4 STRATEGY FOR DEALING WITH I/I/E

Inflow and infiltration/exfiltration can cause a range of problems in sewer systems and to manage these systems effectively, an overall strategy for dealing with I/I/E is required. This strategy should form part of a complete asset management approach and should include a combination of short, medium and long-term measures.

Overall, however, effective management of inflow and infiltration/exfiltration requires a long-term mindset. Since privatisation of water services in the UK, capital expenditure on wastewater infrastructure has been governed by five year spending cycles. Programme constraints often rule out the option of I/I/E reduction, even though an initial assessment has indicated its cost effectiveness. Although the structure of water services in Ireland does not currently suffer from this disadvantage, it is still important that there is general awareness of the long term planning required with regard to I/I/E.

4.1 Short Term Measures

The expression 'short term' is used in this context to refer to a one-off investigation, as opposed to on-going programmes or permanent measures. Such an investigation may take a number of years so 'short term' should not be mistaken for 'quick-fix'.

Whatever the initial trigger for concern over I/I/E, a procedure is required which will address the concern and aid the decision-making process. It is recommended that the approach outlined in the *Sewerage Rehabilitation Manual (SRM) (WRc, 4th Edition, 2001)* be adopted. The general principles of the SRM formed the basis for the *European Standard EN752-5: Drain and Sewer Systems Outside Buildings: Part 5 Rehabilitation.*

The **Infiltration Reduction Procedure** described in Appendix A of the SRM is appropriate for both inflow and infiltration/exfiltration, although only the term infiltration is used in the manual. The following extracts describe the stages and principles of the procedure.

The stages of the procedure are:

i. A preliminary assessment, to establish if infiltration reduction is likely to be feasible and cost effective;

ii. A detailed investigation, through a review of existing data and, where appropriate, the targeted collection of new data;

iii. The development of solutions;

iv. Implementation;

v. Post project appraisal.

The main principles of the infiltration reduction procedure during these stages are:

a. An iterative approach, to gradually focus in on the source of excessive infiltration;

b. The need to consider the potential cost effectiveness of infiltration reduction, at each decision point in the procedure.

The iterative approach is illustrated in Figure 4.1.

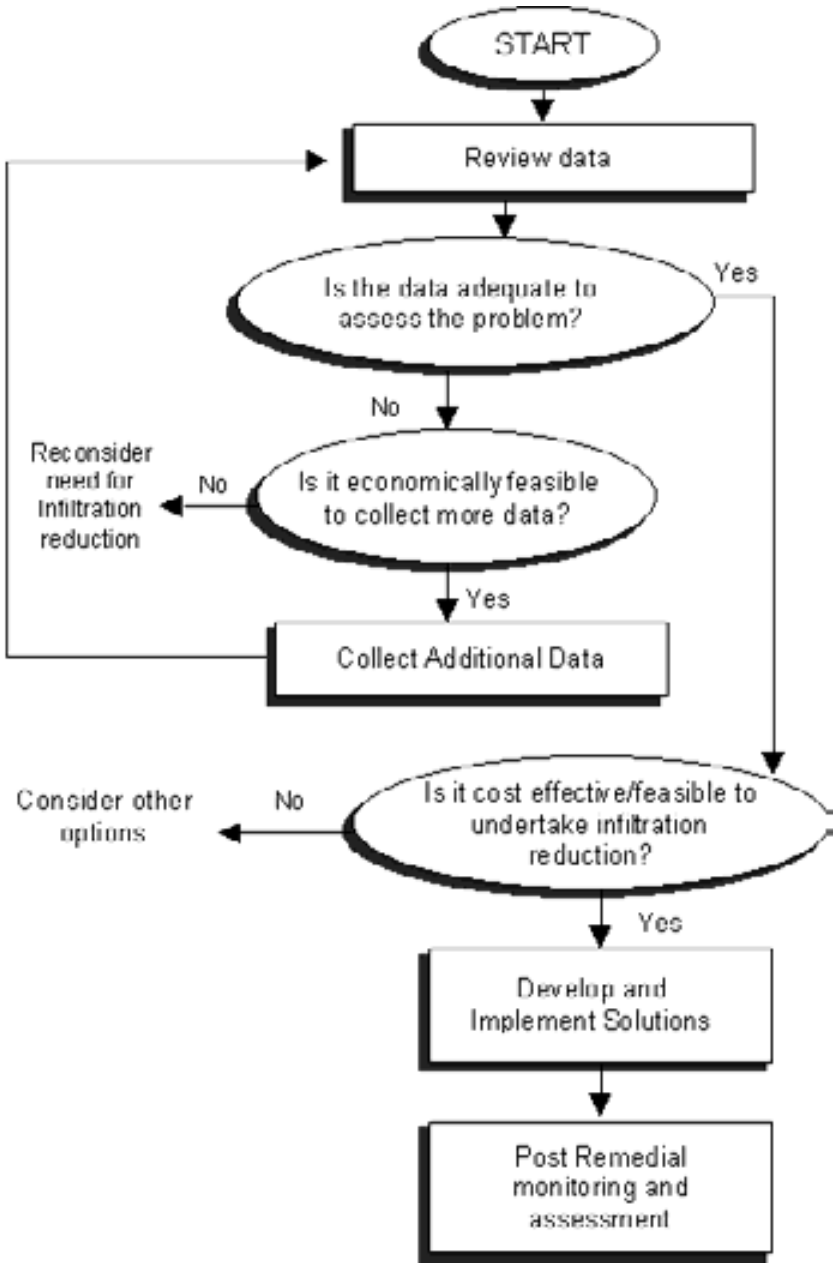

Figure 4.1 I/I/E Reduction Procedure – Iterative Approach

The process ensures that:

- the use of appropriate existing data is maximised and that additional data is only collected where it remains necessary to quantify and identify the location of infiltration;
- the cost of additional data collection is proportional to the potential savings from the proposed infiltration reduction;
- those investigations where infiltration reduction would not be a viable option are identified and, where appropriate, the investigation is terminated at the earliest opportunity.

The “Consider other options” caption in Figure 4.1 would be to retain the illegal flows and provide additional conveyance and treatment facilities.

The principles of cost optimisation were discussed in Section 2.7.

The 'preliminary assessment' and 'detailed investigation' stages mirror the SRM investigation procedure. The first stage can be undertaken in outline as part of the initial planning and the second stage as part of the hydraulic investigation.

The preliminary assessment should therefore include a pilot area for I/I/E reduction to establish the cost-effectiveness of such reduction programmes in the Dublin area. This pilot scheme should concentrate on the areas with various levels of I/I/E as identified by the GDSDS, starting with the worst areas and those with various types and age of development. The pilot study should include private drains to establish their effect on I/I/E in the overall system. The objective would be to establish typical rates of reduction actually achieved, together with the associated costs. Such information would then be used to manage the I/I/E reduction programme for the Region.

There are clear advantages to the 'holistic' approach of the full SRM procedure, i.e. consideration of all sewerage deficiencies in the catchment in order to maximise the benefits of any investment in system improvements. Indeed, it could be argued that the true costs of I/I/E cannot be evaluated without knowing all the deficiencies (hydraulic, environmental, etc.) in the system.

In addition, the benefits of a detailed hydraulic model of the sewerage system should not be underestimated when trying to quantify the individual components of I/I/E. The greater level of understanding provided by modelling means that resources available for I/I/E reduction are targeted more effectively.

However, although it is common for an I/I/E study to be triggered by the findings of a drainage area study, it is not essential that the two be done simultaneously. The preliminary assessment stage could be undertaken on its own to give an initial appreciation of I/I/E and the likely cost-effectiveness of reduction methods.

4.2 Medium Term Measures

Where there is evidence of inflow in a separate sewer system, a programme of identification and re-direction of mis-connections may prove to be cost effective (this should be demonstrated in the manner outlined in Section 2.7). Flow measurement surveys in supposedly fully separate foul sewers often record some degree of storm response. The most common sources of inflow are mis-connected roof downpipes, driveways and yard areas/patios. Roof downpipes from house extensions may be directed to the foul sewer even if the original house roof is drained correctly to a surface water sewer or soakaway.

An operations team can be set up to systematically identify and map these mis-connections. The timescale required will depend on the extent of the problem and the resources available. Solutions may range from simple re-direction of individual drains into the right sewer to larger schemes involving groups of properties. In private properties, the owner would normally be responsible for funding the remedial works. In some cases, an order may need to be imposed on the owner by the local authority to achieve the desired result.

A programme of this type requires considerable contact with the public. This should include informing the public of the reasons and aims of the programme in the broad sense, as well as during the operational phase. The former can be achieved by distributing publicity leaflets and the latter by means of a subsequent letter drop (e.g. 2 to 7 days before work begins in a particular area).

Lateral drains on private land may also be a significant source of infiltration/exfiltration in some catchments but the problem is more likely to be widespread due to general deterioration or poor workmanship. Replacing or repairing sewers and/or drains at the rear of properties in an urban area can be particularly difficult due to access and disruption. Nevertheless, there may be cases where particularly high point sources are traced to private properties and these can be addressed individually.

The requirement for survey of lateral drains as a condition of the sale of the building, and for proper sealing upon change of use or demolition of the premises, will contribute to the lessening of infiltration/exfiltration.

4.3 Long Term Measures

Data Collection and Management

A common problem encountered at the preliminary assessment stage of an I/I/E study is the lack of good quality long-term data of the type needed to draw conclusions about infiltration/exfiltration. Most sewage treatment works include flow measurement facilities of some sort but the collection and storage of the data is often suspect. Similarly at pumping stations, accurate long-term records can be difficult to obtain even though the facilities exist for measurement.

The value of long-term records has been stressed in previous sections and the establishment and maintenance of a system for the collection and storage of relevant data is strongly recommended. The most important data includes:

- sewage treatment works data – incoming flow and quality;
- flow at permanent flow monitor sites at strategic locations within large networks;
- pumping station data – pump run times/power usage;
- rainfall data;
- tide, river and groundwater level data.

There are, of course, many other areas where good records would be beneficial at the initial data review stage of an I/I/E investigation, e.g. flooding records, CCTV data, operational data, groundwater pollution data. However, the data in the list above is the most important and efforts should be focused on maintenance of a complete record of these values. For analysis of long-term variations in infiltration, daily data is adequate. Ideally, all data should be stored in digital database format within a Geographical Information System (GIS). The recommendations for the Regional Drainage GIS contain such proposals.

With this system in place, informed decisions can be made regarding I/I/E, either at the initial planning stage of a drainage area study / infiltration study, or preferably as part of on-going asset management. The existence of this information will also add value to the interpretation of other data such as CCTV and flooding records.

Sewerage Models

There is a growing realisation of the need for better management of existing sewerage assets. To achieve this, hydraulic models are increasingly seen as a potentially valuable tool.

Currently, models are invariably built for one-off studies to achieve a particular aim, such as solving a flooding problem or designing a sewage transfer scheme. On completion of the study, nothing more is done with the model and it becomes out-dated. However, the recent development of sewerage modelling software into a GIS-based approach means that the use of models for on-going asset management is becoming a more practical possibility.

As stated above, dealing with inflow and infiltration/exfiltration requires a long-term approach and on-going management of sewerage models would be consistent with this philosophy. Models verified originally using a single short-term flow survey can be updated and improved using long-term data. Updates can also be made following any remedial works undertaken to reduce I/I/E or capital works undertaken for any other reason. System performance can then be routinely assessed with some degree of confidence. Techniques for representation of I/I/E in sewerage models have improved considerably in recent years and the benefits of modelling for the 'short term' investigation stage have already been highlighted – a further shift in attitude is required to maximise the benefits of such models for long term asset management.

Asset Management

Since no sewerage system is leak free, then inflow/infiltration/exfiltration must be expected. The risk of occurrence must therefore be responsibly managed, as illustrated in Table 4.1.

For example the risk assessment of infiltration/exfiltration would involve a geological map, with a generic risk ranking system being developed based on the likely hydrogeological characteristics of the formation in which the sewers are to be placed, and hence the likelihood or otherwise of leaks having a harmful effect.

Factor	Risk	Management
Location of sewer	Pollution of groundwater from leakage	Minimise sewer construction near aquifers used for water sources. Impose stricter construction and testing requirements for sewers near vulnerable aquifers
Location of sewer	Inflow and infiltration from groundwater	Minimise sewer construction near water sources
Depth of sewer	Third party damage	Lay sewers and drains at minimum depth below other services
Age of sewer	Deterioration with age, previous poor quality	Target for renovation or replacement
Material of sewer	Deterioration with age, previous poor quality	Target for renovation or replacement
New construction of sewer	Poor quality design, materials and workmanship	Impose high quality specifications and rigorous checking regime
New construction of sewer	Inflow from mis-connections	Impose high quality specifications and rigorous checking regime
Existing construction of sewer	Inflow from mis-connections	Public education and inspections of suspect areas
Location of water supply network	Contamination by sewage entering pipework	Unlikely due to internal water supply pressure. Thorough cleansing and disinfection after maintenance of the water supply system
Location of groundwater	High water table interfacing with sewerage system	Minimise location of sewers near areas of high water table
Location of aquifers	Pollution of groundwater from leakage	Minimise sewer construction near aquifers used for water sources
Leakage from lateral drains	Drains in private ownership more likely to leak due to poor maintenance	Impose survey requirement as part of sale approval
Leakage from abandoned sewers and drains	More likely to leak due to lack of knowledge and ownership	Impose sealing requirement and rigorous checking
Water sources	Groundwater, especially that used for human consumption, will be contaminated	Impose requirement for registration of all water sources, and regular sampling and testing. Impose construction and inspection requirements for existing and new boreholes. Minimise groundwater sources in the vicinity of sewerage systems

Table 4.1 Management of I/I/E Risks

Practical requirements such as sewer location and depth will prevail in many instances, but the overall principles should be followed as good drainage design and construction practice. The imposition of high quality construction specifications and checking regime should be actioned, and are included in the New Development Policy.

The interaction between these factors and the risks they represent are best understood on a geographical basis. For that reason these factors are included in the proposals for the Regional Drainage GIS (RDGIS).

4.4 Summary of Measures

The combined set of measures for dealing with inflow and infiltration/exfiltration in sewerage systems is illustrated in Figure 4.2.

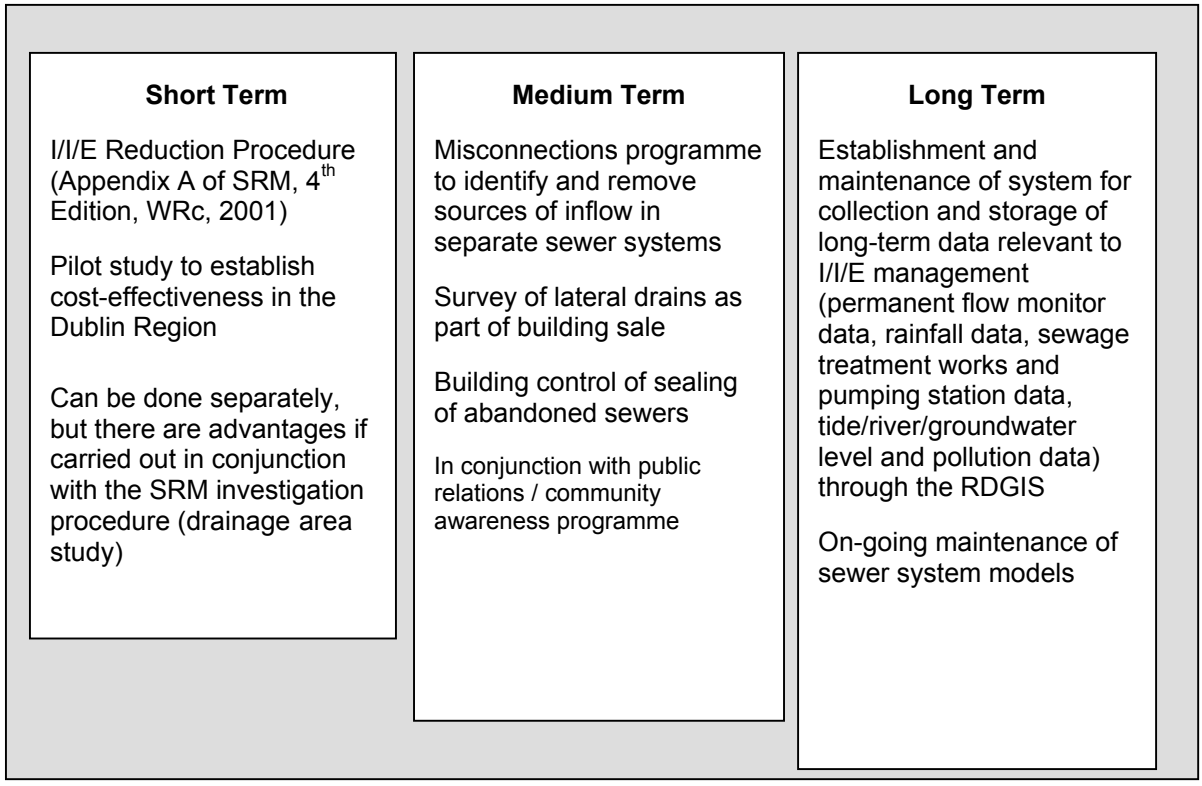

Figure 4.2 – Summary of Measures for Dealing with I/I/E

It is very evident that removal, or more realistically, significant reduction of I/I/E is a time-consuming and expensive process. It is far more cost-effective to avoid its occurrence in the first place. This can best be done by strictly controlling the quality of new and renovated sewerage installations, and by ensuring that best quality materials and construction techniques are used, to provide a long-lasting leak-free system. Connections must also be correctly made, and private drains and abandoned sewers managed to minimise the risk of leakage. Rigorous checking by Council Inspectors will ensure that sewerage construction will achieve its maximum life without defects.

The Regional Drainage Policy for New Development contains the procedures and specifications for implementing these requirements.