management to ensure that the influent material is not allowed to stagnate and hence go stale and so a suitable flow through the plant is required at all times.

The perception of odour at some point downwind of an emission source depends on the number of dilutions in odour free air needed to render the odour barely detectable. The unit generally used in quantification of odour potential is the dilution factor which is the number of times the odorous air sample has to be diluted such that 50% of an odour panel cannot detect the odour.

Local Climatology

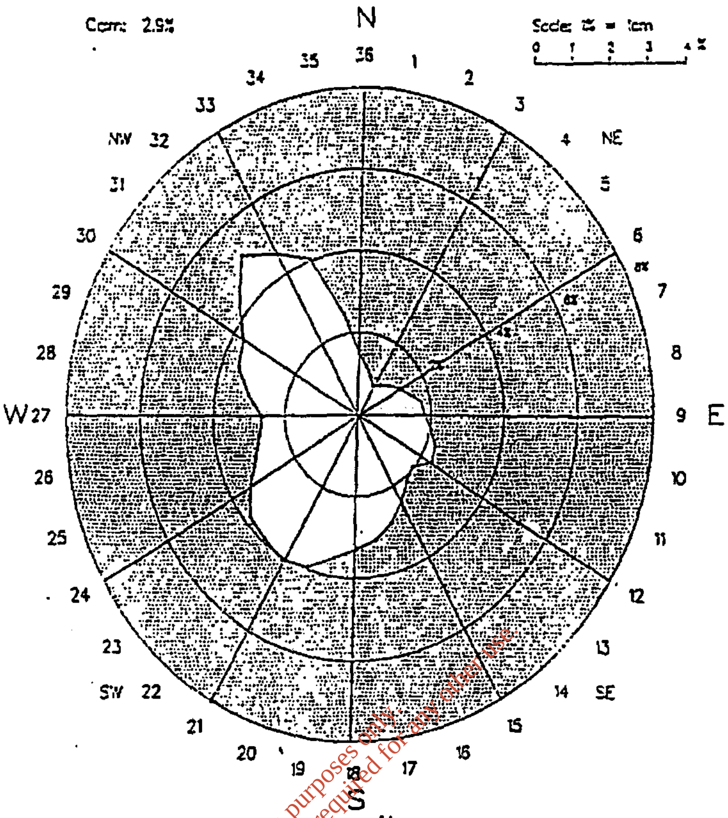
The incidence of wind speed and wind direction will affect the magnitude of any potential odour nuisance at a specific property in the surrounding area. At high winds any odour generated at the treatment plant will be rapidly dispersed in the air and so will quickly reach a concentration below which it is not detected. Conversely, during slack winds the odour plume from the plant may drift some distance before dilution of the odour is such as to be undetectable.

The nearest meteorological station recording wind observations to Carrigrenan, Little Island is at Roches Point at the mouth of Cork Harbour (approx. 12km to SE). Results over a 30 year period indicate that the prevailing wind direction is from a NW direction with a secondary maximum for S-SW winds. The incidence of winds of 5m/s or less is about 44% for the time with speeds of <2m/s (including calms) occurring about 10% of the time (Fig. A-4.1). Recorded wind observations at Cork Airport (13km to W) show similar prevailing wind conditions with winds of 5m/s or less occurring 53% of the time and speeds of <2m/s (excluding calms) occurring 7.5% of the time (Fig. A.4.2). Although the weather station at Roches Point will be affected by sea breezes the pattern of wind direction-speed will be similar for the Cork Harbour area.

The wind will blow towards the small number of houses on the road running parallel to the northern boundary about 40% of the year whereas it will be off-shore i.e. blowing away from potential locations of complaint for about 60% of the time. The wind is from the NE sector, i.e. towards Passage West (approximately 1km away) for about 6% with winds of < 3m/s occurring for less than 2% of the time. The potential for any emissions from the proposed plant to disperse towards this residential area is therefore very low. During the summer period a significant on-shore coastal breeze can develop over the Cork Harbour area during warm calm weather conditions.

Fig. A.4.1.

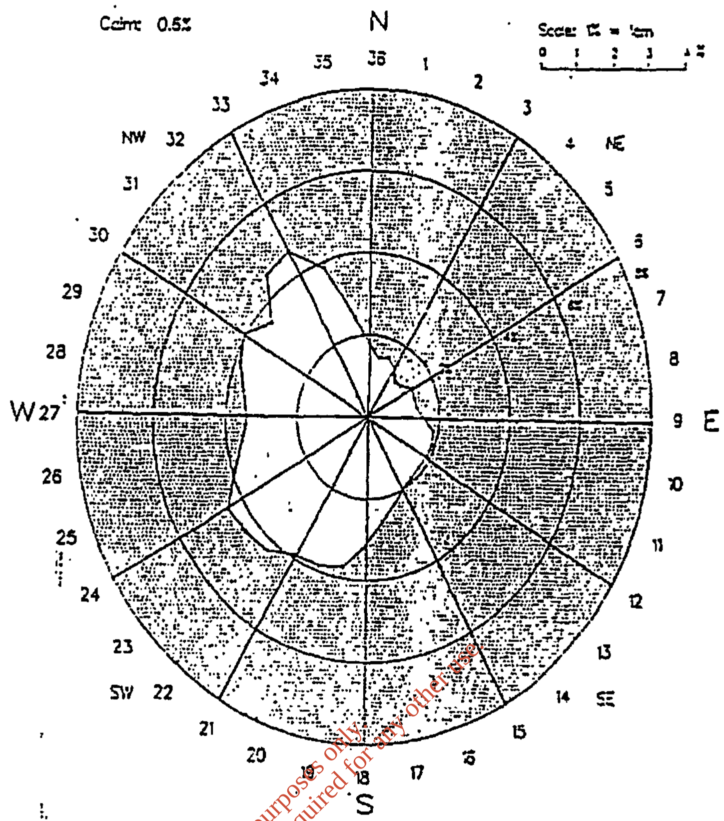
Frequency of Wind Direction & Wind Speed for Hourly Observations at Roches Point (Jan. 1962 - Dec. 1991). Source:- Meteorological Service, Glasnevin Hill, Dublin 9



Direction (Degrees)	Percentage occurrence of Wind Speeds in m/sec.					
	<2	2-3	3-5	5-8	8-10	>10	All
360-30	0.3	0.6	1.1	0.9	0.1	0	3.0
30-60	0.4	0.6	1.2	1.0	0.2	0	3.4
60-90	0.4	0.6	1.3	1.8	0.7	0.4	5.2
90-120	0.5	0.9	2.0	2.2	0.8	0.4	6.8
120-150	0.6	0.9	1.5	1.9	0.9	0.6	6.4
150-180	0.7	1.2	1.9	2.4	1.4	1.6	9.2
180-210	0.6	1.0	2.2	3.7	2.0	2.0	11.5
210-240	0.5	0.9	2.5	3.9	1.8	1.4	11.0
240-270	0.3	0.6	2.1	3.3	1.3	0.9	8.5
270.300	0.5	0.9	2.2	3.5	1.7	1.4	10.2
300-330	1.4	1.8	2.8	4.4	2.0	1.7	14.1
330-360	1.2	1.5	2.0	2.1	0.7	0.4	7.9
Calms	2.8						2.8
Totals	10.2	11.5	22.8	31.1	13.6	10.8	100

Fig. A.4.2.

Frequency of Wind Direction & Wind Speed for Hourly Observations at Cork Airport (Jan. 1962-Dec. 1991): Source:- Meteorological Service, Glasnevin Hill, Dublin 9



Direction (Degrees)	Percentage Occurrence of Wind Speeds in m/sec.					
	<2	2-3	3-5	5-8	8-10	>10	All
360-30	0.6	1.2	1.4	1.0	0.3	0.1	4.6
30-60	0.4	0.9	1.3	1.0	0.2	0	3.8
60-90	0.3	0.6	1.3	1.4	0.4	0.3	4.2
90-12-	0.4	0.8	1.5	1.8	0.7	0.3	5.5
120-150	0.6	0.9	1.3	1.7	0.7	0.4	5.6
150-180	0.6	1.2	1.9	2.5	1.1	0.9	8.2
180-210	0.7	1.4	2.5	3.6	1.7	1.4	11.3
210-240	0.6	1.6	3.4	4.5	1.8	1.2	13.1
240-270	0.6	2.0	3.2	3.3	1.1	0.5	10.7
270-300	0.9	2.3	3.4	3.4	1.1	0.5	11.6
300-330	0.7	2.4	4.6	3.7	1.0	0.4	12.8
330-360	0.6	1.4	2.8	2.5	0.6	0.2	8.1
Calms	0.5						0.5
Total	7.5	16.7	28.6	30.3	10.7	6.2	100

This can result in a southerly air flow over the Cork Harbour area. At night-time under these conditions the air flow will tend to be reversed so that it is towards the mouth of the harbour and hence away from the nearby community.

Air Temperature

The annual mean air temperature for Cork Harbour is about 10.5°C with a range in daily averages of from about 6.3°C in January to about 15°C in July. There would be a small number of days when the maximum air temperature at Little Island can be over 25°C but generally the sea-breeze will tend to prevent stagnation of air flows in Cork Harbour during these very warm dry conditions. However the potential for odour nuisance from the treatment plant will be greatest during this type of weather.

Mist/Fog

The incidence of mist or fog in Cork Harbour provides an indication of the percentage of time when poor dispersion close to the ground is likely which could result in significant odour concentrations from an emission source. For the period 1960-84 the mean total number of hours per year when mist/fog conditions were reported was 859 hours/year (9.8%) with the highest incidence during the early morning and the lowest during the afternoon period. The incidence of fog at Roches Point is about 4% of the time with the highest frequency occurring during the months of June to September.

Existing Ambient Air Quality

The proposed location at Carrigrenan is situated at the southern end of Little Island and is surrounded on three sides by an expanse of water. At the northern end of Little island is an extensive industrial estate which contains a number of light industrial companies including some small chemical/pharmaceutical facilities. The nearest industrial estate is over 1km to the north of Carrigrenan and so the impact on ambient air quality at the proposed treatment plant site from the relatively small number of industrial emission sources is low.

The ambient air quality is good with background organic compounds typical of those that may be detected close to mud flats which are present during low tide around the site. The mud may occasionally be a source of odours especially during warm weather conditions when it is probable that sulphurous compounds are generated in the low lying marshy area at the north west of the proposed site. However, these emissions of marine origin would generally not be of sufficient duration to cause a community nuisance.

Plant Design

The proposed wastewater treatment plant at Carrigrenan is designed to cater for an influent of capacity of 448,350 pop. equivalent. The design of the plant (design loading conditions for year 2025) is described in detail in the main report and may be summarised as follows:-

a) Inlet works Screening/Grit and Grease chamber located at NW end of site.

b) Primary sedimentation tanks - a total of 6 circular tanks with radial flow.

c) 12 activated sludge tanks and secondary clarifiers.

d) Sludge treatment - This part of the plant will consist of sludge picket fence thickeners, anaerobic digesters, sludge de-watering presses, thermal drying plant and bagging and storage of dried sludge.

The receipt of the raw wastewater at the inlet part of the plant in particular during periods of intermittent or low flow can be a serious source of odour nuisance which can be highly objectionable to local residents. The inefficient collection and removal of screenings and grit which may be left on a concrete stand can result in strong sulphide odours being generated.

In the case of the proposed plant at Carrigrenan, the inlet works including inlet distribution channels, screens and screenings treatment will be enclosed in a building with an air filtration system to remove objectionable odours. The grit/grease removal system will also be covered and extracted air treated in the odour removal filtration system. This part of the plant design is important as the inlet works are potentially the main source of odours especially if poorly maintained. It is important therefore that the foul air treatment system works efficiently during the normal operation of the plant and that at all times the influent is kept fresh so that anaerobic decomposition of the wastewater does not take place.

In order that odorous emissions are minimised an advanced odour control system for the sludge handling (press and drying) plant will be installed at the northern end of the building. This will treat all odours generated during the sludge thickening and pressing stages before the air in the building is vented to the outside air. Generally sludge handling especially when the thickener tank or press belt system is not enclosed can be a major source of odorous emissions. Poor housekeeping, in that sludge is not disposed off-site quickly but is kept in open skips, is a source of odours in a number of plants around the country.

However, in the case of the proposed plant design these potential sources will be enclosed so that gaseous emissions are filtered prior to discharge to the air.

Odour Dispersion Modelling

Introduction

Short term odour concentrations downwind of the treatment plant were computed using an air quality gaussian dispersion model developed by the U.S. E.P.A. Calculations were made to predict the rate of dilution from the boundary of the plant to the property in the neighbourhood where a potential odour nuisance could arise. These locations are to the north of the proposed site, approximately 0.3-0.5 km from the centre of the plant (0.1km downwind of northern boundary). The predicted concentrations were based on the worst case climatological conditions, i.e. the combination of wind speed and wind direction that result in the maximum short term ground level concentration at the receptor location for each stability category examined.

Modifications to the input requirements were made to allow for dispersion from an area emission source as in the case of urban wastewater treatment tanks rather than from a point emission source such as a chimney. The emission from the inlet works and sludge handling facility were treated as point sources as such emissions would emanate primarily from vents or air extraction units as fugitive type emissions. The emissions from sedimentation tanks and secondary treatment tanks occur close to ground level with vertical exit velocities of 1 m/s or less and so the plume rise above ground level is small. The rate of dilution from these sources is therefore dependent on the dispersive properties of the air layers close to the ground; i.e. the atmospheric stability.

For the purposes of the modelling study, 3 atmospheric stability categories were examined. These were unstable, neutral and stable weather conditions. The first type is commonly associated with warm sunny weather with relatively light winds (in a coastal environment a sea breeze is likely to dominate in such situations). Data for Roches Point indicates an incidence of about 6%; mostly occurring during the May-September period. Neutral stability conditions are the most common category in Ireland and are characteristic of overcast, windy weather conditions. They occur about 79% of the time in this part of Ireland. Finally stable weather conditions occur at night-time with relatively slack winds (<3 m/s) and little or no cloud cover. This type of weather is likely to create low level temperature inversions close to the ground which may restrict dispersion of air emissions even further. In terms of potential for odour nuisance in the vicinity of the plant, light winds during neutral stability or stable weather conditions will result in the poorest dilution of any odour plume and hence highest ground level concentrations.

Emission Estimates

The emission rate used in the dispersion model was expressed in terms of the dilution factor rather than as a specific pollutant compound emission rate due to the mix of compounds that can be emitted from a specific source. The unit of measurement was odour units /m^2.s (o.u/m^2.s) for emissions from the liquor surface of the primary and secondary treatment tanks. In the case of other types of emissions as in the case of sludge handling or fugitive emissions from various vents the unit used was o.u/s.

Unlike modelling for industrial emissions sources which are normally confined to a few point emissions from vents or stacks, emissions from wastewater treatment plants are much harder to quantify due to the numerous potential sources. In some cases as for large tanks odour plumes from a number of tanks may combine downwind when the wind is blowing in a particular direction, whereas for other wind directions the odour plumes may disperse without merging. There are also no studies available that have measured emissions from tanks with regard to weather conditions which can significantly affect evaporation rates from large water surfaces.

A more basic estimate of emissions is used in predictive modelling for new treatment plants as distinct from up-grading existing ones where measurements in the vicinity can be taken. From observations made at other wastewater treatment plants a number of potential sources for odorous emissions can be identified such as uncovered inlet works, bio-filter beds, primary sedimentation tanks and sludge handling/de-watering components of the plant.

It is evident that the treatment of primary influent and the de-sludging draw-off chambers can be significant sources of odours that can be detected at the boundary of the sites.

On the other hand experience suggests that no significant odours have been detected from secondary clarifiers due to the quality of the effluent which has a low B.O.D. at this stage of the treatment process.

Based on such assessments estimates of emission rates can be made. The following odour emission rates for the proposed plant were used in the model:-

Primary Sedimentation Tanks	-	1 $o.u/m^2.s$
Aeration Tanks	-	0.25 $o.u/m^2.s$
Secondary Clarifiers	-	<0.1 $o.u/m^2.s$
Sludge Treatment Works and associated tanks (fugitive emissions and occasional venting)	-	2000 o.u/s
Sludge De-watering/Storage Housing (air filtration system installed)	-	<0.01 o.u/s
Inlet Works inc. screen and grit/ grease chamber (air filtration system installed)	-	<0.01 o.u/s

The total number of tanks included in the model were based on the works required under present wastewater loading and also the requirement for future construction of tanks as the loading increases.

Dispersion Model Results

A number of options in relation to the design of the treatment plant were examined. These were:

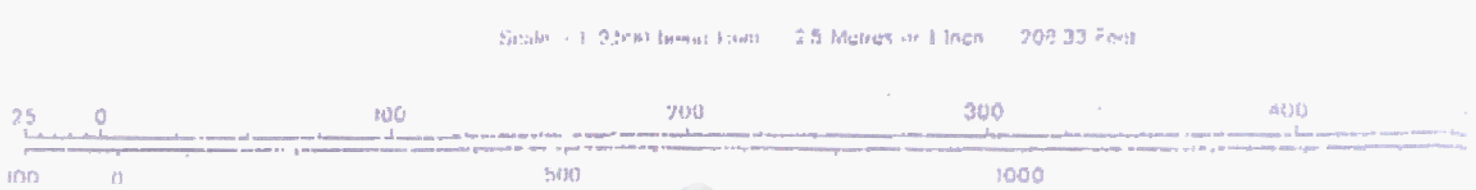
1) Leaving the Primary Sedimentation Tanks uncovered

2) Enclosing the Primary Sedimentation tank weirs but leaving remainder of the tank surface uncovered.

3) Complete enclosure of Primary Sedimentation Tanks.

The results relate to the locations indicated in Fig. A.4.3 along the northern boundary of the proposed site as the nearest community in other directions are at least 1km downwind and separated by a water channel. A number of points along the northern boundary were selected to include length from the access road to a point due east of the location for the aeration tanks. Predictions of odour concentrations were made at the nearest private properties which are about 200m further downwind from the northern end of the developed portion of the site. These results enable the potential for odour nuisance to be made.

FIGURE A.4.3. RECEPTOR LOCATIONS REFERRED TO IN TABLES A.4.1. - A.4.5.



Option No. 1 - Primary Sedimentation Tanks uncovered

One option in the design of the treatment plant examined was the odour potential of leaving the primary sedimentation tanks uncovered. From observations at other wastewater treatment plants these open liquid surfaces can be a significant potential source of odours. A unit emission rate per square metre was used for estimating emission rates from the 6 primary tanks. For example the emission rate from a primary sedimentation tank of diameter 38.5m was calculated to be 1164 o.u/s (4.2 million o.u/hr).

The results given in Tables A.4.1 - A.4.3 indicate the degree of dilution that occurs between the northern boundary and the nearest housing which are located approximately 100m further to the north. There is a significant decrease in computed odour concentrations between the boundary line sites and the housing and so it is critical to have the proposed buffer zone of undeveloped land between the proposed plant and nearby property. The results also show the large decrease in ambient potential odour concentrations that can occur as the air close to the ground changes from stable to unstable conditions resulting in much improved dispersion of any odour plume.

The primary sedimentation tanks have a dominant influence on predicted downwind concentrations with the exception of sites 7, 8 and house No. 12 which are at the eastern end of the aeration tank layout. The relative importance of emissions from the sludge handling part of the plant and the inlet works where emissions are largely controlled by air filtration systems is relatively minor. However any fugitive emissions from the inlet part of the works could have a significant impact on houses 1 and 2 which are close to the existing road at the NW corner of the site. It is therefore very important that plant management ensures that fugitive emissions from the inlet works do not take place.

Odour concentrations above about 5 o.u./m^3 are likely to be a source of complaint especially if occurring over period of time (1). It is evident from the above results that although during neutral and unstable weather conditions maximum odour concentrations are generally below this value at the nearest properties in the case of stable weather conditions peak concentrations are in excess of 10 o.u/m^3. This magnitude of odour concentration would be likely to result in significant odour nuisance at neighbouring properties along the northern boundary.

TABLE A.4.1
Peak short-term odour concentrations - Neutral Stability (odour units/m³)

Location N. Boundary	Source Group		Inlet/ Sludge	Whole Plant
	P. Sed. Tanks	Sec. Treat.		
1	6.2	2.0	2.5	7.8
2	7.7	2.3	1.4	9.2
3	8.4	2.5	1.1	9.9
4	8.6	3.2	0.8	9.3
5	7.0	3.5	0.7	7.0
6	5.1	4.2	0.5	5.3
7	5.0	6.8	0.6	7.1
8	3.9	5.3	0.5	6.7
HOUSES				
1	3.1	1.3	1.6	4.2
2	3.6	1.4	1.8	4.8
3	4.6	1.8	0.6	4.9
4	4.8	1.9	0.5	4.9
5	4.7	1.9	0.5	5.0
6	3.7	1.6	0.5	4.0
7	4.2	1.8	0.4	4.4
8	4.2	1.8	0.4	4.4
9	3.6	1.6	0.4	3.8
10	3.5	1.6	0.5	3.7
11	3.4	1.4	0.5	3.7
12	3.6	4.5	0.4	4.8

NOTE:Refer to Fig. A.4.3 for locations along boundary and houses:

(1) Primary sedimentation tanks were assumed to be uncovered and the above calculations are for the 6 tanks in operation.

(2) Secondary treatment sources consisting of the 12 90 x 22.5m activated sludge tanks and also the secondary clarifiers.

(3) Included in this category are emissions from the inlet works and sludge treatment components of the plant. With the installation of odour control units and the enclosure of the inlet works the emissions will generally be very low. However fugitive emissions may occasionally occur from these parts of the plant and an emission rate was included in the calculations.

TABLE A.4.2

Peak short-term odour concentrations - Stable Stability (odour units/m^3)

Location N. Boundary	Source Group		Inlet/ Sludge	Whole Plant
	P. Sed. Tanks	Sec. Treat.		
1	12.2	4.2	7.7	16.2
2	14.0	5.4	4.7	17.1
3	14.6	5.8	3.5	17.5
4	17.3	6.9	2.8	18.7
5	15.6	7.3	1.7	15.6
6	11.5	8.8	1.6	11.6
7	11.0	12.3	2.1	12.8
8	9.4	10.4	2.0	15.1
HOUSES				
1	7.2	3.2	5.2	10.0
2	8.1	3.7	4.5	11.0
3	10.1	4.6	2.4	10.4
4	11.2	4.8	1.6	11.2
5	11.3	5.0	1.8	11.6
6	8.9	4.1	2.2	9.2
7	10.0	4.4	1.6	10.1
8	10.5	4.1	1.7	11.0
9	9.2	4.1	1.7	9.3
10	8.8	3.9	1.8	8.8
11	8.2	3.3	1.9	9.0
12	8.7	9.2	1.8	10.7

TABLE A.4.3

Peak short-term odour concentrations - Unstable Stability (odour units/m^3)

Location N. Boundary	Source Group		Inlet/ Sludge	Whole Plant
	P. Sed. Tanks	Sec. Treat.		
1	2.2	0.6	0.4	2.9
2	3.0	0.7	0.2	3.6
3	3.5	0.8	0.2	4.0
4	2.9	1.0	0.1	3.0
5	2.4	1.3	0.1	3.5
6	1.6	1.7	0.1	1.7
7	1.5	2.8	0.1	3.1
8	1.0	2.0	0.1	2.5
HOUSES				
1	0.9	0.4	0.3	1.2
2	1.0	0.4	0.3	1.5
3	1.3	0.6	0.1	1.5
4	1.3	0.6	0.1	1.2
5	1.2	0.6	0.1	1.5
6	1.0	0.5	0.1	1.2
7	1.0	0.6	0.1	1.1
8	1.0	0.6	0.1	1.1
9	0.8	0.5	0.1	1.3
10	0.9	0.5	0.1	1.0
11	0.9	0.4	0.1	1.1
12	0.8	1.6	0.1	1.8

Option No. 2 - Covering the Primary Sedimentation overflow weirs.

Data of emission measurements at primary sedimentation tanks published recently (2) indicate that the emissions from the flow of effluent over the perimeter weirs on circular primary sedimentation tanks is about 10% of the total emissions for a tank of similar size to the one considered for this plant design. A reduction of 10% would not significantly reduce predicted concentrations at the housing during neutral and stable weather conditions to below a value of 5 o.u/m^3. Given the large expanse of liquor in the tanks, which for the proposed 6 tanks gives a total surface area of 69,800 m^2 compared to weir length of about 725m covering only the weir part of the tank will not significantly reduce potential emissions.

Option No. 3 - Covering of Primary Sedimentation Tanks

Complete covering of the 6 primary sedimentation tanks would effectively eliminate emissions directly into the air from these area sources. The large reduction in predicted odour concentrations along the northern boundary and neighbouring houses for emissions during neutral and stable weather conditions is shown in Tables A.4.4 and 5. With the exception of sites 7, 8 and House no. 12 at the NE end of the site concentrations are a factor of 2 or more lower than if the sedimentation tanks are left uncovered. The locations at the NE end are more influenced by the extensive group of aeration tanks on the plant which may during SW winds blow directly downwind towards House No. 12.

Conclusions

The results of the modelling study indicate the relative importance of the main sources of potentially odorous emissions from the proposed wastewater treatment plant at receptor locations to the north of the site. Due to the large size of the plant and the array of sedimentation and secondary treatment tanks the contribution of emissions from each group of sources will vary depending on wind direction due to odour plumes combining downwind of the plant.

It is evident that the potential for an odour nuisance from uncovered primary sedimentation tanks is significant. Due to the large area of exposed liquid it is a potential source of emissions especially during warm weather conditions when evaporation from the surface may be significant. Covering of these tanks is recommended to eliminate these emission sources creating a potential odour nuisance at neighbouring property.

TABLE A.4.4
Peak short-term odour concentrations - Neutral Stability (odour units/m^3)

Location N. Boundary	Source Group P. Sed. Tanks	Source Group Sec. Treat.	Inlet/ Sludge	Whole Plant
1	-	2.0	2.5	2.5
2	-	2.3	1.4	2.3
3	-	2.5	1.1	2.5
4	-	3.2	0.8	3.2
5	-	3.5	0.7	3.5
6	-	4.2	0.5	4.3
7	-	6.8	0.6	7.1
8	-	5.3	0.5	5.7
HOUSES				
1	-	1.3	1.6	1.6
2	-	1.4	1.8	1.8
3	-	1.8	0.6	1.8
4	-	1.9	0.5	1.9
5	-	1.9	0.5	2.0
6	-	1.6	0.5	1.6
7	-	1.8	0.4	1.8
8	-	1.8	0.4	1.8
9	-	1.6	0.4	1.6
10	-	1.6	0.5	1.6
11	-	1.4	0.5	1.4
12	-	4.5	0.4	4.7

NOTE Refer to Fig. A.4.3 for locations along boundary and houses.
(1) Primary sedimentation tanks were assumed to be covered and so emissions are negligible.

TABLE A.4.5

Peak short-term odour concentrations - Stable Stability (odour units/m^3)

Location N. Boundary	Source Group P. Sed. Tanks	Sec. Treat.	Inlet/ Sludge	Whole Plant
1	-	4.2	7.7	7.7
2	-	5.4	4.7	5.4
3	-	5.8	3.5	5.8
4	-	6.9	2.8	6.9
5	-	7.3	1.7	7.3
6	-	8.8	1.6	8.8
7	-	12.3	2.1	12.8
8	-	10.4	2.0	12.5
HOUSES				
1	-	3.2	5.2	5.2
2	-	3.7	4.5	4.5
3	-	4.6	2.4	4.7
4	-	4.8	1.6	4.8
5	-	5.0	1.8	5.0
6	-	4.1	2.2	4.1
7	-	4.4	1.6	4.4
8	-	4.1	1.7	4.1
9	-	4.1	1.7	4.1
10	-	3.9	1.8	3.9
11	-	3.3	1.9	3.3
12	-	9.2	1.8	10.6

The contribution by emissions from the aeration tanks is generally much lower at the houses with the exception of House No. 8 which is at the NE end of the site. The proposed layout of the aeration tanks would result in this property being directly downwind of the 12 tanks during SW winds. Reduction in emissions from the aeration tanks is recommended to avoid a potential nuisance at this location. The installation of sub-surface aeration diffusers would result in less surface turbulence and hence potential emissions than would be the case with a vertical shaft surface aeration system commonly used at plants around Ireland.

Overall the plant design is one that ensures that where possible odorous emissions are controlled. There are no bio-filters installed as part of the secondary treatment process which are recognised as major sources of odours at many plants. In addition other potential odour sources such

as the inlet works and the sludge handling facilities are designed with air filtration systems to ensure that emissions from these parts of the plants are negligible. The high flow of wastewater through the works, coupled with efficient plant design, will ensure that the material does not become stale resulting in anaerobic reactions causing very strong odours. All these aspects of plant design should result in a low potential for odour generation and hence potential for nuisance complaints in the neighbourhood. However, it must be stressed that efficient plant management and good housekeeping procedures are vital elements in the successful operation of the plant and that the sludge and grit must be handled or stored so that odorous emissions do not occur.

B AIR QUALITY IMPACT OF PROPOSED URBAN WASTEWATER TREATMENT PLANT LOCATED AT MAHON SITE

General

The assessment for odour potential due to air emissions from the proposed urban wastewater treatment plant at Mahon, between Ballinure and the Douglas river, for the treatment of wastewater from the Cork Main Drainage Scheme was carried out by examining local climatological characteristics, plant design and air dispersion modelling estimates. The proposed facility will treat all domestic, commercial and industrial wastewater from the catchment area which currently discharges directly into the river and Cork Harbour.

Introduction

Odours normally associated with wastewater treatment plants are highly pungent and may be identified at very low air concentrations. For example hydrogen sulphide with the characteristic smell of rotten eggs has an odour detection limit in the order of about 0.2 $\mu g/m^3$. The public perception of treatment plants is based in most cases on problems of old treatment plants where the operational procedures are inadequate to prevent anaerobic conditions occurring that can create an odour nuisance or where de-sludging activities are carried out in open tanks. Many developments such as containment of sludge in enclosed sludge digesters, monitoring of effluent flows through the works, prevention of clogging of channels or sludge chambers and regular maintenance of grit traps and screens have greatly helped to reduce odour nuisance.

The rate of emissions of potentially odorous inorganic and organic compounds from wastewater treatment tanks depend on the volatility of the compounds and the evaporation rate from the tank. The latter is a function of the wind speed, air temperature and turbulence of the liquid. The rate of anaerobic activity within the effluent is also affected by weather conditions such as air temperature and humidity so that odours tend to be greatest during dry warm weather conditions. These conditions may also be associated with periods of low effluent flow through the plant which can significantly affect the efficiency of the plant.

It is virtually impossible to ensure that odours are never detected beyond the boundary fence of a treatment plant. This is because of the nature of the material being handled. The aim however, is to prevent an odour nuisance occurring on a regular basis. This requires good plant management to ensure that the influent material is not allowed to stagnate and hence go stale and so a suitable flow through the plant is required at all times.

The perception of odour at some point downwind of an emission source depends on the number of dilutions in odour free air needed to render the odour barely detectable. The unit generally used in quantification of odour potential is the dilution factor which is the number of times the odorous air sample has to be diluted such that 50% of an odour panel cannot detect the odour.

Local Climatology

The incidence of wind speed and wind direction will affect the magnitude of any potential odour nuisance at a specific property in the surrounding area. At high winds any odour generated at the treatment plant will be rapidly dispersed in the air and so will quickly reach a concentration below which it is not detected. Conversely, during slack winds the odour plume from the plant may drift some distance before dilution of the odour is such as to be undetectable.

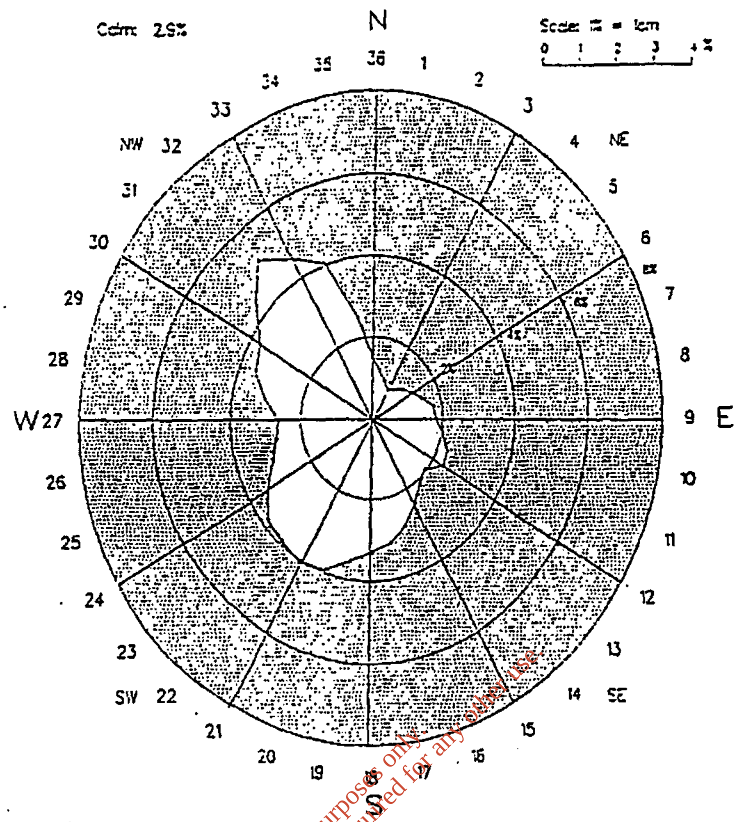
Results from Roches Point meteorological station (approx. 14km to SE) over a 30 year period indicate that the prevailing wind direction is from a NW direction with a secondary maximum for S-SW winds. The incidence of winds of 5 m/s or less is about 44% for the year with speeds of <2 m/s (including calms) occurring about 10% of the time (Fig. B.4.1). Recorded wind observations at Cork Airport (8km to w) show similar prevailing wind conditions with winds of 5 m/s or less occurring 53% of the time and speeds of < 2 m/s (including calms) occurring 7.5% of the time (Fig. B.4.2). Although the weather station at Roches Point will be affected by sea breezes the pattern of wind direction/speed will be similar for the Cork Harbour area.

The nearest residential communities are located to the north (Mahon) and south (Rochestown) of the proposed site. Based on data from Roches Point the wind will blow towards the houses located in Rochestown about 25% of the time and towards the housing estate at Mahon for about 20% of the time. For winds from these directions of less than 3 m/s the incidence is much lower, approximately 6% towards Rochestown and 4% towards Mahon. The wind will therefore be towards locations where a potential complaint may rise at Rochestown or Mahon, and at a speed when dilution of any odour will be restricted, for only about 525 and 350 hours/year respectively.

During the summer period a significant on-shore coastal breeze can develop over the Cork Harbour area during warm calm weather conditions. This can result in a southerly air flow over the Cork Harbour area. At night-time under these conditions the air flow will tend to be reversed so that it is towards Lough Mahon and hence, away from residential areas.

Fig. 8.4.1.

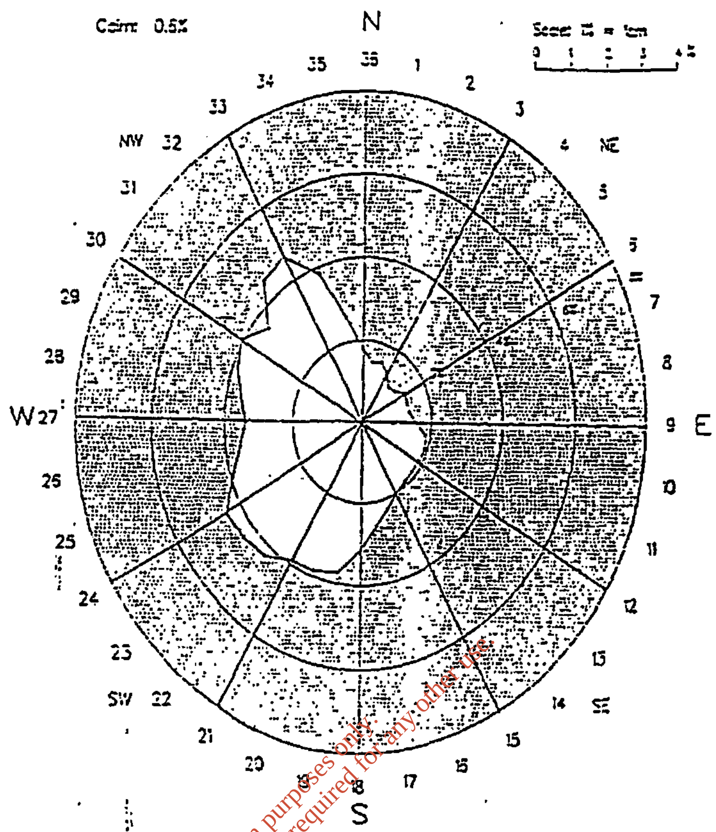
Frequency of Wind Direction & Wind Speed for Hourly Observations at Roches Point (Jan. 1962 - Dec. 1991). Source:- Meteorological Service, Glasnevin Hill, Dublin 9



Direction (Degrees)	Percentage occurrence of Wind Speeds in m/sec.						
	<2	2-3	3-5	5-8	8-10	>10	All
360-30	0.3	0.6	1.1	0.9	0.1	0	3.0
30-60	0.4	0.6	1.2	1.0	0.2	0	3.4
60-90	0.4	0.6	1.3	1.8	0.7	0.4	5.2
90-120	0.5	0.9	2.0	2.2	0.8	0.4	6.8
120-150	0.6	0.9	1.5	1.9	0.9	0.6	6.4
150-180	0.7	1.2	1.9	2.4	1.4	1.6	9.2
180-210	0.6	1.0	2.2	3.7	2.0	2.0	11.5
210-240	0.5	0.9	2.5	3.9	1.8	1.4	11.0
240-270	0.3	0.6	2.1	3.3	1.3	0.9	8.5
270.300	0.5	0.9	2.2	3.5	1.7	1.4	10.2
300-330	1.4	1.8	2.8	4.4	2.0	1.7	14.1
330-360	1.2	1.5	2.0	2.1	0.7	0.4	7.9
Calms	2.8						2.8
Totals	10.2	11.5	22.8	31.1	13.6	10.8	100

Fig. B.4.2.

Frequency of Wind Direction & Wind Speed for Hourly Observations at Cork Airport (Jan. 1962-Dec. 1991): Source:- Meteorological Service, Glasnevin Hill, Dublin 9



Direction (Degrees)	Percentage Occurrence of Wind Speeds in m/sec.						
	<2	2-3	3-5	5-8	8-10	>10	All
360-30	0.6	1.2	1.4	1.0	0.3	0.1	4.6
30-60	0.4	0.9	1.3	1.0	0.2	0	3.8
60-90	0.3	0.6	1.3	1.4	0.4	0.3	4.2
90-12-	0.4	0.8	1.5	1.8	0.7	0.3	5.5
120-150	0.6	0.9	1.3	1.7	0.7	0.4	5.6
150-180	0.6	1.2	1.9	2.5	1.1	0.9	8.2
180-210	0.7	1.4	2.5	3.6	1.7	1.4	11.3
210-240	0.6	1.6	3.4	4.5	1.8	1.2	13.1
240-270	0.6	2.0	3.2	3.3	1.1	0.5	10.7
270-300	0.9	2.3	3.4	3.4	1.1	0.5	11.6
300-330	0.7	2.4	4.6	3.7	1.0	0.4	12.8
330-360	0.6	1.4	2.8	2.5	0.6	0.2	8.1
Calms	0.5						0.5
Total	7.5	16.7	28.6	30.3	10.7	6.2	100

Air Temperature

The annual mean air temperature for Cork Harbour is about 10.5°C with a range in daily averages of from about 6.3°C in January to about 15°C in July. There would be a small number of days when the maximum air temperature at Mahon can exceed 25°C but generally the sea-breeze will tend to prevent stagnation of air flows in Upper Cork Harbour during these very warm dry conditions. However the potential for odour nuisance from the treatment plant will be greatest during this type of weather.

Mist/Fog

The incidence of mist or fog in Cork Harbour provides an indication of the percentage of time when poor dispersion close to the ground is likely which could result in significant odour concentrations from an emission source. For the period 1960-84 the mean total number of hours per year when mist/fog conditions were reported was 859 hours/year (9.8%) with the highest incidence during the early morning and the lowest during the afternoon period. The incidence of fog at Roches Point is about 4% of the time with the highest frequency occurring during the months of June to September.

Existing Ambient Air Quality

The air quality of the Mahon and Rochestown area is generally satisfactory although during the winter periods levels of smoke may occasionally approach the EC Directive Limit and due to the use of domestic solid fuel for home heating. The Corporation monitoring station at Mahon has recorded levels of smoke in excess of 250 μg/m^3 on a small number of days during recent winters due to the formation of smog conditions. Although the housing density in Rochestown is lower than in Mahon local air quality in the vicinity of houses may also be poor due to domestic smoke emissions during periods of calm weather conditions.

During the summer months the air quality in the vicinity of the proposed site is generally good as domestic emissions are very low compared to the winter heating season. It is this period of the year rather than the winter which is of most importance with regard to the potential for the generation of nuisance odours from wastewater treatment operations due to higher air temperatures and generally lower wind speeds. Therefore in regard to the present situation in Mahon where there is considerable local concern over the poor air quality during the winter the operation of the plant would not add significantly to the ambient air quality of the area.

The extensive mudflats which emerge at low-tide at the mouth of the Douglas river near Rochestown are sources of sulphide compounds due to natural bio-degradation processes that create odours similar to those which can originate during the treatment of urban wastewater. The mudflats may extend over 300m from the shoreline at Rochestown and so during warm weather conditions the potential exists for significant odorous emissions from this natural source.

There are no significant industrial emission sources in the vicinity of Mahon and Rochestown. The nearest industrial estates which consists of light activities is approximately 1km from the proposed site. There was no evidence of odorous activities being carried out from the premises on this estate during a site visit.

Plant Design

The proposed wastewater treatment plant at Mahon is designed to cater for an influent capacity of 448,350 pop. equivalent. The design of the plant (design loading conditions for year 2025) is described in detail in the main report and may be summarised as follows:-

a) Inlet works Screening/Grit and Grease chamber located at the western end of the site.

b) Primary sedimentation tanks - a total of 6 circular tanks with radial flow located at the southern end of the site.

c) 12 activated sludge tanks and secondary clarifiers aligned along a N-S axis in the eastern side of the plant.

d) Sludge treatment - This part of the plant will consist of sludge picket fence thickener, anaerobic digesters, sludge de-watering presses, thermal drying plant and bagging and storage of dried sludge.

The receipt of the raw wastewater at the inlet part of the plant in particular during periods of intermittent or low flow can be a serious source of odour nuisance which can be highly objectionable to local residents.

In the case of the proposed plant at Mahon the complete inlet works including inlet distribution channels, screens and screen treatment will

SECTION B

AIR QUALITY IMPACT OF PROPOSED URBAN WASTEWATER TREATMENT PLANT LOCATED AT MAHON

be enclosed in a building with an air filtration system to remove objectionable odours. The grit/grease removal system will also be covered and extracted air treated in the odour removal filtration system. This part of the plant design is important as the inlet works are potentially the main source of odours especially if poorly maintained. It is important therefore that the foul air treatment system works efficiently during the normal operation of the plant and that at all times the influent is kept fresh so that anaerobic decomposition of the wastewater does not take place.

In order that odorous emissions are minimised an advanced odour control system for the sludge handling (press and drying plant) will be installed at the northern end of the building. This will treat all odours generated during the sludge thickening and pressing stages before the air in the building is vented to the outside air. Generally sludge handling especially when the thickener tank or press belt system is not enclosed can be a major source of odorous emissions. Poor housekeeping, in that sludge is not disposed off-site quickly but is kept in open skips, is a source of odours in a number of plants around the country. However in the case of the proposed plant design these potential sources will be enclosed so that gaseous emissions are filtered prior to discharge to the air.

Odour Dispersion Modelling

Introduction

Short term odour concentrations downwind of the treatment plant were computed using an air quality gaussian dispersion model developed by the U.S. E.P.A. Calculations were made to predict the rate of dilution from the boundary of the plant to the property in the neighbourhood where a potential odour nuisance could arise. The predicted concentrations were based on the worst case climatological conditions, i.e. the combination of wind speed and wind direction that result in the maximum short term ground level concentration at the receptor location for each stability category examined.

Modifications to the input requirements were made to allow for dispersion from an area emission source as in the case of urban wastewater treatment tanks rather than from a point emission source such as a chimney. The emission from the inlet works and sludge handling facility were treated as point sources as such emissions would emanate primarily from vents or air extraction units as fugitive type emissions. The emissions from sedimentation tanks and secondary treatment tanks occur close to ground level with vertical exit velocities of 1 m/s or less and so the plume rise above ground level is small. The rate of dilution from these sources is therefore dependent on the dispersive properties of the air layers close to the ground; i.e. the atmospheric stability.

For the purposes of the modelling study 3 atmospheric stability categories were examined. These were unstable, neutral and stable weather conditions. The first type is commonly associated with warm sunny weather with relatively light winds (in a coastal environment a sea breeze is likely to dominate in such situations). Data for Roches Point indicates an incidence of about 6%; mostly occurring during the May-September period. Neutral stability conditions are the most common category in Ireland are characteristic of overcast, windy weather conditions. They occur about 79% of the time in this part of Ireland. Finally stable weather conditions occur at night-time with relatively slack winds (<3 m/s) and little or no cloud cover. This type of weather is likely to create low level temperature inversions close to the ground which may restrict dispersion of air emissions even further. In terms of potential for odour nuisance in the vicinity of the plant light winds during neutral stability or stable weather conditions will result in the poorest dilution of any odour plume and hence highest ground level concentrations.

Emission Estimates

The emission rate used in the dispersion model was expressed in terms of the dilution factor rather than as a specific pollutant compound emission rate due to the mix of compounds that can be emitted from a specific source. The unit of measurement was odour units /m^2.s (o.u/m^2.s) for emissions from the liquor surface of the primary and secondary treatment tanks. In the case of other types of emissions as in the case of sludge handling or fugitive emissions from various vents the unit used was o.u/s.

Unlike modelling for industrial emissions sources which are normally confined to a few point emissions from vents or stacks emissions from wastewater treatment plants are much harder to quantify due to the numerous potential sources. In some cases as for large tanks odour plumes from a number of tanks may combine downwind when the wind is blowing in a particular direction, whereas for other wind directions the odour plumes may disperse without merging. There are also no studies available that have measured emissions from tanks with regard to weather conditions which can significantly affect evaporation rates from large water surfaces.

A more basic estimate of emissions is used in predictive modelling for new treatment plants as distinct from up-grading existing ones where measurements in the vicinity can be taken. From observations made at other wastewater treatment plants a number of potential sources for odorous emissions can be identified such as uncovered inlet works, bio-filter beds, primary sedimentation tanks and sludge handling/de-watering components of the plant.

It is evident that the treatment of primary influent and the de-sludging draw-off chambers can be significant sources of odours that can be detected at the boundary of the sites. On the other hand experience suggests that no significant odours have been detected from secondary clarifiers due to the quality of the effluent which has a low B.O.D. at this stage of the treatment process.

Based on such assessments estimates of emission rates can be made. The following odour emission rates for the proposed plant were used in the model:-

Primary Sedimentation Tanks	-	1 o.u/m^2.s
Aeration Tanks	-	0.25 o.u/m^2.s
Secondary Clarifiers	-	<0.1 o.u/m^2.s
Sludge Treatment Works and associated tanks (fugitive emissions and occasional venting)	-	2000 o.u/s
Sludge De-watering/Storage Housing (air filtration system installed)	-	<0.01 o.u/s
Inlet Works inc. screen and grit/ grease chamber (air filtration system installed)	-	<0.01 o.u/s

The total number of tanks included in the model were based on the works required under present wastewater loading and also the requirement for future construction of tanks as the loading increases.

Dispersion Model Results

A number of options in relation to the design of the treatment plant were examined. These were:

1) Leaving the Primary Sedimentation Tanks uncovered

2) Enclosing the Primary Sedimentation tank weirs but leaving remainder of the tank surface uncovered.

3) Complete enclosure of Primary Sedimentation Tanks.

Residential areas are located within about 0.5km of the site boundary to the north and south and so the potential for dispersion in a number of wind directions needed to be examined. Contour maps of odour dilution concentrations based on the options of covering the primary sedimentation tanks or leaving them open were produced for Mahon. In the case of the alternative site at Carrigrenan the only houses of concern are situated along the northern boundary and so specific downwind distances were used in the modelling study and presented in tabular form rather than as contour maps.

Option No. 1 - Primary Sedimentation Tanks uncovered

One option in the design of the treatment plant examined was the odour potential of leaving the primary sedimentation tanks uncovered. From observations at other wastewater treatment plants these open liquid surfaces can be a significant potential source of odours. A unit emission rate per square metre was used for estimating emission rates from the 6 primary tanks.

For example the emission rate from a primary sedimentation tank of diameter 38.5m was calculated to be 1164 o.u/s (4.2 million o.u/hr).

The results of the dispersion modelling study for stable, neutral and unstable atmospheric stability conditions are shown in Figs. B.4.3 - B.4.5 Contours of odour concentrations (o.u/m^3) indicate the degree of dilution that occurs under these 3 types of weather conditions at various distances downwind from the proposed site. The total emission rate for the whole plant used in the model includes emissions from the primary sedimentation tanks, the aeration tanks as well as fugitive emissions from the sludge handling and inlet part of the works. The concentration pattern therefore reflects the combination of a number of odour emission plumes. For some wind directions the plumes may not combine at all whereas for other directions a combination of odour plumes may reach the same downwind receptor location. The inclusion of fugitive emissions for the inlet and sludge handling parts of the plant provided a measure of their significance as a potential source. Since advanced odour control units should result in negligible emissions then their long-term contribution to odour levels will be very small.

For stable weather conditions (poor dispersion) it is evident that the areal extent of odour concentrations above about 5.o.u/m^3 is quite large and includes parts of Rochestown as well as extending northwards to Mahon. Odour concentrations above about 5 o.u/m^3 are likely to be a source of complaint, especially if occurring over a period of time (1). The primary sedimentation tanks would have a significant influence on the potential impact of odorous emissions on the south side of the

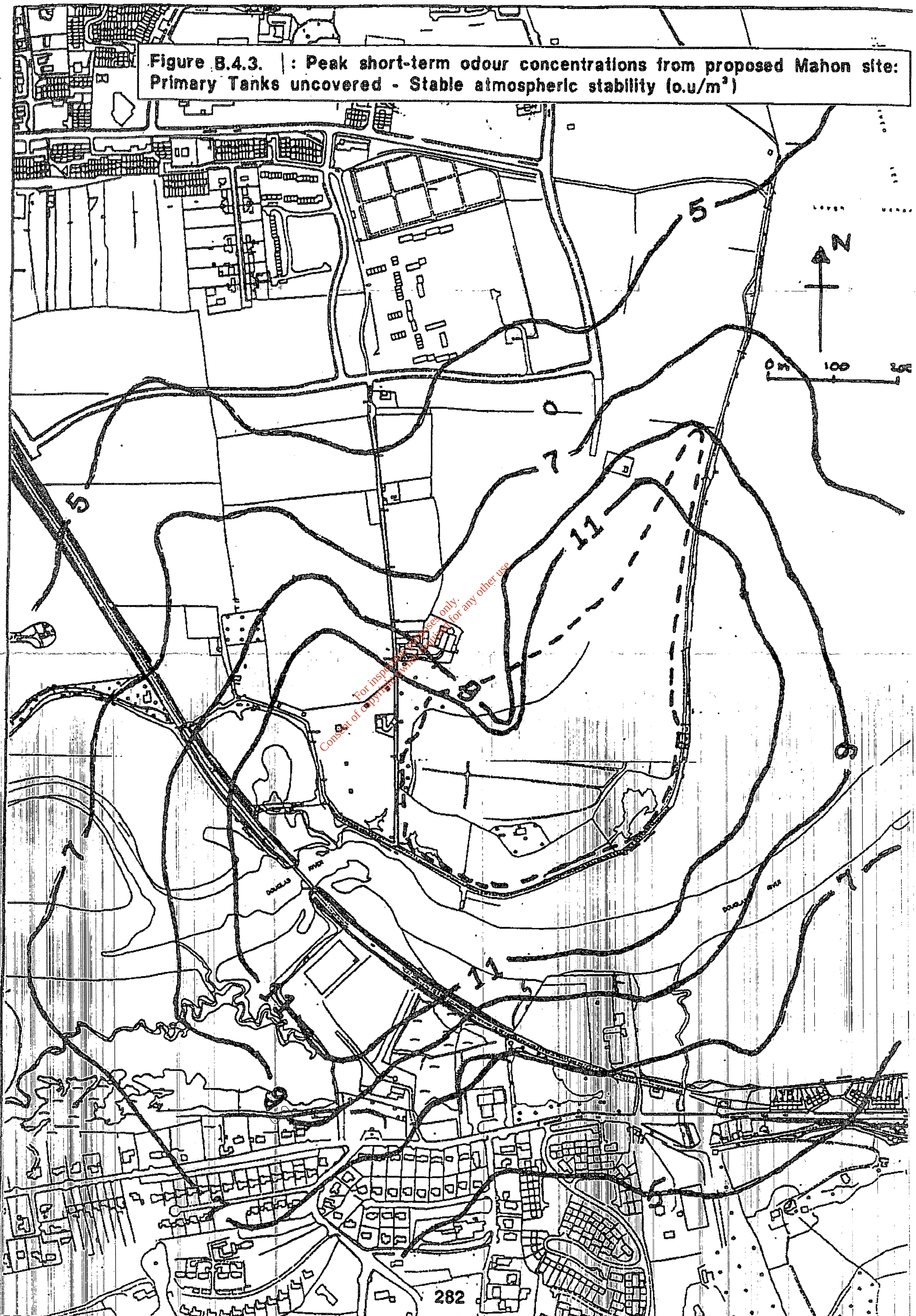


Figure B.4.3. : Peak short-term odour concentrations from proposed Mahon site: Primary Tanks uncovered - Stable atmospheric stability (o.u/m³)

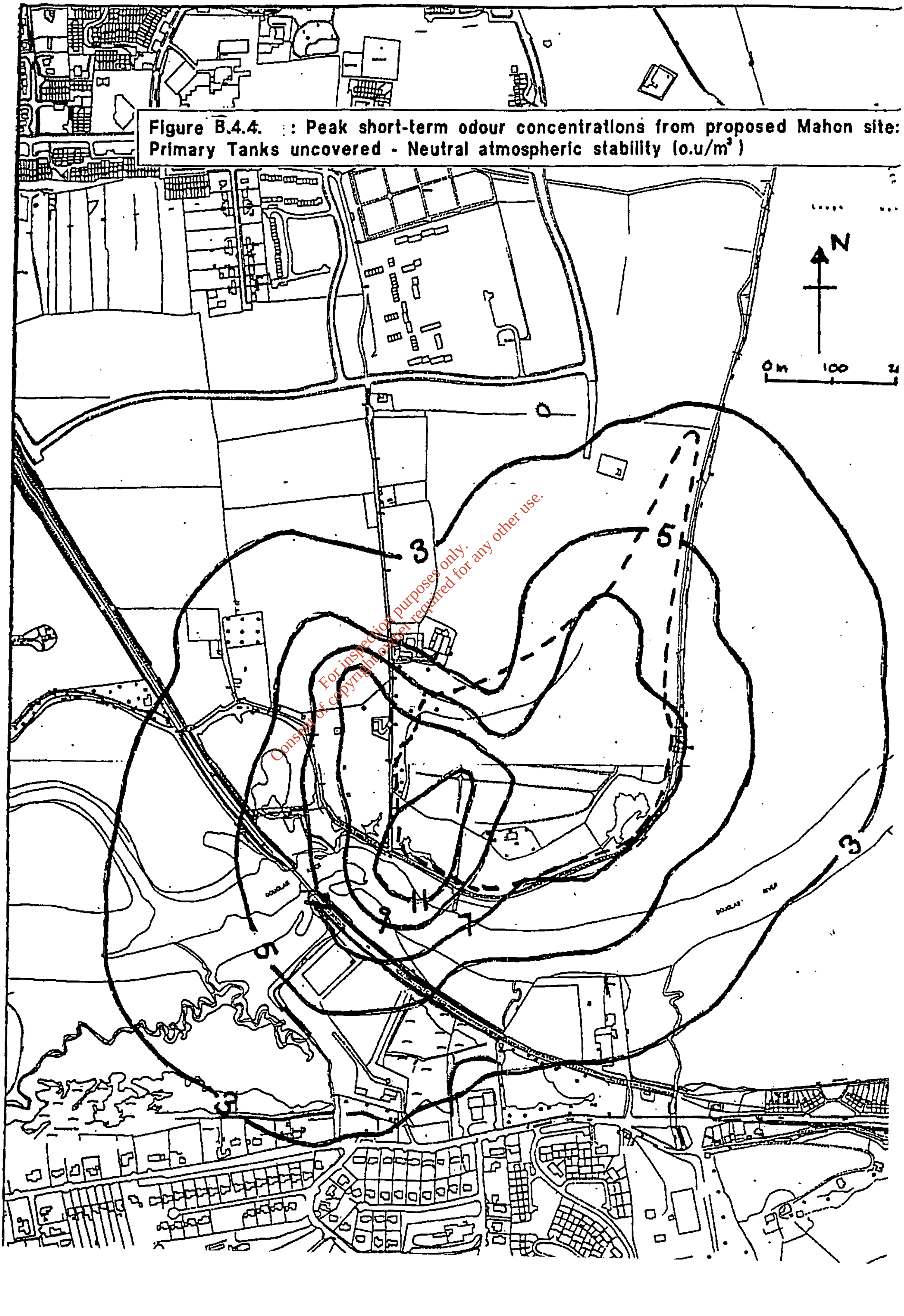


Figure B.4.4. : Peak short-term odour concentrations from proposed Mahon site:
Primary Tanks uncovered - Neutral atmospheric stability (o.u/m³)
N
0m
100
3
5
7
9
11
DOUGLAS
DOUGLAS RIVER