Code of Practice on Assessment and Control of Odour Nuisance from Waste Water Treatment Works

April 2005
Paper 2005/ 9

ISBN: 0-7559-2544-0

Scottish Executive
St Andrew's House
Edinburgh
EH1 3DG

Produced for the Scottish Executive by Astron B41319 04/05

Published by the Scottish Executive, April, 2005

Further copies are available from
Blackwell's Bookshop
53 South Bridge
Edinburgh
EH1 1YS

The text pages of this document are printed on recycled paper and are 100% recyclable.

Scottish Executive Environment Group

Code of Practice on Assessment and Control of Odour Nuisance from Waste Water Treatment Works

April 2005
Paper 2005/9

CONTENTS

1. INTRODUCTION & SCOPE

1.1 Scope and Structure of this Code

There are many different measures that can be used to prevent, reduce or control odour nuisance from waste water treatment works (WWTW). It is acknowledged at the outset that these facilities are likely to produce odours from time to time. This Code of Practice (CoP) provides a framework within which Scottish Water and its contractors, other WWTW operators and local authorities can operate to minimise the impacts of such odours, and identify steps to tackle odours of a significant nature.

This CoP will be of interest to all stakeholders involved with, and affected by, odour from WWTW. Part 1 of this CoP is specifically written to assist local authority Officers and the public in the investigation and assessment of potential odour nuisance from WWTW. Parts 1 and 2 of the CoP will assist when considering enforcement action against odorous works in forming a view on whether the operator has instigated measures which reflect the use of the best practicable means to control odour nuisance. The public, from whom odour complaints invariably arise, will find this CoP better informs them of the possible sources of odours, the steps involved in assessment of complaints and the complexity of the task the operator sometimes faces in implementing control measures.

The contents on Part 2 will be of particular relevance to operators as it outlines technical and management controls that are appropriate for the control of odour, because of their responsibility and ability to put in place the measures to prevent, stop or minimise odour problems from their plant.

Part 2 of this CoP describes appropriate measures which include:

- the general management of the WWTW;
- the design, installation and maintenance of plant, buildings and structures
- the operation of the WWTW and its processes; and
- engineering solutions, e.g. containment, enclosure with venting and end-of-pipe treatment

There is no simple "one-size fits all" solution to odour problems: often there is a combination of measures that go towards resolution of the problem. These can range from very simple (and often very inexpensive) measures, to very complex (and often costly) measures. Therefore, it is important that a timely, realistic, cost effective and proportionate approach is taken to resolve odour issues.

1.2 Legal Status of this Code

This is a voluntary CoP in that it is not underpinned by new legislation and therefore does not confer any new obligations or rights on any party. Its purpose is to inform both operators and regulatory agencies of the best practicable means of administering the existing legislation available within the Statutory Nuisance provisions contained within Part III of the Environmental Protection Act 1990. The Scottish Executive intends to produce statutory codes of practice on odour control at sewerage works by April 2006, using new powers granted to Scottish Ministers contained within the Water Services etc Act (Scotland) 2005.

This CoP is based on the state of knowledge and understanding at the time of writing. It draws on research work carried out for Defra and the Scottish Executive and may be amended from time to time to keep abreast of new developments.

1.3 What this Code applies to

This CoP focuses specifically on odour nuisance from WWTW. Whilst there are many potential odour sources at waste water facilities, this CoP applies to odour nuisance from WWTW themselves, rather than to the wider sewerage network.

This CoP does not apply to the small number of WWTW which are subject to the Integrated Pollution Prevention and Control (IPPC) regime regulated by the Scottish Environment Protection Agency (SEPA) under the Pollution Prevention and Control (PPC) Regulations. Separate guidance on the applicable standards for these processes will be produced in due course by SEPA.

In addition there may be some sites subject to the waste management licensing regime of Part II of the Environmental Protection Act 1990. However, in many cases the waste management licence will only apply to a limited range of operations at WWTW. In this case it is recommended that the local authority and Scottish Environment Protection Agency agree a common approach. In the final assessment of odour, the provisions of this CoP should apply to all releases from a WWTW that are likely to lead to potential odour nuisance.

2. GLOSSARY OF TERMS

Analytical assessment An assessment of an odorous sample using instrumentation to provide information on the concentration and possibly provide identification of the chemical species present. Compare with "sensory" assessment.

Area source A surface-emitting source, which can be solid (for example the spreading of wastes, material stockpiles, surface of a biofilter) or liquid (storage lagoons, effluent treatment plant).

BOD Biochemical Oxygen Demand

bpm Section 79(9) of the Environmental Protection Act 1990 provides that it is a defence against Statutory Nuisance action to prove that Best Practicable Means (bpm) have been used to control and mitigate the nuisance. The key parts of the term can be defined as:-
'practicable' means reasonably practicable having regard among other things to local conditions and circumstances, to the current state of technical knowledge and to the financial implications;
the '*means'* to be employed include the design, installation, maintenance and manner and periods of operation of plant and machinery, and the design, construction and maintenance of buildings and structures*;*

CEN Olfactometry Standard BS EN 13725: 2003, Air Quality - Determination of Odour Concentration by Dynamic Oflactometry

CoP Code of Practice on Assessment and Control of Odour Nuisance from Waste Water Treatment Works

Detection threshold The point at which an increasing concentration of an odour sample becomes strong enough to produce a first sensation of odour in 50% of the people to whom the sample is presented. This is a laboratory-based test and should be conducted according to the relevant CEN standard. The odour concentration at the detection threshold is one odour unit.

Diffuse sources Sources with defined dimensions (mostly surface sources) that do not have a defined waste air flow, such as waste dumps, lagoons, fields after manure spreading, un-aerated compost piles.

Dilution factor The dilution factor is the ratio between flow or volume after dilution and the flow or volume of the odorous gas.

Emission factor The emission per unit product (e.g. for wastewater treatment works expressed in this report the emission rate in $ou_E.s^{-1}$ per kg BOD, in screened sewage)

European odour unit ou_E/m^3 — That amount of odorant(s) that, when evaporated into 1 cubic metre of neutral gas at standard conditions, elicits a physiological response from a panel (detection threshold) equivalent to that elicited by one European Reference Odour Mass (EROM), evaporated in one cubic metre of neutral gas at standard conditions.

European Reference Odour Mass (EROM — The accepted reference value for the European odour unit, equal to a defined mass of a certified reference material. One EROM is equivalent to 123 µg n-butanol (CAS 71-36-3) when evaporated in 1 cubic metre of neutral gas (this produces a concentration of 0.040 µmol/mol).

Fugitive releases — Unintentional emissions from eg flanges, valves, doors, windows – that is, points which are not designated or intended as release points.

Hedonic scale — A judgement of the relative pleasantness or unpleasantness of an odour made by assessors in an odour panel. A methodology is described in VDI 2882. Odours which are more offensive will have a negative hedonic score whilst less offensive will tend towards a positive score.

Nuisance — A nuisance can be defined as "an interference with an interest in the use and enjoyment of private land, or the public interest in the use and enjoyment of public places", or "unacceptable material interference with the personal comfort or amenity of neighbours or a nearby community." There is always an element of professional judgement as to the point at which a nuisance occurs in respect of the particular circumstances of interference with comfort and amenity.

Odorant flow rate — The odorant flow rate is the quantity of odorous substances passing through a defined area at each time unit. It is the product of the odour concentration c_{od} and the outlet velocity v and the outlet area A or the product of the odour concentration c_{od} and the pertinent volume flow rate V, in e.g. m^3/h. Its unit is ou_E/h (or ou_E/min or ou_E/s, respectively).

Odour abatement efficiency — The reduction of the odour concentration or the odorant flow rate due to an abatement technique, expressed as a fraction (or percentage) of the odour concentration in the odorant flow rate of the untreated gas stream.

Odour concentration — The amount of odour present in a cubic metre of sample gas at standard conditions. The odour concentration is measured in European odour units (ou_E/m^3). The odour concentration at the detection threshold is defined to be 1 ou_E/m^3. If an odour sample has been diluted in an olfactometer by a factor of 10,000 to reach the detection threshold, then the concentration of the original sample is 10,000 odour units.

Odour detection To become aware of the sensation resulting from adequate stimulation of the olfactory system.

Odour Nuisance In the Code, it has been assumed that only a local authority or Court can assess whether a particular odour constitutes a Statutory Nuisance. Therefore, the term 'odour nuisance' is used throughout the code to reflect an odour that, if subject to assessment by a local authority or Court, would be regarded as a Statutory Nuisance. In respect of this Code, there is no difference between the characteristics of an odour nuisance and a Statutory Nuisance.

Odour Potential This term is a measure of the total odour which could be released by a liquid – it is the odour concentration in air that has been brought to equilibrium with the liquid sample by blowing air through the sample in a standard apparatus

Odour unit The amount of odorant(s) that, when evaporated into 1 cubic metre of neutral gas at standard conditions, elicits a physiological response from a panel (detection threshold) equivalent to that elicited by one European Reference Odour Mass (EROM), evaporated in one cubic metre of neutral gas at standard conditions

Offensiveness An expression of the degree of unpleasantness of one odour relative to another. The perceived offensiveness of an odour will vary between individuals as a result of both physical and psychosocial differences, but in a population a relatively consistent response on the relative offensiveness of different odours is returned.

Olfactometer Apparatus in which a sample of odorous gas is diluted with neutral gas in a defined way and presented to a odour panel under reproducible conditions.

Olfactometry Measurement of the response of assessors to olfactory stimuli. (ISO 5492).

Olfactory Pertaining to the sense of smell (ISO 5492).

OIP An Odour Improvement Plan (OIP) should be prepared for all processes where the odour nuisance is not abated by the application of Baseline measures as detailed in Section 12. The fundamental requirement of the OIP is to evaluate the sources and causes of odour to ascertain whether a nuisance exists and to development an odour control scheme. The plan should review all available control options and compare the capital and operating costs for each option along with the environmental impacts (for example due to secondary pollutants and energy and raw materials use).

OMP	The Odour Management Plan (OMP) is a core document that is intended to detail operational and control measures appropriate to management and control of odour at the site. The format of the OMP should provide sufficient detail to allow operators and maintenance staff to clearly understand the operational procedures for both normal and abnormal conditions.
pe	Population Equivalent – a term used to define the treatment capacity or load on a WWTW. The EC Urban Waste Water Directive 91/271/EEC (UWWT) defines the term and 1 pe is the biodegradable load in wastewater having a 5-day biochemical oxygen demand (BOD) of 60g of oxygen per day.
PFI	Private Finance Initiative – this is a way of funding major capital investments, without immediate recourse to the public purse. Private consortia are contracted to design, build, and in some cases manage and operate WWTW.
Point source	An intentional point of release such as a vent or chimney, where it may be possible to obtain a sample in order to quantify the concentration and determine the mass release rate
ppb	Parts per billion
ppm	Parts per million
PPP	Public Private Partnership – a mechanism for public bodies and private companies to work together on a project. Private Finance Initiative is one form of Public Private Partnership.
Recognition threshold	The odour concentration which has the probability of 0.5 of being recognised under the conditions of the test. The recognition threshold is generally a higher concentration than the detection threshold. It is generally two or three odour units in a laboratory setting but may be higher than this outside the lab.
Sample	The odorous gas sample which is assumed to be representative of the gas mass or gas flow under investigation, and which is examined to determine the odour concentration, to characterise the odour or to identify constituent compounds.
Sensitive receptor	People who are exposed to odour released from a given source, or have the potential to be exposed. Unlike other pollutants, odour at environmental exposure levels is not considered in terms of possible detrimental effects on animals and plants.
Sensory	Relating to the human response to a particular stimulus (in this case odour).

SEPA	Scottish Environment Protection Agency
Statutory Nuisance	As per Section 79 (1) (d) of the Environmental Protection Act 1990 – smell arising on industrial, trade or business premises and being prejudicial to health or a nuisance. In the Code, it has been assumed that only a local authority or a Court can assess whether an odour constitutes a Statutory Nuisance. Therefore the term has only been used where it relates to such as assessment – in all other cases the term 'odour nuisance' has been used. In respect of this Code, there is no difference between the characteristics of an odour nuisance and a Statutory Nuisance. The final decision on what constitutes a Statutory Nuisance rests with the Courts.
UWWT	The EC Urban Waste Water Directive 91/271/EEC
VOC	Volatile Organic Compounds - Organic substance that will readily evaporate and transfer from a liquid into a gas phase.
WCCP	Water Customer Consultation Panel
WICS	The post of Water Industry Commissioner for Scotland
WWTW	Waste Water Treatment Works – for the purpose of this Code, a WWTW is any location at which waste water is subject to physical, chemical or biological treatment. This Code only relates to treatment works and will not specifically address the potential odour issues associated with the sewerage transport system (drains, sewers and remote pumping stations).

Part 1
Code of Practice on Assessment of Odour Nuisance from Waste Water Treatment Works

3. AN OVERVIEW OF THE PROBLEM

Waste water is produced as a by-product of human existence and numerous industrial processes. Although primarily water, waste water contains various other biological and chemical materials which, if released in an uncontrolled manner to the environment are capable of causing pollution. The production, transmission and treatment of waste water can result in the generation of odour.

There are many different means of preventing, controlling or reducing odours to minimise the impact of odour in the locality of WWTW and avoid creation of odour nuisance. This CoP defines a clear pathway for the development of an action plan for the resolution of odour nuisance. This plan has a series of steps starting with the receipt of a complaint, odour and source assessment and ends up with the measures to prevent odour, and (where that is not practicable) to contain odours and minimise odour emissions. This plan of action should allow all stakeholders to see that the choice of control measures proposed for a specific site has been arrived at in way that is both technically justifiable and takes into account the balance of benefits and costs. This CoP also covers matters to be taken into consideration in the design of future or upgraded works.

Prior to 1996, treatment works were mostly operated by the nine mainland regions and the three island areas of local government. The creation of the three water authorities (East of Scotland Water Authority, North of Scotland Water Authority and West of Scotland Water Authority) in 1996 and the formation of Scottish Water in April 2002 effectively moved WWTW out of local government management.

Scottish Water is responsible for treatment of all municipal waste water in Scotland and serves around 5 million customers. Over 90% of the population of Scotland is connected to a mains sewerage system. In addition, Scottish Water has 20 PPP waste water treatment works that treat approximately 45% of the total waste water produced in Scotland. These are generally the larger WWTW and are governed by 9 PPP contracts.

The incidence of complaints of odour nuisance from WWTW has been steadily increasing over the last two decades. There is little evidence of changes in the raw sewage itself to explain this, but there are a number of other reasons why this might have occurred.

1. The awareness of the public and expectation of a better environment have increased, as has the belief that complaint can lead to action.

2. Housing and other developments have significantly encroached on the land around WWTW increasing the number of people likely to be impacted by odour from WWTW.

3. Implementation of the Urban Waste water Treatment (UWWT) Directive during the 1990s has been a key environmental driver in requiring improvement of waste water treatment plant and discharges. The Directive primarily requires improvements in the discharge quality from WWTW and has resulted in many works installing additional treatment stages in the process. This has resulted in a substantial investment in the construction of new and upgraded treatment works to meet the water quality requirements of this Directive, many of these works being in odour-sensitive locations. There has also been an increased requirement to pump sewage for considerable distances leading to poor aeration that can result in odour. There are also a number of other legislative drivers that may potentially result in higher levels of treatment than required for the UWWT Directive.

4. Implementation of the UWWT Directive also prohibits the disposal of sludge at sea thereby requiring storage and treatment of sludge before final land disposal.

4. LEGAL FRAMEWORK

4.1 Legal Framework

The regulation of odour emissions from WWTW relies upon the Statutory Nuisance controls detailed in Part III of the Environmental Protection Act 1990 that are enforced by local authorities. These controls require that operators of WWTW do not cause a Statutory Nuisance due to emissions of odours.

Section 80 of the Environmental Protection Act 1990 provides that where a local authority is satisfied that a Statutory Nuisance exists, or is likely to occur or recur, they shall serve a notice (an Abatement Notice). This notice can require the execution of such works and other steps, necessary to abate the nuisance or prohibit its occurrence or recurrence.

Further guidance is included in this Part of the CoP on the investigation and assessment of odour nuisance.

The person on whom an Abatement Notice is served has the right of appeal to the sheriff under the provisions of the Statutory Nuisance (Appeals) (Scotland) Regulations 1996. The grounds for appeal include:-

- that the Notice is not justified (no nuisance exists)
- that the authority have refused to accept alternate means of compliance to those specified in the Notice
- that the time limit specified for compliance is insufficient
- where the Statutory Nuisance is one falling within section 79 (1)(d) (which includes smell which is prejudicial to health or a nuisance) and it is arising from industrial, trade or business premises, that the 'best practicable means' (bpm) have been used to prevent or counteract the effects of the nuisance.

In the case of an appeal against a notice that requires significant expenditure, the notice is usually suspended until the appeal it determined. On hearing the appeal, the Court can quash or vary the notice or dismiss the appeal.

A person who fails to comply with the requirements of an Abatement Notice is guilty of an offence and liable to a fine on summary conviction. In the case of Statutory Nuisance due to odour from industrial, trade or business premises, Section 80 (7) of the Act provides a defence for the operator to demonstrate that the 'best practicable means' (bpm) have been used to prevent or counteract the effects of the nuisance.

In circumstances where a local authority is of the opinion that service of an abatement notice under section 80(4) would afford an inadequate remedy, section 81(5) of the Environmental Protection Act 1990 allows the local authority taking proceedings in the Sheriff Court or the Court of Session to seek an interdict.

Finally, the Environmental Protection Act 1990 provides for actions to be taken by members of the public. Section 82 (1) of the Environmental Protection Act 1990 allows any person on the grounds that he is aggrieved by the existence of a Statutory Nuisance to seek an order from the Sheriff to abate the nuisance and prohibit the recurrence of the nuisance.

4.2 Best Practicable Means (bpm)

As outlined in Section 4.1 above, in the case of Statutory Nuisance due to odour from a WWTW, it is a defence for the operator to demonstrate that the ‘best practicable means’ (bpm) have been used to prevent or counteract the effects of the nuisance. The term best practicable means (bpm) is defined in section 79(9) of the Environmental Protection Act 1990 as:-

> *‘the term ‘best practicable means’ is to be interpreted by reference to the following provisions-*
> *a) “practicable” means reasonably practicable having regard among other things to local conditions and circumstances, to the current state of technical knowledge and to the financial implications;*
> *b) the means to be employed include the design, installation, maintenance and manner and periods of operation of plant and machinery, and the design, construction and maintenance of buildings and structures;*
> *c) the test is to apply only so far as compatible with any duty imposed by law;*
> *d) the test is to apply only so far as compatible with safety and safe working conditions, and with the exigencies of any emergency or unforeseeable circumstances;’*

The key issue when determining bpm usually relates to the interpretation of ‘practicable’. It should be noted that the definition of ‘practicable’ is not exhaustive as the list details issues that ‘among other things’ should be taken into account. The definition includes cost consideration but clearly cost is not necessarily the decisive factor. It is finally a matter for the Courts to determine whether in a particular instance the controls adopted are reasonable or the costs are excessive taking account of local conditions and characteristics of the odour nuisance. Finally, it is important to note that it is for the person relying on the defence (that is the WWTW operator) to establish that bpm has been used.

The procedures and controls outlined in this CoP (particularly in Part 2) establish a basis against which the term ‘best practicable means’ (bpm) as a defence against Statutory Nuisance can be compared.

4.3 WWTW Regulated under other Statutory Controls

This CoP is intended to apply to WWTW where the Environmental Protection Act 1990 is the main or only source of regulation for odour emissions. For example, a relatively small number of WWTW fall under the Integrated Pollution Prevention and Control (IPPC) regime and are regulated by the Scottish Environment Protection Agency (SEPA) under the Pollution Prevention and Control (PPC) Regulations.

The PPC Regulations require that certain operations for the treatment of waste are subject to the IPPC regime under SEPA regulation. The definition of installations subject to these controls is included in the Pollution Prevention and Control (Scotland) Regulations 2000 as amended and outlined below:-

> *(a) The disposal of hazardous waste (other than by incineration or landfill) in a facility with a capacity of more than 10 tonnes per day.*
>
> *(b) The disposal of waste oils (other than by incineration or landfill) in a facility with a capacity of more than 10 tonnes per day.*

(c) Disposal of non-hazardous waste in a facility with a capacity of more than 50 tonnes per day by -

(i) biological treatment or

(ii) physico-chemical treatment.

In addition, under the provisions of the Waste Management Licensing Amendment (Scotland) Regulations 2004 (SI 2004 No 275), a waste management licence under Part II of the Environmental Protection Act 1990 is required from SEPA in the following cases:-

a) the treatment of screenings, sludges and septic tank sludge arising within the sewage treatment works at the works where the total quantity in any 12-month period exceeds 10,000 cubic metres
b) the importation to a sewage treatment works for recovery of screenings, sludges and septic tank sludge where the total quantity in any 12-month period exceeds 100,000 cubic metres.

Subject to the guidance in Section 1.3, this CoP will not be applied to those sites and separate guidance on the applicable standards for these processes will be produced in due course by SEPA.

4.4 What this Code applies to

This CoP applies to odour nuisance from WWTW themselves, rather than to the wider sewerage network. For the purpose of this CoP, WWTW with a capacity of less than 500pe are not expected to be major odour sources and hence the requirements for the preparation and implementation of an Odour Management Plan of Part 2 of this CoP should only apply to such works where odour nuisance exists. The other requirements of Part 2 of this CoP should apply in all cases.

4.5 New and Existing Works

This CoP applies to both existing WWTW and new works, as well as to existing works where substantial change is planned. However, it is expected that for new works or substantial changes to existing works operators will want to assess the potential for odour nuisance at the design stage. Consideration of odour control options at the design stage of a project will allow a strategic decision to be made on the measures necessary to avoid the creation of odour nuisance. The incorporation of control measures during the build of new or upgraded plant will limit the need for costly retrofitting of controls at a later date and hence suitable odour controls should be included at the outset.
It is expected that some of the controls in Part 2 (such as the Odour Management Plan) may not be currently in place but all works should meet the minimum standards of this CoP by 1 May 2006.

4.6 Planning Controls and Nuisance

Development of new WWTW, and modifications to existing sites, require planning permission. The Scottish Executive's planning policy for WWTW is included in National Planning Policy Guideline (NPPG) 10–*Planning and Waste Management*. Further advice is set out in Planning

Advice Note (PAN) 63-*Waste Management Planning*. PAN 51-*Planning and Environmental Protection*, is also relevant in setting out the relationship between planning and environmental controls. Developers and planning authorities should have particular regard to the general principles and policies, and to the specific section in NPPG 10 on WWTW under the heading 'sewage treatment' (paragraphs 67-70).

The two primary methods of regulatory control of odours are Statutory Nuisance and IPPC. The controls applied by Statutory Nuisance are largely reactive (they only allow action where a nuisance exists, or is likely to exist or recur). However the powers under IPPC are proactive (that is they allow the permitting of processes by establishing conditions for all aspects of the design, operation and management of processes).

There is a long standing principle that the planning system should not be operated so as to duplicate the statutory responsibilities of other, more appropriate pollution control agencies. In these circumstances, where WWTW come under the control of IPPC it will seek to ensure that control measures are implemented to avoid the creation of odour nuisance. Where WWTW are not subject to IPPC control, the careful use of planning conditions to require inclusion of odour control measures and to establish operating conditions may be appropriate.

PAN 51 states that where the possibility that the release of smell might result in nuisance or loss of amenity from a proposed facility subject to planning control, this may be regarded as a material consideration for planning reasons. It would be good practice as part of the planning process for the WWTW operator to provide an Odour Management Plan (OMP – see Annex 3) to ensure that odour emissions have been considered and also to enable the efficacy of control measures to be assessed.

There is also a need to carefully consider the proximity of proposed new development to existing WWTW. Encroachment of odour sensitive development around WWTW can lead to significant problems, as the occupiers of any new development will expect and demand high amenity standards, often meaning that WWTW become subject to complaint for the first time. A standard size of 'cordon sanitaire' would be inappropriate, given the individual nature of each WWTW; however, the operational and complaints history of a WWTW and other potential odour issues should be carefully considered before permitting new development in the immediate vicinity.

The role of odour modelling in assessment of new or upgraded WWTW and also in considering development in close proximity to existing WWTW is further discussed in Section 11.4.

Under the Environmental Assessment (Scotland) Regulations 1999, proposals for WWTW may require an Environmental Impact Assessment (EIA) to be carried out in support of any planning application. Larger WWTW (in excess of 150,000pe) fall under Schedule 1 of the Regulations and therefore require an EIA. Smaller sites (in excess of 1,000 square metres area) are covered by Schedule 2 of the Regulations and would require to be screened to establish whether they were likely to have significant environmental effects. If this proves to be the case then an EIA is required. SEDD Circular 15/1999 suggests that where the site is in excess of 10 hectares or 100,000pe, although this would come under Schedule 2, a full EIA should generally be required. Where a planning authority decides that a statutory EIA is not required, it is still open to the authority to use its powers under article 13 of the General Development Procedure Order to request additional environmental information.

4.7 The Water Industry Commissioner and Price Controls

The post of Water Industry Commissioner for Scotland (WICS) was created by Part II of the 1999 Water Industry Act and was established on 1 November 1999. The Water Industry Commissioner for Scotland is responsible for regulating all aspects of Scottish Water's economic and customer service performance and the primary role of the Commissioner is to promote the interests of customers of Scottish Water.

The Commissioner advises Scottish Ministers on the amount of revenue that Scottish Water needs to provide a sustainable service to customers and to fund its investment programme efficiently. The Commissioner does not decide the components of the investment programme (which may include investment for odour control), that is a decision made by Scottish Ministers.

The Water Industry (Scotland) Act 2002 created five Water Customer Consultation Panels (WCCP) across Scotland to represent the views and interests of customers of Scottish Water in the areas covered by the Panels. WICS consult the WCCP during the price review process to take account of customers' views on investment plans and required service levels.

It should be noted that the roles of both the WCCP and WICS will be changing as a result of the Water Services etc. (Scotland) Act 2005.

5. WWT PROCESS OVERVIEW

5.1 General

The layout of a particular sewage treatment process will be wholly dependent upon the type of influent to the works, the location, the size and quality of receiving water. However, the following schematic in Figure 1 is a process flow sheet that covers the principal processes undertaken.

There are three principal functions of a waste water treatment plant:-

- Removal of pollutants, (mainly toxic material) and retention of re-usable material
- Treatment of water to permit safe re-use
- Treatment and disposal of the sludge.

The steps of a sewage treatment process are often divided into primary, secondary and tertiary. Primary treatment is largely a mechanical process to separate solids, secondary treatment is a largely biological process whilst tertiary treatment is polishing step for further purification possibly for specific contaminants. The main aim of treatment is to reduce biochemical oxygen demand (BOD) and suspended solids (SS) to acceptable levels. This is achieved by removing solids, and by aeration to satisfy the oxygen demand of the waste water, there being various methods of undertaking this operation. The removal of the solids and reduction of BOD produces sludge that can be recovered for beneficial land use after further treatment or sent for disposal.

5.2 Preliminary Treatment

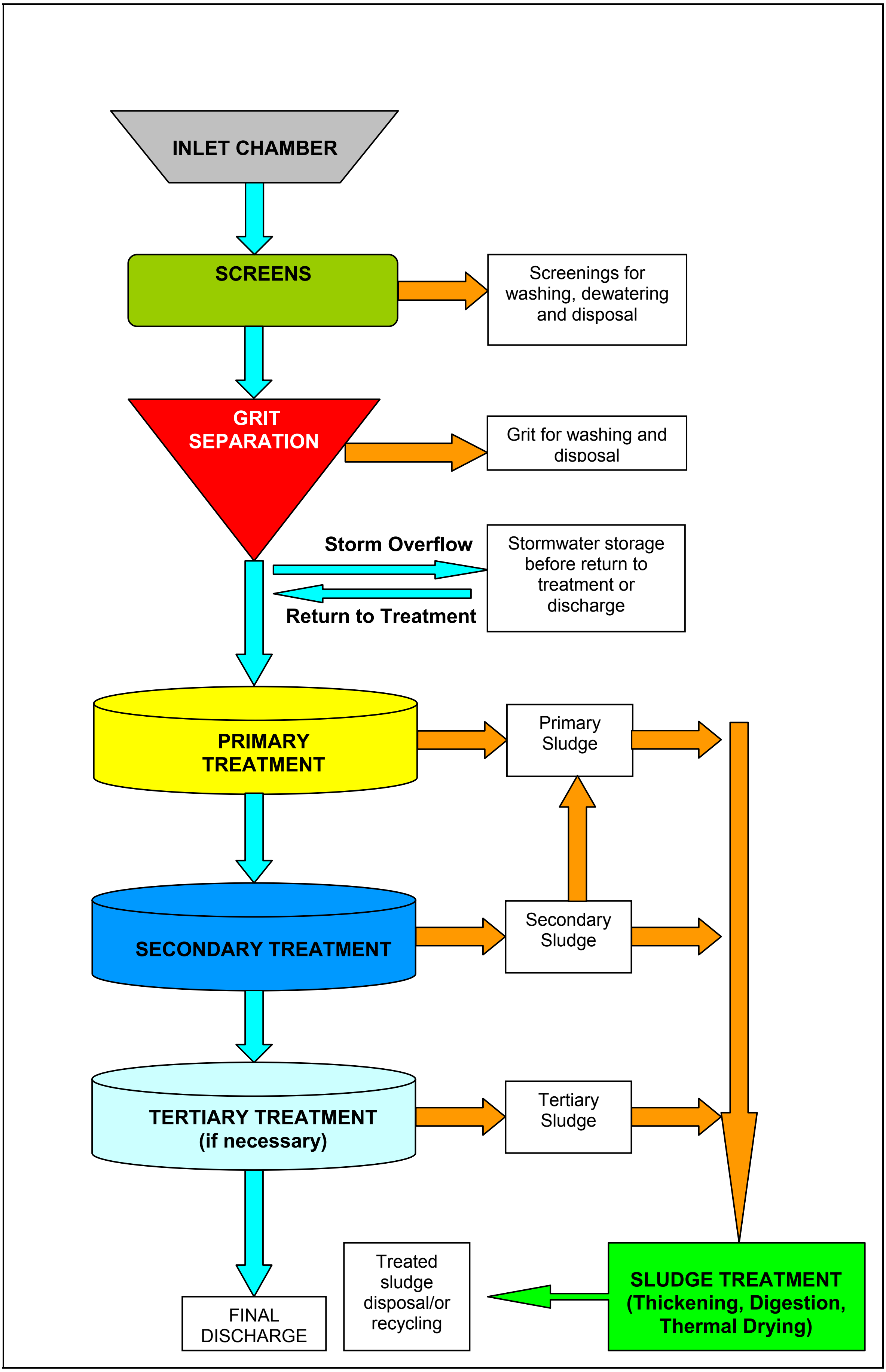
Waste water entering the inlet works is usually screened to remove plastics, paper, cloth and other large debris. During periods of high flow the influent may be diverted to storm water tanks and this may occur before or after screening. Any influent diverted to storm water tanks will be processed as soon as flows return to normal. Effective management of storm water tanks is a key area in the reduction of odour. Screened solids are usually landfilled or incinerated.

Sand and similar heavy particles are removed next in a grit chamber. This chamber can be aerated to separate these particles from other suspended solids. The waste water spends a relatively short period in the grit chamber (in the order of minutes). The sedimented sand and grit is usually landfilled.

5.3 Primary Treatment

The finer solids are then removed in a settling or sedimentation tank, where the waste water spends a number of hours to allow the solids to settle or float and the sludge produced is scraped along the base of the tank for desludging. At this stage up to 70% of the solids and 30% of the BOD can be removed. The mechanical removal of solids as described above is usually called 'primary treatment', the sedimentation tank as the primary sedimentation tank, the overflow from the sedimentation tank as primary-treated waste water (primary effluent) and the sludge produced as primary sludge.

FIGURE 1 – WWTW PROCESS FLOW SHEET



5.4 Secondary Treatment

The activated sludge process is the most widely used biological process for waste water treatment at large and medium-sized works. The activated sludge in the aeration tank consists of flocs of bacteria, which consume the biodegradable organic substances in the waste water. This sludge is kept in the process by separation from the treated waste water and re-circulation.

The primary-treated waste water is passed to an aeration tank. Aeration provides oxygen to the activated sludge and at the same time thoroughly mixes the sludge and the waste water. Aeration is by either bubbling air through diffusers at the bottom of the aeration tank, or by mechanically agitating the surface of the water.

In the aeration tank, the bacteria in the activated sludge consume the organic substances in the waste water. The organic substances are utilised by the bacteria for energy, growth and reproduction. After the aeration stage the waste water enters a second sedimentation tank to separate the activated sludge from the treated waste water. The activated sludge is returned to the aeration tank. There is an increase in the amount of activated sludge because of growth and reproduction of the bacteria. The excess sludge is removed to maintain a desired amount of sludge in the system. This part of the treatment process is called 'secondary treatment', the sedimentation tank as secondary sedimentation tank, the overflow from the sedimentation tank as secondary-treated waste water (secondary effluent) and the excess activated sludge as secondary sludge. This sludge is usually returned to the incoming sewage flow entering the sedimentation tank and is then co-settled with primary solids to form co-settled sludge. At some works excess activated sludge may be kept separate for initial dewatering.

Depending on the flow rate of waste water, several parallel trains of primary and secondary stages can be employed. There are several ways to operate an activated sludge process. In a 'high rate' process a relatively high volume of waste water is treated per unit volume of activated sludge. The high amount of organic waste consumed by the activated sludge produces a high amount of excess sludge that may rapidly decompose and become highly odorous if not treated. In an 'extended aeration' mode of operation the opposite condition takes place. A relatively low amount of organic waste is treated per unit volume of sludge with little excess sludge to be removed. Removal of BOD is higher in the extended aeration mode compared to the high rate mode, but more waste water can be treated with the latter mode. The excess sludge from extended aeration is usually biologically stabilised and not as likely as high rate sludge to decompose and produce significant odour.

An activated sludge treatment process can be operated in batches rather than continuously. One tank is allowed to fill with waste water. It is then aerated to satisfy the oxygen demand of the waste water, following which the activated sludge is allowed to settle. The treated waste water is then decanted, and the tank is filled with a new batch of waste water. At least two tanks are needed for the batch mode of operation, constituting what is called a ‘sequential batch reactor (SBR)’. SBRs are suited to smaller flows, because the size of each tank is determined by the volume of waste water produced during the treatment period in the other tank.

The alternative to the activated sludge process is the use of a percolating trickling filter that is a method of secondary treatment widely used at small WWTW. This is a bed of solid media for bacteria to attach on its surfaces. Waste water is irrigated over a bed of graded mineral material on the solid media (stones, waste coal, and gravel) or specially manufactured plastic media. As waste water trickles over the surfaces of the solid media organic substances are trapped in the layer of bacterial slime. The bacteria consume the organic substances in the same manner as in the activated sludge process, while air diffuses into the slime layer from the air spaces in the bed of the trickling filter. Growth and reproduction of the bacteria take place and result in an increase of thickness of the slime layer, particularly at the top of the biological filter. Periodically bacterial slime sloughs off the surfaces of the filter media and leaves with the treated waste water.

Solids derived from the sloughing off of bacterial slime are separated from the treated waste water in a sedimentation tank (often termed a humus tank). Sludge from this sedimentation tank is not returned to the trickling filter but is usually returned to the inlet sewage flow for co-settlement with the primary sludge for treatment and disposal as a co-settled sludge. The trickling filter and associated sedimentation tank is also termed 'secondary treatment'.

5.5 Sludge Processing

One of the key operations is the final treatment of the excess sludges produced in the process. The purpose of the sludge process is to reduce the liquid content of the sludge and volume to minimise downstream costs and stabilise the sludge to allow safe beneficial use for land conditioning or alternate disposal methods. The stabilisation process minimises the potential for odour generation and also destroys the pathogens.

The main processing stages are as follows (these may be used singly or in any combination):-

a) The first stage will involve thickening to reduce sludge volume by 50 – 70%. This is carried out either by gravitational thickening in tanks or by mechanical means using centrifuges or belt-thickeners. Mechanical thickening requires the addition of a polymer conditioner to the sludge.
b) The thickened sludge is then stabilised by either biological or chemical means.
c) The two main biological methods are:-
   - Mesophilic anaerobic digestion at approximately 35°C. Anaerobic digestion of sludge has four main stages. In the first phase protein, carbohydrates and fats are broken down by hydrolysis to form amino acids, sugar, glycerine and fatty acids. In the second phase acid fermentation occurs producing some fatty acids and alcohols. In the third stage acetogenic bacteria covert organic acids into a mixture of propionic and acetic acids plus hydrogen gas. In the final stage methanogenic bacteria convert the hydrogen and carbon dioxide to methane.
     The key characteristics of anaerobic digestion are:
     - Solids can be reduced by up to 50%
     - The high ammonia content of digested sludge is suitable as a fertiliser due to the readily available nitrogen
     - Pathogens are substantially reduced
     - Sludge is less offensive in odour and appearance
     - The gas produced (digestor gas) is a useful fuel and can be used to heat the digestor and also to generate electricity often through Combined Heat and Power (CHP) systems (municipal waste water sludge can produce approximately 500m^3 of gas per tonne of dry volatile solids).
   - Thermophilic anaerobic digestion (although this technique is not currently applied in Scotland)
d) Chemical stabilisation is relatively straightforward and is quite often used at smaller waste water treatment Works. The stabilisation is achieved by the addition of lime (or other alkaline materials) to raise the pH of the sludge to inhibit the growth of micro

organisms (typically to pH 12 for 2 hours). In order to meet the pathogen removal required for re-use the material is usually held above 55°C for a period of time.

e) Mechanical Dewatering to produce a solid cake of 25 – 50% solids. Dewatering may be achieved by filter pressing, centrifugation or belt-pressing and it always requires the preliminary conditioning of sludge with polymers. Sludge cake may be used in agriculture, disposed of to land or used to feed a thermal dryer.

f) Thermal drying to minimise volume is the ultimate stage of sludge processing and is carried out by various types of heated drying systems. The final water content of the product is less than 10% and the overall volume reduction compared to the original liquid raw sludge volume can be greater than 99%.

6. WHAT CONSTITUTES AN ODOUR NUISANCE?

6.1 What is an odour?

The subject of odour is a complex one. The response of an individual to exposure to an odour is subjective – how strong is it, what does it smell like and how often/when does it occur and in what context? The following characteristics further complicate the assessment of odour:-

- An odour can arise from a single substance or from a combination of substances.
- In combination with other substances, the characteristic odour of a single substance can be modified so as to be unrecognisable.
- Odour from a combination of substances changes as the mixture becomes diluted and the concentration of each component falls below its odour threshold.
- Odours from a substance or mixture of substances can be pleasant when dilute or offensive when concentrated.
- Odours that are pleasant or acceptable to one person can be offensive to another.

6.2 What is an odour nuisance?

The key to understanding the odour control principle of Statutory Nuisance is that the presence of an odour itself does not necessarily constitute a nuisance. The characteristics of an odour that are taken into account when assessing nuisance are odour type (pleasantness or offensiveness), odour strength, frequency and duration of release, persistence in the environment and the extent of interference with enjoyment of the amenity of a neighbourhood. There are also cases when although odours are present, the control measures put in place by the operator fulfil the test of best practicable means (bpm) or are present due to circumstances beyond the control of the operator (such as unforeseen breakdown, adverse weather conditions).

When assessing the levels of polluting substances necessary to avoid harm to health it is usual to determine appropriate numerical values for such limits. In the case of odour, the response of the human nose means that each individual will make his or her own subjective assessment as to whether the odour is offensive and whether it is considered to be acceptable.

Whilst it is possible to measure the odour strength using a standardised method (dynamic olfactometry as detailed in BS EN13725), it is more difficult to quantify the offensiveness of the odour. Where numerical rankings are used to try and simulate the sensory annoyance, they still rely upon subjective analysis and hence standardisation is almost impossible.

In general, odour effects are not caused by one single pollutant or chemical species, odour is a 'cocktail' of chemical species emitted from a process. The nose is an extremely sensitive receptor of odour - it can respond to small variations in concentration over periods of a few seconds and at concentrations of fractions of a part per billion. There are many issues that influence the perception of an odour including variations due to the subjectivity of the receptor, dispersion of odour due to local meteorological conditions and variations in the generation of odour from the process due to raw materials and cycle operations in the process.

In general, there is very little difference between the offensiveness of an odour and its potential to cause nuisance. The assessment of offensiveness of odour remains a subjective sensory olfactory response of observers. However, all odours have the potential to be offensive and cause annoyance.

The following matters should be considered when determining the degree of potential offence or the existence of an odour nuisance.

NATURE – this refers to both strength and character of the odour. Odours that would be generally accepted as ‘unpleasant’ will be potentially offensive. Odours from a sewage process would generally be accepted as more unpleasant in comparison to odour from, for example, a bakery. There are methods of qualitatively assessing ‘pleasantness’ of odour such as the use of the Hedonic scale, but these are still very subjective. Odour can also be described by a subjective descriptor such as ‘sweaty’, ‘faecal’, ‘fishy’, ‘spicy’, ‘fruity’ etc. The strength of an odour referenced to its detection threshold can be quantified and the higher the odour strength, the more the likelihood of an odour being detected. If an odour is present above the threshold of recognition, this will usually lead to the receptor being able to clearly identify the odour and often associate the odour with potential sources or activities. The ability to measure odour concentration often results in this being a major factor in the assessment of an odour problem.

FREQUENCY - odours that are released frequently or continuously from the process are more likely to be determined to be a nuisance. However, in some circumstances odours that are released periodically can be more intrusive and the odour frequency is often assessed in conjunction with the odour's persistence in the environment.

PERSISTENCE - odours which are continuously released from processes or those which are emitted on a frequent basis but persist in the environment for a long period (that is do not readily disperse to a level where the odour is no longer detected) are more likely to be judged as a nuisance. It is possible to put forward a case that even less unpleasant odours (such as food processing odours) may be offensive if the releases are continuous or frequent and persistent. The persistence of an odour is also affected by the meteorological conditions.

METEOROLOGICAL CONDITIONS - as the majority of odour control techniques finally rely on dispersion for minimisation of odour effects, the meteorological conditions will be of prime importance. If conditions exist that are disadvantageous for dispersion, odours may be detected even though the best available control methods are in use. These conditions should normally prevail for less than 1% of the year. Thus in most cases, the detection of an odour which is potentially offensive will result in a detailed process assessment to ensure that the process management and control is operating normally and then to identify possible weather related effects.

LOCALITY AND SENSITIVITY – the potential for amenity interference is largely related to the character of the neighbourhood and the time that the odour occurs. The number of persons affected and the degree of intrusion will depend upon the proximity of the source and receptor. Odours are often subjectively more annoying during periods when members of the public are outdoors (for example daytime periods during summer months).

The assessment as to whether an odour is a nuisance therefore involves the investigation of many characteristics of the odour, the odour source and its causation. The determination of nuisance by an independent body, normally the local authority regulator, involves the collection of information and a balanced view as the degree of interference or annoyance the odour causes.

Chapter 7 below summarises the likely odour sources at a WWTW and Chapter 8 details the mechanisms that can be used to collect data and assess nuisance.

7. CHARACTERISING ODOUR FROM WWTW

The primary odours from WWTW are the result of biological degradation of organic matter by microorganisms under anaerobic conditions. The development of anaerobic conditions in sewage is often referred to as 'septicity'. Septicity can be onset by elevated temperature, high BOD, high sulphate levels and the presence of reducing chemicals. Anaerobic activity leads to the production of methane and hydrogen sulphide (H_2S), ammonia (NH_3), organic sulphur, thiols (mercaptans), amines, indole and skatole. During the fermentation phase of anaerobicity, volatile fatty acids, alcohols, aldehydes and ketones can be produced.

However, odour which is not typical of anaerobic conditions can also be generated by other mechanisms in a treatment works including:-

- Volatile substances in the influent such as petroleum derivatives, solvents
- Air stripping of volatile compounds and odours particularly from industrial effluent often at inlet works or during aeration
- Aerobic odours – which are often described as a 'musty' odour
- Ammonia odour from reactions after liming of sludges or when sludges become re-wetted.

7.1 Hydrogen Sulphide

Hydrogen sulphide (H_2S) is often highlighted as the cause of odour from WWTW. Hydrogen sulphide is a toxic gas and can be a health hazard especially in confined spaces. However, the concentrations typically encountered around WWTW are substantially below the levels at which health effects may occur. Whilst hydrogen sulphide may be a principal component of the odour cocktail, there are other compounds that cannot be ignored. Because it is relatively easy to measure, H_2S is often used as a target indicator for odour. However, it is recognised that H_2S is not a good indicator for industrial effluents, secondary treatment odours and dryers/incinerators, as it is proportionally less important as an odorous component in these sources. Also, based upon observations, the odour threshold for a sewage treatment odour is frequently 5 times larger than the value that would have predicted based upon the H_2S concentration alone. Therefore whilst it is a valuable indicative target pollutant, careful evaluation of data from H_2S measurements alone is essential.

7.2 Odour Components

There are many chemical species which have been detected in WWTW odours. In addition to hydrogen sulphide and other pollutants such as ammonia, there are a wide variety of organic sulphides and organic nitrogen-based compounds along with some oxygenated organic compounds and organic acids.

In addition to these compounds there are many potential substances which may be released depending upon the quality of the influent, for example if it includes industrial effluent. The range of contaminants potentially present in industrial effluent is extensive but those that are likely to be of concern are already odorous liquids (such as waste water from food production), warm effluent which may accelerate anaerobic conditions and volatile organic compounds such as solvents and petroleum derivatives.

7.3 Odour Sources at a WWTW

Whilst this CoP is focusing on WWTW and does not review the issue of odour in the sewerage transport system, the conditions within the drainage system will have a significant impact on the odour generation of the process due to septicity. The odour sources at any particular plant will be specific to that site and operation, however, the following are key sources which should be reviewed at all WWTW:-

- Inlet works – strong odours in influent may be affected by unfavourable sewer conditions (long retention times, brackish water infiltration, poor maintenance, industrial discharges) and long pressure mains – also the inlet works effectively vent any sewer gases
- Imported sludge and septic tank waste – the off-loading and storage of such materials prior to treatment can lead to odours
- Storm water storage – usually due to storage for excessive periods leading to septicity or due to infrequent or insufficient flushing of the tanks after emptying
- Primary settlement – highly odorous feeds or excessive sludge accumulation which goes septic – emissions can be caused by excessive turbulence of waste water at overflow weirs
- Secondary treatment – if highly loaded or odorous feed
- Storage and treatment of sludge – especially non-stabilised sludge
- Biogas leaks (from anaerobic digestors and gasholders, and at the first point of discharge of digested sludge
- Odours can be transported through the system and become airborne at turbulent locations – recycling can increase odour (such as sludge thickening).

Based upon the approach taken above to evaluate the odour potential of liquids and sludges throughout a process, Table 1 below provides a ranking for odour potential at various stages of the waste water treatment process.

SOURCE	ODOUR POTENTIAL
Raw influent – typical	▣▣
Septic sewage from a rising main	▣▣▣▣
Industrial effluent	▣▣▣
Septic tank and sludge import	▣▣▣
Stormwater storage	▣▣
Stormwater tank desludging	▣▣▣▣
Primary tank feed	▣▣
Primary tank overflow	▣▣
Final effluent	▣
Raw sewage sludge	▣▣▣▣
Liquors from raw sludge processing	▣▣▣▣
Digested sewage sludge - fresh	▣▣▣
Digested sewage sludge – after storage	▣▣
Digested sludge filtrate	▣▣
Gravity thickener overflow	▣▣▣
Released digestor gas	▣▣▣

KEY:- ▣ - Low ▣▣ - Medium ▣▣▣ - High ▣▣▣▣ - Very high

TABLE 1 – ODOUR POTENTIAL FOR A RANGE OF OPERATIONAL STEPS

7.4 Assessing Odour Impact

Impacts can be determined by a number of methods, however many of these only assess the effective odour concentration and do not take account of the other parameters which are involved in determining potential nuisance of an odour. In addition, direct measurement of ambient odour concentrations is not practicable.

There are a number of tools that can be helpful when assessing impact, including:-

Qualitative – see also Section 8.1

- Public complaints monitoring – both level of complaint and nature of the odour described. Further details are included in Annex 1.
- Local authority subjective assessment
- Correlation of complaints records with process operations at the time of complaint – use timing of complaints and odour descriptions as well as process data
- Olfactory screening – further details are included in Annex 2

Quantitative – see also Section 11

- Direct measurement of emissions at source – most frequently emissions are sampled and analysed by dilution olfactometry to ascertain odour concentration. It is also possible to measure the concentration of indicative chemical species.
- Measuring the odour destruction efficiency of abatement equipment
- Monitoring flow from ventilation systems serving enclosed or contained sources
- Estimating potential emission by bulk material analysis to determine odour potential
- Estimating odour emission rates based upon concentration or odour potential and flow
- Odour Dispersion Modelling – see Section 11.4.

In the final analysis the determination of acceptability of odour management will be based upon sensory assessment in the area surrounding the process.

8. INVESTIGATION AND ASSESSMENT OF COMPLAINTS

8.1 The general approach to complaint assessment

This section deals with the complaint assessment procedures to be adopted by local authorities. The primary role of this assessment (as detailed in Steps 1 to 7) is to ascertain whether an odour that is the subject of complaint constitutes a Statutory Nuisance. There is additional guidance on the methods of complaint investigation appropriate for WWTW operators in section 12.4 that is focused more on identification of causation of the odour and control options. However, it is important to stress at the outset the need for the local authority and WWTW operator to share information throughout any investigation.

There are many tools that can be used in the investigation and assessment of odour complaints. Sometimes, the problem may be quite simple to deal with, some of the steps will be obvious, and the whole process through to resolution may be fairly intuitive. At other times, the problem may be more complex and a step-wise approach can help clarify for all stakeholders the route through to resolution of the nuisance.

The flow chart in Figure 2 summarises the steps and issues involved in the investigation of odour nuisance complaints by local authorities. It is important that all steps and decisions are documented in order to justify the measures chosen to resolve the odour nuisance. The first stages (Steps 1 to 7) are the key steps in determining the existence of a Statutory Nuisance and are expanded below. Steps 8 and 9 (identifying actions) are further detailed in Chapter 9 and Part 2 of this CoP.

Step 1 – Complaint received

The local authority receives a complaint alleging potential odour nuisance from a WWTW.

Step 2 – Share information

The primary reasons for investigation of complaints are to assess potential nuisance and identify the likely cause and source of the odour. It is essential to utilise the expertise of the process operator at this stage and therefore complaints should be forwarded to the operator without delay. This notification may be by telephone, fax or e-mail but the system should ensure that a named person at the WWTW is the contact and be able to carry out an assessment without delay. In cases where sites are not manned, the local authority should agree a local point of contact with the operator.

It is also good practice for the operator to be involved in liaison with the local community. This is likely to give operators a better understanding of the intensity, scale and emotive nature of any problems arising from their site. It is also likely to better motivate the operator to cure the problems and make them, perhaps, more accountable for the consequences of their development and the controls they exercise upon it. By inclusion of regular site visits within this liaison, it is possible also for the community to feel involved in the improvement of the amenity in the locality where problems are seen to be being overcome.

Step 3 – Determine what to record and how

The local authority will already have a general record keeping and complaint registration format and this should be adapted to avoid duplication. There are some basic details which should be recorded. These include:-

- Complainants details
- Odour source (if known)
- Time of complaint
- Complainants description of odour – including a subjective description of the odour and strength (possibly by comparison with other odours), location and extent of the odour and date, time and duration of the episode
- Weather information
- Any other information the complainant can offer on activities at the alleged odour source.

An example of an odour complaint form is included as Annex 1 of this CoP.

Step 4 – Who to involve

The local authority will obviously involve complainants and the operator of the works in their investigations. However, the local authority will need to determine how widely they seek to involve the various stakeholders such as councillors, residents groups, MSPs and SEPA in their investigations. The number, frequency and geographical spread of the complaints along with the intensity of complaint will largely determine the involvement of councillors and MSPs. It is essential that the operator and the residents are involved in the whole process to ensure that there is transparency and also to establish at the outset clear targets and goals for determining success of control measures.

Step 5 – How to respond

At the outset of any investigation, the local authority should assess realistically how quickly they will be able to respond to complaints and hence the approach which they will use for investigation. If they are able to attend rapidly after a complaint they may be able to carry out effective appraisal of the complaints independently by subjective assessment. If they are not able to respond to complaints at the time that the odour exists, it may be necessary to use the members of the public as indicators of the extent and nature of the odour. This is further reviewed in Step 6 below.

It is important to remember that whoever carries out the assessments, their individual sensitivity to the odour should be determined.

Step 6 – Identify the source and cause of complaint

In order to successfully resolve odour problems, it is essential to fully understand the source and cause of the odour and the operational conditions that lead to the complaint. A common strategy to monitor odours should be devised by consultation between the local authority and the WWTW operator to allow comparisons between the operator's records and those of the local authority.

The first step in the investigation is to select the most appropriate methodology for assessment. There are many techniques, but those commonly applied include:-

- The use of complaints records – timing of complaints, odour descriptions and process operations at the time
- Sniff testing – this is effectively a process site inspection trying to identify and characterize the odour quality and source
- Complaint location assessment – walking around the location of the complainants alleged odour impact allows the matching of the complainants descriptions to those assessed by an independent assessor

Operator process records (including maintenance and breakdown conditions) are an invaluable source of information about process conditions at the time of complaint – this would allow odour trends to be identified and possibly reconciled with particular process operations and maintenance or influent types.

Further guidance on undertaking odour assessment and a specimen record form are included as Annex 2 to this CoP.

The purpose of the assessment is to determine the source and cause of the odour. It is often possible to identify correlation between odour episodes and operational conditions. In order to evaluate the possible sources and causes, in addition to inspections and assessments, the local authority will need to utilise the following:-

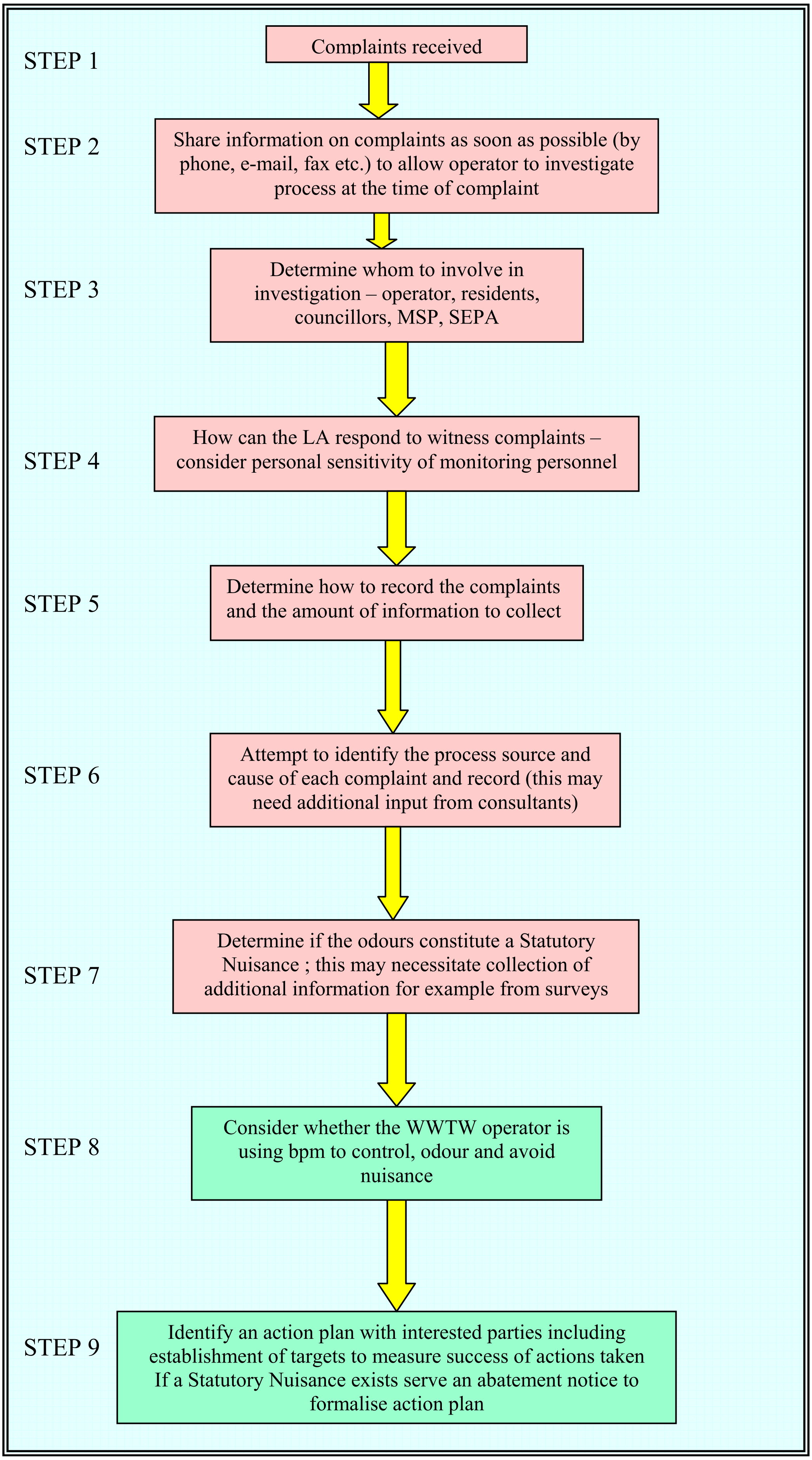
- Expert knowledge of operator or possibly consultants;
- Knowledge of plant operation conditions (especially problems) at time of complaint;
- Investigations, such as observational investigations and engineering investigations;
- Whether the WWTW itself is the source of the problem, or whether the odour results from a problem further upstream:
- Monitoring may be appropriate in some circumstances, usually if the source cannot be identified by any of the preceding techniques or if a high level of certainty is required. Monitoring of source odour releases (sampling and analysis) is covered in Part 2 of this CoP.

Step 7 – Does the odour constitute a Statutory Nuisance?

The key to understanding the odour control principle of Statutory Nuisance is that the presence of an odour itself does not constitute a nuisance. The characteristics of an odour which are taken into account when assessing nuisance are odour type (pleasantness), odour strength, frequency and duration of release, persistence in the environment and the extent of interference with enjoyment of the amenity of a neighbourhood as outlined in Section 5.2 of this CoP.

Where a site is shown beyond all reasonable doubt to be the cause of odour problems in a locality, all relevant potential sources of odours on the site should be identified and examined in more detail. Not every potential source of odour on the site may be generating offensive odours at any one time, but all should be assessed in view of their potential detriment to amenity. There may be other sources of offensive odours in the locality which should be taken into account during any investigation and these too may need to be addressed by the local authority.

FIGURE 2 – ODOUR INVESTIGATION FLOW CHART



The following are issues that should be taken into account to assess the validity of complaints and attempt to identify sources and causes for each complaint:-

- Whether each complaint has been independently 'qualified' by a local authority officer and the "quality" of a complaint (hypersensitive individuals, vexatious complaints, etc);
- the volume of complaints against the alleged nuisance and the geographical spread of complaints – mapping of the complaints and odour assessments of the local authority may help with this assessment;
- Is odour nuisance a one-off event or a regular occurrence – trends in exposure can be verified to some degree by complaint and process records but may involve asking complainants to keep odour diaries or even undertake a survey to determine the attitude of the local population to the odour
- knowledge of potential sources on the WWTW (do complaints correspond to plant problems or activities, are they influenced by wind direction in relation to the WWTW, complainant and the distance of complainant from site).
- knowledge of potential sources other than the WWTW (again whether these correspond to complaints and wind direction in relation to the WWTW, complainant and the distance of complainant from site).

The locality of a process site will influence the assessment of the potential for odour nuisance. In cases where the site has a low odour impact due to its remoteness from sensitive receptors and the escape of odour beyond the site boundary would be unlikely to cause nuisance, the standards of control required will be lower. Assessment of the potential for odour impact beyond the site boundary should take account of all predicted wind directions and weather conditions which are typical of the location in question.

Step 8 – Consider whether the WWTW Operator is using bpm

In the determination of the next steps in cases where the local authority consider that an odour nuisance exists, it is recommended that the local authority assess whether the control measures put in place by the operator fulfil the test of best practicable means (bpm). The possibility that the nuisance is due to circumstances beyond the control of the operator (such as unforeseen breakdown, adverse weather conditions) should also be considered.

In circumstances where an odour nuisance exists but the local authority consider that bpm is being used, the WWTW operator should be required to demonstrate to the satisfaction of the local authority that bpm has been applied. This may involve testing of emissions and investigation of plant design and operating conditions. If the WWTW operator is to undertake such investigations, it is recommended that the service of an Abatement Notice be withheld until these investigations are completed.

If bpm is being applied, it may not be in the public interest or effective use of public funds to proceed further with Statutory Nuisance action. In such cases, if the local authority is of the opinion that service of an abatement notice would afford an inadequate remedy, section 81(5) of the Environmental Protection Act 1990 allows injunctive action to be taken. Also, section 82 (1) of the Environmental Protection Act 1990 allows any person aggrieved by the existence of a Statutory Nuisance to seek an order from the sheriff to abate the nuisance and prohibit the recurrence of the nuisance themselves.

Part 2 of this CoP outlines some of the control measures that can be considered bpm for WWTW.

Step 9 – Identify and implement an action plan

Any plan detailing a programme of works to alleviate an odour nuisance must be fully explained to all stakeholders. If the local authority is satisfied that a Statutory Nuisance exists, they must serve an Abatement Notice. The terms of the notice can require abatement directly but it is recommended that in most cases, further investigation and a step-wise programme of work to resolve the odour nuisance represents the most effective approach.

The first step may involve the collection of additional data to allow a review of the available control options and develop a design specification for any control measures. In some cases the means may be obvious and very little information will need to be collected. Other cases will be more complex, requiring more information to tackle the problem successfully. Thus the amount of effort and detail in obtaining this information will vary depending on the severity of the problem, and the required certainty for confirming the source(s) of the problem and setting the abatement specification.

Next, the information collected will be used to make a judgement of how the previously identified source contributes to the odour nuisance and how much it needs to be reduced to prevent the nuisance. Again this may appear obvious in some cases and one can proceed intuitively based on very little information, e.g. for covering an open tank it is not necessary to work out a quantitative value for how much the emissions should be reduced – the assumption is made that the control measure will be close to 100% effective. Other cases are more complex or a greater level of certainty is required, for example, specifying an abatement system with a minimum odour removal efficiency. Considerably more effort/detail will be used here to assess the impact of the odour release taking into account the environmental pathways to the receptors.

Consideration should also be given to possible changes in the nature of odour due to the implementation of controls. For example if certain odorous compound is reduced below the odour threshold, other odours may become apparent as they are no longer masked by the original odour.

Section 9 below outlines the methods available to deal with the odour problem.

9. ASSESSMENT OF CONTROL MEASURES AND STRUCTURE OF PART 2 OF THIS CODE

9.1 The main approach

There is no single, absolute, technical fix that can be applied to all the different causes of odours from WWTW. There are many different means of preventing, controlling or reducing odours. It is possible, however, to develop an agreed plan of action that starts with developing the options and odour impacts and ends with the resolution of the problem. This plan of action should allow all stakeholders to see that the choice of control measures proposed for a specific site has been arrived at in a way that is both technically justifiable and takes into account the balance of benefits and costs. All stakeholders should be able to have confidence that the option chosen is appropriate to resolve the problem and is justifiable on cost-benefit grounds thus avoiding “gold plating” solutions. The Statutory Nuisance regime provides for a defence that the best practicable means (bpm) have been used to control nuisance odours. Within the context of this CoP, Part 2 provides guidance on the interpretation of bpm.

9.2 Aim of Statutory Nuisance controls

The intent of the Statutory Nuisance provisions is to ensure that WWTW apply adequate controls to prevent emissions where possible and otherwise to ensure that they are minimised and do not cause odour nuisance.

The locality of a process site will influence the assessment of the potential for odour impact – for example the location of a very sensitive land use such as a school or hospital close to a WWTW would result in a different threshold for establishing the presence of a nuisance compared to a commercial land use. It may also be necessary to include additional controls to avoid nuisance odour, for example where local meteorological conditions may more frequently lead to poor dispersion conditions. Whilst the absence of odour complaints beyond the process boundary does not equate to the absence of odour pollution, in cases where the site has a low odour impact due to it’s remoteness from sensitive receptors, the operator should be required to implement less extensive odour controls according to the perceived risk.

9.3 Hierarchy of odour controls

Having identified the source of the nuisance, the WWTW operator should consider the different options that could be used to prevent, contain or control the odour. As a general principle, preventing odour releases is preferred to their control. Where it is not practicable to prevent the odour releases they should be minimised to a level that will not cause odour nuisance. There is a wide range of control measures that can be used, including:

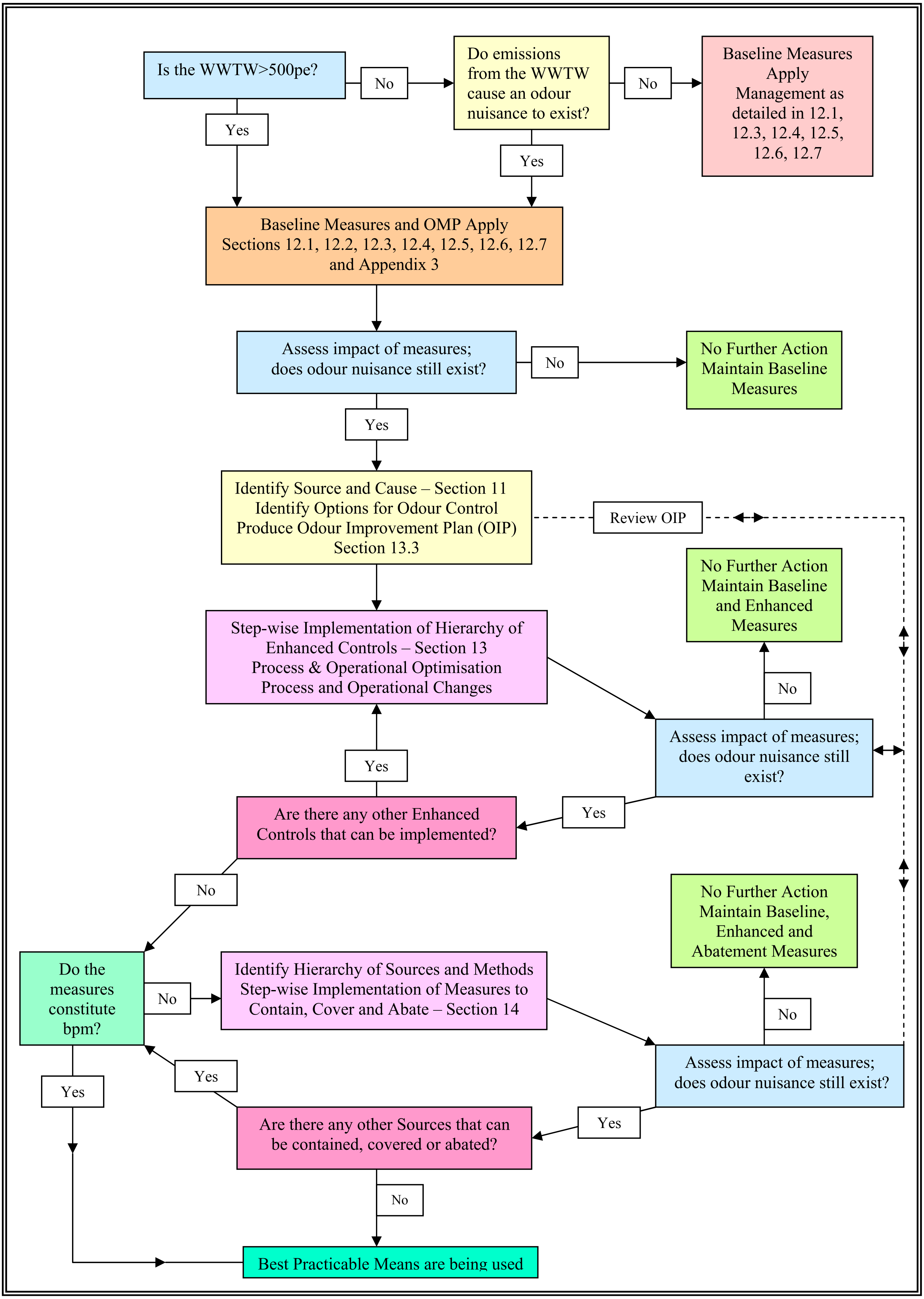
- the general management of the WWTW (including influent and sludge management)
- the design, installation and maintenance of plant, buildings and structures
- the operation of the WWTW and its processes
- engineering solutions, e.g. containment, enclosure with venting and end-of-pipe treatment (dilute and disperse or abatement)

Control options are usually considered in the following order of preference before escalating to the next level:

1. Site management and housekeeping
2. Operational and process changes
3. Containment
4. Enclosure with end-of-pipe treatment of excess air

However, practical, safety and financial restraints mean this hierarchy cannot be applied rigidly to every application and a cost-benefit judgement will determine the most appropriate choice for any given situation.

The approach outlined in this CoP is summarised in Figure 3 below.


Is the WWTW>500pe?
No
Do emissions from the WWTW cause an odour nuisance to exist?
No
Baseline Measures Apply Management as detailed in 12.1, 12.3, 12.4, 12.5, 12.6, 12.7
Yes
Yes
Baseline Measures and OMP Apply Sections 12.1, 12.2, 12.3, 12.4, 12.5, 12.6, 12.7 and Appendix 3
Assess impact of measures; does odour nuisance still exist?
No
No Further Action Maintain Baseline Measures
Yes
Identify Source and Cause – Section 11 Identify Options for Odour Control Produce Odour Improvement Plan (OIP) Section 13.3
Review OIP
No Further Action Maintain Baseline and Enhanced Measures
Step-wise Implementation of Hierarchy of Enhanced Controls – Section 13 Process & Operational Optimisation Process and Operational Changes
No
Assess impact of measures; does odour nuisance still exist?
Yes
Yes
Are there any other Enhanced Controls that can be implemented?
No
No Further Action Maintain Baseline, Enhanced and Abatement Measures
Do the measures constitute bpm?
No
Identify Hierarchy of Sources and Methods Step-wise Implementation of Measures to Contain, Cover and Abate – Section 14
No
Assess impact of measures; does odour nuisance still exist?
Yes
Yes
Yes
Are there any other Sources that can be contained, covered or abated?
No
Best Practicable Means are being used

9.4 Developing control measures

Sometimes, the problem may be quite simple to deal with, some of the steps will be obvious, and the whole process through to resolution may be fairly intuitive. At other times, the problem may be more complex and the step-wise approach can help clarify for all stakeholders the route through to resolution of the nuisance. The operator should document the decisions and findings of each stage so as to be able to justify the measures chosen to resolve the odour nuisance.

The amount of time, effort, detail and cost required for each step will vary according to the complexity of the problem. The response should be proportionate: sufficient to select the right means to stop the nuisance, but without making the process unduly lengthy or complex.

Implementation time of the control measure is an important factor and must be considered along with the effectiveness of the solution and its cost. It may be a deciding factor between several options of equal merit in terms of cost-benefit. Where the most effective control measure identified has a long lead-in time, the implementation of quick, low-cost high-benefit solutions should be considered as additional temporary measures.

By following an accepted and transparent cost-benefit assessment principle, all stakeholders are able to have confidence that the best practicable means was chosen to resolve the problem, but with some protection against "gold plating" for the sake of it. It is important when evaluating control measures that both capital and operating costs and environmental impact (such as energy use, chemical use and secondary pollutant generation) are considered.

9.5 Determining success

Where a plan for implementation of certain measures has been developed, the WWTW operator must document clearly the risks and triggers involved in the action, including:

- the criteria for successful resolution;
- when the next step in odour control measures will be taken; and
- the basis for such a decision.

It is essential that the local authority, in consultation with the WWTW operator and the other stakeholders (particularly the general public), establish and document appropriate criteria to determine when control measures have been successful. This is a very difficult aspect of the control regime and there are likely to be conflicting interests.

Determination of success will be on a site-by-site basis and indicative measures include:-

- reduced frequency of odour generation and detection at odour sensitive locations
- change in the nature of the odour (less offensive) which may be due to reduced intensity or a change in odour character
- reduced extent of area subject to odour complaint (the number of properties affected and geographical distance) - this should only be used for acceptance of interim, temporary or partial solutions .
- in general, using the number of complaints alone will not be an effective measure of success.

In addition to establishing indicative measures of success, the following guidance should assist local authorities is establishing a yardstick against which the performance of the WWTW operator can be measured:-

- subject to Section 4.4, all WWTW should implement the provisions of Section 12 in Part 2 of this CoP irrespective of whether they are subject to odour nuisance
- if these measures do not prevent an odour nuisance, a plan of action should be agreed with WWTW operator (and this may be formalised by service of an Abatement Notice)
- the plan should aim to implement the measures in accordance with the following hierarchy :-
  1. Site management and housekeeping
  2. Operational and process changes
  3. Containment
  4. Enclosure with end-of-pipe treatment of excess air
- at each stage an assessment of the impact of the measures should be made – this may involve surveys of the neighbourhood using sniff-testing or questionnaires to determine the attitude of the local inhabitants to the odour and their views on improvements
- it may be possible to carry out odour emission measurements before and after the implementation of measures (although this is difficult from fugitive sources) – further guidance in included in Section 11 of Part 2 of this CoP
- enclosure and extract ventilation rates can be measured and compared to good operating designs as detailed in Section 14 of Part 2 of this CoP
- Section 14 of Part 2 of this CoP details an odour abatement efficiency that can be used to determine the efficacy of abatement equipment.

Where WWTW operators find that there are competing demands for investment in odour measures at its different sites, it shall use a documented prioritisation process to ensure those sites with the most significant odour impact are targeted first. The prioritisation methodology shall take into account the number and severity of complaints at the different WWTW, but the number will not necessarily be the prime determinant of significance.

The Scottish Executive has established the Scottish Odour Steering Group (SOSG) to oversee the production of the Statutory Code and advise on prioritisation of odour controls at existing WWTW. The Group includes representatives from Scottish Water, Scottish Executive, local authorities, SEPA, WICS and WCCP.

Part 2
Code of Practice on Control of Odour Nuisance from Waste Water Treatment Works

10. Concept of Best Practicable Means

The key to understanding the odour control principle of Statutory Nuisance is that the presence of an odour itself does not constitute a nuisance. The characteristics of an odour which are taken into account when assessing nuisance are odour type (pleasantness), odour strength, frequency and duration of release, persistence in the environment and the extent of interference with enjoyment of the amenity of a neighbourhood. There are also cases when although odours are present, the controls measures put in place by the operator fulfil the test of best practicable means (bpm) or are present due to circumstances beyond the control of the operator (such as unforeseen breakdown, adverse weather conditions).

Part 2 of this CoP details measures that can be regarded as best practicable means for the control of odours from WWTW based upon the following approach:-

- To prevent the generation of odour where possible
- To contain odour and use effective treatment techniques to minimise releases
- To promote good odour control practices such as storage, cleaning, maintenance etc.
- To ensure that sensitive receptors are not exposed to offence to their olfactory senses.

The aim is to ensure that WWTW apply adequate controls to prevent emissions where possible and otherwise to ensure that they are minimised and do not cause nuisance to the human olfactory senses.

There is no single, absolute, technical fix than can be applied to all the different causes of odours from WWTW. There are many different means of preventing, controlling or reducing odours. It is possible, however, to develop an agreed plan of action that starts with developing the options and odour impacts and ends with the resolution of the problem. Similarly, not all WWTW will require the implementation of all measures to avoid odour nuisance. Therefore the control measures should be carefully evaluated and implemented on a phased basis to ensure that only those works which are necessary to abate odour nuisance are implemented.

Also a WWTW operator may apply an alternative bespoke control measure based upon new or developing technology that has been demonstrated as suitable and effective for odour control from WWTW.

There will also be a difference in the options to control odours from new and existing works. Obviously, in the case of new works, plant and equipment locations can be selected based upon prediction of odour emissions (see Section 11) to ensure separation from odour sensitive receptors. However, in the case of existing works, changing the location of plant and equipment, making process technology changes and installing new plant poses greater engineering challenges and has larger cost implications.

11. Assessment of Odour Emissions

11.1 General

There are a number of methods for the assessment of emission rates and odour potential from WWTW. This Section briefly reviews the methods for direct measurement of odours and also methods for assessing emission rates.

11.2 Monitoring for Odour

The primary problem with the measurement of odours is that most odours are mixtures of compounds and knowledge of the chemical compounds present in a mixture does not necessarily give an indication of the human response. A subjective view - what it smells like to those who are actually exposed (ie what people may actually complain about) - can be obtained by using olfactometry and/or characterising the odour

The collection of meaningful samples of ambient air (e.g. at an affected area in the community, or at the installation boundary) for assessment by olfactometry is subject to a number of difficulties (even though a European standardized method EN13725 exists for the technique). The main problem relates to low concentration - generally too low for olfactometry - and so it is not commonly undertaken. However, it is a valuable tool for measuring the performance of odour abatement equipment and sources. In this case the odour concentration is measured on the inlet and outlet of the abatement equipment simultaneously and gives a very good measure of odour abatement efficiency.

Collection of samples for instrumental analysis is sometimes possible but fluctuation in concentration is often rapid and only direct reading instruments can give an indication of the concentration profile. A result that is averaged over a long period is rarely useful as it is the peaks which tend to cause annoyance, even if very transient.

The use of a surrogate for monitoring (namely H_2S) has already been reviewed in Section 7.

11.3 Odour Potential and Emission Rates

Whilst it is possible to measure odour concentrations in the air, it is difficult to measure the odour emission rate for diffuse sources such as tanks and lagoons where there is no controlled flow of the pollutant from the tank. It is useful to be able to assess the likely odour emissions from diffuse sources and also the potential for a liquid to generate odour when analysing possible odour sources. There are two main methods for determining the likelihood of odorous emissions:

- Odour Potential – odour concentration in air that has been brought to equilibrium with the liquid sample by blowing air through the sample in a standard apparatus – ou_E/m^3
- Odour Emission Rate – this defines the total emission of odour from source and is expressed as the odour concentration multiplied by the flow rate – ou_E/s.

The odour emission rate can be used to review the relative importance of sources in terms of odour transport and can also be used in dispersion modelling. In cases where the flow rate and odour concentration cannot be measured directly for example because there is no vent point it is necessary to generate data by other means.

There are three methods for predicting odour emissions:-

- **Floating Hoods/Lindvall Box** – (for liquids without flows/static liquid surfaces) In this method, air is blown into the end of a box on the surface of an odorous liquid at 0.5 – 1.0m/s and a sample of the air at the outlet of box is taken for odour concentration measurement. The product of the odour concentration and airflow rate gives the odour emission rate. The method is relatively low cost but the sampling method does interfere with normal flow conditions in tank and hence alters the true odour emission.
- **Micrometeorological measurements** – measure the mean odour concentrations in ambient air at increasing distances from the source. Combined with wind speed, temperature and solar heating it will allow modelling of emissions. However, the sensitivity of test methods for ambient air monitoring means that this is only really applicable for strong odour sources.
- **Extrapolation of Wind tunnel studies** – allows data derived from studies to be used to model emissions based upon odour potential. It allows the impact of various control options to be reviewed and allows true emission modelling based upon measured or predicted odour emission rates.

Also, some of the emission estimation and impact modelling techniques have a particular role in assisting with the design and impact of new WWTW.

The first step in evaluating the potential for odour impact for existing works is to carry out a detailed process review to identify possible odour generation and process related controls. After this initial process assessment, the next stage is to identify where, how and why odour emissions occur and to measure or estimate emission rates. Specific compound analysis and odour potential measurement in the liquid streams will identify formation of odours whilst air samples can be taken to identify odour sources.

The use of odour or H_2S mapping may help. However, whilst H_2S is in general an indicator used to target odours from WWTW and it is possible to measure H_2S down to around 1ppb instrumentally, the limitation of this approach is that it assumes that H_2S concentrations and odour are proportional. Based upon observations, the odour threshold is frequently 5 times larger than the value that would have predicted based upon the H_2S concentration alone. Also, odours from certain stages of the process may be less dependent upon H_2S for example aerobic odours, stripped organics and ammonia.

The data shows that in respect of mass emissions of odour, often relatively low odour concentrations result in large mass emissions because of the size of the source area, such as the primary sedimentation tanks. The data could be used as input to a dispersion model to assess potential odour impact at sensitive receptors for each source.

11.4 Odour Modelling

Dispersion modelling is addressed in the draft Environment Agency guidance on odours H4[1] however there are a number of issues that should be noted. Firstly, most models are based upon Gaussian theory and are used generally to determine maximum ground level concentrations typically over 1-hour average periods. As odour response relies on variations in odour concentration over much shorter periods of time, the averaging period should be much shorter.

[1] Environment Agency Technical Guidance Note IPPC H4, *Horizontal Guidance for Odour*, DRAFT, October 2002

Small-scale meteorological variations mean that the peak values can be up to 10 times the average values over 1-hour for point sources. Secondly, the model only produces concentration data and this may not be a direct indicator of potential offensiveness or nuisance.

However, modelling has an important role to play in the design of new plant, the assessment of complex odour problems at existing works, assessment of odour generation and control option efficiency for new plant and the assessment of potential impacts on proposed development close to WWTW.

The absence of information on the complex make-up of an odour makes any dispersion model difficult to interpret – for example different odorous substances will have differing odour thresholds and hence during dispersion the perceived nature of the odour may change. Also some strong odours may screen the presence of other intensely odorous substances.

Analysis of the impact of a mixture of odorous substances has a number of difficulties, including:-

- The odour intensity for the mixture may be greater than any of the individual substances but less than the sum of their intensities. As the number of components increase in the mixture, the intensity of the dominant component begins to give a good indication of the intensity of the mixture
- There are no apparent synergistic effects between odorous substances
- The greater the number of substances in a mixture, the greater the suppression of the individual constituents
- The greater the number of components, the more difficult it is to identify individual substances
- Hydrogen sulphide is the least frequently suppressed constituent whilst isovaleric acid and skatole are the most suppressed
- The unpleasantness of mixtures is usually greater than that of the sum of individual components suggesting that models using a single odorant for predicted odour impact will underestimate the potential impact.

The use of boundary odour limits as absolute control values is not recommended due to the difficulty in effective ambient measurement and also the uncertain relationship between odour concentration and nuisance. Their use of ambient odour guideline values may be appropriate as a benchmark for desktop modelling studies when predicting impact of new plant and when evaluating variation in potential odour impact of differing equipment location. In addition they may again be used as benchmark values when studying the odour profile around existing works or when trying to correlate complaint locations with predicted odour concentrations. It must be stressed that the modelling output relates to odour intensity and not odour nuisance and therefore care must be taken in the practical application of this data.

The selection of an appropriate benchmark value would be for the WWTW operator to justify based upon the characteristics of the odour and the locality. There are a number of sources of benchmark values including the current Environment Agency Guidance value of 1.5 ou_E/m^3 as a 98^{th} percentile of hourly averages for more unpleasant odours and a Dutch standard is 0.5 ou_E/m^3 as a 98^{th} percentile of hourly averages. It should also be noted that not only are averaging periods in the order of 1-hour, but they are expressed as percentiles. The 98% percentile is the hourly odour concentration that is achieved for 98% of the year and consequently this value will be exceeded, potentially by very high concentrations of odour over short periods that may themselves be a nuisance by definition.

Whilst there is no preferred method for modelling odour nuisance, the use of models may be appropriate to indicate possible odour impact. In these situations it is recommended that the following principles are adopted:-

- The model used and the inputs to the model should be agreed between the local authority and the WWTW operator
- It is important to consider intermittent sources (such as the operation of storm tanks) when carrying out such assessments.
- The relevant comparative odour guide values and averaging times to be used for assessment should be agreed between the local authority and the WWTW operator
- A consistent approach should be maintained and therefore the experience gained from the previous use of various modelling techniques for WWTW should form the basis of any decision on model and parameter selection.

12. Baseline Measures Applicable to all WWTW

12.1 General

There are certain baseline measures that should be put in place at all WWTW, as a matter of good practice, to minimise the risk of odour nuisance occurring. These baseline good practice measures should be implemented regardless of whether complaints are received or not.

The basic odour control techniques which would be expected to be put in place at all new and existing WWTW include:

- select locations of major sources away from sensitive receptors at the design stage
- good housekeeping and raw material handling practices
- control and minimisation of odours from residual materials and waste (including imported sludge or septic tank waste)
- preparation of an Odour Management Plan (see Section 12.2 and Annex 3)
- maintaining the effluent aerobic other than in processes which are specifically anaerobic
- avoiding anaerobic conditions and prevent septicity
- containment of strong odour sources and treatment in odour control equipment.
- design and operation of the process steps to minimise odour, including:
    - minimise sludge retention time in primary settlement
    - consider avoiding primary settlement by applying extended aeration
    - for new and upgraded WWTW, cover (or allow for covering at a later stage where odour effects are difficult to quantify prior to commissioning)

Other baseline measures that should be put in place at WWTW are described in this Section.

12.2 Odour Management Plan

An Odour Management Plan (OMP) should be prepared for all processes. This is a core document that is intended to detail operational and control measures appropriate to management and control of odour at the site. The format of the OMP should provide sufficient detail to allow operators and maintenance staff to clearly understand the operational procedures for both normal and abnormal conditions. The OMP should also include sufficient feedback data to allow site management (and local authority inspectors) to audit site operations. An example of some of the issues to be considered is included in Annex 3 and this can be summarised as follows:-

- a summary of the site, WWTW, odour sources and the location of receptors
- details of the site management responsibilities and procedures for reporting faults, identifying maintenance needs, replenishing consumables complaints procedure
- odour-critical plant operation and management procedures (e.g. correct use of plant, process, materials; checks on plant performance, maintenance and inspection)
- operative training
- maintenance and inspection of plant (both routine and emergency response)
- spillage management procedures
- record keeping – format, repsonsibility for completion and location of records
- emergency breakdown and incident response planning including responsibilities and mechanisms for liaison with the local authority.

The Odour Management Plan is a living document and should be regularly reviewed and upgraded.

12.3 Good housekeeping

Lack of good housekeeping can result in elevated levels of residual odour, and at times more serious sources of odour. The majority of good housekeeping is, in any case, good working practice and additional costs for odour control are minimal.

Location of odour sources
So far as is practicable, sources of odour shall be located at positions on the site that are likely to minimise the odour impact on nearby receptors. Account should be taken of distance, prevailing wind direction and obstructions. In practice, this will often mean locating the source of odour as far as practicable from the site boundary.

Tanks
The build up of scum or foam on tank surfaces can at times lead to odour and should generally be avoided. (However, a stable scum layer can reduce odour in some instances, e.g. sludge storage).

Draining tanks for cleaning has been implicated as a source of odour complaints. This should be scheduled to minimise impact. Where practicable, appropriate chemicals should be used to minimise this impact.

Storage of sludge
Storage of sludge product on site should be minimised.

Storage of screenings and grit
Screenings should preferably be washed and 'bagged' and grit should be washed to reduce odour potential. Skips containing screenings and grit should be covered, and removed from site as soon as is practicable.

Spillages
Spillages are usually due to plant failure but sources of possible spillage should be considered and avoided at the design stage. Often, spillages involve sludge: an interruption to continuous sludge processing could lead to spillage from a storage tank or cause sludge levels to build up in settlement tanks, one of the known risk factors for odour at WWTW.

12.4 Odour complaints administrative procedure

The WWTW operator shall have in place a procedure specifying how any complaints will be administered and progressed. This will show who is responsible for dealing with the different aspects of the complaint and should be integrated in the Odour Management Plan, for example:

- who in the company and/or at the site are complaints to be directed to as a point of central contact
- who in the company and/or at the site has management responsibility for ensuring complaints are dealt with
- who in the company and/or at the site has technical responsibility for dealing with the resolution of any justifiable complaints
- who in the company and/or at the site is responsible for liaison with regulator and local stakeholders on progress (from acknowledgement of complaint to, where justified, resolution).

It is recommended that complaints that are made to the WWTW operator are forwarded to the local authority. The procedure for notifying such complaints should be detailed in the Odour Management Plan and it is recommended that the WWTW operator submits regular summaries of complaints but only notifies the local authority immediately when incidents are significant and further complaints are likely.

12.5 Plant performance, maintenance, inspection and operator training

Defra research found that some odour problems at WWTW had been due, wholly or partially, to problems with plant maintenance and proper operation of odour abatement equipment. These problems were said to be due partly to difficulties in operation, lack of training and poor after-sales service. Plant performance, maintenance, inspection and operator training are therefore crucial in maintaining the effectiveness of odour control measures.

Plant performance
Operators should ensure the good performance of all plant, both the main treatment processes and odour control equipment. The maintaining of an Odour Management Plan should help to raise the priority given to operating and maintaining abatement systems.

Reagents and consumables
Adequate supplies of reagents and consumables should be kept on site. Records should be kept of the delivery and usage of all chemicals and reagents, and these records should be used to minimise the risk of running out. Schedules should be prepared for the planned replacement of longer-lasting reagents such as activated carbon, dry scrubbing chemicals or bio-filter media, together with any monitoring which has a bearing on the suitability of these plans.

Planned inspection and maintenance
An effective, planned inspection and preventative maintenance regime should be employed on all odour-critical plant and equipment identified in the Odour Management Plan as impacting on odour. Important points are:

- A written maintenance programme should be included in the Odour Management Plan
- A record of maintenance should be made available for inspection
- All external pipework used for scrubbing liquor, condensate, steam, cleaning water, irrigation water and process liquid transfer should be leak-proof and protected against frost
- A method for forewarning the community on intended maintenance works that may lead to odours beyond the site boundary

Emergency breakdown response
The operator should prepare an Odour Management Plan documenting the response for emergency breakdown of odour-critical plant. This should include the foreseeable situations which may compromise his ability to prevent and/or minimise odorous releases from the process and the actions to be taken to minimise the impact. It is intended to be used by operational staff on a day-to-day basis and should detail the person responsible for initiating the action.

The plan should also include clear timescales for response to odour incidents.

The Odour Management Plan should include a list of essential spares for the odour control equipment. Where practicable, spares should be held for items liable to fail on odour-critical plant. The equipment manufacturer should recommend which spares are subject to wear and foreseeable failure and are critical for the correct operation of the odour abatement equipment (such as pumps, adsorption media, nozzles etc.) and these should be held on site. It may be acceptable for certain spares to be available on guaranteed short delivery if the absence of a supply at the site would not lead to complete failure of the odour control equipment or to odour nuisance. The local authority should be notified without delay where the WWTW operator identifies odours that may cause nuisance beyond the site boundary.

Competence and training

Staff at all levels having duties related to the management, operation, maintenance or repair of odour-critical processes and plant should be trained and competent and have documented training records. In order to minimise risk of emissions, particular emphasis should be given to control procedures during start-up, shut down and abnormal conditions. This CoP encourages training to be addressed as part of an Environmental Management System (EMS). The operator should maintain a statement of training requirements for each operational post and keep a record of the training received by each person whose actions may have an impact on the environment. Training should include:

- awareness of their responsibilities for avoiding odour nuisance
- minimising emissions on start up and shut down
- action to minimise emissions during abnormal conditions
- procedures for advising key persons and recording episodes when emissions occur which are likely to lead to odour complaints.

12.6 Maintaining Effectiveness of On-Site Measures

i) Procedural and management systems

- ♦ Odour Management Plan – this formalises odour-critical management procedures, operative training, and operational procedures (e.g. correct use of plant/process/materials; checks on plant performance, maintenance and inspection). Specific reference should be made to methods for the control and management of works which are unmanned for all or part of their operating period.
- ♦ Maintenance, inspection and plant operator training – these are crucial in maintaining the effectiveness of odour control measures.

ii) Technical measures

- ♦ Monitoring of source emissions of odour or a surrogate – for controlled odour emissions (e.g. from stacks, vents, ducts and odour abatement plant) monitoring of the source emissions (or a surrogate quantity) can be carried out. Monitoring may be periodic (e.g. annually to check odour abatement efficiency) or continuously to give an instantaneous indication of performance, often linked to an alarm.

12.7 Checks beyond the Site Boundary

i) Procedural and management systems

- Complaints monitoring **-** the monitoring of complaints is an important method of indicating the effectiveness or otherwise of measures implemented to reduce nuisance due to odour. Complaints can be made either to the operator of the WWTW or direct to other bodies such as the local authority Environmental Health department.

ii) Technical measures

- Monitoring of odour at the boundary-fence/perimeter line – monitoring can range from very simple (e.g. "sniff" tests), to complex (e.g. sampling and analysis of specific odorous compounds, e.g. H_2S). The technique used shall be sufficient to do what is needed, i.e. demonstrate continuing effectiveness. This is analagous with being fit for purpose. The "sniff" test is probably the most common technique for assessing the (continuing) effectiveness of odour abatement measures. It is simple and cheap, although very subjective. One technique that should never be used at site boundaries is standard olfactometry. This is not of sufficient sensitivity for ambient air samples.

iii) Population surveys

- Such tools can be used to help monitor and maintain the effectiveness of abatement measures. Surveys conducted by market research would be too expensive for continuing application. Odour logs and diaries are more appropriate in this case. It is possible for members of the public to typify odours by comparison to common household or everyday odours.

The WWTW operator shall have in place procedures to ensure feedback of checks on the effectiveness of odour control so that appropriate actions can be taken in response to problems. Continuing effectiveness of odour control shall be a standing item on the agenda of appropriate management meetings.
The WWTW should ensure there is liaison with regulator and local stakeholders on the continuing effectiveness of the control measures and any problems that have been encountered or expected.

13. Enhanced Odour Control Measures Applicable to WWTW

There may be circumstances where, having carried out the baseline measures specified in Section 12, the process is still leading to odour nuisance at sensitive receptors.

Some WWTW operators have found it convenient to group these control measures into two bands: a first basic set of actions that can be triggered quickly and inexpensively immediately following the complaint, and a second level of more extensive measures that can be employed if the basic actions are not successful in dealing with the problem (i.e. stemming the complaints). This may include, for example, modifying the process or installing abatement. This CoP encourages tiered approaches where quick fixes can solve the problem, or temporarily alleviate it during further work or investigations.

13.1 Odour Control Aims

The aim of the Statutory Nuisance provisions is to ensure that WWTW apply adequate controls to prevent emissions where possible but in any case to ensure that they are minimised and do not cause odour nuisance.

The hierarchy for implementing control options is usually considered in the following order of preference before escalating to the next level:

1. Site management and housekeeping (largely detailed in Section 12 of this CoP)
2. Operational and process changes
3. Containment
4. Enclosure with extract ventilation and end-of-pipe treatment of exhaust air.

It may be possible that the process can meet the aim of preventing odour nuisance without the use of containment, or enclosure with end-of-pipe treatment. It is often possible to reduce odours by careful process evaluation and changes, for example, by process operation and configuration. However, in cases where the baseline good practice housekeeping and operational controls of Section 12 cannot avoid odour nuisance at sensitive receptors, containment of odours or enclosure of sources and treatment of odorous emissions is likely to be the key to cost-effective control.

In order for the methods available to deal with the problem effectively, it is necessary for the operator to have a number of things in place:-

- sufficient day-to-day control to minimise or contain any problems via frequent and regular full inspections of the site carried out by the operator;
- a scheme to monitor the extent of the odours and to detect when a problem has arisen or is likely to occur;
- techniques and equipment which are acknowledged as being effective need to be in place or available to deal with incidents as they occur;
- a requirement to take effective action in the event of offensive odours being detected.

13.2 New Plant Design

The incorporation of good design practice can greatly reduce the potential for odour releases and can also ensure that plants are provided with sufficient odour control systems to avoid offensive odours in the locality. It can also greatly reduce the costs of retrofitting odour control systems. The environmental drivers for upgrading existing waste water treatment plants offer an ideal opportunity to optimise plant design for minimising and treating odours.

Odour problems can occur at almost any stage of a WWTW depending upon influent and plant location, operation and design. However, the areas most commonly responsible for potentially offensive odour releases are the inlet works, primary sedimentation, high-rate secondary treatment processes and all stages of unstabilised sludge handling and storage. There are opportunities for the selection of process stages which minimise odour release or facilitate more effective odour control.

One stage in particular is primary settlement. As the tanks are usually large, there is a significant surface area to emit odours at this stage. It may be more effective to use a low-rate biological treatment step such as extended aeration of crude sewage or a high-rate process within a building to avoid primary treatment. The choice obviously has cost implications but is more likely to be determined by size of the works and other process considerations. During design it is not uncommon to use dispersion models for selecting plant and process location and also for evaluation of the need to cover primary tanks.

There is extensive guidance on the design of waste water treatment plants in BS EN 12255. In particular, BS EN 12255 – 9 of 2002 deals specifically with odour control and ventilation.

13.3 Developing an Odour Improvement Plan

Once the baseline measures of Section 12 have been implemented, an assessment as to whether an odour nuisance exists should be undertaken. The flow sheet in Figure 3 outlines the key steps in evaluation of the various stages involved in identifying appropriate odour control solutions. In order to undertake the assessment of odour and the development of a control scheme, the operator should carry out a systematic review and analysis of the odour sources and control options. The outcome of this review should be an Odour Improvement Plan.

The plan should identify the odour sources, measurement and assessment methodologies and process data recording. Where an odour nuisance exists, the operator should evaluate the sources and causes of the odour and develop a list of the available options to control the odour release. The approach should be based upon the control hierarchy in Section 9.3 and in the first case these measures should be based upon process optimisation and possibly process change. The various options should be evaluated in relation to both capital and operating costs, environmental impact of the control option (energy use, secondary pollutants and pollutant transfer, raw materials etc.) and the odour reductions predicted. Each of the control options should then be compared to identify those options that are readily available, offer effective odour reduction and offer a well-balanced cost and environmental impact. This information should then be subject to discussion with the local authority to agree an implementation and monitoring programme.

Once the relevant controls have been implemented, a further analysis of the potential for odour nuisance should be carried out. If the odour nuisance has not been prevented, there should be further review of available enhanced measures or containment and abatement systems using the same methodology as before. The process is iterative until all the nuisance is abated, all available control options have been implemented or substantial works that represent bpm have been undertaken.

The Odour Improvement Plan is a living document and should be regularly reviewed and upgraded. The operator may choose to integrate the OMP and the OIP.

13.4 Transport of sewage to the works

This CoP concentrates on odour control options for WWTW and will not specifically address the potential odour issues associated with the sewerage transport system (drains, sewers and remote pumping stations). Some of the measures in this case are outside the scope of this CoP (such as trade effluent) but the WWTW operator should still review the impact and controls possible in such cases.

However, if the influent to the treatment works is already septic and undergoing anaerobic activity, it will have significant impact on the WWTW. Therefore all sewers should include good design, operation and maintenance to avoid septicity. The guidance in European Standard EN 752-4 on the design of sewer systems to minimise septicity will assist in minimising anaerobic conditions.

Measures that can be taken to reduce septicity and minimise the retention time of sewage in transport under anaerobic conditions, include:

- minimise the length of pumped sections
- ensure that the slope of gravity sections prevents sediment accumulation
- minimise intermediate storage
- prevent seawater intrusion
- avoid siphons
- avoid untreated putrescible and warm wastes from industrial sources
- regular cleaning to remove accumulations
- improve ventilation
- if septic conditions are developed, chemical dosing may reduce the amount of odour – this includes adding oxygen, hydrogen peroxide, nitrate or ferric salts
- air stripping at the inlet works and treatment of the stripped air.

13.5 Inlet Works

In general the inlet works are potentially a considerable source of odour from incoming sewage particularly if it is septic sewage at the inlet, odorous imported wastes (such as septic tank emptyings), storm conditions and storage and handling of screenings and grit. In the case of WWTW that are subject to odour complaint, it is common to cover the inlet works and vent to odour abatement equipment. Measures that should be taken to minimise odour releases from this source, include:

- Regular cleaning and flushing of screens and influent channels

- Grit and screenings transfer and storage in a manner to prevent spillage. Ideally screenings after washing should be dewatered and bagged (or contained in a covered skip).
- Lowering discharge points to minimise turbulence and volatilsation of odours
- Balancing the flow of sludge liquors to even the load over the day
- Imported sludges to go straight to sludge storage tanks and not through inlet works

13.6 Primary Sedimentation

The principal odour sources in primary tanks are excessive turbulence in the inlet distribution channel or stilling chamber, the overflow weir and the tank surface. Minimisation of the sludge retention time in the primary tanks can reduce the odour. However, if there is anaerobic activity before or during the primary sedimentation operation, the size of these tanks can make them a significant source.

Measures that should be taken to minimise odour releases from this source, include:

- Pre-treatment of incoming septic sewage or possible chemical dosing with nitrate or iron salts
- Reducing hydraulic retention times,
- Improving desludging both in efficiency and frequency and regular cleaning of the tanks, sumps, scum and grease removal equipment – aim to ensure that sludge is not held on the base of the tanks for more than 1-hour
- Reduce turbulence at the weir overflow by reducing the drop height from the weir
- Recirculation of nitrified final effluent during low flow and avoiding the recirculation of secondary sludge

13.7 Secondary Aerobic Treatment

Ensure that conditions remain aerobic. Maintenance and inspection of the air diffusion system and liquid irrigation are of great importance. Measures that should be taken to minimise odour releases from this source, include:

For trickling filters

- Media should be kept wet and hydraulic overloading or blockage should be avoided
- Clogging or ponding of the filter as a result of organic overloading, inadequate aeration or mixing, blocking of aeration vents or media breakdown may result in anaerobic conditions and odours
- Avoid sludge and solids settling due to low turbulence in the liquor especially close to any recirculated sludge return

For activated sludge plants

- Increased aeration by methods which minimise the generation of aerosols (for example sub-surface diffuse aeration) and maintain the activated sludge flocs in suspension
- Shrouding of the mechanical aerators to reduce aerosol formation
- Covering the inlet distribution chamber and anoxic zone may be sufficient in cases where odours occur

13.8 Final Settlement and Tertiary Treatment

At this stage the effluent and sludges should be oxidised and provided sludge retention times are carefully managed, odour release should not be a problem. Denitrification may be a problem with fully nitrified effluents giving rise to rising sludge and surface solids. This can be avoided by minimising sludge retention periods in the final tank.

13.9 Sludge Handling , Storage and Thickening

Sludge and bio-solids handling are usually the most significant source of odour release and good sludge management is a key issue. All raw sludge and bio-solids will release odour largely dependent upon age. In general, sludge handling, storage and processing should be enclosed or covered and provided with ventilation to odour-abatement equipment.

Measures that should be taken to minimise odour releases from this source, include:

- Unstabilised liquid sludges imported to WWTW should be transported in tankers or (if in solid form) enclosed lorries and should be transferred to storage tanks which are vented to odour abatement equipment
- Sludge which has been lime treated can generate odour, particularly ammonia, and should be stored under cover to prevent odour generation (including avoiding re-wetting of sludge cake)
- Sludges should be processed (thickened, digested or dewatered) as soon as possible after generation as retention will lead to anaerobic conditions. It is good practice to minimise the potential storage of sludge before treatment and storage for unstabilised sludge should be limited to a maximum capacity of 24-hours production
- All tanks and plant for unstabilised sludge storage and processing should be enclosed or covered and vented to odour abatement equipment
- Replacement of lagoons and drying beds with mechanical dewatering plant will help minimise retention and contain odours
- Avoid open storage of sludges or sludge cakes

13.10 Anaerobic Digestion

The gas produced in an anaerobic digestor will be odorous. It should not be released to air in an uncontrolled manner and will only usually be vented untreated in the case of an emergency activation of a safety device. Normally the gas will be used as a fuel in boilers to heat the digestor or used for fuel a combined heat and power system. In some cases an excess of gas production necessitates the operation of the pressure-relief valve and burning-off the surplus through a flare. Measures that should be taken to minimise odour releases from this source, include:

- Routinely drain condensate traps to remove water and avoid back pressure
- Ensure that the digester system is balanced in respect of pressure to reduce emergency pressure relief operation
- If the gas is vented to a combustion unit for energy recovery, a stand-by flare should be provided in case of combustion system malfunction
- Regularly inspect the operation of the flare to check in particular that the pilot will light the flare even if the flare has been overloaded
- Avoid turbulence of the sludge after digestion

- Secondary digestors are often not covered and they can lose up to 10% of methane generated and obviously also any odour associated with the sludge. The operation of the primary digester should reduce the risk of odour generation at the secondary stage. In cases where the operation of the primary digester leads to odour release in the secondary stage, the secondary digester may require covering and venting to an odour and methane treatment facility (it is essential to consider possible explosion hazards associated with this)
- Covering of digested-sludge feed channels, mixing wells and overflow take-offs
- Regular inspection of the seals of floating gasholders
- Any covers or abatement equipment provided for this source will require careful evaluation in relation to safety and explosion control

13.11 Thermal Drying of Sludge

Thermal dryers release a large volume of water during the drying and there are two options for odour emission treatment:

- Maintain the conditions in the exhaust treatment plant to ensure that the moisture did not condense. This would result in a wet emission with odour control provided by thermal oxidation
- Condense the water and use a more traditional odour treatment system such as a biofilter, scrubber or adsorber. There would be concern that by condensing the moisture any solids present would be re-wetted and may liberate more odour and also the generation of potentially odorous liquors.

13.12 Storm Water

The problem with storm water tanks is if they are not emptied soon after filling they can go anaerobic. The other major issue relates to the frequency and efficiency of flushing and cleaning of the tanks after use. These tanks are very large and are rarely covered. Implementation of the following measures should largely avoid odours from the storm tanks:

- Storm tanks should not be used to increase the hydraulic capacity of the WWTW – they should only be used for storm conditions
- If the tanks are to be used for balancing influent flows under normal flow conditions, septic conditions should be avoided either by the use of chemical additives or by maintaining solids in suspension by controlled aeration
- The tanks should be emptied within the shortest possible time once the hydraulic load has reduced to allow the treatment of the storm flow and should be within no more than 72 hours. This requires that the design hydraulic load allows the storm water flow to be treated within this timescale
- The tanks should be operated on a system to ensure that tanks are continually refreshed to avoid liquor standing and also that the tanks are emptied in order of the age of the storm water within them
- The tanks should be desludged and cleaned as soon as possible after use. Allowing the sludge to stand in the tanks will rapidly lead to odour generation. Consideration should be given to the provision of automatic flushing and desludging equipment in these tanks.

14. Odour Containment and Abatement

14.1 Odour Containment, Plant and Tank Covers

The most effective way of controlling odour released during the various process stages is to either fully enclose the plant within a building or to provide localised tank covers. There has been some experience in England of total plant enclosure using what is often termed 'triple containment'. The design and operation of these plants requires the use of different compact process technologies such as lamella settling (almost 10% of the area for traditional settlement), re-aeration and dissolved air flotation rather than activated sludge processing primarily to reduce size. The selection of process stages will have a significant impact on both water quality and odour generation. It is therefore recommended that the operator justifies the selection of technology and controls at the planning stage. At the design stage of new or upgraded works, it is essential that systems are designed to be free from leaks and offer good source containment of odours.

Whilst these full enclosure techniques are available, they carry a significant cost and may not be cost-effective. A more traditional approach to containment is the use of ventilated buildings for certain plant and equipment and covers for tanks. In general the following sources will require containment at source and venting:

- sludge digestion plants, dewatering facilities and tanks
- entire inlet works (pre-primary stage) - low concentration large volume
- grit removal, coarse screens, skips (leakproof and enclosed).

In general it is not necessary to contain emissions from:

- primary tanks (may require covers in sensitive locations odour control but can often be sufficient by good management and maintenance)
- aerobic tanks (need to avoid excessive aerosols from aeration lanes and aerobic tanks – these can act as an odour stripper and could be a health and safety problem)
- final settlement.

The design of covers is relatively straightforward, the main problem being one of engineering such large structures to be able to take load and making provision for inspection and maintenance. They have to be designed to allow for adequate support, to support wind, snow and personnel loads and to give sufficient clearance from process equipment and may have to incorporate walkways. The materials of construction need to be resistant to light and corrosion and are often constructed from either glass re-enforced plastic or aluminium. In addition to loads, the covers need to be designed to allow for bridge scrapers (can use rotating roofs), access, inspection and vents.

The following are some key design requirements:-

- Minimise head space under covers to reduce the volume of air vented due to displacement
- Any inspection hatches or access points should be sealed and any pipework transitions should be sealed

- The design of tanks and covers should minimise the need for regular access for maintenance and inspection as confined space entry systems will be required
- The vent volumes need to be adequate to ensure no odour escape and also to account for air quality inside the cover (occupational exposure, corrosion and explosion hazard).
- Ventilation rates will depend upon the exact process operations but for tanks the design flows are typically 0.5 – 12 air changes per hour based upon the empty tank volume or 120% of the maximum filling rate. In the case of thickener tanks, the volume may increase to 200% of the maximum fill rate
- The design will take account of the fill and empty rate, maximum rate of change in headspace, likely gaps and leakage, evolution rate of flammables to maintain <25% LEL for methane (10% is good design)
- Allowance should be made for emergency ventilation of the tanks
- One problem with tank covers is that they cannot be easily inspected therefore tend to be poorly maintained.

Additionally, guidance on the design of waste water treatment plants in BS EN 12255 advises designers to :-

- Locate sources requiring abatement close together to optimise abatement options and minimise costs
- Consider explosion risk, corrosion, access and health and safety.

14.2 Odour Abatement Equipment

The air which is exhausted from enclosures usually requires abatement to avoid odour nuisance. It is possible to establish performance criteria to reflect what constitutes best practicable means (bpm) in relation to abatement equipment. This can be specified as follows:-

> *Any odour abatement equipment installed on contained emissions (ventilation air from the process building) should have an odour removal efficiency of not less than 95%*[2]*. Determination of the destruction efficiency should be by dynamic olfactometry based upon manual extractive sampling undertaken simultaneously at the inlet and outlet of the odour control equipment. At least three samples should be taken from both the inlet and outlet.*

There is a wide range of odour abatement equipment that can be used to treat emissions of contained air from WWTW. There are many factors which will affect the choice of equipment including required odour removal efficiency, flow rate and inlet odour concentration, type of chemical species in the odour, variability in flow and load, space requirements and infrastructure (power, drainage etc.). The range of technologies available is detailed in the Environment Agency H4 Guidance Note on odour.

---

[2] *Where the inlet odour concentrations are very low and the 95% destruction efficiency is difficult to demonstrate due to measurement reproducibility and equipment efficiency at low concentrations, the final discharge to air should contain less than 500 odour units/m^3.*

It is important when evaluating the most appropriate control technology to consider both total cost (capital and operating) and environmental impact (such as energy use, chemical use and secondary pollutant generation). Often operating costs are closely linked with environmental impact (that is costs for energy, raw materials etc.) and wherever possible the most environmentally sustainable technique should be selected.

As odour abatement plant capacity is usually tightly specified (little spare capacity), the assumption is that all other measures are being correctly used – covers, doors, chemicals replenished etc. This therefore becomes a key management issue that should be included in the Odour Management Plan.

The site layout may permit a centralised plant or due to locational constraints it may be necessary to use more than one system for example on the inlet works and the sludge process. It may be economical to provide a number of smaller biofilters for individual sources but if the selected technology is wet scrubbing it may be more cost effective to provide a single system. In some cases it may be appropriate to divide the odour streams and use different technology based upon the load and characteristics of each system.

Table 2 below summarises the main types of abatement equipment and the odour abatement efficacy that may be achieved.

SYSTEM	CAPITAL	CONSUMABLES	EFFECTIVENESS
Biofilters	Moderate	Need space, fan energy, media replacement 3 – 5 years	High >95% - not able to rapidly adjust to changes in flow or load
Bioscrubbers	Moderate	Fan energy, effluent needs oxygenation	High >95% - can handle higher H_2S loads than biofilters
Activated sludge plant	Low additional	Needs fully aerobic sludge	90 – 95% for H_2S and NH_3 ; may be ideal as a polishing stage
Wet scrubbers	High	Fan energy, pump energy, dosing chemicals and effluent disposal – high energy user	Single stage <80% but multiple stage - >98%
Dry scrubbing (carbon or impregnated media)	High	Media replacement is a high cost with strong odours, suffer with moisture loading	> 95% ; Widely used for passive sources. Need several seconds residence for treatment
Catalytic iron oxidation	Moderate	Low operating cost	Specific for H_2S – good for low flow high load
Thermal oxidation	High	Fan energy and support fuel	>98% ; good for dryer vents and VOC loads
Ozone	Moderate	Replacement of source and energy for fan and ozone generator	>90% on low concentrations – good for building vents
Counteractants and masking	Low	Replenishment of chemicals	Not an abatement method – may be suitable for short-term use

TABLE 2– ODOUR ABATEMENT

Experience in operation of peat and heather type biofilters has shown that they do not perform well when the flow or odour load from the process is variable although other media (shell-type material) appears to perform better for these applications. There has been a considerable amount of biofilter and bioscrubber equipment installed at WWTW. The units range in size from 75 – 435,000m^3/hr but are typically 1600 – 3000m^3/hr. The suppliers tend to offer 95-98% odour removal, 95-99.9% H_2S removal and 300 ou_E/m^3 in exhaust gases.

The industry approach is that emission sources which exhibit strong odour peaks are best treated in wet scrubbers or carbon systems as some bio systems have been overloaded previously. It is increasingly common to have scrubbers on the sludge processing operations (often 3 or 4-stage scrubbers are used).

ANNEX 1

Typical form for the recording an odour-related complaint

Odour Complaint Report Form	Sheet No

Date: Installation to which complaint relates

Name and address of complainant:

Tel no. of complainant:

Time and date of complaint:

Date, time and duration of offending odour:

Location of odour, if not at above address:

Weather conditions (ie, dry, rain, fog, snow):

Cloud cover (none, slight, partial, complete):

Cloud height (low, high, very high):

Wind strength - (light, steady, strong, gusting)
Or use Beaufort scale:
Wind direction:

Complainant's description of odour (i.e. comparison with other odours, strong/weak, continuous, fluctuating):

Has complainant any other comments about the odour?

Are there any other complaints relating to the installation, or to that location? (either previously or relating to the same exposure)

Any other relevant information:

On-site activities at time the odour occurred:

Operating condition at time offensive odour occurred
(e.g. flow to works, flood conditions, maintenance, tank cleaning)

Form completed by Signed

ANNEX 2

Guidance on Odour Assessment and Complaint Investigation – Olfactory Screening ('Sniff-testing')

This is a very useful quick test which can provide a subjective "snap-shot" assessment of the presence, strength and character of an odour either within an installation boundary, at the boundary or in the area/community surrounding the site. A record should be kept of the meteorological conditions at the time of testing together with information relating to the operations and activities being undertaken at the time.

Routine assessments can help to build up a picture of the odour impact of the installation on the surrounding environment over a period of time. Assessments which are targeted at adverse weather conditions or particularly odorous cycles of an operation allow "worst case" scenarios to be developed. Ideally the same methodology should be used to follow up complaints.

The general principles are covered below.

General considerations

When undertaking an assessment, the following points need to be considered.

- The person undertaking the assessment should avoid strong food or drinks, refrain from smoking prior to the test, avoid scented toiletries or strong vehicle deodorisers and avoid undertaking an assessment with a cold or sore throat.
- Individuals that have a less than average sense of smell should be excluded. If necessary this can be compared with the general population by means of olfactometry.
- To improve (or to check) data quality the test can be conducted by two persons working independently during the same time period.
- Frequency of assessment should be determined by the potential for odour generation or the number of complaints as required.
- Remember that the nature of an odour can change over distance as the various components are diluted below their individual detection thresholds
- The health and safety of the individual undertaking the assessment should not be compromised. Containers should never be sniffed where there is any possibility of them containing, or having contained, substances which may be harmful.

Testing location

Where possible move from areas of weaker odour strength towards the more intense odour. The exact location will depend on the purpose of the assessment but when investigating off-installation odour, start well down wind and move towards the installation. It should be remembered that an odour may change in character over a distance as a result of dilution and/or conversion. A number of factors may determine the choice of location, including:

- Permit conditions relating to the installation boundary or sensitive receptors
- Complaints received
- Proximity of housing to the installation
- Wind direction at the time of testing

The wind direction should be ascertained and this will assist in selection of the assessment route. An assessment may involve walking along a route selected according to the above factors, or to the conditions found upon arrival. Alternatively points may be fixed in order to evaluate the changing situation over a period of some weeks or months, or may vary from test to test according to local conditions. The latter may be of use in identifying worst case conditions.

Data collection and recording

The intensity, extent (persistence and distance from the plant or installation boundary) of the odour and the sensitivity of the location where the assessment is being made with regard to receptors, should be recorded as well as any external activities such as agricultural practices that could be either the source, a contributor to, or a confounding factor in a particular odour event.

The categories of intensity, extent and sensitivity are:

INTENSITY

1 No detectable odour
2 Faint odour (barely detectable, need to stand still and inhale facing into the wind
3 Moderate odour (odour easily detected while walking & breathing normally, possibly offensive)
4 Strong odour (bearable, but offensive odour)
5 Very strong odour (very offensive, possibly causing nausea)

EXTENT (assuming odour detectable, if not then 0)

1 Local & transient (only detected on installation or at installation boundary during brief periods when wind drops or blows)
2 Transient as above, but detected away from installation boundary
3 Persistent, but fairly localised
4 Persistent and pervasive up to 50m from plant or installation boundary
5 Persistent and widespread (odour detected >50 m from installation boundary)

SENSITIVITY OF LOCATION WHERE ODOUR DETECTED (assuming detectable, if not then 0)

1 Remote (no housing, commercial/industrial premises or public area within 500m)
2 Low sensitivity (no housing, etc. within 100m of area affected by odour)
3 Moderate sensitivity (housing, etc. within 100m of area affected by odour)
4 High sensitivity (housing, etc. within area affected by odour)
5 Extra sensitive (complaints arising from residents within area affected by odour)

The observation period should be over a standard time, generally 5 minutes at each location. During this time the intensity and extent can be evaluated.

Installation-specific information should be recorded - activities being undertaken, influent flow rate and quality, tank cleaning operations, maintenance etc..

A record should be made of the atmospheric conditions during the assessment. In the absence of an anemometer, the wind speed can be approximated using the Beaufort scale.

Beaufort scale

Force	Description	Observation	km/hr
0	Calm	Smoke rises vertically	0
1	Light air	Direction of wind shown by smoke drift, but not wind vane	1-5
2	Light breeze	Wind felt on face; leaves rustle, ordinary vane moved by wind	6-11
3	Gentle breeze	Leaves and small twigs in constant motion	12-19
4	Moderate breeze	Raises dust and loose paper; small branches are moved	20-29
5	Fresh breeze	Small trees in leaf begin to sway, small branches are moved	30-39
6	Strong breeze	Large branches in motion; umbrellas used with difficulty	40-50
7	Near gale	Whole trees in motion; inconvenience felt when walking against wind	51-61

The key reporting parameters are set out in the following example of a reporting form :

ODOUR ASSESSMENT REPORT **FILE NO. ....**

INSTALLATION/ LOCATION		**DATE**	
Weather		Wind (strength & direction)	
Temperature (deg. C)		Bar. Pressure (mbar) if known	
Ground condition		General air stability, (if known)	
General air quality		Cloud cover/height Low, high, very high	
Time: start		Time: Finish	

Plan attached showing location & extent of odour Yes/No

COMPLAINT RECEIVED	Yes/No	Date & Time complaint(s) received	
Location of complaint area		Number of complaints which may relate to same source	
Grid Reference (where location is not a property)		Time odour noticed & duration	

TEST LOCATION (and time)	**Intensity**	**Extent**	**Sensitivity**	**Installation/ process sources** (potential or actual)	**External sources** (i.e. potentially confounding sources/factors)

Additional comments

Signature: Persons contacted regarding odour:

Action required

ANNEX 3

GUIDANCE ON THE PREPARATION OF AN ODOUR MANAGEMENT PLAN

What is an Odour Management Plan?

An Odour Management Plan is a summary, provided by the operator, of the foreseeable situations which may compromise his ability to prevent and/or minimise odorous releases from the process and the actions he will subsequently take to minimise the impact. This will include operational and control measures for normal as well as abnormal conditions. It is intended to be used as a reference document for operational staff on a day-to-day basis and shows what actions should be taken to minimise the event and who is responsible for authorising or undertaking the action.

The plan is intended primarily to detail operational and control measures appropriate to management and control of odour. It should also document foreseeable events which are outside of the control of the operator, however the operator may wish to include types of failure that are preventable, for example pump failure, biofilter compaction or filter breakthrough in order to highlight the need for the appropriate maintenance work to be undertaken before the failure occurs. It is recommended that the Odour Management Plan becomes the primary odour control document and should therefore include the odour complaints administration procedure.

What is the Format for the Odour Management Plan?

The Odour Management Plan should be a written document which is available on-site and should be available to the local authority and all site personnel.

The operator should address the following issues in the Plan:-

1. the activity which produces the odour and the point of odour release
2. possible process or control failures or abnormal situations
3. potential outcome of a failure in respect of the likely odour impact on local sensitive receptors
4. what actions are to be taken to mitigate the episode, timescales and details of the persons responsible for the actions at the site
5. record keeping.

Examples of the Issues which may be Considered in an Odour Management Plan?

1. Those which have potential to affect the process and the generation of odour

Examples of factors which the operator should normally have made arrangements for are:

- Materials input (seasonal variation in weather may affect odour of influent and intermittent discharge of odorous substances to the sewerage system)
- Process parameters (changes in temperature, aerobic conditions)
- Rate of throughput or increased hours of operation
- Development of anaerobic conditions
- Routine maintenance and inspection.

2 Those which affect the ability to abate/minimise odour

Examples of factors which might be considered to be outside of operator's control and best dealt with by management actions:

- Start-up and shut-down of key plant and equipment
- Power failure (although the provision of backup facilities should be considered)
- Poor performance of biofiltration or poisoning (if not the result of poor maintenance or maloperation)
- Flooding of the biofilter due to abnormally high rainfall
- External failure of other utilities, e.g. water supply (This should also be considered where the operator has signed up to an interruptible gas supply).

Examples of factors which the operator should normally have made arrangements for are:

- Mechanical breakdown of abatement equipment such as pumps, fans etc
- Power failure
- Compaction of the biofilter or surface fissures
- Saturation of a carbon filter bed and subsequent breakthrough of odours
- Below optimum temperature of a thermal oxidiser or boiler etc
- Saturation of scrubber liquor, blocked injection nozzles etc.
- Routine maintenance and inspection.

3. Those which affect the ability to contain odour (where releases are not normally permitted)

Examples of factors which might be considered to be outside of the operator's control and best dealt with by management actions:

- Building damage which affects integrity due to for example storms
- Power failure

Examples of factors which the operator should normally have made arrangements for are:

- Failure of automatic doors, i.e. in open position
- Failure in procedures to maintain containment (human error)
- Routine maintenance and inspection.

4. Those affecting dispersion between the source and sensitive receptors (for permitted release points such as vents, stacks or biofilters):

Examples of factors which might be considered to be outside of the operator's control and best dealt with by management actions:

- Short term weather patterns which fall outside of the normal conditions for that area (ie highly unusual, not just the normal meteorological pattern - for example inversions and other conditions unfavourable to dispersion should have been considered in designing the process).

Examples of factors which the operator should normally have made arrangements for are:

- Weather – wind direction, temperature, inversion conditions if these are normal variants of local weather
- Loss of plume buoyancy/temperature

  Note: many of the above are design issues to a large extent – the process should be designed to prevent/minimise odour to the required level (a level of acceptability) which takes the range of meteorological conditions into account.

Small changes in the way we perform everyday tasks can have huge impacts on Scotland’s environment.

Walking short distances rather than using the car, or being careful not to overfill the kettle are just two positive steps we can all take.

This butterfly represents the beauty and fragility of Scotland’s environment. The motif will be utilised extensively by the Scottish Executive and its partners in their efforts to persuade people they can do a little to change a lot.

ISBN 0-7559-2544-0

This document is also available on the Scottish Executive website: www.scotland.gov.uk
Astron B41319 04/05