

SUCCESS STORIES ON ARTIFICIAL RECHARGE IN ORISSA



Large scale urbanization generally leads to an aura of hydrogeological problems like lesser recharge to groundwater, high groundwater withdrawal, lowering of groundwater table and incidence of flash flood, which are now common in most of the rapidly growing cities of India. Bhubaneswar being one of those exploding city, is not an exception. The conversion of greenery's in to concrete jungles has limited the infiltration of rainfall into ground there by reducing normal groundwater recharge. Moreover lesser infiltration had lead to higher over land flow in the form of flash flood. Heavy pumping of groundwater causes interference with nearby bore wells, which render the shallow ones lesser/unproductive. All these have contributed to the lowering of groundwater regime. Rooftop rainwater harvesting and run-off management are some of the potential solutions to counter all the above mentioned problems.

Thus apart from the regular and routine activities need was felt for taking up of various pilot scale projects on Roof Top Rain Water Harvesting and Artificial Recharge to ground. The primal Pilot Project on "Rain Water Harvesting and Artificial Recharge to Ground Water in Raj Bhawan Premises" have been completed by the Board. Through this project, the annual recharge to phreatic aquifer as well as deeper aquifer has been estimated as 1,030 cu.m.(through recharge trench of 525 metres length) and 23,670 cu.m. (through 3 nos of recharge borewells) respectively.

Under Centrally Sponsored Scheme for Artificial Recharge to Ground Water, GWS&I, Govt. of Orissa has taken up four artificial recharge schemes namely Karlajhor water shed in Khalikot Block, Ganjam; Tamakjhor Water Shed, Saharpara Block, Keonjhar; Barkatia Water Shed, Athgarh Block, Cuttack; Roof top

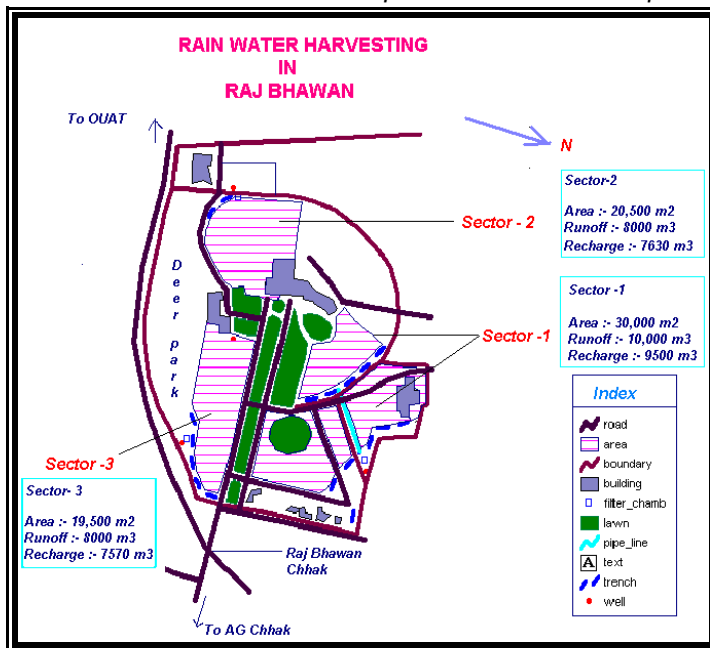
rain water harvesting, HP Building, Bhubaneswar, Secretariat Building, Bhubaneswar. Central Ground Water Board has provided financial and technical assistance to these projects.

A number of projects have been taken up in coastal saline hazard areas utilizing the minor creeks and nalas for storing the fresh water for irrigation and side by side injecting the fresh water into saline water bearing shallow aquifers so that the salinity of water can be reduced and make it useful for irrigation and other purpose. The second part of the project i.e. injection of fresh water into saline water bearing aquifer has been taken up purely on pilot basis.

List of Pilot Artificial recharge scheme taken by the Central Ground Water Board in coordination with State Implementing Agencies is indicated below:

1. Rainwater Harvesting And Artificial Recharge To Ground Water In The Raj Bhawan Premises, Bhubaneswar, Orissa.
2. Arresting Salinity Ingress & Artificial Recharge to Ground Water through creeks
3. Arresting Salinity Ingress & Artificial Recharge to Ground Water in parts of Basudevpur & Chandbali Blocks of Bhadrak District, Orissa". (Under Central Sector Scheme "Recharge to Ground Water")
4. Artificial Recharge to Ground Water Studies(Central Sector Schemes) taken up during IXth plan and spilled over to Xth Plan Period
5. Artificial Recharge to Ground Water in Kalajhore Watershed, Khallikote Block, Ganjam District
6. Artificial Recharge to Ground Water in Tamkajodi Watershed, Saharpada Block, Keonjhar District
7. Study of Artificial Recharge to Ground Water in Barkatia Watershed, Athgarh Block, Cuttack District
8. Roof Top Rain Water Harvesting at Hydrology Project Administrative Building, Bhubaneswar

RAINWATER HARVESTING AND ARTIFICIAL RECHARGE TO GROUND WATER IN THE RAJ BHAWAN PREMISES, BHUBANESWAR, ORISSA.



Layout of Rainwater Harvesting and Artificial Recharge Structure in Raj Bhawan premises, Bhubaneswar

SALIENT FEATURES

1. Project Area : 7.0 Hectares.
2. Normal Annual Rainfall : 1520 mm.
3. Number of Rainy Days : 86.
4. Annual Surface Run off : 26,000 m³.
5. Geology : Athgarh Sandstone of Upper Gondwana age.
6. Hydrogeology :
 - i. Phreatic Aquifer is devoid of sufficient ground water.
 - ii. Fracture zones form deeper aquifers, which are highly potential and are extensively exploited.
 - iii. Pre monsoonal (April) depth to water level
Phreatic - 7.60mbgl ; Deeper - 28.50mbgl.
 - iv. Post monsoonal (November) depth to water level
Phreatic - 5.20mbgl ; Deeper - 20.00mbgl.
7. Rain water harvesting by : 525m long trench system with lined wall, and 75m long open trench system.
8. Recharge bore wells : 80m deep (3 Nos.).
9. Annual recharge to phreatic aquifer : 1155 m³.
10. Annual recharge to deeper aquifer : 23670 m³.
11. Ground water monitoring by : 90m deep (1 piezometer) fitted with Automatic Water Level Recorder.
12. Project cost : Rs. 14.17 Lakhs.

The Project area considered for implementing Rainwater harvesting scheme within the Raj Bhawan premises is about 18.70 ha, which is situated on a low mound having radial slope. The Raj Bhawan main building is located centrally in the project area. Roof top rain water harvesting is planned for the main building, whereas, the open areas such as approach roads, lawns, garden areas and secretariat blocks are considered for harvesting surface run-off (fig. 2.2). Based on rainfall data of Bhubaneswar IMD station, rainfall of 100mm per day is considered as the expected maximum daily rainfall of the city. Therefore the maximum amount of rainwater expected to harvest from these open areas are calculated to 2800 m³ per day. However it is not possible to harvest all the water for the recharge work due to various hydrological/ hydrogeological factors such as, topography of project area, land forms/use, Slopping pattern, Shape of the project area, and the lateritic soil cover on Athagarh sandstone.

Initially, the Recharge trench of size 1m width and 1m depth will be constructed adjacent to the existing 1423m length of boundary wall all along in order to give maximum wetted area per cubic meter of trench thereby allowing optimum recharge. Further another 790m length of recharge trench is to be excavated inside the garden/ lawn area in order to harvest the additional run-off generated from the areas. Iron mesh of 1.5m width will be provided over the top of the trench so as to avoid any mishaps. This recharge structure is designed to accommodate around 2400 cum of water and can sustain the maximum rainfall of 100mm per day. These artificial recharge structures are capable of adding 200 cum per day to groundwater regime from the surface run-off. Since the annual normal rainfall of Bhubaneswar is around 1520mm, these

artificial recharge structures are capable of augmenting additional recharge of around 30000 cum annually to the groundwater regime considering 85% efficiency of structures. The details of sector wise structures is given in figure 2.3(A-E) and table 2.2.

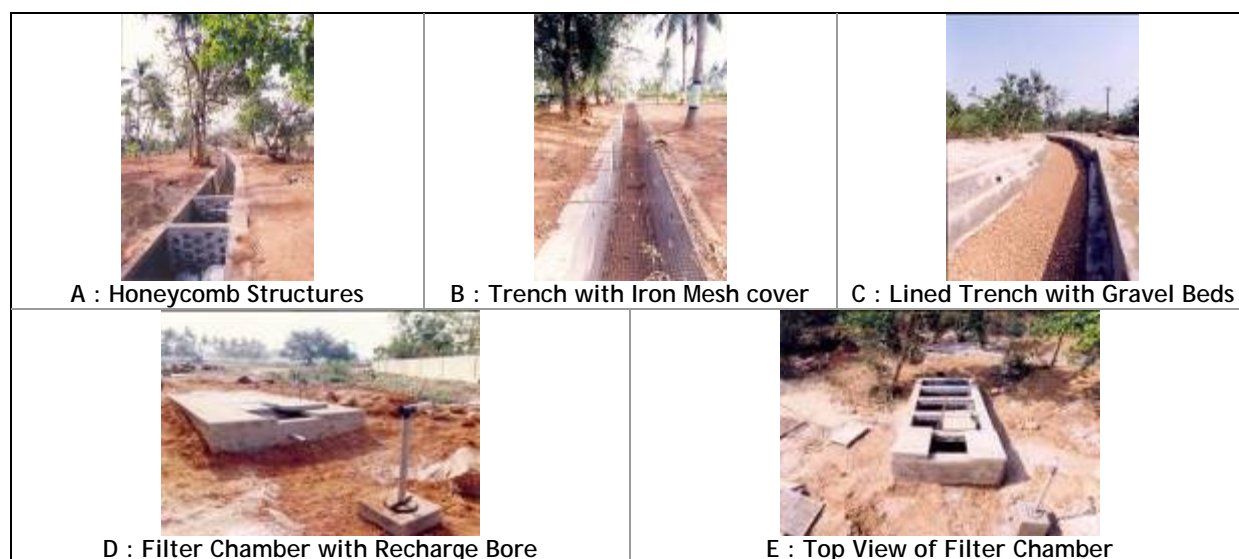


Figure 2.3(A-E) : Civil Structures for Rain Water Harvesting & Artificial Recharge constructed in Raj Bhawan Premises, Bhubaneswar

Table 2.2 : Sector wise details of structures, Raj Bhawan premises, Bhubaneswar

Sectors	Catchment area (m ²)	Expected Annual run-off (m ³)	Length of Trench (m)	Estimated Annual recharge to phreatic aquifer (m ³)	Estimated Annual recharge to deeper aquifer (m ³)
Sector -I (Police barrack)	30,000	10,000	292 (lined) 73 (unlined)	480	9,020
Sector-II (Children's park)	20,500	8,000	48 (lined) 2 (unlined)	290	7,340
Sector-III (Deer park)	19,500	8,000	155 (lined)	260	7,310
Near Garrage	4,000	1,800	30 (lined)	125	-
Total	74,000	27,800	525 (lined) 75 (unlined)	1,155	23,670

Table 2.3 : Construction Details of Recharge Borewells

Recharge Well site (RW)	Depth of Well (mbgl)	Fracture Zones (mbgl)	Individual Discharge (LPS)	Cumulative Discharge (LPS)	Static Water level as on 07-01-02 (mbgl)
RW-I (Police Barrack)	85	35.0 47.0-51.55 78.8-83.0	2.0 5.0 4.0	11.0	25.33
RW-II (Children's park)	80	34.0 53.0 57.3-59.6 73.3-77.8	2.0 2.0 3.0 5.0	12.0	20.54
RW-III (Deer park)	80	32.4-34.7 52.85-55.15	2.0 5.0	7.0	22.24

Table 2.4 : Construction Details of Trenches

Sector	Location	Catchment Area Planned (Sqm)	Size of Trench L x B x H (m)	
			(Lined)	(Unlined)
Sector -I	Police barrack	11,000	106 x 1.0 x 1.2	-
	Ring side	14,000	143 x 1.0 x 1.2	32 x 1.0 x 1.00
	Coconut area	5,000	43 x 1.0 x 1.3 30 x 1.0 x 1.5	41 x 0.45 x 0.5
Sector -II	Children's Park	20500	48 x 2.0 x 0.6	2 x 2.0 x 0.3
Sector -III	Deer's Park	19500	155 x 1.0 x 1.2	-

Table 2.5 : Construction Details of Filter Chambers

ITEM	Location	Size of Filter L x B x H (m)	Material used
Primary filter	In the end/middle of each trench	1.0 x 1.0 x 1.2	Course sand with Pebbles of 10-20mm size, 10cm thick at top and bottom
Main filter (Filtration Chamber)	At every Recharge bore well	5.0 x 2.0 x 1.5	Fine sand(0.6-1 mm) with Pebbles of 10-20mm size, 10cm thick at top and 30 cm at bottom

2.8.4 IMPACT ASSESSMENT

In order to get the necessary feedback about the structure, an Automatic Water Level Recorder is lowered in the Piezometer. The Piezometer is centrally located with reference to the Recharge Borewells and Pumping Borewells in order to get good reflection of recharge and withdrawal impact on the ground water regime. The Automatic Water Level Recorder is capable of recording ground water level data hourly and can be set at any multiple of hour. The data and its analysis are presented in Fig- 5, 6 & 7.

- 1) Pumping impact on the ground water regime is clearly observed in the Hydrograph (Fig-5). The daily water level fluctuation is in the tune of 0.7 meter, which can't be attributed by the diurnal fluctuation of ground water level. Each day there is a peak representing recovery during night and a trough representing pumping during daytime by the three pumping stations present in the campus. Small sharp peaks at trough center represents stoppage of pumping in some pumping stations between 12 noon to 3 P.M.

**COMPOSITE HYDROGRAPH OF THE DEEPER AQUIFER ,
RAJBHAWAN PREMISES**

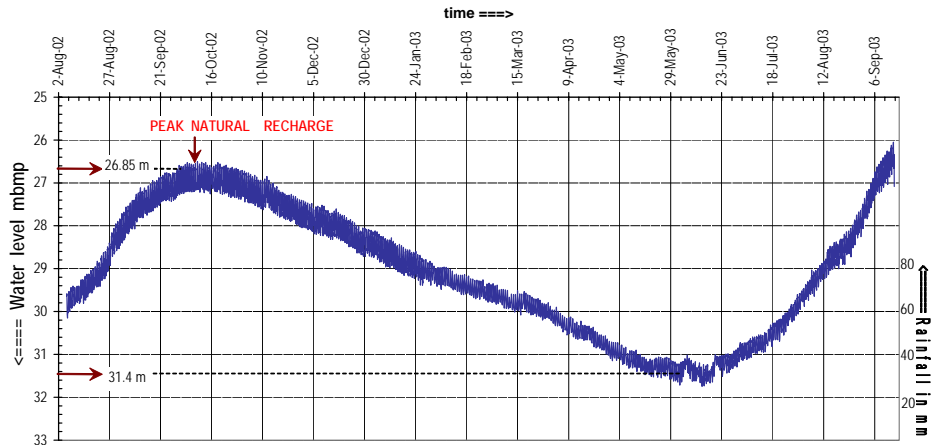


Figure 2.4 : Composite Hydrograph of Deeper Aquifer, Raj Bhawan Premises, Bhubaneswar

2) The water bearing fractures are present approximately at 35, 57 & 79 meter below ground level and are confined in nature. In phreatic aquifer the impact of rain on ground water is immediate, while in case of confined aquifer it takes few hours to few days depending on the distance of the recharge zone from the observed location. So sudden rise of water level during rain is caused by the direct recharge of the aquifer at the recharge well site thus indicating artificial recharge. Early monsoonal showers clearly depict this pattern where as the impact of late showers are being marred by the natural ground water recharge.

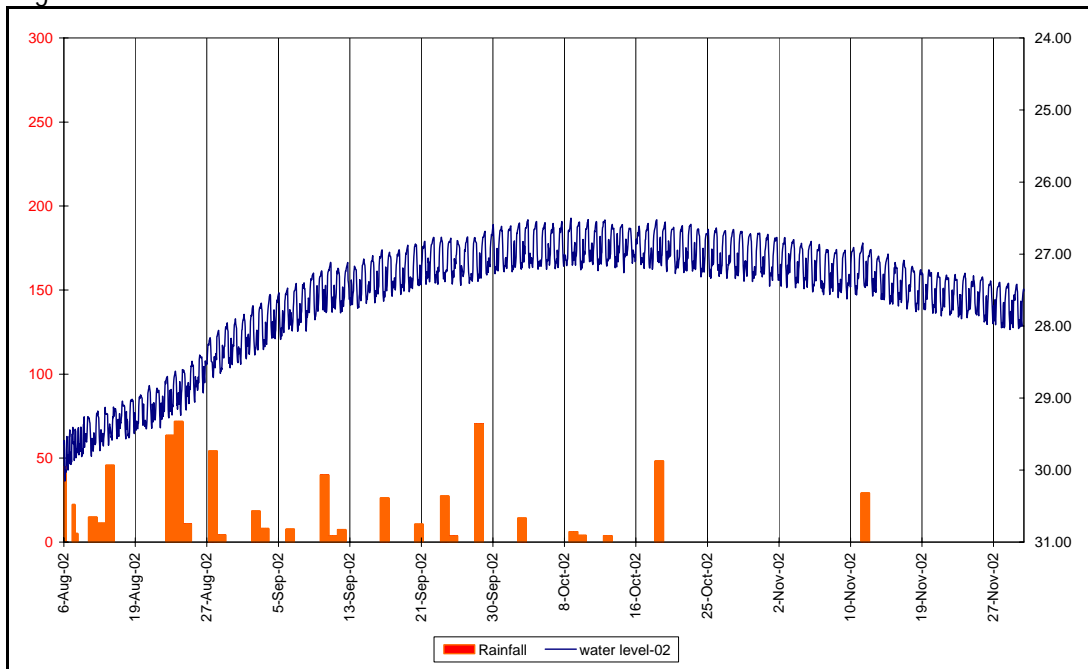


Figure 2.5 : Effect of Rainfall on the Deeper Aquifer

3) Comparison of water level data from early August to Mid September shows a rise of around 1 meter in the ground water regime(Fig-2.7). The cumulative monsoonal rainfall from May onwards, show less rainfall in 2003 than that of the year 2002. Therefore the rise is clearly attributed to the artificial recharge.

The natural monsoonal recharge is around 4.55 meter as depicted in Fig-2.6. A rise of 1.0 meter of water level thus, contributes to 22% of ground water resource augmentation due to artificial recharge.

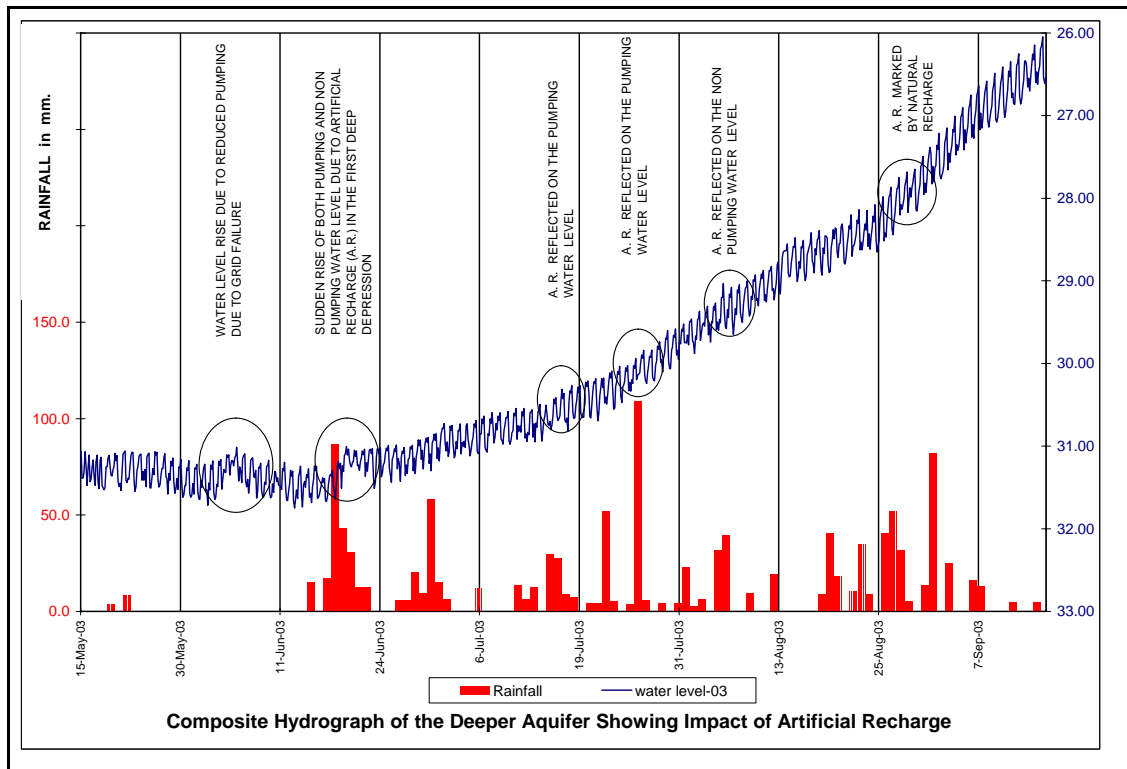


Figure 2.6 : Impact of Artificial Recharge on Deeper Aquifer

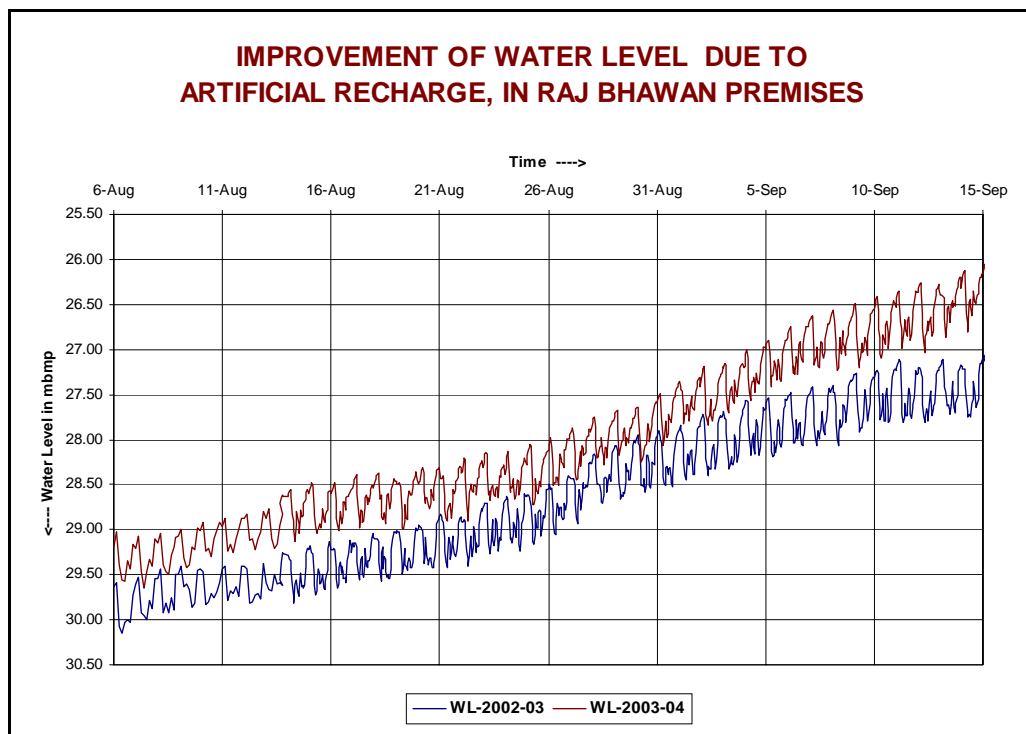


Figure 2.7 : Improvement of Water Level Due to Artificial Recharge, Raj Bhawan Premises, Bhubaneswar

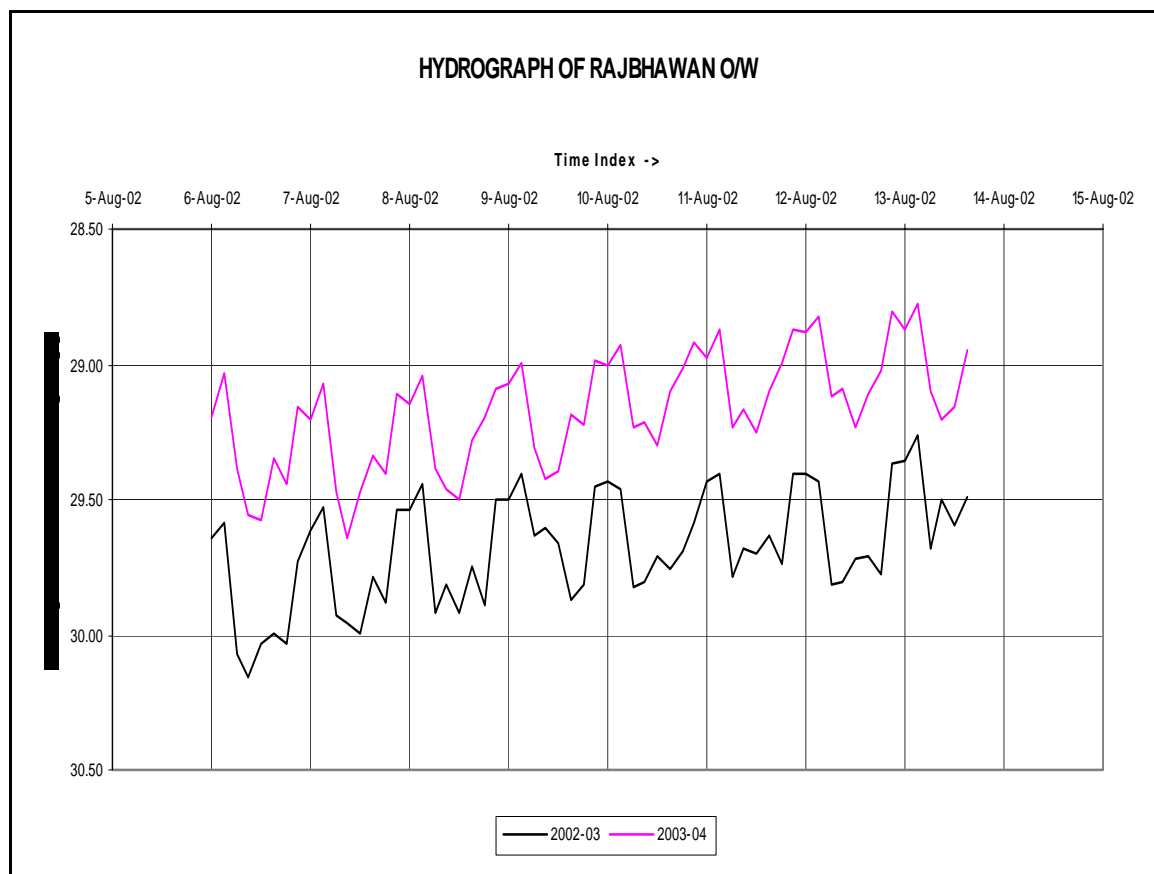


Figure 2.8 : Hydrograph of Observation well, Rajbhawan Premises showing Impact of Artificial recharge

2.0 Arresting Salinity Ingress & Artificial Recharge to Ground Water through creeks

A number of projects have been taken up in coastal saline hazard areas utilizing the minor creeks and nalas for storing the fresh water for irrigation and side by side injecting the fresh water into saline water bearing shallow aquifers so that the salinity of water can be reduced and make it useful for irrigation and other purpose. The second part of the project i.e. injection of fresh water into saline water bearing aquifer has been taken up purely on pilot basis. The salient information on the projects is as below.

At the instance of Ministry of Water Resources, the feasibility study was undertaken by Central Ground Water Board in February and March, 2001 to work out a project with a view to control salinity ingress in the surface flow of creeks as well as recharge to the saline water aquifer to change the quality and availability for its subsequent use. The following observations were made at the onset.

- i. The creeks and sub creeks are required to be desilted
- ii. Suitable outlet should be provided to increase irrigation intensity.
- iii. Sluice gates are required to be maintained properly and should be strengthened.
- iv. Inflow and outflow of fresh/tide water should be monitored.
- v. Salt resistant paddy should be grown.

With a view to above suggestions, the work was taken up by the C.G.W.B under the Central Sector Scheme of water harvesting and recharging to ground water. Seven pilot schemes in parts of Bhadrak, Kendrapara and Puri districts were taken up for this purpose (figure – 3.1). The proposed schemes entitled “Arresting Salinity Ingress and Ground Water Recharge”.

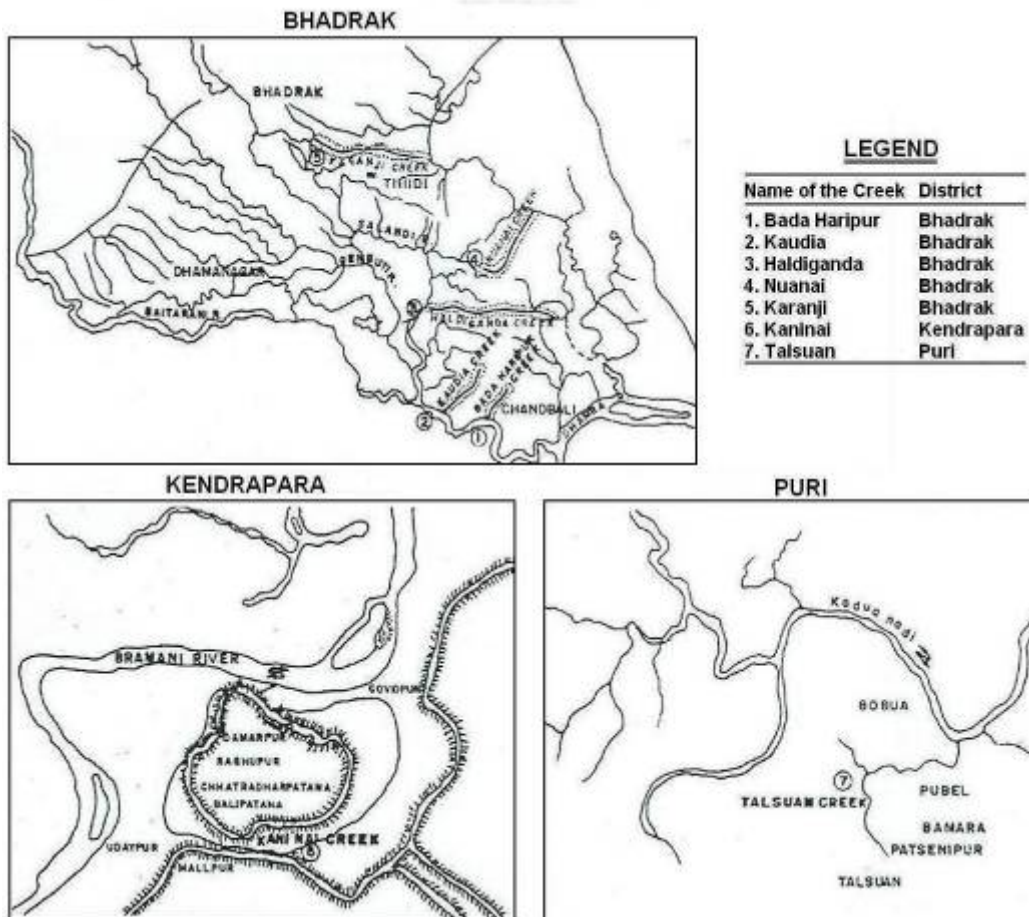


Figure 3.1 : Creeks identified for Arresting Salinity Ingress in Bhadrak, Kendrapara & Puri District, Orissa
There are two components of these schemes.

1. The work of construction of shallow piezometers to monitor ground water build up and improvement in water quality due to water spreading in creeks and work shall be carried out by Central Ground Water Board.
2. The work of strengthening and provisioning of sluice gates / tidal regulators on creeks as well as other related civil works shall be done by WAPCOS and Govt. of Orissa.

The work was proposed to be done at an estimated cost of Rs.4.27 crore under Central Sector Scheme (CSS) and at an estimated cost of Rs.1.65 crore under R & D programme. The people of these areas mainly depend on agriculture and irrigation, which mainly depends on the availability of water in creek and sub creeks. During drought and scattered rainfall years, Kharif paddy gets damaged and Rabi crops could not be raised due to lack of irrigation facilities. On implementation of these schemes, the impounded sweet water in the creek can easily be utilised by the farmers through indigenous devices.

The following creeks were studied and proposed for work.

- i. Haldiganda Creek, Chandabali block, Bhadrak district.
- ii. Kaudia creek, Chandabali block, Bhadrak district.
- iii. Nuanai creek, Chandabali block, Bhadrak district.
- iv. Karanji creek, Tihidi block, Bhadrak district.
- v. Bada Haripur creek, Chandabali block, Bhadrak district.
- vi. Kani creek, Rajnagar block, Kendrapara district.

vii. Talsuan creek, Kakatpur block, Puri district.

The brief descriptions of the above creeks are given below.

3.1 Haldiganda Creek

The Haldiganda (Nunajore) is a drainage channel, which off takes from the river Salandi near the village Hengupati and out falls to the river Matei, which is 2 km down stream of Bansada ferry ghat. The length of the channel is 19.74 km and drains out from an area of 9000 ha in the Chandbali block of Bhadrak district through 34 numbers of sub creeks. The total length of these sub creeks is 79.26 km.

The Haldiganda creek receives sweet / fresh water flow from Salandi river upto mid of March. One sluice gate has been provided near village Hengupati across this creek to impound sweet/fresh water. Another sluice gate has been provided near Matei river side to prevent ingress of saline water from the Sea. At present creek and sub creeks are silted up, which retards the easy flow of water.

However, a small part in the area is being irrigated in the proposed project area. People are utilizing this water for irrigation (mainly Summer Paddy and Wheat) and other selective cash crops. The sluice which has been damaged during last super cyclone, needs repair.

The water flowing from Salandi river is found to be sweet/fresh up to mid of March which can be impounded in Haldiganda creek and sub creeks through sluice gates at Hengupati and Biswanathpur. The impounded water in the creek and sub creeks can easily be utilized by the farmers through indigenous devices. This will cater to irrigate 1103 hectares in Rabi and selective cash crops could be raised along this creek. There are 23 villages to be benefited through this scheme. The main creek will also provide inland transportation of agricultural products of locality as it was in practice earlier. It may also provide connectivity to the villages, through water ways if needed.

3.2 Kaudia Creek

The Kaudiajore off takes from the river Salandi and out falls in the river Baitarani near Chandbali. The length of the jore is 11.85 kms. There are 28 numbers of sub creeks which join the Kaudia jore and the total length of sub creeks is 33.5 kms. The water enters into the main creek and sub creeks and remains fresh/sweet upto 1st week of March which can be utilised for irrigation purpose by the framers through indigenous devices. One sluice gate has been provided across Kaudiajore near Chandbali to prevent ingress of tidal water from the Sea. Creek and sub creeks are silted up which needs renovation. One sluice gate is suggested at suitable point where Kaudiajore meets Salandi.

The impounded fresh/sweet water in the creek and sub creeks on full implementation of scheme could be utilised for irrigation by the farmers especially in Rabi season and Supplement in Kharif during dry spell. This will create an irrigation potential of 1120 ha. in Kharif season and 400 ha. in Rabi season.

3.3 Nuanai Creek

The Nuanai Creek off takes from the river Matei near village Baliapal and ultimately joins to another creek "Terjodia" Nallah. The length of the main creek is 7 Km and sub creeks 21.35 Kms. The creeks are silted up as a result of which flow of water is obstructed.

One sluice gate if provided at Baliapal at Nuanai and Matei confluence it will facilitate flow and prevention of tidal water into Nuanai. The fresh/sweet water may be allowed to impound in the creek/sub

creeks and impounded water may be utilised for irrigation during Rabi and Kharif seasons. The main creek and sub creeks may be renovated which not only help in irrigation but also in quick discharge of accumulated water. The drainage congestion can also be relieved through the drainage after renovation.

3.4 Karanji Creek

The Karanji nala originates from the escape channel of Dasmeriza canal (Salandi irrigation canal). Near Baruni village it bifurcates into Karanji nala and Kundi nala. The catchment of Kundi nala and Karanji nala is 755 ha and 1195 ha respectively. The nalas are situated in the flooded area without any protection embankment. The nalas have joined at a distance of 1 Km down stream of the existing sluice site and flowing for length of 6 Km in the name of Dholi nala which falls into Matei river. The total length of 4 numbers main creeks is 7.10 Kms and 4 numbers of sub creeks is of 6.8 kms. The creeks and sub creeks are silted up.

There are two sluice gates at Kundi and Karanji which are badly damaged. Strengthening of the gates may be ensured for impounding of fresh water and preventing saline water. Provision for construction of additional drainage outlets may be considered. Creeks and sub creeks are to be renovated for proper drainage and impounding fresh water. The irrigation potential likely to be created is around 810 ha in Kharif and 442 ha in Rabi. The agricultural activity in the area will boost the socio-economic condition of the people.

3.5 Bada Haripur Creek

The Bada Haripur creek which is a drainage channel and takes off from the left bank of Baitarani river near the village Bada Haripur extends for a length of 5 Km. It drains out an area of 1500 ha. There are 12 numbers of sub creeks having total length of 20.16 Kms. Due to tidal effect, sweet water is pushed into these creeks which is used for irrigation. Presently creeks and sub creeks are silted up and as a result of which the entry of sweet water from river Baitarani into the creeks has been blocked up.

Existing drainage sluice a Badaharipur is to be strengthened to regulate sweet flow from Baitarani river and prevent tidal ingress. Renovation of drainage channels, creeks and sub creeks for impounding fresh water and provision of outlet will facilitate recharge to ground water regime.

3.6 Kani Creek

The lengths of the Kani creek and sub creeks are 13km and 20 km respectively. It covers drainage area of 1000 ha. There is no regulatory provision for movement of sweet water and prevention of tidal water into the creeks. Presently creeks and sub creeks are silted up with the construction of 3 nos. of sluice gates, renovation of creeks and sub creeks etc, drainage congestion will be relieved and ingress of saline water through control sluice could be checked.

3.7 Talasuan Creek

The length of the Talasuan creek is 3.5km and sub creeks are 7.0 km. The total drainage area is 500 ha. There is no regulatory provisions for movement of sweet water and preventing ingress of saline water in the creeks. Presently creeks and sub creeks are silted up.

It was proposed to construct sluice gate to regulate the flow of sweet/fresh water and renovation of creek and sub creeks of estimated cost of Rs.0.2 crores. With this, drainage congestion will be relieved and ingress of saline water can be checked through sluice gate.

3.8 Advantage of Arresting Salinity Ingress Schemes

On implementation of the above schemes, this will lead to increase the agricultural productivity during Kharif and Rabi seasons. The scheme will ensure sweet/fresh water and mitigate drought and go a long way to stabilize the socio-economic conditions of the people in the area. The fresh water impounded in the main creek and sub creeks will facilitate recharge to ground water regime. The impounding of fresh water in the creeks and sub creeks and through agricultural activities by creek irrigation is likely to improve water quality of phreatic aquifer.

3.9 Execution / Construction Activity

The following works were done for arresting saline ingress

1. Desiltation and renovation of the creeks by excavation
2. Remodelling of old sluices and construction of new ones
3. Construction of 15 small(VRB) bridges and one high level bridge across Bhadrak-Chandbali road over the creeks

The details of renovation work carried out in the creeks are given in table 3.1

Table 3.1 : Details of Renovation Work Done

SI No	Name of Creek	Number of			Excavation	
		Creeks	Sub-Creeks	Total	Estimated Quantity	Executed Quantity
					CuM	CuM
1	Haladiganda	1	31	32	3,31,000	3,30,800
2	Kaudia	1	28	29	1,01,440	1,01,140
3	Badaharipur	1	14	15	93,340	93,340
4	Nuanai	1	24	25	2,16,465	2,12,983
5	Karanji	1	6	7	2,45,685	2,45,685
	Total	5	103	108	9,87,930	9,83,908

3.10 Impact Assessment

After renovation of creeks and remodelling of sluices, the fresh water has been impounded in the year of 2002 – 03. The amount of fresh water impounded in the creeks is given in table 3.2. There has been a remarkable increase in water availability and irrigation potential after implementation of the project. The irrigation potentiality was 30 % during 2002 – 03 and it increased to 60 % during 2003 – 04. The photographic glimpses of the structures constructed have been given in plate 3.2 (A-H) and the impact assessment details are given in table 3.3. The details of Kharif and Rabi ayacut are given in table 3.4

Table 3.2 : Fresh Water Impounded in the Creeks(2002-03)

SI No	Creek Name	Fresh Water Impounded
		CuM
1	Haladiganda	4,65,000
2	Kaudia	1,20,000
3	Badaharipur	1,70,000
4	Nuanai	1,60,000
5	Karanji	1,96,000

Table 3.3 : Impact Assessment of Arresting Salinity Ingress(Under Central Sector Scheme)

Sl. No.	Name of Creek	Water Availability		Increase in Irrigation Potential
		Pre - Execution	Post - Execution	
		m ³	m ³	
1	Haladiganda	10,46,88.40	5,63,115.80	4,58,478
2	Badaharipur	22,660	1,15,640	93,000
3	Nuanai	14,960.25	1,186,380	1,70,000
4	Kaudia	1,23,150	2,84,246	1,60,000
5	Karanji	3,00,00	810,000	5,10,000

Table 3.4 : Impact Assessment – Details of Ayacut Covered under Creek Irrigation

SI No	Creek Name	Ayacut in Target (Ha)		Ayacut Achieved 2002 - 03 (Ha)		Ayacut Achieved 2003 - 04 (Ha)	
		Kharif	Rabi	Kharif	Rabi	Kharif	Rabi
1	Haladiganda	1367	2708	410	812	820	1825
2	Badaharipur	1200	424	360	30	720	255
3	Nuanai	1456	742	437	225	875	445
4	Kaudia	1120	1429	336	430	675	860
5	Karanji	810	142	245	150	500	100
	Total	5953	5445	1788	1647	3590	3285

Table 3.4 : Impact Assessment Details under Creek Irrigation

Creeks		Haldiganda	Badaharipur	Nuanai	Kaudia	Karanji
Effects						
Salinity Ingress Check		Completely Checked and Multiple usage of creek water done	Completely Checked and Multiple usage of creek water done	Completely Checked and Multiple usage of creek water done	Completely Checked and Multiple usage of creek water done	From Mantei river completely checked. 1950 Ha made free of Salinity & Water Logging. Multiple usage of creek water done
Impounding Capacity (CuM)		4,65,000	1,20,000	1,70,000	1,60,000	1,96,875
Ayacut Irrigated (Ha)	Khariff	367	1200	1456	1120	810
	Rabi	2708	424	742	1429	142
Increased Irrigation Potential (HaM)		460	93	170	160	810
Ground Water Recharge		All along the Creek network	All along the Creek network	All along the Creek network	All along the Creek network	17.5 Km Tract Recharged



A. Ricket Chattara Creek - Excavation in progress



B. Ricket Chattara Creek - After Completion of Excavation



C. Sashikadeipur Creek - Excavation in Progress



D. Kalidaspur Sluice - Reinforcement Details



E. Kuhali-Baupokhari Sluice - Reinforcement Details



F. View of Andola Sluice after Completion



G. View of Gahamnali Sluice after Completion



H. View of Karanjadia Sluice after Completion

Figure 3.2 (A – H) : Civil Construction Structures in the Creek Areas of Bhadrak District

3.11 **Arresting Salinity Ingress & Artificial Recharge to Ground Water in parts of Basudevpur & Chandbali Blocks of Bhadrak District, Orissa". (Under Central Sector Scheme "Recharge to Ground Water")**

PROJECT AT A GLANCE

I. General Particulars

(a) Location	:	20°55' and 21°15' North Latitude 86°45' and 86°55' East Longitude
(b) Project Area	:	830 Km ² (Appx.)
(c) District Head quarters	:	Bhadrak
(d) Subdivision	:	Bhadrak
(e) Blocks	:	1. Basudevpur (Part) 2. Chandbali (Part)

II Climatology

(a) Average annual rainfall	:	1528 mm
(b) Maximum temperature	:	36°C (May)
(c) Minimum temperature	:	14°C (December)

III Name of the scheme

"Arresting Salinity Ingress & Artificial Recharge to Ground Water in parts of Basudevpur & Chandbali Blocks of Bhadrak District, Orissa".

Scheme under which funding has been made

Central Sector Scheme "Recharge to Ground Water"

IV Financial outlay of the project

Initial Estimated outlay of the Scheme	Rs. 647 lakhs
Actual expenditure	Rs. 549.25 lakhs

V Date of Launching of the project

09.01.2002

Duration of the project

2002-2004

VI Funding Agency

Ministry of Water Resources, Govt. of India

VII Implementing Agencies

State Water Resources Department,
Govt. of Orissa

Rs. 474.14 lakhs

	Govt. of Orissa.	(Civil and structural works)
	WAPCOS India Ltd.	Rs. 47.07 lakhs (Consultancy and supervision charges)
	CGWB, Govt. of India	Rs. 28.04 lakhs (Construction of recharge wells and allied structures etc)
VIII	Details of Creeks/ sub creeks renovated	
	No. of creeks and sub creeks identified for renovation	27
	Total quantity of earth work carried out for desiltation of creeks	12,27,876 cum
	No. of sluices	6
		1. Kalidaspur Gadala, 4. Karanjadia, 2. Kuhaliboupukhari, 5. Gahama nala 3. Andola jhor, 6. Baliapada
	No. of foot bridges constructed	27
	Total length of creeks/sub creeks renovated	76.60 km
IX	Impact Assessment after construction of sluices and renovation of creeks/sub creeks	
	Quantity of fresh water impounded in 27 creeks/sub-creeks	798119.29 cum
	Irrigation potential created	5500 Ha in Rabi 5500 Ha in Kharif
X	Hydrogeological investigation and construction of recharge structures etc.	
	Geological formation	Alluvium
	Major geomorphic features	Coastal plain, Tidal flat, Marshy land, Estuaries, palaeo-dunes and creeks.
	No. of recharge well constructed	22

No. of piezometers constructed	15
Occurrence of fresh/brackish water zones	0-10 fresh, 10-180 saline, 180-246 fresh, >246 saline
Zones tapped	15-45 m bgl
Yield of the wells	15-32 lps
Transmissivity	274-1798 m ² /day
Specific capacity	2.6-13.3 lps/m
Static water level of shallow piezometers	1.02-2.10 m bgl
EC in $\mu\text{s/cm}$ at 25 ^o C	777- 30525

XI *Findings on Impact Assessment studies*

Intake capacity of recharge wells	5,37,192 cum
Post project observations and data analysis.	Improvement in water quality with passage of time and fresh water lense / ridge created over brackish water to arrest salinity ingress.

3.11.1 AIM OF THE PROJECT

The area represents the zone where land and sea meet and comprise a variety of geomorphic features like estuaries, marshes, palaeo-dunes, tidal flats and tidal channels /creeks. The creeks are tidal in nature and salinity ingress is a regular phenomenon in the area. The project aims at arresting salinity ingress and improving irrigation facilities in the area through the development of creeks/sub creeks, which were silted up over space and time. Moreover, an attempt has been made for improving the ground water quality by injecting the fresh surface water impounded in the creeks/sub creeks to the saline aquifer system by adopting artificial recharge techniques.

3.11.2 BENEFITS FROM THE PROJECT

Improvement of Irrigation facilities. Renovation of the creek system and Sluice and Check weirs have been constructed to regulate sea water ingress and to impound the fresh water in the creeks through tidal influx. Proper sluice arrangement was made at the end of each creek. During full moon and new moon days sluice gate is opened for entry of fresh water into the creeks and once the creek gets filled up, the sluice gate is closed. The fresh water thus impounded is being used for irrigation through indigenous devices. Rabi crops like wheat and mustard, green vegetables are cultivated in the area after these constructions. Now it is observed that people have started double cropping pattern since the implementation of this project. Quantity of fresh water which will be impounded in the 27 creeks/sub-creeks(**figure – 3.3**) has been estimated as 798119.29 cum and irrigation potential of 5500 ha in Rabi and 5500 ha during Kharif has been created from the project.

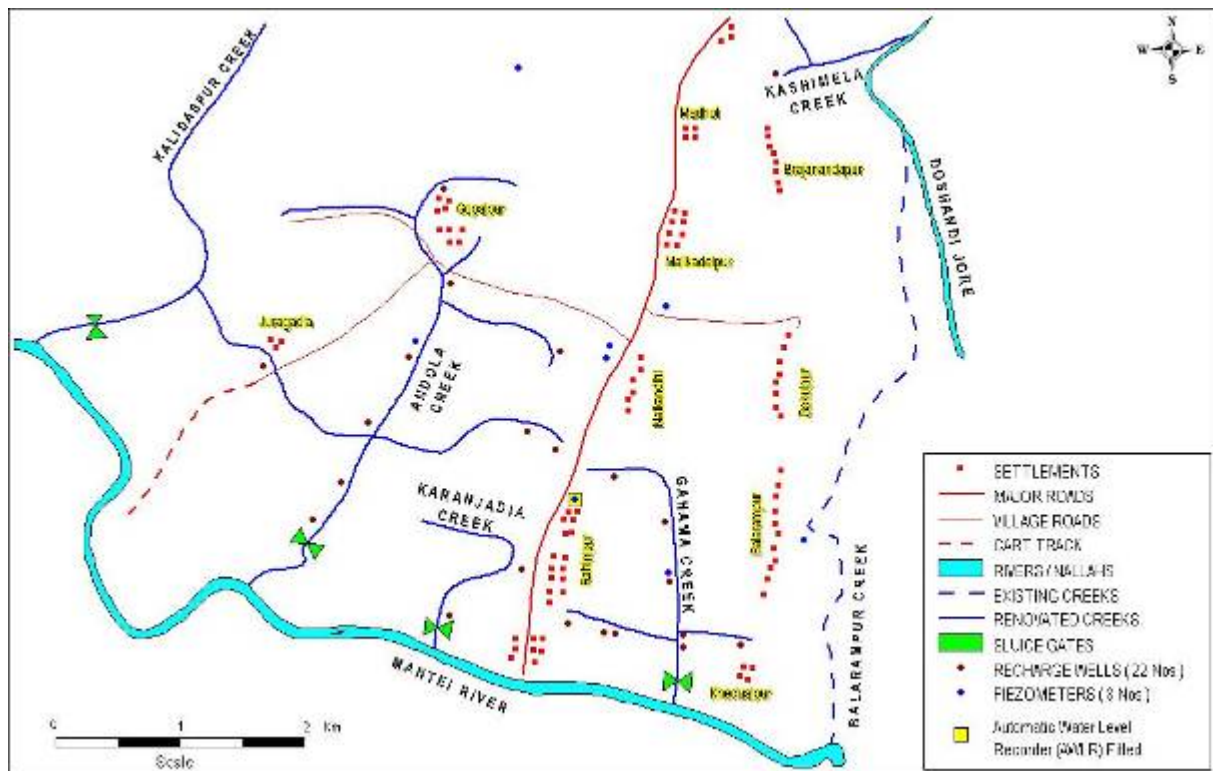


Figure 3.3 : Artificial Recharge Structures in Basudevpur and Chandbali Blocks of Bhadrak District, Orissa

3.11.3 Artificial Recharge Structures

Based on the prevailing hydrogeological conditions of the area, 22 numbers of recharge wells of 152mm diameter has been constructed by means of Water Jet Technique, which is similar to Rotary Drilling. The brackish water zones existing between 15m to 45 meter below ground level were tapped by lowering suitable well assembly. As the water level in the recharge well is around 0.5 to 1 meter below that of the canal water level, a pressure head of around the same is planned to be maintained by siphoning the excess creek water in to the brackish aquifer system.

The excess fresh water is directed to the recharge well by overflow pipes of (2½" dia) with regulatory valve arrangements. A coarse sand filter is constructed to filter effectively the creek water before entering into the recharge well. To check and monitor the recharge, a gate valve and water meter arrangement has been made to each recharge well.

3.11.4 Amount of Recharge into the aquifer

As the canal water head is around 0.5 meter above the water level of the recharge well, thus ideally the well can accept water at the rate of half of the Specific Capacity. 75% of intake capacity is taken into consideration for recharge calculation as recharge depends upon several factors.

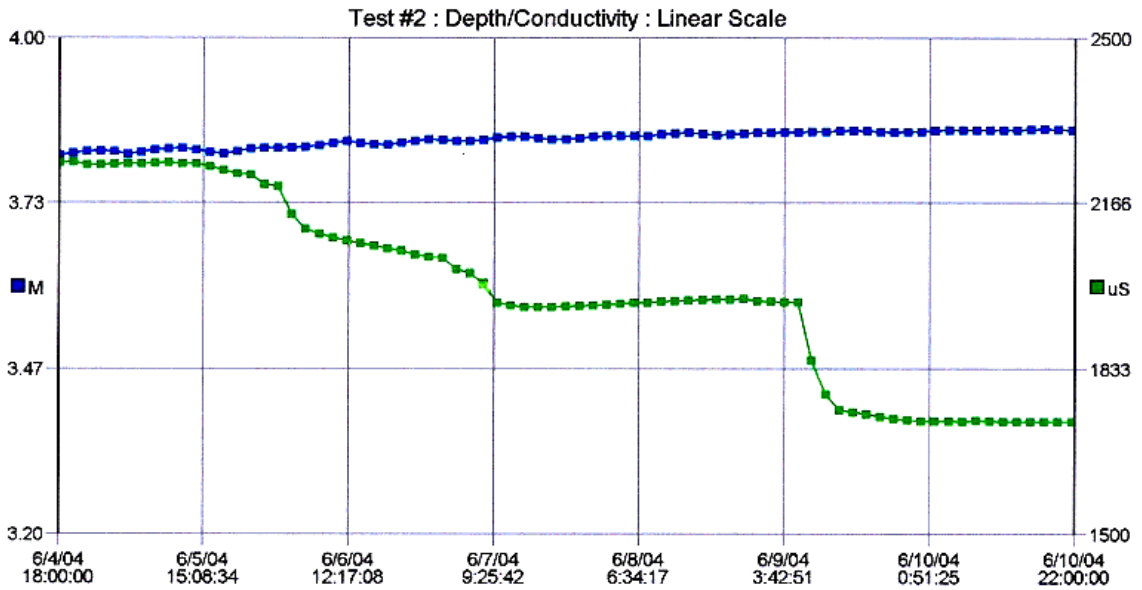
- I. Taking in to consideration of the Specific capacity of the recharge wells as well as the different factors upon which is described above, the total intake capacity works out to be 36.16 lps for 21 number of recharge wells. The total quantity of water that can be recharged for 250 operational days comes to 716256 m³. Hence, the 75% of this quantity i.e. 537192 m³ (716256*0.75) is assessed to be the total quantity for recharge.

- II. Generally, the river (Mantei) water remains fresh up to March and gets brackish to saline during summer i.e. April to June. However, heavy late monsoon showers in 2003 which continued up to December 2003 had led to the availability of fresh water during the full summer. So as the recharge wells were made operational during April 2004, sufficient fresh water had entered into the aquifer system. Thus a floating fresh water lense is detected at the piezometer constructed at Rahimpur village. This floating fresh water has variation of quality downwards. The water sample collected from 4 m bgl on 4.6.2004 has shown EC of 760 $\mu\text{s}/\text{cm}$ at 25⁰C while that collected from 13 m bgl has given EC of 2288 $\mu\text{s}/\text{cm}$ at 25⁰ C. The formation water is found out to be 36000 $\mu\text{s}/\text{cm}$ at 25⁰ C.
- III. The AWLR having the provision of EC measurement was lowered in the above-mentioned piezometer and was programmed for 2 hourly data acquisition. The continuous data on the fresh floating water lense has been collected. The EC has improved continuously in stepwise manner from 2288 to 1727 $\mu\text{s}/\text{cm}$ at 25⁰ C. Though the ground water level is on a decline trend due to summer season, the improvement of ground water quality indicates that artificial recharge is on progress.
- IV. An interesting correlation is observed between the EC and the temperature of the ground water. Sudden rise of ground water temperature coincides with the steps where ground water improves its quality. This can be explained by the differences of temperature between the surface water harvested in the creeks and the ground water existing in the aquifer. During summer seasons the surface water temperature used to be around 31⁰C, which is more than that of the ground water. Thus when large volume of fresh surface water is recharging the aquifer, its reflection on the ground water temperature is imminent.

3.11.5 IMPACT ASESSMENT

As the canal water head is around 0.5 meter above the water level of the recharge well, thus ideally the well can accept water at the rate of half of the Specific Capacity. However the intake capacity of wells seldom matches with that of pumping capacity due to a lot of factors like siltation of the aquifer, air entrapped in the recharged water, clogging of the well screen by bacterial activities and flocculation by mixing of two different type of water (Todd et.al, pp 467-468). Hence 75% of intake capacity is taken into consideration for recharge calculation.

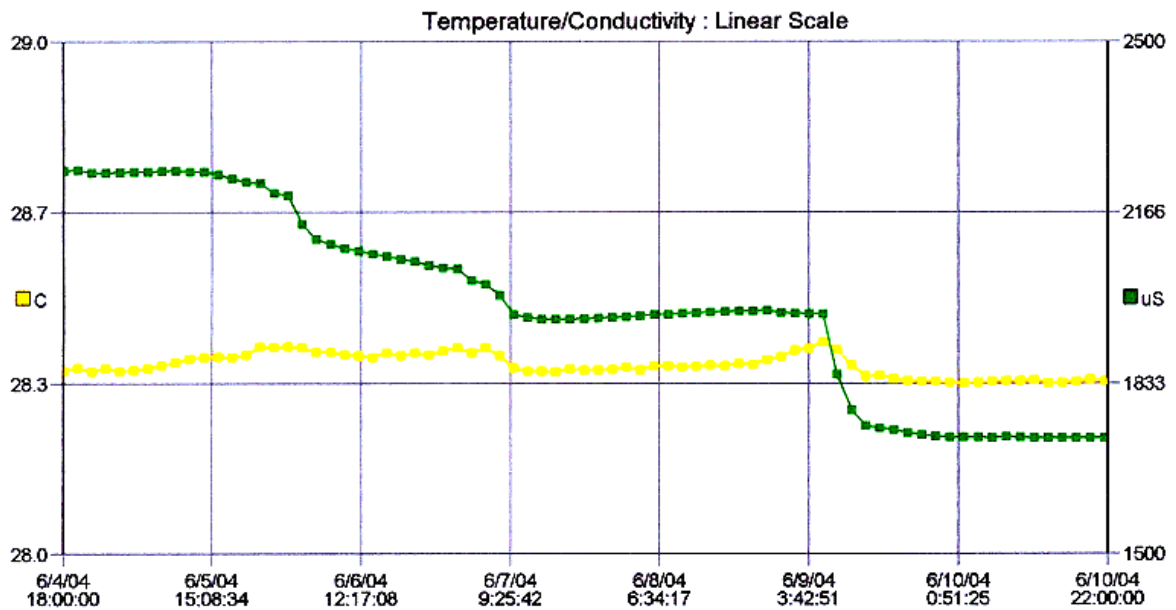
1. Taking in to consideration of the Specific capacity of the recharge wells as well as the factors described above, the total intake capacity works out to be 36.16 lps for 21 number of recharge wells. The total quantity of water that can be recharged for 250 operational days comes to 716256 m³. Hence, the 75% of this quantity i.e. 537192 m³ (716256*0.75) may be taken as total quantity for recharge.
2. Generally, the river (Matei) water remains fresh up to March and gets brackish to saline during summer i.e. April to June. However, heavy late monsoon showers in 2003, which continued up to December 2003, had led to the availability of fresh water during the full summer. So as the recharge wells were made operational during April 2004, sufficient fresh water had entered into the aquifer system. Thus a floating fresh water lense is detected at the piezometer constructed at Rahimpur village. This floating fresh water has variation of quality downwards. The water sample collected from 4 m bgl on 4.6.2004 has shown EC of 760 $\mu\text{s}/\text{cm}$ at 25⁰C while that collected from 13 m bgl has given EC of 2288 $\mu\text{s}/\text{cm}$ at 25⁰ C. The formation water is found out to be 36000 $\mu\text{s}/\text{cm}$ at 25⁰ C.
3. The AWLR having the provision of EC measurement was lowered in the above-mentioned piezometer and was programmed for 2 hourly data acquisition. The continuous data on the fresh floating water lense for 7 days from 4.6.2004 to 10.6.2004 is summarised in the **figure-3.4**. The EC has improved continuously in stepwise manner from 2288 to 1727 $\mu\text{s}/\text{cm}$ at 25⁰ C. Though the ground water level is on a decline trend due to summer season, the improvement of ground water quality indicates that artificial recharge is on progress.



AWLR Data Showing Ground water Quality Improvement Due to Artificial Recharge

Fig – 3.4 : Improvement of Ground Water Quality due to Artificial Recharge (Depth vs Conductivity)

- An interesting correlation is observed between the EC and the temperature of the ground water. Sudden rise of ground water temperature coincides with the steps where ground water improves its quality. This can be explained by the differences of temperature between the surface water harvested in the creeks and the ground water existing in the aquifer. During summer seasons the surface water temperature used to be around 31°C, which is more than that of the ground water. Thus when large volume of fresh surface water is recharging the aquifer, its reflection on the ground water temperature is imminent (fig – 3.5).



AWLR Data Showing Ground water Quality Improvement Due to Artificial Recharge

Fig – 3.5 : Improvement of Ground Water Quality due to Artificial Recharge (Temperature vs Conductivity)

5. Monsoonal rain generally starts from mid June and thus creeks and canals got filled up with rainwater as well as from the fresh river water. Artificial recharge during the whole monsoonal period has improved the quality still further as the EC has reached 1500 $\mu\text{s}/\text{cm}$ at 25^o C during October 2004.
6. To determine the utility of the fresh water lense floating over the brackish / saline zone, the piezometer was pumped on 9.1.2004. In absence of low capacity pump, the same was pumped by a 2 HP Self-Priming Suction Pump at the rate of 5 lps. The water quality was found to be fresh up to 5 minutes of pumping with EC of around 2683 $\mu\text{s}/\text{cm}$ at 25^o C. The water is of Na (Cl + HCO₃) type with the concentration of Chloride is twice that of the Bicarbonate (Table – 3). This can be explained by the fact that the floating fresh water-bearing zone develops on the saline aquifer by replacing the saline water. Thus when the NaCl type of water is getting replaced by Ca (HCO₃)₂ type of water, Ion exchange results in the formation of Na(Cl + HCO₃) type of water. If the undisturbed fresh water of the floating zone could have been collected, then it could have been of Na HCO₃ type.
7. Once pumping was stopped, the water level start recouping by gushing of fresh water from all around. Hence EC started improving from 46000 to 8504 $\mu\text{s}/\text{cm}$ at 25^o C between 11 days as shown in Fig -15. However the improvement is not uniform and sudden jump of EC from 45290 to 16622 $\mu\text{s}/\text{cm}$ at 25^o C within 12 hours was conspicuous (figure – 3.6).

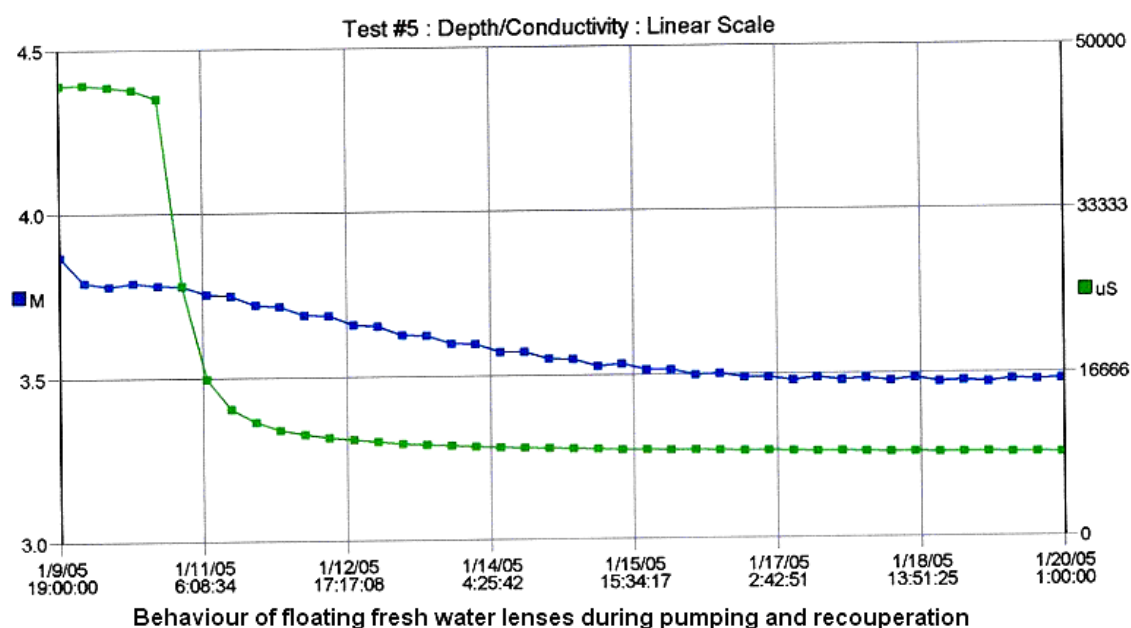


Figure – 3.6 : Behaviour of floating fresh water lenses during pumping & recouperation

3.11.6 Results and Discussion

The pilot project is one of its maiden attempts taken up by Central ground Water Board in the coastal creek areas of Orissa. On successful implementation of the project and based on pre- post project data gathered from field studies, it is observed that there is a remarkable change in water quality with passage of time. Further, the project has accrued many benefits in terms of higher agricultural production through double cropping and has encouraged the local people to adopt cash crops especially during rabi season. Also, the areas, which were prone to drainage congestion and flooding, are now free from such water logging and heavy inundation. Foot bridges have helped the local farmers in transporting their agricultural produces and crossing of castles. The areas that were unapproachable have now become easily accessible.

3.11.7 Recommendations

The recharge wells near to the sluices need frequent maintenance, as the tidal water is muddy and is choking the filter bed. The pipe which is connecting the canal to the recharge structure also require maintenance against the entry of wooden pieces, dead aquatic animals, etc which are responsible for choking the pipe. Hence the following are some of the feedbacks received from this study:

- Around 15% of the project fund can be earmarked for such types of schemes towards the maintenance of the A.R structures, which is vital for its continued operation.
- Recharge structures near sluices are to be avoided as the effect of heavy influx of saline water during high tides may affect the recharge well.
- In future, such structures are to be constructed in the creek / canal itself to avoid use of pipes and gate valves etc. which need constant maintenance.
- The floating fresh water lense can be utilised by deploying low capacity pumps. The drawdown should be kept as low as possible (less than 0.3 meter) as one meter of drawdown can lead to 40 meter rise of fresh-saline water interface (Ghyben – Herzberg Principle).
- To get optimum recharge, the creeks / canals are to be filled up frequently as the recharge amount depends on the differences between the canal level and ground water head. To achieve this, sluice gates require to be properly regulated in time.

4.0 Artificial Recharge to Ground Water Studies(Central Sector Schemes) taken up durin IXth plan and spilled over to Xth Plan Period

Artificial recharge of the aquifers is contemplated when the water table is continuously under stress. The drought prone areas where the rainfall is less, the recharge of the weathered and fractured formations can significantly improve the water table of the area. In the coastal and sub-coastal tract adoption of appropriate recharge techniques for the varied hydrological setups can check the ingress of saline water. The Directorate of Ground Water Survey & Investigation (GWS&I), Govt of Orissa has taken up some pilot projects on artificial recharge to ground water in Orissa, under the Central Sector Scheme, funded by the Govt. of India, for popularizing the artificial recharge techniques in the State. It has been envisaged that these pilot projects are to be executed by GWS&I with the technical supervision of the Central Ground Water Board (CGWB), Eastern Region, Bhubaneswar. These includes the following four schemes

1. Study of Artificial Recharge to Ground Water in Kalajhore Watershed, Khallikote Block, Ganjam District
2. Study of Artificial Recharge to Ground Water in Tamkajodi Watershed, Saharpada Block, Keonjhar District
3. Study of Artificial Recharge to Ground Water in Barkatia Watershed, Athgarh Block, Cuttack District
4. Roof Top Rain Water Harvesting at Hydrology Project Administrative Building, Bhubaneswar

4.1 Artificial Recharge to Ground Water in Kalajhore Watershed, Khallikote Block, Ganjam District

4.1.1 At a Glance

Watershed :	Kalajore
Block :	Khallikote
District :	Ganjam, Orissa
Approximate Project Area:	17 Sq. Km.
Number of villages covered:	09 (Manapali, Kairasi, Thekuapali, Manikpur,

	Luchapada, Kanehipur, Bhikapada, Kandigaon)
Total rainfall	1290 mm
Project Execution by:	GWS & I Division, Berhampur
Total sanctioned cost of the Project:	Rs. 33.15 Lakhs
Total amount spent:	Rs. 33.32 Lakhs
Total volume of Recharge	1.04X10 ⁵ m ³
Rise in water table	0.90m

Table 4.1 : Recharge Structures constructed, Kalajore Watershed, Ganjam.

SI No	Location	Recharge Dug Well	Gully Plug	Recharge Pit	Recharge Tank	Renovation of Tank
1.	Manapali	4	20	3	1	-
2.	Kairasi	12		9	1	-
3.	Thekuapali	1	-	3		-
4.	Manikpur	6	-	-	1	1
5.	Luchapada	1	-	2	-	-
6.	Kanehipur	1	-	3	-	-
7.	Paikanehipur	1	-	-	-	-
8.	Bhikapada	4	-	-	-	-
9.	Kandigaon	-	-	-	-	1
	Total	30	20	20	3	2

4.1.2 Impact Assessment

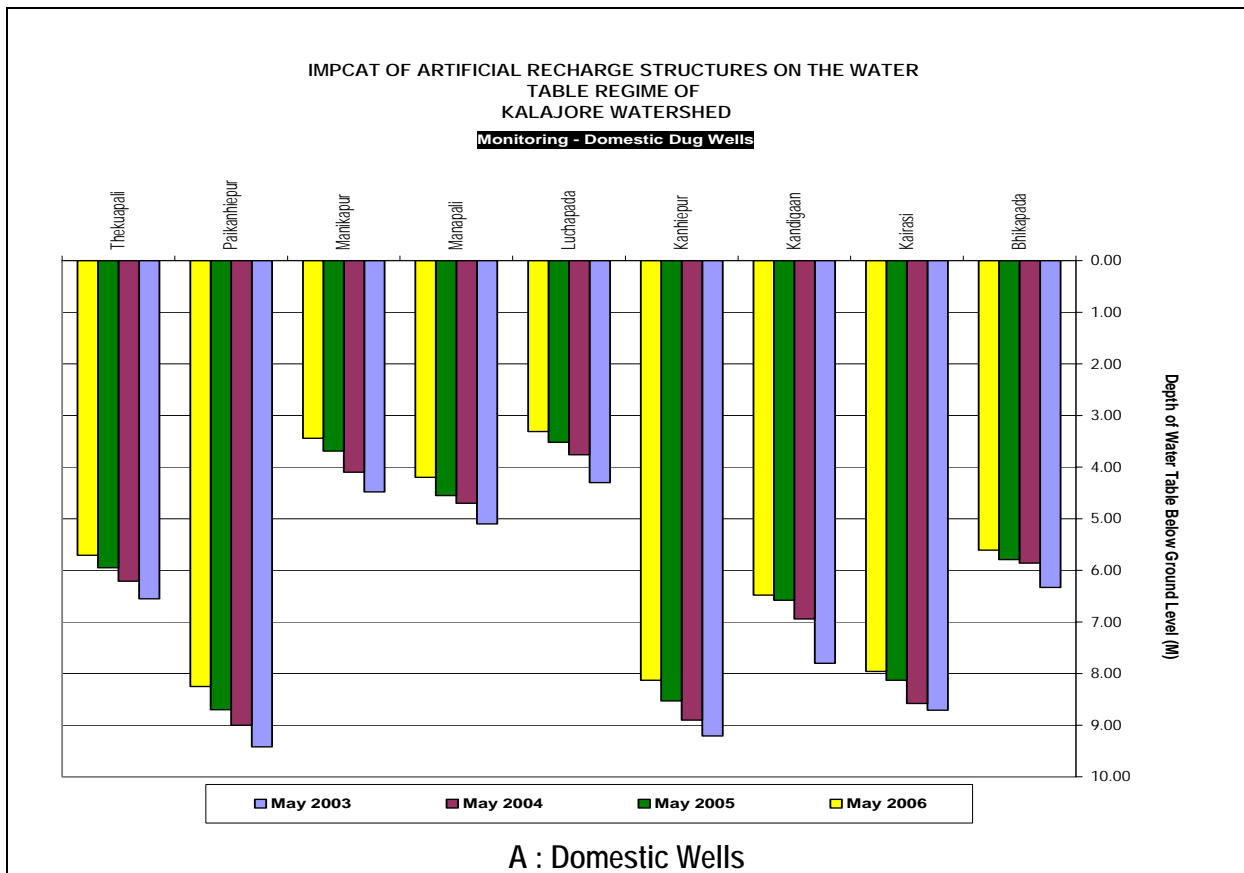
In total, 30 recharge dug wells, 3 recharge tanks and renovation of 2 tanks had been executed in the project area in two phases. All these structures were completed by end of March 2004. The ground water table was monitored periodically in all recharge dug wells and few domestic dug wells in the project area from the benchmarked month of May 2003 up to May 2006. Monitoring of depth to water level indicate the tremendous impact of the recharge structures on the ground water regime of the region (fig. 4.1 A&B). On an average, the impact has resulted in increase of summer water table by 0.90 Meters in domestic dug wells. This ecological impact in the project area has also lead to improvement of soil moisture and created a verdant landscape in summer. People are quite happy to find water in their wells during the worst part of the summer (April-May). They have been eagerly explaining the positive effect of the project to all visiting teams of officers representing Govt. of India / Govt. of Orissa with a hope to increase the density of these artificial recharge structures in the watershed so that they can harvest more water to meet their farming requirements.

The ground water resource of the project area has been impacted due to augmented recharge during monsoon season. The pre-project assessment of ground water resource was made based on the rainfall infiltration factor. It was estimated to be 127 Hectare Meters (HM). During post-project period, the summer water table has been raised on an average 0.90 M, which is equivalent to additional 10.44 HM of ground water resource over and above 127 HM. Hence the present ground water resource of the project area is asessed to be 137.44 HM based on the water table fluctuation.

Table 4.2 : Improvement in Depth to Water Level, Kalajore Watershed, Khallikote Block, Ganjam District

Sl. No.	Location	Depth of water table below ground level Domestic Dug Well (Meters)	Maximum rise in water table (M)
---------	----------	---	------------------------------------

		May 2003	May 2004	May 2005	May 2006	
1	Bhikapada	6.33	5.86	5.79	5.61	0.72
2	Kairasi	8.71	8.58	8.13	7.96	0.75
3	Kandigaan	7.80	6.94	6.58	6.48	1.32
4	Kanhiepur	9.21	8.90	8.53	8.13	0.77
5	Luchapada	4.30	3.76	3.52	3.31	0.99
6	Manapali	5.10	4.70	4.55	4.20	0.90
7	Manikapur	4.48	4.10	3.69	3.44	1.04
8	Paikanhiepur	9.42	9.00	8.70	8.25	0.75
9	Thekuapali	6.55	6.21	5.95	5.71	0.84
	Average	6.88	6.45	6.16	5.90	0.90



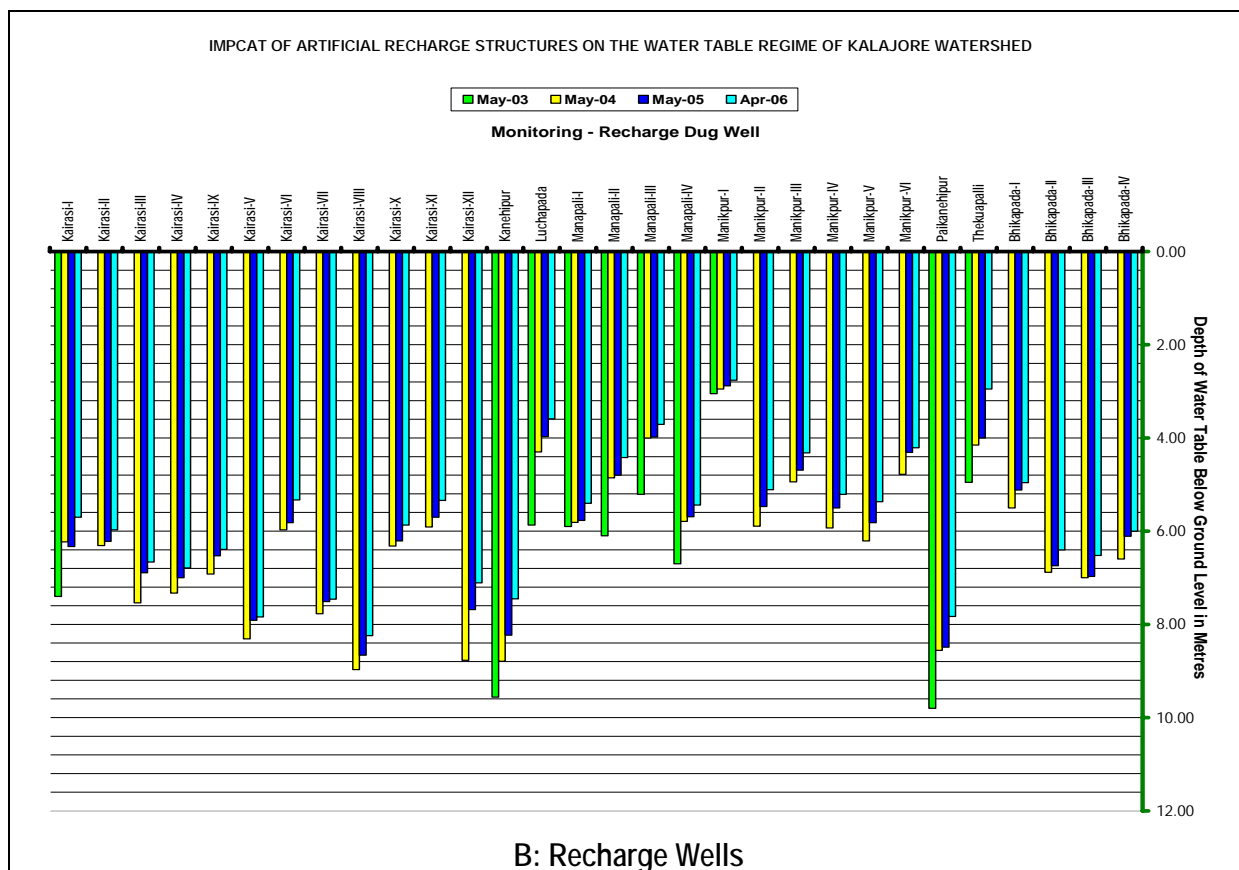


Figure 4.1(A-B) : Impact Assessment – Improvement in Depth to Water level, Kalajore Watershed, Ganjam District

4.2 Artificial Recharge to Ground Water in Tamkajodi Watershed, Saharpada Block, Keonjhar District

4.2.1 At a Glance

Watershed	Tamkajodi
Block	Saharpada
District	Keonjhar, Orissa
Approximate Project Area	15 Sq. Km.
Number of villages covered	07 (Danuatangarpada, Daspada, Gandabeda, Telipada, Sandhanurjaypur, Ghuntanalli, Jamunalli)
Total rainfall	990.78 mm
Project Execution by	GWS & I Division, Baripada
Total sanctioned cost of the Project	Rs. 50.00 Lakhs
Total amount spent	Rs. 49.75 Lakhs
Total volume of Recharge	8.10X10 ⁶ m ³
Rise in water table	0.69-1.54 m (premonsoon) 0.38-2.35 (postmonsoon)

Table 4.3 : Recharge structures have been constructed in the different location of the study area

SI No	Location	Recharge Dug Well	Recharge of Existing Tank	Recharge Tank	Recharge Pit	Percolation Tank	Check Dam
1	Daspada	2	2	2	7	-	1

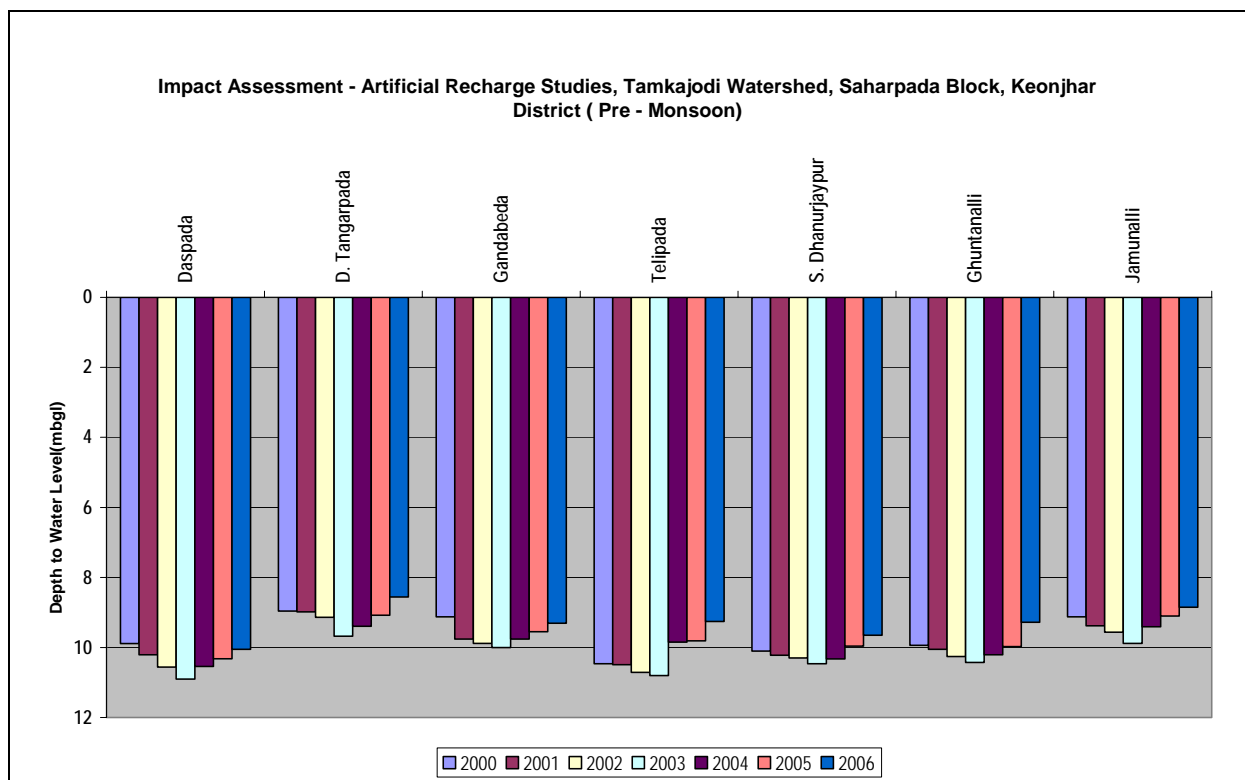
2	D. Tangarpada	4	2	1	5	-	2
3	Gandabeda	2	1	2	5	-	-
4	Telipada	1	1	2	5	1	-
5	S. Dhanurjaypur	2	1	1	3	-	-
6	Ghuntanalli	2	1	1	2	-	-
7	Jamunalli	2	-	1	3	-	-
	TOTAL	15	8	10	30	1	3

4.2.2 Impact Assessment

After execution of the artificial recharge structures which includes renovation of 8 existing ponds and excavation of 10 recharge tanks and 1 percolation tank, 15 recharge dug wells, construction of 3 check dams, ground water recharge was greatly enhanced. The impact of this recharge were monitored regularly. The quantum of recharge was found to be around 64 % of the total run-off ($8.10 \times 10^6 \text{ m}^3$). Lateritic soil and sandy cover seen in many parts of the project area results in increased infiltration and percolation rate for enhanced ground water recharge.

Table 4.3 : Impact assessment – Depth to Water Level Records of Different Locations(Dug Wells), Tamkajodi Watershed

Sl No	Location	2000 mbgl		2001 mbgl		2002 mbgl		2003 mbgl		2004 mbgl		2005 mbgl		2006 mbgl
		Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre
1	Daspada	9.89	5.00	10.21	5.10	10.56	5.52	10.90	5.32	10.54	3.30	10.32	3.25	10.05
2	D. Tangarpada	8.96	4.26	8.98	4.29	9.14	4.95	9.68	4.79	9.39	2.90	9.08	2.83	8.56
3	Gandabeda	9.12	5.10	9.76	5.21	9.88	5.45	10.00	5.40	9.76	3.60	9.55	3.56	9.31
4	Telipada	10.46	5.42	10.49	5.44	10.71	5.81	10.80	5.75	9.85	3.00	9.81	2.98	9.26
5	S. Dhanurjaypur	10.10	5.11	10.22	5.35	10.30	5.61	10.46	5.55	10.33	4.60	9.96	4.52	9.65
6	Ghuntanalli	9.94	5.33	10.05	5.39	10.26	5.46	10.43	5.48	10.21	5.32	9.97	5.16	9.28
7	Jamunalli	9.12	4.68	9.38	4.77	9.56	4.95	9.88	5.08	9.41	4.84	9.10	4.50	8.85



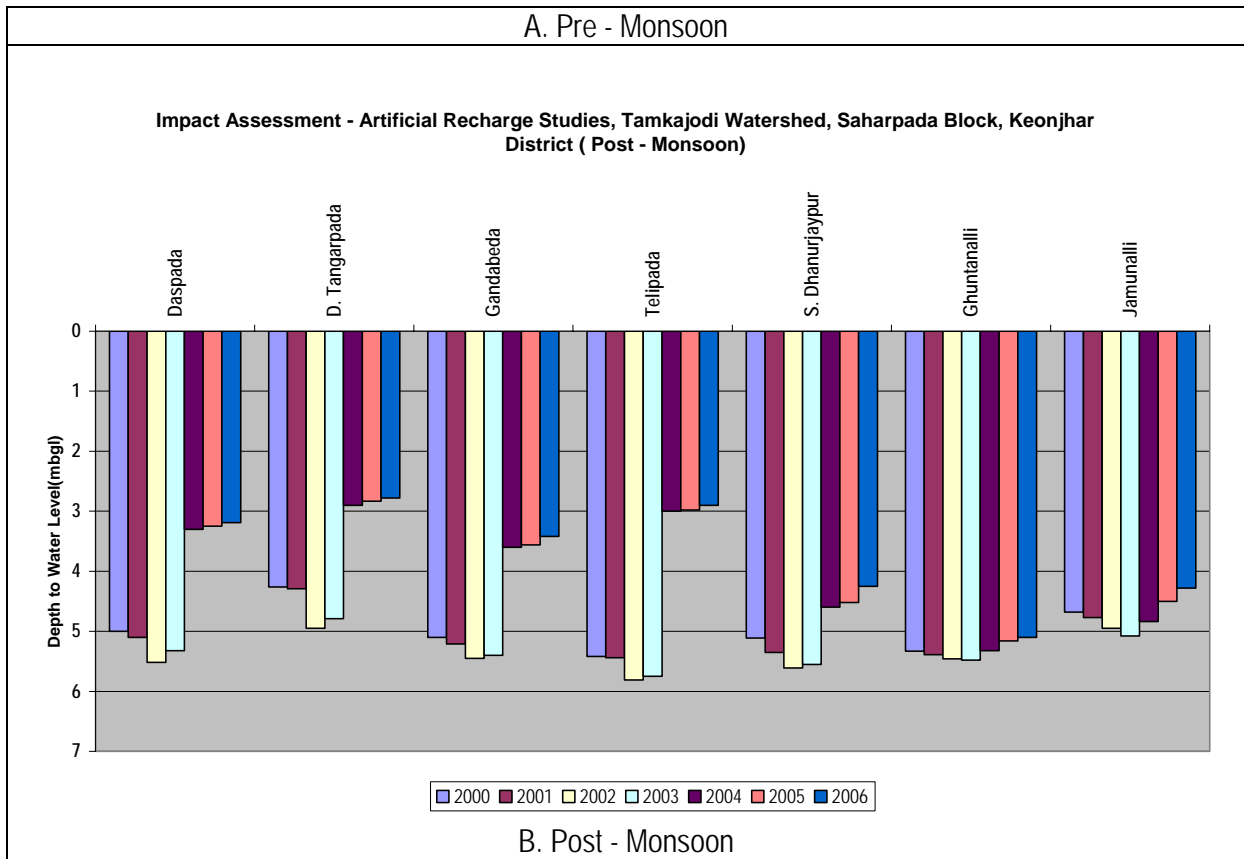


Figure 4.2(A-B) : Depth to Water level in Metres below ground level



A. Tamakjodi Watershed - Check Dam during Construction Phase



B. Tamakjodi Watershed - Check Dam After Completion



C. Tamakjodi Watershed - Percolation Tank during Construction

D. Recharge Well At Daspada

Figure 4.3(A-D) : Artificial recharge structures, Tamkajodi Watershed, Saharpada Block, Keonjhar District

4.3 Study of Artificial Recharge to Ground Water in Barkatia Watershed, Athgarh Block, Cuttack District

4.3.1 At a Glance

Watershed	Barkatianalla
Block	Athagarh
District	Cuttack
Approximate Project Area	20.00 Sq. Km.
Numbers and names of the villages covered	20 (Jemadeipur, Kapusingh, Sarkoli, Oranda, Gurudijhatia, Kotar, Pithakhia, Bali, Baula, Chotiambmba, Sitarampur, Khamarnuagaon, Kaduanuagaon, Chhagaon, Sauria, Gobara, Belda, Danduria, Kolalathapangi, Moharitaila)
Project Execution by	HP Division, Bhubaneswar
Total sanctioned cost of the Project:	Rs. 55.11 Lakhs
Total expenditure	Rs. 54.76 lakhs
Total volume Recharge	13X106 m ³

Table 4.4 : Artificial Recharge Structures (ARS) constructed in the Barakatianalla

Sl.No	Location (Village)	Recharge Dug Well	Recharge BW	Recharge TW	Recharge Pit	Recharge Tank	Renovation of Tank	Check Dam
1	Sitarampur	1	-	1	1	-	-	-
2	Oranda	1	1	-	1	-	1	1
3	Bali	1	-	-	1	2	1	-
4	Jemadeipur	1	-	-	-	1	-	-
5	Sarkoli	1	1	-	1	2	1	-
6	Baula	-	-	-	-	-	1	-
7	Kapursingh	-	1	-	-	-	1	-
8	Kolathapangi	-	1	-	-	3	-	-

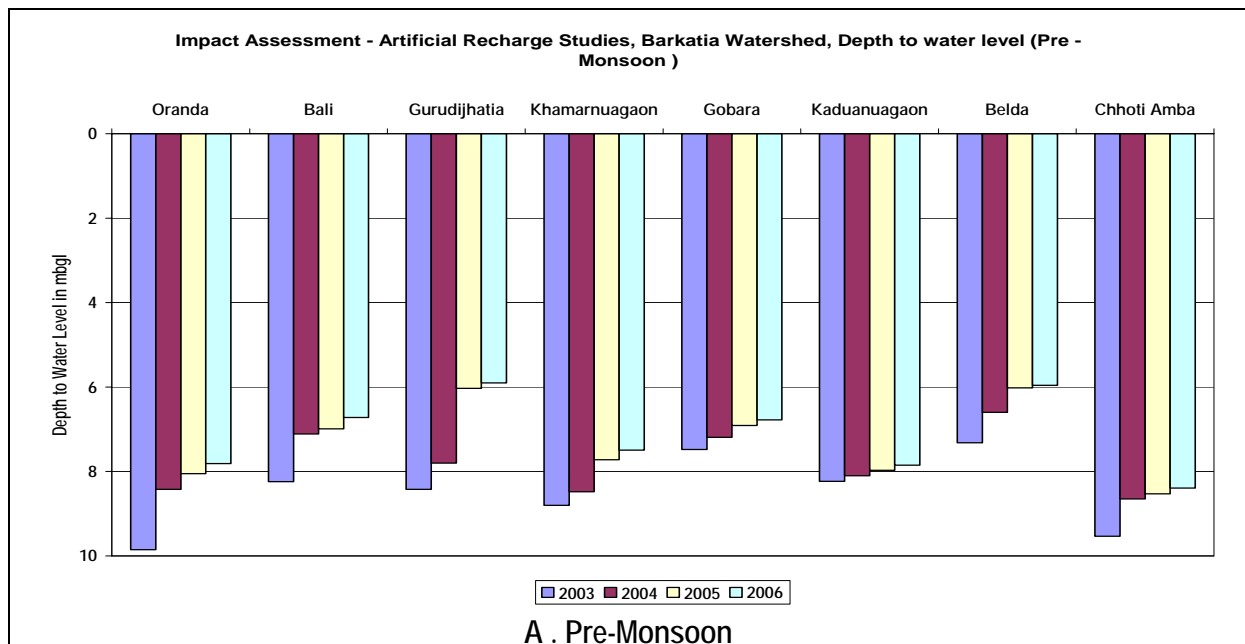
9	Souria	-	1	-	-	3	-	-
10	Pithakhia	-	-	1	-	-	-	-
11	Belda	1	-	-	1	3	-	-
12	Khamarnuagaon	1	-	-	1	-	1	-
13	Chotiamba	1	-	-	1	3	1	-
14	Gurudijhatia	3	-	-	3	-	1	-
15	Kotar	1	-	-	1	-	1	-
16	Danduria	2	-	-	2	-	1	-
17	Kaduanuagaon	2	-	-	2	-	-	-
18	Moharitaila	1	-	-	1	3	-	-
19	Gobara	2	-	-	2	-	-	-
20	Chhagaon	1	-	-	1	-	-	-
	Total	20	5	2	20	20	10	1

4.3.2 Impact Assessment

After execution of the above mentioned structures for artificial recharge, the impact of recharge through renovation of existing pond, recharge tanks, rooftop rainwater harvesting structures, check dam established in the command areas as well as the catchments in the project area were monitored regularly. From the monitoring it was observed that on an average there is a rise of 1 – 2.40 m of water level in the pre-monsoon and 0.6 – 1.07 m in the post-monsoon period. The quantum of recharge being around 55% of the total run off (13 X 10⁶ m³).

Table 4.5 : Impact Assessment – Depth to water level in metres below ground level(in Dug Wells) Barkatia Watershed, Athgarh Block, Cuttack District

SI No	Location	2003		2004		2005		2006	
		Pre	Post	Pre	Post	Pre	Post	Pre	Post
1	Oranda	9.85	5.02	8.42	4.76	8.05	4.41	7.81	4.05
2	Bali	8.24	5.01	7.11	4.95	6.99	4.28	6.72	4.1
3	Gurudijhatia	8.42	6.32	7.80	5.77	6.03	5.25	5.9	5.06
4	Khamarnuagaon	8.80	6.15	8.48	5.98	7.72	5.69	7.49	5.33
5	Gobara	7.48	5.05	7.19	4.83	6.91	4.54	6.78	4.42
6	Kaduanuagaon	8.23	6.01	8.10	5.89	7.97	5.51	7.85	5.47
7	Belda	7.32	5.78	6.60	5.22	6.02	4.87	5.96	4.69
8	Chhoti Amba	9.53	7.64	8.65	7.17	8.53	6.98	8.39	6.84



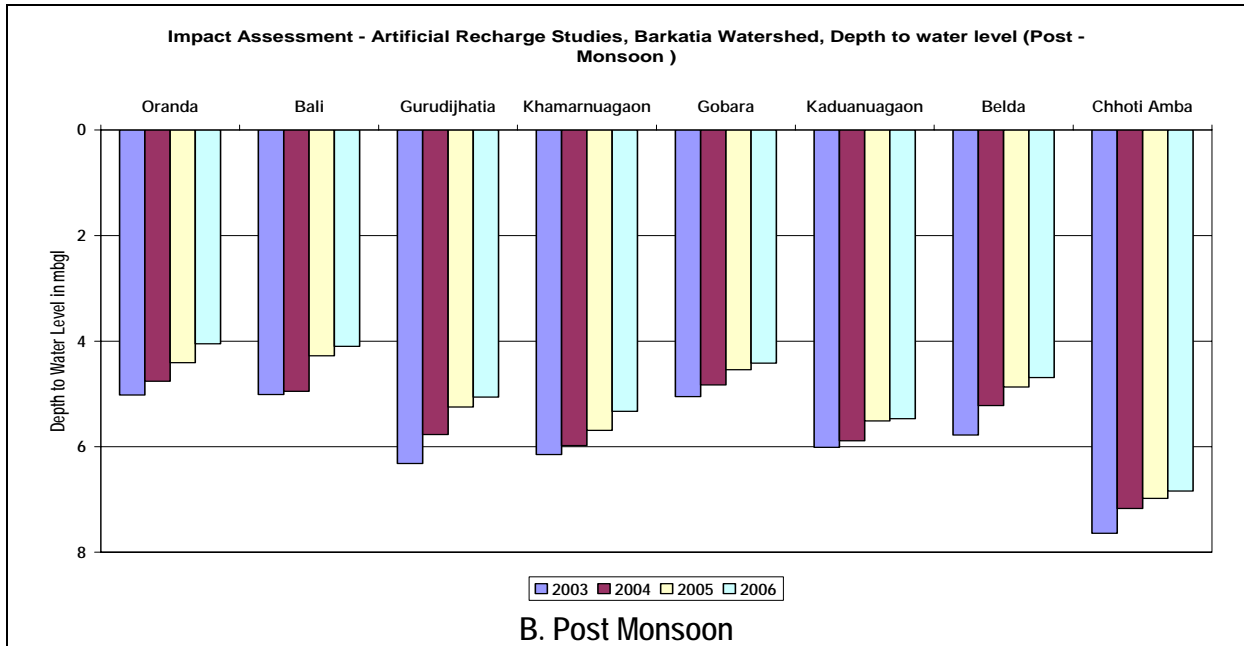


Figure 4.4 (A-B): Impact of Artificial Recharge – Depth to Water level(mbgl)
Barkatia Watershed, Athgarh Block, Cuttack District, Orissa

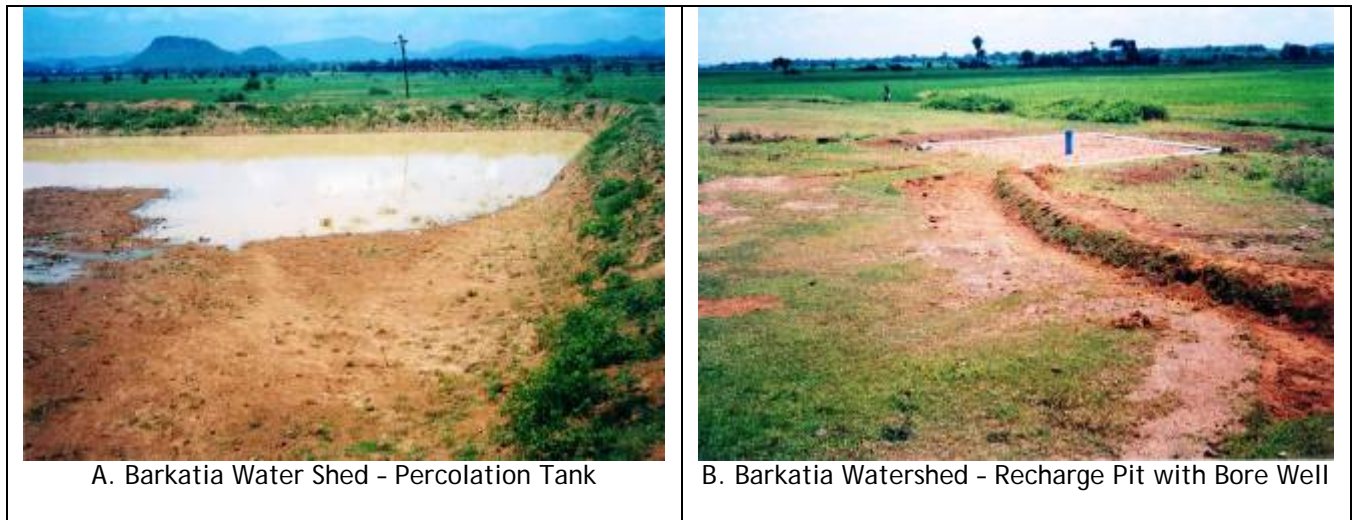




Figure 4.5 (A-D): Artificial Recharge Structures, Barkatia Watershed, Athgarh Block, Cuttack District

4.4 Roof Top Rain Water Harvesting at Hydrology Project Administrative Building, Bhubaneswar

4.4.1 At a Glance

Location	HP BUILDING, BHUBANESWAR
District	Khurda, Orissa
Year of construction	2004
Total rainfall	1691.07 mm
Total sanctioned cost of the Project	Rs. 8.13 Lakhs
Total amount spent	Rs. 8.56 Lakhs
Total volume of Recharge	2174.23 m ³
Rise in water table	0.70m (premonsoon) 2.04 m (post monsoon)
Formation	Sandstone.
Recharge Structures constructed	Recharge dug well (dia-6m) with three shafts of 125 mm dia.

Ground water is the only source of water in the campus of the Hydrology Project Administrative Building, Bhubaneswar. There are two bore wells in the campus and one additional bore well is for depth to water level monitoring which is fitted with DWLR. One dug well is excavated for recharge purpose.

HP administrative building is having a roof top area of 1000 sq. m and that of OWPO quarters is 800 sq. m. nearby Rengali Liason Office is 450 sq. m. The total Roof top area of the project is 2250 sq. m. 15 rainwater outlets at the roof top were connected to 15 number of PVC pipes of 100 mm diameter to bring down rain water to the collection and a first flush device too is installed. The collection chambers are half filled with gravels for rainwater filtration. The chambers are connected with 150 mm diameter PVC pipes with the excavated dug well at the backward of the building. The silt settling tank, filter chambers are properly arranged and the roof tops were maintained and cleaned regularly.

4.4.2 Impact Assessment

The project was monitored weekly and rainfall data, depth to water level and water quality data was collected on a regular periodicity. The monitoring records shows instant response of rain water harvesting in the dug well with a 1.5 – 2 m rise in water level from October 2003 to that of 2006. The comparison of water levels in the bore well and that in the dug wells are given below in table 4.5. However, in the year 2006 due to excessive pumping the water levels showed a pseudo decline.

Table 4.6 : Impact Assessment – Depth to Water Level, HP Building, Bhubaneswar

Year	Bore Well		Dug Well		Rainfall (mm)	Rainwater Harvested (m ³)
	Pre	Post	Pre	Post		
2000	12.60	10.24	-	-		
2001	14.80	8.88	-	-		
2002	14.31	9.79	-	-		
2003	15.20	8.01	8.70	5.24		
2004	13.82	8.50	7.80	4.50	1096	2096
2005	13.60	7.61	7.40	3.20	1579	2566.86
2006	15.00	9.30	7.25	3.00	1881	2174.23

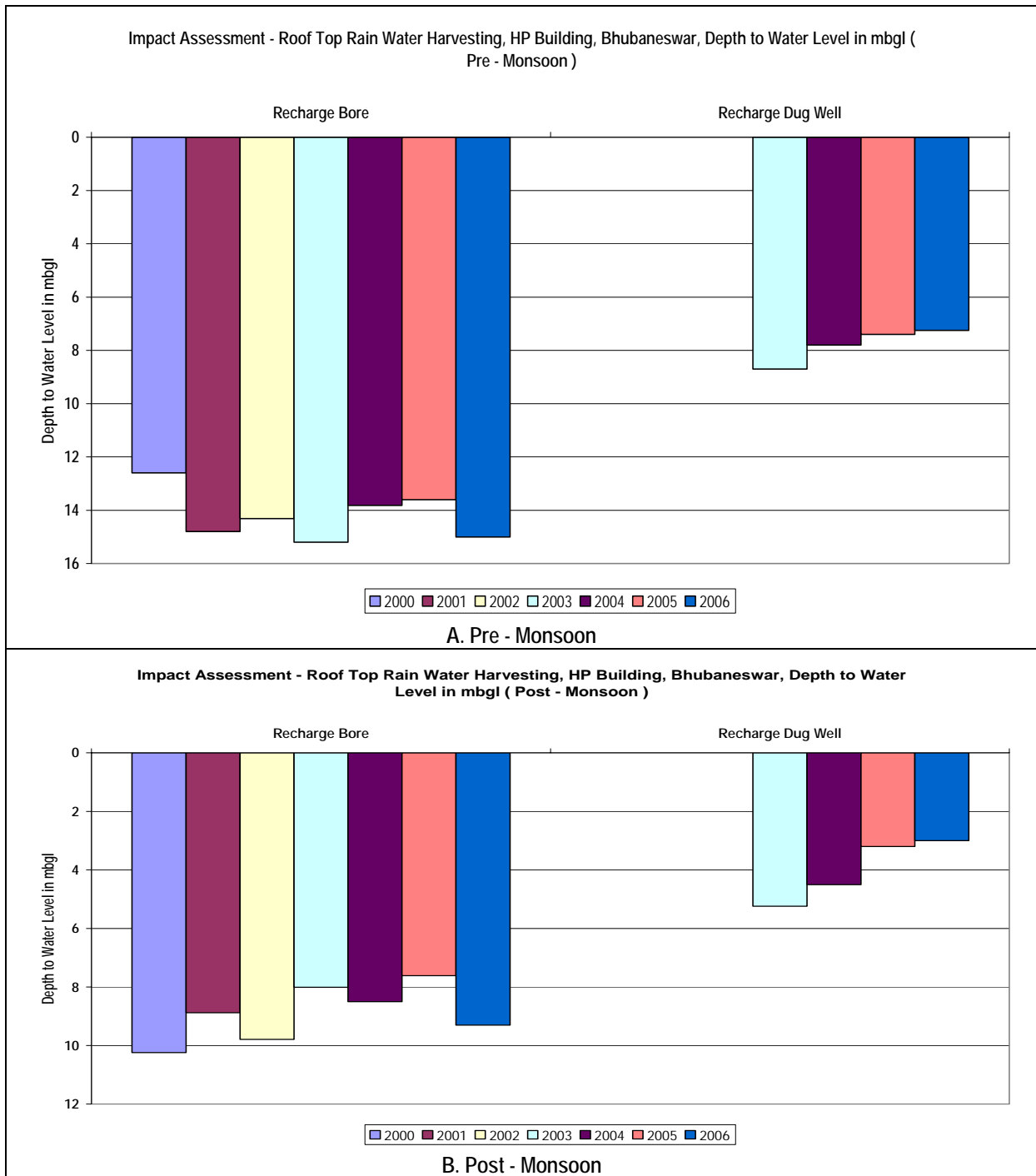


Figure 4.6 (A-B) : Impact Assessment – Roof Top Rain Water Harvesting, HP Administrative Building, Bhubaneswar

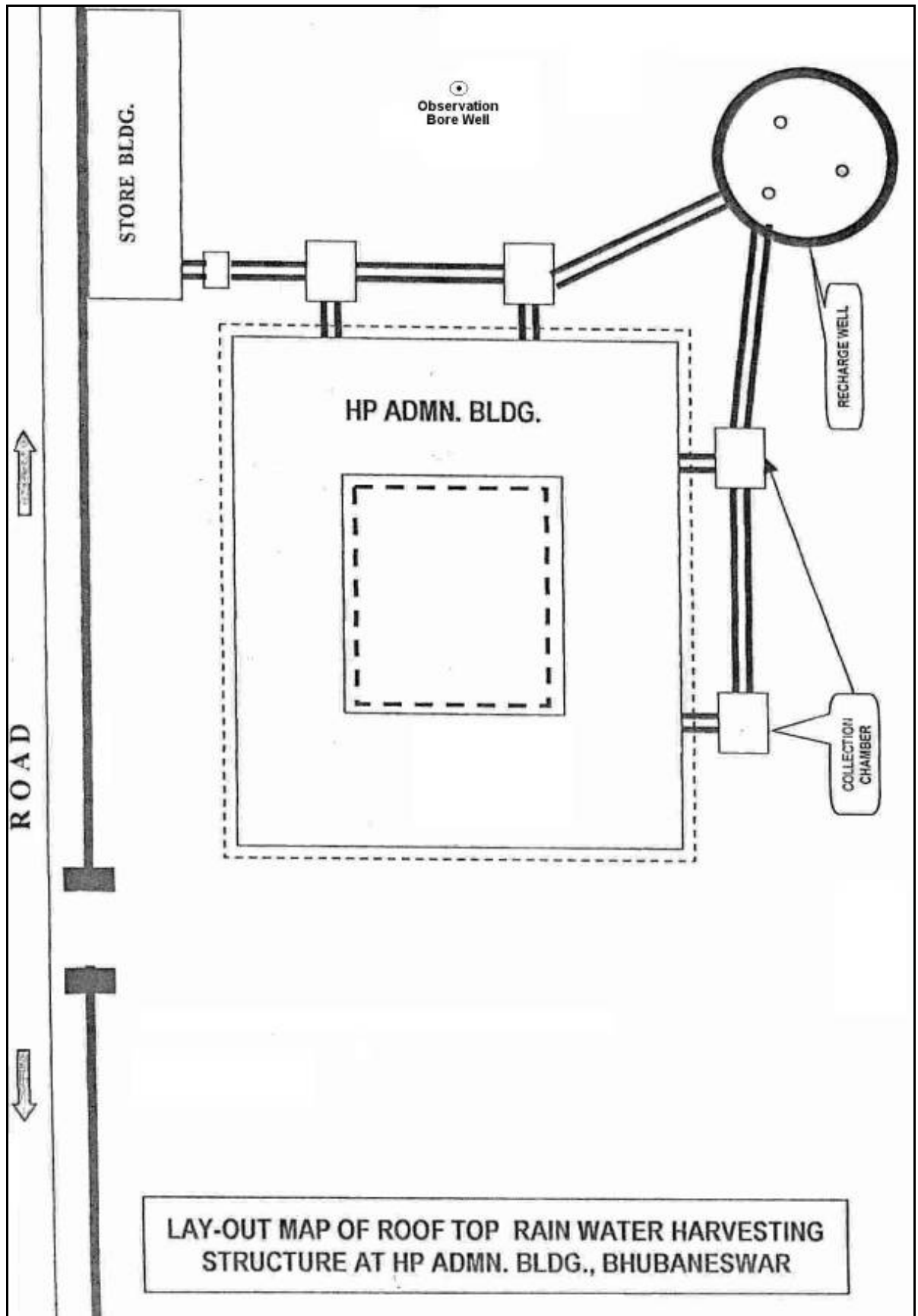


Figure 4.7 : Layout Map of Roof Top Rainwater Harvesting Structure at HP Administrative Building, Bhubaneswar

