GUJARAT TECHNICAL UNIVERSITY

Technological intervention to improve Quality of Drinking Water in Urban Gujarat

Synopsis of the proposed research plan

Submitted for the degree of

Doctor of Philosophy in
Civil Engineering

Of

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by

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Title of research proposal	: **Technological intervention to improve Quality of Drinking Water in Urban Gujarat**
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Place of work	: **Gujarat**

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TITLE OF THE THESIS: THE TECHNOLOGICAL INTERVENTIONS TO IMPROVE QUALITY OF DRINKING WATER IN URBAN GUJARAT

1. **Abstract:** This study by Gujarat Technological University (GTU) under PhD programme is taken to assess quality of water supply in all ULBs area and help them to suggest to improve the quality of water in case of any issue in quality of water by suitable technological solutions for drinking water quality in Urban Gujarat. It is also aimed to develop and make available aneroid based app to citizens of urban Gujarat to know quality of drinking water available to them at any point of time.

   Gujarat is a state in Western India, with population in excess of 60 million. Gujarat is one of the most urbanized states of India. It has an urban population of 24 million accounting for 42.6 % of total population. Gujarat falls under semi-arid zone. The long sea coastline along Saurashtra, Kutch and other parts creates the problem of salinity ingress, which affects the ground water quality on coastal belt and because of scanty and uncertain rainfall, the replenishment in dam is also not reliable, hence this areas are always under water deficiency. There are 8 Municipal Corporations and 162 Municipalities. Responsibility of water supply in all these cities lies with Urban Local Bodies and water supply is largely concerned in cities of Gujarat. Based on data collection and analysis it is found that, about 85% house-holds are covered by water supply. Total production of water is about 4100 MLD. About 21% of total production of water is dependent on ground water while 66% is in form bulk purchased water. Only 78 ULBs are supplying water more than 100 LPCD with average 1.4 hours of duration.

   All WTP in the state are conventional Rapid Sand Filter Plant. No advance technology like UV/ Membrane based/ High filter is being used. Due to high level of dependency on ground water, more than 10% of people are getting water with salts i.e. TDS, fluorides, Chlorides etc., which can be considered water quality risk. It has been found that, South Gujarat area particularly Navsari district suffers Fluoride and Nitrate while North Gujarat suffers the most by excessive fluoride followed by Saurashtra – Kutch and Patan suffer from excessive fluoride in their water supply. High level TDS and salinity is common scenario across the state. Salinity water quality is seen in west Saurashtra & Kutch area. In many cities it is observed that, due to low quantity of water supplied, people often go for tapping private water sources and eventually in many cases it turns out to be ground water, this is an additional risk.

2. **Brief description on the state of the art of the research topic:** Over the past three decades Gujarat has emerged as one of India's most urbanised states with a high level of industrialisation. With nearly 38 percent of its population living in urban areas, Gujarat ranks high on the scale of urbanization, next only to Tamilnadu (43.9%) and Maharashtra (42.4%). Given this pace of urbanisation, the need to augment the investment levels in improving the urban infrastructure levels would be critical. Gujarat falls under semi-arid zone. The long sea coastline along Saurashtra, Kutch and other parts creates the problem of salinity ingress, which affects the ground water quality on coastal belt and because of scanty and uncertain rainfall, the replenishment in dam is also not reliable, hence these areas are always under water deficiency. It has just 2.28% of India's water resources and 6.39% of country's geographical area. The per capita fresh water availability in the State as per the study done in 2001 has been estimated as 1,137 M^3 /annum as against the country's per capita renewable freshwater availability of 2,000 M^3/annum. Around 80% of the State's surface water resources are concentrated in central and southern Gujarat, whereas the remaining three-quarters of the State have only 20%. The State has an average annual rainfall of 80 cm with a high coefficient of variance over time and space and as a result droughts have been frequent. This study is focused on assessment of quality of supplied drinking water in all municipalities of Gujarat and in case of water quality issues to suggest suitable technological options to improve water quality.

Data regarding availibility of water, sources, network facilities, Water Treatment Plants, supply duration, quality of water etc., from all 167 ULBs of Gujarat covering 162 Municipalities & 8 Municipal Corporations have been collected and analyzed. Water samples from all municipalities are collected for different time period at supply level and tested at Public Health laboratory covering all critical physical, chemical and biological parameters. Results obtained are analyzed and plotted on AutoCAD maps. User friendly web site www.gtureserchonwater.com is developed to facilitate all ULBs to enter day to day water quality test results, with assigning log-in facilities to all ULBs. A MIS is developed which will be user friendly and handy with all ULBs associate with an android based app available to all citizen to know quality of water they receive.

The study will be useful to all ULBs in the state as well as region specific to adopt correct technological solutions in conventional or non-conventional way

along macro financial analysis for each solution. Finally, study has covered sample collection proto-call to do the corrective measure during the water supply hour, if any quality issues are found. The study will also be useful to all citizens of the state to know quality of water they are getting.

3. Definition of the problem:

Gujarat falls under water scare region and more than 20% ULBs are supply water to their citizen through ground water source. Depletion of Ground water resources, more and groundwater quality deteriorates due to the discharge of untreated industrial effluents, urban wastewater, over use of pesticides by irrigators and seawater intrusion either directly from casual disposal or indirectly as seepage from treatment lagoons or infiltration from surface watercourses or canals are likely water quality threat. There are region specific issues and require to identified each one and have to provide appropriate type of the technological solution at treatment level as well as at monitor level.

4. Objective and Scope of work:

With aiming to assess and to provide various technological options for better quality of water supply, following are objectives of the research work.

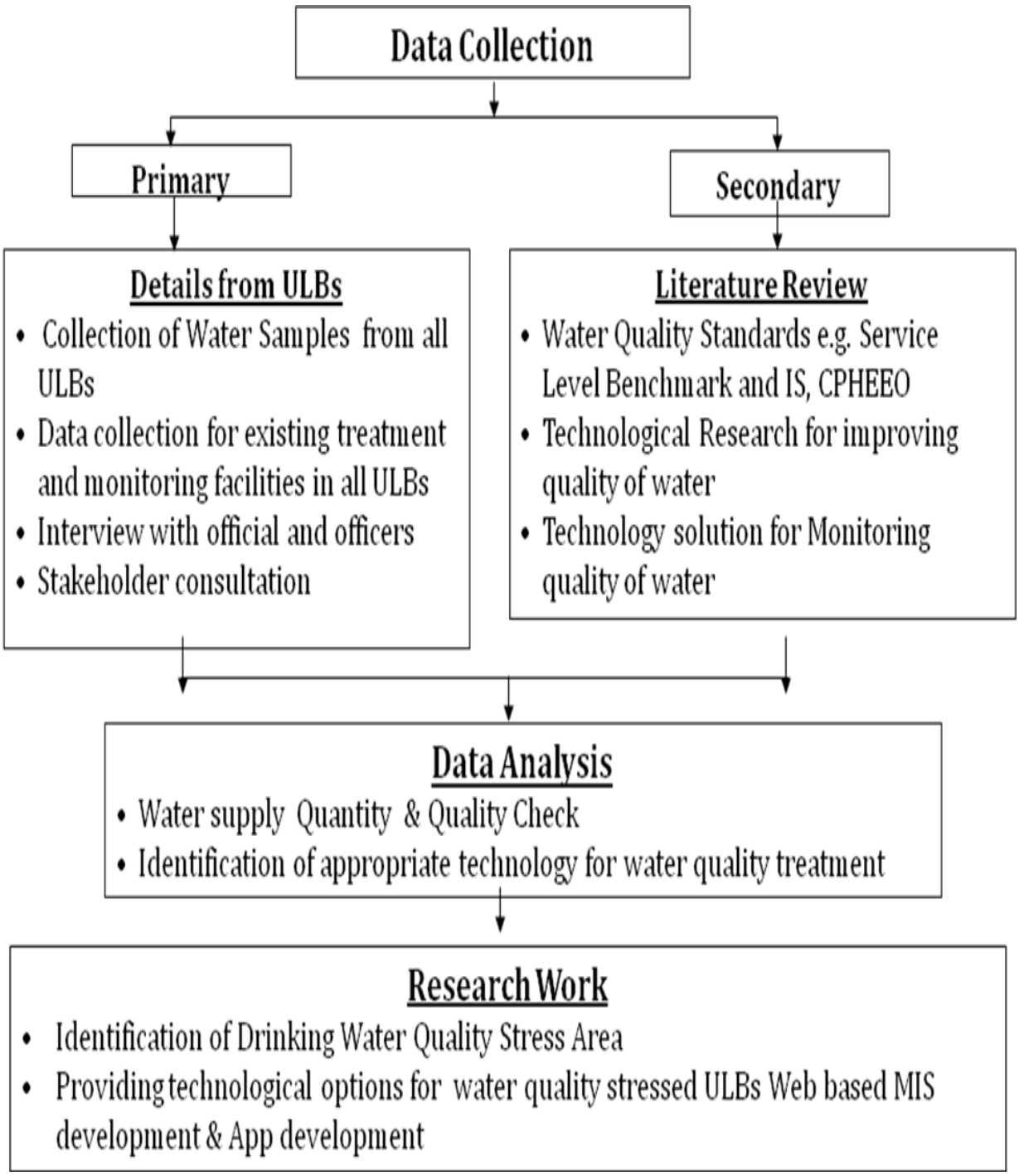
- To understand and assess the role and responsibility of Urban Local Bodies of Gujarat
- To check basic parameters of quality of drinking water of all municipal area of Gujarat
- To identify conventional and non-conventional technological options to improve quality of water
- Depends upon city specific and problem specific probable various technological options to improve the quality of drinking water.
- To develop a much needed database of city level information
- To develop web based, predictive and integrated MIS aap based system of existing water supply systems with respect to water quality records

5. Original contribution by the thesis:

This study covers total 167 Municipalities and Municipal Corporation area of Gujarat for Quality of water supply to their citizen. Testing of sample of drinking water for quality with at least 3 samples from each ULBs at different time period are done through third party water quality laboratory. Plotting are made for water quality stress area for Fluoride, Nitrate, Salinity and TDS to formulates ACAD maps. Combinations of various conventional and non conventional water quality improvement methods are suggested. To generate MIS for day to day & time to time water quality sampling data at ULBs level web site www.gtureserchonwater.com is developed and registered. A master data sheet is also prepared to allow adding, updating or deleting existing ULBs or water zone in bigger municipal corporations. Besides, to provide information of water quality supplied to citizens on their water zone area of own city an android based mobile App with name **Urban Water** is launched and made available from Google play store at free of cost. By this study, it is attempted to cover all stakeholders.

6. Methodology or research, results /comparisons:

The research methodology is framed based on achievement of the study objectives and divided in to two parts viz., Primary sources and Secondary sources. Secondary sources essentially consist of literature survey like GPCB, CPHEEO norms standards, central and state policy lead to existing situation of water supply facilities, water born water born disease registered at each municipality. This will also support by primary survey including extensive field evaluation including sample collection and test at selected municipalities, interviews with stakeholders in different municipalities. Data based will be analyzed on prepared scale or index to form common platform of evaluation. A definite framework shall be worked out to analyze appropriate measures of water quality at each urban centre level.

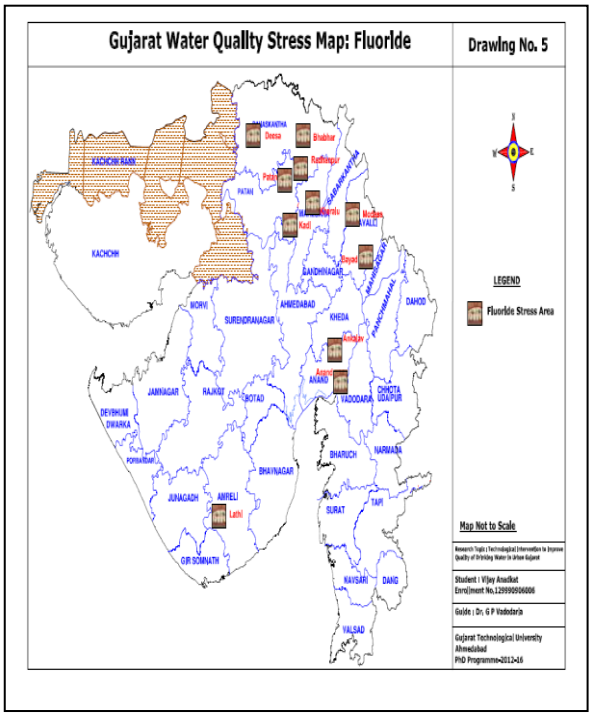

Data Collection
Primary
Secondary
Details from ULBs
• Collection of Water Samples from all ULBs
• Data collection for existing treatment and monitoring facilities in all ULBs
• Interview with official and officers
• Stakeholder consultation
Literature Review
• Water Quality Standards e.g. Service Level Benchmark and IS, CPHEEO
• Technological Research for improving quality of water
• Technology solution for Monitoring quality of water
Data Analysis
• Water supply Quantity & Quality Check
• Identification of appropriate technology for water quality treatment
Research Work
• Identification of Drinking Water Quality Stress Area
• Providing technological options for water quality stressed ULBs Web based MIS development & App development

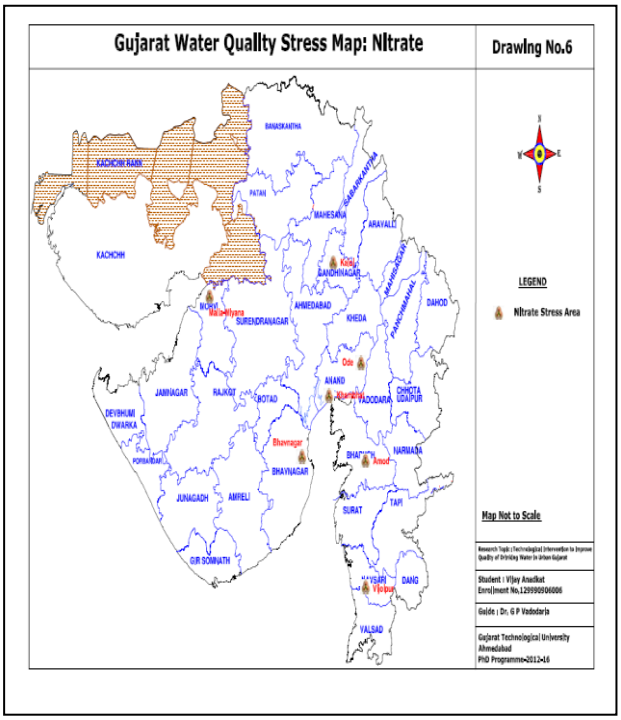
7. Achievement with respect to objectives:

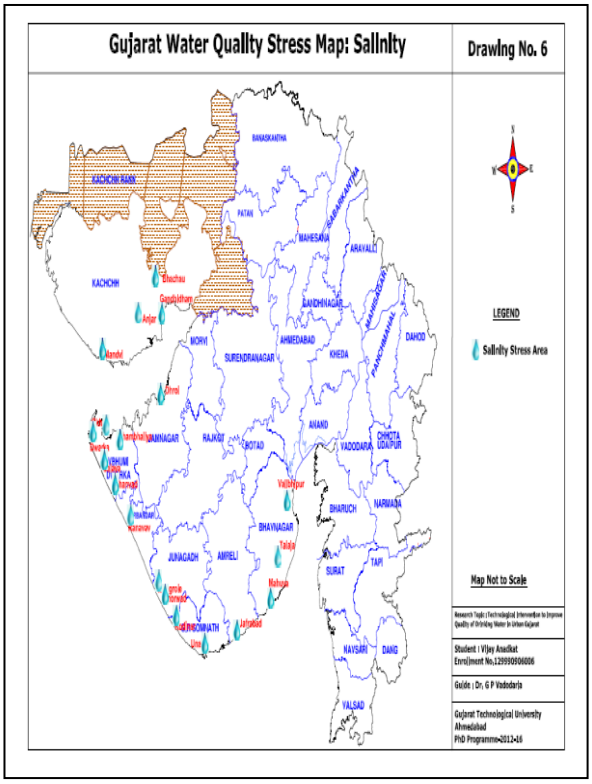
Data from 167 municipalities and municipal corporation covering all urban area of Gujarat state in form of sources of water, treatment facilities, piped water network, level of services, in form LPCD, duration of supply, details of testing facilities are collected. Interviews with ULBs officials, state officials are conducted to verify and conciliation of data. More than 550 water samples and water quality test reports from 167 municipalities and municipal corporations are collected and analyzed. Data from Govt. Gazette and PAS (Performance Assessment System) by CEPT & UMC under gate foundation are also collected and analyzed. Literature review for drinking water quality technical options are also made. Achieved results can be summarized as under:

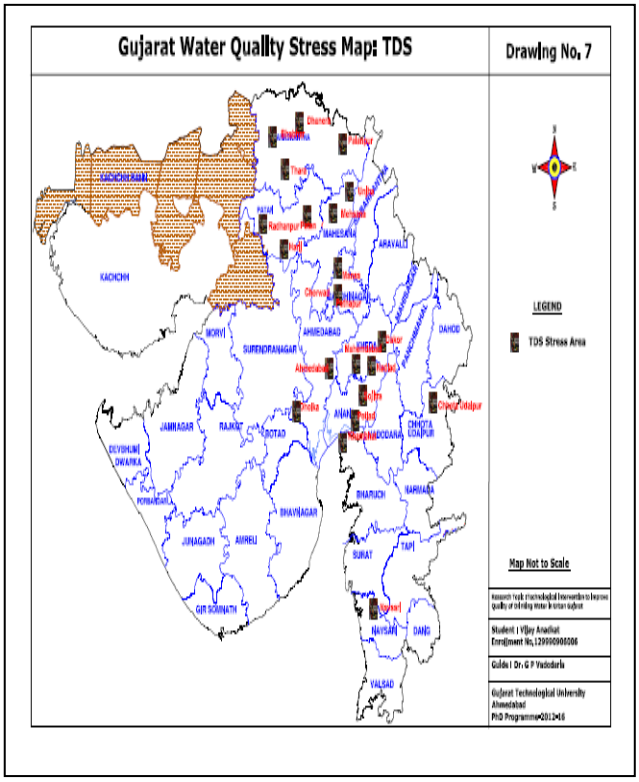
Based on data collection and analysis it is found that, about 85% house-holds are covered by water supply. Total production of water is about 4100 MLD. About 21% of total production of water is dependent on ground water while 66% is in form bulk purchased water. Only 78 ULBs are supplying water more than 100 LPCD with average 1.4 hours of duration. All WTP in the state are conventional Rapid Sand Filter Plant. No advance technology like UV/ Membrane based/ High filter is being used. Due to high level of dependency on ground water, more than 10% of people are getting water with salts i.e. TDS, fluorides, Chlorides etc., which can be considered water quality risk. It has been found that, South Gujarat area particularly Navsari district suffers Fluoride and Nitrate while North Gujarat suffers the most by excessive fluoride followed by Saurashtra – Kutch and Patan suffer from excessive fluoride in their water supply. High level TDS and salinity is common scenario across the state. Salinity water quality is seen in west Saurashtra & Kutch area. In many cities it is observed that, due to low quantity of water supplied, people often go for tapping private water sources and eventually in many cases it turns out to be ground water, this is an additional risk.

Water Quality Stress area are mapped as under:









Referring various literature and looking to the international practice and available combinations of options for quality of water in Urban Gujarat can be_

Technique for removal of Fluoride:

- Ion-exchange
- Coagulation and precipitation
- Membrane Filtration Processes

Technique for removal of Arsenic:

- Oxidation/reduction
- Coagulation and precipitation
- Membrane technique

Nitrate Removal Technologies

- Ion exchange
- Biological de-nitrification
- Catalytic reduction
- Reverse Osmosis
- Electro dialysis
- Blending

Based on which recommendation for improving quality of water in specific area with costing can be listed as under;

- **Fluoride control Measures:**
  - **Area can be covered:** Deesa, Patan, Radhanpur, Bhabhar, Modasa, Ananad, Anaklav, Kadi, Kheralu , Lathi etc.,
  - **Fluoride control consists:** at the source or at the point of use (the household level)
    - **Conventional Method:**
      - Provision of a new and alternate source of water
      - Transporting water from a distant source
      - Blending high fluoride with low fluoride water
      - The traditional system of removing fluoride from drinking water is liming and the attending precipitation of fluoride.
      - Use of technology for Technical Method for de-fluoridation
        - Chemical additive methods
        - Contact precipitation
        - Adsorption/ion exchange methods
    - **Non-Conventional Method:**
      - Rain water harvesting; Storage or Recharge
      - Dual water sources development
    - **Costing**
      - Adding Lime - Cost Rs.0.25/Litre
      - Developing Activated Alumina based WTP pre stage unit- Cost Rs.1-2/ Litre
      - Developing RO based WTP- Cost Rs. 55-Rs.65 /KL
      - Rainwater Storage- Rs.5-8/litre (Capital costing)
      - Rainwater recharge- Rs.0.5 to Rs.1per L (Capital costing)

- **Nitrate control Measures:**
    - **Area can be covered:** Bhavnagar, Ode, Kalol (G), Malia-miyana, Vijolpur, Khambhat etc.,

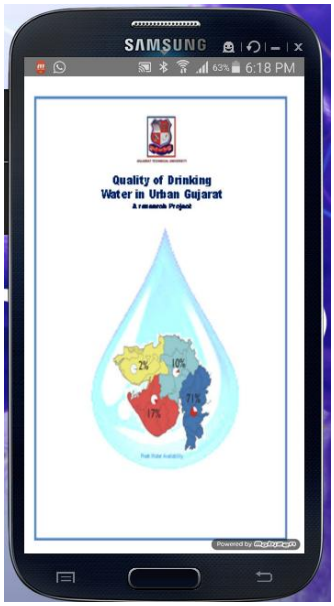
    - **Nitrate Control measures:**
        - Distillation system - expensive for CoPEX & OpEX
        - Reverse-osmosis units
        - Anion-exchange units - unit becomes saturated and needs to be recharged
    - **Costing**
        - Adding Lime - Cost Rs.0.25/Litre
        - Developing Activated Alumina based WTP pre stage unit- Cost Rs.1-2/ Litre
        - Developing RO based WTP- Cost Rs. 55-Rs.65 /KL
        - Rainwater Storage- Rs.5-8/litre (Capital costing)
        - Rainwater recharge- Rs.0.5 to Rs.1per L (Capital costing)
- **Salinity / TDS control Measures :**
    - **Area can be covered :** Saurashtra Costal Sides & TDS on North & Central Gujarat & dependent on ground water
- Area: Addition to Options for Control measure for Fluoride_
    - Resin basis technology
    - Can be developed Community based ATW machines which costs about Rs. 3-5 per litre

8. Conclusion:

To summarize first hand data collection information, following points can be highlighted

- All WTP are conventional Rapid Sand Filter Plant, followed by the Chlorination
- No advance technology like UV/ Membrane based/ High filter
- Water quality threat is when water is tapped from sedimentary formation due to water flow in adjacent rock types and mineral compositions of rocks, water quality is affected. Often over-exploitation of groundwater magnifies inherent salts i.e. TDS, fluorides, Chlorides.
- South Gujarat area particularly Navsari district suffers Fluoride and Nitrate, North Gujarat suffers the most by excessive fluoride followed by Saurashtra – Kachchh and Patan suffer from excessive fluoride in their water supply, High level TDS and salinity are common scenario across the state. Salinity water quality stress is seen in west saurashtra & Kuchh area
- In many cities it is observed that, due to low quantity of water supplied, people often go for tapping private water sources and eventually in many cases it turns out to be ground water.
- Filtration media up gradation of technology like microfiltration technology

- Scope for using multimedia structure in new and existing filter beds can be adopted instead of constructing new water treatment plant
- Option for U/V against Chlorination can be thought of and adopted at suitable ULBs
- Drinking water pre-paid card based kiosk can be installed similar to Dwarka, Delhi (an attempt by MoUD, Govt of India) at water quality stress area to ensure good quality of drinking water
- MIS system for ULBs and an app for all citizens is also developed to provide information about quality of water across the Gujarat.



9. Copies of paper published and a list of all publication arising from the thesis:

Published paper in India Water Works Association (IWWA) Journal on the eve of celebration of 37th Annual day at Ahmedabad during January 2015

10. Patent:

No Patent

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