Safe Drinking Water

SUJALA SCHEME

...an Initiative in Rural Transformation

Byrraju Foundation

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INTRODUCTION

"In an age when man has forgotten his origins and is blind even to his most essential needs for survival, water along with all the other resources he inherited from a bountiful Nature has become the victim of his indifference"

Water is one of nature's most important gifts to mankind; Man's survival depends on water. It is one of the most essential elements to good health. With two thirds of the earth's surface covered by water, it is evident that water is one of the prime elements responsible for life on earth.

Our natural resources (rivers, seas and oceans) have been relentlessly exploited, ill-utilised and contaminated. As a result most of our drinking water today, contains a little over two hundred deadly chemicals.

Many past studies have shown that communities, with proper water supply and hygiene and/or sanitation had improved overall health standards. WHO reports that more than 1.1 billion people across the globe draw their water from unsafe sources, causing widespread diseases like diarrhoea. Of these, 84% live in rural areas. Drinking-water quality is especially difficult to control and even in the most developed countries, small community water supplies frequently fail on basic microbiological quality (WHO, 2001).

Unlike the arid hinterland, in delta regions adequate quantities of water is available, often through irrigation canals and sometimes from subsurface sources. Most villages depend on the availability of this water for drinking purposes. However, over the years, the canal waters have become highly polluted, with the presence of both physical and chemical impurities and harmful bacteria. Tests carried out on the presently available drinking water, even after filtration and chlorination, indicated a failure in meeting drinking water standards in all most all habitations.

The Byrraju Foundation, a not-for-profit organisation, dedicated to rural transformation, has embarked on providing safe drinking water, conforming to World Health Organisation's (WHO) standards, in the 154 villages adopted for development. To do so, it was essential to first reduce contamination of water bodies and improve the current purification and distribution system. One viable option, the Foundation discovered, was to separate the drinking water sources from the rest of the water available as this would help in addressing the issue expeditiously.

Accordingly, 31 drinking water plants, in as many villages, have been established so far. Each plant serves the drinking water needs of the village where it is situated as well as 3-4 other neighbouring villages. While the capital cost is shared between the community and the Foundation, consumers pay for the operation and maintenance of the plant. The plant is operated by purpose-trained local youth, incidentally creating livelihoods as a by-product. Quality control is ensured with the active involvement of local science colleges. The project is sustained through user charges, which are very nominal, making safe drinking water accessible to the poorest of the poor.

About this binder:

This process binder is a comprehensive document, so called because it admits the addition and deletion of information and reports dynamically. It is intended to provide a record of the steps and phases in the development of a drinking water initiative by

- Non-Government Organisations
- Government Departments
- Agencies
- Individuals
- Society/Associations
- Corporate Social Responsibility Groups
- Village Communities

The information contained herein is derived from the actual experience of the **Byrraju Foundation;** a not-for-profit organisation established by Mr B Ramalinga Raju and his brothers, in memory of their father Shri Byrraju Satyanarayana Raju, as part of their contribution to Rural Transformation.

The drinking water initiative of the Foundation covers 154 villages across five districts of Andhra Pradesh. So far 31 pure drinking water plants, in as many villages, have been established. Each plant serves the drinking water needs of the host village as well as a few surrounding villages.

The purpose of this binder is to help readers to be able to set up either an entire drinking water programme on their own or do so with help from the Foundation or any other agency experienced in the process.

It will also be of use wherever lacunae are noticed in any Safe Drinking Water programme.

Table of Contents

Conventions used in the binder:

The binder will explain every feature of the process, including the steps leading up to it and the follow-up reports where available. The language used will be British English simply written and structured so that its universality will aid in comprehension and subsequent application. All abbreviations will be listed in <2.0> below and will be expanded on first use except where such abbreviations are brand names or commonly in used in normal conversation.

1. CONCEPTS & DEFINITIONS

1.1 Scientific terminologies:

Water Purification – To remove specified contaminants from a water source.

Water Disinfection – Specifically, a purification process that kills or removes biological contaminants (cysts, bacteria, viruses, protozoa etc.) from a water source.

1.2 Concepts:

Sujala: In order to provide safe drinking water in the adopted villages, the Foundation with active participation from the community has set up water treatment plants. Such water, should maintain the same quality as that of reputed packaged drinking water brands in the market, and should be affordable by the poorest of the poor in the village. This water is branded as 'Sujala' which translated means "Good Water".

Grama Vikasa Samithi (GVS): This is a committee of the local community nominated by the Village Council (Gram Sabha), consisting of interested and involved members of all communities within the village. Each GVS has nine members, with alternate members who take the place of those that are unable to attend to the assigned tasks for any reason. Each member is responsible for a module of intervention by the Foundation.

1.3: Abbreviations

TDS	Total Dissolved Solids
HDPE	High Density Poly Ethylene (tanks/pipes/cans)
RO	Reverse Osmosis (membrane filtration technology)
SSF	Slow Sand Filters
RWS	Rural Water Supply
WHO	World Health Organisation
BIS	Bureau of Indian Standards
NTU	Nephlometric Turbidity Units
UVS	Ultra Violet System
NRV	Non-Resident Villagers

2. SYSTEM REQUIREMENTS & INSTALLATION

BACKGROUND

The surface water from irrigation canals is the drinking water source for a vast majority of villages in the Godavari and Krishna delta. Being close to the coast, most of the ground water has high levels of salinity. The existing water purification process, under the Rural Water Supply (RWS) Scheme, in the villages of delta region, involves storing canal water in a pond; passing it through Slow Sand Filters (SSFs), chlorination and pumping to an overhead tank for subsequent supply within the village through pipes.

2.1) BYRRAJU FOUNDATION'S EFFORTS TOWARDS PROVISION OF SAFE DRINKING WATER IN THE VILLAGES:

The Foundation is presently working in 154 villages, across East Godavari, Guntur, Krishna, Ranga Reddy and West Godavari Districts of Andhra Pradesh, India, influencing over 850,000 lives directly and nearly double that number indirectly, in the villages adjoining these adopted villages.

Vision

To provide safe drinking water, as per WHO standards (See Annexure I for details), in all the 154 adopted villages.

Safe Drinking Water

As per WHO standards, the average consumption of drinking water is 2 litres per capita per day.

Need for Pure Drinking Water

Diseases due to contamination of drinking water constitute a major burden on health. Improvement in the quality of drinking water will significantly benefit the health and well being of people. The Foundation therefore, is working towards providing pure drinking water to the maximum extent possible in its adopted villages.

Sources of Drinking Water in Godavari Delta

- 63% of villages are dependent on irrigation canals.
- 37% of villages are dependent on ground water.
- Being a delta region, most of the ground water is highly saline.

Also the water quality in canals has deteriorated over the years due to pollutants from various sources.

Pollution of Irrigation Canals

The quality of water in the canals has deteriorated drastically over the years due to various reasons. Some of the main reasons for poor quality of water are:

- The canal waters are highly polluted due to letting sewage/sullage, effluents from fish/prawn tanks, agricultural waste water carrying toxic chemicals, dumping of garbage and dead animals and human defecation along the canal banks.

- SSFs are designed for 16 hours of operation with 3-phase power. But, 3-phase power is available at most for 6-8 hours in a day in villages, with frequent interruptions.

- During availability of 3-phase power, SSFs are unable to produce the 40 litres per capita per day, as per the norms prescribed by the Government of India, in rural areas

- To meet the demand, often both filtered and unfiltered (raw) water is pumped, thus contaminating the quality of supplied water

- SSFs are designed to handle turbidity of 30 NTU in the raw water. But the actual turbidity is highly variable, particularly during the rainy season, when the canal water carries a lot of suspended particulate matter. Also during the summer months, the rapid growth of algae, aided by intense sunlight for longer hours, clogs the SSFs.

- High turbidity in raw water leads to accumulation of particulate matter, choking the filter beds rapidly. To overcome this, the top layer of the sand bed is scraped every 1-2 weeks, instead of the normal 6 weeks, leading to the non-formation of the biological layer required to prevent coliform organisms.

- Inadequate capacity of filter beds and storage sumps lead to shortage in supply of treated water.

- The operators are neither equipped with the required testing kits nor trained properly for checking the quality of water and maintenance of filter beds.

- The poor quality and inadequate quantity of chlorine (bleaching powder – which in itself is halogenic and proved to be carcinogenic) cannot ensure complete elimination of bacteria.

- The Grama Panchayats do not have adequate funds for proper maintenance of SSF's.

Present water supply scheme

- Most of the villages in Godavari delta are dependent on irrigation canals for drinking water.
- Each village has a pond, fed by an irrigation canal, storing the required quantity of water.
- Under the Rural Water Supply (RWS) scheme, in most villages the water in the pond is passed through Slow Sand Filters.
- The filtered water is chlorinated and pumped into an overhead tank for distribution through a network of pipes.

Test Results of Filtered Water

A test conducted of water samples, after filtration and chlorination in 133 villages of West Godavari, East Godavari, Krishna and Guntur Districts indicated the appalling condition of water in these regions.

The test results showed the presence of coliform, turbidity, chlorides and other physical as well as chemical impurities in the water supplied by the RWS Scheme. It was observed that 78% of the villages did not meet the safe water requirements due to these. If the need for 0.2 ppm of residual Chlorine is also considered, 128 out of 133 villages, (96%) failed to meet the safe water standard. The result of the test can be seen in Table-2 (See Tables).

2.2) SOLUTIONS TO AVOID/MINIMISE POLLUTION TO IRRIGATION CANALS:

In order to reduce pollution levels in the irrigation canals, various initiatives, like treating and diverting liquid waste into drainage canals, converting solid waste into compost/organic manure, burying dead animals/birds/fish, etc., are to be followed. The Foundation, having studied the problems, has developed a strategy to address the situation.

Foundation's initiatives in reducing pollution:

A background paper highlighting the problems has been prepared. The Foundation has also surveyed some stretches of the canals and identified the sources of pollution and its locations.

- A questionnaire, seeking details on source of water consumption, was devised and distributed amongst 1000 families, living along the Anakoderu and Losarai canals, stretching across some densely populated villages over a 30 km length near Bhimavaram, a major town serving as a hub for most of these villages.

- The Foundation has also conducted workshops and awareness camps on saving the drinking water canals from pollution.

- In order to create awareness, the Foundation has prepared posters on safe drinking water and displayed them at schools, colleges, hospitals, Gram Panchayat offices and health centres of the Foundation.

- The Foundation has also conducted a survey in Bhimavaram Municipality to identify the drainage outlets into the irrigation canals. The Survey identified 15 drainage outlets into irrigation canals. These issues were brought to the notice of concerned authorities, who took necessary action in blocking all the drainage outlets into the canals within the Municipality limits.

- Analysis of the above study and other problems were presented to the concerned authorities in the Government of Andhra Pradesh. Discussions were also held with relevant groups, including District Collectors, Engineers of Irrigation and Panchayat Raj Departments, faculty from Colleges, Doctors and the public in Godavari Districts.

As a follow up measure, the Government in the first instance, ordered the repair of SSFs and allocated a budget for all the filter beds, mostly in the delta regions of the state.

However, other steps needed towards improving existing water treatment include availability of 3-phase power for 16 hours a day, qualified and well trained operator/s, proper maintenance and continuous up gradation of the filter beds, proper chlorination, etc. In the present scenario, when the availability of funds is a constraint, it is difficult to ensure most of these steps in many villages.

The challenges

Though the Foundation's aim is that every person in the village has access to safe drinking water, many are yet to benefit. The following are some of the challenges that are being addressed by the Foundation to reach 100% coverage:

- To ensure that the poorest of the poor also have access to safe drinking water.
- Create awareness about the need to drink safe water.
- Income generation initiatives for affordability of treated clean and potable water.

Strategy for all the villages

- One plant for every 3-4 villages, using the best technology
- Plant operated by the trained youth of the village
- Creation of livelihoods
- Sustainability through user charges
- Quality control, by involving local science colleges

Strategy for Providing Safe Drinking Water

- Creating awareness about the quality of water and need for its purification before consumption.
- Reduce pollution in the irrigation canals by various methods. This calls for tremendous resources and time.
- Improve the functioning of Slow Sand Filters. This is also a difficult and time consuming task.
- Rural Water Supply Schemes are designed to supply 40 litres of water per capita per day. Out of the 40 litres per capita per day, only 2-3 litres of water is used for drinking and cooking purposes, which is about 5-7.5% of total quantity to be supplied in villages.
- It is much easier to treat this 5-7.5% of water supplied rather than the entire quantity.

(To provide safe drinking water in villages, the Foundation commissioned a pilot plant, using Reverse Osmosis (RO) membrane technology, with 1000 litres/hr capacity, in Gollalakoderu (near Bhimavaram in West Godavari District) on July 1st 2004. For more details, log on to: http://www.byrrajufoundation.org/waterplant.htm

Safe Drinking Water Plants in Other Villages

Based on the success of the Gollalakoderu Plant and the response from the host village and nearby villages, similar plants were setup in seven other villages-- Juvvalapalem and Vempadu in West Godavari, Podagatalpalli, Ponnamanda and Pallamkurru in East Godavari, Pothumarru in Krishna, and Khajipalem in Guntur during the year 2004.

Methodology

- Regular monitoring of drinking water quality at the plant and also in a laboratory set up in DNR College, Bhimavaram.
- Creating awareness among water users, authorities at local and state level.
- Training filter bed operators and monitoring their performance.
- Ensuring availability of required chemicals for water treatment.
- Facilitating repair and maintenance of filtration system.
- Providing water filters in schools.
- Educating public about water-borne diseases and methods to combat them.
- Preventing pollution of water channels through effective use of local government machinery.
- Developing a cost effective home based water filtration system in collaboration with experts

Foundation's trial efforts in reducing pollution in irrigation canals within Bhimavaram Municipality

- All 15 drainage outlets into the irrigation canals within the Bhimavaram Municipal limits have been diverted to a drainage system.
- This approach needs to be adopted in all other Municipalities to prevent the pollution of canals.

Alliances

- Department of Panchayat Raj (Rural Water Supply), Government of Andhra Pradesh.
- Department of Environment, Forest, Science and Technology, Government of Andhra Pradesh.
- District & Mandal level authorities.
- DNR College, Bhimavaram.
- Andhra Pradesh Pollution Control Board.

2.3) SUJALA WATER PLANT:

FINANCING MODEL FOR SUJALA WATER PLANT-VILLAGE PARTNERSHIP:

The Foundation strongly believes that active the participation and involvement of local bodies, villagers and others are essential for successful implementation of the Sujala Water Scheme. The Foundation therefore proposed the sharing of initial costs between the villagers and the Foundation. In order to ensure its sustainability, the cost of operation and maintenance has to be the responsibility of the beneficiaries through user charges at INR 1.50 for 12 litres.

OPERATION AND MAINTENANCE OF SUJALA WATER PLANTS:

In order to ensure 100% satisfactory performance of the Sujala Water Plants, the following steps have been taken:

- The quality of input water is checked thoroughly for various contaminants like turbidity, physical and chemical impurities, bacteria, etc., on a continuous basis. Based on the levels of impurities/bacteria, the process parameters are set for effective removal of the same.

- To overcome the power outages and interruptions, the plant is operated at timings that are flexible. In addition, voltage stabilisers are installed for maintaining the quality of the power.

- A 100% standby for all the critical components, like, Pumps, Motors, UV Lamps, Voltage Stabilisers, Multi-port Valves and adequate stocks of consumables are always ensured.

- Continuous training and updating the skills of the operators.

- Annual maintenance contract initially for 5 years, with the suppliers of the Plant to ensure trouble-free operation.

- For every 5 Sujala water plants, a maintenance team, consisting of a well-trained technician, together with plumber-cum-electrician, has been deployed within close vicinity of a cluster of the villages, to attend to regular preventive maintenance and immediately rectify any break-down problems in the plant.

- Layout and components of the plant have been standardised so that the plants, operating on with similar/identical conditions, can effectively share inventories for effective operation.

- Grama Vikasa Samiti (GVS), a team of volunteers formed and institutionalised by the Foundation in all the adopted villages monitor the Foundation's initiatives at the village level. The GVS member(s) identified for water supply and treatment look after the operation and maintenance of the Sujala Water plant.

Unique Features of the Scheme:

The Sujala water plants have some unique features, which are listed below:

- Identification of the issues, such as pollution of water sources, availability of safe water, suitable processes and specifications thereof.
- Critical analysis of existing RWS scheme and identification of deficiencies.
- Design of systems to suit local conditions, considering the variability in the quality of water throughout the year.
- Keeping the cost of water low for affordability.
- Community participation/partnership.
- Training of the local youth and creation of livelihood opportunities within the villages.
- Constant monitoring of the water quality in a cost effective manner.
- Involvement of local institutions for water quality testing.
- Sustainability through user charges.
- An ozonisation unit has been installed in a couple of plants to monitor improvements in the quality of product water.

Read more about: Byrraju Foundation-Sujala scheme-Safe drinking water for all

3. QUICK START GUIDE

The initiatives for reducing pollution in the canals and improving the existing water supply system, requires huge resources and time. The Foundation believes that the viable solution to overcome the problem is to make available clean water for drinking purpose alone. As mentioned earlier out of the 40 litres per capita per day, it is estimated that approximately 2 litres are used for drinking and cooking purposes, which is about 5% of total quantity specified for supply in villages. It is much easier to bring this amount of water to drinking water standards rather than the entire quantity supplied for other needs.

3.1) Water Treatment Steps

1. Have water tested for contaminants.
2. Remove fine sand, silt, clay and other particles, using a mechanical filter or by sedimentation.
3. Treat bacterial contamination, using chlorination or other forms of disinfection.
4. Remove hydrogen sulphide gas and other odour-causing substances, using chlorination, an oxidising filter, or activated carbon.
5. Remove insoluble iron and manganese particles using:
   - a mechanical filter
   - a water softener for small amounts of dissolved iron and manganese
   - an oxidising filter for higher amounts of dissolved iron and manganese
   - a chlorinator followed by a mechanical filter or an activated carbon filter for very high amounts of dissolved iron and manganese.
6. Treat for hardness using a water softener.
7. Neutralise acidity using a neutralising filter.
8. Remove volatile organic chemicals, trihalomethanes, certain pesticides and radon, using an activated carbon filter.
9. Remove heavy metals and dissolved solids, such as lead, mercury, arsenic, or cadmium, with reverse osmosis units or a distiller.

3.2) Technologies for Drinking Water Treatment

- Slow Sand Filtration and Chlorination – For surface water
- Chlorination – For ground water
- Micron filtration + UV - for surface water where TDS is within acceptable limits
- Micron filter + Reverse Osmosis + UV - for surface and ground water where TDS is not within acceptable limits

3.3) **Options for Membrane Filtration:**

Micro Filtration	**Ultra Filtration**	**Reverse Osmosis**
Low pressure (10-100 psig) process for separating larger size solutes from aqueous solutions by means of a semi-permeable membrane	Low pressure (5 - 150 psig) process for separating larger size solutes from aqueous solutions by means of a semi-permeable membrane	RO membranes will reject dissolved and suspended materials including monovalent salts
Pore ranges from 0.1 - 3 micron	Pore sizes ranges from 0.005 – 0.1 micron	Passes molecules in the range of 0.0001- 0.0005 micron
Retains large suspended solids	Retains oils, particulate matter, bacteria and suspended solids large macromolecules and proteins	Retains salts and organics
Passes some suspended solids and all dissolved material	Passes most surfactants, water, acid and alkaline compounds	Passes essentially only water

3.4) **Process to be followed if any problem occurs in the Sujala Plant**

1. The plant staff should inform the Service Engineer /Water Coordinator and concerned people in the CRT about the problem
2. Service engineer should address the problem within 24 hours
3. If the service engineer fails to attend the problem within 24 hours, plant staff should again inform the Water Coordinator; in turn the Water Coordinator should alert the Service Engineer.
4. If the problem is not solved even after 48 hours by the Service Engineer, the Water Coordinator should inform the plant Supplier and CRT
5. Plant supplier should inform the Service Engineer to attend to the problem within another 24 hours.
6. Service Engineer should inform the Water Coordinator as soon as he rectifies the problem.
7. Ideally, any problem arising in the plant should be solved within 72 hours

3.5) PROCESS LOGS

3.5.1) Problems encountered/Lessons Learnt

- Quality of raw water is highly varied, with high levels of turbidity especially during the monsoon
  -Coagulation Plants have been set up to reduce turbidity

- Frequent choking of micron Filters and/or Membranes
  -Cleaning and chemical de-scaling procedures have been adopted.

- Limited availability of 3-phase electric power
  -Operation converted to single phase and for long power outages
  DG Set (4 KVA/6 KVA) has been deployed

3.5.2) Foundation's Experiment at Gollalakoderu, near Bhimavaram, W.G.Dt.

- A pilot plant, using Reverse Osmosis(RO) membrane technology, with 1000 litres/hr capacity, was commissioned in Gollalakoderu on 1st July 04.
- Few villagers voluntarily contributed 50% towards the cost of the plant and also borne entire cost of the building. Remaining cost was met by the Foundation.
- The plant produces quality bottled water, meeting BIS specifications (See Annexure II)
- The product water is delivered in a 12- litre can to the host village as well as to nearby villages.
- The beneficiary contributes an amount of INR 1.50 for 12 litres of water to meet the cost of Operation and Maintenance of the plant.

Initial Problems with Gollalakoderu RO Plant

- After the plant was set up, turbidity of raw water in the pond increased to a very high level (monsoon effect).
- High turbidity led to frequent choking of filters.
- Also, the quantity of input water to the membranes reduced with increased levels of turbidity.

Handling the problems of Gollalakoderu RO Plant

- Coagulation system has been installed for reducing turbidity.
- Chlorine dosing system was introduced for removing initial levels of bacteria.
- With coagulation and chlorine dosing, the time for backwash has been restored to every 5 hours (normal).
- Stainless Steel Micron Filters, with reusable cartridges were also introduced in place of cotton filters.

Review of Design Concepts and Fabrication

- Discussions were held with experts at IIT Madras, IIT Delhi, Water Systems International Ltd, Chennai and NEERI, Nagpur, on other technological interventions for reducing the cost of the plant and its operational expenses.
- The design concepts and technology proposed for producing pure water were reviewed and necessary changes incorporated.
- Discussions were held with manufacturers of electrical pumps/motors. The Kirloskar Electric Company in particular for producing required motors that could operate on single phase power supply.

3.6) FOUNDATION'S ALTERNATIVE FOR SUPPLY OF PURE DRINKING WATER:

3.6.1) Options for producing safe drinking Water:

The Foundation has studied different options to improve the existing water supply system, like, constructing a coagulation system to the present RWS Scheme, so as to reduce the level of turbidity in the raw water and also prevent frequent choking of SSFs. But this option alone will not solve the odour problem in the treated water. Moreover, the dosage of chlorine is an issue, as insufficient levels do not destroy bacteria and an over dosage, beyond the prescribed safe limit, makes it carcinogenic, which is harmful for health.

The Foundation's water treatment plants that produce the 'Sujala' water have to take into consideration two specific scenarios that depend on the quality/characteristics of input water available in the area.

Scenario -1: In case the levels of Total Dissolved Solids (TDS) are less than 500 ppm in input water the process route of purification consists of coagulation to remove the majority of sediments, chlorination to kill the bacteria, pressure sand filter to further reduce the sediments, activated carbon filter to eliminate the odour, micron filters to prevent the finer particles and ultraviolet irradiation to kill the residual bacteria.

The product water, stored in a food-grade High Density Poly Ethylene (HDPE) tank, is again passed through another UV system, as an additional precaution, before being filled in 12 litre HDPE cans. The schematic arrangement of the Sujala Water Plant for this option is shown in Figure-1

-Cost of Unit		: INR 700,000
-Plant	-- INR 400,000	
-Building (540 sq feet)	-- INR 300,000	

(Please Note: The Cost of the Unit has been calculated as on August 2006)

Process Design- Non RO Plant:

Component	**Use**
Coagulation System	Agglomeration of fine particles and colloids
Raw Water Settling Tank	To settle the flocs and remove the suspended solids
Pressure Sand Filter	To remove fine suspended flocs
Activated Carbon Filter	To remove odour and dissolved organics and further polish the water and remove the residual chlorine
Micron filters	10, 5 and 1 micron filters for removal of fine particle dust
UV Irradiation (Stage-I)	To further disinfect the product water and for virus inactivation
Ozonation Unit	To improve shelf life and quality of product water
Storage Tank	To store the product water for further distribution
Water Filling Skid with UV Unit (Stage-II)	To eliminate bacteria, if any, developed in the storage tank (as extra precaution) and fill the 12-litre cans for distribution

Scenario-2: If the TDS levels are in excess of 500 ppm, the process, in addition to what is listed above under Scenario-1, will also employ Reverse Osmosis (RO) Membranes after Micron Filtration. The process diagram in this case is shown in Figure-2

Cost of Unit : INR 800,000
-Plant -- INR 500,000
-Building (540 sq feet) -- INR 300,000

Process Design- RO Plant:

Component	Use
Coagulation System	Agglomeration of fine particles and colloids
Raw Water Settling Tank	To settle the flocs and remove the suspended solids
Pressure Sand Filter	To remove fine suspended flocs
Activated Carbon Filter	To remove odour and dissolved organics and further polish the water and remove the residual chlorine
Softener	To exchange the Calcium and Magnesium ions with the sodium ions (for RO scale control)
Micron filters	10, 5, 1 micron filters for removal of fine particle dust
High Pressure Pump	To boost the required feed pressure to the RO systems
RO System	To remove pesticides and to reduce Total Dissolved Solids (TDS)
UV Irradiation (Stage-I)	To further disinfect the product water and for virus inactivation
Ozonation Unit	To improve shelf life and quality of product water
Storage Tank	To store the product water for further distribution
Water Filling Skid with UV Unit (Stage-II)	To eliminate bacteria, if any, developed in the storage tank (as extra precaution) and fill the 12-litre cans for distribution

The list of **major components of the Sujala Drinking Water Plant**, both for conventional and RO processes, is listed in Table-3 (See Tables)

3.6.2) Process of selection of tenders

- Tenders are called for different capacities of plants by providing parameters for water quality.
- Evaluation of tenders will be done by the Foundation.
- Lowest quoted manufacturer/supplier with proper technology backup will be chosen for setting up of the plants.

3.6.3) Operation and Maintenance Strategy

- Adequate training has been given for the plant operators by the manufacturer/supplier.
- 5 years maintenance contract with the manufacturer/ supplier of the plant has been proposed.
- For monitoring the plants in East Godavari District a maintenance unit has been established by the manufacturer at Amalapuram. Like wise, in Bhimavaram, 3 maintenance teams are deployed to take care of Sujala plants in Guntur, Krishna and West Godavari districts.
- Initial ownership by the Foundation with the full responsibility to ensure 100% quality water.
- Quality of water is being monitored by the Foundation regularly.

3.6.4) Operation Manual for Non RO Plants

Cleaning:

- Wash the raw water tanks with raw water and sponge, minimum once in a week.
- Rinse the raw water tanks with chlorine water (@ 10% concentration i.e. 500 ml of chlorine in 5 litres of raw water) minimum once in a week.
- Wash the product water tanks with product water and sponge minimum once in a week.
- Rinse the product water tanks with chlorine water (@ 10% concentration i.e. 500 ml of chlorine in 5 litres of product water) every week minimum once in a week.

Coagulation Unit:

- Before emptying the settled water in the settling tank –1, drain out the settled mud by opening the drainage valve.
- Check the voltage level in the voltmeter, which is in the electrical panel board. (It should be minimum 180 volts)
- Start raw water pump-2 to empty the settling tank-1 by opening outlet valve to the plant for processing.
- After emptying settling tank-1, clean the tank with raw water
- See whether there is Alum in the alum-dosing tank
- Alum dosing depends on the alkalinity of the raw water. The same shall be checked by the technician and dosing levels shall be fixed by the technician every 2 months.
- Start the raw water pump-1 to pump the raw water in to the clariflocculator and then to the settling tank –1.
- Start the alum dosing pump simultaneously
- Before emptying the settled water in the settling tank –2, drain out the settled mud by opening the drainage valve.
- Empty the settling tank-2 by opening outlet valve to the plant for processing.
- After emptying settling tank-2, clean the tank with raw water

- Close the inlet valve of settling tank –1, after it is filled with raw water and open the inlet valve of settling tank –2 for processing.
- Before emptying the settled water in the settling tank –3, drain out the settled mud by opening the drainage valve.
- Empty the settling tank-3 by opening outlet valve to the plant for processing.
- After emptying settling tank-3, clean the tank with raw water
- Close the inlet valve of settling tank –2, after it is filled with raw water and open the inlet valve of settling tank –3 for filling the raw water.
- Open the drainage valve of clariflocculator at every 30 minutes to drain the settled mud.
- Fill all the 3 settling tanks with raw water before closing the operation of the plant for settling.

Processing Unit:

- Adjust the sand filter multi-port valve in the backwash position and start backwash with raw water for 15 minutes.
- Adjust the sand filter multi-port valve in rinse position and start the rinsing process with raw water for 5 minutes.
- Repeat step 2 and step 3 for backwash of carbon filter.
- After backwash and rinsing, adjust the multi port valves in the normal filtration position and run the plant.
- Repeat backwash and rinsing after every 5 hours of operation.
- Check whether the micron filters are choked.
- Replace the micron filters once in a week.
- Check the UV indicator.
- If UV is not working do not start operation of the plant
- Check whether raw water tanks and product water tanks are properly closed. There should not be a gap between lid and the opening of tank.
- All the windows and doors should be covered with mosquito nets.
- Every day, conduct H2S Vial Test for the product water
- Every Friday, along with the report of H2S vial test, samples of raw and product water to be handed over to office in charge of Water Quality Testing Lab and Coordinator (Water) in Bhimavaram Learning Centre.

Report of H2S Vial Test					
		Result			
Village Name	Date & Time of Sampling	After 24 hours	After 48 hours	After 72 hours	
Name of the Operator:					
Signature:			Date:		

Steps to be followed for bacterial contamination:

- If the colour of H_2S vial after 24 hours becomes black, stop the operation of the plant.
- Remove and clean the filter media in sand and carbon filters.
- Replace all the micron filters.
- Clean all the settling tanks, raw water tanks and also product water tanks.
- Increase the dosage of gramicid from 20 ppm to 30 ppm.
- Recheck the product water for microbial test.

3.6.5) Precautions related to Water Cans:

- Inspect the empty cans while unloading from the van.
- Separate the damaged cans from the stock.
- Wash outside of the cans with soap water to remove dust or stains.
- Segregate the bad smelling cans for special cleaning as explained below.
- Contaminated cans should be washed with chlorine water and filled again with chlorine water. Stand for not less than 24 hours and check; if it continues to emit bad smell, keep it as it is for another 24 hours without removing chlorine water. If the smell persists discard the can.
- Use washing machine for internal cleaning with 5% chlorine added to 100 litres of product water. This solution can be used for cleaning 200 cans.
- Clean all the inner caps and outer caps with 5 % chlorine solution and soak them in 5 % chlorine solution till they are screwed on the spout.
- Rinse the can with product water before it is filled.
- Screw on the inner and outer caps tightly immediately after filling the can with product water.
- Maintain 1 inch (min.) gap between cans and the wall.
- Filled cans be sent out only after getting dispatch clearance by the Plant Manager.
- Send the filled cans on first come first despatch
- Check the cleanliness of distribution vehicle
- Don’t throw the cans into the vehicle. Place them gently and neatly.
- Cover the bottom and sides of the vehicle with rubber sheets. Place tarpaulin sheet over the cans to avoid exposure to sun.
- At all the distribution points/ stock points in the villages, the cans must be kept under cover.
- The cans should not be exposed to sunlight.

3.6.6 Report on Complaints

a) Report by Operator

- Date and time of breakdown
- List items/systems failed
- Reason for the failure
- Record the complaints in a register

b) Report by Service Engineer

- Date and time of reaching the plant
- Time taken to rectify the failure
- Total idle time of the plant
- List of component(s) repaired/replaced
- Reason(s) for the failure
- Action taken on complaints to be recorded in a register

3.6.7) Model formats:

Visit report by the water coordinators/project consultants (See Annexure III)

Compliance report by service engineer of the plant supplier to be given on 15th and 30th of every month (See Annexure IV)

3.7) FAQs on Sujala Water Scheme

On what criteria do you select a village for setting up plant?

Selection of a village is preceded by its compliance to the following factors:

1. A village where the extant quality of drinking water is not up to WHO standards
2. Approval of Gram Panchayat to draw raw water
3. Enrolment of 30% families for use of water within village
4. Enrolment of 10% families in nearby villages (2-3 villages)
5. Support from village:
    - Land for the Plant (if Panchayat Land, resolution from Panchayat)
    - Building (including electric connection, coagulation tank) (approximately - INR 250,000)
    - Plant and machinery (50% - INR 200,000 for Non-RO, INR 250,000 for RO)
    - Willingness of GVS to oversee operation of the plant and distribution of product water as per guidelines of Foundation
    - Name of GVS Member and his/her alternate responsible for the programme (within the village and nearby villages)
    - Demand assessment should have revealed that at least 30% families of the base village are willing to consume 12 litres of water on payment of user charges
    - Demand assessment should have revealed that at least 10% families of the neighbouring villages are willing to buy the 12 litre HDPE can and regularly pay for drinking water
    - 1500 square feet land for the Plant should be available on long lease basis for the drinking water plant.
    - The Gram Panchayat should have passed the resolution agreeing to provide uninterrupted supply of raw water
    - If separate raw storage pond is required for the proposed plant, the Panchayat should identify the land and make it available on long lease basis. (the cost of excavation would have to be borne by the villagers/Panchayat)
    - The community should make available a suitable building of 540 square feet or construct a new one for this purpose (If the plant is proposed to be run on entrepreneurial basis the cost of the building can be included in the Project cost).
    - Community should commit to contribute 50% of the cost of plant machinery and equipment (if the plant is proposed to be run on entrepreneurial basis the entire cost of the contribution can be included in the Project cost)
    - The Gram Vikasa Samiti (GVS) or Village Development Committee should agree to oversee operations of the plant and distribution of product water as per guidelines of the NGO.

<u>Detailed Check list</u> (See Annexure V)

How can we decide on the size of the plant to be constructed?

Plant size is determined by considering the following parameters:

- Population of the village
- Short term and medium term demand
- The number of villages to be serviced, hours of single phase power availability per day
- Willingness of the village to supply drinking water to neighbouring villages

<u>Computation of Plant Size</u>

Computation of Plant Sizing		
Population of base village	5000	
Population of neighbouring villages(within 5 km radius of proposed plant site)	15000	
Maximum penetration possible in base village (%)	80	
Maximum penetration possible in neighbouring villages (%)	30	
No of hours single phase power supply	16	
Projected daily consumption per capita per day(litres)	2	
Estimated daily demand(Litres)	13000	
Minimum plant capacity (Per day basis) restricted to demand in base village	8000	
Hourly capacity required	500	
Add for back wash, cleaning etc, (%)	15	
Hourly capacity required	588	
Plant efficiency (%)	60	
Required plant capacity (Hourly)	980	
Say (Litres per hour)	1000	
Since base village is usually unwilling to supply drinking water to neighbouring villages the plant capacity at base village is restricted to the final estimate of the demand of the base village		
Quantity of Raw Water Required		
Capacity of the Plant (litres per hour)	1000	lph
Total Hours of Operation	24	
Daily raw water requirement for RO plant (40% drained + 10% for other purposes)	48000	
Daily raw water requirement for Non RO plant(10% for other purposes)	26667	

Acreage required for raw water pond		
Depth of storage(m)	1	
No of days storage required (days)	90	
Water required for RO plant (litres)	4320000	
Storage required for RO plant after adjusting to water evaporation loss (Level reduces by 5 cm in 3 months	4550000	
Water required for Non RO plant(litres)	2400000	
Storage required for Non RO after adjusting to water evaporation loss (Level reduces by 5 cm in 3 months)	2530000	

Acreage Required for Raw Water Pond

Depth of storage(m)	1
No of days storage required(days)	90
water required for RO plant(litres)	4320000
Acreage of the Pond	1.07
Grossed up for evaporation & seepage and bunding loss(acres)	2.13
Storage required for Non RO will be 50% of RO plant	

No separate storage pond is required if uninterrupted supply is possible from existing storage pond or from ground water.

What are the things to look for while selecting an ideal location to set up plant?

- The plant should be set up in close proximity to the source of raw water, where at least 1500 square feet of open land is available
- If an existing building is to be utilised, it should facilitate optimal plant layout, should have storage area and easy access for consumers to take delivery in person and through motorised vehicle such as an auto rickshaw
- If possible, the plant should be located close to the largest potential consuming sections of the village to minimise transportation of product water
- The surrounding area should be neat and tidy

What are the minimum basic infrastructural requirements of the plant?

Land requirement area 3 cents (1300 square feet)

Shed/buildings – area and cost

Area: 540 Square feet

Cost: INR 300,000

Water – Quantity and wastage

What are the various kinds of machinery available? And where is it available?

There are two kinds of machinery available the non-Reverse Osmosis and Reverse Osmosis. The cost of the non RO and RO machinery are INR 400,000 and INR 500,000 respectively. The machinery is available with any drinking water plant manufacturer/supplier.

What are the training requirements of the personnel?

A minimum of 2 weeks training by the plant supplier (expert in the subject) to the personnel should be imparted on the skills required to monitor and run the plant effectively.

What are the problems encountered and methods employed to overcome the problems

Follow the link for answer: Problems encountered (See Process Logs)

How can we ensure quality drinking water to a village? What methods are available to test the quality of water?

- The evaluation of community water supplies requires considering a number of quantitative factors.
- The indicators most commonly used to evaluate community water supplies are quality, quantity, coverage, cost and continuity.

What measures can be taken to improve the utilisation of pure drinking water plants?

- Initially, the distribution of water should start at the plant in a 12-litre can (Food grade HDPE) at INR 1.50.
- Expand distribution to the neighbouring villages.
- Water in cans is transported to the identified secondary place, within as well as neighbouring villages, for further distribution therein.
- Create awareness in the villages by interacting with villagers and also distributing posters, handouts on ill effects of drinking polluted water.
- Plant managers/operators should visit 10 families a day to create awareness on safe drinking water.

How long can we store the water in the can?

Water can be stored up to six months and used subsequently, provided the cap is not opened. Once the cap is opened, it is preferable to consume the water within 3 days.

How can we distribute the processed water?

The villagers should take the initiative and arrange for the distribution of processed water. The neighbouring villages can arrange for vehicles for transportation. Transportation for the villagers where the plant is located has not been found necessary as they usually carry water cans manually.

What is the size of the container the villagers use to carry water? How much does a single container cost?

The container can hold up to twelve litres and is made up of food grade HDPE costing INR 70. The villagers own the containers. The Foundation is in the process of giving a subsidy for water cans for the following categories of people:

- Aged/Widows and pensioners
- Physically challenged persons

Identification of those that are eligible for subsidy is done by the nodal coordinators and GVS members.

What is the exact quantity of water supplied to each family per day?

The average quantity of water supplied in a month from each plant is about 5000 litres a day. Twelve (12) litres of water per family of 4 to 5 members at the rate of INR 1.50 is supplied.

Is there any list of eligible users maintained?

Yes, a list of eligible users is maintained as it will avoid any complications in the future.

Are the users permitted to share / sell water among themselves or to others?

NO, the users are not allowed to sell the water to anybody.

Do the users need to register? If yes, is any ID card given?

The users need to register themselves. The Foundation is considering the option of giving ID cards to the users.

Can canal water be treated to deliver safe drinking water?

Yes, through efficient treatment.

What does this Slow Sand Filtration refer to? How does it work?

- Slow Sand Filters are designed to treat water with turbidity < 30 NTU, actual turbidity is between 5-100 NTU, resulting in frequent choking of filter beds.
- Though the filters are designed for 16 hours of operation, the power availability restricts it to about 6-8 hours.
- Filter beds are not designed to remove odour. This requires passing it through Activated Carbon Filter.
- Proper chlorination process involves:
    - Using right quantity of bleaching powder
    - Using bleaching powder of acceptable quality
    - Dosing it in a proper manner to ensure uniform blending

Minimum facilities for testing raw/treated water

- Trained manpower
- Major problem with ground water is Total Dissolved Solids(TDS)
- Fluorides (some regions)
- E.Coli (in most locations)
- E.Coli can be treated through chlorination
- Removing TDS and Fluorides is possible only through Reverse Osmosis process. This depends on the quality of water presently being supplied

Schematic view of Slow Sand Filtration

Process Features

Process	Purpose
Slow Sand Filtration	Removes suspended particles
Chlorination	Removes bacteria
Coagulation System	Collection of fine particles and colloids (A mixture with properties between those of a solution and fine suspension). Process facilitated by alum dosing
Pressure Sand Filter	Removes fine suspended flocs (A small loosely aggregated mass of flocculent material suspended in or precipitated from a liquid)
Activated Carbon Filter	Removes odour and dissolved organics and further polishes the water and removes the residual chlorine
Softener	Removes scale-forming calcium and magnesium ions from hard water

Micron filters	10 micron filter removes fine particle dust of size > 10 micron (0.01 mm) 5 micron filter removes fine particle dust of size > 5 micron (0.005 mm) 1 micron filter removes fine particle dust of size > 1 micron (0.001 mm)
RO System	Reduces Total Dissolved Solids (TDS) to acceptable levels. If the process removes all the TDS, it results in unacceptable taste and also eliminates essential minerals. Hence this requires blending to bring TDS to acceptable levels
UV Irradiation	Inactivates viruses

Technology Selection Criteria

S No	Characteristics of presently supplied drinking water	Treatment process Required
1	TDS < 500 ppm, Turbidity <5 NTU and no bacteria, no odour and chemical parameters are within acceptable limits	No action. Maintain present system of filtration and chlorination
2	TDS < 500 ppm, Turbidity < 5NTU, no odour and chemical parameters are within acceptable limits; bacteria present	Maintain present system of filtration, improve chlorination and also add UV System
3	TDS < 500 ppm, Turbidity > 5NTU no odour and chemical parameters are within acceptable limits; bacteria present	Introduce Coagulation, Chlorination, Rapid Sand Filtration and UV System
4	TDS < 500 ppm, Turbidity > 5NTU and chemical parameters are within acceptable limit; odour; bacteria present	Coagulation, Rapid Sand Filtration, Activated Carbon Filtration, Micron Filtration and UV System
5	TDS > 500 ppm, Turbidity > 5NTU and chemical parameters are beyond acceptable limits; no odour; bacteria present	Coagulation, Rapid Sand Filtration, Micron Filtration, RO Membrane Filtration and UV System
6	TDS > 500 ppm, Turbidity > 5NTU and chemical parameters are beyond acceptable limits; odour, hardness within acceptable limits; bacteria present	Coagulation, Rapid Sand Filtration, Activated Carbon Filtration, Micron Filtration, RO Membrane Filtration and UV system
7	TDS > 500 ppm, Turbidity > 5NTU and chemical parameters are beyond acceptable limits; odour; hardness beyond acceptable limits; bacteria present	Coagulation, Rapid Sand Filtration, Activated Carbon Filtration, Softner, Micron Filtration, RO Membrane Filtration and UV system

3.6.9) Infrastructural requirements:

CONSTRUCTION MATERIALS:

Structure	: Brick walled building with RCC roof slab.
Cement	: Cement can be ordinary Portland or Pozzalona of 43 grade.
Reinforcement	: High Yield Strength Deformed (HYSD) bars shall be used.
Bricks	: Locally available well burnt bricks or fly ash bricks can be used.
Wall Tiles	: Grey vitreous wall tiles shall be provided up to 3' height in the washing area.
Floor Tiles	: Grey non – skid tiles with blue tile pattern and for Product Water Tank platform – Top surface shall have grey tiles and the sides shall have blue tiles. Blue and grey colours to match Byrraju Foundation's colours.
Doors	: Made of locally available wood
Windows	: Locally available steel windows with steel frames with grills. Netlon should be fixed to prevent entry of insects.
Plinth Protection	: Plinth protection shall be done with rough Kadapa slabs.
Basement Fill	: Sandy soil to be used for filling the basement

SANITATION:

Toilet : Toilet design shall be the same as ISL being built in the villages.

ELECTRICAL REQUIREMENTS:

Electrical : Copper wiring with ISI fittings

Lights / Fans : Tube lights and ceiling fans of standard make shall be used.

PAINTING : Painting of internal walls and ceilings is done with oil bound distemper over a primer coat and two coats of OBD (total 3 coats) of white colour and of standard make.

Painting of external walls should be ideally done with Snowcem in two coats over a primary coat (total 3 coats) of ivory colour and standard make. For the 1 foot parapet and the plinth a darker shade of ivory shall be used.

BUILDING COST ESTIMATE

- Building cost estimates have to be made taking into consideration the site conditions and prevailing labour and material rates

CONSTRUCTION SCHEDULE

- Building construction and plant manufacturing proceed concurrently.

Construction Schedule (See Annexure VI)

BUILDING LAY OUT

Technical Details – Major Components

S.No	Item	Number /Unit	Make	Material of Construction
1	Pump (1 HP) for Coagulation Tanks	1	Kumar	---
2	Alum dosing system (6 litres per hour)	1	Etetron/ UKL	---
3	Coagulation Tanks (1500 litres)	4	---	Cement Concrete Rings
4	Chlorine dosing system consisting of tank (100 litres), pump and injector	1	Etetron/ UKL	---
5	Pump (1 hp) for pressure sand filter	1	Fischer/ Aroma	---
6	Pressure sand filter with multi port valve (450 litres)	1	---	SS: 304 or FRP
7	Activated carbon filter with multi port valve (110 litres)	1	---	SS:304 or FRP
8	Micron filters (10, 5 and 1 micron)	3	Filtration	---
9	Casing for Micron filters	3	---	SS:304
10	Ultra Violet (UV) irradiation Unit (Stage-1)	2	Philips lamp (36 watt)	SS:304 Casing
11	Ozonator	1	ELVEAR	---
12	Storage tank for product water (3000 litres)	2	Kinetic	HDPE Food Grade
13	Washing Unit (2-jet)	1	---	SS:304 Basin and nozzles mounted / supported on MS base
14	Skid with UV Unit (Stage-2)	1	---	SS:304
15	Taps (1/2” dia) for filling cans	4	---	SS:304

16	Skid (Stand) for mounting filters, Electrical panels etc.	1	---	SS:304
17	Piping	---	---	Food grade UPVC
18	Voltage Stabiliser (6 KVA)	1	Real Guard	---
20	Pressure vessel (RO Plant)	1	---	SS:304
21	Reverse Osmosis Membranes (RO Plant)	4	Trisep/ Hydronautics	---
22	Softener (110 litres) (RO Plant)	1	---	SS:304
23	High Pressure Pump (2 hp) (RO Plant)	1	Grundfoss/ Ramesh	---
24	Cans for distribution of water	1000	12 litre Capacity	HDPE-Food Grade

Vendor Selection Criteria

- Vendors should have rich experience in manufacturing of water treatment plants
- They should have erected a minimum of 20 water treatment plants

List of Equipment Suppliers

Equipment Supplier	E Mail
A.G.Engineers	a_g_engineers@rediffmail.com
Bibo Water	psrao@bibowater.com
Indwa Technologies	ravi@manikya.com
Ion Exchange (India) Ltd	s.mahendra@ionexchange.co.in
LVR Enterprises	lvrenterprises_2004@yahoo.com
Poorvi Enterprises	pftl@rediffmail.com
Revolve Engineers	bhaskar@revolveengineers.com
Sip Ro Water Systems	Sipro_water@yahoo.com
Tata Projects Ltd	bravi@tataprojects.com

Contract for Equipment Supply

- A 5-year maintenance contract with the supplier Including Spares, ie., Motors, High pressure pump, RO membranes, Multi-port valve, UV Lamp

Operating Spares

- Micron Filters
- Liquid Chlorine
- Alum for coagulation
- Soap Solution
- Orthotolidine Arsenate Chemical for chemical cleaning of membranes
- Gramicid (bactericidal effect, along with ozone acts as oxidising agent for removal of organic acids and some of the pesticides)
- Scrubbers for cleaning of tanks/cans

Operating Consumables Required

S.No.	Quantity	Description	Rate (INR.)
1	Catridge Filters 10"	1 No.	80
2	Catridge Filters 20"	1 No.	160
3	Jumbo Filters 20"	1 No.	800
4	Liquid Chlorine	1 Litre	14
5	Alum	1 kg	18
6	Soap Solution	1 Litre	14
7	Gramcid	1 Litre	280
8	Scrubbing Pads	1 No.	12
9	Orthotolidine Arsenate	1 Litre	650

Commissioning Process

- After the release of payment order, equipment will be supplied to the village within 4 weeks
- Commissioning of plant will be done by the service engineers within 3 days

Trial Run, Testing and Taking over Process

- The equipment will be tested by conducting a trial run for 2-3 days based on the quality of raw water
- Product water samples will be sent to the laboratory to check the quality
- For the first 3 days, every day's product water will be tested at the plant by H2S vial to know the presence/ absence of bacteria
- If the product water meets the limits of WHO/BIS standards, distribution of water will be started to the villagers

Daily Power Requirement

Item	Qty	Capacity	Units	Power Consumption (KWH)	
				RO Plant	Non RO Plant
Feed Pump to Coagulation	1	1	HP	0.75	0.75
Alum Dosing Pump	1	0.5	HP	0.37	0.37
Pump to Pressure Sand Filter	1	1	HP	0.75	0.75
High Pressure Pump	1	2	HP	1.49	0.00
UV Lamp	2	40	Watts	0.08	0.08
Pump to Washing Unit	1	1	HP	0.75	0.75
Ozonator Pump	1	0.5	HP	0.37	0.37
Fans	2	60	Watts	0.12	0.12
Tube Lights	4	40	Watts	0.16	0.16
	TOTAL			5.21	3.71

Single Phase vs. Three Phase

- In villages, three phase power is available only for 6-7 hours, but single phase power is available for 15-16 hours.
- Both RO and conventional plants are designed to run on single phase power

Standby Power Requirement- Why?

- As water is an essential commodity, if normal power supply is not available for more than 1 day due to any reason, a standby generator is needed in the plant.

Consessional Power Tariff

- L.T.TARIFFS (2004-05)
- L.T. CATEGORY-VI

Applicable for supply of energy for lighting on public roads, streets, thoroughfares including parks, markets, cart-stands, taxi stands, bridges and also for PWS scheme in the local bodies viz. Panchayats/ Municipalities/ Municipal Corporations. Metering is compulsory irrespective of tariff structure.

B. PWS Schemes:	
Minor/Major Panchayats	
Up to 2500 units/year	20 paise per unit
Above 2500 unit	50 paise per unit

TARIFF ORDER 2005 - 06

Please log on to : http://aptranscorp.com/LT-tariff-04-05.html

Manpower Requirement

- Plant Manager cum Operator : 1 No
- Plant Operator/Asst Operator : 1 No
- Plant Helpers : 2 Nos

Total manpower required per plant : 4 Nos

Skills Requirement

- Plant Managers : Intermediate
- Plant Operators : ITI/10th
- Plant Helpers : Literate

CONCLUSION:

The water sources of the delta regions are highly polluted from various sources. The present system of SSFs and chlorination in supplying drinking water to the villages is inadequate in providing safe drinking water as evidenced by the extensive testing done by the Byrraju Foundation. While all efforts should be made to minimise pollution and improve the present water supply system, the immediate solution, in the experience of the Foundation, is to separate the drinking water requirement from the rest of the water supplied.

The experience of setting up of 31 pure water plants, branded 'Sujala', has shown that the community and Non-Resident Villagers (NRV) are willing to contribute towards the capital cost along with the Foundation. Optimum design of the plant and training of local youth to operate the plant made it possible to provide safe drinking water (bottled water quality) at INR 1.50 for 12 litres.

There is no easy formula to ensure sustainability of small water supply systems. However there are general measures that can contribute to reaching sustainability:

- Formulate the water supply scheme together with the community.
- Establish a sound management scheme for each plant, taking advantage of the existing institutional resources, such as water associations, NGOs and the participation of industry.
- Set up support systems for small water supply units, facilitating the availability of technical services required for the operation, maintenance and management of these plants.

PRE-PROCESS ACTIVITIES

Demand Forecasting
Estimating demand in the village where the plant is to be located

- **Demand can be assessed by considering the following parameters:**
    - Family income
    - Awareness about drinking safe water
    - Distance from the proposed location of water treatment plant

The demand forecast should ideally be followed by stratification of the village:

- Stratify the village into 4 categories i.e , High, Medium, Low and Below poverty line (BPL),based on **apparent family income** (not based on the status of ration card)

The criteria for classification of families are as given:
- BPL - Family income less than INR 1,500 per month (thatched house, agricultural labour as main source of income, owns no land, no cattle or poultry except for self consumption)
- Low - Family income below INR 3,000 per month (Tiled/RCC house, land holding less than 3 acres, having children studying in a Govt. school)
- Medium- Income below INR 5,000 per month (Tiled/ RCC house, land holding less than 10 acres, owns two wheeler, telephone and sends children to private school)
- High - Family income exceeding INR 5,000 per month (Tiled/ RCC house, land holding more than 10 acres, owns two wheeler, telephone and sends children to private school)

- Stratify the village into 5 sectors based on **distance** from the present location of water treatment facility (Slow sand filter or main bore well)

- **Select sample for demand assessment based on the following:**

Income category	Percentage of families	No of families	No. of families to be covered in survey	
High	5	50	50	
Medium	15	150	50	10 in each sector
Low	50	500	50	10 in each sector
BPL	30	300	30	10 in each sector
Total	100	1000	180	

- Determine the actual demand based on extrapolation of survey findings

Survey Format: Demand Assessment for Safe Drinking Water (See Annexure VII)

Estimating demand in neighbouring villages

- Neighbouring villages are villages which share a common boundary with the village where the drinking water plant is proposed to be setup and villages which are with in the radius of 5 km from the proposed location
- Assume 5 villages satisfy the above criteria.
- For determining demand in neighbouring villages list the high and medium income families of these villages and conduct survey as follows:

Income category	% of families in all the neighbouring villages	No. of families in all the neighbouring villages	No. of families to be covered in survey
High	5	250	250
Medium	15	750	150
Low	50	2500	Not to be surveyed
BPL	30	1500	Not to be surveyed
Total	100	5000	400

- Determine the actual demand based on extrapolation of survey findings

  Survey Format: Demand Assessment for Safe Drinking Water- Neighbouring (See Annexure VIII)

  Check list for setting up pure drinking water plant and preliminary demand assessment (See Annexure IX)

IMPACT ASSESSMENT

BYRRAJU FOUNDATION

SUJALA WATER - SURVEILLANCE AND EDUCATION

Village Name:…………………………….. Date:……………

We came here to conduct a survey and to apprise you on the quality of drinking water sources.

My name is. ………………………… I am a student of DNR College, Bhimavarm.

Queries for survey:

A. Name of head of the family:…………………………………………………
   No of members ……………………………

B. Are you aware of Byrraju Foundation's activities in your village Yes/No

C. Do you know about Sujala Water Plant, set up jointly by your villagers and the Byrraju Foundation Yes/No

D. Which water do you and your family members use for drinking purpose:
   a) Rural Water Supply (RWS) water b) Well water
   c) Sujala Water d) others (specify)…………..….

If drinking RWS water or well water (or others) check the following:

Why are you not using Sujala Water for your drinking? Reasons for

a. Used to drinking (this) RWS/Well water for long time…not keen to change/switch over
b. Can not bear the cost of Sujala water
   (if this is the reason ask) how much it should be……..
c. Plant is far from my residence
   (if this is the reason ask) if home delivered would he like to start using Sujala Water and at what cost ……………
d. Other reasons (to be noted)

……………………………………………………………………………………..

For this you could appraise him on the following:

i. The sources of drinking water, like canals, ponds (village tanks) and wells are polluted with sewage, effluents from agricultural and aqua culture fields and industries. Further, the water sources contain E.Coli bacteria from faecal matter.
ii. The inorganic fertilizers and pesticides, which are used for farming, leach into the ground water resources. Our laboratory tests conducted during the last two years confirmed that the ground water is polluted and contaminated badly.
iii. According to World Health Organisation (WHO), 80% of diseases are caused by drinking unsafe water.
iv. A survey and laboratory test conducted by an American NGO, on the quality of drinking water among 122 countries, revealed that our country stands at 120th rank.
v. RWS filter beds are not able to remove the high levels of impurities, bacteria and odour. Due to lack of funds, chlorination to kill bacteria is not done properly most of the times. But some times, whenever any complaint is made by large section of villagers, little higher dosage of chlorine is given. Both these measures pose danger to health.
vi. Tests conducted by Byrraju Foundation revealed that 85% of water supplied through RWS in villages is not suitable for drinking.
vii. Due to the above reasons, Foundation with the help of the villagers came up with the idea of setting up of pure drinking water plants to supply clean and bacteria free just for drinking purpose.
viii. The water produced by the Foundation is same as the bottled water, which costs INR 10-12 a litre.
ix. The user has to contribute just 12.5 paise per litre i.e. INR 1.50 for 12 litres supplied in HDPE can to meet the cost of operation and maintenance of the plant.

Would you like to start using the Sujala Water from now onwards? Yes/No

If drinking Sujala Water, then enquire about the following:

1) How long you and your family are using Sujala Water…………Months
2) How much of Sujala Water you and your family are drinking daily (cans?)
   1. <¼ Can 2. ¼ to ½ can 3. ½ can to 1 can 4. more than 1 can (specify the number)_______
3) How is the Sujala Water:
   Colour:……. Smell: ……….. Taste: …………..
4) Are you satisfied with the quality of Sujala Water: Yes/No
5) How is the general health in your family after usage of Sujala Water:
6) Would you like to advise your neighbours to drink this water for keeping good health? Yes/No
7) Are you able to afford user charges (12.5 paisa per litre) Yes/No
8) If the user charges are more or less, suggest how much it should be………..
9) How do you collect the Sujala Water…………………………..
10) What should be preferred mode of delivery……………………….
11) What extra charges would you like to pay for door delivery………………...
12) Any suggestions/comments that you would like to offer
    1. …………………………………………………………..
    2. …………………………………………………………..

Survey on use of Sujala Drinking Water:

In December 2004, TNS Mode, Hyderabad has conducted a survey, covering 213 families both the users and non-users of Sujala water, in a few adopted villages of the Foundation. Some of the survey results, on type of consumers, sources of drinking water and impressions on consumption of Sujala water, are given in **Table-4** and **Table-5** (Survey by TNS Mode, 2004).

Another survey, covering 2000 families in 7 adopted villages of the Foundation, has also been conducted by the students of a local Science college in February 2005. This was basically aimed to know the percentage of families utilising Sujala water and also effect on their health. Summary of these results is furnished in **Table-6** and **Table-7** (Survey by DNR College, 2005).

Sujala Water Plants-Progress Made:

The Foundation had set up 16 plants (9 in West Godavari, 4 in East Godavari, and one each in Krishna, Guntur, and Ranga Reddy districts) by August 2005. Out of these, 5 plants follow Reverse Osmosis route; 11 plants are based on conventional treatment, followed by with 2-Stage UV irradiation in both the cases.

Foundation's strategy is to set up one plant for 3 or 4 villages, in total about 40 or 50, which it hopes to achieve by the end of October 2005. Eventually, when the consumption levels go up, each village would need a plant of its own.

The key here is the active participation of the village community and non-resident villagers. Training and engaging local youth and their willingness to work on flexible timings is another factor in the operation of the plant. Above all, contribution of villagers towards setting up of the plant as well as its operation ensures smooth and economical operation of the plant.

Survey on Drinking Water (2nd)

- Date of Survey : Feb 2005
- Survey coverage : 2000 Families (7 villages)
- Agency : Students of DNR College, Bhimavaram

Refer to Table-8: Survey on Drinking Water (2nd)

Experience gained so far:

Based on the experience gained in operation and maintenance of Sujala water plants, over the last one year, the Foundation is continuously improving the working of these as well as new plants, being set up in a phased manner in future. Experts from Indian Institute of Technology-Madras, Water Systems International Ltd, Chennai and National Environmental Engineering Research Institute (NEERI), Nagpur, on inspecting/reviewing the working of these plants, suggested technological interventions to improve the performance and also reduce the cost and operational expenses. Based on their suggestions, the design concepts and technology adopted for producing pure water have been reviewed and necessary changes were duly incorporated. Some of the improvements and changes affected are listed below:

- Increase in sediments in input water during monsoon period and the high rate of algae growth, when irrigation canals are closed for feeding the village pond during summer, raises the turbidity in input water. This leads to frequent choking of filters. To overcome this problem, a coagulation system has been installed.

- Some of the components, made up of Mild Steel, in the plant get rusted due to constant exposure to water. To avoid this and to increase the life as well as appearance of the plant, material of the components, where possible, has been changed to Stainless Steel.

- To overcome the restricted availability of power in the villages, the rate of production and product water storage capacity have been increased right from design stage. Further, the hours of operation are made flexible to run the unit, whenever normal power is available.

Government of Andhra Pradesh, United Nations Human Resettlement Programme (UN-HABITAT), Dow Chemicals International Pvt. Ltd., and a few non governmental organisations, having seen the successful working of Sujala water plants, expressed their interest to set up pure drinking water plants on similar lines in other villages. Foundation is willing to share the expertise and help such agencies in adopting this methodology.

TABLES:

Table-1: Surface water resources of Andhra Pradesh

River Basin	Availability, BCM (TMC)	Utilisation, BCM (TMC)
Godavari	41.90 (1480)	20.39 (720)
Krishna	22.96 (811)	22.96 (811)
Pennar	2.77 (98)	2.77 (98)
Others	10.12 (357)	3.51 (124)
Total	77.75 (2746)	49.63 (1753)

(Source: Water Conservation Mission- Water Vision, Vol.-1, 2003)

Table-2: Test results of water supplied by RWS in the villages adopted by the Foundation

SL.NO	Parameter and Units	IS: 10500-1991 (Desirable Limit)	Remarks
1	Coliform organisms	Absent	Present in 50 % of villages
2	Turbidity, NTU, Max	5	45 % of villages have >5
3	Chlorides, mg/1, Max	250	13 % of villages have > 250
4	Residual, Free chlorine, mg/1, Min	0.2	82 % villages have< 0.2

(Source: Prasada Raju, D.R, Report on Production and Supply of Safe Drinking Water in Rural Areas of Godavari Delta, 2005)

Table-3: List of major components of Sujala water plant

S No	Number/Unit	Item
1	Coagulation system (including alum dosing pump) with pump	-1 No
2	Raw water tank with pump	-1 No
3	Chlorine dosing system consisting of Tank, Pump and Injector	-1 No
4	Pressure sand filter with multi port valve and pump	-1 No
5	Activated carbon filter with multi port valve	-1 No
6	Micron filters	-3 Nos
7	Ultra Violet irradiation Unit (Stage –1)	-2 Nos
8	Storage tank for product water (3000 litres)	-2 Nos
9	Washing Unit (2-jet)	-1 No
10	Skid with UV (Stage-2) and taps (3 Nos) for filling cans	-1 No
11	Skid (Stand) for mounting filters, Electrical panels etc.	-1 No
12	Membranes (4 Nos) with Softener and High Pressure Pump (RO Plant)	-1 Unit

Note: In case of conventional type, RO membranes, high-pressure pump, blending tank and softener are not needed**.**

Table-4: Sources of drinking water; Survey results
Coverage: 213 families, 10 villages

Source	User Families	
	Nos	%
Common well in the Village	18	8
Well in the House	21	10
Public Tap/Hand Pump	84	39
Tube Well/Bore Well	15	7
Tanker/Truck	3	1
Pump at Home	72	34
Total	213	100

(Source: Survey by TNS Mode, Hyderabad, 2004)

Table-5: Impressions on 'Sujala' water: Survey results

Coverage: 213 families (Users: 71, Non-users: 142), 10 villages

Level of Satisfaction	User Families	
	Nos	%
Not Satisfied	1	1
Somewhat Satisfied	2	3
Satisfied	40	56
Highly Satisfied	28	39
Total	71	100

(Source: Survey by TNS Mode, Hyderabad, 2004)

Table-6: Utilisation of Sujala Water: Survey results

Coverage: 2000 families, 7 villages

Village	% Dependence of Families	
	Sujala Water	Other Water
Vempadu (with Plant)	67	7
Kopalle (2 km)	25	20
Gollalakoderu (with Plant)	17	13
Garagaparru (3 km)	30	33
Palakoderu (2 km)	93	75
Mogallu (7 km)	80	83
Srungavruksham (12 km)	87	70

(Source: Survey by DNR College, Bhimavaram, 2005)

Table-7: Improvement in health reported on drinking 'Sujala' water

Coverage: 2000 families, 7 villages

Usage pattern	Number of people with type of ailments				
	Head	Cold	Dysentery	Body ache	Digestive pains problems
Pre-use (before consuming Sujala Water)	51	57	79	55	42
Post-use (after consuming Sujala Water)	22	25	29	21	28
Improvement reported-Percentage	43	44	37	38	67

(Source: Survey by DNR College, Bhimavaram, 2005)

Table-8: Survey on Drinking Water (2nd)

Villages	% Dependence of Families	
	Sujala Water	Other Water
Vempadu (with Plant)	67	33
Kopalle (2 km)	7	93
Gollalakoderu (with Plant)	25	75
Garagaparru (3 km)	20	80
Palakoderu (2 km)	17	83
Mogallu (9 km)	13	87
Srungavruksham (15 km)	30	70

- Date of Survey : Feb 2005
- Survey coverage : 2000 Families (7 villages)
- Agency : Students of DNR College, Bhimavaram

FIGURES

Figure-1: Sujala Water Plant-Schematic arrangement of Conventional with 2-Stage UV Radiation System

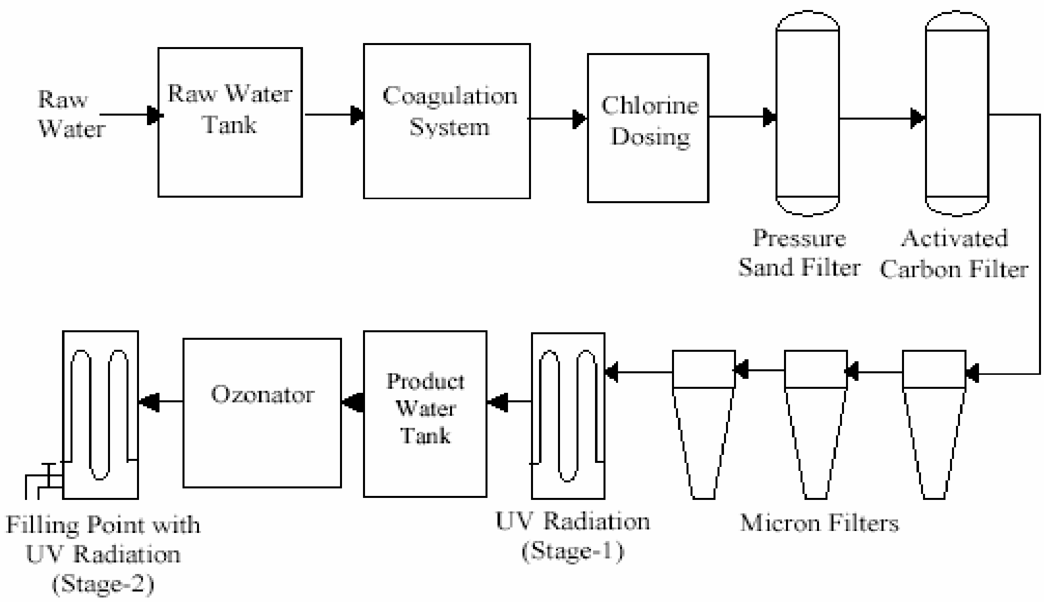
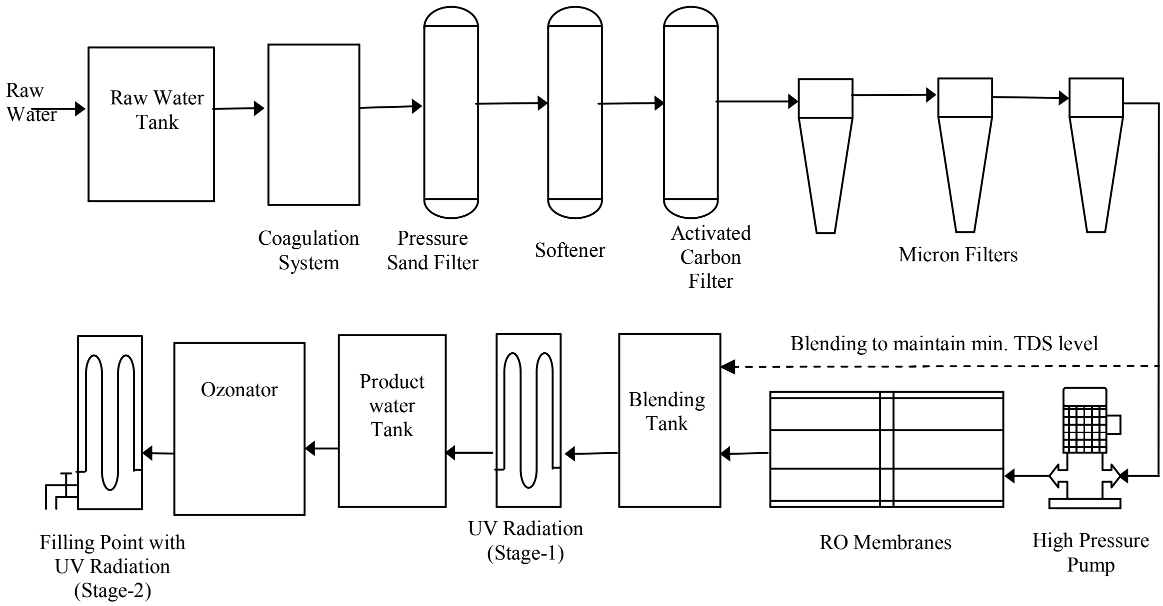


Figure-2: Sujala Water Plant-Schematic arrangement of Reverse Osmosis with 2-stage UV Radiation System



Pictures:

<u>Refer to annexure VIII to view-Building Lay out</u>