RESEARCH PAPER | Engineering | Volume : 3 | Issue : 10 | Oct 2013 | ISSN - 2249-555X

Technical Appraisal of Regional Rural Water Supply Scheme for Fagane & 20 Villages – A Case Study

KEYWORDS: Condition Assessment, Failure, Regional Rural Water Supply, Technical Appraisal, Weighted Score

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ABSTRACT *It is evident from the records of national and state governments that the infrastructure for safe drinking water has been provided to more than 97% of India's urban and rural population in most of the states. The current issue in rural drinking water sector for safe drinking water is to sustain these infrastructures through maintenance mechanism. The various reforms in the rural drinking water sector were adopted in 1999 through Sector Reform project (SRP) on pilot basis and scaled up throughout the country in the form of Swajaldhara launched on 25 December 2002. These programme were a paradigm shift from supply driven to demand driven, centralized to decentralized implementation and transforming the government's role from service provider to facilitator.*

In Maharashtra state the various Regional Rural Water Supply Schemes (RRWSS) were planned and executed by Maharashtra Jeevan Pradhikaran (MJP), which was the nodal agency in water supply and sanitation area in Maharashtra. These schemes were funded by the United Kingdom through Overseas Development Institute (ODI). The concept was developed in United Kingdom in 1970s and the same was introduced in developing nation in 1990 onward. The RRWS Schemes for Fagane and 20 villages, which is one of the schemes funded by national and state government, executed in 1999-2000 and started functioning in 2001, is selected for study. The scheme was operated by MJP for about five years and thereafter taken over by Zilha Parishad Dhule. The scheme is facing the crisis since its beginning. Many times the scheme was inoperative for many months due to various reasons. It is observed that in spite of huge capital investment and flawless technological features, the consumers in many of the villages are unsatisfied with the functioning of scheme. There are always disputes among the various local governments i.e. Zilha Parishad, Group Grampanchyats and Grampanchyats. The operation and maintenance (O&M) and the financial matters in the running of scheme are being dealt on adhoc basis in absence of proper framework. The aim of this paper is the appraisal of technical components of the RWSS through a developed methodology and to draw the conclusions and recommendations for the better functioning.

INTRODUCTION

The main issue in rural drinking water, at present, is not so much setting up schemes for safe drinking water but the sustaining the existing infrastructures through a maintenance mechanism. The various reforms in the rural drinking water sector were adopted in 1999 through Sector Reform project (SRP) on pilot basis and scaled up throughout the country in the form of Swajaldhara launched on 25th December 2002 and Bharat Nirman Programme thereafter [10]. These programmes are paradigm shift from supply driven to demand driven, centralized to decentralized implementation and transforming the government's role from service provider to facilitator. In spite of the massive investment, and impressive improvements in 'coverage', there is a large numbers of people who still don't have access to adequate water supplies, especially in rural part of the country. As per various survey records, the many of the water supply systems, are not functioning adequately. There are many causes of failures of water supply systems. Many of these are not inevitable, but rather reflect fundamental failings in the implementation and subsequent management of facilities. This is true even within the confines of the water supply sector but these failures are compounded when the process fails to take account of other water management sectors such as commercial and industrial provision.

As per norms of accelerated rural water supply projects (ARWSP), the coverage means, the access to a public drinking water source and or systems, which is capable to provide potable water at the rate of 40 lpcd in normal situation and additional 30 lpcd for cattle in DDP areas with potable water source/point within 1.6 km in plains or 100 meter elevation in hilly areas with one hand pump/ stand post for every 250 persons. The coverage may be classified on the basis of rate of supply; as Fully Covered (FC) for 40 lpcd or more, Partially Covered (PC) for 10 lpcd or more but less than 40 lpcd and Not Covered (NC) when the rate of supply is less than 10 lpcd. According to WHO/UNICEF an improved source of drinking water includes water piped into dwelling/yard/plot, water available from public tap or stand pipe or a tube well or borehole, or a protected well or spring [3].

According to the various surveys conducted by government and non government organizations that the infrastructure for safe drinking water has been provided to more than 97% of India's urban and rural population, however the ground realities shows that there are remaining significant challenges in providing sustainable services, especially in rural India. The coverage of FC category villages in 2002, 2005 and 2007 were 82.00%, 95.00% and 97.06% respectively, however based on record of Planning Commission and Habitation Survey the coverage in these years have been slipped down by 22.65%, 23.16% & 10.90% respectively [5]. In Maharashtra state the various Regional Rural Water Supply Schemes (RRWSS) were planned and executed by Maharashtra Jeevan Pradhikaran (MJP), which is the nodal agency in water supply area in Maharashtra. These schemes were funded by the United Kingdom through ODI. The concept was developed in United Kingdom in 1970s and the same was introduced in developing nation thereafter. It is observed that in spite of huge capital investment and flawless technological features in RRWSS, the stakeholders in many of the villages are unsatisfied with the functioning of scheme. There are always disputes among the various local governments i.e. Zilha Parishad, Group Grampanchyats and Grampanchyats. The operation and maintenance (O&M) and the financial matters

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in the running of scheme are being dealt on adhoc basis in absence of proper framework [2].

REASONS OF FAILURE OF WSS

Many of the systems do not function adequately. There are many causes of failures. Some of the most important are summarized in Table 1. Many of these are inevitable, and reflect fundamental failings in the details of the design, planning, implementation and subsequent management of facilities. This is true even within the confines of the water supply sector but these failings are compounded when the process fails to take account of other water management sectors such as irrigation or industrial provision [3].

Table – 1 : Principle Causes of Failure of Water Supply System

Causes of water shortages	Examples
Physical constraints not properly addressed during planning	Poor aquifer with limited storage
	Arsenic/fluoride risks
	Potential competitions with other uses especially irrigation not addressed
Engineering shortcoming	Reticulation system that are too expensive to operate and maintain
Institutional/ management failure	Illegal connection to water supply systems and consequent problems in tail-end villages
	Overexploitation of groundwater under conditions of open access
	Poor cost recovery leading to lack of investment/maintenance
	Lack of maintenance e.g. hand pumps
	Poor institutional organization for the O&M of communal facilities
Corruption	Incentives for some to maintain and profit from water shortages e.g. vendors, tanker operators, kick-backs associated with large engineering contracts
Rising demands	Increasing population
	Incentives to use water inefficiently especially for irrigation
	Changing patterns of water use with changes to lifestyles
Social factors	Social barriers to access to water supply facilities (e.g. caste, restriction on women)

SET BACK IN RURAL WATER SUPPLY SECTOR

At the end of decade 1991~2000, the discrepancies in records of various surveys conducted for coverage of rural water supply system (RWSS), forced the nodal agencies to rethink about the ground situation. It has been observed that there is significant gap between the covered and actually remaining as covered, as thousands of villages earlier covered have slipped-back to uncovered stage.

In 2002 : Planning Commission Working Group for 10th Plan estimated about 2.8 lakh slipped-back habitations

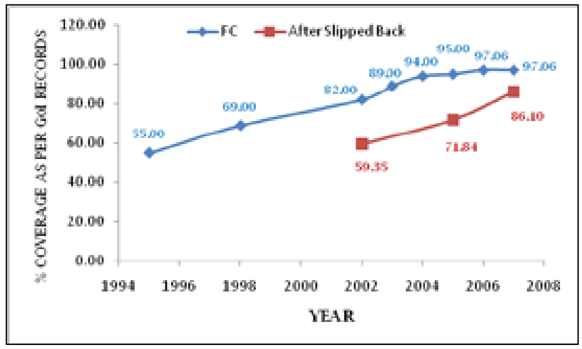
In 2005 : based on Habitation Survey–2003 & after revalidation : 3,31,604 slipped-back habitations in 27 States

Major States – Bihar (47,597), Tamil Nadu (44,080), Madhya Pradesh (37,269), Rajasthan (33,680), Andhra Pradesh (29,744), Uttar Pradesh, (19,886), Chhattisgarh (19,007) and Jharkhand (17,225)

In 2007 : 1,59,429 slipped-back habitations in 21 States; Major States - Andhra Pradesh (22,271), Assam (10,636), Bihar (30,545), Jharkhand (13,272), Madhya Pradesh (13,753), Rajasthan (14,228) and Tamil Nadu (14,291)

The coverage of FC category villages in 2002, 2005 and 2007 were 82.00%, 95.00% and 97.06% respectively, however based on record of Planning Commission and Habitation Survey the coverage in these years have been slipped down by 22.65%, 23.16% & 10.90% respectively as shown Figure 1 [5].

Figure – 1 : Coverage of RWS and Slipped Back as per GoI Records



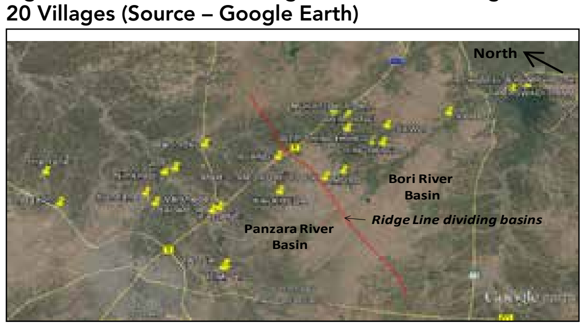
There are a number of reasons for this slippage. Some of these are summarized below -

- Water supply in more than 80 per cent rural habitations is based on groundwater making the system vulnerable to overdraw or fluctuation in the water table;
- Due to competing demands from other sectors and overdraw, drinking water sources become dry;
- Once considered safe, groundwater sources have started reporting quality problems;
- Poor management, operation and maintenance of the water supply systems;
- Systems have outlived their lifespan and have thus become defunct; and,
- Increase in population beyond the carrying capacity.

BACKGROUND

The Dhule is a district place of Maharashtra situated on the junction of NH-3, N_6 and NH-211. There are four Talukas Dhule, Sakri, Shirpur and Shindkheda. There are three RRWSS functioning in Dhule taluka, one of the which i.e. RRWSS for Fagane and 20 village was planned and designed by civil engineering department of SSVPS BSD College of Engineering in 1998. The entire consultancy project was coordinated by second author of the paper. The RWSS for Fagane and 20 villages includes the 20 villages from Dhule taluka and 1 from Parola taluka of district Jalgaon. The geographical area of the RWSS is in two different river basins i.e. Bori river basin and Panzara river basin. Out of 21 villages, the six villages lies in left side of Bori river basin and fifteen in both side of Panzara river basin. The location of various villages and the source of RWSS is shown in Figure 2. The scheme was executed in 1999-2000 and started functioning in 2001. The scheme was operated by MJP for about five years and thereafter taken over by Zilha Parishad Dhule. The capital cost of the scheme was around Rs. 25 Crores. The scheme is facing the crisis since its beginning. Many times the scheme was inoperative for many months due to various reasons.

Figure – 2 : Location of Villages in RRWSS for Fagane and 20 Villages (Source – Google Earth)



The scheme was planned for the design period of 30 years. The pumping machineries were planned for 15 years as per norms of MJP. The population of all the villages was fore-

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casted on the basis of census record from 1951 to 1991, as available with the Directorate of Census GoI. The forecasted populations of villages are shown in Table 2.

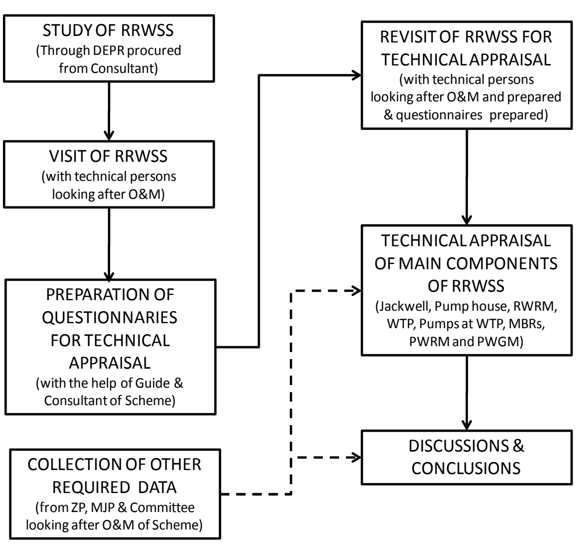
Table – 2 : Population of Villages

Sr	Name of Village	Year 2015	Year 2030	Sr	Name of Village	Year 2015	Year 2030
1	Karadi	1382	1863	12	Pimpari	3778	5625
2	Sawli & Tanda	933	1315	13	Balapur	4500	6822
3	Chinchkheda	4772	6447	14	Varkhedi	6752	9498
4	Bhirdai	756	1038	15	Arni	2053	3075
5	Bhirdane	977	1196	16	Vani(Bk)	3203	4481
6	Mukati	8611	10764	17	Kundane	2652	3836
7	Amdad	1084	1573	18	Nimkhedi	1243	1701
8	Kalkheda	3980	5729	19	Biladi	4420	6258
9	Ajang	4759	6511	20	Dhamane	2496	3115
10	Fagane	14581	20283	21	Nagaon	9004	13595
11	Vadjai	3488	4195		Sum	85424	118920

METHODOLOGY

The different components of RWSS for Fagane and 20 villages are assessed critically, for which the first author visited the different locations starting from source at Tamaswadi dam to water treatment plant at Chinchkheda and thereafter up to tail ends of different pure water rising and gravity mains, master balancing reservoirs and elevated/ground service reservoirs at different locations. The conditions of pumps and different valves such as air relief valves, wash out valves etc. are also assessed. The assessment is done through a set of questionnaires. The other required information are procured from the concerned sub-divisions and division of rural water supply department of Zilha Parishad, Dhule. The committee looking for maintenance of the scheme have well cooperated in the assessment programme. The flow chart showing the methodology is shown in Figure 3.

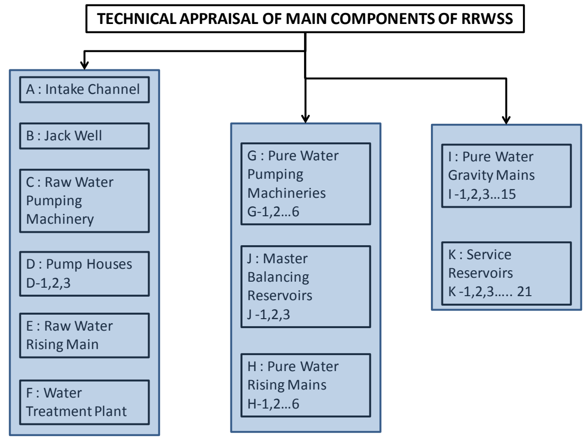
Figure – 3 : Flow Chart Showing the Methodology of Assessment



Grouping of Components

The different components of the RWSS are grouped in three main groups and thereafter sub-divided into sub-groups for technical appraisal. The divisions of the components are shown in Figure 4.

Figure – 4 : Grouping and Sub-grouping of Components for Technical Appraisal



Scale of Condition Assessment

The existing condition of the different components is assessed on five point scale. The scale covers a wide range with scores ranging from 4 to 0. The highest score shows the excellent condition just like new one, whereas the lowest score represents the just existence or trace of existence of item of components which are found not working. The description of the same is shown in Table 3;

Table – 3 : Scale of Condition Assessment

Sr.	Description of Condition	Score
1	Working/Looking in Excellent Condition just like new, Regularly Maintained	4
2	Working/Looking in Good Condition, Being Maintained	3
3	Working/Looking in Satisfactory Condition, Although Not Well Maintained	2
4	Working/Looking in Poor Condition, Not Well Maintained	1
5	Not Working at all – Just Existing	0

Questionnaire and Scoring

The questionnaire for condition assessment of different components of RWSS is prepared. The score of the different sub components is obtained as sum of the response of the all the questions for condition assessment and is converted with respect to score obtained on maximum 100 point.

S – Score Obtained

M – Maximum Score (No. of Questions x 4)

Score Converted to 100 of a Sub Component $S_S = (S/M) \times 100$

The converted score of a major component are weighted by a weight factor, which is calculated for each sub-component. The weight factor for a sub component is calculated as a fraction of load of population on it, as shown below.

Design Population on a Sub Component = P_S

Total Design Population on RWSS = P_D

Weight Factor for Sub Component $W_S = P_S / P_D$

The score of the major component is calculated as a weighted mean of the obtained score and weight factor of different sub components.

Score Converted to 100 of different Sub Components = $S_{S1}, S_{S2}, S_{S3}, \ldots$

Weight Factor for different Sub Components = $W_{S1}, W_{S2}, W_{S3}, \ldots$

Score of Major Component (Weighted Mean)

$= [S_{S1} \times W_{S1} + S_{S2} \times W_{S2} + S_{S3} \times W_{S3} + \ldots] / [W_{S1} + W_{S2} + W_{S3} + \ldots]$

The overall score of the RWSS is calculated by taking the arithmetical mean of the score of major components as cal-

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culated above.

RESULTS

The weighted score of different components of RWSS are calculated as per procedure discussed. The overall score of the RWSS for Fagane and 20 Villages is calculated as arithmetic average of weighted score of all components. The weighted score of the different components are shown in Appendix - A.

The overall score of the condition assessment is the arithmetical average of weighted score and is shown in Table – 4.

Table – 4 : Overall Scores of Different Components

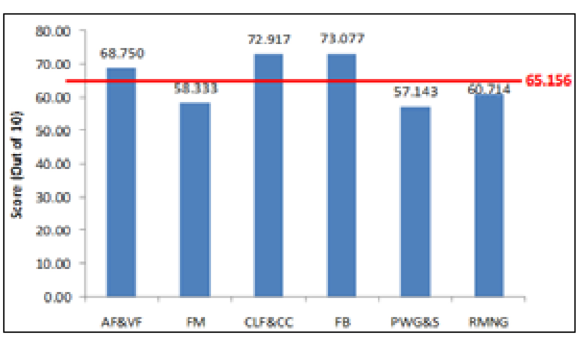
Sr	Component	Score	Sr	Component	Score
1	Intake Channel	87.500	7	Pure Water Pumping Machineries	93.530
2	Jack Well	81.250	8	Pure Water Rising Mains	93.496
3	Raw Water Pumping Machinery	68.750	9	Pure Water Gravity Mains	73.286
4	Pump Houses	73.039	10	Master Balancing Reservoirs	72.246
5	Raw Water Rising Main	79.167	11	Service Reservoirs	79.362
6	Water Treatment Plant	65.156		**Sum**	**866.781**
				Overall Score (Average)	**78.798**

CONCLUSIONS

The following conclusions are drawn from the analysis of scores of condition assessment of different components of RWSS.

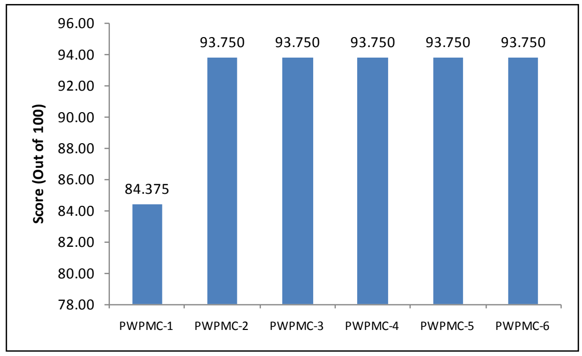
- The source and other infrastructures at source such as intake channel (Score - 87.500) and jack well (Score – 81.250) are in excellent condition and the pump house (Score – 73.031) is in good condition. The source is perennial as far as the demand of the RWSS is concern.
- The raw water pumping machineries are in working condition along with its various accessories such as valves and electrical installations. However the score i.e. 68.750 is just satisfactory.
- The raw water rising main and its all components are working in good condition. Its score i.e. 79.167 is quite good.
- The water treatment plant is in quite good condition. All of its components are working, although score of some of the sub-components is well below the average. The average score of all the components is 65.156. The scores of different sub components and the overall average score is shown in the Figure 5.

Figure – 5 : Score of Different Components of Water Treatment Plants



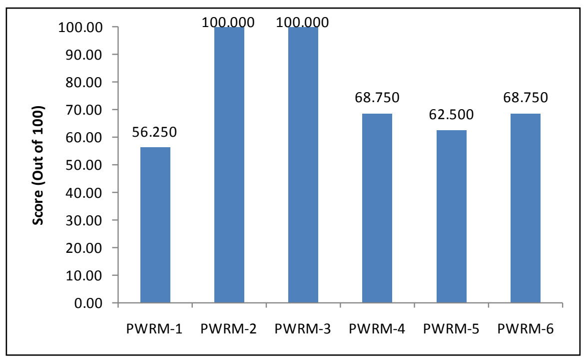
All the pumping machineries for lifting the pure water from respective sumps are in excellent condition along with their accessories including the electrical installations. The availability of technical personnel at these places is helpful in maintaining them in excellent condition. The scores of different pumping machineries is shown in the Figure 6.

Figure – 6 : Score of Different Pure Water Pumping Machineries



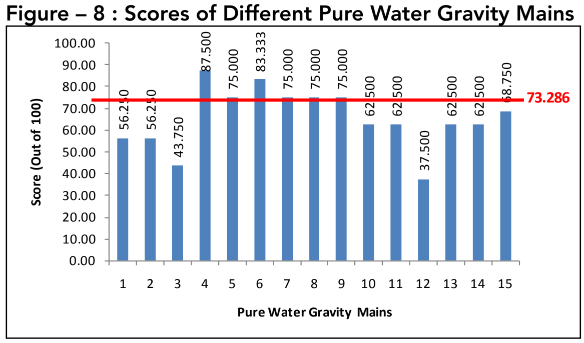
The condition of all the pure water rising mains is average for which the score varies in range of 56 ~ 69, except for PWRM-2 and 3 (Score-100), which are very short in length and are in premises of WTP and thus are well maintained. The PWRM-1 is in very poor condition and needs immediate attention. The scores of the different PWRMs are shown in the Figure 7.

Figure – 7 : Score of Different Pure Water Rising Mains



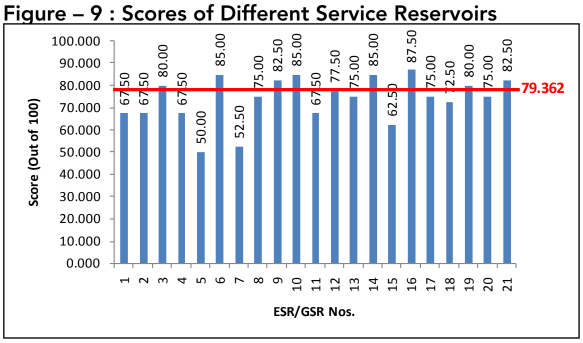
The scores of gravity mains is shown in figure 7, which varies from very poor condition for PWGM-12 (score - 37.5) to very good condition for PWGM -7,8 and 9 (score-75.0). The PWGM which are in poor conditions are the branch lines and major portion of them are cross country. The weighed score of all the PWGMs is 73.286 and total nine PWGMs have the score below it.

Figure – 8 : Scores of Different Pure Water Gravity Mains



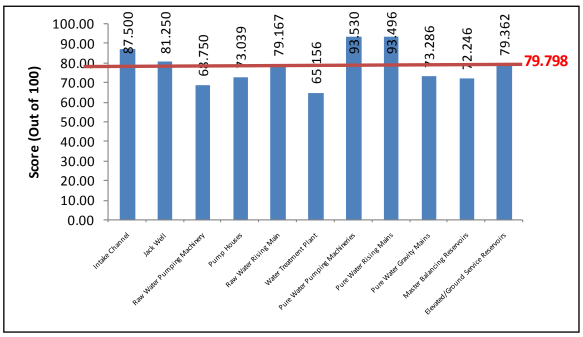
The service reservoirs are in quite good condition, however some of them have scored less due to poor maintenance of valves, overall cleanliness around and frequency of cleaning. The scores of all the service reservoirs (ESRs/GSRs) at villages are shown in Figure 8. The weighted average score of all is 79.362.

Figure – 9 : Scores of Different Service Reservoirs



The weighted score of the individual components of RWSS are shown in the Figure – 9. The overall score of the RWSS is taken as the arithmetical average of the weighted mean of all components and is obtained as 79.198. The overall score of the RWSS exhibit that the scheme is working and satisfying the end users demand at most of the places.

Figure – 10 : Scores of Different Components of RWSS



RECOMMENDATIONS

The following are the recommendations based on observations and condition assessment for the better functioning of the RWSS:

- The proper record keeping should be done and the personnel involved should be properly trained for it. They should also be educated regarding the benefit of it.
- The ball of air valves, few air valves, sluice valves and non-return valves and similar items which are required frequently should be kept in store, so that the same may be immediately replaced or repaired after failure, thus reducing the mean time required for repairing (MTTR).
- The wash out valves should be operated frequently.
- The frequency of cleaning of ESRs and MBRs should be done on regular basis and the record of the same should be maintained. At the same time the premises of WTP, MBR and ESR/GSR should be maintained for aesthetically good appearance. It is essential for ensuring the users' trust in WSS and thus has direct impact on tax collection.
- The qualified filter operators and chemist should be appointed at WTP, to manage the unit operations scientifically to ensure the better quality of water.
- All the leakage, whether through pipes or valves should be controlled immediately. It will reduce the overall cost of operation.

LIMITATIONS OF STUDY

This study is conducted under various limitations and constraints. The study would have been possible, as the many documents are made available to the author by the consultant, who prepared, the DEPR. The questionnaire on the basis of which the condition assessment of different components of RWSS is done is biased to the available information and thus may affect the quality and genuineness of assessment.

DISCLAIMER

The scores obtained are based on perception of the author 1 who did the survey and the calculation of composite index is based on the methodology developed by the authors. The authors do not claim that the appraisal is as per norms and standard laid down by the local or state governments.

Appendix - A : Weighted Average of Scores of Different Components

Sr. No.	Code	Component	Marks			Load on Component	Weight	Weighted Average
			Maximum	Scored	Score out of 100			
1	A	Intake Channel	8	7	87.500	118920	1.000	**87.500**
2	B	Jack Well	16	13	81.250	118920	1.000	**81.250**
3	C	Raw Water Pumping Machinery	48	33	68.750	118920	1.000	**68.750**
4	D	Pump Houses						**73.039**
	D-1	PH-1	36	25	69.444	118920	1.000	
	D-2	PH-2	36	28	77.778	118920	1.000	
	D-3	PH-3	36	23	63.889	16710	0.141	
5	E	Raw Water Rising Main	24	19	79.167	118920	1.000	**79.167**
6	F	Water Treatment Plant						**65.156**
	F-1	AF&VF	32	22	68.750	118920	1.000	
	F-2	FM	12	7	58.333	118920	1.000	
	F-3	CLF&CC	48	35	72.917	118920	1.000	
	F-4	FB	156	114	73.077	118920	1.000	
	F-5	PWG&S	28	16	57.143	118920	1.000	
	F-6	RMNG	56	34	60.714	118920	1.000	
7	G	Pure Water Pumping Machineries						**93.530**
	G-1	PWPMC-1	32	27	84.375	3178	0.027	
	G-2	PWPMC-2	32	30	93.750	12998	0.109	
	G-3	PWPMC-3	32	30	93.750	96297	0.810	
	G-4	PWPMC-4	32	30	93.750	6447	0.054	
	G-5	PWPMC-5	32	30	93.750	3115	0.026	
	G-6	PWPMC-6	32	30	93.750	13595	0.114	
8	H	Pure Water Rising Mains						**93.496**
	H-1	PWRM-1	16	9	56.250	3178	0.027	
	H-2	PWRM-2	4	4	100.000	12998	0.109	
	H-3	PWRM-3	4	4	100.000	96297	0.810	
	H-4	PWRM-4	16	11	68.750	6447	0.054	
	H-5	PWRM-5	16	10	62.500	3115	0.026	
	H-6	PWRM-6	16	11	68.750	13595	0.114	
9	I	Pure Water Gravity Mains						**73.286**
	I-1	PWGM-1	16	9	56.250	12998	0.109	
	I-2	PWGM-2	16	9	56.250	10764	0.091	
	I-3	PWGM-3	16	7	43.750	1196	0.010	
	I-4	PWGM-4	8	7	87.500	1573	0.013	
	I-5	PWGM-5	16	12	75.000	94724	0.797	
	I-6	PWGM-6	12	10	83.333	82484	0.694	
	I-7	PWGM-7	16	12	75.000	62201	0.523	
	I-8	PWGM-8	16	12	75.000	45559	0.383	
	I-9	PWGM-9	16	12	75.000	28505	0.240	
	I-10	PWGM-10	16	10	62.500	22968	0.193	
	I-11	PWGM-11	16	10	62.500	6511	0.055	
	I-12	PWGM-12	16	6	37.500	9820	0.083	
	I-13	PWGM-13	16	10	62.500	7556	0.064	
	I-14	PWGM-14	16	10	62.500	4481	0.038	
	I-15	PWGM-15	16	11	68.750	1701	0.014	
10	J	Master Balancing Reservoirs						**72.246**
	J-1	MBR-1	24	19	79.167	12998	0.109	
	J-2	MBR-2	24	17	70.833	96297	0.810	
	J-3	MBR-3	24	18	75.000	16710	0.141	
11	K	Elevated/Ground Service Reservoirs						**79.362**
	K-1	ESR/GSR-1	40	27	67.500	1863	0.016	
	K-2	ESR/GSR-2	40	27	67.500	1315	0.011	
	K-3	ESR/GSR-3	40	32	80.000	6447	0.054	
	K-4	ESR/GSR-4	40	27	67.500	1038	0.009	
	K-5	ESR/GSR-5	40	20	50.000	1196	0.010	
	K-6	ESR/GSR-6	40	34	85.000	10764	0.091	
	K-7	ESR/GSR-7	40	21	52.500	1573	0.013	
	K-8	ESR/GSR-8	40	30	75.000	5729	0.048	
	K-9	ESR/GSR-9	40	33	82.500	6511	0.055	

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	K-10	ESR/GSR-10	40	34	85.000	20283	0.171	
	K-11	ESR/GSR-11	40	27	67.500	4195	0.035	
	K-12	ESR/GSR-12	40	31	77.500	5625	0.047	
	K-13	ESR/GSR-13	40	30	75.000	6822	0.057	
	K-14	ESR/GSR-14	40	34	85.000	9498	0.080	
	K-15	ESR/GSR-15	40	25	62.500	3075	0.026	
	K-16	ESR/GSR-16	40	35	87.500	4481	0.038	
	K-17	ESR/GSR-17	40	30	75.000	3836	0.032	
	K-18	ESR/GSR-18	40	29	72.500	1701	0.014	
	K-19	ESR/GSR-19	40	32	80.000	6258	0.053	
	K-20	ESR/GSR-20	40	30	75.000	3115	0.026	
	K-21	ESR/GSR-21	40	33	82.500	13595	0.114	

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