Phosphorous Standard for Wastewater Treatment Works

1.0 Introduction

Carlow County Council has to set a phosphorous discharge standard for the wastewater treatment works(WWTWs) in its region. To do so it must comply with current environmental legislation namely the Urban Wastewater Treatment Directive and the Phosphorous Regulations.

2.0 Legislation

The urban waste water treatment directive (UWWTD) is concerned with the collection, treatment and disposal of urban waste waters and the treatment and discharge of industrial waste waters.

The principal elements of the Directive are summarised as requiring:

- Collection systems (sewerage) in urban agglomerations designed and constructed in accordance *with Best Available Technology Not Entailing Excessive Cost* (**BATNEEC**) having regard to:
    - Volume and characteristics of urban waste water.
    - Prevention of leaks.
    - Limitation of pollution of receiving waters due to stormwater overflows.
- Collection systems to be in place by 31 December 1998, 2000 and 2005 for discharges to sensitive waters, populations of more than 15,000 and populations between 2,000 and 15,000 respectively.
- Waste water to be subjected to Secondary Treatment or equivalent prior to discharge.
- Treatment to be in place by 31 December 2000 and 2005 depending on size and location.
- **A higher level of treatment where discharge is to 'sensitive' waters.**
- The disposal of waste water be the subject of regulation.
- The discharge of industrial waste water into urban collection systems and treatment plants be the subject of regulation.
- The elimination of the disposal of sludge to surface waters by 31 December 1998.
- Sludge arising from waste water be reused whenever appropriate.
- **Discharges from treatment plants be monitored and reported.**
- A concession in relation to the classification of waters as *'less-sensitive'* and allowing treatment of a lower order than Secondary Treatment is included in the Directive.

The UWWT Directive was transposed into Irish Law by the Environmental Protection Agency Act, 1992 (Urban Waste Water Treatment) Regulations 1994 (SI 419 of 1994).

The UWWTD sets P discharge consent standards of 2mg/l of total phosphorous for WWTW between 10,000 and 100,000 pe and 1mg/l total P for WWTW greater than 100,000 pe where the WWTW is discharging into 'sensitive waters'. An equivalent percentage reduction in inlet P concentrations is also permissible. A list of 'sensitive' receiving waters is included in the Regulations. All these waters are inland. No waters around Ireland are classified as 'less-sensitive'.

The implications of the UWWTD for P reduction in WWTW are as follows:

- There is no P standard required by the UWWTD for WWTW under 10,000 pe.
- For WWTW greater than 10,000 pe and less than 100,000 pe a 2mg/l total P standard is required if the receiving water is designated 'sensitive'
- For WWTW greater than 100,000 pe a 1mg/l total P standard is required if the receiving water is designated 'sensitive'
- Employ the principle of BATNEEC in treatment of wastewater.

The other legislation concerning control of P discharges from wastewater treatment works is the Phosphorous Regulations of 1998 (Local Government (Water Pollution) Act, 1977 (Water Quality Standards for Phosphorous) Regulations, 1998). These regulations require that a Local Authority review the EPA's water quality data of inland river and lake waters and prepare a baseline report by 1998 of inland surface waters within their boundaries. The regulations require that the existing water quality or biological quality rating, as set out in this baseline report, be maintained if it is currently satisfactory or where the baseline biological rating is less than satisfactory that the rating is improved over time to a satisfactory condition and then is maintained. The Third Schedule of the Regulations defines various ratings and the improvements required. The Third Schedule uses both Biological Quality Ratings – Q Ratings and Molybdate Reactive Phosphate(MRP) concentrations. MRP concentrations are matched against Q Ratings. The LA is then required to plan, report and implement(under the BATNEEC principle) any measures required to maintain and/or improve the baseline water quality as required by the regulations.

The MRP concentrations detailed in the Third Schedule are very low and range from 0.015 mgMRP/l to 0.07 mgMRP/l in the surface water. These are median concentrations and by the sampling regime required to measure the median concentration they are based on an annual variation in surface water conditions. The relationship between total P and MRP is not easily defined and a useful guide when assessing discharges from WWTW is that the MRP is taken as half of the total P concentration.

The implications of the Phosphorous Regulations of 1998 for P reduction in WWTW are as follows:

- Very low annual median concentrations of MRP are set depending on the baseline water quality of the surface water as set by the EPA data available up to 1998.
- There is no method proposed for relating median MRP concentrations in the surface waters to WWTW final effluent discharges.

- Employ the principle of BATNEEC in maintaining/improving the baseline Biological Rating of the surface water.

3.0 Defining P Reduction Concentrations.

The UWWTD does not apply to WWTW under 10,000 pe with regard to P consent standards and for works greater than 10,000 pe it only applies if the receiving water has been designated sensitive. Therefore the principle environmental legislation that controls the discharges of phosphorous to surface water is the Phosphorous Regulations of 1998 (Local Government (Water Pollution) Act, 1977 (Water Quality Standards for Phosphorous) Regulations, 1998).

To evaluate the requirements of the P Regulations with regard to effluent discharges from WWTW a spreadsheet has been developed that calculates the MRP concentration in a stream/river for various sizes of WWTW and for various total P discharges. Three tables from this spreadsheet demonstrate the impact of P reduction concentrations for WWTW from 500 pe up to 2000 pe for three different discharge levels of total P – 10mgP/l, 2mgP/l and 1 mgP/l. The MRP value has been taken as half the total P concentration for calculating the MRP concentration in the receiving water. For discussion purposes a stream with a low 95%ile flow(10l/s) has been used to examine the MRP concentrations, this is a small stream but one that dose not quite dry up in the summer usually. The median flows are based on estimates for similar sized streams using data from the EPA.

Table 1 shows a total P discharge of 10 mg/l which is for a WWTW without any P reduction process in place. The light shading show the MRP concentrations at the 95% ile flow and at the estimated median flows. The P Regulations Third Schedule has the following MRP levels defined;

Existing Q Rating	Minimum Target Q Rating	MRP Median Concentration (mg/l)
5	5	0.015
4-5	4-5	0.020
4	4	0.030
3-4	4	0.030
3	3-4	0.050
2-3	3	0.070
<=2	3	0.070

Table 1 shows that WWTW discharges without P reduction can increase the level of MRP above the 0.070 mgMRP/l very quickly at median flows ie unless the river has a fairly high flow or the WWTW is small (<500 pe). The 0.070 MRP concentration is associated with seriously polluted waters as seen from the above data. For WWTW to require no P reduction the median flows would have to be very high as shown

by the heavier shaded boxes on the table – 350l/s for a 500pe works, 600l/s for a 800 pe works and 700l/s for a 1000pe works and this would be without background P levels in the river being taken into account. Therefore P reduction is required at WWTW.

In deciding what level of P reductions is required the levels set in the UWWTD are used as a guide. These are 2 mg/l and 1 mg/l. Table 2 shows the impact of a 2mg/l total P discharge in the final effluent and clearly shows that the river water concentrations of MRP for a Q5 water quality are more readily achieved for small WWTW(500 pe). However for larger works of 1500pe and over the MRP level from the WWTW alone is above 0.030 mg/l which is equivalent to a slightly polluted water and when background levels of MRP are taken into account could be equivalent to a moderately polluted water with MRP values in excess of 0.05 mg/l. Also when the 95%ile flows are considered the MRP levels are an order of magnitude greater than those required at the median level in the river throughout the year by the regulations.

Table 3 shows the impact of a 1mg/l total P discharge in the final effluent from a range of WWTWs and the table demonstrates that the MRP levels(0.015 – 0.03 mg/l) associated with Q4, Q4-5 and Q5 is achievable for WWTW of 2,000pe and under discharging into a fairly small stream as represented by the lighter shaded area. The MRP levels at the 95%ile flows are also significantly reduced and while still high compared to the median values required they will only occur in the river/stream for a short period and statistically a high value that occurs in the lower 50 % of results does not affect the median value. P unlike BOD and ammonia is not immediately toxic and therefore relatively high levels for a short period will not cause a pollution incident. The relevance of an annual median value of MRP appears to be that it reflects or relates to the biological diversity and hence health of the river/stream over an annual cycle. As can be see from Table 3 for the smaller works the Q5 MRP value is being well exceeded in the receiving water, but it must be remembered that there will be background P levels which are unaccounted for in the table. It is very difficult to evaluate the background level of MRP as an existing small WWTW without P reduction will be contributing a significant amount to the MRP level in any given waterway as is demonstrated by Table 1.

Reviewing Table 1 clearly shows that there is requirement for P reduction at WWTWs. Table 2 shows that a 2mg/l total P in the final effluent from a WWTW is insufficient to meet the requirements of the 1998 P Regulations on all but the smallest of WWTWs. Table 3 indicates that a 1mg/l level of total P in the final effluent will meet the requirements of the P Regulations unless there is a relatively large works (2,000 pe) discharging into a small stream with very low median flows.

Another consideration with regard to setting a P reduction standard is the process technology available to reduce the P to the required level. The traditional P reduction process is the use of an acid such as ferric chloride which changes the solubility of the P and makes it more readily settleable. Then more recently particularly on larger works there is biological P reduction which uses alternating anaerobic, anoxic and aerobic conditions to adsorb the soluble P. The third principle method is the use of membrane technology

which physically removes the soluble P. To achieve a lower than 1 mg/l total P is not feasible using biological P reduction on its own. The chemical addition method can achieve lower concentrations but not without other process difficulties as the addition of the acid reduces the pH which will prevent nitrification if there is insufficient alkalinity. Also the acid addition significantly increases the sludge production from a works. Membrane technology can achieve lower P concentrations down to quite low values of less than 0.1 mg/l, however it is very expensive to install and operate. Under the principle of BATNEEC the cost of membrane technology is unacceptable on both capital and operating grounds for P reduction alone as it can more than double the cost of the treatment works. If there are other factors driving final effluent requirements such as very low BOD or Faecal Coliform standards then the use of membrane technology could be considered.

4.0 Selecting the P Concentration for Final Effluent Discharges

A 1 mg/l total P final effluent standard is therefore selected and set for all WWTWs in the Carlow County Council region as this will meet the requirements of the regulations and maintain the principle of BATNEEC. There are two exceptions to this that can apply:

- Where a WWTW is less than 200 pe and is demonstrated as discharging into a stream with suitable 95%ile and median flows, as shown in Table 4, for this exception to apply supporting data must be fully and clearly presented.
- Where a WWTW is discharging into a river with larger median flows as shown in Table 5, in this case P reduction will still be required however the standard can be increased to a total P of 5 mg/l provided that the river can sustain this and that that the river flow data is available to demonstrate this.

The implications to Carlow County Council in setting a P reduction standard are as follows

- WWTW effluents will meet the 1998 P Regulations
- The UWWTD will be met in that the standard is greater than set by the UWWTD for P reduction into ‘sensitive waters’ unless one of the above exceptions are considered and then the UWWTD must be taken into account.
- There will be an increase in the amount of sludge produced from each works and this should be accounted for in the final design of the sludge handling stream and sludge treatment centre. For small works sludge treatment using sludge reed beds should be considered as these are more cost effective than transporting and treating sludge from these small works, particularly given the additional volumes expected.
- There will be an additional cost of treatment both in capital and operating costs at each WWTW.