9.

Wastewater storage and treatment reservoirs

While it is true that waste stabilization ponds can more easily produce effluents suitable for agricultural reuse (principally crop irrigation – see Section 10) than other wastewater treatment processes, they share the same disadvantage with these other processes, namely that their effluent can only be used for crop irrigation during the irrigation season. During the other months of the year, the effluents are discharged, essentially to waste, to a surface watercourse.

Wastewater storage and treatment reservoirs (WSTR), also called effluent storage reservoirs, were originally developed in Israel to overcome this disadvantage and permit the whole year's treated wastewater to be used for crop irrigation during the irrigation season. WSTR are especially advantageous in arid and semi-arid areas (such as Israel) where agricultural production is limited by the quantity of water (including treated wastewater) available for irrigation. Wastewater is too valuable to waste in arid and semi-arid areas, and the use of WSTR prevents such waste.

9.1 SINGLE-WSTR SYSTEM

In Israel, where treated wastewater is extensively reused, mainly for the irrigation of cotton, the practice is to treat the wastewater in an anaerobic pond and to discharge its effluent into a single WSTR which is 5-15 m deep (Figure 9.1). The irrigation season in Israel is four months long, and so the single WSTR has a storage capacity equivalent to eight months wastewater flow. It is full at the start of the irrigation season, and empty at the end of it.

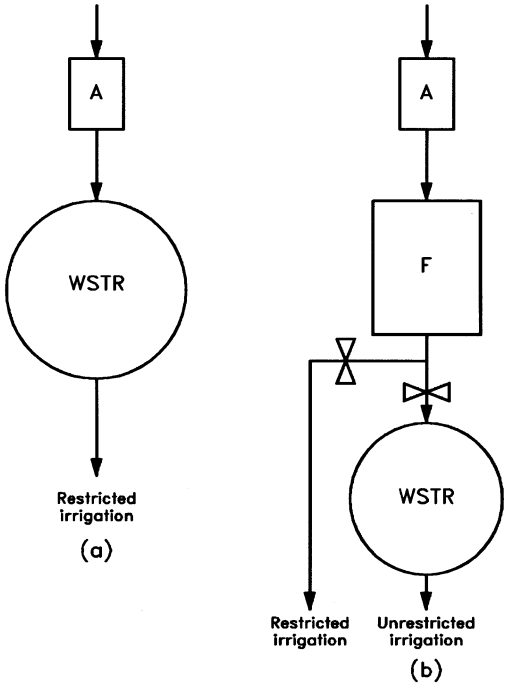

Figure 9.1
(a) single-WSTR system for restricted irrigation, (b) hybrid WSP-WSTR system for both restricted and unrestricted irrigation. A, anaerobic pond; F, facultative pond. In (b) a maturation may be necessary after the facultative pond – see text.

In this way three times as much land can be irrigated, and three times as much cotton (or other crops) produced. Further details are given in Juanico and Shelef (1991, 1994) and Juanico (1995).

Design Example No. 5(a) in Annex I shows how a single-WSTR system is designed for restricted irrigation.

9.2 HYBRID WSP-WSTR SYSTEM

The Israeli system described above is for restricted irrigation (see Section 10.1), and the long retention time in the WSTR ensures that the effluent contains > 1 intestinal nematode egg per litre, which is the WHO (1989) guideline for restricted irrigation (Table 10.1). However, if farmers wish to practise unrestricted irrigation (i.e. the irrigation of vegetables, including salad crops eaten raw), the above single-WSTR system is not suitable as the effluent will contain >1,000 faecal coliform bacteria per 100 ml, which is the WHO (1989) guideline for unrestricted irrigation (Table 10.1).

For unrestricted irrigation, two WSTR options are available:

(a) three or four sequential batch-fed WSTR (Mara and Pearson, 1992), and
(b) a "hybrid" WSP-WSTR system.

Only option (b) is described here as the O&M requirements of option (a) are somewhat complicated. Furthermore all the effluent produced by option (a) is suitable for unrestricted irrigation, whereas option (b) produces roughly equal proportions of effluent suitable for restricted and unrestricted irrigation, which is what most agricultural production systems need. Option (b) is highly cost-effective (see Mara *et al.*, 1997) and cheaper than option (a), and only slightly more expensive than the Israeli single-WSTR system (which produces effluent suitable only for restricted irrigation).

The hybrid WSP-WSTR system is shown in Figure 9.1. The wastewater is treated in an anaerobic and facultative pond. During the months when effluent is not required for irrigation, the facultative pond effluent is discharged into a single WSTR; during this period the long retention time ensures that faecal coliform numbers in the WSTR fall to below 1000 per 100 ml. During the irrigation season the facultative pond effluent is used for restricted irrigation, and the WSTR contents for unrestricted irrigation.

Depending on the retention times in the anaerobic and facultative ponds, and the number of intestinal nematode eggs in the raw wastewater, it may be necessary to have a single maturation pond between the facultative pond and the WSTR. This is to ensure that the effluent used for restricted irrigation contains ≤ 1 intestinal nematode egg per litre (see Section 4 and Design Example No. 2 in Annex I).

Thus if, for example, the irrigation season is six months long, the hybrid WSP-WSTR system permits twice the area of land to be irrigated – half for restricted irrigation and half for unrestricted irrigation. As noted in Section 10, discussions must be held with the local farmers to ensure that they are aware of these two irrigation water qualities. In order to protect public health the facultative (or maturation) pond effluent can *only* be used for restricted irrigation.

Design Example No. 5(b) in Annex I shows how a hybrid WSP-WSTR system is designed.