DISPOSAL ON LAND

8.6. Disposal of Sewage Effluents on Land for Irrigation

In this method, the sewage effluent (treated or diluted) is generally disposed of by applying it on land. The percolating water may either join the water-table, or is collected below by a system of under-drains. This method can then be used for irrigating crops.

This method, in addition to disposing of the sewage, may help in increasing crop yields (by 33% or so) as the sewage generally contains a lot of fertilising minerals and other elements*. However, the sewage effluent before being used

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*Fertilising elements like nitrogen, phosphate, potash, etc. do help in increasing the yields of cash crops like cotton, sugarcane, plantain, etc. However, crops to be eaten raw or which do not have any skin to be removed before eating, should not be grown on sewage farms, although this is seldom practised by the farmers.

as irrigation water, must be made safe. In order to lay down the limiting standards for sewage effluents, and the degree of treatment required, it is necessary to study as to what happens when sewage is applied on to the land as irrigation water.

When raw or partly treated sewage is applied on to the land, a part of it evaporates, and the remaining portion percolates through the ground soil. While percolating through the soil, the suspended particles present in the sewage are caught in the soil voids. If proper aeration of these voids is maintained, the organic sewage solids caught in these voids get oxidised by aerobic process. Such aeration and aerobic conditions will more likely prevail, if the soil is sufficiently porous and permeable (such as sands and porous loams). However, if the land is made up of heavy, sticky and fine grained materials (such as clay, rock, etc.), the void spaces will soon get choked up, and thus resulting in non-aeration of these voids. This will lead to the developing of non-aerobic decomposition of organic matter, and evolution of foul gases. Moreover, excessive clogging may also result in ugly ponding of sewage over the farm land, where mosquitoes may breed in large number, causing further nuisance.

Application of too strong or too heavy load of sewage will also similarly result in the quick formation of anaerobic conditions. The greater is the sewage load, more likely it will be for the soil to get clogged. Hence, if the sewage load is reduced either by diluting it or by pre-treating it, it may be possible to avoid the clogging of the soil pores. The degree of treatment required will, however, considerably depend upon the type of the soil of the land. *If this soil, to be irrigated, is sandy and porous, the sewage effluents may contain more solids and other wastes, and thus requiring lesser treatment, as compared to the case where the soil is less porous and sticky.*

8.7. Quality Standards For Wastewater Effluents to be Discharged on Land For Irrigation

The Bureau of Indian Standards (BIS), previously known as Indian Standard Institution (ISI), has vide its Code IS : 3307-1965, laid down the tolerance limits for various polluting characteristics/constituents of wastewater effluents for their discharge on land for irrigation. These standards are based upon the quality of irrigation water required by the crops, and thus limit the concentrations of pollutants contained in sewage or industrial liquid wastes, which may prove harmful to the crops. The prescribed BIS standards are shown in table 8.8.

Table 8.8. BIS (ISI) Standards of Wastewater Effluents to be Discharged on Land for Irrigation

S. No.	*Characteristic/constituent of Effluent wastewater*	*Tolerance limit as per IS : 3307-1965*
(1)	(2)	(3)
1.	BOD_5 at 20°C	500 mg/l*
2.	pH value	5.5 to 9.0
3.	Total Dissolved Solids (TDS)	2100 mg/l
4.	Oil and grease	30 mg/l
5.	Chlorides (as Cl)	600 mg/l
6.	Boron	2 mg/l
7.	Sulphates	1000 mg/l
8.	Percentage of Sodium with respect to total content of Sodium, Calcium, Magnesium and Potassium	60%
9.	Radioactive Materials	
	(*i*) α-emitters	10^{-9} μC/ml
	(*ii*) β-emitters	110^{-6} μC/ml

The effluent irrigation method for disposal of sewage can be favourably adopted under the following conditions :

(*i*) When some natural rivers or water courses are not located in the vicinity, the land treatment is the only alternative left, and has to be adopted.

(*ii*) When irrigation water is scarcely available, the use of sewage for irrigating crops is a good alternative.

(*iii*) When large areas of open land are available, broad irrigation may be practised over it with the help of sewage effluents, and good returns can be earned by raising cash crops. Crops like wheat, cotton, sugarcane, plantain, grasses, fodder, coconut, orange trees. etc. have been successfully grown with advantage on sewage farms.

(*iv*) The method of effluent irrigation will prove useful in areas of low rainfall, as this will help in maintaining good absorption capacity of the soil.

(*v*) The area for land treatment or sewage farming should preferably be porous, such as sandy, loamy, or alluvial soils, or soft moorum. It should not be made of heavy retentive soils like clay, etc., which prevent easy aeration of the soil voids, and thus creating anaerobic conditions.

(*vi*) This method of disposal of sewage, poses problems during the periods when no irrigation water is required for the crops especially during rains. This method is, therefore preferred when sewage can be diverted to some river streams (flowing high during rainy season).

(*vii*) This method is preferred in areas of low water-table, where rate of percolation may be quite high.

8.8. 'Effluent Irrigation' and 'Sewage Farming'—Difference Thereof

Although, outwardly, both these terms are used as synonyms to each other, yet there is one basic difference between them. This difference is that : *in 'effluent irrigation' (or broad irrigation), the chief consideration is the successful disposal of sewage, while in 'sewage farming', the chief consideration is the successful growing of the crops.*

Hence, in *broad irrigation*, the raw or settled sewage is discharged on a vacant land, which is provided underneath, with a system of properly laid under-drains. These under-drains, usually, consist of 15 to 20 cm dia porous tile pipes, laid open jointed at a spacing of 12 to 30 m. The effluent collected in these drains after getting filtered through the soil pores is generally small (as a large quantity gets evaporated) and well stabilised, and can be easily disposed into some natural water courses, without any further treatment.

In case of *sewage farming*, however, the stress is laid upon the use of sewage effluents for irrigating crops and increasing the fertility of the soil. The pre-treatment of sewage, in removing the ingredients which may prove harmful and toxic to the plants is, therefore, necessary in this case.

However, in general, for all practical purposes, both these terms are used as synonyms, and both means : use of sewage effluents for irrigating crops.

8.9. Methods of Applying Sewage Effluents to Farms

The sewage effluents can be used for irrigating farms exactly in the same manner as irrigation water is used for farming. The various techniques that are employed for irrigating crops are :

(1) *Surface Irrigation called Broad Irrigation*. In this method, sewage is applied in different ways, on to the surface of the land. Depending upon the mode of application, it can be of different types, such as :

(*i*) Free flooding ; (*ii*) Border flooding ;

(*iii*) Check flooding ; (*iv*) Basin flooding ; and

(*v*) Furrow irrigation method.

(2) *Sub-surface Irrigation*. In this method, sewage is supplied directly to the root zone of crops, through a system of properly laid open-jointed pipes. Sewage, as it flows through these pipes, percolates through the open joints, and is distributed in the surrounding area by the action of capillarity.

(3) *Sprinkler or Spray Irrigation*. In this method, sewage is spread over the soil through nozzles, which are fitted at the tips of pipes carrying sewage

under pressure. The process, being costly, is not preferred in India, although it gives very good results, like those of a natural rainfall.

All these methods of irrigation have been thoroughly discussed in "Irrigation Engineering and Hydraulic Structures" (Chapter 1) by the same author ; and can be referred to in special needs.

8.10. Sewage Sickness

When sewage is applied continuously on a piece of land, the soil pores or voids may get filled up and clogged with sewage solids retained in them. The time taken for such a clogging will, of course, depend upon the type of soil* and the load present in sewage. But when once these voids are clogged, free circulation of air will be prevented, and anaerobic conditions will develop within the pores. Due to this, the aerobic decomposition of organic matter will stop, and anaerobic decomposition will start. The organic matter will thus, of course, be mineralised, but with the evolution of foul gases like hydrogen sulphide, carbon dioxide and methane. This phenomenon, of soil getting clogged, is known as *sewage sickness of land* in question.

In order to prevent the sewage sickness of a land, the following preventive measures may be adopted :

(*i*) *Primary Treatment of Sewage*. The sewage should be disposed of, only after primary treatment, such as screening, grit removal, and sedimentation. This will help in removing settleable solids and reducing the B.O.D. load by 30% or so ; and as such, soil pores will not get clogged, quickly.

(*ii*) *Choice of Land*. The piece of land used for sewage disposal should normally be sandy or loamy. Clayey lands should be avoided.

(*iii*) *Under-drainage of Soil*. The land on which the sewage is being disposed of, can be better drained, if a system of under-drains (*i.e.* open joined pipes) is laid below, to collect the effluent ; and this will also minimise the possibilities of sewage sickness.

(*iv*) *Giving Rest to the Land*. The land being used for disposal should be given rest, periodically, by keeping some extra land as reserve and standby for diverting the sewage during the period the first land is at rest. Moreover, during the rest period, the land should be thoroughly ploughed, so that it gets broken up and aerated.

(*v*) *Rotation of Crops*. Sewage sickness can be reduced by planting different crops in rotation instead of growing single type of a crop. This will help in utilising the fertilising elements of sewage and help in aeration of soil.

(*vi*) *Applying shallow Depths*. The sewage should not be filled over the area in larger depths, but it should be applied in thin layers. Greater depth of sewage on a land does not allow the soil to receive the sewage satisfactorily, and ultimately results in its clogging.

A sewage-sick land can be improved and made useful by thoroughly ploughing and breaking the soil, and exposing it to the atmosphere.

8.11. Crops Grown in Sewage Farms and Their Hygienic Aspect

Infact, the city sewage is screened and sedimented before discharging it for irrigation. Neither biological treatment is given to it, nor it is disinfected. Due to this fact, the sewage effluents used for irrigation, normally remain contaminated. And since ifi all the broad irrigation methods (except furrow irrigation method), sewage applied for irrigation will come in direct contact with the plants, it may endanger the life and health of the people, if at all the crops grown are eaten raw, as the sewage is a potential carrier of germs and pathogenic bacteria, likely to cause diseases like typhoid, cholera, dysentery, etc. From public health point of view, therefore, no *crops which are to be eaten raw or without any skin removal, and which come in direct contact with the sewage, should be grown on sewage farms.*

Green vegetables, potatoes, etc. should, therefore, never be grown in such farms. However, crops like cotton, groundnut, grains, tobacco, sugarcane, etc. may be raised successfully on a sewage farm. Grass and fodder may also be raised, provided however, care is taken to see that the cattle do not graze on sewage wet fodder.

In any case, the crops grown on sewage farms should be properly labelled and marked*, so that the public knows about their source, and is cautious in their use.

It is suggested that, if at all vegetables are grown and sold in the market without any control, as is happening in Delhi (the capital city of India), the public should take preventive measures by keeping the raw vegetables submerged for at least 10 minutes in 1 in 400 water solution of bleaching powder, and then thoroughly wash them with water, before use. The use of potassium permanganate for disinfecting vegetables is not recommended, as by its use, the vegetables tend to loose freshness and crispness.

The health of the farmers working in the fields, is also an important factor. They should also take adequate precautions by wearing gum boots and gloves, as otherwise, the larvae present in sewage effluent may get into their body, through direct contact, causing diseases, most commonly the intestinal worms.

8.12. Dilution Method *Vs.* Land Disposal Method for Disposal of Sewage

(*i*) For disposal by dilution, large volumes of natural clean waters (with nil or very low B.O.D.) are required ; whereas, for land disposal, large areas of land, preferably with sandy soils, are required.

(*ii*) The cost of land, in land disposal method, is generally very high, specially in cities and urban areas, which are generally situated near rivers or oceans, and thus suggesting the choice of dilution method. Whereas, in the rural areas, where the amount of sewage produced is less, land being available at lesser cost, no easy water source being available, the land disposal method is a better choice.

(*iii*) When the cost of land is high in land disposal method, some return may be available due to sewage farming ; but then good management is also

required. Dilution method of disposal, however, when possible, is a simple method, and does not require too much of management.

(*iv*) Land disposal method requires either no pre-treatment of sewage or only preliminary treatment ; whereas, dilution method of disposal, generally requires either full or at least partial treatment.

(*v*) Dilution method of sewage disposal requires nil or small head pumping, because rivers flow through the lowest contours, while land disposal requires high head pumping, thus making the land disposal method costlier.

(*vi*) Land disposal method is generally found to be a better choice in hot climatic areas. This is because of the fact that in hot areas, D.O. contents of natural waters are reduced, while fish and aquatic life need higher D.O. concentrations, thus rendering rivers (particularly those with small dry weather flows) susceptible to too much pollution and unfit for throwing untreated or less treated sewage. A lot of pretreatment, if required, will make the dilution method costlier.

(*vii*) Land disposal saves the inland rivers from getting polluted by sewage, and returns to the land the fertilising elements, which were once drawn from it. Dilution in river water will naturally cause downstream river water to become polluted, and an unavoidable health hazard. The towns and the cities situated downstream of the disposal point (particularly those near the zone of degradation and zone of active decomposition) cannot utilise river water without thorough and costlier treatment. Sometimes, the river water may get so much polluted that it may become almost impossible to purify it within the normal economics. Due to the pollution of the river, fish life may be lost, resulting in a good loss to the economy. Moreover, the recreational uses of the river will be gone, if it becomes polluted.

For most of the Indian towns and cities, the land disposal method is a better choice, because of the following reasons :

(*i*) Due to hot climate, D.O. contents of river waters are low, while the fish and aquatic life requires higher D.O. concentrations for their survival, thus rendering the dilution method more difficult and prohibitive.

(*ii*) There are only a few coastal towns in India, which have strong tidal currents moving in the forward directions, and the necessary depth of water at the point of disposal, thus, prohibiting the disposal of sewage in the sea on large scale.

(*iii*) Most of the inland rivers, flowing in the vicinity of our cities and towns, do have very small amounts of dry weather flows in them. Most of them run dry during summer season. Even the perennial rivers like Yamuna, have very low dry weather flows in them. Further, these very rivers are the only sources of water supply to these cities and towns. All these factors make it almost imperative upon us, as not to throw away our sewage in rivers, but to throw it away on land. Even if it is decided to be thrown into the rivers, a lot of pre-treatment will be required, which will make it very costly.

(*iv*) Except for a few major cities, the water supplies in India are very low (90 to 120 litres per capita per day), thus resulting in the production of highly concentrated sewage, which on travelling in our hot climate, becomes very stale and septic by the time it reaches the disposal point, thus prohibiting the use of dilution method for its disposal.