3. The Proposed Project

3.1 Preliminary considerations

As a result of the growing problems of wastewater management in Auroville and particularly in the Industrial Zone, several possibilities strategies for wastewater management had been evaluated by those concerned with planning in the area. The points indicated below led to the conclusion that a common treatment of effluents through small to medium-scale decentralized wastewater treatment systems (DTS) should be investigated.

Current state and trends of development
Considering that the Industrial Zone has been earmarked for production and commercial activities and that the number of commercial activities in Auroville has grown significantly in the last few years and is expected to grow even more in the near future, it was found that at this point of time strategies to manage in a concerted manner the wastewater that would be produced in the area would be preferred. This was based on the considerations that:

1. Commercial and production activities vary constantly in time and so would the amount of wastewater that would be produced by such activities. Individual treatment plants for each production or commercial unit would not be able to handle such variations as treatment plants are designed for pre-determined amounts of wastewater flow. By collecting jointly the wastewater from several units these variations are reduced. Moreover, production units may change the type of their production (for example a food processing unit may shift or close down and a tailoring unit may take over the space and related infrastructure) and therefore the nature, quality and quantity of wastewater produced by such a unit would also change. Thus, by combining the wastewater from different sources evenness of flow and quality can be more easily maintained thus allowing the optimisation of the wastewater treatment system.

2. Shared infrastructure is more cost-effective to built, operate, maintain and monitor.

Therefore, taking into consideration the development strategy and the infrastructure requirements of the area, it has been concluded that at this point of time it would be appropriate and advisable to investigate the treatment of wastewater in the industrial zone collectively in a CETP.

Location of units
The up-coming units in the area are not anymore spread out in such a way so as to make it disadvantageous to collectively convey the effluents into a common drainage system. On the contrary, all of the units in the area are grouped within a distance of a hundred metres or so.

Therefore it was found that the location of the various units is suitable for the connection of all the units to a common drainage network. Thus connecting all the units to a CETP through a common drainage network is practicable and desirable.

Topography
A survey conducted by the Auroville Surveying Department shows that the topography of the concerned industrial area is ideal for draining wastewater solely by gravity. Thus it was found that wastewater could be conveniently drained to a CETP in this area.

Environment
Much of the Industrial Zone is in the vicinity of the groundwater recharge zone of the first acquifer and therefore extra care should be taken so that polluted water doesn't enter that zone. Moreover, the wells in the Industrial Zone don't yield large amounts of water and therefore increased demand of water would result in water shortage. Therefore, the protection and conservation of limited freshwater resources as well as the re-use of wastewater has been of primary importance and consideration as this approach would both reduce any risks of environmental and groundwater pollution and decrease the dependency on groundwater for non-potable uses of water (such as irrigation, cleaning of open spaces, etc.).

In addition to fulfilling the infrastructure requirement, this proposal also seeks to implement systems and technologies that are suitable and appropriate for the prevailing physical, environmental, social and economic conditions present at the project site. Thus concepts for systems and technologies that adhere to the principles of resource optimization and sustainable development have been developed and proposed here. In particular it has been ensured that the proposed systems and technologies meet the following criteria:

- Minimum dependency on complex infra-structure services and systems,
- High self-sufficiency in respect to operation and maintenance of systems,
- Low vulnerability to degradation and destruction,
- Can accommodate significant variations in hydraulic and pollution loads without significant loss of efficiency,
- Can handle a large variety of pollutants present in today's wastewater,
- High efficiency in treatment of wastewater – up to tertiary treatment and removal of pathogens,
- No or limited use of mechanical parts,
- Use of simple hardware.
- Minimized inputs of energy,
- No use of chemicals for the treatment process,
- No skilled manpower required,

- Low long-term capital, operation and maintenance costs,
- Applicable at any site and scale.
- Allows phasing of systems,
- Can be easily and cost-effectively expanded to accommodate increased loads,
- Simple construction,
- Use of appropriate and suitable materials,
- Use of indigenous materials and building technologies to the maximum extent,
- Reduction of sludge production (in the rootzone treatment process no sludge is generated, therefore the sludge handling and disposal problem is restricted only to primary and secondary sludge).
- Allows re-cycling and safe re-use of waste water,
- Allows recovery and reuse of useful by-products also at or nearby the site (e.g. fertilizer and compost),
- Achieves conversion of wastes into re-usable high quality by-products,
- Allows complete utilization of all possible waste resources,
- Ensures a proper final destination for any type of residues,
- Long life span of system,
- Large re-use of materials when system is decommissioned,
- Prevents environmental pollution problems in particular pollution of air, water and soil,
- Ensures environmental protection,
- Enhances or maintains the quality of the surrounding environment (e.g. root zone treatment systems enhance bio-diversity by creation of a wetland ecosystem),
- High public participation and acceptability to all social players.

3.2 Wastewater Treatment and Re-use Systems

While at present the wastewater production has been estimated to have a hydraulic load of 125 PE and a pollution load of 220 PE, resulting in a maximum load of 220 PE, for planning purposes it is proposed to consider at this stage a wastewater management system that could cater to a total load of up to 300 PE. The additional 35% capacity is taken into consideration in anticipation of increased loads resulting from either the expected increase of production activities in the concerned production units considered in this study or increase in the number of production units that shall connect to the CETP in the near future.

3.2.1 Description of project components

Overall scheme

The entire wastewater management system for the common treatment of wastewater for re-use consists of seven major components. These are listed below and detailed in drawing no.

1. Wastewater collection and conveyance system to convey untreated wastewater to the CETP by gravity flow,
2. Imhoff Tank (IT) system for the primary treatment and clarification of wastewater as well as digestion of primary sludge,
3. Root Zone Treatment system (RZTS) for the secondary and tertiary treatment of wastewater,
4. Sludge Drying (SD) system for the final treatment of sludge.
5. Storage Tank (ST) system for the storage of treated wastewater suitable for irrigation,
6. Pumping system for the supply and distribution of treated wastewater.
7. Infiltration system for disposal and dispersion of excess treated wastewater.

Wastewater collection and conveyance system

A underground piped wastewater collection and conveyance system shall be used to convey untreated wastewater from the various units to the CETP. The proposed layout of this system is indicated in drawing no.. The proposed wastewater collection and conveyance system is estimated to have a total length of 300 m.

Imhoff Tank system

The Imhoff tank consists of a two-story tank in which sedimentation is accomplished in the upper compartment and digestion of settled solids is accomplished in the lower compartment. The upper compartment contains longitudinal sedimentation chambers in which water flows horizontally. Settled solids pass through an opening in the bottom of the settling chamber and are deposited in the lower compartment for digestion. Anaerobic digestion of the settled solids is accomplished in the digestion chamber. The digestion chamber shall also receive secondary sludge drawn from the Dortmund Tank system.

The digested solids are removed through a sludge drawing mechanism. Gases that are produced in the digester are collected beneath the sedimentation chamber. These gases are either dispersed or can be collected for use as biogas. The entire Imhoff tank system is covered and ventilated.

For the primary treatment and clarification of wastewater as well as digestion of primary and secondary sludge an Imhoff tank is proposed. The proposed Imhoff tank is designed to cater to a PE of 220, a wastewater flow of up to 30 m^3/d with a maximum peak flow of 2.0 m^3/h.

The proposed Imhoff tank will have a sedimentation chamber of 5.6 m3 with a cross-section area 1.9 m^2 and a digester volume of 16.3 m^3. This is is illustrated in drawing no..

Root Zone Treatment System

The Root Zone Treatment system (RZTS) is a sealed filter bed (also known as the reed bed) consisting of a sand/gravel/soil system, occasionally with a cohesive element, planted with vegetation that can grow in wetlands. After removal of coarse and floating material, the wastewater passes through the filter bed where biodegradation of the wastewater takes place. This is illustrated in drawing no..

The functional mechanisms in the soil matrix that are responsible for the mineralization of biodegradable matter are characterized by complex physical, chemical and biological processes, which result from the combined effects of the filter bed material, wetland plants, micro-organisms and wastewater.

The treatment processes are based essentially on the activity of microorganisms present in the soil. Smaller the grain size of the filter material and consequently larger the internal surface of the filter bed higher would be the content of microorganisms. Therefore the efficiency should be higher with finer bed material. This process, however is limited by the hydraulic properties of the filter bed; finer bed material, lower the hydraulic load and higher the clogging tendency. The optimization of the filter material in terms of hydraulic load and biodegradation intensity is therefore the most important factor in designing RZTS.

The oxygen for microbial mineralization of organic substances is supplied through the roots of the plants, atmospheric diffusion and in case of intermittent wastewater feeding through suction into the soil by the out-flowing wastewater. The roots of the plants intensify the process of biodegradation also by creating an environment in the rhizosphere, which enhances the efficiency of microorganisms and reduces the tendency of clogging of the pores of the bed material caused by an increase of bio-mass.

RZTS contain aerobic, anoxic and anaerobic zones. This, together with the effects of the rhizosphere causes the presence of a large number of different strains of microorganisms and consequently a large variety of biochemical pathways are formed. This explains the high efficacy of biodegradation of substances that are difficult to treat.

The filtration by percolation through the bed material is the reason for the very efficient reduction of pathogens, depending on the size of grain of the bed material and thickness of filter, thus making the treated effluent suitable for reuse.

Conversion of nitrogen compounds (nitrification / De-nitrification) occurs due to planned flow of wastewater through anaerobic and aerobic zones.

Reduction of phosphorous depends on the availability of acceptors like iron compounds and the redox potential in the soil.

The proposed RZTS shall be used for the secondary and tertiary treatment of wastewater, particularly for the removal of pathogenic germs. **It should be noted that no other treatment system, without the implementation of additional chemicals or physical processes, can ensure the extensive elimination of pathogenic germs.**

The proposed RZTS shall have an reedbed area of about 600 m^2 consisting of 4 modules, each with an area of about 150 m^2. At the beginning and end of each module and reed bed, wastewater collection and distribution chambers are located.

From past experiences in tropical conditions it has been established that a horizontal filter bed area of about 2 m^2/PE (it should be noted that while the horizontal filter bed area is used as a common and convenient parameter for the dimensioning of RZTS, this is not the only parameter to be considered) is sufficient for the complete secondary and tertiary treatment of wastewater including the removal of pathogenic germs. Therefore, together the four reedbed modules will be able to provide treatment to a load of 300 PE.

It should be noted that to fully cater to the current estimated load of wastewater production, at least three modules or 450 m^2 of reedbed have to setup. The remaining module or 150 m^2 of reedbed can be setup when the wastewater load is found to increase. The above or other suitable phasing strategies could be adopted for the setting up of the RZTS.

Sludge Drying system

The proposed sludge drying system consists of sealed reed beds of about 100 m^2 in which the digested sludge is deposited for dewatering. Digested sludge drawn from the Imhoff tank shall be deposited in this system. With the help of reeds, the digested sludge shall be dewatered and further mineralized. The dried sludge can be composted together with garden wastes and used as manure for horticultural purposes.

Storage Tank system

For the storage of treated wastewater for re-use in irrigation a storage tank of 15.0 m^3 is proposed.

Pumping system

For the supply and distribution of treated wastewater for re-use in irrigation a pumping system is proposed.

Infiltration and disposal system

An infiltration system for disposal and dispersion of excess treated wastewater is proposed. This system shall ensure that further purification of wastewater occurs before it penetrates the surrounding soil and does not result in groundwater contamination.

3.2.2 Area Requirement for CETP

The total area required for setting up the CETP is about 800 m^2. This leaves about 5,000 m^2 of land free for expansion or other uses. This is detailed in the table below.

Area requirement (m^2) for individual components and full CETP.

System	Area required (m^2)
1. Imhoff tank	20
2. Root zone treatment plant	600
3. Sludge drying beds	100
4. Storage and infiltration	80
total	**800**
Space available:	**6,000**
Space for expansion:	**5,200**

3.4 Operation, control, maintenance and monitoring of CETP

In the proposed CETP much emphasis has been given to proposing systems and technologies that require low operation and maintenance (O & M) requirements. Although the proposed systems have reduced O & M requirements, minimum inputs for their upkeep is still required. A brief description of the O & M requirements is described below.

3.4.1 Proposed wastewater treatment system

Imhoff Tank

Digested sludge from the Imhoff tank needs to be regularly drawn from the digester compartment. The amount of sludge that accumulates in the digestion chamber needs to be regularly monitored. Sludge should not be allowed to reach the bottom of the sedimentation (upper) chamber. It has been calculated that when the Imhoff tank is receiving the full designed load of wastewater, sludge will have to be drawn out about every two months. The sedimentation chamber of the Imhoff tank is to be cleaned occasionally. Distribution installations within the sedimentation chamber are to be kept clean in order to ensure an even feed. The sloping walls of the sedimentation chamber are to be kept free from sludge deposits. The floor and sidewalls of the inlet and outlet channels are to be kept clean. Floating material within the settling chamber and the inlet and outlet chambers is to be removed. If the floating material is biodegradable it can be moved to the digestion chamber of the Imhoff tank. The sludge pumping system should be serviced regularly.

Root Zone Treatment system

Distribution installations within the inflow and outflow chambers of the rootzone treatment plant need to be occasionally (once a year initially) inspected and kept clean in order to ensure an even feed. Reeds have to be pruned after they have reached maturity and have flowered.

Sludge Drying

Dewatered sludge should be regularly removed from the drying beds.

Pumping system for the supply and distribution of treated wastewater.

Pumps and valves have to be routinely checked for problems and corrective measures taken accordingly.

3.4.2 Monitoring of water management systems

A record of the operation and maintenance (O & M) of the entire water management system will have to be kept. This will enable a proper and accurate assessment of the performance of the entire wastewater treatment system. The following information along with relevant details should be typically recorded for all influents and effluents:

- Physico-chemical and microbiological data,
- Hydraulic data.

3.5 Implementation schedule

3.5.1 Wastewater treatment and re-use system

The wastewater collection and conveyance system, the Imhoff tank, 450 m^2 of the root zone treatment system, and about 75 m^2 of the sludge drying beds would have to be setup in phase 1 in order to cater to the current estimated wastewater load and achieve full treatment and re-use of wastewater.

According to the treatment efficiency achieved in the root zone treatment system during the initial phases, the installation of this system and other remaining systems may be determined in due course of time.

However, if required the setting up of the rootzone treatment system may be further phased in which case each phase could consist of one module of 150 m^2 each. It should however be noted that if the rootzone modules are overloaded, proper treatment and re-use may not be able to be achieved.