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Rehabilitation and upgrading

10.1 REHABILITATION

Some WSP systems may not be functioning properly. This may simply be due to overloading (in which case the WSP system needs extending – see Section 10.2), but it can often be the result of:

(a) poor process and/or physical design;
(b) poor design and/or operation of the inlet works; and/or
(c) inadequate maintenance of the ponds.

The effects can be quite serious: odour release from both anaerobic and facultative ponds; fly breeding in anaerobic ponds; floating macrophytes or emergent vegetation in facultative and maturation ponds leading to mosquito breeding; and in extreme cases the ponds can silt up and completely “disappear”.

Rehabilitation is achieved by a combination of the following:

(a) a complete overhaul (or redesign) of the inlet works, replacing any units that cannot be satisfactorily repaired;
(b) repairing or replacing any flow measuring devices;
(c) ensuring that any flow-splitting devices actually split the flow into the required proportions;
(d) desludging the anaerobic or primary facultative ponds, and any subsequent ponds if necessary;
(e) unblocking, repairing or replacing pond inlets and outlets;
(f) repositioning any improperly located inlets and/or outlets, so that they are in diagonally opposite corners of each pond;
(g) repairing, replacing or providing effluent scum guards;
(h) preventing “surface streaming” of the flow when the pond is stratified by discharging the influent at mid-depth (or by installing a baffled inlet to achieve the same effect);
(i) removing scum and floating or emergent vegetation from the facultative and maturation ponds;
(j) checking embankment stability, and repairing, replacing or installing embankment protection;
(k) checking for excessive seepage (>10 percent of inflow) and lining the ponds if necessary;
(l) cutting the embankment grass; and
(m) repairing or replacing any external fences and gates; fences may need to be electrified to keep out wild and domestic animals.

As rehabilitation can be expensive, good routine maintenance (Section 8.2) is very much more cost-effective.

10.2 UPGRADING AND EXTENDING EXISTING WSP

Prior to upgrading or extending a WSP system its performance should be evaluated as described in Section 9.2, as this will generally permit the correct decision about how to upgrade and/or extend the system to be made.

A number of strategies can be used to upgrade and extend WSP systems (EPA, 1977). In addition to any rehabilitation measures needed (Section 10.1), these include:

(a) provision of anaerobic ponds;
(b) provision of additional maturation ponds;
(c) provision of one or more additional series of ponds; and/or
(d) alteration of pond sizes and configuration – for example, removal of an embankment between two ponds to create a larger one.

Figure 10.1 shows how (a), (b) and (d) above can be combined to upgrade a single series of WSP to receive twice its original design flow – at a lower overall retention time, and with the production of a higher quality effluent which meets the WHO guideline value for unrestricted irrigation (see Section 10.1).

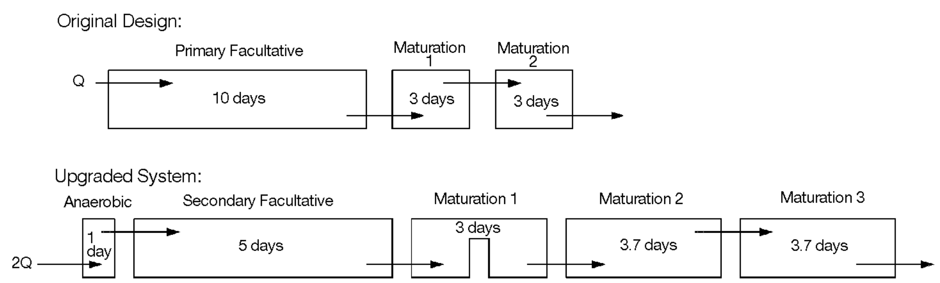

Figure 10.1 Upgrading a WSP series to treat twice the original flow. The embankment between the original maturation ponds becomes a baffle in the upgraded first maturation pond. The total retention time is increased only from 16 to 16.4 days. The improvement in mircrobiological quality can be illustrated as follows, by using equation 6.12 with N_i = 5×10^7 per 100 ml and $k_T = 2.6\ d^{-1}$ (i.e. for 20ºC):

Original system: $N_e = 5 \times 10^7 / [(1 + (2.6 \times 10))\ (1 + (2.6 \times 3))^2]$
$= 24{,}000$ per 100 ml

Upgraded system: $N_e = 5 \times 10^7/[(1 + (2.6 \times 1))\ (1 + (2.6 \times 5))\ (1 + (2.6 \times 3))\ (1 + (2.6 \times 3.7))^2]$
$= 1{,}000$ per 1000 ml

10.3 ALGAL REMOVAL

The algae in a WSP effluent contribute to both its suspended solids content and BOD. If the local regulatory agency does not make allowance for the inherent difference between algal SS and BOD and “ordinary” effluent SS and BOD (see Section 6.1), it may be necessary to incorporate an algal removal technique to “polish” the WSP effluent. The most appropriate technique for this is a rock filter, although it should be noted that algal removal is not necessary if the effluent is used for crop irrigation or fish culture (Section 12).

Rock filters consist of a submerged porous rock bed within which algae settle out as the effluent flows through. The algae decompose releasing nutrients which are utilized by bacteria growing on the surface of the rocks. In addition to algal removal, significant ammonia removal may also take place through the activity of nitrifying bacteria growing on the surface of the filter medium.

Performance depends on loading rate, temperature and rock size and shape. Permissible loading increases with temperature, but in general an application rate of 1.0 m^3 of pond effluent per m^3 rock bed per day should be used. Rock size is important, as surface area for microbial film formation increases with decreasing rock size but, if the rocks are too small, then problems can occur with clogging. Rock size is normally 75 – 100 mm, with a bed depth of 1.5-2.0 m. A typical rock filter is shown in Figure 10.2 (see also Figure 3.5). The effluent should be introduced just below the surface layer because odour problems are sometimes encountered with cyanobacterial films developing on wet surface rocks exposed to the light.

Construction costs are low and very little maintenance is required, although periodic cleaning to remove accumulated humus is necessary, but this can be carried out during the cooler months when algal concentrations are lowest. BOD and SS removals of 50 and 70 percent have been reported for maturation pond effluents in the USA (Middlebrooks, 1988).

Figure 10.2 Rock filter installed in the corner of a pond at Veneta, Oregon, USA