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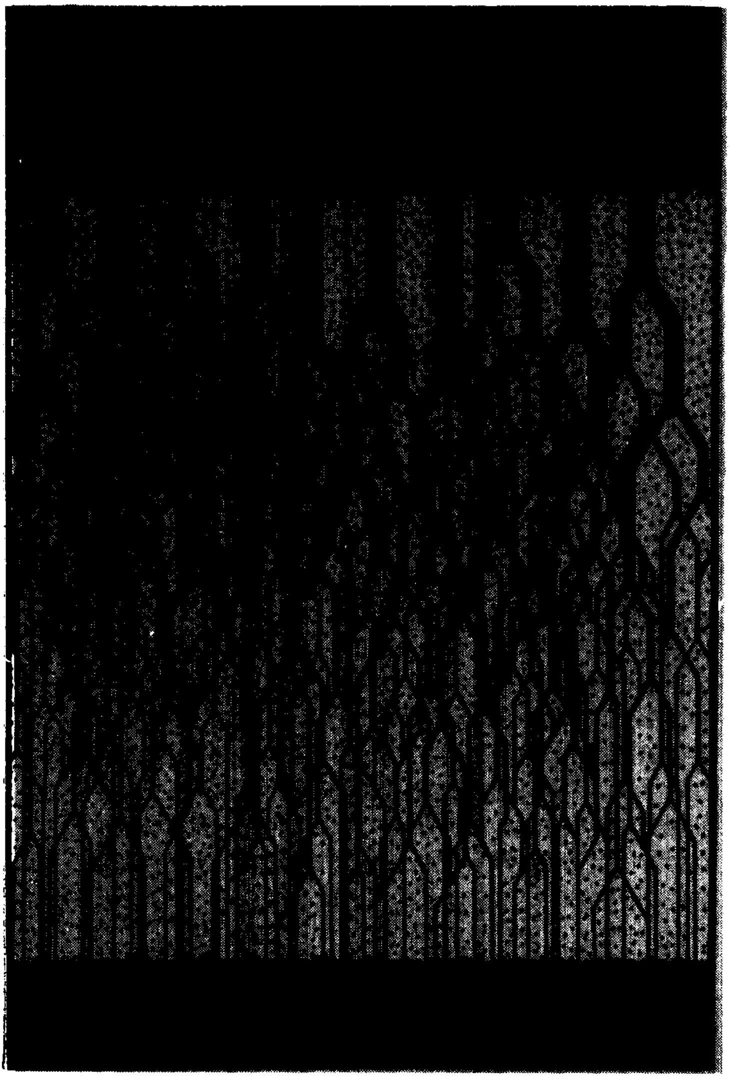
A Practical Technology

Rapid Infiltration

A Viable Land Treatment Alternative



Rapid Infiltration - A Viabl

Objective: Simplicity
As we move through the 1980s, the need to protect our streams, lakes, and ground waters continues to warrant high priority. This task is made more difficult by the ever-increasing costs of energy, chemicals, and equipment necessary for wastewater treatment systems. Today, municipal officials and consultants agonize over the many decisions required to achieve the objective of satisfactory water quality at a cost which can be borne by the community without creating serious financial hardships.

If we are to achieve the objective of cost-effective waste treatment, new alternatives are needed to compete with the traditionally accepted methods. In some cases, this means uncommon and innovative techniques. In others, it simply means a reshaping and refining of old ideas into improved processes, for instance, the land treatment process known as rapid infiltration. Used with established knowledge and suitable site conditions, rapid infiltration can offer a very efficient and cost-effective wastewater treatment alternative.

Process Description
Rapid infiltration is a very site-specific wastewater treatment process which can be used effectively only at certain sites. These sites must contain well drained soils which have moderate to moderately high permeability rates. Wastewater is first given an appropriate level of preapplication treatment and then applied to the treatment site at relatively high hydraulic loading rates.

A variety of application techniques can be used such as sprinkler irrigation or, as shown on Figure 1, flooding of an infiltration basin. As a basin is flooded, the applied wastewater percolates down through the bottom of the basin, through the soil profile, and eventually into the ground water. Depending on site conditions the renovated water may remain in the ground water aquifer or eventually enter surface waters. As in any land treatment system, the wastewater is renovated by a combination of physical, chemical, and biological processes prior to entering the aquifer.

After an individual basin is filled to a shallow depth, it is allowed to drain and dry. This restores aerobic conditions in the soil prior to the next application. In

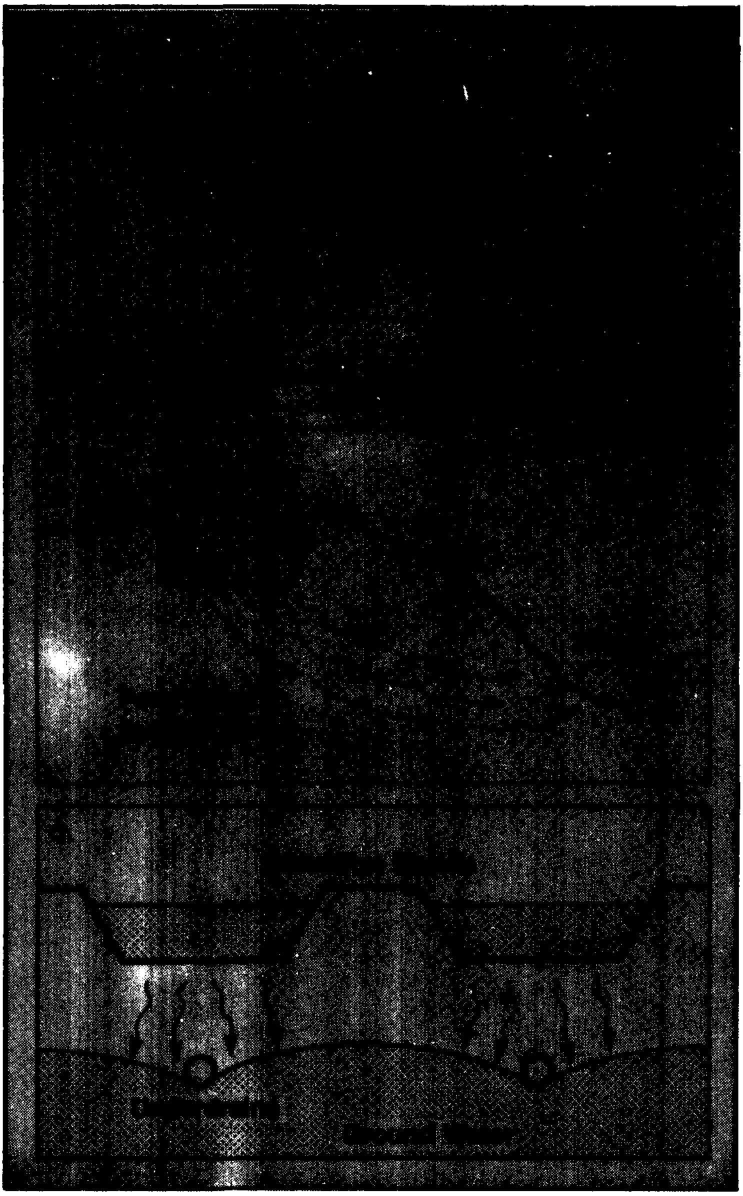


Figure 1 Rapid Infiltration Schematics

order to accomplish the alternate wetting and drying cycles without interrupting continuous treatment, more than one basin is required, and several are often used in a single system.

Compared to other land treatment processes (e.g. slow rate irrigation and overland flow), vegetation plays a minor role, and in many cases, is not used at all. Rapid infiltration systems have also shown an ability to operate effectively in both wet and cold weather, thereby minimizing or eliminating the need for cold season storage.

Certain sites contain soils which are well suited for the use of rapid infiltration, but also contain limitations which will restrict the effective use of the process. Examples of these are sites with a high ground water table and sites underlain with low permeability soils or shallow fractured bedrock. However, even here, if suitable soils are of sufficient depth, it is often possible to utilize subsurface wells or drainage systems to help overcome many of these limitations (see Figure 1c).

Design Considerations

Rapid infiltration, following primary clarification, can be used in lieu of a conventional secondary treatment process, or it can be used as a polishing process following conventional secondary treatment. Many of the process design parameters are very site specific. Therefore, it is not possible to provide a set of design criteria which will be applicable for all situations. Table 1 lists key design factors and ranges which are applicable to most rapid infiltration systems. Full details are contained in the EPA Process Design Manual on Land Treatment of Municipal Wastewater.

[illegible]	[illegible]

Table 1 Rapid Infiltration Design Factors

Performance
Rapid infiltration systems are capable of providing high levels of treatment. BOD and suspended solids are removed almost completely by filtration and biological degradation at or near the soil surface. Fecal coliform removal efficiencies are proportional to the depth of the soil through which the wastewater must travel. Removal efficiencies are excellent with adequate distance. Phosphorus and trace element removals are dependent on the composition of the soil as well as the distance of travel. Travel of 10 feet to a few hundred feet achieves excellent removals in most circumstances.

Total nitrogen removal will vary according to the operating scheme used. Very high levels of nitrification are typical in a rapid infiltration system. Rapid infiltration systems can be managed to achieve microbial denitrification to change nitrate to nitrogen gas and prevent the nitrate from entering the ground water. Managing to achieve denitrification requires special expertise and considerations in the design and operation of a project at the present time.

Table 2 shows the type of treatment performance which can be expected from a rapid infiltration system.

[illegible]	Typical Average	Upper Range
[illegible]	5	<10
[illegible]	2	<5
[illegible]	0.5	<2
[illegible]	10	<20
[illegible]	1	[illegible]
[illegible]	10	[illegible]

Table 2 Expected Quality of the Percolate from a Rapid Infiltration System

Current Use
The rapid infiltration process is currently being used for the treatment of both municipal and industrial wastewaters. Table 3 shows the location and size of selected rapid infiltration systems that are presently treating municipal wastewaters.

[illegible]

Table 3 Selected Operational Rapid Infiltration Facilities

Costs
Both the capital and operating and maintenance costs for a rapid infiltration system can be very competitive with the costs of other treatment technologies. The actual costs will depend on various factors such as land costs, transport distance, soil permeability, and degree of preapplication treatment. However, four important factors help keep the costs of these systems low. These factors, common to most rapid infiltration systems, are: (1) high hydraulic loading rates that keep the land area requirements to a minimum; (2) minimal need for seasonal storage; (3) no need for a high pressure application system; and (4) very low operation and maintenance costs. This makes both construction costs and energy requirements very low.

One example of the potential savings offered by the rapid infiltration process is the Bozeman, Montana, project, a 5.57 mgd system which became operational in 1982. The stream discharge requirements for this facility included an ammonia limitation. The Facilities Plan recommended the use of a rapid infiltration system, preceded by activated sludge, at an estimated cost of $9.0 million. The next lowest treatment option which could meet the ammonia limitations was a secondary treatment system followed by a fixed growth process at a projected cost of $11.1 million, 23% higher than the rapid infiltration process option. The actual construction cost of the combination activated sludge/rapid infiltration system was only $7.8 million, due chiefly to the elimination of the ammonia limitation during winter.

Advantages

Used under the proper conditions, rapid infiltration systems offer the following advantages:

- Lower land requirements compared to other land treatment processes.
- Can be operated in cold and wet weather without storage.
- Low construction costs.
- Low energy requirements and operating costs.
- Simplicity of operation.
- Performance equal to or better than comparable conventional treatment processes.

Limitations

The following factors must be adequately considered in order to use rapid infiltration as an effective wastewater treatment process:

- The soil conditions must be favorable and construction must not destroy the needed permeability.
- The hydrogeologic conditions must be favorable (i.e. adequate depth of soils and depth to ground water, favorable subsurface drainage).
- Careful site testing and conservative safety factors are needed to select successful design hydraulic load rates.
- Close operational control is needed when nitrogen removal must be achieved to meet system requirements.

Figure 2 Flooding of a Rapid Infiltration Basin

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