Hospital Hazardous Waste Management

By
Ali Sher A. Baloch
&
Asma Iftikhar

ABSTRACT

The environmental factors have a major effect on human health. A rapid technological change, increasing population and unplanned growth of urban areas are making it difficult to develop and maintain a healthy and safe environment. The hospital waste management is an important issue in the environmental agenda of society which calls for an emergent and practical plan.

1. Objectives

The objectives of this paper are:

- Study and carry out critical analysis of current hazardous waste management practice in our hospitals that includes assessment of both, the management of waste within the hospital and once the waste has left the source. It also looks into level of knowledge among staff.
- Identify the deficiencies and inadequacies of present system.
- Identify the level of hospital hazardous waste management that will be relevant to help, implement and enforce proper health and environmentally sound, technically feasible, economically viable and socially acceptable systems for hospital hazardous waste management.

2. Methodology

In order to achieve above mentioned objectives following methodology is adopted.

- Examination of current practices in different hospitals
- Practical implementation
- Recommendations suitable for our country at regional and national levels.

1 Chief Engineer, CDO (Water) WAPDA.

This paper is concerned with the risks and importance of segregating hazardous healthcare wastes. It also throws light at the various stages and aspects of hazardous hospital waste management. At the end, the paper proposes a hospital hazardous wast management system for the local conditions with an aim of improving the existing practice. For this paper, the data was collected by interviewing the various hospital authorities in Lahore.

1. INTRODUCTION

Healthcare waste is a unique form of waste, comprising of a diverse mixture of liquids and solids generated through medical activities such as diagnosis, monitoring, treatment, prevention of disease.

- Typically, 80 to 90% of hospital waste is composed of general wastes similar to domestic and commercial wastes which represent no potential infectious, chemical or radioactive risk.
- The hazardous waste, which is only a 10% to 20% of whole waste, is potentially contaminated with an infectious, chemical or radioactive agent, generated at any hospital. These are not a uniform mixture. They can be further categorized into several distinct categories, each requiring some difference in their collection or disposal arrangements.

This waste if not disposed off properly, can pose grave biological hazards. This hazardous waste when mixed with non hazardous waste can act as a double edged weapon and in certain cases can be catastrophic for the inhabitants living around.

2. HAZARDOUS HOSPITAL WASTE:

Hazardous Hospital wastes are categorized according to their weight, density and constituents. Infectious waste is the waste which has the potential to spread & cause diseases. Material-containing pathogens in sufficient concentrations or quantities that, if exposed, can cause diseases. This is generated in rooms such as ICU, CCU, dialysis units. The patients, nursing staff, Laboratory staff and operation theater staff generate and handle infectious waste.

This also includes waste from surgery and autopsies on patients with infectious diseases, like cotton swabs, disposable gloves, surgical dressing and Pus or blood soaked dressings.

The World Health Organization (WHO)* has classified medical infectious waste into different categories

***Source from** www.wwfpak.org

(a) Sharps

This includes disposable hypodermic and intra-venous needles, syringes, saws, blades, broken glasses, nails, drips, Glass slides, razors or any other item that could cause a cut.

(b) Pathological waste

This includes tissues, organs, body parts, human flesh, fetuses, blood and body fluids, usually generated in operation theaters, removed during surgery, autopsy or other medical procedures, cultures and discarded live or expired vaccines etc.

(c) Pharmaceutical waste

This includes drugs and chemicals that are returned from wards, spilled, outdated, contaminated, or are no longer required.

(d) Radioactive waste

This includes chemotherapy waste and solids, liquids and gaseous waste contaminated with radioactive substances used in diagnosis and treatment of diseases like toxic goiter. According to the data collected by EPA (Environmental Protection Agency) Government of Punjab, the amount of waste produced averages 1.18 Kg/bed/day.

3. IMPACTS OF HAZARDOUS HOSPITAL WASTE:

Hazards due to Infectious waste are the diseases such as: Tetanus, Typhoid, Gastro-Infectious, Hepatitis, AIDS, skin, respiratory and eye infections, spread by entering through skin such as:

- Spills
- Splashes of contaminated liquid or fluid,
- By being inhaled through nose,
- By being injured by sharps,
- By being ingested i.e. food is eaten by contaminated hands through punctured wound.

4. HOSPITAL WASTE MANAGEMENT SYSTEM

In order to overcome the above mentioned menace of hospital waste disposal, Hospital Waste Management System has been introduced in major Hospitals of the Provincial Capitals of the country.

Hospital Waste Management means the management of waste produced by hospitals using such techniques that will help to check the spreading of diseases through it. In the past there was no proper way for the management and disposal of hospital waste. The standard practice of hospital waste disposal was dumping it in municipality containers. This waste was treated as common waste by municipal corporations. The Hospitals, Labs & Health Facilities mostly generate tons of clinical waste everyday. All of this waste was dumped openly without proper arrangements.

Such waste not only pose a threat to the hospital employees but also to the environment surrounding it, because anyone coming in contact with it can easily be infected with diseases. The syringes etc. dumped in the waste may be re-used, either by addicts or corrupt traders. Some hospitals burn the medical waste in their premises to get rid of the infectious material. Open burning of such waste produces serious hazards. Installation of Hospital Waste Management System is the first step towards infection control and improving the quality of health care.

Three different categories of participants involved in Hospital Waste Management are:-

- Doctors & Administrators
- Nurses and paramedics
- Sanitary Workers.

The Hospital Hazardous Waste Management System consists of the following steps:

1. Segregation
2. Collection
3. Transportation
4. Storage
5. Disposal

1.Waste Segregation

I. General waste such as Fruit peals, paper etc. generated by patient

a) White bags are used for general wastage.

Fig. 1: General Waste Collector

1. Infectious wastes such as blood, pus soaked dressings, cotton swabs.

(a) Yellow bags are used for infectious waste, made of non-chlorinated plastic such as polyethylene and polypropylene. There are double bagged to avoid puncturing, spillage and leakage of the infectious waste. The bags are knotted or tied with a string when it is two third full. They are not filled till the mouth at any cost.

(b) Sharp containers are used for the collection of sharp disposals. These containers are rigid and puncture resistant to needle penetration. The opening of these containers should be narrow to prevent retrieval of discarded needles and syringes.

Fig 2: Sharps Container

(c) Radioactive Isotopes are kept in drum/containers marked "RADIOACTIVE WASTE", for specified period of time, so that decay of radioactivity of these isotopes is completely ensured before its disposal with other hospital waste.

Fig. 3: Sanitary Worker with Protective Clothing

3. Waste Transportation:

Trolleys for collection in house infectious waste are used to convey the containers from the point of generation to the storage area. The trolley is easy to move to avoid injury, accident and spillage, cleanable and easily disinfected. All concerned staff members are properly trained in the handling, loading and unloading, transportation and disposal of yellow bagged waste.

4. Waste Storage

Containers of infectious waste are maintained in an intact state in the storage area. The storage area is accessible to the vehicle, which comes for collection of infectious waste. The storage area is totally enclosed and secured from unauthorized access, especially inaccessible to animals, insects and birds. The transportation of waste is properly documented, and all vehicles carry a consignment note from the point of collection to the incinerator.

Fig. 4: Yellow & White Bags in Storage Area

Fig. 5: Waste Transfer Truck

5. Waste Disposal

Incineration is a process that effectively and efficiently disposes off all hazardous and infectious waste through burning. The incinerator is run by gas and works at temperatures of around 700 degrees Celsius in the lower chamber and 1100 degrees Celsius in the upper chamber.
The idea is to burn the waste to make sure that it is not harmful anymore and also reduce it in volume to an amount that is minimal. The ash that remains is then buried in landfills, as a completely non-toxic ash. The non-toxic air that results is then released into the atmosphere via a tall chimney.

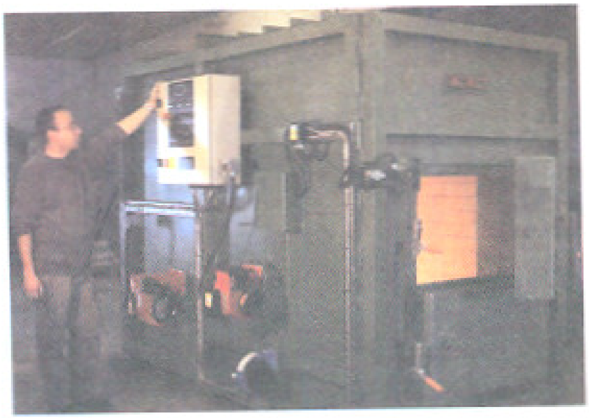


Fig. 6: Incinerator

5. OTHER WASTE MANAGEMENT TECHNOLOGIES

Various alternative technologies other than incineration are available at hospitals in many developed countries. As these techniques are either too complicated or very expensive, hence they are not being used in Pakistan. Though, these techniques should also be applied here, for proper waste disposal. The brief description of the techniques is as below.*

(a) Steam Autoclaving

Steam Autoclaving is the most widely used and most efficient alternative medical-waste-treatment technology. Most available autoclaves are designed to handle both biohazard and normal hospital wastes simultaneously. However, they cannot treat pathological wastes, chemotherapy wastes, and low level radioactive wastes. These wastes have to be treated separately.

Medical waste autoclaves usually jointly operate with a shredder, and a compactor (to minimize the waste volume). In autoclaves, the effects of heat from saturated steam and increased pressure decontaminate medical waste by inactivating and destroying microorganisms.
*Source from www.wwfpak.org

(b) **Chemical Treatment**

In chemical treatment systems, an anti-micro-biological chemical, such as sodium hypochlorite, chlorine dioxide decontaminates the medical waste. Most chemical treatment systems, currently in use, operate at ambient temperature.

(c) **Microwave Radiation**

In Microwave Radiation, medical waste enters the system by batch or continuous mode, where it is wetted with steam or water and heated by microwave radiation at de-contaminating temperatures.

(c) **Other Thermal Systems**

Some systems use a combination of infrared radiation and forced hot-air convection to treat the waste. The waste then is compacted, preparing it for landfill. Other systems use gamma radiation to heat the waste to disinfecting temperatures. A portion of the solid residue obtained is recycled, while the remainder is disposed. Several other thermal systems currently use steam, oil, electricity or some form of radiation as their source of heat.

a) Disposal of Pathological waste

For disposal of such waste, either Crematoria (burning of the body) or burial is performed.

Safety Measures for persons at risk:

Precautions while handling infectious waste:

1. Needle cutters especially designed for breaking needles and syringes should always be used.
2. The drip sets should be separated form the bag/bottle before disposal to avoid re-use.
3. Smelling or putting hands inside any liquid/chemical waste should be strictly prohibited.

4. If there is needle injury or splashing of liquid on broken skin it should be immediately reported to the Supervisor/Sanitary Inspector and the exposed area be washed.

5. Certain diseases such as Hepatitis B, Tetanus, Typhoid, Influenza and other infections can be prevented by immunization. Therefore, the workers should be encouraged to get vaccination.

6. Conclusions

This paper is taken up with an objective to check the existing local practice of hospital waste management with incinerator. After implementation of hospital waste management plan in 2005, the following immediate results are partially achieved.

- Improved Environmental and Sanitary Conditions.
- Decrease in occupational Injuries caused by sharps.
- Elimination of chances of reuse.
- Enhanced customer satisfaction.

APPROPRIATE TECHNOLOGIES OF SEWAGE TREATMENT FOR URBAN CENTERS AND LARGE VILLAGES OF PUNJAB

BY

Engr. Shabir Ahmed Qureshi
M.Sc (Civil Engg:)

1. Background

There is a need for a focused approach to the treatment of our municipal waste water given our present state of environment.

It was in 1969 that the American President, Mr. Richard Nixon, in his New Year's address to the nation said that "the 1970s absolutely must be the years when America pays its debt to the past by reclaiming the purity of its air, its waters and our living environment. It is literally now or never." The resulting commitment of both the American Government and the public resulted in a turn-around in the environment culminating in cleaner water bodies and pollution free water resources in the USA.

With neglect and procrastination, today we stand in a situation much worse than what the American President had alluded to in 1969. We are also faced with a financial constraint, that is, on a comparative basis. Our planners and engineers need to act and act soon as it is already late.

Although waste disposal problems have been with us ever since our independence, they did not pose a threat to our survival till a couple of decades ago. It is largely the tremendous increase in our population and the resulting accelerated pollution of our water resources that makes this issue so critical and insistent of solution. Not only is the population rising at a high rate, but so are the per capita consumption of water and other resources ancillary to waste production. All the while, our known resources of water remain essentially the same, that is, if we choose to ignore the curtailment through the Indus Basin Treaty. Thus we must contend with the conditions we create. Let us face the realities–the raw municipal sewage of Lahore, which did not perceptibly affect River Ravi in the 1950s, has now choked the river to death and turned it into a sullage carrier in which no aquatic life survives.

The untreated municipal effluents, now including those in the rural areas, have reached a stage where they pose a threat not only directly to the human health but also a long-term threat to our potable water resources.

1 Chief Engineer (South), Punjab Public Health Engg: Department & Executive Member of Pakistan Engineering Congress

The shallow water table in almost the whole of Punjab has now been contaminated by, interalia, the untreated domestic and industrial wastes. The other sources of water contamination include the fertilizers and pesticides from agricultural activities.

Traditionally, stabilization ponds in the anaerobic, facultative, oxidation, maturation series or a combination has been considered but so far not practically implemented even in areas of Punjab where land is available and machinery and power costs are relatively high. Both the land and financial resources are fast becoming scarce. We urgently need to **find and implement** a low-cost sustainable and appropriate solution for treatment of our municipal waster waters.

2. What is Sewage

Sewage is the waste water of community. Domestic sewage is composed of human body wastes (faeces and urine) and sullage which is the wastewater resulting from personal washing, laundry, food preparation and the cleaning of kitchen utensils. Sullage contributes a wide variety of chemicals, such as detergent, soaps, fats and greases of various kind and pesticides etc. Industrial sewage can contain inorganic and organic chemicals.

Sewage, therefore, needs to be treated prior to its ultimate disposal into a receiving watercourse in order to reduce the spread of diseases caused by the pathogenic organisms in it and also to prevent the pollution of surface and ground waters. A polluted body of water is a potential source of infection, particularly in hot climates. One of the best ways to prevent the pollution of surface waters is to use the treated sewage to produce some beneficial end product. Domestic sewage can, with the correct treatment, become a valuable raw material.

3. The Process of Treatment of Sewage

Raw sewage contains complex organic and inorganic materials, including proteins, cellulose, fats, carbohydrates, detergents and soaps. In the biological process of sewage treatment, bacteria, fungi, zooplankton and algae breakdown and then use these complex materials, resulting in an effluent rich in nitrogen, potassium, phosphorus and other elements. These biological processes utilize natural bacteria to clean sewage. Aquatic plants can be used to transform polluted effluent into clean water.

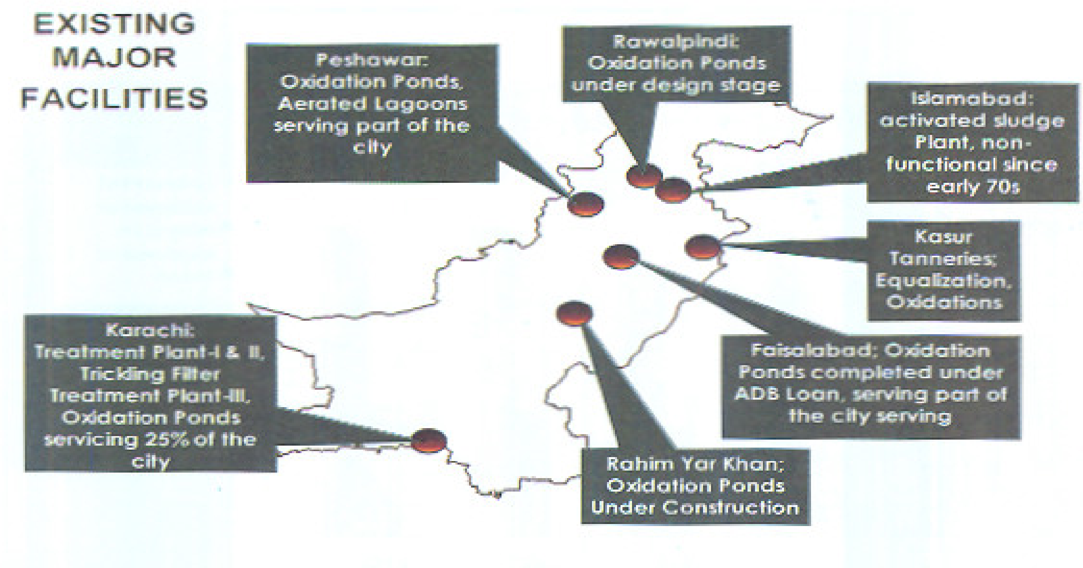
Various types of bacteria can also be used to clean sewage. These bacteria are nature's workers and they digest the organic matter to produce inorganic compounds which is food for the aquatic plants. The inorganic compounds are consumed by the aquatic plants and the purified water can then be used for agricultural, industrial and non-drinking domestic uses.

4. The Way Forward

We need to take stock of our situation in qualitative and quantitative terms and find

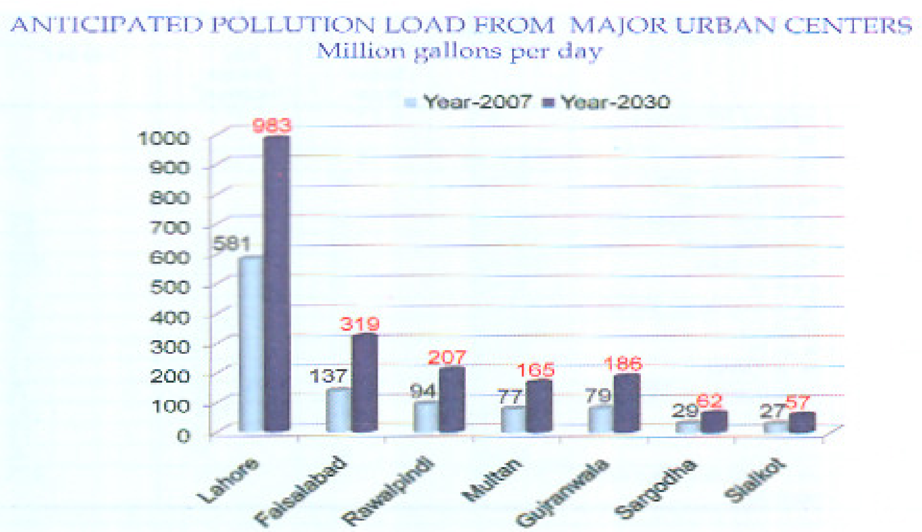
means of addressing the issue in a cost effective and sustainable manner.
The existing major sewage treatment facilities are shown in

Fig-1 below: -



(Fig-1)

Compared to the enormity of the problem, the situation is not a happy one.
The anticipated sewage load from major urban centers of Punjab is given in
Fig-2 below: -



(Fig-2)

There is thus an urgent need to find and implement appropriate and sustainable solutions for elimination of the huge quantities of pollution loads depicted in Fig-2

The 1985 to 1999 wastewater output of Pakistan and the EPA standards for the disposal of sewage into water bodies and in sewage treatment plants are given in

Figure-3 & 4 below: -

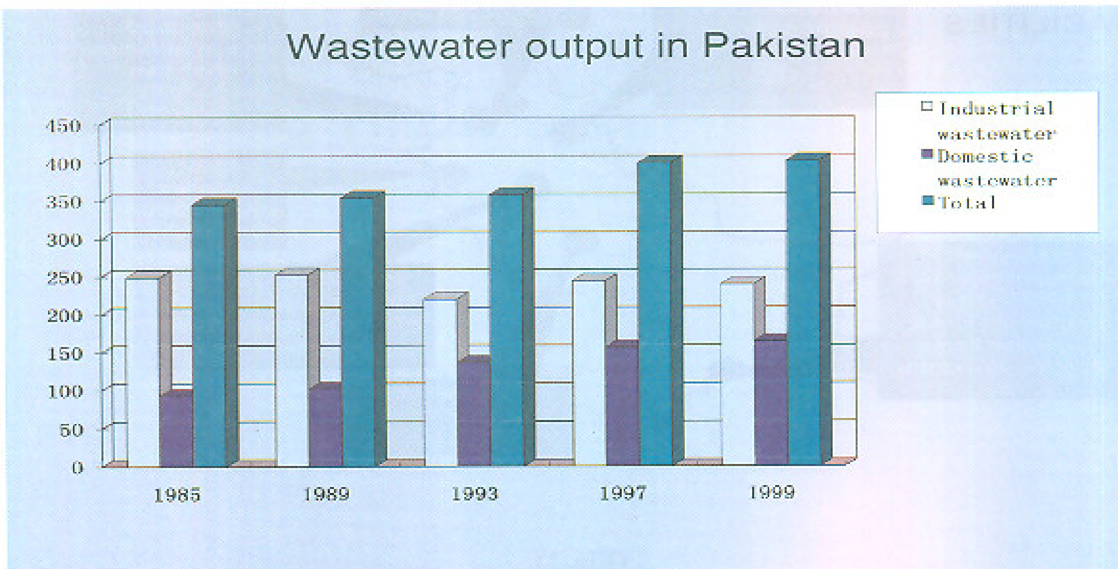


Fig-3

S.No	Parameter	Existing Standards	Revised Standards		
			Into Inland Water	Into Sewage Treatment[5]	Into Sea[5]
1.	Temperature or Temperature increase[*]	40°C	=<3 °C	=< 3 °C	=<3 °C
2.	pH value	6-10 pH	6 - 9	6 - 9	6 - 9
3.	5-days Biochemical Oxygen Demand (BOD_5) at 20°C[1]	80 mg/l.	80	250	80**
4.	Chemical Oxygen Demand (COD)[1]	150 mg/l.	150	400	400
5.	Total suspended solids	150 mg/l.	200	400	200
6.	Total dissolved solids	3500 mg/l.	3500	3500	3500
7.	Grease and oil	10 mg/l.	10	10	10
8.	Phenolic compounds (as phenol)	0.1 mg/l.	0.1	0.3	0.3
9.	Chloride (as Cl)	1000 mg/l.	1000	1000	SC
10.	Fluoride (as F)	20 mg/l.	10	10	10
11.	Cyanide (as CN) total	2 mg/l.	1.0	1.0	1.0
12.	An-ionic detergents[2] (as MBAS)	20 mg/l.	20	20	20
13.	Sulphate (SO_4)	600 mg/l.	600	1000	SC
14.	Sulphide (S)	1.0 mg/l.	1.0	1.0	1.0
15.	Ammonia (NH_3)	40 mg/l.	40	40	40
16.	Pesticides, herbicides, fungicides and insecticides[3]	0.15 mg/l.	0.15	0.15	0.15

Fig-4

Sewage comprises over 99% water. The composition of sewage is given in Fig-5 below:

-

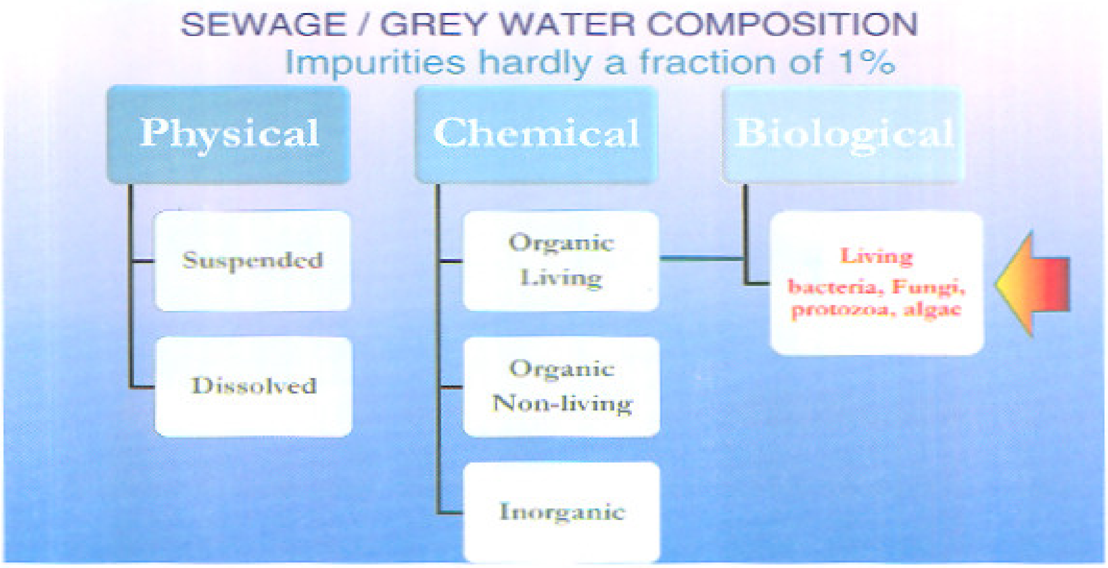


Fig-5

The following figures-"A to G" depict the natural treatment process of sewage: -

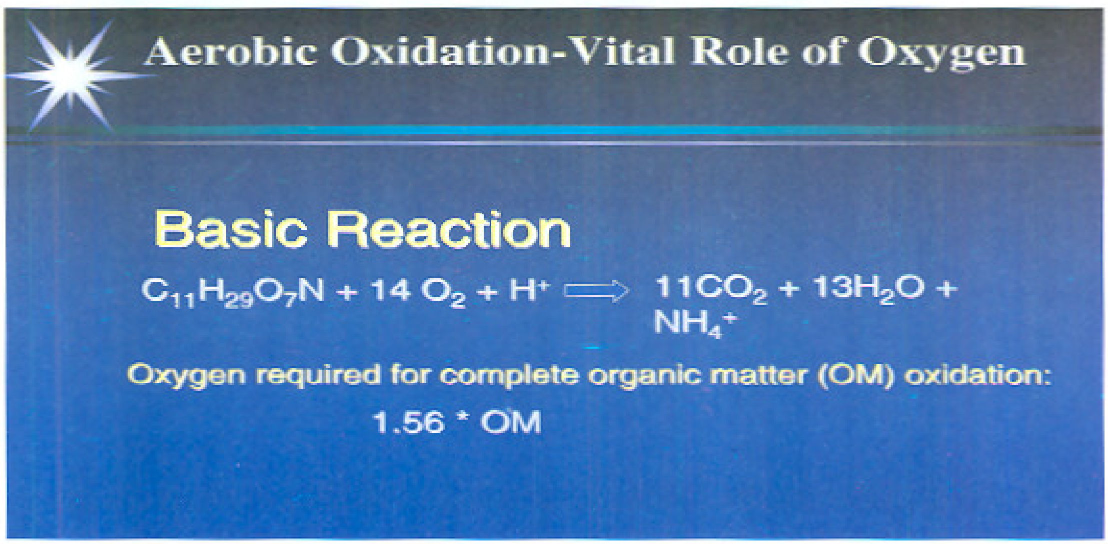


Fig-A

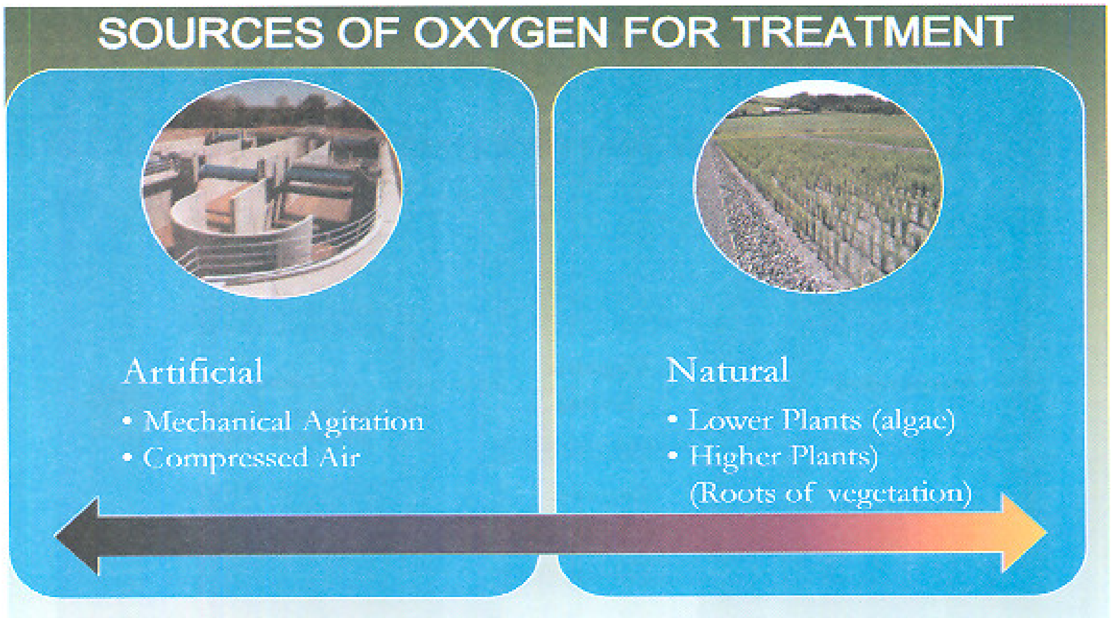

SOURCES OF OXYGEN FOR TREATMENT
Artificial
• Mechanical Agitation
• Compressed Air
Natural
• Lower Plants (algae)
• Higher Plants)
(Roots of vegetation)

Fig-B

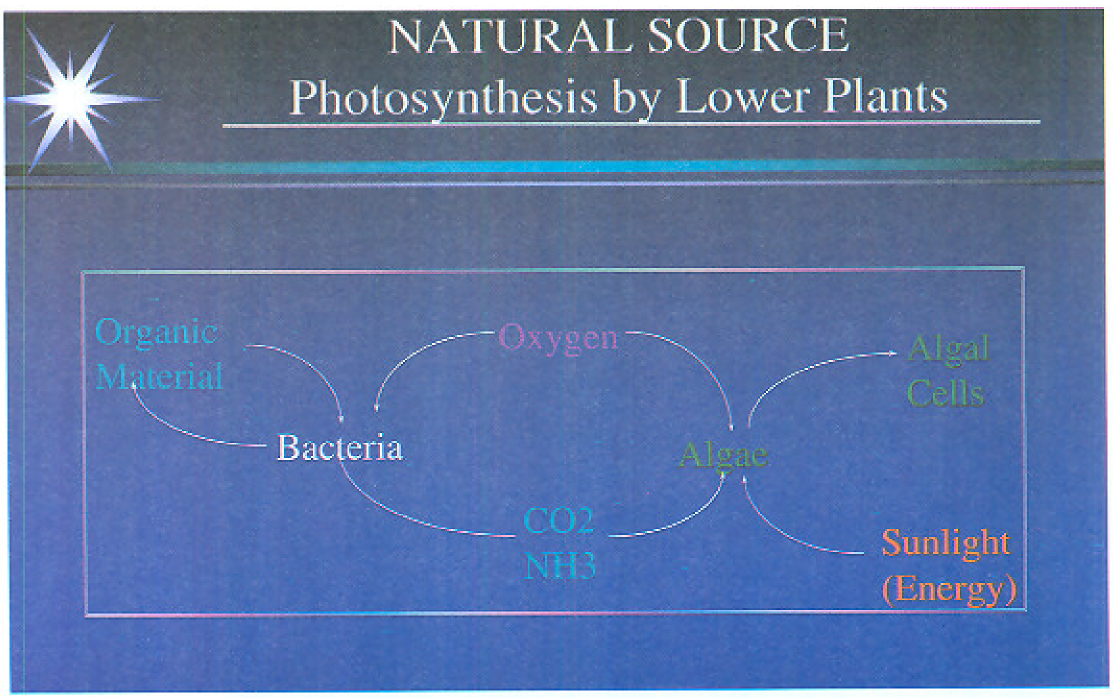

NATURAL SOURCE
Photosynthesis by Lower Plants
Organic Material
Oxygen
Algal Cells
Bacteria
Algae
CO2
NH3
Sunlight
(Energy)

Fig-C

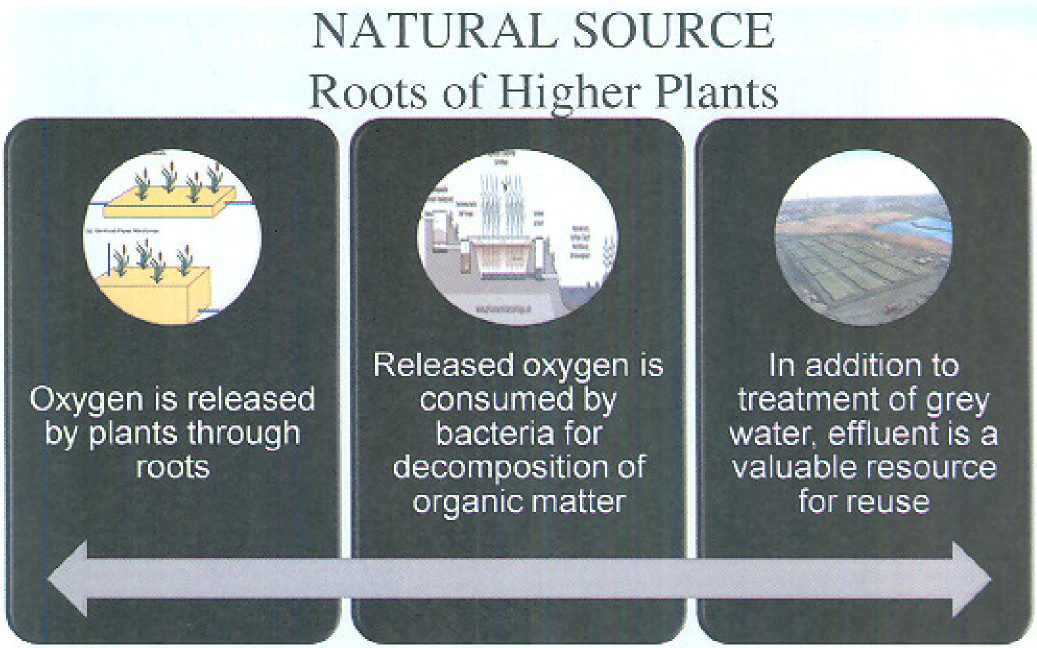

NATURAL SOURCE
Roots of Higher Plants
Oxygen is released by plants through roots
Released oxygen is consumed by bacteria for decomposition of organic matter
In addition to treatment of grey water, effluent is a valuable resource for reuse

Fig-D

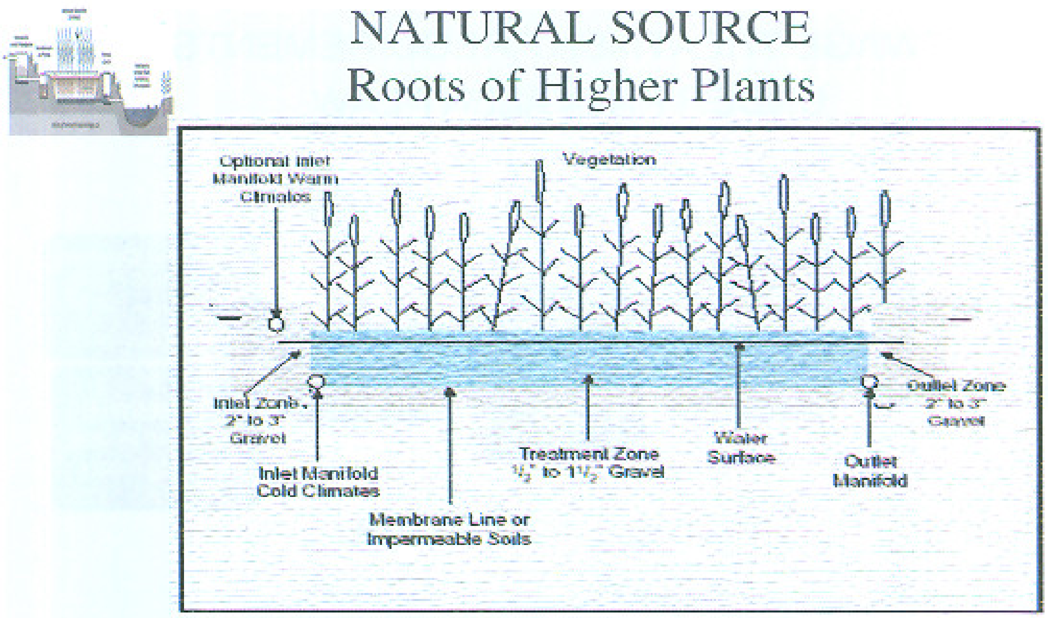

NATURAL SOURCE
Roots of Higher Plants
Optional Inlet Manifold Warm Climates
Vegetation
Inlet Zone, 2" to 3" Gravel
Inlet Manifold Cold Climates
Membrane Line or Impermeable Soils
Treatment Zone 1/2" to 1 1/2" Gravel
Water Surface
Outlet Manifold
Outlet Zone 2" to 3" Gravel

Fig-E

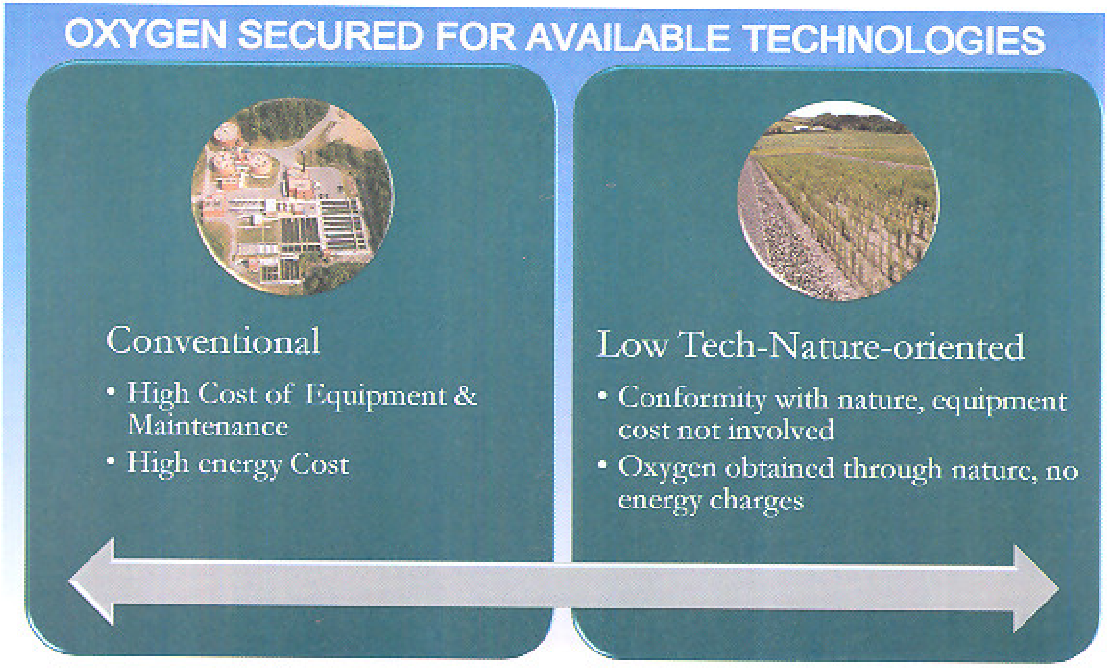

OXYGEN SECURED FOR AVAILABLE TECHNOLOGIES
Conventional
• High Cost of Equipment & Maintenance
• High energy Cost
Low Tech-Nature-oriented
• Conformity with nature, equipment cost not involved
• Oxygen obtained through nature, no energy charges

Fig-F

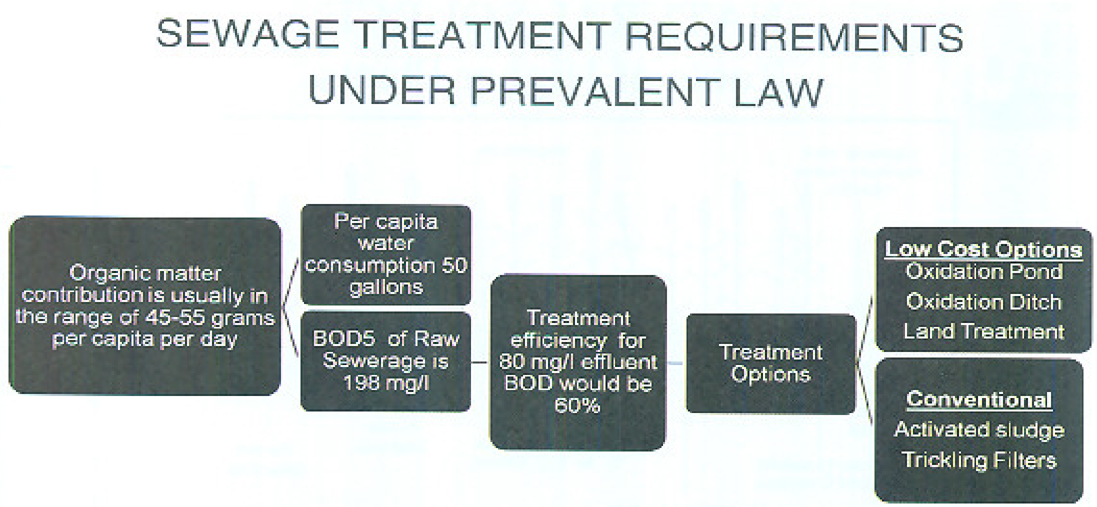

SEWAGE TREATMENT REQUIREMENTS UNDER PREVALENT LAW
Organic matter contribution is usually in the range of 45-55 grams per capita per day
Per capita water consumption 50 gallons
BOD5 of Raw Sewerage is 198 mg/l
Treatment efficiency for 80 mg/l effluent BOD would be 60%
Treatment Options
Low Cost Options
Oxidation Pond
Oxidation Ditch
Land Treatment
Conventional
Activated sludge
Trickling Filters

Fig-G

The usual treatment efficiencies in terms of BOD reduction are as given below: -

Primary Treatment--------------------------------40%
Secondary Treatment---------------------------95%
Tertiary Treatment---------------------------------98%

A comparison of national and international experience of various methods of sewage treatment are given in Fig-H below: -

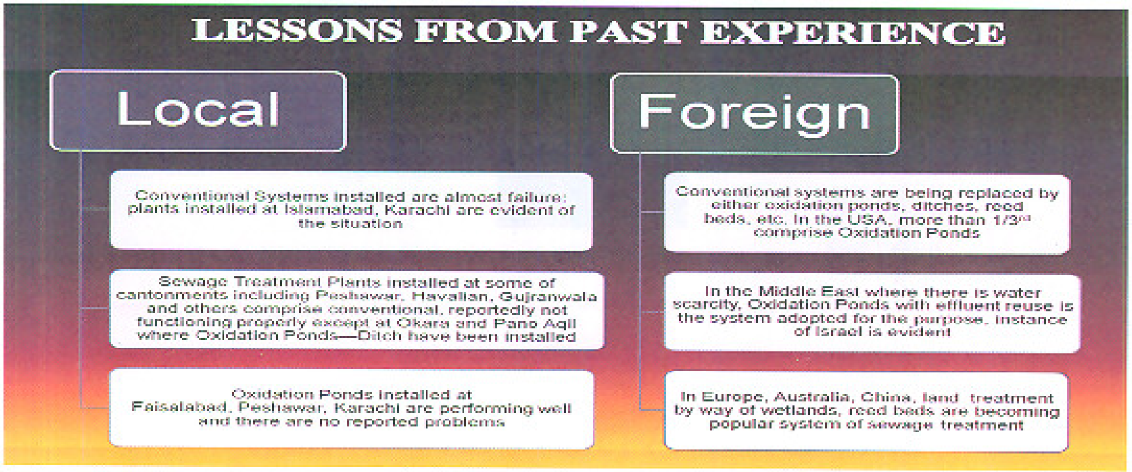


Fig-H

A summary of technical and financial comparison of different sewage treatment options is given in the following figures: -

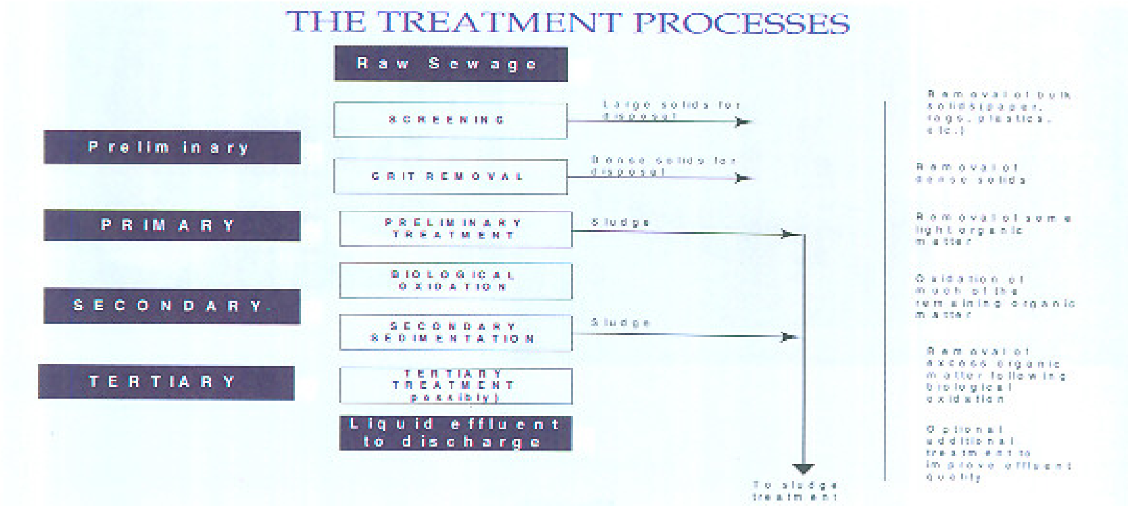


Fig-(i)

OPTION SELECTION – LAND COST A VITAL ELEMENT

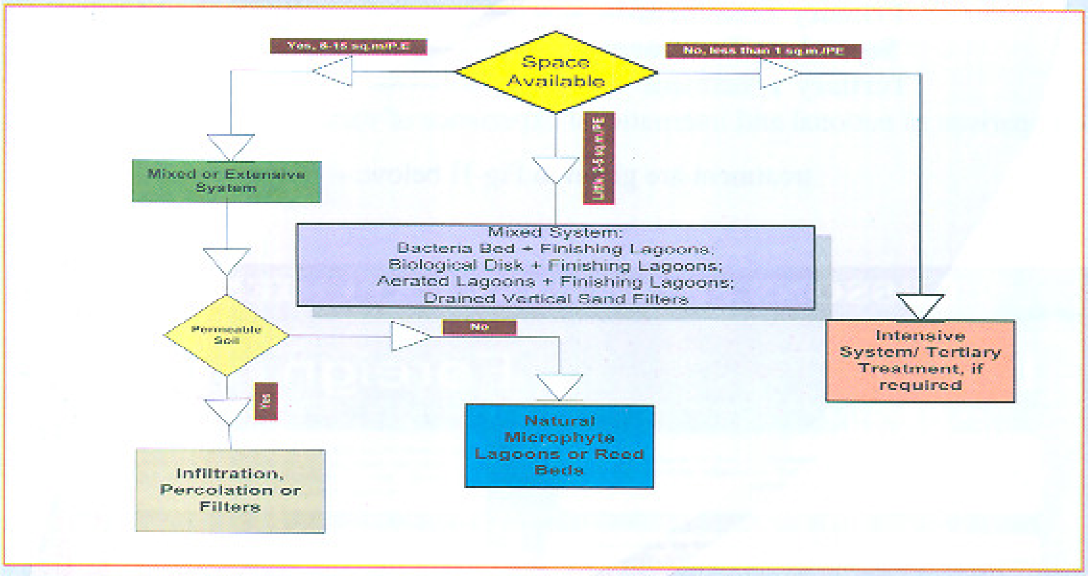
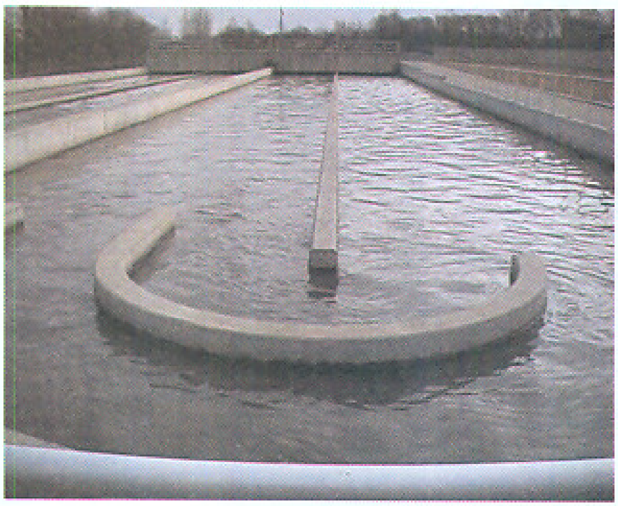


Fig-(ii)

OXIDATION DITCHES



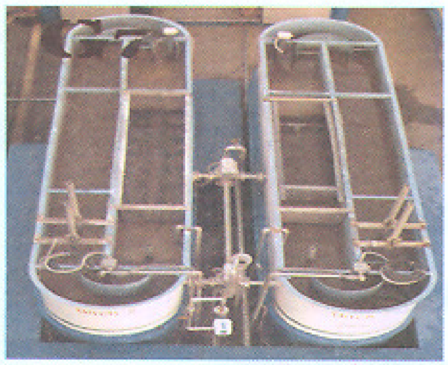


Fig-(iii)

Low-Tech Solutions – Oxidation Ponds

- Anaerobic ponds
- Facultative ponds
- Maturation ponds

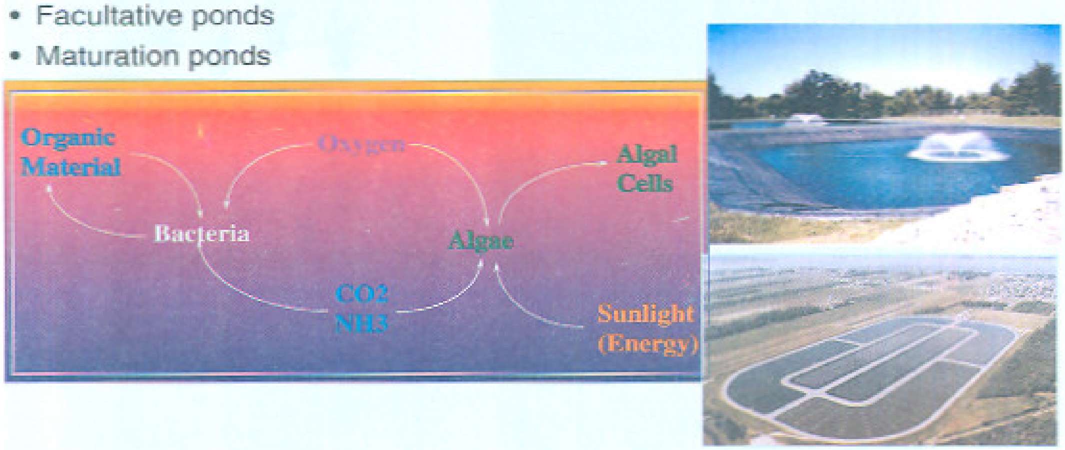


Fig-(iv)

Oxidation Ponds-The Process

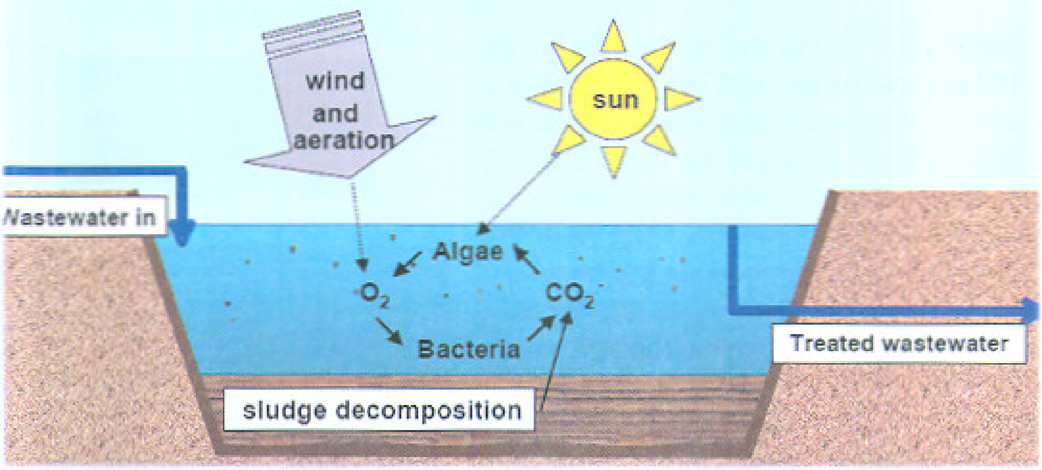


Fig-(v)

REED BEDS – Natural Process

A reed bed is an artificially created wetland planted with specially selected species of reed that have the ability to absorb oxygen from the air and release it through their roots. This creates ideal conditions for the development of huge numbers of micro-organisms which are able to break down any soluble material present.

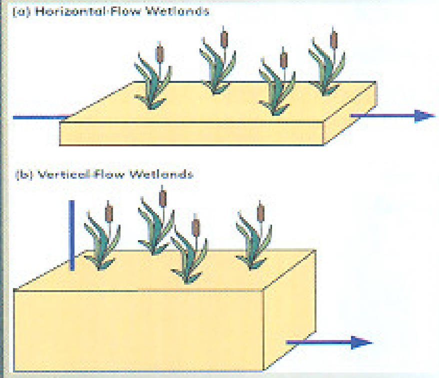


Fig-(vi)

Low-Tech Solutions – REED BEDS

In soil-based reed bed systems, the effluent to be treated percolates through the biologically active soil and roots of a large bed of reeds and then drains through a pipe at the base of the bed. The function of the reeds is to pump oxygen into the soil through the roots. Near the roots, there is an aerobic (oxygen-containing) zone and further away, there is an anaerobic (oxygen-free) zone. Thus, within the soil, a range of processes exist that allow the transformation of environmentally undesirable components of waste water.

Fig-(vii)

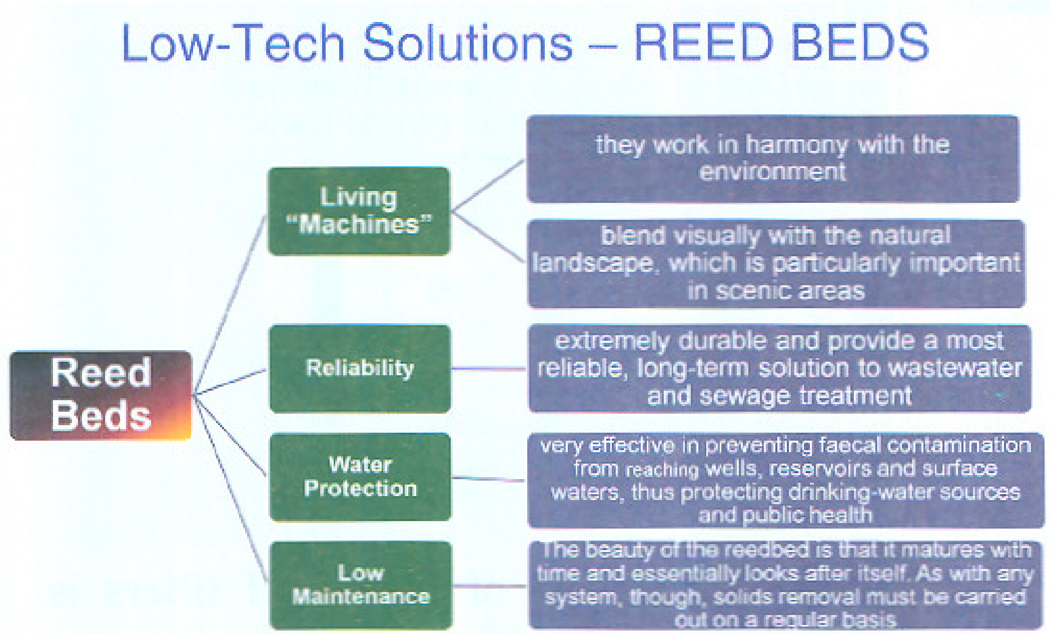


Fig-()

USUAL LAND REQUIREMENTS UNDER OPTIONS

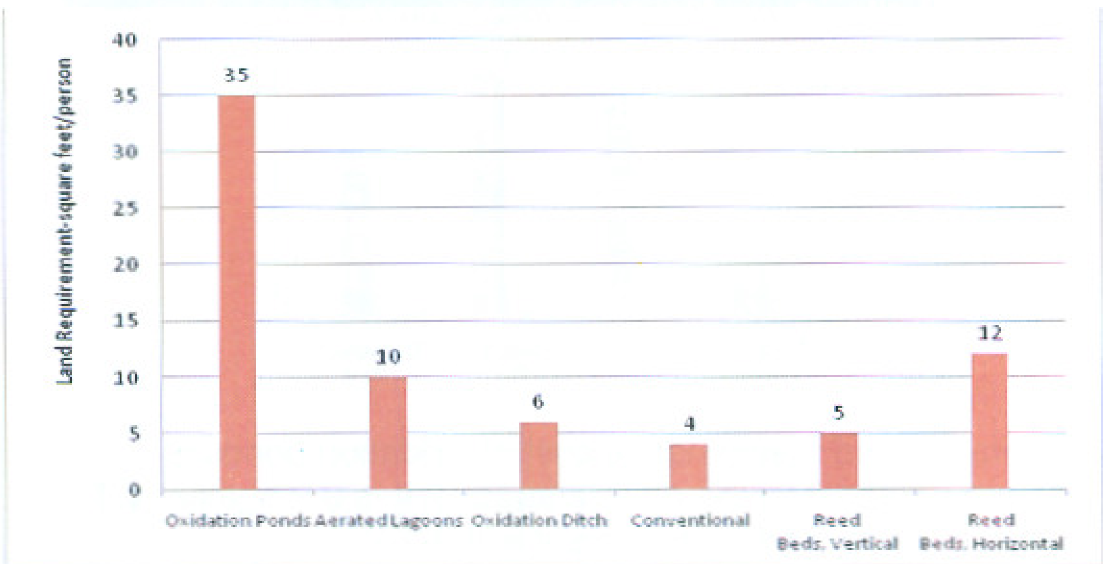
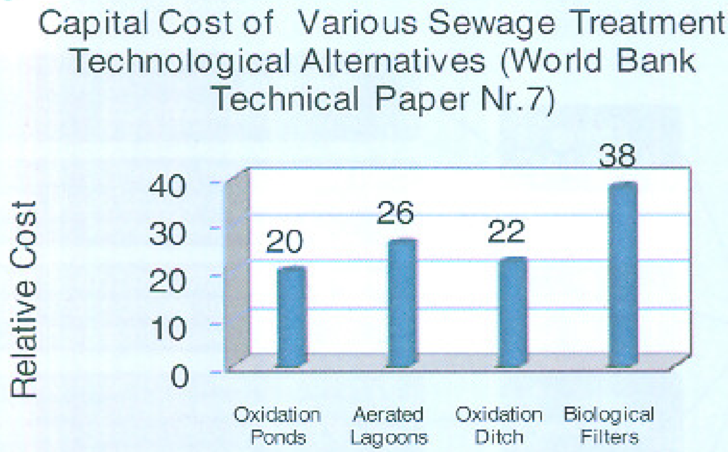
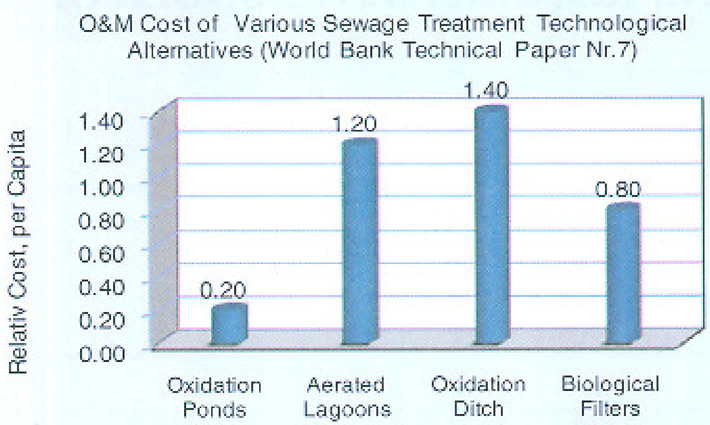


Fig-



Evidently, the capital cost of biological filters is almost double the cost of oxidation ponds.

Fig-(iii)



The operation and maintenance cost of oxidation ponds is significantly lower than the other alterative; it is 0.2 against 1.4 for oxidation ditch, while for others it is 0.8-1.2.

Fig-(iv)

5. Conclusion:

Given our situation, prima faciae stabilization ponds and reed beds or artificial methods offer promising solution provided cost of land is within means. Where land is very expensive, conventional treatment methods could be considered. However, one thing is very certain – we have to make a beginning immediately.

References:

1. New concepts in Water Purification by Gordon L. Culp and Russell L. Culp. Published by Van Nostrand Reinhold Company N.Y.

2. Bleeding for Water – NGO World Launch Issue 2007

3. Waste Water Treatment Options in Punjab – A presentation by Engr. M. Hanif Chaudhary.