CITY SEWERAGE AND SOLID WASTE MANAGEMENT

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INTRODUCTION

Development of a green city entails the maintenance of ecological balance by taking care of environmental quality, in order to make tne city remain healthy, secure, livable, eco-friendly as well as lovable. The ecological balance if achieved will obviously lead to clean environment and the economic indicators of the people will improve by achieving this dream.

For clean environment in the city three aspects of pollution have to be considered, water pollution, air pollution and noise pollution. The aspects of water pollution and to some extent air pollution are closely related to domestic wastewater termed as sewage and also to the disposal of solid waste from different sources.

STATUS OF SANITATION & SEWERAGE IN INDIA:

As per 2001 census, India's population was 1027 million out of which 285 miilion (27.8%) lived in 5161 towns. Out of this urban population, 37% lived in 35 metropolitan cities and at the rate of about 2.3% population growth in urban areas per year, it is expected that 549 million (41 %) will be living in urban areas by 2021. Considering intermittent water supply for two to six hours, the urban population having access to the water supply worked out to 89% and sewerage and sanitation, 63%. This doesn't indicate the quality of the water supply as well as adequate provision for sanitation if compared with required standards.

The water pollution is closely connected to the generation of sewage and solid waste.

The rapid growth in population and particularly in urbanization has resulted in sharp increase in generation of these two wastes. In India alone, about 19000 million liters of sewage is generated every day of which more than 25% is attributed to class I cities (more than 1 lakh population). Out of generation of this quantity of sewage 13, 000 million liters per day is collected out of which at the most half is treated to some extent(TABLE 1).

TABLE 1

Sr. No.	Name of the river basin	No. of class-I cities	Population	Volume of Wastwater			Volume of wastwater collected (mld)	Parcantage wastwater collected	Wastwater treatment capacity (mld)
				Domestuc (mld)	Industrial (mld)	Total (mld)			
1	Brahmani	1	3,98,864	17.3	NA	17.30	13.0	75	NA
2	Brahmaputra	4	14,15,601	178.88	NA	178.88	91.92	51	NA
3	Cauvery	16	62,12,963	701.90	25.00	726.90	471.48	65	396.10
4	Ganga	103	4,94,76,976	5764.02	48.40	5812.42	4.341.10	69	1618.90
5	Indus	15	41,92,909	624.	NA	624.26	330.46	53	93.80
6	Godavari	25	62,19.320	634.77	NA	634.77	467.76	74	65.40
7	Krishna	27	1,26,59,457	1288.82	25.00	1313.82	1055.50	80	489.00
8	Mahanadi	9	24,76,450	412.88	NA	412.88	321.86	78	86.00
9	Mahi	3	13,11,534	140.60	20.00	160.60	121.80	76	81.00
10	Narmada	4	11,83,593	43.36	NA	43.96	22.20	51	NA
11	Panar	6	971,371	60.70	NA	60.70	43.70	72	12.00
12	Sabarmati	7	3,678,921	614.96	36.40	651.38	532.40	82	471.00
13	Suvarnarekha	2	10,59,883	280.00	NA	280.00	210.00	75	471.00
14	Tapi	8	34,44,041	274.85	NA	274.85	218.35	79	70.00
15	Coastal	29	2,32,75,720	4320.88	231.90	4561.78	3853.05	85	389.10
16	Punjab	10	32,06,603	360.5	NA	360.5	266.3	74	NA
17	Rajasthan	14	49,79,301	763.2	NA	763.2	614.8	81	27.00
18	Non major basin Non-costal	37	74,24,362	903.64	5.00	908.66	525.20	58	639.00
	Total	299	12,81,13,865	16,270.8	391.7	16662.5	11.938.2	72	4.037.20

In terms of nutrients and water availability, economic value of this quantity of domestic sewage has been estimated as Rs. One crore per day. As regards industrial waste water generation, the same is estimated at 10,000 MLD, 40% is from small scale industries. The waste water generated from class I cities and class II (50,000 to 1 lakh population) has also been estimated. The survey also indicate Maharashtra, Delhi, Uttarpradesh, West Bengal, Gujarat are major contributors of domestic waste water (60 to 70%) and only small quatity is reported to be treated. The survey has estimated the waste water quantities for all class I and II cities in India. The nutrient value of this quantity of sewage at N (30 mg / L), P(7.5 mg / L), K (25 mg / L) can be worked out and compared with cost of construction and operation of treatment process of UASB, ASP, TF & OP(TABLE 2). The fact that most of the water bodies in India are already in alarming situation due to very less treatment given to the waste water, the large amount of organic matter & nutrients from waste water is lost and has to be utilized for energy and fertilizer

TABLE 2

DIFFERENT TREAIMENT STEPS

Pollutant	Primary Treatment	Sceondary Treatment Neutralization	Tertiary Treatment
Suspended	Screening Sedimentation	Coagulation Sedimenuation Fillration	
BOD	Sedimentation Coagulation Sedimention	Acitvated Sludge Trickling Filter Methane Fermentaion	Activated Carbon Adsoption Reverse Osmosis Oxidation with Cl_2 of O_2
Oil	Oil Separator	Floatation	
Phenol		Activated Sludge	Activated Carbon Adsorption
Cynide		Decomposition with O_2	Eletrodialysis
Chrome		Reduction and Sedimentation	Ion Exchange, Electrodialysis
Iron		Filtration of Hydroxide	Ion Exchange, Electrodialysis
Heavy Metals		Filtration of Hydroxide or Sulphide	Ion Exchange, Electrolialysis
Chlorine		Neutralisation Alkali of Thiosulphate	Activated Carbon Adsorption
Sulphide		Activated Sludge Chemical Oxidation	Reverse Osmosis
Odor		Activated Sludge Chemical Oxidation	Activated Carbon Adsorption
Colour		Coagulation Sedimentation Oxidation/Reduction	Activated Carbon Adsorption Reverse Osmosis

Removal Efficiency - Primary Treatment <50%, Secondary Treatment 90%, Tertiary Treatment 98-99%

In most of the towns sewage is not properly drained, thereby accumulating within city's premises or outskirts creating unhygienic conditions acting as excellent breeding grounds for mosquitoes and other vectors, resulting wide spread water borne diseases. The situation of sanitation in rural areas is also quite unsatisfactory. The coverage in rural area for individual household latrines as per the national sample survey in 1999 indicated 17.5% rural population using toilets. The growth in this coverage has not been keeping pace with the rural drinking water. Obviously this is because of more concentration on drinking water infrastructure rather than on sanitation.

As per 2001 census a great disparity is noted using rural home toilet as high as 80% in Kerala, 60% in Asam and 9 to 8% in Madhya Pradesh & Orissa. The Maharashtra scores only about 18 to 20%. Thus, it will be seen that sanitation never received priority both in rural and peri-urban areas, except few metropolis. Obviously, this has resulted in pollution of all the water bodies. In fact we have forgotten that direct relationship exists between water, sanitation, health, nutrition and human well being. The consumption of contaminated drinking water, improper disposal of human excreta, solid and liquid wastes, have been major causes of many diseases in country like India leading to high infant mortality rate, high levels of mal-nutrition (69, 41% resp) attributing to vicious cycle of poor sanitation, leading to disease morbidity and poor health indices. For cities to be turned into green cities, this situation requires to be corrected as early as possible. The target in MOO (Johannesburg 2002) have to be seriously taken if vision of green cities is to come in reality.

STATUS OF SOLID WASTE DISPOSAL IN INDIA :-

Keeping green city clean off solid waste is a huge task,' It is difficult to local Governments as well as private sectors, without community participation and required team work. Major objective should be to minimize impact of solid waste on public health, pollution and urban environment with required sustainability. The solid waste clearing involves small items but results big consequences if not designed and handled properly.

The disposal of waste should be financially and environmentally sustainable without polluting water, land & air. The wide spread of dumping of solid waste cannot satisfy these requirements. Hence, composting is environmental friendly disposal method using bio-degradable methods. The sanitary land filling can be environmental acceptable with proper design. The cities giving low priority for solid waste disposal lack of good examples to enable other" cities to follow lack of trained people, are the real hurdles. It is necessary to allow to develop new thoughts to change old damaging methods being followed in solid waste disposal. The green city management should adopt aU these suggestions in respect of solid waste disposal.

The Indian cities generate average 200 to 500 grams (TABLE 3 & 4) of solid waste per capita per day.

TABLE 3
Rates of Waste Generation for Different Sources

Sources	Per capita / day (in Qms)
Residential areas	350 -500
Commercial areas	15 - 300
Road Sweepings	100 - 250
Institutional areas	50 - 150

TABLE 4
Generation of Municipal Solid Waste (per person, per day)

Population (range in lakhs)	Average Waste (Gms *I* Person *I* Per day)
1 to 5 lakhs	210
5 to 10 lakhs	250
10 to 20 lakhs	270
20 to 50 lakhs	350
50 lakhs and	above 500

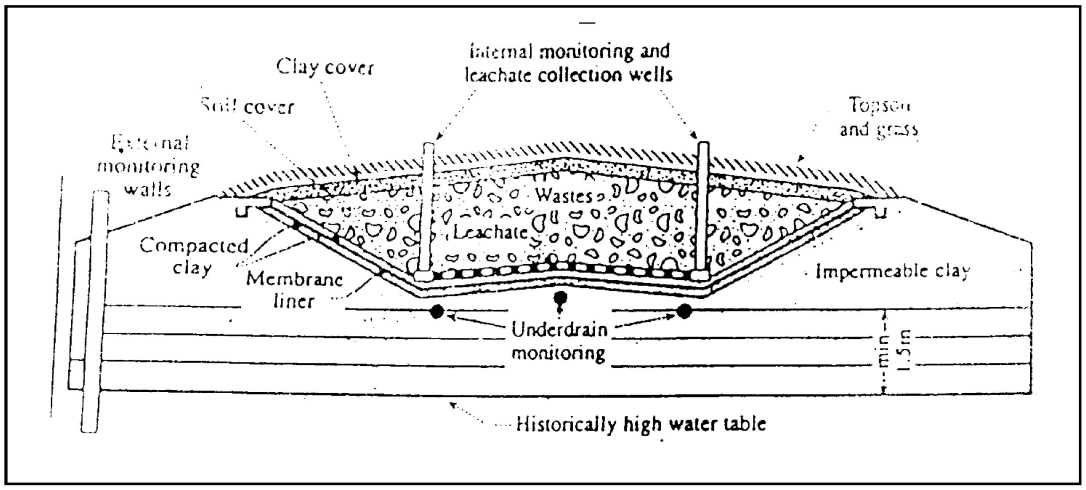
Source: NEERI Strategy Paper on 'Solid Waste Management in India', Feb,'i995.

Considering appropriate density of the waste, it is reported that Indian cities develop about 80,000 metric tons per day or 30 million metric ton per annum, of the solid waste quantity. Out of this 1/3 is generated by metropolis. Depending on the efficiency of collection of solid waste it is observed that about 3/4 is collected in various types of vehicles and remaining disintegrates on roads. The average recyclable part of the solid waste is about 20%, the compostible part 40% and remaining construction material. The generation of Municipal waste is less for small town and more in bigger towns as per NEERI's survey. The various disposal methods adopted are dumping, sanitary land filling, composting, vermi composting, incineration, pelletisation, gasification, pyrolysis, anaerobic treatment, bio-methenation, hydro pulping etc. In India most of the cities are adopting dumping which is causing various problems like water contamination, ground water pollution etc. Even in metropolis the dumping is adopted, which is one of the main hurdles to avoid water and air pollution. The sanitary land filling consisting of confine compact - cover methodology is even not adopted scientifically by Indian cities, leave about gas or energy recovery from such sites. Though composting and vermi composting has been adopted at few locations there are quite less examples to follow.

NORMS FOR PROPER SOLID WASTE DISPOSAL IN GREEN CITY:

The solid waste including hazardous waste in the city can be taken care of by properly designing the units for disposal of the waste. For this purpose analyze these waste, for leachability which can be sent for stabilization or chemical processes. For the units of land fill use of synthetic liner both at bottoms and sides should be considered. (FIG.1)

(FIG.1)



The consolidation, compaction and runoff causes leachate leading to ground water poliution(TABLE 5). Hence isolate ground water sources. The incineration of certain hazardous waste reduces weight and volume but air pollution has to be taken care off. This method reduces other potential environmental risks. In India about 25 industrialized cities produce 60,000 metric tons of hazardous waste annually. The hospital waste generating infectious waste, can be taken care of through incineration.

There are few examples of disposal of hospital waste by this method operated by private institution backed up by local bodies, handling commercially, at reasonable rates. By any means, the potential risks of hazardous waste such as leachate, contamination, gas migration, dust odor etc. in the city should be avoided.

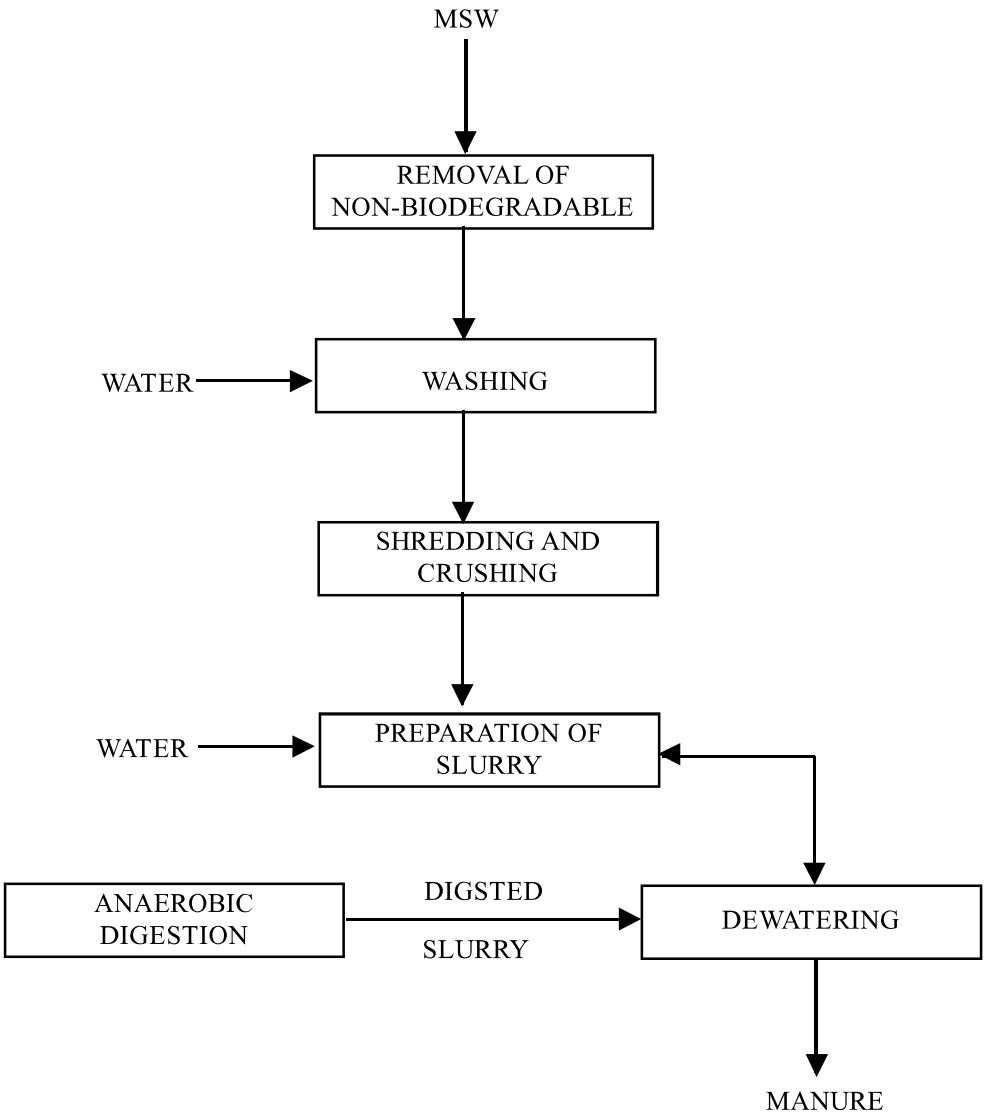
TABLE 5

Source	Pathway	Receptors	Risks
Liner failure ; leachate leakage	Hydrogeological	Groundwater, potable water supply; the rivers and associated flora and fauna	Pollution of ground water loss of a potable supply, public health risk damage or loss of flora and fauna
Leachate discharge	Sewer	Sewage treatment works	Effects upon biological process
Contaminnted surface water	Run-off	Soils, flora and fauna. watercourses, the public (via ingestion of water)	Water pollution, public health risk damage or loss of fauna
Gas migration	Geological; soils, landfill cap, to air	Buildings and people, flora	Explosion and fire, death or serious injury, asphyxiation, damage and loss of flora
Dust	Air	people and flora	Health risk
Odour	Air	people	Loss of amenity and nuisance
Exposed wastes	Direct contact	People	Health risk

FIG. 2

AEROBIC COMPOSTING

FLOW CHART



The domestic solid waste should have a secured collection and transfer system. The decentralization and community participation in metropolis could be one of the most efficient. methods to handle domestic solid waste, but for willingness of the people in general and politicians and planners in particular in such metropolis. The apathy is, this is not happening as quickly as expected. The small groups doing segregation of domestic waste with smaller composting units even generating electrical energy by biomithenation in cities like Mumbai, Delhi, Chennai, Kolkotta, Banglore, Hyderabad etc. can take care of domestic waste effectively to help the cities convert into green cities. However it is difficult to spell out any time aspect for achieving this. In case of other small cities and semi-urban areas etc. the centralized plants, using dry fermentation method, aerobic - anaerobic processes for composting (FIG. 2) with the help local bodies can be considered as useful, for disposal of domestic waste. Though there are few examples in operation of this suggestion in places like Kolhapur etc. much is required to be done for such Indian cities to help covert them into green cities. It is only because of failure of community participation, the municipalities and local bodies have to adopt treatment and disposal methods for domestic solid waste at centralized locations.

In fact a considerable leap is necessary in respect of treatment and disposal of solid waste, particularly domestic, to achieve target of green cities. The few facts for utilization are:

* Waste dumping ground can be converted to land fill gas for commercial exploitation.

* The methane gas, thus produced is a good candidate to mitigate global warming.
* Methane market to be launched.
* About 80 to 100 m3 of gas per ton of solid waste can be availed of for its life time.
* Most suitable project economics can be worked out and designed to use the gas as fuel in industries, generate electricity for local power greed, injections in gas pipelines.
* The potential for power generation should be worked out for acceptable rates.
* Kitchen waste can be used in smaller plants of bio-methenation to produce fuel, compost electrical energy.
* The smaller units in individual flats can be used to produce compost for backyards and garden plants etc.
* Smaller units of plastic baskets or aluminum composting units can be utilized in the flats.

NORMS FOR PROPER SANITATION & SEWERAGE IN GREEN CITY:

As we have seen large volume of domestic sewage as well as from industry is being let out into receiving water bodies including lakes, rivers, estuaries, creeks etc. all over India. It is expected in a green city:

* A fool proof sewerage system is available in the city.
* As prescribed by CPCB, minimal national standards (MINAS) are observed for treatment of waste water.
* If sewerage & treatment is not available. in the city, as an alternative technologically, all colored waters are taken care of, possibly with returning the available nutrients in the waste water to the nature (ECOSAN Philosophy)
* A technological option of reuse of waste water may be implemented in the city as an available water source as well as nutrient for agricultural & other usages. .
* In any sewerage system consisting of conveyance, transport, treatment & disposal about, 70 to 90% cost is involved in conveyance & transport. depending upon topography, spread etc. of the city. The collection system should obviously satisfy .
    - No leakage from joints of sewage conveyance.
    - Extremely low percentage of infiltration into sewers
    - Avoiding cross connection with storm water drainage in case of separate system.
    - Scientific design of sewerage with properly adopted self cleaning velocities.
    - Proper planning of having house connections to pick up entire quantity of sewage.
    - Proper maintenance of sewerage with minimal chokages and well designed diameter and grade to avoid decomposition of organic matter within the system.
    - Proper ventilation of sewerage.
* Minimum pumping arrangement & more effective low energy consumption.
* Use of economic and rational design criteria.
* System should be affordable to maintain, acceptable to pollution control authorities, manageable by system operators and supervisors.
* Keeping part of mechanization to minimum for domestic wastewater.
* Avoid use of high take methodologies.
* Selection of minimum electrical power requirement.
* Minimum land requirement with proper commissioning, for collection & treatment.
* Proper exploitation for reuse of treated wastewater, with scientific methods, for agriculture & other usages.
* Evaluation for option of the de-centralization of sewerage, treatment & disposal. Proper consideration for combination of domestic and industrial wastewater.
* Encourage location specific options, for lower capital cost, operating cost, & simple to operate.
* In a warm climate in India the STPS should endeavor for screening, degritting, anaerobic treatments, resource recovery, aerobic to meet discharge standard, avail of land irrigation, avoid surface discharge, avoid contami nation due to reuse and finally, resource recovery like crop, fish etc. In case of land availability think of faculta-tive processes.

ACHIEVING GOOD PERCENTAGE OF REUSE OF CITY EFFLUENTS IN A GREEN CITY:

In case of surface water resource for drinking purposes it receives lot of pollutants, hence plan to arrest these pollutants should be prepared and implemented. At the same time treated Municipal domestic effluents should endeavor, after treatment, for agricultural (TABLE 6) and other than agricultural 'usages and revenue so collected should be utilized for treatment of sewage to achieve the reuse of city effluents from city's several areas.

A master plan with following considerations should be pre-pared.

* Public to be explained & convinced with the concept of reuse of waste water for non potable usages.
* Similarly, for the beneficial use of treated sludge.
* Epidemiological aspects to be taught to the people.
* Testing laboratories to be kept ready and well equipped.
* Farmers should be made aware of nutrients available from waste water.
* Operation of reuse fields should implement visible strin gent management, self regulations, monitoring, reliable reporting.
* City's local body should carry out demonstration programs for public education.
* Any adverse report should be allowed to be taken cognizance of by local authority & regulator should

assign clearly to the local authority such powers.

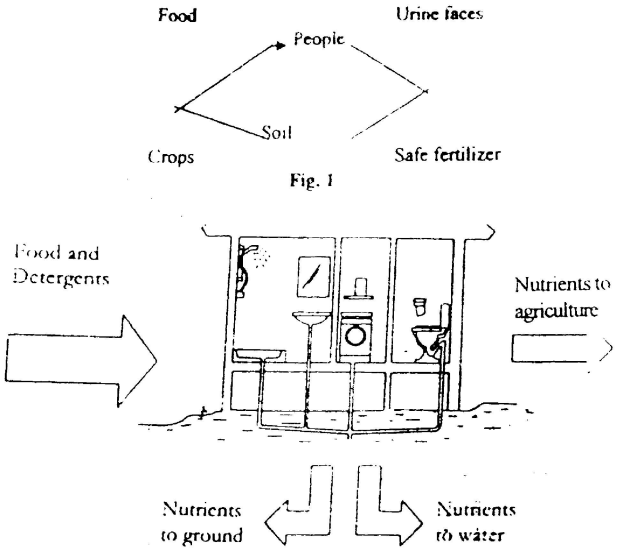
In the cities, practice of reuse of untreated wastewater prevail in developing countries. Though the practice results in micro level benefrts, health impacts on human and other animal also prevail. Hence continued work with a specific program as mentioned above should be evolved in a green city from the point of view of water resource, use of nutrient, avoiding pollution of water body etc. This will bring some good results & practices in a green city.

POSSIBLE SOLUTION TO REPLACE SEWERAGE & UTILIZE NUTRIENTS:

In case o(convential sewerage all the colored waters from community (yellow, gray, black) is mixed up, collected, conveyed, treated & disposed in water body. Some partial utilization of sewage is being done but, by & large the treated *I* untreated sewage is let out in the near by water body. In fact the world wide percentage of treated sewage is only 5 to 10 %. On downstream of such water body the water utilization for a city is sought. Such short coming exist in case of conventional sewerage system.

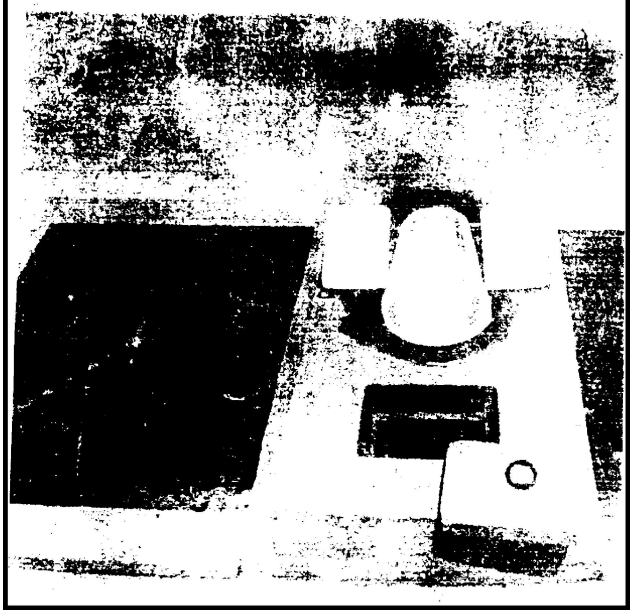
The estimated extraction of nutrients per capita per year in India is N, P, K - 2.7, 0.4, 1.5 kg respectively, out of which urine gives 2.3, 0.3 and 1.1 kg respectively, and faeces 0.3, 01, 0.4 kg respectively. Considering number of users in common toilets, flats, other residences etc. Ecological sanitation (Ecosan) looks for separation of all the three colored waters at the source & use the nutrients for nutritional requirements of common fields, crops, fruits, trees etc. (FIG,3). The ecosan envisages separations of urine faeces in a specially designed squatting pan (FIG.4). The waste water from kitchen & bathroom can be treated and used as water source by removing harmful detergents etc. The urine is collected in tank and black water treated either dry or UASB or modified septic tank taking the available nutrients again to the nature

FIG. 3



Looking to India's scenario of toilets it is estimated that about 10 crores household in rural, 3crores in Peri - urban & urban and 0.5 crore in metropolitan are without hygienic sanitation or well designed toilets. It is suggested that for a green city development, aspects of ecosan for India & South Asia can be useful. In fact few European countries have already started such systems. This can also become part of total sanitation program in India.

FIG. 4



PLAN FOR GREEN CITY'S ACHIEVEMENT & CONCLUSION:

The buildings, roads, open spaces, heritage, sanitation, water supply, pollutional aspects, traffic & solid waste etc. are the integrated part to be considered for any green city. The good social and economic aspects become obvious out come, if these integrated parts are taken care of. Since, purpose of this presentation is to highlight two components e.g. sanitation - sewerage and solid waste a scenario of these components has been presented here before.

It is suggested that "green city mainstreaming partnerships" may be developed on global basis. Obviously, today's global scenario is quite diverse, the developed countries have become successful in mostly achieving the desired standards for all these elements but for developing and under developed countries. Moreover, those who have practically achieved the norms for the green city, are yet not taking the holistically desired approach to bring in those who have not yet achieved. The green city partnership should be

created by developing countries with a total desired attitude *to* convert their cities into green cities. The developed one are yet *to* take proper stand for not exploiting others for their own achievements.

For the partnership following is suggested

* Establish base lines for green cities.
* Support formation of city partnership.
* Consider policy support to the partnership.
* Use financial product to scale up the concepts.
* Quantify the performance of each city.
* Assess difference between green city project & conventional project.
* Use the concept of benchmarking.
* Diffuse required technologies.
* Work out awareness and capacity building plan.
* Create market for sustainability.
* Work out plan for each element for the green city.
* Consider suggested norms for sanitation - sewerage & solid waste in this presentation.
* Give weightage to the different focus areas with relation *to* environmental impact.
* Develop mechanism for assessment criteria within the partnership.
* Start from situation analysis up to achievement by creating designed path.
* Work out cost benefit to convince the people. It is concluded that in case of above road map it is expected to implement norms for sanitation - sewerage and solid waste disposal which will play a very important role along with other elements.

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