CHAPTER – VII
Chapter 7

Assessment of Formulation, Implementation and Maintenance of Solid Waste and Sewage Water Management Projects in Mysore City

Solid waste and sewage water management are the important and obligatory services provided by Mysore City Corporation. The City Corporation and the citizens of Mysore were experiencing hysterical situation of solid waste and sewage water management about three years ago (before 2002). The researcher took up the study to analyze the projects on solid waste and sewage water management in Mysore City and to examine whether the situation has improved after the projects were implemented by the MCC. Based on the assessment of the projects, findings and recommendations are deduced based on the analysis.

Specifically the researcher took up the study keeping in mind the following objectives

- To study the effectiveness of management of solid waste projects in Mysore City after the installation of mechanical compost plant
- To assess the impact of qualitative and quantitative project benefits of the Mechanical Compost Plant project vis-à-vis earlier system of open dumping.
- To study the effectiveness of formulation of Sewage Treatment Plant Project
- To study the implementation strategy of the Sewage Water Management Project
- To analyse the positive and negative aspects of the project

During the research, following tasks were undertaken to obtain the information and necessary data of the projects,

1. Discussions with 40 households, in JP Nagar, Chamundipuram & Vidyaranyapuram areas as both the projects were located side by side.
2. Discussions and secondary data from Mysore City Corporation Officers and Census data using the checklist
3. Discussions with 15 Waste Collectors in the above survey areas
4. Discussions with workers and Managers of Excel Mechanical Compost plant and sewage Treatment plant in Mysore using the checklist
5. Discussions with NGOs
6. Discussions with Officers of KUWSDB, Batli Boi, Dalal Consultants etc using the checklist
In the first instance, the Solid Waste Management Project is taken up and study of sewage water management project is given in the second part.

7.0 Introduction

Mysore is a medium city with a population of 7.42 Lakhs as per 2001 census. The city population is increasing at the rate of 3.1 per cent per annum. Mysore City Corporation manages the collection, transportation and disposal of solid waste generated within municipal limits. The total corporation area is 91.23 sq. km which includes areas of Chamundihill, Hootagalli, and Hinakal. The city is divided into 6 mohallas each comprising ten to eleven wards namely, (1) Devaraja mohalla(10 wards), (2) Mandi Mohalla(9 wards), (3) Lashkar Mohalla(11 wards), (4) Fort and Nazarbad mohalla(11 Wards), (5) Chamaraja Mohalla(11 Wards), (6) Krishnaraja Mohalla(13 Wards).

The City attracts floating population of 15 to 25 thousand per day due to its tourist importance. In 8 localities, civic forums/NGOs are collecting and segregating the solid waste to the extent of 3 MT/Day.

The total solid waste generated at present is estimated to be 300 to 320 MT/Day(800 CUM). The projected waste generation in 2011 is estimated to be 680 MT/Day. The per capita waste generated is 380 gms/capita/day.

| Table 7.1: General Information of Mysore City – 2001 Census |
|---------------------------------|----------------|
| Total population of Mysore city | 7,42,261       |
| Male                            | 3,77,132       |
| Female                          | 3,65,129       |
| No of wards                     | 65             |
| No of slums                     | 38             |
| Waste Generated                 | 320 MT/Day     |
| Manpower for Solid waste management | 851 nos        |
| Average Daily no. of Vehicle Trips | 66 to 70     |
7.1 Collection, Transportation and Disposal of Waste

Collection and Segregation

The sweeping and primary collection of waste is done by the paura karmikas. As against the minimum requirement of 2 PKs for every thousand population, only 1.07 PKs are present in the MCC. On average, there are 44 community bins per sq. km of area, each bin with a capacity of 2425 Cum. There is also a practice of segregation of waste at household level as responded by 40 families of low and middle income groups out of 60 families surveyed. The wastes such as plastic, glass and metals, paper etc., are taken out for selling to the Kabadiwallas. The wastes are not segregated in separate bags as per the norms. As a result, the quality of waste received by Excel plant is not consistent.

Collection by the NGOs and Civic Forums

As discussed earlier, about 3 MT/Day of waste is collected and disposed by the local civic forums in Mysore. In Ramakrishnanagar, the local residents association called Surabhi Mahila Sangha(Association of women) has employed three street beautifiers paying them Rs. 400/month. They collect and segregate the recyclable materials and earn from the sale of such materials such as plastic, glass, metals etc. They work between 7 am to 10 am. They are supplied with push cart by Lions Club. Residents are paying monthly fees of Rs. 10 to these waste collectors. The collected waste after segregation is composted in a land provided by the Dept. of Forestry.

Similar Civic forums in Yadavagiri, Kuvempunagar Residents Association, Kuvempunagar Friends Forum, Parisara Jagriti Sanghatane, Swachata Sneha Balaga in Vivekanandnagar are a few civic forums that are actively involved in collection, segregation and disposal of wastes.

Transportation

MCC has 27 vehicles to transport about 160 to 200 MT/Day of solid waste to the compost plant. Before the installation of mechanical compost plant, the MCC was finding a great difficulty in disposing the waste owing to the scarcity of land. From 2002, the entire waste is transported to the mechanical compost plant, where the MCC has
earmarked 25 acres of land for the treatment and manure production by the Excel Industries, a private company.

The focus of this study is mainly to assess the various project components of the Mechanical Compost Plant set-up jointly by the MCC, Excel Industries Pvt. Ltd. and a third party called Vennar Organic Fertilizers Ltd.

7.2 Solid Waste Management by Mechanical Composting in Mysore City

Project Formulation

7.2.1 Project Concept

Until May 2002, the Mysore City Corporation was facing difficulty in scientific management of solid waste in Mysore City. The improper methods followed in all the 5 stages of waste management namely door to door collection, segregation at house-hold level, secondary storage, transportation, processing and disposal have led to environmental pollution. In this background, the Mysore City Corporation decided to launch a new project to manage the city’s 200-250 tones of solid waste in a systematic manner by installing a mechanical composting plant.

7.2.2 Project Identification

Land was a major constraint for the city corporation as the project required huge land. Mysore City Corporation identified it’s own vacant land to the extent of 25 acres on the outskirts of Mysore in an area called Vidyaranyapuram. The Corporation had no money for the capital investment in the project, therefore the ADB’s financial assistance was sought for the project. The technology suitable for the project was brought from the Excel Industries, a Mumbai based private sector company.

- **Organisations Involved in the formulation**: (1) The Mysore City Corporation, (2) Excel Industries/Vennar Organics, (3) NGOs/CBOs (4) People

- **Land**: Vacant land to the extent 25 acres for the project belonged to the City Corporation.

- **Cost Estimation**:
  1. Civil Works = 1.80 Crores
  2. Impervious RCC Platform

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2. Mechanical Equipment and Plant
Including the cost of Dust Bins,
Wheel barrows, etc. = 2.45 Crores

Total = 4.25 Crores

Figure 7.1: Compost Plant

7.2.3 Roles and Responsibilities of Various Organizations

- The Mysore City Corporation would supply the entire solid waste generated in the city to the mechanical compost plant set-up by the Excel Industries (200-250 Tones per day) and provide its own land for the project.
- The Excel Industries will do the operation and maintenance for 10 years on lease basis.
  Responsibilities are;
  a. Providing the technology for Mechanical Compost Plant
  b. Erection of Plant
  c. Recovery of compost from solid waste
  d. Selling of Compost
  e. Maintenance and repair of the plant
  f. Paying annual royalty to the City Corporation based on the revenue generated
- The Excel Industries has in turn sub-contracted the above responsibilities to another private sector company called 'Vennar Organic Fertilizer Pvt. Ltd.
  One of the conditions of the sub-contract is that the Vennar Organics has to purchase the Microbial Culture (Fouling Bacteria used for converting the raw solid waste into manure by spraying it over mounds of raw wastes)

- 'Vennar Organic Fertilizers Pvt. Ltd., is buying the Fouling Bacteria (Microbial Culture) at the rate of Rs. 0.85 Lakh per month at a cost of Rs. 80 per kg.
Vennar Organics would pay the annual royalty to the City Corporation based on the sales of compost and income generated. So far, the Vennar Organics has paid a royalty of Rs. 12.0 Lakhs per annum during the last two years (2002-2003).

7.2.4 Management of the Compost Plant

The figure shows the organizational structure working in the mechanical compost plant.

The managers work under the Managing Director (MD) of the Excel Industries. The plant works for 6 days in a week. The marketing and production managers have field assistants and supervisors working under them. The production unit has 23 labour workers who work on shift basis. The working hours for the production unit are 07.00AM to 03.00PM and for the second shift 03.00PM to 11.00PM.

7.2.5 Stages of Production of Compost

On an average, the Mysore City Corporation supplies 200 tones per day of solid waste to the plant. After initial segregation, about 120 tones of waste will be utilized for production of organic manure. Before, it is processed in the mechanical plant, the waste will be treated by culture media decaying for 28 days. As soon as the waste is received in the entrance after passing through weighing bridge, it is unloaded and arranged in
windrows over the surface of non-porous concrete platform. Each mound will be subjected intense decaying by Microbial Culture known as “Fouling Bacteria’ This bacteria is sprayed over the surface of each mound. After 7 days, the mound will be subjected to turning and mixing by a machine. This procedure will be done four times for each mound thereby requiring 28 days. By this time, the pathogens get died and other harmful weeds decayed and the entire waste is completely decayed and is ready for further processing namely, Grinding, Segregation and Sieving in the mechanical plant. Due to microbial culture, the temperature in the waste mass rises to more than 70 degree Celsius. The turning of waste mass in four stages with each stage requiring 7 days converts the raw bio-degradable waste into rich organic manure. The entire process of conversion of raw waste into manure takes 28 days.

7.2.6 Quantity and Quality of Organic Manure

On an average, 15 to 17 tones of pure organic manure is produced out of total 120 tones of waste.

7.2.7 Marketability of Organic Manure

The plant has established markets in Karnataka, Kerala, Andra Pradesh. The clients are farmers, NGO and Government agencies. An average of 330 tones per month of manure is sold.

7.2.8 Operation & Maintenance Expenditure of the Plant

<table>
<thead>
<tr>
<th>Cost of Production Unit</th>
<th>=0.68 Lakh per month</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Salary of Staff of Production</td>
<td>= 0.70 Lakh per month</td>
</tr>
<tr>
<td>2. Diesel</td>
<td>= 0.70 Lakh per month</td>
</tr>
<tr>
<td>3. Electricity</td>
<td>= 0.90 Lakh per month</td>
</tr>
<tr>
<td>4. Repairs &amp; Maintenance</td>
<td>= 0.22 Lakh per month</td>
</tr>
<tr>
<td>5. Gunny Bags etc.</td>
<td>= 0.85 Lakh per month</td>
</tr>
<tr>
<td>Total</td>
<td>=4.05 Lakhs per month</td>
</tr>
</tbody>
</table>

Cost of Marketing Unit

1. Salary of Marketing Executives, telephone and other accessories =2.50 Lakhs per month
2. Royalty to Mysore City Corporation =1 Lakh (Tentative)
Cost of Manure per tone

- Average of Cost of Production at site = 1700 per tone
- Average Cost of Production inclusive of the cost of marketing and royalty = 2100 per tone

The average market price of organic manure is taken as Rs. 2300 per tone.

Packaging of manure in the plant

7.2.9 Other important Assumptions & Conditions

- Since, the MCC is supplying the solid waste to the plant, the cost of supply of waste is not included in the above calculations.
- Fluctuations in Electricity charges, Diesel and other materials will affect the cost
- The plant is assumed to run for 25 days and the MCC supplies 160 tones/day of solid waste to the plant.
- Any taxes imposed by Government, Poor sales of manure due to drought, Interest on Bank Advances, Breakdown of machinery etc., would affect the cost of production.

The following table is given based on the responses of the Manager of the plant.
Table 7.2: Tentative Income and Expenditure of the Compost Plant

<table>
<thead>
<tr>
<th>Year</th>
<th>Income</th>
<th>Expenditure</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>0</td>
<td>425 Lakhs</td>
</tr>
<tr>
<td>2001-2002</td>
<td>72.50 Lakhs</td>
<td>72.00 Lakhs</td>
</tr>
<tr>
<td>2002-2003</td>
<td>72.50 Lakhs</td>
<td>72.00 Lakhs</td>
</tr>
</tbody>
</table>

On an average, the plant is incurring a huge operation and maintenance expenditure of Rs. 6.00 Lakhs per month. The marketability of the compost again depends on the good monsoon rains as the agricultural activity depends on rains.

So far, the project yielded good revenues as there is huge demand by the farmers across the state and other states as well. So far there is no loss incurred in the project.

7.3.0 Financial Cost Benefit Analysis of the Mechanical Compost Plant Project

Considering 20 years of design period and increasing demand for the organic manure produced at the plant. Following Cash Flow analysis could be derived. The income from the sale of manure would be 2300 Rs per tone x 17 tones = 39100/- per day. If the plant works for 25 days in a month, the total revenue/income per year works out to be 39100x25x12 = 117,30,000 (Rs. 1.17 Crores). Taking the operation and maintenance expenditure as Rs. 72 Lakhs per annum during the first year. And assuming an incremental growth in the production and sale at the rate of 3 per cent every year and Operation and maintenance expenditure at the rate of 2.5% per year. The Net Present value (NPV) of the plant project can be worked out by applying discount cash flow technique.

Table 7.3: Cost Benefit Analysis and NPV Calculation

<table>
<thead>
<tr>
<th>Year</th>
<th>Income</th>
<th>Expenditure</th>
<th>Net Cash Flow</th>
<th>SPPWF at 10% Discount rate</th>
<th>PV at 10% Discount Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>425</td>
<td>-425</td>
<td>1</td>
<td>-425</td>
</tr>
<tr>
<td>1</td>
<td>117</td>
<td>72</td>
<td>45</td>
<td>0.909090909</td>
<td>40.909090909</td>
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<tr>
<td>2</td>
<td>120.51</td>
<td>73.8</td>
<td>46.71</td>
<td>0.826446281</td>
<td>38.6030579</td>
</tr>
<tr>
<td>3</td>
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<td>75.645</td>
<td>48.4803</td>
<td>0.751314801</td>
<td>36.4236694</td>
</tr>
<tr>
<td>4</td>
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<td>77.536125</td>
<td>50.312934</td>
<td>0.683013455</td>
<td>34.364109</td>
</tr>
<tr>
<td>5</td>
<td>131.6845</td>
<td>79.4745281</td>
<td>52.2100026</td>
<td>0.620921323</td>
<td>32.41830392</td>
</tr>
<tr>
<td>6</td>
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<td>81.4613913</td>
<td>54.1736754</td>
<td>0.564473939</td>
<td>30.57962744</td>
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<tr>
<td>7</td>
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<td>83.4979261</td>
<td>56.2061926</td>
<td>0.513158118</td>
<td>28.84266402</td>
</tr>
<tr>
<td>8</td>
<td>143.8952</td>
<td>85.5853743</td>
<td>58.309868</td>
<td>0.466507378</td>
<td>27.20198376</td>
</tr>
<tr>
<td>9</td>
<td>148.2121</td>
<td>87.7250086</td>
<td>60.4870909</td>
<td>0.424097618</td>
<td>25.65243119</td>
</tr>
<tr>
<td>10</td>
<td>152.6585</td>
<td>89.9181338</td>
<td>62.7403287</td>
<td>0.385543289</td>
<td>24.1891127</td>
</tr>
<tr>
<td>11</td>
<td>157.2382</td>
<td>92.1660872</td>
<td>65.0721292</td>
<td>0.350493899</td>
<td>22.80738431</td>
</tr>
</tbody>
</table>
Cost Benefit Ratio=NPV incomes/NPV of Costs=496.53/425=1.17

The project would become financially viable if the net cash flows of incomes and expenditures are maintained as projected in the above table. It may not be practically possible for the plant to maintain the income projections as indicated in the table above due to factors such as draught or any other crisis. It may be noted that the initial huge capital investment of 425 lakhs for setting-up of the plant can not be weighed against the incomes since the project is totally social development oriented. The social and environmental benefits to the city if properly assessed could far exceed financial benefits. Other tangible and intangible benefits of the project are explained in the following paragraphs.

### 7.3.1 Social Cost Benefits

The impact of the waste management plant on neighbourhood pollution and other adverse effects were studied by undertaking a survey of the neighbouring resident families. Plant is located at a distance of 300 to 500 Mts away from the residential and industrial houses. The plant location comes under the industrial zone as per the Comprehensive Development Plan and is a an industrial suburb. A temple is also located at a distance of 500 Mts from the plant.

A few families very close to the plant have expressed that they are experiencing foul smell whenever the wind blows towards them. But, many of them expressed that the magnitude of the foul smell and flies menace has come down drastically due to the improved methodology of treatment of waste thereby endorsing the scientific management of waste in the plant. A few of them even quoted their own household waste
collection and management problems by saying that a 5 kgs waste collection bin if kept open for 12 hours in the back yard of their house, would result in unbearable foul smell and flies. Then, what to talk of the huge waste that is being received daily in the plant. On the one hand, they were positively supporting the process of scientific waste management as followed in the plant, and on the other hand were of the opinion that such plants need to be located far away from the city.

A few of them also narrated their experiences on how the city was facing the environmental problems of solid waste management when there was no mechanical compost plant. Clogging of roads due to indiscriminate dumping, flies and mosquito menace, rag picking, health problems etc., were a few instances given by the people.

None of the families were of the opinion that the waste plant has caused them health related problems such as diseases.

Therefore, they justified the working of the plant where a huge 250 metric tones of solid waste from the entire city is received and managed without causing any environmental pollution.

A high compound wall is constructed and trees are grown all around the plant to maintain the cleanliness and to prevent pollution.

The psychological feeling that their houses are located nearer to the Waste Plant is another factor that has led to inferiority complex in their mind. However, they were also of the opinion that such a plant is necessary for managing the waste. Nevertheless, they expressed that instead of dumping the waste all across the roads and vacant lands, the present system of processing waste is most appropriate. But, such plants need to be located at least 2 Kms from the habitation.

7.3.2 Social Benefits

- Entire City is free from indiscriminate dumping of solid waste
- Roads and drains are now free from solid waste
- Residents of the city are all benefited in terms of better environment
• Rich organic Manure is sold relatively at cheaper costs to the farmers of the city and across the state and country
• Enrichment of soil fertility due to organic manure instead of chemical fertilizer
• Employment to unemployed youth in the plant
• Plastic and other recyclable materials sieved out during the mechanical composting process are reused for making plastic pipes etc.

7.3.3 Other Benefits of the Project

• The City Corporation monitors the number of vehicle trips and the weight of solid waste received daily by the plant by means of weighing bridge installed at the entrance of the Plant. So that the non-working vehicles and concerned staff will be supervised and controlled by the Corporation’s Health Officer and Commissioner.

• The expenditure of Mysore City Corporation for transportation and land filling has been reduced by 3 to 4 Lakhs per month due to installation of this plant since the transportation and land filling costs are reduced. These costs on diesel, repair cost of vehicles, land filling and over head costs were enormous before installation of this plant.

• The Plant is processing the entire waste generated in the City and recovering the organic manure and recyclable materials to the extent of 60-70 per cent of the raw solid waste received every day

• The problem of City Corporation transporting the waste to a distant place and dumping it openly thereby requiring huge area of land is overcome now.

• Every day 200 tones of solid waste is treated in a scientific manner and the rich organic manure recovered through mechanical plant

7.3.4 Long term Benefits of the Project

• Requirement of huge land area for solid waste management is reduced due to installation of Mechanical Plant. Since only 20 to 30 percent of net unusable waste materials such as polythene, glass pieces etc. are land filled now as compared to land filling of all the wastes in the absence of mechanical plant.

• Environmental pollution is totally overcome due to scientific management of wastes
• Farmers are getting cheaper and rich organic manure for all types of crops. Unlike, chemical fertilizers, organic manure requires less water and enriches the soil fertility and suitable for all types of soils.

7.3.5 Non-Existence of Sanitary Land Fill

The survey indicated that the waste residues after screening process in the mechanical compost plant are partly taken away by the rag pickers and plastics are sold to private vendors who in turn use it for production of PVC pipes and other plastic based materials. But, still about 50 to 60 percent of inert and non-usable materials are coming out in process. These materials at present are just dumped around the open land located around the plant. There is an urgent need for constructing a sanitary landfill by the city corporation.
7.3.6 Assessment of Project Parameters as per the Evaluation Model

Project Concept and Objectives of the project

Social Survey

Demand survey of the requirement

Engineering Survey

Preparation of Project

Role of Government

Role of ULB

Role of State level agency

Role of Consultant

Role of Contractor

Role of Community

Appraisal
- Technical Appraisal to determine whether the technical parameters are soundly conceived, realistic and technically feasible.
- Financial Appraisal to determine whether the financial costs and returns are properly estimated and whether the project is financially viable
- Institutional Appraisal to determine whether the implementing agencies are capable for effective implementation, monitoring, and evaluation of the scheme.
- Environmental appraisal to see any detrimental environmental impacts and how to minimise the impacts.

Technical Appraisal
- Feasibility
- Specifications
- Technology options
- Quality and durability
- Standards
- Designs etc

Financial Appraisal
1. Loans/Grants
2. Own Sources
3. Subsidies
4. Capital investment
5. O&M investment
6. Cost-Benefit analysis
7. Cost Recovery Mechanism
8. Repayment of Loans

Legal Appraisal
- Legal documentation

Social Appraisal (Social cost and benefits, target group)

Project Execution
- Tendering
- Contractor
- Schedule
- Target
- Procurement of materials/equipment
- Performance
- Payments
- Likely hurdles
- Scope etc

Monitoring and supervision
- Progress reports
- Site Inspection
- Cost and Time Control
- Deviations
- Completion Reports

Project Evaluation Documentation
Project study
Project performance

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1. **Project Concept**: The project was well conceived by the Mysore City Corporation. For a long time, the solid waste of 200 to 250 tones generated per day in Mysore city was not finding a safe place for processing and disposal. The efforts of the City Corporation to bring awareness among the public to segregate the waste at source had failed miserably. Under these circumstances, the City Corporation had no other option except going for a mechanical composting method by installing a capital intensive machinery which can segregate the mixed waste by sieving at various stages and remove the recyclables such as plastics, glass, metal and other inorganic waste on the one side and organic matter/manure on the other side. The indiscriminate dumping of solid waste by the corporation across the city wherever open spaces were available was to be dispensed with immediately by a systematic method. The transition from the existing system to innovative and scientific system was inevitable for the Corporation. The MSW Rules -2000 were also stringent for those failing to implement. The major deficiency at the conceptual stage was leaving out the component of sanitary fill.

2. **Project Objective**: The project objective was to process and dispose the solid waste of 200 to 250 tones per day in a mechanical compost plant and recover the organic manure and recyclable materials from the waste.

3. **Social Survey**: The feedback obtained from the 70% of the respondents among residents and 90% of elected representatives expressed that the plant was required. The corporation officials such as health Officer and Sanitary Inspectors explained the health benefits of the project. A few NGOs expressed that about 50 to 60% of the waste was dumped on either side of the road prior to installation of the plant. After the plant started functioning, all the waste goes to plant site. About 30% of the respondent residents located in the vicinity of the plant had complaints such as foul smell and mosquito menace. The researcher has assessed the social benefits of the project under Para 7.3.1 and 7.3.2.

4. **Demand Survey**: The city had a reached a stage where there was almost no open space to dump the waste. Although, there were some complaints and resistance by
the public to locate the plant in the present land, the corporation went ahead with
the project in the larger interest of the city.

5. **Engineering Survey**: The Excel Industries was given the task of installation
of the plant. The land of 25 acres on Nanjanagud road near Vidyaranyapuram for the
plant was given by the City Corporation. The layout plans, specifications,
technical option, designs etc., were prepared by the Excel Industries.

6. **Roles of various agencies**: Institutional framework and organizational structure
are given under Para 7.2.3 and 7.2.4. One of important weaknesses is the failure
of the corporation to ensure sustainability of operation and maintenance of the
project. If the excel industries/Vennar Organics leaves the project for any reason,
there should be an alternative system in line to take over the operation and
maintenance. The corporation needed to create a dedicated maintenance staff
to maintain the system.

7. **Technical Appraisal**: The technology suitable to process the waste to the extent
of 200 to 250 tones was selected. But, during rainy season, the plant would find it
difficult to process this quantity due to wetness. Also, the roof cover area required
over the solid waste would be very large which is not taken into account while
designing. Normally, the residual left should go to sanitary landfill site. In this
case, the residuals are still lying by the side of the plant. These issues should have
been properly appraised.

8. **Financial Appraisal**: The financial appraisal was not done earlier. The
researcher assessed the return on investment by calculating the Net Present Value
by making suitable assumptions based on the income and expenditure of the plant
since its inception. The project would become remunerative and could run on
profit if managed in a systematic way. The financial appraisal is given under para
7.3.0. The uncertainties in such project may occur due to marketability of manure,
breakdown of the plant, future land requirement, increased capacity etc. The
project was implemented with the assistance of ADB loans and has to paid. At present, the incomes from the sale of manure would just meet the cost of operation and maintenance.

9. **Environmental Appraisal:** The land belonged to the corporation and was located at present on the outskirt of the city about 6 Kms from the city centre. The corporation was finding a great difficulty in getting land/site away from the city due to resistance of the villagers. The present location although do not pollute the environment at present may become a hazard if future quantity and capacity are not appraised. As already explained, a few residents have expressed concerns about the foul smell emanating from the plant. These issues needed to be addressed by the City Corporation.

10. **The Project Implementation:** It is public-private partnership venture. Under the lease agreement for 10 years, the Excel Industries, has executed the project. The project would be handed over to the Corporation after the period. The Corporation is the owner and the Excel Industries is the private party which has the responsibility for providing technology, machinery, staff for execution and also for operation and maintenance during the lease period. The Excel Industries has sub contracted the operation and maintenance to a third party called Vennar Organics. About 4 to 8 % royalty needs to be paid annually by the Excel Industries to the Corporation depending on the sale proceeds from the manure. The capital cost of more than 4 crores is met by the Corporation out of the ADB Loan and is paid to the Excel Industries for installation of the plant. The important condition was that the City Corporation has to supply 200 to 250 tones per day of solid waste to the plant on its own expenditure. As per the feedback of the Officials at the Corporation and Excel Industries, the plant is running smoothly with minor operational problems.

11. **Monitoring and Evaluation:** The solid waste received at the plant is weighed while passing the weigh bridge provided at the entrance gate. The quality and
The quantity of waste received by the plant daily is recorded and trips sheets are sent to the Corporation Commissioner. The Corporation Commissioner and the Health Officer in turn monitor the vehicles, drivers, PKs and sanitary staff deployed for the job of collecting, storing and transporting the waste to the plant. The Health Officer is the immediate monitoring and supervising authority. There is a manager to oversee and manage the plant operations, sale of manure, maintenance of the plant etc. The quality of manure is tested in the laboratory set up in the plant site before it is sold. There is a chemist appointed to monitor the quality of the manure. Vegetables and other plants are grown by the side of the plant to demonstrate the quality of the manure to the public.

### 7.3.7 Findings and Recommendations

Although, the Mechanical Compost Plant is working very well for managing the solid waste, there still exist some problems. The first problem is the non existence of sanitary land fill. As about 60 percent of the waste is still remained as non-recyclables and non-usable, this material has to be safely disposed to a sanitary landfill. There is adequate land by the side of the existing plant, but the City Corporation has to initiate the proposal and construct the land fill.

In the present system, non-segregated waste is collected and transported to plant requiring the plant to screen out the inorganic and inert materials. In the process, the expenditure involved for electricity and maintenance is huge to the tune of Rs. 72 Lakhs per annum approximately.

If the City Corporation introduces the method of segregation at the household level, the cost of production of manure could be greatly reduced and even the initial investment for installing huge mechanical plants would not have been required.

At the time of launching of the Waste Management Project during the year 2000 in Vidyaranyapuram in Mysore City, the location was purely an industrial area. The area has now grown and residential houses have come nearer to the Plant within a radius of
300 to 500 Mts. This may lead to the adverse effects on the residents. It may be noted that the waste generation would also increase year after year and the existing plant may not be able to cope with future waste processing. As seen from the plant area, heaps of inert and non usable materials are already mounting and the area is expanding automatically to the adjacent vacant land of City Corporation.

In view of the circumstances, another plant away from the existing location may be considered by the MCC. This is important and necessary because already there is a 67 mld sewage treatment plant operating by the side the solid waste management plant. There is also a shortage land in the present location.

The City Corporation has to make a detailed analysis of the situation and find out alternative sites for future requirement away from the habitation.

It is also found that the leachate from the waste was not properly collected in a impervious tank. From the field observation, it was flowing on the soil surface on the sides the heaps of garbage and particularly the quantity of leachate would be more during rainy season. The leachate being harmful can contaminate the subsoil and ground water source. The city corporation has to construct separate impervious tanks to receive the excess leachate and reuse it for spraying it on the windrows which helps to reuse the nutrient rich leachate. Spraying of leachate again over the windrows helps in accelerating the process of decomposition of organic waste.

The NGOs and Resident Associations could be involved in the management of solid waste at the ward level. This not only help the segregation of wastes at the ward level, but also minimizes the burden on the City Corporation. The efficiency of NGOs and resident associations who are already working in a few wards/areas in Mysore City may be assessed. Based on the performance, the Corporation could assign additional areas for management of wastes at the ward level.

At ward level, the methods such as vermi composting could be adopted.
7.4.0 Formulation of Urban Sewage Treatment Plant(STP) Projects - Study of STP Project in Mysore City

The researcher has gone in depth to study the practical and theoretical issues of STP at B drainage district located at Vidyaranyapuram in Mysore. Both the solid waste and sewage management plants are located alongside. This being the largest among the three sewage treatment projects, the researcher took up the project for assessment study. The researcher visited the STP and discussed on the technical and managerial issues with the MCC Engineers, KUWS & DB Engineers and the Staff of Batli Boi and Dalal Consultants and the residents.

7.4.1 Introduction

Domestic waste water constitutes a major source of pollution especially of aquatic bodies as waste waters generated in urban communities are discharged either without or with partial treatment. Though several factors are responsible for inadequate treatment facilities, the primary constraints are paucity of financial resources, high energy inputs required for treatment technologies e.g., Activated Sludge Process and Extended Aeration Systems (12-20 kWh/person/year) and low or insignificant return on capital investments to build treatment plant facilities.

The purpose of public waste water collection and disposal system is to ensure that sewage or excreta and sullage discharged from communities is properly collected, transported, treated to the required degree and finally disposed off without causing any health or environmental problems. The purpose of sewage treatment is to destabilize decomposable organic matter present in sewage so as to produce an effluent and sludge which can be disposed of in the environment without causing health hazards or nuisance.

It is estimated that poor quality and inadequate quantity of water accounts for about 10 percent of the total burden of disease in the state. Waterborne diseases occur mainly due to lack of safe drinking and sanitation facilities. In India every year, large number of deaths of children under the age of five is attributed to poor quality of drinking water. Apart from health effects, inadequate quantity of water supply and sanitation
services leave adverse impacts on the environment mainly leading to contamination of soil and water due to stagnation of sewage.

Sanitation facilities like sewerage system, storm water drain, latrines (public or private), and other community sanitation services are important in maintaining good hygiene and clean environment. Factors such as population pressure, discharge of effluents, addition of agricultural chemicals into water bodies and inappropriate water pricing mechanisms have contributed to deterioration of water quality, depletion of water and unhygienic sanitation.

7.4.2 Status of Sewage Treatment in Urban Areas in Karnataka

The sewage generation in cities mainly depends on the consumption of water by the households and other industrial establishments as almost 80 percent of the water supplied by the local bodies converts into sewage. The level of water supply in some of the city municipal councils in Karnataka is indicated in the following table. The level of water supply ranges between 50 LPCD to 152 LPCD. Almost two third of the municipalities lack normative levels of water supply. As per the second State Finance Commission Report, the capital required to provide the sewerage system in 208 municipalities in Karnataka excluding Bangalore City is Rs. 3854.63 Crores and for provision of water supply is estimated to be Rs. 1815.29 Crores.

The final report of the high powered committee on ‘Redressal of Regional Imbalance in Karnataka’ has estimated the financial requirement of Rs.2713crores to provide sewerage systems in the towns and cities of Karnataka.

Table 7.4: Per capita Water Supply in different Municipalities in Karnataka

<table>
<thead>
<tr>
<th>Name of the Municipality</th>
<th>Level of water Supply(in LPCD)</th>
<th>Name of the Municipality</th>
<th>Level of water Supply(in LPCD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hubli-Dharwad</td>
<td>100</td>
<td>Hassan</td>
<td>115</td>
</tr>
<tr>
<td>Gulbarga</td>
<td>86</td>
<td>Chikmagalur</td>
<td>50</td>
</tr>
<tr>
<td>Belgaum</td>
<td>85</td>
<td>Udupi</td>
<td>50</td>
</tr>
<tr>
<td>Mysore</td>
<td>141</td>
<td>Bhadravati</td>
<td>110</td>
</tr>
<tr>
<td>Mangalore</td>
<td>152</td>
<td>Shimoga</td>
<td>105</td>
</tr>
<tr>
<td>Kolar</td>
<td>45</td>
<td>Davanagere</td>
<td>51</td>
</tr>
</tbody>
</table>
Table 7.5: Water supply norms for urban areas of Karnataka

<table>
<thead>
<tr>
<th>Size of Population</th>
<th>Class of ULB</th>
<th>Norm (Litre per capita per day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Above 1 Lakh</td>
<td>Class -I</td>
<td>135</td>
</tr>
<tr>
<td>20000-1 Lakh</td>
<td>Class -II &amp; III</td>
<td>100</td>
</tr>
<tr>
<td>Upto 20000</td>
<td>Class- IV, V and VI</td>
<td>70</td>
</tr>
</tbody>
</table>

From the records of the Karnataka Urban Water supply and Drainage Board, it is seen that only 36 urban local bodies, except Bangalore and City Municipal Councils around Bangalore have been covered with underground drainage facilities. Even in those towns where the underground drainage is being provided, the percentage coverage of the households is relatively less. Further, 182 urban local bodies are yet to be provided with underground drainage system in the state.

Most of the urban local bodies do not have sewage treatment plants to treat wastewater. For instance, out of 36 urban local bodies where underground drainage system is provided, 9 urban local bodies do not have treatment plants. Even among other urban local bodies where sewage treatment plants are provided, they are either oxidation plants (in 16 towns) or primary treatment plants (in 6 towns). In none of the towns secondary and tertiary treatment plants are established. Belgaum and Hubli Dharwad Corporations do not have treatment plants. Treatment plants in Jamkhandi, Bhatkal, Chikmagalur and Ilkal were not functioning.

Lack of proper sanitation facilities increases the environmental problems particularly during rainy season. Overflowing soak pits contaminate water and soil and also affect the health of people. The problem gets worsened in low lying areas, where usually poor people live.

7.4.3 Sewage Treatment in Bangalore City

Bangalore being the largest city in Karnataka State, it is necessary to draw lessons from the city. From the data available with the Bangalore Urban Water Supply and Sewerage Board, a brief analysis is done on the sewerage system. The Bangalore Water
Supply and Sewerage Board manages the water supply and sewage treatment in Bangalore city. 80 percent of the water supplied in the city gets into the sewers as waste water, which amounts to about 528 million litres per day. At present only about 38.6 percent of the geographical area of Bangalore city is covered with sewerage system. Some of the sewers are in critical condition due to crown corrosion and require immediate replacement. Thus a project has been formulated by the Bangalore Water Supply and Sewerage Board to upgrade the trunk system to convey the estimated sewage flow into all the sewage treatment plants. This scheme funded under the National River Conservation Programme will also ensure prevention of pollution of the Ponniah and Cauvery rivers. Bangalore Water Supply and Sewerage Board has identified 66 Km length of sewers for rehabilitation. These works are to be completed in order to achieve the goal of zero discharge of raw sewage into storm drains and lakes.

Out of 7 sewage treatment plants in the city, 5 are extended aeration tanks where as 2 are with up flow anaerobic sludge blanket reactor (UASB) followed by extended aeration. The existing sewerage system of Bangalore City is divided in to three drainage zones namely Vrishabhavathi (303MLD), Koramangala-Challaghatta (163MLD) and Hebbal (60 MLD). The total capacity of these plants is 526 MLD which is expandable up to another 308 MLD. In addition, there are three minor valleys namely Kethamranahally and Arkavathi, Tavarekere and Kathriguppe with inadequate capacity to carry the sewage which contributes to wastewater stagnation and other related problems.

### 7.4.4 Problems of Sewage Treatment Services in Bangalore City

- Siltation, blocking of solid waste and damage in the sewerage system
- The sewage is left in open at many places creating unhygienic conditions in the surrounding area.
- Dumping of Solid Wastes in manholes
- Sewer lines having crown corrosion and reverse gradient and discontinuity.
- Absence of sewers in slums and isolated areas.

The problems of under ground drainage and sewage treatment in cities and towns is starkly visible in Karnataka. The State Government needs to provide funds and provide the sewerage and treatment facilities in all the cities of Karnataka after meeting the water supply requirements. Bangalore city has 7 treatment plants with a capacity of 526 MLD,
The area covered under sewerage is 38.6% only. There are also problems in maintenance of the treatment plants and sewerage network. With this background, the researcher went into detailed study and analysis of the sewage treatment plant project in Mysore.

7.5.0 Mysore

Sewage Treatment Project in B-Drainage District located at Vidyaranyapuram of Mysore City– Study of Formulation Process and Implementation in Mysore City

The researcher had visited several times and discussed with the officers, engineers and other project functionaries connected with project both on the field and at offices to get the data. The project was completed in the year 2002. But, the researcher took up the study in the year 2003-04 after one and half years of completion of the project. Therefore, it was possible to mainly concentrate on the post assessment of various project components from the stage of launching to the completion and maintenance. As various agencies were involved in the project, the researcher had to approach all these agencies to derive various issues, problems and solutions that were handled during implementation of project.

The study is limited to the issues related development and management of the project and the researcher has not gone in depth into the minute details of technical design of treatment plant project developed by the consultant of the project viz. ‘Dalal Consultants’.

The topographic map of Mysore city and the drainage areas connected to each sewage treatment plant were studied and analyzed. The study brings out the innovative aspects and also improvements required to be adopted or could have been adopted to make the project more viable and efficient. The project components were assessed with respect to various stages of formulation and implementation.
7.5.1 Water Supply and Sewage Generation in Mysore City

Mysore is the 3\textsuperscript{rd} biggest city in Karnataka and is known as cultural capital of Karnataka. It is one of the famous tourist centers in Karnataka with large floating population of about 10 to 20 thousand people every day. The city is growing both in population and area. For the first time in the year 1896, a 2.27 MLD water treatment plant was set up at vani vilas works compound at Yadavagiri to treat the water pumped from Belagola. The water supply was increased progressively as the demand increased and in the year 1998, the increase in water supply was 140 MLD.

The continuous growth of new residential and industrial areas is commonly seen in the city. The city is rapidly expanding both in area and population as new infrastructure facilities such as Airport, IT industries etc., are going to be established. As a result, the consumption of water is also increasing. Earlier, prior to the implementation of sewage treatment projects, the sewage water was left untreated. Also, the system was lacking adequate networking of main sewer lines. As a result, the sewage water was allowed to flow in storm water drains which in turn was flowing into the important natural tanks of Mysore City namely Kukkarahalli tank, Lingambudi tank, Dalawai tank, Bogadi tank, Karanji tank causing pollution of these tanks. The steady degradation of natural beauty of water tanks and infrastructure facilities had visible and greater environmental impact on the flora and fauna of Mysore.
The Mysore City Corporation therefore initiated three Sewage Treatment Plant projects besides augmenting the sewerage network in Mysore City during the year 1998-99 under the ADB assistance. The details of the project are given in the Tables.

Table 7.6: Details of Sewage Treatment Plants and Outfall Sewers in Mysore

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Description</th>
<th>Design Capacity (MLD)</th>
<th>Designed Population (lakh)</th>
<th>Size of Lagoons</th>
<th>No. of aeration tanks</th>
<th>HP of aeration</th>
<th>Estimated Cost Rs. in Lakhs</th>
<th>Expenditure Rs. in Lakhs</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 A &amp; D</td>
<td>30.0 0</td>
<td>2.0</td>
<td>155x1554.30m</td>
<td>155x100x1.60</td>
<td>24</td>
<td>15.00</td>
<td>325.24</td>
<td>518.24</td>
</tr>
<tr>
<td>2 B</td>
<td>67.6 5</td>
<td>4.10</td>
<td>150x300x4.5m</td>
<td>150x175x2.07</td>
<td>36</td>
<td>20.00</td>
<td>914.80</td>
<td>1027.00</td>
</tr>
</tbody>
</table>

Table 7.7: Details of Outfall Sewers

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Description</th>
<th>Length of Sewer Line KM</th>
<th>Estimated Cost Rs. in Lakhs</th>
<th>Expenditure Rs. in Lakhs</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>A &amp; D District(300mm to 1400mm dia)</td>
<td>17.316</td>
<td>818.00</td>
<td>726.00</td>
</tr>
<tr>
<td>2</td>
<td>B District(400mm dia to 1400mm dia)</td>
<td>6.337</td>
<td>325.00</td>
<td>348.40</td>
</tr>
<tr>
<td>3</td>
<td>C District(350mm dia to 900mm dia)</td>
<td>6.45</td>
<td>168.00</td>
<td>240.50</td>
</tr>
<tr>
<td>4</td>
<td>Linking of sewer lines(150mm dia to 600mm dia)</td>
<td>33.80</td>
<td>667.00</td>
<td>616.70</td>
</tr>
</tbody>
</table>

7.5.2 Area covered by the Sewage Treatment Plant in B drainage District.

The sewage from ‘B’ drainage district of Mysore city covering the areas of Mandimohalla, Bangalore-Mysore Road, Government Guest House, Nazarbad, Ittige Goodu, Jyothinagar, Police colony, Siddharthanagar, Venkatalingiah colony, Dairy, Central Government housing colony, K C Colony, Body guard employees housing colony, Lakshmipuram, Nanjumalige, Agrahara, Krishnamurthipuram, Ashokapuram, Vidyaranyapuram, and JP Nagar flows through gravity to the sewage treatment plant located at Vidyarnyapuram.
7.5.3 Organizations Involved in the Implementation of the Project

1. The Karnataka Urban Infrastructure Development and Finance Corporation (KUID & FC) with its head office in Bangalore is the nodal agency in the state for developing and funding the urban infrastructure projects in Karnataka. The fund/loan obtained from the ADB was channelized through the KUID & FC.

2. The Dalai Consultants, a private consultancy firm was appointed to provide the consultancy support to the Project.

3. The Karnataka Urban Water Supply and Sewerage Board (KUWS & DB) was to supervise and monitor the project as a nodal agency of the state to undertake and implement the water supply and sewerage projects.

4. The Mysore City Corporation (MCC) is owner of this project since it is one of the important obligatory functions of the municipal corporation to provide and maintain the sanitation facilities and protect the environmental pollution.

5. Batli Boi Ltd., a construction company is the building contractor of this STP Project.

7.5.4 Capital Cost of the STP Project

The capital cost of the project is Rs.10.37 Crores. Capital costs included all initial costs up to plant start up such as

- Civil Construction, equipment supply and erection costs
- Land purchase costs (Mysore City Corporation itself is the owner of the Land)
- Consultancy costs for Engineering Design and Supervision charges
- Interest charge on loan during construction period

7.5.5 Basic Design Considerations

Topographical, engineering and other considerations at the project formulation stage are given below;

1. STP Project serving the B drainage district area is designed for a period up to 2025, stage-wise population to be served and expected sewage flow and fluctuations were duly considered. Normally, as per the CPHEEO guidelines, the design period for any
STP is 30 years. At present, the flow of sewage to the plant is about 25 to 30 mld, where as the plant is designed for 67.5 mld.

2. Sufficient land has been reserved to take care of the future requirements by the side the existing plant

3. Based on the Topography of Mysore City, the five drainage districts A, B, C, D and E were formed. The area to be served by each STP, its slope and terrain, the sites for treatment plant, pumping stations and disposal works were identified and designed.

4. Seasonal fluctuations in ground water depth affecting construction, sewer infiltration, structural design etc.

5. Soil bearing capacity and type of strata expected to be met in construction

6. On site disposal facilities, including the possibilities of segregating the sullage water and sewage and reuse of sullage water.

7.5.6 Forecast of Population and Water Requirements in the design of STP

As per 2001 Census, the population of Mysore City is 7,85,800. The projected population during 2011 and 2026 will be 11 lakhs and 17 lakhs respectively. The requirement of water during 2011 and 2023 will be 185 MLD and 273 MLD respectively at the rate of 135 LPCD(85%) through house connection and 70 LPCD(15%) through stand post as per CPHEEO norms. It is also estimated that the industrial demand of water supply is about 20 MLD. The present gross water supply to the city is 190 MLD. The present net per capita supply of water is about 150 LPCD.

The future demand for water supply is also being under the 4th Stage of water supply Scheme to Mysore City at a cost of Rs. 31.47 Crores. The demand of additional 50 MLD water requirement of 2011 population will be met under phase I of the scheme and a further demand of 100 MLD of water for the 2026 population will be met under phase II of the scheme.

As per the topography of Mysore City, the present sewage system in Mysore City comprises five main drainage areas (also called drainage districts) covering an area of about 100 Sq. KM. At present, the sewage generated is drained into three sewage treatment plants. The five drainage districts are named as A, B, C, D and E. The sewage
collected from the outfall sewers of A and D drainage districts is treated at the common
treatment plant at ‘Rayanakere near HD Kote Road’. The sewerage from drainage district
B is treated at the treatment plant at ‘Vidyaranyapuram’ and sewage from the drainage
district C is treated at plant located in ‘Kesare’

All the outfall sewers are designed for the 2026 population of 17.00 Lakhs. The
sewage treatment plants of A, D & C drainage districts are designed for the population of
2011 and the sewage treatment plant of B district is designed for the ultimate population
of 2026 as the area coming under this district is already fully developed.

7.5.7 Obstacles Encountered in Land and Environmental Issues during the
Launching Stage of STP Project at Vidyaranyapuram in Mysore

The environmental and socio-economic impacts of a sewage treatment plant may
prove adverse during the operational stage. During the launching stage of STP Project in
Vidyaranyapuram in Mysore during 1998 the cattle owners residing in Mysore opposed
to the implementation of STP Project since the land of 80-100 acres earmarked for the
STP project was for ages serving the cattle owners by cultivating grass. The cattle owners
regularly purchased the grass grown on this land from Mysore City Corporation by
paying 45 paisa per kilogram. The cattle owners all of a sudden felt that their cattle
would be deprived of grass if the plant is constructed on this land. Although, the land
belonged to Mysore City Corporation, the cattle owners started agitation against the STP
project.

The grass on this entire land is managed by Mysore City Corporation. It is grown
by feeding the raw sewage water which was flowing by gravity to this area.
Notwithstanding the fact that the grass grown using raw sewage water is harmful to the
cattle and also the human being consuming the cattle milk, these cattle owners went to
court and lodged a case against construction of plant on this land.

The Mysore City Corporation fought the case in the court putting forward the
need for immediate measures required to be taken up to protect the environmental
hazards due to untreated raw sewage water and won the case against the cattle owners and in due course after more than a year, the STP project was started.

The project was delayed by more than a year in the process and construction started in the year 1999-2000.

7.5.8 Analysis of Sewage Characteristics by conducting Laboratory Tests

The characterization of wastes present in the sewage helps in the selection of treatment method for an effective and economical sewage management.

In order to assess the sewage characteristics of both raw and treated sewage of STP, the researcher took the samples of raw and treated sewage water to the laboratory for testing and analysed the samples. An analysis was made based on the test reports obtained to assess whether the treated sewage water is within permissible limits or not. The following laboratory report explains the kind of range and permissible limits for different sewage characteristics. The reports helped me in assessing whether the treatment method selected is appropriate.

The standard permissible limits as per the environmental(Protection) Act-1986 are given in the following table.

Table 7.8: Standard Limits for the Required Parameters of Waste Water as per Environmental(Protection) Act, 1986, Rule 3A under Schedule VI

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Parameter</th>
<th>Unit</th>
<th>Standard as per Environment Act(1986)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>pH</td>
<td>Value</td>
<td>5.5-9.0</td>
</tr>
<tr>
<td>2</td>
<td>Bio-Chemical Oxygen Demand(BOD)</td>
<td>Mg/L</td>
<td>Below 30</td>
</tr>
<tr>
<td>3</td>
<td>Chemical Oxygen Demand(COD)</td>
<td>Mg/L</td>
<td>Below 250</td>
</tr>
<tr>
<td>4</td>
<td>Total Solids(TS)</td>
<td>Mg/L</td>
<td>Below 2100</td>
</tr>
<tr>
<td>5</td>
<td>Total Dissolved Solids(TDS)</td>
<td>Mg/L</td>
<td>Below 2100</td>
</tr>
<tr>
<td>6</td>
<td>Chloride</td>
<td>Mg/L</td>
<td>Below 400</td>
</tr>
<tr>
<td>7</td>
<td>Nitrate</td>
<td>Mg/L</td>
<td>Below 45</td>
</tr>
<tr>
<td>8</td>
<td>Total Suspended Solids</td>
<td>Mg/L</td>
<td>Below 600</td>
</tr>
<tr>
<td>9</td>
<td>Dissolved Phosphates</td>
<td>Mg/L</td>
<td>5.00</td>
</tr>
</tbody>
</table>

To assess the characteristics of raw sewage water, the researcher undertook the analysis of the samples of raw sewage water in the lab.
The table 7.9 illustrates the raw sewage water analysis report at STP-B drainage district conducted on 19/2/2005 and 26/2/2005.

**Table 7.9: Raw Water Analysis Report of STP-B**

<table>
<thead>
<tr>
<th>Date</th>
<th>Sampling Location</th>
<th>BOD5 Mg./L</th>
<th>COD Mg./L</th>
<th>TS Mg./L</th>
<th>TDS Mg./L</th>
<th>TSS Mg./L</th>
<th>Chlorides Mg./L</th>
<th>Nitrates Mg./L</th>
</tr>
</thead>
<tbody>
<tr>
<td>19/2/2005</td>
<td>MCC1 Inlet</td>
<td>250</td>
<td>300</td>
<td>1650</td>
<td>1520</td>
<td>130</td>
<td>210</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>MCC2 Inlet</td>
<td>250</td>
<td>298</td>
<td>1640</td>
<td>1520</td>
<td>120</td>
<td>210</td>
<td>17</td>
</tr>
<tr>
<td>26/2/2005</td>
<td>MCC1 Inlet</td>
<td>248</td>
<td>298</td>
<td>1648</td>
<td>1516</td>
<td>132</td>
<td>210</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td>MCC2 Inlet</td>
<td>247</td>
<td>299</td>
<td>1640</td>
<td>1518</td>
<td>122</td>
<td>208</td>
<td>17</td>
</tr>
</tbody>
</table>

The researcher also undertaken the study of samples of treated sewage water for laboratory analysis to assess the quality of water for safe disposal. Following table illustrates the laboratory analysis report of the treated sewage water.

**Table 7.10: Laboratory Analysis Report of Treated Sewage Water of STP-B**

<table>
<thead>
<tr>
<th>Date</th>
<th>Sampling Location</th>
<th>pH (5.5-9.0)</th>
<th>BOD5 Mg./L Below 30</th>
<th>COD Mg/L Below 250</th>
<th>TS Mg/L Below 2100</th>
<th>TDS Mg/L Below 2100</th>
<th>TSS Mg./l Below 30</th>
<th>Chlorides Mg./l Below 400</th>
<th>Nitrates Below 45</th>
</tr>
</thead>
<tbody>
<tr>
<td>26/3/05</td>
<td>MCC1 MCC2</td>
<td>8.5-8.3</td>
<td>20/18</td>
<td>80/70</td>
<td>930/530</td>
<td>902/505</td>
<td>28/25</td>
<td>85/80</td>
<td>5/5</td>
</tr>
<tr>
<td>28/3/05</td>
<td>MCC1 MCC2</td>
<td>8.5-8.4</td>
<td>19/18</td>
<td>85/75</td>
<td>928/530</td>
<td>900/506</td>
<td>28/24</td>
<td>89/80</td>
<td>5/5</td>
</tr>
<tr>
<td>29/3/05</td>
<td>MCC1 MCC2</td>
<td>8.4-8.2</td>
<td>19/17</td>
<td>85/78</td>
<td>935/535</td>
<td>905/508</td>
<td>30/27</td>
<td>85/79</td>
<td>5/4</td>
</tr>
<tr>
<td>30/3/05</td>
<td>MCC1 MCC2</td>
<td>8.4-8.3</td>
<td>18/17</td>
<td>80/75</td>
<td>930/532</td>
<td>902/506</td>
<td>28/26</td>
<td>80/75</td>
<td>5/5</td>
</tr>
</tbody>
</table>

Based on the laboratory results obtained above, it is seen that 8 parameters i.e., pH, BOD5, COD, TS, TDS, TSS, Chlorides and Nitrates are within the standard permissible limits after treatment of raw sewage water and is safe for disposal.

Domestic sewage comprises spent water from kitchen, bathroom, lavatory etc. The factors which contribute to variations in characteristics of the domestic sewage are
daily per capita water use, quality of water supply and the type. The municipal sewage which contains both domestic and industrial waste water may differ from place to place depending upon the type of industries and number of industrial establishments.

7.5.9 **Effect of Industrial Wastes**

The sewage characters as described above explain the quality of waste water coming to the treatment plant. The sewage water does not contain the toxic metals and chemicals having adverse effects.

However in certain instances, it is more economical to tackle the industrial waste at the source itself. Where the wastes have a high or low pH, corrective measures are necessary before admitting them to the sewers or the treatment plant. Toxic metals and chemicals having adverse effects on biological treatment processes or upon fish life in a natural water course or render the receiving water unfit as a source of water supply should be brought down to acceptable limits at the source itself. For instance, grease and oil in excessive amounts not only add to the cost of treatment but also pose a disposal problem.

Industrial wastes containing solids which might clog conduits or damage pumping equipment usually require treatment prior to their entry into the sewer. These substances include ash, cinder, sand, mud, straw shavings, metal, glass, rags, feathers, plastics, wood, hair and chemical residues etc. The sewage may look clear in appearance but may contain high dissolved organic and mineral matter adding to the load on the secondary treatment processes and reclamation of water.

The industrial waste water may be discharged into public sewers if the industrial effluents meet the tolerance limits as prescribed by IS:3306-1974. If the waste waters are to be discharged inland surface waters, tolerance limits set by IS:2490-1963 are to be satisfied. For industrial effluents to be discharged on land for irrigation purposes, BIS code IS:3307-1965 should be followed.

Surface water quality considerations include compliance with treated effluent standards at the discharge point with respect to parameters like BOD, suspended and
floating solids, oil and grease, nutrients, coli forms etc. Special consideration may be given to the presence of public bathing ghats downstream. The aquatic ecosystem (including fish) may also need protection in case of rivers through minimum dissolved oxygen downstream, uptake of refractory and persistent substances in the food chain and protection of other legitimate uses to which the river waters may be put.

7.5.10 Technology Selection and Degree of Treatment in the STP Project

The design of process flow sheet involves selection of an appropriate combination of various unit operations and processes to achieve a desired degree of contaminant removal. The selection of operations and processes primarily depends on the characteristics of raw sewage water and required levels of contaminants permitted.

The main contaminants in domestic waste water to be removed are biodegradable organics as usually measured by BOD, suspended solids and pathogens with the first two having been traditionally considered as the performance indicators for various treatment units. It is generally the objective of domestic waste water treatment plant to produce treated effluents having BODS of 30 mg/l or less and suspended solids of 50 mg/l or less for disposal into inland water bodies.

The process adopted in the existing STP is Secondary Treatment Plant. However, the treatment of this nature is decided as initial step considering the financial constraints of treatment. Before proceeding with the design of the treatment plant, the characteristics of the solid waste were analyzed.

Tertiary treatment is adopted when reuse of effluent for industrial purposes is contemplated or when circumstances dictate the requirement of higher quality effluents.

7.6.0 Processes in Sewage Treatment Plant Project

The processes of treatment of sewage are classified as primary, secondary and tertiary. The general yardstick of evaluating the performance of sewage treatment plants is the degree of reduction of biological oxygen demand, suspended solids and Total coli forms. The efficiency of a treatment plant depends not only on proper design and
construction but also on good operation and maintenance. The efficiencies of different treatment plants are given in the table

**Table 7.10.1: Efficiencies of Various Treatment Plants**

<table>
<thead>
<tr>
<th>Process</th>
<th>Percentage Reduction of Suspended Solids</th>
<th>Percentage Reduction of BOD</th>
<th>Percentage Reduction of Total Coli form</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary Treatment(Sedimentation)</td>
<td>45-60</td>
<td>30-45</td>
<td>40-60</td>
</tr>
<tr>
<td>Chemical Treatment</td>
<td>60-80</td>
<td>45-65</td>
<td>60-90</td>
</tr>
</tbody>
</table>
| Secondary Treatment
  i. Standard Trickling Filter   | 75-85                                    | 70-90                       | 80-90                                   |
  ii. High rate trickling filter |                                          |                             |                                        |
       (a) Single Storage          | 75-85                                    | 75-80                       | 80-90                                   |
       (b) Two Stage               | 90-95                                    | 90-95                       | 90-60                                   |
  iii. Activated Sludge Plants  | 85-90                                    | 85-95                       | 90-96                                   |
  iv. (a) Stabilization ponds (Single Cell) | 80-90                                    | 90-95                       | 90-95                                   |
       (b) Stabilization Pond(Two Cell) | 90-95                                    | 95-97                       | 95-98                                   |


Cost is the prime consideration in the selection of treatment method. It should include the cost of installation, capitalized cost of maintenance and operation taking into account interest charges and period of amortization. An alternative will be to consider the annual cost covering amortization and interest charges for the loan obtained for the installation together with the annual operating and maintenance costs. In some cases there is a component of subsidy granted by the Government for the installation of the treatment works and the maintenance cost is borne entirely by the local body or the agency concerned. Many sewerage and sewage treatment projects in Karnataka were launched with the assistance of ADB and World Bank.
Other factors that may influence are ease of construction and maintenance, benefits that accrue from better environmental sanitation, location, availability of land and topographical conditions.

The waste water disposal projects formulated by various agencies at present do not always contain all the essential elements for appraisal. When the projects are assessed for their cost benefit ratio and for institutional or funding purposes, they are not amenable for comparative study and appraisal. Also at times, different standards are adopted by the central and state agencies regarding various design parameters. It is necessary therefore to specify appropriate standards and design criteria and avoid different approaches.

Waste water disposal systems can be either on-site type or the kind water-borne wastes are disposed off-site into a water body or on land. To keep overall costs down, most urban systems today are planned as an optimum mix of the two types depending on various factors.

### 7.6.1 Aerated Lagoons in the B Drainage District of Mysore City

Aerated lagoons are of two types depending on how the microbial mass of solids in the system is handled. Facultative Aerated Lagoons are those in which some solids may leave with the effluent stream and some settle down in the lagoon since aeration power input is just enough for oxygenation and not for keeping all solids in suspension. As the lower part of such lagoons may be anoxic or anaerobic while the upper layers are aerobic, the term facultative is used.

In the present STP, the sewage is treated in facultative aerated lagoons and further in sedimentation basin. The raw sewage is detained in the lagoons for five days. The mechanical aerators transfer the oxygen from atmosphere so as to prevent production of foul smell. The treated sewage from the lagoons is allowed to collect at the sedimentation basin and detained for one day before it is discharged to the natural valley/tank.
Aerobic lagoons on the other hand are fully aerobic from top to bottom as the aeration power input is sufficiently high to keep all the solids in suspension besides meeting the oxygenation needs of the system. No settlement occurs in such lagoons and under equilibrium conditions, the new solids produced in the system equal the solids leaving the system.

The dimension of each aerated lagoon is 150mx300mx4.50m with a capacity to treat 67.65 mld of sewage. There are 18 aerators with 20 HP capacity. The detention period of water in lagoons is 5 days. In the process of treatment, both aerobic and anaerobic reactions take place. The aerators supply the oxygen to water up to a depth of 2.00 M and beyond 2.00 M depth anaerobic reactions take place and in the process the sludge and solids settle down at the bottom. About 87 percent BOD removal and 87 percent suspended solids are removed. The remaining 6 percent of BOD and Suspended solids are removed in the sedimentation basin. The water is treated to the extent of 93 percent.

There is screen chamber to at the entrance of sewage to remove things like plastics, rubber, paper and any such materials. Both options are provided for mechanical and manual screening.
The grit that comes along with sewage will settle down to the bottom in grit chamber. The division box separates the raw water to flow equally in both the lagoons.

Facultative type aerated lagoons have been more commonly used the world over because of their simplicity in operation and minimum need of machinery. They are often referred to simply as aerated lagoons.

**Table 7.10.2: Some Characteristics of Facultative Aerated Lagoon**

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Detention time (days)</th>
<th>Depth (m)</th>
<th>Land required Sq. m/person</th>
<th>BOD removal efficiency %</th>
<th>Suspended solids (SS) Mg/L</th>
<th>Desirable power level Watts/Cu. M</th>
<th>Power requirement Kwh/pers on/year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Facultative aerated lagoon</td>
<td>3-5</td>
<td>2.5-5.0</td>
<td>0.15-0.30</td>
<td>80-90</td>
<td>40-150</td>
<td>0.75</td>
<td>12-15</td>
</tr>
</tbody>
</table>

The power level in the facultative aerated lagoons has to be adequate only to diffuse dissolved oxygen uniformly in the system; no effort is made to keep the solids in suspension. Hence, a minimum power level of 0.75 Watts per cu.m lagoon volume should be adequate. This should be checked with equipment supplier for its oxygenation characteristics and compatibility with proposed depth and shape of lagoon.

For treating domestic sewage, the power requirement varies from 2-2.5 HP per 1000 population equivalent. Spacing of aerators should be adequate for uniform aeration all over the lagoon area without much overlap of the circle of influence of adjoining aerators as specified by the manufacturers.

In winter, the BOD removal can be possible below 30-40 mg/l. At other times of the year BOD less than 30 mg/l. may be possible. This range of BOD is more than adequate for irrigational purposes, but for river disposal the applicable standards should be ascertained and design made accordingly. Where necessary, further reduction of BOD can be achieved either by a small increase in detention time or by more efficient interception of solids flowing out by provision of an additional treatment unit.
7.6.2 Sedimentation

The sedimentation basin as constructed is shown in the Photo. The purpose of sedimentation of sewage is to separate the settleable solids so that the waste water if discharged into water courses, does not form sludge banks and when used for land disposal does not lead to clogging of soil pores and excessive organic loading. Sedimentation is used in this treatment plant to remove (1) inorganic suspended solids or grit, (2) organic and residual inorganic solids, free oil and grease and other floating material, (3) bio-flocculated solids or bio-flocs from effluents, (4) chemical flocs.

The removal of contaminants is brought by a sequencial combination of various physical unit operations and chemical and biological processes. The physical unit processes include screening, grit removal, and sedimentation. In the existing STP, the chemical processes including chemical coagulation followed by flocculation are not used for treatment as the waste water is predominantly domestic in nature.

Sedimentation of domestic sewage in the present STP accomplish 30-45 percent removal of BOD and 45 to 60 percent of SS depending on concentration and characteristics of solids in suspension. Secondary settling tanks, if considered independently, remove a very high percentage of flocculated solids, even more than 99 percent. The BOD is reduced from 300 mg/l to 20 mg/l and suspended solids from 400 mg/l to 30 mg/l.

Figure 7.5: Sedimentation Basin
7.6.3 Sludge Accumulation

Sludge accumulation occurs at the rate of 0.03-0.05 cu.m per person per year as in the case of oxidation ponds and is manually removed once in 5 – 10 years and used as good agricultural manure. The depth of the lagoon may be increased a little to allow for sludge accumulation if required.

The greatest advantage with aerated lagoons lies in their simplicity and ruggedness in operation. The only moving piece of equipment being the aerator. Civil construction mainly entails earthwork and land requirement is not excessive. The overall efficiency of the sewage treatment plant is 93 per cent.

7.6.4 Cost Benefit Analysis

The return on the huge capital investment of Rs. 10.37 crores including the regular operation and maintenance cost of Rs. 7 Lakhs per year can not be simply measured in terms of monetary returns as the social benefits that are accrued on account of STP project in protecting the environmental pollution, health and cleanliness of the city are intangible to measure. There are multiple benefits from the STP which can be classified into primary, secondary and long term benefits. The example of primary or immediate benefit is that the health hazards due to untreated openly flowing raw sewage is prevented. The treated water will be used for lawn watering, gardening and industrial use tree plantation etc., across the entire Mysore city. The effect of treatment of sewage water could be that the farmers who were earlier using the raw water are now using treated sewage water for agriculture and irrigation which will prevent the contamination of vegetables and crops. The secondary effects may be recharging of ground water in the vicinity of treatment plant. The other benefit can be production of bio-gas from the STP effluent for domestic and industrial use.

Table 7.10.3: Cash Flow Statement of STP from 1999-2005.

<table>
<thead>
<tr>
<th>Year</th>
<th>Capital Cost(Rs.)</th>
<th>Maintenance Cost(Rs.)</th>
<th>Income from the STP(Rs.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1999-2002</td>
<td>10.31 Crores</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>2002-2003</td>
<td>-</td>
<td>72 Lakhs</td>
<td>-</td>
</tr>
<tr>
<td>2003-2004</td>
<td>-</td>
<td>72 lakhs</td>
<td>1 lakh per annum from Fish Tendering</td>
</tr>
<tr>
<td>2004-2005</td>
<td>-</td>
<td>72 Lakhs</td>
<td>1 lakh</td>
</tr>
</tbody>
</table>
From the above table, it is clear that the return in monetary terms is almost negligible during the last 2 to 3 years. The Mysore City Corporation, the owner of the STP has to evolve mechanisms for generating monetary returns at least for meeting the regular maintenance and operation cost. The options could be (1) Judicious charging of farmers who are using the treated water for irrigation, (2) supplying treated water to industries, Zoo, Race course, Golf Course, and all other institutions maintaining gardens, lawns and plantation by collecting user charges.

7.6.5 Social Cost Benefits from the STP Project

- The pollution due to untreated sewage water in the city is now eliminated
- The greatest benefit from the STP project is that the treated water is used for irrigation purposes by the farmers.
- The ground water recharging around the Dalwai tank by constantly flowing treated water to the tank.

The researcher interviewed 10 farmers in the vicinity of the plant located on the bank of Dalwai tank (Natural Water Tank) on the usage of the treated sewage water. These farmers are using the treated sewage water for irrigating the coconut plants, vegetables, paddy etc. These farmers were using the raw sewage water prior to the installation of the plant. They expressed that the stinking smell level has come down. Earlier, they were using the Dalwai tank water which was mixed with inflow of raw sewage water. They said that the quality of vegetables was not good when they were using such water. For them, earning livelihood and income from farm output is more important than the quality as they are dependent on the farm produce. Now, with the treated sewage water being used for irrigation they have the feeling of healthy and hygienic farming. When asked about the health hazards and consequences of using raw sewage water, most of them although expressed on the minor health problems, were not so serious about the consequences.

7.6.6 Effluent Disposal and Utilization and Strategy Required to Generate Income from the Treated Water.

At present, the treated water from the STP is allowed to flow to a natural tank called ‘Dalwai’ on Mysore-Nanjangud road. Farmers are using treated water from the
Dalwai tank for irrigation. The coconut farms, sugar cane crops, paddy fields, mango plants, vegetable farms etc., are using this water in large quantity. But, the Mysore City Corporation is not collecting any user charges from these farmers or owners of these farms.

The only marginal income from the STP at present is from the ‘Fish Pond’. The treated water from the aerated lagoons directly flows to the sedimentation tank having an area of 3.5 acres. It is also called as fish pond as it is used for growing fish. Every year, the fish grown in this pond are auctioned and the income accrued is about Rs. 1 Lakh per annum.

The researcher has noted that the plant requires regular maintenance expenditure to the tune of Rs. 6-7 Lakhs per month. Therefore, the MCC needs to evolve a long term income generating strategy by marketing the treated sewage water to different clients namely; (1)farmers by collecting the user charges since they are at present using the treated water free of cost, (2)Industrial reuse, (3)Re-use in agriculture and horticulture, watering of lawns in important organizations like ATI, Race Course, Golf course, Zoo Garden and such purposes. As during the summer season, majority of the industries and gardens face scarcity of water in Mysore. There is a large demand for this water. The Mysore City Corporation has to initiate laying the pipelines and pumping of this treated water to all these clients across the entire Mysore City.

The present method of collecting only one time underground drainage(UGD) connection charges to the households and other establishments needs to be reviewed and if possible, regular monthly minimum UGD charges based on proper pricing mechanism needs to be evolved by the Mysore City Corporation to sustain the STP operation and maintenance. The billing can made along with with regular water bills for easy collection. It should be noted that if the sewage effluent is to be discharged into the inland surface waters, tolerance limits prescribed by IS:4764 should be followed.
7.6.7 Operation and Maintenance of STP

The construction was completed in the year 2002 and project was started functioning. As per the contract agreement, the Batli Boi company maintained the plant by providing its maintenance staff and also the repairs and replacement of materials for one year period 2002-03. During the year 2003-04, the maintenance part of Batli boi was limited to replacement of parts/materials only and the service of maintenance staff was provided by the Mysore City Corporation. From the year 2004 onwards, the entire maintenance was handed over to the Mysore City Corporation who is the owner of the STP.

The primary aim of sewage treatment plant operation is the running and maintenance of plant, efficiently and economically so that the effluent from the plant meet the prescribed standards in terms of BOD/COD/SS/pH etc., laid down as per the rules of Environmental Protection Act and the statutory body such as Karnataka Pollution Control Board while discharging the effluent safely in public sewer, on land or in the water body.

Maintenance comprises those operations which are well planned systematic programme of maintaining the machinery by taking appropriate steps to prevent breakdown well in advance before it causes major damage. This prevents wastage of time, production loss and prolongs the life of machine. This maintains better efficiency in the system and economizes the running cost of the plant. It can be classified as (a) preventive maintenance which constitutes works and precautions to be taken to prevent breakdown and (b) corrective maintenance which involves carrying out repairs after breakdown. Preventive maintenance is more economical than corrective maintenance and provides uninterrupted service which is essential to achieve the basic objectives of treatment, viz. protection of health of community and prevention of nuisance.

Proper maintenance does not start at repairs and maintenance but starts right at the time of planning, selection and the installation of machinery. In fact much of the preparation starts at the planning stage itself. If due care is not taken in properly forming
specification and selection, then it results in poor performance and frequent damage to the machinery.

The operating costs after start up of the plant include direct operating costs and fixed costs.
The direct operation and maintenance costs basically include the costs on;
- Staff
- Chemicals
- Fuel and Electricity
- Transport
- Maintenance and Repairs
- Insurance
- Overheads

And the fixed costs basically comprise of amortization and interest charges on capital borrowings.

In the STP at B drainage district area of Mysore, the following 21 employees are working as maintenance staff appointed through private contract and these employees do not belong to Mysore City Corporation. The cost of these 21 employees is estimated at Rs.50,000 per month is met out by the Mysore City Corporation. The Electricity Bill is Rs. 4 to 5 Lakhs per month

**Maintenance Staff**

<table>
<thead>
<tr>
<th>Role</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engineer</td>
<td>1 no.</td>
</tr>
<tr>
<td>Mechanic</td>
<td>1 no.</td>
</tr>
<tr>
<td>Helper</td>
<td>5 nos.</td>
</tr>
<tr>
<td>Operators</td>
<td>6 nos.</td>
</tr>
<tr>
<td>Watchman</td>
<td>2 nos.</td>
</tr>
<tr>
<td>Sweepers</td>
<td>3 nos.</td>
</tr>
<tr>
<td>Chemist</td>
<td>1 no.</td>
</tr>
<tr>
<td>Chemist’s helper</td>
<td>1 no.</td>
</tr>
</tbody>
</table>

**Total** 21

In addition, there are also the employees deputed from Mysore City Corporation and the details are given below;

1. Cutters 6 nos.
2. Sweepers 2 nos.
3. Watchmen 3 nos.

**Total** 11 nos.
These 11 employees are permanent staff of Mysore City Corporation. The salary expenditure of these 11 employees estimated at Rs. 50,000. The total maintenance cost of STP at present is estimated at Rs. 6 to 7 Lakhs per month.

The researcher assessed the maintenance procedure followed in the STP for each of the treatment units such as screens, Grit Chamber, Aerators, lagoons, sedimentation basin, building and equipment. The personnel working in the plant are all on duty. For example, on the surface of some of the aerated lagoons and a part surface of the sedimentation basin was covered with floating materials and corners and sides with algae. All these weeds and vegetation should be removed by suitable implements. The overall cleanliness is maintained well in the plant. Mosquito and fly breeding should be prevented by removing all weed growth and vegetation.

As already, a huge land to the extent of 100 acres has been utilized to grow grass by the side of the plant. The farmers have been buying the grass since years. The treated water will now be used to grow this grass instead of raw sewage water.

7.6.8 Safety of the Plant and Workers

The work of an operator in a sewage treatment plant presents many hazards that must be guarded against. Common type of accidents are injuries from falls, deaths from drowning and asphyxiation. Narrow walks or steps over tanks(particularly in darkness, rains and wind), ladder etc., are potential danger spots where the operator should be alert; overexertion during operation of valves, moving weights and performing other tasks should be avoided. Adequate lighting within the plant and around the plant should be provided which gives better working facility reducing accidents on account of slipping etc.

The staff need training and should be compelled to use helmets, gumboots, hand gloves etc. It is also required to display sign boards drawing attention to the potential danger spots.
A first aid kit and fire extinguishers are required to be provided in the plant. Adequate number of toilets and bathing facilities, drinking water facilities for the convenience of operating staff and protection from risk of infection.

All workers should be compelled to observe personal hygiene such as washing with soap after work as well as washing before taking food. The use of antiseptics along with washing should be emphasized. The employees should be medically checked after every six months specially for eye sight, hearing, indigestion, mental capability, TB, Diabetes, heart troubles etc.

7.6.9 Training of Operating Staff

All operating staff engaged in technical and skilled work should be trained. At present in the STP, an engineer having sufficient experience in the sewage treatment is in charge of supervision. It is desirable that the STPs are maintained by operators who hold certificates of competency. The operating staff should undergo training and refresher courses from time to time to keep themselves conversant with the latest technological advances in the field. The staff should also be encouraged by sending them to other similar plants.

7.6.10 Sewage Treatment Plant Laboratory

A well designed and adequately equipped laboratory with a trained Chemist has been provided in the STP. The laboratory has the facility to conduct daily tests of the sewage water and monitor the quality of treatment. The facility analysis of BOD, COD, SS, TDS, Nitrates, Phosphates, pH etc., are provided in the laboratory and daily reports are produced in the STP.
### 7.7.0 Assessment of Project Parameters as per the Evaluation Model

**Project Concept and Objectives of the project**

- Social Survey
- Demand survey of the requirement
- Engineering Survey

**Preparation of Project**

- Role of Government
- Role of ULB
- Role of State level agency
- Role of Consultant
- Role of Contractor
- Role of Community

**Appraisal**

- **Technical Appraisal** to determine whether the technical parameters are soundly conceived, realistic and technically feasible.
- **Financial Appraisal** to determine whether the financial costs and returns are properly estimated and whether the project is financially viable.
- **Institutional Appraisal** to determine whether the implementing agencies are capable for effective implementation, monitoring, and evaluation of the scheme.
- **Environmental appraisal** to see any detrimental environmental impacts and how to minimise the impacts.

### Technical Appraisal

- Feasibility
- Specifications
- Technology options
- Quality and durability
- Standards
- Designs etc

### Financial Appraisal

1. Loans/Grants
2. Own Sources
3. Subsidies
4. Capital investment
5. O&M investment
6. Cost-Benefit analysis
7. Cost Recovery Mechanism
8. Repayment of Loans

### Legal Appraisal

- Legal documentation

### Social Appraisal (Social cost and benefits, target group)

### Project Execution

- Tendering
- Contractor
- Schedule
- Target
- Procurement of materials/equipment
- Performance
- Payments
- Likely hurdles
- Scope etc

### Monitoring and supervision

- Progress reports
- Site Inspection
- Cost and Time Control
- Deviations
- Completion Reports

### Project Evaluation Documentation

- Project study
- Project performance

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1. **Project Concept:** The Mysore City Corporation conceived the project together with Karnataka Urban Water Supply and Drainage Board. The city being the second largest in the state had no treatment plant for the sewage effluent. As a result, the sewage was flowing in the storm water drains and was finally receding at natural water tanks in and around the city polluting the natural water tanks and ground water and surrounding environment. Foul smell and insanitary condition were the features in and around the city as the untreated sewage used to accumulate. This project came to the rescue of the city’s sanitary condition.

2. **Project Objective:** The objective of the STP project was to treat about 67.5 mld sewage effluent up to secondary treatment in the B-drainage district of Mysore city.

3. **Social Survey:** There was resistance and litigation in the court by the public particularly the farming community and cattle owners who were dependent on the grass grown on the land of about 80 to 100 acres earmarked for the project. The project was delayed by more than one year due to the litigation. The land belonged to the city corporation.

4. **Demand Survey:** There was a visible deterioration in the environment and degradation of quality of natural water tanks and ground water sources due to the disposal of untreated sewage effluent. The City Corporation was waiting for the funds to go ahead with the project.

5. **Engineering Survey:** A detailed engineering survey was done by the Dalal Consultants and Karnataka Urban Water Supply and Drainage Board. The topographic map of Mysore city was prepared under the project indicating five drainage districts and location of sewage treatment plants. Based on the topography of the land, the treatment plants were located and the land was earmarked. The location of STPs was chosen in such a way that the sewage effluent from the drainage district/areas flow by gravity through the sewer network.
6. **Preparation of project:** The Dalai Consultants, a private consultancy firm was appointed to provide the consultancy support and prepare the project. The Karnataka Urban Water Supply and Drainage Board (KUWS & DB) was to supervise and monitor the project and provided technical inputs in the preparation of the project. The Corporation helped in the survey and location of land and plant. The technical inputs and designs were prepared by the Dalai Consultants.

7. **Roles of various agencies:** The institutional framework for implementation is given under para 7.5.3. As discussed with officials of these agencies, the roles were clearly defined and each performed their roles.

8. **Technical Appraisal:** The Dalai Consultants who were appointed for the consultancy support assessed various technical options and designed the plant. They finally decided to go for the aerated lagoons and sedimentation basin i.e., up to secondary treatment considering the cost and funds available for the project. In this project, pumping of sewage effluent into the aerated lagoons is totally avoided thereby saving in the energy.

8. **Financial Appraisal:** Adequate financial appraisal in terms of returns on investment was not done. This is evident from the fact that the plant is not yielding any revenue except a small amount by auctioning fish grown in the sedimentation basin (Rs.2 lakhs approximately per annum). The City corporation has to repay the ADB loan of Rs.10.37 crores and also meet the monthly operation and maintenance expenditure to the extent of Rs. 6.0 Lakhs. There is a potential to generate revenue by selling treated sewage effluent to various agencies such as zoo, race course, golf course, road side gardens, industries etc. This needed to explored and the necessary laying of pipelines, pumping stations etc., need to be worked out.

9. **Environmental Appraisal:** Although, the secondary treatment ensures safe disposal of municipal domestic sewage. It needs to be constantly monitored since
the chances of industrial and hazardous sewage might be let into the municipal sewers. Even with current treatment, the oils, grease other industrial substances will not be treated. The ground water pollution, water quality of bore wells, agricultural produce need to be constantly monitored. The location of the plant is appropriate. At present the treated sewage effluent is let into a natural water tank which again needs to be monitored.

10. **Social Appraisal:** The social benefits and costs are assessed under para 7.6.5.

11. **Project Execution:** The project was executed as per the performance standards and designs. Initially there was delay due to land litigation in the court. But, the corporation won and managed the successful execution. The project was executed by the Batli Boi company as per the contract agreement.

12. **Project Monitoring and Supervision:** Execution of project was monitored by Dalal Consultants, Karnataka Urban Water Supply and Drainage Board and the City Corporation. The quality, performance and progress were regularly monitored during each stage of the project. The Batli Boi has to maintain the project for a period of initial two years at its own cost and then hand it over to Mysore City Corporation for regular maintenance there on. At present, the Batli Boi staff are deployed on the plant. Except a few problems such as break down of the mechanical screening equipment, the plant is maintained well. The maintenance staff are provided with housing near the project. The laboratory is maintained well with a chemist working full time. The cutting of grass, removal of solid wastes are removed regularly.
7.7.1 Findings, Conclusions and Recommendations

- Tertiary treatment can be adopted in order achieve higher quality of effluents, but cost is the prime consideration in the selection of the treatment method.

- The extent of mechanization adopted in the present STP is the minimum possible and also the operating equipment and its ancillary control equipment is easy to operate and maintain with indigenously available spare parts.

- At present, there is no system for methane gas collection, scrubbing to remove hydrogen sulphide wherever necessary and its conversion to electricity as it requires a high level of operation and maintenance skills.

- The option of gas collection from the STP and supplying to nearby industries which are at present located within half a kilo metre could be initiated.

- The present STP satisfies the removal of BOD, nitrogen and phosphorous, coli forms, helminthes etc.

- The overall cost of both capital and operating cost have to be determined in order to arrive at the most optimum solution and selection of technology.

- The social issues related to land acquisition for the project need to be assessed and resolved before launching the project as otherwise they hinder the progress and delay or even halt the implementation of project.

- At present the raw sewage is treated up to secondary treatment, but the industrial waste contain hazardous elements which can be treated only by tertiary treatment by bio-chemical treatment.

- The Dalwai natural tank which receive the treated sewage water now may pollute the ground water of the surrounding area, tube wells/open wells. This aspect requires greater examination by the Municipal Corporation and has to initiate suitable remedial measures.

- Much of the land except grass cultivated land surrounding the treatment plant is now lying idle. This land could be developed as bio-diversity park.

- The solid and sewage waste water plants are located side by side in Vidyaranyapuram area of Mysore, From the field observation, it is seen that solid wastes such as plastic
and other debris was flying into the sedimentation basin, MCC has to construct high
wall compound between both the plants.

The next chapter deals with the study of Tumkur City where in the formulation and
implementation of projects under the scheme of Integrated Development of Small and
Medium Towns were taken up for the research. The projects were implemented during
80s but no attempt has been so far to assess the impact of the projects. The researcher
therefore took up the study.