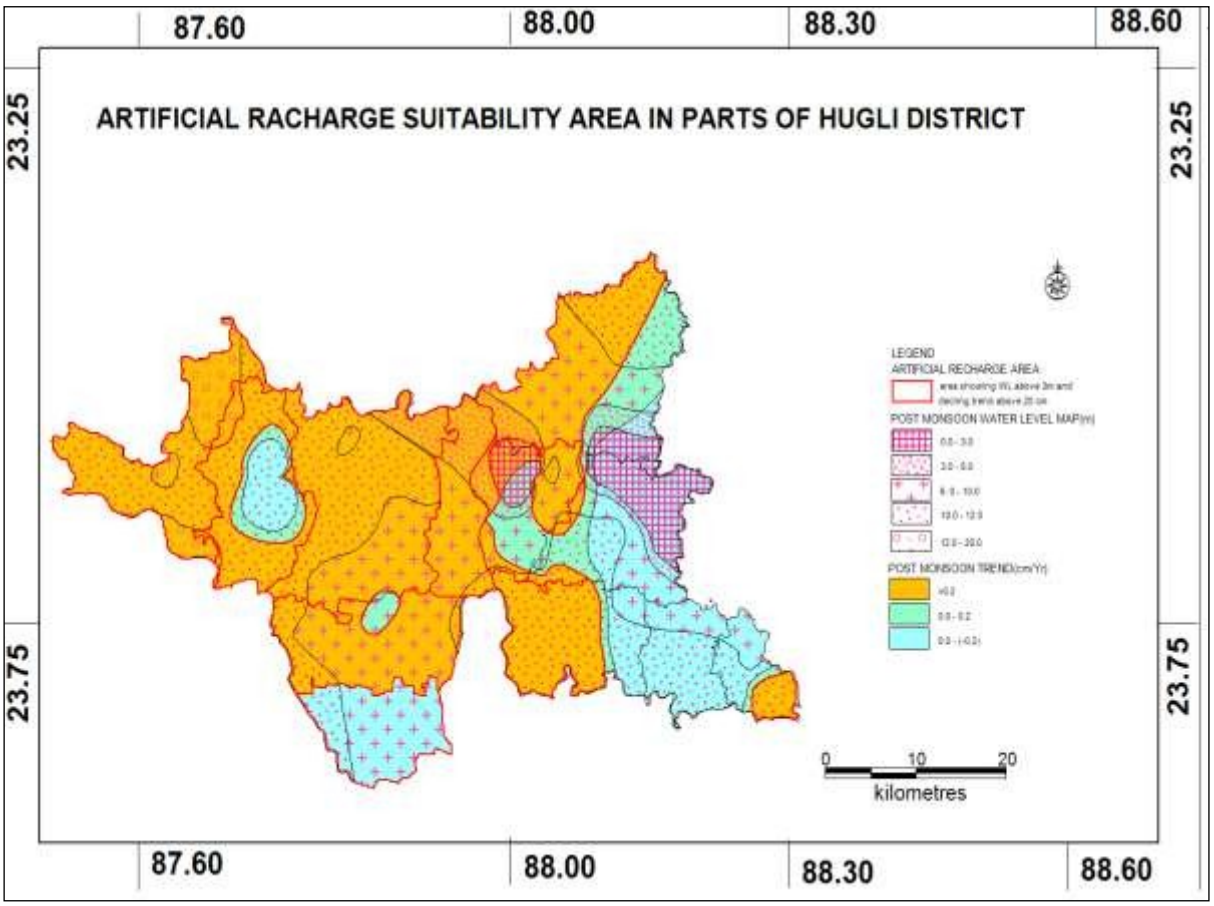
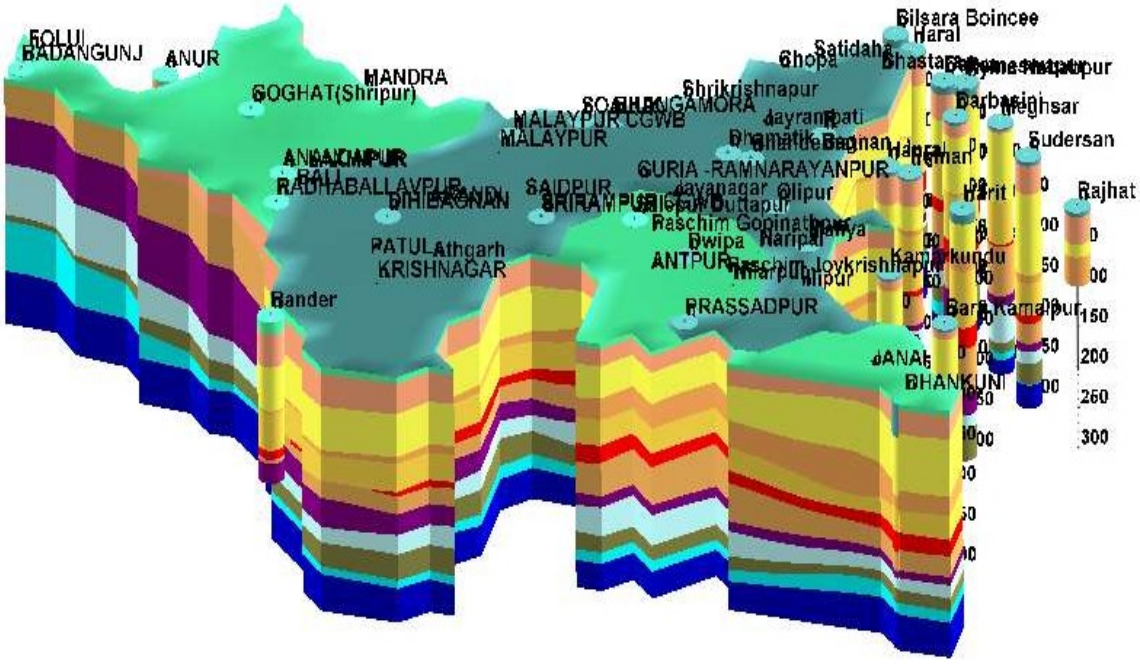


Figure 8.1 Parts suitable for artificial recharge in study area

PART II: BLOCK WISE MANAGEMENT PLAN IN PARTS OF HUGLI DISTRICT

AAP-2017-18



By

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Central Ground Water Board

Eastern Region,Kolkata

2019

9.0 DHANIYAKHALI BLOCK

9.1 Salient Information

- **Block Name: Dhaniyakhali**
- **Reported area (in ha)**: **27568**
- **District**: **Hugli**
- **State**: **West Bengal**
- **Population (as on 2011):**

Table 9.1 Details of Population in Dhaniyakhali block

Rural	Urban	Total
320534	-	320534

- **Rainfall:** Average annual rainfall (Hugli district) for the period 2013-17 (in mm): 1336.96

Table 9.2 Details of Rainfall Pattern in Dhaniyakhali block

Block	District Normal	Actual (Annual)				
		2013	2014	2015	2016	2017
Dhaniyakhali	**1362**	1365.3	1114.4	1549.1	1218.6	1437.4

- *Agriculture & Irrigation (area in ha):*

Table 9.3 Details of Land use pattern of block (Source-West Bengal Land use and Land cover Department)

Name of Block	Reporting area (Ha)	Area under non agriculture use (Ha)	Barren and uncultivable land (Ha)	Total agricultural land (Ha)	Pasture (Ha)	Orchard (Ha)	Cultivable waste (Ha)	Fallow land other than Current Fallow (Ha)	Current Fallow (Ha)	Forest (Ha)	Net sown area (Ha)
Dhaniyakhali	**27568**	**5960**	-	**21001**	**43**	**160**	**160**	**11**	**650**	-	**20089**

- **Aquifer Wise Ground Water Resource Availability & Extraction:**

Table 9.4 Details of aquifer wise resource availability and draft (in MCM) in Block

Resource Availability	Aquifer Group I	Aquifer Group II	Aquifer Group III	Extraction (for Aquifer Group I)
Dynamic Resource	103.18	0.04	-	45.64
Static Resource	47.77			-

9.2 Disposition of Aquifer:

In Dhaniyakhali Block Three Aquifer Groups are explored.

- The depth range of Aquifer I Group is from 5m to 110 m, comprises aquifer IA only, and it is part of Younger Alluvium Formation. In Aquifer 1, sporadic contamination of ground water by arsenic has been reported.
- The depth range of Aquifer Group II is from 26m to 224 m. It is divided into sub aquifers, IB and II.
- The depth range of IB aquifer is 26m to 169 m and aquifer II is 125m to 224m, which is part of Older Alluvium Formation. In aquifer II, iron concentration is High.
- The depth range of Aquifer Group III is 185m to 295m. It is divided into sub aquifers, III & IV.
- The range of aquifer III is 185 m to 293m, and aquifer IV is 253.5m to 295m, which is part of Tertiary formation. In Aquifer III, ground water potentiality is low.

Table 9.5 Details of aquifer disposition/depth range in block

Block	Depth range of Aquifer in mbgl		
Dhaniyakhali	Aquifer Group I	Aquifer Group II	Aquifer Group III
	IA: 5-110	IB: 26-169 II: 125-224	III: 185-293 IV: 253.5-295

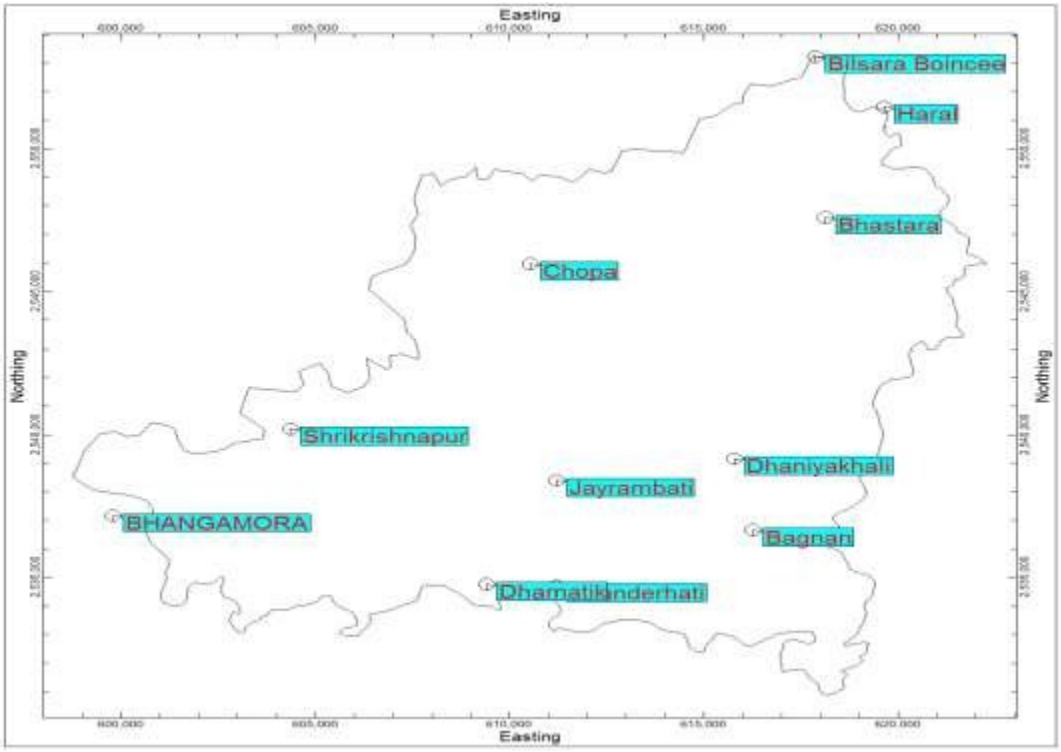

Figure 9.1 Index map of Dhaniyakhali Block

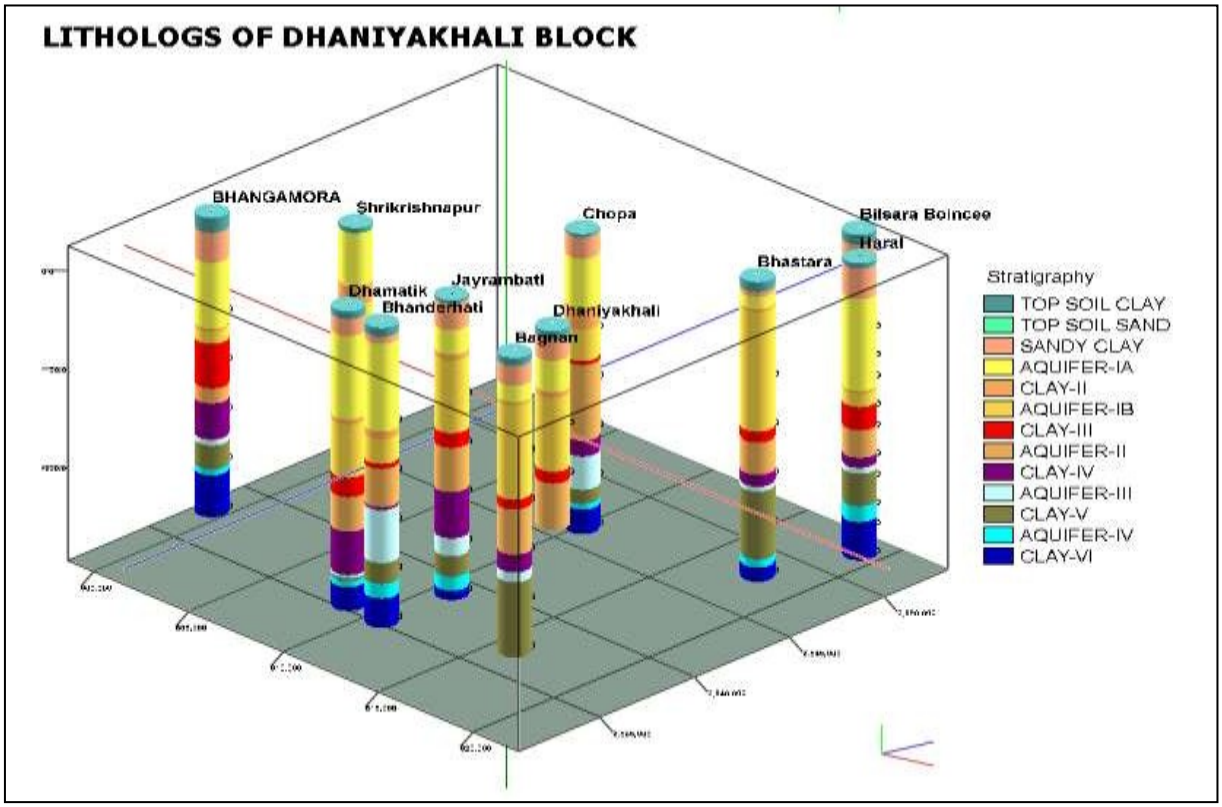

Figure 9.2 Lithologs of Dhaniyakhali Block

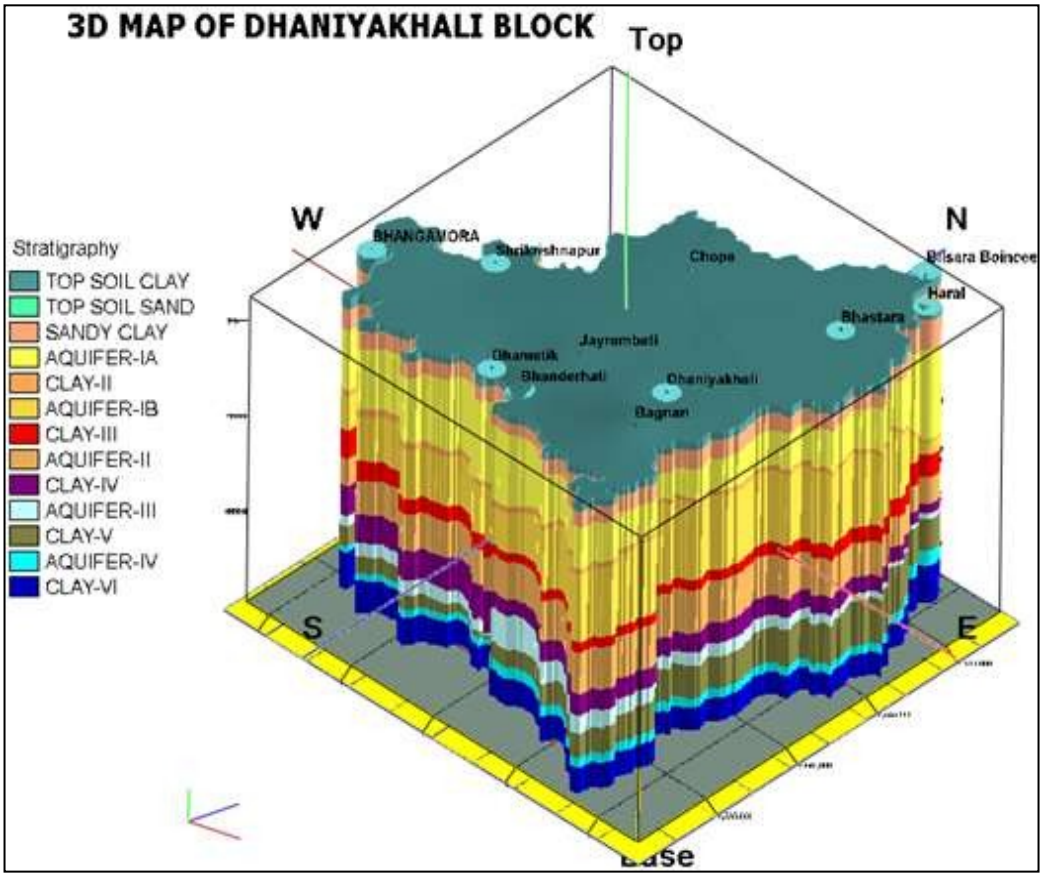

Figure 9.3 3D map of Aquifer disposition in Dhaniyakhali Block

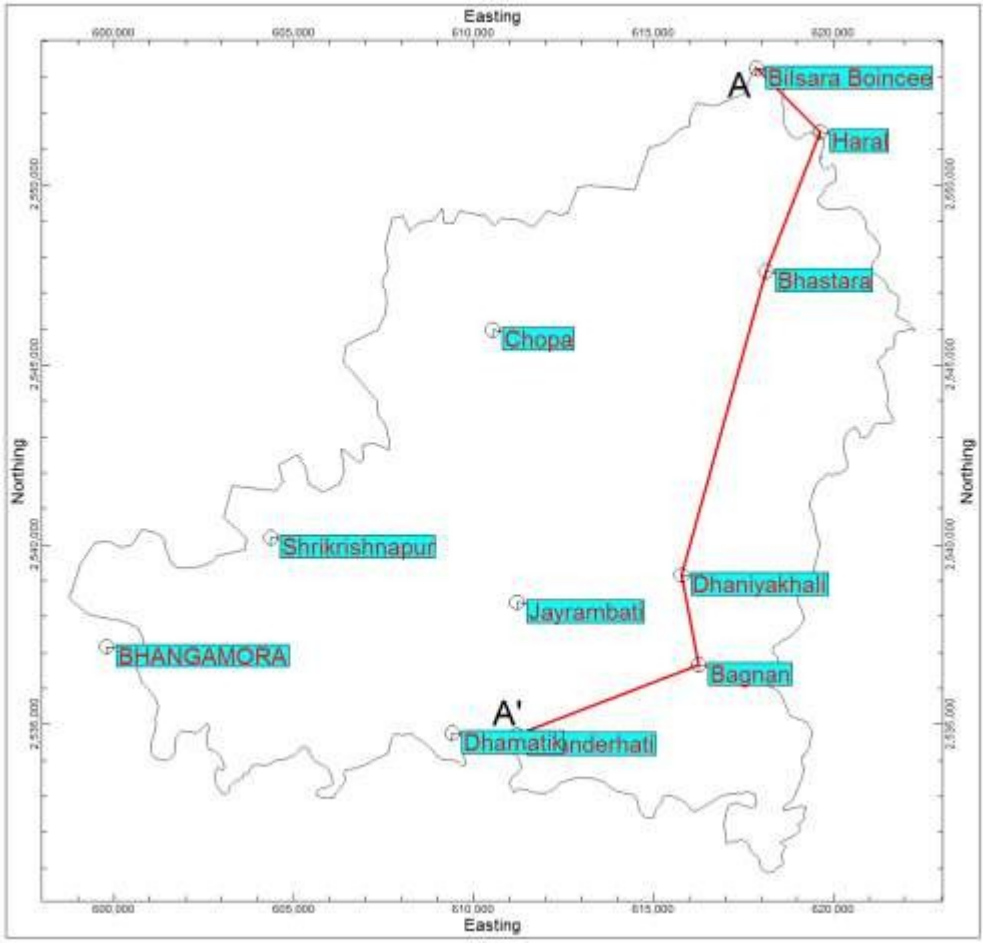

Figure 9.4 N-S Section Index line in Dhaniyakhali Block

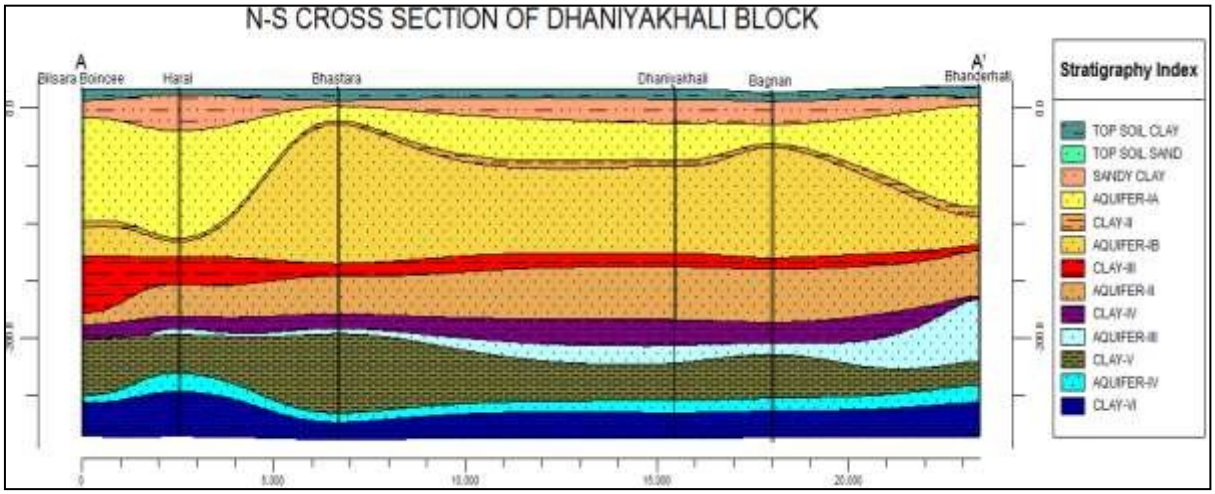

Figure 9.5 N- S Cross section in Dhaniyakhali Block

Table 9.6 Details of Aquifer Wise Water Level Ranges & seasonal long-term water level trends (2006 to 2017)

Block	Aquifer Groups	Pre-monsoon Trend			Post-monsoon Trend		
		Water Level Range (mbgl)	**Rise (cm/year)**	**Fall (cm/year)**	**Water Level Range (mbgl)**	**Rise (cm/year)**	**Fall (cm/year)**
Dhaniyakhali	I	1.7-13.11	-	27.31	7.16-11.16	-	29.27
Dhaniyakhali	II	7.18-13.14	-	-	7.36-8.36	-	-
Dhaniyakhali	III	10.92-18.17	-	-	0.63-11.16	-	-

Table 9.7 Aquifer wise (Maximum) thickness

Block	Area (sq km)	Thickness of the Granular Zone in Aquifer Group I (m)	Thickness of the Granular Zone in Aquifer Group II (m)	Thickness of the Granular Zone in Aquifer Group III (m)
Dhaniyakhali	275.68	105	IB: 143 II: 99	III: 108 IV: 41.5

Table 9.8 Aquifer-wise depth range and parameters (Based on CGWB exploration)

Group	**Sub Aquifer**	**Depth Range (mbgl)**	**Discharge (m^3/hr) with DD**	**T (m^2/day)**	**S**	**Specific capacity (m^3/day per m)**
Aquifer Group I	IA	IA 5 - 110	22.64 (DD 1.07)	615.05(J*)/560.06(T**)	$1.139x10^{-4}$	21.16
Aquifer Group II	IB	26- 169	93.99 (DD-5.27)	1212.8	$1.20 X 10^{-4}$	24.98
	II	125 -224				
Aquifer Group III	III	185 - 293	32.4 (DD 6.0)	430.5	$9.6 X 10^{-10}$	5.4
	IV	253.5 - 295				

J* – Jacob's method; T** - Theis's method

9.3 Ground Water Resource & Extraction

Aquifer Wise Resource Availability & Extraction: Dynamic ground water resources as on 31st March'13

Table 9.9 Availability of Ground Water resource in top aquifer i.e. Aquifer I

Block	Annual Extractable Ground	Current Total Extraction	Stage of development (%)	Category	Annual GW Allocation for Domestic
Dhaniyakhali	67.7428	63.6766	94	**Critical**	4.7698

Static (in-storage) Resources: 47.77 MCM

9.4 Chemical Quality of Ground Water & Contamination:

Based on Key well data and CGWB outsourced exploratory well data blocks wise Average data of chemical parameter is given below.

Table 9.10 Aquifer wise average chemical parameter of block

Aquifer Group	pH	Conductivity (µs/cm)	TH	Ca	Mg	Na	K	Bicarbonate	Cl	NO_3	SO_4 (<5)	F (<1)	SiO_2 (<5)	TDS
I	8.23	446.5	147.5	18.5	24.60	31.9975	3.36	202.83	40.76	0	1.655	0.08	19.86	264.54
II	8.08	437.33	146.67	18	24.71	33.07	2.46	213.5	22.45	0	8.96	0	16.29	256.17
III	8.02	427	135.75	24.5	16.35	31.72	3.74	219.08	18.30	0.27	6.12	0.22	14.36	251.06

9.5 Ground Water Resource Enhancement & Management Plan

Management Plan for drinking purposes-

- The block is under Critical category and as per Ground Water Policy first priority of water is for drinking purpose.
- Regular Field monitoring is necessary for Arsenic concentration in tube wells.
- As per WBPHED Data a total population of 164559 in 129 villages is under risk zone where no water supply scheme exists.

Table 9.11 Details of drinking water uncovered population in Block

Block	Number of Villages to be covered by water supply schemes	Population in risk zone (as per Census 2011) to be covered by water supply schemes.	Comments on providing water supply to the risk population
Dhaniyakhali	129	164559	In Dhaniyakhali block, Aquifer-III is less productive (discharge 35.4 m^3/hr) compared to Aquifer-II (discharge 93.99 m3/hr); considering average discharge of 50 m^3/hr for both aquifers, number of wells is recommended. A cost estimate of 320 lakh has been worked out for construction of 16 Tube wells.

- In Dhaniyakhali block, Aquifer-III is less productive (Discharge 35.4 m^3/hr) compared than Aquifer-II (discharge 93.99 m^3/hr).
- One well has been constructed in Jayrambati, tapping only Aquifer-III by outsourcing; that well reveals a discharge of 32.4 m^3/hr.
- In Dhaniyakhali block, in villages of Abhirampur Bhastara, Bagnan, Belmuri, Dhamaitika, Satidaha and Chopa, wells have been constructed at sites provided by PHED, Govt. of West Bengal by outsourcing, tapping Aquifer-II reveal discharge of 87 m^3/hr, 147 m^3/hr, 51.6 m^3/hr., 93.6 m^3/hr, and 60.6 m^3/hr respectively. Wells have also been constructed at

Shrikrishnapur and Bhanderhati villages at sites proposed by PHED, Govt. Of west Bengal, by outsourcing, tapping both Aquifer II & III and have revealed discharge of 102 m^3/hr and 32.4 m^3/hr respectively. All these wells could be used for supply of drinking water in that part of block.

- Considering overall situation for preparation of village wise water supply schemes, the average discharge has been taken as 50 m^3/hr.

A	**Village**
B	**Population 2011**
C	**Projected Population 2021 (decadal growth rate 9.49%)**
D	**Present Water Requirement for Human Population in m^3 @70 lpcd**
E	**Projected Water Requirement for Human Population in m^3 @70 lpcd**
F	**Cattle 2011**
G	**Projected Cattle 2021**
H	**Present Water Requirement for cattle m^3 @20lpcd**
I	**projected Water Requirement for cattle m^3 @20lpcd**
J	**Total Water Requirement/day as on 2011 in m^3**
K	**Total Water Requirement cubic m/day as on 2021 in m^3**
L	**Discharge (m3/hr)**
M	**Discharge of one TW in m^3/day after 8 hours of pumping**
N	**No of TW**
O	**Cost of Tube well of 300 m depth (approx.) 10”x6" dia @ Rs. 20 lakhs (In lakh) as per EFC**

Table 9.12 Village wise number and cost for construction of Tube wells calculated on the basis of Human and Cattle population and CGWB in house and outsourced Exploratory well Discharge data for Dhaniyakhali block

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
Jerur	1345	1473	94.15	103.11	135	140	2.7	2.8	96.85	105.91	50	400	0	0
Harirampur	773	846	54.11	59.22	77	80	1.54	1.6	55.65	60.82	50	400	0	0
Chaughata	1557	1705	108.99	119.35	156	162	3.12	3.23	112.11	122.58	50	400	0	0
Uttar Jagannathpur	525	575	36.75	40.25	53	55	1.06	1.1	37.81	41.35	50	400	0	0
Gurbari	1898	2078	132.86	145.46	190	197	3.8	3.94	136.66	149.4	50	400	0	0
Uttar Mamudpur	721	789	50.47	55.23	72	75	1.44	1.49	51.91	56.72	50	400	0	0
Mahishgara	914	1001	63.98	70.07	91	94	1.82	1.89	65.8	71.96	50	400	0	0
Balidanga	1731	1895	121.17	132.65	173	179	3.46	3.59	124.63	136.24	50	400	0	0
Hazipur	1702	1864	119.14	130.48	170	176	3.4	3.52	122.54	134	50	400	0	0
Kashipur	676	740	47.32	51.8	68	70	1.36	1.41	48.68	53.21	50	400	0	0
Dakshin Sankarpur	1094	1198	76.58	83.86	109	113	2.18	2.26	78.76	86.12	50	400	0	0
Madpur	1201	1315	84.07	92.05	120	124	2.4	2.49	86.47	94.54	50	400	0	0
Sirijpur	687	752	48.09	52.64	69	72	1.38	1.43	49.47	54.07	50	400	0	0
Rajipur	3659	4006	256.13	280.42	366	379	7.32	7.59	263.45	288.01	50	400	1	20
Salalpur	744	815	52.08	57.05	74	77	1.48	1.53	53.56	58.58	50	400	0	0
Byaspur	897	982	62.79	68.74	90	93	1.8	1.87	64.59	70.61	50	400	0	0
Dedhara	1706	1868	119.42	130.76	171	177	3.42	3.55	122.84	134.31	50	400	0	0
Paschim Banpur	427	468	29.89	32.76	43	45	0.86	0.89	30.75	33.65	50	400	0	0
Baharampur	1112	1218	77.84	85.26	111	115	2.22	2.3	80.06	87.56	50	400	0	0
Gangeshnagar	3333	3649	233.31	255.43	333	345	6.66	6.9	239.97	262.33	50	400	1	20
Dashghara	3116	3412	218.12	238.84	312	323	6.24	6.47	224.36	245.31	50	400	1	20
Nimdanga	1044	1143	73.08	80.01	104	108	2.08	2.16	75.16	82.17	50	400	0	0
Shrirampur	4170	4566	291.9	319.62	417	432	8.34	8.65	300.24	328.27	50	400	1	20
Sahbazar	1233	1350	86.31	94.5	123	128	2.46	2.55	88.77	97.05	50	400	0	0
Beguna	630	690	44.1	48.3	63	65	1.26	1.31	45.36	49.61	50	400	0	0

Gobindapur	1286	1408	90.02	98.56	129	134	2.58	2.67	92.6	101.23	50	400	0	0
Dakshin Jagannaathpur	940	1029	65.8	72.03	94	97	1.88	1.95	67.68	73.98	50	400	0	0
Banna	1626	1780	113.82	124.6	163	169	3.26	3.38	117.08	127.98	50	400	0	0
Rautpur	824	902	57.68	63.14	82	85	1.64	1.7	59.32	64.84	50	400	0	0
Deora	1555	1703	108.85	119.21	156	162	3.12	3.23	111.97	122.44	50	400	0	0
Radha Nagar	1746	1912	122.22	133.84	175	181	3.5	3.63	125.72	137.47	50	400	0	0
Paschim Gopinathpur	3825	4188	267.75	293.16	383	397	7.66	7.94	275.41	301.1	50	400	1	20
Jamdara	1153	1262	80.71	88.34	115	119	2.3	2.38	83.01	90.72	50	400	0	0
Habibpur	2660	2912	186.2	203.84	266	276	5.32	5.51	191.52	209.35	50	400	1	20
Chaitanya Bati	1577	1727	110.39	120.89	158	164	3.16	3.28	113.55	124.17	50	400	0	0
Nischintapur	202	221	14.14	15.47	20	21	0.4	0.41	14.54	15.88	50	400	0	0
Paschim Kalikapur	1341	1468	93.87	102.76	134	139	2.68	2.78	96.55	105.54	50	400	0	0
Kumrul	3324	3639	232.68	254.73	332	344	6.64	6.88	239.32	261.61	50	400	1	20
Jiara	2228	2439	155.96	170.73	223	231	4.46	4.62	160.42	175.35	50	400	0	0
Paschim Narayanpur	3081	3373	215.67	236.11	308	319	6.16	6.39	221.83	242.5	50	400	1	20
Chautara	3353	3671	234.71	256.97	335	347	6.7	6.95	241.41	263.92	50	400	1	20
Bishnupur	3361	3680	235.27	257.6	336	348	6.72	6.97	241.99	264.57	50	400	1	20
Parambua	2813	3080	196.91	215.6	281	291	5.62	5.83	202.53	221.43	50	400	1	20
Nalthoba	524	574	36.68	40.18	52	54	1.04	1.08	37.72	41.26	50	400	0	0
Sitipalashi	1034	1132	72.38	79.24	103	107	2.06	2.14	74.44	81.38	50	400	0	0
Kankrakuli	1075	1177	75.25	82.39	108	112	2.16	2.24	77.41	84.63	50	400	0	0
Dakshin Abhirampur	379	415	26.53	29.05	38	39	0.76	0.79	27.29	29.84	50	400	0	0
Makhalpur	1545	1692	108.15	118.44	155	161	3.1	3.21	111.25	121.65	50	400	0	0
Dakshin Fatepur	511	559	35.77	39.13	51	53	1.02	1.06	36.79	40.19	50	400	0	0
Jayharipur	857	938	59.99	65.66	86	89	1.72	1.78	61.71	67.44	50	400	0	0

Tegachhi Bhabanipur	1205	1319	84.35	92.33	121	125	2.42	2.51	86.77	94.84	50	400	0	0
Dipa	954	1045	66.78	73.15	95	98	1.9	1.97	68.68	75.12	50	400	0	0
Kamalpur	1488	1629	104.16	114.03	149	154	2.98	3.09	107.14	117.12	50	400	0	0
Purba Banpur	1232	1349	86.24	94.43	123	128	2.46	2.55	88.7	96.98	50	400	0	0
Ghana Shyampur	1101	1205	77.07	84.35	110	114	2.2	2.28	79.27	86.63	50	400	0	0
Jot Kamal	385	422	26.95	29.54	39	40	0.78	0.81	27.73	30.35	50	400	0	0
Purba Kalikapur	2461	2695	172.27	188.65	246	255	4.92	5.1	177.19	193.75	50	400	0	0
Konan	3023	3310	211.61	231.7	302	313	6.04	6.26	217.65	237.96	50	400	1	20
Ala	1029	1127	72.03	78.89	103	107	2.06	2.14	74.09	81.03	50	400	0	0
Jadupur	566	620	39.62	43.4	57	59	1.14	1.18	40.76	44.58	50	400	0	0
Harpur	2054	2249	143.78	157.43	205	213	4.1	4.25	147.88	161.68	50	400	0	0
Simla	1337	1464	93.59	102.48	134	139	2.68	2.78	96.27	105.26	50	400	0	0
Uttar Malikapur	401	439	28.07	30.73	40	41	0.8	0.83	28.87	31.56	50	400	0	0
Madhusudanpur	773	846	54.11	59.22	77	80	1.54	1.6	55.65	60.82	50	400	0	0
Chhota Mallikpur	873	956	61.11	66.92	87	90	1.74	1.8	62.85	68.72	50	400	0	0
Galgale	319	349	22.33	24.43	32	33	0.64	0.66	22.97	25.09	50	400	0	0
Pitha	747	818	52.29	57.26	75	78	1.5	1.55	53.79	58.81	50	400	0	0
Hatkamalpur	500	547	35	38.29	50	52	1	1.04	36	39.33	50	400	0	0
Mukundapur	850	931	59.5	65.17	85	88	1.7	1.76	61.2	66.93	50	400	0	0
Lokabati	2035	2228	142.45	155.96	204	211	4.08	4.23	146.53	160.19	50	400	0	0
Chitla	1249	1368	87.43	95.76	125	130	2.5	2.59	89.93	98.35	50	400	0	0
Mahamaya	1546	1693	108.22	118.51	155	161	3.1	3.21	111.32	121.72	50	400	0	0
Gete Gari	2574	2818	180.18	197.26	257	266	5.14	5.33	185.32	202.59	50	400	1	20
Balidaha	1376	1507	96.32	105.49	138	143	2.76	2.86	99.08	108.35	50	400	0	0
Bara Mallikpur	375	411	26.25	28.77	38	39	0.76	0.79	27.01	29.56	50	400	0	0
Purbba Gopinathpur	988	1082	69.16	75.74	99	103	1.98	2.05	71.14	77.79	50	400	0	0
Ghoshla	2355	2578	164.85	180.46	236	245	4.72	4.89	169.57	185.35	50	400	0	0

Block wise Management plan in parts of Hugli District, West Bengal

Sheapur	676	740	47.32	51.8	68	70	1.36	1.41	48.68	53.21	50	400	0	0
Barul	2683	2938	187.81	205.66	268	278	5.36	5.56	193.17	211.22	50	400	1	20
Sonajol	722	791	50.54	55.37	72	75	1.44	1.49	51.98	56.86	50	400	0	0
Gopikantapur	1968	2155	137.76	150.85	197	204	3.94	4.08	141.7	154.93	50	400	0	0
Masuria	530	580	37.1	40.6	53	55	1.06	1.1	38.16	41.7	50	400	0	0
Akabpur	1272	1393	89.04	97.51	127	132	2.54	2.63	91.58	100.14	50	400	0	0
Basipur	1062	1163	74.34	81.41	106	110	2.12	2.2	76.46	83.61	50	400	0	0
Bhotar	950	1040	66.5	72.8	95	98	1.9	1.97	68.4	74.77	50	400	0	0
Manipur	464	508	32.48	35.56	46	48	0.92	0.95	33.4	36.51	50	400	0	0
Jhuma	532	582	37.24	40.74	53	55	1.06	1.1	38.3	41.84	50	400	0	0
Melki Kutubpur	2008	2199	140.56	153.93	201	208	4.02	4.17	144.58	158.1	50	400	0	0
Kathalgaria	642	703	44.94	49.21	64	66	1.28	1.33	46.22	50.54	50	400	0	0
Uliara	488	534	34.16	37.38	49	51	0.98	1.02	35.14	38.4	50	400	0	0
Itachona	980	1073	68.6	75.11	98	102	1.96	2.03	70.56	77.14	50	400	0	0
Dumro	640	701	44.8	49.07	64	66	1.28	1.33	46.08	50.4	50	400	0	0
Dulfa	387	424	27.09	29.68	39	40	0.78	0.81	27.87	30.49	50	400	0	0
Pachhra	264	289	18.48	20.23	26	27	0.52	0.54	19	20.77	50	400	0	0
Bathangaria	1124	1231	78.68	86.17	112	116	2.24	2.32	80.92	88.49	50	400	0	0
Saturia	782	856	54.74	59.92	78	81	1.56	1.62	56.3	61.54	50	400	0	0
Bara Khanpur	931	1019	65.17	71.33	93	96	1.86	1.93	67.03	73.26	50	400	0	0
Majinan	1173	1284	82.11	89.88	117	121	2.34	2.43	84.45	92.31	50	400	0	0
Heregari	486	532	34.02	37.24	49	51	0.98	1.02	35	38.26	50	400	0	0
Balagari	548	600	38.36	42	55	57	1.1	1.14	39.46	43.14	50	400	0	0
Gopalpur	1432	1568	100.24	109.76	143	148	2.86	2.96	103.1	112.72	50	400	0	0
Durgapur	1441	1578	100.87	110.46	144	149	2.88	2.99	103.75	113.45	50	400	0	0
Kanta Garia	330	361	23.1	25.27	33	34	0.66	0.68	23.76	25.95	50	400	0	0
Purbba Narayanpur	590	646	41.3	45.22	59	61	1.18	1.22	42.48	46.44	50	400	0	0
Uttar Basudebpur	532	582	37.24	40.74	53	55	1.06	1.1	38.3	41.84	50	400	0	0

Block wise Management plan in parts of Hugli District, West Bengal

Bhabanipur	772	845	54.04	59.15	77	80	1.54	1.6	55.58	60.75	50	400	0	0
Deluara	1114	1220	77.98	85.4	111	115	2.22	2.3	80.2	87.7	50	400	0	0
Khajurdaha	2600	2847	182	199.29	260	270	5.2	5.39	187.2	204.68	50	400	1	20
Shibpur	675	739	47.25	51.73	68	70	1.36	1.41	48.61	53.14	50	400	0	0
Kanajuli	1508	1651	105.56	115.57	151	157	3.02	3.13	108.58	118.7	50	400	0	0
Mallikpur	1222	1338	85.54	93.66	122	126	2.44	2.53	87.98	96.19	50	400	0	0
Rudrani	2694	2950	188.58	206.5	269	279	5.38	5.58	193.96	212.08	50	400	1	20
Podpara	444	486	31.08	34.02	44	46	0.88	0.91	31.96	34.93	50	400	0	0
Akilpur	834	913	58.38	63.91	83	86	1.66	1.72	60.04	65.63	50	400	0	0
Gauripur	700	766	49	53.62	70	73	1.4	1.45	50.4	55.07	50	400	0	0
Parameswarpur	437	478	30.59	33.46	44	46	0.88	0.91	31.47	34.37	50	400	0	0
Hariharpur	699	765	48.93	53.55	70	73	1.4	1.45	50.33	55	50	400	0	0
Dakshin Malikapur	562	615	39.34	43.05	56	58	1.12	1.16	40.46	44.21	50	400	0	0
Dhantikari	506	554	35.42	38.78	51	53	1.02	1.06	36.44	39.84	50	400	0	0
Chelua	2261	2476	158.27	173.32	226	234	4.52	4.69	162.79	178.01	50	400	0	0
Sandhanpur	351	384	24.57	26.88	35	36	0.7	0.73	25.27	27.61	50	400	0	0
Dakshin Basudebpur	212	232	14.84	16.24	21	22	0.42	0.44	15.26	16.68	50	400	0	0
Purandarpur	707	774	49.49	54.18	71	74	1.42	1.47	50.91	55.65	50	400	0	0
Nakira Para	700	766	49	53.62	70	73	1.4	1.45	50.4	55.07	50	400	0	0
Jot Mahes	674	738	47.18	51.66	67	69	1.34	1.39	48.52	53.05	50	400	0	0
Purbba Keshabpur	609	667	42.63	46.69	61	63	1.22	1.26	43.85	47.95	50	400	0	0
Bajitpur	1356	1485	94.92	103.95	136	141	2.72	2.82	97.64	106.77	50	400	0	0
Pora Bazar	1740	1905	121.8	133.35	174	180	3.48	3.61	125.28	136.96	50	400	0	0
Nalitajol	2034	2227	142.38	155.89	203	210	4.06	4.21	146.44	160.1	50	400	0	0
Total	**164559**	180176	**11519.13**	**12612.25**	**16457**	**17059**	**329.14**	341.18	**11848.27**	**12953.48**	50	**51600**	**16**	**320**

- 16 Tube wells are required for supply of drinking water in uncovered area of Dhaniakhali block (Table 9.12).
- For monitoring of the ground water regime, if observation well is needed then cost of construction of the same should also be included in the expenditure.
- Phase wise drilling should be started for accurate results. In the initial stage of development for drinking purpose, 25 % wells should be constructed. Based on results, whole plan could be implemented.
- Regular quality monitoring, e.g., arsenic and heavy minerals in ground water is necessary.

Management Plan for irrigation:

- Based on Ground Water Resource Estimation, this block is **Critical**. Stage of Ground Water development is 94%, with continuous declining Ground Water Trend.
- As per **4th MI Census** irrigation data in this block number of Shallow Tube Wells are more used for irrigation purpose (given in Table 9.16)
- Iirrigation from surface water bodies like river, canal and other water bodies should be carried out.
- Application of modern technologies like Sprinkler, Drip irrigation and even fresh and arsenic bearing ground water, if encountered, may be blended in a suitable ratio and the same could be used for irrigation purpose at least on experimental basis.
- Cultivation of Low water requirement crops should be encouraged.
- Artificial recharge is must in **Critical** block.
- Regular monitoring of Arsenic concentration in crops is also necessary.
- R & D study is necessary for finding out concrete and permanent solution for tackling ground water need.
- In Dhaniyakhali block, according to soil and climatic condition Jute, rice and potato are crops that are more suitable.
- Considering Socio-economic factor Cash crops are suggested for benefit of farmers.

From Statistical handbook-2014 data, current cropping pattern is given in Figure 9.7 Status of drinking water supply scheme in Dhaniyakhali Block (Source-WBPHED) according (Census -2011)

Table 9.13 and percentage wise crop covering area of block is given Table 9.14.

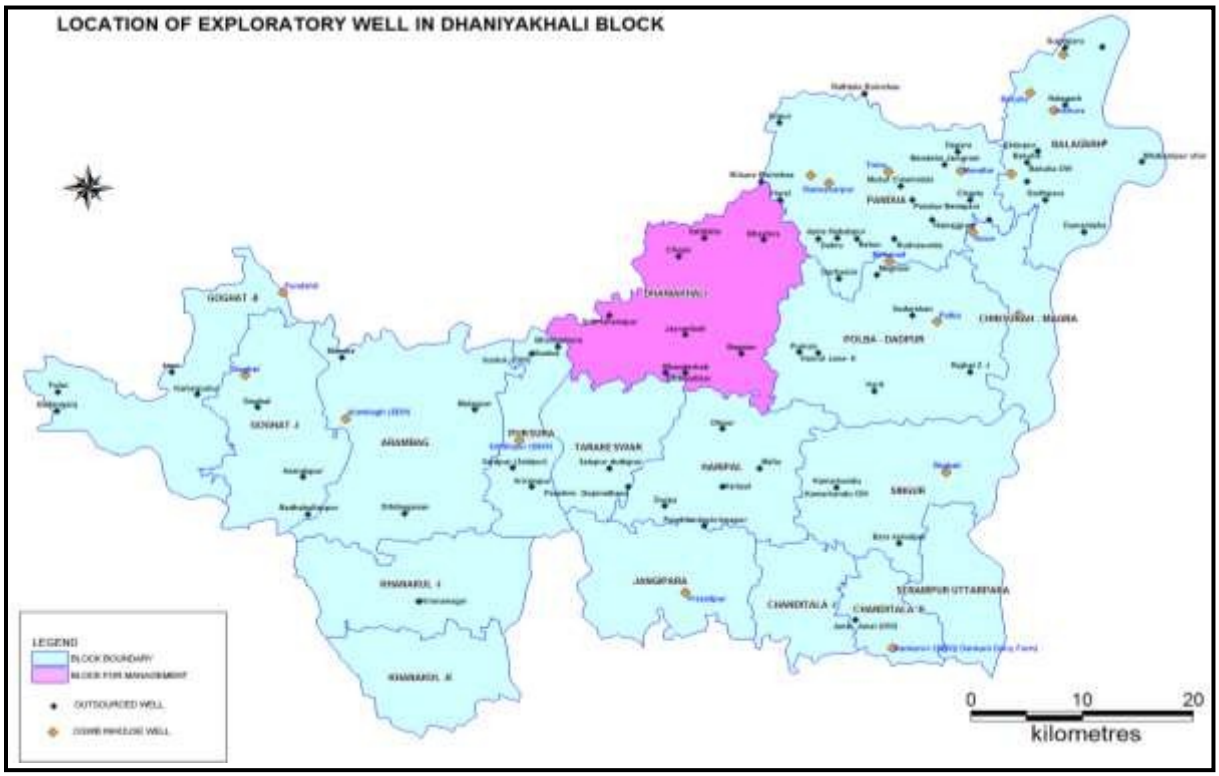

Figure 9.6 Location of Exploratory wells in Dhaniyakhali Block

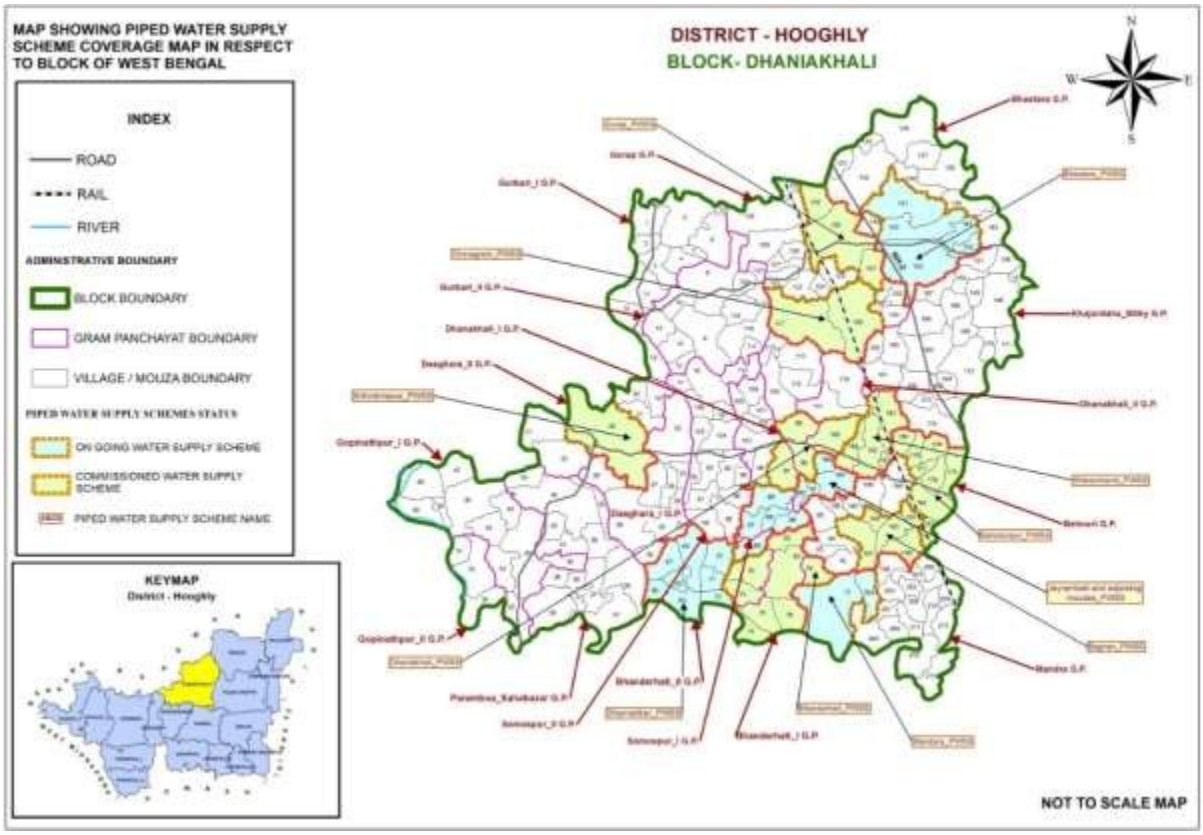

Figure 9.7 Status of drinking water supply scheme in Dhaniyakhali Block (Source-WBPHED) according (Census -2011)

Table 9.13 Details of Regular practice crops in Block

(Source: Department of Economics and Statistics)

Name of Block		Dhaniyakhali
Aus	Area	34
	Prod.	0.084
	Yield	2483
Aman	Area	18893
	Prod.	50.670
	Yield	2682
Boro	Area	4489
	Prod.	13.300
	Yield	2963
Wheat	Area	40
	Prod.	0.083
	Yield	2072
Jute	Area	1311
	Prod.*	25.499
	Yield**	19.45
Mustard	Area	1174
	Prod.	1.190
	Yield	1013
Til	Area	4734
	Prod.	3.928
	Yield	830
Potato	Area	5800
	Prod.	95.184
	Yield	16411

(Area in hectare, Production in Thousand MT and Yield in kg/ha)

Table 9.14 Area wise percentage of current practice of crops in Dhaniyakhali Block

Area wise Current Practice of crops								
Rabi Crops (Wheat, Mustard and oil seeds water column requirement=0.21) Cultivation		**Boro Cultivation (Water column requirement-1.2 m)**		**Vegetable (water column requirement Potato=0.6m)**		**Pulses (water column requirement =0.11 m)**		**Total Area covered (ha)**
%	**Area (ha)**	**%**	**Area (ha)**	**%**	**Area (ha)**	**%**	**Area (ha)**	
37	5948	28	4489	36	5800	0	0	16237

- The weighted average of water column used based on above data is about 0.6. For remaining area of 14318.57 Ha to be cultivated using same practice, estimated water required is 8591.14 Ham. Bur, resource estimation as on 31st March 2017 shows only 275.88 Ham is available from top aquifer.
- So, for further irrigation of remaining area of 14318.57 Ha, Surface run off should have to be utilised by constructing sufficient number of rainwater harvesting structures e.g. conservation and artificial recharge in a big way is suggested (discussed at the end).

Table 9.15 Number of ground water abstraction structures and Cultivable command area created by structure in Dhaniyakhali Block (Source 4th MI Census)

Block Name	Dug well		Shallow Tube well		Deep Tube well		Surface Flow		Surface Lift		CCA (ha.)		Total CCA (ha.)
	No.	**CCA**	**No**	**CCA**	**No**	**CCA**	**No.**	**CCA**	**No**	**CCA**	**Ground Water**	**Surface Water**	
Dhaniakhali	1	0	1260	3760	27	910	0	0	602	2010	4671	2010	6682

<u>Special intervention in Critical Block for monitoring of Ground water situations –</u>

- As per GEC Norms, for Critical Block, for proper estimation of ground water resources increase in observation wells are needed before GW Extraction. By doing this, Rainfall recharge during monsoon season by water table fluctuation method and trend of water table during pre- monsoon and post-monsoon can be estimated/evaluated with greater accuracy.
- Regular Water level monitoring is necessary.
- Rainwater harvesting is must in semi critical block.

Table 9.16 Irrigation scenario in Dhaniyakhali block

Geographical area in ha	**27568**	**Geographical area in ha**
Cultivable area in ha	21001	Cultivable area in ha
Net irrigated Command area (GW) in ha	4671.67	Net irrigated Command area (GW) in ha
Net irrigated Command area (SW) in ha	2010.76	Net irrigated Command area (SW) in ha
Net irrigated Command area (GW +SW) in ha	6682.43	Net irrigated Command area (GW +SW) in ha
Net area available for Irrigation	14318.57	Net area available for Irrigation
GW available for Future irrigation (ham)	275.88	GW available for Future irrigation (ham)
Pre monsoon WL Trend 2017 in cm/yr	F-27.31	Pre monsoon WL Trend 2017 in cm/yr
Post monsoon WL Trend 2017 in cm/yr	F-29.27	Post monsoon WL Trend 2017 in cm/yr
Average Pre monsoon WL in mbgl	9.21	Average Pre monsoon WL in mbgl
Average Post monsoon WL in mbgl	8.54	Average Post monsoon WL in mbgl
SOD in %	94	SOD in %
Category	Critical	Category
Remarks summary of Irrigation management plan	To arrest the declining trend of water level, more SW may be used than that of Ground water.	Remarks summary of Irrigation management plan

Rainwater harvesting & Artificial Recharge:

Table 9.17 Area suitable for recharge in the study area:

District	Block Name	Block Area (in ha)	Area suitable for recharge (Considering area having DTW more than 3m in Post-monsoon and showing 0.20m/yr and more falling trend) (in ha)
Hugli	**Dhaniyakhali**	**27511**	**16540**

Table 9.18 Estimation of Surface Runoff based on Run off co-efficient, Land slope, soil type, etc. (after Dhruvanarayana, 1993)

Block	Major type of soil available in that block	Normal Monsoon rainfall in m (50 years data from data.gov.in) 'Rn'	Total volume of surface runoff available Annually 'Vt' (Rn X A X C) ham	75% of 'Vt' = V	50% of V (Non committed) = Vnc	60% of Vnc (initially considered for harvesting) = Vf
Dhaniyakhali	**Sandy Loam/ Clay loam**	**1.098 (Average run off coefficient – 0.45)**	**13593.19**	**10194.89**	**5097.44**	**3058.47**

Table 9.19 Details of possible Conservation & artificial Recharge structures in block:

Row 1	Block Area in Ha	27511
Row 2	Area in Ha suitable for recharge	16540
Row 3	Soil type(3)	Sandy Loam/Clay loam
Row 4	Amount of water to be harvested	3058.47
Row 5	Amount of water for artificial recharge of top aquifer and conservation (Ham) - 70 % of Row. 4 (5)	2140.93
Row 6	Source water allocation for for Irrigation Cum Recharge Pond - 35% of Row 4 (6)	1070.46
Row 7	Source water allocation for REET with recharge shaft -35% of Row 4 (7)	1070.46
Row 8	Source water allocation for for injection well to recharge deeper aquifer -20% of Row 4 (8)	611.69

Row 9	Source water allocation for Farm Pond/Irrigation pond – 10 % of Row 4 (9)	305.84
Row 10	Nos. of Irrigation Cum Recharge Pond @ 50 Ham per unit (10)	21
Row 11	Nos. of REET with recharge shaft @ 10 Ham per unit	107
Row 12	Nos. of injection well suggested @ 30 Ham per unit (12)	20
Row 13	Nos. of Farm Pond @ 10 Ham per unit (12)	31
Row 14	Cost of Irrigation Cum Recharge Pond @ Rs 8 lakh per unit	168
Row 15	Cost of REET with recharge shaft @ Rs 8 lakh per unit	856
Row 16	Cost of injection well @ Rs 20 lakh per unit	600
Row 17	Cost of Farm Pond @ Rs 8 lakh per unit	248

Remarks

2/3 & 1/3 of block area is covered by clay & sand respectively; Conservation & artificial recharge structures proposed

Total Cost = 1872 lakh;

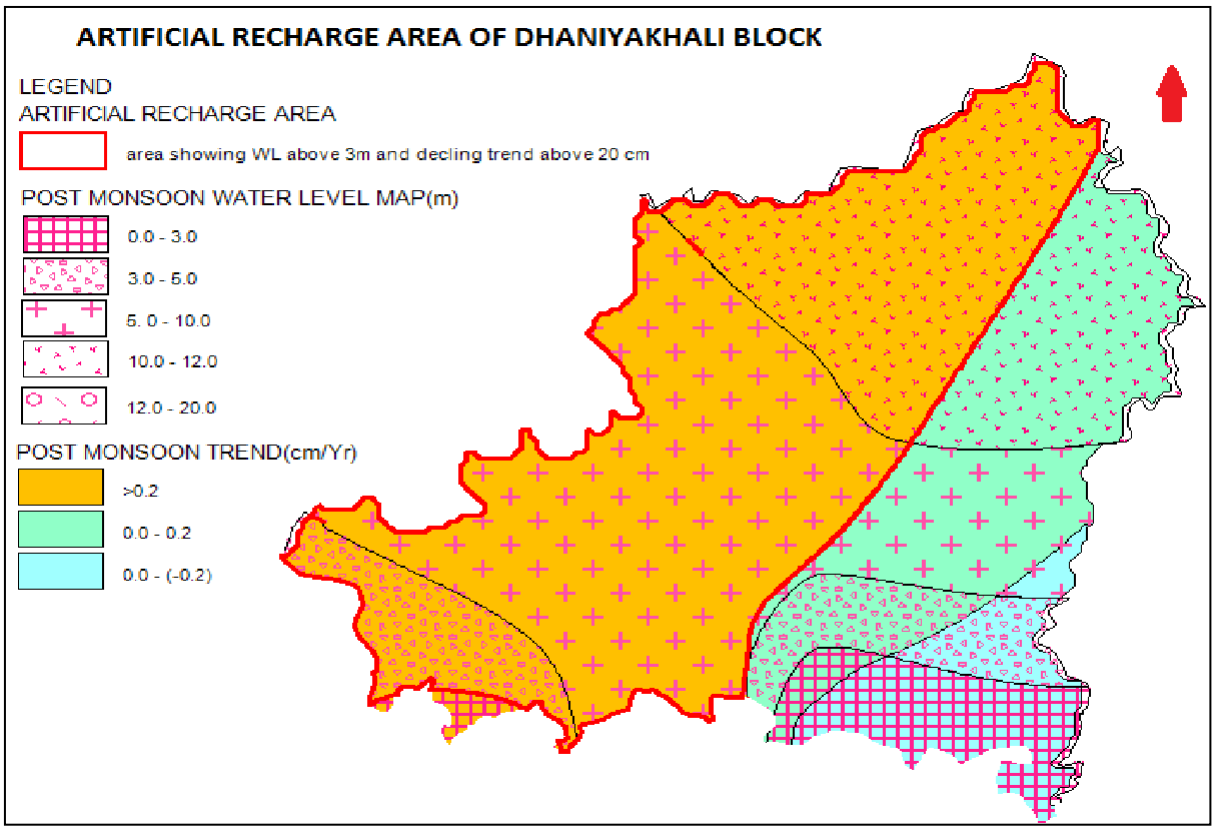

Figure 9.8 Area suitable for artificial recharge in Dhaniyakhali Block

10.0 HARIPAL BLOCK

10.1 Salient Information

- **Block Name: Haripal**
- **Reported Area (in ha): 18442**
- **District: Hugli**
- **State: West Bengal**
- **Population (as on 2011):**

Table 10.1 Details of Population in Haripal block

	Rural	Urban	Total
Haripal	**256507**	**4566**	**261073**

- **Rainfall:** Average annual rainfall (**Hugli district**) for the period 2013 -17 (in mm): **1336.96**

Table 10.2 Details of Annual Rainfall for last five years

Block	District Normal	Actual (Annual in mm)				
		2013	**2014**	**2015**	**2016**	**2017**
Haripal	1362	1365.3	1114.4	1549.1	1218.6	1437.4

- **Agriculture & Irrigation (area in ha):**

Table 10.3 Land-use pattern (Source-West Bengal Land use and Land cover Department)

Block	Aarea (Ha)	Area under non agriculture use (Ha)	Barren and un cultivable land (Ha)	Total agricultural land (Ha)	Pasture (Ha)	Orchard (Ha)	Cultivable waste (Ha)	Fallow land other than Current Fallow (Ha)	Current Fallow (Ha)	Forest (Ha)	Net sown area (Ha)
Haripal	18442	4473	5	14071	-	316	105	1	-	-	13799

10.2 Aquifer Wise Ground Water Resource Availability & Extraction:

Table 10.4 Details of aquifer wise resource availability and draft (in MCM)

Resource Availability	Aquifer I	Aquifer II	Aquifer III	Extraction (for Aquifer I)
Dynamic Resource	**67.64**	**0.16**	**-**	**28.75**
Static Resource	**31.25**			**-**

9.2.2: Disposition of Aquifer*:* In Haripal Block: 3 Aquifer Groups are explored:

- Depth range of Aquifer I Group is 18.28 m to 109.72 m, and it is part of Younger Alluvium Formation. In Aquifer I Group, sporadic ground water contamination by arsenic has been reported.
- The depth range of Aquifer II Group is 82.29 m to 201.15 m. It is divided into sub aquifers, aquifer IB and aquifer II; IB aquifer: 82.29 m to 155.44 m and aquifer II: 113m to 201.15 m, which is part of Older Alluvium Formation. In aquifer II, iron concentration in ground water is High.
- The range of Aquifer III Group is 188.97m - 278 m. It is divided into sub aquifers, III &IV: aquifer III: 188.97 m to 255 m, aquifer IV: 234.68 m to 278 m. This group is a part of Tertiary Formation. In this group, ground water potentiality is low.

Table 10.5 Aquifer disposition (depth range) in block

Block	Depth range of Aquifer Groups in mbgl		
	Aquifer I	**Aquifer II**	**Aquifer III**
Haripal	18.28 - 109.72	IB: 82.29 - 155.44 II : 113 - 201.15	III: 188.97-255 IV : 234.68-278

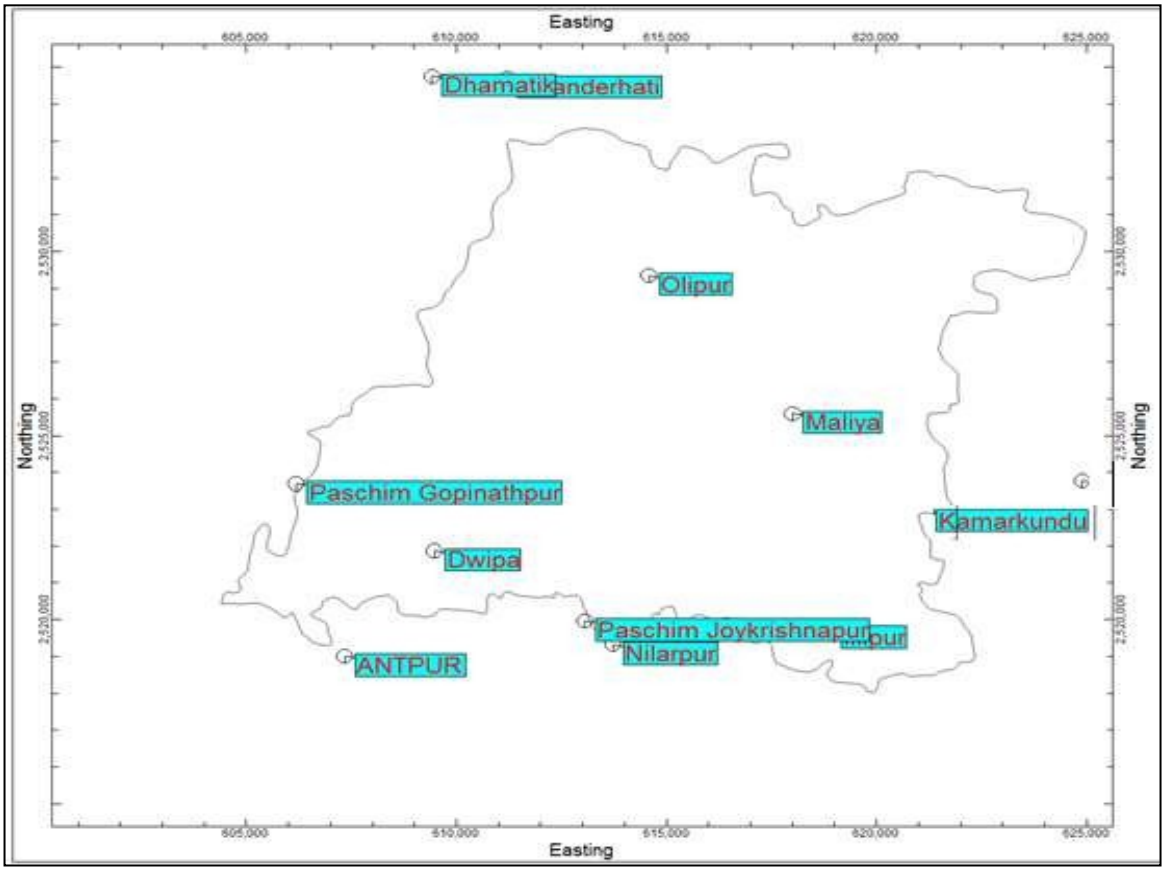

Figure 10.1 Index map of Haripal Block

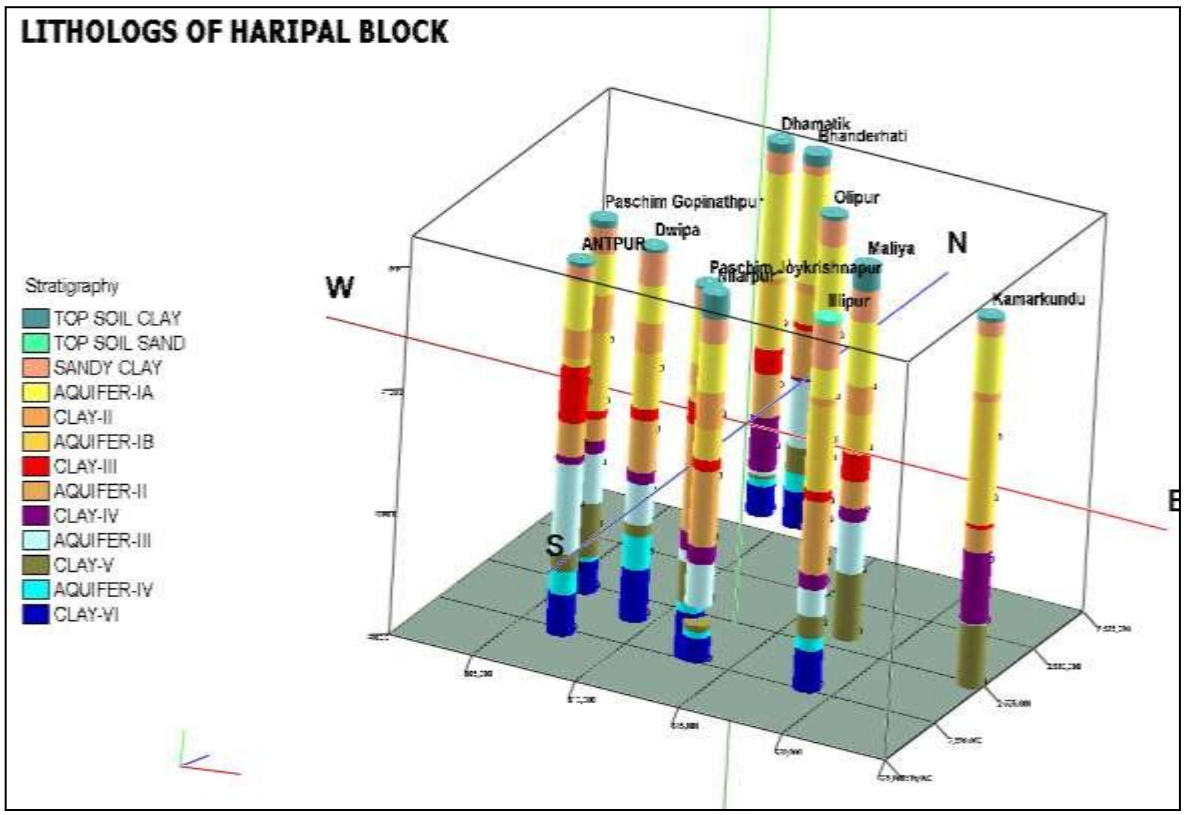

Figure 10.2 Lithologs in Haripal Block

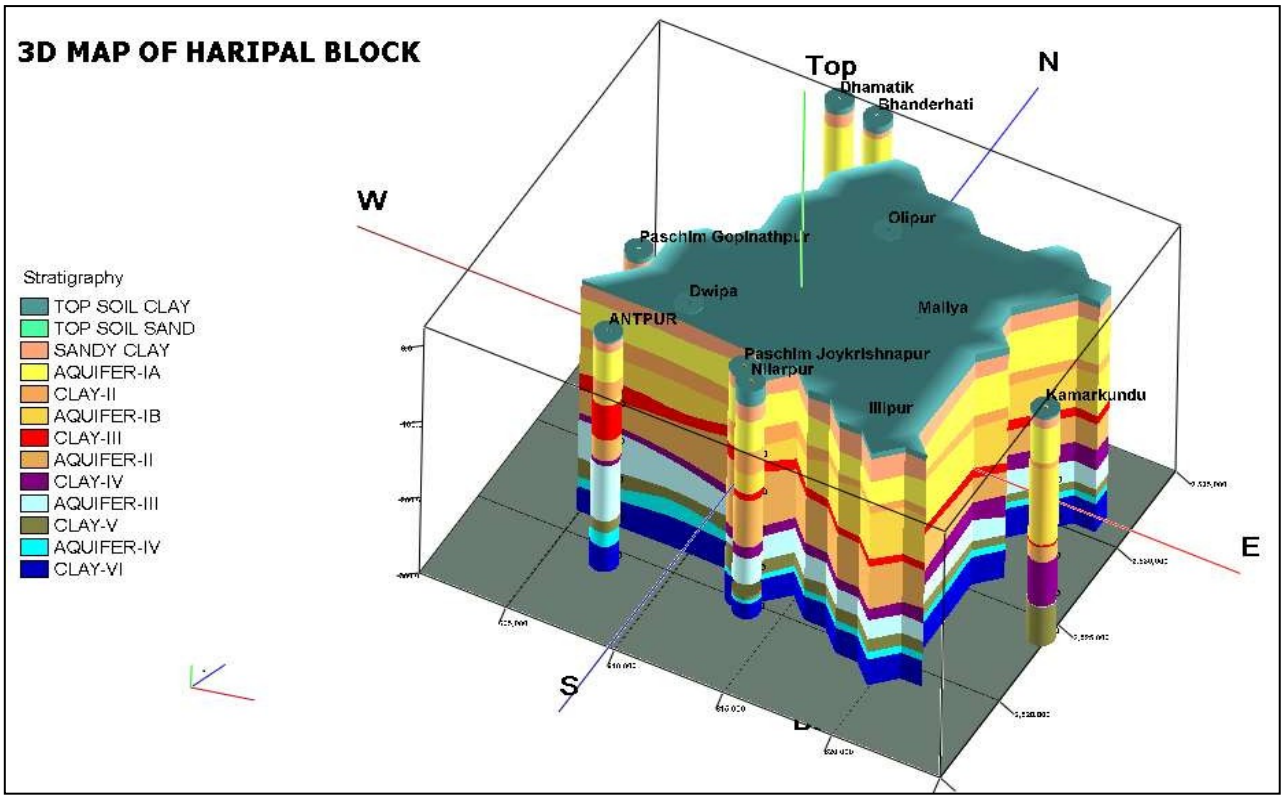

Figure 10.3 Aquifer disposition in Haripal Block

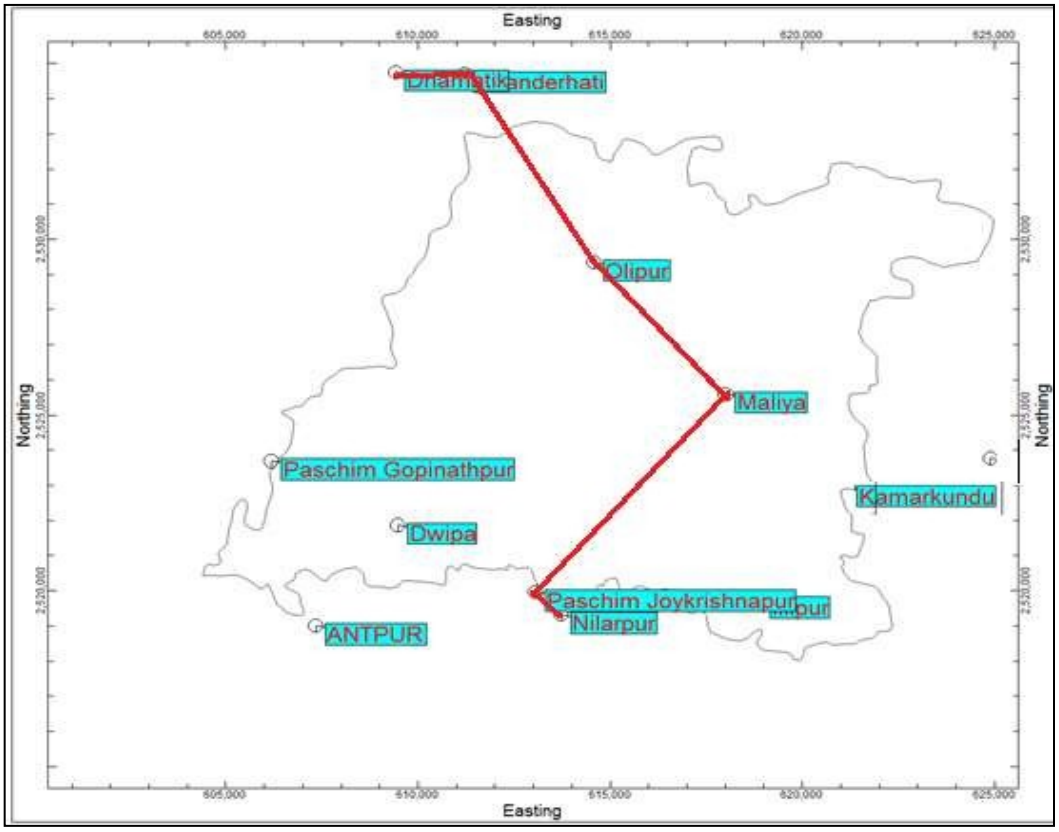

Figure 10.4 N - S Section Index line in Haripal Block

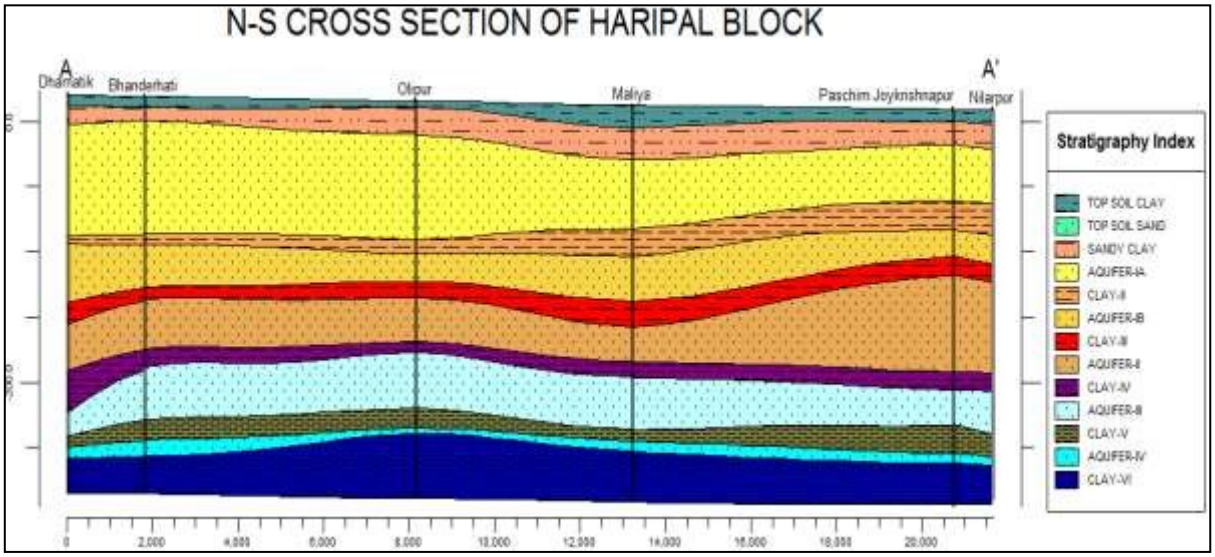

Figure 10.5 N-S Cross section in Haripal Block

Table 10.6 Aquifer disposition (depth range)

Aquifer Wise Water Level Ranges & Seasonal long term water level trends (2006 to 2017)

Block	Aquifer Groups	Pre-monsoon Trend			Post-monsoon Trend		
		Water Level Range	**Rise (cm/year**	**Fall (cm/year**	**Water Level**	**Rise (cm/ye**	**Fall (cm/year)**
Haripal	I	3.81-16.9	13.20	-	1.06-11.69	16.86	-
Haripal	II	13.84-14.23	-	-	5.9-6.44	-	-
Haripal	III	8.30 - 13.52	-	-	13.9 - 18.85	-	-

Table 10.7 Aquifer wise (Maximum) thickness

Block	Area (Sq km)	Thickness of the Granular Zone in Aquifer Group I (m)	Thickness of the Granular Zone in Aquifer Group II (m)	Thickness of the Granular Zone in Aquifer Group III (m)
Haripal	184.42	91.44	IB: 73.15 II: 88.15	III: 66.03 IV: 43.32

Table 10.8 Aquifer-wise depth range and parameters

Group	Sub Aquifer	Depth Range (mbgl)	Discharge (m^3/hr) with DD	T (m^2/day)	S	Specific capacity (m^3/day per m)
Aquifer Group I	IA	**18.28-109.72**	**6.29 (DD 1.07)**	**615.05(J*)/560.06(T**)**	**1.139x10^{-4}**	**21.16**
Aquifer Group II	IB	**82.29 - 155.4**	**90.4 (DD 6)**	**575.99**	**1.20 X 10^{-4}**	**15.06**
	II	**II**	**113 - 201.15**			
Aquifer Group III	III	**188.97 - 255**	**73.8 (DD 6)**	**430.5**	**9.6 X 10^{-10}**	**12.3**
	IV	**234.68 - 278**				

J*- Jacob's method; T - Theis's method**

10.3 Ground Water Resource, Extraction, Contamination & Other Issues

Aquifer Wise Resource Availability & Extraction: Dynamic ground water resources as on 31st March'17 in top aquifer i.e., Aquifer I

Table 10.9 Availability of Ground Water resource in Block

Block	Annual Extractable Ground Water	Current Total GW Extraction	Stage of development	Category	Annual GW Allocation for domestic use as on
Haripal	56.0862	38.5271	68.69	Safe	3.7567

Static (in-storage) Resources: 31.25 MCM

10.4 Chemical Quality of Ground Water & Contamination:

Based on Key well data and CGWB outsourcing exploratory well data blocks wise Average data of chemical parameter is given in Table 10.10.

Table 10.10 Aquifer wise average chemical parameter of block

Aquifer Groups	pH	EC (µs/cm)	TH	Ca	Mg	Na	K	HCO_3	Cl	NO_3	F(<1)	SiO_2(<5)	TDS
I	8.2	533.86	140.71	17.14	23.78	61.3	2.19	259.69	33.42	0	0.17	16.83	313.24

II	7.4	662.25	220.25	44	24.86	19.40	2.20	347.2	14.82	1.2	0.25	55.70	379.97
III	7.6	747.5	213.5	44.5	28.5	43.2	4.35	372	31	1.65	0.34	34.55	440

10.5 Ground Water Resource Enhancement& Management Plan:

Ground Water Management Plan for drinking purposes-

- The block is a 'Safe' block and as per Ground Water Policy priority of water is for drinking purpose.
- Regular Field monitoring is necessary for Arsenic concentration in tube wells.
- As per WBPHED Data, 82569 of population with 61 villages under risk zone where no water supply scheme exists.

Table 10.11 Details of drinking water uncovered population in Block

Block	Number of Villages to be covered by water supply schemes	Population in risk zone (2011) to be covered by water supply schemes.	Suggestions for providing water supply to the risk population
Haripal	61	82569	Aquifer-III is less productive (73.8 m^3/hr in comparison to aquifer-II and Aquifer-II is highly productive (90.40 m^3/hr)

- In Haripal block, Aquifer-III is less productive (73.8 m^3/hr) in comparison to Aquifer-II (90.40 m^3/hr).
- One well has constructed in Haripal tapping Aquifer-III through outsourcing reveals discharge of 73.8 m^3/hr.
- In Haripal block, Maliya, Olipur and Paschim Jaykrishnapur villages, three outsourced wells have been constructed in sites provided by PHED, Govt. Of west Bengal through outsourcing drilling of CGWB, tapping Aquifer-II reveal discharge of 72 m^3/hr, 79.2 m^3/hr, 120 m^3/hr respectively. Some wells have been constructed in villages, e.g., Dwipa, Paschim-Gopinathpur (sites provided by PHED, Govt. of west Bengal) by outsourcing; in these wells both aquifer II & III having have been tapped and discharge of 24 m^3/hr and

66 m^3/hr respectively have been encountered. All these wells can be used for supply of drinking water in that part of block.

- Considering overall values of discharge, an average discharge of 60 m^3/hr has been taken into consideration for village wise water supply schemes.

Table 10.12 : Village wise number and cost for construction of Tube wells based on Human and Cattle population

A	**Village**
B	**Population 2011**
C	**Projected Population 2021 (decadal growth rate 9.49%)**
D	**Present Water Requirement for Human Population in m^3 @70 lpcd**
E	**Projected Water Requirement for Human Population in m^3 @70 lpcd**
F	**Cattle 2011**
G	**Projected Cattle 2021**
H	**Present Water Requirement for cattle m^3 @20lpcd**
I	**projected Water Requirement for cattle m^3 @20lpcd**
J	**Total Water Requirement/day as of 2011 in m^3**
K	**Total Water Requirement cubic m/day as of 2021 in m^3**
L	**Discharge (m3/hr)**
M	**Discharge of one TW in m^3/day after 8 hours of pumping**
N	**No of TW**
O	**Cost of Tube well of 300 m depth (approx.) 10”x6" dia @ Rs. 20 lakhs (In lakh) as per EFC**

Block wise Management plan in parts of Hugli District, West Bengal

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
Harishpur	769	842	53.8	58.9	77	80	1.5	1.6	55.4	60.5	60	480	0	0
Balia	3116	3412	218.1	238.8	312	323	6.2	6.5	224.4	245.3	60	480	1	20
Bhagabatipur	636	696	44.5	48.7	64	66	1.3	1.3	45.8	50.1	60	480	0	0
Jigra	1061	1162	74.3	81.3	106	110	2.1	2.2	76.4	83.5	60	480	0	0
Bahir Khanda	3861	4227	270.3	295.9	386	400	7.7	8.0	278.0	303.9	60	480	1	20
Dulla	2232	2444	156.2	171.1	223	231	4.5	4.6	160.7	175.7	60	480	0	0
Paschim Narayanpur	4184	4581	292.9	320.7	418	433	8.4	8.7	301.2	329.3	60	480	1	20
Tajpur	934	1023	65.4	71.6	93	96	1.9	1.9	67.2	73.5	60	480	0	0
Chak Dumur	1273	1394	89.1	97.6	127	132	2.5	2.6	91.7	100.2	60	480	0	0
Sundarpur	425	465	29.8	32.6	43	45	0.9	0.9	30.6	33.4	60	480	0	0
Basuri	1319	1444	92.3	101.1	132	137	2.6	2.7	95.0	103.8	60	480	0	0
Sirazpur	1347	1475	94.3	103.3	135	140	2.7	2.8	97.0	106.1	60	480	0	0
Shrirampur	620	679	43.4	47.5	62	64	1.2	1.3	44.6	48.8	60	480	0	0
Joyrampur	935	1024	65.5	71.7	94	97	1.9	2.0	67.3	73.6	60	480	0	0
Maheshwarpur	1252	1371	87.6	96.0	125	130	2.5	2.6	90.1	98.6	60	480	0	0
Bhupatipur	52	57	3.6	4.0	5	5	0.1	0.1	3.7	4.1	60	480	0	0

Sahara	974	1066	68.2	74.6	97	101	1.9	2.0	70.1	76.6	60	480	0	0
Gopal Prosad	1000	1095	70.0	76.7	100	104	2.0	2.1	72.0	78.7	60	480	0	0
Paschim Mallikpur	1112	1218	77.8	85.3	111	115	2.2	2.3	80.1	87.6	60	480	0	0
Kanakpur	1697	1858	118.8	130.1	170	176	3.4	3.5	122.2	133.6	60	480	0	0
Krishna Ballabhbati	1277	1398	89.4	97.9	128	133	2.6	2.7	92.0	100.5	60	480	0	0
Sipai Gachhi	1729	1893	121.0	132.5	173	179	3.5	3.6	124.5	136.1	60	480	0	0
Paharpur	378	414	26.5	29.0	38	39	0.8	0.8	27.2	29.8	60	480	0	0
Chak Chandinagar	1414	1548	99.0	108.4	141	146	2.8	2.9	101.8	111.3	60	480	0	0
Raghubati	1047	1146	73.3	80.2	105	109	2.1	2.2	75.4	82.4	60	480	0	0
Hara	2066	2262	144.6	158.3	207	215	4.1	4.3	148.8	162.6	60	480	0	0
Brahmanpara	1220	1336	85.4	93.5	122	126	2.4	2.5	87.8	96.1	60	480	0	0
Rajaballabhbati	2056	2251	143.9	157.6	206	214	4.1	4.3	148.0	161.8	60	480	0	0
Kalachhara	982	1075	68.7	75.3	98	102	2.0	2.0	70.7	77.3	60	480	0	0
Mirzzapur	314	344	22.0	24.1	31	32	0.6	0.6	22.6	24.7	60	480	0	0
Faridpur	1533	1678	107.3	117.5	153	159	3.1	3.2	110.4	120.6	60	480	0	0

Chandanpur	2347	2570	164.3	179.9	235	244	4.7	4.9	169.0	184.8	60	480	0	0
Porra	1039	1138	72.7	79.7	104	108	2.1	2.2	74.8	81.8	60	480	0	0
Harat	933	1022	65.3	71.5	93	96	1.9	1.9	67.2	73.5	60	480	0	0
Kumragari	703	770	49.2	53.9	70	73	1.4	1.5	50.6	55.4	60	480	0	0
Dogeria	356	390	24.9	27.3	36	37	0.7	0.8	25.6	28.1	60	480	0	0
Kangai	485	531	34.0	37.2	49	51	1.0	1.0	34.9	38.2	60	480	0	0
Chapsara	525	575	36.8	40.3	53	55	1.1	1.1	37.8	41.4	60	480	0	0
Bakula	1142	1250	79.9	87.5	114	118	2.3	2.4	82.2	89.9	60	480	0	0
Mahisatikri	2474	2709	173.2	189.6	247	256	4.9	5.1	178.1	194.8	60	480	0	0
Aimachapsara	923	1011	64.6	70.8	92	95	1.8	1.9	66.5	72.7	60	480	0	0
Uttar Ramchandrapur	788	863	55.2	60.4	79	82	1.6	1.6	56.7	62.1	60	480	0	0
Madanmohonpur	1400	1533	98.0	107.3	140	145	2.8	2.9	100.8	110.2	60	480	0	0
Lakshmanpur	346	379	24.2	26.5	35	36	0.7	0.7	24.9	27.3	60	480	0	0
Bade Digaria	357	391	25.0	27.4	36	37	0.7	0.8	25.7	28.1	60	480	0	0
Dank	1263	1383	88.4	96.8	126	131	2.5	2.6	90.9	99.4	60	480	0	0
Baje Ichhlampur	923	1011	64.6	70.8	92	95	1.8	1.9	66.5	72.7	60	480	0	0

Ichhlampur	3417	3741	239.2	261.9	342	355	6.8	7.1	246.0	269.0	60	480	1	20
Parjana	1478	1618	103.5	113.3	148	153	3.0	3.1	106.4	116.3	60	480	0	0
Kinkarkati	1267	1387	88.7	97.1	127	132	2.5	2.6	91.2	99.7	60	480	0	0
Purbba Gopinathpur	2622	2871	183.5	201.0	262	272	5.2	5.4	188.8	206.4	60	480	0	0
Hasimpur	871	954	61.0	66.8	87	90	1.7	1.8	62.7	68.6	60	480	0	0
Santipur	1023	1120	71.6	78.4	102	106	2.0	2.1	73.7	80.5	60	480	0	0
Dakshin Ramchandrapur	460	504	32.2	35.3	46	48	0.9	1.0	33.1	36.2	60	480	0	0
Panrra	3919	4291	274.3	300.4	392	406	7.8	8.1	282.2	308.5	60	480	1	20
Prasadpur	1019	1116	71.3	78.1	102	106	2.0	2.1	73.4	80.2	60	480	0	0
Kamalpur	691	757	48.4	53.0	69	72	1.4	1.4	49.8	54.4	60	480	0	0
Kulpai	918	1005	64.3	70.4	92	95	1.8	1.9	66.1	72.3	60	480	0	0
Purba Jaykrishnapur	345	378	24.2	26.5	35	36	0.7	0.7	24.9	27.2	60	480	0	0
Jhinka	1154	1264	80.8	88.5	115	119	2.3	2.4	83.1	90.9	60	480	0	0
Bargachhia	4566	4999	319.6	349.9	457	474	9.1	9.5	328.8	359.4	60	480	1	20
Total	**82569**	**90405**	**5779.8**	**6328.6**	**8259**	**8561**	**165.2**	**171.2**	**5945.0**	**6499.9**	**60**	**29280**	**6**	**120**

- From Table 10.12, it is estimated that 6 wells are required for supply of drinking water in uncovered villages of Haripal block, Hugli district, West Bengal; the existing pipe water supply status by PHED has been presented in Figure 10.7.

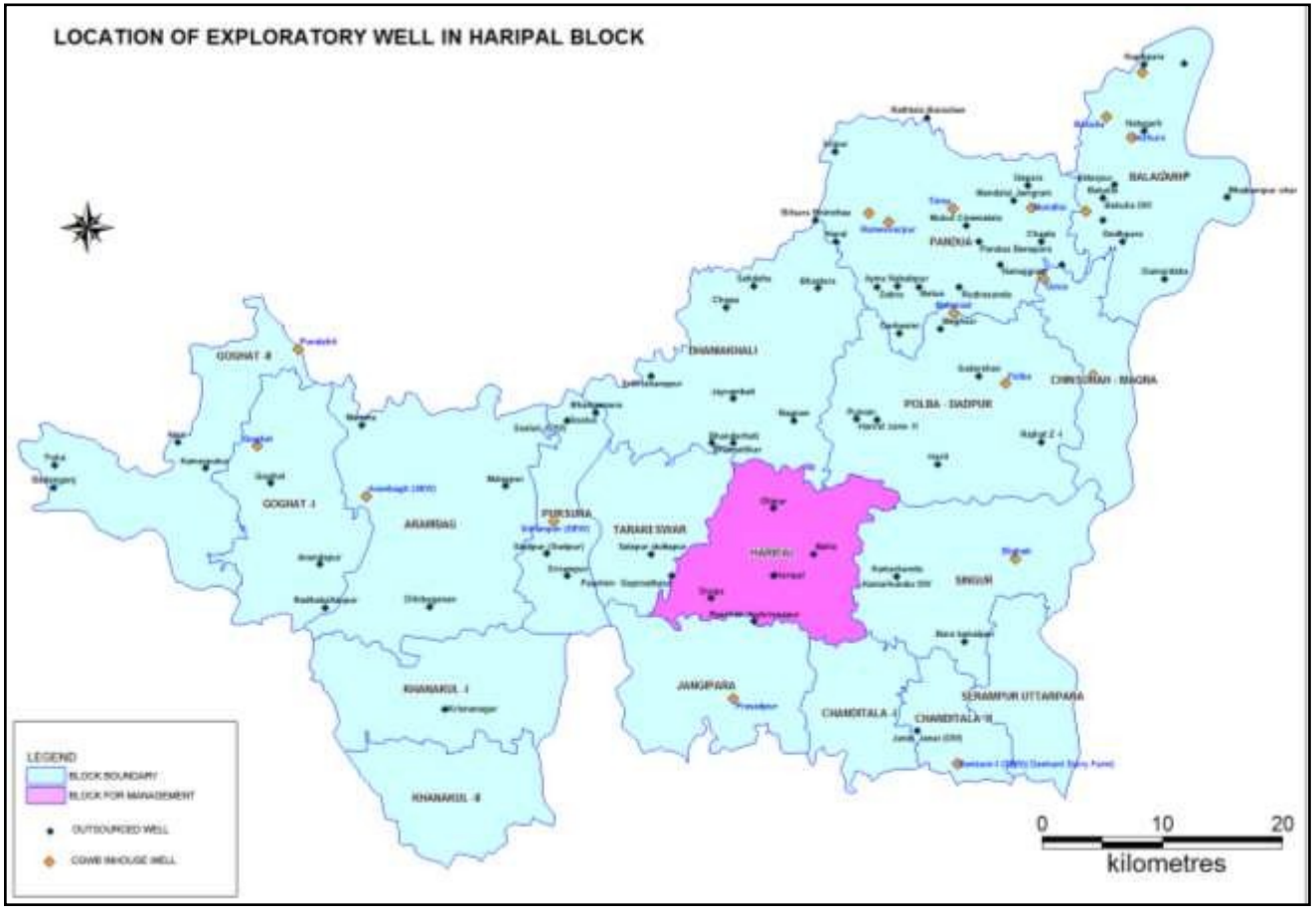

Figure 10.6 Location of Exploratory wells through outsourcing in Haripal Block

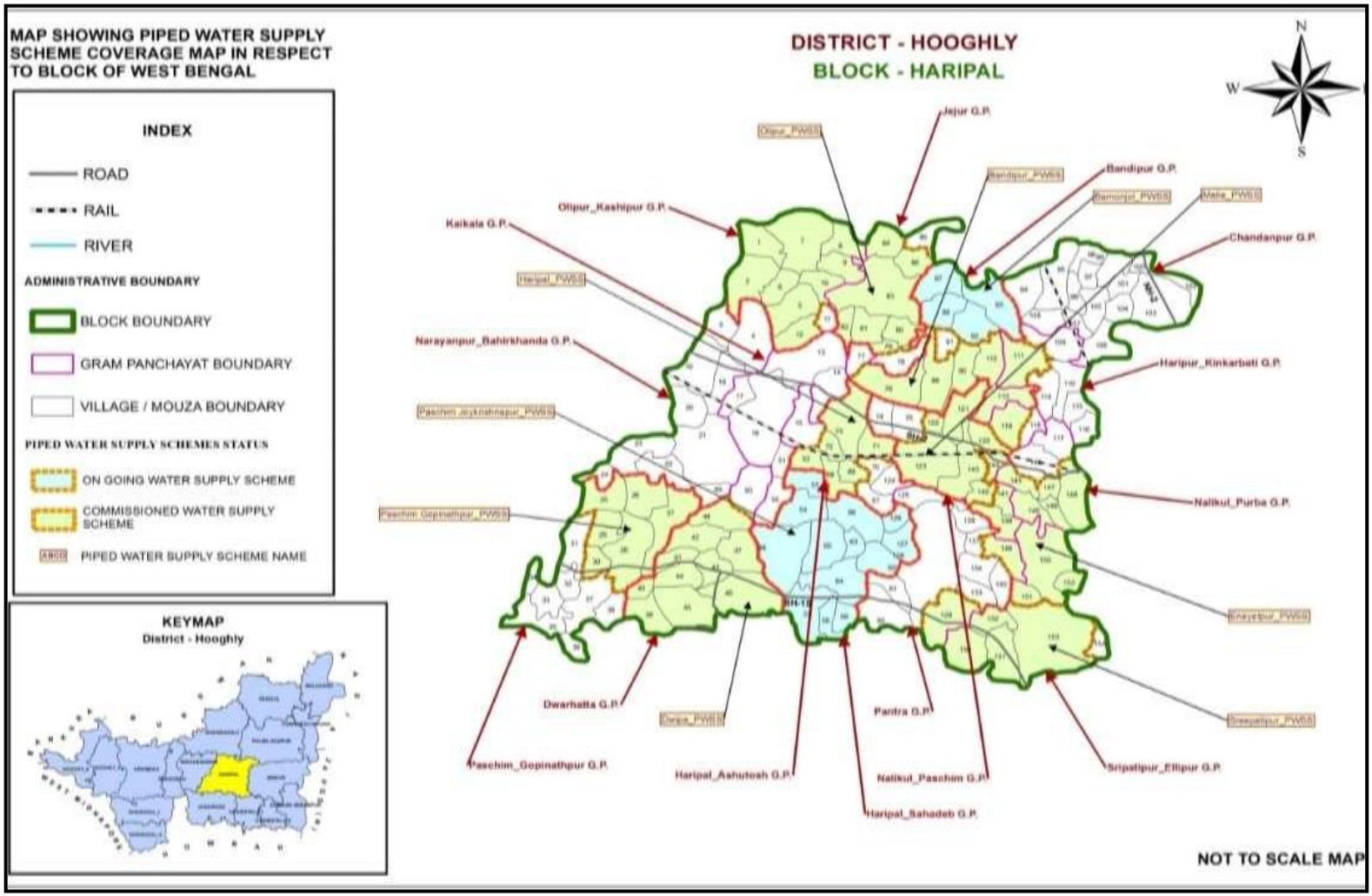

Figure 10.7 Drinking water supply scheme status in Haripal Block (Source-WBPHED) according to Census -2011

- 3 wells constructed in Aquifer-II Group and one well-constructed in Aquifer-III Group and two wells are constructed tapping both Aquifer Groups.
- These wells can be used for supplying surplus water in that part of the block
- For monitoring of the ground water, regime if observation well is needed then cost of construction of the same should also include in the expenditure.
- In the initial stage of development of drinking water management, plan 25 % wells should be constructed. Based on result whole plan should be implemented.
- Phase wise drilling should be started for accurate results.
- After construction of wells, analysis of arsenic and other 'heavy' metals should be done.

Management Plan for irrigation:

- Based on CGWB Resource data, block is under Safe Category. Stage of Ground Water development is 68.69 %, with rising long term ground water level.
- As per 4th MI Census irrigation data in this block number of Shallow Tube Wells and Surface water is also used (given in Table 10.12)
- Application of modern technologies like Sprinkler, Drip irrigation may be implemented; also, fresh and Arsenic bearing water, if any, in a suitable ratio may be blended and used for irrigation at least on experimental basis.
- As this part in West Bengal is prone to arsenic contamination, regular monitoring of arsenic concentration in crop is necessary.
- R & D study is necessary for obtaining better solutions in future.
- In Haripal block according to soil and climatic condition Jute, rice and potato are more suitable for cultivation.
- Water is, under present situation, is available so cash crops can be cultivated with caution.

Table 10.13 Cropping pattern under practice in block

Name of Block		Haripal
Aus	Area	187
	Prod.	0.551
	Yield	2944
Aman	Area	13688
	Prod.	35.819
	Yield	2617
Boro	Area	4568
	Prod.	13.073
	Yield	2862
Jute	Area	1195
	Prod.*	24.593
	Yield**	20.58
Mustard	Area	194
	Prod.	0.177
	Yield	914
Til	Area	2264
	Prod.	1.788
	Yield	790
Potato	Area	8466
	Prod.	173.968
	Yield	20549

(Area in hectare, Production in Thousand MT and Yield in kg./hec)

(Courtesy: Department of Economics and Statistics)

From Table 10.13, percentage wise crop covering area of block has been estimated and presented in Table 10.14.

Table 10.14 area wise percentage of current practice of crops in Haripal Block

Area wise Current Practice of crops						
Rabi Crops (Wheat, Mustard and oil seeds water Column requirement=0.21) Cultivation		**Boro Cultivation (Water Column requirement-1.2 m)**		**Vegetable (water Column requirement Potato=0.6m)**		**Total Area covered (ha)**
%	**Area (ha)**	**%**	**Area (ha)**	**%**	**Area (ha)**	
16	2458	29	4568	55	8466	15492

Based on data of Table 10.14, the factor of weighted average of water column required is 0.7; so, for irrigation of remaining cultivable area of 8365.12 Ha, 5855.58 Ham water is required. But resource estimation as of 2017, only 1662.25 Ham water from top aquifer is available. However, available water resource could be used for irrigation with change in cropping pattern as given in Table 10.15, below; but, whatsoever cropping pattern is used, but still some cultivable area will remain left out and for irrigation in that area harvested run off component of rainfall could be utilised for complete coverage of cultivable land by irrigation as described at the end.

Table 10.15 Future Water allocation for remaining cultivable area considering SOD, Soil conditions and cropping pattern of the block

Present water availability	Considering total available water for future irrigation	Rabi Crops (Wheat, Mustard and oil seeds water Column requirement=0.21) Cultivation		Boro Cultivation (Water Column requirement-1.2 m)		Vegetable (water Column requirement Potato=0.6m)		Total Area covered(A)	Remaining Cultivable area (ha) (8365.12-A)
		% of water	Area (ha)	% of water	Area (ha)	% of water	Area (ha)		
1662.25	1662.25	40	3166.19	20	277.04	40	1108.17	4351.40	4013.72
1662.25	1662.25	60	4749.28	10	138.53	30	831.13	5718.94	2646.19
1662.25	1662.25	90	7123.93	0	0	10	277.05	7400.98	964.14

Table 10.16 Number of structures and Cultivable command area created by structure in Dhaniyakhali Block

Block Name	Dug well		Shallow Tube well		Deep Tube well		Surface Flow		Surface Lift		CCA		Total CCA (ha.)
	No.	**CCA**	**No.**	**CCA**	**No**	**CCA**	**No**	**CCA**	**No**	**CCA**	**Ground Water**	**Surface Water**	
HARIPAL	0	0	681	3934.49	23	788.79	0	0	338	982.6	4723.28	982.6	5705.88

Table 10.17 Summary of irrigation plan in Dhaniyakhali block

Cultivable area in ha	**14071**
Net irrigated Command area (GW) in ha	4723.28
Net irrigated Command area (SW) in ha	982.6
Net irrigated Command area (GW +SW) in ha	5705.88
Net area available for Irrigation	8365.12
GW available for Future irrigation (ham)	1662.25
Pre monsoon WL Trend 2017 in cm/yr	R-13.20
Post monsoon WL Trend 2017 in cm/yr	R-16.86
Average Pre monsoon WL in mbgl	13.38
Average Post monsoon WL in mbgl	6.64
SOD in %	68.69
Category	Safe
Remarks summary of Irrigation management plan	SOD is low and GW trend is rising; Boro cultivation should be reduced in phases.

Rainwater harvesting & Artificial Recharge

Table 10.18 Area suitable for recharge in the study area:

District	Block	Area (in ha)	Area suitable for recharge(Considering area having DTW above 3m in post monsoon and showing 0.2m/y falling trend)(in ha)
Hugli	Haripal	18438	1483

Table 10.19 Estimation of Surface runoff based on Run off coefficient, Land slope, soil type, etc. (after Dhruvanarayana, 1993)

Block	Major type of soil available in that block	Normal Monsoon rainfall in m (50 yrs data from data.gov.in) 'Rn'	Total volume of surface runoff available Annually 'Vt' (RnXAXC) Ham	75% of 'Vt' = V	50% of V (Non committed)= Vnc	60% of Vnc (initially considered for harvesting)= Vf
Haripal	**Clay**	**1.098 (average run off co-efficient – 0.50)**	**10122.46**	**7591.85**	**3795.92**	**2277.55**

On the basis of soil characteristic, Slope, Rain fall data and Long term trend of ground water number of structures are calculated and given below.

Table 10.20 Details of possible Conservation & Recharge structures in block

Row 1	Block Area in Ha	**18438**
Row 2	Area in Ha suitable for recharge	1483
Row 3	Soil type(3)	Clay Loam/sandy clay Loam
Row 4	Amount of water to be harvested	2277.55
Row 5	Amount of water for artificial recharge of top aquifer and conservation (Ham) - 70 % of Row. 4 (5)	1594.29
Row 6	Source water allocation for for Irrigation Cum Recharge Pond - 35% of Row 4 (6)	797.14
Row 7	Source water allocation for REET with recharge shaft -35% of Row 4 (7)	797.14
Row 8	Source water allocation for for injection well to recharge deeper aquifer -20% of Row 4 (8)	455.51
Row 9	Source water allocation for Farm Pond/Irrigation pond – 10 % of Row 4 (9)	227.75
Row 10	Nos. of Irrigation Cum Recharge Pond @ 50 Ham per unit (10)	16
Row 11	Nos. of REET with recharge shaft @ 10 Ham per unit	80
Row 12	Nos. of injection well suggested @ 30 Ham per unit (12)	15
Row 13	Nos. of Farm Pond @ 10 Ham per unit (12)	23
Row 14	Cost of Irrigation Cum Recharge Pond @ Rs 8 lakh per unit	128
Row 15	Cost of REET with recharge shaft @ Rs 8 lakh per unit	640
Row 16	Cost of injection well @ Rs 20 lakh per unit	300
Row 17	Cost of Farm Pond @ Rs 8 lakh per unit	184

Remarks: ¾ area & 1/4 area is covered by clay & sand respectively; Total cost = 1252 lakh

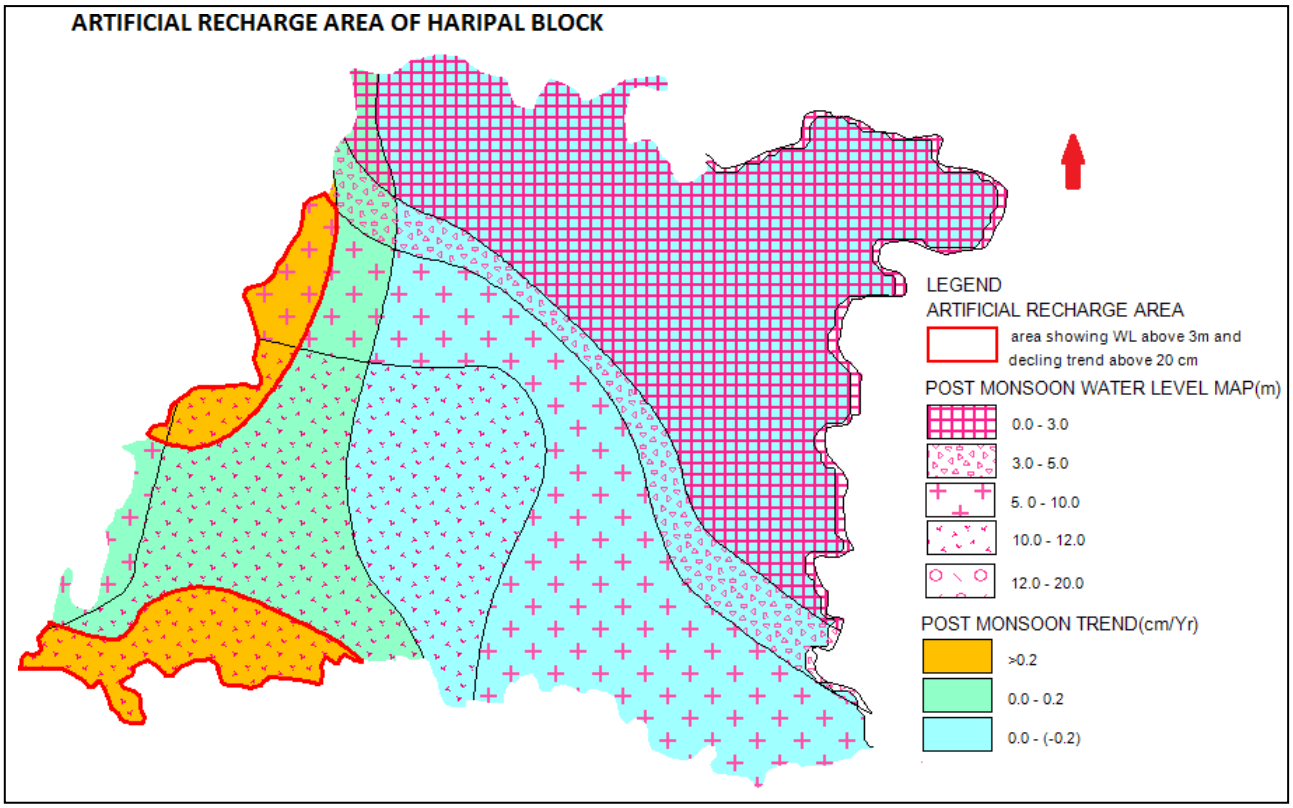

Figure 10.8 Map showing area suitable for artificial recharge in Haripal Block

11.0 CHANDITALA-II BLOCK

11.1 Salient Information

- **Block Name: Chanditala-II**
- **Area (in ha):7042**
- **District: Hugli**
- **State: West Bengal**
- **Population (as on 2011):**

Table 11.1 Details of Population in Chanditala-II block

Rural	Urban	Total
48894	**109502**	**158396**

- **Rainfall:** Average annual rainfall (**Hugli district**) for the period 2013 -17 (in mm):**1336.96**

Table 11.2 Details of Annual Rainfall since last Hugli district five year

Block	District	Actual (Annual)				
	Normal	**2012**	**2013**	**2014**	**2015**	**2016**
Chanditala-II	**1362**	**1365.3**	**1114.4**	**1549.1**	**1218.6**	**1437.4**

- **Agriculture & Irrigation (area in ha):**

Table 11.3 Details of Land use pattern of block (Source-West Bengal Land use and Land cover Department) Area in ha.

Block	area (Ha)	Area under non agriculture use	Barren and un-cultivable land)	Total agricultural land	Pasture	Orchard	Cultivable waste	Fallow land other than Current Fallow	Current Fallow	Forest	Net sown area
Chanditala-II	7042	3147	2	2548.22	-	250	45	-	-	-	2421

11.2 Aquifer Wise Ground Water Resource Availability & Extraction:

11.3 Ground Water Resource, Extraction, Contamination & Other Issues:

Aquifer Wise Resource Availability & Extraction: Dynamic ground water resources as on 31st March'17 in top aquifer i.e. Aquifer I

Table 11.9 Availability of Ground Water resource in Block

Block	Annual Extractable Ground Water Recharge (MCM)	Current Annual Total Extraction (MCM)	Stage of development (%)	Category	Annual Ground Water Allocation for Domestic use as on 2042 (MCM)
Chanditala-	**16.7644**	**10.5877**	**63.76**	**Safe**	**3.763**

Static (in-storage) Resources: 11.24 MCM

11.4 Chemical Quality of Ground Water &Contamination:

Based on 10- 12 Key well data and CGWB outsourced exploratory well data blocks wise Average data of chemical parameter is given below.

Table 11.10 Aquifer wise average chemical parameter of block

Aquifer Groups	pH	Conductivity (µs/cm)	TH	Ca	Mg	Na	K	Bicarbonate	Cl	NO_3	SO_4 (<5)	F (<1)	SiO_2 (<5)	TDS
I	**8.2**	**619.3**	**100.7**	**10.9**	**17.9**	**95.9**	**2.8**	**304.1**	**42.5**	**0.0**	**0.0**	**0.3**	**14.4**	**370.2**
II	**8.1**	572.0	120.0	16.0	19.4	74.7	3.1	280.6	28.4	0.0	4.1	0.0	19.3	336.1
III	**7.5**	1040.0	259.0	55.0	23.0	36.0	1.8	400.0	57.0	2.3	BDL	0.5	39.9	520.0

11.5 Ground Water Resource Enhancement& Management Plan:

Ground Water Management Plan for drinking purposes-

- The block is under Safe Category; as per Ground Water Policy first priority of ground water is for drinking purpose.
- Regular monitoring is necessary for assessment ground water contamination by Arsenic in tube wells.
- As per WBPHED Data 60380 population in 18 villages where no water supply scheme is exist.

Table 11.11 Details of drinking water uncovered population in Block

Block	Number of Villages to be covered by water supply schemes	Population in risk zone (as per Census 2011) to be covered by water supply schemes.	Comments on providing water supply to the risk population
Chanditala - II	18	60380	Aquifer - III is less productive (73.8 m^3/hr) in comparison to Aquifer-II, which is highly productive (182.89 m^3/hr). Considering average discharge of 73.8 m^3/hr, number of tube wells has been estimated for pipe water supply of potable water in uncovered villages.

- In Chanditala-II block, outsourced tube well tapping Aquifer - III at Jannai (shown in Fig - 9.3.6.) has been found less productive (73.8 m^3/hr) in comparison to well tapping Aquifer - II (182.89 m^3/hr).
- These wells could be used for supply of drinking water in that part of block.
- Visualising overall situation for preparation of village wise water supply schemes average discharge 73.86 m^3/hr has been considered.

Block wise Management plan in parts of Hugli District, West Bengal

A	**Village**
B	**Population 2011**
C	**Projected Population 2021 (decadal growth rate 9.49%)**
D	**Present Water Requirement for Human Population in m^3 @70 lpcd**
E	**Projected Water Requirement for Human Population in m^3 @70 lpcd**
F	**Cattle 2011**
G	**Projected Cattle 2021**
H	**Present Water Requirement for cattle m^3 @20lpcd**
I	**projected Water Requirement for cattle m^3 @20lpcd**
J	**Total Water Requirement/day as on 2011 in m^3**
K	**Total Water Requirement cubic m/day as on 2021 in m^3**
L	**Discharge (m3/hr)**
M	**Discharge of one TW in m^3/day after 8 hours of pumping**
N	**No of TW**
O	**Cost of Tube well of 300 m depth (approx.) 10”x6" dia @ Rs. 20 lakhs (In lakh) as per EFC**

Table 11.12 Village wise number of Tube wells and cost for construction estimated in Chanditala-II block

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
Gokulpur	560	613	39.2	42.91	56	58	1.12	1.16	40.32	44.07	73.8	590.4	0	0
Bamandanga	2743	3003	192.01	210.21	274	284	5.48	5.68	197.49	215.89	73.8	590.4	0	0
Kalachhara	4225	4626	295.75	323.82	423	438	8.46	8.77	304.21	332.59	73.8	590.4	1	20
Pairagachha (CT)	4703	5149	329.21	360.43	470	487	9.4	9.74	338.61	370.17	73.8	590.4	1	20
Benipur	1161	1271	81.27	88.97	116	120	2.32	2.4	83.59	91.37	73.3	590.4	0	0
Jagannathbati	1846	2021	129.22	141.47	185	192	3.7	3.84	132.92	145.31	73.8	590.4	0	0
Sanka	1265	1385	88.55	96.95	127	132	2.54	2.63	91.09	99.58	73.8	590.4	0	0
Okardaha	2944	3223	206.08	225.61	294	305	5.88	6.1	211.96	231.71	73.8	590.4	0	0
Sahana	1944	2128	136.08	148.96	194	201	3.88	4.02	139.96	152.98	73.8	590.4	0	0
Kapashanria	5148	5637	360.36	394.59	515	534	10.3	10.68	370.66	405.27	73.8	590.4	1	20
Tisa	4882	5345	341.74	374.15	488	506	9.76	10.12	351.5	384.27	73.8	590.4	1	20
Madhabpur	3982	4360	278.74	305.2	398	413	7.96	8.25	286.7	313.45	73.8	590.4	1	20
Duttapur	2285	2502	159.95	175.14	229	237	4.58	4.75	164.53	179.89	73.8	590.4	0	0
Khoragari	1827	2000	127.89	140	183	190	3.66	3.79	131.55	143.79	73.8	590.4	0	0
Barijhati (CT)	7136	7813	499.52	546.91	714	740	14.28	14.8	513.8	561.71	73.8	590.4	1	20
Makhalpara	113	124	7.91	8.68	11	11	0.22	0.23	8.13	8.91	73.8	590.4	0	0
Garalgachha (CT)	5411	5925	378.77	414.75	541	561	10.82	11.22	389.59	425.97	73.8	590.4	1	20
Krishnapur (CT)	8205	8984	574.35	628.88	821	851	16.42	17.02	590.77	645.9	73.8	590.4	1	20
Total	60380	66109	4226.6	4627.63	6039	6260	120.78	125.2	4347.38	4752.83	73.8	10627.2	8	160

from Table 11.12, 8 wells are required for supply of drinking water in uncovered part of Chanditala-II Block, Hugli District, West Bengal; Pipe Water Supply status already done by PHED has been given in Table 11.11

- Already wells have been constructed by outsourcing; these wells could be used for supply of water.
- If observation well is needed for monitoring of the ground water regime, then cost of construction of the same should also be included in the cost estimate.
- Phase wise drilling should be started for having better result; at the initial stage 25 % of estimated nos. of wells should be constructed. Afterwards, whole plan should be implemented.
- After construction of well analysis of arsenic and heavy metal content in ground water should be done.

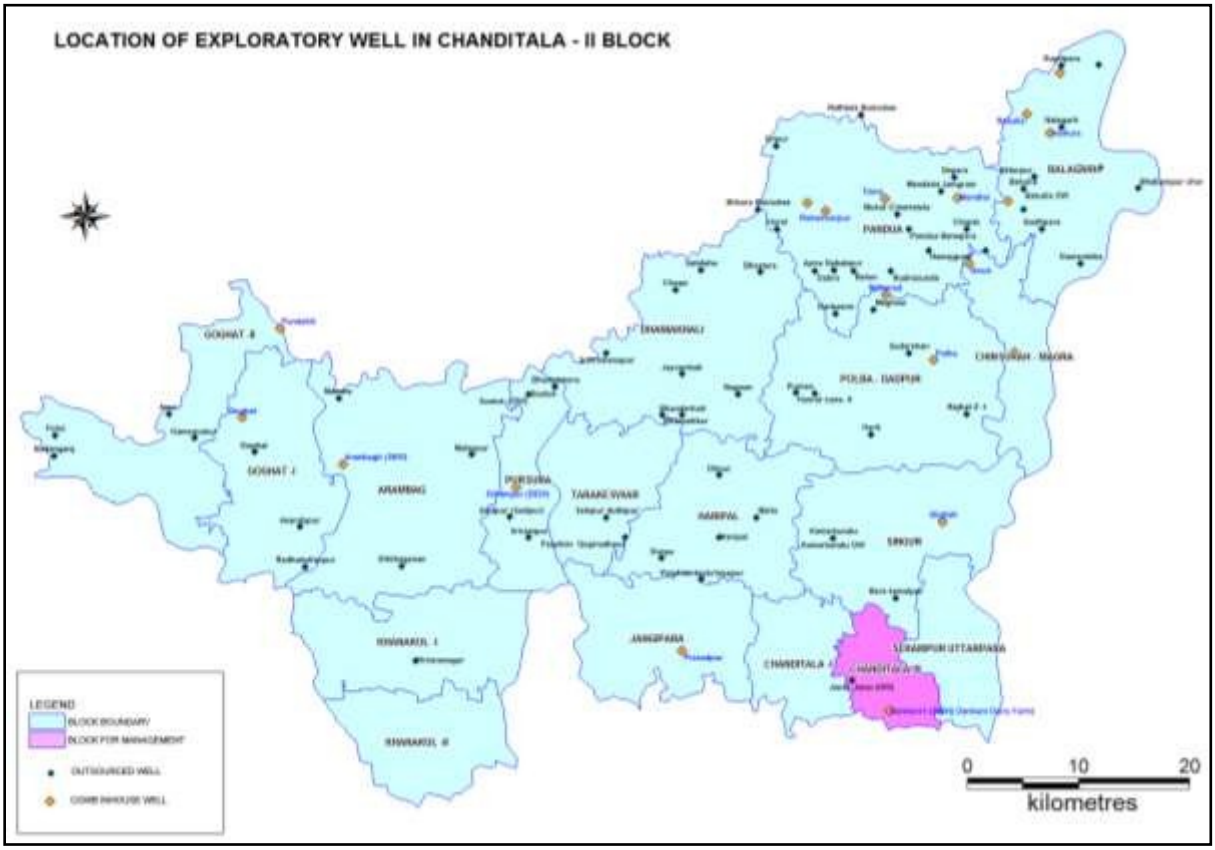

Figure 11.6 Location of Exploratory wells constructed by outsourcing in Chanditala-II Block

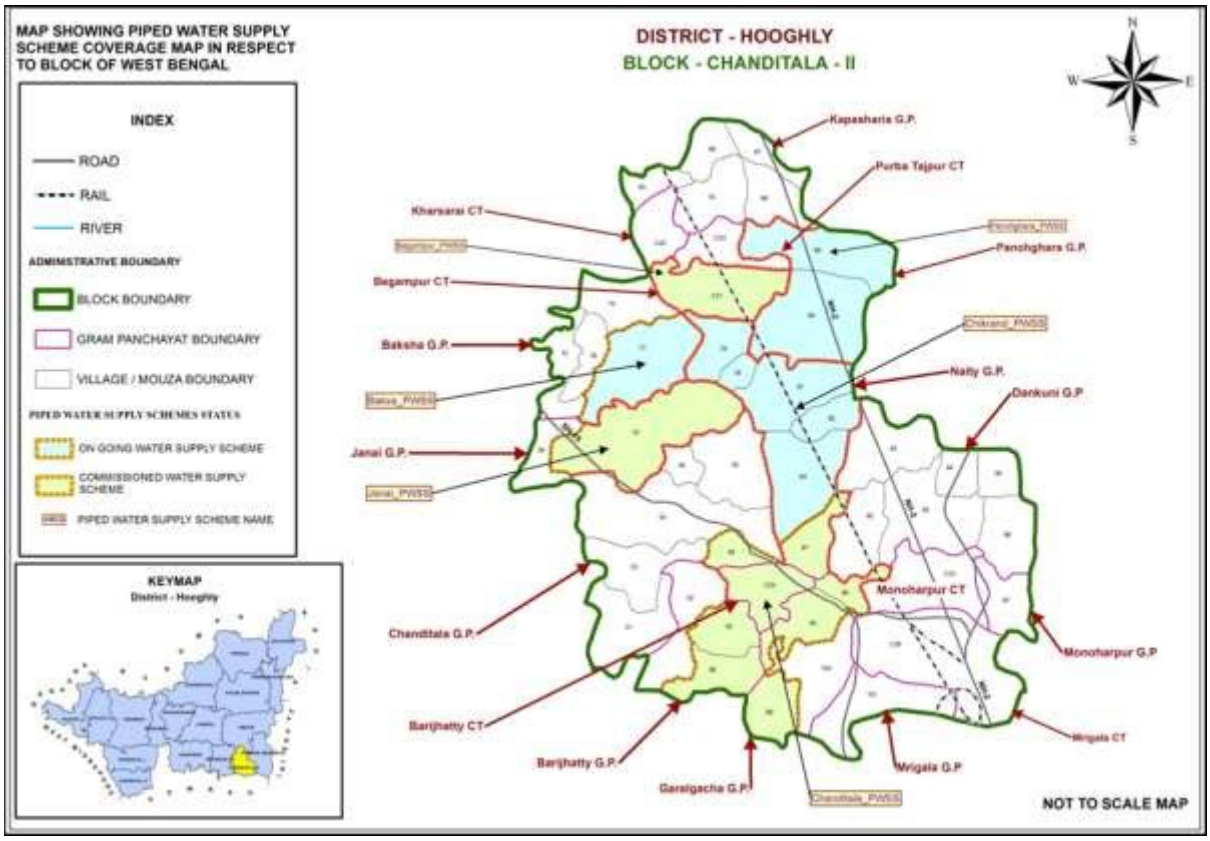

*Figure 11.7 Status of Drinking water supply scheme in Chanditala-II Block (Source-WBPHED) according to Census -2011****Management Plan for irrigation:***

- Based on CGWB Resource data as on 2017, block is under **Safe Category**. Stage of Ground Water development is 63.16 **%,** with falling long term ground water trend in post monsoon.
- As per **4th MI Census** irrigation data in this block number of Shallow Tube Wells and Surface water is also used (**given in** Table 11.15)
- The whole cultivable area has already been covered by irrigation
- There is scope of change in cropping pattern by use of surface water.
- Schemes of Artificial Recharge may also be implemented.
- Application of modern technologies like Sprinkler, Drip irrigation and use of blended Fresh and arsenic bearing ground water, if any, in a suitable ratio can also be applied for irrigation purpose.
- Regular monitoring of arsenic concentration in crop is also necessary.
- R & D study is necessary to get a dependable solution to tackle arsenic menace in future.

- In this block, as per soil and climatic condition, Jute, rice and potato are more suitable crops.

Table 11.13 Details of cops under practice in Chanditala II block

Name of Block		Chanditala-II
Aman	Area	293
	Prod.	0.737
	Yield	2514
Boro	Area	1435
	Prod.	4.984
	Yield	3473
Jute	Area	171
	Prod.*	3.637
	Yield**	21.27
Musur	Area	1
	Prod.	0.001
	Yield	513
Gram	Area	1
	Prod.	0.001
	Yield	1256
Mustard	Area	4
	Prod.	0.004
	Yield	955
Til	Area	1008
	Prod.	1.824
	Yield	1809
Potato	Area	1478
	Prod.	39.004
	Yield	26390

(Area in Ha., Production in Thousand MT and Yield in kg./Ha.)

(Source: Department of Economics and Statistics)

Table 11.14 area wise percentage of current practice of crops in Chanditala-II Block

Area wise Current Practice of crops				
Rabi Crops (Wheat, Mustard and oil seeds water Column	**Boro Cultivation (Water Column requirement-1.2 m)**	**Vegetable (water Column requirement Potato=0.6m)**	**Pulses (water Column requirement =0.11 m)**	**Total Area covered (ha)**

requirement=0.21) Cultivation								
%	**Area (ha)**	**%**	**Area (ha)**	**%**	**Area (ha)**	**%**	**Area (ha)**	
26	1012	36	1435	37	1478	0	39.004	3964.004

(Source: Department of Economics and Statistics)

NO cultivable area is left out for irrigation.

Table 11.15 Number of ground water abstraction structures and Cultivable command area created by structure in Chanditala-II Block

Block Name	Dug well		Shallow Tube well		Deep Tube well		Surface Flow		Surface Lift		CCA (ha.)		Total CCA (ha.)
	No	**CCA**	**No**	**CCA**	**No**	**CCA**	**No**	**CCA**	**No**	**CCA**	**Ground Water**	**Surface Water**	
Chanditala-II	0.0	0.0	83.0	654.2	14.0	797.5	0.0	0.0	229.0	1096.5	1451.7	1096.5	2548.2

Table 11.16 Summary of irrigation plan in Chanditala-II block

Cultivable area in ha	2548.22
Net irrigated Command area (GW) in ha	1451.74
Net irrigated Command area (SW) in ha	1096.48
Net irrigated Command area (GW +SW) in ha	2548.22
Net area available for Irrigation	0
GW available for Future irrigation (ham)	515.02
Pre monsoon Long Term WL Trend 2017 in cm/yr, if falling	No
Post monsoon Long Term WL Trend 2017 in cm/yr, if falling	Yes, 31
Average Pre monsoon WL in mbgl	14.6
Average Post monsoon WL in mbgl	9.68
SOD in %	63.16
Category	Safe

Remarks summary of Irrigation management plan	SOD high, GW trend declining in post monsoon; Cultivable area already covered by irrigation; cropping pattern can be changed, more SW can be used than GW

Special intervention for Chanditala II block

- SOD is quite high; water level shows long term falling trend in post monsoon.
- Regular water level monitoring is necessary.
- Rainwater harvesting may be implemented.

Rainwater harvesting & Artificial Recharge:

Table 11.17 Area suitable for recharge in the study area:

District	Block Name	Area (in ha)	Area suitable for recharge (Considering area having DTW more than 3m in post monsoon and showing 0.2m/yr falling trend) (in ha)
Hugli	Chanditala-II	7042	1914

Table 11.18 Estimation of Surface runoff based on Land slope, Soil, etc. (after Dhruvanarayana, 1993)

Block	Major type of soil available in that block	Normal Monsoon rainfall in m (50 yrs data from data.gov.in) 'Rn'	Total volume of surface runoff available Annually 'Vt' (RnXAXC) Ham	75% of 'Vt' = V	50% of V (Non committed)= Vnc	60% of Vnc (considering 60% of water to be harvested)= Vf
Chanditala-II	**Clay Loam/Silty Clay Loam**	**1.098**	**1805.1 (average run off coefficient 0.50)**	**3866.06**	**1933.03**	**1159.82**

On the basis of soil characteristic, Slope, Rain fall data and Long term trend number of structures are estimated and are given below

Table 11.19 Details of possible artificial Recharge & conservation structures in block

Block wise Management plan in parts of Hugli District, West Bengal

Row 1	**Block Area in Ha**	7042
Row 2	Area in Ha suitable for recharge	1914
Row 3	Soil type(3)	Clay
Row 4	Amount of water to be harvested	1159.82
Row 5	Amount of water for artificial recharge of top aquifer and conservation (Ham) - 70 % of Row. 4 (5)	811.87
Row 6	Source water allocation for for Irrigation Cum Recharge Pond -35% of Row 4 (6)	405.94
Row 7	Source water allocation for REET with recharge shaft -35% of Row 4 (7)	405.94
Row 8	Source water allocation for for injection well to recharge deeper aquifer -20% of Row 4 (8)	231.96
Row 9	Source water allocation for Farm Pond/Irrigation pond – 10 % of Row 4 (9)	115.98
Row 10	Nos. of Irrigation Cum Recharge Pond @ 50 Ham per unit (10)	8
Row 11	Nos. of REET with recharge shaft @ 10 Ham per unit	41
Row 12	Nos. of injection well suggested @ 30 Ham per unit (12)	8
Row 13	Nos. of Farm Pond @ 10 Ham per unit (12)	12
Row 14	Cost of Irrigation Cum Recharge Pond @ Rs 8 lakh per unit	64
Row 15	Cost of REET with recharge shaft @ Rs 8 lakh per unit	328
Row 16	Cost of injection well @ Rs 20 lakh per unit	160
Row 17	Cost of Farm Pond @ Rs 8 lakh per unit	96

3/4rd part of the block is clay; injection wells are more effective structure; Total Cost – 648 Lakh

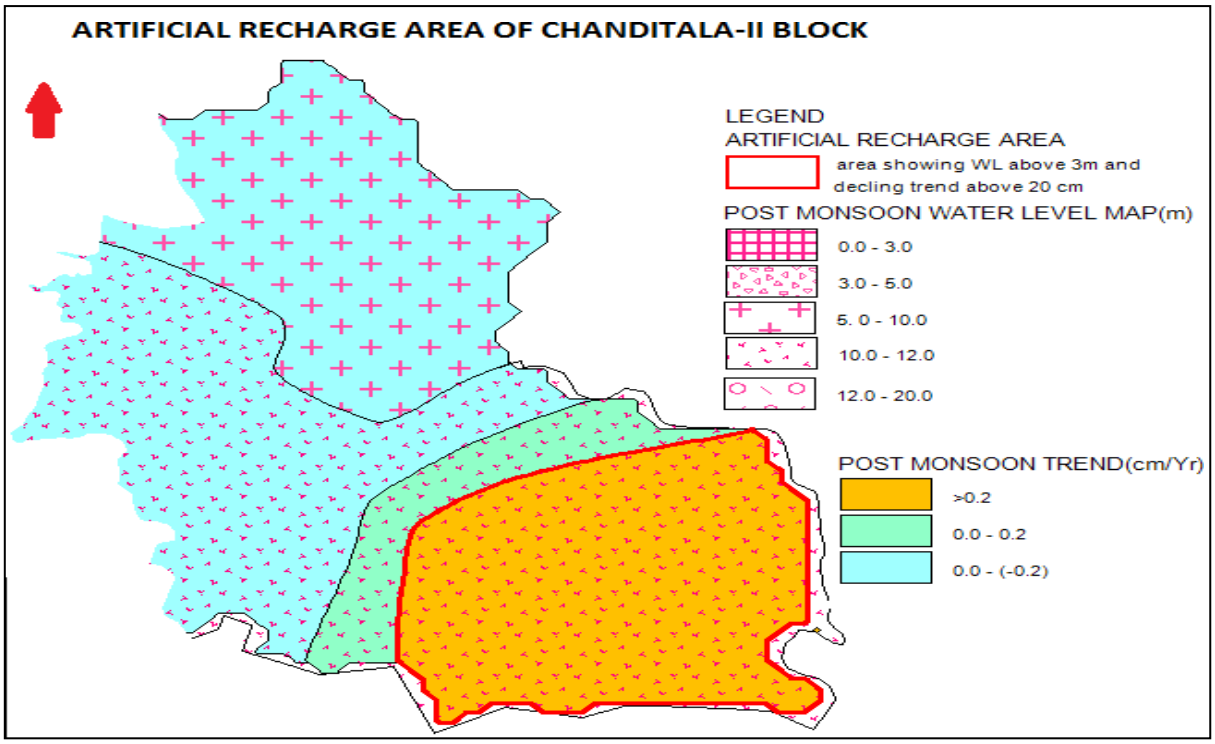

Figure 11.8 Area suitable for artificial recharge in Chanditala-II Block

12.0 TARKESWAR BLOCK

12.1 Salient Information

- **Block Name: Tarkeswar**
- **Area (in ha): 12118**
- **District: Hugli**
- **State: West Bengal**
- **Population (as on 2011):**

Table 12.1 Population in Tarkeswar block

Rural	Urban	Total
179148	**30947**	**210095**

- **Rainfall:** Average annual rainfall (**Hugli district**) for the period 2013 -17 (in mm):**1336.96**

Table 12.2 Annual Rainfall since last five year

Block	District Normal	Actual (Annual)				
		20123	**2014**	**2015**	**2016**	**2017**
Tarkeswar	1362	1365.3	1114.4	1549.1	1218.6	1437.4

- **Agriculture & Irrigation (area in ha):**

Table 12.3 Land use pattern of block (Source-West Bengal Land use and Land cover Department

Name of Block	Reporting area (Ha)	Area under non agriculture use(Ha)	Barren and unculturable land (Ha)	Total agricultural land (Ha)	Pasture (Ha)	Orchard (Ha)	Cultivable waste (Ha)	Fallow land other than Current Fallow (Ha)	Current Fallow (Ha)	Forest (Ha)	Net sown area (Ha)
Tarakeswar	12118	2993	-	8279	3	35	47	35	-	-	8232

12.2 Aquifer Wise Ground Water Resource Availability & Extraction:

Table 12.4 Aquifer wise resource availability and draft (in MCM) in Block

Resource Availability	Aquifer I Group	Aquifer II Group	Aquifer III Group	Extraction (for Aquifer I Group)
Dynamic Resource	47.95	0.47	-	20.98
Static Resource	21.11			

Disposition of Aquifer: In **Tarkeswar** Block, 3 Aquifer Groups are explored.

- The range of Aquifer I Group is 29m to 110m and it is part of Younger Alluvium formation.
- The range of Aquifer II Group is 70m to 251m. It is divided into two aquifers: IB and II: the range of aquifer IB is 70m to 169m and Aquifer II is 84m to 251m. This group is a part of Older Alluvium Formation. In Aquifer II, Iron concentration i ground water is high.
- The range of Aquifer III Group is 171m to 278m. It is divided into two aquifers: III & IV; the range of aquifer III is 205m to 283m and aquifer IV is 260m to 278m; this is a part of Tertiary Formation. In Aquifer III, Ground Water potentiality is low.

Table 12.5 Aquifer disposition in block

Block	Depth range of Aquifer in mbgl		
Tarkeswar	**Aquifer I Group**	**Aquifer II Group**	**Aquifer III Group**
	aquifer IA: 29 - 110	**aquifer IB: 70-169** **aquifer II: 84-251**	**aquifer III: 171-283** **aquifer IV: 260-278**

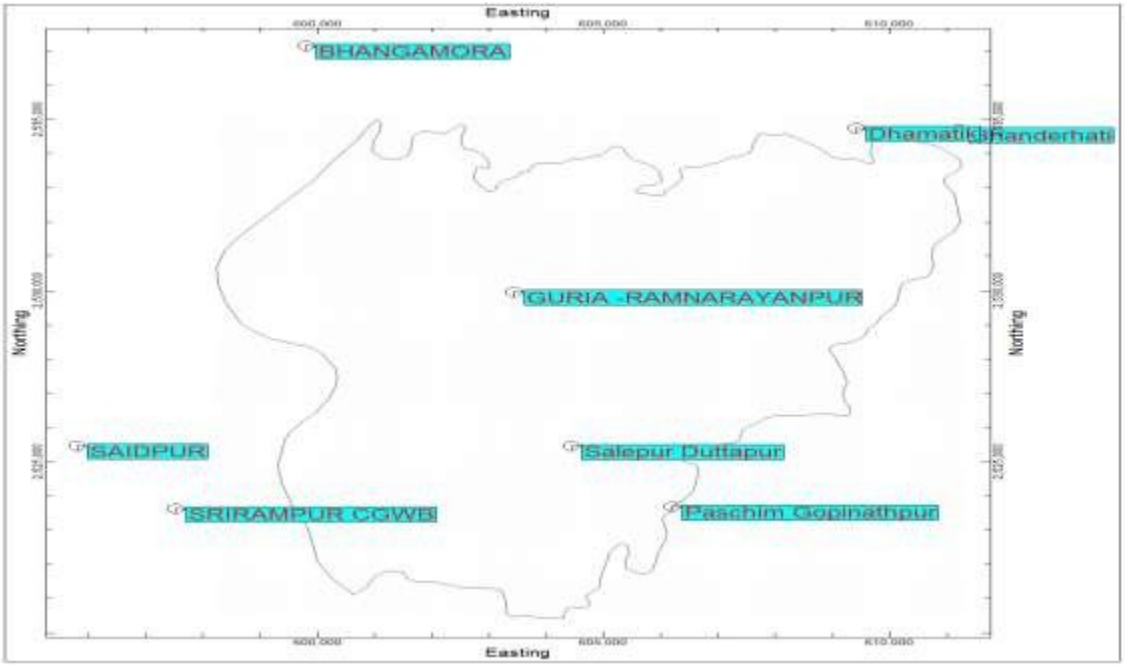

Figure 12.1 Index map of Tarkeswar Block

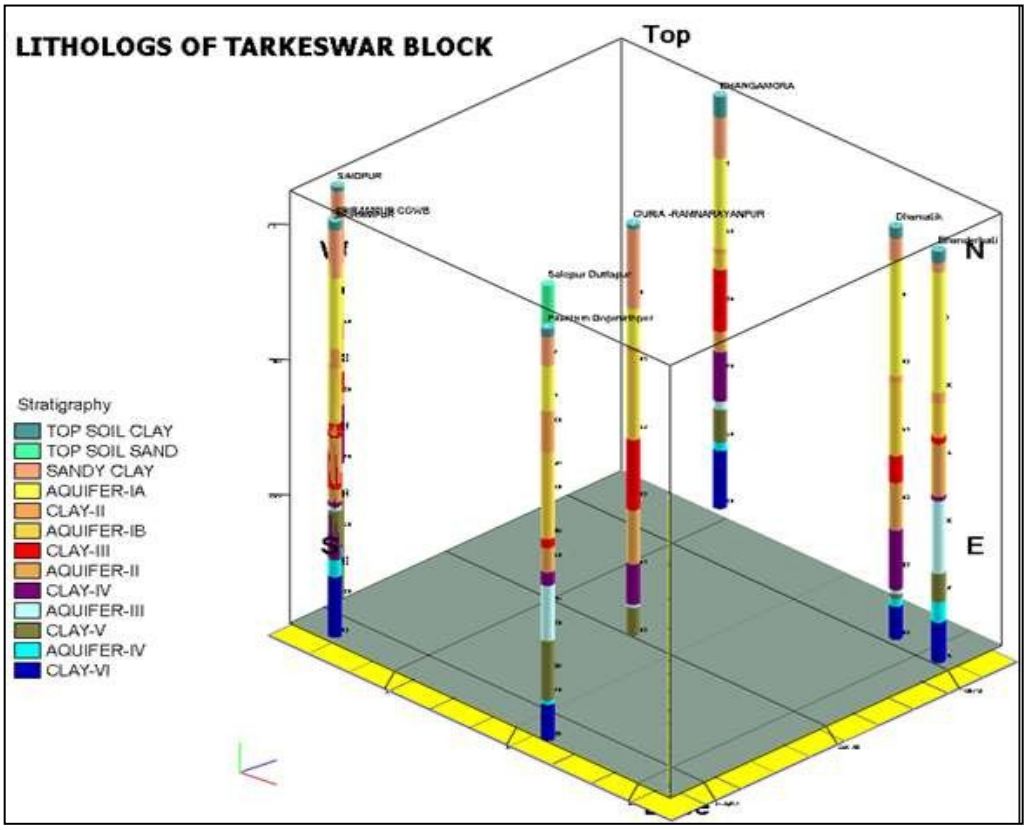

Figure 12.2 Lithologs in Tarkeswar Block

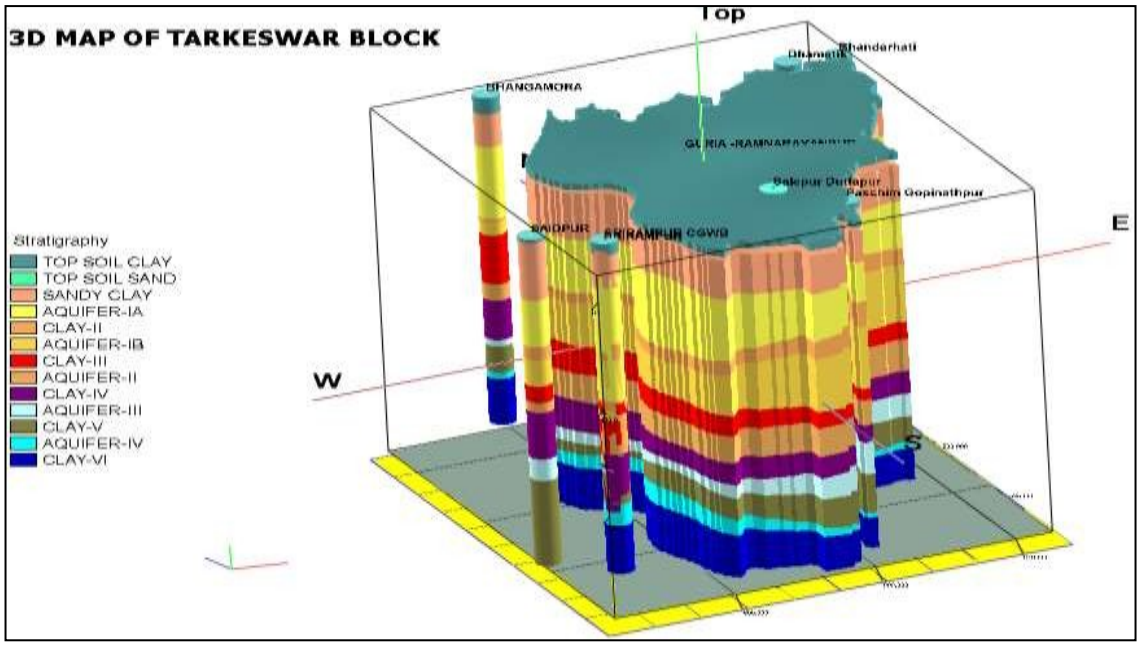

Figure 12.3 3D Aquifer Disposition in Tarkeswar Block

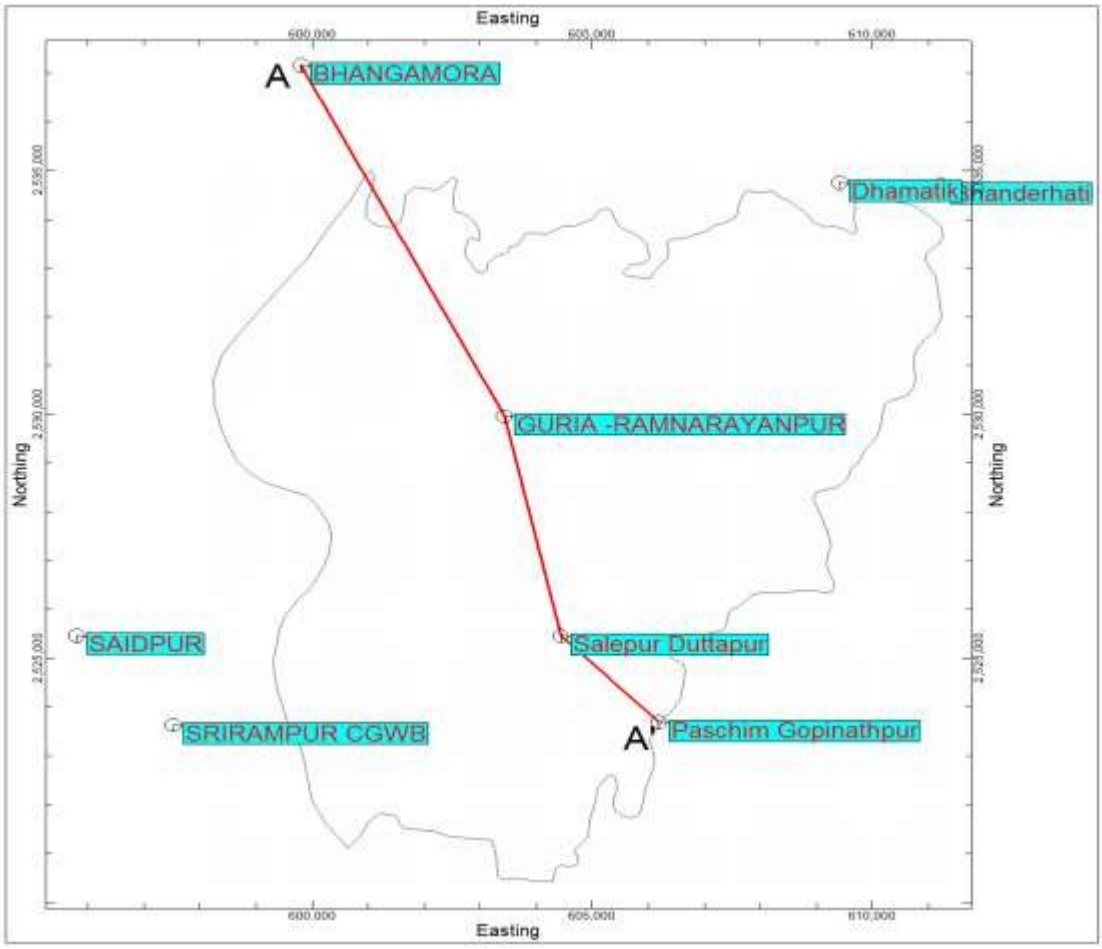

Figure 12.4 NW- SE Cross section Index Line in Tarkeswar Block

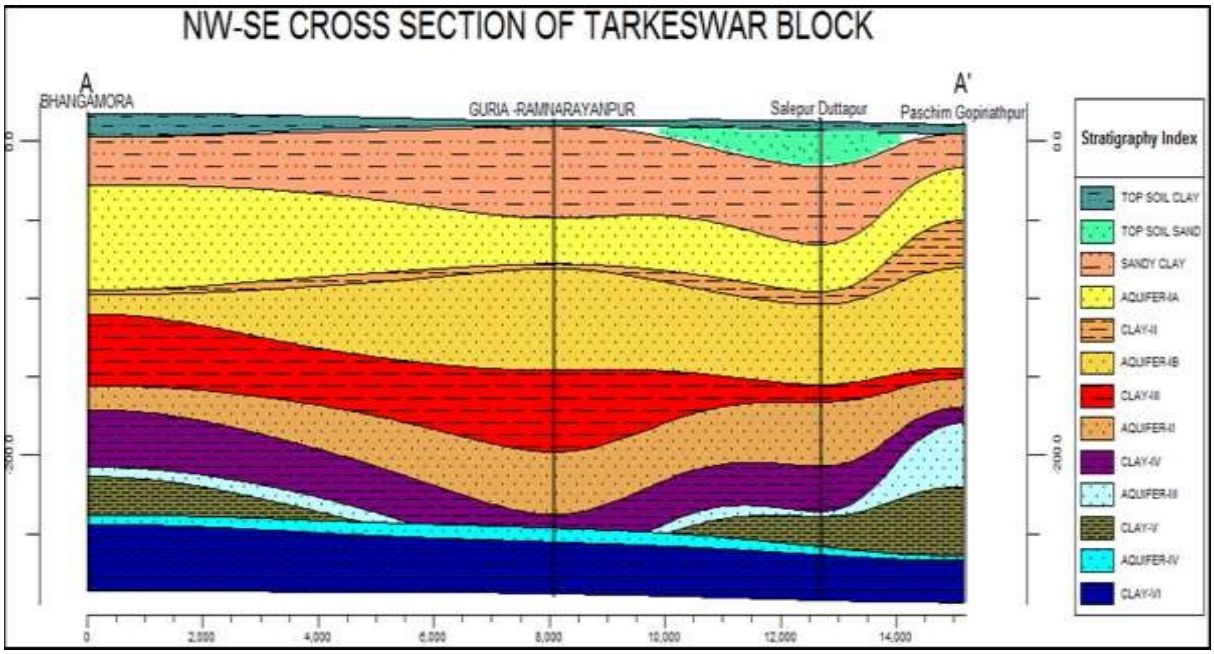

Figure 12.5 NW - SE cross section in Tarkeswar Block

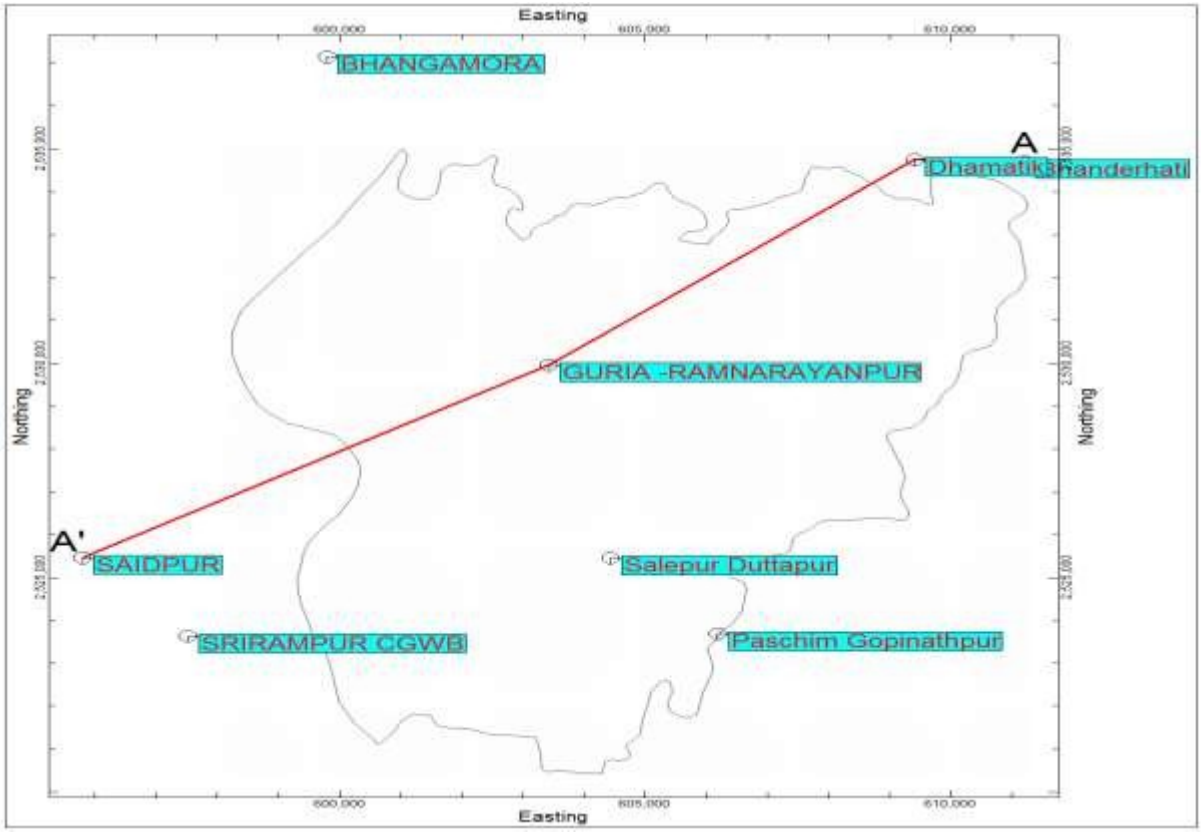

Figure 12.6 NE-SW cross section Index Line in Tarkeswar Block

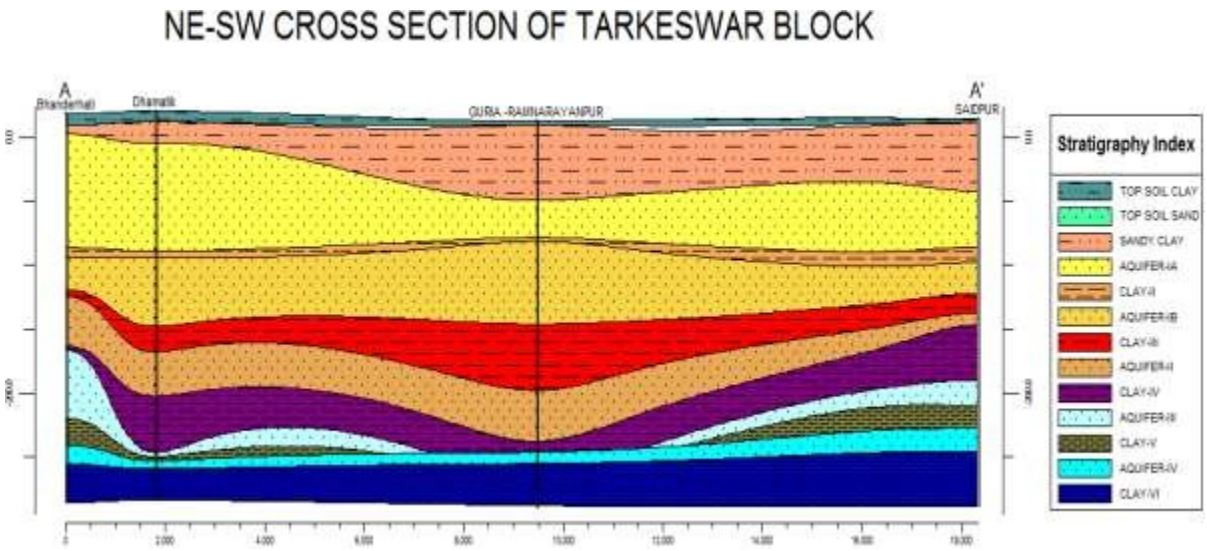

Figure 12.7 NE-SW cross section in Tarkeswar Block

Table 12.6 Aquifer Wise Water Level Ranges & Seasonal long g term water level trends (2006 to 2017)

Block	Aquifer Groups	Pre-monsoon Trend			Post-monsoon Trend		
		Water Level Range (mbgl)	**Rise (cm/year)**	**Fall (cm/year)**	Water Level Range (mbgl)	**Rise (cm/year)**	**Fall (cm/year)**
Tarkeswar	I	3.46-18.62	-	20.62	0.83-9.55	-	26.45
Tarkeswar	II	16.22-16.33	-	-	8.16-10.3	-	-
Tarkeswar	III	8.9 - 10.6	-	-	11.67 - 13.2	-	-

Table 12.7 Aquifer wise maximum thickness

Block	Area (sq km)	Thickness of the Granular Zone in Aquifer Group I (m)	Thickness of the Granular Zone in Aquifer Group II (m)	Thickness of the Granular Zone in Aquifer Group III (m)
Tarkeswar	121.18	81	IB: 99 II: 167	III: 112 IV: 18

Table 12.8 Aquifer-wise depth range and parameters

Group	**Sub Aquifer**	**Depth Range (mbgl)**	**Discharge (m^3/hr) with DD**	**T** (m^2/day)	**S**	**Specific capacity (m^3/day per m)**

Aquifer Group I	IA	**29 - 110**	**47.9 (DD 4.1)**	**1688.33**	**4.16 X 10^{-1}**	**11.68**
Aquifer Group II	IB	**70 - 169**	**52.04 (DD 4.88)**	**2358**	3.17 X 10^{-4}	11.82
	II	**84 - 251**				
Aquifer Group III	III	**171 - 283**	**39.6 (DD 6)**	**147.86**	**5.5 X 10^{-10}**	**6.6**
	IV	**260 - 278**				

J*- Jacob's method; T - Theis's method**

12.3 Ground Water Resource, Extraction, Contamination & Other Issues:

Aquifer Wise Resource Availability & Extraction: Dynamic ground water resources as on 31st March'17 in top aquifer i.e. Aquifer I.

Table 12.9 Availability of Ground Water resource in Block

Block	Annual Extractable Ground Water	Current Annual GW	Stage of developme nt	Category	Annual GW Allotment for drinking water to
Tarkeswar	67.55	36.90	54.63	Safe	2.75

Static (in-storage) Resources: 21.11 MCM

12.4 Chemical Quality of Ground Water & Contamination:

Based on 10- 12 Key well data and CGWB outsourced exploratory well data blocks wise Average data of chemical parameter is given below.

Table-9.4.10.: Aquifer wise average chemical parameter of block

Aquifer	pH	EC	TH	Ca	Mg	Na	K	HCO_3	Cl	NO_3	SO_4	F	SiO_2	TDS	Fe	Mn	Zn	As
		(µs/cm)									(<5)	(<1)	(<5)			(<0.05)	(<0.05)	(<0.002)
I	8.2	592.13	177.50	27.50	26.43	46.80	3.88	214.26	71.79	1.57	11.49	0.17	16.66	336.98	0.27	0.06	0.060	0.003
II	8.2	410.33	130.00	24.00	17.01	28.40	1.35	195.20	21.27	0.00	7.27	0.09	14.07	264.36	0.19	0.13	BDL	BDL
III	7.4	600.00	194.00	30.00	36.00	43.00	1.40	277.00	22.00	1.60	BDL	0.30	15.50	368.00	0.81	BDL	BDL	0.003

12.5 Ground Water Resource Enhancement& Management Plan:

Ground Water Management Plan for drinking purposes-

- The block is under Safe category.
- Regular Field monitoring is required to study arsenic concentration in ground water of tube wells.
- As per WBPHED Data, 70629 population with 38 is still without PWSS (Pipe Water Supply Scheme).
- In Tarkeswar block, Aquifer-III is less productive (45.82 m^3/hr) in comparison to Aquifer-II (52.04 m^3/hr).
- Considering overall situation for preparation of village wise water supply schemes, average discharge has been considered as 45.82 m^3/hr.

Table 12.10 Still uncovered population by PWSS in Block

Block	Number of Villages to be covered by water supply schemes	Population in risk zone (as per Census 2011) to be covered by water supply schemes.	Comments on providing water supply to the risk population
Tarkeswar	38	70629	In Tarkeswar block, Aquifer-III is less productive (45.82 m^3/hr) in comparison to Aquifer-II (52.04m^3/hr). Average discharge of 45.82 m^3/hr of Aquifer III has been taken to consideration to work out number of wells are required for supply to still uncovered parts.

Table 12.11 Estimated number of Tube wells and cost for construction in Tarkeswar block

A	**Village**
B	**Population 2011**
C	**Projected Population 2021 (decadal growth rate 9.49%)**
D	**Present Water Requirement for Human Population in m^3 @70 lpcd**
E	**Projected Water Requirement for Human Population in m^3 @70 lpcd**
F	**Cattle 2011**
G	**Projected Cattle 2021**
H	**Present Water Requirement for cattle m^3 @20lpcd**
I	**projected Water Requirement for cattle m^3 @20lpcd**
J	**Total Water Requirement/day as on 2011 in m^3**
K	**Total Water Requirement cubic m/day as on 2021 in m^3**
L	**Discharge (m3/hr)**
M	**Discharge of one TW in m^3/day after 8 hours of pumping**
N	**No of TW**
O	**Cost of Tube well of 300 m depth (approx.) 10”x6" dia @ Rs. 20 lakhs (In lakh) as per EFC**

Block wise Management plan in parts of Hugli District, West Bengal

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
Aknapur	2096	2295	146.7	160.7	210	218	4.2	4.35	150.9	165	75.06	600.5	0	0
ligari	804	880	56.28	61.6	80	83	1.6	1.66	57.88	63.26	45.82	600.5	0	0
Astara	6590	7215	461.3	505.1	659	683	13.18	13.66	474.5	518.7	45.82	600.5	1	20
Baidyapur	3088	3381	216.2	236.7	309	320	6.18	6.41	222.3	243.1	45.82	600.5	0	0
Bajitpur (P)	2473	2708	173.1	189.6	247	256	4.94	5.12	178.1	194.7	45.82	600.5	0	0
Baligari	5845	6400	409.2	448	585	606	11.7	12.13	420.9	460.1	45.82	600.5	1	20
Ballabhipur	593	649	41.51	45.43	59	61	1.18	1.22	42.69	46.65	45.82	600.5	0	0
Belband	744	815	52.08	57.05	74	77	1.48	1.53	53.56	58.58	45.82	600.5	0	0
Beremul	1273	1394	89.11	97.58	127	132	2.54	2.63	91.65	100.2	45.82	600.5	0	0
Bhabanipur	961	1052	67.27	73.64	96	100	1.92	1.99	69.19	75.63	45.82	600.5	0	0
Bhanjipur (P)	4433	4854	310.3	339.8	443	459	8.86	9.18	319.2	349	45.82	600.5	1	20
Bharamalpur	556	609	38.92	42.63	56	58	1.12	1.16	40.04	43.79	45.82	600.5	0	0
Bhata (P)	1253	1372	87.71	96.04	125	130	2.5	2.59	90.21	98.63	45.82	600.5	0	0
Binagram	3950	4325	276.5	302.8	395	409	7.9	8.19	284.4	310.9	45.82	600.5	1	20
Dhalyan	794	869	55.58	60.83	79	82	1.58	1.64	57.16	62.47	45.82	600.5	0	0
Ekdalu	461	505	32.27	35.35	46	48	0.92	0.95	33.19	36.3	45.82	600.5	0	0
Gauribati	2093	2292	146.5	160.4	209	217	4.18	4.33	150.7	164.8	45.82	600.5	0	0
Hauli	2498	2735	174.9	191.5	250	259	5	5.18	179.9	196.6	45.82	600.5	0	0
Jagannathpur	1080	1182	75.6	82.74	108	112	2.16	2.24	77.76	84.98	45.82	600.5	0	0
Jaynagar	3218	3523	225.3	246.6	322	334	6.44	6.68	231.7	253.3	45.82	600.5	0	0

Block wise Management plan in parts of Hugli District, West Bengal

Kalapukur	1230	1347	86.1	94.29	123	128	2.46	2.55	88.56	96.84	45.82	600.5	0	0
Kulut	1080	1182	75.6	82.74	108	112	2.16	2.24	77.76	84.98	45.82	600.5	0	0
Kunjaban	1270	1391	88.9	97.37	127	132	2.54	2.63	91.44	100	45.82	600.5	0	0
Malpaharpur	2116	2317	148.1	162.2	212	220	4.24	4.4	152.4	166.6	45.82	600.5	0	0
Manoharpur	817	895	57.19	62.65	82	85	1.64	1.7	58.83	64.35	45.82	600.5	0	0
Mirzapur	3909	4280	273.6	299.6	391	405	7.82	8.11	281.5	307.7	45.82	600.5	1	20
Naita	3506	3839	245.4	268.7	351	364	7.02	7.28	252.4	276	45.82	600.5	0	0
Naypara	1504	1647	105.3	115.3	150	155	3	3.11	108.3	118.4	45.82	600.5	0	0
Panchgachhi	1174	1285	82.18	89.95	117	121	2.34	2.43	84.52	92.38	45.82	600.5	0	0
Paschimramnagar	1378	1509	96.46	105.6	138	143	2.76	2.86	99.22	108.5	45.82	600.5	0	0
Rambati	976	1069	68.32	74.83	98	102	1.96	2.03	70.28	76.86	45.82	600.5	0	0
Ramchandrapur	431	472	30.17	33.04	43	45	0.86	0.89	31.03	33.93	45.82	600.5	0	0
Sainta	1242	1360	86.94	95.2	124	129	2.48	2.57	89.42	97.77	45.82	600.5	0	0
Shyampur	1317	1442	92.19	100.9	132	137	2.64	2.74	94.83	103.7	45.82	600.5	0	0
Somserpur	918	1005	64.26	70.35	92	95	1.84	1.91	66.1	72.26	45.82	600.5	0	0
Tajpur	1149	1258	80.43	88.06	115	119	2.3	2.38	82.73	90.44	45.82	600.5	0	0
Tarakeswar (P)	1264	1384	88.48	96.88	126	131	2.52	2.61	91	99.49	45.82	600.5	0	0
Timna	545	597	38.15	41.79	55	57	1.1	1.14	39.25	42.93	45.82	600.5	0	0
Total	**70629**	**77334**	**4944**	**5413**	**7063**	**7321**	**141.3**	**146.4**	**5085**	**5560**	**45.82**	22818	5	100

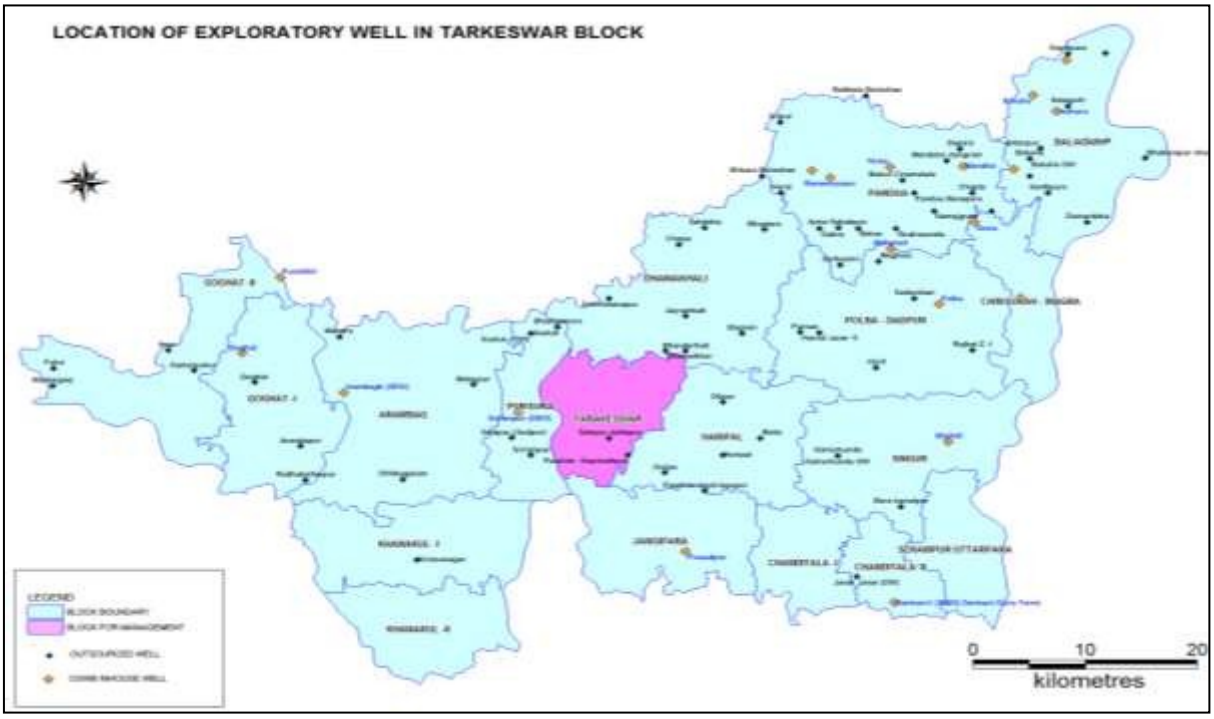

Figure 12.8 Location of Exploratory wells in Tarkeswar Block

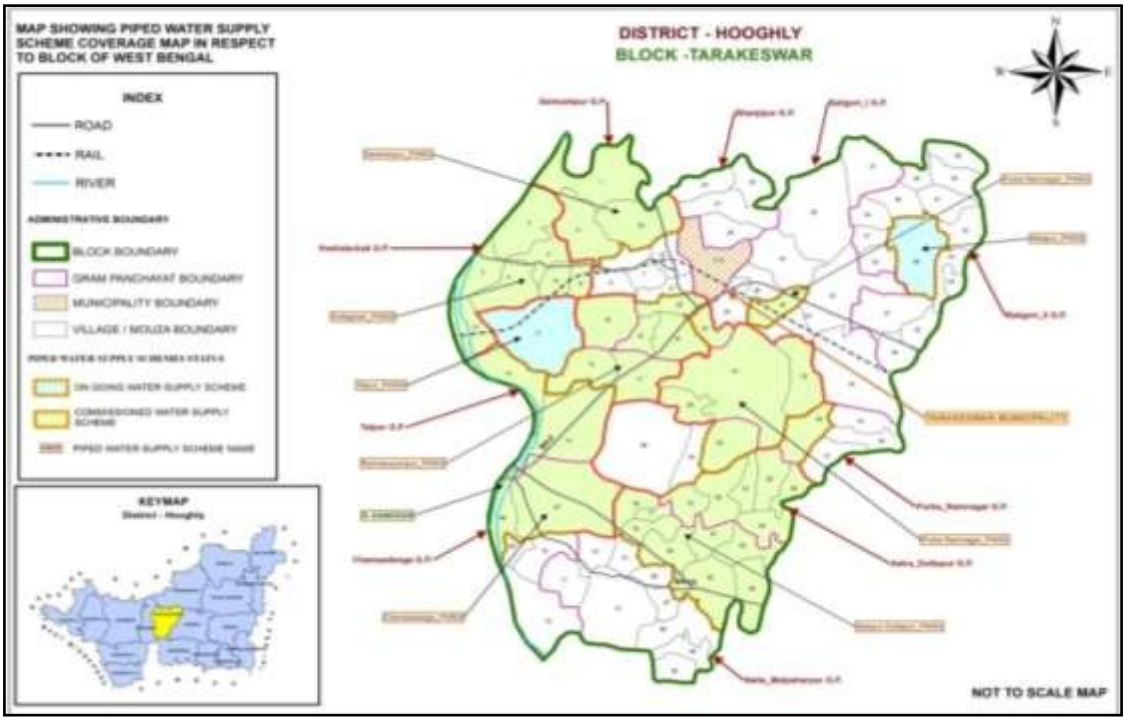

Figure 12.9 Drinking water supply scheme status in TarkeswarBlock (Source-WBPHED) according to Census -2011

- From Table-9.4.12., 5 wells are required for supply of drinking water in still uncovered parts in Tarkeswar Block, Hugli District, West Bengal; Status of already existing PWSS schemes of PHED has been presented in Fig-9.4.9.

- Maximum part of block has already been covered through PWSS by PHED.
- For monitoring of the ground water regime if Observation well is needed then cost of construction of the same should also be included in the expenditure.
- Phase wise construction of tube wells are needed; initially, 25 % wells should be constructed. On the basis of result whole plan should be implemented.
- After construction of well analysis of arsenic and heavy metals' content in ground water should be assessed.

Management Plan for irrigation:

- Based on CGWB Resource data, block is under **Safe Category**. Stage of Ground Water development is 54.63 **%,** with declining long term water level in post monsoon.
- As per **4th MI Census** irrigation data in this block number of Shallow Tube Wells and Surface water is also used (**given in Table-9.4.16**)
- The block shows continuous falling trend of long term ground water level; Artificial Recharge should have to be implemented.
- Application of modern technologies like Sprinkler, Drip irrigation are to be used
- Ground water contamination by arsenic is encountered in nearby areas; Regular monitoring of arsenic concentration in crop is needed.
- R & D study is necessary to get better solutions in terms of ground water management in future.
- According to soil and climatic condition, Jute, rice, potato and Til are most suitable crops to grow in Tarkeswar block.
- Cash crops could only be cultivated with strong vigil.

Table-9.4.13.: Cropping pattern in block

Name of Block		Tarakeswar
Aman	Area	27792
	Prod.	81.189
	Yield	2921
Boro	Area	1668
	Prod.	5.229
	Yield	3135
Jute	Area	2730
	Prod.*	58.340

	Yield**	21.37
Mustard	Area	312
	Prod.	0.253
	Yield	810
Til	Area	3398
	Prod.	3.168
	Yield	932
Potato	Area	5105
	Prod.	81.573
	Yield	15979

(Area in Ha, Production in Thousand MT and Yield in kg./Ha)

(Source: Department of Economics and Statistics)

Current cropping pattern is presented in Table 12.11 and percentage wise crop covering area of block is given in Table 12.12.

Table 12.12 Area wise percentage of current practice of crops in Tarkeswar Block

Area wise Current Practice of crops						
Rabi Crops (Wheat, Mustard and oil seeds water Column requirement=0.21) Cultivation		**Boro Cultivation (Water Column requirement-1.2 m)**		**Vegetable (water Column requirement Potato=0.6m)**		**Total Area covered (ha)**
%	**Area (ha)**	**%**	**Area (ha)**	**%**	**Area (ha)**	
35	3710	16	1668	49	5105	10483

Based on data of Table 12.12, the factor of weighted average of water column required is 0.6 m; so for irrigation of remaining cultivable area of 2828.82 Ha 1697.29 Ham water is required. But, resource estimation as on 2017 a total of 3015.46 Ham water from top aquifer is available and it is sufficient to cover the still uncovered cultivable land for irrigation.

Using 60 % water of present available water remaining cultivable area can be harvested and 40 % water is saved for future irrigation. Considering availability of water, Boro Rice could be cultivated but with care. Also, change in cropping pattern has been suggested as given in Table 12.13

Table 12.13 Future Water allocation for remaining cultivable area considering SOD, Soil conditions and cropping pattern of the block

Present water availability (ham)	Considering 60% water for irrigation of remaining cultivable area (ham)	Rabi Crops (Wheat, Mustard and oil seeds water Column requirement = 0.21) Cultivation		Boro Cultivation (Water Column requirement - 1.2 m)		Vegetable (water Column requirement Potato=0.6m)		pulses(water Column requirement =0.11 m)		Total Area covered (A)	Remaining Cultivable area (Ha) (2828.82 -A)
		% of water	Area (Ha)	% of water	Area (Ha)	% of water	Area (Ha)	% of water	Area (Ha)		
3015.46	1809.28	30	2584.69	30	452.32	30	904.64	10	1552.98	5494.63	-2665.81
3015.46	1809.28	25	2153.90	50	753.87	25	753.87	0	0	3661.64	-832.82
3015.46	1809.28	15	1292.72	70	1055.73	15	452.46	0	0	2800.91	27.91

Based on Table 12.13, out of 2828.82 ha area 2800.91ha area could be covered by cropping pattern of 15: 70: 15 ratio of areas of Rabi crops, Boro and Vegetables.

Table 12.14 Number of structures and Cultivable command area created by structure in Tarakeswar Block

Block Name	Dug well		Shallow Tube well		Deep Tube well		Surface Flow		Surface Lift		CCA (ha.)		Total CCA (ha.)
	No	CCA	No	CCA	No	CCA	No	CCA	No	CCA	Ground Water	Surface Water	
Tarakeswar	0	0	523	2009.88	17	651.71	40	2247.8	89	540.76	2661.59	2789	5450.18

Table 12.15 Summary of irrigation plan in Tarakeswar block

Geographical area in ha	Cultivable area in ha	Net irrigated Command area (GW) in ha	Net irrigated Command area (SW) in ha	Net irrigated Command area (GW +SW) in ha	Net area available for Irrigation	GW available for Future irrigation (ham)	Pre monsoon Long Term WL Trend in cm/yr, if falling.	Post monsoon Long Term WL Trend in cm/yr	Average Pre monsoon WL in mbgl	Average Post monsoon WL in mbgl	SOD in %	Category
12118	8279	2661.59	2788.59	5450.18	2828.8	3015.5	No	F-25.17	14.47	7.3	54.6	Safe

REMARKS: SOD moderate, falling long term trend of GW level in post monsoon; more SW to be used

Rainwater harvesting & Artificial Recharge in rakeswar Block:

Table 12.16 Area suitable for recharge in the study area

District	Block Name	Area (in ha)	Area suitable for recharge (Considering area having DTW more than 3m in post monsoon and showing 0.2m/yr falling trend) (in ha)
Hugli	Tarkeswar	12000	5998

Table 12.17 Estimation of Surface run off component based on Land slope, soil, etc. (after Dhruvanarayana, 1993)

Block	Major type of soil available in that block	Normal Monsoon rainfall in m (50 yrs data from data.gov.in) 'Rn'	Total volume of surface runoff available Annually 'Vt' (RnXAXC) Ham	75% of 'Vt' = V	50% of V (Non committed)= Vnc	60% of Vnc (considering 60% of water to be harvested) = Vf
Tarkeswar	**Silty Clay/Clay**	**1.098**	**4611.6 (average run off coefficient – 0.35)**	**3458.7**	**1729.35**	**1037.61**

On the basis of soil characteristic, Slope, Rain fall data and Long term trend number of artificial recharge and conservation structures have been estimated and presented in Table 9.4.20.

Table 12.18 Details of Possible artificial recharge & Conservation structures in block

Row 1	**Block Area in Ha**	**12000**
Row 2	Area in Ha suitable for recharge	5998
Row 3	Soil type(3)	Sandy Loam/Clay Loam
Row 4	Amount of water to be harvested	1037.61
Row 5	Amount of water for artificial recharge of top aquifer and conservation (Ham) - 70 % of Row. 4 (5)	726.33
Row 6	Source water allocation for for Irrigation Cum Recharge Pond - 35% of Row 4 (6)	363.16
Row 7	Source water allocation for REET with recharge shaft -35% of Row 4 (7)	363.16
Row 8	Source water allocation for for injection well to recharge deeper aquifer -20% of Row 4 (8)	207.52
Row 9	Source water allocation for Farm Pond/Irrigation pond – 10 % of Row 4 (9)	103.76
Row 10	Nos. of Irrigation Cum Recharge Pond @ 50 Ham per unit (10)	
Row 11	Nos. of REET with recharge shaft @ 10 Ham per unit	7
Row 12	Nos. of injection well suggested @ 30 Ham per unit (12)	36
Row 13	Nos. of Farm Pond @ 10 Ham per unit (12)	7
Row 14	Cost of Irrigation Cum Recharge Pond @ Rs 8 lakh per unit	10
Row 15	Cost of REET with recharge shaft @ Rs 8 lakh per unit	56
Row 16	Cost of injection well @ Rs 20 lakh per unit	288
Row 17	Cost of Farm Pond @ Rs 8 lakh per unit	140

2/3rd & 1/3rd parts are sandy loam & clay loam respectively: Injection wells and perRowation tank are effective structur; Total cost – 564 lakh

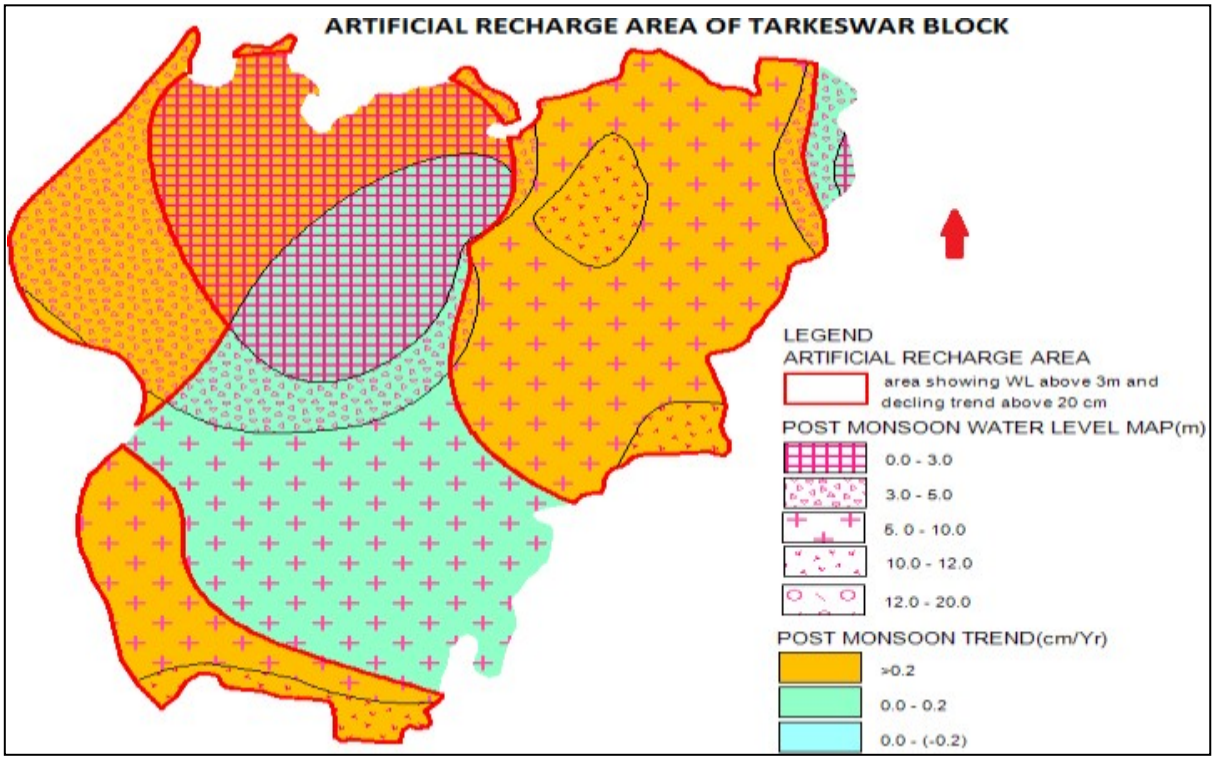

Figure 12.10 Area suitable for artificial recharge in Tarkeswar Block

13.0 JANGIPARA BLOCK

13.1 Salient Information

- **Block Name: Jangipara**
- **Area (in ha)**:16423
- **District: Hugli**
- **State**: West Bengal
- **Population (as on 2011):**

Table 13.1 Details of Population in Jangipara block

Rural	Urban	Total
205099	16479	221578

- **Rainfall:** Average annual rainfall (**Hugli district**) for the period 2012 -16 (in **mm):**

  129.6467 Average annual rainfall (**Hugli district**) for the period 2013 -17 (in mm):

  1336.96

Table 13.2 Details of Annual Rainfall since last five year

Block	District Normal	Actual (Annual)				
		2013	2014	2015	2016	2017
Jangipara	1447	1365.3	1114.4	1549.1	1218.6	1437.4

- **Agriculture & Irrigation (area in ha):**

Table 13.3 Landuse pattern of (Source-West Bengal Land use and Land cover Department) Area in hactares

Block	Reporting area	Area under non agriculture use	Barren and un cultivable land	Total agricultural land	Pasture	Orchard	Cultivable waste	Fallow land other than Current Fallow	Current Fallow	Forest	Net sown area
Jangipara	16423	4873	-	11693	-	322	94	-	-	-	11496

13.2 Aquifer Wise Ground Water Resource Availability & Extraction:

Table-9.5.4. Details of aquifer wise resource availability and draft (in MCM) in Block

Resource Availability	Aquifer I Group	Aquifer II Group	Aquifer III Group	Extraction (for Aquifer I)
Dynamic Resource	60.00	0.65	-	27.57
Static Resource	17.41			

1) <u>Disposition of Aquifer:</u>

- In Tarkeswar Block, three Aquifer Groups are explored.
- The range of Aquifer I is 15m to 18m and it is a part of Younger Alluvium Formation.
- The range of Aquifer II is 78.28m to 206m and it is part of Older Alluvium; It is further classified into two aquifers, IB and II: range of aquifer IB is 78.28m to 135m and aquifer II is 131.06m to 206m. In Aquifer II, Iron concentration in ground water is high.
- The range of Aquifer III is 164.58m to 280m; it is further divided into two aquifers, aquifer III & aquifer IV: range of aquifer III is 164.58m to 255m and aquifer IV is 252.36m to 280m. This Aquifer Group belongs to Tertiary Formation and in it Ground Water potentiality is low.

Table 13.4 Aquifer disposition (depth range) in block

Block	Depth range of Aquifer Groups in mbgl		
	Aquifer I Group	**Aquifer II Group**	**Aquifer III Group**
Jangipara	aquifer IA: 15-18	aquifer IB: 78.28-135 aquifer II: 131.06-206	aquifer III: 164.58-255 aquifer IV: 252.36-280

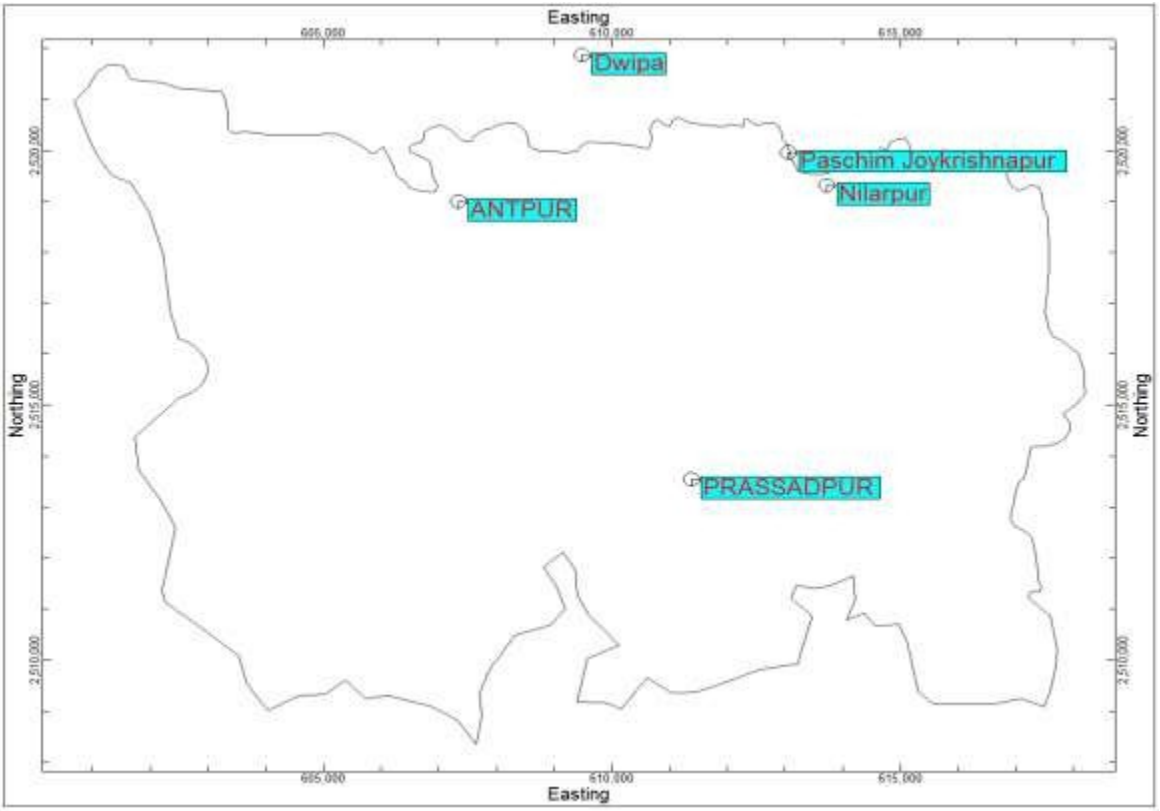

Figure 13.1 Index map of Jangipara Block

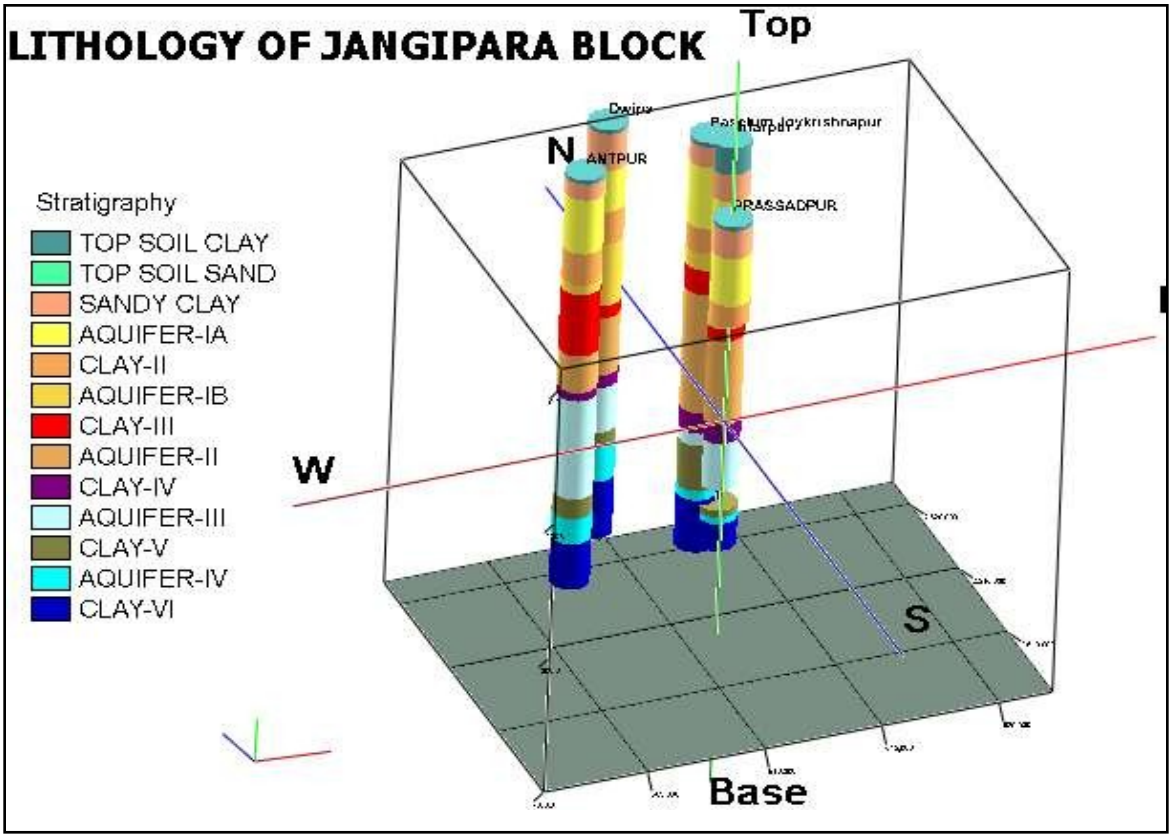

Figure 13.2 Lithologs in Jangipara Block

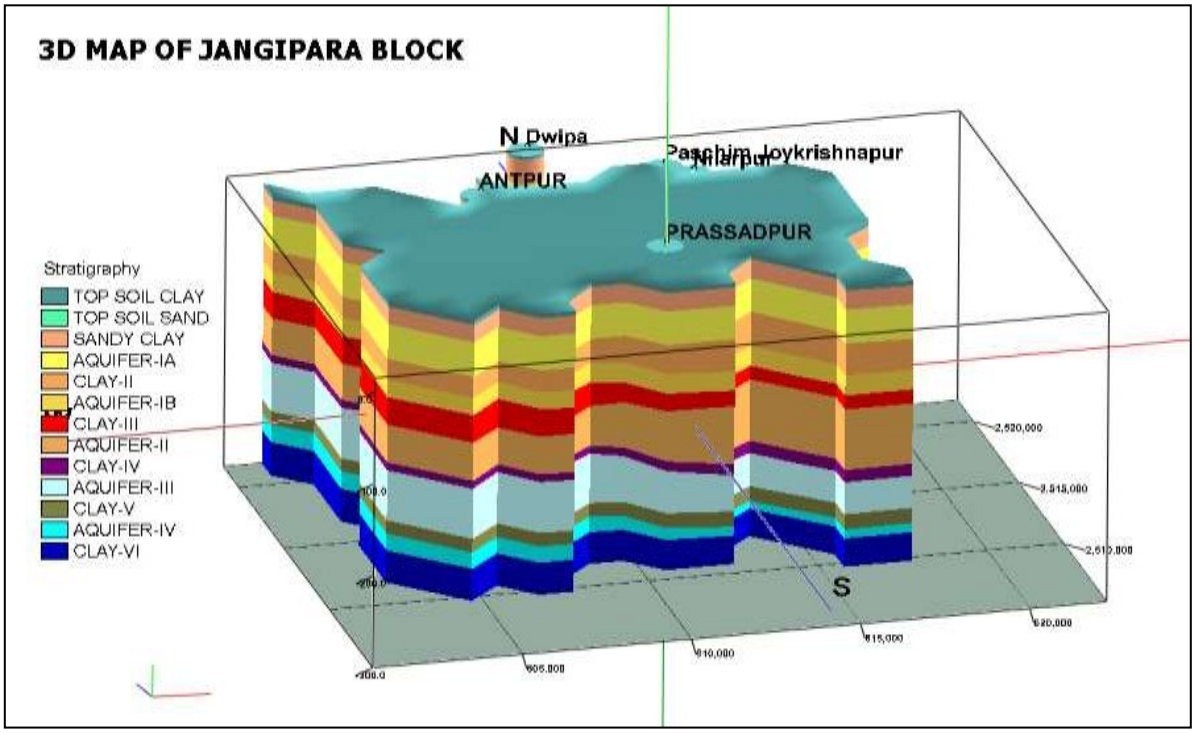

Figure 13.3 3D Aquifer deposition in Jangipara Block

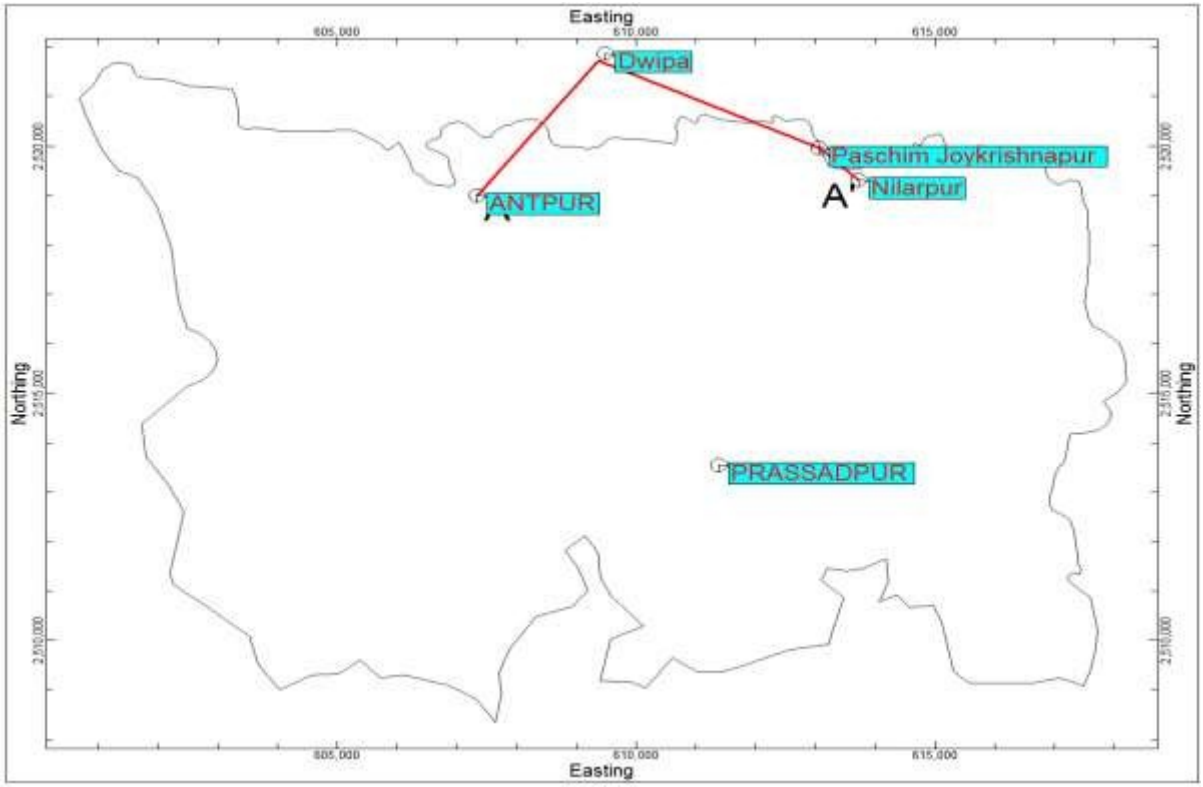

Figure 13.4 EW Cross section Index Line in Jangipara block

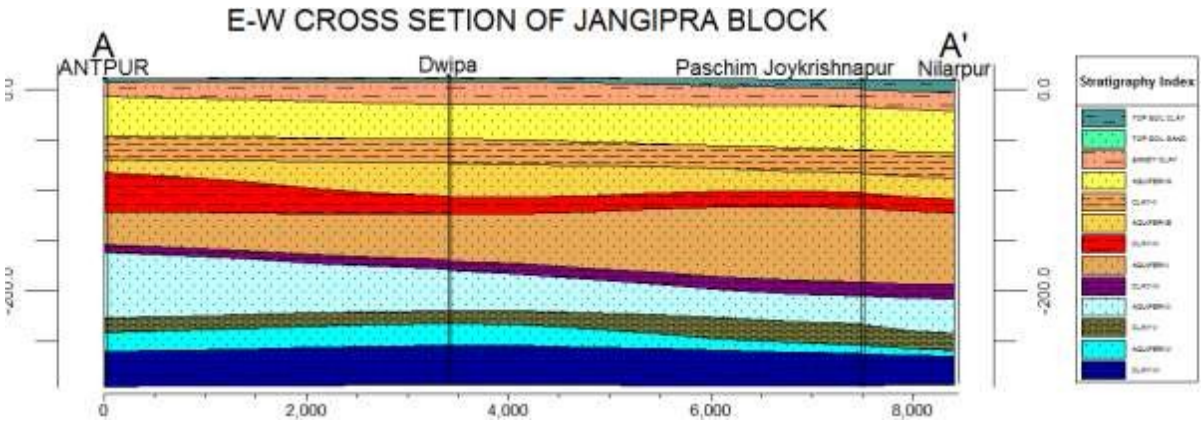

Figure 13.5 EW Cross section Index Line in Jangipara block

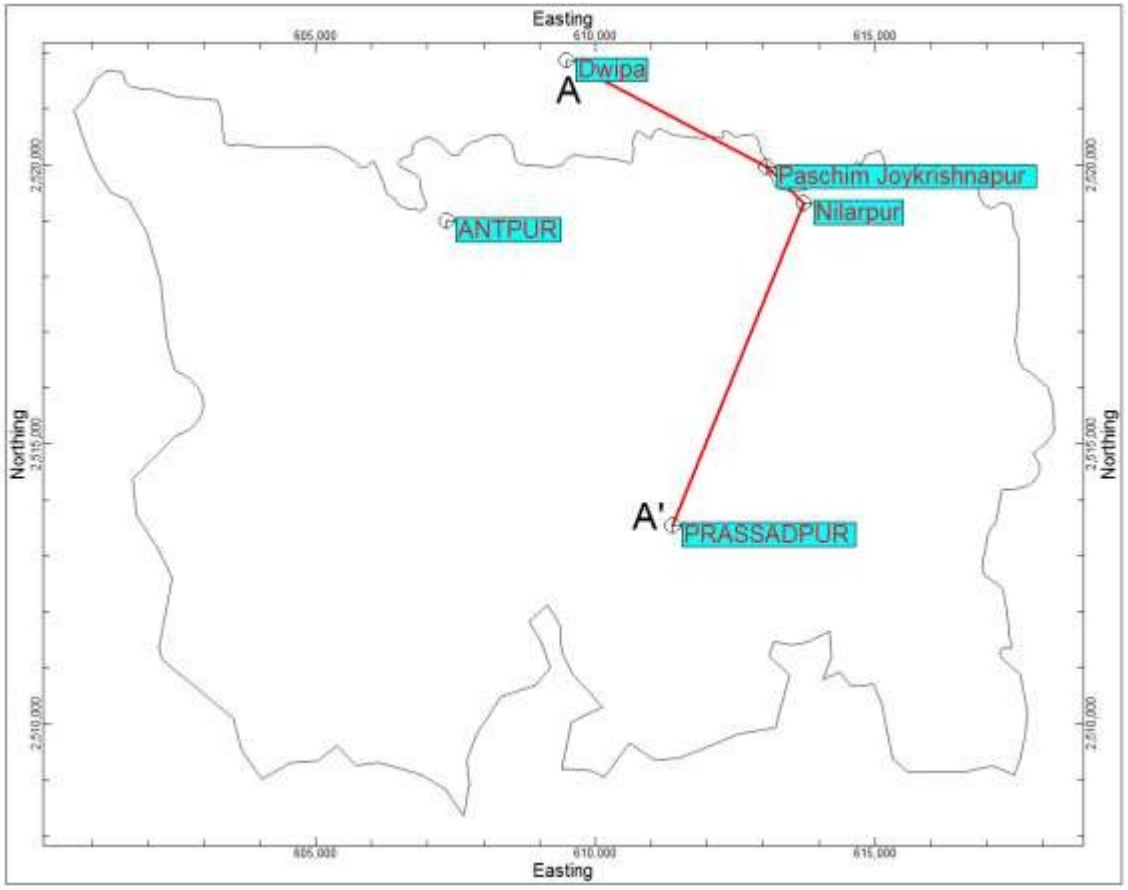

Figure 13.6 N - S Cross section Index Line in Jangipara block

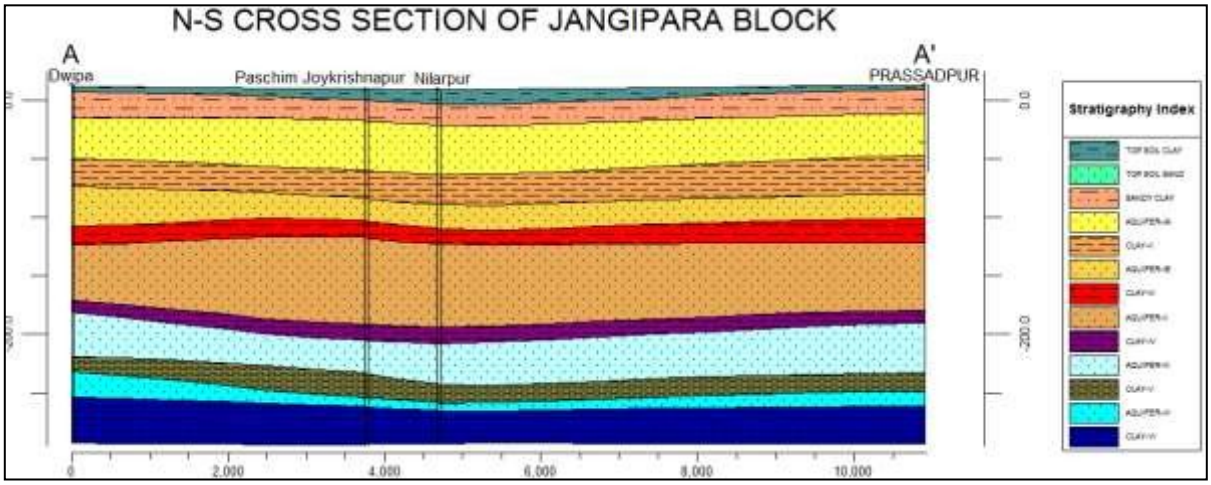

Figure 13.7 N-S cross section in Jangipara Block

Table 13.5 Aquifer Wise Water Level Ranges & Seasonal long-term water level trends (2006 to 2017)

Aquifer	Pre-monsoon Trend			Post-monsoon Trend		
	Water Level Range (mbgl)	Rise (cm/year)	Fall (cm/year)	Water Level Range (mbgl)	Rise (cm/year)	Fall (cm/year)
I	13.75-17.47	-	28.55	8.99-10.84	-	26.65
II	11.43-16.34	-	-	-	-	-
III	14.4-24	-	-	-	-	-

Table 13.6 Aquifer wise maximum thickness of Aquifer

Block	Area (Sq Km)	Thickness of the Granular Zone in Aquifer I Group (m)	Thickness of the Granular Zone in Aquifer II Group (m)	Thickness of the Granular Zone in Aquifer III Group (m)
Jangipara	164.23	65	IB: 56.72 II: 74.94	III: 90.42 IV: 27.64

Table 13.7 Aquifer-wise depth range and parameters (Based on CGWB exploration data)

Group	Sub Aquifer	Depth Range (mbgl)	Discharge (m^3/hr) with DD	T (m^2/day)	S	Specific capacity (m^3/day per m)
Aquifer Group I	IA	15 - 80	30.6 (DD-1.52)	615.05 (J)/560.06 (T)	$1.139x10^{-4}$	20.13
Aquifer Group II	IB	78.28 - 135	90.4(DD 6)	2358	$3.17 X 10^{-4}$	
	II	131.06 - 206				
Aquifer Group III	III	164.58 - 255	56.7 (DD 6)	907.344	$3.13 X 10^{-7}$	9.45
	IV	252.36 - 280				

J*- Jacob's method; T - Theis's method**

13.3 Ground Water Resource, Extraction, Contamination & Other Issues:

Aquifer Wise Resource Availability & Extraction: Dynamic ground water resources as on 31st March'17 in top aquifer i.e., Aquifer I

Table 13.8 Availability of Ground Water resource in Block

Block	Annual Extractable GW	Current Annual GW	Stage of development (%)	Category	Annual GW Allocation for domestic use to
Jangipara	47.5026	38.0482	80.1	Semi-critical	3.2353

Static (in-storage) Resources: 17.41 MCM

13.4 Chemical Quality of Ground Water &Contamination:

Based on Key well data and CGWB outsourced exploratory well data blocks wise Average data of chemical parameter is given below.

Table 13.9 Aquifer wise average chemical parameter of block

Aquifer	pH	EC (µs/cm)	TH	Ca	Mg	Na	K	CO_3	HCO_3	Cl	NO_3	SO_4 (<5)	F (<1)	SiO_2 (<5)	TDS
I	8.14	567.33	123.33	12	22.68	76.36	3.005	1	298.9	23.63	0	2.82	0.12	17.11	340.66
II	8.21	502	112.5	13	19.44	67.25	2.745	0	292.8	17.73	0	0	0	15.28	314.05
III	8.24	569.5	100	11	17.62	78.57	1.92	1.5	301.95	28.36	0	0	0	14.40	336.95

13.5 Ground Water Resource Enhancement& Management Plan:

Ground Water Management Plan for drinking purposes-

- The block is under Semi Critical Category and Ground Water Policy ensures priority of use of ground water is for drinking purpose.
- Regular Field monitoring is necessary for assessment of arsenic concentration in ground water.
- As per WBPHED Data 81 villages with 140767 population do not have pipe water supply scheme.

Table 13.10 Still uncovered population by PWSS in Block

Block	Number of Villages to be covered by water supply schemes	Population in risk zone (as per Census 2011) to be covered by water supply schemes.	Comments on providing water supply to the risk population
Jangipara	81	140767	In Jangipara block, Aquifer-III is less productive (56.7 m^3/hr) in comparison to Aquifer-II (90.04m^3/hr). Average discharge of 56.70 m^3/hr of Aquifer - III has been considered for working out of number of wells required.

- In Jangipara block, Aquifer-III is less productive (56.7 m^3/hr) in comparison to Aquifer-II (90.04 m^3/hr).
- In jangipara block CGWB has constructed two wells (shown in Figure 13.8.) by in house exploration.

Table- 9.5.12.: Estimated Village wise number of Tube wells and cost for construction required in Jangipara block

A	**Village**
B	**Population 2011**
C	**Projected Population 2021 (decadal growth rate 9.49%)**
D	**Present Water Requirement for Human Population in m^3 @70 lpcd**
E	**Projected Water Requirement for Human Population in m^3 @70 lpcd**
F	**Cattle 2011**
G	**Projected Cattle 2021**
H	**Present Water Requirement for cattle m^3 @20lpcd**
I	**projected Water Requirement for cattle m^3 @20lpcd**
J	**Total Water Requirement/day as on 2011 in m^3**
K	**Total Water Requirement cubic m/day as on 2021 in m^3**
L	**Discharge (m3/hr)**
M	**Discharge of one TW in m^3/day after 8 hours of pumping**
N	**No of TW**
O	**Cost of Tube well of 300 m depth (approx.) 10”x6" dia @ Rs. 20 lakhs (In lakh) as per EFC**

Block wise Management plan in parts of Hugli District, West Bengal

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
Rajbalhat	16479	18043	1153.5	1263	1648	1708	32.96	34.17	1186.5	1297.2	56.7	453.6	3	60
Gultia	1415	1549	99.05	108.43	142	147	2.84	2.94	101.89	111.37	56.7	453.6	0	0
Gopalpur	2093	2292	146.51	160.44	209	217	4.18	4.33	150.69	164.77	56.7	453.6	0	0
Mirpur	897	982	62.79	68.74	90	93	1.8	1.87	64.59	70.61	56.7	453.6	0	0
Rajhati	904	990	63.28	69.3	90	93	1.8	1.87	65.08	71.17	56.7	453.6	0	0
Bilara	1674	1833	117.18	128.31	167	173	3.34	3.46	120.52	131.77	56.7	453.6	0	0
Arabindapur	1175	1287	82.25	90.09	118	122	2.36	2.45	84.61	92.54	56.7	453.6	0	0
Tarajol	1700	1861	119	130.27	170	176	3.4	3.52	122.4	133.79	56.7	453.6	0	0
Binodbati	61	67	4.27	4.69	6	6	0.12	0.12	4.39	4.81	56.7	453.6	0	0
Chaiman Chak	140	153	9.8	10.71	14	15	0.28	0.29	10.08	11	56.7	453.6	0	0
Dakshin Gultia	745	816	52.15	57.12	75	78	1.5	1.55	53.65	58.67	56.7	453.6	0	0
Tripan	648	709	45.36	49.63	65	67	1.3	1.35	46.66	50.98	56.7	453.6	0	0
Nabagram	2208	2418	154.56	169.26	221	229	4.42	4.58	158.98	173.84	56.7	453.6	0	0
Jabni	280	307	19.6	21.49	28	29	0.56	0.58	20.16	22.07	56.7	453.6	0	0
Rahimpur	3483	3814	243.81	266.98	348	361	6.96	7.21	250.77	274.19	56.7	453.6	1	20
Hariharpur	1246	1364	87.22	95.48	125	130	2.5	2.59	89.72	98.07	56.7	453.6	0	0
Soari	1029	1127	72.03	78.89	103	107	2.06	2.14	74.09	81.03	56.7	453.6	0	0
Rasidpur	4325	4735	302.75	331.45	433	449	8.66	8.98	311.41	340.43	56.7	453.6	1	20
Singti	2332	2553	163.24	178.71	233	242	4.66	4.83	167.9	183.54	56.7	453.6	0	0
Guti Atra	1784	1953	124.88	136.71	178	185	3.56	3.69	128.44	140.4	56.7	453.6	0	0

Block wise Management plan in parts of Hugli District, West Bengal

Dakshin Dogachhia	396	434	27.72	30.38	40	41	0.8	0.83	28.52	31.21	56.7	453.6	0	0
Dogachhia	1580	1730	110.6	121.1	158	164	3.16	3.28	113.76	124.38	56.7	453.6	0	0
Bilaspur	1646	1802	115.22	126.14	165	171	3.3	3.42	118.52	129.56	56.7	453.6	0	0
Khanda Kshetra	793	868	55.51	60.76	79	82	1.58	1.64	57.09	62.4	56.7	453.6	0	0
Senpur	1851	2027	129.57	141.89	185	192	3.7	3.84	133.27	145.73	56.7	453.6	0	0
Pashpur	2792	3057	195.44	213.99	279	289	5.58	5.78	201.02	219.77	56.7	453.6	0	0
Bira Chak	4	4	0.28	0.28	0	0	0	0	0.28	0.28	56.7	453.6	0	0
Ranjapur	3318	3633	232.26	254.31	332	344	6.64	6.88	238.9	261.19	56.7	453.6	1	20
Mohanbati	677	741	47.39	51.87	68	70	1.36	1.41	48.75	53.28	56.7	453.6	0	0
Chakpur	2036	2229	142.52	156.03	204	211	4.08	4.23	146.6	160.26	56.7	453.6	0	0
Harirampur	1361	1490	95.27	104.3	136	141	2.72	2.82	97.99	107.12	56.7	453.6	0	0
Kotalpur	6948	7607	486.36	532.49	695	720	13.9	14.41	500.26	546.9	56.7	453.6	1	20
Prasadpur	2791	3056	195.37	213.92	279	289	5.58	5.78	200.95	219.7	56.7	453.6	0	0
Purbba Gobindapur	1958	2144	137.06	150.08	196	203	3.92	4.06	140.98	154.14	56.7	453.6	0	0
Jagannathpur	2110	2310	147.7	161.7	211	219	4.22	4.37	151.92	166.07	56.7	453.6	0	0
Beli	770	843	53.9	59.01	77	80	1.54	1.6	55.44	60.61	56.7	453.6	0	0
Ichhabati	454	497	31.78	34.79	45	47	0.9	0.93	32.68	35.72	56.7	453.6	0	0
Bishnupur	942	1031	65.94	72.17	94	97	1.88	1.95	67.82	74.12	56.7	453.6	0	0
Neramadhabpur	824	902	57.68	63.14	82	85	1.64	1.7	59.32	64.84	56.7	453.6	0	0
Raspur	1632	1787	114.24	125.09	163	169	3.26	3.38	117.5	128.47	56.7	453.6	0	0
Ghanashyampur	996	1091	69.72	76.37	100	104	2	2.07	71.72	78.44	56.7	453.6	0	0

Block wise Management plan in parts of Hugli District, West Bengal

Majurkha	396	434	27.72	30.38	40	41	0.8	0.83	28.52	31.21	56.7	453.6	0	0
Maheshpur	841	921	58.87	64.47	84	87	1.68	1.74	60.55	66.21	56.7	453.6	0	0
Shrihatta	993	1087	69.51	76.09	99	103	1.98	2.05	71.49	78.14	56.7	453.6	0	0
Somnagar	671	735	46.97	51.45	67	69	1.34	1.39	48.31	52.84	56.7	453.6	0	0
Krishnapur	745	816	52.15	57.12	75	78	1.5	1.55	53.65	58.67	56.7	453.6	0	0
Nilarpur	2692	2947	188.44	206.29	269	279	5.38	5.58	193.82	211.87	56.7	453.6	0	0
Chaurpur	499	546	34.93	38.22	50	52	1	1.04	35.93	39.26	56.7	453.6	0	0
Bakcha	1156	1266	80.92	88.62	116	120	2.32	2.4	83.24	91.02	56.7	453.6	0	0
Kashipur	2057	2252	143.99	157.64	206	214	4.12	4.27	148.11	161.91	56.7	453.6	0	0
Ramchandrapur	816	893	57.12	62.51	82	85	1.64	1.7	58.76	64.21	56.7	453.6	0	0
Hazipur	1849	2024	129.43	141.68	185	192	3.7	3.84	133.13	145.52	56.7	453.6	0	0
Bhimpur	745	816	52.15	57.12	75	78	1.5	1.55	53.65	58.67	56.7	453.6	0	0
Gopalnagar	1106	1211	77.42	84.77	111	115	2.22	2.3	79.64	87.07	56.7	453.6	0	0
Hosenpur	1233	1350	86.31	94.5	123	128	2.46	2.55	88.77	97.05	56.7	453.6	0	0
Dakshindihi	1557	1705	108.99	119.35	156	162	3.12	3.23	112.11	122.58	56.7	453.6	0	0
Rampara	2293	2511	160.51	175.77	229	237	4.58	4.75	165.09	180.52	56.7	453.6	0	0
Toralpur	1653	1810	115.71	126.7	165	171	3.3	3.42	119.01	130.12	56.7	453.6	0	0
Rajibpur	668	731	46.76	51.17	67	69	1.34	1.39	48.1	52.56	56.7	453.6	0	0
Chak Barada	195	214	13.65	14.98	20	21	0.4	0.41	14.05	15.39	56.7	453.6	0	0
Belpara	2206	2415	154.42	169.05	221	229	4.42	4.58	158.84	173.63	56.7	453.6	0	0
Ramnagar	420	460	29.4	32.2	42	44	0.84	0.87	30.24	33.07	56.7	453.6	0	0
Amarpur	667	730	46.69	51.1	67	69	1.34	1.39	48.03	52.49	56.7	453.6	0	0
Kanaipur	1074	1176	75.18	82.32	107	111	2.14	2.22	77.32	84.54	56.7	453.6	0	0

Block wise Management plan in parts of Hugli District, West Bengal

Hijali	651	713	45.57	49.91	65	67	1.3	1.35	46.87	51.26	56.7	453.6	0	0
Santoshpur	1619	1773	113.33	124.11	162	168	3.24	3.36	116.57	127.47	56.7	453.6	0	0
Basantapur	1058	1158	74.06	81.06	106	110	2.12	2.2	76.18	83.26	56.7	453.6	0	0
Mohanpur	1101	1205	77.07	84.35	110	114	2.2	2.28	79.27	86.63	56.7	453.6	0	0
Mahestikuri	416	455	29.12	31.85	42	44	0.84	0.87	29.96	32.72	56.7	453.6	0	0
Chechua Dingalhati	3316	3631	232.12	254.17	332	344	6.64	6.88	238.76	261.05	56.7	453.6	1	20
Kaparpur	693	759	48.51	53.13	69	72	1.38	1.43	49.89	54.56	56.7	453.6	0	0
Kamdebpur	1349	1477	94.43	103.39	135	140	2.7	2.8	97.13	106.19	56.7	453.6	0	0
Ganeshbati	2429	2660	170.03	186.2	243	252	4.86	5.04	174.89	191.24	56.7	453.6	0	0
Baganda	2374	2599	166.18	181.93	237	246	4.74	4.91	170.92	186.84	56.7	453.6	0	0
Mandalika	5946	6510	416.22	455.7	595	617	11.9	12.34	428.12	468.04	56.7	453.6	1	20
Dhitpur	1850	2026	129.5	141.82	185	192	3.7	3.84	133.2	145.66	56.7	453.6	0	0
Panchberia	1985	2173	138.95	152.11	199	206	3.98	4.13	142.93	156.24	56.7	453.6	0	0
Kodalipoa	1367	1497	95.69	104.79	137	142	2.74	2.84	98.43	107.63	56.7	453.6	0	0
Sonamaguri	1328	1454	92.96	101.78	133	138	2.66	2.76	95.62	104.54	56.7	453.6	0	0
Seoraberia	2248	2461	157.36	172.27	225	233	4.5	4.66	161.86	176.93	56.7	453.6	0	0
Lakshmanpur	4008	4388	280.56	307.16	401	416	8.02	8.31	288.58	315.47	56.7	453.6	1	20
Total	**140767**	**154125**	**9853.7**	**10789**	**14083**	**14598**	**281.66**	**291.97**	**10135**	**11081**	**56.7**	**36742**	**10**	**200**

- Table 13.10, 10 wells are required for supply of drinking water in still uncovered part of Jangipara block
- Pipe Water Supply Status by PHED has been given in Figure 13.9
- For monitoring of the ground water regime, if observation well is needed then cost of construction of the same should also be included in the expenditure.
- Phase wise drilling should be initiated. In the initial stage, 25 % of total wells required should be constructed; afterwards, based on achievement whole plan could be implemented.

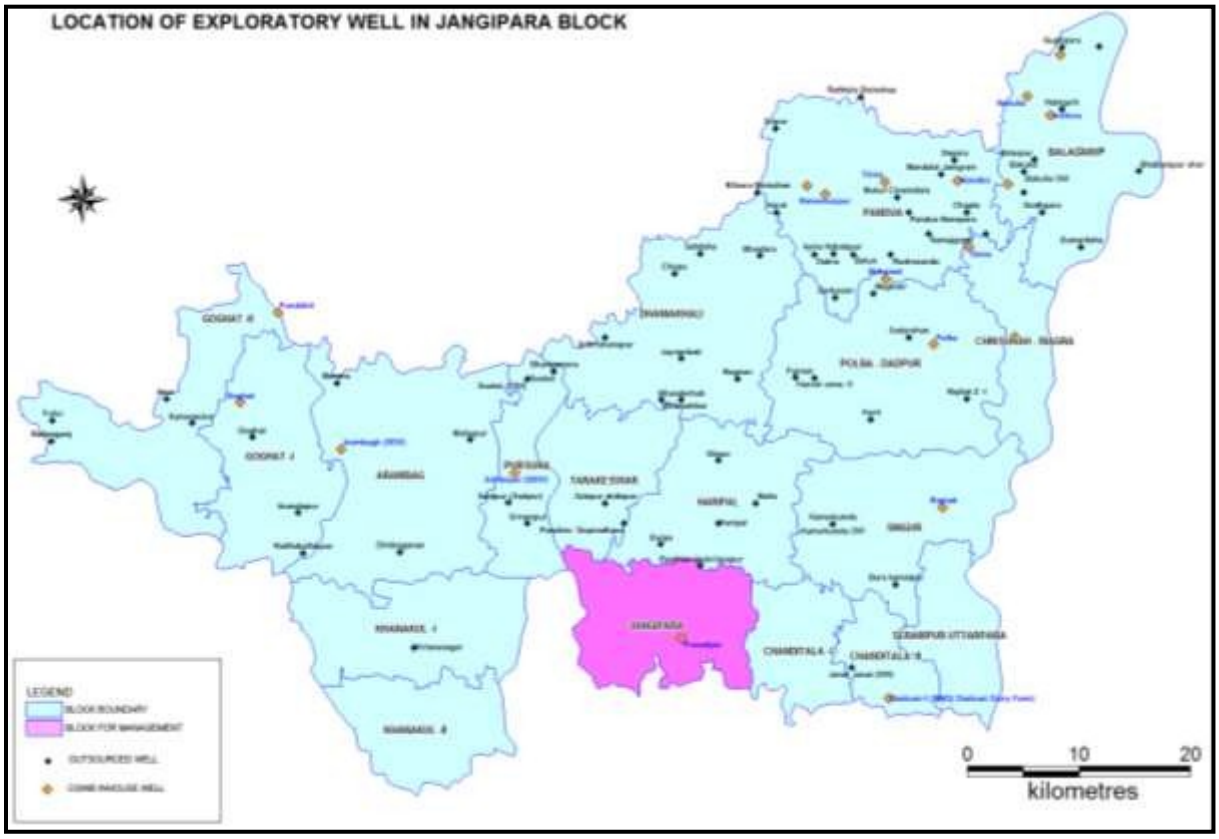

Figure 13.8 Exploratory wells through outsourcing in Jangipara Block

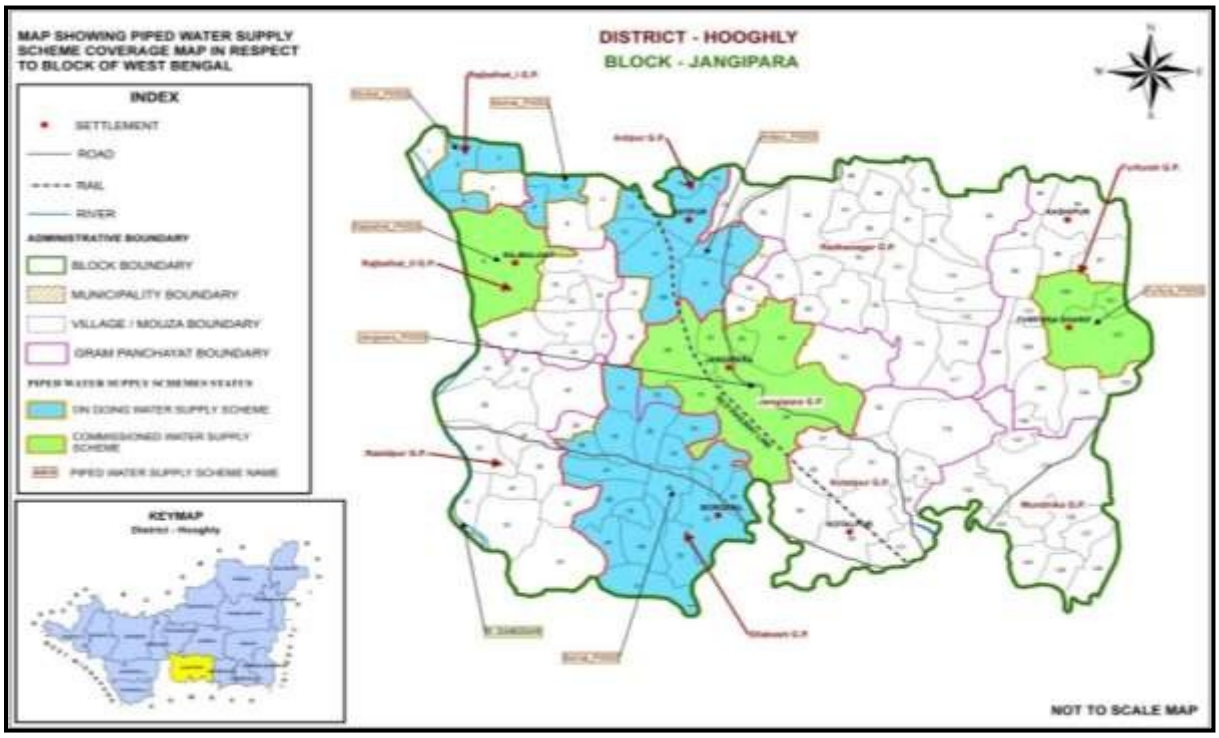

Figure 13.9 Pipe water supply schemes in Jangipara Block (Source-WBPHED)

- After construction of wells, analysis of arsenic and heavy metals in ground water are needed.
- Deeper potential aquifers should always be tapped for drinking purpose.

Management Plan for irrigation:

- Based on CGWB Resource data, block is under **Semi-Critical Category**. Stage of Ground Water development is 80.1 **%,** with declining long term Ground Water level Trend in both seasons.
- As per **4th MI Census** irrigation data in this block number of Shallow Tube Wells are used more (presented in able 13.14).
- Area of cultivation of Boro rice is to be lessened.
- Block shows continuous declining trend of water level; so surface water should be used more than ground water.
- Artificial recharge is must in **Semi Critical** Block.
- Application of modern technologies like Sprinkler, Drip irrigation is highly beneficial for ground water regime.
- Ground water in nearby areas have been infested by arsenic contamination; regular monitoring of arsenic concentration in crop is necessary.

- Continuous R & D study is required to get better solution in future.
- In Jangipara block according to soil and climatic condition, mustard, Jute, rice, potato and Til are suitable crops to grow.

Table 13.11 Cropping pattern in Block

Name of Block		Jangipara
Aman	Area	32638
	Prod.	94.861
	Yield	2906
Boro	Area	4601
	Prod.	14.528
	Yield	3158
Jute	Area	1347
	Prod.*	30.806
	Yield**	22.87
Mustard	Area	1815
	Prod.	1.919
	Yield	1057
Til	Area	2315
	Prod.	2.502
	Yield	1081
Potato	Area	11830
	Prod.	342.597
	Yield	28960
Sugarcane	Area	2
	Prod.	0.305
	Yield	152253

(Area in Ha, Production in Thousand MT and Yield in kg./Ha)

(Source: Department of Economics and Statistics)

Table 13.12 Area wise percentage of current practice of crops in Jangipara Block

Area wise Current Practice of crops								
Rabi Crops(Wheat, Mustard and oil seeds water Column requirement=0.21) Cultivation		**Boro Cultivation (Water Column requirement-1.2 m)**		**Vegetable (water Column requirement Potato=0.6m)**		**Sugarcane(water Column requirement =0.5 m)**		**Total Area covered (ha)**
%	**Area (ha)**	**%**	**Area (ha)**	**%**	**Area (ha)**	**%**	**Area (ha)**	
20	4130	22	4601	58	11830	0	2	20563

Based on data of Table 13.12, the factor of weighted average of water column required is 0.7; so, for irrigation of remaining cultivable area of 6312.99 Ha 4419.09 Ham water is required. But resource estimation as of 2017 a total of 861.26 Ham water from top aquifer is available. Furthermore, change in cropping pattern is also proposed.

However, the available 861.26 Ham ground water resource could be used for irrigation as below:

Table 13.13 Future Water allocation by remaining available water resources in the block

Present water availability	Total available GW resource for future Irrigation	Rabi Crops (Wheat, Mustard and oil seeds water Column requirement=0.21) Cultivation		Boro Cultivation (Water Column requirement -1.2 m)		Vegetable (water Column requirement Potato=0.6m)		Sugarcane(water Column requirement =0.5 m)		Total Area covered(A)	Remaining Cultivable area (ha) (6312.99-A)
		%	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)		
861.26	861.26	50	2050.62	0	0	50	717.72	0	0	2768.32	3544.67
861.26	861.26	75	3075.93	0	0	25	358.86	0	0	3434.79	2878.20
861.26	861.26	100	4101.23	0	0	0	0	0	0	4101.24	2211.75

Based on Table 13.13, by using 100% of available 861.26 ham of ground water in Rabi crop cultivation, 4101.24 Ha area could be covered and 2211.75 Ha of area still remains uncovered by irrigation. For this, surface run off component of rain fall may be harvested (described below).

able 13.14 Number of ground water abstraction structures and Cultivable command area created by structure in Jangipara Block

Block Name	Dug well		Shallow Tube well		Deep Tube well		Surface Flow		Surface Lift		CCA (ha.)		Total CCA (ha.)
	No.	CCA (ha.)	No.	CCA (ha.)	No.	CCA (ha.)	No.	CCA (ha.)	No.	CCA (ha.)	Ground Water	Surface Water	
JANGIPARA	0	0	712	3961.83	24	897.18	0	0	75	512	4859.01	512	5371.01

Table 13.15 Summary of irrigation plan in Jangipara Block

Cultivable area in ha	Net irrigated Command area (GW) in ha	Net irrigated Command area (SW) in ha	Net irrigated Command area (GW +SW) in ha	Net area available for Irrigation	GW available for Future irrigation (ham)	Pre monsoon long term WL Trend 2017 in cm/yr, if falling	Post monsoon long term WL Trend 2017 in cm/yr, if falling	Average Pre monsoon WL in mbgl	Average Post monsoon WL in mbgl	SOD in %	Category
11693	4859.01	521	5380.01	6312.99	861.26	F-28.50	F-30.71	15.29		80.1	Semi-Critical

SOD high, declining long term GW level trend in both seasons, Semi critical Block. More use of SW than GW suggested.

Special intervention for monitoring of Ground water regime

- It is necessary to increase the density of observation wells in the block.
- The rainfall recharge during monsoon by water table fluctuation method should be estimated with greater accuracy.
- The trend of water table during pre- monsoon and post-monsoon intervals can be evaluated with greater accuracy.
- The trend of water table during pre- monsoon and post- monsoon intervals consequent to further groundwater development can be more effectively monitored.
- Regular Water level monitoring is necessary.Rainwater harvesting is strongly suggested in semi critical block.

Rainwater harvesting & Artificial Recharge in Jangipara Block:

Table 13.16 Area suitable for recharge in the study area

District	Block Name	Area (in ha)	Area suitable for recharge (Considering area having DTW more than 3m in post monsoon and showing 0.2m/yr or more falling trend) (in ha)
Hugli	Jangipara	16424	11270

Table 13.17 Estimation of surface run off based on Land slope, soil, etc. (after Dhruvanarayana, 1993)

Block	Major type of soil available in that block	Normal Monsoon Rainfall (m)	Total volume of surface runoff available Annually 'Vt' (RnXAXC) Ham	75% of 'Vt' = V	50% of V (Non committed)= Vnc	60% of Vnc (considering e-flow)= Vf
Jangipara	**Sandy Loam/Clay Loam**	**1.098**	**8115.10 (average Run off coefficient – 0.50)**	**6086. 32**	**3043.16**	**1825.90 (considering 60% of water to be harvested)**

Table 13.18 Details of possible Artificial Recharge & Conservation structures in block

Row 1	Block Area in Ha	16424
Row 2	Area in Ha suitable for recharge	11270
Row 3	Soil type(3)	Silty Clay/Clay
Row 4	Amount of water to be harvested	1825.9
Row 5	Amount of water for artificial recharge of top aquifer and conservation (Ham) - 70 % of Row. 4 (5)	1278.13
Row 6	Source water allocation for for Irrigation Cum Recharge Pond -35% of Row 4 (6)	639.07
Row 7	Source water allocation for REET with recharge shaft -35% of Row 4 (7)	639.07
Row 8	Source water allocation for for injection well to recharge deeper aquifer -20% of Row 4 (8)	365.18
Row 9	Source water allocation for Farm Pond/Irrigation pond – 10 % of Row 4 (9)	182.59
Row 10	Nos. of Irrigation Cum Recharge Pond @ 50 Ham per unit (10)	13
Row 11	Nos. of REET with recharge shaft @ 10 Ham per unit	64
Row 12	Nos. of injection well suggested @ 30 Ham per unit (12)	12
Row 13	Nos. of Farm Pond @ 10 Ham per unit (12)	18
Row 14	Cost of Irrigation Cum Recharge Pond @ Rs 8 lakh per unit	104
Row 15	Cost of REET with recharge shaft @ Rs 8 lakh per unit	512
Row 16	Cost of injection well @ Rs 20 lakh per unit	240
Row 17	Cost of Farm Pond @ Rs 8 lakh per unit	144

Total Cost – 1000 lakh: ¾ of top surface covered by clay & 1/4 area covered by sand; irrigation ponds and REET with Recharge Shaft are suitable.

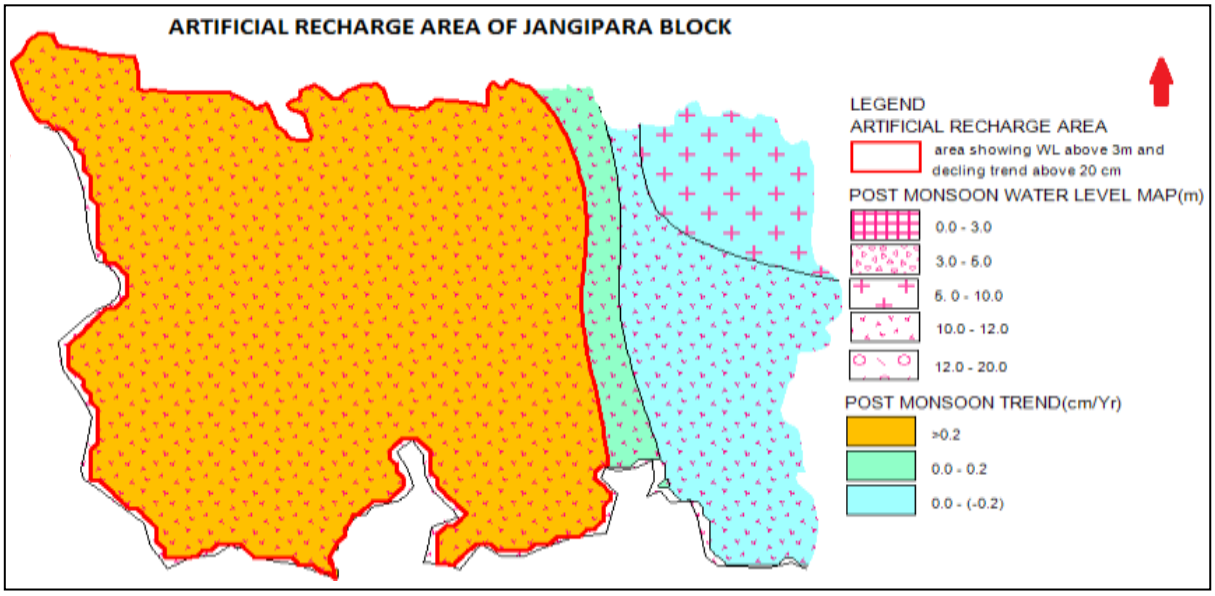

Figure 13.10 Map showing area suitable for artificial recharge in Jangipara Block

14.0 PURSURA BLOCK

14.1 Salient Information

- **Block Name: Pursura**
- **Area (in ha): 10042**
- **District: Hugli**
- **State: West Bengal**
- **Population (as on 2011):**

Table 14.1 Population in Pursura block

	Rural	Urban	Total
Pursura	173437	-	173437

- **Rainfall:** Average annual rainfall (**Hugli district**) for the period 2012 -16 (in mm):129.6467 Average annual rainfall (**Hugli district**)for the period 2013 -17 (in mm): **1336.96**

Table 14.2 Annual Rainfall since last five year

Block	District Normal	Actual (Annual)				
		2013	2014	2015	2016	2017
Pursura	1362	1365.3	1114.4	1549.1	1218.6	1437.4

- **Agriculture & Irrigation (area in ha):**

Table 14.3 Land use pattern of block (Source-West Bengal Land use and Land cover Department)

Block	Area	Area under non agriculture use	Barren and uncultivable	Total agricultural land	Pasture (Ha)	Orchard	Cultivable waste	Fallow land other than Current Fallow (Ha)	Current Fallow	Forest	Net sown area (H
Pursura	10042	2980	-	7499	-	13	15	1	-	-	7405

14.2 Aquifer Wise Ground Water Resource Availability & Extraction:

Table 14.4 Details of aquifer wise resource availability and draft (in MCM) in Block

Resource Availability	Aquifer I Group	Aquifer II Group	Aquifer III Group	Extraction (for Aquifer I)
Annual Extractable GW Recharge/Dynamic Resource	40.94	0.39	-	28.56
Static Resource	20.73			

Disposition of Aquifer:

- In Pursura Block, 3 Aquifer Groups are explored.
- The range of Aquifer Group I is 9.14m to 143.5m and it is a part of Younger Alluvium formation.
- The range of Aquifer II Group is 108.7m to 204.75m. It is divided into two aquifers, IB and II; the range of IB aquifer is 108.7m to 167.63m and II aquifer is 152.39m to 204.75m; this group is a part of Older Alluvium Formation. In Aquifer II, iron concentration in ground water is high.
- The range of Aquifer III is 201.15m to 262.11 m. It is divided into two aquifers: III &IV; the range of III aquifer is 201.15m to 231.63m and IV aquifer is 240m to 262.11m. This Group belongs to Tertiary Formation. In Aquifer III, ground water potentiality is low.

Table 14.5 Aquifer disposition with depth range in block

Block	Depth range of Aquifer Groups in mbgl		
	Aquifer I	**Aquifer II**	**Aquifer III**
Pursurah	aquifer IA: 9.14-143.5	aquifer IB: 108.7-167.63 aquifer II: 152.39-204.75	aquifer III: 201.15-231.63 aquifer IV: 240-262.11

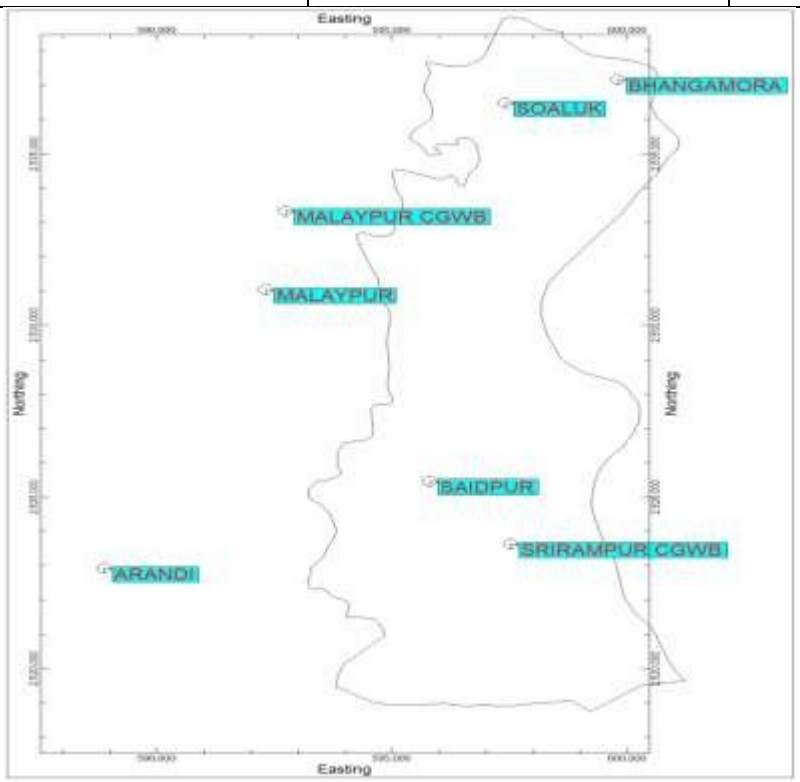

Figure 14.1 Index Map in Pursura Block

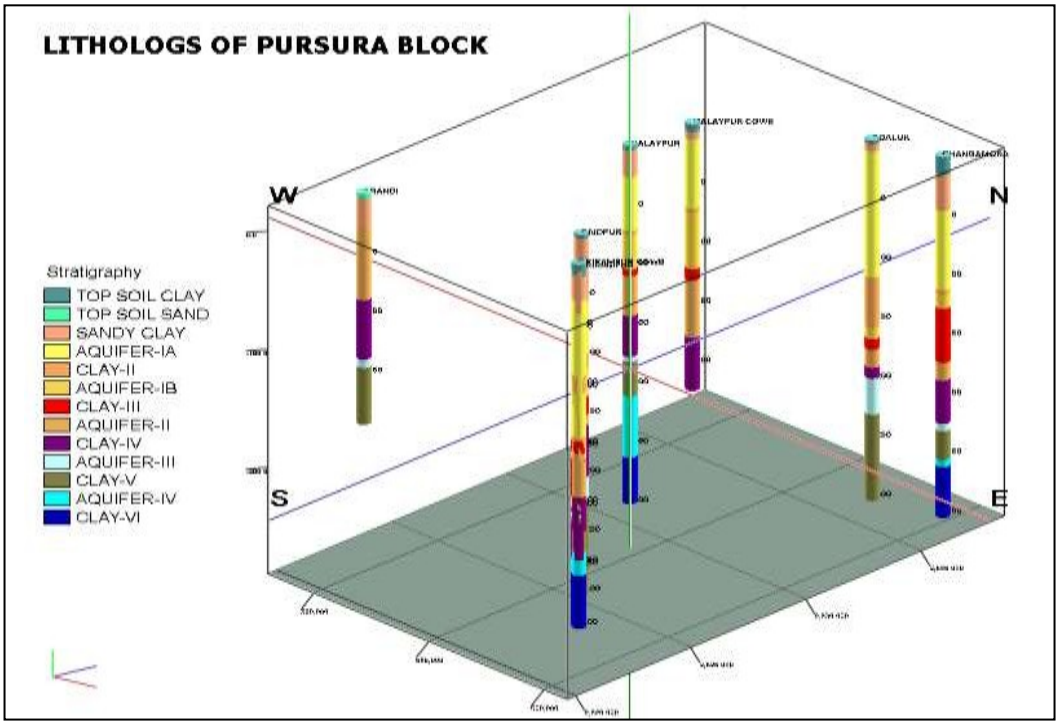

Figure 14.2 Lithologs in Pursura Block

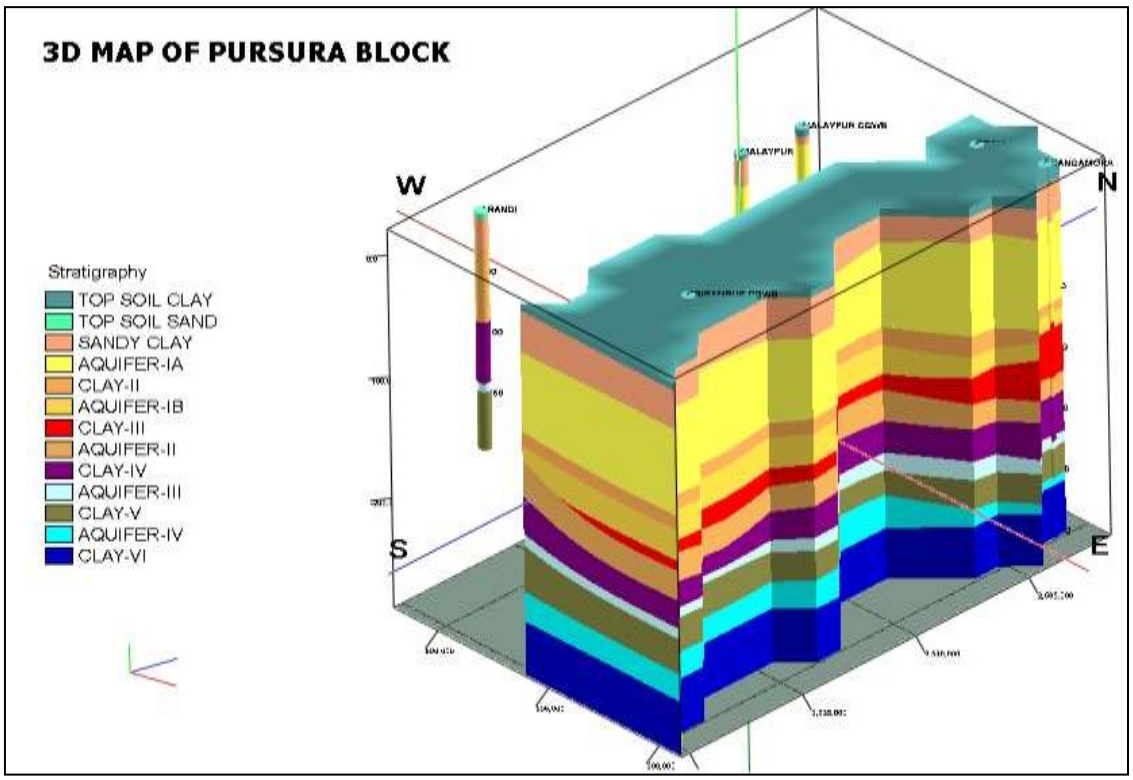

Figure 14.3 3D Aquifer disposition in Pursura Block

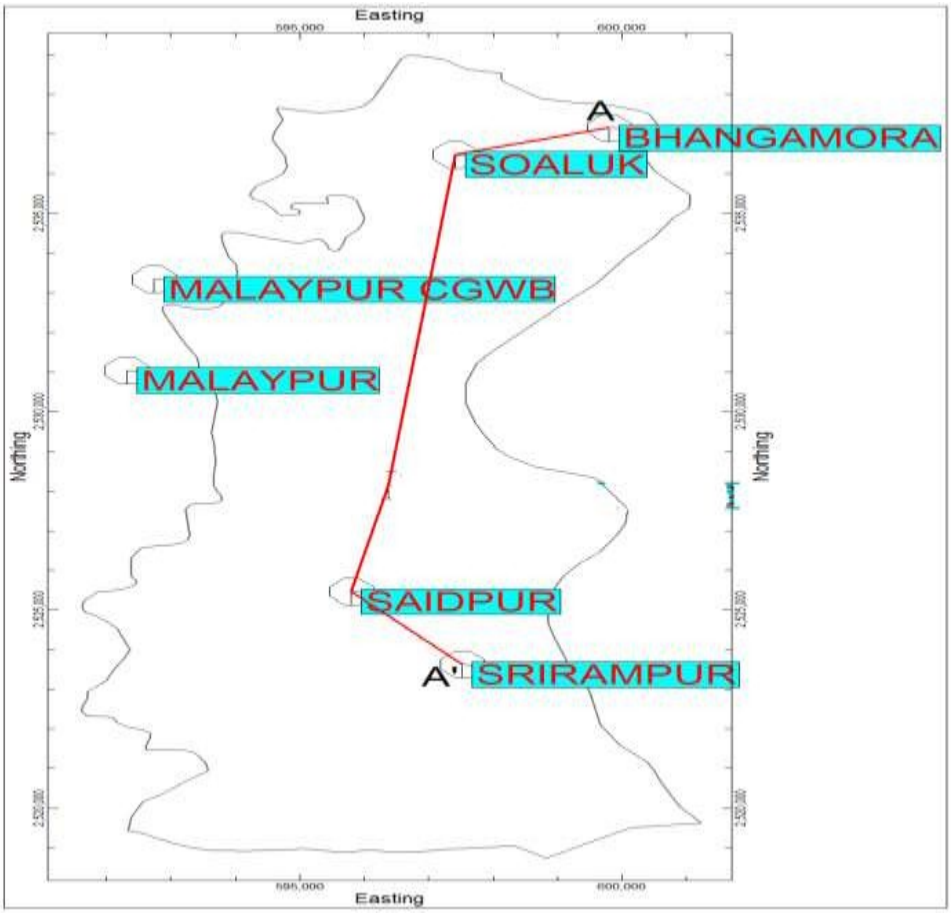

Figure 14.4 N-S Cross section Index Line (Eastern Part) in Pursura Block

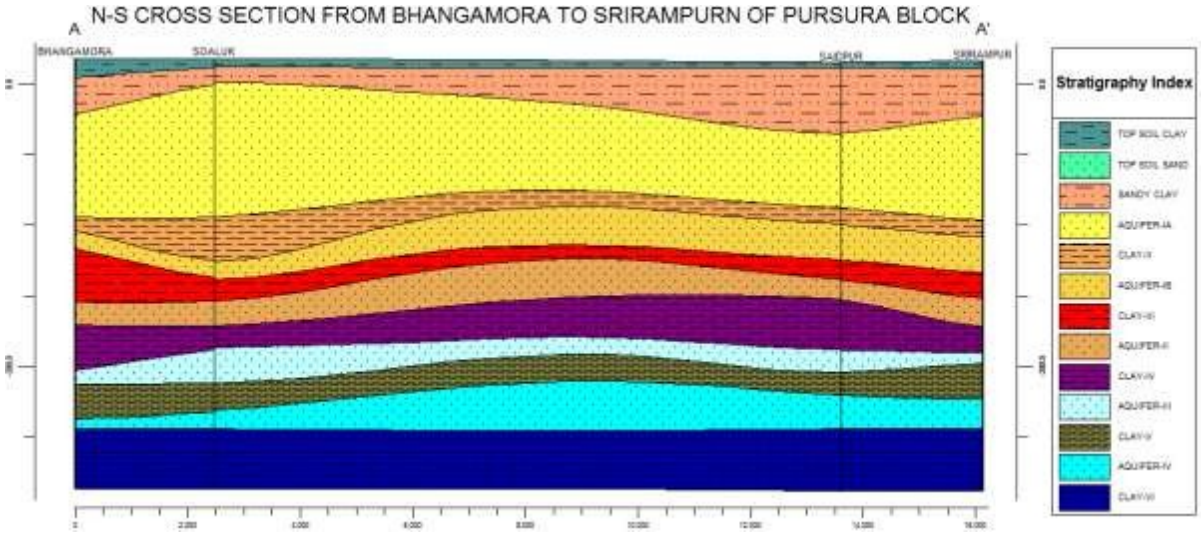

Figure 14.5 N-S Cross section (Eastern Part) in Pursura Block

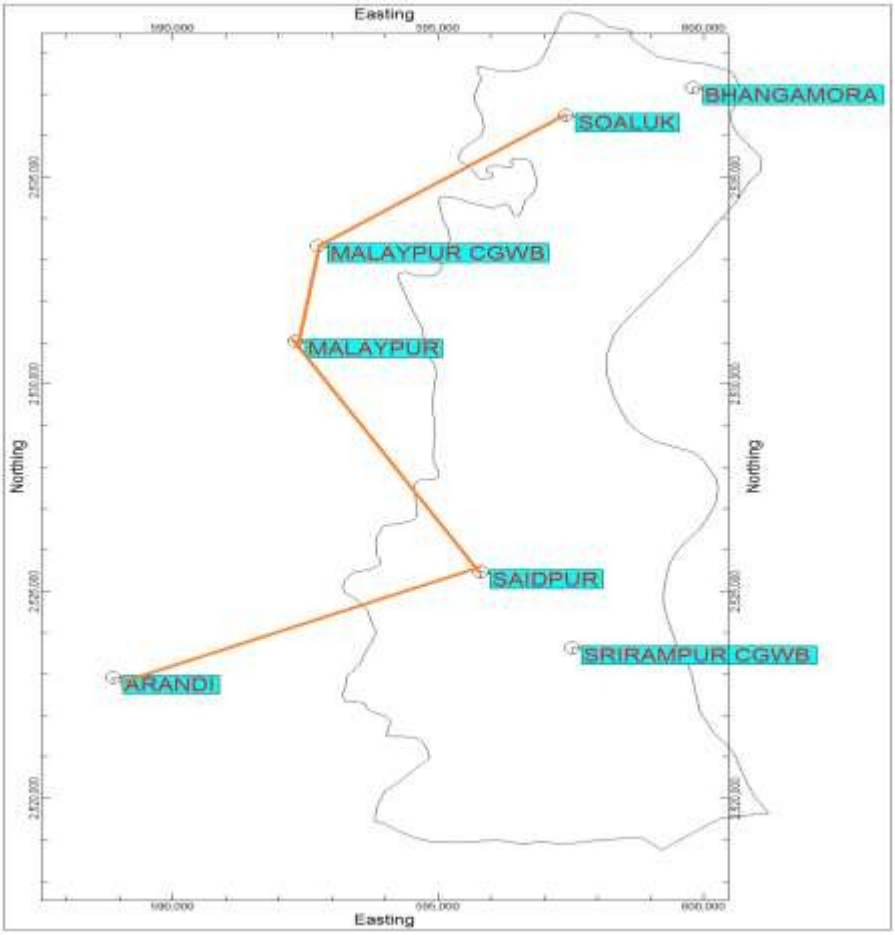

Figure 14.6 N-S (Western Part) Cross section Index Line in Pursura Block

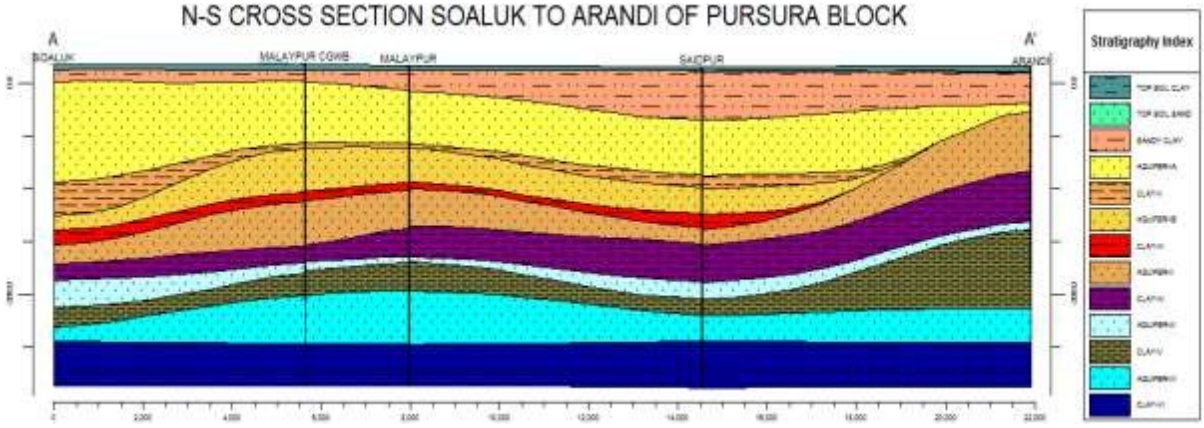

Figure 14.7 N-S (Western Part) Cross section in Pursura Block

Table- 9.6.6.: Aquifer Wise Water Level Ranges & Seasonal long term water level trends (2006 to 2017)

Block	Aquifer	Pre-monsoon Trend			Post-monsoon Trend		
		Water Level	Rise (cm/year)	Fall (cm/year)	Water Level Range	Rise (cm/year)	Fall (cm/year)

		Range (mbgl)			(mbgl)		
Pursura	**I**	**14.49-21.85**	**-**	**20.12**	**14.49-21.85**	**-**	**27.52**
Pursura	**II**	**16.1-18.08**	**-**	**-**	**9.65-11.2**	**-**	**-**
Pursura	**III**	**9.4 - 11.4**	**-**	**-**	**13.55 - 14.17**	**-**	**-**

Table-9.6.7. Aquifer wise maximum thickness

Block	Area (Sq Km)	Thickness of the Granular Zone in Aquifer I Group (m)	Thickness of the Granular Zone in Aquifer Group II (m)	Thickness of the Granular Zone in Aquifer Group III (m)
Pursurah	100.42	134.36	IB: 58.93 II: 52.36	III: 30.48 IV: 22.11

Table- 9.6.8.Aquifer-wise depth range and parameters (On the basis of CGWB exploration data)

Group	Sub Aquifer	Depth Range (mbgl)	Discharge (m^3/hr) with DD	T (m^2/day)	S	Specific capacity (m^3/day per m)
Aquifer Group I	IA	9.14 - 143.5	11.047 (DD 3.23)	1688.33	4.16 X 10^{-1}	25.59
Aquifer Group II	IB	108.7 - 167.6	52.04 (DD 4.88)	2358	3.17 X 10^{-4}	11.82
	II	152.39 - 204.75				
Aquifer Group III	III	201.15 - 231.63	39.6 (DD 6)	147.86	5.5 X 10^{-10}	6.6
	IV	240 - 262.11				

J*- Jacob's method; T - Theis's method**

14.3 Ground Water Resource, Extraction, Contamination & Other Issues:

Aquifer Wise Resource Availability & Extraction: Dynamic ground water resources as on 31st March'17 in Aquifer I

Table 14.6 Availability of Ground Water resource in Block

Block	Annual Extractable GW	Current Annual GW	Stage of GW	Category	Annual GW Allocation for domestic use to
Pursura	**108.5971**	**45.8102**	**46.87**	Safe	2.5691

Static (in-storage) Resources: 20.73 MCM

14.4 Chemical Quality of Ground Water & Contamination:

Based on 10- 12 Key well data and CGWB outsourced exploratory well data blocks wise Average data of chemical parameter is given below.

Table 14.7 Aquifer wise average chemical parameter of block

Aquifer	pH	EC (µs/cm)	TH	Ca	Mg	Na	K	HCO_3	Cl	NO_3	SO_4 (<5)	F (<1)	SiO_2 (<5)	TDS	Fe	Mn (<0.05)	As (<0.002)
I	7.89	438	150.33	27.66	19.48	26.76	1.48	234.13	10.575	0.37	0	0.13	26.95	255.9897	0.34	0.16	0.003
II	7.78	565.25	127	23.75	21.41	26.13	3.22	286.78	19.32	0.7	0	0.33	19.69	323.38	0.26	0.11	0.003

14.5 Ground Water Resource Enhancement& Management Plan:

Ground Water Management Plan for drinking purposes-

- The block is a 'Safe' Block.
- However, Regular monitoring of ground water regime is needed for assessment of its contamination by arsenic in tube wells.
- As per WBPHED, 75061 population in 24 villages do not get pipe water for drinking.

Table 14.8 Uncovered population by Pipe Water Supply in Block

Block	Number of Villages to be covered by water supply schemes	Population (as per Census 2011) still un covered by water supply schemes.	Comments on providing water supply to the risk population
Pursurah	24	75061	In Pursura block, Aquifer-III is less productive (39.6 m^3/hr) in comparison to Aquifer-II (52.04 m^3/hr). Average discharge of 45.82 m^3/hr has been considered to work out nos. of wells required.

- In Pursurah block, Aquifer-III is less productive (39.6 m3/hr) in comparison to Aquifer-II (52.04 m^3/hr).
- Two wells have been constructed by outsourcing: one at Shrirampur tapping Aquifer-II reveals discharge of 16.8 m^3/hr and 2nd well at Soaluk (shown in Fig-9.6.8.) tapping both Aquifer –II & Aquifer III reveal discharge of 26.4 m^3/hr. These wells could be used for supply of drinking water in that part of block.

Table- 9.6.12.: Estimated Village wise number of Tube wells and cost for construction:

A	**Village**
B	**Population 2011**
C	**Projected Population 2021 (decadal growth rate 9.49%)**
D	**Present Water Requirement for Human Population in m^3 @70 lpcd**
E	**Projected Water Requirement for Human Population in m^3 @70 lpcd**
F	**Cattle 2011**
G	**Projected Cattle 2021**
H	**Present Water Requirement for cattle m^3 @20lpcd**
I	**projected Water Requirement for cattle m^3 @20lpcd**
J	**Total Water Requirement/day as on 2011 in m^3**
K	**Total Water Requirement cubic m/day as on 2021 in m^3**
L	**Discharge (m3/hr)**
M	**Discharge of one TW in m^3/day after 8 hours of pumping**
N	**No of TW**
O	**Cost of Tube well of 300 m depth (approx.) 10”x6" dia @ Rs. 20 lakhs (In lakh) as per EFC**

Block wise Management plan in parts of Hugli District, West Bengal

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
Sahapur	2424	2654	169.7	185.8	242	251	4.84	5.02	174.5	190.8	45.82	366.6	1	20
Baikunthapur	8794	9629	615.6	674	879	911	17.58	18.22	633.2	692.3	45.82	366.6	2	40
Kelepara	3949	4324	276.4	302.7	395	409	7.9	8.19	284.3	310.9	45.82	366.6	1	20
Dulalbati	1390	1522	97.3	106.5	139	144	2.78	2.88	100.1	109.4	45.82	366.6	0	0
Ranbagpur	1940	2124	135.8	148.7	194	201	3.88	4.02	139.7	152.7	45.82	366.6	0	0
Rasulpur	3073	3365	215.1	235.6	307	318	6.14	6.36	221.3	241.9	45.82	366.6	1	20
Paschimpara	4829	5287	338	370.1	483	501	9.66	10.01	347.7	380.1	45.82	366.6	1	20
Harinakhali	2356	2580	164.9	180.6	236	245	4.72	4.89	169.6	185.5	45.82	366.6	1	20
Rasik Chak	404	442	28.28	30.94	40	41	0.8	0.83	29.08	31.77	45.82	366.6	0	0
Takipur	1861	2038	130.3	142.7	186	193	3.72	3.86	134	146.5	45.82	366.6	0	0
Saota	3402	3725	238.1	260.8	340	352	6.8	7.05	244.9	267.8	45.82	366.6	1	20
Kadipur	637	697	44.59	48.79	64	66	1.28	1.33	45.87	50.12	45.82	366.6	0	0
Bheuta	2423	2653	169.6	185.7	242	251	4.84	5.02	174.5	190.7	45.82	366.6	1	20
Bhunyera	1910	2091	133.7	146.4	191	198	3.82	3.96	137.5	150.3	45.82	366.6	0	0
Samaspur	1114	1220	77.98	85.4	111	115	2.22	2.3	80.2	87.7	45.82	366.6	0	0
Hati	3518	3852	246.3	269.6	352	365	7.04	7.3	253.3	276.9	45.82	366.6	1	20
Akri Fatepur	4776	5229	334.3	366	478	495	9.56	9.91	343.9	375.9	45.82	366.6	1	20
Chilladangi	7492	8203	524.4	574.2	749	776	14.98	15.53	539.4	589.7	45.82	366.6	2	40
Harua	2170	2376	151.9	166.3	217	225	4.34	4.5	156.2	170.8	45.82	366.6	0	0
Benegachhi	1284	1406	89.88	98.42	128	133	2.56	2.65	92.44	101.1	45.82	366.6	0	0
Jasar	1712	1874	119.8	131.2	171	177	3.42	3.55	123.3	134.7	45.82	366.6	0	0
Gopimohanpur	2165	2370	151.6	165.9	217	225	4.34	4.5	155.9	170.4	45.82	366.6	0	0
Bara Digrui	4739	5189	331.7	363.2	474	491	9.48	9.83	341.2	373.1	45.82	366.6	1	20
Ghol Digrui	6699	7335	468.9	513.5	670	695	13.4	13.89	482.3	527.3	45.82	366.6	1	20
Total	**75061**	**82185**	**5254**	**5753**	**7505**	**7780**	**150.1**	**155.6**	**5404**	**5909**	**45.82**	**8797**	**15**	**300**

From Table 14.8., 15 wells are required for supply of drinking water in uncovered part of Pursura Block, Hugli District West Bengal; Present Pipe Water Supply Status by PHED has been given in Figure 14.9

- Number of tube wells required is more so these wells could be constructed in both aquifers separately.
- For monitoring of the ground water regime if observation well is needed then cost of construction of the same should also be included in the expenditure.

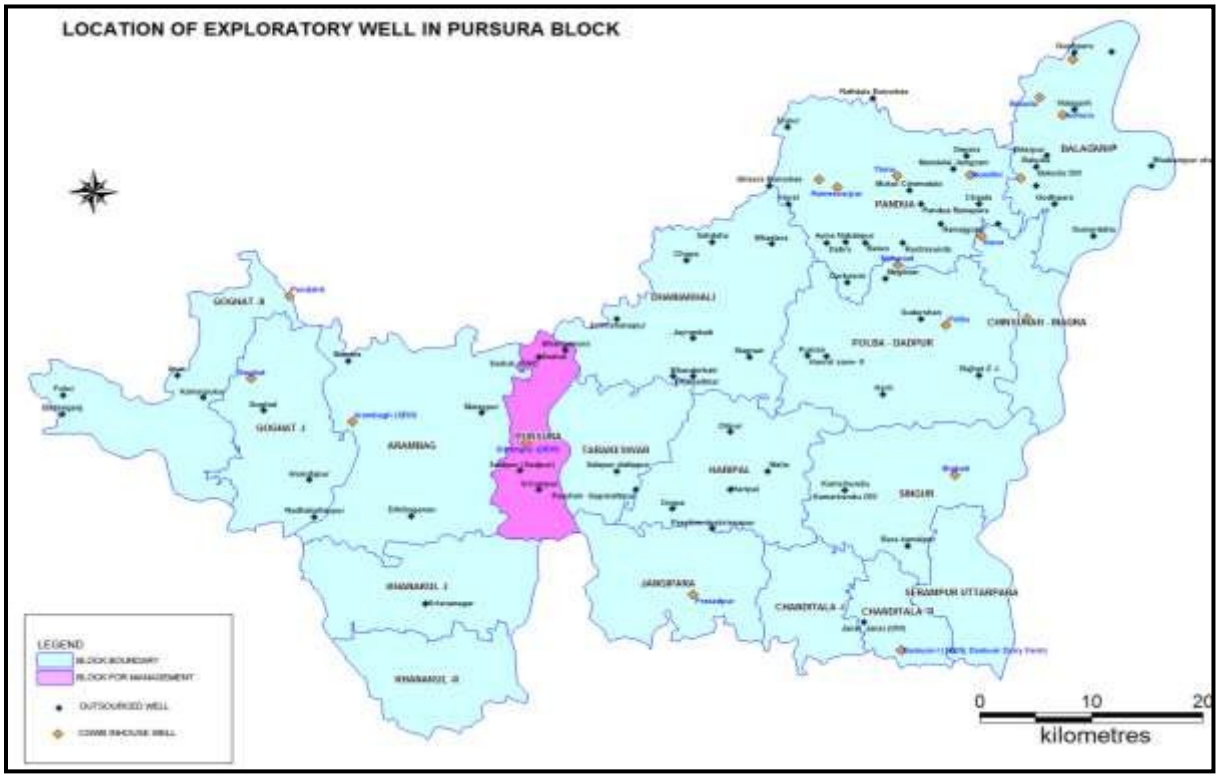

Figure 14.8 Location of Exploratory wells through outsourcing in Pursura Block

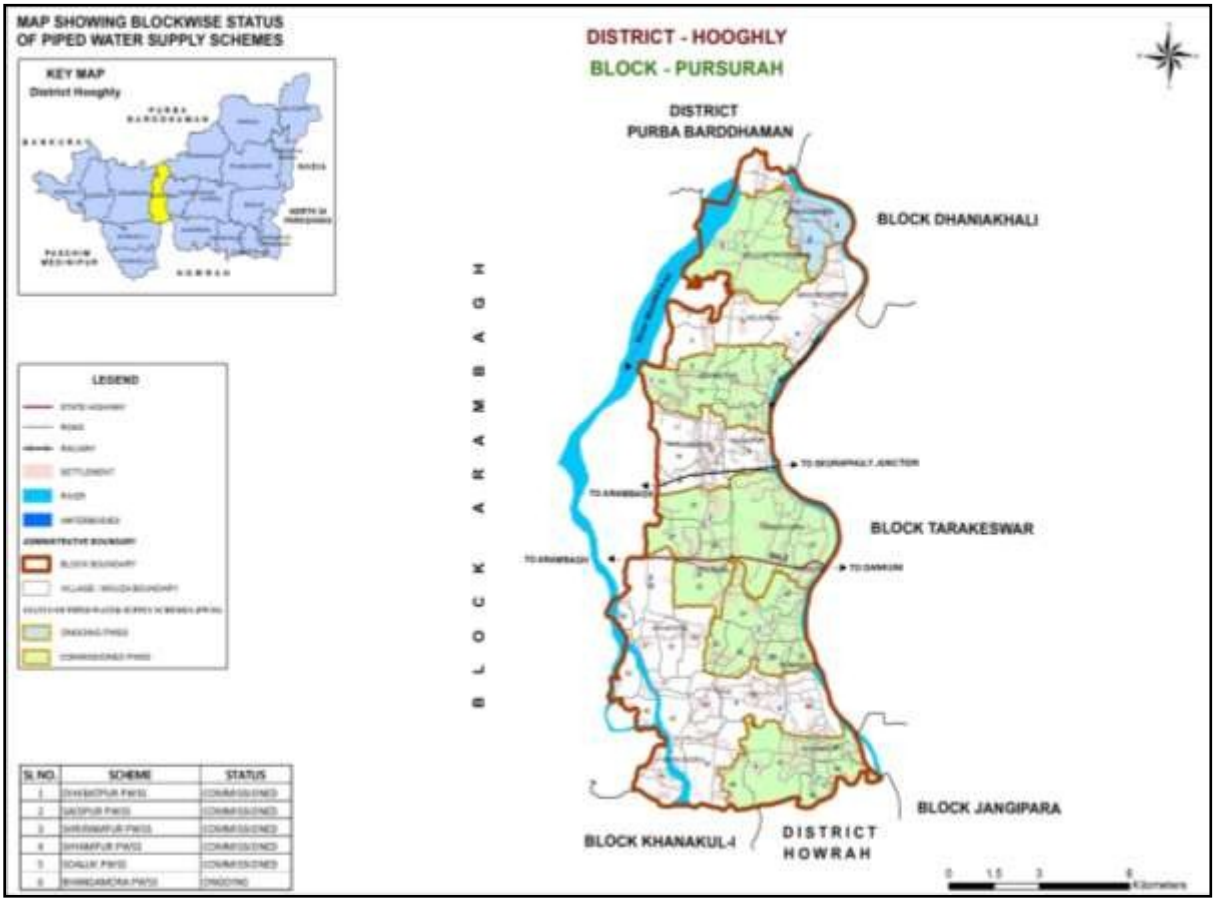

Figure 14.9 Present Pipe Water Supply Schemes in Pursura Block (Source-WBPHED)

- Phase wise drilling could be initiated first; initially 25 % of wells should be constructed and afterwards, the whole plan could be implemented.
- After construction of well, analysis of arsenic and heavy metals in ground water could be done.

Management Plan for irrigation:

- Based on CGWB Resource data, block is under **Safe Category**. Stage of Ground Water development is 46.87 **%,** with declining long term ground water level in post monsoon.
- As per **4th MI Census** irrigation data, nos. of Shallow Tube Wells are used more.
- Artificial recharge should be implemented in this block.
- Application of modern technologies like Sprinkler& Drip irrigation should also be followed.
- In areas in nearby places, ground water contamination by arsenic has been encountered; monitoring at regular interval of arsenic concentration in crop is also

necessary.

- Regular R & D study is necessary to obtain better solution of management of water resources in future.
- In Pursura block soil and climatic condition are suitable for Mustard, Wheat, Jute, rice, potato and Til crops to grow.

Table 14.9 Cropping pattern in Block

Name of Block		Pursura
Aman	Area	690
	Prod.	1.663
	Yield	2410
Boro	Area	112
	Prod.	0.288
	Yield	2575
Wheat	Area	10
	Prod.	0.025
	Yield	2506
Jute	Area	2601
	Prod.*	54.049
	Yield**	20.78
Gram	Area	9
	Prod.	0.011
	Yield	1256
Mustard	Area	7
	Prod.	0.006
	Yield	905
Til	Area	1785
	Prod.	1.474
	Yield	826
Potato	Area	8017
	Prod.	126.139
	Yield	15734
Sugarcane	Area	814
	Prod.	123.934
	Yield	152253

(Area in Ha., Production in Thousand MT and Yield in kg./Ha.)

(Source: Department of Economics and Statistics)

From above Table, percentage wise crop covering area of block has been estimated and presented in Table 14.10.

Table 14.10 Area wise percentage of current practice of crops in Pursura Block

Area wise Current Practice of crops								
Rabi Crops (Wheat, Mustard and oil seeds water Column requirement=0.21) Cultivation		Boro Cultivation (Water Column requirement-1.2 m)		Vegetable (water Column requirement Potato=0.6m)		Sugarcane (water Column requirement =0.5 m)		Total Area covered (ha)
%	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	
17	1802	1	112	75	8017	8	814	10745

Based on data of Table 14.10, the factor of weighted average of water column has been estimated to be 0.5; so, for irrigation of remaining cultivable area of 2078.42 Ha 1039.21 Ham water is required. Ground water resource estimation as of 2017 shows that 5123.16 Ham from top aquifer is available. Therefore, the remaining cultivable area could be covered by irrigation facility for cultivation. However, planning is being done to bring the remaining cultivable area for coverage with some change in cropping pattern for better management of water resources as follows.

Using 60 % water of present available water remaining cultivable area can be harvested and 40 % water is saved for future irrigation. Considering availability of water is more. Therefore, as such Boro Rice cultivation could be done in the area, but with care. Again, cultivation of Sugarcane may be done with some regulation from the authority. In

Table 14.11 Water allocation for remaining cultivable area with change in cropping pattern

Present water availability	Considering 60% water and 40 % for future irrigation	Rabi Crops (Wheat, Mustard and oil seeds water Column requirement=0.21) Cultivation		Boro Cultivation (Water Column requirement-1.2 m)		Vegetable (water Column requirement Potato=0.6m)		Sugarcane (water Column requirement =0.5 m)		Total Area covered (A)	Remaining Cultivable area (ha) (2078.42-A)
		%	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)		
5123.16	3073.90	55	8050.69	20	512.32	20	1024.63	5	307.39	9895.03	-7816.61
5123.16	3073.90	25	3659.40	50	1280.79	25	1280.79	0	0	6220.98	- 4142.56
5123.16	3073.90	0	0	70	1793.10	20	1024.63	10	614.78	3432.51	- 1354.09

Based on Table 14.11., in remaining area of 2078.42 ha, Rabi crops, Boro, Vegetables & sugarcane are suggested in ratio of 0: 70: 20: 10.

Table 14.12 Number of ground water abstraction structures and Cultivable command area created by structure in Pursura Block

Block Name	Dug well		Shallow Tube well		Deep Tube well		Surface Flow		Surface Lift		CCA (ha.)		Total CCA (ha.)
	No.	CCA (ha.)	No.	CCA (ha.)	No.	CCA (ha.)	No.	CCA (ha.)	No.	CCA (ha.)	Ground Water	Surface Water	
PURSURA	0	0	739	2727.22	29	1019.4	0	0	99	1673.96	3746.62	1673.96	5420.58

Table 14.13 Salient features of Irrigation scenario in Pursura block

Block	Geographical area in ha	Cultivable area in ha	Net irrigated Command area (GW) in ha	Net irrigated Command area (SW) in ha	Net irrigated Command area (GW +SW) in ha	Net area available for Irrigation	GW available for Future irrigation (ham)	Average Premonsoon WL in	Average Postmonsoon WL in	Premonsoon Long Term WL Trend in cm/yr, if falling	Postmonsoon Long Term WL Trend in cm/yr, if falling	SOD (%)	Category
Pursura	10042	7499	3746.62	1673.96	5420.58	2078.42	5123.16	18.17	7.5	**No**	**Yes, 27.52**	**46.87**	**Safe**

Remarks: To arrest the declining trend of water level in post monsoon, more SW may be used than GW

Rainwater harvesting & Artificial Recharge in block:

In Pursura Block, data show that there is sufficient ground water resources. However, in future there may be requirement of more water. Therefore, measures have been taken for artificial recharge and conservation methods.

Table 14.14 Area suitable for recharge in the block

District	Block Name	Area (in ha)	Area suitable for recharge (Considering area having DTW more than 3m in post monsoon and showing more than 0.2m/yr falling trend) (in ha)
Hugli	Pursurah	10030	10030

On the basis of soil characteristic, Slope, Rain fall data, etc. run off component in the block has been estimated as shown in Table 14.15

Table 14.15 Estimation of Surface runoff based on soil, Land slope, etc. (after Dhruvanarayana, 1993)

Block	Major type of soil available in that block	Normal monsoon Rainfall	Total volume of surface runoff available Annually 'Vt' (RnXAXC) Ham	75% of 'Vt' = V	50% of V (Non committed)= Vnc	60% of Vnc (considering 60 % of water to be harvested)= Vf
Pursurah	**Slity Clay loam/Silty Clay/Sandy Loam**	**1.098**	**4405.18 (average run off coefficient – 0.40)**	**3303.88**	**1651.94**	**991.16**

Table 14.16 Estimation of possible Conservation & artificial recharge structures in block

Row 1	Block Area in Ha	**10030**
Row 2	Area in Ha suitable for recharge	10030
Row 3	Soil type(3)	Sandy Loam/Loam
Row 4	Amount of water to be harvested	991.16
Row 5	Amount of water for artificial recharge of top aquifer and conservation (Ham) - 70 % of Row. 4 (5)	693.82
Row 6	Source water allocation for for Irrigation Cum Recharge Pond -35% of Row 4 (6)	346.91
Row 7	Source water allocation for REET with recharge shaft -35% of Row 4 (7)	346.91
Row 8	Source water allocation for for injection well to recharge deeper aquifer -20% of Row 4 (8)	198.23
Row 9	Source water allocation for Farm Pond/Irrigation pond – 10 % of Row 4 (9)	99.12
Row 10	Nos. of Irrigation Cum Recharge Pond @ 50 Ham per unit (10)	7
Row 11	Nos. of REET with recharge shaft @ 10 Ham per unit	35
Row 12	Nos. of injection well suggested @ 30 Ham per unit (12)	7
Row 13	Nos. of Farm Pond @ 10 Ham per unit (12)	10
Row 14	Cost of Irrigation Cum Recharge Pond @ Rs 8 lakh per unit	56
Row 15	Cost of REET with recharge shaft @ Rs 8 lakh per unit	280
Row 16	Cost of injection well @ Rs 20 lakh per unit	140
Row 17	Cost of Farm Pond @ Rs 8 lakh per unit	80

Total Cost 556 lakh; 1/2 of the block area covered by sand and other ½ covered by clay; Conservation structures and REET with recharge shafts are suitable structures

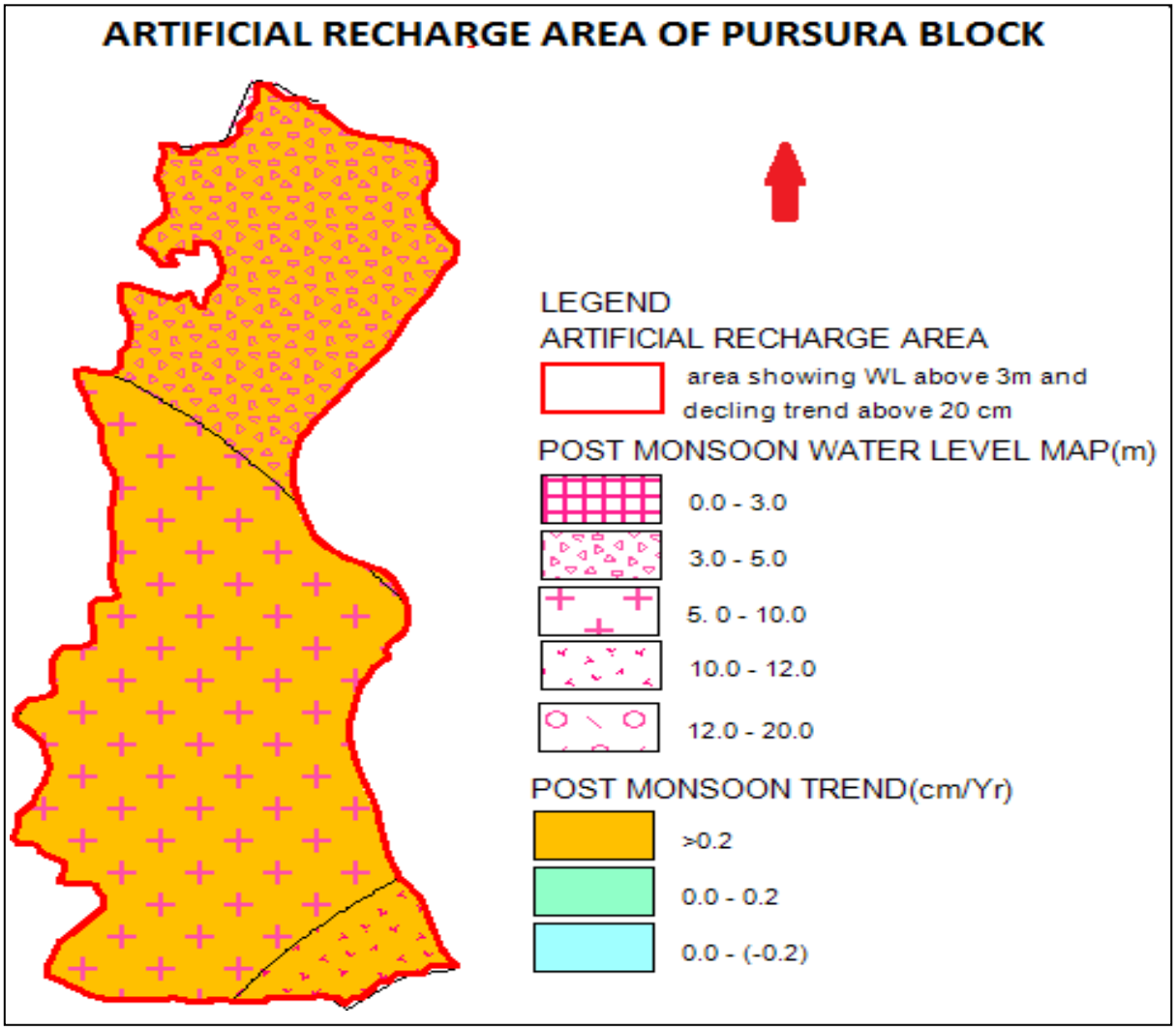

Figure 14.10 Area suitable for artificial recharge in Pursura Block

15.0 KHANAKUL-I BLOCK

15.1 Salient Information

- **Block Name: Khanakul-I**
- **Area (in ha): 17240**
- **District: Hugli**
- **State: West Bengal**
- **Population (as on 2011):**

Table 15.1 Details of Population in Khanakul –I block

Rural	Urban	Total
254434		**254434**

- **Rainfall:** Average annual rainfall (**Hugli district**)for the period 2013 -17 (in mm):

  1336.96

Table 15.2 Details of Annual Rainfall since last five year

Block	District Normal	Actual (Annual)				
		2013	2014	2015	2016	2017
Khanakul-I	1362	1365.3	1114.4	1549.1	1218.6	1437.4

- **Agriculture & Irrigation (area in ha):**

Table 15.3 Land use pattern in block (Source-West Bengal Land use and Land cover Department)

Block	Reporting area	Area under non agriculture use	Barren and uncultivable	Total agricultural land	Pasture	Orchard	Cultivable waste	Fallow land other than Current Fallow(Ha)	Current Fallow(Ha)	Forest (Ha)	Net sown area (Ha)
Khanakul-I	17240	4000	-	13308	-	131	-	-	-	-	13184

15.2 Aquifer Wise Ground Water Resource Availability & Extraction:

Table 15.4 Aquifer wise resource availability and draft (in MCM) in Block

Resource Availability	Aquifer I Group	Aquifer II Group	Aquifer III Group	Extraction (for Aquifer I)
Dynamic Resource	**79.40**	**0.45**	**-**	**38.78**
Static Resource	26.81			

Disposition of Aquifer: In **Khanakul – I** Block, 3 Aquifer Groups are explored.

- The range of Aquifer I is 30m to 112.77m; it is part of Younger Alluvium Formation. In Aquifer I Group, probability of Arsenic has been reported.
- The range of Aquifer II Group is 82m to 210.3m; it is sub divided into two aquifers: IB and II; the range of IB aquifer is 82m to 146.3m and II aquifer is 137m to 210.3m. This Group belongs to Older Alluvium Formation. In Aquifer II, Iron concentration in ground water is high.
- The range of Aquifer III is 240m to 242 m. and it is a part of Tertiary Formation. In Aquifer III Group, ground water potentiality is low.

Table 15.5 Aquifer disposition (depth range) in block

Block	Depth range of Aquifer in mbgl		
Khanakul -I	**Aquifer I Group**	**Aquifer II Group**	**Aquifer III Group**
	aquifer IA: 30-112.77	aquifer IB: 82-146.3 aquifer II: 137-210.3	aquifer III: 240-242

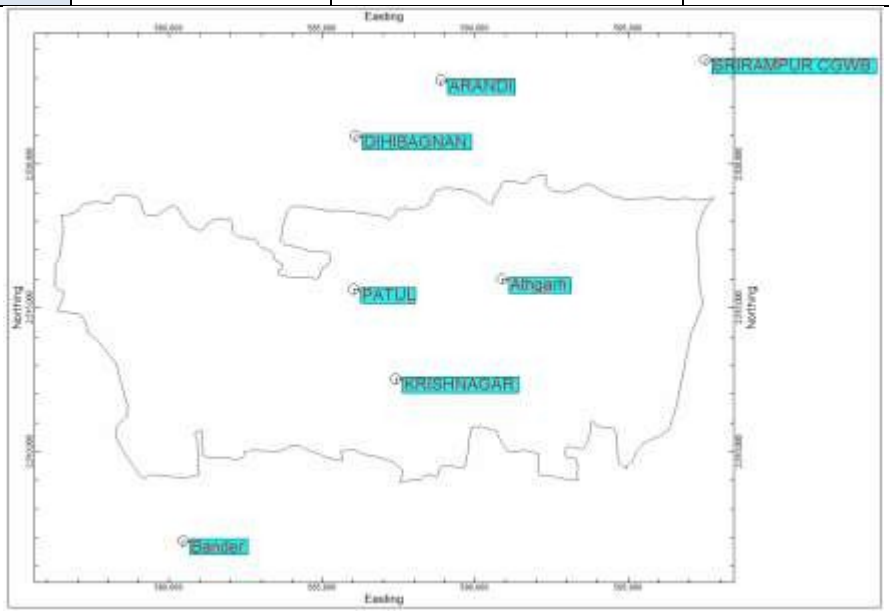

Figure 15.1 Index map of Khanakul- I Block

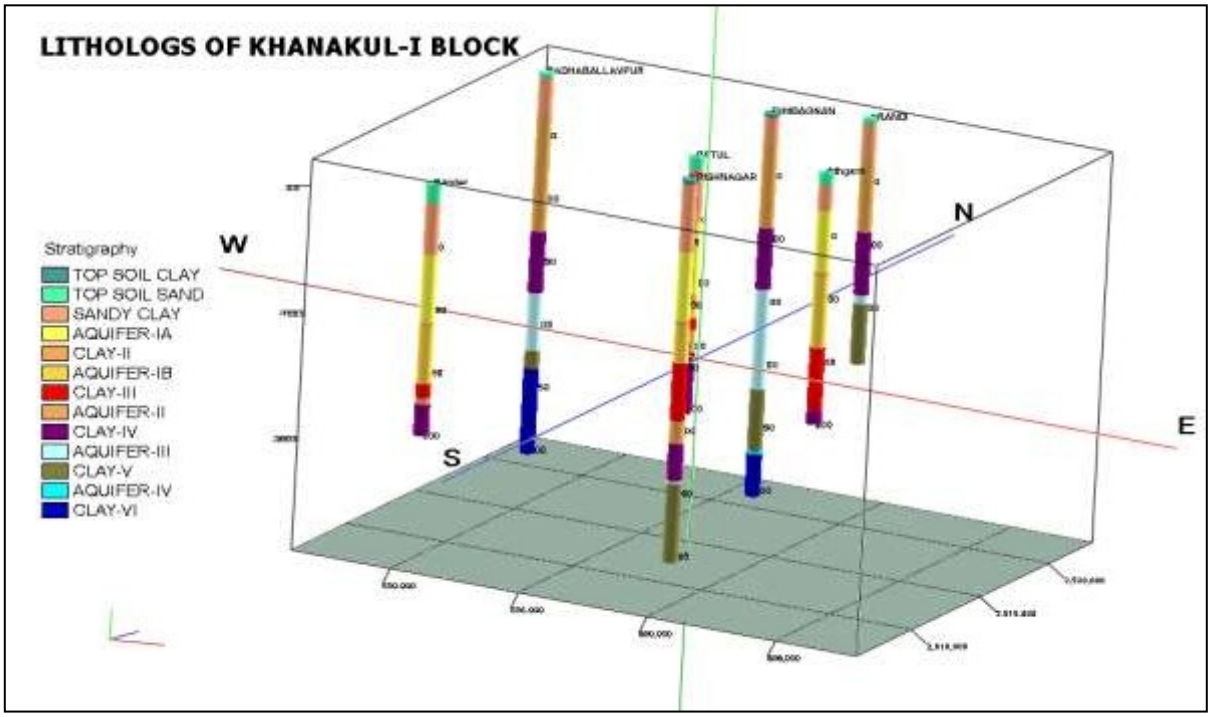

Figure 15.2 Lithologs in Khanakul-I Block

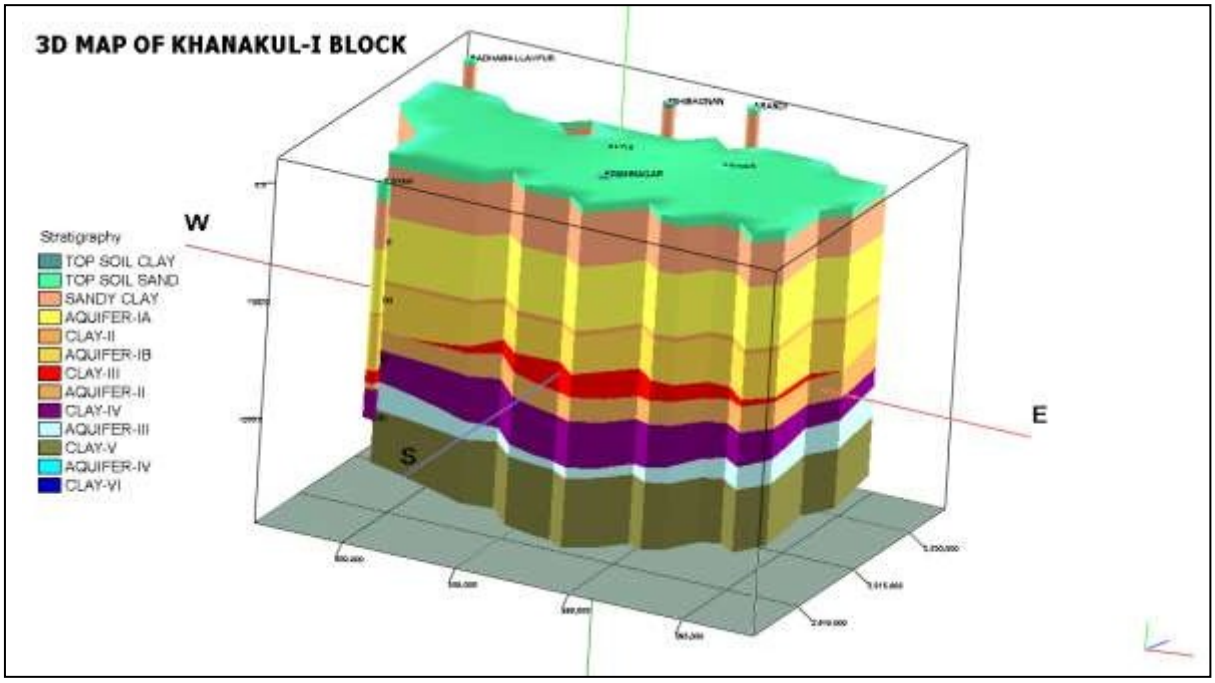

Figure 15.3 3D aquifer Disposition in Khanakul-I Block

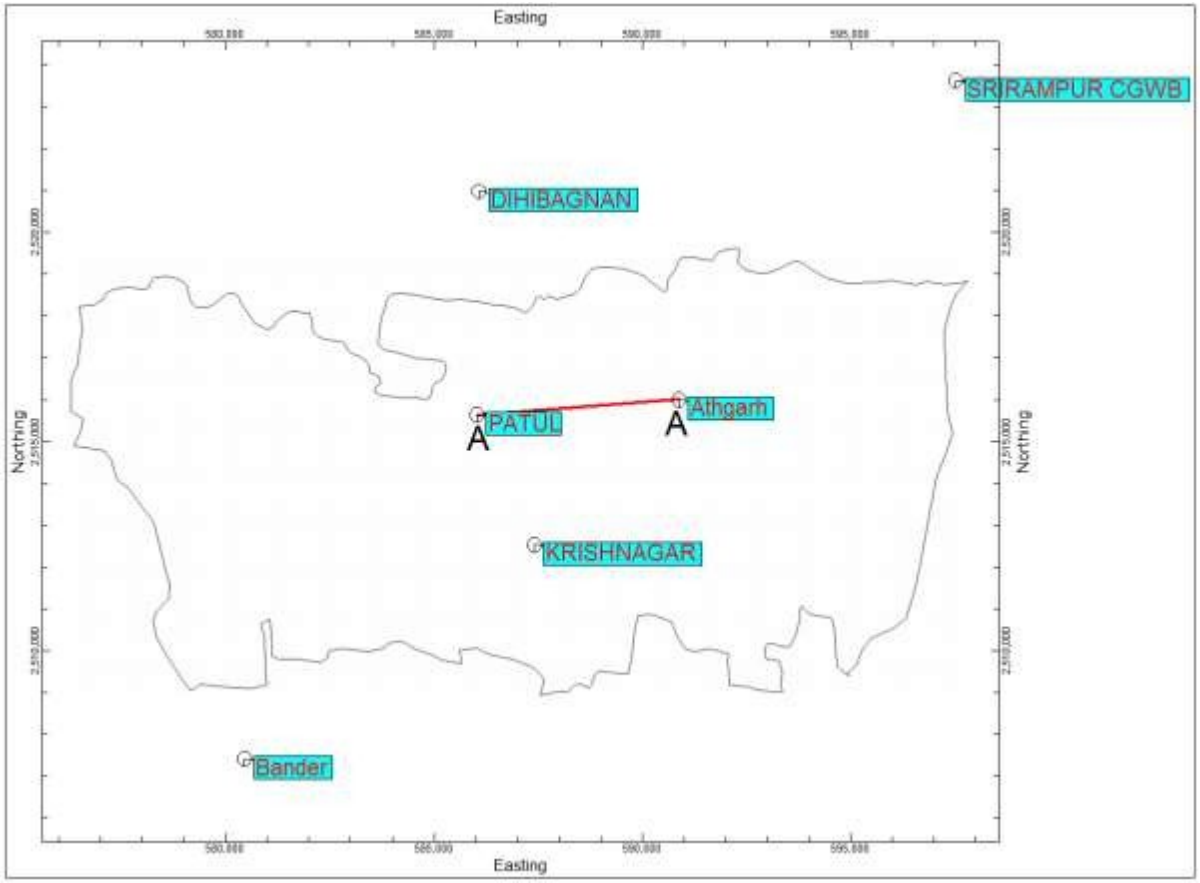

Figure 15.4 E-W Cross section Index line in Khanakul-I block

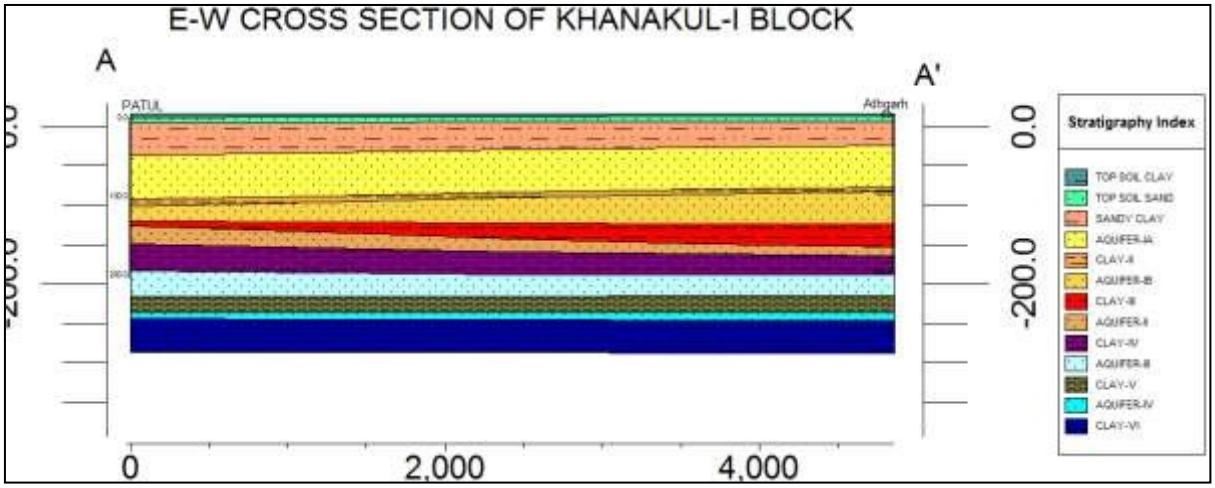

Figure 15.5 E-W Cross section in Khanakul-I block

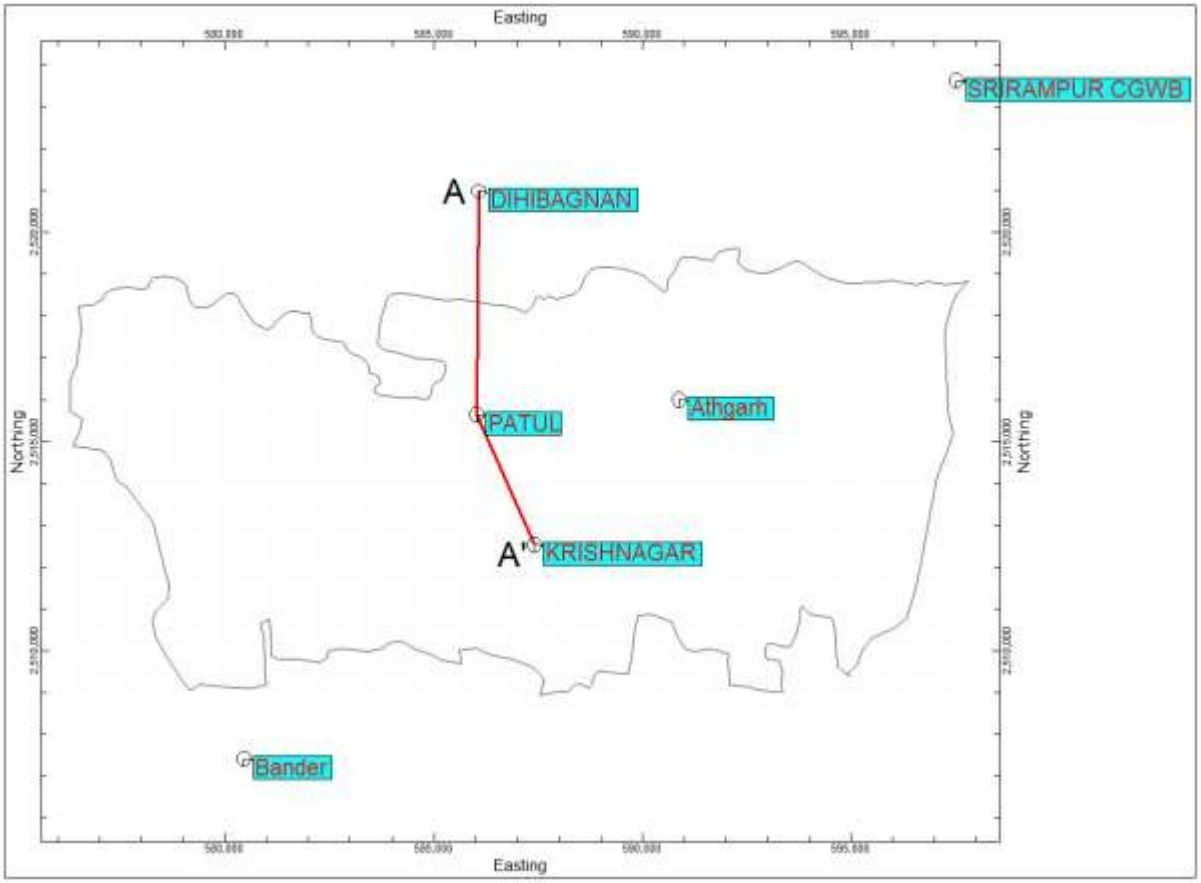

Figure 15.6 N-S Cross section Index line in Khanakul-I block

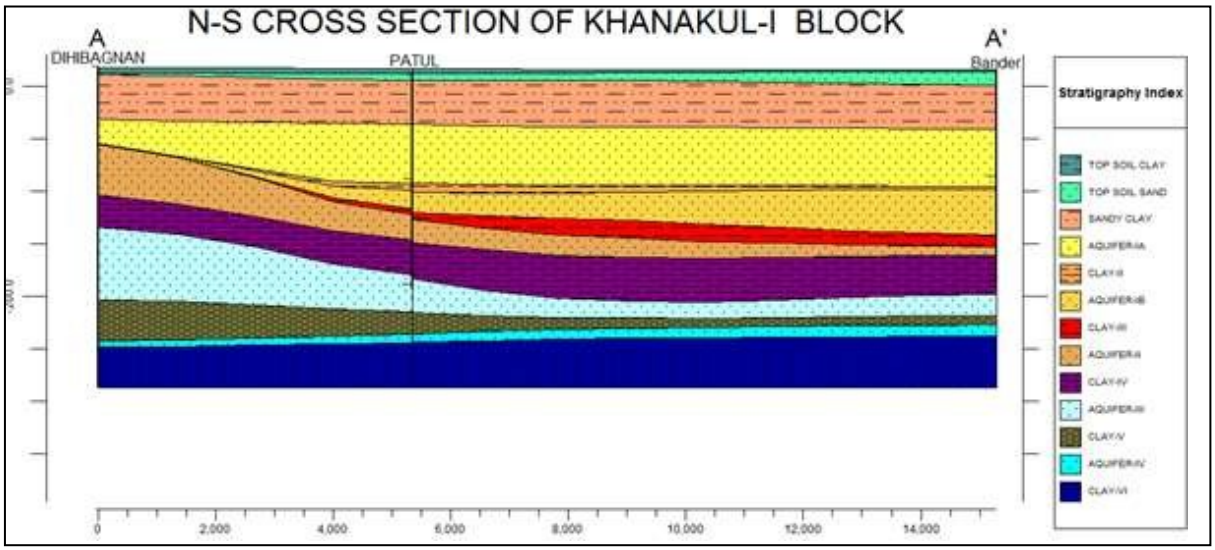

Figure 15.7 N-S Cross section in Khanakul-I block

Table 15.6 Aquifer Wise Water Level Ranges & Seasonal long term water level trends (2006 to 2017)

Block	Aquifer	Pre-monsoon Trend			Post-monsoon Trend		
		Water Level Range (mbgl)	Rise (cm/year)	Fall (cm/year)	Water Level Range (mbgl)	Rise (cm/year)	Fall (cm/year)
Khanakul-I	I	15.29-16.86	-	30.45	7.92-8.81	-	31.36
Khanakul I	II	16.92-18.11	-	-	7.8-9.1	-	-
Khanakul-I	III	8.5-11.8	-	-	12.6-14.2	-	-

Table 15.7 Aquifer wise maximum thickness

Block	Area (Sq Km)	Thickness of the Granular Zone in Aquifer I Group (m)	Thickness of the Granular Zone in Aquifer II Group (m)	Thickness of the Granular Zone in Aquifer III Group (m)
Khanakul-I	172.40	82.77	IB: 64.3 II: 73.3	III: 2

Table 15.8 Aquifer-wise depth range and parameters

Group	Sub Aquifer	Depth Range (mbgl)	Discharge (m^3/hr) with DD	T (m^2/day)	S	Specific capacity (m^3/day per m)
Aquifer Group I	IA	**30 - 112.77**	**47.9 (DD 4.1)**	**1688.3**	**4.16 X 10^{-1}**	**11.68**
Aquifer Group III	IB	**82 - 146.3**	**66 (DD- 6)**	**4768.6**	**2.85 X 10^{-3}**	**11**
	II	**137 -210.3**				
Aquifer Group III	III	**40 - 242**	**59.83**	**205**	**5.5 X 10^{-10}**	**9.972**

J*- Jacob's method; T - Theis's method**

15.3 Ground Water Resource, Extraction, Contamination & Other Issues:

Aquifer Wise Resource Availability & Extraction: Dynamic ground water resources as on 31st March'17 in top aquifer i.e., Aquifer I

Table 15.9 Availability of Ground Water resource in Block

Block	Annual Extractable GW	Current Annual GW Extraction	Stage of GW Extraction	Category	Annual GW Allocation for domestic use to 2042 (MCM)
Khanakul-I	70.2195	46.4476	66.15	Safe	3.873

Static (in-storage) Resources: 26.81 MCM

15.4 Chemical Quality of Ground Water & Contamination:

Based on 10- 12 Key well data and CGWB outsourced exploratory well data blocks wise Average data of chemical parameter is given below.

Table 15.10 Aquifer wise average chemical parameter of block

Aquifer	pH	EC (µs/cm)	TH	Ca	Mg	Na	K	HCO_3	Cl	NO_3	SO_4 (<5)	F (<1)	SiO_2 (<5)	TDS
I	8.1	400.75	125	17.5	19.74	36.38	1.96	224.18	15.95	0	0	0.40	23.01	251.69
II	7.7	425	196	37.5	24.61	42.29	2.2	246.05	12.32	0.5	2.85	0.50	25.86	265.63

15.5 Ground Water Resource Enhancement& Management Plan:

Ground Water Management Plan for drinking purposes-

- The block is under 'Safe' Category.
- Regular Field monitoring is necessary to check ground water contamination by arsenic in tube wells.
- As per WBPHED Data, 146539 population in 56 villages is still uncovered by PWSS.

Table 15.11 Population still uncovered by PWSS in Block

Block	Number of Villages to be covered by water supply schemes	Population in risk zone (as per Census 2011) to be covered by water supply schemes.	Comments on providing water supply to the risk population
Khanakul - I	56	146539	In Khanakul-I block, Aquifer-III is less productive (59.83 m^3/hr) in comparison to Aquifer-II (66 m^3/hr). Average discharge of 62.91 m^3/hr for both aquifers has been considered to work out number of wells required.

- In Khanakul-I block, Aquifer-III is less productive (59.83 m3/hr) in comparison to Aquifer-II (66 m^3/hr).
- One well-constructed in Krishanagar tapping Aquifer-II by outsourcing reveals discharge of 66 m^3/hr and this well could be used for supply of drinking water in that part of block.

A	**Village**
B	**Population 2011**
C	**Projected Population 2021 (decadal growth rate 9.49%)**
D	**Present Water Requirement for Human Population in m^3 @70 lpcd**
E	**Projected Water Requirement for Human Population in m^3 @70 lpcd**
F	**Cattle 2011**
G	**Projected Cattle 2021**
H	**Present Water Requirement for cattle m^3 @20lpcd**
I	**projected Water Requirement for cattle m^3 @20lpcd**
J	**Total Water Requirement/day as on 2011 in m^3**
K	**Total Water Requirement cubic m/day as on 2021 in m^3**
L	**Discharge (m3/hr)**
M	**Discharge of one TW in m^3/day after 8 hours of pumping**
N	**No of TW**
O	**Cost of Tube well of 300 m depth (approx.) 10”x6" dia @ Rs. 20 lakhs (In lakh) as per EFC**

Table 15.12 Estimation of village wise number of Tube wells and cost of construction in Khanakul-I block

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
Chuadanga	1634	1789	114.38	125.23	163	169	3.26	3.38	117.64	128.61	62.91	503.28	0	0
Gujrat	2283	2500	159.81	175	228	236	4.56	4.73	164.37	179.73	62.91	503.28	0	0
Madanbati	2238	2450	156.66	171.5	224	232	4.48	4.64	161.14	176.14	62.91	503.28	0	0
Mahishgot	4414	4833	308.98	338.31	441	457	8.82	9.14	317.8	347.45	62.91	503.28	1	20
Ghashua	2918	3195	204.26	223.65	292	303	5.84	6.05	210.1	229.7	62.91	503.28	0	0
Gangpur	346	379	24.22	26.53	35	36	0.7	0.73	24.92	27.26	62.91	503.28	0	0
Pilkhan	4176	4572	292.32	320.04	418	433	8.36	8.67	300.68	328.71	62.91	503.28	1	20
Paschim Ghoshpur	2846	3116	199.22	218.12	285	295	5.7	5.91	204.92	224.03	62.91	503.28	0	0
Madhabkundu	804	880	56.28	61.6	80	83	1.6	1.66	57.88	63.26	62.91	503.28	0	0
Paschim Thakurani Chak	5514	6037	385.98	422.59	551	571	11.02	11.42	397	434.01	62.91	503.28	1	20
Purbba Thakurani Chak	7076	7748	495.32	542.36	708	734	14.16	14.68	509.48	557.04	62.91	503.28	1	20
Sankarpur	3389	3711	237.23	259.77	339	351	6.78	7.03	244.01	266.8	62.91	503.28	1	20
Duadanda	1567	1716	109.69	120.12	157	163	3.14	3.25	112.83	123.37	62.91	503.28	0	0
Kanchra	4068	4454	284.76	311.78	407	422	8.14	8.44	292.9	320.22	62.91	503.28	1	20
Mainan	5623	6157	393.61	430.99	562	583	11.24	11.65	404.85	442.64	62.91	503.28	1	20
Dharmmapur	3325	3641	232.75	254.87	333	345	6.66	6.9	239.41	261.77	62.91	503.28	1	20
Pol	11038	12086	772.66	846.02	1104	1144	22.08	22.89	794.74	868.91	62.91	503.28	2	40
Shulut	2004	2194	140.28	153.58	200	207	4	4.15	144.28	157.73	62.91	503.28	0	0
Sapath	2533	2773	177.31	194.11	253	262	5.06	5.25	182.37	199.36	62.91	503.28	0	0

Radhaballabhpur	5168	5658	361.76	396.06	517	536	10.34	10.72	372.1	406.78	62.91	503.28	1	20
Chak Bhedua	2351	2574	164.57	180.18	235	244	4.7	4.87	169.27	185.05	62.91	503.28	0	0
Saibona	2178	2385	152.46	166.95	218	226	4.36	4.52	156.82	171.47	62.91	503.28	0	0
Gauran Mandaran	328	359	22.96	25.13	33	34	0.66	0.68	23.62	25.81	62.91	503.28	0	0
Gauran	1422	1557	99.54	108.99	142	147	2.84	2.94	102.38	111.93	62.91	503.28	0	0
Kalimba	1211	1326	84.77	92.82	121	125	2.42	2.51	87.19	95.33	62.91	503.28	0	0
Nabasan	2799	3065	195.93	214.55	280	290	5.6	5.8	201.53	220.35	62.91	503.28	0	0
Jayananda Golanandapur	1068	1169	74.76	81.83	107	111	2.14	2.22	76.9	84.05	62.91	503.28	0	0
Kamdebpur	894	979	62.58	68.53	89	92	1.78	1.85	64.36	70.38	62.91	503.28	0	0
Chakrapur	1969	2156	137.83	150.92	197	204	3.94	4.08	141.77	155	62.91	503.28	0	0
Udaypur	2995	3279	209.65	229.53	300	311	6	6.22	215.65	235.75	62.91	503.28	0	0
Jayram Chak	346	379	24.22	26.53	35	36	0.7	0.73	24.92	27.26	62.91	503.28	0	0
Lausar	1056	1156	73.92	80.92	106	110	2.12	2.2	76.04	83.12	62.91	503.28	0	0
Kedarpur	1692	1853	118.44	129.71	169	175	3.38	3.5	121.82	133.21	62.91	503.28	0	0
Dhamla	3402	3725	238.14	260.75	340	352	6.8	7.05	244.94	267.8	62.91	503.28	1	20
Sonatikri	1565	1714	109.55	119.98	157	163	3.14	3.25	112.69	123.23	62.91	503.28	0	0
Tantisal	4759	5211	333.13	364.77	476	493	9.52	9.87	342.65	374.64	62.91	503.28	1	20
Majpur	3368	3688	235.76	258.16	337	349	6.74	6.99	242.5	265.15	62.91	503.28	1	20
Udna	3878	4246	271.46	297.22	388	402	7.76	8.04	279.22	305.26	62.91	503.28	1	20
Kanakpur	3612	3955	252.84	276.85	361	374	7.22	7.48	260.06	284.33	62.91	503.28	1	20
Kurkuri	3008	3293	210.56	230.51	301	312	6.02	6.24	216.58	236.75	62.91	503.28	0	0
Durgapur	1712	1874	119.84	131.18	171	177	3.42	3.55	123.26	134.73	62.91	503.28	0	0

Jagannathpur	2448	2680	171.36	187.6	245	254	4.9	5.08	176.26	192.68	62.91	503.28	0	0
Amarpur	809	886	56.63	62.02	81	84	1.62	1.68	58.25	63.7	62.91	503.28	0	0
Jakri	1459	1597	102.13	111.79	146	151	2.92	3.03	105.05	114.82	62.91	503.28	0	0
Arunda	5291	5793	370.37	405.51	529	548	10.58	10.97	380.95	416.48	62.91	503.28	1	20
Garbere	854	935	59.78	65.45	85	88	1.7	1.76	61.48	67.21	62.91	503.28	0	0
Bandhaipur	2345	2568	164.15	179.76	235	244	4.7	4.87	168.85	184.63	62.91	503.28	0	0
Dhara Shimul	3118	3414	218.26	238.98	312	323	6.24	6.47	224.5	245.45	62.91	503.28	0	0
Chabbishpur	3815	4177	267.05	292.39	382	396	7.64	7.92	274.69	300.31	62.91	503.28	1	20
Par Chabbishpur	1831	2005	128.17	140.35	183	190	3.66	3.79	131.83	144.14	62.91	503.28	0	0
Sola Asta	518	567	36.26	39.69	52	54	1.04	1.08	37.3	40.77	62.91	503.28	0	0
Sarda	1891	2070	132.37	144.9	189	196	3.78	3.92	136.15	148.82	62.91	503.28	0	0
Chak Jalkar	296	324	20.72	22.68	30	31	0.6	0.62	21.32	23.3	62.91	503.28	0	0
Kabilpur	2317	2537	162.19	177.59	232	240	4.64	4.81	166.83	182.4	62.91	503.28	0	0
Uttar Sudam Chak	274	300	19.18	21	27	28	0.54	0.56	19.72	21.56	62.91	503.28	0	0
Jugikundu	696	762	48.72	53.34	70	73	1.4	1.45	50.12	54.79	62.91	503.28	0	0
Total	**146539**	**160447**	**10257.7**	**11231.3**	**14658**	**15195**	**293.16**	**303.89**	**10550.9**	**11535.2**	62.91	**28183.7**	**18**	**360**

- From Table 15.12., 18 wells are required for supply of drinking water in still uncovered area of Khanakul-I Block. Status of PWSS by PHED supply status as of now has been presented in Figure 15.9. Number of tube wells required is more so wells should be constructed tapping both the aquifers, i.e. Aquifer II and Aquifer III, but separately.
- For monitoring of the ground water regime, if observation well is needed then cost of construction of the same should also be included in the expenditure.

- Phase wise drilling should be initiated for better result. Initially 25 % of total wells should be constructed; based on outcome, the whole plan could be implemented.
- After construction of wells, analysis of concentration of arsenic and heavy metals in ground water could be analyzed.

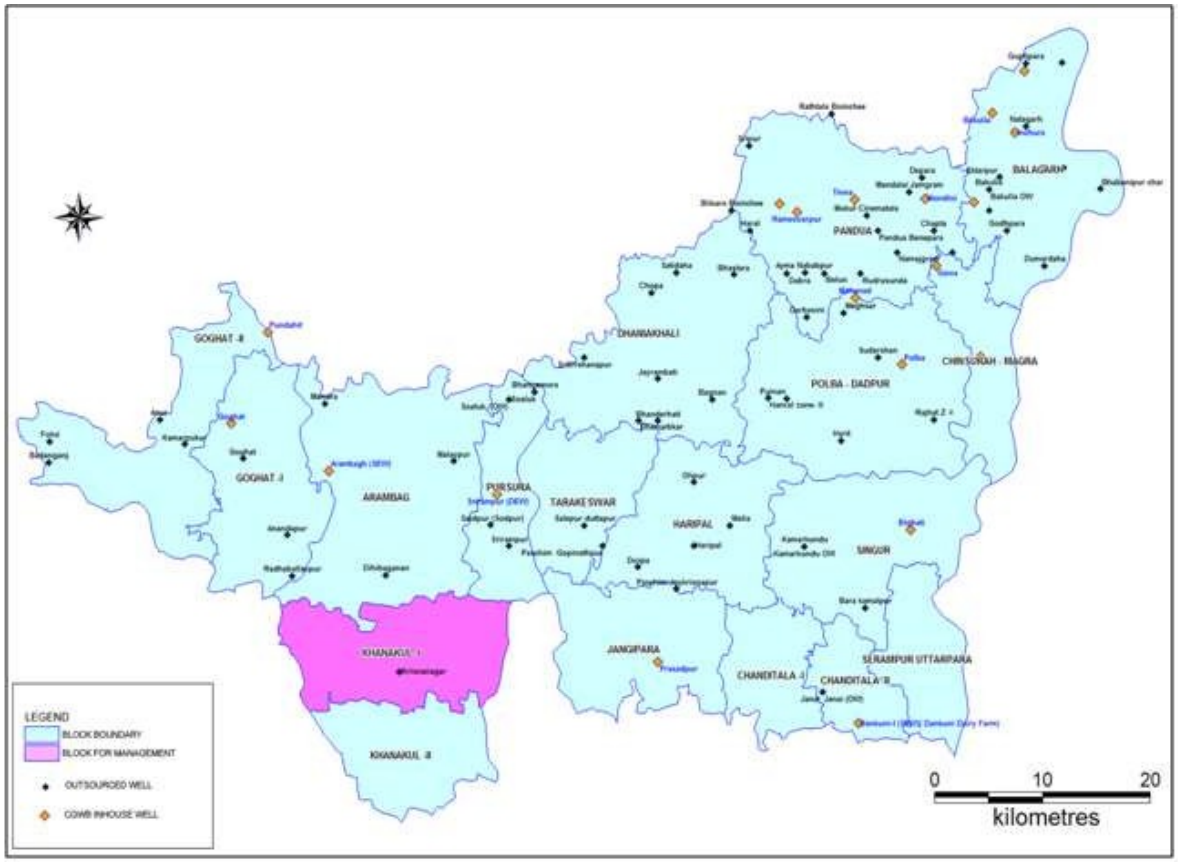

Figure 15.8 Exploratory wells constructed by outsourcing in Khanakul- I Block

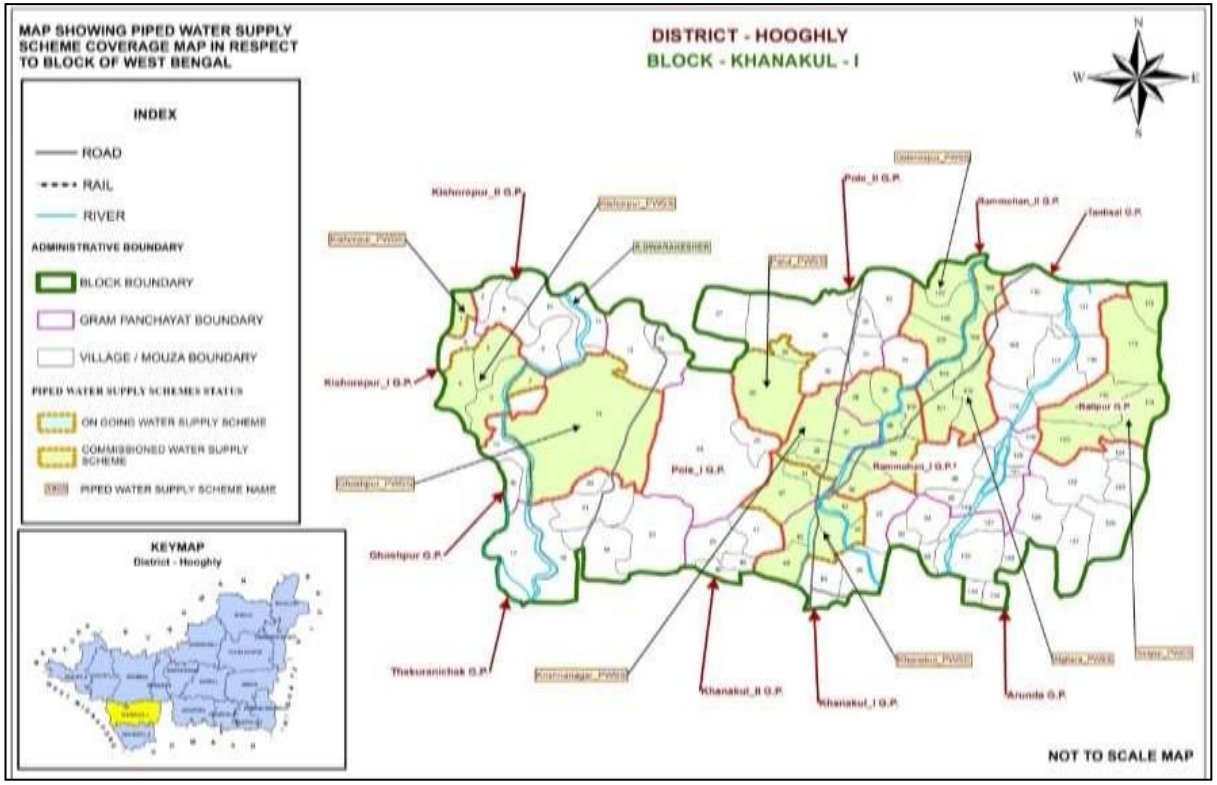

Figure 15.9 Status of Existed Drinking water supply schemes in Khanakul-I Block (Source-WBPHED) according to Census -2011

Management Plan for irrigation:

- Based on CGWB Resource data, block is under Safe Category. Stage of Ground Water development is 66.15 %, with declining long term ground water level trend in both seasons.
- As per 4th MI Census irrigation data, number of Shallow Tube Wells are used more (presented Table 15.16) in this block.
- Block is showing continuous declining trend of water level in top aquifer; so, more use of surface water than ground water is needed to avoid further declining.
- Artificial recharge could be a possible alternative.
- Application of modern technologies like Sprinkler, Drip irrigation should be used too. Also, fresh & arsenic bearing ground water, if any, may be blended in a suitable ratio, and may be applied for irrigation at least on experimental basis.
- In areas nearby ground water contamination by arsenic has been encountered; regular monitoring of Arsenic concentration in crop is also necessary.
- R & D study is necessary so as to get better solution in respect water management in future.
- In Khanakul-I block, as per soil characteristics and climatic condition Mustard, Wheat, Jute, rice, potato and Til are suitable crops to grow.
- Considering Socio-economic factor Cash crops (sugarcane) also suggested according to cropping quality of area for benefit of farmers.

Table 15.13 Cropping pattern under practice in Block

Block Name		**Khanakul-I**
Aus	Area	2544
	Prod.	6.025
	Yield	2368
Aman	Area	1513
	Prod.	3.263
	Yield	2157
Boro	Area	6389
	Prod.	17.805

	Yield	2787
Wheat	Area	10
	Prod.	0.024
	Yield	2377
Jute	Area	2600
	Prod.*	55.380
	Yield**	21.30
Mustard	Area	976
	Prod.	0.676
	Yield	692
Til	Area	1358
	Prod.	1.222
	Yield	900
Potato	Area	11426
	Prod.	187.352
	Yield	16397

(Area in ha, Production in Thousand MT and Yield in kg./ha)

(Courtesy: Department of Economics and Statistics)

From Table 15.13, percentage wise crop covering area in this block has been estimated and presented in Table 15.14.

Table 15.14 Area wise percentage of current practice of crops in Khanakul-I Block

Area wise Current Practice of crops								
Rabi Crops (Wheat, Mustard and oil seeds water Column requirement=0.21) Cultivation		**Boro Cultivation (Water Column requirement-1.2 m)**		**Vegetable (water Column requirement Potato=0.6m)**		**Pulses (water Column requirement =0.11 m)**		**Total Area covered (ha)**
%	**Area (ha)**	**%**	**Area (ha)**	**%**	**Area (ha)**	**%**	**Area (ha)**	
12	2344	32	6389	57	11426	0	0	20159

Based on data of Table 15.14, the factor of weighted average of water column has been estimated to be 0.7; so for irrigation of remaining cultivable area of 4131.24 Ha 2891.87 Ham water is required. Ground water resource estimation as of 2017 shows that 2264.73 Ham from top aquifer is available. Therefore, the remaining cultivable area could not be covered by irrigation for cultivation. However, planning is being done to bring the remaining cultivablearea for coverage with some change in cropping pattern for better management of water resources as follows.

From Table 15.15**,** remaining cultivable area (4131.24 ha), Rabi, Boro, Vegetables could be cultivated in ratio of 10:30:60 for almost total coverage.

Table 15.15 Future Water allocation (Ham) for remaining cultivable area

Present water availability	Considering 60% water and 40 % for future irrigation	Rabi Crops (Wheat, Mustard and oil seeds water Column requirement=0.21) Cultivation		Boro Cultivation (Water Column requirement-1.2 m)		Vegetable (water Column requirement Potato=0.6m)		Pulses (water Column requirement =0.11 m)		Total Area covered (A)	Remaining Cultivable area (ha) (4131.24-A)
		%	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)		
2264.73	2264.73	10	1078.44	30	566.18	60	2264.73	0	0	3909.35	221.89
2264.73	2264.73	20	2156.89	20	377.46	60	2264.73	0	0	4799.08	-667.84
2264.73	2264.73	20	2156.89	10	188.73	70	2642.19	0	0	4987.81	- 856.57

Table 15.16 : Number of abstraction structures and Cultivable command area in Khanakul-I Block

Block Name	Dug well		Shallow Tube well		Deep Tube well		Surface Flow		Surface Lift		CCA (ha.)		Total CCA (ha.)
	No.	CCA (ha.)	No.	CCA (ha.)	No.	CCA (ha.)	No.	CCA (ha.)	No.	CCA (ha.)	Ground Water	Surface Water	
KHANAKUL-I	0	0	897	4267.84	30	1106.3	0	0	284	3802.58	5374.18	3802.58	9176.76

Table 15.17 Irrigation scenario in Khanakul-I block

Block	Khanakul-I
Area (ha)	17240
Cultivable area (ha)	13308
Net irrigated Command area (GW) in ha	5374.18
Net irrigated Command area (SW) in ha	3802.58
Net irrigated Command area GW +SW) in ha	9176.76
Net area available for Irrigation	4131.24
GW available for Future irrigation (ham)	3972.38
Pre monsoon Long Term WL Trend, if falling in cm/yr	**Yes, 30.45**
Post monsoon Long Term WL Trend ' if falling in cm/yr	**Yes, 31.36**
Average Pre monsoon WL in mbgl	16.02
Average Post monsoon WL in mbgl	8.35
SOD in %	**66.15**
Category	**Safe**
Remarks summary of Irrigation management plan	**To arrest declining trend more SW than GW to be used**

Rainwater harvesting & Artificial Recharge in block:

Table 15.18 Area suitable for recharge in the study area:

District	Block Name	Area (in ha)	Area suitable for recharge (Considering area having DWL of shallow aquifer more than 3m in post-monsoon and showing 0. 2m/yr or more falling trend) (in ha)
Hugli	Khanakul-I	17240	15870

Table 15.19 Estimation of Surface run off based on Land slope, soil, etc. (after Druvanarayana, 1993)

Block	Major type of soil available in that block	Normal Monsoon Rainfall (m)	Total volume of surface runoff available Annually 'Vt' (RnXAXC) Ham	75% of 'Vt' = V	50% of V (Non committed)= Vnc	60% of Vnc (considering e-flow)= Vf
Khanakul-I	**Sandy Loam/Loam**	**1.098**	**7571.81 (average run off coefficient – 0.40)**	**5678.86**	**2839.43**	**1703.66**

On the basis of soil characteristic, slope, Rain fall data, etc. number of conservation & artificial recharge structures are estimated.

Table 15.20 Details of possible conservation & artificial recharge structures in block & cost of construction:

Row 1	**Block Area in Ha**	**17240**
Row 2	Area in Ha suitable for recharge	15870
Row 3	Soil type(3)	Clay Loam/Silty Clay Loam
Row 4	Amount of water to be harvested	1703.66
Row 5	Amount of water for artificial recharge of top aquifer and conservation (Ham) - 70 % of Row. 4 (5)	1192.56
Row 6	Source water allocation for for Irrigation Cum Recharge Pond -35% of Row 4 (6)	596.28
Row 7	Source water allocation for REET with recharge shaft -35% of Row 4 (7)	596.28
Row 8	Source water allocation for for injection well to recharge deeper aquifer -20% of Row 4 (8)	340.73
Row 9	Source water allocation for Farm Pond/Irrigation pond – 10 % of Row 4 (9)	170.37
Row 10	Nos. of Irrigation Cum Recharge Pond @ 50 Ham per unit (10)	12
Row 11	Nos. of REET with recharge shaft @ 10 Ham per unit	60
Row 12	Nos. of injection well suggested @ 30 Ham per unit (12)	11
Row 13	Nos. of Farm Pond @ 10 Ham per unit (12)	17
Row 14	Cost of Irrigation Cum Recharge Pond @ Rs 8 lakh per unit	96
Row 15	Cost of REET with recharge shaft @ Rs 8 lakh per unit	**480**
Row 16	Cost of injection well @ Rs 20 lakh per unit	**220**
Row 17	Cost of Farm Pond @ Rs 8 lakh per unit	**136**

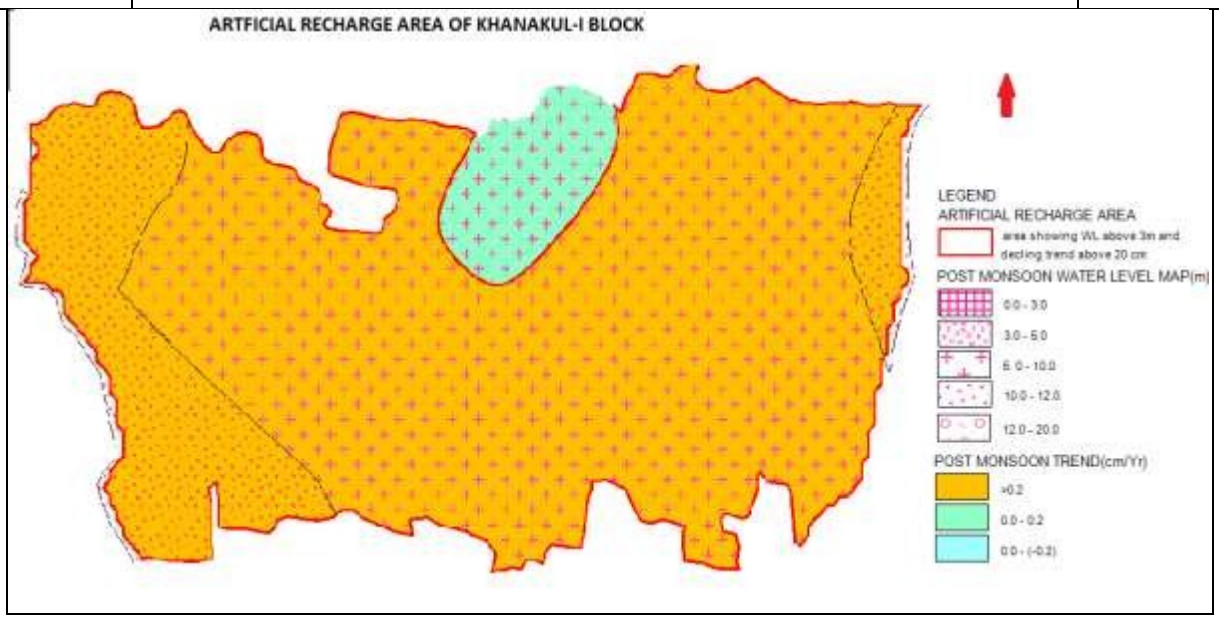

Figure 15.10 Map showing area suitable for artificial recharge in Khanakul –I Block

16.0 KHANAKUL-II BLOCK

16.1 Salient Information

- **Block Name: Khanakul-II**
- **Area (in ham): 12183**
- **District: Hugli**
- **State: West Bengal**
- **Population (as on 2011):**

Table 16.1 Details of Population in Khanakul-II block

Rural	Urban	Total
184734		184734

- **Rainfall:** Average annual rainfall (**Hugli district**) for the period 2013 -17 (in mm): **1336.96**

Table 16.2 Details of Annual Rainfall since last five year

Block	District Normal	Actual (Annual)				
		2013	2014	2015	2016	2017
Khanakul-II	1362	1365.3	1114.4	1549.1	1218.6	1437.4

- **<u>Agriculture & Irrigation (area in ha):</u>**

Table 16.3 Land-use pattern of block (Source-West Bengal Land use and Land cover Department)

Name of Block	Reporting area (Ha)	Area under non agriculture use (Ha)	Barren and uncultivable Ha)	Total agricultural land (Ha)	Pasture (Ha)	Orchard (Ha)	Cultivable waste (Ha)	Fallow land other than Current Fallow (Ha)	Current Fallow (Ha)	Forest (Ha)	Net sown area (Ha)
Khanakul-II	12183	2406	-	10093.14	-	40	-	-	-	-	8631

16.2 Aquifer Wise Ground Water Resource Availability & Extraction:

Table 16.4 Aquifer wise resource availability and draft (in MCM) in Block

Resource Availability	Aquifer I	Aquifer II	Aquifer III	Extraction (for Aquifer I)
Annual Extractable GW Recharge/Dynamic Resource	66.9469	0.31	-	10.76
Static Resource	19.63			

Disposition of Aquifer: In **Khanakul-II** Block, 2 Aquifer Groups are explored.

- The depth range of Aquifer Group I is 56m to 110m and it is part of Younger Alluvium Formation. In Aquifer I Group, probability of ground water contamination by arsenic is encountered.
- The range of Aquifer II Group is 112m to 175m; it is sub divided into two aquifers: IB and II: the range of aquifer IB is 112m to 159m and aquifer II is 170m to 175m; this group is part of Older Alluvium Formation. In Aquifer II, iron concentration in ground water is high.

Table 16.5 Aquifer disposition (depth range) in block

Block	Depth range of Aquifer Groups in mbgl		
	Aquifer I	**Aquifer II**	**Remarks**
Khanakul-II	**aquifer I: 56-110**	**aquifer IB: 112-159 aquifer II: 170-175**	

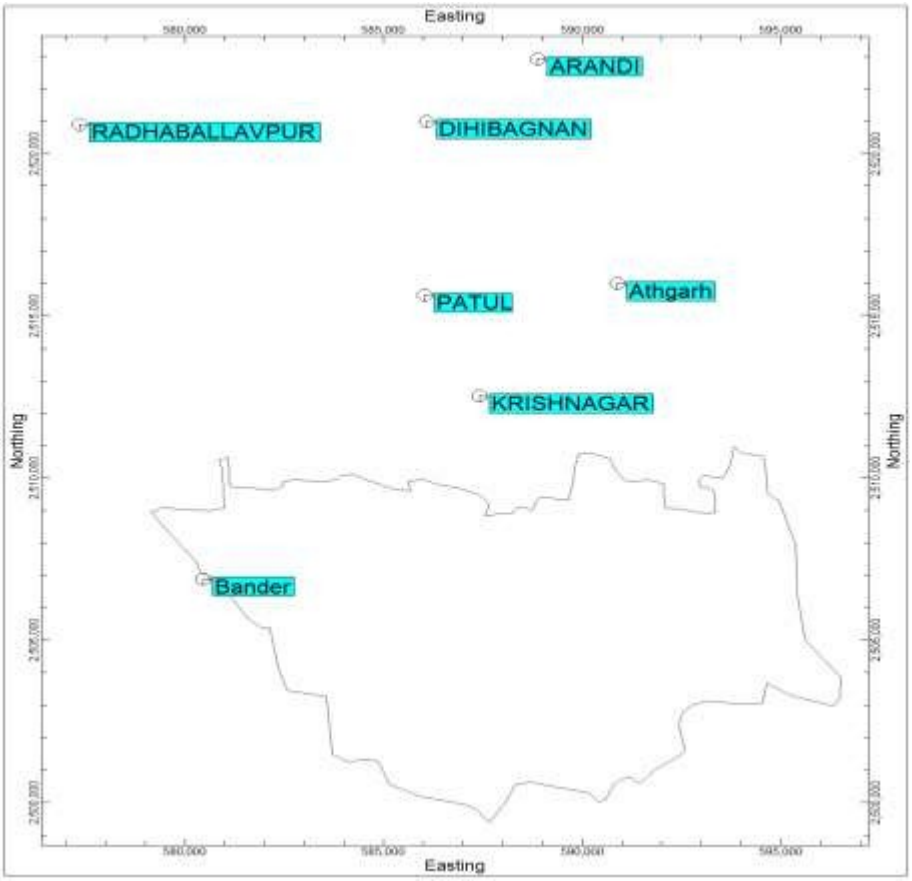

Figure 16.1 Index map of Khanakul-II Block

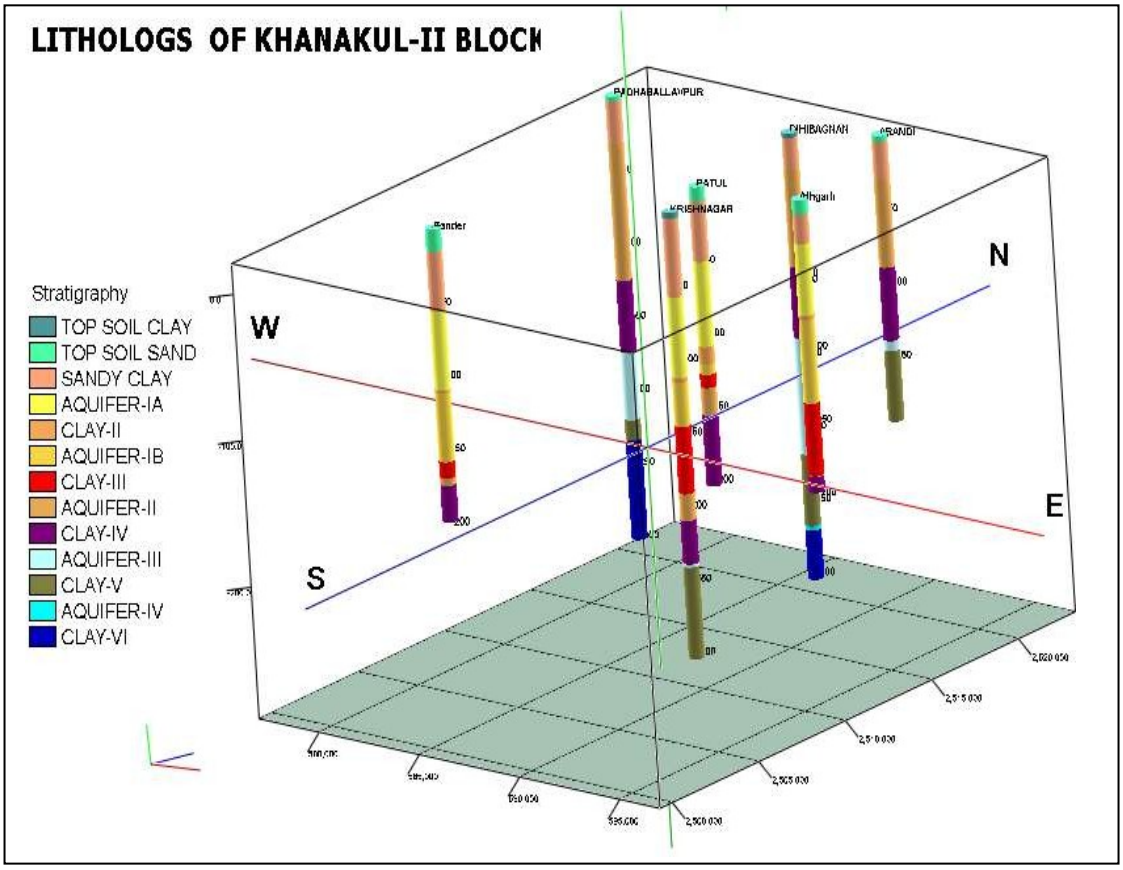

Figure 16.2 Lithologs in Khanakul-II Block

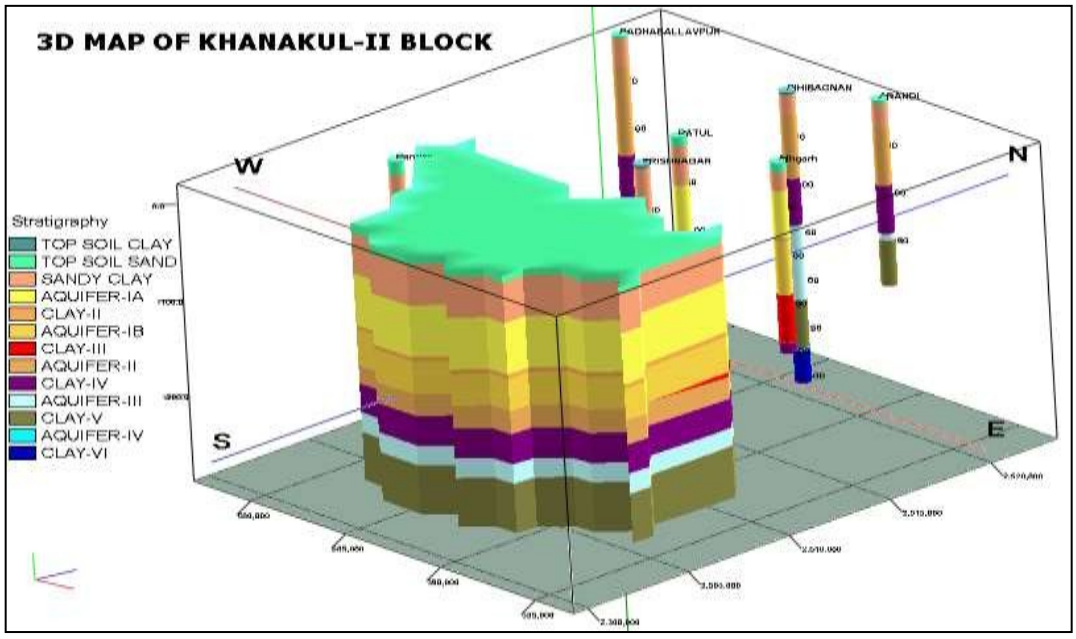

Figure 16.3 3D Aquifer disposition in Khanakul-II Block

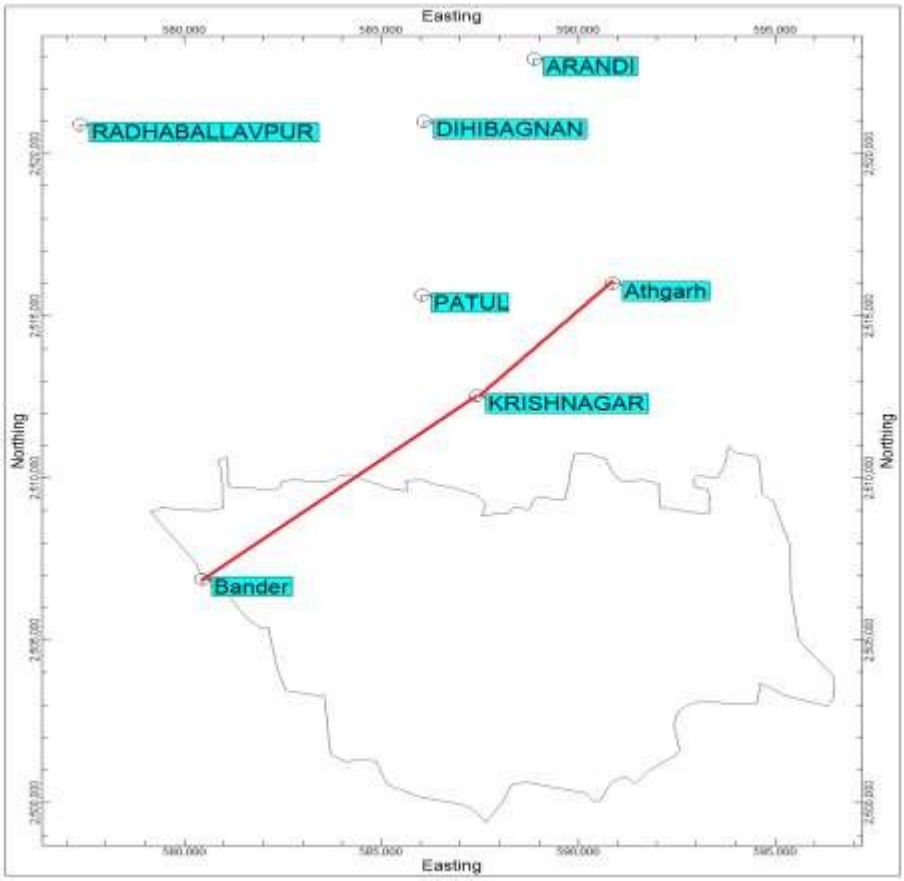

Figure 16.4 NE-SW cross section Index Line in Khanakul-II Block

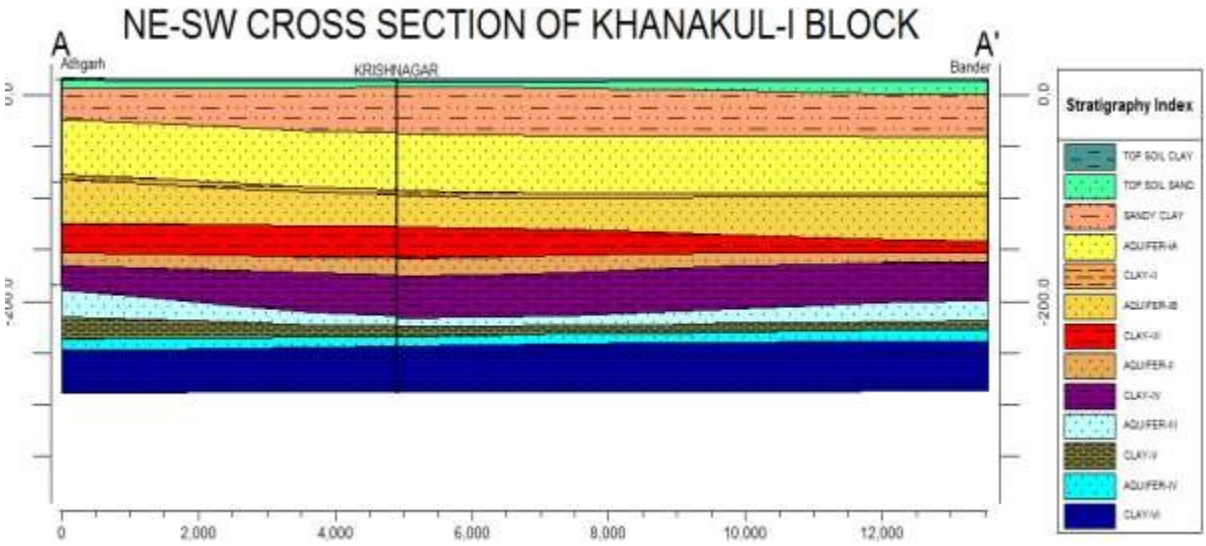

Figure 16.5 N-S cross section in Khanakul-II Block

Table 16.6 Aquifer Wise Water Level Ranges & Seasonal long term water level trends (2006 to 2017)

Block	Aquifer Groups	Pre-monsoon Trend			Post-monsoon Trend		
		Water Level Range (mbgl)	Rise (cm/year)	Fall (cm/year)	Water Level Range (mbgl)	Rise (cm/year)	Fall (cm/year)
Khanakul-II	**I**	**9.32-15.98**	**29.38**	**-**	**9.7-10.1**	**-**	**18.16**
Khanakul-II	**II**	**16.9-18.11**	**-**	**-**	**7.8-9.1**	**-**	**-**
Khanakul-II	**III**	**-**	**-**	**-**		**-**	**-**

Table 16.7 Aquifer wise maximum thickness

Block	Area (Sq Km)	Thickness of the Granular Zone in Aquifer I Group (m)	Thickness of the Granular Zone in Aquifer II Group (m)
Khanakul-II	121.83	**54**	**IB: 47** **II: 5**

Table 16.8 Aquifer-wise Statement

Group	Sub Aquifer	Depth Range (mbgl)	Discharge (m^3/hr) with DD	T (m^2/day)	S	Specific capacity (m^3/day per m)
Aquifer Group I	IA	**56 - 110**	**47.9 (DD 4.1)**	**615.05(J*)/560.06(T**)**	**$1.139x10^{-4}$**	**11.68**
Aquifer Group II	IB	**112 - 159**	**66 (DD- 6)**	**4768.59**	**$2.85 X 10^{-3}$**	**11**
	II	**170 - 175**				

J*- Jacob's method, T** - Theis's method

16.3 Ground Water Resource, Extraction, Contamination & Other Issues:

Aquifer Wise Resource Availability & Extraction: Dynamic ground water resources as on 31st March'17

Table 16.9 Availability of Ground Water resource in top aquifer i.e. Aquifer I

Block	Annual Extractable GW Recharge MCM)	Current Annual GW Extraction (MCM)	Stage of GW Extraction (%)	Category	Annual GW Allocation for domestic use to 2042 (MCM)
Khanakul-II	**66.9469**	**12.8682**	**19.22**	**Safe**	**2.6434**

Static (in-storage) Resources: 19.63 MCM

16.4 Chemical Quality of Ground Water & Contamination:

Based on 10- 12 Key well data and CGWB outsourced exploratory well data blocks wise Average data of chemical parameter is given below.

Table 16.10 Aquifer wise average chemical parameter in block

Aquifer	pH	EC (µs/cm)	TH	Ca	Mg	Na	K	HCO_3	Cl	NO_3	SO_4 (<5)	F (<1)	SiO_2 (<5)	TDS	Fe	Mn (<0.05)	Zn (<0.05)
I	8.2	442	135	10	26.73	41.34	2.18	231.8	24.82	0	0	0	22.29	268.75	0.21	0.19	0.05
II	8.2	687	115	14	19.44	115.46	1.15	280.6	92.17	0	4.61	0.46	19.82	438.28	0.33	0.11	BDL

16.5 Ground Water Resource Enhancement& Management Plan:

Ground Water Management Plan for drinking purposes-

- The block is under Safe condition and as per Ground Water Policy priority of water use is for drinking.
- Regular Field monitoring is necessary for ground water contamination by arsenic in tube wells.
- As per WBPHED Data 100293 population in 35 villages is still uncovered by PWSS.

Table 16.11 Population still uncovered in Khanakul – II Block

Block	Number of Villages to be covered by water supply schemes	Population (as per Census 2011) to be covered by water supply schemes.	Comments on providing water supply to the risk population
Khanakul - II	35	100293	In Khanakul-II block, Aquifer-III is less productive (59.83 m^3/hr) in comparison to Aquifer-II (66m^3/hr). A discharge of 62.91 m^3/hr for both Aquifer Groups has been taken into account to work out number of wells required.

- One well has been constructed at Krishnagar (shown in Fig-9.8.6.), near Khanakul-II block,

- From Table-9.8.12., it is visualized that 14 tube wells are required for supply of drinking water in still uncovered parts of Khanakul-II Block.
- Status of PWSS by PHED has been presented in Fig-9.8.7.

A	**Village**
B	**Population 2011**
C	**Projected Population 2021 (decadal growth rate 9.49%)**
D	**Present Water Requirement for Human Population in m^3 @70 lpcd**
E	**Projected Water Requirement for Human Population in m^3 @70 lpcd**
F	**Cattle 2011**
G	**Projected Cattle 2021**
H	**Present Water Requirement for cattle m^3 @20lpcd**
I	**projected Water Requirement for cattle m^3 @20lpcd**
J	**Total Water Requirement/day as on 2011 in m^3**
K	**Total Water Requirement cubic m/day as on 2021 in m^3**
L	**Discharge (m3/hr)**
M	**Discharge of one TW in m^3/day after 8 hours of pumping**
N	**No of TW**
O	**Cost of Tube well of 300 m depth (approx.) 10”x6" dia @ Rs. 20 lakhs (In lakh) as per EFC**

Table 16.12 Estimation of village wise number of Tube wells and cost for construction in n Khanakul II Block

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
Kumarhat	1838	2012	128.66	140.84	184	191	3.68	3.81	132.34	144.65	62.91	503.28	0	0
Khantara	1350	1478	94.5	103.46	135	140	2.7	2.8	97.2	106.26	62.91	503.28	0	0
Hirapur	5486	6007	384.02	420.49	549	569	10.98	11.38	395	431.87	62.91	503.28	1	20
Kushali	1887	2066	132.09	144.62	189	196	3.78	3.92	135.87	148.54	62.91	503.28	0	0
Ramchandrapur	5299	5802	370.93	406.14	530	549	10.6	10.99	381.53	417.13	62.91	503.28	1	20
Radhakrishnapur	3305	3619	231.35	253.33	331	343	6.62	6.86	237.97	260.19	62.91	503.28	1	20
Banhijli	3298	3611	230.86	252.77	330	342	6.6	6.84	237.46	259.61	62.91	503.28	1	20
ChandKundu	2884	3158	201.88	221.06	288	299	5.76	5.97	207.64	227.03	62.91	503.28	0	0
Dhaldanga	2972	3254	208.04	227.78	297	308	5.94	6.16	213.98	233.94	62.91	503.28	0	0
Marakhana	5526	6050	386.82	423.5	553	573	11.06	11.46	397.88	434.96	62.91	503.28	1	20
Manikdwip	300	328	21	22.96	30	31	0.6	0.62	21.6	23.58	62.91	503.28	0	0
Joariachak	259	284	18.13	19.88	26	27	0.52	0.54	18.65	20.42	62.91	503.28	0	0
MahishnalaDamk	117	128	8.19	8.96	12	12	0.24	0.25	8.43	9.21	62.91	503.28	0	0
Hayatpur	7805	8546	546.35	598.22	781	810	15.62	16.19	561.97	614.41	62.91	503.28	1	20
Bhairabpur	659	722	46.13	50.54	66	68	1.32	1.37	47.45	51.91	62.91	503.28	0	0
ParKalahar	333	365	23.31	25.55	33	34	0.66	0.68	23.97	26.23	62.91	503.28	0	0
Mansuka	13	14	0.91	0.98	1	1	0.02	0.02	0.93	1	62.91	503.28	0	0
KamdebChak	550	602	38.5	42.14	55	57	1.1	1.14	39.6	43.28	62.91	503.28	0	0
Sasapota	2414	2643	168.98	185.01	241	250	4.82	5	173.8	190.01	62.91	503.28	0	0

Block wise Management plan in parts of Hugli District, West Bengal

Hanua	3407	3730	238.49	261.1	341	353	6.82	7.07	245.31	268.17	62.91	503.28	1	20
DakshinSudamCh	7	8	0.49	0.56	1	1	0.02	0.02	0.51	0.58	62.91	503.28	0	0
Tetulia	457	500	31.99	35	46	48	0.92	0.95	32.91	35.95	62.91	503.28	0	0
Routkhana	6114	6694	427.98	468.58	611	633	12.22	12.67	440.2	481.25	62.91	503.28	1	20
Jayrampur	1698	1859	118.86	130.13	170	176	3.4	3.52	122.26	133.65	62.91	503.28	0	0
Naopara	531	581	37.17	40.67	53	55	1.06	1.1	38.23	41.77	62.91	503.28	0	0
Ranjitbati	4208	4607	294.56	322.49	421	436	8.42	8.73	302.98	331.22	62.91	503.28	1	20
Ketedal	2476	2711	173.32	189.77	248	257	4.96	5.14	178.28	194.91	62.91	503.28	0	0
Chinra	12924	14150	904.68	990.5	1292	1339	25.84	26.79	930.52	1017.29	62.91	503.28	2	40
Baligari	850	931	59.5	65.17	85	88	1.7	1.76	61.2	66.93	62.91	503.28	0	0
Ganeshpur	1528	1673	106.96	117.11	153	159	3.06	3.17	110.02	120.28	62.91	503.28	0	0
Natibpur	6466	7080	452.62	495.6	647	671	12.94	13.41	465.56	509.01	62.91	503.28	1	20
Balpai	5856	6412	409.92	448.84	586	607	11.72	12.15	421.64	460.99	62.91	503.28	1	20
Mostafapur	5670	6208	396.9	434.56	567	588	11.34	11.75	408.24	446.31	62.91	503.28	1	20
ChakMagri	493	540	34.51	37.8	49	51	0.98	1.02	35.49	38.82	62.91	503.28	0	0
Katashia	1313	1438	91.91	100.66	131	136	2.62	2.72	94.53	103.38	62.91	503.28	0	0
	100293	**109811**	**7020.51**	**7686.77**	**10032**	**10399.1**	**200.64**	**207.98**	**7221.15**	**7894.74**	62.91	**17614.8**	**1**	**28**

Figure 16.6 Location of Exploratory wells through outsourcing in Khanakul-II Block

- Number of tube wells is more so wells should be constructed tapping both the aquifers separately.
- For monitoring of the ground water regime, if observation well is needed then cost of construction of the same should also be included in the expenditure.
- In the initial stage, 25 % of total wells should be constructed. Afterwards, the whole plan could be implemented.
- After construction of wells, analysis of arsenic and heavy metals in ground water should be done.

Management Plan for irrigation:

- Based on CGWB Resource data, block is under **Safe Category**. Stage of Ground Water development is 19.22 **%,** with declining long term ground water level only in post monsoon, although rising long term water level is shown in pre-monsoon
- As per **4th MI Census** irrigation data in this block number of Shallow Tube Wells are less and surface water is used more.
- The whole cultivable area has already been covered.
- In this block cropping pattern could be changed, if needed in future by more use of surface water.

- Application of modern technologies, eg. Sprinkler, Drip irrigation, etc. may be implemented. Also, fresh water and arsenic bearing ground water, if any, may be blended in a suitable ratio and may be used for irrigation at least on experimental basis.
- Regular monitoring of ground water contamination by arsenic in crop is also necessary.
- R & D study is necessary to get better solution of water management in future.
- In Khanakul-Il block, as per soil and climatic condition, Jute, Mustard, Til, Boro rice and potato are suitable crops to grow.
- Water is available there is no bar in cultivation of cash crops, but with care, in this block for benefit of farmers.

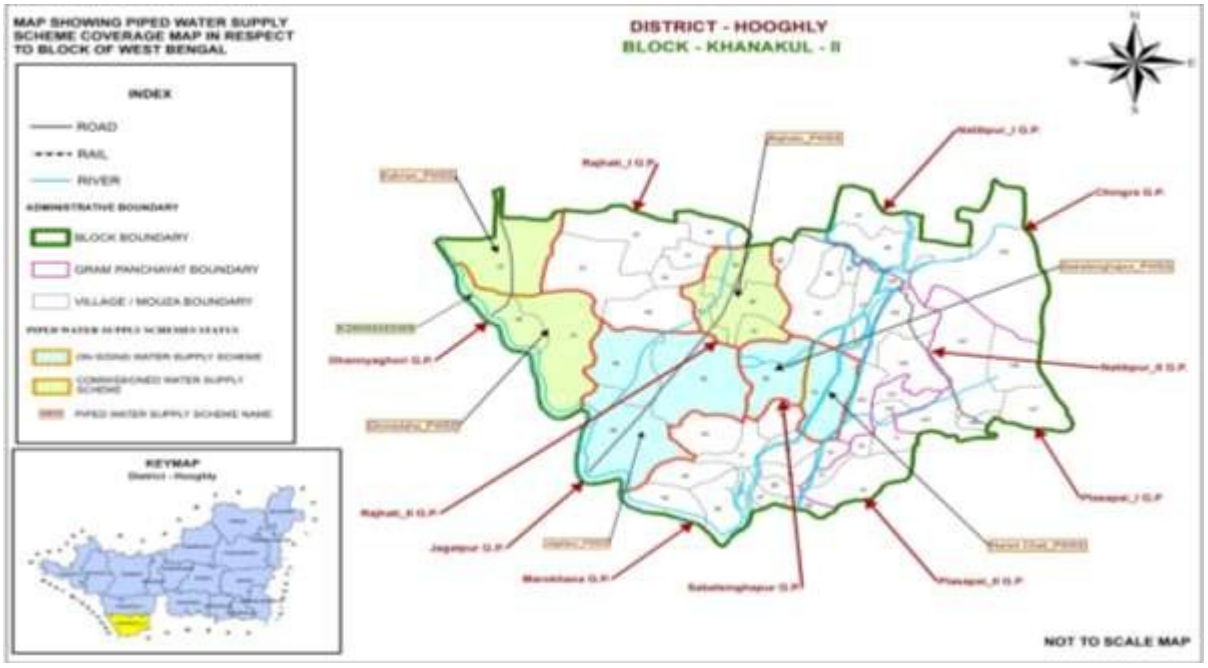

Figure 16.7 Drinking water supply scheme status in Khanakul-II Block (Source-WBPHED)

Figure 16.8 Cropping pattern under practice in Block

(Courtesy: Department of Economics and Statistics)

Name of Block		Khanakul-II
Aus	Area	52
	Prod.	0.114
	Yield	2194
Aman	Area	823
	Prod.	1.102
	Yield	1339
Boro	Area	6129
	Prod.	16.374
	Yield	2672
Wheat	Area	9
	Prod.	0.024
	Yield	2676
Jute	Area	1207
	Prod.*	23.090
	Yield**	19.13
Gram	Area	15
	Prod.	0.019
	Yield	1256
Mustard	Area	1796
	Prod.	1.363
	Yield	759
Til	Area	461
	Prod.	0.405
	Yield	878
Potato	Area	2000
	Prod.	15.076
	Yield	7538

(Area in Ha, Production in Thousand MT and Yield in kg./Ha)

From Table 16.9, percentage wise crop covering area in Khanakul II Block has been worked out and presented in Table 16.9.

Figure 16.9 Area wise percentage of current practice of crops in Khanakul-II Block

Area wise Current Practice of crops								
Rabi Crops (Wheat, Mustard and oil seeds water Column requirement=0.21) Cultivation		Boro Cultivation (Water Column requirement-1.2 m)		Vegetable (water Column requirement Potato=0.6m)		pulses(water Column requirement =0.11 m)		Total Area covered (ha)
%	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	

22	2266	59	6129	19	2000	0	15	10410

Figure 16.10 Number of abstraction structures and CCA created in Khanakul-II Block

Block Name	Dug well		Shallow Tube well		Deep Tube well		Surface Flow		Surface Lift		CCA (ha.)		Total CCA (ha.)
	No.	CCA (ha.)	No.	CCA (ha.)	No.	CCA (ha.)	No.	CCA (ha.)	No.	CCA (ha.)	Ground Water	Surface Water	
KHANAKUL-II	0	0	139	588.73	20	675	34	5201.6	145	3627.86	1263.73	8829.41	10093.14

Figure 16.11 Irrigation Scenario in Khanakul-II block

Block	Geographical area in ha	Cultivable area in ha	Net irrigated Command area (GW) in ha	Net irrigated Command area (SW) in ha	Net irrigated Command area (GW +SW) in ha	Net area available for Irrigation	GW available for Future irrigation (ham)	Pre monsoon Long Term WL Trend 2017 in cm/yr, if falling	Post monsoon Long Term WL Trend 2017 in cm/yr, if Falling	SOD in %	Average Pre monsoon WL in mbgl	Average Post monsoon WL in mbgl	Category
Khanakul-II	12183	10093.1	1263.73	8829.41	10093.1	0	5343.08	No	Yes, 30	19.22	12.65	9.7	Safe

REMARKS: Rising trend of water level in pre monsoon, but in post monsoon water level shows falling trend; SW.use for irrigation in this block may be increased.

Artificial Recharge & conservation in Khanakul II Block

Table 16.13 Area suitable for recharge in the study area

District	Block Name	Area (in ha)	Area suitable for recharge (Considering area having DTW more than 3m in post monsoon and showing 0.2m/yr & more long term falling trend) (in ha)
Hugli	Khanakul-II	12137	12137

Table 16.14 Estimation of Surface runoff based on Land slope, soil characteristics, etc. (after Dhruvanarayana,1993)

Block	Major type of soil available in that block	Normal Monsoon Rainfall (m)	Total volume of surface runoff available Annually 'Vt' (RnXAXC) Ham	75% of 'Vt' = V	50% of V (Non committed) = Vnc	60% of Vnc (considering e-flow)= Vf
Khanakul-II	**Silty clay/Clay loam**	**1.098**	**5330.57 (Average Run off coefficient – 0.40)**	**3997.93**	**1998.96**	**1199.38 (60 % of water to be harvested)**

- This block is a Safe block and Stage of Total GW Extraction is very low i.e. 19.22 %; also, long term ground water level shows rising trend in pre monsoon. Therefore, there is no need for Artificial Recharge structures.

17.0 ARAMBAGH BLOCK

17.1 Salient Information

- **Block Name: Arambagh**
- **Area (in ha)**: 30390
- **District: Hugli**
- **State**: **West Bengal**
- **Population (as on 2011):**

Table 17.1 Details of Population in Arambag Block

Rural	Urban	Total
285207	**66175**	**351382**

- **Rainfall:** Average annual rainfall (**Hugli district**) for the period 2013 -17 (in mm):

  1336.96

Table 17.2 Annual Rainfall since last five years

Block	District Normal	Actual (Annual)				
		2013	2014	2015	2016	2017
Arambagh	**1362**	**1365.3**	**1114.4**	**1549.1**	**1218.6**	**1437.4**

- **Agriculture & Irrigation (area in ha):**

Table 17.3 Land use in Arambagh Block (Source-West Bengal Land use and Land cover Department)

Name of Block	Reported area (Ha)	Area under non agriculture use (Ha)	Barren and uncultivable (Ha)	Total agricultural land (Ha)	Pasture (Ha)	Orchard (Ha)	Cultivable waste (Ha)	Fallow land other than Current Fallow(Ha)	Current Fallow (Ha)	Forest (Ha)	Net sown area (Ha)
Arambagh	30390	9052	-	20559	-	60	-	1	-	528	20455

17.2 Aquifer Wise Ground Water Resource Availability & Extraction:

Table 17.4 Aquifer wise resource availability and draft (in MCM) in Block

Resource Availability	Aquifer II Group	Aquifer III Group	Extraction (for Aquifer II)
Annual Extractable GW Recharge/Dynamic Resource	**113.26**	**-**	**71.21**
Static Resource	**36.09**		

Disposition of Aquifer: In Arambagh Block, 2 Aquifer Groups are explored.

- The range of Aquifer II Group is **19.5m to 91.43m.;** this is a part of Older Alluvium Formation. In Aquifer II, iron concentration in ground water is high.
- The range of Aquifer III is **140m to 220m.; this is a** part of Tertiary Formation. In it, ground water potentiality is low.

Table 17.5 Aquifer disposition (with depth range) in block

Block	Depth range of Aquifer in mbgl	
	Aquifer II	**Aquifer III**
Arambagh	Aquifer II: 19.5-91.43	Aquifer III: 140-220

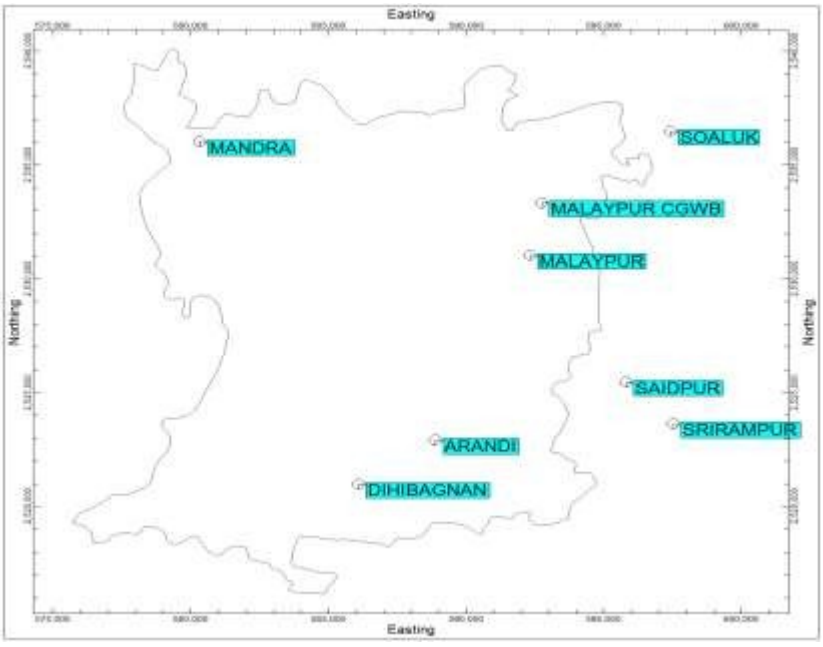

Figure 17.1 Index map of Arambagh Block

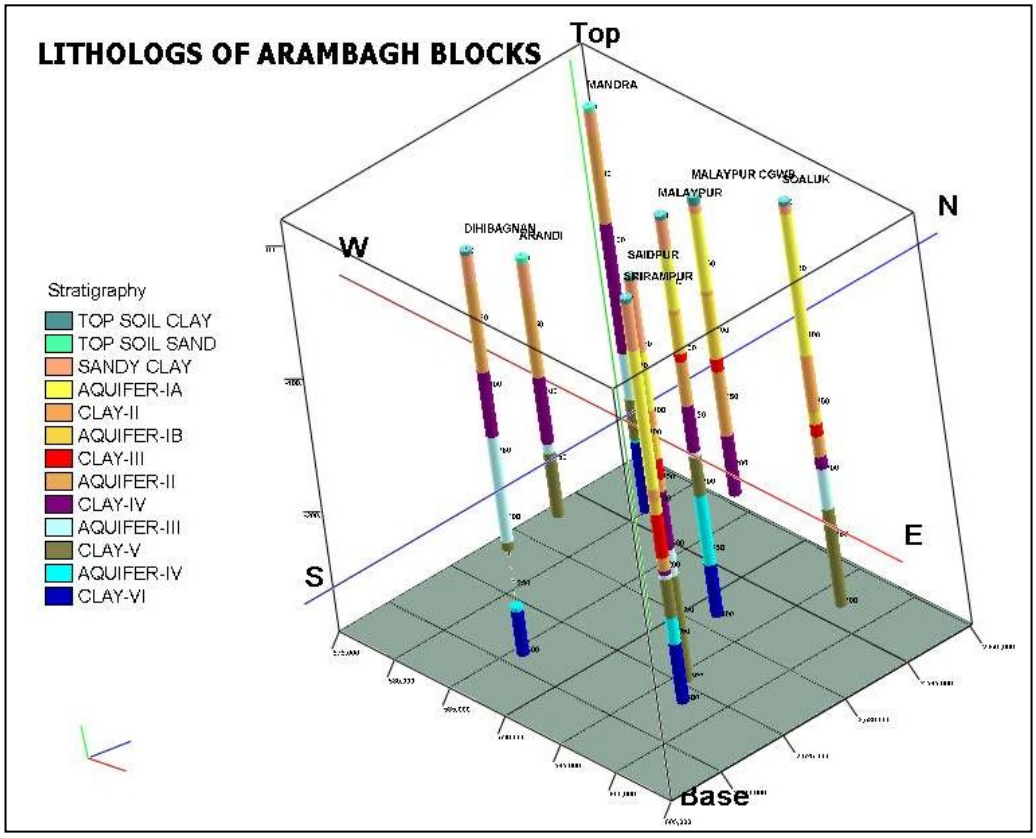

Figure 17.2 Lithologs in Arambagh Block

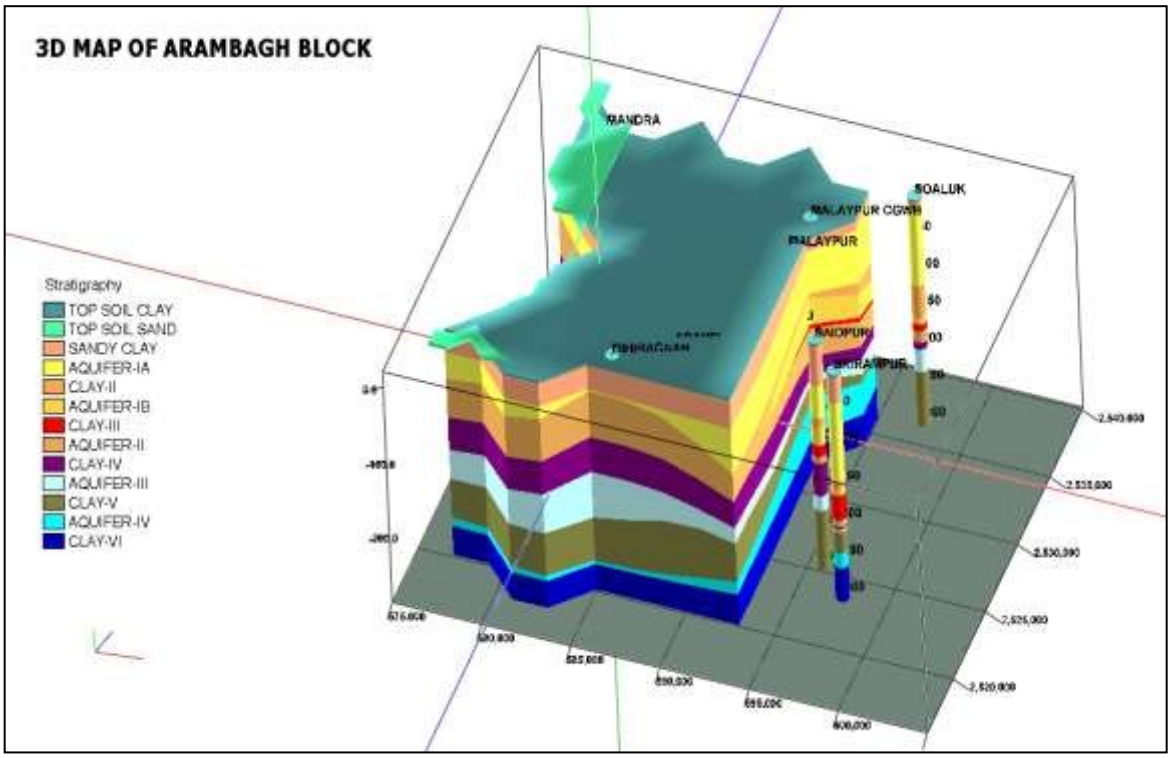

Figure 17.3 3D Aquifer Disposition in Arambagh Block

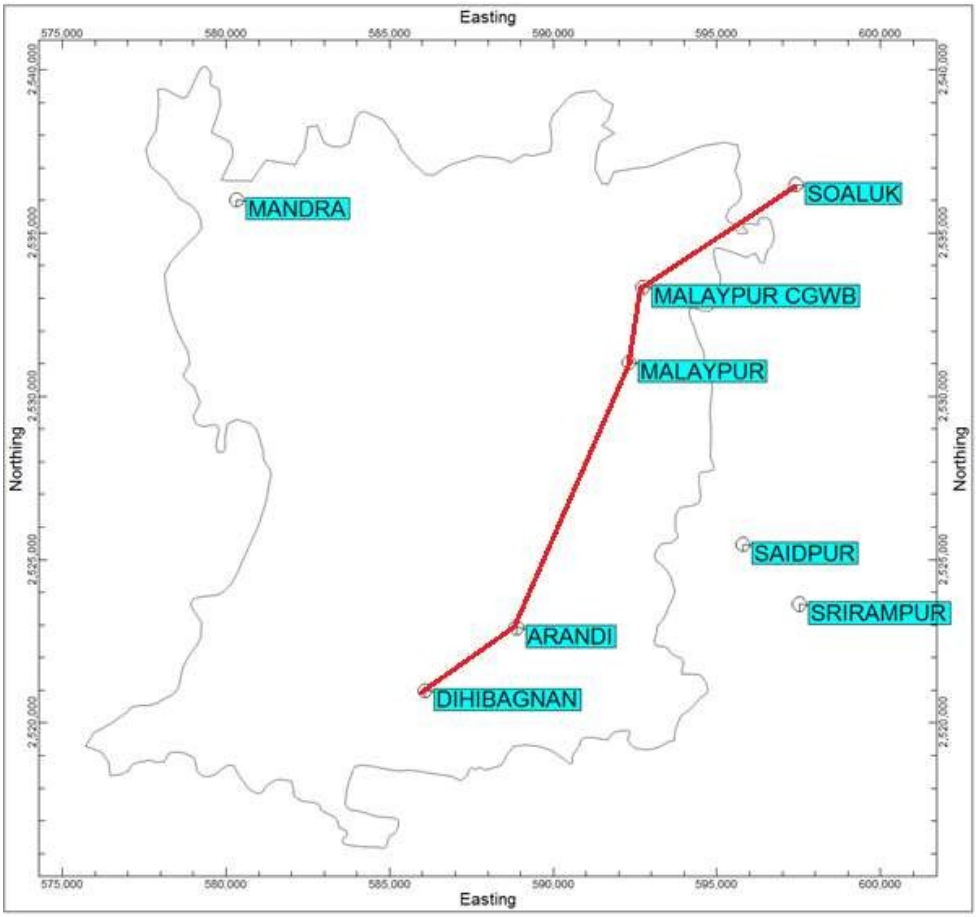

Figure 17.4 NE-SW Cross section Index Line in Arambagh Block

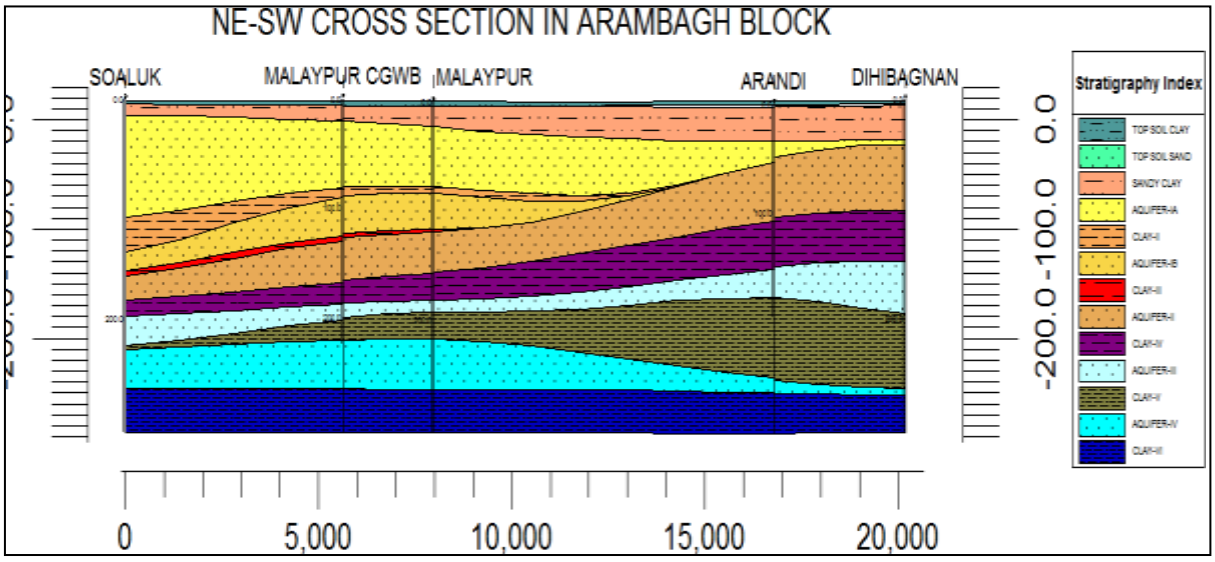

Figure 17.5 NE-SW cross section in Arambagh Block

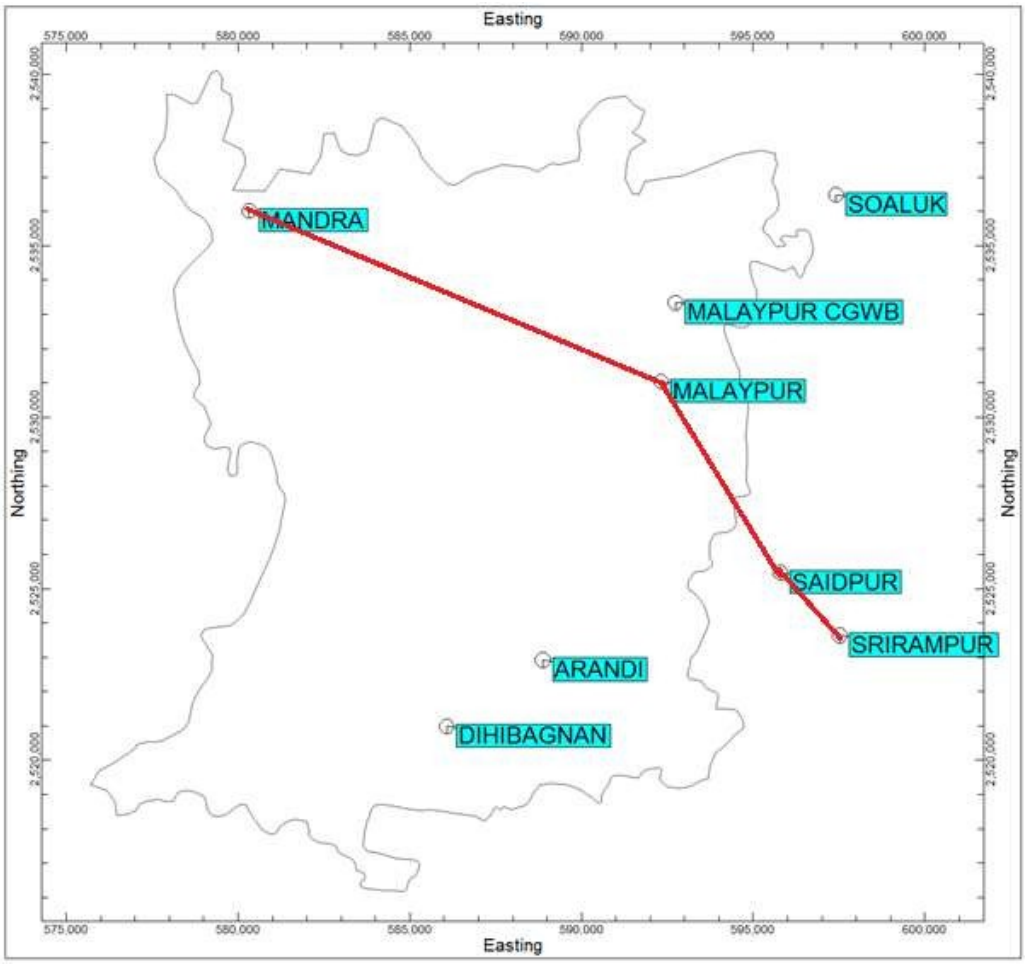

Figure 17.6 NW-SW Cross section Index Line in Arambagh Block

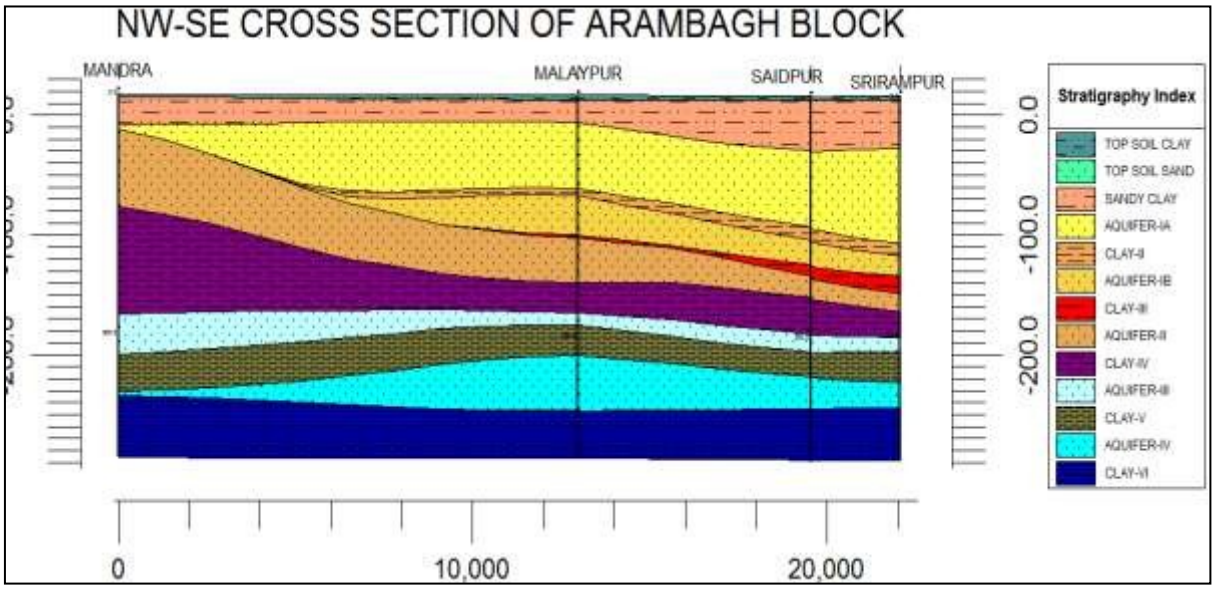

Figure 17.7 NE-SW Cross section in Arambagh Block

Table 17.6 Aquifer Wise Water Level Ranges & Seasonal long term water level trends (2006 to 2017)

Block	Aquifer Groups	Pre-monsoon Trend			Post-monsoon Trend		
		Water Level Range (mbgl)	Rise (cm/year)	Fall (cm/year)	Water Level Range (mbgl)	Rise (cm/year)	Fall (cm/year)
Arambagh	**II**	**13.2-19.65**	**-**	**33.69**	**9.03-14.75**	**-**	**39.75**
Arambagh	**III**		**-**	**-**		**-**	**-**

Table 17.7 Aquifer wise maximum thickness

Block	Area (Sq Km)	Thickness of the Granular Zone in Aquifer II (m)	Thickness of the Granular Zone in Aquifer III (m)
Arambagh	303.90	**Aquifer II: 71.93**	**Aquifer III: 80**

Table 17.8 Aquifer-wise depth range and parameters

2nd Aquifer						3rd Aquifer					
Sub Aquifer	Depth Range (mbgl)	Discharge (m^3/hr) with DD	T (m^2/day)	S	Specific capacity m^3/day per m	Sub Aquifer	Depth Range (mbgl)	Discharge (m^3/hr) with DD	T (m^2/day)	S	Specific capacity (m^3/day per m)
II	**19.5 - 91.43**	**137.79 (DD- 4.62)**	**476 8.59**	**2.8 5 X 10^{-3}**	**29.85**	**III**	**140 - 220**	**59.83 (DD- 6)**	205	**5.5 X 10^{-10}**	**9.972**

17.3 Ground Water Resource, Extraction, Contamination & Other Issues:

Aquifer Wise Resource Availability & Extraction: Dynamic ground water resources as on 31st March'17 in top aquifer.

Table 17.9 Availability of Ground Water resource in Block

Block	Annual Extractable GW Recharge (MCM)	Current Annual Ground Water	Stage of GW Extraction (%)	Category	Annual Allocation for domestic use to 2042 (MCM)
Arambagh	**95.8613**	**93.3874**	**97.58**	Critical	0.9989

Static (in-storage) Resources: 36.09 MCM

17.4 Chemical Quality of Ground Water & Contamination:

Based on Key well data and CGWB outsourced exploratory well data blocks wise Average data of chemical parameter is given below.

Table 17.10 Aquifer wise average chemical parameter of block

Aquifer	pH	EC (µs/cm)	TH	Ca	Mg	Na	K	HCO_3	Cl	NO_3	SO_4(<5)	F(<1)	SiO_2(<5)	TDS
II	8.1	441.4	160	27.33	22.28	25.36	1.62	185.71	41.36	0.42	7.91	0.11	22.06	261.73

17.5 Ground Water Resource Enhancement& Management Plan:

Ground Water Management Plan for drinking purposes-

- The block is under Critical category and as per Ground Water Policy first priority of water is for drinking purpose.
- Regular Field monitoring is necessary for assessment of ground water contamination by arsenic in tube wells.
- As per WBPHED Data, 22136 population in 95 villages is still uncovered by PWSS.

Table 17.11 Still uncovered population by PWSS for drinking water in Arambagh Block

Block	Number of Villages to be covered by water supply schemes	Population still uncovered by PWSS (as per Census 2011) & to be covered by water supply schemes.	Comments on providing water supply to the risk population
Arambagh	95	182707	Aquifer-III is productive (59.83 m^3/hr) only in Northern part of the block and Aquifer-II is highly productive (137.79 m^3/hr). A lower discharge of 60 m^3/hr has been considered to work out number of wells required.

- In Arambagh block, Aquifer-III is productive (59.83 m3/hr) only in Northern part of the block and Aquifer-II is highly productive (137.79 m3/hr).

- In Arambagh block one well has been constructed by outsourcing towards northern side of the block, tapping Aquifer-III, giving yield 59.0 m^3/hr. This well could be used for supply of drinking water in that part of block.
- In other Part of block, wells constructed tapping Aquifer-III, are not successful.
- For monitoring of the ground water regime, if observation well is needed then cost of construction of the same should also be included in the expenditure.
- Phase wise construction of tube wells drilling should be done.
- Initially, 25 % of wells should be constructed; afterwards, the whole plan should be implemented.

Table 17.12 Still uncovered population by PWSS for drinking water in Arambagh Block

Estimation of village wise number of Tube wells and cost for construction in Arambagh Block

A	**Village**
B	**Population 2011**
C	**Projected Population 2021 (decadal growth rate 9.49%)**
D	**Present Water Requirement for Human Population in m^3 @70 lpcd**
E	**Projected Water Requirement for Human Population in m^3 @70 lpcd**
F	**Cattle 2011**
G	**Projected Cattle 2021**
H	**Present Water Requirement for cattle m^3 @20lpcd**
I	**projected Water Requirement for cattle m^3 @20lpcd**
J	**Total Water Requirement/day as on 2011 in m^3**
K	**Total Water Requirement cubic m/day as on 2021 in m^3**
L	**Discharge (m3/hr)**
M	**Discharge of one TW in m^3/day after 8 hours of pumping**
N	**No of TW**
O	**Cost of Tube well of 300 m depth (approx.) 10”x6" dia @ Rs. 20 lakhs (In lakh) as per EFC**

Block wise Management plan in parts of Hugli District, West Bengal

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
Bhabapur	299	327	20.93	22.89	30	31	0.6	0.62	21.53	23.51	60	480	0	0
Candidate	1740	1905	121.8	133.35	174	180	3.48	3.61	125.28	136.96	60	480	0	0
Donga Bathan	793	868	55.51	60.76	79	82	1.58	1.64	57.09	62.4	60	480	0	0
Eadpur	1076	1178	75.32	82.46	108	112	2.16	2.24	77.48	84.7	60	480	0	0
Tirol	4523	4952	316.61	346.64	452	469	9.04	9.37	325.65	356.01	60	480	1	20
Puin	3202	3506	224.14	245.42	320	332	6.4	6.63	230.54	252.05	60	480	1	20
Benga	2374	2599	166.18	181.93	237	246	4.74	4.91	170.92	186.84	60	480	0	0
Chak Jalal	1760	1927	123.2	134.89	176	182	3.52	3.65	126.72	138.54	60	480	0	0
Chak Madan	587	643	41.09	45.01	59	61	1.18	1.22	42.27	46.23	60	480	0	0
Ruitchak	765	838	53.55	58.66	77	80	1.54	1.6	55.09	60.26	60	480	0	0
Bora	699	765	48.93	53.55	70	73	1.4	1.45	50.33	55	60	480	0	0
Karui	2395	2622	167.65	183.54	240	249	4.8	4.98	172.45	188.52	60	480	0	0
Golta	1197	1311	83.79	91.77	120	124	2.4	2.49	86.19	94.26	60	480	0	0
Teghari	869	951	60.83	66.57	87	90	1.74	1.8	62.57	68.37	60	480	0	0
Parbbati Chak	358	392	25.06	27.44	36	37	0.72	0.75	25.78	28.19	60	480	0	0
Chandsit	244	267	17.08	18.69	24	25	0.48	0.5	17.56	19.19	60	480	0	0
Jayrampur	1327	1453	92.89	101.71	133	138	2.66	2.76	95.55	104.47	60	480	0	0
Gopinathpur	760	832	53.2	58.24	76	79	1.52	1.58	54.72	59.82	60	480	0	0
Keledona	1337	1464	93.59	102.48	134	139	2.68	2.78	96.27	105.26	60	480	0	0
Kulbayara	530	580	37.1	40.6	53	55	1.06	1.1	38.16	41.7	60	480	0	0
Raghunathpur	504	552	35.28	38.64	50	52	1	1.04	36.28	39.68	60	480	0	0
Kashtadahi	1104	1209	77.28	84.63	110	114	2.2	2.28	79.48	86.91	60	480	0	0
Balundi	3300	3613	231	252.91	330	342	6.6	6.84	237.6	259.75	60	480	1	20
Uttar	2175	2381	152.25	166.67	218	226	4.36	4.52	156.61	171.19	60	480	0	0

Block wise Management plan in parts of Hugli District, West Bengal

Behala	466	510	32.62	35.7	47	49	0.94	0.97	33.56	36.67	60	480	0	0
Batanal	5585	6115	390.95	428.05	559	579	11.18	11.59	402.13	439.64	60	480	1	20
Sastipur	508	556	35.56	38.92	51	53	1.02	1.06	36.58	39.98	60	480	0	0
Chak Fazil	999	1094	69.93	76.58	100	104	2	2.07	71.93	78.65	60	480	0	0
Uttar Rasulpur	2032	2225	142.24	155.75	203	210	4.06	4.21	146.3	159.96	60	480	0	0
Uttar Sekhpur	929	1017	65.03	71.19	93	96	1.86	1.93	66.89	73.12	60	480	0	0
Chak Amad	919	1006	64.33	70.42	92	95	1.84	1.91	66.17	72.33	60	480	0	0
Ghar Gohal	2021	2213	141.47	154.91	202	209	4.04	4.19	145.51	159.1	60	480	0	0
Chak Benshe	1252	1371	87.64	95.97	125	130	2.5	2.59	90.14	98.56	60	480	0	0
Chak Behala	120	131	8.4	9.17	12	12	0.24	0.25	8.64	9.42	60	480	0	0
Chak Hazi	2549	2791	178.43	195.37	255	264	5.1	5.29	183.53	200.66	60	480	0	0
Bhalia	2452	2685	171.64	187.95	245	254	4.9	5.08	176.54	193.03	60	480	0	0
Telua	2702	2958	189.14	207.06	270	280	5.4	5.6	194.54	212.66	60	480	0	0
Jasapur	373	408	26.11	28.56	37	38	0.74	0.77	26.85	29.33	60	480	0	0
Chakanar	879	962	61.53	67.34	88	91	1.76	1.82	63.29	69.16	60	480	0	0
Keshabpur	12687	13891	888.09	972.37	1269	1315	25.38	26.31	913.47	998.68	60	480	2	40
Ashanpur	2451	2684	171.57	187.88	245	254	4.9	5.08	176.47	192.96	60	480	0	0
Mazaffarpur	804	880	56.28	61.6	80	83	1.6	1.66	57.88	63.26	60	480	0	0
Purbba	2672	2926	187.04	204.82	267	277	5.34	5.54	192.38	210.36	60	480	0	0
Purbba Shibpur	619	678	43.33	47.46	62	64	1.24	1.29	44.57	48.75	60	480	0	0
Madhurpur	2788	3053	195.16	213.71	279	289	5.58	5.78	200.74	219.49	60	480	0	0
Mayapur	10871	11903	760.97	833.21	1087	1127	21.74	22.54	782.71	855.75	60	480	2	40
Hat Basantapur	2878	3151	201.46	220.57	288	299	5.76	5.97	207.22	226.54	60	480	0	0
Mohanpur	1036	1134	72.52	79.38	104	108	2.08	2.16	74.6	81.54	60	480	0	0
Rajhati	729	798	51.03	55.86	73	76	1.46	1.51	52.49	57.37	60	480	0	0

Block wise Management plan in parts of Hugli District, West Bengal

Balarampur	1479	1619	103.53	113.33	148	153	2.96	3.07	106.49	116.4	60	480	0	0
Satpur	973	1065	68.11	74.55	97	101	1.94	2.01	70.05	76.56	60	480	0	0
Krishnabati	782	856	54.74	59.92	78	81	1.56	1.62	56.3	61.54	60	480	0	0
Ajaypur	867	949	60.69	66.43	87	90	1.74	1.8	62.43	68.23	60	480	0	0
Chand Chak	519	568	36.33	39.76	52	54	1.04	1.08	37.37	40.84	60	480	0	0
Ramnagar	2852	3123	199.64	218.61	285	295	5.7	5.91	205.34	224.52	60	480	0	0
Mobarakpur	1357	1486	94.99	104.02	136	141	2.72	2.82	97.71	106.84	60	480	0	0
Salepur	5965	6531	417.55	457.17	597	619	11.94	12.38	429.49	469.55	60	480	1	20
Manikpat	4097	4486	286.79	314.02	410	425	8.2	8.5	294.99	322.52	60	480	1	20
Paschim Raypur	1145	1254	80.15	87.78	115	119	2.3	2.38	82.45	90.16	60	480	0	0
Dahar Kundu	6464	7077	452.48	495.39	646	670	12.92	13.39	465.4	508.78	60	480	1	20
Fate Chak	556	609	38.92	42.63	56	58	1.12	1.16	40.04	43.79	60	480	0	0
Dongal	1579	1729	110.53	121.03	158	164	3.16	3.28	113.69	124.31	60	480	0	0
Gaurhati	13084	14326	915.88	1002.8	1308	1356	26.16	27.12	942.04	1029.9	60	480	2	40
Khordalalur Chak	448	491	31.36	34.37	45	47	0.9	0.93	32.26	35.3	60	480	0	0
Mahishgot	1019	1116	71.33	78.12	102	106	2.04	2.11	73.37	80.23	60	480	0	0
Basuli Chak	1176	1288	82.32	90.16	118	122	2.36	2.45	84.68	92.61	60	480	0	0
Sonagachhi	352	385	24.64	26.95	35	36	0.7	0.73	25.34	27.68	60	480	0	0
Kanpur	2657	2909	185.99	203.63	266	276	5.32	5.51	191.31	209.14	60	480	0	0
Ranhat	1155	1265	80.85	88.55	116	120	2.32	2.4	83.17	90.95	60	480	0	0
Jot Ram	292	320	20.44	22.4	29	30	0.58	0.6	21.02	23	60	480	0	0
Hamirbati	1754	1920	122.78	134.4	175	181	3.5	3.63	126.28	138.03	60	480	0	0
Krishna	1095	1199	76.65	83.93	110	114	2.2	2.28	78.85	86.21	60	480	0	0
Dharmapota	797	873	55.79	61.11	80	83	1.6	1.66	57.39	62.77	60	480	0	0
Sahapur	1398	1531	97.86	107.17	140	145	2.8	2.9	100.66	110.07	60	480	0	0

Block wise Management plan in parts of Hugli District, West Bengal

Taral	1207	1322	84.49	92.54	121	125	2.42	2.51	86.91	95.05	60	480	0	0
Haraditya	4011	4392	280.77	307.44	401	416	8.02	8.31	288.79	315.75	60	480	1	20
Shyamgram	2586	2831	181.02	198.17	259	268	5.18	5.37	186.2	203.54	60	480	0	0
Arunbera	1587	1738	111.09	121.66	159	165	3.18	3.3	114.27	124.96	60	480	0	0
Golami Chak	1020	1117	71.4	78.19	102	106	2.04	2.11	73.44	80.3	60	480	0	0
Amgaon	4022	4404	281.54	308.28	402	417	8.04	8.33	289.58	316.61	60	480	1	20
Chhandra	768	841	53.76	58.87	77	80	1.54	1.6	55.3	60.47	60	480	0	0
Tajpur	3425	3750	239.75	262.5	343	356	6.86	7.11	246.61	269.61	60	480	1	20
Birati	1715	1878	120.05	131.46	172	178	3.44	3.57	123.49	135.03	60	480	0	0
Katabani	1610	1763	112.7	123.41	161	167	3.22	3.34	115.92	126.75	60	480	0	0
Pirijpur	1406	1539	98.42	107.73	141	146	2.82	2.92	101.24	110.65	60	480	0	0
Selalpur	2363	2587	165.41	181.09	236	245	4.72	4.89	170.13	185.98	60	480	0	0
Eloma	782	856	54.74	59.92	78	81	1.56	1.62	56.3	61.54	60	480	0	0
Madhabpur	1263	1383	88.41	96.81	126	131	2.52	2.61	90.93	99.42	60	480	0	0
Chunait	786	861	55.02	60.27	79	82	1.58	1.64	56.6	61.91	60	480	0	0
Bhandarhati	350	383	24.5	26.81	35	36	0.7	0.73	25.2	27.54	60	480	0	0
Balai Chak	737	807	51.59	56.49	74	77	1.48	1.53	53.07	58.02	60	480	0	0
Samta	1110	1215	77.7	85.05	111	115	2.22	2.3	79.92	87.35	60	480	0	0
Takshal	519	568	36.33	39.76	52	54	1.04	1.08	37.37	40.84	60	480	0	0
Siara	1162	1272	81.34	89.04	116	120	2.32	2.4	83.66	91.44	60	480	0	0
Gopaldaha	1177	1289	82.39	90.23	118	122	2.36	2.45	84.75	92.68	60	480	0	0
Total	**182707**	**200046**	**12789**	**14003**	**18278**	**18947**	**365.56**	**378.97**	**13155**	**14382**	**5700**	**45600**	**16**	**320**

From Table 17.12., it has been shown 15 wells are required for supply of drinking water in still uncovered part of Arambagh Block, Hugli District, West Bengal; status of already existing PWSS by PHED has been given in Fig-9.9.9. After construction of wells, analysis of arsenic and heavy metals' in ground water in those structures are necessary.

Management Plan for irrigation:

- Based on CGWB Resource data, block is **Critical Category**. Stage of Ground Water development is 97.58 **%,** with declining long term ground water level Trend in both the seasons.
- As per **4th MI Census** irrigation data in this block number of Shallow Tube Wells are used more.
- Block is showing continuous declining trend so surface water should be used more than that of Ground water.
- Artificial recharge is essential in **Critical** block.
- Application of modern technologies like Sprinkler, Drip irrigation, etc. are needed in this Block.
- Regular monitoring of arsenic concentration in crop is also necessary.
- R & D study is necessary to get better solutions of water management in future.
- In **Arambagh block, as per s**oil and climatic condition, Mustard, Wheat, Jute, potato and Til are suitable crops to grow.
- Area of cultivation of Boro rice and cash crops should be reduced.

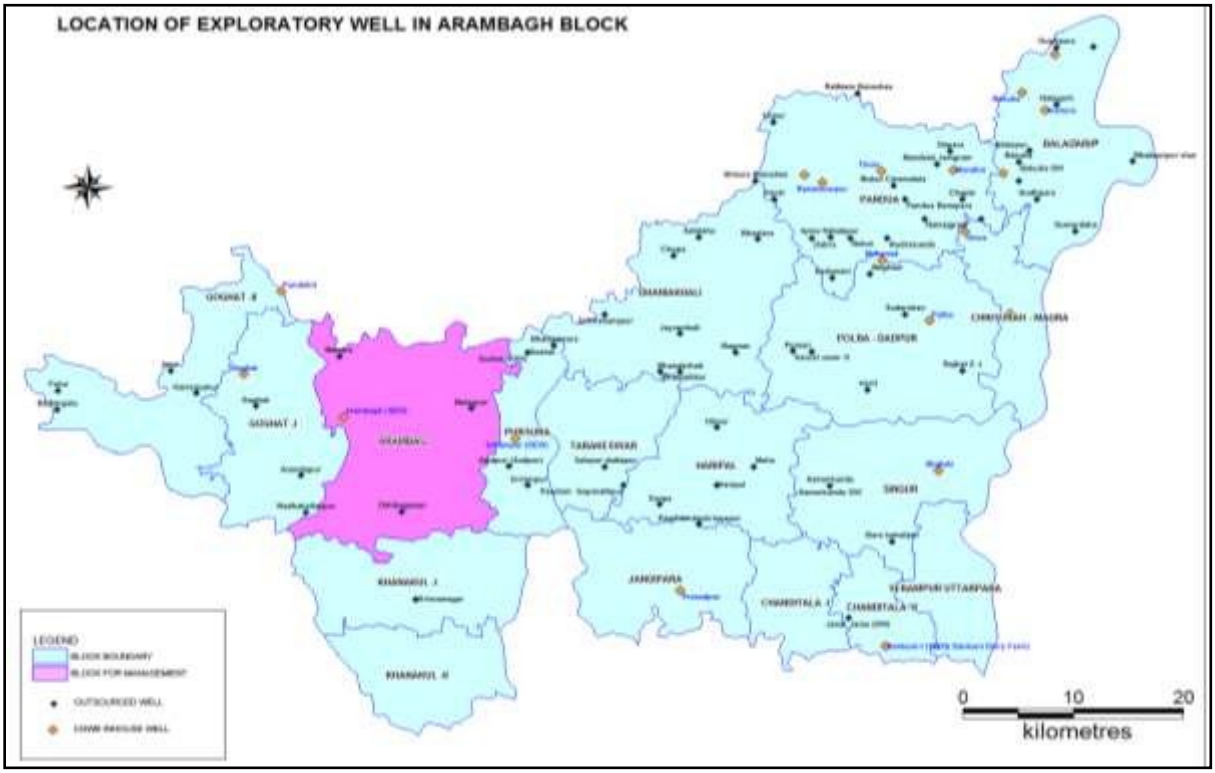

Figure 17.8 Location of Exploratory wells through outsourcing in Arambagh Block

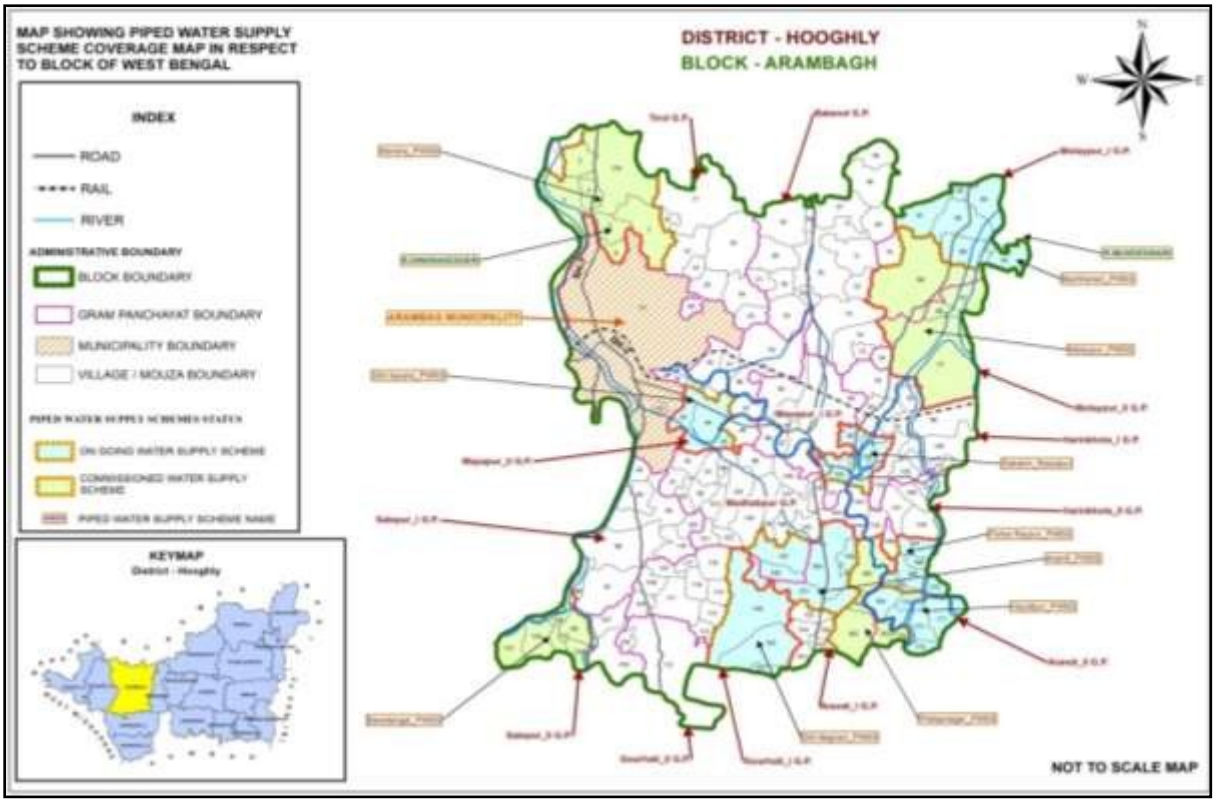

Figure 17.9 Drinking water supply schemes in Arambagh Block (Source-WBPHED) as per Census -2011

Table 17.13 Cropping pattern under practice in Block

Name of Block	Arambagh	
Aus	Area	211
	Prod.	0.516
	Yield	2447
Aman	Area	1132
	Prod.	2.890
	Yield	2553
Boro	Area	12293
	Prod.	40.358
	Yield	3283
Jute	Area	110
	Prod.*	2.022
	Yield**	18.38
Mustard	Area	2061
	Prod.	1.893
	Yield	919
Til	Area	3053
	Prod.	3.191
	Yield	1045
Potato	Area	5066
	Prod.	60.883
	Yield	12018

(Area in Ha, Production in Thousand MT and Yield in kg./Ha.)

(Courtesy: Department of Economics and Statistics)

percentage wise crop covering area in block has been estimated and the same has been presented in Table 17.14

Table 17.14 Area wise percentage of crops under practice in Arambagh Block

Area wise Current Practice of crops								
Rabi Crops (Wheat, Mustard and oil seeds water Column requirement=0.21) Cultivation		Boro Cultivation (Water Column requirement-1.2 m)		Vegetable (water Column requirement Potato=0.6m)		pulses(water Column requirement =0.11 m)		Total Area covered (ha)
%	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	
23	5114	55	12293	23	5066	0	0	22473

Based on data of Table 17.14, the factor of weighted average of water column has been estimated to be 0.8; so, for irrigation of remaining cultivable area of 8859.34 Ha 7087.47 Ham water is required. Ground water resource estimation as of 2017 shows that only 99.89 Ham from top aquifer is available. Therefore, the remaining cultivable area could not be covered by irrigation for cultivation. Under this situation, it is proposed to reduce area of cultivation of Boro Rice and cash crops; by doing so, the water thus saved could be used to grow less water requiring crops, viz. pulses & oil seeds, vegetable, rabi crops including wheat, etc. In this way, more cultivable area could be brought under irrigation facility.

Also, artificial recharge and conservation techniques from surface run off component of rainfall should have to be adopted and necessary structures have to be constructed at suitable locations. By use of harvested water from aforesaid structures, remaining cultivable area of 8859.34 Ha could be covered under irrigation for cultivation.

Table 17.15 Number of abstraction structures and CCA created in Arambagh Block

Block Name	Dug well		Shallow Tube well		Deep Tube well		Surface Flow		Surface Lift		CCA (ha.)		Total CCA (ha.)
	No.	CCA (ha.)	No.	CCA (ha.)	No.	CCA (ha.)	No.	CCA (ha.)	No.	CCA (ha.)	Ground Water	Surface Water	
ARAMBAGH	0	0	1935	7410.25	60	2388	0	0	41	1901.41	9798.25	1901.41	11699.66

Table 17.16 Summary of irrigation plan in Arambagh block

Block	Geographical area in ha	Cultivable area in ha	Net irrigated Command area (GW) in ha	Net irrigated Command area (SW) in ha	Net irrigated Command area (GW+SW) in ha	Net area available for Irrigation	GW available for Future irrigation (ham)	Premonsoon Long Term WL Trend 2017 in cm/yr, if falling	Post monsoon Long Term WL Trend 2017 in cm/yr, if falling	SOD in %	Average Premonsoon WL in mbgl	Average Postmonsoon WL in mbgl	Category
Arambagh	30390	20559	9798.25	1901.41	11699.66	8859.34	99.89	**Yes, 28.03**	**Yes, 37.28**	**97.58**	**16.15**	**11.17**	**Critical**

To arrest the declining trend of water level, SW may be used more than Ground water.

Rainwater harvesting & Artificial Recharge:

Table 17.17 Area suitable for recharge in the study area

District	Block Name	Area (in ha)	Area suitable for recharge(Considering area having DTW & more than 3m in post monsoon and showing 0.2m/yr & more falling trend) (in ha)
Hugli	**Arambagh**	30390	29890

On the basis of soil characteristic, Slope, Rain fall data, etc. run off component has been estimated as follows:

Table 17.18 Estimation of Surface runoff based on Land slope, soil characteristics, etc. (after Dhruvanarayana, 1993)

Block	Major type of soil available in that block	Normal Monsoon Rainfall (m)	Total volume of surface runoff available Annually 'Vt' (RnXAXC) Ham	75% of 'Vt' = V	50% of V (Non committed)= Vnc	60% of Vnc (60 % of water to be harvested)= Vf

Arambagh	**Clay Loam/Silty Clay Loam**	**1.098**	**13347.29 (Average Run off coefficient – 0.4)**	**10010.47**	**5005.23**	**3003.14**

Table 17.19 Details of possible conservation & artificial recharge structures & cost estimate in block

Row 1	Block Area in Ha	30390
Row 2	Area in Ha suitable for recharge	29890
Row 3	Soil type(3)	Sandy clay to Sandy
Row 4	Amount of water to be harvested	3003.14
Row 5	Amount of water for artificial recharge of top aquifer and conservation (Ham) - 70 % of Row. 4 (5)	2102.2
Row 6	Source water allocation for for Irrigation Cum Recharge Pond - 35% of Row 4 (6)	1051.1
Row 7	Source water allocation for REET with recharge shaft -35% of Row 4 (7)	1051.1
Row 8	Source water allocation for for injection well to recharge deeper aquifer -20% of Row 4 (8)	600.63
Row 9	Source water allocation for Farm Pond/Irrigation pond – 10 % of Row 4 (9)	300.31
Row 10	Nos. of Irrigation Cum Recharge Pond @ 50 Ham per unit (10)	21
Row 11	Nos. of REET with recharge shaft @ 10 Ham per unit	105
Row 12	Nos. of injection well suggested @ 30 Ham per unit (12)	20
Row 13	Nos. of Farm Pond @ 10 Ham per unit (12)	30
Row 14	Cost of Irrigation Cum Recharge Pond @ Rs 8 lakh per unit	168
Row 15	Cost of REET with recharge shaft @ Rs 8 lakh per unit	840
Row 16	Cost of injection well @ Rs 20 lakh per unit	600
Row 17	Cost of Farm Pond @ Rs 8 lakh per unit	240

Details of possible conservation & artificial recharge structures & cost estimate in block

(Irrigation Cum Recharge Tank & Injection Well are most suitable) Total Cost 1848 lakh;

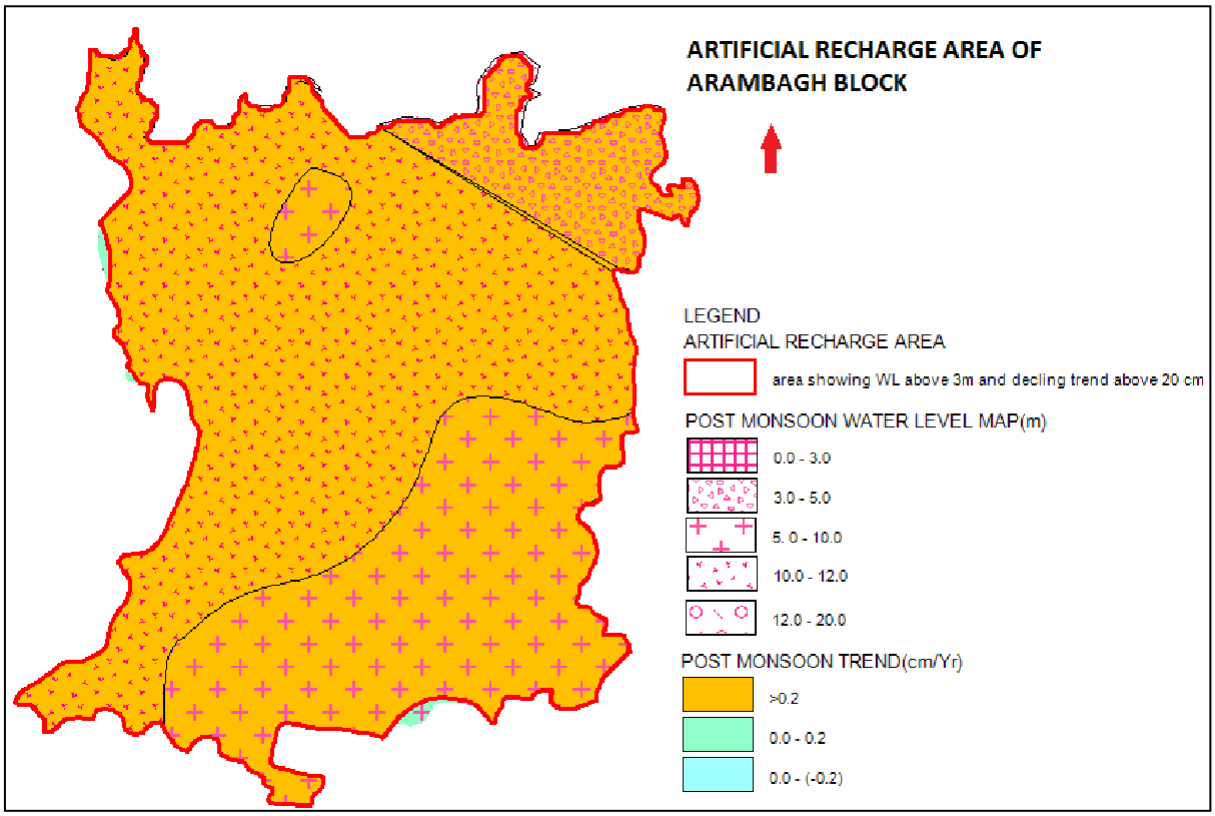

Figure 17.10 Map showing area suitable for artificial recharge in Arambagh Block

18.0 GOGHAT-I BLOCK

18.1 Salient Information

- **Block Name: Goghat-I**
- **Area (in ha): 18641**
- **District: Hugli**
- **State: West Bengal**
- **Population (as on 2011):**

Table 18.1 Details of Population in Goghat-I block

Rural	Urban	Total
140030	**-**	**140030**

- **Rainfall:** Average annual rainfall (**Hugli district**) for the period 2013 -17 (in mm):**1336.96**

Table 18.2 Annual Rainfall for last five years

Block	District Normal	Actual (Annual)				
		2013	**2014**	**2015**	**2016**	**2017**
Goghat-I	1362	1365.3	1114.4	1549.1	1218.6	1437.4

- **Agriculture & Irrigation (area in ha):**

Table 18.3 Land use in block (Source-West Bengal Land use and Land cover Department)

Block	area	Area under non agriculture use (Ha)	Barren and uncultivable (Ha)	Total agricultural land (Ha)	Pasture (Ha)	Orchard (Ha)	Cultivable waste (Ha)	Fallow land other than Current Fallow (Ha)	Current Fallow (Ha)	Forest (Ha)	Net sown area (Ha)
Goghat-I & Goghat II	37644	8912	68	27684	11	109	-	378	-	2	27302

18.2 Aquifer Wise Ground Water Resource Availability & Extraction:

Table 18.4 Aquifer wise resource availability and draft (in MCM) in Block

Resource Availability	Aquifer II Group	Aquifer III Group	Extraction (for Aquifer II)

Annual Extractable GW Recharge/Dynamic Resource	64.21	-	33.56
Static Resource	24.43		

Disposition of Aquifer: In **Goghat-I** Block, 2 Aquifer Groups are explored.

- The range of Aquifer II is **9.14m to 126m** and it is part of Older Alluvium Formation. In Aquifer 2nd iron concentration in ground water is high.
- The range of Aquifer III is **135m to 275m.; i**t is sub divided into two sub aquifers: **III & IV: the range of aquifer III is 135m to 237.25m and aquifer IV is 220.68m to 275m**. This is a part of Tertiary Formation. In Aquifer III, ground water potentiality is low.

Table 18.5 Aquifer disposition (depth range) in block

Block	Depth range of Aquifer in mbgl	
Goghat-I	**Aquifer II**	**Aquifer III**
	aquifer II: 9.14-126	**aquifer III: 135-237.25** **aquifer IV: 220.68-275**

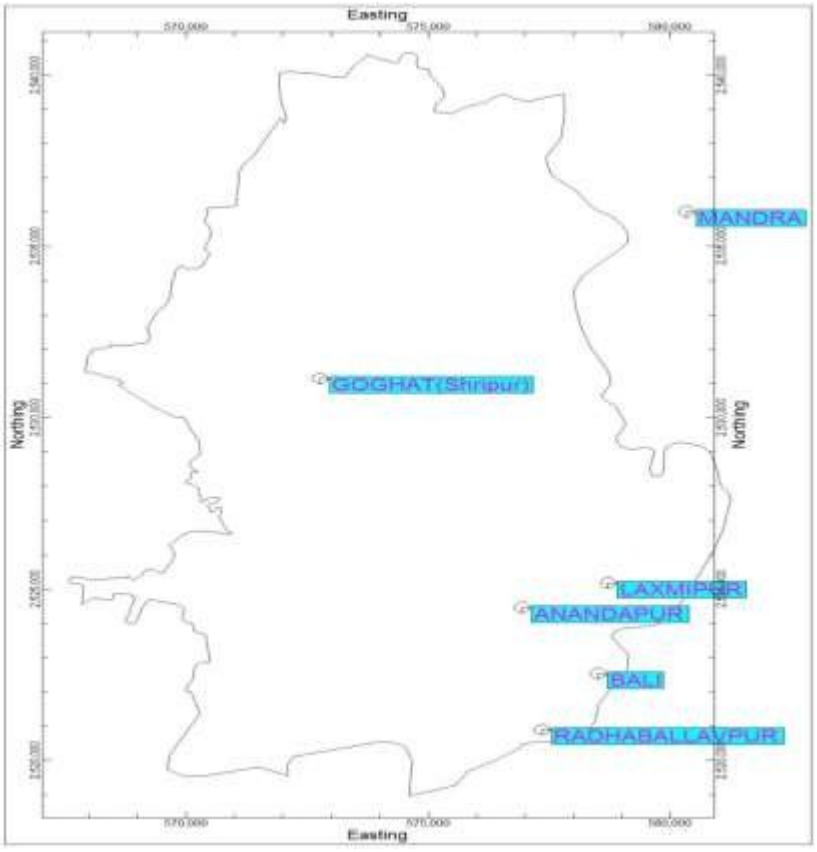

Figure 18.1 Index map of Goghat-I Block

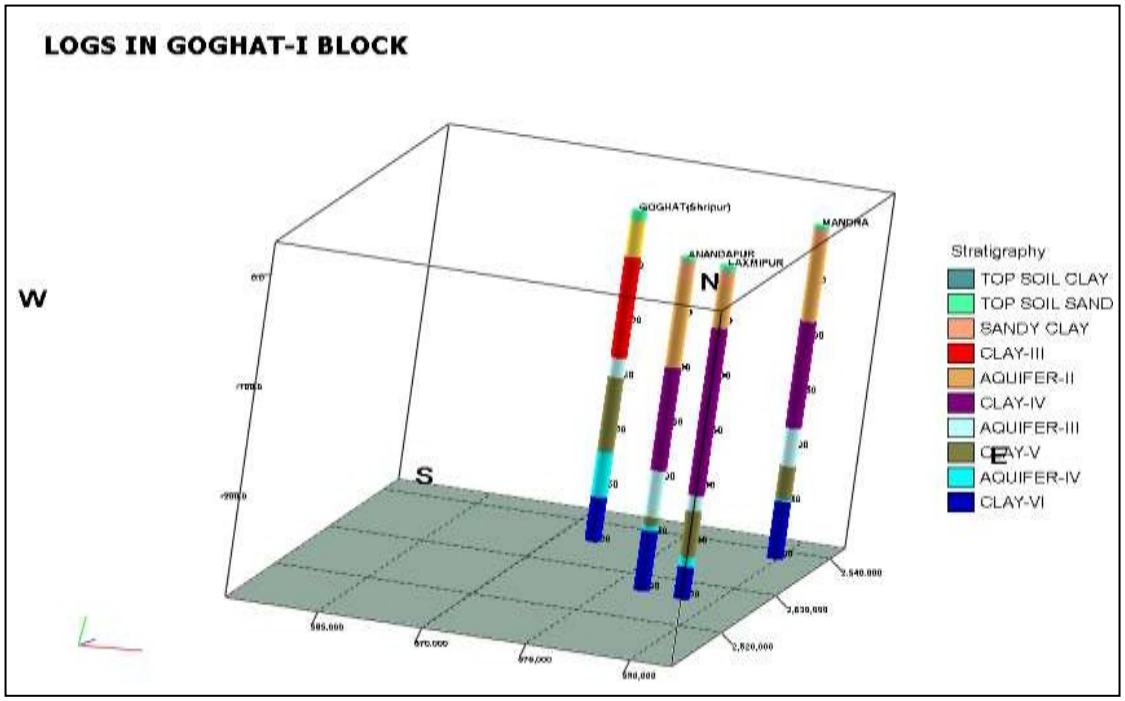

Figure 18.2 Lithologs in Goghat-I

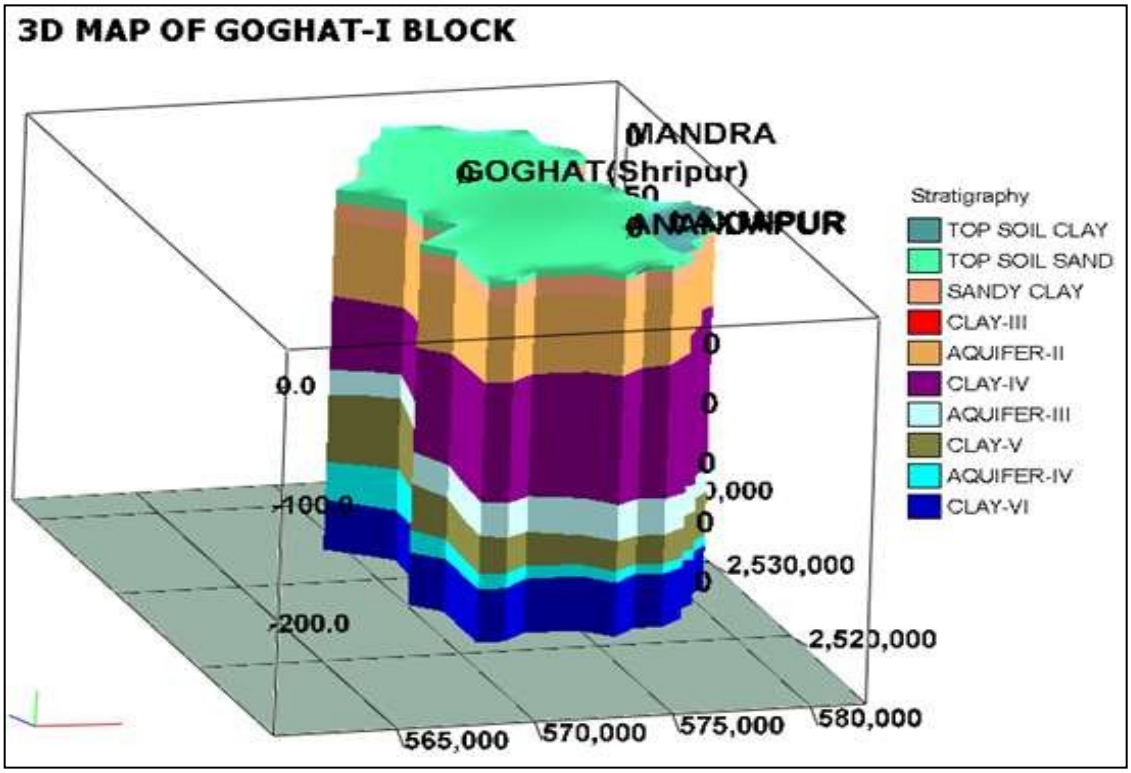

Figure 18.3 3D Aquifer Disposition in Goghat-I

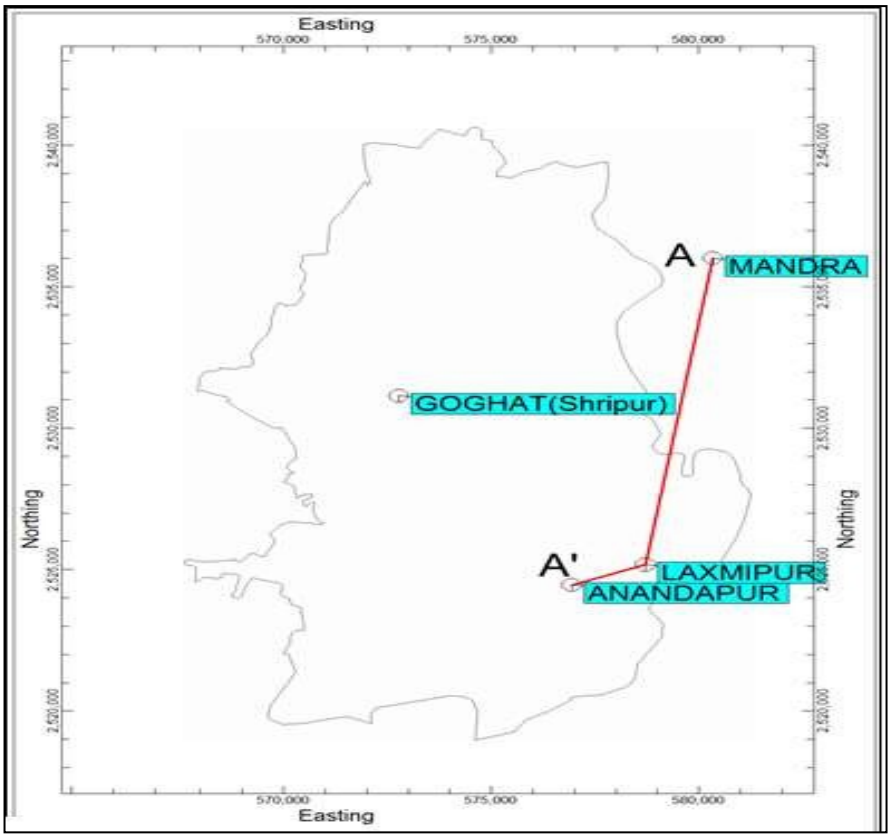

Figure 18.4 N-S cross section Index Line in Goghat-I Block

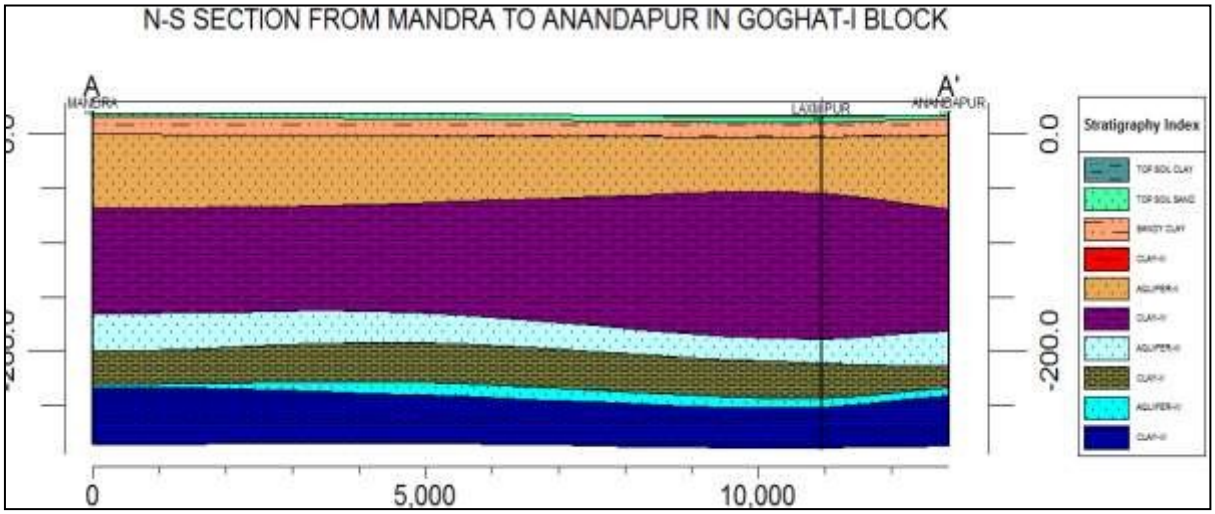

Figure 18.5 N-S Cross section in Goghat I Block

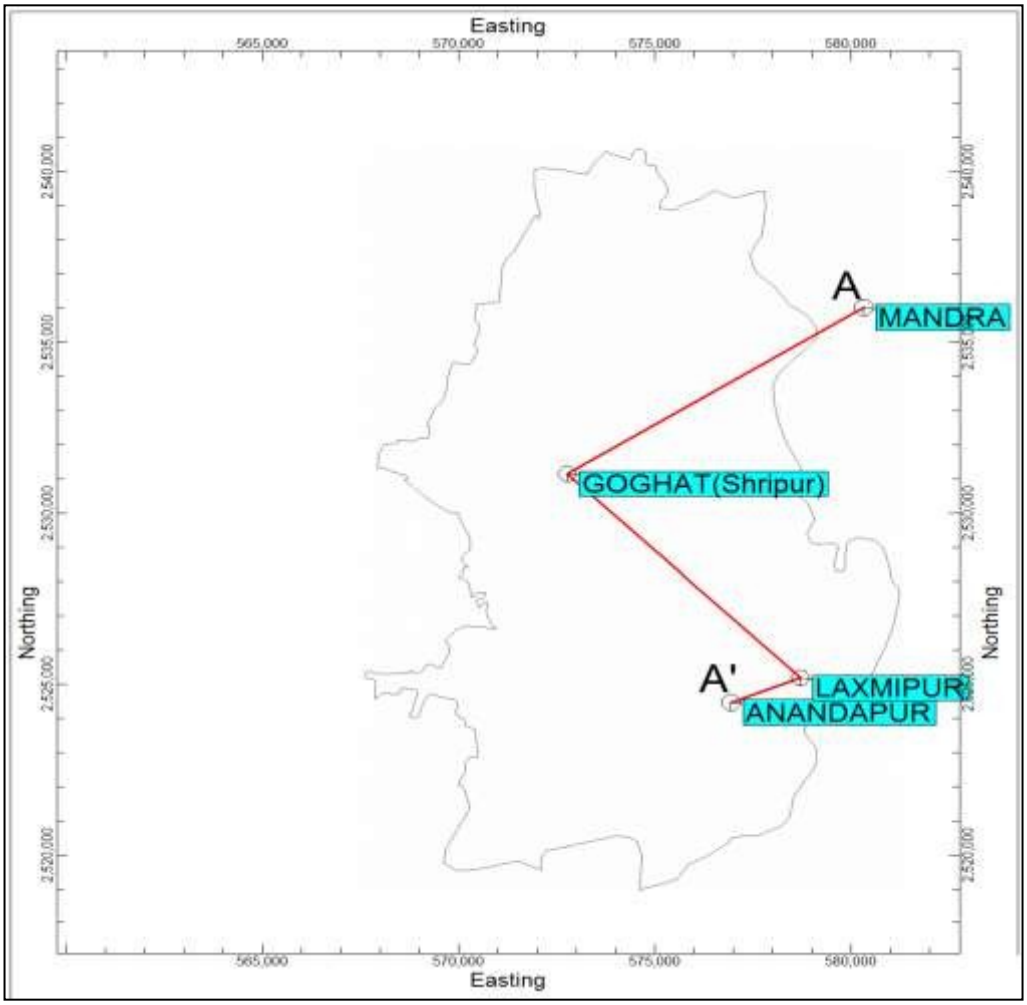

Figure 18.6 : N - S(Central Part) cross section Index Line in Goghat-I Block

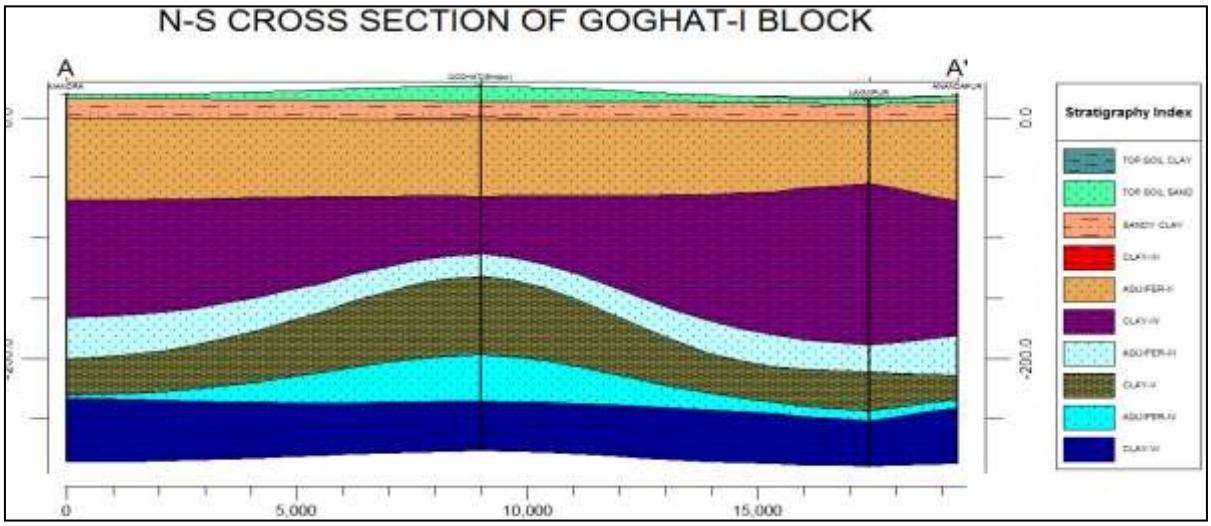

Figure 18.7 N – S (Central part) Cross section in Goghat-I Block

Table 18.6 Aquifer Wise Water Level Ranges & Seasonal long term water level trends (2006 to 2017)

Block	Aquifer Groups	Pre-monsoon Trend			Post-monsoon Trend		
		Water Level Range (mbgl)	Rise (cm/year)	Fall (cm/year)	Water Level Range (mbgl)	Rise (cm/year)	Fall (cm/year)
Goghat-I	II	16.73-20.6	-	**32.88**	11.97-14.75	-	65.32
Goghat-I	III	8.25-19.21	-	-	14.2-19	-	-

Table 18.7 Aquifer wise maximum thickness

Block	Area (Sq Km)	Thickness of the Granular Zone in Aquifer II (m)	Thickness of the Granular Zone in Aquifer III (m)
Goghat-I	186.41	**aquifer II: 116.86**	**aquifer III: 102.25** **aquifer IV: 54.32**

Table 18.8 Aquifer-wise Statement

Aquifers	Sub Aquifer	Depth Range (mbgl)	Discharge (m^3/hr) with DD	T (m^2/day)	S	Specific capacity (m^3/day per m)
Aquifer II	**II**	**9.14 - 126**	**59.52 (DD- 6)**	**4768.59**	**2.85 X 10^{-3}**	**19.2**
Aquifer III	**III**	**135 - 237.25**	**11.6 (DD- 6.20)**	205	5.5 X 10^{-10}	1.87
		IV	**220.68 - 275**			

18.3 Ground Water Resource, Extraction, Contamination & Other Issues:

Aquifer Wise Resource Availability & Extraction: Dynamic ground water resources as on 31st March'17 in top aquifer

Table 18.9 Availability of Ground Water resource in Block

Block	Annual Extractable	Current Annual GW Extraction	Stage of GW	Category	Annual GW Allocation for domestic use to
Goghat-	**53.1688**	**43.6259**	**82.05**	**Semi-**	**2.1884**

Static (in-storage) Resources: 24.43 MCM

18.4 Chemical Quality of Ground Water &Contamination:

Based on Key well data and CGWB outsourced exploratory well data blocks wise Average data of chemical parameter is given below.

Table 18.10 Aquifer wise average chemical parameter of block

Aquifer	pH	EC (us/cm)	TH	Ca	Mg	Na	K	CO_3	HCO_3	Cl	NO_3	SO_4 (<5)	F (<1)	SiO_2 (<5)	TDS
II	8.2	353.8	137.5	27	17.01	15.76	1.96	0	157.08	29.25	0.073	0	0.01	16.82	203.69
III	7.9	396.5	155.5	35	14.47	29.41	2.78	0	183.05	35.23	0.6	5.65	0.67	23.52	232.86

18.5 Ground Water Resource Enhancement& Management Plan:

Ground Water Management Plan for drinking purposes-

- The block is under Semi Critical situation and as per Ground Water Policy first priority of water is for drinking purpose.
- Regular monitoring is necessary to assess arsenic concentration in ground water.
- As per WBPHED Data, 74664 population in 55 villages are still uncovered by PWSS.

Table 18.11 Uncovered Population by PWSS in Goghat-I Block

Block	Number of Villages to be covered by water supply schemes	Population in risk zone (as per Census 2011) to be covered by water supply schemes.	Comments on providing water supply to the risk population
Goghat-I	55	74664	In Goghat- I block, Aquifer-III is productive (11.6 m^3/hr) only in Northern part (Aprrox.-50% area) of the block and Aquifer-II is highly productive (59.52 m^3/hr) in whole block. A discharge of 35.4 m^3/hr of both aquifers has been considered to work out number of wells required.

- Two wells tapping Aquifer-III have been constructed in Goghat-I Block, by outsourcing, reveals discharge of 73.8 m^3/hr. Again, two outsourced wells at Shripur & Bali, in the northern part of the block have been constructed by outsourcing tapping Aquifer-III, reveal discharge of 15 m^3/hr & 10m^3/hr respectively. In other part of block, wells constructed tapping Aquifer-III, are not successful.

- Two wells at Goghat and Paba by outsourcing both tapping Aquifer II show discharge of 181 m^3/hr and 115.0 m^3/hr respectively. All these wells can be used for supply of drinking water in that part of block.
- Visualizing overall situation for preparation of village wise water supply schemes, average discharge of 35.4 m^3/hr has been taken into consideration.
- From Table 9.10.12, 14 wells are required for supply of drinking water; Status of existing PWSS by PHED is presented in Figure 18.9.
- For monitoring of the ground water regime, if observation well is needed then cost of construction of the same should also be included in the expenditure.
- Phase wise construction of wells should be done; initially, 25 % of wells should be constructed; afterwards, the whole plan should be implemented.
- After construction of wells, arsenic and heavy metals' concentration in ground water should be analyzed.

Table 18.12 Estimation of village wise number of Tube wells and cost for construction in Goghat-I block

A	**Village**
B	**Population 2011**
C	**Projected Population 2021 (decadal growth rate 9.49%)**
D	**Present Water Requirement for Human Population in m^3 @70 lpcd**
E	**Projected Water Requirement for Human Population in m^3 @70 lpcd**
F	**Cattle 2011**
G	**Projected Cattle 2021**
H	**Present Water Requirement for cattle m^3 @20lpcd**
I	**projected Water Requirement for cattle m^3 @20lpcd**
J	**Total Water Requirement/day as on 2011 in m^3**
K	**Total Water Requirement cubic m/day as on 2021 in m^3**
L	**Discharge (m3/hr)**
M	**Discharge of one TW in m^3/day after 8 hours of pumping**
N	**No of TW**
O	**Cost of Tube well of 300 m depth (approx.) 10"x6" dia @ Rs. 20 lakhs (In lakh) as per EFC**

Block wise Management plan in parts of Hugli District, West Bengal

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
Sulut	666	729	46.62	51.03	67	69	1.34	1.39	47.96	52.42	35.4	283.2	0	0
Khatgram	1038	1137	72.66	79.59	104	108	2.08	2.16	74.74	81.75	35.4	283.2	0	0
Bijalkona	1702	1864	119.1	130.5	170	176	3.4	3.52	122.5	134	35.4	283.2	0	0
Bajua	2949	3229	206.4	226	295	306	5.9	6.12	212.3	232.2	35.4	283.2	1	20
Santoshpur	1337	1464	93.59	102.5	134	139	2.68	2.78	96.27	105.3	35.4	283.2	0	0
Palpukur	128	140	8.96	9.8	13	13	0.26	0.27	9.22	10.07	35.4	283.2	0	0
Raghubati	1785	1954	125	136.8	179	186	3.58	3.71	128.5	140.5	35.4	283.2	0	0
Madina	1877	2055	131.4	143.9	188	195	3.76	3.9	135.2	147.8	35.4	283.2	1	20
Barul	302	331	21.14	23.17	30	31	0.6	0.62	21.74	23.79	35.4	283.2	0	0
Rajgram	1027	1124	71.89	78.68	103	107	2.06	2.14	73.95	80.82	35.4	283.2	0	0
Sitanagar	1078	1180	75.46	82.6	108	112	2.16	2.24	77.62	84.84	35.4	283.2	0	0
Gobindapur	2977	3260	208.4	228.2	298	309	5.96	6.18	214.4	234.4	35.4	283.2	1	20
Bhanjapara	518	567	36.26	39.69	52	54	1.04	1.08	37.3	40.77	35.4	283.2	0	0
Beli	495	542	34.65	37.94	50	52	1	1.04	35.65	38.98	35.4	283.2	0	0
Belibela	1751	1917	122.6	134.2	175	181	3.5	3.63	126.1	137.8	35.4	283.2	0	0
Patulsara	2076	2273	145.3	159.1	208	216	4.16	4.31	149.5	163.4	35.4	283.2	1	20
Chak Netara	280	307	19.6	21.49	28	29	0.56	0.58	20.16	22.07	35.4	283.2	0	0
Mirga	1026	1123	71.82	78.61	103	107	2.06	2.14	73.88	80.75	35.4	283.2	0	0
Chatra	1408	1542	98.56	107.9	141	146	2.82	2.92	101.4	110.9	35.4	283.2	0	0

Uttar Balarampur	2391	2618	167.4	183.3	239	248	4.78	4.95	172.2	188.2	35.4	283.2	1	20
Bhabadighi	887	971	62.09	67.97	89	92	1.78	1.85	63.87	69.82	35.4	283.2	0	0
Kantali	695	761	48.65	53.27	70	73	1.4	1.45	50.05	54.72	35.4	283.2	0	0
Madanmohanpur	1186	1299	83.02	90.93	119	123	2.38	2.47	85.4	93.4	35.4	283.2	0	0
Brahmangram	402	440	28.14	30.8	40	41	0.8	0.83	28.94	31.63	35.4	283.2	0	0
Gopalbati	1202	1316	84.14	92.12	120	124	2.4	2.49	86.54	94.61	35.4	283.2	0	0
Buintya	486	532	34.02	37.24	49	51	0.98	1.02	35	38.26	35.4	283.2	0	0
Kamche	2396	2623	167.7	183.6	240	249	4.8	4.98	172.5	188.6	35.4	283.2	1	20
Chak Hari	1251	1370	87.57	95.9	125	130	2.5	2.59	90.07	98.49	35.4	283.2	0	0
Kumursa	4449	4871	311.4	341	445	461	8.9	9.23	320.3	350.2	35.4	283.2	1	20
Teligram	980	1073	68.6	75.11	98	102	1.96	2.03	70.56	77.14	35.4	283.2	0	0
Hariharpur	1115	1221	78.05	85.47	112	116	2.24	2.32	80.29	87.79	35.4	283.2	0	0
Bara Kumursa	224	245	15.68	17.15	22	23	0.44	0.46	16.12	17.61	35.4	283.2	0	0
Badla	833	912	58.31	63.84	83	86	1.66	1.72	59.97	65.56	35.4	283.2	0	0
Chak Mamrej	364	399	25.48	27.93	36	37	0.72	0.75	26.2	28.68	35.4	283.2	0	0
Khorda Kanpur	1524	1669	106.7	116.8	152	158	3.04	3.15	109.7	120	35.4	283.2	0	0
Dahiakanda	1800	1971	126	138	180	187	3.6	3.73	129.6	141.7	35.4	283.2	1	20
Kurmana	1382	1513	96.74	105.9	138	143	2.76	2.86	99.5	108.8	35.4	283.2	0	0
Sunia	2329	2550	163	178.5	233	242	4.66	4.83	167.7	183.3	35.4	283.2	1	20
Amadpur	1001	1096	70.07	76.72	100	104	2	2.07	72.07	78.79	35.4	283.2	0	0

Bamunia	501	549	35.07	38.43	50	52	1	1.04	36.07	39.47	35.4	283.2	0	0
Darinakunda	2041	2235	142.9	156.5	204	211	4.08	4.23	147	160.7	35.4	283.2	1	20
Gohalpota	580	635	40.6	44.45	58	60	1.16	1.2	41.76	45.65	35.4	283.2	0	0
Nakunda	4228	4629	296	324	423	438	8.46	8.77	304.4	332.8	35.4	283.2	1	20
Jot Mahabat	245	268	17.15	18.76	25	26	0.5	0.52	17.65	19.28	35.4	283.2	0	0
Saora	4290	4697	300.3	328.8	429	445	8.58	8.89	308.9	337.7	35.4	283.2	1	20
Dumurpara	320	350	22.4	24.5	32	33	0.64	0.66	23.04	25.16	35.4	283.2	0	0
Rautara	380	416	26.6	29.12	38	39	0.76	0.79	27.36	29.91	35.4	283.2	0	0
Kulia	1632	1787	114.2	125.1	163	169	3.26	3.38	117.5	128.5	35.4	283.2	0	0
Dewan Chak	147	161	10.29	11.27	15	16	0.3	0.31	10.59	11.58	35.4	283.2	0	0
Kota	2753	3014	192.7	211	275	285	5.5	5.7	198.2	216.7	35.4	283.2	1	20
Goalpara	1152	1261	80.64	88.27	115	119	2.3	2.38	82.94	90.65	35.4	283.2	0	0
Belekusuma	2103	2303	147.2	161.2	210	218	4.2	4.35	151.4	165.6	35.4	283.2	1	20
Dakshin Balarampur	702	769	49.14	53.83	70	73	1.4	1.45	50.54	55.28	35.4	283.2	0	0
Amdoba	1224	1340	85.68	93.8	122	126	2.44	2.53	88.12	96.33	35.4	283.2	0	0
Muktarpur	1049	1149	73.43	80.43	105	109	2.1	2.18	75.53	82.61	35.4	283.2	0	0
	74664	**81751**	**5226**	**5723**	**7470**	**7743**	**149.4**	154.9	**5376**	**5877**	35.4	**15576**	**14**	**280**

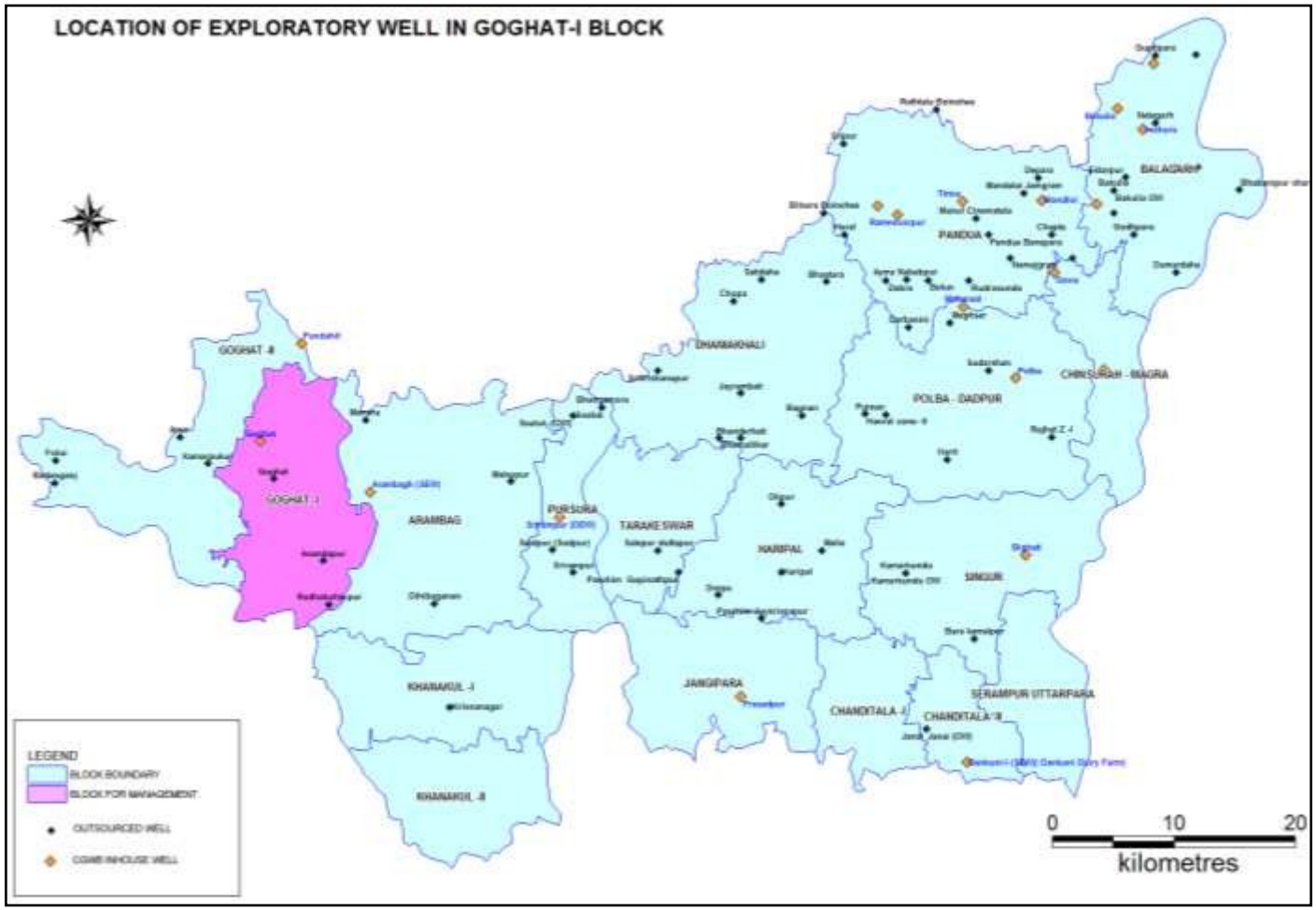

Figure 18.8 Location of Exploratory wells through outsourcing in Goghat-I Block

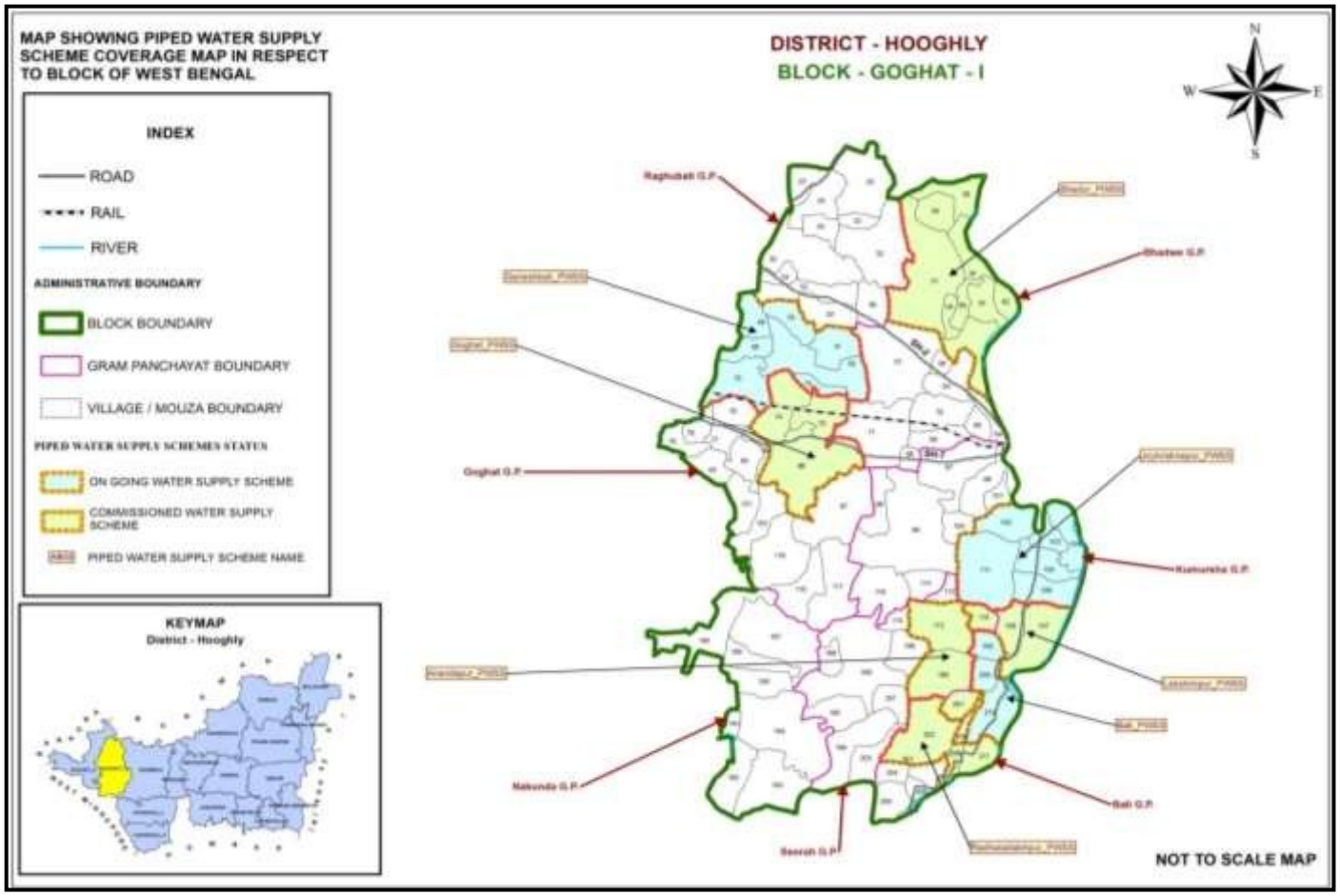

Figure 18.9 Drinking water supply scheme status in Goghat-I Block (Source-WBPHED) according to Census -2011

Management Plan for irrigation:

- Based on CGWB Resource data, block is under **Semi-Critical Category**. Stage of Ground Water development is 82.05 **%,** with declining long term Ground Water level Trend in both pre monsoon and post monsoon.
- As per **4th MI Census** irrigation data in this block number of Shallow Tube Wells are used more.
- Block is showing continuous declining trend of ground water levels. Surface water should be used more than Ground water.
- Artificial recharge is must in **Semi Critical** block.
- Application of modern technologies like Sprinkler, Drip irrigation, etc. are to be implemented; Also, fresh and arsenic bearing ground water in a suitable ratio may be blended and used for irrigation purpose in an experimental way.
- Regular monitoring of arsenic concentration in crop is also necessary.
- R & D study is necessary to get better solutions of water management in future.
- In **Goghat-I block,** as per existing soil and climatic condition, Boro Rice, Mustard, Wheat, Jute, potato and Til are suitable crops to grow.
- However, because of Semi Critical Category, area of Boro cultivation is proposed to be reduced.

Table 18.13 Cropping pattern in practice in the block

Name of block		Goghat-I
Aus	Area	1170
	Prod.	3.063
	Yield	2618
Aman	Area	12992
	Prod.	34.577
	Yield	2661
Boro	Area	5491
	Prod.	17.589
	Yield	3203
Mustard	Area	345
	Prod.	0.318
	Yield	922
Til	Area	2878

	Prod.	3.017
	Yield	1048
Potato	Area	4724
	Prod.	84.730
	Yield	17936

(Area in Ha, Production in Thousand MT and Yield in kg./Ha)

(Courtesy: Department of Economics and Statistics)

From Table 18.13, percentage wise crop covering area of block has been estimated and the same has been presented in Table 18.14

Table 18.14 Area wise percentage of current practice of crops in Goghat-I Block

Area wise Current Practice of crops								
Rabi Crops (Wheat, Mustard and oil seeds water Column requirement=0.21) Cultivation		Boro Cultivation (Water Column requirement-1.2 m)		Vegetable (water Column requirement Potato=0.6m)		Pulses(water Column requirement =0.11 m)		Total Area covered (ha)
%	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	
24	3223	41	5491	35	4724	0	0	13438

Based on data of Table 9.10.14, the factor of weighted average of water column has been estimated to be 0.8; so for irrigation of remaining cultivable area of 7110.26 Ha 5688.21 Ham water is required. Ground water resource estimation as on 2017 shows that only 886.71 Ham from top aquifer is available. Therefore, the remaining cultivable area could not be covered by irrigation for cultivation by available source.

Considering availability of area is more in comparison to water available, Boro Rice is not suggested for cultivation; also, area of cultivation of Boro should also be reduced. However, under present situation change in cropping pattern is also suggested in Table 18.15

Table 18.15 Future Water allocation for remaining cultivable area in block

Present water availability	Total water available for	Rabi Crops (Wheat, Mustard and oil seeds water Column	Boro Cultivation (Water Column	Vegetable (water Column requirement Potato=0.6m)	Pulses (water Column requirement =0.11 m)	Total Area covered (A)	Remaining Cultivable area (ha) (7110.26-A)

	future irrigation	requirement=0.21) Cultivation		requirement-1.2 m)							
		% of water	Area (ha)	% of water	Area (ha)	% of water	Area (ha)	% of water	Area (ha)		
886.71	886.71	30	1266.73	30	221.68	40	591.14	0	0	2079.55	5030.71
886.71	886.71	70	2955.7	0	0	30	443.36	0	0	3399.06	3711.21
886.71	886.71	100	4222.43	0	0	0	0	0	0	4222.43	2887.83

Data in Table-9.10.15 shows that even if total available water is used only for Rabi crops, then also a vast part (2887.83 Ha) of remaining cultivable area could not be irrigated. Therefore, for covering that part the only option left is use of surface run off component of rainfall, which is to be harvested by means of artificial recharge and conservation structures.

Table 18.16 Number of structures and Cultivable command area created by structure in Goghat-I Block

Block Name	Dug well		Shallow Tube well		Deep Tube well		Surface Flow		Surface Lift		CCA (ha.)		Total CCA (ha.)
	No.	CCA (ha.)	No.	CCA (ha.)	No.	CCA (ha.)	No.	CCA (ha.)	No.	CCA (ha.)	Ground Water	Surface Water	
GOGHAT-I	0	0	1091	4957.6	16	480	0	0	29	725.14	5437.6	725.14	6162.74

Table 18.17 Summary of irrigation plan in Goghat-I block

Block	Geographical area in ha	Cultivable area in ha	Net irrigated Command area (GW) in ha	Net irrigated Command area (SW) in ha	Net irrigated Command area (GW +SW) in ha	Net area available for Irrigation	GW available for Future irrigation (ham)	Pre monsoon Long Term WL Trend 2017 in cm/yr, if falling	Post monsoon Long Term WL Trend 2017 in cm/yr, if falling	Average Premonsoon WL in mbgl	Average Postmonsoon WL in mbgl	SOD in %	Category
Goghat-I	18641	13273	5437.6	725.14	6162.74	7110.26	886.71	Yes, 32.12	Yes, 60.32	18.34	13.19	82.05	Semi-Critical

Remarks summary of Irrigation management plan: To arrest the declining trend of water level, SW may be used more than Ground water.

Semi-Critical Block - special intervention

- It is necessary to increase the density of observation wells.
- The rainfall recharge during monsoon by water table fluctuation method could be estimated with greater accuracy.
- The trend of water table during pre- monsoon and post-monsoon intervals could be evaluated with greater accuracy.
- The trend of water table during pre- monsoon and post- monsoon intervals consequent to further groundwater development should be effectively monitored. Regular Water level monitoring is necessary.
- Rainwater harvesting is must in semi critical block.

Artificial Recharge & rainwater harvesting :

Table 18.18 Area suitable for recharge in the study area:

District	Block Name	Area (in ha)	**Area suitable for recharge (Considering area having DTW & more than 3m in post-monsoon and showing 0.2m/yr & more falling trend) (in ha)**
Hugli	**Goghat-I**	**18641**	**11220**

Table 18.19 Estimation of Surface runoff based on Land slope, soil characteristics, etc. (after Dhruvanarayana, 1993)

Block	**Major type of soil available in that block**	**Normal Monsoon Rainfall (m)**	**Total volume of surface runoff available Annually 'Vt' (RnXAXC) Ham**	**75% of 'Vt' = V**	**50% of V (Non committed) = Vnc**	**60% of Vnc (60 % of water to be harvested)= Vf**
Goghat-I	**Clay Loam/Silty Clay Loam**	**1.098**	**8187.13(Average Run off Coefficient – 0.40)**	**6140.35**	**3070.17**	**1842.10**

Table 18.20 Details of possible artificial recharge & conservation structures, and cost estimate

Row 1	Block Area in Ha	**18641**
Row 2	Area in Ha suitable for recharge	11220
Row 3	Soil type(3)	Sandy
Row 4	Amount of water to be harvested	1842.1
Row 5	Amount of water for artificial recharge of top aquifer and conservation (Ham) - 70 % of Row. 4 (5)	1289.47
Row 6	Source water allocation for for Irrigation Cum Recharge Pond -35% of Row 4 (6)	644.74
Row 7	Source water allocation for REET with recharge shaft -35% of Row 4 (7)	644.74
Row 8	Source water allocation for for injection well to recharge deeper aquifer -20% of Row 4 (8)	368.42
Row 9	Source water allocation for Farm Pond/Irrigation pond – 10 % of Row 4 (9)	184.21
Row 10	Nos. of Irrigation Cum Recharge Pond @ 50 Ham per unit (10)	13
Row 11	Nos. of REET with recharge shaft @ 10 Ham per unit	64
Row 12	Nos. of injection well suggested @ 30 Ham per unit (12)	6
Row 13	Nos. of Farm Pond @ 10 Ham per unit (12)	18
Row 14	Cost of Irrigation Cum Recharge Pond @ Rs 8 lakh per unit	104
Row 15	Cost of REET with recharge shaft @ Rs 8 lakh per unit	**512**
Row 16	Cost of injection well @ Rs 20 lakh per unit	**120**
Row 17	Cost of Farm Pond @ Rs 8 lakh per unit	**144**

Total Cost – 880 lakh; Irrigation Cum Recharge Tank & Injection well are suitable

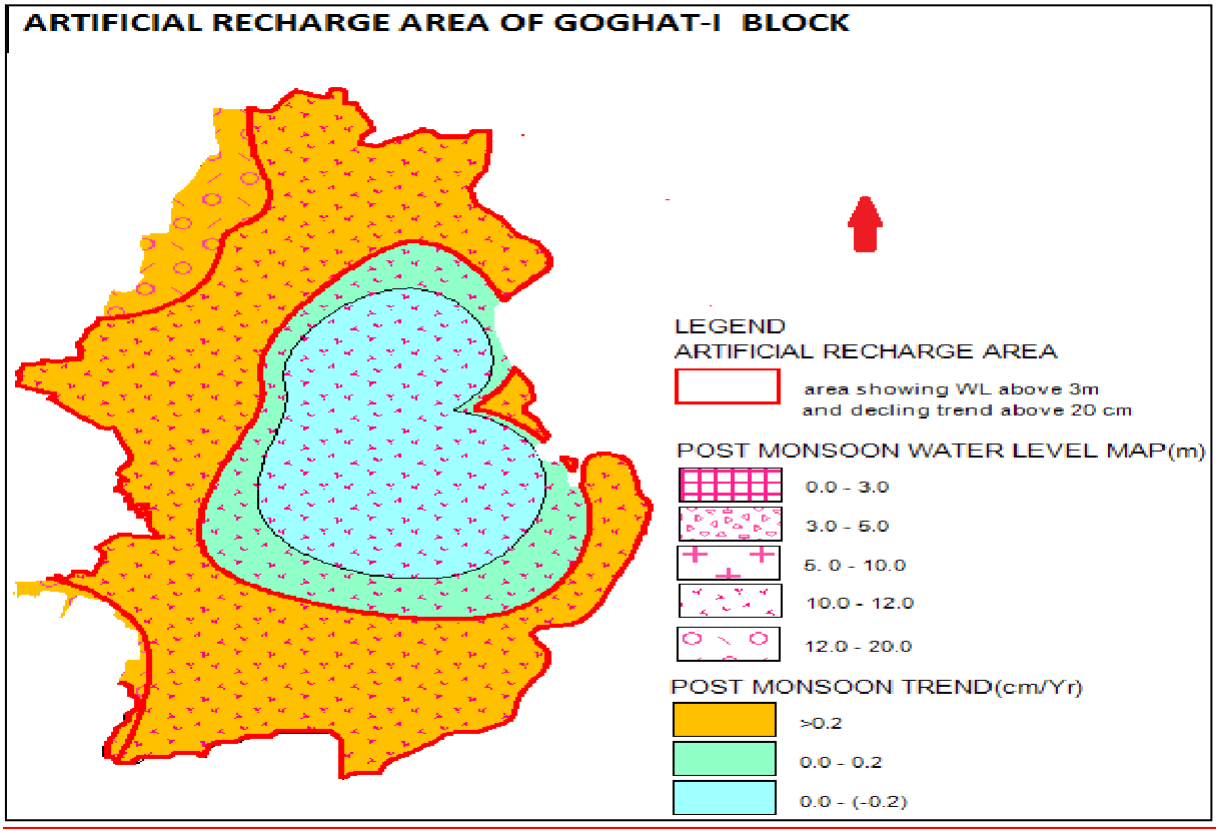

Figure 18.10 Map showing area suitable for artificial recharge in Goghat-I Block

19.0 GOGHAT-II BLOCK

19.1 Salient Information

- **Block Name: Goghat-II**
- **Area (in ha): 19003**
- **District: Hugli**
- **State: West Bengal**
- **Population (as on 2011):**

Table 19.1 Population in Goghat-II block

Rural	Urban	Total
160585		160585

- **Rainfall:** Average annual rainfall (**Hugli district**) for the period 2013 -17 (in mm):

  1336.96

Table 19.2 Annual Rainfall for last five years

Block	District Normal	Actual (Annual)				
		2013	**2014**	**2015**	**2016**	**2017**
Goghat-II	1362	1365.3	1114.4	1549.1	1218.6	1437.4

- **Agriculture & Irrigation (area in ha):**

Table 19.3 Land use pattern in block (Source-West Bengal Land use and Land cover Department)

Name of Block	Reporting area (Ha)	Area under non agriculture use (Ha)	Barren and uncultivable (Ha)	Total agricultural land (Ha)	Pasture (Ha)	Orchard (Ha)	Cultivable waste (Ha)	Fallow land other than Current Fallow (Ha)	Current Fallow (Ha)	Forest (Ha)	Net sown area (Ha)
Goghat II	37644	8912	68	27684	11	109	-	378	-	2	27302

19.2 Aquifer Wise Ground Water Resource Availability & Extraction:

Table 19.4 Aquifer wise resource availability and draft (in MCM) in Block

Resource Availability	Aquifer II Group	Aquifer III Group	Extraction

			(for Aquifer II Group)
Annual Extractable Ground Water Recharge/Dynamic Resource	72.4344	-	54.57
Static Resource	8.51		

Disposition of Aquifer: In **Goghat-II** Block, 2 Aquifer Groups are explored.

- The range of Aquifer Group II is 3.04m to 48.76m and this is part of Older Alluvium Formation. In Aquifer II Group, iron concentration in ground water is high.
- The range of Aquifer III Group is 100m to 301.73 m.; it is sub divided into two aquifers: III & IV: the range of aquifer III is 100m to 165m and aquifer IV is 176.78m to 301.73m. This Group is part of Tertiary Formation. In Aquifer III, ground water potentiality is low.

Table 19.5 Aquifer disposition (depth range) in block

Block	Depth range of Aquifer in mbgl	
Goghat-II	**Aquifer II**	**Aquifer III**
	aquifer II: 3.04-48.76	**aquifer III: 100-165** **aquifer IV: 176.78-301.73**

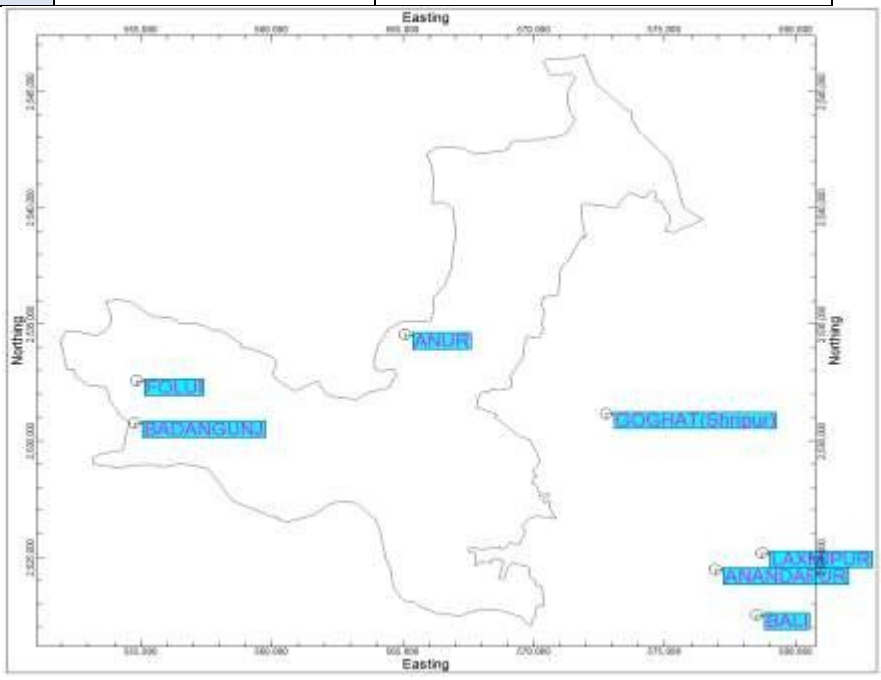

Figure 19.1 Index map of Goghat-II Block

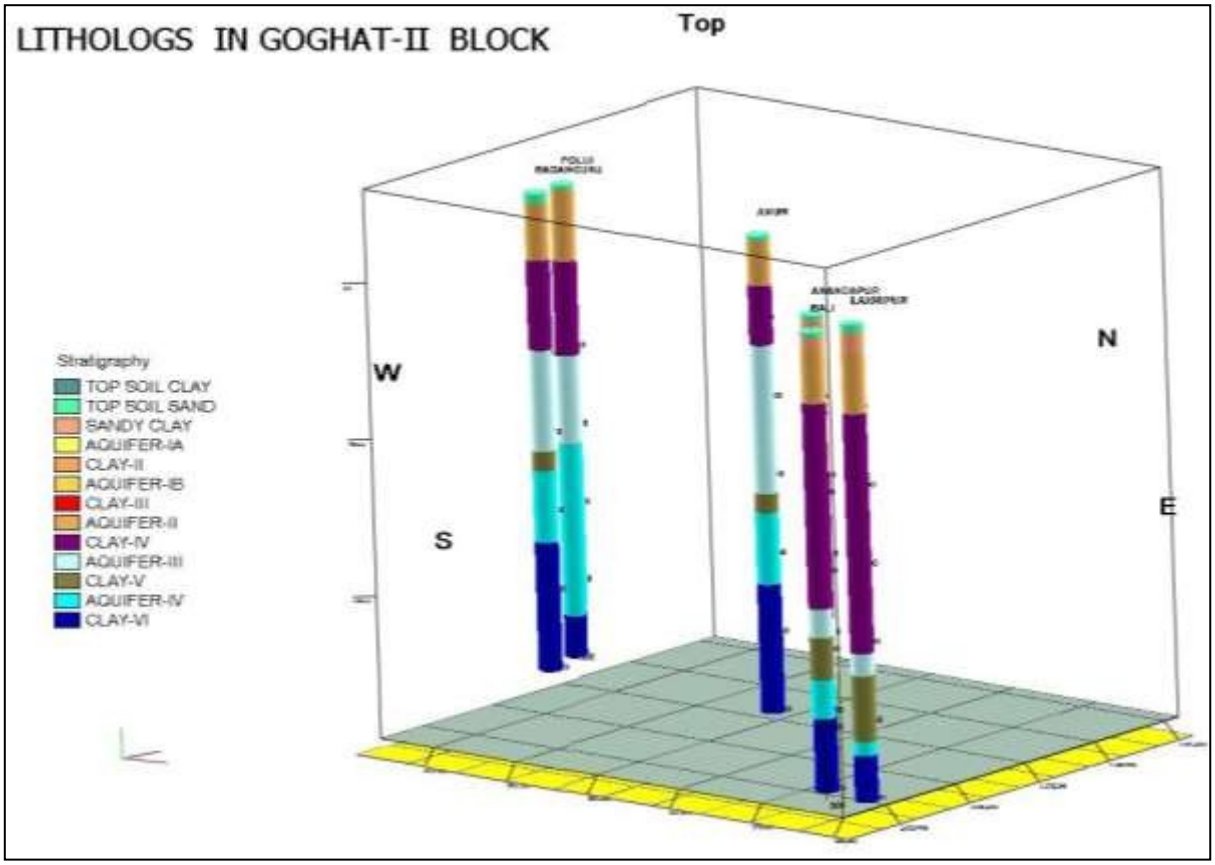

Figure 19.2 Lithologs in Goghat-II Block

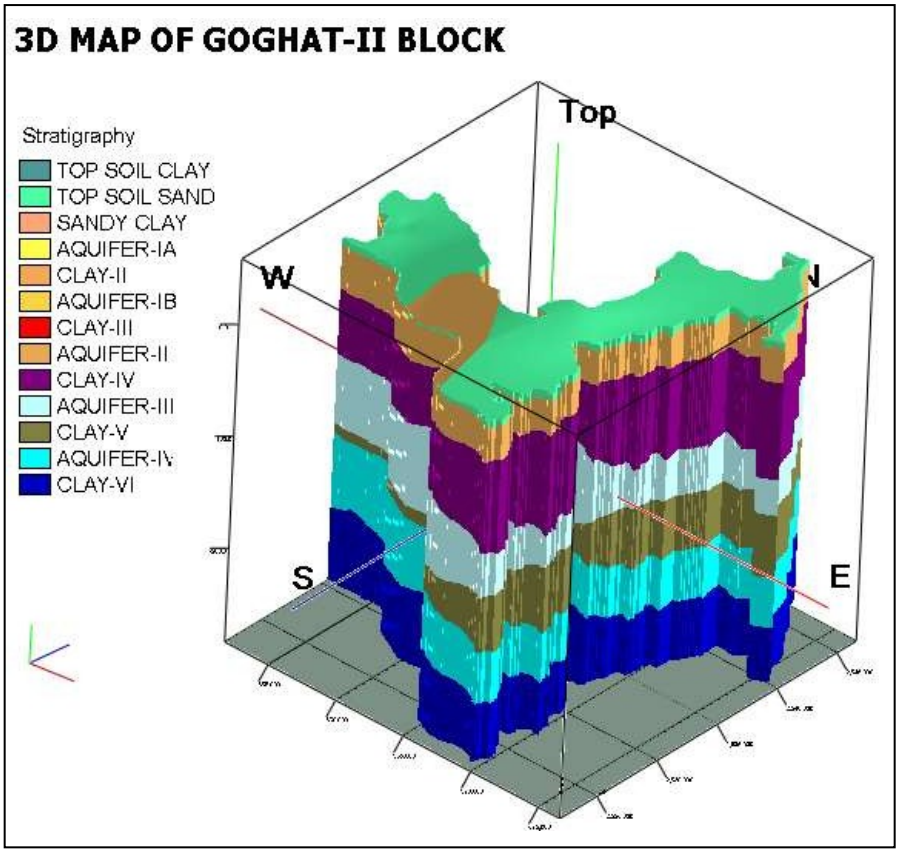

Figure 19.3 3D Aquifer disposition in Goghat II

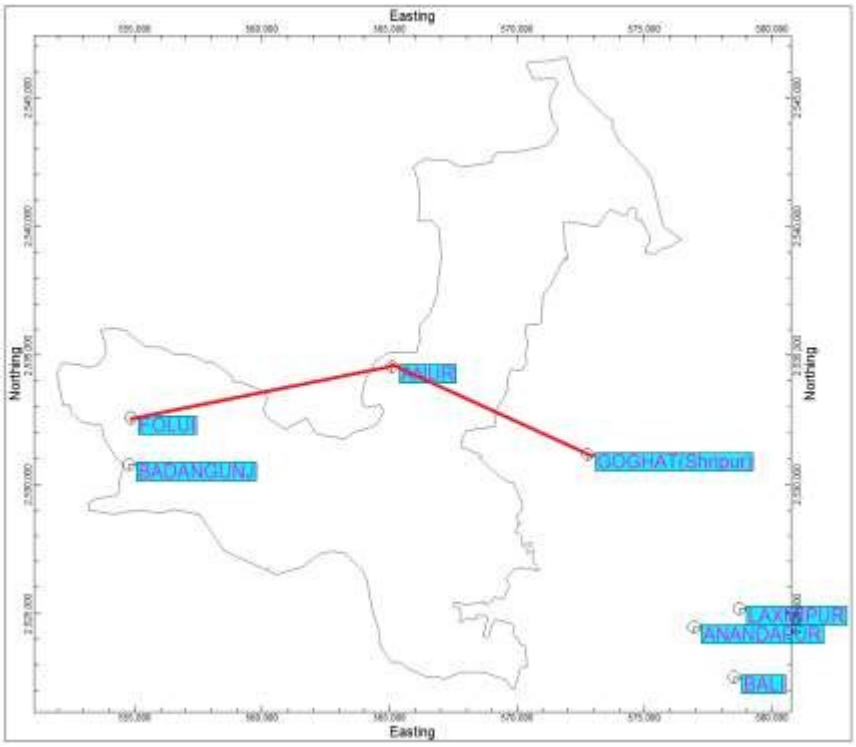

Figure 19.4 E - W Cross section Index Line in Goghat-II Block (northern part)

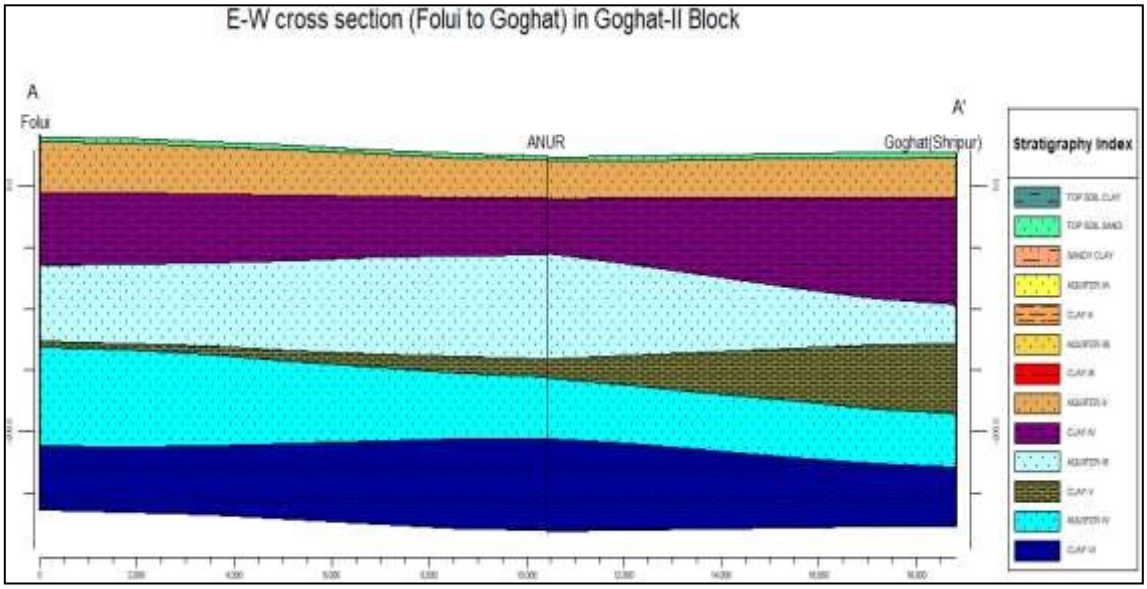

Figure 19.5 .: E-W cross section in Goghat II Block (northern part)

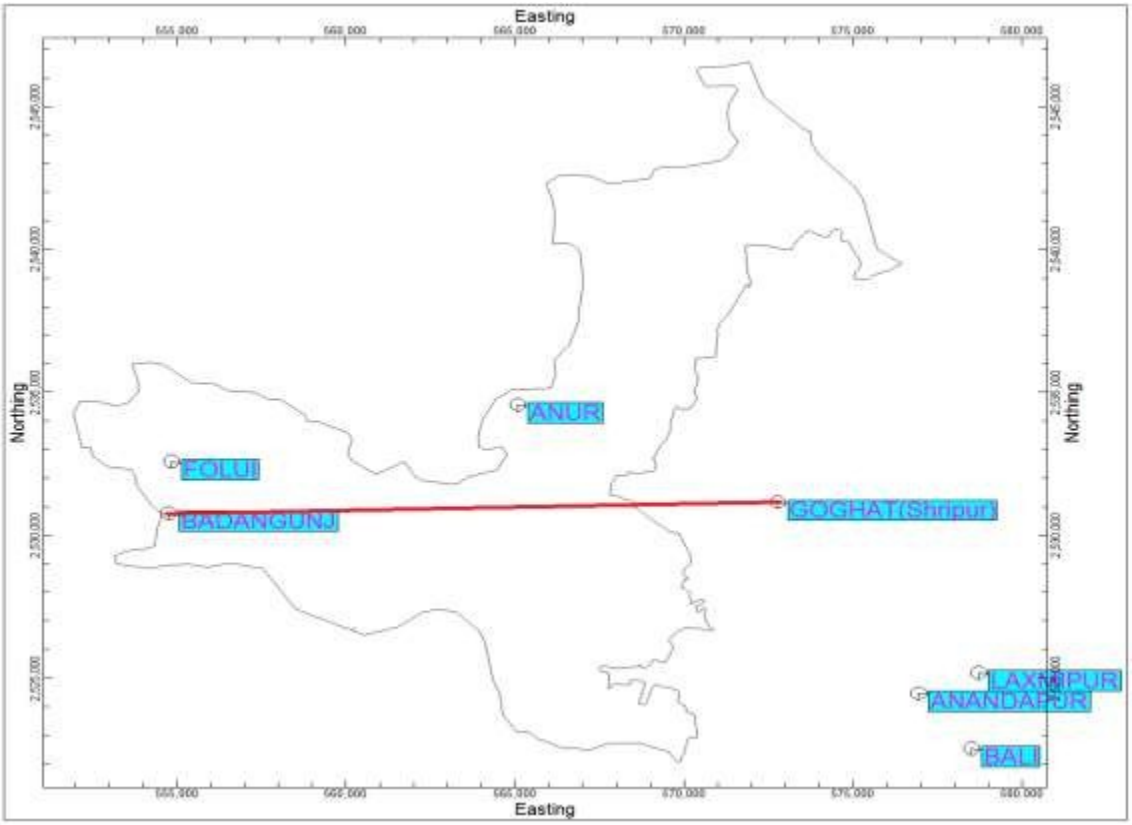

Figure 19.6 .: E - W cross section Index Line in Goghat II Block (southern part)

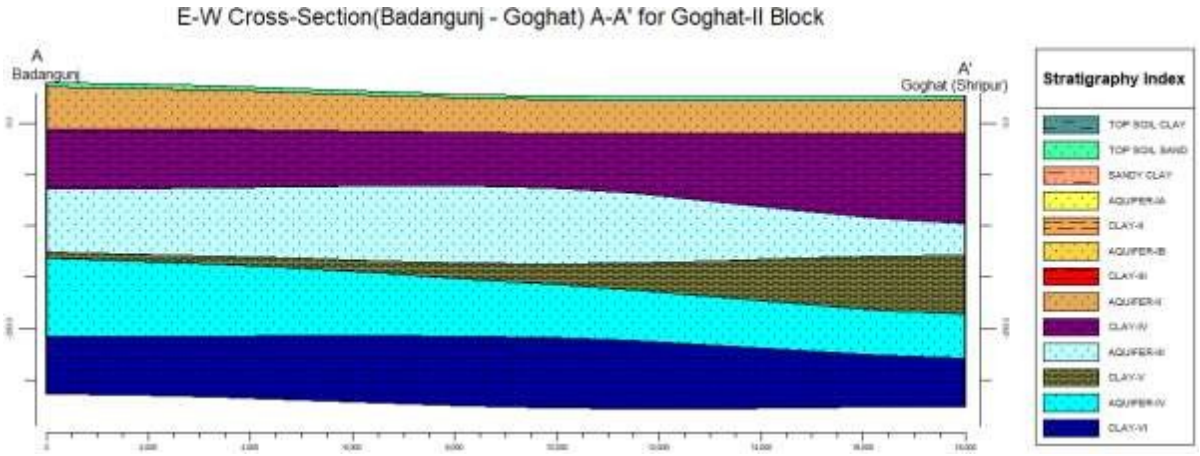

Figure 19.7 E-W cross section in Goghat II Block (southern part)

Table 19.6 Aquifer Wise Water Level Ranges & Seasonal long term water level trends (2006 to 2017)

Block	Aquifer Groups	Pre-monsoon Trend			Post-monsoon Trend		
		Water Level Range (mbgl)	Rise (cm/year)	Fall (cm/year)	Water Level Range (mbgl)	Rise (cm/year)	Fall (cm/year)
Goghat-II	**II**	**11.43-21.54**	-	32.88	**8.82-19.17**	-	65.32
Goghat-II	**III**	**21.3-19.65**	-	-	**12.59-19.65**	-	-

Table –9.11.7.: Aquifer wise maximum thickness

Block	Area (sq km)	Thickness of the Granular Zone in Aquifer II Group (m)	Thickness of the Granular Zone in Aquifer III Group (m)
Goghat-II	190.03	**aquifer II: 45.72**	**aquifer III: 65** **aquifer IV: 124.95**

Table 19.7 Aquifer-wise depth range and parameters (On the basis of CGWB exploration data)

Group	Sub Aquifer	Depth Range (mbgl)	Discharge (m^3/hr) with DD	T (m^2/day)	S	Specific capacity (m^3/day per m)
Aquifer Group II	II	**3.04 - 48.76**	**59.52 (DD- 6)**	**4768.59**	**2.85×10^{-3}**	**19.2**
Aquifer Group III	III	**100 - 165**	**35.2 (DD- 6.0)**	205	5.5×10^{-10}	5.87
	IV	**176.78 - 301.73**				

19.3 Ground Water Resource, Extraction, Contamination & Other Issues:

Aquifer Wise Resource Availability & Extraction: Dynamic ground water resources as on 31st March'17 in top aquifer

Table 19.8 Availability of Ground Water resource in Block (from top aquifer)

Block	Annual Extractable ground water Recharge (MCM)	Current Annual ground water Extraction (MCM)	Stage of ground water extraction (%)	Category	Annual Allocation of ground water for domestic use t 2042 (MCM)
Goghat-II	**72.4344**	**69.268**	**95.64**	**Critical**	**2.3891**

Static (in-storage) Resources: 8.51 MCM

19.4 Chemical Quality of Ground Water &Contamination:

- Based on Key well data and CGWB outsourced exploratory well data blocks wise Average data of chemical parameter is given below.

Table 19.9 Aquifer wise average chemical parameter of block

Aquifer	pH	EC (µs/cm)	TH	Ca	Mg	Na	K	HCO_3	Cl	NO_3	SO_4 (<5)	F (<1)	SiO_2 (<5)	TDS
II	8.1	387.3	137	26	17.50	24.74	2.49	162.87	37.93	0.304	7.34	0.077	16.72	232.45
III	7.8	414	151.17	31.67	17.76	19.81	2.30	185.12	17.55	0.95	3.67	0.19	16.69	223.17

19.5 Ground Water Resource Enhancement& Management Plan:

Ground Water Management Plan for drinking purposes-

- The block is under Critical Category and as per Ground Water Policy, first priority of use of water is for drinking purpose.
- Regular monitoring is necessary for ground water contamination by arsenic in tube wells.
- As per WBPHED Data, **112145** population in 83 villages are still uncovered by PWSS

Table 19.10 Still uncovered population by PWSS in Goghat-II Block

Block	Number of Villages to be covered by water supply schemes	Population in risk zone (as per Census 2011) to be covered by water supply schemes.	Comments on providing water supply to the risk population
Goghat-II	83	112145	**In Goghat- II block, Aquifer-III is productive (35.2 m^3/hr) only in Northern part (Aprrox.-50% area) of the block and Aquifer-II is highly productive (59.52 m^3/hr) in whole**

			part. A discharge of 47.36 m^3/hr for both Aquifers has been considered to work out number of wells required.

- Two wells constructed in Goghat-I Block, tapping Aquifer-III by outsourcing reveals discharge of 73.8 m^3/hr (described in aforesaid section).
- In Goghat-II block, Northern side of the block, in villages, eg. Badangunj, Anur and folui villages (shown in Fig-9.11.8.) three wells have been constructed by outsourcing tapping Aquifer-III by outsourcing, reveal discharge of 60 m^3/hr,21 m^3/hr & 24 m^3/hr respectively.
- In other Part of block, wells constructed tapping Aquifer-III, are not successful.
- From Table-9.11.12., it is found that 23 wells are required for supply of drinking water in still uncovered parts of Goghat-II Block; Status of PWSS so far done by PHED has been given in Fig- 9.11.9.
- For monitoring of the ground water regime, if observation well is needed then cost of construction of the same should also be included in the expenditure.
- Phase wise construction of wells should be done. Initially, 25 % of total wells formulated could be constructed; afterwards, the whole plan should be executed.
- After construction of wells, arsenic and heavy metals' concentration in ground water could be analyzed to know its potability.

Block wise Management plan in parts of Hugli District, West Bengal

A	**Village**
B	**Population 2011**
C	**Projected Population 2021 (decadal growth rate 9.49%)**
D	**Present Water Requirement for Human Population in m^3 @70 lpcd**
E	**Projected Water Requirement for Human Population in m^3 @70 lpcd**
F	**Cattle 2011**
G	**Projected Cattle 2021**
H	**Present Water Requirement for cattle m^3 @20lpcd**
I	**projected Water Requirement for cattle m^3 @20lpcd**
J	**Total Water Requirement/day as on 2011 in m^3**
K	**Total Water Requirement cubic m/day as on 2021 in m^3**
L	**Discharge (m3/hr)**
M	**Discharge of one TW in m^3/day after 8 hours of pumping**
N	**No of TW**
O	**Cost of Tube well of 300 m depth (approx.) 10”x6" dia @ Rs. 20 lakhs (In lakh) as per EFC**

Table 19.11 Estimation of village wise number of Tube wells required & and cost for construction in still uncovered parts of Goghat-II block

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
Samantakhanda	2973	3255	208.11	227.85	297	308	5.94	6.16	214.05	234.01	47.36	378.88	1	20
Gotai	771	844	53.97	59.08	77	80	1.54	1.6	55.51	60.68	47.36	378.88	0	0
Khatul	2643	2894	185.01	202.58	264	274	5.28	5.47	190.29	208.05	47.36	378.88	1	20
Agai	2090	2288	146.3	160.16	209	217	4.18	4.33	150.48	164.49	47.36	378.88	0	0
Narasinbati	1157	1267	80.99	88.69	116	120	2.32	2.4	83.31	91.09	47.36	378.88	0	0
Gauripur	459	503	32.13	35.21	46	48	0.92	0.95	33.05	36.16	47.36	378.88	0	0
Bhurkunda	2361	2585	165.27	180.95	236	245	4.72	4.89	169.99	185.84	47.36	378.88	0	0
Rayan	713	781	49.91	54.67	71	74	1.42	1.47	51.33	56.14	47.36	378.88	0	0
Jitarpur	131	143	9.17	10.01	13	13	0.26	0.27	9.43	10.28	47.36	378.88	0	0
Shalikona	1194	1307	83.58	91.49	119	123	2.38	2.47	85.96	93.96	47.36	378.88	0	0
Kamala	505	553	35.35	38.71	51	53	1.02	1.06	36.37	39.77	47.36	378.88	0	0
Punia	789	864	55.23	60.48	79	82	1.58	1.64	56.81	62.12	47.36	378.88	0	0
Ashpur	1548	1695	108.36	118.65	155	161	3.1	3.21	111.46	121.86	47.36	378.88	0	0
Paschim Chakla	594	650	41.58	45.5	59	61	1.18	1.22	42.76	46.72	47.36	378.88	0	0
Purba Chakla	357	391	24.99	27.37	36	37	0.72	0.75	25.71	28.12	47.36	378.88	0	0
Masidbera	467	511	32.69	35.77	47	49	0.94	0.97	33.63	36.74	47.36	378.88	0	0
Ambaula	484	530	33.88	37.1	48	50	0.96	1	34.84	38.1	47.36	378.88	0	0
Belun	344	377	24.08	26.39	34	35	0.68	0.7	24.76	27.09	47.36	378.88	0	0
Pundahit	1317	1442	92.19	100.94	132	137	2.64	2.74	94.83	103.68	47.36	378.88	0	0
Kumarganj	1171	1282	81.97	89.74	117	121	2.34	2.43	84.31	92.17	47.36	378.88	0	0

Block wise Management plan in parts of Hugli District, West Bengal

Kotai	1185	1297	82.95	90.79	119	123	2.38	2.47	85.33	93.26	47.36	378.88	0	0
Ria	851	932	59.57	65.24	85	88	1.7	1.76	61.27	67	47.36	378.88	0	0
Jharikhanda	439	481	30.73	33.67	44	46	0.88	0.91	31.61	34.58	47.36	378.88	0	0
Balitakunda	34	37	2.38	2.59	3	3	0.06	0.06	2.44	2.65	47.36	378.88	0	0
Idalbati	1980	2168	138.6	151.76	198	205	3.96	4.1	142.56	155.86	47.36	378.88	0	0
Naraharbati	190	208	13.3	14.56	19	20	0.38	0.39	13.68	14.95	47.36	378.88	0	0
Daulatbati	509	557	35.63	38.99	51	53	1.02	1.06	36.65	40.05	47.36	378.88	0	0
Senai	1195	1308	83.65	91.56	120	124	2.4	2.49	86.05	94.05	47.36	378.88	0	0
Jotchandi	1505	1648	105.35	115.36	151	157	3.02	3.13	108.37	118.49	47.36	378.88	0	0
Shaljhar	2079	2276	145.53	159.32	208	216	4.16	4.31	149.69	163.63	47.36	378.88	0	0
Bengai	4674	5118	327.18	358.26	467	484	9.34	9.68	336.52	367.94	47.36	378.88	1	20
Durgapur	1111	1216	77.77	85.12	111	115	2.22	2.3	79.99	87.42	47.36	378.88	0	0
Anur	3320	3635	232.4	254.45	332	344	6.64	6.88	239.04	261.33	47.36	378.88	1	20
Kapsit	197	216	13.79	15.12	20	21	0.4	0.41	14.19	15.53	47.36	378.88	0	0
Belepara	740	810	51.8	56.7	74	77	1.48	1.53	53.28	58.23	47.36	378.88	0	0
Tarui	640	701	44.8	49.07	64	66	1.28	1.33	46.08	50.4	47.36	378.88	0	0
Dashghara	1458	1596	102.06	111.72	146	151	2.92	3.03	104.98	114.75	47.36	378.88	0	0
Shripur	4727	5176	330.89	362.32	473	490	9.46	9.81	340.35	372.13	47.36	378.88	1	20
Kamarpukur	3121	3417	218.47	239.19	312	323	6.24	6.47	224.71	245.66	47.36	378.88	1	20
Indira	471	516	32.97	36.12	47	49	0.94	0.97	33.91	37.09	47.36	378.88	0	0
Raghunathpur	370	405	25.9	28.35	37	38	0.74	0.77	26.64	29.12	47.36	378.88	0	0
Pukhuria	1446	1583	101.22	110.81	145	150	2.9	3.01	104.12	113.82	47.36	378.88	0	0

Dwariapur	310	339	21.7	23.73	31	32	0.62	0.64	22.32	24.37	47.36	378.88	0	0
Satberia	1378	1509	96.46	105.63	138	143	2.76	2.86	99.22	108.49	47.36	378.88	0	0
Subir Chak	1079	1181	75.53	82.67	108	112	2.16	2.24	77.69	84.91	47.36	378.88	0	0
Gar Mandaran	6264	6858	438.48	480.06	626	649	12.52	12.98	451	493.04	47.36	378.88	1	20
Betbani	549	601	38.43	42.07	55	57	1.1	1.14	39.53	43.21	47.36	378.88	0	0
Naldubi	656	718	45.92	50.26	66	68	1.32	1.37	47.24	51.63	47.36	378.88	0	0
Kajla	192	210	13.44	14.7	19	20	0.38	0.39	13.82	15.09	47.36	378.88	0	0
Laluka	2497	2734	174.79	191.38	250	259	5	5.18	179.79	196.56	47.36	378.88	1	20
Rangamati	551	603	38.57	42.21	55	57	1.1	1.14	39.67	43.35	47.36	378.88	0	0
Arazi Kirttibaspur	77	84	5.39	5.88	8	8	0.16	0.17	5.55	6.05	47.36	378.88	0	0
Krittibaspur	371	406	25.97	28.42	37	38	0.74	0.77	26.71	29.19	47.36	378.88	0	0
Tarahat	3501	3833	245.07	268.31	350	363	7	7.26	252.07	275.57	47.36	378.88	1	20
Mulluk	737	807	51.59	56.49	74	77	1.48	1.53	53.07	58.02	47.36	378.88	0	0
Meherbanpur	198	217	13.86	15.19	20	21	0.4	0.41	14.26	15.6	47.36	378.88	0	0
Laskarpukur	1059	1159	74.13	81.13	106	110	2.12	2.2	76.25	83.33	47.36	378.88	0	0
Khejurbandi	535	586	37.45	41.02	54	56	1.08	1.12	38.53	42.14	47.36	378.88	0	0
Mamudpur	2109	2309	147.63	161.63	211	219	4.22	4.37	151.85	166	47.36	378.88	0	0
Pandugram	2290	2507	160.3	175.49	229	237	4.58	4.75	164.88	180.24	47.36	378.88	0	0
Beldiha	2185	2392	152.95	167.44	219	227	4.38	4.54	157.33	171.98	47.36	378.88	0	0
Andua	911	997	63.77	69.79	91	94	1.82	1.89	65.59	71.68	47.36	378.88	0	0
Krishnaganj	2321	2541	162.47	177.87	232	240	4.64	4.81	167.11	182.68	47.36	378.88	0	0

Block wise Management plan in parts of Hugli District, West Bengal

Sikil Beldiha	275	301	19.25	21.07	28	29	0.56	0.58	19.81	21.65	47.36	378.88	0	0
Bara Salabeltala	661	724	46.27	50.68	66	68	1.32	1.37	47.59	52.05	47.36	378.88	0	0
Selampur	4471	4895	312.97	342.65	447	463	8.94	9.27	321.91	351.92	47.36	378.88	1	20
Karnapur	344	377	24.08	26.39	34	35	0.68	0.7	24.76	27.09	47.36	378.88	0	0
Dharmmapur	239	262	16.73	18.34	24	25	0.48	0.5	17.21	18.84	47.36	378.88	0	0
Kuchedahari	288	315	20.16	22.05	29	30	0.58	0.6	20.74	22.65	47.36	378.88	0	0
Baburampur	807	884	56.49	61.88	81	84	1.62	1.68	58.11	63.56	47.36	378.88	0	0
Jharia	947	1037	66.29	72.59	95	98	1.9	1.97	68.19	74.56	47.36	378.88	0	0
Sundarpur	2505	2743	175.35	192.01	251	260	5.02	5.2	180.37	197.21	47.36	378.88	1	20
Shantipur	3768	4126	263.76	288.82	377	391	7.54	7.82	271.3	296.64	47.36	378.88	1	20
Anupnagar	1721	1884	120.47	131.88	172	178	3.44	3.57	123.91	135.45	47.36	378.88	0	0
Kultala	556	609	38.92	42.63	56	58	1.12	1.16	40.04	43.79	47.36	378.88	0	0
Gurulia Bhatsala	2064	2260	144.48	158.2	206	214	4.12	4.27	148.6	162.47	47.36	378.88	0	0
Paschim Para	2975	3257	208.25	227.99	298	309	5.96	6.18	214.21	234.17	47.36	378.88	1	20
Bhagabanpur	1149	1258	80.43	88.06	115	119	2.3	2.38	82.73	90.44	47.36	378.88	0	0
Sinrapur	1629	1784	114.03	124.88	163	169	3.26	3.38	117.29	128.26	47.36	378.88	0	0
Kantagarya	1049	1149	73.43	80.43	105	109	2.1	2.18	75.53	82.61	47.36	378.88	0	0
Kayrakhali	556	609	38.92	42.63	56	58	1.12	1.16	40.04	43.79	47.36	378.88	0	0
Uttar Sainte	1467	1606	102.69	112.42	147	152	2.94	3.05	105.63	115.47	47.36	378.88	0	0
Dakshin Sainte	594	650	41.58	45.5	59	61	1.18	1.22	42.76	46.72	47.36	378.88	0	0
	112145	122788	**7850.2**	**8595.2**	**11215**	**11625**	**224.3**	232.51	**8074.5**	**8827.7**	47.36	**378.88**	**23**	**460**

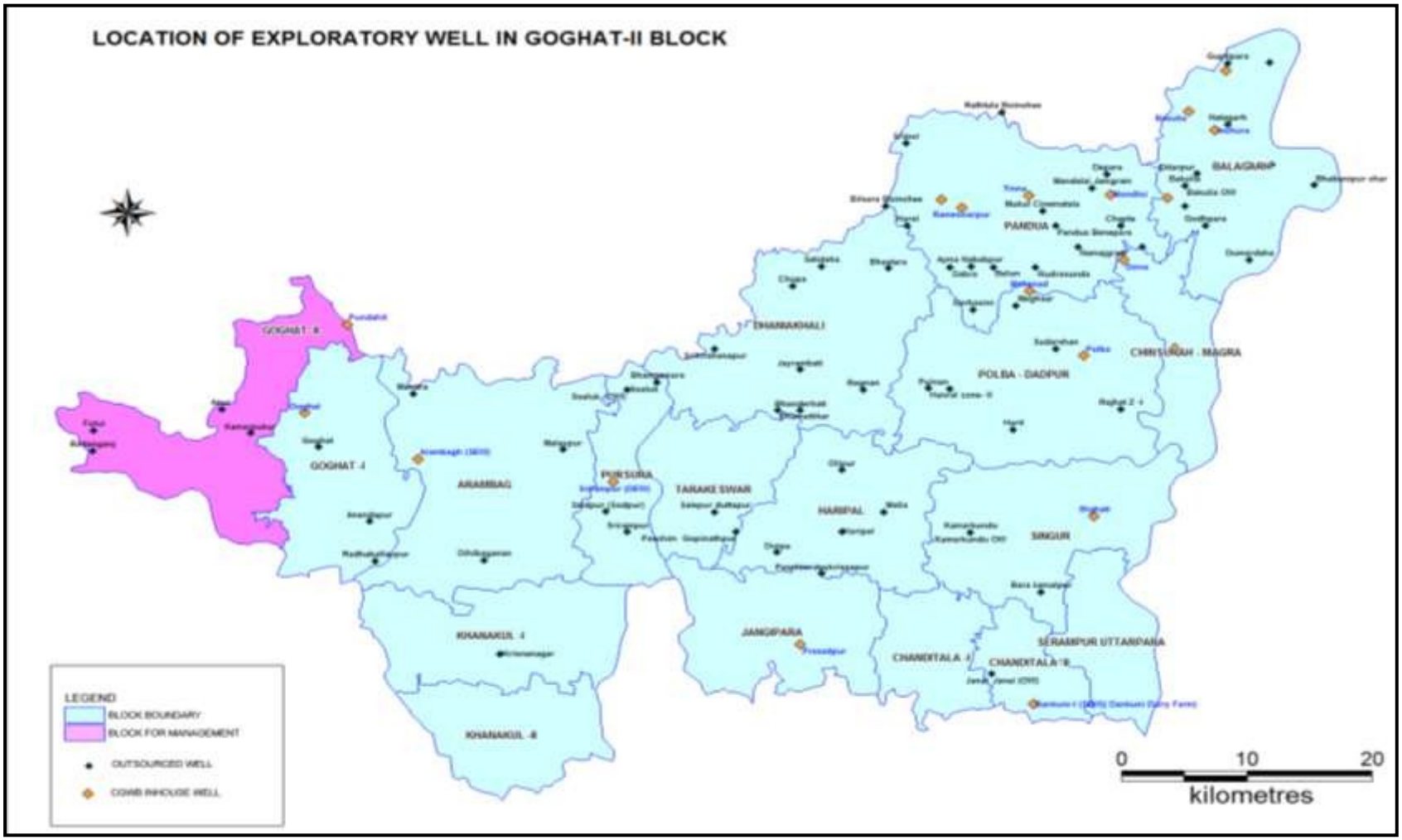

Figure 19.8 Location of Exploratory wells through outsourcing in Goghat-II Block

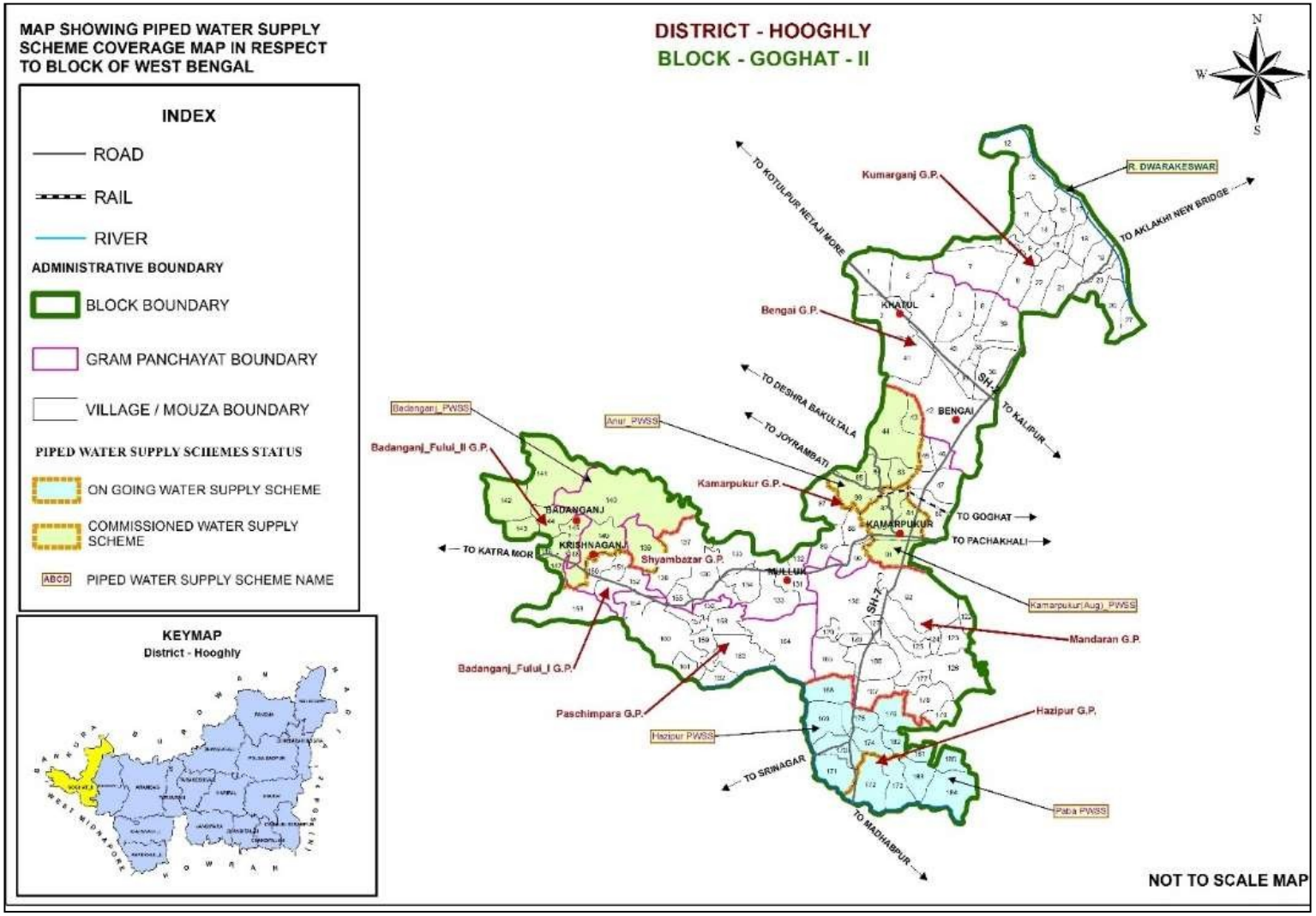

Figure 19.9 Drinking water supply scheme status in Goghat-II Block (Source-WBPHED) according to Census -2011

Management Plan for irrigation:

- Based on CGWB Resource data, block is under **Critical Category**. Stage of Ground Water development is 95.64 **%,** with declining long term ground water level trend in both seasons.
- As per **4th MI Census** irrigation data in this block number of Shallow Tube Wells are used more.
- Water level in the block is showing continuous declining trend so surface water irrigation (Ponds, Canals) should be done more than by Ground Water.
- Artificial recharge is must in **Critical** block.
- No irrigation is allowed in critical block. In this block, change in cropping pattern is an option along with use of surface water.
- Application of modern technologies like Sprinkler, Drip irrigation should be encouraged in a big way.
- Regular monitoring of arsenic concentration in crop is also necessary.
- R & D study is necessary to get better solution of water management in future.
- In **Goghat-II block,** as per soil and climatic condition, Boro Rice, Aman, Mustard, Wheat, Jute, potato and Til are suitable crops to grow.

Table 19.12 Cropping pattern under practice in Block

Name of Block		**Goghat-II**
Aus	Area	550
	Prod.	1.346
	Yield	2447
Aman	Area	32498
	Prod.	95.203
	Yield	2930
Boro	Area	4271
	Prod.	13.351
	Yield	3126

Wheat	Area	1
	Prod.	0.002
	Yield	2168
Mustard	Area	966
	Prod.	0.895
	Yield	927
Til	Area	4626
	Prod.	5.107
	Yield	1104
Potato	Area	3350
	Prod.	40.723
	Yield	12156

(Area in Ha, Production in Thousand MT and Yield in kg./Ha)

(Courtesy: Department of Economics and Statistics)

From Table 19.13 percentage wise crop covering area of block has been estimated and the same has been presented in Table 19.14

Table 19.13 Area wise percentage of crops under current practice, in Goghat-II Block

Area wise Current Practice of crops								
Rabi Crops (Wheat, Mustard and oil seeds water Column requirement=0.21) Cultivation		**Boro Cultivation (Water Column requirement-1.2 m)**		**Vegetable (water Column requirement Potato=0.6m)**		**Pulses (water Column requirement =0.11 m)**		**Total Area covered (ha)**
%	**Area (ha)**	**%**	**Area (ha)**	**%**	**Area (ha)**	**%**	**Area (ha)**	
42	5593	32	4271	25	3350	0	0	13214

Based on data of Table 19.14, the factor of weighted average of water column has been estimated to be 0.6; so, for irrigation of remaining cultivable area of 7893.38 Ha 4736.03 Ham

water is required. Ground water resource estimation as of 2017 shows that only 240.37 Ham, which is very less amount, from top aquifer is available. Therefore, the remaining cultivable area could not be covered by irrigation by aforesaid amount of water.

Table 19.14 Number of abstraction structures and CCA created in Goghat-II Block

Block Name	Dug well		Shallow Tube well		Deep Tube well		Surface Flow		Surface Lift		CCA (ha.)		Total CCA (ha.)
	No.	CCA (ha.)	No.	CCA (ha.)	No.	CCA (ha.)	No.	CCA (ha.)	No.	CCA (ha.)	Ground Water	Surface Water	
Goghat-II	0	0	1653	5662.12	16	490	0	0	32	365.5	6152.12	365.5	6517.62

Table 19.15 Summary of irrigation plan in Goghat-II block

Block		Goghat-II
Geographical area in ha		19003
Cultivable area in ha		14411
Net irrigated Command area (GW) in ha		6152.12
Net irrigated Command area (SW) in ha		365.5
Net irrigated Command area	**(GW +SW) in ha**	6517.62
Net area available for Irrigation		7893.38
GW available for Future irrigation (ham)		1298.15
Pre monsoon Long Term WL Trend 2017 in cm/yr, if falling		Yes, 27.81
Post monsoon Long Term WL Trend 2017 in cm/yr, if falling		Yes, 45.10
Average Pre monsoon WL in mbgl		17.4
Average Post monsoon WL in mbgl		14.34
SOD in %		95.64
Category		Critical

Block is under critical condition; further irrigation not allowed; change in cropping pattern suggested; To arrest the declining trend of water level, SW may be used more than ground water.

Special intervention for Critical Block

- The area may be sub-divided into different hydrogeological sub-areas, eg. recharge area, discharge area and transition zone and also on quality terms.
- The number of observation wells should be increased to represent each such sub areas with at least one observation well with continuous monitoring of water levels.
- Hydrological and hydrogeological parameters, eg. specific yield of individual sub area should have to be selected.
- Other parameters, eg. seepage from canals and other surface water bodies & projects should also be selected by field studies, etc. Base flow should be estimated based on stream gauge measurement.
- The data of number of existing structures and unit draft should be reassessed after fresh surveys and should match with the actual irrigation pattern in the sub-area.
- Ground water assessment for each sub-areas may be computed adopting the recommended methodology and using freshly selected values of different parameters.
- The assessment may be made separately for monsoon and non-monsoon periods as well as for command and non-command areas.
- The ground water potential so worked out may be cross-checked with behavior of ground water levels in the observation wells. If it does not, the factor that causes such an anomaly should be identified and the revised assessment should be made.

Rainwater harvesting & Artificial Recharge:

Table 19.16 Area suitable for recharge in the study area

District	Block Name	Area (in Ha)	Area suitable for recharge(Considering area having DTW more than 3m in Post-monsoon and showing 0.2m/yr & more falling trend)(in ha)
Hugli	**Goghat-II**	**19003**	**19003**

Table 19.17 Estimation of Surface runoff based on Land slope, soil characteristics, etc. (after Dhruvanarayana, 1993)

Block	Major type of soil available in that block	Normal Monsoon Rainfall (m)	Total volume of surface runoff available Annually 'Vt'(RnXAXC) Ham	75% of 'Vt' = V	50% of V (Non committed)= Vnc	60% of Vnc (60 % of water to be harvested)= Vf
Goghat-II	**Sandy Clay loam/Silty Clay loam**	**1.098**	**8118.08 (Average Run off Coefficient – 0.40)**	**6088.56**	**3044.28**	**1826.57**

On the basis of soil characteristic, Slope, Rain fall data and Long term trend number of structures are calculated and given below

Table 19.18 Details of possible artificial recharge & conservation structures in block

Total Cost – 1000 Lakh; Irrigation Cum Recharge Pond, Injection well are most suitable

Row 1	Block Area in Ha	**19003**
Row 2	Area in Ha suitable for recharge	19003
Row 3	Soil type(3)	Sandy
Row 4	Amount of water to be harvested	1826.57
Row 5	Amount of water for artificial recharge of top aquifer and conservation (Ham) - 70 % of Row. 4 (5)	1278.6
Row 6	Source water allocation for for Irrigation Cum Recharge Pond - 35% of Row 4 (6)	639.3
Row 7	Source water allocation for REET with recharge shaft -35% of Row 4 (7)	639.3
Row 8	Source water allocation for for injection well to recharge deeper aquifer -20% of Row 4 (8)	365.31
Row 9	Source water allocation for Farm Pond/Irrigation pond – 10 % of Row 4 (9)	182.66
Row 10	Nos. of Irrigation Cum Recharge Pond @ 50 Ham per unit (10)	13
Row 11	Nos. of REET with recharge shaft @ 10 Ham per unit	64
Row 12	Nos. of injection well suggested @ 30 Ham per unit (12)	12
Row 13	Nos. of Farm Pond @ 10 Ham per unit (12)	18
Row 14	Cost of Irrigation Cum Recharge Pond @ Rs 8 lakh per unit	104
Row 15	Cost of REET with recharge shaft @ Rs 8 lakh per unit	**512**
Row 16	Cost of injection well @ Rs 20 lakh per unit	**240**
Row 17	Cost of Farm Pond @ Rs 8 lakh per unit	**144**

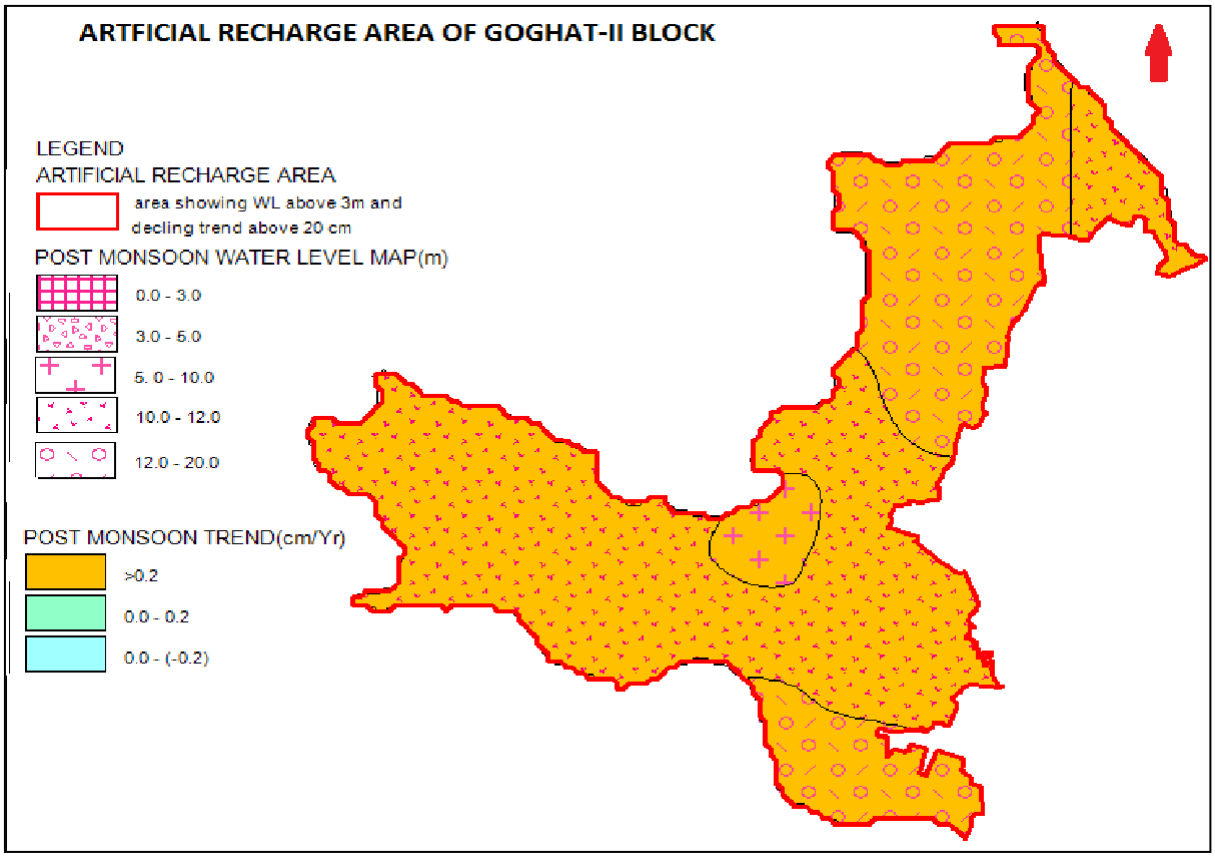

Figure 19.10 Map showing area suitable for artificial recharge in Goghat-II Block