

# **SUGAVE AND SIX VILLAGES WATER SUPPLY SCHEME**

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By

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## **Abstract**

The Anjap Sugave multi village water scheme was sanctioned in the year 1998 for 7 villages and their wadis in the Karjat Taluka of Raigad district to address the scarcity of drinking water. The designed project was expected to provide 55lpcd water to a population of 1147 at an initial estimated cost of Rs. 234 lakhs. However, as of 2011, the implementation of this scheme is still not complete and the drinking water problem remains unresolved. The goal of this project is to understand this scheme and analyse it in terms of its technical design, economic viability and social acceptance. This report describes the issues that were found and attempts to provide some solutions. It also encapsulates the inputs of the major stakeholders involved directly or indirectly in the project.

## **Acknowledgment**

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## Chapter 1 - Introduction

A multi village pipelined water supply scheme serves more than one village with drinking water from a common water source. Such schemes may be solutions to provide drinking water to regions facing groundwater scarcity and no perennial non-contaminated surface source of water. Multi village schemes have potential to operate at economy of scale, provide quality service and can also offer long term feasible solution in areas with acute water shortage. However they may require significantly higher investment, substantial technical capabilities and coordinated involvement of multiple agencies.

To understand all of the above, a multi-village scheme, “Sugave and Six village Rural Regional Water Supply Scheme”, is studied. Inputs from all the stakeholders involved both directly and indirectly with the scheme were taken to analyse the scheme.

The project started with study of past relevant work done by CTARA. An initial field trip of Karjat taluka and meeting with concerned officials at Karjat city made an excellent picture of current scenario. In due course of time, technical analysis was performed to grasp the network system. The difficulties and inconsistencies in the technical simulations were discussed with the concerned organization i.e. Maharashtra Jeevan Pradhikaran. The detailed analysis is presented further in this report. On the other side, inputs from the end consumers i.e. the villagers were taken during Participatory Rural Appraisal (PRA) session and field trips. A picture of current situation of the scheme was captured based on input from these stakeholders.

Moreover an attempt was made to analyse the operational issues, estimate the expenditures and revenue collection once the scheme becomes operational. Our views on certain topics, for instance handing over of the scheme, managing delays, etc are also expressed towards the end of report.

Finally a few open issues that may require future study are mentioned. The report ends with our conclusions and our learning from the semester long project (January 2011 to May 2011)

## Chapter 2 - Villages, Hamlets and populations

Sugave and six villages RR water supply scheme is intended to provide drinking water to the villages namely Anjap, Borivali, Sugave, Naldhe, Gudwan, Antrad-T-Varedi, Antrad-T-Need and their 9 associated wadis. These villages are located in Karjat taluka of Raigad district. The major occupation here is agriculture with paddy being the only major crop. Owing to acute scarcity of water, it is cultivated only in the months of monsoon. Besides agriculture, the people are working as daily wage labours at nearby construction sites or small business. The basic amenities like electricity, anganwadi primary school education are available in the villages. The villages are well connected amongst each other and with the nearby towns and railway station via pucca road.

### 2.1 Habitations and geography

The villages are located in between longitude 73°-20' to 71°-25' and latitude 18°-55' to 19°-5'. These 7 villages and their wadis have been pictorially represented below.

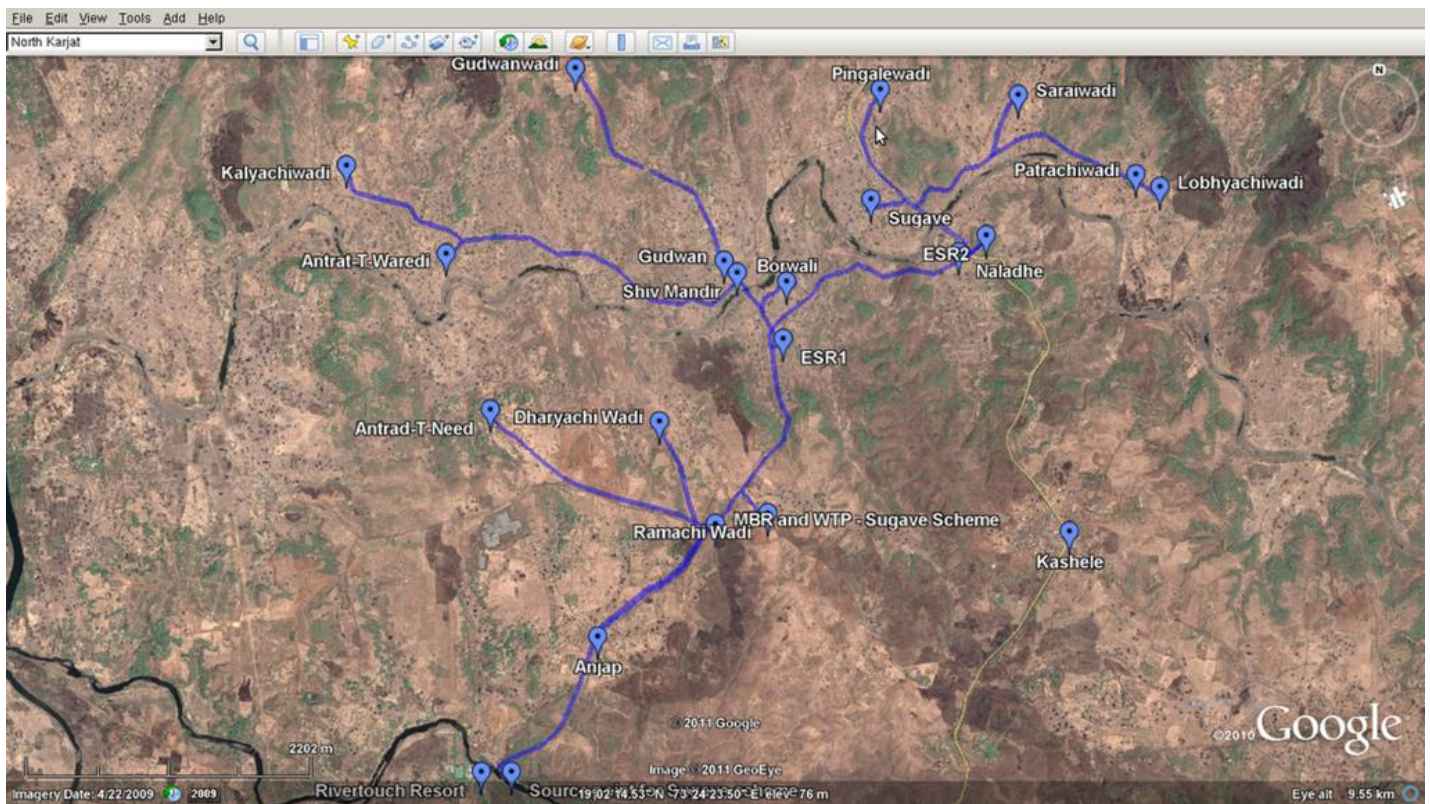


Figure 2.1 : Google map snapshot of target area with villages and important physical assets indicated by nodes and pipelines indicated by blue lines.

As per the census data the population of the villages under consideration is obtained [1]

| Sr | Villages        | Wadi                                                        | Pop<br>1991 | Pop<br>2001 | Pop<br>2030 |
|----|-----------------|-------------------------------------------------------------|-------------|-------------|-------------|
| 1  | Sugave          | Sarai wadi<br>Pinglewadi<br>Lobhyachi wadi<br>Patrachi wadi | 986         | 1590        | 2149        |
| 2  | Gudwan          | Gudwan wadi                                                 | 646         | 1111        | 1558        |
| 3  | Borivali        |                                                             | 360         | 450         | 515         |
| 4  | Anjap           | Ramachi wadi                                                | 598         | 980         | 1329        |
| 5  | Naldhe          | Patryachi wadi                                              | 450         | 776         | 1090        |
| 6  | Antrad-t-Need   | Dharyachi wadi                                              | 537         | 822         | 1047        |
| 7  | Antrad-t-Waredi | Kalyachi wadi                                               | 713         | 960         | 1147        |
|    |                 | Total                                                       | 4290        | 6689        | 8835        |

Table 2.1: Population forecast

The villages are generally heterogeneous group of society .A larger portion is open and OBC category and a smaller portion is a SC/ST category. The wadis belong to some weaker section .The larger portion of the society is socially and economically well settled. It is observed that they have larger land holdings, cattle and stronger “say” in any decisions taken in the villages. Majority of the houses were pucca well- furnished with basic amenities with at least one bathroom per household.

Men in village are fairly educated. In Anjap, Borivali, Gudwan, Naldhe villages it was observed that the men have had their education upto matriculation. Angandwadis are present in every hamlet. Majority of the villages have primary schools, i.e. upto fifth to seventh grade. Secondary and high school education can be pursued at Kashele or Karjat town.

Agriculture is the main occupation in this area. Besides cultivation it was observed that majority of families are involved in local businesses of selling wood, working as labors for nearby construction work or craftwork related activities. It is to be noted that women are active participants in these activities.

## 2.2 Village level institutional setup and responsibilities

The Gram Sabha, Gram Panchayat and Pani Samiti are the three institutes at village level. The responsibilities of the three with respect to water supply are as follow.

**Gram Sabha:** The Gram Sabha comprises of the larger community and is responsible for decisions like:

- a) Amount of water required, current sources of drinking water
- b) How much household charges can the user pay
- c) What subsidies can be given to Schedule Casts (SCs), Schedule Tribes (STs) and Below Poverty Line (BPL) households.

**Gram Panchayat :** Gram Panchayats are local self-governmental at village level in India. The Sarpanch is the head and is elected among the elected members of the GP. The GP has a responsibility

- a) Providing facilities for sanitation, drinking water, public health and education.
- b) Looking after the repair and maintenance of village infrastructure –roads, wells, market.
- c) The source of income property tax levied on the buildings and the open spaces within the village. taxes on pilgrimage, animal trade, grant received from the State Government in proportion of land revenue and the grants received from the Zilla Parishad, a district level administrative body.

**Pani Samiti:** It is a standing committee of the GP and is responsible for planning, implementation, operation maintenance and management of village drinking water security. The responsibilities include:

- a) Collecting household contributions and user fees
- b) Preparing annual budgets and recommendations for user fee charges
- c) Organizing people to be vigilant about not wasting water and keeping water clean
- d) Ensuring professional support for handpump caretakers and piped water supply operators

The Sugave Scheme covers three gram panchayats namely Borivali , Patraj and Pimploli villages. Most of the villages fall in the Borivali gram panchayat area. Lobhyachiwadi is under Patraj gram panchayat . Two villages Kalaychiwadi and Antrad-T-Varedi are under Pimploli gram panchayat. The Borivali gram panchayat head ie Sarpanch for current term is a tribal uneducated woman. The majority of paper work is handled by Upsarpanch, Mr. Sunil Mashe. The Budget of the Borivali GP is around 3 lakh per annum (as reported by Mr. Mashe).

Presence of multiple strong political groups was observed in Anjap village. No such situation was observed in any other hamlets.

### **2.3 Water sources-access, strength and seasonality**

The villages in the study lie in the north Karjat region which is a relatively water scarce region. All though average rainfall (3945 mm) is a moderate, this hilly terrain does not hold water. The groundwater completely collapses in summer season [9]. Most of the beneficiary villages bank on the Shilar river. Shilar river is a non perennial seasonal river and it dries up during the summer and spring season making it unfit for drinking.

Wells and borewells are the predominant water source for these villages since a couple of decades. Now under the Sugave scheme every village and wadi has at least one standpost. In the recent years, it was noted that during the monsoon there is no scarcity of water and water from wells and borewells are sufficient for drinking and daily domestic activities. But during the summer months of March to June, there is acute water scarcity. Water from the standpost is the only source since the last four years.

Women are engaged in arranging daily water requirements from nearby wells and handpumps.

In summer time fetching water from nearby wells or borewells takes almost one third of the day. Women fill water twice a day and make two or three trips every time. During a field trip the residents informed that some wadis were supplied with tanker water in summer season.

## Chapter 3 - Other Stake-holders

### 3.1 MJP and Contractor

Maharashtra Jeevan Pradhikaran (MJP) is a regulatory body which looks into the provision of water supply and sewage services in the state of Maharashtra [3]. With respect to water supply schemes MJP performs the technical designing of the system, looks for feasibility study, outsources the construction to a contractor, monitors the progress of leased construction work and finally decides the operation, maintenance and sustainability of the scheme before handing over to the administrative unit. The administrative units can be the Zilla Parishad or the Gram Panchayats or MJP itself depending upon the nature of scheme.

Water supply schemes are generally started as an expression of demand from the villages in question. This prompts an survey from MJP. MJP completes a preliminary report for the scheme and submits for ministry level approval. Once approved, a tender is issued to the contractor with the lowest bid, i.e., the agency which can construct the water supply scheme at the least cost is handed over the job to construct the scheme. MJP monitors every activity of the contractor through RA bills. This bill is issued by the contractor to the MJP. It contains work done by him and he receives funds based on predefined rates. The scheme receives funds from the state government based on which category it is based. Category 1 being the most preferred to Category 5 being least. The scheme under study receives grants under the NABARD government aid program.

### 3.2 The Taluka Administration and organization

The Passive Stakeholders of the water supply scheme are –the Tehsildar, Block Development Office (BDO) and Minor Irrigation (MI) department. They are indirectly involved in the project as they are responsible for overall well being of the state.

The Zilla Parishad is a district level institute and looks into the district level administration just like the gram panchayat looks into the village level. ZP has a budget of around 20 crores.

The following flowchat represents the administrative structure of India [Courtesy: Wikipedia, [http://en.wikipedia.org/wiki/Zilla\\_parishad](http://en.wikipedia.org/wiki/Zilla_parishad) ].

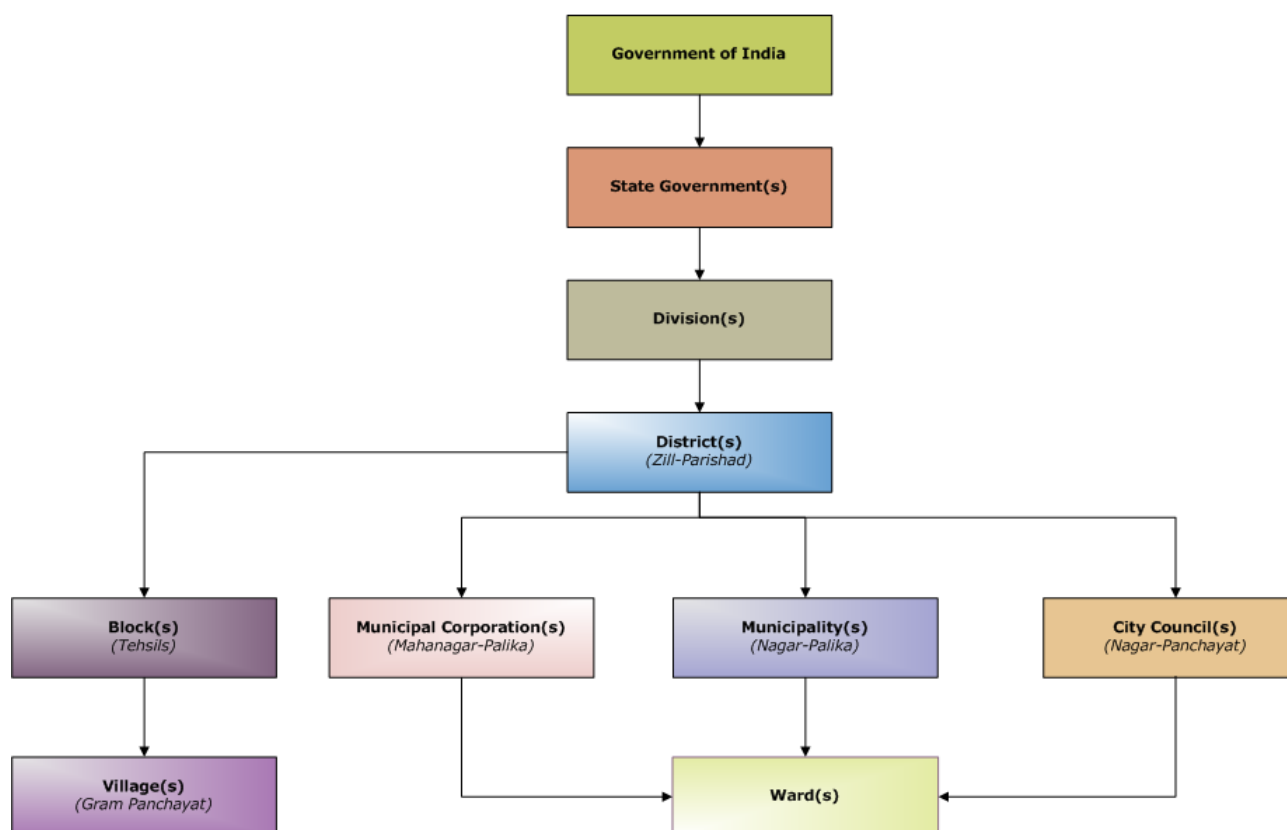
**Administrative structure of India**

Figure 3.1 : Administrative Structure of India

## Chapter 4 - Original Plan

A multi-village pipelined water supply scheme was planned to serve 7 villages and 9 wadis with a norm of 55 liters per capita per day(lpcd). This section describes the plan as it was originally designed and approved. The current infrastructure is different from the original plan and is described separately in chapter 6.

The origination of the project was because of the people's demand based on water scarcity in these villages and wadis. A letter was received from the sarpanch of the GP, separately from the 3 sarpanchs requesting for a scheme[Photocopy of the letters, written in Marathi, is available]. This prompted an investigation from MJP. Surveys were carried out by MJP to determine source of water along with preliminary report on technical and economical feasibility. This report was sent to higher MJP authority, division office and finally to the state government for approval. Once the government level approval was sanctioned, the scheme received green signal to proceed further. A detailed feasibility report and dispatch of tender followed soon.

This water supply scheme was approved in early 1998 and work order was issued in 1999. The construction was supposed to be completed in 2 years of time frame. The economic viability of scheme was shown considering 12 months of operation every year. In contrast, the villagers may not desire water from pipelined scheme during the monsoon months due to cheaper alternatives.

As per the original plan, water would be pumped from the perennial Pej river to a big reservoir located at high altitude almost half way between the river and the villages after physical and chemical treatment. It would then be distributed to all the villages through 2 smaller reservoirs and temporary storage tanks in most villages.

### 4.1 Physical Assets

The original plan comprises of different physical assets spread throughout the target geographical area: Jackwell and Pump house, WTP, MBR, ESRs, Pipeline distribution network, Standposts and Pumping machinery as indicated in figure below. Each of these are described in greater detail in following sub-sections. Appendix 3 contains the map frequently used by MJP indicating location of different physical assets and villages.

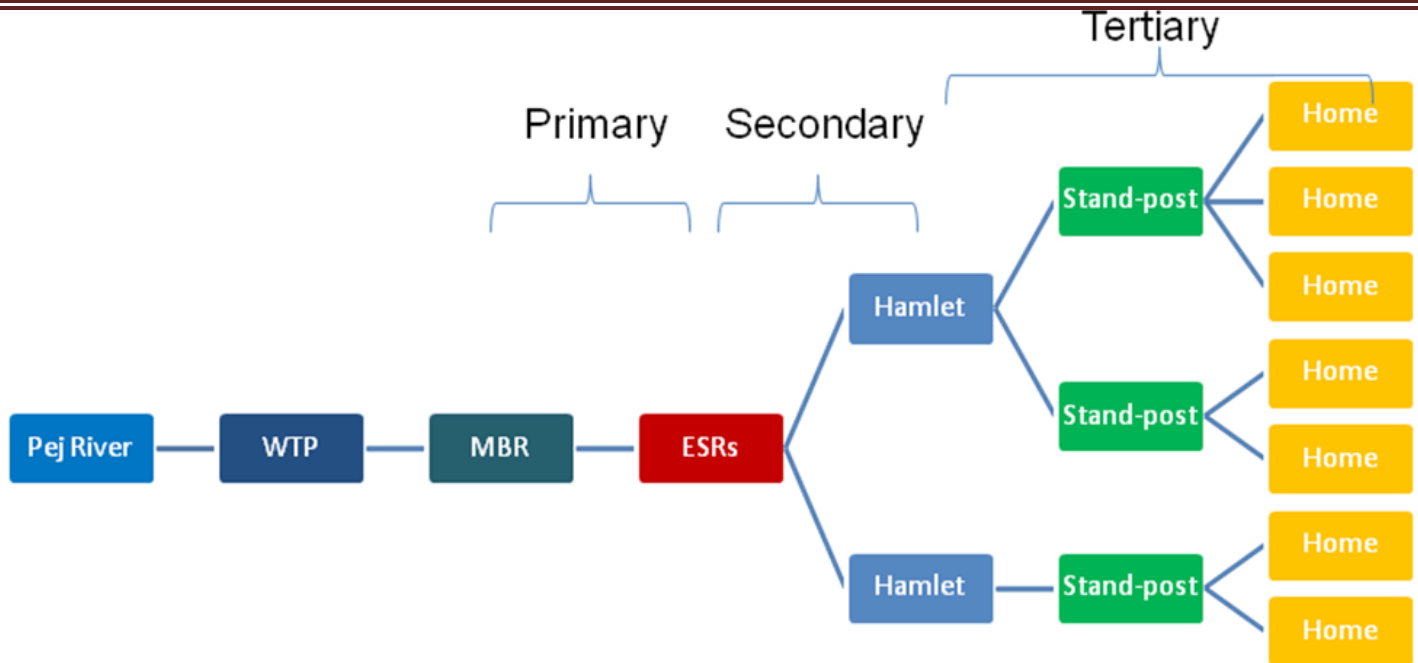


Figure 4.1: Layout of typical rural pipelined drinking water supply system. In Sugave MVS scheme, pipeline connection upto home was not a part of first plan, but was included in the revised scheme.

#### 4.2 Lift-up point

Water is sourced from Pej river located almost 1 km south of Anjap. It is 3-4 km distant from other villages. As the water is discharged from TATA hydro plant built on the large Thokarwadi dam, it is a perennial source of water. Almost 1000 million cubic metre per day of water is realized from the dam. The water is not directly suitable for drinking purpose as it get polluted due to high human activities carried on Pej river, the only source of water in non-monsoon seasons.

A Jackwell and Pump house is constructed at the river bank to pump water upto Water Treatment Plant (WTP). Master Balancing Reservoir (MBR) is constructed close to WTP. The Jackwell is basically a well having its bottom level below the lowest water surface level in the river. The storage water in the jackwell is used for pumping of water. Also the lowest point of the jackwell acts as a buffer for continuous pumping of water. The Jackwell has a depth of 7 meters and is fitted with a submersible pump of rating 25 BHP. According to demand estimate 442,000 liters of water is planned to be sourced daily via 16 hours of operation at a rate of 27375 liters/hour.

#### 4.3 WTP and Tanks

An unconventional type Water Treatment Plant (WTP) is planned to be built. Water is cleaned through physical treatments like mixing, filtering, settling etc and chemical treatment with alum and TCL powder. The WTP has a capacity of 0.874 MLD (million liters per day).

Tanks have been classified in two categories -

1. Master Balancing Reservoir (MBR) – MBR is RCC based primary storage tank for temporary storage of water after it has been treated in WTP. The MBR in Sugave scheme is of the capacity of 170,000 Liters located at Anjap phatak.
2. Elevated Storage Reservoir (ESR) - ESR is also a RCC based storage tank raised to some height on RCC columns. There are two ESRs in the proposed design, one at Borwali and other at Naldhe, both of equal capacity of 102,000 Liters.

#### 4.4 Pipeline network

Pipeline network of the system is qualified in 3 stages

1. Primary Network – The main pipes that supply water from pick up point to WTP and further till MBR and other ESRs are classified under primary network. This is called primary as failure of this section will stall water supply in the entire pipeline. Pipes are generally more than 100 mm wider in diameter. Three important sections in primary network are

Raw Water Rising Main – Pipe carrying untreated water from Jackwell to WTP. It is 150mm in diameter and 2660 meters in length.

Pure Water Rising Main – Pipe carrying treated water from WTP to MBR. It is 150 mm in diameter and merely 100 meters in length and hence requires just a 7.5 BHP pump to push water to MBR.

Pure Water Gravity Main – This pipe-section being longest of all, 8475 meters, carries water to both the ESRs only on the action of gravity.

2. Secondary Network – This network consists of pipes from ESRs to villages and wadis. Pipes are 50 to 100 mm wider depending upon water it carries, length of pipes and hydraulic pressure difference.
3. Tertiary Network – This network constitutes of intra-village supply pipelines. The scheme originally did not have any tertiary design.

#### 4.5 Standposts and other delivery points

The secondary network pipelines end at public standposts in different villages and wadis. The number of standposts in a village is based upon different factors like dimension of village, the amount of water to be drawn for that village depending on population in a supply driven system like sugave scheme, etc.

| Sr. No. | Village | 1991 | 2015 | 2030 | No. of Planned Standposts |
|---------|---------|------|------|------|---------------------------|
|         |         |      |      |      |                           |

|   |                 |      |      |      |    |
|---|-----------------|------|------|------|----|
| 1 | Sugave          | 989  | 1590 | 2149 | 7  |
| 2 | Gudvan          | 646  | 1111 | 1558 | 3  |
| 3 | Borwali         | 360  | 450  | 515  | 2  |
| 4 | Anjap           | 598  | 980  | 1329 | 4  |
| 5 | Naldhe          | 450  | 776  | 1090 | 4  |
| 6 | Antrat-T-Need   | 537  | 822  | 1047 | 4  |
| 7 | Antrat-T-Varedi | 713  | 960  | 1147 | 4  |
|   | Total           | 4290 | 6689 | 8835 | 28 |

Table 4.1: Villages with standposts distribution

The methodology that was used for determining the number and location of standposts is unclear. For example, it is unclear why Anjap was planned to have more standposts than Gudwan inspite of having lower population.

The number of standposts currently present in different villages are quite different and have been described in section 6.3 in chapter 6.

#### 4.6 Detailed Sanctioned cost

Technical parameters like length and diameter of pipe, rating of pump, etc, are calculated by MJP based on system requirements. Depending on this, the cost for each sub-section is estimated on the basis of thumb rule in accordance with “District Schedule of Rates”(DSR) as documented by MJP every year. [One such DSR : Ref 4]

The following table provides a breakup of the original plan for this MVS scheme.

| Sr. No. | Sub Estimate                       | Amount (Rs) |
|---------|------------------------------------|-------------|
| 1       | Working Survey                     | 20,000      |
| 2       | Jack Well with overhead pump house | 4,86,000    |
| 3       | Raw Water Pumping Machinery        | 3,38,705    |
| 4       | Raw water rising main              | 34,15,000   |
| 5       | WTP                                | 15,45,000   |
| 6       | Pure Water Pumping Machinery       | 2,01,500    |
| 7       | Pure Water Rising Main             | 1,18,000    |
| 8       | Master Balancing Reservoir         | 12,53,000   |

|       |                                  |           |
|-------|----------------------------------|-----------|
| 9     | Gravity Main                     | 62,75,100 |
| 10    | Sump for Thakurwadi              | 22,100    |
| 11    | Pumping machinery for Thakurwadi | 1,07,920  |
| 12 a) | Rising Main to Thakurwadi        | 3,98,000  |
| 12 b) | Sintex tank to Thakurwadi        | 40,000    |
| 13    | ESR at Borvali                   | 7,30,000  |
| 14    | ESR at Naldhe                    | 7,18,000  |
| 15    | Distribution System              | 34,01,000 |
| 16    | Misc. Work                       | 3,31,000  |
| 17    | Running the scheme               | 50,000    |
| 18    | Land Acquisition                 | 1,50,000  |
| 19    | Staff Quarter                    | 3,00,000  |

Table 4.2 :Detailed Sub-section cost

Net Cost: Rs. 1,99,00,325

Add 17.5% ETP Charges: Rs. 34,82,557

Gross: Rs. 2,33,82,882 (Rs. 234 lakhs when rounded off to lakhs)

The estimated cost for the original plan was Rs. 234 lakhs.

#### 4.7 Operations and maintenance Charges

This sub-section briefs the operational and maintenance charge estimates by MJP. All the figures are in rupees per year. A more detailed workout of O&M statement can be found in General report [pages 93-94, 95-96]

##### A) Operational Charges [Rs /annum]

|    |                                                 |          |
|----|-------------------------------------------------|----------|
| 1) | Establishment Charges                           | 3,31,200 |
|    | 1. Pump Operators (2 in number)                 | 86400    |
|    | 2. Fitter                                       | 50400    |
|    | 3. Valve-man / watchman / mazdoor (4 in number) | 144000   |
|    | 4. Filter Attendance                            | 50400    |

|    |                             |                  |
|----|-----------------------------|------------------|
| 2) | Electrical Energy Charges   | 18,200           |
|    | 1. Motors                   | 17600            |
|    | 2. Lighting                 | 600              |
| 3) | Chemicals (Alum)            | 5,200            |
| 4) | TCL requirement             | 11,900           |
| 5) | Raw water charges           | 85,100           |
| 6) | Water Sampling Testing fees | 3,000            |
| 7) | Sundry Materials            | 1,000            |
|    |                             | Total = 4,55,600 |

|                        |          |
|------------------------|----------|
| B) Maintenance Charges | 1,71,751 |
| Total = 6,27,351       |          |

As shown above, the estimated O&M related expenses for the original scheme was expected to be Rs 6.3 Lakhs annually.

#### 4.8 Proposed Taxes and Economic Viability of scheme

The following table shows the amount that was expected to be collected from the beneficiaries in order to pay for the running of this scheme.

| Sr. No. | Particulars                                 | Value       |
|---------|---------------------------------------------|-------------|
| 1       | Total no. of houses                         | 1770        |
| 2       | Taxable houses leaving 10% for poor section | 1593        |
| 3       | General Water Tax per house per annum       | 150         |
| 4       | Total general water tax                     | Rs 2,38,950 |
| 5       | No. of house connections (30%)              | 480         |
| 6       | Rate of house connection per annum          | Rs 850      |
| 7       | Revenue from house collection               | Rs 4,08,000 |
| 8       | Total Revenue                               | Rs 6,46,950 |

Table 4.3 : Describing proposed tax with underlying statistical assumptions

[Ref: General Report pages 40-41]

With above proposed tax of Rs 150 as water tax per house per annum and Rs 850 per household connection, the original scheme was economically sustainable.

## Chapter 5 – Project Timeline

The chapter discusses the timeline of the scheme from its approval to the current year. The issues for major delay, allocation of additional funds and the development of every subpart is analyzed. The current operations have been separately discussed in the coming chapters.

### 5.1 Key milestones and time line of the project

A timeline has been constructed based on discussions with MJP officials, the contractor and MJP official website[5].

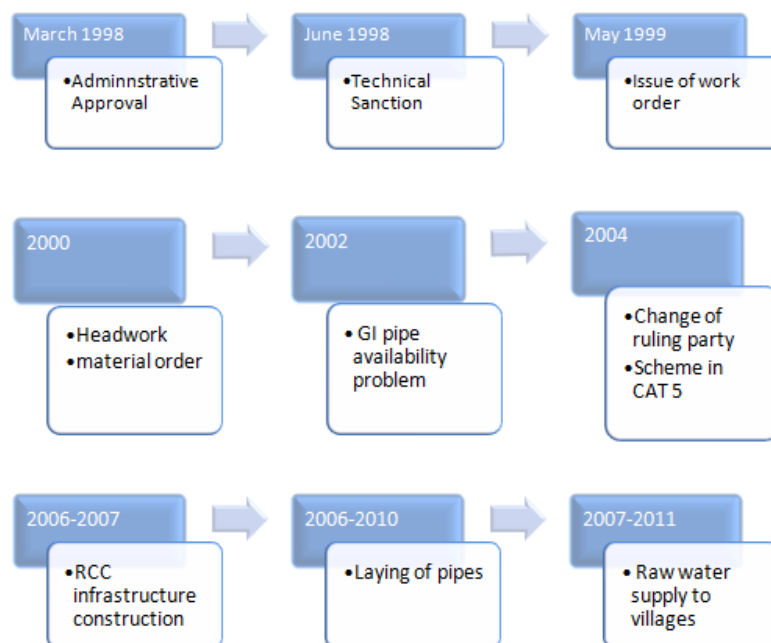


Figure 5.1: Timeline of Project

The above flowchart gives the key events in the project. The scheme was granted Administrative Approval in March 1988 followed by the Technical Sanction in June 1988 with a sanction cost of Rs 234 lakhs. The tender was issued in May 1999. To understand the order of events, a meeting with the MJP officials and contractor was arranged. An approximate timeline as shown above was constructed based on the discussion. The work began in year 2000 with the construction of headwork and Jackwell. The construction work hit stagnation for almost over 5 years due to lack of government funds. On receiving grants the project was restarted with the construction of MBR then WTP RCC construction followed by ESR borivali and laying of pipes. Since 2007 the scheme is run in summer months and the following villages are supplied raw water according to MJP

Mar 2007 onwards: Anjap, Antrad-t-need, Ramachiwadi, Dharyachiwadi

Apr 07 onwards: Borivali, Gudwan

May 07 onwards: Sugave, Naldhe

May 08 onwards: Pingalewadi

Feb 08 onwards: Lobhyachiwadi, Patrachiwadi, Saraiwadi

Apr 09 onwards: Antrad-T-Varedi

2010 onwards: Kalyachiwadi

On ground inspection, it was found that while MJP believes that these villages are currently receiving water under the scheme, the reality is very different. Section 6.3 in next chapter based on Siddhartha's report[8] and interaction with villagers describes the same in detail.

## 5.2 Reasons and Analysis for the delays

Problems encountered during the execution of the work.

1. Due to change of ruling party at the state level, the scheme was placed in Category 5 i.e. least preference category for funds allocation. As per the discussions with the MJP and contractor no funds were granted for the Sugave Scheme up to 2007. This the major reason for delay.
2. In the year 2002 the work for laying of pipeline network was scheduled and a huge order for Galvanized Iron i.e. GI pipe was placed. The project stuck its first stagnation due to non availability of the GI pipes as reported by MJP and Contractor.
3. The location assigned to construct the ESR Naldhe is owned by a resident of Naldhe. A stamp paper[6] regarding the transaction of possession of his land was found but a clear understanding of further dealing needs to be made. The resident is no more ready to give his land away unless he is offered a private free connection.

On analyzing the above reasons

1. A year wise allocation of funds can help in understanding the exact effect of delay in payment on the completion of the scheme. This information has been asked to MJP in the previous letter, appendix 2
2. According to the contractor and MJP non availability of GI pipe was stated as a reason for the delay which is explained above. To analyze this RA bills were analyzed to understand the supply of GI pipes. According to RA bill 30 Ref[7]

| Sr No | Type of GI pipe | Issued to contractor on 26 -01-2000(m) | Issued to contractor on 31 -03-2008(m) | Consumed Till Dec2010 | Balance with contractor |
|-------|-----------------|----------------------------------------|----------------------------------------|-----------------------|-------------------------|
| 1     | 80 mm dia       | 119.94                                 | 930.24                                 | 959.08                | 121.10                  |
| 2     | 65 mm dia       | 3453.06                                | 79.12                                  | 1889.09               | 1643.09                 |
| 3     | 50 mm dia       | 1398.66                                | 790.04                                 | 883.11                | 1305.95                 |

3. There is an inconsistency in the information provided by the MJP and the contractor and availability of GI pipes to the contractor documented in RA bill. Thus non availability of GI pipes can't be a reason for the delay.

### 5.3 Additional sanctioned funds

Due to tremendous delay which leads to price escalation and additions in subsystem construction work, an additional 96 lakhs have been sanctioned. A revised scheme was proposed with the total cost of the project of 334 lacs and cost per capita is Rs 3445. A breakup for the additional sanctioned funds for the subsystem is as follows.

| Sub System               | Amount(Rs) |
|--------------------------|------------|
| Jackwell and Pump House  | 1,97,550   |
| Raw Water Rising Main    | 2,561      |
| RCC E.S.R Borivali       | 4,855      |
| Distribution System      | 25,65,697  |
| Internal Distribution    | 21,59,400  |
| Electrification          | 5,68,450   |
| Road Crossing Permission | 68,826     |
| Total                    | 55,67,339  |

Table 5.1: Excess allocated fund for major sub-sections.[Ref 2, pages 30-31]. A more detailed estimate of additional fund can be referred in General Report, pages 98-102.

The following points describe the reasons for need of additional funds

**Jackwell and Pump House:** The design had expected soft strata uptill 4.5 m and hard strata below 4.5 m. But during execution hard strata was met after 1 m. Thus a major reason for additional funds. Difficulty in understanding the design assumption has been addressed to the MJP in letter also attached as appendix 2. Minor changes in Jackwell design like increasing the height of pump house by one meter, landing around the pump house and increasing the thickness of roof slab were proposed later and demanded additional funds.

**Raw Water Rising Main:** The length of rising main is increased.

**RCC E.S.R Borivali:** A minor change in the provision of inlet and outlet assembly.

**Distribution System:** Price escalation in pipeline prices is one of the major contributors. ACP pipes that had been proposed in scheme have now been banned. All ACP pipes are replaced by higher strength higher cost GI pipes. The lengths estimated for the lines are insufficient in some areas thus larger pipes lengths led to higher costs.

**Internal Distribution:** Tertiary network proposal is a part of the revised scheme.

**Electrification:** Electrification was not sufficient.

**Road Crossing Permission:** To the P.W.D department road crossing charges are now paid, road crossing was not considered earlier. Help from the MJP to understand this issue has been asked through letter attached as appendix 2.

The analysis of some of the above mentioned heads for additional funds is done as follows.

1. **Jackwell and Pump:** In order to estimate the excess cost due to the encounter of hard strata instead of expected soft strata the RA bill 30 Ref[7] was analyzed. The following table has been taken from RA bill 30

| Sr No. | Hard Rock level | Excavation (m <sup>3</sup> ) | Rate ( Rs/m <sup>3</sup> ) | Total Amount Rs |
|--------|-----------------|------------------------------|----------------------------|-----------------|
| 1      | 0 to 1.5m       | 26.32                        | 283.8                      | 7,469           |
| 2      | 1.5 to 3m       | 126.88                       | 290                        | 36,845          |
| 3      | 3 to 4.5 m      | 80.01                        | 297                        | 23,762          |
|        | Total           | 233.21                       |                            | 68,076          |

Thus the total expenditure occurred for the hard rock strata is Rs 68,076. It is to be noted that even though it is reported that the hard rock strata was met after 1 m in the RA bill the level is taken from ground level.

The average rate (Rs/m<sup>3</sup>) for soft strata is 43 Rs/m<sup>3</sup> Ref[7]. If the design estimation had been correct then the expenditure would have been  $43 \times 233.21 = \text{Rs } 10,028$ .

Thus the excess approximate cost for this process is Rs 58,048 which is around 30% of the sanctioned cost. (The additional fund sanctioned for Jackwell and Pump House is Rs 1.97 lakhs).

2. **Distribution system:** As stated in general report all the ACP pipes are replaced with higher cost GI pipe which is the reason for excess cost. According to the RA bill 30 Ref [7] the ACP pipes are used.

| Sr No | Type of GI pipe | Issued to contractor on 26 -01-2000(m) | Issued to contractor on 07-03-2003(m) | Consumed Till Dec2010 | Balance with contractor |
|-------|-----------------|----------------------------------------|---------------------------------------|-----------------------|-------------------------|
| 1     | 150 mm dia      | 680                                    | 0                                     | 462                   | 218                     |
| 2     | 100 mm dia      | 4620                                   | 0                                     | 4543.30               | 76.70                   |
| 3     | 80 mm dia       | 3092                                   | 320                                   | 3213.30               | 198.70                  |

This inconsistency of use of ACP pipes when banned needs to be studied.

#### 5.4 Current Status

The following table summarises the sub system work done. This table 5.2 is based on detailed report of sanctioned and revised sanctioned costs attached as appendix 1.

Running Account bill i.e RA bill refer to a periodic (generally monthly) account statement issued by contractor stating the work completed in that time frame. It is checked by MJP, and then passed and the payment is made. In course of our study of project, four R.A bills were analyzed[7]. RA bill 26

refers to 26<sup>th</sup> issue of the bill. With the help of these bills a estimate of expenditure on the subworks is obtained.

| Sr | Sub Work                | Revised cost (Rs) | Perceived Work done         | Additional Comment                  |
|----|-------------------------|-------------------|-----------------------------|-------------------------------------|
| 1  | Working Survey          | 11,750            | -                           | No documents found                  |
| 2  | Jackwell & Pump House   | 7,84,335          | Work completed              |                                     |
| 3  | R.W.Pumping             | 2,22,205          | operational                 |                                     |
| 4  | WTP                     | 18,09,026         | RCC construction completed  |                                     |
| 5  | P.W.Pumping Machine     | 2,25,849          | operational                 |                                     |
| 6  | Pure Water Rising Main  | 1,21,186          | Work completed              |                                     |
| 7  | MBR                     | 14,10,205         | Work completed              |                                     |
| 8  | Pure Water Gravity Main | 65,98,727         | Operational                 |                                     |
| 9  | ESR Borwali             | 8,78,966          | Work completed              |                                     |
| 10 | ESR Naldhe              | 8,64,978          | Location is decided         |                                     |
| 11 | Distribution System     | 6,44,200          | Majority of network is done | Gudwanwadi sump & piping remaining. |
| 12 | Internal Distribution   | 21,59,400         | none                        | Tertiary design approved            |

Table 5.2 : Break-up of Revised cost across different sections

The timeline of the construction of sub-work is discussed below after the discussion with MJP and contractor.

**Working Survey:** The working survey analysis is not found. The documents to understand the working survey have been asked to the MJP [Appendix 1]. Table in appendix 1 shows revised sanctioned cost for working survey to be lower than originally allocated. Further understanding of the working survey is needed.

**Jackwell and Pump House :** The contractor had reported that the construction was done during the period 2000-2002

**Raw Water Pumping Machinery:** The contractor and MJP had reported that the setup was done during the period 2007-2008

**WTP:** RCC construction of the WTP is done. The internal chambers, treatment plant, testing lab are yet to be constructed.

**Pure Water Rising Machinery:** The contractor and MJP had reported that the setup was done during the period 2007-2008

**Pure Water Rising Main:** The contractor and MJP had reported that the setup was done during the period 2007-2008

**MBR:** The contractor and MJP had reported that the construction was done during the period 2007-2008

**Pure Water Gravity Main:** The contractor and MJP had reported that the setup was done during the period 2007-2008

**ESR Borivali:** The contractor and MJP had reported that the construction was done during the period 2009-2010

**ESR Naldhe:** The location has been decided. The construction is yet to be done

**Distribution System:** It can observed that up till Dec 2010 around 2.6 lac have been spent whereas the sanctioned cost is around 6.4 lac .Thus maybe most of laying of pipeline is done recently.

**Internal Distribution System:** The tertiary network is approved in the revised sanction scheme. No work is done yet.

## Chapter 6 – Current Operations

This chapter captures the current situation by understanding the present water supply arrangements in the villages, identifies some the problems in the current scenario and estimates the current operation cost.

During summer season, April, May and June, the contractor runs the scheme and supplies untreated water. As discussed in previous chapter water has been supplied since four years and each year new villages and wadis get added in the network. The contractor pays the electricity bill by collecting money from the villagers which generally corresponds to 50% of the bill as reported by MJP .The rest of the money is paid by the contractor from his own pocket. MJP moderates the activities of the contractor.

### 6.1 Current physical assets

This section describes progress of different physical assets as of May'2011.

- 1) **Jackwell and Pumping house** – Construction of jackwell and pumping house is complete and both are operational. The 25 BHP pump located at lift up point was designed to lift water upto WTP, i.e, a few meters above the ground level of MBR. Owing to non-functionality of WTP, the water from lift up point is directly being pumped to MBR using the pump at jackwell. Therefore, all water currently being provided in the scheme is untreated water.
- 2) **Primary Network** – Each of the three sections of primary network, i.e., raw water rising main, pure water rising main and pure water gravity main have been constructed. But the pipes actually used differ in diameter than the one simulation software after optimization suffers. We could not find any record of the simulation with actually used pipes.
- 3) **WTP** – Only external RCC structure of WTP has been constructed. Important components for filtering and chemical treatment like internal chambers are to be constructed. Furthermore new arrangement for water to be pumped upto MBR are to be done.
- 4) **ESRs**
  1. **ESR at Borwali** – Construction is complete and is being used to distribute water in Borwali, Gudwan and other villages.
  2. **ESR at Naldhe** – Only the base and height coloumns (typo) are partially constructed. The storage tank is yet to be constructed. Besides supporting assets like, pipeline to and fro from ESR is to be constructed.
- 5) **Secondary Distribution Network** – All secondary network has been layed out. Kalyachiwadi is the only village where standpost or storage tank has not been installed even though pipe has been layed till there.

6) **Tertiary Distribution Network** – Adding tertiary network, that is distribution network within the village, to supply water at gali and house level was added in the revised plan. Currently all the villages are served with community standposts without any tertiary distribution network

## 6.2 Present Supply Networks

Presently the water supply is through MBR and ESR Borivali. The following table shows the network line and the villages served by it. The wadis marked in red state that there is no water supply through standpost.

| Sr No | Network Line                          | Villages                                                                                       |
|-------|---------------------------------------|------------------------------------------------------------------------------------------------|
| 1     | Direct from MBR                       | Ramachiwadi, Dharyachiwadi, Antrad-t-need                                                      |
| 2     | MBR to ESR Borivali                   | Borivali, Gudwan, <i>Kalyachiwadi</i> ,<br><i>Gudwanwadi</i>                                   |
| 3     | Direct from MBR instead of ESR Naldhe | Naldhe, Sugave, <i>Pingalewadi</i> , Saraiwadi,<br><i>Patryachiwadi</i> , <i>Lobhyachiwadi</i> |

Table 6.1: Present Network

## 6.3 Daily Operations Plan

There is no formal operation log plan to execute the scheme and a hit and trial methodology is followed. Based on load shedding a suitable timing is decided to run the pumps. Methodology adopted presently is that MBR and ESR Borivali is filled every night and the network of villages obtaining water directly from MBR and ESR are supplied in such a way that every village and wadi gets 1 hour of water supply. MBR is refilled depending on availability of electricity and villages and wadi following the ESR Naldhe network are supplied. This network gets water once in two-three days.

It was also surprising to know that water to Naldhe village, Sugave region and Pinglewadi region are supplied in turns of 30 minutes, whereas the designed network should have the capability to server to all the beneficiary villages and wadi simultaneously.

#### 6.4 Existing sources of water

A tabular representation of the water arrangement in the villages and wadis is as shown below[8].

| Village                        | Standposts | Wells | Borewells | Duration                                    | Water cess per month per household (Rs) |
|--------------------------------|------------|-------|-----------|---------------------------------------------|-----------------------------------------|
| Naldhe                         | 1          | 2     | 2         | 2 hours every day for 2 months for 4 years  | 50-100                                  |
| Sugave                         | 1          | 1     | 3         | 2-3times a week for 2 months for 4 years    | 50-100                                  |
| Pingalewadi                    | -          | 1     | -         | Water testing is done                       | 0                                       |
| Saraiwadi                      | 1          | 1     | -         | 1 hour per week for two months for one year | 20                                      |
| Patrachiwadi and Lobhyachiwadi | 1          | 2     | 4         | No water supply                             | 0                                       |
| Kalyachiwadi                   | -          | 1     | -         | No water supply                             | 0                                       |
| Antrad Waredi                  | 1          | -     | -         | -                                           | N/A private scheme                      |
| Antrad Need                    | 2          | 2     | 2         | Sufficient water for 2 months for 4 year    | 80                                      |
| Dharyachiwadi                  | 1          | 2     | -         | Sufficient water for 2 months for 4 year    | 20                                      |
| Anjap                          | 11*        | -     | 9         | -                                           | N/A private scheme                      |
| Ramachiwadi                    | 1          | 1     | 2         | 2 months for 4 years                        | 30                                      |
| Borvali                        | 3          | 2     | 3         | 2-3 hours for 2 months for 3 years          | 40-50                                   |
| Gudwan                         | -          | 1     | 1         | Water filled in tank , supply for 3 years   | 10                                      |

Table 6.2: Existing observed situation (*Courtesy: Siddharth Sohoni*)

## 6.5 Present O&M Costs

In order to understand the daily operations the 30<sup>th</sup> RA bill[7] was studied. The abstract under study is show below.

| Quantity executed | Item of work                              | Rate     | Unit  | Payment up-to date | Payment since prev bill |
|-------------------|-------------------------------------------|----------|-------|--------------------|-------------------------|
|                   | D)Proposed For 1st Mar-Jul 2010-5 months  |          |       |                    |                         |
| 3.6               | a) For upto first 3 villages              | 186068.4 | month | 65046.31           | 65046.31                |
| 36                | b)Add for every villages or part there of | 4997.3   | month | 179902.8           | 179902.8                |

Table 6.3 : Extract from RA bill 30

According to the RA bill the scheme is operated from 5 months i.e from March2010 to July 2010. The cost included in the RA bill does not include the cost of energy. It only includes labour, and raw water charges cost.

| Year   | Electricity Rs | Consumption KWH |
|--------|----------------|-----------------|
| Feb-08 | 2352           | 1882            |
| Mar-10 | 5500           | 3207            |

Table 6.4 : Electricity bills

The MSEB electricity bill for March 2010 was obtained to calculate the electricity charges. Bills for the months April, May, June and July should actually be obtained to get a fair idea of electricity bill which could not be done due to limited scope of time.

A rough estimate of the money collected from villages is as follows.[8]

| <b>Village</b> | <b>Water cess (Rs)</b> |
|----------------|------------------------|
| Naldhe         | 50-100                 |
| Sugave         | 50-100                 |
| Pingalewadi    | 0                      |
| Saraiwadi      | 20                     |
| Patrachiwadi   | 0                      |
| Lobhyachiwadi  | 0                      |
| Kalyachiwadi   | 0                      |
| Antrad Waredi  | N/A private scheme     |
| Antrad Need    | 80                     |
| Dharyachiwadi  | 20                     |
| Anjap          | N/A private scheme     |
| Ramachiwadi    | 30                     |
| Boriwali       | 40-50                  |
| Gudwan         | 10                     |

Table 6.5 : Money collected from villagers per month per household

## Chapter 7 – Future Plans and issues

The chapter mainly focuses on the construction plans, MJP to local bodies handing over options and the daily operation plan.

### 7.1 Construction Plans and Handing over

The construction is expected to be completed in the next six months. The remaining work includes WTP internal work, ESR Naldhe construction, Gudwanwadi network line and minor mechanical work.

After construction the contractor has to run the scheme for a season and after a successful trial period the contractor is expected to hand over the scheme to MJP. The MJP will hand over the scheme to the local bodies for administration.

The handing over can be done in three ways:

- a) Ownership lies with ZP
- b) Ownership lies collectively with GPs
- c) Ownership lies with Private Party

#### 7.1.1 Ownership lies with ZP

MJP has reported that the handling over will be to the ZP .The official documents for the agreement between MJP-ZP was not obtained. Details of the handing procedure are not decided. The handing over can be analysed as the following.

ZP generally has a budget of around 20 lac. Zilla Parishad can co-ordinate with the Gram panchayats for water tax collection. Since the level of competence of engineers of ZP is at par with the deputy engineers of MJP, ZP can have an upper hand when it comes to technical expertise required for maintenance and repair and water quality maintenance than any other local administrative body.

ZP having a higher authority than the GP can co-ordinate the functioning of the three GPs smoothly. In the Sugave Scheme the involvement of the three GPs is highly disproportionate. The borivali GP has majority of villages and wadis and the Pimploli and Patraj constitute Kalayachiwadi and Lobhayachiwadi respectively. Moreover since these two wadis are the end corner of the network, it is likely that they may at times face problems of low pressure at the standpost. Co-ordination of the GPs in-case of leakages, repair and maintenance may not be smooth. Borivali GP may dominate the operations. The disadvantage ZP can have is door to

door tax collection. The co-ordination with the GPs needs to be stronger not only to collect water tax but also understand the local issues if any.

#### **7.1.2 Ownership lies collectively with GPs**

In Shirol taluka of Kolhapur district a joint management body (mandal) is running the MVS scheme since 19 years. The mandal consists of 3 GPs , a technician, sub division officer and some active stake holders[10]. The success of the scheme is solely due to dedication of the mandal, the motivation of all the sarpanchs and transparency in operations.

Presently the GPs of Sugave scheme does not have any confidence about the scheme. Due to a delay of over 10 years residents have lost hope in the scheme. A further study needs to be done before drawing any conclusions about GPs ownership.

#### **7.1.3 Ownership lies with Private Party**

If a private party is confident about the sustainability of the scheme, then handing over the scheme to a private party is a good option. As informed by MI department, a private party is running a water supply scheme in Utkrud and Umbroli villages successfully for over a couple of years . A private agency may set up its own meter to ensure equal distribution. Looking at Antrad's private scheme it can be stated that the villagers will be satisfied with the service

### **7.2 Seasonality**

The villagers have been using water from wells and borewells in the monsoon since a long time. It is quite likely that villagers would not want the scheme in monsoon period. It is a tradeoff between getting treated water at a price and traditional system of fetching water from wells and borewells. The choice depends on the quality of water provided by the scheme. A further study can be done when the scheme is fully operational.

### **7.3 Daily Operations Plan**

A formal guideline on daily operations should be prepared and provided to scheme maintaining body while handing over. This operations plan should include timing details like start time and durations for each on-off knob in entire network. The schedule should be such that fairness and equality is guaranteed to all the beneficiaries. Such log can be obtained after a thorough technical analysis of capacity of storage tanks, pumps and other factors influencing water flow like Hazen's constant.

## 7.4 Estimation of O&M cost

Operations and maintenance cost of scheme once according to current schedule of rates is calculated. Methodology same as used by MJP is adopted to arrive at an estimate.

The Operational charges constitute four major categories. The Establishment costs, Electrical Energy charges, Chemical consumption and Raw water charges.

### 1. Establishment Charges

Using the revised rates from the book, District Schedule Rates[4], the wages were obtained and the table was constructed.

| Sr. No. | Establishment     | AvPay/Day | Nos | Amount/ Year |
|---------|-------------------|-----------|-----|--------------|
| 1       | Pump Operator     | 275       | 2   | 1,98,000     |
| 2       | Filter            | 300       | 1   | 1,09,500     |
| 3       | Valve men         | 230       | 4   | 3,31,200     |
| 4       | Filter Attendance | 300       | 1   | 1,09,500     |
|         | Total             |           |     | 7,48,200     |

Table 1: Establishment charges as per DSR-2010

### 2. Electrical Energy Charges

| Sr. No. | Qunantity                       | Value        | Assumption/Calculation                                                   |
|---------|---------------------------------|--------------|--------------------------------------------------------------------------|
| 1       | Rate of pumping                 | 1.6 Rs/KWH   | Taken from bill fixed rate                                               |
| 2       | Hours of pumping                | 16 hours     | Assumption                                                               |
| 3       | Cost of running 32 BHP per year | Rs 2, 20,000 | 1.6Rs/KHW *16 hrs/day*30 days/month *12months/year *32 BHP*0.746 KWH/BHP |
| 4       | Demand Charges                  | Rs 6,720     | Fixed charge take from MSEB bills                                        |
| 5       | Estimated Electrical Charges    | Rs 2, 26,720 |                                                                          |

Table 7.2 : Electricity charges estimations

### 3. Chemicals Consumption Charges

| Sr. No. | Particulars                  | Requirement | Assumption/Calculation                           |
|---------|------------------------------|-------------|--------------------------------------------------|
| 1       | Daily Demand                 | 0.583 ML    | Known                                            |
| 2       | Yearly Demand                | 212.80 ML   | Calculated                                       |
| 3       | Alum @ 6kg/ML                | 1276.80 Kg  | Rates from General Report                        |
| 4       | Cost Of Alum @Rs 4000 per MT | Rs 5200     | From General report [Ref 2, page 95]             |
| 5.      | T.C.L Requirement @4kg/ML    | 851.20 Kg   | From General Report and recent rate from RAbills |
| 6.      | Cost Of T.C.L @14000 per MT  | Rs 11,900   | Calculated                                       |

Table 7.3: Chemical's cost estimations

## 4. Raw Water Charges

- Non Monsoon period for 270 days  
Rate of water: Rs 5 per 10000Litres  
Yearly cost = 270 days x 0.583 ML x Rs 5 = Rs 78705
- Monsoon period for 95 days  
Rate of water: Rs 1.15 per 10000Litres  
Yearly cost = 95 days x 0.583 ML x Rs 1.15 = Rs 6369.27
- Total charge paid to irrigation department = Rs 85074.27

## 5. Miscellaneous Charges

- Water sample testing fees: Rs 3000
- Sundry Material: Rs 1000

| Sr .No | Charges                      | Total Amount (Rs) |
|--------|------------------------------|-------------------|
| 1      | Establishment Charges        | 7, 48,200         |
| 2      | Electrical Energy Charges    | 2,26,720          |
| 3      | Chemical Consumption Charges | 17,100            |
| 4      | Raw water Charges            | 85,074            |
| 5      | Miscellaneous Charges        | 4,000             |
|        | Total                        | 10,81,095         |

Table 7.4: Net Operations cost

In order to account for depreciation, a percentage ranging from 0.25 to 4.0 % of establishment cost of corresponding subwork based on its life and abberation is calculated. The total value of depreciation turns out to be Rs. 1,71,000. [General Report, Pages 93-94]

Thus the total estimated annual O&M can be around Rs 12, 52,000.

**7.5 Economic Sustainability**

The approximate revenue generation that can be achieved is calculated. The following data is used by MJP in General Report, page41.

No. Of households : 1770  
General Water tax : Rs 150 per annum  
Private house connection: Rs 850 per annum

## Assumptions

1. Anjap and Antrad do not participate in Sugave Scheme:

Population of Anjap +its wadi = 900 ( 2001 ) , Population of Antrad + wadi = 925 (2001)

Say 70% of population comprises of villages and 5 people per house, then no. Of house which do not e scheme are =256

Now the no. of households are = 1770-256= 1514

2. 10% of houses will not be charged. The no. of households = 1514 \*0.9 = 1363

Possible revenue collections are

| %HC    | GWT Rs. 150<br>PHC Rs. 850 | GWT Rs. 250<br>PHC Rs. 1000 | GWT Rs. 350<br>PHC Rs. 1250 |
|--------|----------------------------|-----------------------------|-----------------------------|
| 30% HC | Rs 5, 52,100               | Rs 7, 49,650                | Rs9, 88,175                 |
| 35% HC | Rs 6, 09,942               | Rs 8, 17,800                | Rs10, 73,363                |
| 40% HC | Rs6, 67,870                | Rs8, 85,950                 | Rs11, 58, 550               |
| 45% HC | Rs7, 25,797                | Rs9, 54,100                 | Rs12, 43,738                |
| 50% HC | Rs7, 83,725                | Rs10, 22, 250               | Rs13, 28,925                |
| 55% HC | Rs 8, 41,653               | Rs10, 90,400                | Rs14, 14,113                |
| 60% HC | Rs 8, 99,580               | Rs11, 58,550                | Rs14, 99,300                |
| 65%HC  | Rs 9, 57,508               | Rs12, 26,700                | Rs15, 84,488                |

GWT: General Water Tax

PHC: Private House Connection

%HC : percentage of House Connection

From the table it can be inferred that with general water tax rate of Rs 150 and private house connection rate of Rs 850, it is unlikely that a self sustainable system can be achieved. On increasing the general water tax rate to Rs 250 and private house connection rate to Rs 1000 with almost 65% or more of the households opting for private connection the scheme can reach sustainability. On similar line if the general water tax rate of Rs 350 and private house connection rate of Rs1250 then even with 45% of the households taking private connection will make the scheme self sustainable.

A better understanding of the socio-economic status and the willingness to pay for the much delayed scheme of the villagers is needed to comment on the percentage of household opting for house connection.

## Chapter 8 - Simulation and Analysis

### 8.1 Technical simulation

The design process of a pipeline network can be supplemented with computer simulation to lower down installation cost with the help of open sourced softwares like BRANCH and LOOP. These simulators require topological data, water inflow/outflow and head due to external factors, like pumps or elevated tanks. The pipeline network is described by set of nodes and pipe-sections between them. Elevation at nodes and length of each pipe-section are raw topological data required to simulate the network. Water outflow at each outlet node can be estimated from pipeline design norm and population being catered to. External head owing to pumped supply or elevated tank can be estimated from their specification, i.e., pumping capacity or the height of tank respectively.

The simulator helps in determining the diameter of pipe to be used for each pipe-section from a list of user-fed commercial pipes and their rates. It should be noted that the simulator suggests pipes that optimizes the cost of pipes and not the entire system consisting of elevated tanks, pumping machinery, excavation cost, maintenance cost, federal taxes, etc besides pipeline network.

The design details including the simulation data and results were obtained from MJP office at Karjat. Firstly, we re-simulated the same network with same raw data as used by MPJ and results were consistent.

### 8.2 Inconsistency in elevation data

The raw data consisting of distance between nodes and elevation of nodes were compared with that obtained from Google Earth. Google Earth(GE) elevation data is reasonably accurate (except at region of sharp transitions) as verified using GPS at a few nodes. The elevations used by MPJ and the one obtained using GE differ significantly in absolute figure but confined to 8 meters. For all further simulation we have used MJP data, wherever not specified exclusively.

| Sr No. | Location     | MJP    | GE  | Diff  | Diff – (Avg Diff) |
|--------|--------------|--------|-----|-------|-------------------|
| 1      | Jackwell     | 100.1  | 52  | 48.1  | -7.9              |
| 2      | Anjap        | 127.1  | 78  | 49.1  | -6.9              |
| 3      | MBR/WTP      | 156.6  | 101 | 55.6  | -0.4              |
| 4      | Ramachi      | 161.6  | 104 | 57.6  | 1.6               |
| 5      | ESR borwali  | 125.3  | 67  | 58.3  | 2.3               |
| 6      | Borwali      | 121.3  | 63  | 58.3  | 2.3               |
| 7      | Nalde        | 133.36 | 74  | 59.36 | 3.36              |
| 8      | ESR Naldhe   | 150.3  | 89  | 61.3  | 5.3               |
| 9      | Sugave       | 130.5  | 69  | 61.5  | 5.5               |
| 10     | Sarai        | 142.5  | 84  | 58.5  | 2.5               |
| 11     | Patrachi     | 137.8  | 85  | 52.8  | -3.2              |
| 12     | Lobhyachi    | 137.3  | 88  | 49.3  | -6.7              |
| 13     | Pingale      | 141.5  | 81  | 60.5  | 4.5               |
| 14     | Gundwan      | 113.6  | 62  | 51.6  | -4.4              |
| 15     | Gundwadi     | 170.8  | 114 | 56.8  | 0.8               |
| 16     | Antradwadi   | 113.7  | 56  | 57.7  | 1.7               |
| 17     | Kalyachiwadi | 119    | 62  | 57    | 1                 |
| 18     | Antraneed    | 142    | 86  | 56    | 0                 |
| 19     | Dharyachi    | 146.56 | 91  | 55.56 | -0.44             |

Avg Diff = 56.04842105

Table 8.1: Analysis of elevation data from MJP and Google Earth(GE)

### 8.3 Inconsistency in length and related issue

Length between the nodes were also calculated using Google Earth. Most of the lengths were within +- 10% of length as reported by MJP, but the following distances differ by large enough factor to affect the flow and cost of entire system.

1. Length between Antrat-T-Waredi and node 57(trisection just before Gudwan) – The length used by MJP in simulation is 1030 meters where as estimates from GE is at least 2500 meters.
2. Length between Antrat-T-Waredi and Kalyachiwadi – Reported length is 420 meters whereas estimate from GE is at least 1000 meters.

These two pipe-sections are part of sub-network with Borwali ESR as the source. Because of huge increase in length of the pipes, simulation shows cost of Borwali pipeline subnetwork has gone from INR 12.09 lakhs to 22.5 lakhs. One of the reasons for increased cost is need of larger diameter pipes to lower down the increased head requirement.

#### 8.4 Simulation of network with current physical assets

As the pipes actually used in primary and secondary network differ in spec from cost optimized pipes as obtained from computer simulation, a post simulation should be carried out to rule out possibility of any technical snag. Branch allows to fix the diameter of pipes and solve for head at nodes. Diameters of pipes have been used as reported in general report with correct hazzen's constants for different type of pipes.

| ===== |      |      |         |          |          |
|-------|------|------|---------|----------|----------|
| Pipe  | From | To   | Length  | Diameter | Hazzen's |
| No.   | Node | Node | m       | mm       | Const    |
| ----- |      |      |         |          |          |
| 1     | 51   | 52   | 15.00   | 150.0    | 130.00   |
| 2     | 52   | 53   | 40.00   | 150.0    | 130.00   |
| 3     | 53   | 54   | 1300.00 | 80.0     | 140.00   |
| 4     | 54   | 55   | 115.00  | 65.0     | 120.00   |
| 5     | 53   | 56   | 120.00  | 80.0     | 140.00   |
| 6     | 56   | 57   | 980.00  | 50.0     | 120.00   |
| 7     | 56   | 58   | 1780.00 | 80.0     | 140.00   |
| 8     | 58   | 59   | 60.00   | 65.0     | 120.00   |
| 9     | 52   | 60   | 420.00  | 150.0    | 130.00   |
| 10    | 60   | 61   | 350.00  | 65.0     | 120.00   |
| 11    | 60   | 62   | 1220.00 | 150.0    | 130.00   |
| 12    | 62   | 63   | 160.00  | 80.0     | 120.00   |
| 13    | 62   | 64   | 2400.00 | 150.0    | 130.00   |
| ----- |      |      |         |          |          |

The nodes used here are same as those used by MJP in simulation. The complete output file with input for this simulation is attached as Appendix 5. More details about the initial simulation is available in General report [page 68-72].

The Gravity main line was simulated with different outflow at node 63, i.e., the ESR at Borwali. The design flow at Borwali is 3.36 lps.

| Sr. No. | Flow (in lps) | Head at Naldhe ESR (in m) |
|---------|---------------|---------------------------|
| 1       | 1.5           | 8.62                      |
| 2       | 2.5           | 8.04                      |
| 3       | 3.5           | 7.39                      |
| 4       | 4.5           | 6.67                      |
| 5       | 5.5           | 5.88                      |
| 6       | 6             | 5.45                      |
| 7       | 6.5           | 5.01                      |
| 8       | 7             | 4.56*                     |
| 9       | 7.5           | 4.08*                     |

Table 8.2 : Head at Naldhe ESR for various flow at ESR Borwali

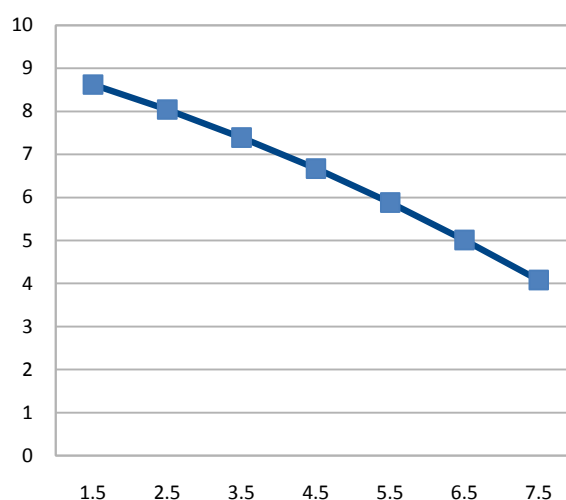


Figure 8.1 : Plot of head (in m) at Naldhe ESR as function of flow output (in lps) at Borwali ESR with current physical assets

The above simulation shows if water outflow at Borwali ESR crosses 6.5 lps then the head at Naldhe will drop less than 5 meters. Though system is designed for outflow of 3.36 lps at Borwali ESR, it may go much beyond it with wrongly configured pressure valve as the head is as high as 24 meters.

### 8.5 ESR Height optimization

Change in height of ESR can affect decision of pipe diameters in two sub networks, viz, GM and one in which the ESR acts as a source. It will also affect the construction cost of ESR depending upon the raised column height on which the storage tank rests. According to guidelines by MJP on costing of ESRs, cost will change by 2% per meter of height changed. Therefore one can optimize the total cost of construction by choosing a height where the sum of all three cost components minimizes (as shown in table below).

Using the original raw data obtained from MJP, the system was simulated again for various heights of raised column for ESR at Naldhe. Individual cost for all the three components were reported and total cost of the system was analyzed.

| Height of ESR<br>(in meters) | Cost of RM<br>(in INR lakhs) | Cost of ESR<br>network<br>(in INR lakhs) | Approx cost of<br>Raised Columns<br>(in INR lakhs) | Total Cost<br>(in INR lakhs) | Change in<br>cost per unit<br>height<br>(in INR lakhs) |
|------------------------------|------------------------------|------------------------------------------|----------------------------------------------------|------------------------------|--------------------------------------------------------|
| 0                            | 43.36                        | 20.27                                    | 0                                                  | 63.63                        |                                                        |
| 1                            | 43.61                        | 19.58                                    | 0.14                                               | 63.33                        | -0.3                                                   |
| 2                            | 43.87                        | 18.92                                    | 0.28                                               | 63.07                        | -0.26                                                  |
| 3                            | 44.13                        | 18.25                                    | 0.42                                               | 62.8                         | -0.27                                                  |
| 4                            | 44.39                        | 17.72                                    | 0.56                                               | 62.67                        | -0.13                                                  |
| 5                            | 44.64                        | 17.3                                     | 0.7                                                | 62.64                        | -0.03                                                  |
| 6                            | 44.89                        | 16.88                                    | 0.84                                               | 62.61                        | -0.03                                                  |
| 7                            | 45.51                        | 16.47                                    | 0.98                                               | 62.96                        | 0.35                                                   |
| 8                            | 46.33                        | 16.13                                    | 1.12                                               | 63.58                        | 0.62                                                   |
| 9                            | 47.17                        | 15.86                                    | 1.26                                               | 64.29                        | 0.71                                                   |
| 10                           | 48.27                        | 15.66                                    | 1.4                                                | 65.33                        | 1.04                                                   |
| 11                           | 50.63                        | 15.45                                    | 1.54                                               | 67.62                        | 2.29                                                   |

Table 8.3: Cost of two pipeline networks as height of ESR at Naldhe is varied from 0 to 11 meters.

The above calculations show that cost of the system minimizes when height of the raised column is around 6 meters whereas it has been designed for 10 meters. Lowering down the design height to optimal level and using optimal diameter pipes could have potentially saved little over INR 2.5 lakhs.

### 8.6 Use of inappropriate height level of ESR at Naldhe in simulation

An important deviation in original simulation by MJP is regarding elevation used for ESR at Naldhe. As reported, the ESR has outlet at 160.34 meters and FSL of 163.85 meters. In simulation of Gravity Main(GM) pipeline network, FSL should be used as the elevation at ESR, but outlet level has been used instead. Re-simulating the GM network with FSL as the elevation being the only change, the network cost changes from INR 45.12 lakhs to INR 48.27 lakhs.

| Storage Reservoir       | FSL (in meters) | Outlet (In meters) | Height used in simulation (in meters) |
|-------------------------|-----------------|--------------------|---------------------------------------|
| MBR (Inlet)             | 176.2           | 172.2              | 172.2                                 |
| ESR at Borwali (outlet) | 140.82          | 137.32             | 140.82                                |
| ESR at Naldhe (outlet)  | 163.84          | 160.34             | 160.34                                |

Table 8.4: Table showing discrepancy in height used for ESR at Naldhe

## **Chapter 9 –Recommendation Conclusions and Learning Experience**

### **9.1 Recommendation to reduce delay**

It is observed that non availability of government funds has led to severe problems the foremost being the no safe drinking water to the villagers for over 10 years now and the difficulties for the contractor to work with large time gaps, accumulate his human resources and pay the balance electricity bills.

A solution for this problem can be as follows.

A clause in the concerned documents can be in such a way that in case there is a halt in the allocation of funds the contractor will continue with the construction work and will be paid back with a predefined interest rate.

For the Sugave Scheme no funds were allocated from 2000 to 2007 and the construction work stopped after 2000. Had the contractor continued to work the scheme could have been completed in by 2002 and the contractor could have been paid back with the predefined interest rate. The villagers could have received drinking water since 11 years.

It can be seen that the payment of the excess money by the government will be either less or equivalent to the expenditure the government has to bear because of price escalations and time value of the money. Completion of the project in continuation will ensure good quality service and solve the water scarcity problem in concerned areas.

### **9.2 Conclusions**

North Karjat suffers from acute water scarcity during spring and summer season. Despite average annual rainfall during monsoon season, the ground water dries up because of hilly terrain. Women spend one third of their day in arranging enough water for domestic use. Even a public standpost based supply in these villages can improve the life of people significantly and encourage them to try other opportunities.

Sugave multi-village scheme is under construction for more than 11 years now. Such a long delay has lead to inhabitants with no belief that the multi-village scheme will ever complete. Their leaders speculate huge maintenance cost even if the scheme becomes operational as pipes are reported to be busted or leaking at some place. As a result, they are demanding alternative single village based solution wherever possible. The construction has gained some pace in last couple of years and is expected to complete within 6 months.

Even when the scheme becomes fully operational, questions regarding fairness and equality in water sharing between all these villages and wadis remain unanswered. A possible solution could be making a timing schedule for control knobs ensuring same quantity of water per head is supplied to all the villages. Such a operational log would need good technical analysis and should be transferred to operational institute be it Zila Parisad or Gram Panchayat. An alternative could be using automatic valve with meters.

Maintenance issues for such multi-village scheme may become a problem. The cost of frequent maintenance problem for a few villages may have to be borne equally by all others. A proper constitution about the same should be formed as guidelines for operational and maintenance body. Tax collection could be another potential problem in case of dissatisfaction by some villages.

MVS schemes are said to operate at economies of scale, but our own O&M analysis following MJP methodology and based on 2009-10 schedule of rates by MJP indicates requirement of a in-depth study. An approximate supply curve is obtained and a demand curve needs to be analysed to find a sustainable operating point.

As we discovered, the scheme suffers from problems which could be eradicated during preliminary design stage itself. Measured elevation at different places and length between them are itself prone to huge inaccuracy at some places. With these inaccurate inputs, entire design process loses its meaning and the system is not guaranteed to meet the design specification. This is reflected in low water supply at Kalyachiwadi, Sugave and associated wadis like Lobhyachiwadi, Pingalewadi, etc.

**A thorough technical design process was followed but the results of computer-aided simulation were not closely followed in actual implementation. More surprising was the fact that system was not re-simulated with inputs corresponding to actually used pipes.**

**At last, based on our interaction with all the beneficiaries, we conclude that a single village scheme is better for design, construction, operations and maintenance provided a perennial source exists in vicinity of target area. In geographical areas like North Karjat, a multi-village is apt and it can become realistic solving the above mentioned issues.**

### 9.3 Learning from the project

Study of MVS-Sugave scheme was a first experience of working on a social cum technical project for us. Major beneficiaries being the people at the bottom of pyramid makes the project stand aloft in otherwise demand driven academic sphere of India.

What makes it even more interesting and rather challenging is involvement of multiple government agencies. Meeting with officials at MJP, GSDA (Groundwater survey and development agency), BO (Block office), MI(Minor Irrigation) and private contractors helped us get better insights into co-ordinated functionality and methodology adopted for such projects.

Staying in villages for a couple of days and night was an eye opening experience. It gave us better understanding of the rural India, their way of living, culture, occupations and problems. We were

moved looking at the importance of water in villagers life and efforts, specially by women, to collect it for domestic purposes.

Digging out the founding pillars and understanding them always remains a challenge in a scenario where multiple stake holders are present, especially where some are receivers and others are providers of service. Moreover every sub part is complex and the forms an interconnected complex network .The working of the whole scheme is dependent not only on the individual parts but also on the coordination of the subparts. We realized the importance of planning and sticking to schedule in large-scale project. A project of this scale should be thoroughly compiled and revised before being approved, otherwise the delay due to these unforeseen obstacles lead to price escalation which may further lead to delay and worsen the situation.

We realised that higher technical skill and experience can better be used in solving our own third world problem. These are equally challenging and interesting and require attention of open mind with good technical skill and ability to understand social problem at its root.

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## Chapter 10 - The Next Step

This chapter discuss the future analysis required based on the results and conclusions obtained in the above chapters.

### 10.1 Evaluation of O&M and sustainability

Based on the calculation done in the chapter 6, the annual operation and maintenance cost of the scheme is around 12.5 lac. In order to have a self sustainable scheme a general water tax of Rs. 250 and Rs. 1000 for private connection with more than 65% of the households obtain house connection or a general water tax of Rs. 350 and Rs. 1250 for private connection with more than 45% of the households obtain house connection.

A further study of the above two solutions to understand which of the two can be achieved and captures the actual situation of all the villages and wadis. A detail study of the socio-economic and financial condition of the wadis needs to be looked at. Along with financial conditions it is also important to understand the acceptance of the scheme among the residents. Despite having the ability to pay may be the willingness to pay for a scheme which has been delayed over the decade may be missing.

In order to understand sustainability a study of running schemes can be done to understand the problems faced during operations and if any steps could be taken during the construction phase to solve those problems. For instance installation of a metering system will solve the disputes regarding water share.

### Standard methodology for operation log

Depending on the load-shedding and other constraints of a region, water is supplied to the hamlets in hit and trail way. The schematic operation log format of MJP can be studied and can be included in the general report of the scheme.

### 10.3 Naldhe ESR height optimization

Height of raised coloumns of Naldhe ESR, which is yet to be fully constructed, is very crucial technically. It should be within a bound that ensures water from MBR flows in at prescribed rate and head is sufficient to supply water to end locations specially Lobhyachiwadi and Patrachiwadi as they are at higher altitude.

Such a study was done and a least cost height was identified as mentioned in section 8.5. But the calculations assumed elevation as reported by MJP which are inconsistent with other sources like Google Earth and GPS data. To ensure water reaches all the end villages and wadis, a detailed study

may be carried out with authentic elevation measurements of places in Naldhe ESR network and Gravity main lines. Moreover, the cost of the system can then be reduced by optimising technique like one discussed in section 8.8.

#### **10.4 Open Issues and questions**

A stamp paper document regarding the deal of land for ESR Naldhe lies with MJP. The signed document states that land will be sold for ESR Naldhe to MJP under government norms. But it is unclear if any such transfer of land actually happened on paper.

Working Survey Documentation could not be found with MJP. Upon verbal query with official at MJP, we were told that no such working survey was carried out. The revised estimates for working survey documentation was brought down to Rs. 11,750 from Rs. 20,000. But the question remains open if any working survey documentation was actually done.

Hard Strata was expected to be found after 4.5 meters of depth, but it was actually met only after 1 meter of excavation at the Jackwell site. This was one of the reason for delay and required an additional amount over 1 lac. The reason for initial estimate of 4.5 meter is unclear to us as the hard strata can be seen the surface itself.

- The criteria for number of standposts in a village is not clear. It should depend upon the water requirement and hence the population, but despite of Anjap having lower population than Gudwan, it was assigned more standposts initially. Then there is huge difference in standpost initially proposed and the ones actually constructed. Reasons behind this is unclear to us.
- Sources of inconsistency in elevations and length as reported in section 8.2 and 8.3 is hitherto unknown.
- In technical simulation, a set of commercially available pipes along with its cost and Hazen's constant are fed as input. The simulator uses the Hazen's constant to decide on least cost pipe configuration. It was surprising to find Hazen's constant of all the pipes to be taken as same constant 100 in original simulation by MJP.

## References

1. Census Data Document
2. General Report of revised scheme obtained from MJP office at Karjat
3. MJP official website  
[www.mahamjp.com](http://www.mahamjp.com)
4. District Schedule of Rates  
<http://www.mahamjp.com/Works/dsr-0708/Index.asp>
5. Online information about Sugave scheme on MJP website  
<http://mjpmaharashtra.org/SchemeDetails.aspx?SchemeId=25>
6. Stamp copy of land use permission for ESR Naldhe , Certificates for Sugave Scheme
7. RA bills - 26, 27, 28, 19 ,30 obtained from MJP office at Panvel
8. “Report on the Anjap Sugave RR scheme in its fifth year of operation ” - Siddharth Sohoni
9. “Piped water supply system for North Karjat – Techno-Economic feasibility study” by Abhishek Sinha, Vikram Vijay and Janhvi Doshi
10. Sustainable Community Management of a Multi-village Water Supply Scheme in Kolhapur, Maharashtra, India  
[http://www.wsp.org/wsp/sites/wsp.org/files/publications/sa\\_kolhapur.pdf](http://www.wsp.org/wsp/sites/wsp.org/files/publications/sa_kolhapur.pdf)
11. Participatory Rural Appraisal reports of 3 groups – Anjap, Gudwan and Naldhe  
<http://ctara.iitb.ac.in/index.php/events/pra>
12. MSEB electricity bills for Sugave scheme for the month of February'08 and March'10

## Appendix

### Appendix 1 : Work history, sanctioned cost and expenditure

With the help of RA bills a estimate of expenditure on the subworks is obtained. The red figures in the table refer to the completion of work in that RA bill i.e. no further amount is spent on that subwork after that bill.

| Sr | Sub Work                | Sanctio<br>ned<br>cost | Revisd<br>Cost | Work<br>remaining                            | RA 26   | RA27   | RA28    | RA29    | RA30<br>Expend<br>i |
|----|-------------------------|------------------------|----------------|----------------------------------------------|---------|--------|---------|---------|---------------------|
|    |                         |                        |                |                                              | Feb-09  | Mar-09 | Sep-09  | Mar-10  | Dec-10              |
| 1  | Working Survey          | 23500                  | 11750          |                                              | -       | -      | -       | -       | -                   |
| 2  | Jackwell & Pump House   | 571100                 | 784335         | Minor work                                   | 689928  |        |         |         |                     |
| 3  | R.W.Pumping             | 398000                 | 222205         | Done                                         | 237825  |        |         |         |                     |
| 4  | WTP                     | 1815400                | 1809026        | Internal Constructio<br>n except<br>RCC work | 293526  | 293526 | 293526  | 793527  |                     |
| 5  | P.W.Pumping Machine     | 236800                 | 225849         | Installation of Centrifugal Pump             | 237825  |        |         |         |                     |
| 6  | Pure Water Rising Main  | 138700                 | 121186         | Minor work                                   | 7429    |        |         |         |                     |
| 7  | MBR                     | 1472300                | 1410205        | Minor work                                   | 1104103 |        |         |         |                     |
| 8  | Pure Water Gravity Main | 7373300                | 6598727        | 1000 metre laying of pipes                   | 1632952 |        |         |         |                     |
| 9  | ESR Borwali             | 857800                 | 878966         | Minor work                                   | 596908  | 596908 |         | 616059  |                     |
| 10 | ESR Naldhe              | 843700                 | 864978         | Work ater design approval                    | 88877   | 88877  |         | 162213  |                     |
| 11 | Distribution System     | 3996200                | 644200         | To be started                                |         | 190251 | 1902521 | 1990626 | 2681143             |
| 12 | Internal Distribution   | 0                      | 2159400        | Design approved                              | 0       | 0      | 0       | 0       | 0                   |

Work History Table A1

From the above table one can infer the duration i.e. from February 2009 to December 2010 the when the work was executed. It is to be noted that the subwork which has be shown executed in 26<sup>th</sup> RA (Feb 2009) can be carried out anytime in the years 2007 to 2009.

**Appendix 2 : Letter to MJP by IIT Bombay dated 22nd March 2011**

March 24th, 2011

To:

Shri Nivdange,  
Deputy Engineer,  
Karjat Subdivision,  
Maharashtra Jeevan Pradhikaran,  
Karjat, Dist. Raigad, Maharashtra

Dear Shri Nivdange,

You may recall the ongoing IIT-Bombay analysis of the Sugve multi-village drinking water scheme. As a part of this, we have analysed the initial documents supplied by your office and have consulted various stakeholders from MJP, local NGO (Disha Kendra) and the residents of Naldhe, Gudwan and Anjap. We conducted a Participatory Rural Analysis (PRA) during our stay in these three villages from 4/3/2011 to 6/3/2011 (formal report will be submitted shortly). Additionally, we performed a technical analysis of the pipeline network using computer simulation. Based on the analysis so far, we have the following points which we would like your office to help us with in order for us to complete our study.

1. **Working Survey:** Was an initial working survey [Ref1, Pgs 99,102] conducted before the construction started? If so, can you please provide the detailed documents from this survey? This will help us understand many of the discrepancies that we notice between our estimates and the data used by you.

1. **Land Ownership:** We understand that Naldhe ESR is locked in a land ownership issue. This was stated as a reason for delay [Ref2]. Can you please explain if an NOC was obtained or an alternate agreement made with the land owner before the construction was started?

7) **Road crossings:** Another mention for delay was permission and payments for road crossing [Ref1, Pg31]. Was this road crossing required in a new design?

8) **Jackwell & Pump House:** We believe that one reason for the construction delay is that hard rock strata that was expected to be met after 4.5m was actually met after 1m [Ref1, Pg 30]. Can you please help us understand the basis for the initial estimate of 4.5m? Our own visual inspection of the site seems to indicate hard strata rather immediately.

9) **Pipe specifications:**

1. In the Branch Simulation performed by MJP, [Ref1, Pg82] the following commercial diameters have been used:

| Pipe Diameter(mm) | Hazen's Constant |
|-------------------|------------------|
| 50                | 100              |
| 65                | 100              |
| 80                | 100              |
| 100               | 100              |
| 150               | 100              |
| 200               | 100              |

However, the material which is used during implementation [Ref1, Pg91] are pipe diameters of three types (ACP, CI ,GI) of diameters 50mm , 65mm, 80mm, 100mm, 125mm,150mm. Is there a reason to not input the actual pipe-set in the simulation? (E.g. 125 mm pipe has been used in the

physical construction but was not used as input in the simulation). Also, for the pipe-set used, what are the Hazen constants?

2. Assuming that the Hazen constants are the same and that the simulation is valid, we also see many discrepancies in the pipe-dimensions between the simulation output [Ref1, Pgs 70,82,83,88] and the one physically used [Ref1, Pgs 90, 91] in the implementation (see examples below). Is there any reason to deviate from the simulated dimensions?

| Location of pipe                          | According to simulation | Implemented        |
|-------------------------------------------|-------------------------|--------------------|
| From ESR Naldhe Across Shilar River       | 100 ACP                 | 125 CI             |
| From ESR Naldhe branch towards Sugave     | 80ACP                   | 100 CI             |
| From ESR Borivali towards Gudwan          | 150 ACP                 | 150CI+150ACP+150GI |
| In MRB branch , connecting Dharyachi wadi | 50GI                    | 50GI +65GI         |

**10) Length between nodes:** We found significant discrepancy in length of two pipe sections (part of Boriwali ESR sub-network).

1. Length between Antrat-T-Waredi and node 57 (trisection just before Gudwan) – The length used by MJP in simulation is 1830 meters [Ref1, Pgs 81,85] whereas estimate from Google Earth is atleast 2500 meters.
2. Length between Antrat-T-Waredi and Kalyachiwadi – Reported length is 420 meters [Ref1, Pgs 81,85] whereas estimate from Google Earth is atleast 1000 meters.

Can you please validate our understanding? Because of huge increase in length of the pipes, simulation shows that cost of Boriwali pipeline subnetwork would go from INR 12.09 lakhs to 22.5 lakhs. One of the reasons for increased cost would be the need of larger diameter pipes to lower down the increased head requirement.

**11) Elevation:** The elevation difference between Lobhyachiwadi and ground level of ESR at Naldhe taken in your simulation is 8.78m (150.33m - 141.55m) (node 61 and node 51) [Ref1, Pgs 87,89]. Our estimate [Ref3] based on Google Earth[Ref4], is around 1m (89m – 88m), which is substantially lower than the elevation difference in your calculations. Can you please verify the actual height and location of Lobhyachiwadi?

**12) Naldhe ESR height:** Assuming that the Lobhyachiwadi elevation is indeed 141.55m, there seems to be no reason to have Naldhe ESR at the current designed height of 10m. In fact, we performed an exercise to optimize the ESR height by minimizing the total cost of pipe network and ESR construction cost [Ref5]. For ESR at Naldhe we found that the optimal height was 6 meters instead of the current design of 10 meters and by using optimal pipe diameters, there is a potential to save upto INR 2.5Lakhs. Similar analysis may also be done to optimize the height of Boriwali ESR.

**13) ESR elevation:** At Naldhe, the ESR outlet is reported at 160.34 meters with Full Supply Level (FSL) of 163.85 meters [Ref1, Pgs 69, 72]. In simulation of Gravity Main (GM) pipeline network, FSL should be used as the elevation at ESR, but outlet level has been used instead. Re-simulating the GM network with FSL as the elevation being the only change, the network cost changes from INR 45.12 lakhs to INR 48.27 lakhs. Can you please validate this cost differential?

| Storage Reservoir       | FSL (in meters) | Outlet (In meters) | Height used in simulation (in meters) |
|-------------------------|-----------------|--------------------|---------------------------------------|
| MBR (Inlet)             | 176.2           | 172.2              | 172.2                                 |
| ESR at Borwali (outlet) | 140.82          | 137.32             | 140.82                                |
| ESR at Naldhe (outlet)  | 163.84          | 160.34             | 160.34                                |

14) **Operation Log:** Can you please provide the daily operation schedule for the network? What are the control points in the network?

15) **Operation & Maintenance:**

1. The cost of electricity reported [Ref1, Pg 95, Statement no. 21] is Rs 550 per BHP per year. Can you please provide a breakdown of this cost? Our estimate is Rs17,400 per BHP per year (assuming 0.746kW/BHP for 16 hours pumping per day, 365 days per year and a rate of Rs 4 per kWhr)
2. Upon examining RA bill [Ref6, Pg15], we notice that there is a bill for the delivery of water for every summer starting 2007 as follows:

| Quantity executed | Item of work                                                                      | Rate     | Unit  | Payment up-to date | Payment since prev bill |
|-------------------|-----------------------------------------------------------------------------------|----------|-------|--------------------|-------------------------|
|                   | 1. Commissioning , running & maintaining the scheme to quantities ,rated capacity |          |       |                    |                         |
|                   | A) For 10th March2007 to Jul 2007 -4months                                        |          |       |                    |                         |
| 4                 | a) For upto first 3 villages                                                      | 1008.3   | month | 40333.32           | 40333.32                |
| 14                | b)Add for every villages or part there of                                         | 2420     | month | 33880              | 33880                   |
|                   | B) For 15th Jan 2008 to Jun 2008 -6months                                         |          |       |                    |                         |
| 5.5               | a) For upto first 3 villages                                                      | 13108.33 | month | 72095.82           | 72095.82                |
| 43.6              | b)Add for every villages or part there of                                         | 3190     | month | 139084             | 139084                  |
|                   | C)For 1st March 2009 to Jul 2009 -5 months                                        |          |       |                    |                         |
| 4.5               | a) For upto first 3 villages                                                      | 15711.67 | month | 70702.52           | 70702.52                |
| 44                | b)Add for every villages or part there of                                         | 4345     | month | 191180             | 191180                  |
|                   | D)Proposed For 1st Mar-Jul 2010-5 months                                          |          |       |                    |                         |

|      |                                                |          |           |          |          |
|------|------------------------------------------------|----------|-----------|----------|----------|
| 3.6  | a) For upto first 3 villages                   | 186068.4 | mont<br>h | 65046.31 | 65046.31 |
| 36   | b)Add for every villages or<br>part there of   | 4997.3   | mont<br>h | 179902.8 | 179902.8 |
|      |                                                |          |           |          |          |
| 1500 | 2.Providing TCL powder<br>while running scheme | 16.2     | Kg        | 24300    | 24300    |

We would like to have a more detailed explanation of the above entries, such as list of wadis served, annotations by gram-sewak, gram panchayat, members etc., and other supporting documents, such as collection of water-cess from the wadis, tariff charged and actual electricity bills. Also, can you please explain the first column above which is titled in the table as “Quantity executed upto date as per measurement book”?

**16) Observations from PRA and related questions:** During our interaction with the residents, we made the following observations [Ref7]

1. Anjap village already has a private pipeline. Hence the residents seem unwilling to subscribe to the MVS scheme. All other villages also expressed scepticism about the scheme. Their apprehension about the condition of the infrastructure that was installed 10 years ago is a big reason for their unwillingness to subscribe to the scheme. Based on this, we would like to understand if there was any survey or agreement performed with the villages initially. Also, is there any procedure in place for handing over the scheme to them?
2. Currently the scheme only provides raw water to the villages. We believe that if treated water is provided instead of raw water, there is likely to be better acceptance of the scheme. Additionally, since the construction of WTP is independent of other sub-works, can its construction be prioritized so that the villages and wadis get treated water?
3. In light of the current reservations about the scheme, was there a formal expression of demand received from the villages at any stage in the project?
4. We would like to understand the historical timeline of this MVS scheme. Can you please provide information regarding this? It will help us understand the major milestones in the project. Can you also explain what resulted in the lack of funding for the project between 2002 and 2007?

**17) MBR:** It appears that the MBR construction has some minor work including installation of safety equipment remaining. Considering the comparatively low cost of installation of a lightening conductor, is it possible to prioritize its installation to avert risk? Also, please share what insurance policies, if any, are in place to cover the pipeline network.

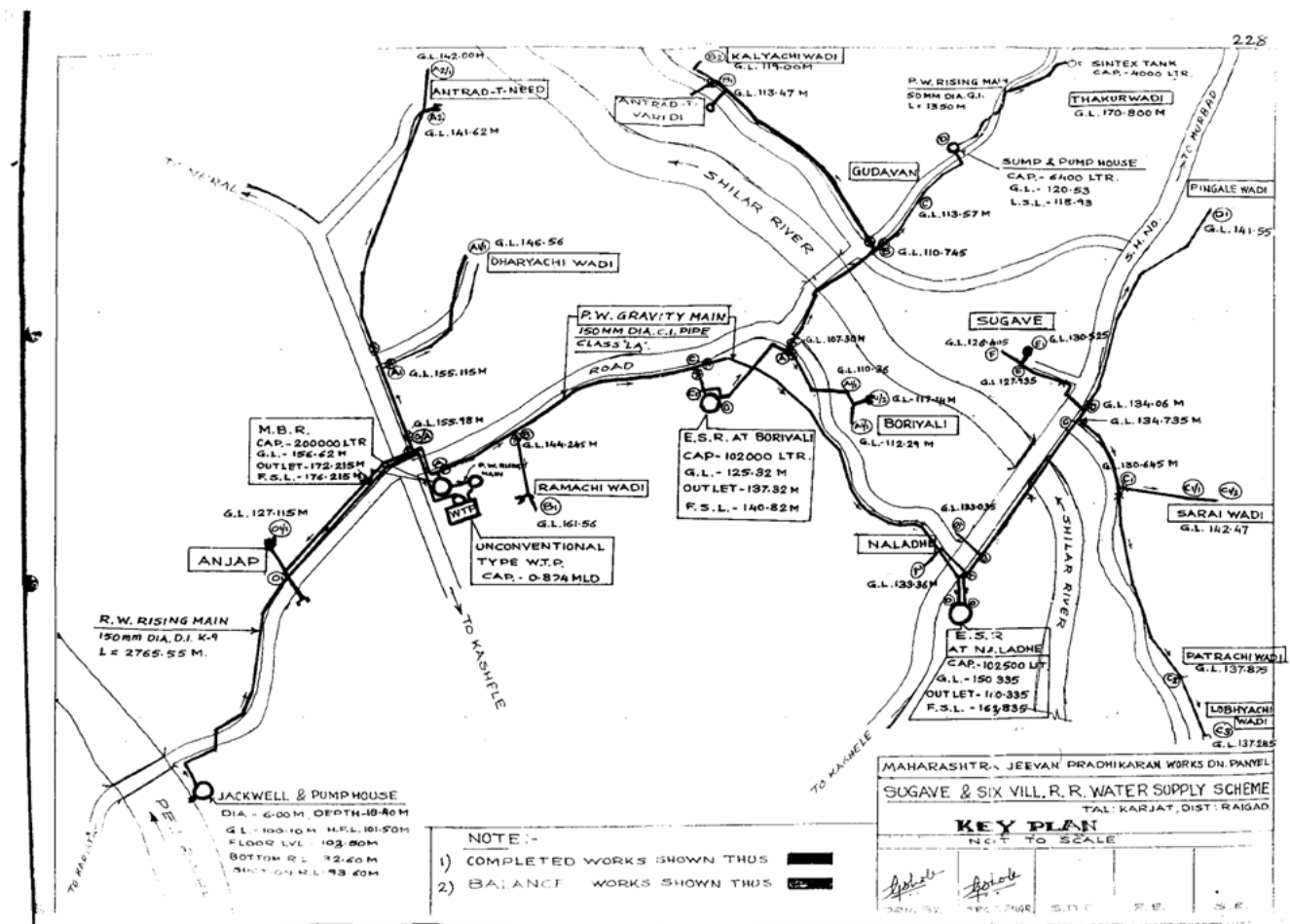
**18) Pipe strength:** Since the ACP pipes have now been banned, GI pipes have been physically used in the network. However, the revised design continues to show ACP pipes in the network design. Can you please send us the latest design with this change?

Please let us know if you need clarity on any of the above questions. Attached with this letter you will also find a CD containing data used in our technical analysis. We would like to propose a meeting on Saturday, April 3<sup>rd</sup> to discuss your response. Thank you for your help and support in our analysis.

Best regards,

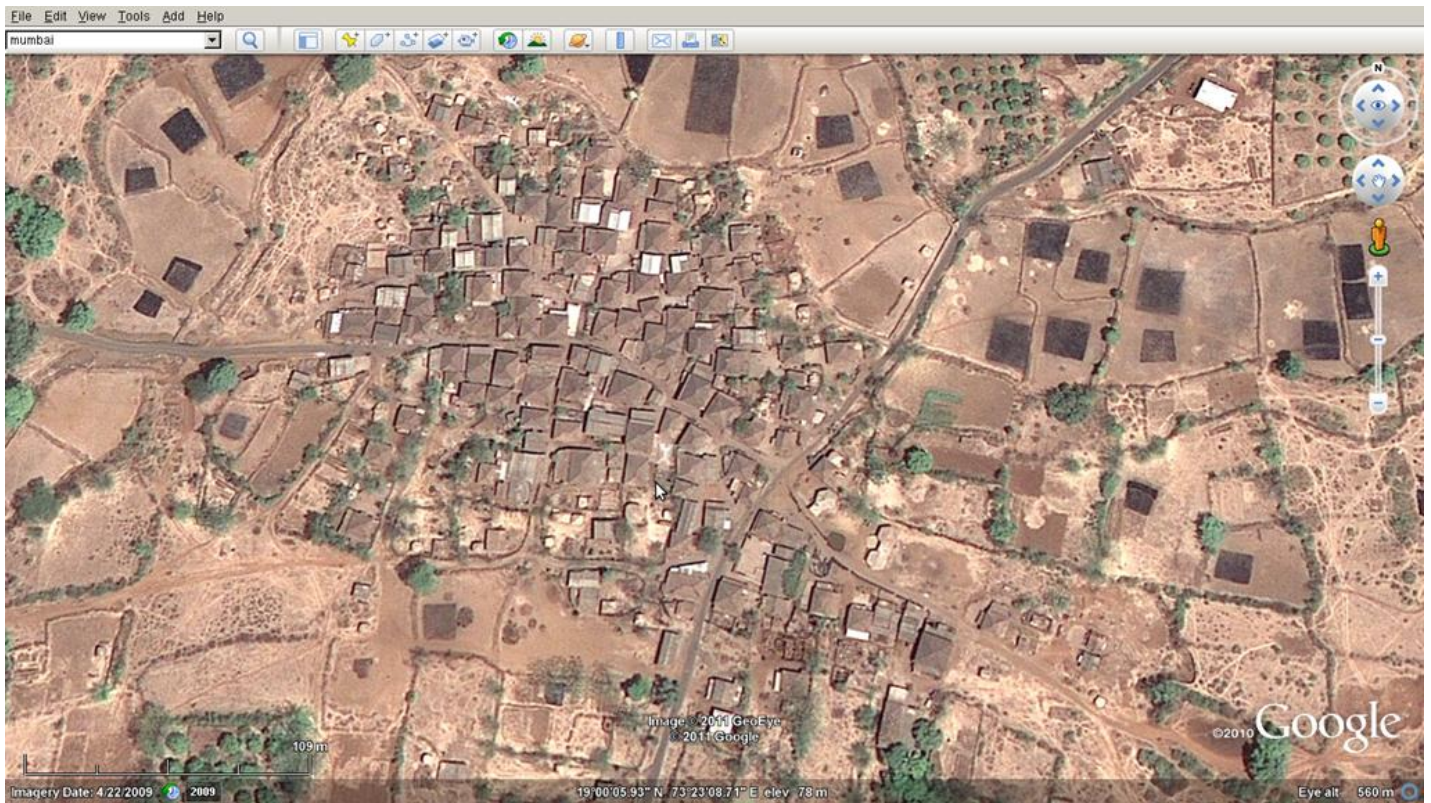
Mridul Joshi  
Senior Undergraduate Student  
I.I.T. Bombay

Nikhil Kumar Goyal  
Senior Undergraduate Student  
I.I.T. Bombay



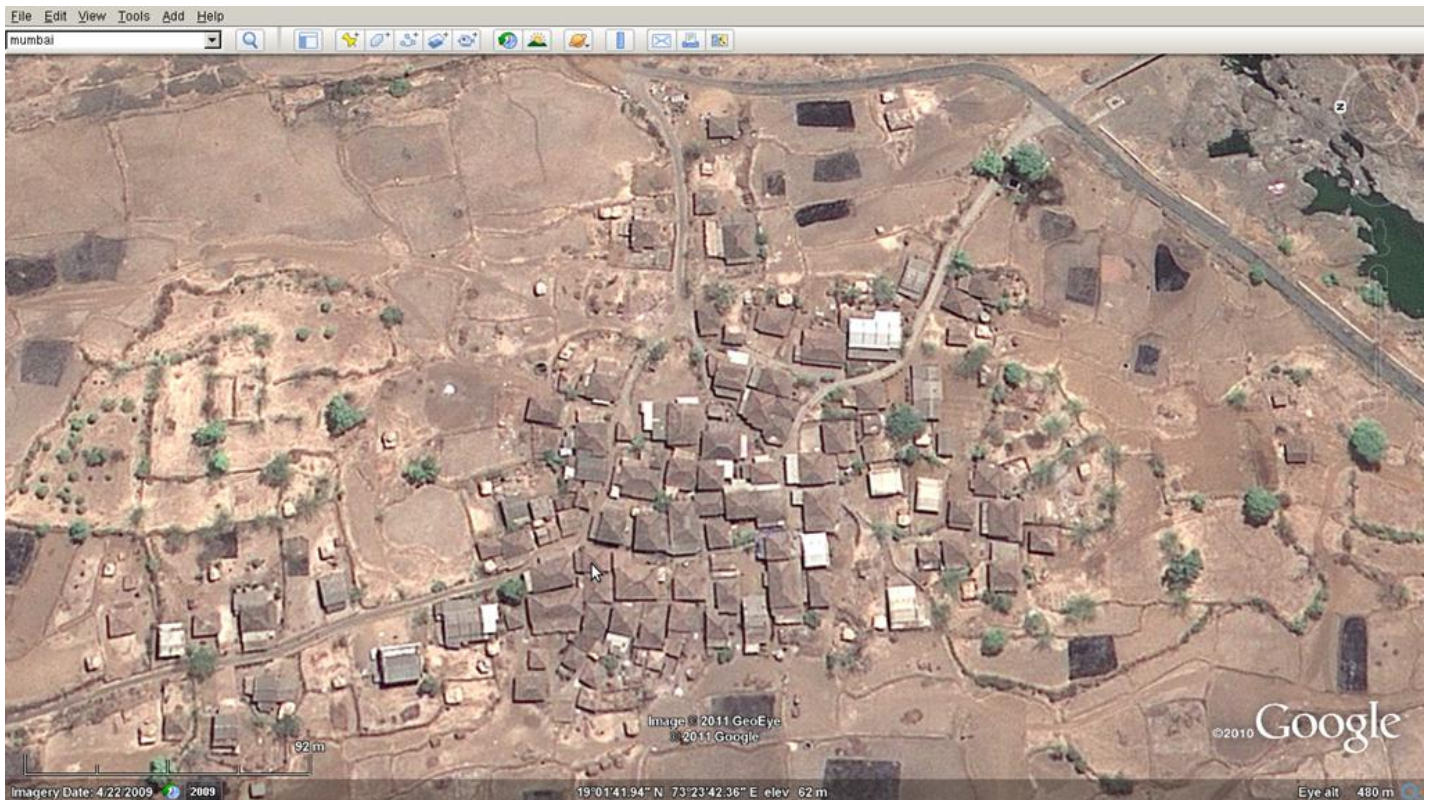
Appendix 3 : Map of target area by MJP

**Appendix 4 : Top view of Anjap, Gudwan, Borwali, Naldhe and Gudwanwadi from Google map, updated**



march'10

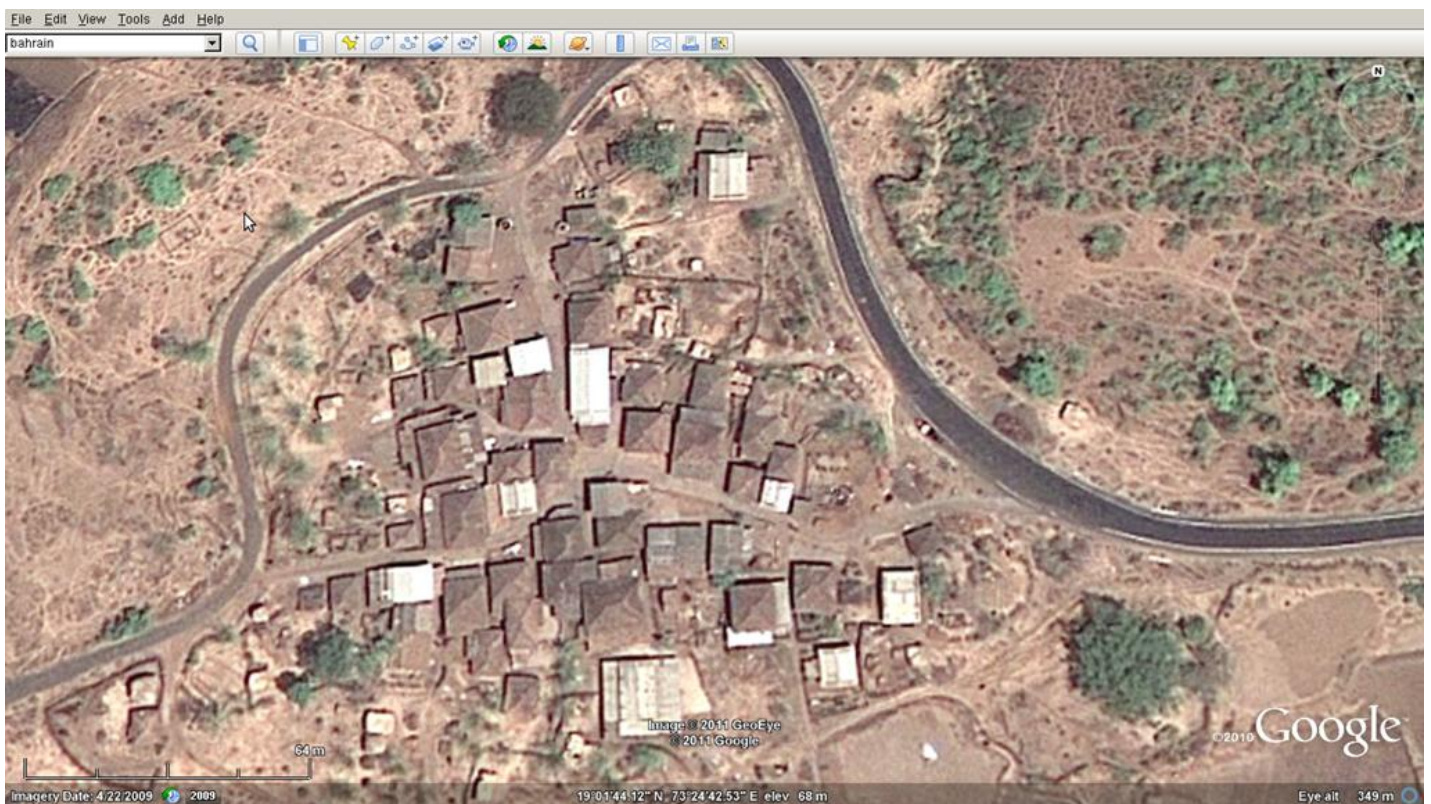
Anjap



Gudwan



Borwali



Naldhe



Gudwanwadi

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**Appendix 5 : Simulation output file for Gravity Main Simulation with current physical asset**


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B R A N C H

Version 3.0

## Branched Water Distribution Network Design Program

BRANCH: Branched Water Distribution Design Program - (C) The World Bank

Output Data File : GM.OUT    14 May 2011    Page # 1

## Echoing Input Variables

-----

Title of the Project            : GM  
 Name of the User               : MN  
 Number of Pipes                : 13  
 Number of Nodes               : 14  
 Number of Commercial Diameters    : 5  
 Peak Design Factor            : 1  
 Minimum Headloss in    m/km    : .01  
 Maximum Headloss in    m/km    : 25  
 Minimum Residual Pressure   m     : 5  
 Type of Formula               : Hazen's

## Pipe Data

-----

=====

| Pipe No. | From Node | To Node | Length m | Diameter mm | Hazen's Const | Status (E/P) |
|----------|-----------|---------|----------|-------------|---------------|--------------|
|----------|-----------|---------|----------|-------------|---------------|--------------|

-----

|   |    |    |         |       |           |  |
|---|----|----|---------|-------|-----------|--|
| 1 | 51 | 52 | 15.00   | 150.0 | 130.00000 |  |
| 2 | 52 | 53 | 40.00   | 150.0 | 130.00000 |  |
| 3 | 53 | 54 | 1300.00 | 80.0  | 140.00000 |  |
| 4 | 54 | 55 | 115.00  | 65.0  | 120.00000 |  |

|    |    |    |         |       |           |
|----|----|----|---------|-------|-----------|
| 5  | 53 | 56 | 120.00  | 80.0  | 140.00000 |
| 6  | 56 | 57 | 980.00  | 50.0  | 120.00000 |
| 7  | 56 | 58 | 1780.00 | 80.0  | 140.00000 |
| 8  | 58 | 59 | 60.00   | 65.0  | 120.00000 |
| 9  | 52 | 60 | 420.00  | 150.0 | 130.00000 |
| 10 | 60 | 61 | 350.00  | 65.0  | 120.00000 |
| 11 | 60 | 62 | 1220.00 | 150.0 | 130.00000 |
| 12 | 62 | 63 | 160.00  | 80.0  | 120.00000 |
| 13 | 62 | 64 | 2400.00 | 150.0 | 130.00000 |

## Node Data

| Node No. | Peak Factor | Flow Ips | Elevation m | Res. Press m | Meet Res. Pres (Y/N)? |
|----------|-------------|----------|-------------|--------------|-----------------------|
|----------|-------------|----------|-------------|--------------|-----------------------|

|    |      |        |        |      |  |
|----|------|--------|--------|------|--|
| 51 | 1.00 | 0.000  | 156.63 | 5.00 |  |
| 52 | 1.00 | 0.000  | 156.62 | 5.00 |  |
| 53 | 1.00 | 0.000  | 155.98 | 5.00 |  |
| 54 | 1.00 | -1.320 | 127.11 | 5.00 |  |

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Output Data File : MB.OUT 14 May 2011 Page # 2

## Node Data cont`d

| Node No. | Peak Factor | Flow Ips | Elevation m | Res. Press m | Meet Res. Pres (Y/N)? |
|----------|-------------|----------|-------------|--------------|-----------------------|
|----------|-------------|----------|-------------|--------------|-----------------------|

|    |      |        |        |      |  |
|----|------|--------|--------|------|--|
| 55 | 1.00 | -0.150 | 127.11 | 5.00 |  |
| 56 | 1.00 | 0.000  | 155.12 | 5.00 |  |
| 57 | 1.00 | -0.340 | 146.56 | 5.00 |  |
| 58 | 1.00 | -1.310 | 141.62 | 5.00 |  |
| 59 | 1.00 | -0.870 | 142.00 | 5.00 |  |
| 60 | 1.00 | 0.000  | 144.24 | 5.00 |  |

|    |      |        |        |      |
|----|------|--------|--------|------|
| 61 | 1.00 | -0.340 | 161.56 | 5.00 |
| 62 | 1.00 | 0.000  | 144.88 | 5.00 |
| 63 | 1.00 | -6.500 | 140.82 | 5.00 |
| 64 | 1.00 | -4.480 | 160.34 | 5.00 |

## Reference Node Data

-----

=====

| Node | Grade Line |
|------|------------|
| No.  | m          |

-----

|    |        |
|----|--------|
| 51 | 172.21 |
|----|--------|

=====

## Commercial Diameter Data

-----

=====

| Pipe Dia. | Hazen's | Unit Cost    |
|-----------|---------|--------------|
| Int. (mm) | Const   | Rs /m length |

-----

|       |           |         |
|-------|-----------|---------|
| 200.0 | 100.00000 | 1000.00 |
| 150.0 | 100.00000 | 824.00  |
| 80.0  | 100.00000 | 310.00  |
| 65.0  | 100.00000 | 239.00  |
| 50.0  | 100.00000 | 192.00  |

=====

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Output Data File : MB.OUT 14 May 2011 Page # 3

## Branched Water Distribution Network Design OutPut

## Pipe Details

=====

| Pipe No. | From Node | To Node | Peak Flow (lps) | Diam (mm) | Hazen's Const | HL (m) | HL/1000 (m) | Length (m) | Status (E/P) |
|----------|-----------|---------|-----------------|-----------|---------------|--------|-------------|------------|--------------|
|----------|-----------|---------|-----------------|-----------|---------------|--------|-------------|------------|--------------|

-----

|    |    |    |        |       |           |      |       |         |  |
|----|----|----|--------|-------|-----------|------|-------|---------|--|
| 1  | 51 | 52 | 15.310 | 150.0 | 130.00000 | 0.09 | 6.00  | 15.00   |  |
| 2  | 52 | 53 | 3.990  | 150.0 | 130.00000 | 0.02 | 0.50  | 40.00   |  |
| 3  | 53 | 54 | 1.470  | 80.0  | 140.00000 | 1.87 | 1.44  | 1300.00 |  |
| 4  | 54 | 55 | 0.150  | 65.0  | 120.00000 | 0.01 | 0.09  | 115.00  |  |
| 5  | 53 | 56 | 2.520  | 80.0  | 140.00000 | 0.47 | 3.92  | 120.00  |  |
| 6  | 56 | 57 | 0.340  | 50.0  | 120.00000 | 1.23 | 1.26  | 980.00  |  |
| 7  | 56 | 58 | 2.180  | 80.0  | 140.00000 | 5.31 | 2.98  | 1780.00 |  |
| 8  | 58 | 59 | 0.870  | 65.0  | 120.00000 | 0.12 | 2.00  | 60.00   |  |
| 9  | 52 | 60 | 11.320 | 150.0 | 130.00000 | 1.42 | 3.38  | 420.00  |  |
| 10 | 60 | 61 | 0.340  | 65.0  | 120.00000 | 0.12 | 0.34  | 350.00  |  |
| 11 | 60 | 62 | 10.980 | 150.0 | 130.00000 | 3.89 | 3.19  | 1220.00 |  |
| 12 | 62 | 63 | 6.500  | 80.0  | 120.00000 | 4.79 | 29.94 | 160.00  |  |
| 13 | 62 | 64 | 4.480  | 150.0 | 130.00000 | 1.46 | 0.61  | 2400.00 |  |

=====

## Node Details

=====

| Node No. | Peak Flow (lps) | Elevation (m) | H G L (m) | Cal Pres (m) | Spc Pres Pres. (Y) | Meet Res |
|----------|-----------------|---------------|-----------|--------------|--------------------|----------|
|----------|-----------------|---------------|-----------|--------------|--------------------|----------|

-----

|      |        |        |        |       |      |  |
|------|--------|--------|--------|-------|------|--|
| 51 S | 15.310 | 156.63 | 172.21 | 15.58 | 5.00 |  |
| 52   | 0.000  | 156.62 | 172.12 | 15.50 | 5.00 |  |
| 53   | 0.000  | 155.98 | 172.10 | 16.12 | 5.00 |  |
| 54   | -1.320 | 127.11 | 170.23 | 43.12 | 5.00 |  |
| 55   | -0.150 | 127.11 | 170.22 | 43.11 | 5.00 |  |
| 56   | 0.000  | 155.12 | 171.63 | 16.51 | 5.00 |  |

=====

|    |        |        |        |       |      |
|----|--------|--------|--------|-------|------|
| 57 | -0.340 | 146.56 | 170.40 | 23.84 | 5.00 |
| 58 | -1.310 | 141.62 | 166.32 | 24.70 | 5.00 |
| 59 | -0.870 | 142.00 | 166.20 | 24.20 | 5.00 |
| 60 | 0.000  | 144.24 | 170.70 | 26.46 | 5.00 |
| 61 | -0.340 | 161.56 | 170.58 | 9.02  | 5.00 |
| 62 | 0.000  | 144.88 | 166.81 | 21.93 | 5.00 |
| 63 | -6.500 | 140.82 | 162.02 | 21.20 | 5.00 |
| 64 | -4.480 | 160.34 | 165.35 | 5.01  | 5.00 |

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Output Data File : MB.OUT 14 May 2011 Page # 4

#### Cost Summary

| Diameter<br>(mm) | Length<br>(m ) | Cost<br>(1000 Rs ) | Cum. Cost<br>(1000 Rs ) |
|------------------|----------------|--------------------|-------------------------|
| 50.0             | 980.00         | 188.16             | 188.16                  |
| 65.0             | 525.00         | 125.47             | 313.64                  |
| 80.0             | 3360.00        | 1041.60            | 1355.23                 |
| 150.0            | 4095.00        | 3374.28            | 4729.52                 |

#### Pipe-wise Cost Summary

| Pipe No | Diameter<br>(mm) | Length<br>(m ) | Cost<br>(1000 Rs ) | Cum. Cost<br>(1000 Rs ) |
|---------|------------------|----------------|--------------------|-------------------------|
| 1       | 150.0            | 15.00          | 12.36              | 12.36                   |
| 2       | 150.0            | 40.00          | 32.96              | 45.32                   |
| 3       | 80.0             | 1300.00        | 403.00             | 448.32                  |
| 4       | 65.0             | 115.00         | 27.49              | 475.80                  |
| 5       | 80.0             | 120.00         | 37.20              | 513.01                  |
| 6       | 50.0             | 980.00         | 188.16             | 701.16                  |

---

---

|    |       |         |         |         |
|----|-------|---------|---------|---------|
| 7  | 80.0  | 1780.00 | 551.80  | 1252.96 |
| 8  | 65.0  | 60.00   | 14.34   | 1267.31 |
| 9  | 150.0 | 420.00  | 346.08  | 1613.39 |
| 10 | 65.0  | 350.00  | 83.65   | 1697.04 |
| 11 | 150.0 | 1220.00 | 1005.28 | 2702.31 |
| 12 | 80.0  | 160.00  | 49.60   | 2751.92 |
| 13 | 150.0 | 2400.00 | 1977.60 | 4729.52 |

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