भारत सरकार
जल संसाधन, नदी विकास और गंगा संरक्षण मंत्रालय
केन्द्रीय भूमि जल बोर्ड

GOVERNMENT OF INDIA

MINISTRY OF WATER RESOURCES, RIVER DEVELOPMENT & GANGA REJUVENATION

CENTRAL GROUND WATER BOARD

Artificial Recharge Plan for the Over Exploited Rahata Taluka of Ahmadnagar District

मध्य क्षेत्र, नागपुर
CENTRAL REGION, NAGPUR
जुलाई - 2016 / July - 2016

ARTIFICIAL RECHARGE PLAN AT A GLANCE

1.	Total Geographical Area of the Rahata Block (Taluka)	649.80 km^2			
	❖ Area occupied by Hard Rock (Basalt)	649.80 km^2			
	❖ Area occupied by Soft Rock (Alluvium)	-			
2.	Major land use pattern	Agriculture particularly sugarcane cultivation			
3.	Average Annual Rainfall (mm)	510 mm			
4.	Major Drainage	Parvara River			
5.	Area identified for Artificial Recharge *(considering average decadal (2005-14) post-monsoon water level more than 5 m bgl, long term post-monsoon water level trend, depth of weathering and lineaments)*	507.00 km^2			
6.	Overall quality of groundwater	Suitable for domestic, industrial and irrigation use			
7.	Availability of Surplus surface runoff (MCM)	72.885 MCM			
8.	Surplus surface runoff considered for planning (MCM)	26.66 MCM			
9.	Runoff for RWH in Urban Household	0.140 MCM			
10.	Sub-surface storage potential available (MCM)	22.66 MCM			
11.	Proposed Artificial Recharge & Water Conservation Plan				
	Item	**Percolation Tank**	**Check Dam**	**Water Conservation Structure**	**Roof Top Rain Water Harvesting (for 10% houses)**
	❖ Proportionate Allocation of surplus runoff MCM)	18.66	6.66	1.34	0.140
	❖ Feasible number of structures	93	222	89	6471
	❖ Unit cost of structures (Rs. Crores)	0.70	0.07	0.0025	0.0008
	❖ Estimated Cost (Rs. Crores)	65.10	15.54	0.2225	5.17
	❖ Expected Recharge (MCM) (considering 85 % efficiency)	15.86	5.66	1.14	0.12
12.	Total estimated cost (Rs. Crores)	Rs. 86.03 crores			

Artificial Recharge Plan for the Over Exploited Rahata Taluka of Ahmadnagar District

1. INTRODUCTION

Groundwater being most dependable source of water supply is under tremendous stress to meet the ever increasing demand of irrigation, industrial and domestic sector. The over exploitation of this resource has resulted in to decline in water levels in many part of the Country and many of the water assessment units are thus categorised as over-exploited blocks. The state of Maharashtra also faces the problem of groundwater over- development in some of the areas. Many talukas have been identified as Critical / Over-Exploited based on the ground water resources estimation based on GEC-97 Methodology. As per the latest groundwater resource assessment as on March 2011, 10 talukas have been identified as Over-Exploited.

Immediate remedial measures are therefore required to be taken up for converting these talukas into Critical / Semi-critical / Safe categories. The present artificial recharge plan has been prepared for the Rahata taluka of Ahmadnagar district which will form the base for the future strategy.

2. LOCATION

The Rahata Taluka lies on the northern central part of Ahmadnagar district and lies between North latitude 19° 44' to 19°46'43" and East longitude 74°24'29" to 74°27' 15". It covers geographical area of 759.20 sq. Km. (**Fig.1a and 1b)**. The population of the taluka is 3,20,485 persons as per 2011 census. There are 55villages in the taluka. The Rahata taluka is known for its sugarcane cultivation.

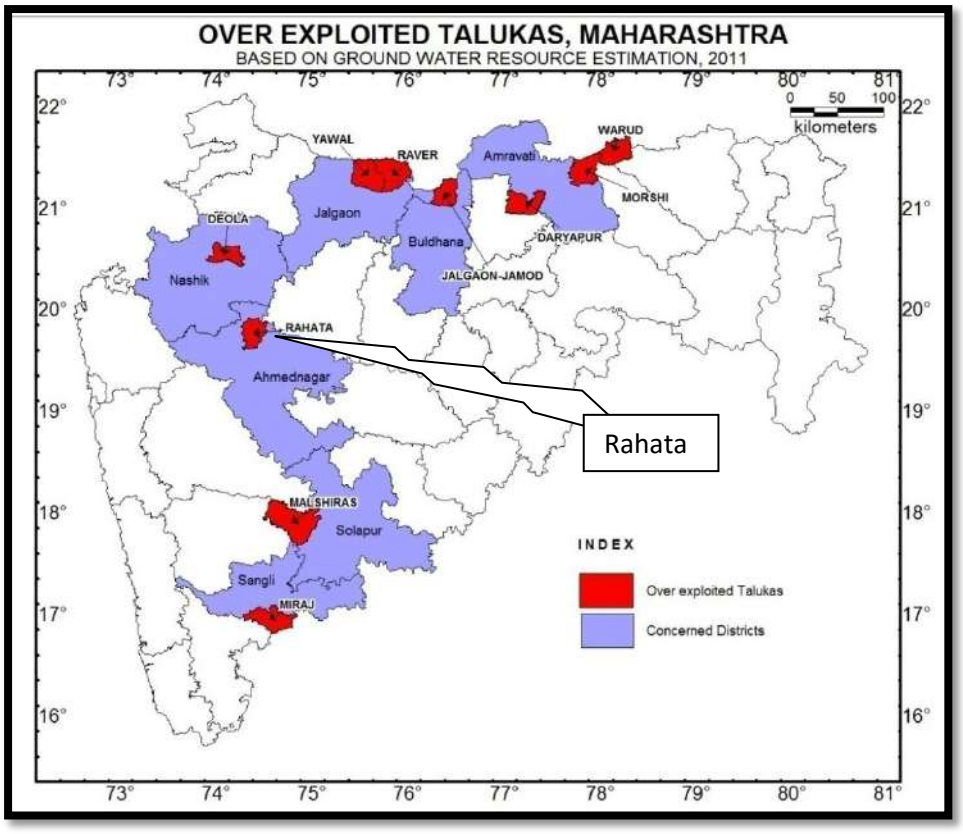


Figure1a: Location of Rahata taluka, Ahmadnagar District, Maharashtra

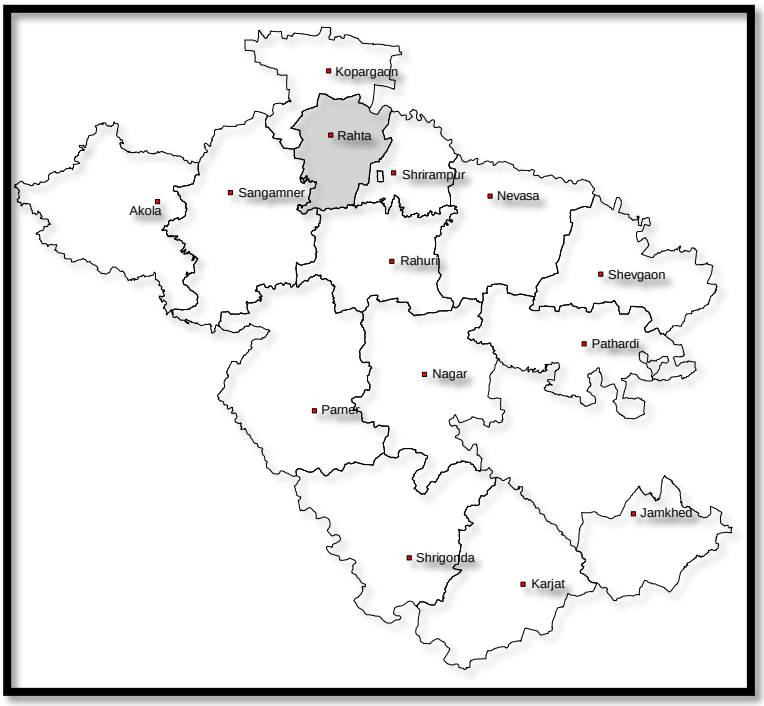


Figure1b: Location of Rahata Taluka, Ahmadnagar District

3. PHYSIOGRAPHY & DRAINAGE

Physiographically the taluka forms part of Deccan Plateau. The taluka is more or less a plain area with small hill ranges in the South-western part of the taluka. The topographical elevation ranges from 520 m above MSL to 420 m amsl (**Fig. 2a**).The taluka is mainly drained by Pravara river and its tributaries. The sub dendritic to dendritic drainage pattern is observed in the taluka. The drainage is mainly geomorhologically controlled in the taluka. A digital elevation model of Rahata taluka indicating the village boundaries is shown in **Fig. 2b**.

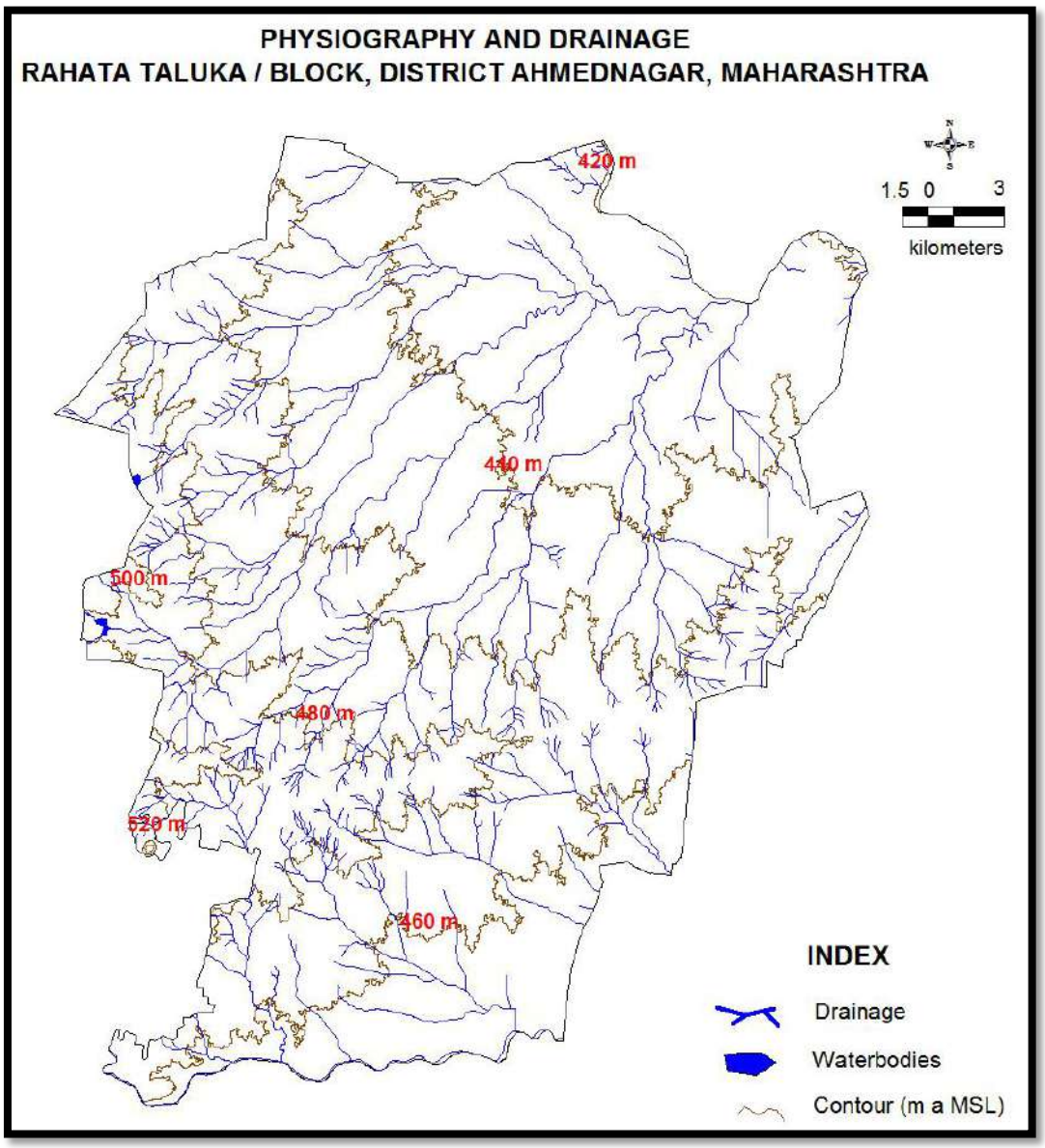


Figure2a: Physiography and Drainage, Rahata Taluka

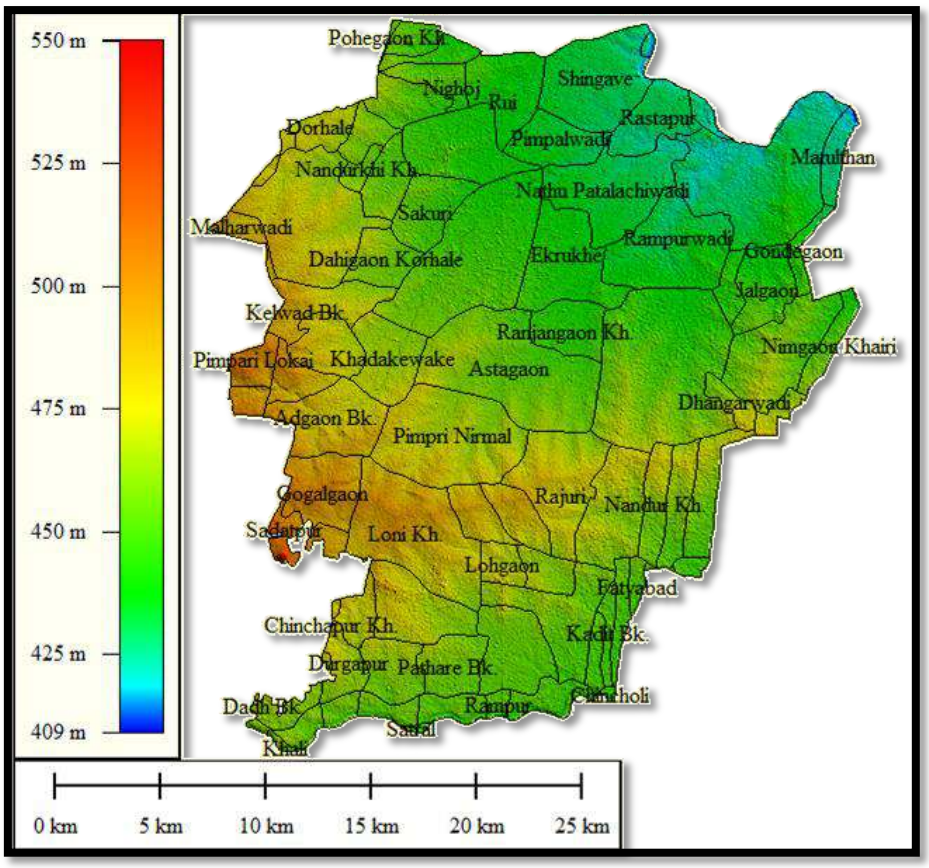


Figure2b: Digital Elevation Model, Rahata Taluka

4. RAINFALL

The area receives rainfall due to the south-west monsoon and about 90% of the rainfall takes place during the months of June to September. The Taluka is situated in the "Rain Shadow" zone of Western Ghats, it often suffers the drought conditions and receives average annual rainfall of about 510 mm and hence talukas comes under "Drought Area" of Maharashtra.

5. LAND USE PATTERN

The land use of the area prominently reflects significance of agriculture activity, with isolated scattered patches of notified forest area and unmodified hilly forest. The double-crop (Kharif and Rabi) area is evenly distributed in the entire taluka, especially sugarcane crop.

6. HYDROGEOLOGY

Rahata taluka is covered by Deccan Trap Basalt, belonging to upper Cretaceous to lower Eocene age occurs in the entire taluka where the ground water potential is not

uniformly distributed due to inherent heterogeneity of the formation. These flows occur in layered sequence ranging in thickness from 15 to 50 m. Flows are represented by massive portion at bottom and vesicular portion at top and are separated from each other by marker bed known as bole bed. The thickness of weathering varies widely in the district form 5 to 25 m bgl. The weathered and fractured trap occurring in topographic lows form the main aquifer in the taluka.

The ground water occurs under phreatic, semi-confined and confined conditions. Generally the shallower zones down to the depth of 20 m bgl form phreatic aquifer. The water bearing zones occurring between the depths of 20 and 40 m are weathered interflow or shear zones and yield water under semi-confined conditions. Deeper semi-confined to confined aquifers occur below the depth of 40 m as the borewells drilled have shown presence of fractured zones at deeper depths at places. The vesicular portion of different lava flows varies in thickness from 8 to 10 m and forms the potential aquifer zones **(Fig. 3)**.

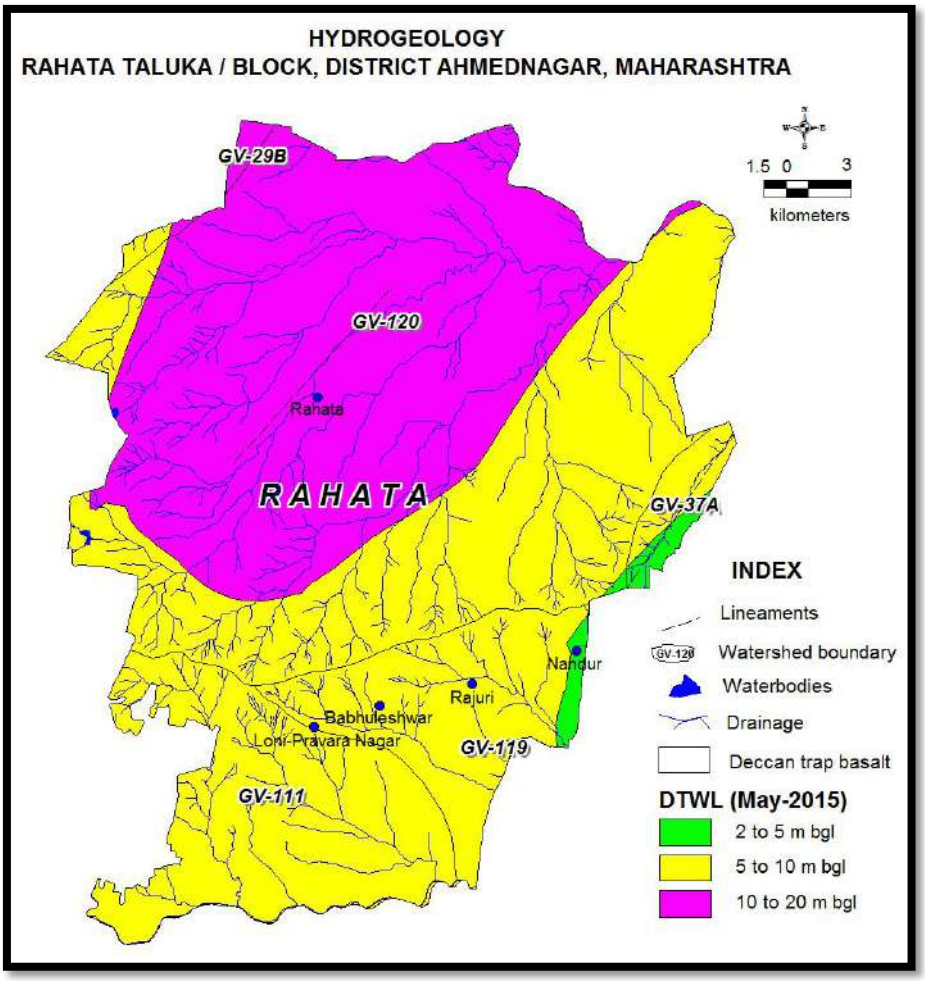


Figure 3: Hydrogeology, Rahata Taluka

7. GROUND WATER LEVEL SCENARIO

CGWB regularly monitors ground water levels in the taluka 4 times in a year during May, August, November and January through its network of Ground Water Monitoring Wells (GWMW). The water levels recorded during the pre-monsoon season in May (2014), ranging from 5.8-14.05 m bgl. Shallow water levels within 10 m bgl are observed in major parts of the taluka. Moderately deeper water levels between 10-20 m are observed in northern parts of area (**Fig 4**). The water levels recorded in post-monsoon season (Nov. 2014) are ranging from 3.7- 12.40 m bgl. Shallow water levels within 10 m bgl are observed in major parts of the taluka covering southern and central parts. Moderately deeper water levels between 10-20 m are confined to northern parts of area (**Fig 5**).

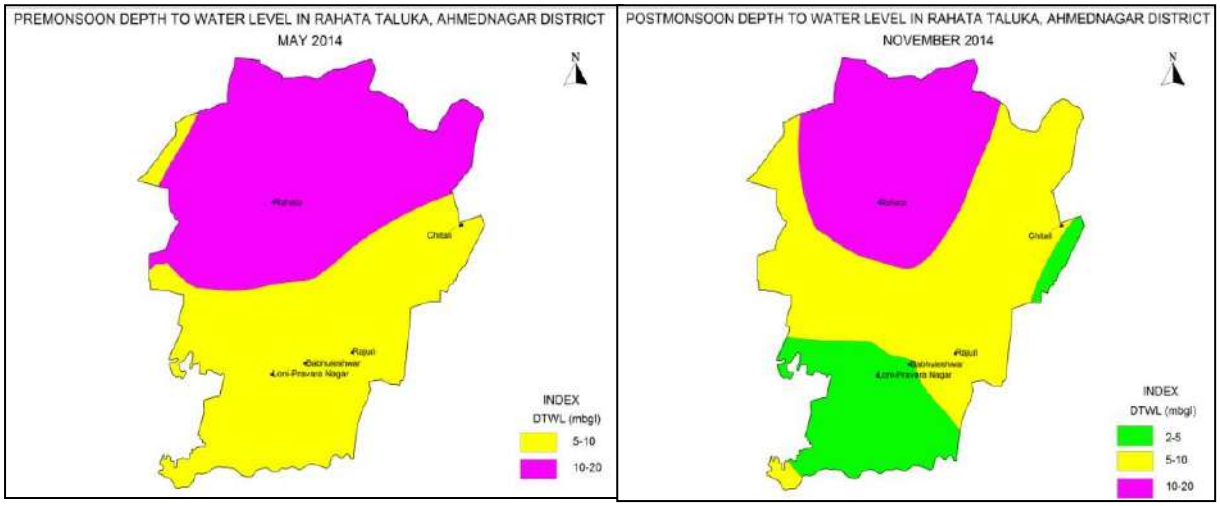


Fig 4 and 5: Pre and Post-monsoon (2014) Depth to Water Level, Rahata Taluka

The overall ground water quality in the taluka is good and suitable for drinking and irrigation purpose. The EC ranges from 510 to 770 microsiemens/cm; TH ranges from 225 300 mg/l and Fluoride ranges from 0.12 to 0.81 mg/l.

8. DYNAMIC GROUND WATER RESOURCE

Ground Water Resources Assessment for the year 2011 indicates Net Annual Ground Water Availability of 9511.48ham, draft for all uses is 9891.87ham with irrigation being the major consumer withdrawing 9737.37 ham and stage of ground water development is also high about 104% **(Table 1)**. The taluka is categorised as Over Exploited. The comparison of 2009 and 2011 ground water resource assessment indicates that the stage of ground water development has decreased from 141.42% in 2009 to 104% in 2011. So far the taluka has not been notified by CGWA/SGWA for ground water regulation.

Table 1: Dynamic Ground Water Resources of Rahata Taluka (As on March 2011)

Sl. No.	Particulars	GW Resources (Ha.m)
1.	Net Annual Ground Water Availability	9511.48
2.	Existing Gross Ground Water Draft for irrigation	9737.37
3.	Existing Gross Ground Water Draft for domestic and industrial water supply	154.50
4.	Existing Gross Ground Water Draft for All uses	9891.87
5.	Provision for domestic and industrial requirement supply to 2025	250.71
6.	Net Ground Water Availability for future irrigation development	77.19
7.	Stage of Ground Water Development	104 %
8.	Category of the Assessment Unit	Over Exploited

9. NEED FOR ARTIFICIAL RECHARGE AND CONSERVATION MEASURES

Rahata taluka is major sugarcane growing area in Marathwada region of Maharashtra. For cultivation of perennial sugarcane crop, huge amount of groundwater is required. This has led to over-exploitation of groundwater resources from both the shallow and deeper aquifers in the taluka. These practices are being continued since last few decades and stage of groundwater development in the taluka even exceeded more than 100% of its natural recharge which lead to heavy depletion of ground water level. The over development of ground water has brought the taluka in over exploited category. Therefore there is an urgent need for taking up various artificial recharge and water conservation measures in the area.

10. JUSTIFICATION OF THE ARTIFICIAL RECHARGE PROJECT

The various State Government Agencies like department of Agriculture, Irrigation, Forest have already taken up some water conservation / artificial recharge measures in Rahata taluka. However, a robust consolidated plan for artificial recharge measures are also required for converting the entire Over-Exploited Rahata taluka into Critical / Semi-critical / Safe category.

11. FEASIBLE AREA FOR ARTIFICIAL RECHARGE OR CONSERVATION

The feasible area for artificial recharge to groundwater in Rahata taluka has been identified based on the following criteria's.

1. Long term average decadal post-monsoon depth to water level (2005-2014)
2. Long term post-monsoon water level trend (2005-14)
3. Depth of weathering in the taluka
4. Lineaments in the area

Thematic layers are prepared for all the above mentioned four criteria's and are superimposed on one another to generate the integrated map for identification of the feasible area for artificial recharge. The long term post-monsoon depth to water level data for the period 2005-14 reveals the deepest water level of 10.00 m bgl. Water level contour map is prepared wherein 2 categories of observed water levels are made i.e. less than 5 m bgl and 5 to 10 m bgl **(Fig. 6)**. Area having depth to water level less than 5 m bgl is not recommended for artificial recharge to ground water since it may lead to water logging and leaching of salts problems.

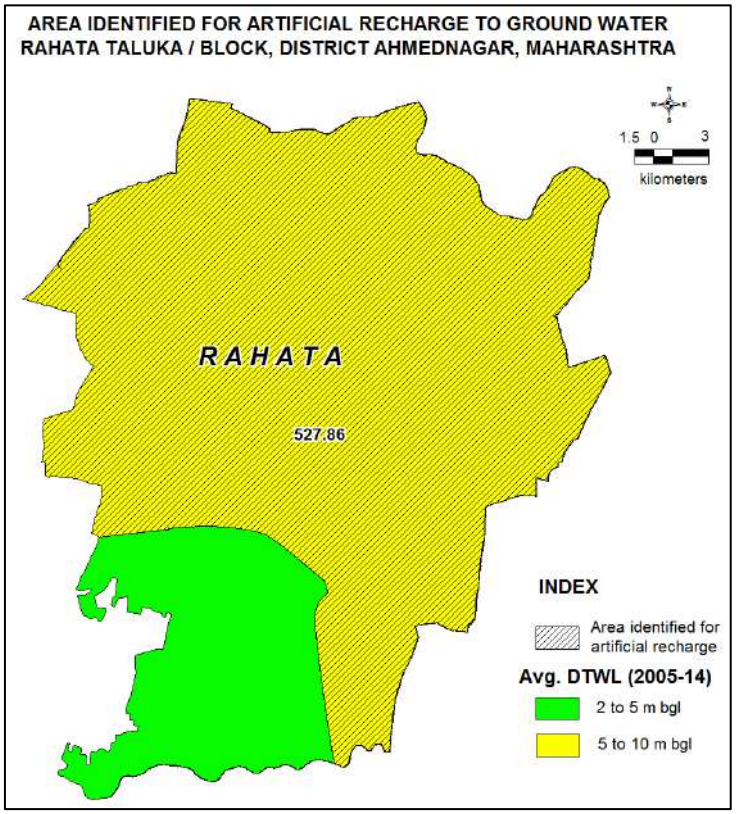


Fig 6: Average Decadal Post-monsoon depth to water level, Rahata Taluka

The depth to water level map reveals that an area of 528.00 is having depth to water level more than 5.0 m bgl.

The long term water level trend map for the period 2005-2014 has been prepared and is shown in **Figure 7**. The water level trend map reveals both the rising water level trend from 0.0 to 0.2 m/year and falling water level trend 0.0 to 0.6 m/year and 0.2 to 0.4 m/year. The area showing rising water trend has been excluded for taking up artificial recharge measures in the area and the area showing falling water level trend is only considered and recommended for artificial recharge to groundwater in Rahata taluka **(Fig 7).**

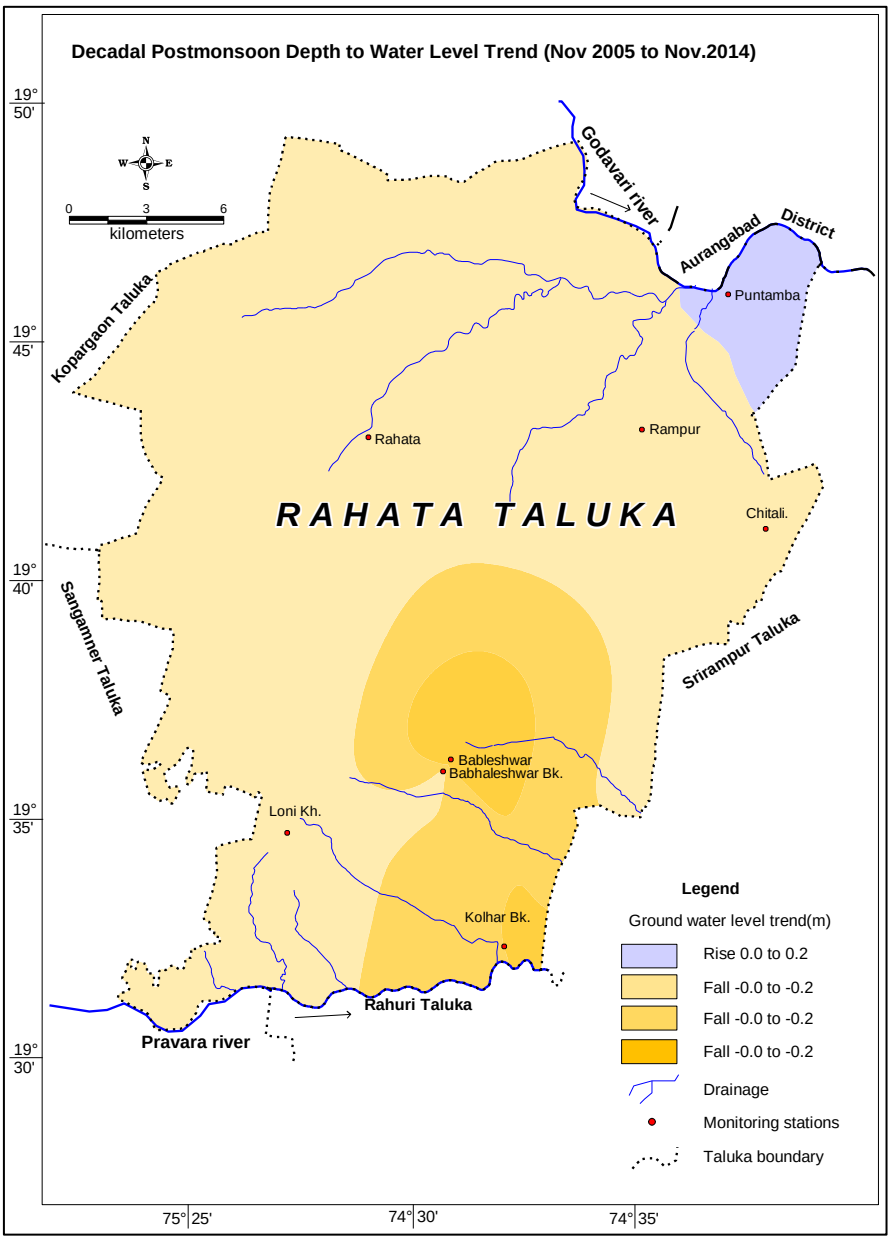


Figure 7: Map showing long term post monsoon water level trend (2005-14)

Based on the data available on depth of weathering form key wells established during the various hydrogeological studies in the area and also groundwater exploration data, a map showing area under various categories of depth of weathering has been prepared and considered for preparation of artificial recharge plan **(Fig. 8)**. The map reveals that most of the area of Rahata taluka is having sufficient thickness of weathered zone varying from 10 to 35 m and therefore found feasible for artificial recharge to groundwater. Some of the area of Rahata taluka in its northern part is also traversed by few lineaments (**Figure 9)** indicating promising scope for artificial recharge in that area.

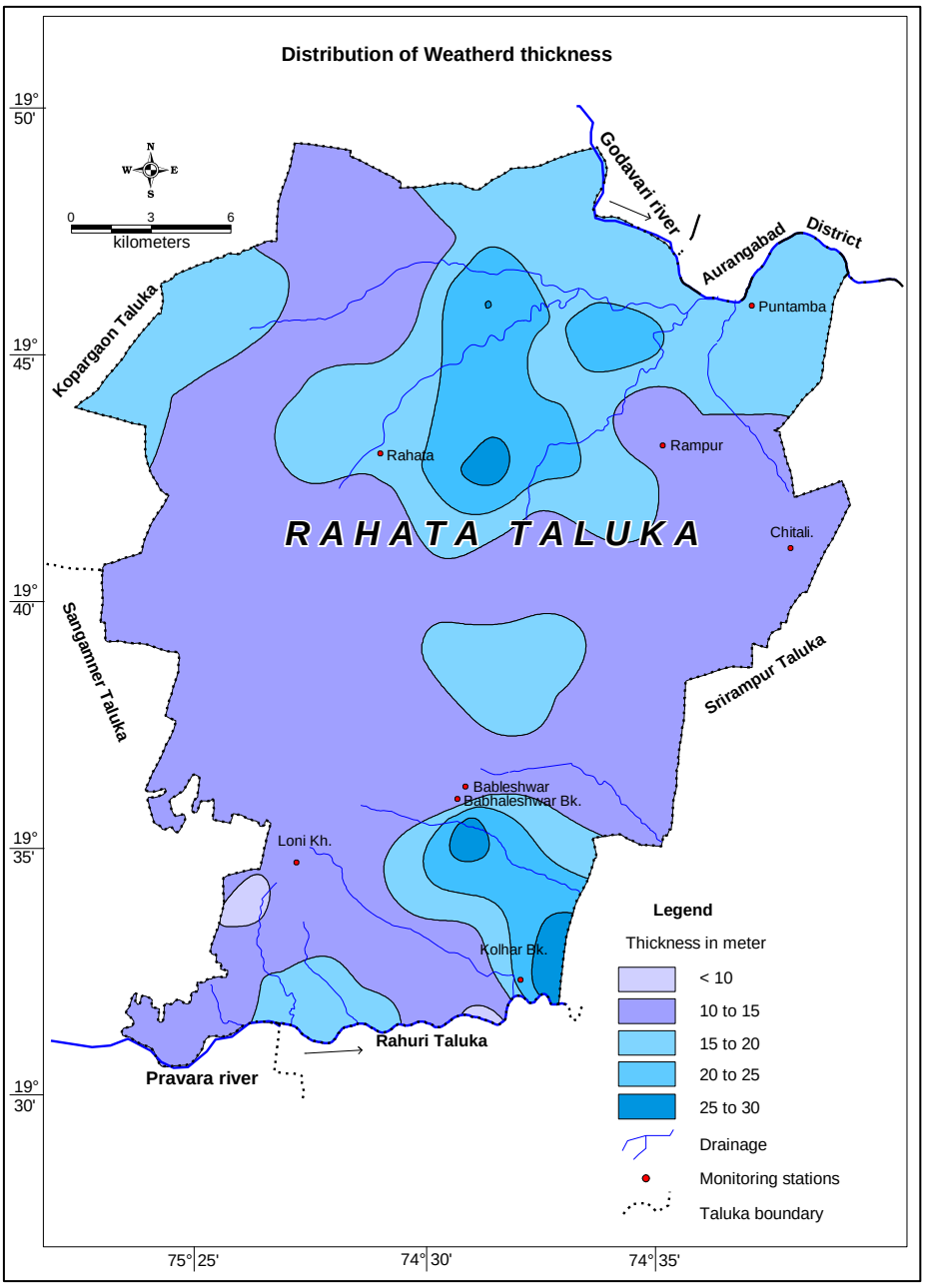


Figure 8: Map showing weathered thickness in Rahata taluka

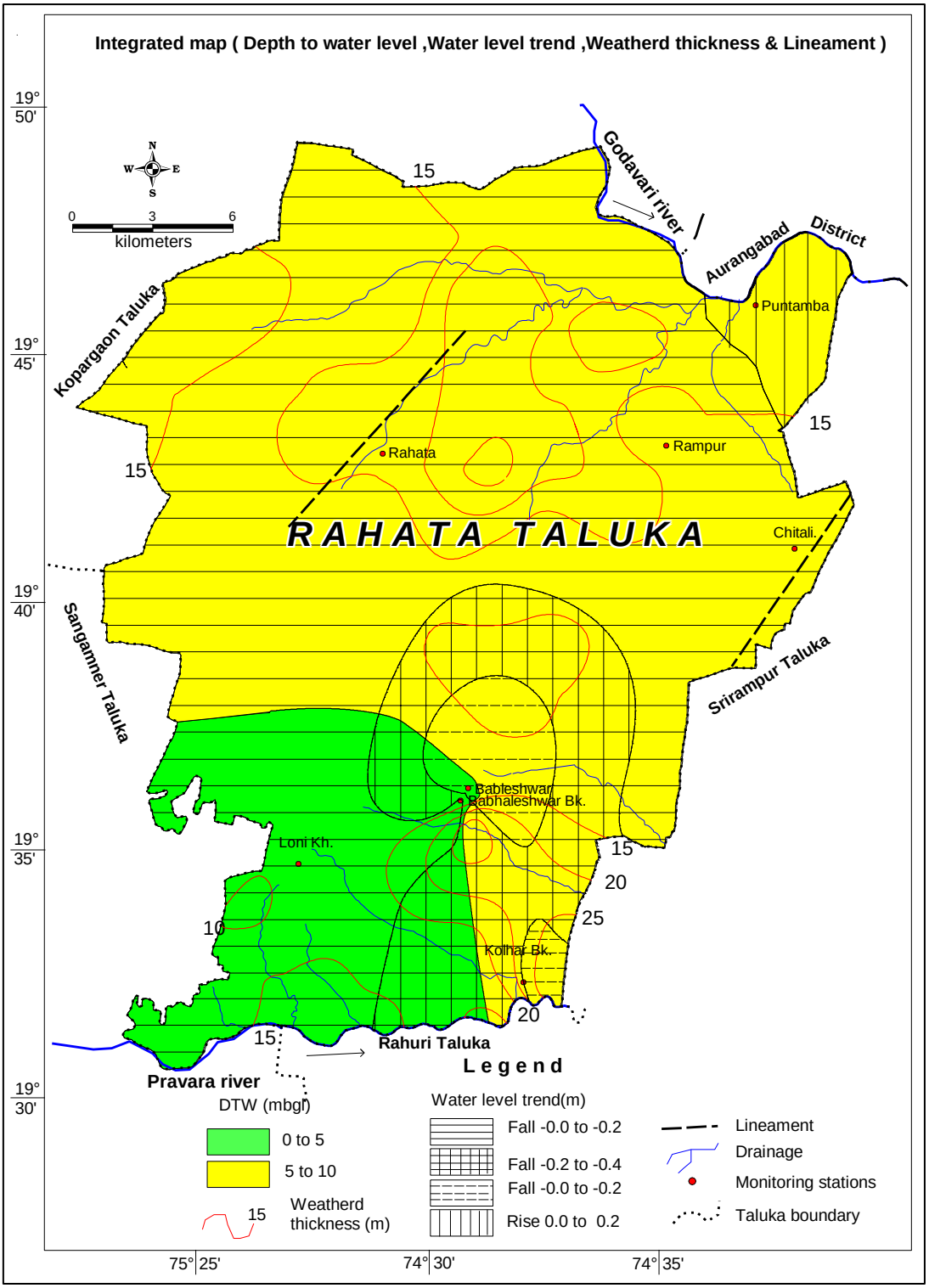


Figure 9: Integrated Map showing feasible area for artificial recharge to groundwater in Rahata taluka

An integrated map containing all the layers i.e. depth to water level, water level trend and weathered thickness, lineaments is prepared and is shown in **Figure 9**. Based on the map, an area of 507.00 sq.km is identified for artificial recharge to groundwater.

12. AVAILABILITY OF SURPLUS SURFCE WATER FOR ARTIFICIAL RECHARGE OR CONSERVATION

The availability of non-committed surplus runoff as source water is one of the main requirements for any artificial recharge scheme. In India in general and Maharashtra in particular, the monsoon rainfall is the chief source of water which can be utilized for artificial recharge. Normally the surplus / non-committed monsoon runoff can be utilized as source water for artificial recharge scheme.

The rainfall received during northwest monsoon between June and September is the principal source of water in the state of Maharashtra. The actual availability of surface water in the area depends upon the rainfall incidences, climate, Physiography, land use and hydrogeology. These components vary drastically in space and time and is not uniform in the state of Maharashtra. Therefore basin and sub-basin wise availability of water and its utilization status is considered to depict the realistic scenario of source water availability. For this purpose the hydrological data available with the state government was collected and compiled basin wise for Godavari, Krishna and Tapi basins.

Rahata taluka of Ahmadnagar district falls in Godawari river basin. The total geographical area of Godawari basin is 312812 sq.km. in Maharashtra. As per the Irrigation Department, Government of Maharashtra it has the surplus surface runoff of 44969MCM in Maharashtra. Thus, the proportionate surplus surface water availability for Rahata taluka which forms part of Godawari basin comes out to be 72.885 MCM whereas the sub-surface storage potential in Rahata taluka is 22.66 MCM. To create the sub-surface storage potential of 22.66 MCM, about 26.22 MCM of surface water will be required considering the recharge efficiency of 85 %. The total availability in the Rahata taluka is estimated as 72.885 MCM. Therefore 26.22 MCM surplus surface water has been considered for preparation and implementation of master plan for artificial recharge in the over-exploited Rahata taluka and for estimation of number of structures required for augmentation of groundwater resource in the area. The estimated availability on surplus surface runoff in Morshi taluka is finalised in consultation with the State Government and hence confirmed for taking up artificial recharge measures in the taluka.

13. FEASIBLE ARTIFICIAL RECHARGE / CONSERVATION STRUCTURES

Hydrogeology, Physiography, climatic conditions and source water availability are the major factors which affect the selection of site, dimension of the artificial recharge scheme. The surface spreading techniques consisting of percolation tanks and cement plug/bund/check dam are most appropriate techniques in areas occupied by hard rocks. In alluvial areas i.e. alluvial part of Tapi and Purna basin, the percolation tanks in mountain fronts and recharge shaft in alluvial/bazada zone are the most feasible structures. Accordingly these structures have been recommended for artificial recharge to groundwater. Other structures like continuous contour trenches, gabion structures, nala bunds, village ponds etc. may also be taken up side by side which would be more appropriate for soil and moisture conservation. The underground bandharas or sub surface dykes are ground water conservation structures and hence can be taken up a site specific location to conserve the ground water. Beside this roof top rain water harvesting and storm water harvesting in public parks, play grounds are the most appropriate techniques as in urban areas most of the nala / river carries domestic sewage and non-availability of land for submergence.

Various artificial recharge studies carried out by CGWB so far in the State of Maharashtra and the findings of the artificial recharges schemes implemented under Central Sector Scheme are highly helpful is preparation of plan for artificial recharge for any given area. The findings of these studies / schemes are considered in formulating the artificial recharge plan and are mentioned below.

- A percolation tank of 100 Thousand Cubic Metre (TCM) capacity (single filling) will actually store 200% more due to multiple fillings during monsoon. This will have gross storage capacity of 200 TCM. However, desilting of percolation tank on regular basis in 1-2 year before the onset of monsoon should be carried out for effective infiltration of stored water into the sub-surface.
- A check dam / cement plug of 10 TCM capacity (single filling) will actually store 300 % more due to multiple fillings in monsoon. This will provide gross storage of 30 TCM for check dam. However, it is also required to be desilted to maintain the storage capacity and recharge efficiency.
- Unlike various water conservation schemes, percolation tank and check dam provide about 85% recharge to ground water out of total storage.

- With regard to the amount of surface water considered for planning the artificial recharge, it can be considered that 70 % storage would be through percolation tank and remaining by check dam.

The number of recharge structures required to store and recharge the ground water reservoir have been worked out as follows

$$\text{No. Of structures} = \frac{\text{Total surface water considered}}{\text{Average gross capacity of Percolation Tank/Check Dam (considering multiple fillings)}}$$

Based on the above field findings, it is proposed to allocate about 70% of the surplus water for construction of percolation tanks, about 25% surplus water for construction of check dam. The remaining 5% surplus available water is proposed for allocation for construction of various water conservation structures like loose boulder structures, gabbion structures etc. The average recharge efficiency of artificial recharge structure is considered as 85% on safer side.

The tentative locations of proposed artificial recharge structures are shown in **Figure 10** and the location of sites are listed in **Annexure – I**. The design of percolation tank and check dam are presented as **Annexure-II**. However, the final design of the individual structures will be site specific and will be prepared based on the hydrogeological survey in consultation with the implementing agency.

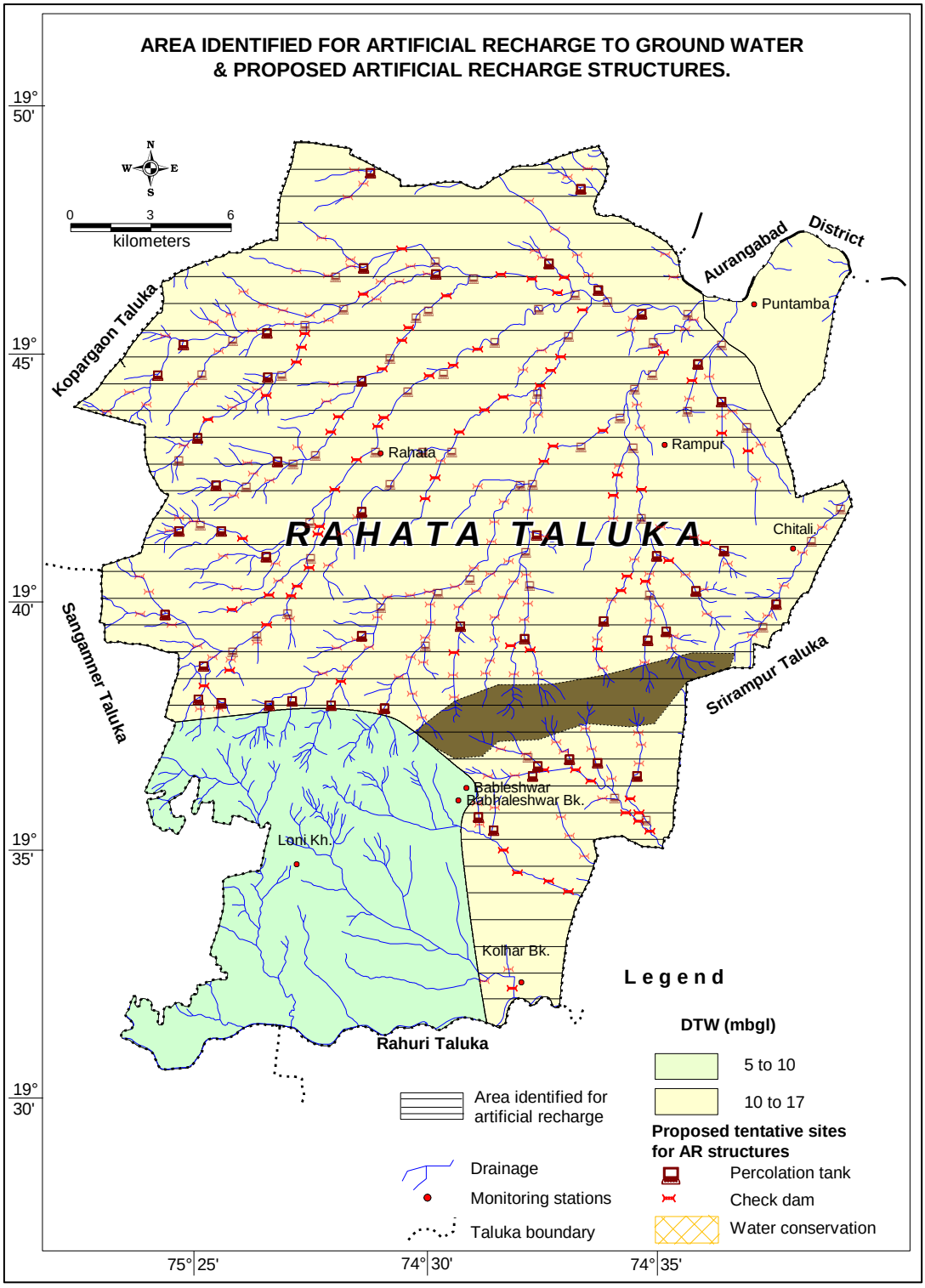


Figure 10: Tentative sites of percolation tank, Check Dam and Water Conservation Structure, Rahata Taluka

14. TENTATIVE COST ESTIMATES

For estimating the tentative cost for construction of various types of artificial recharge and water conservation structures, schedule of rates **(**SOR) of Government of Maharashtra available for the year 2011 have been considered. In the state of Maharashtra, SOR of each district vary marginally from each other. It is estimated that the total expenditure to be incurred for construction of various water conservation and recharge structures will be Rs. 86.03 crores (As per 2011 SOR). However, it is likely that the actual cost will vary depending upon the actual period of construction and location of sites which will be finalised after detailed hydrogeological consultation and survey by the implementing agencies.

Percolation Tanks

It is estimated that the total available surplus water for recharge through percolation tank is 18.66 MCM. Thus about 93 percolation tanks shall be required to be constructed in Rahata taluka. Considering the recharge efficiency of 85%, it is expected that about 15.86 MCM of surface water shall be recharged. As per the SOR available for the year 2011, it is estimated that for construction of one percolation tank with average gross capacity of 200 TCM, Rs. 70 lakh will be required. Therefore the total estimated cost involved for construction of 93 percolation tanks will be Rs. 65.10 crores. For enhancing the ground water recharge, it is proposed to utilise the stored water of the percolation tanks for irrigation of the surrounding areas.

Check Dams

It is estimated that about 6.66 MCM of surplus was can be made available for construction of check dams. Hence it is estimated that about 222 check dam can be constructed to recharge the proportionate allocated surplus water of 6.66 MCM. Considering the recharge efficiency of 85%, it is expected that about 5.66 MCM of surface water shall be recharged into sub-surface. The SOR available for the year 2011 indicate that for construction of one check dam with average gross capacity of 30 TCM, Rs. 7 lakh will be required. Therefore, the total estimated cost involved for construction of 222 check dams will be Rs. 15.54 crores.

Water Conservation Structures

After the allocation of surplus runoff water for the major structures like percolation tanks and check dams, the remaining quantum of surplus water can be taped by means of feasible water conservation structures for soil and water conservation. Thus about 1.34 MCM of surplus water can be made available for water conservation structures. The feasible water conservation structures in the area are loose boulder structure and gabbion structures. It is estimated that about 89 number water conservation structures will be required to tap the 1.34 MCM of surplus runoff water. Considering the recharge efficiency of 85%, about 1.14 MCM water shall be conserved and recharged. These structures can be constructed on lower order streams i.e. streams of 1st and 2nd order. As per the SOR 2011, an approximate expenditure of Rs. 25,000 will be required for construction of one water conservation structure. Therefore the total expenditure involved for construction of 89 water conservation structures will be Rs. 0.2225 crores.

Roof Top Rain Water Harvesting

In this first phase, it is proposed to take up roof top rain water harvesting measures in the urban households of Rahata Taluka. As per census 2011, there are about 64711households in Rahata taluka. It is assumed that about 10 % of the households i.e. 6471 households may have the average roof area of about 50 sq.m. Therefore, considering the average annual rainfall of 510 mm, average roof area of 50 sq.m and runoff coefficient of 0.85, the total rainwater harvesting potential generated in the urban households of Rahata taluka is about 0.140 MCM.

For taking up roof top rain water harvesting and artificial recharge through individual household, it is proposed to recharge roof top runoff through a recharge pit having dimension of size 1m X 1m and having a depth of 1.50 m. The top 0.6 m portion of the pit will be open for pouring the harvested rainwater whereas the bottom portion of 0.90 m depth shall be filled with boulder, gravel and sand each having a thickness of about 0.30 m.

It is anticipated that about 85% of the harvested water shall be recharged. Thus about 0.12 MCM shall be recharged through adoption of rainwater harvesting in the urban households.

15. TIME SCHEDULE

After the release of funds, the proposed plan can be implemented within a stipulated time of 2-3 years by the implementing agency of concerned State Department, Government of Maharashtra.

Time schedule	Activity to be carried out
0 To 3 months	Finalization of sites for construction of artificial recharge / water conservation structures by the Implementing Agency
4 To 6 months	Finalization of designs / specifications and budget Estimation as per the Schedule of Rates by the Implementing Agency
7 To 20 months	Implementation of the project by the Implementing Agency
20 To 24 months	Preparation of report and report submission by the Implementing Agency
25 To 36 months	Impact Assessment by the Implementing Agency

Annexure-I

Tentative Locations of Proposed Artificial Recharge Structure in Rahata taluka, Ahmadnagar district

S. No.	Village	Longitude	Latitude	Type of structure
1	Wakadi	74.5666	19.6945	Check dam
2	Kolhar Bk.	74.5291	19.5432	Check dam
3	Kolhar Kh	74.5205	19.5392	Check dam
4	Rajuri	74.5242	19.5974	Check dam
5	Babhaleshwar Bk.	74.5179	19.599	Check dam
6	Tisgaon	74.5189	19.5917	Check dam
7	Fatyabad	74.5562	19.5811	Check dam
8	Mandve	74.5509	19.588	Check dam
9	Mamdapur	74.5479	19.5943	Check dam
10	Nandur Kh.	74.5626	19.6006	Check dam
11	Nandur Bk.	74.5757	19.6123	Check dam
12	Nandur Bk.	74.5766	19.6187	Check dam
13	Nandur Bk.	74.5756	19.6227	Check dam
14	Mamdapur	74.5567	19.6239	Check dam
15	Mamdapur	74.5588	19.6172	Check dam
16	Mamdapur	74.5462	19.6193	Check dam
17	Mamdapur	74.5488	19.6164	Check dam
18	Rajuri	74.5354	19.6154	Check dam
19	Rajuri	74.5264	19.6172	Check dam
20	Rajuri	74.5314	19.6084	Check dam
21	Rajuri	74.5218	19.608	Check dam
22	Nandur Kh.	74.566	19.6072	Check dam
23	Rajuri	74.5394	19.6426	Check dam
24	Rajuri	74.5312	19.6424	Check dam
25	Rajuri	74.521	19.6427	Check dam
26	Pimpri Nirmal	74.5094	19.6421	Check dam
27	Pimpri Nirmal	74.4841	19.6297	Check dam
28	Pimpri Nirmal	74.4899	19.6415	Check dam
29	Pimpri Nirmal	74.4982	19.6278	Check dam
30	Pimpri Nirmal	74.4947	19.6358	Check dam
31	Pimpri Nirmal	74.4943	19.6481	Check dam
32	Pimpri Nirmal	74.4994	19.6547	Check dam
33	Pimpri Nirmal	74.4987	19.6462	Check dam
34	Rajuri	74.5098	19.6346	Check dam
35	Astagaon	74.5225	19.6468	Check dam
36	Astagaon	74.5243	19.6542	Check dam
37	Astagaon	74.5243	19.6613	Check dam

38	Astagaon	74.5272	19.6683	Check dam
39	Astagaon	74.5309	19.6734	Check dam
40	Astagaon	74.5354	19.6758	Check dam
41	Astagaon	74.536	19.6659	Check dam
42	Astagaon	74.5348	19.6606	Check dam
43	Astagaon	74.5114	19.6648	Check dam
44	Astagaon	74.5177	19.6703	Check dam
45	Astagaon	74.5227	19.6759	Check dam
46	Ranjangaon Kh.	74.5291	19.6803	Check dam
47	Ranjangaon Kh.	74.5417	19.6888	Check dam
48	Astagaon	74.5013	19.6598	Check dam
49	Astagaon	74.5012	19.6656	Check dam
50	Astagaon	74.5101	19.6718	Check dam
51	Astagaon	74.5169	19.678	Check dam
52	Ranjangaon Kh.	74.5231	19.6869	Check dam
53	Ranjangaon Kh.	74.5242	19.6934	Check dam
54	Ranjangaon Kh.	74.5275	19.7003	Check dam
55	Astagaon	74.4859	19.6683	Check dam
56	Astagaon	74.494	19.6688	Check dam
57	Astagaon	74.5007	19.67	Check dam
58	Pimpri Nirmal	74.4717	19.6446	Check dam
59	Pimpri Nirmal	74.4793	19.6514	Check dam
60	Pimpri Nirmal	74.4822	19.6616	Check dam
61	Pimpri Nirmal	74.4747	19.6539	Check dam
62	Pimpri Nirmal	74.4628	19.6426	Check dam
63	Khadakewake	74.4647	19.6788	Check dam
64	RAHTA PIMPLAS	74.4698	19.6896	Check dam
65	RAHTA PIMPLAS	74.4752	19.6952	Check dam
66	Wakadi	74.5628	19.6441	Check dam
67	Wakadi	74.5608	19.654	Check dam
68	Wakadi	74.5658	19.6671	Check dam
69	Wakadi	74.5742	19.6811	Check dam
70	Wakadi	74.5797	19.6603	Check dam
71	Wakadi	74.5795	19.6759	Check dam
72	Wakadi	74.5829	19.6653	Check dam
73	Wakadi	74.5778	19.6463	Check dam
74	Wakadi	74.5873	19.6511	Check dam
75	Wakadi	74.5881	19.6551	Check dam
76	Chitali	74.6001	19.6625	Check dam
77	Chitali	74.5988	19.6707	Check dam
78	Dighi	74.6163	19.6554	Check dam
79	Dighi	74.6218	19.6621	Check dam
80	Chitali	74.6275	19.672	Check dam
81	Chitali	74.6343	19.683	Check dam

82	Nimgaon Khairi	74.6412	19.6917	Check dam
83	Wakadi	74.5924	19.6757	Check dam
84	Wakadi	74.5955	19.6882	Check dam
85	Chitali	74.6074	19.6794	Check dam
86	Wakadi	74.5835	19.6917	Check dam
87	Rampurwadi	74.5687	19.7123	Check dam
88	Ranjangaon Kh.	74.536	19.6974	Check dam
89	Ekrukhe	74.5181	19.7054	Check dam
90	Rampurwadi	74.5762	19.7252	Check dam
91	Rampurwadi	74.575	19.7329	Check dam
92	Jalgaon	74.6176	19.7076	Check dam
93	Jalgaon	74.6192	19.7195	Check dam
94	Puntamba	74.6091	19.7305	Check dam
95	Puntamba	74.6052	19.7287	Check dam
96	Rampurwadi	74.5938	19.7348	Check dam
97	Nathu Patalachiwadi	74.5398	19.7294	Check dam
98	Nathu Patalachiwadi	74.5385	19.7334	Check dam
99	RAHTA PIMPLAS	74.4993	19.7013	Check dam
100	RAHTA PIMPLAS	74.5049	19.7139	Check dam
101	Puntamba	74.6008	19.7423	Check dam
102	Puntamba	74.5922	19.7583	Check dam
103	Puntamba	74.5953	19.7615	Check dam
104	Puntamba	74.582	19.7526	Check dam
105	Puntamba	74.5725	19.7579	Check dam
106	Nathu Patalachiwadi	74.5736	19.7617	Check dam
107	Nathu Patalachiwadi	74.5343	19.7445	Check dam
108	Nathu Patalachiwadi	74.541	19.7513	Check dam
109	Rastapur	74.5577	19.7763	Check dam
110	Shingave	74.5536	19.7831	Check dam
111	Shingave	74.5386	19.7845	Check dam
112	Shingave	74.5412	19.7824	Check dam
113	Rui	74.5003	19.7769	Check dam
114	WARI	74.588	19.7756	Check dam
115	WARI	74.5852	19.7833	Check dam
116	Shingave	74.5458	19.7919	Check dam
117	Shingave	74.5364	19.8015	Check dam
118	Shingave	74.5502	19.8094	Check dam
119	Shingave	74.5574	19.8121	Check dam
120	SHIRDI	74.4901	19.7743	Check dam
121	SHIRDI	74.4819	19.7684	Check dam
122	SHIRDI	74.4728	19.7795	Check dam
123	Nimgaon Korhale	74.4727	19.7817	Check dam
124	Sawali Vihir Bk.	74.474	19.8116	Check dam
125	Sawali Vihir Bk.	74.4774	19.8072	Check dam

126	Nighoj	74.4717	19.8026	Check dam
127	SHIRDI	74.4648	19.7762	Check dam
128	Nimgaon Korhale	74.4533	19.7778	Check dam
129	Kankuri	74.4346	19.7708	Check dam
130	Kankuri	74.4416	19.7663	Check dam
131	Nandurkhi Bk.	74.4486	19.7645	Check dam
132	SHIRDI	74.4582	19.7628	Check dam
133	Nandurkhi Bk.	74.4508	19.7602	Check dam
134	SHIRDI	74.465	19.7611	Check dam
135	SHIRDI	74.4836	19.7744	Check dam
136	SHIRDI	74.4941	19.7795	Check dam
137	Nandurkhi Kh.	74.4376	19.7577	Check dam
138	Korhale	74.43	19.7632	Check dam
139	Korhale	74.4238	19.7605	Check dam
140	Korhale	74.4065	19.756	Check dam
141	Korhale	74.3998	19.7329	Check dam
142	Malharwadi (n.v.)	74.3857	19.7307	Check dam
143	Malharwadi (n.v.)	74.3938	19.737	Check dam
144	Korhale	74.4163	19.7398	Check dam
145	Korhale	74.4257	19.7508	Check dam
146	Korhale	74.4305	19.732	Check dam
147	Korhale	74.4394	19.738	Check dam
148	Korhale	74.4132	19.7191	Check dam
149	Dahigaon Korhale	74.4359	19.7134	Check dam
150	Kelwad Bk.	74.4311	19.7024	Check dam
151	Kelwad Bk.	74.438	19.7096	Check dam
152	Kelwad Bk.	74.4437	19.7073	Check dam
153	Dahigaon Korhale	74.4539	19.7187	Check dam
154	Sakuri	74.4641	19.7341	Check dam
155	Sakuri	74.4666	19.7397	Check dam
156	Kelwad Kh.	74.4168	19.6937	Check dam
157	Kelwad Bk.	74.408	19.6904	Check dam
158	Kelwad Bk.	74.4115	19.6948	Check dam
159	Pimpari Lokai	74.3974	19.6751	Check dam
160	Pimpari Lokai	74.4008	19.67	Check dam
161	Lohare	74.3976	19.6625	Check dam
162	Adgaon Kh.	74.4089	19.659	Check dam
163	Adgaon Bk.	74.4181	19.6519	Check dam
164	Adgaon Bk.	74.4233	19.6479	Check dam
165	Adgaon Bk.	74.4357	19.6663	Check dam
166	Khadakewake	74.447	19.6739	Check dam
167	Kelwad Kh.	74.4321	19.6712	Check dam
168	Khadakewake	74.4458	19.6793	Check dam
169	Kelwad Kh.	74.4272	19.6821	Check dam

170	Gogalgaon	74.4191	19.6307	Check dam
171	Gogalgaon	74.4255	19.6305	Check dam
172	Pimpri Nirmal	74.4679	19.6512	Check dam
173	Adgaon Bk.	74.4299	19.6471	Check dam
174	Adgaon Bk.	74.4395	19.6527	Check dam
175	Khadakewake	74.4511	19.6609	Check dam
176	Nimgaon Korhale	74.4624	19.789	Check dam
177	Adgaon Bk.	74.4204	19.6384	Check dam
178	Adgaon Bk.	74.4296	19.6437	Check dam
179	Adgaon Bk.	74.4428	19.6589	Check dam
180	Khadakewake	74.4536	19.6719	Check dam
181	RAHTA PIMPLAS	74.4617	19.692	Check dam
182	RAHTA PIMPLAS	74.4671	19.7044	Check dam
183	RAHTA PIMPLAS	74.4846	19.7286	Check dam
184	Pimpri Nirmal	74.4692	19.6399	Check dam
185	Mamdapur	74.5531	19.6102	Check dam
186	Mamdapur	74.5418	19.6102	Check dam
187	Mamdapur	74.5585	19.6063	Check dam
188	Nandur Bk.	74.5725	19.6005	Check dam
189	Nandur Bk.	74.5709	19.5957	Check dam
190	Ukkalgaon	74.5796	19.5896	Check dam
191	Tisgaon	74.5272	19.5832	Check dam
192	Kolhar Bk.	74.5323	19.5756	Check dam
193	Kadit Bk.	74.5434	19.5728	Check dam
194	Mandve	74.5504	19.5692	Check dam
195	Kolhar Kh	74.5305	19.5367	Check dam
196	Nandur Bk.	74.5755	19.5929	Check dam
197	Nandur Bk.	74.5758	19.5957	Check dam
198	Astagaon	74.5097	19.6495	Check dam
199	RAHTA PIMPLAS	74.4749	19.7143	Check dam
200	RAHTA PIMPLAS	74.4824	19.7255	Check dam
201	RAHTA PIMPLAS	74.5094	19.7461	Check dam
202	Nathu Patalachiwadi	74.5477	19.7489	Check dam
203	Ekrukhe	74.5205	19.7311	Check dam
204	RAHTA PIMPLAS	74.5116	19.7237	Check dam
205	Rampurwadi	74.5628	19.7242	Check dam
206	Rampurwadi	74.545	19.7189	Check dam
207	Ekrukhe	74.5418	19.7138	Check dam
208	Wakadi	74.5766	19.7044	Check dam
209	Rampurwadi	74.568	19.7092	Check dam
210	Wakadi	74.5666	19.7024	Check dam
211	Wakadi	74.5715	19.6752	Check dam
212	Wakadi	74.5863	19.6805	Check dam
213	Sakuri	74.4684	19.7288	Check dam

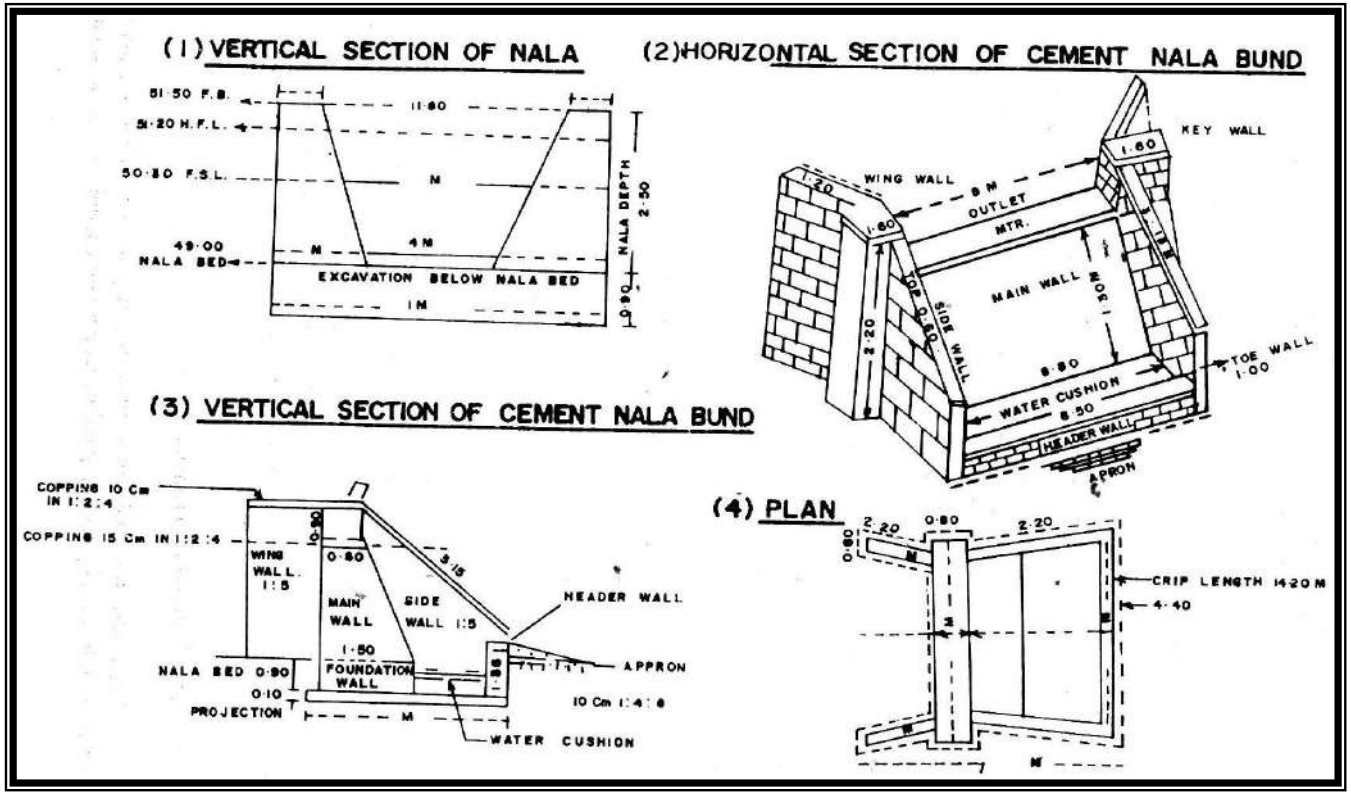
214	Kelwad Kh.	74.4341	19.6879	Check dam
215	Khadakewake	74.4436	19.6688	Check dam
216	Adgaon Bk.	74.4304	19.664	Check dam
217	RAHTA PIMPLAS	74.4611	19.6894	Check dam
218	Ekrukhe	74.5272	19.7354	Check dam
219	Nathu Patalachiwadi	74.5404	19.7392	Check dam
220	Jalgaon	74.6146	19.7174	Check dam
221	Korhale	74.4217	19.7278	Check dam
222	Korhale	74.4425	19.7359	Check dam
223	Shingave	74.5434	19.781	Percolation tank
224	Rastapur	74.5611	19.7721	Percolation tank
225	Sawali Vihir Bk.	74.4797	19.8115	Percolation tank
226	SHIRDI	74.4772	19.7795	Percolation tank
227	Korhale	74.4037	19.7435	Percolation tank
228	Korhale	74.4128	19.7538	Percolation tank
229	Nandurkhi Kh.	74.4427	19.7576	Percolation tank
230	Korhale	74.4179	19.7224	Percolation tank
231	Nandurkhi Bk.	74.443	19.7429	Percolation tank
232	Rui	74.503	19.7775	Percolation tank
233	Kelwad Bk.	74.4245	19.7065	Percolation tank
234	Dahigaon Korhale	74.4464	19.7145	Percolation tank
235	Shingave	74.5548	19.8062	Percolation tank
236	Sakuri	74.4766	19.7417	Percolation tank
237	Puntamba	74.6051	19.7346	Percolation tank
238	Puntamba	74.5966	19.7473	Percolation tank
239	Babhaleshwar Bk.	74.5182	19.5951	Percolation tank
240	Kelwad Bk.	74.4113	19.6911	Percolation tank
241	Kelwad Kh.	74.4263	19.6911	Percolation tank
242	Khadakewake	74.4424	19.6825	Percolation tank
243	Adgaon Kh.	74.4062	19.663	Percolation tank
244	Gogalgaon	74.4182	19.6346	Percolation tank
245	Gogalgaon	74.4263	19.6334	Percolation tank
246	Adgaon Bk.	74.4201	19.6458	Percolation tank
247	Loni Kh.	74.4436	19.6325	Percolation tank
248	Pimpri Nirmal	74.4518	19.634	Percolation tank
249	Pimpri Nirmal	74.4656	19.6325	Percolation tank
250	Pimpri Nirmal	74.4848	19.6316	Percolation tank
251	Pimpri Nirmal	74.4766	19.6559	Percolation tank
252	RAHTA PIMPLAS	74.4766	19.6976	Percolation tank
253	Astagaon	74.5118	19.6592	Percolation tank
254	Astagaon	74.5347	19.655	Percolation tank
255	Wakadi	74.563	19.6609	Percolation tank
256	Wakadi	74.5787	19.6544	Percolation tank
257	Wakadi	74.5853	19.6574	Percolation tank

258	Chitali	74.596	19.671	Percolation tank
259	Wakadi	74.5818	19.6828	Percolation tank
260	Chitali	74.606	19.6846	Percolation tank
261	Chitali	74.6246	19.6665	Percolation tank
262	Mamdapur	74.5507	19.6145	Percolation tank
263	Mamdapur	74.5394	19.6121	Percolation tank
264	Nandur Kh.	74.5608	19.6133	Percolation tank
265	Nandur Bk.	74.5749	19.6089	Percolation tank
266	Mamdapur	74.5375	19.6089	Percolation tank
267	Tisgaon	74.5237	19.5905	Percolation tank
268	Ranjangaon Kh.	74.539	19.6898	Percolation tank
269	Nathu Patalachiwadi	74.5766	19.7642	Percolation tank
270	RAHTA PIMPLAS	74.458	19.694	Percolation tank
271	RAHTA PIMPLAS	74.4814	19.7177	Percolation tank
272	RAHTA PIMPLAS	74.4929	19.7379	Percolation tank
273	Nathu Patalachiwadi	74.524	19.7545	Percolation tank
274	Pimpalwadi	74.5397	19.7656	Percolation tank
275	Nathu Patalachiwadi	74.5504	19.7566	Percolation tank
276	Ekrukhe	74.5375	19.7069	Percolation tank
277	Rampurwadi	74.5548	19.7195	Percolation tank
278	Rampurwadi	74.5688	19.7292	Percolation tank
279	Sakuri	74.4866	19.7492	Percolation tank
280	Pimpalwadi	74.5164	19.7759	Percolation tank
281	Dahigaon Korhale	74.4599	19.7163	Percolation tank
282	Wakadi	74.5764	19.6954	Percolation tank
283	Rampurwadi	74.5734	19.7191	Percolation tank
284	RAHTA PIMPLAS	74.4866	19.7069	Percolation tank
285	SHIRDI	74.4699	19.7656	Percolation tank
286	Puntamba	74.5803	19.7437	Percolation tank
287	Puntamba	74.593	19.764	Percolation tank
288	Rastapur	74.5526	19.7704	Percolation tank
289	Puntamba	74.605	19.7536	Percolation tank
290	Pimpalwadi	74.5003	19.7651	Percolation tank
291	Rui	74.5027	19.7817	Percolation tank
292	Nandurkhi Bk.	74.4562	19.76	Percolation tank
293	RAHTA PIMPLAS	74.5086	19.7177	Percolation tank
294	Khadakewake	74.4582	19.6818	Percolation tank
295	Ranjangaon Kh.	74.535	19.6839	Percolation tank
296	Puntamba	74.614	19.726	Percolation tank
297	Ekrukhe	74.5332	19.7064	Percolation tank
298	Rampurwadi	74.5928	19.7313	Percolation tank
299	Puntamba	74.5806	19.7545	Percolation tank
300	Dahigaon Korhale	74.4519	19.7136	Percolation tank
301	Kelwad Bk.	74.4352	19.7059	Percolation tank

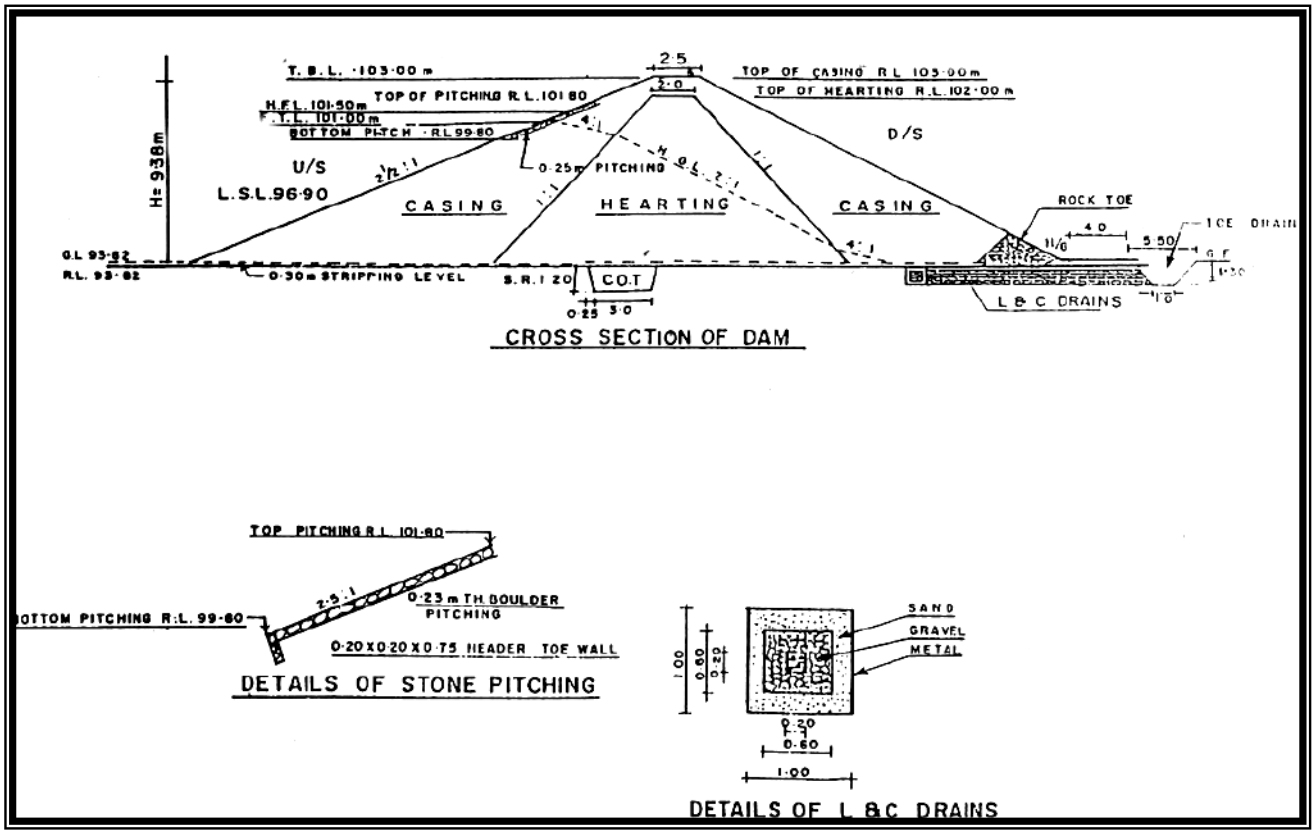
302	Kelwad Kh.	74.4188	19.693	Percolation tank
303	Khadakewake	74.4501	19.6635	Percolation tank
304	Astagaon	74.4832	19.6653	Percolation tank
305	Astagaon	74.5037	19.6704	Percolation tank
306	Astagaon	74.5364	19.6729	Percolation tank
307	Korhale	74.4304	19.755	Percolation tank
308	Nandurkhi Bk.	74.4479	19.7433	Percolation tank
309	Korhale	74.4112	19.7148	Percolation tank
310	Adgaon Bk.	74.439	19.6559	Percolation tank
311	Adgaon Bk.	74.4304	19.6506	Percolation tank
312	Wakadi	74.5793	19.6696	Percolation tank
313	Nandur Kh.	74.5669	19.6015	Percolation tank
314	Khandala	74.5779	19.5939	Percolation tank
315	Rajuri	74.5359	19.615	Percolation tank
316	Pimpri Nirmal	74.4992	19.6526	Percolation tank

Annexure-II

Design of Check Dam

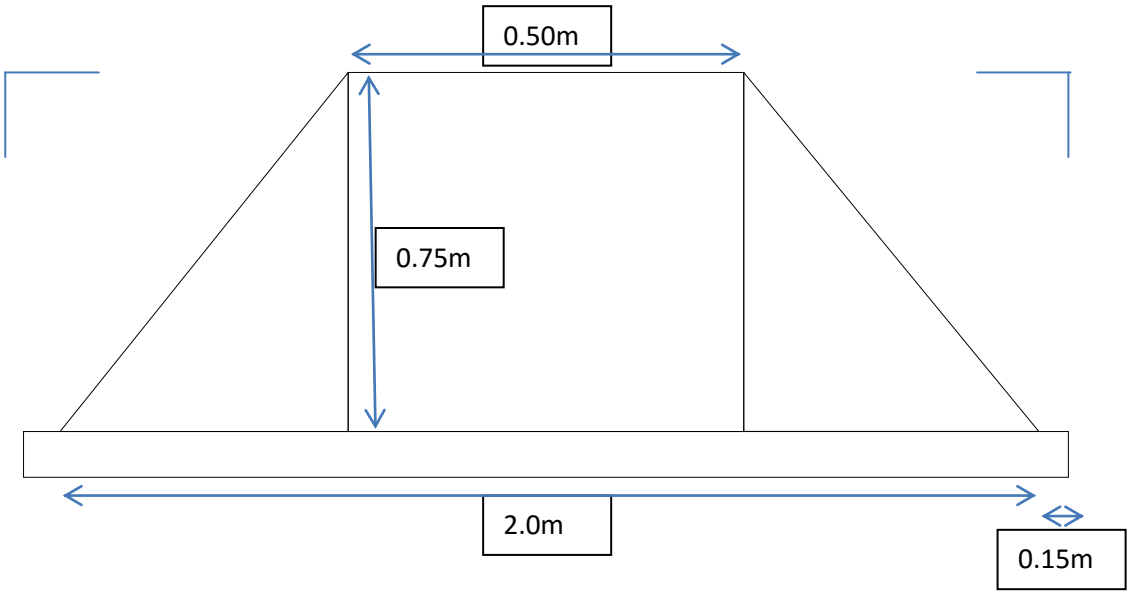


Design of Percolation Tank



DESIGN OF WATER CONSERVATION STRUCTURES

Cross Section of Loose Boulder Structure



Cross Section of Gabbion Structure