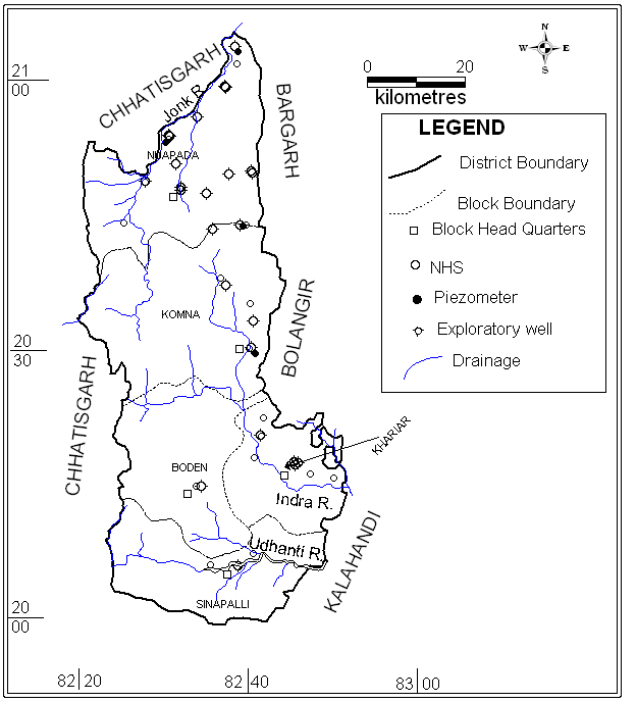
GROUND WATER INFORMATION BOOKLET

NUAPADA DISTRICT, ORISSA

Plate :- 1

INDEX MAP OF NAWAPADA DISTRICT, ORISSA



Ministry of Water Resources
Central Ground Water Board,SER
Bhubaneswar
May, 2013

DISTRICT AT A GLANCE

Sl No	ITEMS	Statistics
1.	**GENERAL INFORMATION**	
	i. Geographical Area (Sq. Km.)	3852
	ii. Administrative Divisions as on 31.03.2007	
	Number of Tehsil / Block	2 Tehsils, 5 Blocks
	Number of Panchayat / Villages	109 Panchayats 663 Villages
	iii Population (As on 2011 Census)	606,490
	iv Average Annual Rainfall (mm)	1378.2
2.	**GEOMORPHOLOGY**	
	Major physiographic units	Gently undulating terrain, Isolated Mounds & Hills
	Major Drainages	Indra, Udanti, Hatti, Sagada, Jonk
3.	**LAND USE (Sq. Km.)**	
	a) Forest Area	318.07
	b) Net Sown Area	1295.38
	c) Cultivable Area	1891.70
4.	**MAJOR SOIL TYPES**	Vertisols, Alfisols
5.	**AREA UNDER PRINCIPAL CROPS (As on 31.03.2011)**	Paddy 4067 Ha, Cereals 1082 Ha Pulses etc. 13,169 Ha
6.	**IRRIGATION BY DIFFERENT SOURCES (Areas and Number of Structures)**	
	Dugwells, Tube wells / Borewells	8354 nos
	Medium Irrigation Projects	14,755 Ha (Kharif)4630 Ha (Rabi)
	Minor Irrigation Projects	6175 Ha (Kharif)1011 Ha (Rabi)
	Minor Irrigation Projects(Lift)	1840 Ha (Kharif)1396 Ha (Rabi)
7.	**NUMBERS OF GROUND WATER MONITORING WELLS OF CGWB (As on 31-3-2011)**	
	No of Dugwells	19
	No of Piezometers	4
10.	**PREDOMINANT GEOLOGICAL FORMATIONS**	Granites, Granite Gneiss & its variants, Khondalite, Shale, Sandstone, Limestone.
11.	**HYDROGEOLOGY**	
	Major Water bearing formation	Granites, Granite Gneiss
	Pre-monsoon Depth to water level during 2011	3.25 - 12.64mbgl
	Post-monsoon Depth to water level during 2011	0.83 - 5.38 mbgl
	Long term water level trend in 10 yrs (2001-2011) in m/yr	Pre-monsoon 63.6% show rising and 36.4% show declining trend. Post-monsoon84.6% show rising and 15.4% show declining trend
12.	**GROUND WATER EXPLORATION BY CGWB**	

Sl No	ITEMS	Statistics
	(As on 31-03-2007)	
	No of wells drilled(EW, OW, PZ, SH, Total)	45,8,4, Total- 57
	Depth Range (m)	50-200.2
	Discharge (litres per second)	0.5-20
	Transmissivity (m^2/day)	1.0 to 34.1
13.	**GROUND WATER QUALITY**	
	Presence of Chemical constituents more than permissible limit (e.g. EC, F, As, Fe)	F is present above the permissible limit of 1.5 mg/l which causes fluorosis problem.
	Type of Water	Ca + (Na +K) – HCO_3 in shallow aquifer. Ca + Mg– HCO_3 + (Cl + NO_3) in deeper aquifer.
14.	**DYNAMIC GROUND WATER RESOURCES(2009) – in Ham**	
	Annual Replenishable Ground Water Resources	33686.00
	Net Annual Ground Water Draft	6441.00
	Projected Demand for Domestic and Industrial Uses upto 2025	3262.00
	Stage of Ground Water Development	19.12%
15.	**AWARENESS AND TRAINING ACTIVITY**	
	Mass Awareness Programmes organized	Nil
	Date	-
	Place	-
	No of Participants	-
	Water Management Training Programmes organized	Nil
	Date	-
	Place	-
	No of Participants	-
16.	**EFFORTS OF ARTIFICIAL RECHARGE & RAIN WATER HARVESTING**	
	Projects completed by CGWB (No & Amount spent)	Nil
	Projects under technical guidance of CGWB (Numbers)	Nil
17.	**GROUND WATER CONTROL AND REGULATION**	
	Number of OE Blocks	Nil
	No of Critical Blocks	Nil
	No of Blocks notified	Nil
18.	**MAJOR GROUND WATER PROBLEMS AND ISSUES**	Fluorosis problem is prevalent in the district.

1.0 INTRODUCTION

Nawapada one of the economically backward district of western Orissa with a geographical area of 3852 sq. km is an integral part of Western Orissa Development Council constituted by Govt. of Orissa and very often reels under severe drought condition. About 93 percent of the population of the district live in rural areas and agriculture is the main stay of the people. The agriculture is mostly rainfed and due to lack of adequate irrigation facilities and recurring severe drought conditions in the district, the agricultural production is very often curtailed. Severe drought occurred in the year 1974, 1996, 2000 and 2002. Nawapada district lies between North latitudes 21°0' and 21° 06' and East longitude 82° 19' and 82°60', falling in Survey of India toposheet nos. 64K, 64L. It is bounded on the north by Raipur district of Chhatishgarh; on the east by Bargarh and Bolangir districts, on the south by Kalahandi districts, and on the west by Chhatisgarh. The district has only one subdivision. There are 5 community development blocks in the district.The district is well connected by rail and roads. The Nawapada railway station falls on Bhubaneshwar- Raipur broad gauge railway tracts. All the block headquarters are connected by metalled roads. The district comprises only one subdivision and 5 Community Development Blocks with the district headquarters at Nawapada (Plate-1). According to 2001 census data, the total population of the district is 5,30,690 constituting 1.44 % of the total population and 2.47% of total land area of Orissa. The rural and urban populations are 5,00,652 and 30,038 respectively. The density of population is 138 against the state figure of 236 persons per sq. km.

The drainage of the district is controlled by the tributaries of the Mahanadi river, like the Tel and Ong rivers. The main tributaries of the Tel are Indra, Udanti, Hatti, Sagada etc. which are perennial and effluent in nature and maintain sluggish flow during peak summer months. The Jonk river is a tributary of the river Mahanadi, flows in the westerly direction and forms the state border in the northwest. The general drainage pattern in the undulating terrain is dendritic to sub-dendritic. More or less sub-parallel drainage is observed in the western part comprising Chattisgarh group of rocks, near foothill regions. Studies on satellite imageries and hydrogeological surveys have revealed that the drainage pattern in the district is controlled by the fracture system which is developed due to tectonic activity in the area.

Nawapada district has varied agro-climatic conditions. Though rainfall in the district is moderately high but the irrigation facilities are inadequate. Only 9% of the cultivable area is irrigated. The total cultivable land in the district is 189170 Ha. The Lower Indra is a Medium Irrigation Project, which caters to flow irrigation. There are mainly two crop seasons, Kharif and Rabi. The Kharif crops are Paddy, Maize, Cereal and Pulses etc. The Rabi crops are Paddy, Wheat, Maize, Pulses, Oilseed, and Vegetables etc. Paddy is the principal crop of the district and is cultivated in 49929 Ha in Kharif and 3793 Ha in Rabi-2006.

Systematic geological mapping of the district has been completed by the officers of Geological Survey of India. The entire district has been covered by systematic hydrogeological survey by S/Shri B.B. Basak, P.K. Das, Scientist

'B'during the field seasons1976-77, 77-78, 80-81, Shri S.Suresh, Scientist'B' of Central Ground Water Board during the period 1989 – 1990.The district has further been covered through reappraisal surveys by S/Shri. P.K.Naik (2005-06), of CGWB, SER on 1:50,000 scale. The district report on hydrogeological framework and groundwater development prospects in Nawapada District, Orissa was prepared by Sh. P.K. Mohapatra, Scientist 'D' and Sumita Sarkar, Asst. Hydrogeologist, on July, 2007.

Ground water exploration by deep drilling upto 200m has been taken up in the district and 25nos. exploratory wells so far has been drilled to delineate the deeper potential water saturated fracture zones. The location of the wells are depicted in Plate –I Ground water monitoring is being done through 19 hydrograph network stations four times in a year.

2.0 RAINFALL & CLIMATE

The south-west monsoon is the principal source of rainfall in the district. Average annual rainfall of the district is 1378.2 mm. About 75% of the total rainfall is received during the period from June-September. Droughts are quite common in the district. As the district falls in the rain shadow region the rainfall is very erratic. Analysis of 40 years of rainfall data from 1966 to 2006 reveals that the rainfall is uneven with maximum rainfall (1663mm) in 1990 and minimum (612mm) in1974.

The climate of the district is subtropical with hot and dry summer and pleasant winter. The summer season extends from March to middle of June followed by the rainy season from June to September. The winter season extends from November till the end of February. Humidity is high during middle of June and it's less in post-monsoon period. The potential evapo-transpiration values varies from 3.62 cm to 23.74 cm. Wind is generally light to moderate. During summer and southwest monsoon months wind velocity increases.

3.0 GEOMORPHOLOGY & SOIL TYPES

The study area presents conspicuous geomorphic variations comprising moderately high hills, isolated hillocks, undulating plains, intermontane valleys etc. The hilly tract lying to the west ranges in elevation from 610 to 915 m. amsl. with an average elevation being 700m. amsl. They are represented by structural hills, denudational hills, ridges, narrow intermontane valleys and escarpment. Denudational hills or residual hills occur in the eastern and south eastern part of the study area. Lateritic uplands are met within the border areas of hills. Also, the undulating terrain which varies in altitudes from 350 to 240m above mean sea level and occurs bordering the hilly tract has dissected patches of inselbergs and residual hills. The various hydrogeomorphological units are flood plains, deep buried pediplains, moderately buried pediplains, shallow buried pediplains, pediment inselberg complex, pediment, intermontane valleys, linear ridges, residual hills, denudational hills and structural hills.

The distribution of different soil types in the district depends much on its physiographic and lithologic variations. Based on the physical and chemical characteristics, mode of origin and occurrence, soils of the district may be classified into three groups namely Alfisols, Ultisols and Vertisols.

Alfisols :

(i) Red soil (Sandy): This is the most predominant soil mixed with lateritic nodules. Lateritic soil profile varying from 2- 15 meters containing hard ferruginous concretions form the duricrust. This soil is porous and acidic in nature and poor in organic matter.
These occupy comparatively lower elevations especially valley fills and are composed of clay mixed with sand and Kanker nodules.

(ii) Red and Black soil (loamy) : These are are fertile which supports luxuriant plant growth.

Vertisols :

(i) Black soil: Black soils are found in localized pockets in in Khariar tehsil. It is rich in potassium and nitrogen but poor in phosphorous.

4.0 GROUNDWATER SCENARIO

4.1 Hydrogeology

The hydrogeological framework of the district is mainly controlled by the geological set up, rainfall distribution and the degree of secondary and primary porosities in the geological formations for storage and movement of ground water. Since major parts of the district are underlain by hard rocks of diverse lithological composition and structure, the water bearing properties of the formations also vary to a great extent. The area has undergone several phases of intense tectonic deformations which has been responsible for the development of deep seated intersecting fracture system. Hydrogeological surveys in the district reveals the lithological characteristics and the role of tectonic deformation on the occurrence and distribution of ground water reservoirs and their water bearing and water yielding properties. The district is located at the boundary between the Eastern Ghat Mobile Belt and Bastar Craton which is faulted and represents a first order lineament. Lineaments formed due to tensile deformation were picked up from remote sensing studies. The structural elements mainly control the occurrence and movement of groundwater in the typical fractured crystalline basement terrain. The major hydrogeologic units in the district can be subdivided into two broad groups.

(i) Areas underlain by fractured, fissured and consolidated basement rock formations.

(ii) Areas underlain by recent unconsolidated alluvial formations.

Water bearing properties of the Consolidated formations :

The crystalline rocks like granite gneisses, charnockites, khondalites, quartzites and anorthosites and amphibolites, which are devoid of primary porosity, occupy about 95% of the area of the district. The weathered residuum and jointed & fractured portion of these consolidated rocks constitute principal water bearing

horizons. The thickness of the weathered zone is generally more in the topographic lows and undulating plains than in the high land areas. Ground water occurs under phreatic condition in the weathered zone and in semi-confined to confined condition in deeper fractured zones. The water yielding capacity of fractured rocks largely depends on the extent of fracturing, openness and size of fracture and nature of their inter connections. Usually two to four water bearing fractures occur down to a depth of 100m below ground level. Potential fracture zone is encountered even at depth of 163 m at Sarabong (Block-Nawapada).

Granites and Granite Gneisses:

These are the most predominant rock types occurring in the undulating plains and topographic lows. Depending upon the topographic set up, the depth of weathering ranges from 8.6m to 25.6m and occasionally extends up to 30.4m depth at Parkod. The weathered residuum and fracture zones form principal aquifers. In deeper fracture zones ground water occurs under semi-confined to confined conditions. In general the deep bore wells in these rocks can sustain yield of 05 to 20 LPS depending upon topographic setting, proximity to the major lineaments, thickness of weathered residuum and number of saturated and interconnected fractures encountered. The granites and granite gneisses can be developed through open wells and borewells. High yielding wells are recorded in the southern parts of the district where the discharge ranges from 1.2 to 12.93 LPS. Transmissivity values of borewells varies from 1.0 to 34.1 m^2/day. Specific capacity of the bore wells ranges from 3.23 to 42.35 LPM/M drawdown . Specific capacity of the dug wells tapping the weathered zone ranges from 4.2 to 30 LPM/M drawdown.

Khondalites: Khondalites usually occupy hills and forest area, and have meagre groundwater development potentials. Due to highly foliated nature of these rocks the depth of weathered zone is high. Khondalites are also well jointed and in general the thickness of weathered zone ranges from 12 to 25m. The depth of the open wells varies from 9.3 – 11.5mbgl. The yield of open well in low-lying areas is less than 2lps.

Charnockites: The formation occurs as minor patches in the extreme southern part of the district. These rocks are sometimes jointed but not very extensive. Because of hard and compact nature of these formations it do not form good aquifers. Weathering is not generally pronounced and thickness of weathered zone varies from 6 – 10 m.

Amphibolites and Anorthosites : These occur as discontinuous lenses in the country rocks and are moderately weathered and jointed. Open wells in amphibolites yield upto 3lps, while the yield of wells in anorthosite is less than 2lps.

Quartzites: The quartzites are hard compact and resistant to weathering. The depth of the wells varies from 7 - 11 mbgl. The yield of open wells is generally less than 2 lps.

Shale: The shales are hard and highly fractured. The depth of weathering ranges from 5 to 10 mbgl. The depth of the wells varies from 7.9 to 8.1 mbgl. The yield of the open wells is generally less than 2lps.

Unconsolidated formation: Laterites and alluvium constitute the unconsolidated formations. Laterites occur in isolated patches as capping over the older formation and are usually porous in nature forming good shallow aquifers which are developed through open wells. The yield of the open wells ranges upto 5lps.

Alluvium occurs as small discontinuous patches along the course of major stream. The maximum thickness is around 10 –12m. The depth to water level during pre-monsoon varies from 1.9 to 6.1m. The average seasonal fluctuation is within 2.0 m. The yield of the open wells is generally around 5lps. Specific capacity of the dug wells is 21 LPM/M drawdown.

Aquifer Characteristics of Crystalline: In the hard crystalline rock recharge of ground water from precipitation or seepage from surface water bodies percolate into the weathered (saprolite) zone. In case the underlying basement rocks (both weathered and fresh) are incised by open fractures, the downward movement of the water from the upper regolith zone (comprising the top soil and saprolite horizon) is facilitated. In the saprolite/regolith horizon ground water generally occurs under unconfined condition where as in the fractured bedrock aquifers it occurs under semi-confined to confined conditions. The ground water potentials of various zones i.e. saprolite (tapped by dug wells), weathered basement rock and shallow fractured basement rock horizon (tapped by the hand pumps) and deeper fractured basement rock (tapped by the deep boreholes by CGWB) vary considerably depending upon their lithological and structural characteristics. A total of 7 pumping tests were conducted in dug wells tapping the saprolite horizons of various rock formations. The various aquifer parameters were derived following methods given by Slichter (1906) and Hvorslev (1951). Perusal of all result indicates that granite gneiss forms the most potential aquifer both in shallow and deeper horizons followed by alluvium, khondalite and charnockite. Anorthosites are poor water yielder in deeper horizons where as in the weathered horizon some considerable amount of yield may be obtained from the anorthosites.

4.2 Groundwater Exploration

Exploratory drilling has been taken up by the Central Ground Water Board in Nawapada district with the objective to delineate deeper water bearing fractures in the consolidated formation and their yield potentiality within a maximum depth of 200.2m. Till March 2007, 25 exploratory and 4 observation wells were drilled in hard crystalline formations in the district under Normal Ground Water Exploration

Programme and Accelerated Exploration Drilling Programme. The depth range of these wells varies from 50m to 200.2m below ground level. The thickness of the overburden ranges from 8.6 to 30.4m. The yield of exploratory wells vary from 0.5 to 20 LPS. Formation wise yield range of the wells is given in the table 4.1.

Table 4.1 Details of Exploration (Lithounit wise)

Sl.	Lithological Unit	No. of Wells	Depth range of wells (mbgl)	No. of wells with yield (LPS)		
				<2	2-5	>5
1.	Granite and granite gneisses	28	50 - 200.2	11	9	8
2.	Quartzite	1	138.2	-	-	1

Depth to Water Level (Pre-monsoon and Post-monsoon, 2011)

The depth to water level is measured from the National Hydrograph Staions situated in different blocks of the Nawapada district. The pre- monsoon, 2011 water level data varies from 3.25 mbgl (Boden) to 12.64 mbgl (Lakhna). The depth to water level map of pre -monsoon, 2011 is displayed in Plate II.

The depth to water level data of Post-monsoon, 2011 represents 0.83 mbgl (Boden) to 5.38 mbgl (Lakhna). Plate III represents depth to water level map of post –monsoon,2011.

Seasonal Fluctuation

The fluctuation of depth to water level in 2011 between pre-monsoon and post-monsoon varies from 8.43 m (Nawapada) to 1.53 m (Lachhipur).

Long Term Water Level Trend in last 10 years in Ground Water Monitoring wells

The long term trend of (10 years) in water level for the pre-monsoon shows rise of 0-2m in 54.5% of monitored wells and 2-4 m rise in 9.1% of wells in Nawapada district. Fall in water level within 0-2m range is observed in Nuapada and Komna block and 2-4 m fall is also observed in Nawapada block.

The long term trend of (10 years) in water level for post- monsoon season shows rise in water level for 0-2m in 76.9% of wells and 2-4 m rise in 7.7 % wells in the district. The fall in water level in the range of 0-2 m and 2-4 m is exhibited by 7.7% of wells monitored.

Table 4.2 Litho unit wise depth to water level range in various seasons

Sl. No.	Formation	No. of wells	Depth to water level range (mbgl)	
			Pre-monsoon (April)	Post-monsoon (November)
1.	Granite gneiss	18	3.25 – 11.88	0.83 – 5.38
2.	Khondalite and Calc Silicate rocks	1	4.2	5.09

4.3 Ground Water Resources

The Ground Water Resources of the district has been assessed adopting the methodology recommended by the Groundwater Estimation Committee (1997), constituted by Govt. of India. The task was jointly carried out by the Central Ground Water Board and Ground water Survey & Investigation, Department of Water Resources, Govt. of Orissa. The block wise computation of ground water resources in the district has been presented in Table 4.3. The Annual replenishable ground water resources in the district are computed as 33683 HaM, out of which the existing Ground Water Draft for irrigation is 4947 HaM. The ground water draft for irrigation is through dug wells and tube wells. A large number of hand pumps fitted in PHED bore wells and tube wells also cater to the rural and urban water supply needs. On the basis of the estimated ground water potentials a detailed scheme for ground water development may be launched in the district. So far ground water development in the district has been meagre, and all the blocks fall under the safe category. The stage of ground water development varies from 11.43% (Komna) to 37.88% (Khariar) in different blocks. The overall Stage of Groundwater development of the district is 19.12%. There is ample scope for stepping up ground water development in the district. The ground water budget of the district is presented in Plate No.IV.

Table-4.3Ground water Resource Potential of Nuapara District As on 31.03.2009

Figures in hectare metre

Sl. No.	Assessment unit/block	Net Annual Ground Water Availability	Existing gross ground water draft fo irrigation	Existing gross ground water draft for domesti and industrial water supply	Existing gross ground water draft for all uses	Allocation for domestic and industrial requirement supply up to next 25 years	Net ground water availability fo future irrigation development	Stage of ground water developme nt (%)
1	Boden	5247	848	199	1047	411	3988	19.95

2	Khariar	3973	1201	304	1505	576	2196	37.88
3	Komna	11661	971	337	1309	771	9919	11.23
4	Nuapada	7833	963	364.71	1328	851	6019	16.95
5	Sinapali	4972	964	288	1252	653	3355	25.18
6	District Total	33686	4947	1492	6441	3262	25477	19.12

4.4 Ground Water Quality

The chemical quality of ground water in the district has been assessed on the basis of ground water samples collected during ground water monitoring, hydrogeological surveys and ground water exploration. The range of different chemical constituents in shallow and deeper aquifers is given in Table-4.4.

Table 4.4 Range of Chemical Constituents in Different Aquifers

	Shallow aquifer		Deeper aquifer	
Chemical constituents	Range	Average	Range	Average
E.C. (µs/cm at 25^0c)	61-1434	200-700	117-778	263-552
p^H	7.25- 8.21	7.38 – 7.96	7.1-8.45	7.1-8.23
Bicarbonate (mg/l)	31- 573	60-226	85-354	146-299
Chloride(mg/l)	4-121	11-89	3.5-145	8.9-92
Nitrate(mg/l)	0.0-139	6 - 64	0.77-16	1-12
Fluoride(mg/l)	0.03 – 7.2	0.33- 4.95	0.45-4.1	0.45-3.3
Total Hardness(mg/l)	30 - 540	90 - 390	50-290	103-195
Calcium(mg/l)	6 - 148	24 - 94	16-76	22-53
Magnesium(mg/l)	2.4 - 91	7.3 - 29	2.4-24	5.5-18
Sodium(mg/l)	1.9 - 185	7.3 -63	14-110	17-48
Potassium(mg/l)	.1 – 9.9	0.32 – 3.5	0.9-5.9	0.9-2.7
Carbonate(mg/l)	0	0	0	0
Sulphate(mg/l)	0-60	2.8-48	0.86-27	0.98-24
Iron(mg/l)	-	-	0.01-0.16	0.01-0.16

The chemical analysis data of both deeper and shallow aquifer reveals that except fluoride all the other parameters are within the permissible limit. The water is potable and good for drinking purposes. But fluoride above the permissible limit of 1.5 mg/l is reported in Komna, Boden and Sinapalli block and problem of fluorosis is acute. In Khariar block fluorosis problem is less and in Nawapada block high fluoride is sporadically distributed in the southern part. The fluorosis problem in detail is discussed in later chapter. The suitability of ground water for irrigation in the district has been assessed by use of US salinity diagram prepared on the basis of sodium absorption ratio (SAR) and specific conductance. The classification of water in the district is given in Table 4.5 below.

Table –4.5 US Salinity Classification

Classification based on salinity diagram	Grade	No. of Samples			
		Phreatic aquifer (Total-28)	Deeper aquifer (Total-18)	Shallow aquifer (%)	Deeper aquifer (%)
C_1S_1	Good	6	1	10	-
C_1S_2	Moderately Good	-	-	-	-
C_1S_3	Unsuitable	-	-	-	-
C_1S_4	Highly Unsuitable	-	-	-	-
C_2S_1	Good	10	16	67	69
C_2S_2	Moderately Good	-	-	-	-
C_2S_3	Unsuitable	-	-	-	-
C_3S_1	Moderately Good	10	1	23	31
C_3S_2	Unsuitable	2	-	7	-
C_4S_1	Unsuitable	-	-	-	-

It may be noted that about 100% of the groundwater samples collected from deeper aquifers and 90%from phreatic aquifers are good for irrigation purposes. From Piper diagram it is interpreted that in deeper aquifer the water type is Ca + (Na+K) $–HCO_3$ and in shallow aquifer Ca +Mg – HCO_3 + (Cl + NO_3) type.

4.5 Status of Ground Water Development

Ground water development in the district is mainly through dug wells, Dug-cum-bore wells and bore wells. Ground water is mainly used for domestic and irrigation purpose and in limited scale for industrial purposes. The stage of development of ground water in the district is low. So far only 15.89% of its resources has been exploited. Hence a strategy for detailed ground water development is required. The hydrogeological, remote sensing studies and ground water exploration so far carried out in the district depict the tentative possibilities of ground water development through suitable ground water abstraction structures in various hydrogeological settings (Plate –VI).

Dugwells : The wells may be sited in the topographic lows and should tap the maximum saturated thickness of the weathered zone. The depth of the dugwells

may vary from 8 to 12m with 4 to 6m diameter. The wells may be fitted with 1.5 to 2 H.P. centrifugal pumps. The wells may sustain yield maximum up to 3 lps.

Dug-cum-borewells : Dug-cum-borewells may drilled down to a depth of 20 to 25m below ground level, tapping the saturated shallow fracture below the regolith and in top portion of the hard basement. The wells should be fitted with 2 H.P. centrifugal / submersible pumps may sustain yield up to 2.5 lps.

Borewells : Borewells may tap the deeper saturated fractures found to occur in the depth range of 30 to 140m. The borewells should be 100 to 150mm. diameter and may be flitted with submersible pumps of 2 to 3H.P. capacities. The wells drilled in the vicinity of NE-SW and NW-SE trending lineaments are likely to be successful which has been established based on exploratory drilling by CGWB in the southern parts of the district. The yield of borewells is better in the southern part of the district. he suitable sites for drilling may be selected in the district with the aid of Remote Sensing studies, Surface Geological, Hydrogeological and Geophysical surveys.

Since the surface water resources are inadequate and the district often comes under the grip of drought, development of ground water resources may help in expanding irrigated agriculture in the district. An optimal utilisation of ground water in the district requires adoption of a suitable cropping pattern and energisation of the wells. The block wise additional ground water structures feasible as per Study Group Report (March, 2009) has been given in Table-9.4 below.

Table-4.6Irrigation potential of additional ground water structures feasible in the area

Sl.No.	Block	No. of additional GW structures feasible for irrigation use				Additional annual draft (HM)	Additional irrigation potential (H)
		DW	FPTW	STW	MDTW		
1	***2***	***3***	***4***	***5***	***6***	***7***	***8***
1	Boden	1973				1263	2604
2	Khariar	1784				1142	2355
3	Komna	6870				4397	9068
4	Nawapara	14153				9058	18682
5	Sinapalli	2361				1511	3117
	District Total	*27141*	*0*	*0*	*0*	*17371*	*35826*

5.0 Ground Water Management Strategy

5.1 Ground Water Development

The Ground Water Development of the entire Nawapada District is depicted in Plate -VI. Depending on the hydrogeological condition of the area the development possibilities has been predicted.

5.2 Water Conservation & Artificial Recharge

Nawapada district is mostly traversed by Precambrian consolidated formations. The deeper water level of the order of 5-10 mbgl is observed in 74 % of the dugwells in Pre-monsoon and 21% of the dugwells in Post-monsoon. Deeper water level is recorded in Nawapada, Khariar Road, Dharambandh, Lakhna in Northern part and Bargaon-K, Palsada, Khariar etc. The area show deeper water condition during pre- monsoon and post- monsoon periods due to rapid recessation of ground water level. The data of water level of 10 years shows fall in the Komna and Nawapada block in Pre-monsoon and Nawapada block in Post-monsoon. This is mainly due to prevailing topographic conditions and water table gradient, which facilitates flow of ground water through nalas and rivers and streams as base flows. To arrest the rapid decline of water table in these areas special studies may be taken up to pin point the areas where water scarcity problems are more pronounced during post-monsoon and pre-monsoon period. In these pockets suitable sites are required to be pin pointed to adopt artificial recharge techniques and rain water harvesting methods based on site specific conditions. This artificial recharge will also help in increase in storage and also in improving the quality of water etc. The most feasible artificial recharge and rain water harvesting structures are percolation tanks, nala/contour bunding, small check dams/weirs, renovation of old tanks to percolation tanks, subsurface dykes, water spreading, gully plugging, gabion structures etc.

Implementation of Integrated Watershed Development Programme:

Watershed or a drainage basin is an unit draining runoff water to a common point. Watersheds are divided into sub-watershed, mini-watershed and micro-watershed. Micro-watershed is the unit of development whose area is around 500 hectare. Watershed development is nothing but a process of natural regeneration. The different harvesting structures implemented in the project area are: contour bunds, contour trenching, minor pit, gully plug, lose boulder check dams, check dams etc.

Bhoomijal Samvardhan Puraskar-2007, by Ministry Water Resources, Govt. of India for East Zone was awarded to Chilnala Watershed Association, Kurumpuri Grampanchayat of Nuapada District, Orissa. Chilnala watershed Association's work is focused in two drought-prone villages Chahakapada and Daldali village of Komna Block. The association has treated 612.29 ha of land through watershed development works. They successfully roped in the community in all stages of the process.

Benefits of Watershed Development Project:

After implementation of the watershed development project the different benefits in Nawapada district are given below:

1. It has checked soil erosion. Erosive affects of rainwater have been reduced by vegetation through cover crops or structures like bunds etc. Different conservation structures like check dams has stopped further gully erosion

and promoted land reclamation and made it suitable for cultivation, which was not possible earlier.

2. It has increased the quality of soil (texture/structure) because of availability of water.
3. It has enhanced ground water recharge. Dried wells/bore wells have got recharged and there is about 2m rise of water level after implementation of the project. Runoff water has been conserved in the field itself.
4. Improved the vegetation in the watershed area. Root systems have affected soil properties, and vegetation density has dominated the functioning of hydrological properties through modification of interception, infiltration, evapotranspiration, surface runoff, and ground water recharge.
5. Increased moisture in soil- helped the paddy/monsoon crops protecting them from dry spell due to erratic rain.
6. Oil seeds are also planted in the watershed area which is collected by the self help group.
7. The project impounded runoff water, which acts as percolation tank. Percolation tank has helped in water retention, served as aquifer recharge structure, provided drinking water to bovine population as also to humans in many cases. In the project pisiculture is also done.
8. After implementation of the project people have started two crop system and cash crops in summer season also. People have started cultivation of vegetables like onion, potato, tomato by directly lifting water from the project or dug wells in summer which was not possible earlier.
9. Increased moisture regime in the soil led to oozing out of excess water in the medium/ lower portion of the watershed area. Here one can dig a small pond to use it for various purpose which is called “chahala” in local language.
10. Land treatment of various types has helped generation of biomass (vegetative growth). It has helped to increase the fodder and fuel. There is increase in livestock population and also in their condition.
11. It controls both drought and flood.
12. Out of various treatments, one land treatment measure is called 30X40 model. Here unbunded uplands are made plots of 30’ width and 40’ length (across the slope). In a treated plot one can see dense vegetative growth and the near by untreated plot (of the same patch) totally barren.
13. Enhanced “ CARRYING CAPACITY” of the land. This refers to the capacity of a land mass of an area to sustain the need of whole living system (need of human being, cattle population and other living being). Due to environmental degradation, the carrying capacity decreases and people are unable to get their sustenance and migrate for wage earning. Watershed development has helped to increase the carrying capacity potential and people do come back to their area in Nawapada district where migration is a common problem.
14. In Nawapada district watershed development is implemented in micro-watershed basis, which has improved the agricultural production as well as the socio –economic background. It has checked the migration of labour.

6.0 Ground Water related issues & Problems

Ground Water Problems: The ground water problems include frequent drought and health hazards due to fluorosis problem.

Fluoride content in both dugwell and borewell show high value upto 7.2 mg/l which is much higher than the safe limit of 1.5ppm. In contrast, the Indra river flowing in the area has low concentration (0.88 mg/l) of fluoride in its water. The fluoride content of different rock types are given below:

Arial distribution of high fluoride:

Karlakot is reported earlier for its acute fluorosis problem. But with increasing use of ground water in rural areas more endemic fluorosis affected areas are delineated. It is observed that fluorosis problem is prevailing in all the four blocks except the northern Nawapada block.

Karlakot grampanchayat of Nawapada district is well known for its acute fluorosis problem. But with increase in population and increase in use of ground water more fluorosis-affected areas are reported. Study in 2005 reveals that endemic fluorosis areas exist in Sinapalli, Komna, Boden and Khariar block except the Nawapada block. In Karlakot area the source of fluoride is the alkaline rocks and granite. In Nawapada district wherever these rocks are present there are chances of occurrence of high fluoride. The fluoride content varies from 0.14 – 7.2 mg/l.

In Jagannthpalli – Haripur and Kirkita area for the first time fluorosis problem is reported. In Jaramunda village of Bhela grampanchayat also fluorosis problem is reported. Recently acute fluorosis problem is reported from Nangalbor grampanchayat of Sinapalli block.

The fluorosis problem in different blocks are given below:

Block	Description	Upper limit of F
Boden	Acute Fluorosis problem exist in Karlakot grampanchayat and adjacent areas.	4.95 mg/l
Sinapalli	Worst affected and high fluoride is mostly prevalent, Fluorosis problem exist in Nangalbor and Jharbandh grampanchayat .	3.4 mg/l
Komna	Fluorosis problem reported in 2005 in Belgaon area of Rajna grampanchayat and Jagannathpalli-Haripur villages of Pendrawan grampanchayat.	7.2mg/l
Khariar	Fluorosis problem is reported in December-2005 in Kirkita grampanchayat which is bordered by Sinapalli block.	4.8 mg/l
Nawapada	Fluorosis problem so far not reported but high fluoride is present in Banjipani-Dharambandh area.	3.0mg/l

In the high fluoride areas like Karlakot people suffer from dental and skeletal fluorosis. Mottling of teeth is a common problem among the children of lees than 15 years of age. Adults suffering from skeletal fluorosis have deformed bones and acute pains. Most cannot straighten their backs and get exhausted very easily. Some people are even not aware that the problem is due to drinking of high fluoride water and think it is a different disease.

In Karlakot area there is piped water supply schemes where low fluoride water is supplied from other source. But because of irregular power supply there is no water supply for 2- 3 days. So sometimes they are bound to use the high fluoride water for which they suffer. But arrangement should be made for continuous water supply in these areas. Ground water should be analysed at grampanchayt level to delineate the high fluoride areas and alternative arrangements should be made by RWS&S. People's awareness is also necessary to minimize the impact of high fluoride.

Ground Water Pollution: Based on the chemical analyses of water samples collected from different aquifers, it is observed that almost all chemical constituents are well within the permissible except for fluoride and suitable for drinking as well as irrigational purposes, excepting the areas where high fluoride values have been observed. As such there is no ground water pollution in the district.

Ground Water Depletion: The stage of ground water development in different blocks varies from 8.99% (Nawapada) to 31.45% (Khariar) with the overall stage of development 15.89% in the district. From the perusal of 10 years of data it has been realized that there is a falling trend in 36.4% of water level measuring wells in pre monsoon and 14.7% of wells during post monsoon. There is fall in the Komna and Nawapada block in Pre-monsoon and Nawapada block in Post-monsoon.

7.0Awareness & Training Activity

7.1 Mass Awareness Programme (MAP) & Water Management Training Programme (WMTP) by CGWB

No Mass Awareness Programme (MAP) & Water Management Training Programme (WMTP) so far has been organised by CGWB in the district.

8.0 Areas Notified by CGWA

The stage of Groundwater development is well within safe category and there is no overexploitation and major threat of groundwater pollution and depletion. Hence no area has been notified by CGWA.

9.0Recommendations

1. Harvesting of rainwater is the only solution to solve the water crisis in the district by Implementation of Integrated Watershed Development Programme

throughout the district on microwater shed basis. Water has to be conserved where it falls. The state of Orissa receives upto 100mm. rainfall in summer.If the water is properly utilized it will help in agricultural production.

2. Large scale planning for ground water resources development should be preceded by intensive hydrogeological and geophysical survey aided by Remote Sensing studies and ground truth data.

3. Bore wells/dug wells should be located in the vicinity of NE-SW and NW-SE trending lineaments which have been proved to be high yielding and productive and in thickly buried pediment areas. Generally 30 % bore wells is having discharge between 1-3 lps which are not properly utilized. In these wells water supply schemes are not economically feasible. But in water scarce areas and particularly in summer season pump can be lowered in these wells and in situ overhead tank can be made which the rural people can utilize. These wells have to be utilized only after proper pumping test to know the sustainability of the aquifer.

4.Existing dug wells should be deepened to tap the maximum saturated thickness of the weathered mantle or vertical bores maybe drilled to enhance the yield of the well where normally the dug wells get dried up. Desiltation and renovation of dugwells from time to time is necessary.

5.Renovation of old ancestral structures like ponds/tanks etc should be renovated wchich enhances ground water recharge and stores rainwater. Experiments have shown that removal of bottom clay enhances ground water recharge upto 10 times.

6 .Energisation of wells should be stepped up to ensure optimal utilisation of the ground water resources to create additional irrigation potential. Minor irrigation schemes also should be implemented throughout the district.

7.The State Ground Water Organization should render expert guidance for sitting ground water structures in favourable hydrogeological settings.

8.The farmers should be educated through agricultural extension services, Mass Awareness and water management training programme to adopt suitable cropping pattern, conservation of ground water and irrigation practices especially for drought tolerant crops for optimal utilisation of available ground water resources.

9. Programme for artificial recharge may also be taken up in areas where deeper water table condition coupled with high fluctuation is observed for augmentation of ground water resources through construction of percolation tanks, subsurface dykes, check dams, nala bunding and contour bunding and other site specific favorable artificial recharge structures.

10. In areas of shallow water table lying with in 0 to 5 m bgl during post monsoon period, surface water bodies like local ponds, farm ponds and small earthen dam along small streams may be constructed to hold water for long duration and for replenishment of soil moisture. Implementation of Integrated

Watershed Development Programme throughout the district is the only solution to solve the water crisis.

11. For augmentation of drinking water supply to the major towns and villages near the major rivers, infiltration galleries or collector wells may be constructed in suitable locales to fruitfully harness the base flow /subsurface flow which otherwise goes as waste.

12.Growing of sugarcane and cash crops may be encouraged along the thin linear alluvial patches lying adjacent to major rivers where prolific ground water is available throughout the year.

13. All the ground water structures/sources in the district should be tested for high fluoride. Sources having concentration of fluoride > 1.5 mg/l has to be abandoned. Acute fluorosis problem is reported in Komna, Boden and Sinapalli block. Alternative water supply has to be made in fluorosis affected villages. To reduce the impact of fluorosis people's awareness is necessary by Mass Awareness Programme at grampanchayat level.

Plate :- 1

INDEX MAP OF NAWAPADA DISTRICT, ORISSA

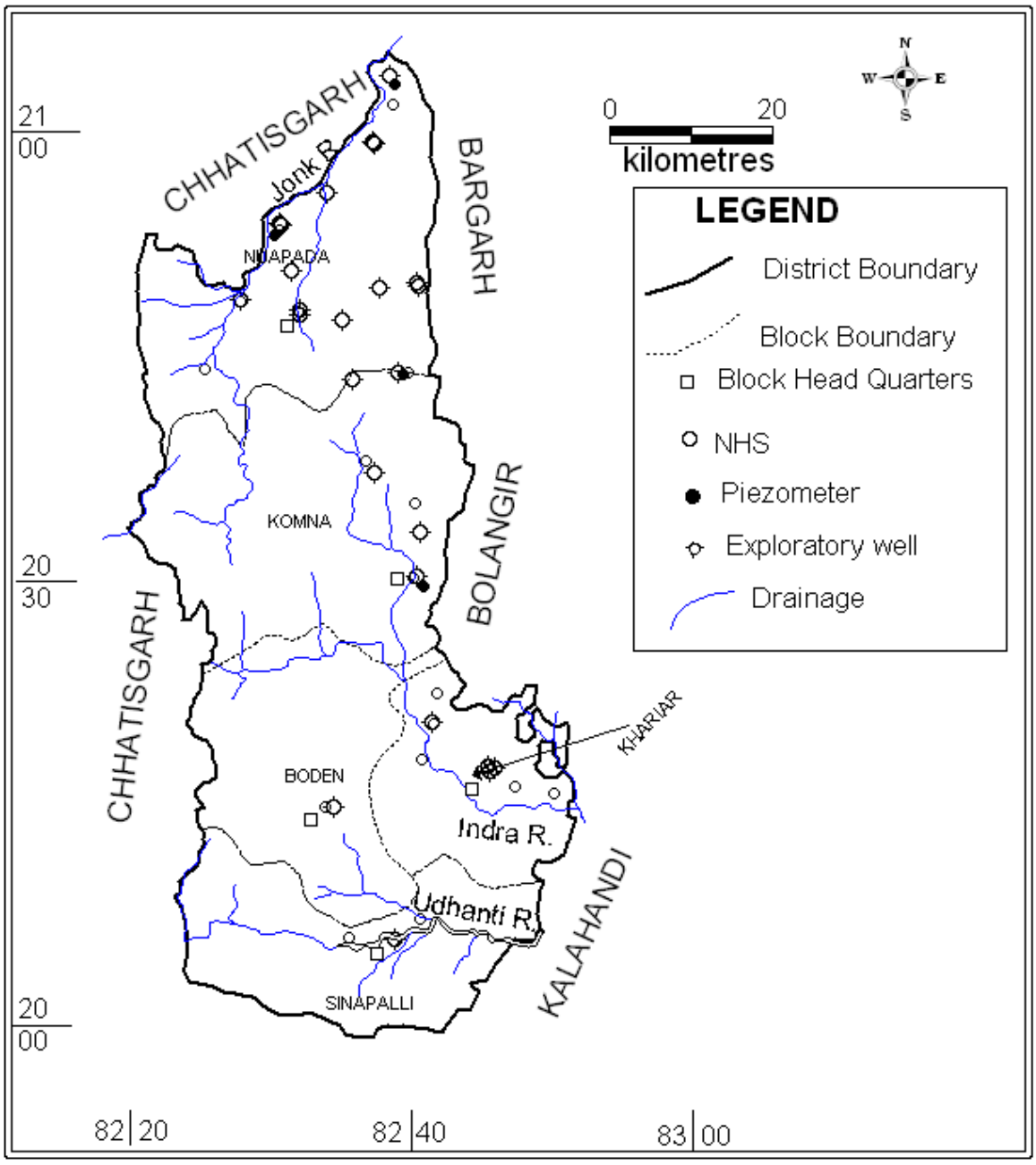


Plate :- 2

PRE-MONSOON DEPTH TO WATER LEVEL MAP OF NAWAPADA DISTRICT, ORISSA (APRIL-2011)

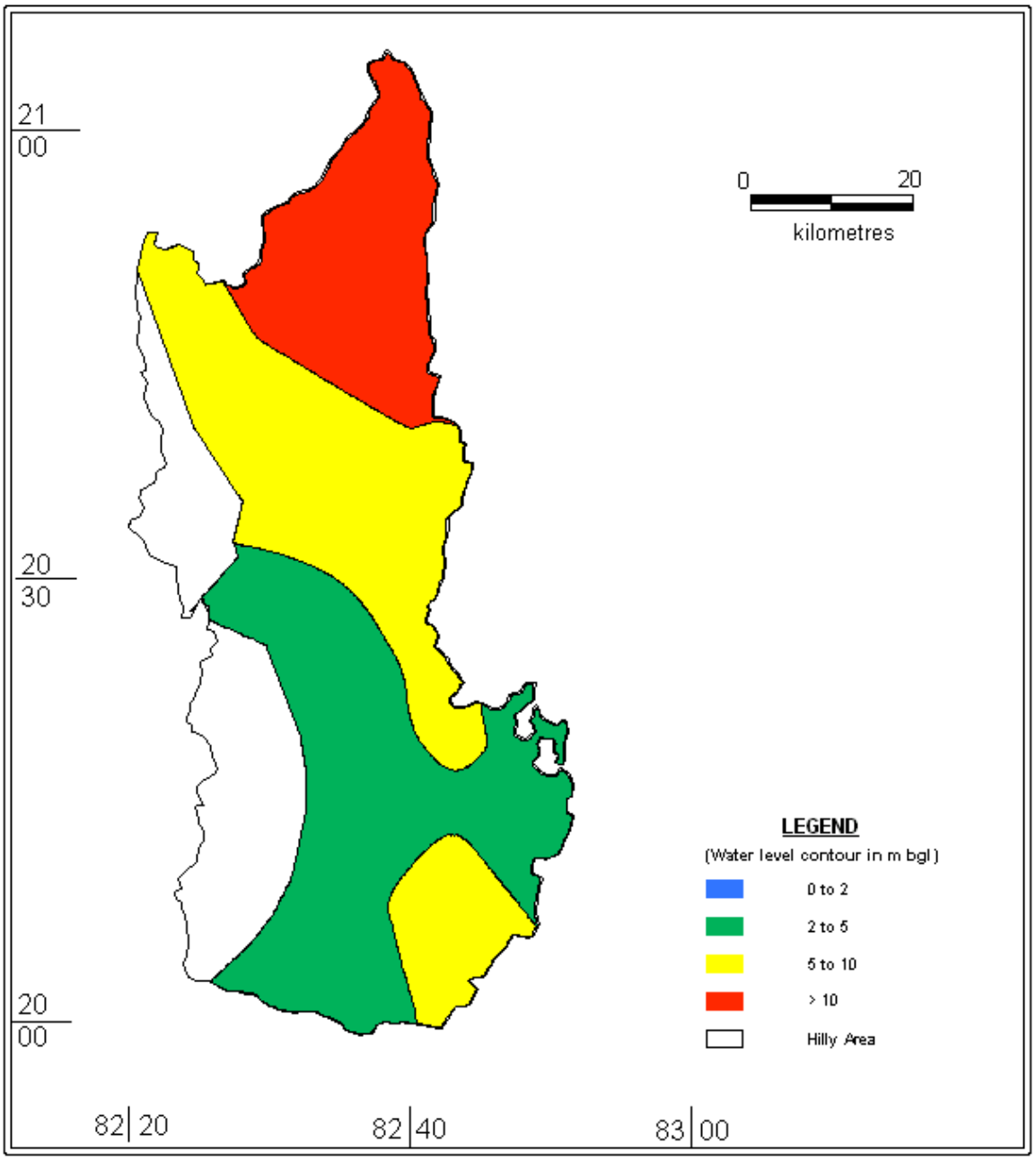
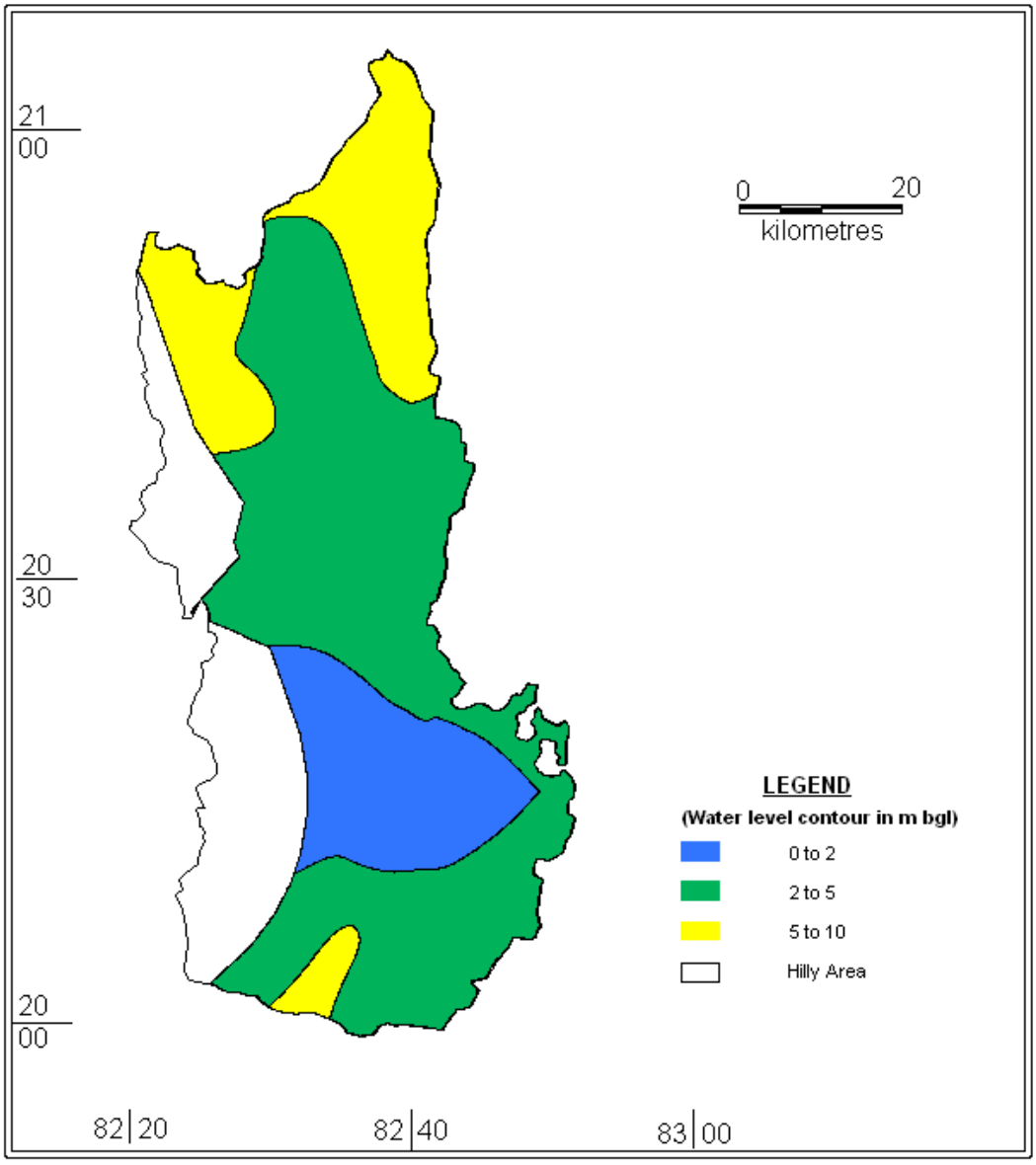


Plate:- 3

POST MONSOON DEPTH TO WATER LEVEL MAP OF NAWAPADA DISTRICT, ORISSA (NOVEMBER-2011)



NAWAPARA DISTRICT

Dynamic Ground Water Resources
(As on 31.03.2009)

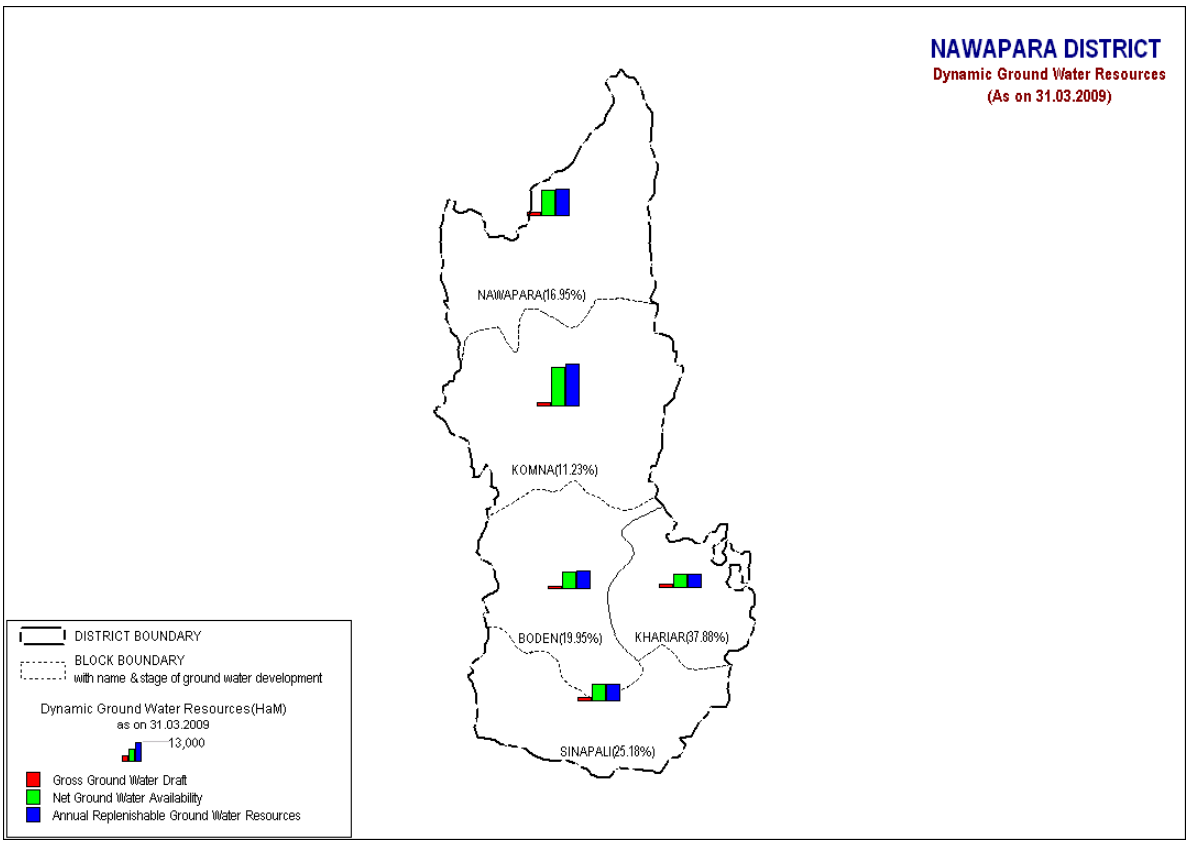
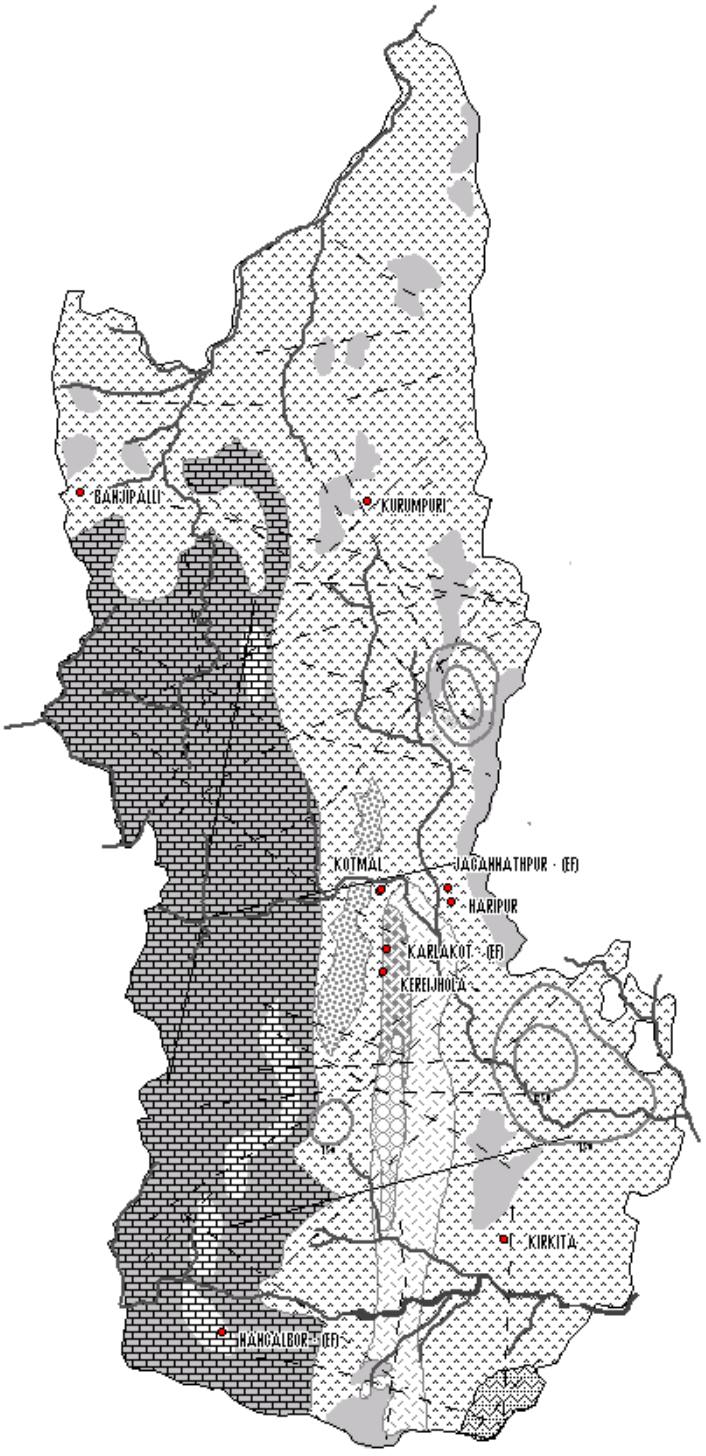


PLATE - 5

NAWAPARA

Hydrogeology



N
W E
S

0 10 20
Kilometres

- District Boundary
- Minor Rivers / Streams
- Major River with Quaternary Alluvial Deposits, Yield < 5 Lps

Pre - Cambrian

- Shale / Sandstone / Limestone Yield < 2 Lps
- Amphobolites, Yield < 3 Lps
- Anorthosites, Yield < 2 Lps
- Alkaline Rocks, Yield < 3 Lps
- Granites & Granite Gneiss Yield upto 13 Lps
- Charnockites, Yield < 2 Lps
- Khondalites, Yield < 2 Lps
- Hilly Areas with Negligible Yield Prospect
- Lineaments
- Faults
- Electrical Conductivity Contours in Micromhos/cm
- Locations with Fluoride > 1.5 mg/L (EF) - Endemic Fluorosis Reported

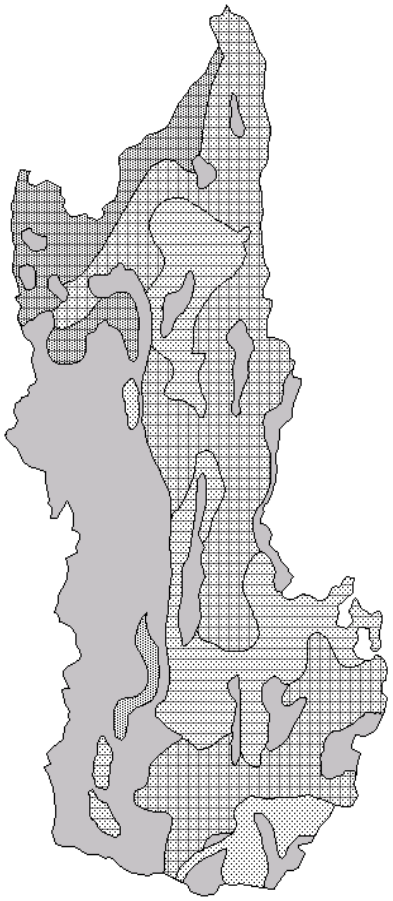
Plate - VI

NAWAPARA

Ground Water Development Possibilities

0 15 30

kilometres



DISTRICT BOUNDARY

Dug Well : 10 - 12m deep, 4.5 - 6m dia
Yield : < 5 Lps - Centrifugal Pump(1 - 1.5 HP)

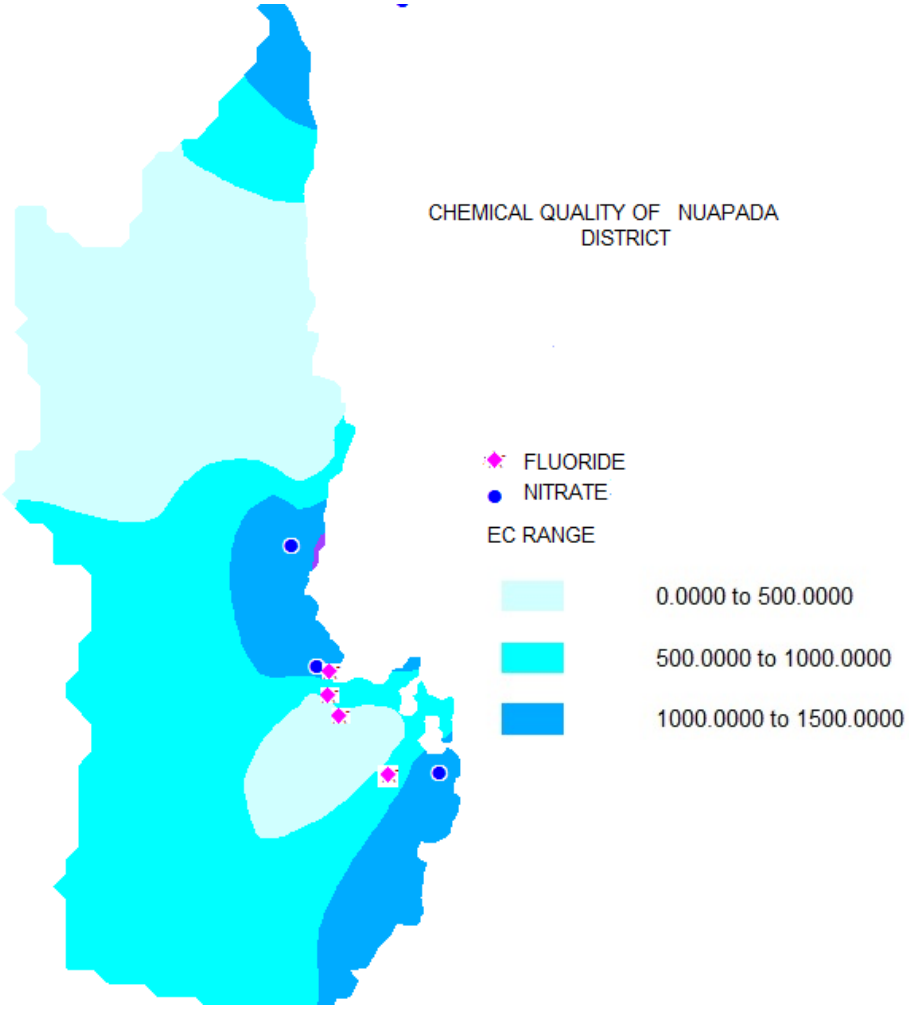
Dug Cum Bore Well - Submersible/Centrifugal(1 - 1.5 HP)
Bore Well : 30m deep, 100mm dia, Yield <=5 Lps
Dug Well : 10m deep, 4.5 - 6m dia, Yield <5 Lps

Dug Well : 12 - 15m deep, 4.5 - 6m dia
Yield : < 3 Lps - Centrifugal Pump(1 - 1.5 HP)

Bore Well upto 100m deep, Dia 100 - 150 mm
Yield : < 10 Lps, Submersible Pump (2 - 5 HP)

Hilly Areas, Negligible Yield Prospect
Except in Narrow Valley Fills

Artificial Recharge schemes should be taken up on micro water shed basis for maximum benefit in majority of the areas. In hilly areas - normal small scale check dams, contour bunds etc may be adopted


CHEMICAL QUALITY OF NUAPADA DISTRICT
FLUORIDE
NITRATE
EC RANGE
0.0000 to 500.0000
500.0000 to 1000.0000
1000.0000 to 1500.0000