Cork County Council

Comhairle Chontae Chorcai

Expansion and Upgrading of Mallow Sewage Treatment Works

Environmental Impact Statement

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CHAPTER ONE

INTRODUCTION TO ENVIRONMENTAL IMPACT ASSESSMENT OF EXPANSION TO MALLOW WASTEWATER TREATMENT PLANT

1.1 ENVIRONMENTAL IMPACT ASSESSMENT

Throughout the world there is increasing evidence and awareness of the immediate and long term detrimental effects on the natural environment brought about by mans' activities in the name of progress and development. With the growing recognition that all natural resources are finite, despite ever increasing demands upon them, there is now much greater acceptance of the principle of balancing the needs of man and nature and conserving resources - *i.e.* the principle of sustainability.

Therefore, where significant developments are proposed it is essential that a systematic examination be carried out to assess the likely effects such developments may have on the environment. This is also desirable to 1) ensure that the development is environmentally sustainable and 2) to maximise the positive aspects while simultaneously minimising the negative effects of the project on the environment.

The systematic examination of the effects of a proposed development is known as the process of Environmental Impact Assessment (EIA) and the Environmental Impact Statement (EIS) is a statement of those effects. The evaluation of the EIS to determine whether a proposed development should be permitted to proceed is undertaken by a competent approval authority and interested members of the public and this evaluation is part of the overall EIA process. The competent authority in this case is the Minister of the Environment.

Ryan (1990) defines the role of environmental impact assessment in the development of projects as follows:

"Environmental impact assessment (EIA) involves a systematic examination of the likely effects on the environment of proposed development, and incorporation into the decision making process of the results of that examination. Its purpose is to ensure that adequate consideration is given to the environmental effects of a development. It is important to understand that EIA forms part of, rather than pre-empts, decision-making processes. It is, therefore, a formal mechanism for ensuring that the environmental dimension is properly considered along with, for example, the social and economic aspects of the development….."

1.2 LEGISLATIVE BACKGROUND

The greatest single influence on Irish environmental legislation has been the EC and much of the recent legislation which has been enacted has been done so in order to comply with the requirements of the EC Action Programs on the Environment (Simons, 1994). Therefore, in order to fully understand the basis of Irish environmental legislation, the associated influencing factors must first be considered.

1.2.1 EU Directives and Regulations

The harmonious development of economic activities at a continued and balanced rate of expansion - *i.e.* the principle of sustainability - is among the main objectives of the Community. The Council of Ministers declared in 1973 that this could not be achieved in the absence of an effective campaign to combat pollution and protect the environment (Simons, 1994).

Simons (1994) outlines the basic tenets of sustainable development as:

1. "the polluter pays" principle;
2. the need for integrated pollution control and waste minimisation;
3. the need to assess environmental impacts at the earliest possible stage in all decision making processes.

With regard to the last tenet of sustainability as defined above, Environmental Impact Assessment is an attempt to ensure that the environmental effects that may arise from a proposed development are given due consideration from the outset of the planning process. In order to achieve this , the European Council issued Directive No. 85/337/EEC on the 27th of June 1985 regarding the assessment of the effects of certain public and private projects on the environment. This provides for the mandatory and discretionary assessment of projects on the basis of their inclusion in the Directive's two Annexes - Annex I contains nine classes of project and these are subject mandatory EIA (however, special exemption procedures can apply) whereas Annex II contains a more extensive list of 83 types of project which is in turn divided into 12 classes (Kiely, 1997). The projects listed in Annex II require an EIA only in certain circumstances. Wastewater treatment plants are listed under Annex II.

Other Irish and EU environmental directives that can apply to the EIA process as it relates to wastewater treatment plants are listed as follows:

Regulation Name	Number
Quality of Bathing waters	S.I. No. 155 of 1990
Water Pollution Regulations	S.I. No. 271 of 1992
Quality of Salmonid Waters	S.I. No. 293 of 1988
Water Pollution Regulations	S.I. No. 108 of 1978
Quality of Shellfish Waters Regulations	S.I No. 200 of 1994
Urban Waste Water Treatment Regulations	S.I. No. 419 of 1994
Use of Sewage Sludge in Agriculture	S.I. No. 183 of 1991

Table 1.1 Irish and EU Environmental Regulations

The Urban Wastewater Directive 91/271/EEC is the most relevant of those listed in Table 1.1 and the salient aspects of which are as follows (Kiely, 1997):

- "general need for secondary treatment of urban wastewater" for industrial and municipal discharges;
- treated effluent BOD (biochemical oxygen demand) of 25 mg/l;
- treated effluent COD (chemical oxygen demand) of 125 mg/l;
- treated effluent TSS (total suspended solids) of 35 mg/l;
- nutrient removal (2 mg/l of Phosphorous and 10 to 15 mg/l of Total Nitrogen) for "sensitive receiving waters".

The terms BOD, COD and TSS are expanded upon in Chapter Two.

In addition of the Urban Wastewater Directive, the Quality of Freshwater Supporting Fish Directive 78/659/EEC is also particularly important when the treatment works are discharging to a freshwater environment - *e.g.* a river. This directive lists minimum and desired values for 14 physical and chemical parameters which determine whether or not a freshwater environment can be deemed to support salmonid or coarse fish.

1.2.2 Local Government (Planning and Development) Regulations

The effect of Directive No. 85/377/EEC (EIA) on Irish legislation can be seen in the following quotation which is taken from the proceedings of a seminar entitled "Designing under the European Community Directives on the Environment" (Ryan, 1990) presented to the Institution of Engineers of Ireland:

"The European Communities (Environmental Impact Assessment) Regulations, 1989 (S.I. No. 349 of 1989), made by the Minister in December, 1989, provided for incorporation of the Directive into Irish Law for relevant developments other than motorways. These latter Regulations came into operation on 1st February, 1990. To coincide with this, the Minister made the Local Government (Planning and Development) Regulations, 1990 (S.I. No. 25 of 1990). These Regulations set out detailed requirements as to the operation of EIA in planning applications and appeals, and established the procedure through which EIA will take place for relevant development undertaken by or on behalf of local authorities."

In view of the above, this EIS has been prepared for Cork County Council in accordance with the provisions of the following documents:

1. Statutory Instrument No. 349 of 1989:- European Communities (Environment Impact Assessment) Regulations 1989, and
2. Statutory Instrument No. 25 of 1990:- Local Government Planning and Development Regulations 1990.

The provisions of the above regulations stipulate which projects must be subjected to an Environmental Impact Assessment prior to the granting of the necessary approval for the project to proceed to construction stage.

The particular provisions of the Regulation applicable to this study are those pertaining to development by or on behalf of State Authorities - *i.e.* Part IV of S.I.

No. 349, 1989 and Part IV of S.I. No. 25, 1990 - with Cork County Council as the Developer (acting on behalf of Mallow Urban District Council, pursuant to Section 59 of the Local Government Act 1955) and the Minister of the Environment as the competent approval authority.

The subject of the proposal, the upgrading and expansion of an existing sewage treatment works at Mallow , Co. Cork, falls within the scope of Article 24.11(d) of S.I. No. 349 of 1990 - *i.e.* Wastewater treatment plants with a capacity greater than 10,000 population equivalent (p.e.). It will be seen in Chapter Two that the upgrading and expansion of the existing 9000 p.e. works at Mallow will increase the p.e. being served by that plant to a figure in excess of 13,500.

1.3 DEVELOPMENT PLAN RECOMMENDATIONS

The town of Mallow is strategically located in the Blackwater Valley on the National primary routes N20 Cork/Limerick and N72 Rosslare/Killarney (at the crossroads of Munster). It is situated on the banks of the River Blackwater, downstream of the confluence with the Clyda River. The game fishing in the area is famous and attracts anglers from the continent. The area has potential for further tourism development. This potential can be seen in the amenity and scenic value of the river, the town park playing pitches and Mallow golf course. The 1991 Development Plan states that it is a definite policy that both the river, scenic landscape and town be kept free and protected from all forms of pollution.

The town is served by the main Cork-Dublin railway line. To assist in Mallow becoming an effective satellite town for Cork, Irish Rail have expressed interest expanding their arrow-rail services which would operate on an hourly basis to and from Cork.

Mallow racecourse was re-developed within the last five years and now operates under the name Cork Racecourse. Regular race-meetings are held with numbers as large as expected. Additional functions are catered for at the racecourse including a summer garden show, which drew crowds from all over the country and abroad. The town's swimming pool has also been redeveloped using warm spring spa water as a heat source. The heated water is treated and then re-cycled so that the waste discharged from the pool is small. Also the Spa House has been opened by the Cork County Council as an Energy Awareness Centre.

The existing water pollution licences issued at present may need to be reviewed in light of the present water quality management plan, requirements by the fisheries and the standards to which the proposed sewage treatments will be required to perform.

In line with the current housing boom, a number of private housing schemes have gone up within the past few years, in the Ballyviniter, St. Joseph's Road, Kennel Hill and Quartertown areas.

1.4 BASIS OF EIS

The EIS for the proposed upgrading and expansion of the wastewater treatment plant at Mallow has been prepared on the basis of a preferred process design and layout.

However, under procurement procedures for the construction of the facility, tenderers are permitted to propose alternative designs and layouts provided that the alternative can provide an equivalent, or better, level of performance as detailed in the written specification for the project.

If alternative designs are submitted and satisfy the above criteria, then the Tendering Authority (Cork County Council) must give due consideration to them.

It is therefore important to note that the process design and layout of the proposed upgrading and expansion works on which this EIS is based must be taken as indicative only.

1.5 CONCLUSION

In summary, this study:

1. outlines the necessity for improving the existing sewage treatment works at Mallow;
2. gives the information required in an environmental impact statement as specified in Article 25 of European Communities (EIA) regulations, 1989 (S.I. No. 349 of 1989 and Amendments S.I. No. 84 of 1994 and S.I. No. 101 of 1996);
3. complies with the requirements of the Local Government (Planning and Development) Regulations, 1994 (S.I. No. 86 of 1994).
4. shows that the scheme is in accordance with the relevant Plans and Directives including:
   a) the 1996 County Development Plan for North Cork;
   b) the 1998 Draft Mallow Development Plan;
   c) the Environment Action Programme (Department of the Environment, 1990);
   d) the EC Council Directive, 91/271/EEC (EC, 1991), concerning urban waste-water treatment.

Figure 1.1 Aerial Photograph of Mallow Town (taken in 2000 AD)

Figure 1.2 Geographical Map

CHAPTER TWO

DESCRIPTION OF EXISTING WORKS

2.1 SITE LOCATION

The site is located east of the town downstream of Mallow Bridge, in the townland of BallyEllis on the south bank of the river. It is situated adjacent to the old Colaiste De La Salle. The entrance to the site is on the Killavullen road, just beyond Mallow Golf Club. See Drawing No. L3 Mallow Sewage Treatment Works - Location Map

Figure 2.1 Mallow STW Site Location Map

Figure 2.2 Aerial Photograph of Mallow STW viewed looking north-west

For further photographs see Appendix 1.

2.2 HYDRAULIC AND BIOLOGICAL LOADINGS

Two key criteria in the design of a wastewater treatment plant are:

1. the hydraulic loading;
2. the biological loading.

Other factors include the diurnal and seasonal variations of the above.

The hydraulic loading can be defined as the quantity of wastewater arriving at the treatment works requiring purification. It is derived from the population equivalent (p.e.) contributing to the wastewater plant and this in turn estimated by considering the domestic, industrial/commercial and infiltration contributions to the plant and assigning appropriate p.e. figures to each. The overall hydraulic loading is then determined by multiplying the total p.e. value by a per capita consumption estimation. Typical values range from 150 to 300 l/head/day.

The biological loading is defined as the total p.e. value multiplied by the BOD per capita. BOD is an abbreviation for biochemical oxygen demand which gives an indication of the biological instability or pollution capacity of a wastewater. A typical organic load for domestic wastewater is 60 g/head/day.

Fluctuations in both the hydraulic and biological loading will occur over any given day with typical domestic peak hydraulic flows occurring in the morning and early evening for example. As the collection system is still predominantly a combined one, excessive hydraulic loading (both excessive and shock) occurs regularly during heavy rainfalls. The flows arriving at the treatment works are a function of the pumping capacity of the pumphouse located at Mallow Bridge. These pumps were replaced in the early 1990s and were of greater capacity than the original pumps thereby leading to slight overloading of the existing inlet works units (screens and macerator). Flows in excess of the foul pump capacity are overflowed to the river 400 m downstream of Mallow Bridge via storm pumps and a rising main. Flows in excess of the combined pump capacity are overflowed to the river at the pumphouse.
See Drawing no. E3 Mallow Sewage Treatment Works – Existing Site Layout

2.2.1 Original Design Loadings

The design per capita hydraulic and biological contributions (for an ultimate population equivalent of 9000) were taken as being 50 gpd (227 l/day) and 300 mg/l or 0.15 lbs/day (68 g/day) respectively. These equate to a total hydraulic and biological loadings of 2043 m3/day and 614 kg/day BOD respectively. The existing plant was designed to handle these loadings. These loadings included for moderate trade waste, but excluded the high biochemical demands of food-processing plants i.e. the Creamery and the Sugar Company Factory.

2.2.2 Current Loadings

The current hydraulic and biological loadings have been established as follows:
Minimum Pumped Flow = 1300 m3/day;
Maximum Pumped Flow = 6100 m3/day;
Average Pumped Flow = 2900 m3/day;
Average BOD Concentration = 330 mg/l;
Average BOD Load = 957 kg/day.

SECTION C - TABLE OF WASTEWATER ANALYTICAL RESULTS FOR PLANTS >1,000 P.E.)							
Sanitary Authority:		Cork County Council North		Wastewater Treatment Plant			Mallow, 1999
Type of Influent sample (Composite or Grab)			Both	Type of Effluent sample (Composite or Grab)			Grab
INFLUENT DATA mg/l							
DATE	BOD	COD	TSS	TOTAL P	o-P	NH3	FLOW m3
20/01/99	-	592	68	-	11.25	11.6	(3480)
25/02/99	378	757	253	-	24.4	23.4	2121
29/03/99	360	866	160.6	-	24.3	23.4	5653
14/04/99	460	950	336	-	24.2	25.7	(4318)
18/05/99	336	835	210	-	12	33.4	6136
28/06/99	516	1358	237	-	18.4	23.4	3996
30/07/99	348	516	225	31.5	24	29.1	(1421)
13/08/99	390	831	240.8	29	25.5	22	1351
19/08/99	82	277	56	9	9	11.8	3251
20/08/99	252	469	119	-	22.5	26	(2224)
10/09/99	330	736	172	-	31	26	1785
18/10/99	426	709	241	40.2	22.8	24.9	3885
11/11/99	305	600	183	17.3	15.9	28.1	1584
15/12/99	192	356	-	19	14.6	28.8	3145
						X=	2991.5

Table 2.1 Sewage influent water quality records

2.3 TREATMENT PROCESSES

Various methods of sewage treatment can be considered when designing a wastewater treatment plant. In choosing a treatment method (i.e. a secondary treatment method) items to be items to be considered include :

a) characteristics of the raw sewage,

b) sewage flow, present and future,

c) final effluent standard required,

d) acceptability of certain process related hazards such as smell, fly nuisance , etc.

e) ambient temperature,

f) disposal routes for the treated effluent and sludge

g) capital and running costs,

h) land requirements, and

i) civil works requirements

Conventional 'full' treatment to provide a Royal Commission quality effluent normally comprises:

a) Preliminary treatment: consisting of screening and grit removal,

b) Primary treatment (if included): in which solid matter is settled out as sludge in sedimentation tanks with the settled sewage (liquid) going forward for further treatment,

c) Secondary treatment of the settled sewage, and

d) Sludge treatment of the solid matter removed.

In addition to the above, provision can be made for nutrient removal based on the criteria set down in EC directive 91/271/EEC discussed previously. Primary sedimentation can be omitted if screens and grit removal are provided, and so normally only secondary treatment and sludge treatment process options are considered. The individual stages of treatment are described briefly below by reference to the existing plant at Mallow which is a conventional activated sludge installation of its time:

The unit processes are outlined briefly below.

2.3.1 Preliminary Treatment

The preliminary treatment (pre-treatment) is defined as the process or processes that prepare a wastewater to a condition whereby it can be further treated in conventional secondary treatment processes (Kiely, 1997).
The pre-treatment process units which are installed in the Mallow plant are as follows:

- bar screen (20 mm bar spacings) (with mechanical rakes)
- macerator of screening of the incoming flow;
- grit removal (pista trap).
- flow measurement equipment.

2.3.2 Primary Treatment

Primary treatment (also known as sedimentation, clarification or settling) involves allowing the pre-treated wastewater to settle for a period (usually in the region of 2 hrs) thereby producing two effluent streams - 1) a moderately clarified wastewater stream (BOD concentration reduced by 25 %) and 2) a liquid-solid sludge stream. The main objective of primary treatment is to remove part of the loading (gross solids) and to produce a settled sewage of sufficient quality for secondary treatment.

There is no provision for primary treatment in the existing Mallow works.

2.3.3 Secondary Treatment

Kiely (1997) defines secondary treatment as the unit process which biodegrades the organic material in the primary effluent and converts it into non-polluting end products - e.g. H_2O, CO_2 and biomass (sludge). The resulting effluent has a further reduced BOD concentration.

The treatment works at Mallow uses the activated sludge / extended aeration method of secondary (biological) treatment. This is achieved by first treating the effluent from the pre-treatment processes in the aeration tanks which promotes the biodegradation of unstable organic matter in an oxygen-rich environment. The effluent from the aeration tanks is then subject to clarification in secondary settling tanks from which there are two outgoing streams - 1) the treated wastewater and 2) a microbe-rich sludge. Approximately 20% of this sludge is returned to the aeration tank in order to maintain a sufficiently large microbial population in the aeration tank and the remaining 80% is sent to the sludge treatment processes. The sludge returned to the aeration process is referred as the RAS (returned activated sludge) and that which is sent directly to the sludge treatment processes is referred to as the WAS (waste activated sludge).

The secondary treatment units at Mallow are as follows:

- 2 no. extended aeration tanks (plan dimensions 20x20 m ea., volume 1300 m^3 ea.);
- 2 no. secondary clarification tanks (diameter 13 m).

Figure 2.3 Aeration and Clarifier Tank with Sludge Dewatering Building behind

2.3.4 Tertiary Treatment

With regard to municipal wastewaters, disinfection or polishing of treated effluent is normally referred to as tertiary treatment.

Disinfection of effluent discharges is uncommon. However, where the receiving water body is considered particularly "sensitive" - e.g. bathing waters, waters used for shellfish farming and waters used for potable water abstraction - it may be considered as an option. The EC have issued directives governing the quality of bathing waters (76/160/EEC), shellfish waters (79/923/EEC) and waters from which potable water is abstracted (75/440/EEC). The following Irish regulations apply to Bathing Waters: S.I. No. 154 of 1992 Quality of Bathing waters, Recovation, Regulations, SI No. 145 of 1994 Quality of Bathing waters (amendment) regulations 1994. These may, in turn, determine whether or not tertiary treatment is required and, if so, to what standard.

There is no provision at present for tertiary treatment.

2.3.5 Nutrient Removal

Nutrient removal refers to the reduction of phosphorous and/or total nitrogen levels. This is required where the receiving water body is deemed sufficiently "sensitive" - *e.g.* waters susceptible to eutrophication. Since some algae can fix atmospheric nitrogen it is generally accepted that phosphorus is the limiting nutrient in water. Phosphates occur in sewage effluents due partly to human excretion and partly to their use in synthetic detergents. The principal means of phosphorus removal is chemical precipitation, though removal can be incorporated into primary or secondary treatment or may be added as a tertiary process.

In raw wastewater the predominant forms of nitrogen are organic nitrogen and ammonia. The most common processes for removing ammonia are air stripping and biological nitrification-denitrification.

2.3.6 Sludge Treatment and Disposal

As stated above, approximately 80% of the sludge arising from the secondary clarification process is not returned to the aeration process and so requires disposal. However, given the biological instability of the sludge, it is standard practice to treat this sludge prior to disposal. In the context of sludge arising from the treatment of municipal wastewater various forms of treatment (aerobic and anaerobic) are used to stabilise the sludge. For example anaerobic sludge digestion involves the biological degradation of the sludge by microbial action in the absence of oxygen, the by-products of which include CH_4, CO_2 and a more stable biomass.

It is common practice to condition the waste activated sludge by thickening it and then dewatering it. Thickening and dewatering have essentially the same effect - i.e. increasing the dry solids (DS) content of the effluent sludge by reducing the water content. The water abstracted during these processes is returned to the aeration tanks where it will again, undergo secondary treatment.
Dewatering facilities are provided via 2 no. filter belt presses. The dewatered sludge is then re-watered before removal off-site in a tanker for sub-soil injection.
It would seem that it should be possible to produce the required moisture content by using less poly or increasing the pressing rate but the caretaker is of the opinion that this will not work. The press manufacturers have been contacted and they have confirmed that it is possible to convert the presses to sludge thickeners which appear to be required. The sludge conveyor would be replaced by sludge pumps.
Safety railings need to be fitted here.

2.4 EFFLUENT STANDARD

The required effluent standard is a function of the sensitivity of the receiving environment as well as legislative requirements as outlined in Chapter One of this report. The two main parameters governing the quality of a treated effluent are:

1. BOD - biochemical oxygen demand;

2. SS - suspended solids.

SS represents the organic constituent of the wastewater that could not be settled out of solution because of practical restrictions on residence times and/or unsettleable particle sizes.

Other parameters might include COD (chemical oxygen demand), nitrogen and phosphorous. However, these are generally applicable to more specialised forms of treatment - e.g. wastewater arising from industrial processes - or in situations where the plant is discharging to an environmentally sensitive area - e.g. a water body susceptible to eutrophication.

The UK Royal Commission standard of 20/30 was applied at design stage in the case of the Mallow Wastewater Treatment Plant. This implies that the treated effluent has a BOD of 20 mg/l and a SS content of 30 mg/l. Attaining a 20/30 standard approximately equates to a 90 %/ 95 % reduction of raw wastewater BOD/SS values.

Regarding the Blackwater River the minimum flow was estimated at the time as 50,000,000 gpd (2.6 m^3/s) which was deemed to provide a dilution of 1 in 110. The limits required for most sewage treatment plants have been revised subsequently to 25 mg/l BOD and 35 mg/l SS under the EC Urban Wastewater Directive.

Figure 2.4 Control House

2.5 IDENTIFICATION OF DEFICIENCIES

The original design caters for a population equivalent of 9,000 whereas the current contributing p.e. has been estimated as being between 12,000 and 13,000. In order to cope with the existing overloading and facilitate future developments in the Mallow area, the existing treatment plant will require upgrading and expansion.

The following has been identified as the main deficiencies associated with the Mallow works: Flows entering the works contain large quantities of storm water; the main foul pumps are all capable of operating simultaneously allowing a flow greater than the design flow to be pumped to the aeration basin and secondary clarifiers thereby hydraulic overloading the works for short periods (less than 16 hours);

2.5.1 Preliminary Treatment

The bar screen operates reasonably well but the wide bar spacing allows plastics and rags through to the aeration tanks. The macerator, while programmed to cut in automatically is operated manually on a regular basis to reduce excessive wear and tear. The wash water flow system (to wash out the screenings trough) blocks frequently due to solids getting into the rising main. The flow meter has not been calibrated in recent times and flow readings are suspect. The grit trap is a standard Jones and Attwood pista strap and has suffered normal wear and tear over the years.

Figure 2.5 Inlet works with raked screen

2.5.2 Secondary Treatment

The aeration tanks appear to be working satisfactorily. However there is no automatic means of cutting back the DO input if it rises too high. In the original design, the motors reversed if the DO rose above set concentrations to reduce power consumption but since the gear box was changed this is no longer an option. However, the DO records do not show the situation at times of minimum inflow. DO is shown to drop to 0.3 mg/l during the day so clearly there is little spare capacity in the system. The max. DO reading on the record (morning record) is about 2.0 mg/l.
When one aeration tank is taken out of service the inlet pipe cannot cope if the flow is high and the upstream channel tends to overflow. These tanks are not operating satisfactorily with scum, rags and plastics floating and getting out with the effluent. The presence of scum may result from some industrial waste entering the collection system. Plastics and rags result from inefficient screening at the inlet works. The fact that there is no scum - skimming device compounds the problem and it will be necessary to retrofit a scum baffle and scum removal mechanism in the existing tanks.

Furthermore, the settling tank inlet pipe does not seem to be able to deal with the peak flow discharged by the new pumps which would appear to indicate that they are sending up more than the design flow. This causes the upstream manhole chamber to overflow if the pumps are on for a continuous period, which could happen in the case of prolonged rainfall or in flood conditions.

The flow is not split evenly between the two settling tanks. This is probably due to some hydraulic difference or possibly a partial blockage in one of the pipes. The caretaker has fitted a restriction on one of the inlet pipes in an effort to even up the flows. This matter needs to be investigated and rectified.

The sludge drawoff bellmouth tends to collect rags; again this would be partially relieved if there was better screening at the inlet. The return sludge pumps have been replaced. The original ones were low speed (so as not to break up the floc). It is not clear if the new ones are the same since they are of different manufacture.

Figure 2.6 Aeration Tank with green space in the background

Figure 2.7 Clarifier Tank with thick foaming on surface

2.5.3 Sludge Handling

Sludge for dewatering is taken directly from the sludge recycle system so the solids content is probably 0.5 % to 1.0 % max. One of the two single belt machines can deal with the flow running 24 hours per day and on this basis there is 100 % standby. It does not appear to be possible to split the flow evenly between the two presses so that they can be run in parallel. The cake looks reasonable for single belt machines - possible 12 -15 % solids content. However, since the sludge is now used for direct injection to agricultural land it has to be re-watered before being removed by tanker. This is done by putting water into the sludge bins before they are emptied by the haulier contractor.

The sludge bins in use were provided at a time when the sludge was removed off site in cake form. From a safety point of view the present arrangement is not satisfactory because when standing on the platform over the bins, one is directly over what is a bin full of liquid slurry when water has been added to render it suitable for sub-soil injection. This arrangement presents a serious safety hazard.

The control panel is located in the sludge press house and appears to have suffered badly from the corrosive environment. The IP rating (measure of corrosion resistance) may not be sufficient for this environment.

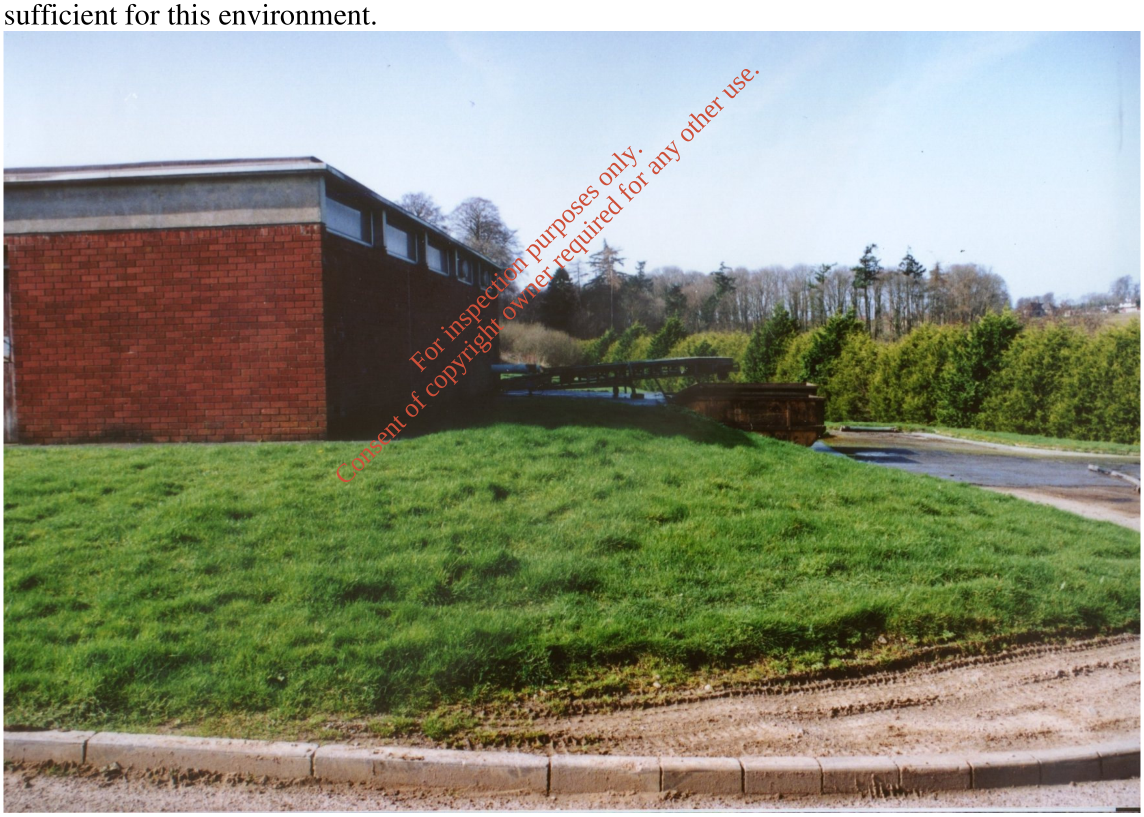

Figure 2.8 Sludge Dewatering House with conveyor to skip

2.6 CONCLUSION

In summary, the load to the existing wastewater treatment plant at Mallow is currently in excess of its design capacity of 9,000 p.e. Existing deficiencies have been highlighted with regard to the inlet works in particular, especially in relation to the control of flow through the works. The proposed design population equivalent and the necessary upgrading and expansion of the works are discussed in the following chapter.

CHAPTER THREE

PROPOSED UPGRADING AND EXPANSION OF WORKS

3.0 INTRODUCTION

It is intended that the expansion and upgrading works required at the Mallow Sewage Treatment Plant will be procured under Design/Build form of contract. This method of procurement is favoured for works of this nature so as to allow the maximum flexibility to tenderers / contractors in the type of equipment and treatment plant units to be designed and installed to meet the specific needs of the individual facility. It is also in keeping with the objective of the Department of the Environment and Local Government (DOELG) as set out in the circular letter L3/99.

The indicative upgrading and expansion process described below is based on the Employers Requirements for the works.

Accordingly, the proposed upgrading and expansion works described below should be taken as an indicative layout only of the type of plant that will be installed at Mallow. Any process and layout arising from the design/build method of contract procurement will be considered appropriate provided:

a) Its impacts are equal to the impacts described in the EIS

or

b) Its positive impacts are of greater significance than those outlined in the EIS

or

c) Its negative impacts are of lesser significance than those outlined in this EIS.

3.1 PREDICTED LOADINGS

It is suggest a proposed population equivalent of 18,000 based on existing and predicted usage - residential, industrial and commercial/tourism. It is noted that this population equivalent is in excess of the 10,000 threshold for mandatory EIA (see Chapter One).

Based on the above report and the proposals in the County Development Plan for the Mallow area it is proposed that the upgrading and expansion works at the wastewater plant be designed to cater for the following population equivalents:

Assuming a *per capita* contribution of 225 l/day, this p.e. figure implies a design dry weather flow of 4050 m^3/day.

The biological loading associated with this flow, assuming a *per capita* contribution of 60 g/day, is 1080 kg/day.

3.2 REQUIRED EFFLUENT STANDARD

The Blackwater River is not designated as a "sensitive area" under the third schedule of the Environmental Protection Agency Act, 1992 and (Urban Wastewater) Regulations, 1994. Therefore, under article 4(1) of the Regulations, secondary treatment of the wastewater is normally required yielding an effluent with at least the following requirements:

- BOD ≤ 25 mg/l;
- SS ≤ 35 mg/l;
- COD ≤ 125 mg/l.

Another standard commonly applied is the Royal Commission on Sewage Disposal standard (1912). This standard requires an effluent BOD of 20 mg/l and a SS of 30 mg/l. With this standard it can be shown that an 8 times dilution with clean river water is required to prevent the BOD exceeding 4 mg/l below the discharge. The main reason for limiting SS in effluents is that they may settle to the stream bed and inhibit certain forms of aquatic life. Flood flows may re-suspend these bottom deposits and exert sudden oxygen demands. This standard will be reached in the proposed effluent quality below.

Due to the dilution capacities of the Blackwater River even during dry weather flows (DWF), as examined in section 4.1, it is proposed to treat to the standard proposed under the Urban Wastewater Treatment Regulations. Table 3.1 indicates the available dilutions during DWF .

Stage	Population	Design Flow rate	Dilution at DWF	Allowable Effluent BOD	
		[m^3/day]	1 in	BOD [mg/l]	SS [mg/l]
Original	9,000	2043	76	20	30
Proposed	18,000	4050	38	25	35

Table 3.1 Effluent Flow Rate v. Allowable Effluent standard

3.3 PROPOSED IMPROVEMENTS TO TREATMENT PROCESSES

See Drawing No. P3 Mallow Sewage Treatment Works – Proposed Site Layout

3.3.1 Preliminary Treatment

New inlet works are proposed comprising of:

- replacement of bar screen and installation of screening removal equipment, consistent with the DoE current guidelines (remove screenings down to 5 mm or perhaps 3 mm in size).
- replacement of flow measuring equipment
- upgrading/replacement of grit trap equipment
- installation of "flow-forge" type walkways over channels
- installation of safety features including hand-rails.
- flow balancing tank

Also, this would make the end sludge product more acceptable for disposal on agricultural land.

3.3.2 Primary Treatment (if provided)

Primary treatment could be provided through the construction of 2 no. circular sedimentation tanks. They would normally be designed to remove approx. 30 % of the BOD load and 60 % of TSS load, and would have a retention time of about 2 hours. The settled primary sludge could require further stabilisation before being pumped on to the Sludge Holding Tank and then eventually on to the de-watering house. It is unlikely that primary settlement tanks will be provided in the current upgrading works, as the facilities to stabilise the primary sludge are not available in North Cork.

3.3.3 Secondary Treatment

It is proposed that another aeration basin of equal dimensions to the existing basin be constructed. It is proposed that surface mounted aerators, similar to the existing be utilised. In order to keep the MLSS in suspension during low load periods, it is proposed that submersible mixers or flow boosters be installed in each aeration basin.

To allow the aerated effluent to settle, one or two additional secondary clarifiers are proposed. It is to be of similar size to the existing clarifiers and is again to return a portion of the activated sludge to the aeration tank. The waste activated sludge is to be pumped forward to the existing sludge holding tank.

3.3.4 Tertiary Treatment

There are no proposals at present to provide disinfection treatment.

3.3.5 Nutrient Removal (if provided)

Some phosphorus removal could be achieved by maintaining the aeration basin with rotor control of the flow, but diverting the influent and return sludge to well upstream of the diffused air supply to cause an anaerobic zone. The aim would be to achieve maximum nutrient removal through optimum design of conventional type processes.

3.3.6 Sludge Treatment and Disposal

It is proposed that the sludge de-watering system be completely upgraded with the addition of a new double belt press, capable of dealing with the total design load. De-watered sludge would be conveyed to the exterior of the building using a screw conveyor. The existing belt presses would be used as a back-up for the new system.

It is proposed to use large cylindrical steel bins, possibly with a mixer and an outlet pipe suitable for a hose connection to the sludge tanker. In the meantime safety railings need to be fitted to the sludge bins in use.

If primary settlement is used the sludge produced may be less stable than the existing sludge produced because of the primary sludge component and the appropriate odour control measures would have to be incorporated to ensure compliance with the criteria specified later in section 5 of the EIS.

3.3.7 Telemetry and Security

It is proposed to install telemetry to each process within the plant to allow complete monitoring of all operations. All operational data would be recorded for future review and analysis. It is also proposed to install a CCTV system and security system which would sound an alarm should the plant be broken into. It is proposed to retain and repair any defective sections in the existing fence.

3.4 Conclusion

It is concluded that if the stated proposed works are constructed the final effluent produced will meet the required standards and that the expanded and upgraded plant will meet the emissions and other criteria specified later herein (e.g. odour, noise, etc.). The predicted developments in the serviced areas may then go ahead to the extent of a population equivalent of 18,000.

CHAPTER FOUR

WATER QUALITY

4.1 Baseline Conditions

These refer to the average existing water quality in the water body affected.

4.1.1 Receiving Water Body

The EPA has defined a biotic index to describe the degree of pollution and the faunal diversity of a water body. This index is summarised in the table below:

Biotic Index	Quality Status	Water Quality	Condition
Q5	Unpolluted	Good	Satisfactory
Q4	Unpolluted	Fair	Satisfactory
Q3	Moderately Polluted	Doubtful	Unsatisfactory
Q2	Seriously Polluted	Poor	Unsatisfactory
Q1	Seriously Polluted	Bad	Unsatisfactory

The intermediate indices Q1-2, 2-3, 3-4 and 4-5 are also used to denote transitional conditions. The biotic index may be used to evaluate the community diversity, with a water body designated as Q5 having a high degree of diversity. A consequence of increasing pollution is a decrease in faunal diversity and an increase in the density of tolerant forms; in extreme cases all life may be obliterated. It is therefore possible to relate certain faunal groupings or community types to particular levels of pollution.

The Blackwater river is designated a Salmonid River under the Freshwater Fish Regulations (S.I. No. 293, 1998). A Draft Water Quality Management Plan for the River Blackwater Catchment was prepared by Cork County Council in 1988. This contains objectives for the prevention and abatement of pollution of the river in accordance with Section 15 of the Water Pollution Act 1977. The main beneficial uses of the river resource are listed as:

1. Salmonid and Cyprinid Fisheries
2. Water abstraction (Domestic & Industrial)
3. Recreation and amenity

4.1.2 EPA Water Quality Standards for designated Salmonid waters

The standards recommended by the EPA for Biochemical Oxygen Demand (BOD) and Dissolved Oxygen (D.O.) are as follows:

BOD (95% samples)	less than	4 mg/l
BOD (50% samples)	less than	3 mg/l
D.O. (99.9% samples)	more than	4 mg/l
D.O. (95% samples)	more than	6 mg/l

D.O.(50% samples) more than 9 mg/l

High concentrations of Ammonia cause concern on two grounds. In the un-ionised form NH_3 is toxic to fish and other aquatic life. Also ammonia reacts with chlorine and may lessen the effectiveness of the disinfection process in water treatment plants. In light of this the following standard has been recommended:

N in NH_3 (95% samples) less than 0.02 mg/l

There are no specific standards for Oxidised Nitrogen concentrations in the EC Fishery Directive. However because of a number of abstractions for potable uses the following standards are recommended:

N (99.9% samples) less than 23 mg/l
N (95% samples) less than 11 mg/l

The 1995-1997 Water Quality in Ireland states that The Local Government (Water Pollution) Act, 1977 (Water Quality Standards for Phosphorus), Regulations, 1988 will tend to focus increasing attention on river catchment management. To limit eutrophication and the development of weeds, the following standards were provisionally recommended for Orthophosphate concentrations in the river:
P (95% samples) less than 0.2 mg/l
P (50% samples) less than 0.1 mg/l

4.1.3 Blackwater River Water Quality Records

The 1997 EPA assessment of the entire length of the Blackwater was as follows:

River Name	**Code**	**Year**	**Channel length (km) in Class**				
			A	**B**	**C**	**D**	**Total (km)**
Blackwater (Munster)	18B02	1997	99.0	41.5	0.5	0	141.0

The biological quality classes are defined as follows:
A - Unpolluted
B - Slightly polluted / eutrophic
C -Moderately polluted
D - Seriously polluted

An extract of the report Water Quality in Ireland 1995-1997 by the EPA is given below on the Mallow, Fermoy section of the Blackwater River (hydrometric area 18):

River and Code : **BLACKWATER (MUNSTER)** **18/B/02**
Tributary of : Sea - Youghal Bay OS Catchment No: 190
OS Grid Ref : X 098 997

Sampling Stations Biological Quality Ratings (Q Values)

No.	**1971**	**1974**	**1975**	**1978**	**1979**	**1980**	**1982**	**1984**	**1986**	**1990**	**1994**	**1997**
1400	5	5	5	4-5	-	5	4-5	4-5	4	4	4	4
1500	-	-	-	-	-	-	4	**3**	**3-4**	**3**	4	**3-4**
1510	4	**3**	4	**3-4**	-	**3-4**	**3**	**3**	**3-4**	**3**	4	**3-4**
1700	-	-	-	-	-	-	-	-	**3**	**3**	-	-
1800	**3**	**3**	**2-3**	**3**	-	**3**	**3**	**3**	**3**	**3**	4-5	**3-4**
1900	4	**3**	**3-4**	**3-4**	-	**3**	**3-4**	**3**	**3**	**3-4**	4	**3-4**
2000	4	-	4	-	-	4	4	-	**3-4**	**3-4**	4-5	**3-4**
2100	4	-	4	-	-	4	**3-4**	-	**3-4**	4	-	-
2200	-	-	-	-	-	-	-	-	-	-	4	**3**
2300	4	-	4	-	-	-	**3-4**	-	-	-	-	-
2450	5	-	5	-	-	4	4	-	4	-	4-5	4

No.	Location
1400	Longfield's Br
1450	2km u/s Rly Br Mallow (LHS)
1460	2km u/s Rly Br Mallow (RHS)
1500	Rly Br Mallow (LHS)
1510	Rly Br Mallow (RHS)
1700	1.5km d/s Mallow Br
1800	Ballymagooly
1900	Killavullen Br
2000	Ballyhooley Br
2100	Cregg Castle
2200	Fermoy Br
2300	2km d/s Fermoy Br
2400	Careysville
2450	W of Kilmurray Ho

Results of Chemical Analyses 1995 to 1997:
Hardness Range : 3-213 mg l^{-1} $CaCO_3$
Alkalinity Range : 29-167 mg l^{-1} $CaCO_3$
Data Set: 1 18B02 Cork County Council

Station No.	pH				Conductivity				Temperature			
					µS cm^{-1}				oC			
	No.	Min	Med	Max	*No.*	Min	Med	Max	*No.*	Min	Med	Max
1500	*36*	7.2	7.8	8.8	*31*	149	195	268	*33*	4.0	11.0	19.0
1700	*34*	6.7	7.8	8.8	*29*	150	206	323	*32*	4.0	11.5	19.0
1900	*36*	7.2	7.7	8.6	*31*	151	222	310	*34*	4.0	11.0	19.0
2000	*36*	7.3	7.8	8.2	*31*	180	278	366	*34*	4.5	11.0	19.0
2100	*36*	7.4	7.8	8.2	*31*	175	286	370	*34*	4.5	10.8	19.0
2300	*36*	7.4	7.8	8.5	*31*	154	299	431	*34*	4.5	10.8	19.5
2450	*35*	7.4	7.9	8.4	*30*	161	290	422	*33*	4.5	10.0	19.0

Station No.	Dissolved Oxygen				Dissolved Oxygen				B.O.D			
	% Saturation				mg $O_2 1^{-1}$				mg $O_2 1^{-1}$			
	No.	Min	Med	Max	*No.*	Min	Med	Max	*No.*	Min	Med	Max
1500	*36*	**41**	100	126	*36*	**6**	11	15	*35*	0.1	1.4	3.4
1700	*34*	**38**	100	127	*34*	**5**	11	15	*33*	0.5	1.6	4.1
1900	*36*	**42**	97	**135**	*36*	**6**	11	15	*36*	0.2	1.3	4.4
2000	*36*	**35**	96	122	*36*	**5**	11	14	*35*	0.5	1.4	4.2
2100	*36*	**38**	93	114	*36*	**5**	11	14	*35*	0.6	1.3	4.5
2300	*35*	**35**	98	118	*35*	**5**	11	14	*34*	0.8	1.5	3.4
2450	*34*	**44**	100	123	*34*	**6**	11	15	*33*	0.7	1.4	**8.7**

Station No.	Chloride				Total Ammonia				Un-Ionised Ammonia			
	mg Cl 1^{-1}				mg N 1^{-1}				mg NH_3 1^{-1}			
	No.	Min	Med	Max	*No.*	Min	Med	Max	*No.*	Min	Med	Max
1500	-	-	-	-	*36*	0.008	0.030	**0.303**	*33*	0.0001	0.0005	0.0059
1700	-	-	-	-	*34*	0.008	0.038	**0.793**	*32*	<0.0001	0.0007	**0.0309**
1900	-	-	-	-	*36*	0.008	0.025	**0.684**	*34*	0.0001	0.0004	0.0071
2000	-	-	-	-	*36*	0.006	0.023	**0.507**	*34*	0.0001	0.0004	0.0047
2100	-	-	-	-	*36*	0.008	0.020	**0.560**	*34*	<0.0001	0.0004	0.0027
2300	-	-	-	-	*36*	0.005	0.022	**0.644**	*34*	<0.0001	0.0004	0.0042
2450	-	-	-	-	*34*	0.008	0.021	**1.794**	*32*	0.0001	0.0005	0.0165

Station No.	Oxidised Nitrogen				Ortho-Phosphate				Colour			
	mg N 1^{-1}				mg P 1^{-1}				Hazen			
	No.	Min	Med	Max	*No.*	Min	Med	Max	*No.*	Min	Med	Max
1500	*36*	0.51	2.34	3.92	*36*	0.002	**0.042**	0.086	*31*	10	40	**200**
1700	*34*	1.62	2.47	4.02	*34*	0.010	**0.089**	**1.060**	*29*	10	40	**225**
1900	*36*	0.51	2.54	4.11	*36*	0.010	**0.064**	**0.188**	*31*	10	30	**225**
2000	*36*	0.51	2.94	4.27	*36*	0.010	**0.057**	0.150	*30*	10	30	**250**
2100	*36*	0.51	3.05	4.28	*36*	0.010	**0.054**	0.113	*30*	10	30	**250**
2300	*36*	0.51	3.09	4.39	*36*	0.010	**0.055**	0.140	*30*	10	30	**250**
2450	*34*	0.51	3.56	4.85	*34*	0.010	**0.048**	**0.226**	*29*	5	30	**250**

Results of Chemical Analyses 1995 to 1997:

Hardness Range : 3-213 mg l^{-1} $CaCO_3$

Alkalinity Range : 29-167 mg l^{-1} $CaCO_3$

Data Set: 2 18B02 EPA

Station No.	pH				Conductivity $\mu S\ cm^{-1}$				Temperature oC			
	No.	Min	Med	Max	*No.*	Min	Med	Max	*No.*	Min	Med	Max
1900	*33*	7.4	7.8	8.7	*34*	144	239	356	*34*	5.1	11.9	19.9
2500	*32*	7.6	8.0	8.6	*33*	225	343	537	*33*	5.7	12.4	20.8

Station No.	Dissolved Oxygen % Saturation				Dissolved Oxygen mg $O_2 1^{-1}$				B.O.D mg $O_2 1^{-1}$			
	No.	Min	Med	Max	*No.*	Min	Med	Max	*No.*	Min	Med	Max
1900	*34*	77	95	123	*34*	8	10	12	*32*	0.5	1.7	4.7
2500	*33*	79	98	115	*33*	8	11	13	*32*	0.4	1.5	4.2

Station No.	Chloride mg Cl 1^{-1}				Total Ammonia mg N 1^{-1}				Un-Ionised Ammonia mg NH_3 1^{-1}			
	No.	Min	Med	Max	*No.*	Min	Med	Max	*No.*	Min	Med	Max
1900	*31*	13	22	51	*30*	<0.01	0.024	0.238	*29*	0.0001	0.0009	0.0026
2500	*31*	20	26	69	*29*	<0.01	0.019	0.187	*28*	0.0002	0.0008	0.0031

Station No.	Oxidised Nitrogen mg N 1^{-1}				Ortho-Phosphate mg P 1^{-1}				Colour Hazen			
	No.	Min	Med	Max	*No.*	Min	Med	Max	*No.*	Min	Med	Max
1900	*64*	1.15	2.28	4.74	*30*	<0.02	**0.046**	**0.152**	*33*	10	40	**225**
2500	*64*	1.99	3.22	5.42	*30*	<0.02	**0.045**	0.142	*32*	<5	20	100

Table 4.1 Blackwater River Water Quality records from above Mallow to below Fermoy

Station 9

Date	Appearance	Temperature Deg C	pH	Dissolved Oxygen [mg/l O2]	DO Sat. [%]	BOD [mg/l]
20/01/99	brown	7.0	7.4	11.2	92	2.0
10/02/99	clear	5.0	7.5	12.2	96	1.3
10/03/99	clear	7.0	7.9	13.4	110	1.3
29/04/99	clear	13.0	7.6	10.9	102	1.0
19/05/99	clear	12.0	7.7	10.5	96	0.7
14/07/99	clear	17.0	7.9	9.0	92	1.0
18/08/99	turbid	15.0	8.1	9.7	95	2.2
15/09/99	coloured	15.0	7.6	9.9	97	0.9
13/10/99	clear	10.0	7.6	10.6	93	0.4
10/11/99	clear	9.0	7.6	10.7	92	0.8
08/12/99	turbid	8.0	7.5	10.5	88	1.4

Table 4.2 Blackwater River Water Quality records just downstream of Mallow town (upstream of STW)

Station 10

Date	Appearance	Temperature Deg C	pH	Dissolved Oxygen [mg/l O2]	DO Sat. [%]	BOD [mg/l]
20/01/99	turbid	7.0	7.5	11.0	90	1.2
10/02/99	clear	5.0	7.5	12.3	96	1.2
10/03/99	clear	7.0	7.7	12.7	104	0.8
29/04/99	clear	12.5	7.7	10.6	98	1.2
19/05/99	clear	12.0	7.7	10.6	97	0.9
14/07/99	clear	17.0	7.8	9.6	98	2.0
18/08/99	turbid	15.0	8.0	9.5	93	1.3
15/09/99	clear	15.0	7.7	8.6	84	2.3
13/10/99	clear	10.0	7.7	10.8	95	0.3
10/11/99	clear	9.0	7.6	10.5	90	0.5
08/12/99	flood	7.0	7.5	10.4	85	2.1

Table 4.3 Blackwater River Water Quality records at Killavullen (downstream of STW)

The only noticeable difference is the slight decrease (2% saturation) in dissolved oxygen levels.

The Water Quality in Ireland 1995-1997, EPA, states that the Q rating at the station directly downstream of the outfall (station no. 1800, Ballymagooly) is 3 - 4. This rating is deemed unsatisfactory. The EPA describes the deterioration in quality as of minor order, but also of concern in view of the high quality conditions needed to sustain the salmonid fish populations. The recommended interim target Q rating is 4, which is borderline satisfactory in itself, and is only a beginning in the process of improving water quality.

4.1.4 Blackwater River Flows

The following figures have been extracted from the Draft Water Quality Management Plan (Cork County Council, Dec. 1988). These figures do not relate to a specific station but the river as it passes through the town where the catchment area is stated as 1196 km^2. The next station upstream of Mallow is 1806 (where the catchment area is 1058 km^2).

Town	Mallow
Flows	m^3/sec
Long Average	27.5
95 % Flow	3.7
Lowest Recorded	2.3
DWF	1.8

Table 4.4 Blackwater River Flows

The definitions associated with the above data is:
The 95 percentile flow rate is defined as the daily mean flow with a probability of exceedance of 0.95 in the long term. The Dry Weather Flow rate (DWF) has been defined in water quality management plans as the annual minimum daily mean flow with a probability of exceedance of 0.98 (i.e. with a return period of 50 years).

4.1.5 Mallow STW Influent and Effluent Quality records

SECTION C - TABLE OF WASTEWATER ANALYTICAL RESULTS (FOR PLANTS >1,000 P.E.)							
Sanitary Authority:		Cork County Council North		Wastewater Treatment Plant			Mallow, 1999
Type of Influent sample (Composite or Grab)			Both	Type of Effluent sample (Composite or Grab)			Grab
EFFLUENT DATA mg/l							
DATE	**BOD**	**COD**	**TSS**	**TOTAL P**	**o-P**	**NH3**	**FLOW m3**
20/01/99	-	50	20.1	-	10.1	0.4200	(3480)
25/02/99	11.4	38	20.7	-	10.9	0.0686	2121
29/03/99	10.5	46	14.0	-	11.7	0.0006	5653
14/04/99	13.5	37	7.7	-	10.0	0.0004	(4318)
18/05/99	21.6	27	4.5	-	9.8	0.6400	6136
28/06/99	11.0	33	33.4	18.2	15.6	1.2500	3996
30/07/99	23.5	31	8.0	19.8	9.4	1.6000	(1421)
13/08/99	6.9	29	5.4	16.5	15.5	0.6980	1351
19/08/99	6.9	36	7.0	2.8	13.2	0.1350	3251
10/09/99	18.9	60	26.1	-	21.4	0.2120	1785
18/10/99	15.6	27	20.4	17	14.4	0.1480	3885
11/11/99	12.2	35	9.0		13.0	0.1460	1584

Table 4.5 Effluent Water quality records Part 1(source Environmental Office, Annabella, Mallow)

Date	pH	BOD mg/l	COD mg/l	SS mg/l
26/06/97	7.1	2.9	25	---
05/12/97	7.1	13.0	37	28
28/01/98	7.2	19.0	45	43
11/02/98	7.4	11.0	28	6
03/02/99	7.0	6.6	33	11
18/02/99	7.2	---	33	12
10/12/99	7.1	16.0	32	11
13/01/00	7.4	3.5	24	11

Table 4.6 Effluent Water quality records Part 2 (source Inniscarra Laboratory)

4.1.6 Other Water Bodies

There are no lakes on the Blackwater river.

4.2 Development Features

The inlet works should have the significant impact on water quality by removing screenings and by easing complications involved in the remaining processes downstream. The expansion of the secondary treatment will allow the system to act as originally designed in biodegradation of the organic material subject to the new design load. The re-arrangement of the secondary treatment to encourage the release of phosphorus should have the greatest impact of all the development features in the proposed works.

4.3 Predicted Impacts

Without the proposed works, the town developments would cause a much greater BOD loading to the river, greater than that allowable by the Urban Wastewater Directive 91/271/EEC. The discharge of the final effluent should not noticeably affect the dissolved oxygen levels, which are critical to the salmonid populations.

The degree of treatment provided will reduce the concentration of BOD in the final effluent to below 25 mg/l. The design hydraulic load is taken at 4050 m^3/day.

4.3.1 Dissolved Oxygen (DO):Minimum levels

To assess compliance with the regulations regarding the predicted minimum dissolved oxygen the following calculations have been made:

Parameter	Dissolved Oxygen	BOD	Temperature	DWF Rate Q
	DO [mg/l]	[mg/l]	Deg. Celsius	[m3/s]
DWF River	10	1.2	14	1.80

Proposed effluent flow	2	25	14	0.047

Table 4.7 Dissolved Oxygen calculation data

Oxygen Sag curve calculations taken from Streeter &Phelps, US Public Health Service, Washington DC, Bulletin No. 146

Critical Oxygen deficit $Dc = \frac{K1}{K2} * Lo * e^{(-K1 * tc)}$

Where K1 is the BOD reaction rate at 14 deg. Celsius
K120 is the BOD reaction rate at 20 deg. Celsius = 0.23 /day
K2 is the stream re-aeration rate at 14 deg. Celsius
K220 is the stream re-aeration rate at 20 deg. Celsius = 0.4 /day
Lo is the ultimate BOD of the combined flow
L is the BOD5 of the combined flow
tc critical time for minimum oxygen levels

$K1 = K120*(1.047^{(14-20)}) = 0.175$ /day
$K2 = K220*(1.016^{(14-20}) = 0.36$ /day

$$DOmix = \frac{(10 * 1.8) + (2 * 0.047)}{1.8 + 0.047} = 9.8 \text{ mg/l}$$

Initial oxygen deficit Di = 10 – 9.8 = 0.2 mg/l

$$L = \frac{(1.8 * 1.2) + (25*0.047)}{1.847} = 1.8 \text{ mg/l}$$

$$Lo = \frac{L}{1 - e^{(-5 * K1)}} = \frac{1.8}{1 - e^{(-0.23 *5)}} = 2.63 \text{ mg/l}$$

Dc = 0.8 mg/l

Minimum Dissolved Oxygen level = DOo - Dc = 10 – 0.8 = 9.2 mg/l

The calculated minimum dissolved oxygen level is above the stated level of 6 mg/l for designated salmonid rivers. Also, these levels are expected to occur only during a significant dry spell (drought).

If the upgrading of the plant is not undertaken, a gradual increase in the load to the works is still likely to occur. The effect of this will be shorter retention times in the aeration and settlement tanks yielding a lower quality effluent discharged with a higher BOD. Oxygen levels would be continually reduced as a result, particularly during low flows. The associated impact to the aquatic habitat is predicted in Chapter 7. The importance of the proposed works and the reduced BOD levels discharged is evident in light of the above predicted oxygen levels.

4.3.2 Dissolved Oxygen : Average Levels

Parameter	Dissolved Oxygen	BOD	Temperature	Flow Rate Q
	DOo[mg/l]	[mg/l]	Deg. Celsius	[m3/s]
DWF River	10	1.2	14	27.5
Proposed Effluent	2	25	14	0.047

Table 4.8 Dissolved Oxygen calculation data

$$\text{DO mix} = \frac{(27.5 * 10) + (0.047 * 2)}{27.547} = 9.98 \text{ mg/l}$$

Initial Oxygen Deficit Di = 10 – 9.98 = 0.02 mg/l

$$\text{BODmix} = \frac{(27.5 * 1.2) + (0.047 * 25)}{27.547} = 1.24 \text{ mg/l}$$

K1 = 0.175/day, K2 = 0.36/day;

$$\text{Lo} = \frac{1.24}{1 - e^{(-.23*5)}} = 1.82 \text{ mg/l}$$

tc = 3.08 days Dc = 0.52 mg/l

Average Dissolved Oxygen Dav. = 10 – 0.52 = 9.48 mg/l

This level is above the salmonid requirements stated in section 4.1.1: 50 % of samples to be greater than 9 mg/l DO. Overall we conclude that the water quality with respect to oxygen levels will be in keeping with the standards required for the encouragement of the growth of the salmonid populations.

4.3.3 BOD Levels

To assess compliance with the regulations mentioned in section 4.1.1, the calculation below is made applying the mass balance formula and using the 95 % river flow:

$$\text{BOD level of receiving water d/s of discharge} = \frac{Q*C + q*c}{Q + q}$$

Symbol	Parameter	Proposed	Unit
Q	95 % river flow u/s of discharge	3.7	m^3/s
q	effluent discharge flow rate	0.047	m^3/s
C	BOD level of river water u/s of discharge	1.2	mg/l
c	Proposed BOD level of effluent	25.0	mg/l

Table 4.9 BOD calculation data

$$\text{Resultant River BOD} = \frac{(3.7*1.2) + (0.047*25)}{(3.7 + 0.047)} = 1.50 \text{ mg/l}$$

These calculated BOD levels are well below that required by the regulations (maximum of 5 mg/l). The predicted BOD levels are only slightly above the average existing recorded BOD levels stated in Table 4.1 (the maximum BOD level recorded downstream of the works on the Blackwater River is 2.0 mg/l). The dilution factor for at DWF is 38. These predicted BOD level is below those recommended by The Royal Commission on Sewage Disposal . They considered that a clean stream would normally have a BOD of 2 mg/l and if the BOD exceeded 4 mg/l, the stream was on the verge of becoming a nuisance. Also recent work has indicated that most rivers can in fact easily assimilate a BOD of 4 mg/l without affecting fishing and water supply requirements. Thus it predicted that the water quality will not suffer, but will be protected by the proposed works.

4.4 Proposed Mitigation of Impacts

The expansion proposals for the plant should ensure efficient biological treatment in the aeration tanks, resulting in a more consistent quality of effluent discharged. The twin-stream of flow from the inlet works to the outfall pipe will facilitate easier maintenance of the individual wastewater treatment plant units, without having to take the entire plant off-line.
The proposed level of treatment is sufficient to meet the water quality standards such that no mitigation measures are required.

4.5 Residual Impact

The increase in population and industry in the Mallow area will place additional demands on the wastewater treatment facilities in the area and if not provided for could be expected to result in a deterioration of the water quality in the Blackwater River downstream of the town. However, the proposed upgrading and expansion works at the Wastewater Treatment plant are designed to protect the water body downstream of the outfall sufficiently to restore its quality rating to around Q4. Without the proposed works, the town developments would cause a much greater BOD loading to the river, so that the effect of the treatment works expansion is positive.

CHAPTER FIVE

AIR QUALITY

5.0 Introduction

The aspects of the environment, relating to the air, which may be affected by the operation of the sewage treatment works are air quality, noise, and climate. The wastewater treatment plant, while very well screened, is located within 100 m of a residential housing estate. Therefore, due regard must be paid to ensure that acceptable emission standards are set and complied with in the ongoing operation of the plant so as to ensure that no significant impacts result which would have the potential to adversely affect the air quality at the nearby residential housing area.

Air quality may be affected by the emission of odours and aerosols, noise and dust.
These aspects are considered separately below. The background noise levels are important to the extent that if the noise of the proposed works is less than the background noise in the area then no increase in noise levels are actually perceived.

5.1 Baseline Conditions

These refer to the existing air quality at the plant prior to any expansion.

5.1.1 Odour

The main source of odours in the existing plant are the inlet works, the aeration tank (with surface aerators), the secondary clarifier and the sludge handling and dewatering operations.

Bord na Mona have undertaken an odour survey of the existing plant. The results of this survey are contained in a separate report, see Appendix 2. They also modelled the odours arising from the existing plant for a range of worst case weather conditions.

5.1.2 Aerosols

The existing surface aerators have the potential to generate aerosol spray or droplets, containing micro-organisms. These tiny microdroplets have the potential of being carried and dispersed by the wind.

5.1.3 Noise

A sewage treatment works operates on a 24 hr basis and, hence, it is a source of some noise at all times. At night, in particular, when background noise levels are low, noise can travel a long way, although the level diminishes with distance. Pumps, motors, trucks, compressors and aerators will all generate noise. The tolerance of noise levels can vary depending on noise source, duration, time of day and frequency. Table 5.1 gives a graphical representation of typical noise levels for a range of everyday activities.

The current noise levels in the Mallow plant are not a cause for concern, due to the size of the plant, the fact that the site is well screened and also because of the distance to the nearest sound receiver (i.e. nearby housing estate).

Table 5.1 Typical Sound Levels

Sound Level (dBA)	**Subjective Evaluations**	**Environment**	
		Outdoor	**Indoor**
140	Deafening	Near jet engine, artillery fire	---
130	Threshold of pain	Jet aircraft (within 500 ft)	---
120	Threshold of feeling	Elevated train	Hard-rock band
110		Jet flyover at 1000 ft	Inside propeller plane
100	Very loud	Motor cycle at 25 ft.	Crowd noise in arena
90		Noisy urban street	Full band, noisy factory
80	Moderately loud	Diesel truck at 40 mph at 50 ft.	Dishwasher
70	Loud	Heavy urban traffic	Face to face conversation
60	Moderate	Air conditioner at 15 ft	General Office
50	Quiet	Large transformer at 100 ft	Large public lobby
40		Bird calls	Private office
30	Very Quiet	Quiet residential neighbourhood	Residence without stereo
20		Rustling leaves	Whisper
10	Just audible	Still night in rural area	Recording studio
0	Threshold of hearing	---	---

5.1.4 Dust

The extent of dust emission depends on meteorological conditions; strong winds at dry spells could increase dust emissions whereas humid conditions could reduce it. These are unlikely to occur in the existing treatment works, and so dust is not considered a problem at present.

5.1.5 Climate

Due to the small scale of the existing plant, it is very unlikely that the local climate has changed as a result of its construction. Thus the climate is taken as typical for the area's topography.

5.2 Development Features

Proposed Plant Design

The primary areas of concern relating to air quality at the wastewater treatment works are the inlet works, the primary settlement tanks and the sludge handling and de-watering systems. While the proposed works provide for increased areas and an increased number of treatment units at the site, increased standards and mitigation measures are proposed for the upgrading works designed to ensure that improvements will result in the air quality in and around the wastewater treatment plant site. .

The design of the treatment works will be carried out by the prequalified contractors under a design/build method of procurement. However, the individual plant units likely to be installed may be summarised as follows in relation to the potential of certain components to affect air quality.

- Inlet works
- Primary treatment (if provided)
- Biological Oxidation
- Final clarification
- Sludge handling, storage, and de-watering

5.3 Predicted Impacts

The impacts should be low because of the mitigation measures to be incorporated in the upgraded works, the reasonably long distance to the nearest housing estate i.e. (approx. 100 m to the southeast), coupled with the natural screening around the site boundary which gives the opportunity for any noise to attenuate and for odours to be dispersed and diluted, before they may be detected. However, much of the land surrounding the treatment works site is zoned as residential. If dwellings are built up against the treatment works site boundary, the impacts may be greater than those discussed below. The likely significant impacts arising from the works in the existing terrain are discussed below :

5.3.1 Odour

Fresh wastewater arriving at a treatment works via a properly constructed sewer system has a slight smell, normally described as musty in character. As long as a certain level of dissolved oxygen is maintained in the sewage, anaerobic conditions will not take place. However, if the oxygen content of the sewage is used up then gases such as hydrogen sulphide, nitrogen and sulphur based organic compounds (mercaptans, ketones, amines, indoles and skatoles) are produced and a general septic condition develops with typical pungent odours being emitted.

A sufficient detention time is required for the formation of anaerobic conditions and warm weather conditions above about 20 ºC will also assist the rapid growth of anaerobic bacteria. The operation of a wastewater treatment works involves many locations within the process where anaerobic conditions can occur; from poor maintenance of the inlet works, overloaded secondary treatment through to the dumping of the dewatered sludge in open skips prior to disposal off-site. In many cases the odour problem can be solved by regular cleaning of channels and general maintenance whereas sometimes overloading or sludge treatment may necessitate more extensive mitigation measures such as covering and removing waste gases via an odour control system.

The majority of odour nuisance problems associated with wastewater treatment works are due to the age of the works or where the sewage loading arriving at the works results in regular overloading of the facility. This tends to adversely affect the public perception of sewage treatment works. However, with modern technology, treatment works can exist close to residential areas without causing any problems of odours in the surrounding area. Modern day standards for monitoring of the effluent flow through the works to ensure an adequate flow and to prevent clogging, control of oxygen content and pH levels as well as the containment of the sludge in enclosed units have greatly helped to reduce community nuisance.

The rate of emissions of potentially odorous inorganic and organic compounds from wastewater treatment tanks depend on the tank surface area, organic concentrations and BOD of the tank liquor, volatility of the compounds and the evaporation rate from the tank. The rate of evaporation is lower from a quiescent liquid surface than from a turbulent surface with higher air temperatures and/or wind speeds increasing the evaporation rate. 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. Materials left on the walls or deposited on the floor of the connecting channels can quickly become septic resulting in odorous emissions. Unless there is a strong upward movement within the tank the volume of the tank is not important with respect to the emission rate since compounds near the floor of the tank will not quickly diffuse to the surface.

It is virtually impossible to ensure that odours are never detected beyond the boundary fence of a treatment works. This is because of the nature of the material that is being handled. The aim however, is to prevent an odour nuisance. 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 works is required at all times.

The perception of odour at some point downwind of an emission source depends on the type of odour compound and the air concentration of the odorous gas. The measure used to quantify odour nuisance potential is the odour concentration (odour unit per cubic metre, o.u./m^3). This concentration is equal to the number of times a sample must be diluted with odour free air before 50% of an odour panel cannot detect the odour.

Plant components with the potential to generate odours

Inlet works

The inlet works of a sewage treatment works can be a major source of odours due to the collection and deposition of solid matter in the wastewater. Screening devices can clog with material such as rags and plastics, if not cleaned regularly, which can cause anaerobic conditions to occur as well as causing flow rate reductions upstream along the incoming sewer pipe leading to deposition in the pipe Grit chambers are also another possible source of odours from the organic coating on the finer material collected or deposited in the channel due to low flow rates, especially during low flow conditions. The material collected if stored in an open skip for a number of days can also create offensive odours. In the design of this part of the works the potential for these odour-forming aspects to arise needs to be addressed. Bord na Mona have identified the existing inlet works skip as a significant source of odour, see Appendix 2.

Primary Settling Tanks (if provided)

Primary settlement tanks may be installed for primary treatment of the wastewater at the treatment plant. The potential for odours from these tanks depends on the BOD load of the influent, the rate of evaporation of odorous components from the surface of the liquid and the turbulence at the peripheral overflow weirs. The surface area of liquor in the tanks rather than the depth of the tank is important in relation to odour potential. In addition the peripheral overflow weir results in the generation of turbulence as the liquor flows out over a drop of 0.3m to a collecting trough and this may be a source of odours, especially during warm weather conditions.

Activated Sludge Treatment

Activated sludge treatment tanks will continue to be used. The system will utilise either surface aeration equipment similar to the existing plant or fine bubble diffused aeration from subsurface pipes.

Odour emissions from activated sludge treatment tanks are normally low since the high aeration (either surface or sub-surface) will provide high levels of oxygen in the tank liquor so that most of the odorous compounds are oxidised and anaerobic reactions do not take place.

Final Clarifiers

Final clarifier tanks for secondary settlement will be retained and additional tanks will be provided. Due to the low BOD and relatively stable sludge from the activated sludge tanks the potential for further decay of the sludge and resulting odorous emissions is very low. In addition the liquor in the tanks covers the sludge and so this prevents odorous compounds reaching the surface.

Evidence from existing wastewater treatment works around Ireland indicates that odours from final clarifiers are very low and are normally not detected beyond a few metres from the tank sides.

Sludge Thickeners

The sludge would likely be thickened in the existing picket fence thickening tank and stored in the holding tank prior to dewatering. A sludge blanket forms in the bottom of the tank and as this depth increases the thicker the solids will be. However, excessive retention times can lead to anaerobic conditions resulting in production of gases and buoying of solids to the surface. Another source of odours is from the draw-off valve manifold.

Sludge De-watering Building (if provided)

The sludge from the thickening and holding tanks will be dewatered by double belt filter presses or similar type equipment which produces a sludge cake with a dry solids content of 15-25%. In the case of belt presses, the sludge would be flocculated with a polymer and then fed onto a wedge shaped belt where the excess water is removed by passing the belt through a series of rollers. The final dewatered sludge cake is removed from the belt by scraper blades and transferred to containers for disposal off-site (for land spreading / injection).

Bord na Mona have identified the sludge dewatering building as the source with the greatest potential to generate odours, see Appendix 2. They have shown in their assessment of odours that the predicted impact of the upgrading and expansion of the works will lead to a considerable improvement in the air quality experienced in and around the site. The odour concentration plots contained within the Bord na Mona report show that the predicted odours at the nearest housing and at lands zoned for housing shall be much lower than the existing odours. This is due mainly to the mitigation measures outlined in Section 5.4.

5.3.2 Aerosols

Aerosols are introduced into the air at aeration tanks in the activated sludge process due to the turbulent nature of the process, i.e. the injection of air into the liquid. Aerosols take the form of a fine mist of tiny droplets (smaller than 5 μm). The concentration of bacteria and viruses in the aerosols can be high. However, because of the very small size of the fine mist droplets, they evaporate very quickly. Hence the micro-organisms will be dehydrated rapidly and will not survive and the risk of inhalation, with the possible risk of infection, does not normally arise outside the site boundary.

Aerosols introduced into the air at the aeration tanks should only present a public hazard to anyone within approx. 20 m of these tanks. Even then the risk is very small as there is little evidence that aerosols affect the plant operatives at treatment works. At distances greater than 20 m the risk of contamination falls away rapidly so there is little reported risk to people or animals outside the treatment works boundary.

There will be a low level of microbe bearing aerosols generated at the works. International experience shows that these pose little or no risk to exposed populations. It is considered that operation of the plant will not generate sufficient aerosol bearing viable microbes to properties outside the site boundary. These properties are already screened from the treatment works site by trees along the site boundary.

5.3.3 Noise

The only source of noise expected from the inlet works building is from the screening and grit removal equipment. Maintenance of the equipment will limit this noise to an acceptably low level. The primary tanks do not tend to emit any noise other than water trickling over the overflow weir. The addition of another aeration tank will cause a slight increase in noise at the works due to the action of the surface aerators. Fortunately when one noise source is replaced by two identical sources the increase in noise detected is only 3 dB. As the nearest housing is

situated a reasonable distance away (over 100 m), only a fraction of this additional 3 dB will be recognised. Even at the plant boundary the increase in noise from the aerators should be less than 2 dB.
The nature of the de-watering system is not noisy, and the upgraded de-watering system will remain housed as before. The installation of odour control equipment outside the building in a walled off area may result in fan noise propagating around the building.
The spray irrigation system, if repaired, is not expected to cause much noise, just a light sprinkler sound.

The tolerance of noise levels can vary depending on noise source, duration, time of day and frequency.

In the short term, some noise nuisance will be associated with construction traffic to and from the works and with the operation of machinery and plant during the construction of the Treatment Works.

During the operation of the treatment works itself, noise will be generated by plant and mechanical equipment and from traffic associated with the removal of sludge from the site. Items of plant which will generate some noise include pumps, aeration equipment and other motors.

The principal noise sources would include :

- horizontal aerators;
- exhaust fans;
- sludge draw-off units at primary and secondary settlement tanks;
- sludge presses.
- screening and grit removal equipment

Significant noise attenuation will occur over the 100 m distance from the works boundary to the Nearby housing estate boundary.
It is proposed that a rigorous criterion for noise of 45 dB(A) : maximum allowable 15 minute Leq, be adopted at the site boundary due to operations within the site. This is the proposed standard by the EPA. 15 minute Leq refers to an average noise level over a 15 minute period. In order to achieve this level, certain mitigation measures may be adopted by the contractors depending on their own plant designs and choice of treatment process.
Although the site is located close to the nearby housing estate, it is considered that the noise emissions associated with the operations of the plant are not likely to have a significant impact once standard designs are adopted.

5.3.4 Dust

Dust at the wastewater treatment works can be generated from screenings and grit removal systems and from dewatered sludge with a low moisture content. The extent of dust formation depends on meteorological conditions; strong winds increase dust emissions whereas humid conditions reduce it. The screening systems proposed for the Mallow wastewater treatment

works will allow all particles which are less than 5 mm in diameter to pass through to the treatment process and therefore no dust particles will be produced at that stage. Grit classifiers remove only particles heavier than grit and which will again not create dust emissions.
Dust can be generated from settled solids in empty open tanks but the possibility of dust emissions from these sources can be prevented by washing of tanks after emptying.

The construction works will tend to increase the dust levels around the plant and the access roads. The sources of dust in this case are cutting of existing concrete sections and road sweeping. There are no powder additives proposed in the expansion of the works, so that dust will only arise during the construction period (approx. 4 months).

5.3.5 Climate

Due to the scale of the proposed works, there is no change in climatic conditions expected.

5.4 Proposed mitigation of impacts

5.4.1 Odour

While the final design for the plant will rest with the particular contractor under the design/build contract, the following or similar type measures to reduce odorous emissions would be proposed as part of any plant design.

(1) The inlet channels including screening equipment would be enclosed or covered with the air extracted through a high efficiency odour control unit and so odorous emissions from this part of the plant would not occur. The grit traps and channel would not be covered. The screened material and grit would be washed and deposited in covered skips which would be regularly removed for disposal off-site to landfill.

(2) The proposed use of diffused aeration rather than a surface aeration system in the aeration tank would be the preferred method to reduce turbulence and hence the potential for generating malodours or aerosols from the surface of these tanks. However surface aeration equipment similar to the existing plant would be permitted provided the overall plant met the Odour Compliance Criteria specified for the site boundary.

(3) The sludge draw-off chambers, sludge buffer tank, sludge thickening tank and sludge holding tanks would be covered and the air extracted via a biofilter odour control unit.

(4) The dewatering building is already completely enclosed. A with high rate of extraction of odorous fumes would be provided through hoods located about the belt presses. An odour control system would also be installed in the de-watering building with 3 to 6 air changes per hour to prevent toxic fumes building up within the building and posing a threat to employees. A concentration of 14 mg/m^3 for hydrogen sulphide would represent the maximum level employees should be exposed to within the building in terms of occupational exposure thresholds over a normal 8 hour working day. The proposed odour extraction system will ensure levels are much lower than this concentration.

The odour control system to be installed in the sludge dewatering building air handling unit would have a very high removal efficiency rate with values in excess of 95% of the inlet odours being removed. This should ensure that odours are not detected beyond a few metres from the building. A Bord na Mona system e.g. Monafil biofiltration system using specialised peat is typically used.

The de-watered sludge, which is relatively stable and hence has a low odour potential, would be stored in covered skips for subsequent disposal off-site (land spreading, injection).

The intensity of an odour from various parts of the wastewater treatment works will depend on the strength of the initial odour concentration from the surface of the tank or other emission source and the distance downwind at which the prediction, or indeed measurement, is being made. Where the odour emission plumes from a number of sources combine downwind then the predicted odour concentrations may be significantly higher than that resulting from an individual emission source. An odour concentration of 1 o.u./m^3 is the level at which there is a 50% probability that, under laboratory conditions using a panel of qualified observers, an odour may be detected. At levels below 1 o.u./m^3 the concentration of the gaseous compound causing the odour in the air will be less than the detection level and so although the gas is still present in the air no nuisance will occur.

The intensity of an odour ranges from 1 o.u./m^3 = odour detection, 2 = sought odour up to 5 o.u./m^3 is used as a criteria for predicting the potential for complaints over periods of 15-30 minutes. Sensitivity to an odour also depends on the location; for example an odour from agricultural related activities will be tolerated by the community longer in a rural setting than in an urban area.

The individual mitigation measures to be adopted in the various elements of the plant must be such that the following criteria is complied with at the site boundary:

Odour concentrations should not exceed 1 o.u./m^3 at the site boundary at a 98 percentile probability of occurrence or it should not exceed this limit for more than 2% of the year whichever is the lesser.

and

Odour concentration should not exceed 2 o.u./m^3 at the site boundary at a 99.5 percentile probability of occurrence or that it should not exceed this level for more than 2% of the year, whichever is the lesser.

The Contractor will be required to submit detailed calculations to show that the above criteria is satisfied by the mitigation measures he is to adopt for dealing with the treatment of odours emanating from the individual elements of his plant.

5.4.2 Aerosols

The generation of aerosols arises mainly from the aeration tanks. Aerosols, therefore, are really only of concern within the treatment works. Operatives may need to take precautions, such as wearing of face masks during certain operations, to prevent the inhalation of the aerosols. While there is no reported problems of aerosol transmission outside the site, installation of sub-surface aeration diffusers would reduce aerosol generation by reducing surface turbulence compared to the existing surface aeration systems. Maintaining the boundary of the site with dense tree plantation will also reduce the risk of aerosol transmission outside the site.

5.4.3 Noise

Noise is generated by the mechanical and ventilation equipment at the site and mitigation measures may need to be incorporated in the works to keep resulting noise levels within acceptable criteria at the site and thereby minimise the possibility of community response to the operation of the works. It is proposed that a rigorous criterion for noise of 45 dB(A) (maximum) be adopted at the site boundary due to operations within the site. In order to achieve this level, certain mitigation measures may be adopted by the contractors depending on their own plant designs and choice of treatment process. However the following measures are likely to be considered in order to achieve the 45 dB(A) criterion:

- A proposed diffused-air aeration system may be adopted on account of its low noise level, over the surface aeration system;
- Perimeter banking be constructed between the proposed site and the nearest adjacent residences;
- Air blowers could be enclosed in a block-walled building, with a concrete roof to minimise their noise impact at any residence. Double glazed windows of thickness 6 mm and 9 mm, in separate frames, separated if possible, by 100 mm air-gap, are recommended for this building;
- The generator housing, if provided should be provided with sound attenuators, acoustic doors, and a 125 mm thick concrete roof to achieve the recommended noise level;
- The exhaust pipes and air openings of the generator (if provided) be subject to noise attenuation in order to achieve a noise limit of 70 dB(A) at 3metres;
- Elements of the Inlet Works be housed for sound attenuation if necessary;
- If any of the mechanical elements are not set to run at efficient motor speeds, they will tend to cause greater noise levels than those specified by the manufacturer. Any such elements will be replaced by elements sized to handle the loads more efficiently.
- The access to the storm pump sump may be sealed to further reduce the noise caused by the occasional use of the storm pumps. Ventilation pipes from the storm tanks may be lined with acoustical duct liner and a silencer may also be fitted to prevent piping of the noise to the outdoors.
- The odour control equipment for the de-watering building may need to be housed, i.e. not just walled off, a concrete roof may provide the necessary transmission losses.
- Ventilation fans should be located so as to give the maximum noise screening in respect of any building. The noise level from any fan should not exceed 25 dB(A) at any building.

Fan silencing may therefore be required.

The net results should be no noise disturbance outside the site boundary thereby resulting in a minimal possibility of adverse community response.

Appropriate steps should be taken to timetable the construction traffic so as to minimise disruption in this regard. Likewise every effort should be made to muffle noisy plant during the construction period. Working hours will be restricted as far as possible to reasonable hours. The British Standard B.S.5228 recommends practical methods for noise control on construction sites. In addition, S.I. 320 of 1988 sets down limits for noise from construction plant and these will be set out in the Specification requirements for the construction of the Works.

5.4.4 Dust

As it is proposed that the sludge thickeners and holding tanks will be covered, this will eliminate dust emissions. Digested and thickened sludge at 15 - 25 % dry solids is a wet cake and will not create dust emissions. Higher dry solid content sludge would have a higher dust emission rate and to prevent any such dust emissions, dewatered sludges will be transported in covered containers to the final disposal or treatment location.

Based on the proposed treatment process for the incoming waste load and generated sludge, the possibility of dust emissions will be very low. In addition, humid conditions predominate because of high average annual rainfall and dust emissions rarely if ever occur at the site in the current situation. The dense mature screening around the site boundary also curtails the risk of dust nuisance from the site.

Dust is also likely to be generated during the construction period by construction traffic on the public roads, and also from within the site itself during the various stages of the construction process. Regular hosing with bowsers along construction haulage routes will mitigate any such problems in dry spells.

Road sweeping can be done during the construction period at times agreed with the residents in the area to suit their needs.

5.5 Residual Impacts

The overall effect of the expansion and upgrading of the works will cause a definite improvement in air quality, mainly because of the housing of the inlet works and the provision of the odour control equipment at the inlet works and the de-watering building. Noise at the plant boundary will also be less than before.

Monitoring of odour will be carried out by the full-time personnel based at the sewage treatment works. In the event of excessive odour emissions due to process malfunction, personnel will take prompt remedial action to ensure that odour nuisance is not caused outside the site.

CHAPTER SIX

SOILS

6.1 Baseline Conditions

This refers to the existing soil conditions at the plant. A site investigation using trial holes is to be carried out at the site. The proposed works are to be built within the sewage works site, so one anticipates similar conditions to those encountered during the first construction.
All soils not covered by the existing works are at present topsoiled with grass, providing cover from the elements. Old Red Sandstone is the type of rock shown on the GSI map of Ireland's geology for this area. The depth to rock is at present unknown. There does not appear to be any rock exposed at the surface.

6.2 Development Features

The proposed development will result in the loss of soil area on the site of no more than 10 %. The topsoil removed for the construction of the primary and new secondary tanks should be kept on site for landscaping of the works when construction is complete. The ground pressure under the new tanks will be greater than before, so ground heave should not be a problem. Excavated topsoil on the site will be re-used to form earth screening embankments.

6.3 Predicted Impacts

Construction works will generally cause damage to green areas within the site, due to the driving of heavy vehicles and the storage of materials. In the steep corner of the site, the excavated materials may, if stored at steep slopes, be unstable.

6.4 Proposed Mitigation of Impacts

The landscaping of the finished works is always one of the last items of work to be done. Reinstatement of topsoil and grass-seeding will be done to the effected areas.
The storage of excavated material will be restricted to a maximum exposed slope to ensure stabile storage of materials. Additional landscaping of shrubs and trees will be provided and the existing dense natural tree boundary will be maintained and enhanced wherever this is required.

6.5 Residual Impacts

With the excavated topsoil to be retained on-site and the small size of the works, no residual impacts on the soil are expected.

CHAPTER SEVEN

ECOLOGICAL IMPACTS

7.1 Baseline Conditions

These describe the ecological habitats as they exist at the moment.

7.1.1 Land Based Habitats

Fortunately, due to extensive landscaping the habitat for land based animals is quite stable and healthy. The regular mowing of the grass may not suit some of the ground based animals, but it may also benefit the bird population providing easier access to the rich topsoil feeding areas. The resident bird life appears to be well catered for with plenty of trees and dense shrubs for refuge. The nearby river is a renewable source of food with flies and fish available.
There is also a lot of feeding from the agricultural lands surrounding the site.

7.1.2. Aquatic Habitats

The fly populations on the river surface and larvae in the water column will tend to explode during the summer months and are not evident for the remainder of the year. The fish populations are generally good, but vary with the spawning salmon returning in spring from their seaward travels.

7.2 Predicted Impacts

7.2.1. Land Based Habitats

The land based habitat will be disturbed in the area of the works, but once it is restored properly should be resilient enough to recover rapidly. Selective removal of surrounding trees and shrubs will ensure that sufficient cover is retained to shield the existing wildlife populations from the rapidly changed environment.
The main disturbance will occur during construction when noise and exhaust emissions will be temporarily high.

7.2.2. Aquatic Habitats

In the short-term, if construction practises do not allow for the proximity of the river to the new works, rainfall may act as a form of transportation of pollutants including dust and washings to the watercourse. However this can be prevented with proper construction techniques.
The most significant long-term impact will be the improvement in aquatic habitat to the extent that during the heavy rains, storm water overflow occurrences and volumes will be minimised and the storm overflows that do occur will be screened. The final effluent discharged to the river will meet the discharge criteria laid down in the relevant standards and directives. The

quantity of suspended solids will be reduced and the oxygen levels during flood should remain high.

As the bulk of the waste is to remain composed primarily of municipal wastewater and therefore does not contain significant quantities of materials that would be toxic to the flora and fauna of the stream. If the upgrading of the works is not undertaken, the suitability of the aquatic environment for salmonid populations will noticeably decrease. Oxygen levels may tend to below 40 % of saturation, bacteria and algae will tend to flourish as the conditions tend towards septic. However, with the proposed works, the river has every chance to retain its current water quality status and its diversity of species.

7.3 Proposed Mitigation

Construction based run-off should not be allowed to enter the river, but should be collected at a temporary sump and transferred to the inlet works for treatment. This procedure is to include washings from concrete lorries and pumped water from excavations and run-off from excavated material.

7.4 Conclusion

As with any change to the habitat, the resident populations will receive knock-on effects, this effect will only be measurable during and for a short period after the construction period.

The completed works will provide as much of a stable living environment as the rest of the river bank in the area.

The aquatic habitats will not be adversely affected but rather will be improved downstream of the works as a result of the upgrading works at the plant and the continued compliance with the required discharge standards to the river. This will lead to less weed and algal growth and higher dissolved oxygen levels than existed prior to the works being undertaken.

CHAPTER EIGHT

SOCIO-ECONOMIC IMPACTS

8.1 Baseline Conditions

These describe the conditions that exist at present.

8.1.1 Land Use

Adjacent to the existing treatment works, the current land use is a combination of agriculture and housing.

8.1.2 Fisheries

The receiving water body, the Blackwater River contains a reportedly reduced number of trout and salmon. However, it is still regarded as a good salmon river though catches have declined since the 1960s (due to overfishing at sea and pollution of the upper stretches). The fishing of these waters is for coarse and game only (non-commercial) and is controlled by the local angling clubs (Ref. Draft Water Quality Management Plan for River Blackwater Catchment, 1988, pp 4.10).

8.1.3 Agriculture

The scale of agriculture in the area is large, with some of the land being developed for housing sites. The fertilisation of the agricultural lands is done in accordance with present farming standards.

8.1.4 Industry

The industries as mentioned in Chapter 1 are important to the town as major employers.

8.1.5 Residential

In accordance with the 1998 town development plan and the 1996 county development plan, the number of houses in the area is set to increase noticeably in the short term. The number has increased slowly over the years. New housing has been constructed in reasonably close proximity to the sewage treatment plant site, this is evident in the drawings in Appendix 3.

8.1.6 Recreational and Leisure

Given that the Blackwater River is not a designated bathing water, the recreation and leisure related to the proposed works includes fishing and the visual amenity value of the river.

8.1.7 Electricity and Water

The town is well served with electricity supply at present. The water scheme is due to be expanded and will eventually ensure that water supply will not be the limiting factor for future development.

8.1.8 Transport

The traffic tends to be mainly local and only a portion is through traffic. The road networks in the area are generally sufficient.

8.2 Predicted Impact

8.2.1 Land Use

The present use of the land is expected to remain both housing and agriculture. The impact of the works will be negligible to the suitability of either use. As the proposed works will be contained within the bounds of the existing site, the expansion will not cause any change of land use in the area.

8.2.2 Fisheries

The benefit of the works to the fisheries will be gradual and lasting. The proposed removal of phosphorus will limit growth of algae. The decrease in competition for dissolved oxygen will tend to encourage fish growth and reproduction. This will concur with the charge of the Southern Regional Fisheries Board of protection, conservation and promotion of fisheries.
Angling tourism will tend to increase as a result of better fishing and once licensed by the angling clubs will benefit the area and facilitate conservation of stocks.

8.2.3 Agriculture

The expansion of the treatment works will have no real effect on the industry of agriculture in the area. The improvement of quality of effluent from the works may tend to turn the attention of those monitoring the river water quality towards agriculture. The prevention of run-off from land as a non-point source of phosphorus will gradually become an issue of greater concern.
A side benefit of the increased volumes of sludge produced, is the availability of more sludge for land injection and spreading of sludge as a cheap source of fertiliser.

8.2.4 Industry

Given that the larger industries discharges to the river without passing through the Council's treatment works, they will tend to pollute as before. The river water quality does not benefit in this regard. Monitoring of the loading of the discharges to assess compliance with licence will remain important. Additional industry draining to the works can be accommodated within the serviced areas as set out in the town development plan. The additional industry will in turn, tend to stimulate additional housing.

8.2.5 Residential

Expansion of the works will facilitate the proposed local authority housing to proceed in the Mallow area. Also the zoned private residential areas in the development plan can be accommodated while maintaining standards of effluent discharged.

8.2.6 Recreational and Leisure

The river is not designated as a bathing water, so expansion of the works will not directly impact the recreational and leisure facilities. The use of the river as a visual amenity will be noticeably improved because of the cleaner effluent discharged with less suspended solids and less storm overflow of solids.

8.2.7 Electricity and Water

The area is well served with electricity and water, so that the proposed plant expansion should not put a noticeable increase on the load on either service.

8.2.8 Transport

As the treatment works are not proposed to be major collection centres for the treatment of sludge, there should not be a noticeable increase in the volume of traffic delivering sludge. But because of the proposed increased biological load to the proposed works, there will be an increased volume of sludge produced. This will result in a minor increase in the volume of traffic disposing of sludge to land.

There is no necessity to upgrade the access road or public roads in the vicinity of the works as a result of the upgrading works at the site.

8.3 Proposed Mitigation

For the sake of the existing housing and the possibility of further housing, the treatment works site should continue to be heavily screened and landscaped. The enclosure of the site with hedging and trees limits the extent to which the wind can disperse odours and cause nuisance to the neighbours.

The disposal of sludge should be reviewed in future in light of a sludge management study for the county.

8.4 Residual Impact

The town will benefit generally so that the proposed extension of facilities is an essential element of the infrastructure development and will therefore have positive impacts on the socio-economic environment.

CHAPTER NINE

MATERIAL ASSETS

9.1 Land Ownership and Access

The proposed expansion and upgrading works will be procured through a design and build form of contract. The treatment works and the land on which it is sited will at all times remain within the ownership of Cork County Council (their heirs or assigns). Access to the site will be the right of the local authority at all times during the construction period and process proving period.

9.2 Development Potential and Expansion.

The proposed expansion will require some part of the remaining limited unused space.
The ultimate capacity of the site will depend on the process type used by the Contractor and the space used per cubic meter of capacity. The treatment works will be designed to cater for populations well into the 21st Century. Depending on changes in technology in the future, the ultimate capacity of the site should be sufficient until the middle of the 21st Century.

9.3 Sludge

In line with current practices of waste minimisation and energy efficiency, the sludge produced from wastewater treatment plants is now seen as a potentially useful by-product. The value of the sludge increases with further stabilisation. This further stabilisation does not form part of this project.The County Cork Sludge Management Plan has indicated Mallow as a hub-centre, whereby the proposed form of treatment is lime stabilisation. It is then proposed to dispose of the treated sludge on soils in the region which have a lime deficit.

9.4 Conclusion

The local authority is making the anticipated and reasonable use of the land which was the retained for this purpose. The material asset originally purchased years ago is now proving to be a very valuable asset to cater for the increasing wastewater treatment needs and continued development of the Mallow area.

CHAPTER TEN

VISUAL IMPACTS

10.1 Baseline Conditions

These describe the conditions that exist at present.

10.1.1 Topography

The land is lies within the Blackwater Valley and is on a continual slope down toward the river.

10.1.2 Buildings and Landscaping of Works

The buildings comprise mainly of low concrete tanks, together with a brick-clad sludge de-watering building. The remaining site is well grassed, and these grassed areas are well maintained. There is a light scatter of trees around the site, with a complete ring of evergreen hedging and trees around the site perimeter just inside the fence.

10.1.3 Light

As the tanks are generally sunken into the ground, the density of planting is low, and with the low area of building, daytime lighting is not a problem. The shadows cast within the site are minimal. The perimeter fence and evergreens cast a very minor shadow around the outside of the site. Night-time lighting is by means of lamp-standards on the side of the roadways. These lamps are not normally on (except during urgent works and monitoring).

10.2 Predicted Impact

10.2.1 Topography

The shape of the land will not change dramatically with the construction of the proposed works. The lie of the land will be as before, a river flood plain sloping continually towards the river.

10.2.2 Buildings and Landscaping of Works.

The existing sludge buildings will be retained and will receive minor refurbishment as part of the upgrading works the others being concrete tanks. The new buildings will most likely consist of similar size to the existing and will be equally sunken into the existing ground contours to minimise the quantities of cut and fill required. The grassed area will decrease marginally as a result, but the overall impression of the site will remain as being a generally green landscaped developed area.

10.2.3 Light

No noticeable decrease in daylight shall occur. Sufficient lighting from the lamp standards during the hours of darkness will be provided around the upgraded works.

10.3 Proposed Mitigation

Additional lamp standards are to be installed to provide sufficient luminance of the buildings for safe operation at night when required.
Additional planting shall be undertaken to blend the new works into the landscape and help retain the overall green appearance of the area. The new buildings and treatment units will be constructed with standard building materials. New buildings may be brick or blockwork with traditional tiled pitched roofs or alternatively may be enclosed with coated steel cladding and roofing. New tanks will be either concrete or coated steel units similar to the existing circular tanks.

10.4 Conclusion

The visual impact of the treatment works will not change in nature. The most striking artificial features will be the exterior face of the concrete tanks and the existing control / sludge dewatering building and the upgraded site will remain in harmony with the surrounding terrain.

CHAPTER ELEVEN

CULTURAL HERITAGE

As there are no listed sites of archaeological interest or sites of monumental records contained in the site , it is not expected that the proposed works will have any effect on the cultural heritage. Neither were any items of archaeological interest discovered during the construction of the existing works. If, in the unlikely event, some remains of interest are exposed, an archaeologist shall inspect the same and the contractor will co-operate with the archaeologists team in the process of detailed excavation and recording.

CHAPTER TWELVE

CONCLUSION

12.1 Summary of Impacts : interaction of the foregoing

The impacts to the general environment are predicted to be positive overall with improvement in water quality where this is currently being affected by the discharges from the existing treatment works which is becoming increasingly overloaded.
The preservation of the quality of the water environment will benefit the general amenity of the area. With the increase in plant capacity and the provision of storm tanks, the occurrence and quantities of overflows will tend to decrease.
The high standard of the works proposed, including comprehensive landscaping and architecturally sensitive building works will ensure that there is diminution of the amenities enjoyed in the area.
The economic effects of the scheme will be to facilitate residential and commercial development in Mallow and the adjoining area, some of which may have been postponed due to the fact that the existing treatment works is already overloaded. Increased tourism related activities, including fishing, will result from the improvement in water quality.
The volume of traffic will increase marginally with increasing volumes of sludge produced. The increase will be of the order of 2 trucks in and out per week.

The principle impact on the physical assets arises from the fact that some part of the existing site will be used for the proposed works. However this represents about 20 % of the remaining area available for future expansion.

The construction stage will involve short-term impacts caused by increased traffic and traffic disruption.

12.2 Recommendations

The perception of wastewater treatment works may be regarded as undesirable with respect to adjacent properties. To improve this perception, the upgrading of the works will enhance the visual amenity while noise and odour emissions will be contained and controlled within acceptable recognised standards in keeping with the location of the works and the nearby housing estate.

The future of the Blackwater River as a significant water body downstream of the town will be better safeguarded, such that the proposed works should go ahead as a matter of importance.

APPENDIX 1

Aerial Photographs

A1.1 Mallow Sewage Treatment Works viewed looking east

A1.2 Mallow Sewage Treatment Works viewed looking north

A1.3 Mallow Sewage Treatment Works viewed looking west

A1.4 Mallow Sewage Treatment Works viewed looking south-west

APPENDIX 2

Bord na Mona assessment of odours

BORD NA MÓNA

BORD NA MÓNA ENVIRONMENTAL LIMITED

A DISPERSION MODELLING ASSESSMENT OF ODOUR EMISSIONS FROM THE EXISTING AND PROPOSED MALLOW SEWAGE TREATMENT WORKS, MALLOW, CO. CORK FOR CORK COUNTY COUNCIL

REPORT NO: L470-M

ATTENTION: Mr. Ben Gaffney
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Corrig Road
Sandyford
Dublin 18

PREPARED BY: Ms. Lisa Blyth
Environmental Consultant

REVIEWED BY: Dr. Michael Donlon
Principal Consultant

DATE: 16th March 2000

Executive Summary

Bord na Móna Environmental Limited was commissioned by T.J. O'Connor & Associates on behalf of Cork County Council to conduct an extensive air dispersion modelling assessment of odour emissions from the existing Mallow Sewage Treatment Works. This survey included a comprehensive sampling and analysis programme of the existing odour emissions from the facility. The results of this survey were subsequently used to conduct an impact assessment of odour emissions on the surrounding locality, and in particular on the residential properties situated immediately to the east of the facility, at a distance of less than 40m. An additional impact assessment was carried out to assess the impact of odour emissions following the improvements and expansion works at the treatment plant.

The impact assessments are presented in the form of odour concentration contours produced using US EPA approved dispersion modelling techniques (Industrial Source Complex Short Term 3 - ISCST3). Concentration contours are plotted on Ordnance Survey Maps of the locality indicating maximum odour concentrations (using a year of hourly meteorological data). Meteorological data from Cork Airport Meteorological Station covering the years 1993 - 1997 was used in the modelling exercise.

The results of the preliminary baseline assessment demonstrate that odour emissions from the **existing** sewage treatment works will result in ground level odour concentrations less than 10 ou/m^3 (98 Percentile) above baseline anywhere along the boundary, and more importantly less than 3ou/m^3 (98 Percentile) above baseline at the nearest sensitive location. In summary, on comparison with the relevant Dutch guidelines on immission concentrations for wastewater treatment plants the 98 percentile value is within the recommended guideline.

Moreover, the results of the modelling assessment of the proposed improvement works demonstrate that the predicted ground level odour concentrations at both the northern and eastern site boundaries have reduced significantly compared to the existing situation. In fact the odours from the proposed works are less than those for the existing. Thus the upgrading and expansion of the works will improve the air quality around the works. Overall, the results illustrate that the predicted ground level odour concentrations will reduce to 8ou/m^3 (98 Percentile) anywhere along the boundary and more importantly to 1.4ou/m^3 (98 percentile) at the nearest odour sensitive location.

In conclusion, it is contended that the resulting ground level odour concentrations from the proposed improvement works will not have any adverse effect on the surrounding environment.

Respectively Submitted

Lisa Blyth
Environmental Consultant

Dr. Michael Donlon
Principal Consultant

TABLE OF CONTENTS

1.0 INTRODUCTION

T.J. O'Connor & Associates, on behalf of Cork County Council, are preparing an Environmental Impact Statement for the proposed expansion and upgrading of the Mallow Sewage Treatment Works. Bord na Móna Environmental Limited was commissioned by T.J. O'Connor & Associates to conduct an impact assessment of odour emissions from the existing Mallow Sewage Treatment Works (STW's). This survey included a comprehensive sampling and analysis programme of the existing odour emissions from the facility. The results of this survey were subsequently used to conduct an impact assessment of the odour emissions on the surrounding locality, and in particular on the residential properties situated immediately to the east of the facility. An additional assessment was carried out to assess the impact of odour emissions following the proposed expansion and upgrading of the existing works.

The impact assessments are presented in the form of odour concentration contours produced using US EPA approved dispersion modelling techniques (Industrial Source Complex Short Term 3 - ISCST3). Concentration contours are plotted on Ordnance Survey Maps of the locality indicating maximum odour concentrations (using a year of hourly meteorological data). Meteorological data from Cork Airport Meteorological Station covering the years 1993 - 1997 was used in the modelling exercise.

This report details the findings of this desk-based assessment together with a description of the Dispersion Model used.

2.0 SAMPLING METHODOLOGY

The site was visited by Environmental Consultants from Bord na Móna Environmental Limited on the 31st of January 2000 for the purpose of sampling odour emissions from the existing sewage treatment works. The following locations were chosen and identified as being the most likely sources of odour emissions.

1. Inlet Works
2. Aeration Tanks (x 2)
3. Settlement Tanks (x 2)
4. Sludge Dewatering Building
5. Sludge Storage Skips (x 2)
6. Sludge Storage Skip during emptying
7. Sludge Holding Tank

2.1 Olfactometry

Samples of gas of approximately 80 - 100 litres were collected via Teflon tubing into Tedlar® gas sampling bags by means of the "lung principle" method. Using this method, the sample bag is housed in a sealed carbuoy that is evacuated using a small air pump. The volume of air removed from the carbuoy is replaced by sample gas entering the bag, thus avoiding contamination of sample by pumps or meters. Sampling was carried out in accordance with German Standard Method VDI 3881 (1987).

Samples from the locations without outward flow were taken using a Lindvall box. This device consists of a stainless steel rectangular box that is open at one side and is used to cover an area of 0.333 m^2 of the emitting surface. Using a fan and an activated carbon filter, odour-free air is passed through the box to simulate wind movements across the surface (i.e. wastewater). Analysis of the samples collected at the outlet of the box in conjunction with the box dimensions and windspeed generated allows calculation of the odour emission rate per unit area from the surface. Consideration of the total surface area of the source allows calculation of the total odour emission rate from each source.

The samples were analysed by Dynamic Olfactometry. The instrument used was an Olfactomat-e Olfactometer (Project Research Amsterdam) and the analytical procedures were in accordance with the CEN Standard TC264 (1999) using a trained panel of 8 assessors. The odour concentration of the sample is expressed in odour units per cubic metre of gas (ou/m^3). These values, sometimes referred to as "dilutions to threshold" are equivalent to the number of times the sample gas required dilution with odour free air to reach the panels odour threshold (i.e. the concentration at which there is a 50% probability of the panelists detecting the odour).

2.2 Control Chain Of Custody

As part of the Quality System in place at Bord na Móna, Environmental Limited, measures are taken to ensure controlled chain of custody. An outline of the chain of custody is given overleaf.

2.3 Quality Control

The Environmental Laboratory complex has been awarded ILAB accreditation by the ILAB secretariat. A stringent six point quality control approach is at present implemented in the laboratories.

(i) Controlled chain of custody.

(ii) Operator competence - all analysts must be suitably qualified to carry out the required analysis.

(iii) Certified Reference Materials (CRM). The accuracy of a series of determinations is checked against known standards.

(iv) Duplicate - 10% duplication is normal.

(v) Quality Control Charts.

(vi) Inter Laboratory Testing - The Environmental Limited Laboratories are members of the WASP Interproficiency Testing Scheme and the W.R.C. Aquacheck Scheme. The Laboratory also participates in the Environmental Protection Agency's Intercalibration Programme and is listed on the Agency's Draft Register of Quality Approved Testing Laboratories for 1999/2000.

BORD NA MÓNA

BORD NA MÓNA ENVIRONMENTAL LIMITED

CONTROLLED CHAIN OF CUSTODY

SITE		TRANSPORT		LABORATORY
Sampling and packaging of all samples were carried out by Bord na Móna Technical Team: Mr. John Conway, Ms Lisa Blyth	Transport Document Form →	Transport to laboratory by Bord na Móna Technical Team.	Sample Reception Form →	Receiving of samples at Bord na Móna Environmental Laboratory complex by: Dr. J. Reilly, Laboratory Manager (Secure laboratory complex access to authorised personnel only) ↓ Storage of all samples for 1 month period after report issue. ↓ Supervised Disposal

3.0 DISPERSION MODELLING DESCRIPTION

The Industrial Source Complex Short-Term 3 (ISCST3) model provides options to model emissions from a wide range of sources that may be present at typical industrial facilities.

The basis of the model is the straight-line, steady-state Gaussian plume equation, which is used with some modifications to model simple point source emissions from stacks that experience the effects of aerodynamic downwash due to nearby buildings, isolated vents, multiple vents, storage piles, conveyor belts, and the like. Essentially, emission sources are categorised into four basic types of sources, i.e., point sources, volume sources, area sources, and open pit sources.

The ISCST3 Model accepts hourly meteorological data records to define the conditions for plume rise, transport, diffusion, and deposition. The model estimates the concentration or deposition value for each source and receptor combination for each hour of input meteorology, and calculates user-selected short term averages.

3.1 Terrain Description

For the purpose of this modelling assessment elevated terrain data was used. The terrain heights ranged from 46 meters to the north of the STW's to 61 meters to the south.

3.2 Sources

Practically all odour sources at a treatment works are situated in the open air, usually with no cover and no outward flow. The sources at the existing Mallow STW's can be classified as area or volume sources.

3.2.1 Area Sources:

Tanks are typically modelled as area sources. In order to take a representative air sample from these sources a portable wind tunnel sampling device known as a Lindvall box is used. The principal of the wind tunnel system is that controlled 'odour free' air (filtered through an activated carbon device) flows over the water surface body absorbing any odours from the surface. The odour emission rate is defined as the quantity of odour emitted per m^2 of surface area per unit of time. The aeration, settlement tanks and the sludge holding tank were all modelled as area sources.

The sludge storage skips are another significant odour source at the treatment works. Since the odour emission has no outward gas flow they are also modelled as an area source. Calculation of the odour emission rate (OER) is based on typical ambient wind speed values.

3.2.2 Volume Sources:

The sludge from the thickening and holding tanks is dewatered by belt filter presses housed in the sludge dewatering building. This building is another significant odour source at the site. Building sources are generally modelled as volume sources. In such cases the odour emission rate is based on the general ventilation rate from the buildings. This is dependent on operational conditions (opening of doors) and ambient wind speeds.

The final significant source at the site; the inlet works were also modelled as a volume source. As in the case of the storage skips above, a general ambient wind speed has been assumed.

3.2.3 Point Sources:

As part of the improvements during the proposed expansion works the sludge dewatering building will be enclosed with the foul air being treated with an odour control unit. The outlet of this unit is modelled as a point source.

When one or more buildings in the vicinity of a point source interrupt wind flow, an area of turbulence known as a building wake is created. Pollutants emitted from a relatively low level (e.g. a roof vent or a short stack) can be caught in this turbulence, affecting their dispersion. This phenomenon is called building downwash. In order to conduct an extensive analysis of downwash effects of the odour control unit outlets, the dimensions of all significant buildings and structures (i.e. sludge dewatering building, the tanks and the odour control unit biofilter) on site were obtained from the site layout drawing in ***Appendix 1*** and inputted into the model.

3.3 Meteorological Data

The meteorological data for the five years from 1993 to 1997 for Cork Airport was obtained from Trinity Consultants. This is the nearest representative station to the STW's. Graphical depictions of the frequency of wind speed and wind direction for each year are included in ***Appendix 3***.

3.4 Receptor Locations

The receptor grid consists of 17 x 13 receptor points spaced 50m apart. The co-ordinates of the receptor grid corners are given below:

NE Corner	(157720, 98290) (Easting, Northing)
NW Corner	(156920, 98290) (Easting, Northing)
SW Corner	(156920, 97690) (Easting, Northing)
SE Corner	(157720, 97690) (Easting, Northing)

The elevations of the 221 receptor grid locations and the 64 boundary receptor grid locations were obtained from both a site drawing provided by the client and a 25" map of the area obtained from the Ordnance Survey. Terrain heights were taken into account for all of the modelling undertaken. Elevations were taken from map contours and bench marks throughout the area of the receptor grid.

4.0 BASELINE DISPERSION MODELLING ASSESSMENT

4.1 Introduction

A detailed modelling assessment of odour emissions from the existing sewage works was carried out to determine the baseline impact prior to any expansion.

4.2 Source Input Data

Table 4.2.1 below details the most significant odour emissions at the site.

TABLE 4.2.1: Existing Source Input Data

Source	Source Type	Odour Conc. (ou/m^3)	OER ($ou/m^2/s$)	OER (ou/s)
Inlet Works	Volume	58	-	0.0696
Aeration Tank (x2)	Area	<10	0.6	-
Settlement Tank (x2)	Area	<10	1.0	-
Sludge Dewatering Building	Volume	86	-	34.818[1] 20.89[2]
Sludge Storage Skip (x2)	Area	415	41.5	-
Sludge Storage Skip During Emptying Process	Area	2,573	257.3	-
Sludge Holding Tank	Area	<10	2.387	

OER – Odour Emission Rate

Note: The sludge dewatering building was modelled under two different scenarios as follows:

1. Door open - The door is usually left open for 1 hour during the day for access purposes.
2. Door closed – When the door is closed the foul air in the building essentially escapes via the sludge filter press conveyor and the number of air change reduces significantly.

4.3 **Dispersion Modelling Results**

Table 4.3.1: Predicted Maximum Ground Level Odour Concentrations			
Year	**99.5 Percentile of 1-hour Average Odour Concentration (ou/m³)**	**99 Percentile of 1-hour Average Odour Concentration (ou/m³)**	**98 Percentile of 1-hour Average Odour Concentration (ou/m³)**
93	22.8	15.7	10.0
94	19.0	11.9	8.1
95	19.9	15.3	9.7
96	29.9	19.9	13.9
97	38.0	25.9	15.9
Location	***Within the site boundary***		

5.0 DISPERSION MODELLING ASSESSMENT OF THE PROPOSED WORKS

5.1 Introduction

The proposed works provide for an increased number of treatment units together with an overall upgrading of the works to ensure that all modifications will result in a reduction of odour emissions. A prequalified contractor under a design/build method of procurement will carry out the final design of the proposed expansion and improvement works. However, the following/similar measures will be taken to reduce the odour emissions:

- The inlet channels including screening equipment will be enclosed/covered
- The screened material and grit will be stored in a covered skip prior to disposal off-site
- The sludge holding tank will be covered and the air extracted via a biofilter control unit
- The dewatering building is already completely enclosed. Fume hoods will be located above the presses to provide a high rate of extraction. Furthermore, an odour control system will be installed providing a general building extraction rate of between 3-6 air changes per hour.
- The sludge storage skips will be covered.

5.2 Source Input Data

Taking into account the mitigation measures outlined above, together with the increased number of units, the input data detailed in Table 5.2.1 overleaf is used to model the Mallow STW's following expansion.

Table 5.2.1: Proposed Works Source Input Data				
Source	Source Type	Assumed Odour Conc. (ou/m^3)	OER (ou/m^2/s)	OER (ou/s)
Inlet Works Storage Skip[1]	Volume	500	-	1.5
Inlet Works [2]	Volume	58	-	0.0696
Aeration Tank (x4)	Area	<10	0.6	-
Settlement Tank (x4)	Area	<10	1.0	-
Sludge Dewatering Building Biofilter Outlet	Point	30	-	17.7
Sludge Storage Skips (x2)[1]	Volume	415	-	1.245
Sludge Storage Skips during emptying[1]	Volume	2,573	-	7.719

OER – Odour Emission Rate

The following assumptions have been made:

1. Since the skips will be covered they are modelled as volume sources.
2. Due to the small volume of the proposed enclosed inlet works the resulting emissions from the odour control unit will be negligible. Subsequently, the covered area was not modelled. However, the exposed grit traps area was modelled using an odour concentration of 58 ou/m^3.
3. The odour emission rates for the aeration tanks and settlement tanks are the same as per the baseline assessment. However, the number of each has increased twofold.
4. The odour measured from the sludge holding tank during the existing assessment was very low and since it will be covered it is not considered necessary to include this as a source for the proposed assessment.
5. The physical specification data for the odour control units are based on Bord na Mona Monashell Biofiltration systems.

5.3 Dispersion Modelling Results

Table 5.3.1: Predicted Maximum Ground Level Odour Concentrations			
Year	99.5 Percentile of 1-hour Average Odour Concentration (ou/m^3)	99 Percentile of 1-hour Average Odour Concentration (ou/m^3)	98 Percentile of 1-hour Average Odour Concentration (ou/m^3)
93	10.6	9.0	6.7
94	11.5	10.0	7.5
95	11.5	9.7	7.5
96	14.1	11.0	9.7
97	17.2	13.3	10.6
Location	*Within the site boundary*		

6.0 DISCUSSION

Odour emissions resulting from the most significant sources within the Mallow Sewage Treatment Works were modelled for each of the 5 years meteorological data from Cork Meteorological Station (1993 – 1997) under two different scenarios. Scenario I represents the baseline assessment of the Sewage Treatment Works prior to the proposed expansion. Scenario II represents the likely impact following the proposed expansion and improvement work. Since 1997 represented the worst case year in terms of dispersion, these results are discussed.

Generally, a combination of low wind speeds and low mixing height (the height above the surface through relatively vigorous mixing occurs) result in the worst case in terms of dispersion. This typically occurs at night with light winds and few clouds or clear skies. The outgoing infrared radiation from the surface cools the ground and the air adjacent to it. This cool air has negative buoyancy and as a result allows for little vertical mixing. These conditions of low wind speed and mixing height (temperature inversion conditions) do not allow for rapid dispersion of ground level emissions.

In the absence of Irish legislation regarding odour emission limits, the Dutch and Danish standards have been adopted as a guideline in this assessment. The policy on odour emission in the Netherlands is the prevention of new nuisance and the application of the ALARA principle (As Low As Reasonably Achievable). Concerning wastewater treatment plants, the following guidelines have been established:

At locations with residential areas, ribbon-development or other odour sensitive objects:

1ou/m^3 as a 98th percentile for new situations
3ou/m^3 as a 98th percentile for existing situations

At locations with scattered houses, industrial estates or houses at industrial areas:

2ou/m^3 as a 98th percentile for new situations
7ou/m^3 as a 98th percentile for existing situations

The odour abatement policy in Denmark is based upon the guidelines issued in 1985 by the Danish Environmental Protection Agency; 'Guidelines for the Abatement of Odour Pollution'. The guidelines prescribed that the calculated ground level concentration should not exceed 0.6-1.2ou/m^3 as a 99th percentile (1-hour averaging period) depending on the location of the source (residential or urban).

Note: 99 percentile concentrations indicate that the odour concentrations along the contours are as indicated or less for 99% of the year (i.e. exceeded for only 88hrs/year)).

Based on these guideline limits, the 98, 99 and 99.5 percentile analysis for odour emissions from the plant were calculated for the maximum 1-hour averages using the ISCST3-PERCENT post-processing utility. This utility determines the maximum concentration of a pollutant from all receptors at a specific percentile, for a specific averaging period. Employing the percentile facilitates the omission of unusual short term meteorological events that may cause elevated pollutant concentrations and hence a more accurate representation of the likely average pollutant concentrations over an averaging period. All isopleth plots of the percentile concentration values are presented in *Appendix 2*.

6.1 Existing Baseline Assessment

Table 4.3.1 in Section 4.0 presents the results of the impact assessment of odour emissions from the existing sewage treatment works. Figures 3 to 5 represent the 99.5, 99 and 98 percentile analysis respectively, of the 1-hourly average ground level odour emissions for Scenario I. Examination of each plot demonstrates the following maximum odour concentrations at the boundary and nearest residences:

Table 6.1.1: Maximum Ground level Odour Concentrations at the Boundary and Nearest Residences

Percentile	Maximum Odour Concentrations at the:				
	Northern Boundary	Western Boundary	Southern Boundary	Eastern Boundary	Nearest Residences
99.5 Percentile	21.0	4.0	13.0	16.0	5.0
99 Percentile	14.0	2.7	10.5	9.5	3.8
98 Percentile	9.4	1.6	7.8	6.0	2.0
Dutch 98 Percentile Guideline Value	-	-	-	-	*3*

Contributors to these odour concentrations are predominantly the two aeration tanks, the two settlement tanks and the sludge storage skips.

Notwithstanding these levels it is contended that the odours associated with the aeration and settlement tanks, are not likely to impact negatively. The actual odour emission rates measured on the day were well within the typical ranges for both treatment parts (aeration tanks were measured at 0.6ou/m^2/sec, while the settlement tanks were measured at 1ou/m^2/sec). Concentrations of 0.2-5ou/m^2/sec are typical of values associated with a fully functional aeration system operating at optimum performance*. The range is slightly higher for settlement tanks (1-6ou/m^2/sec).

Most importantly, it should also be noted that because of their large surface area these tanks do sometimes contribute considerably to the overall odour emission of the plant and therefore also to the immission concentration calculated. In this way, the degree of odour nuisance may be over estimated. **However, these odours are not in general experienced as being a nuisance.** It is suggested that 'odour emissions of these parts could be considered a locally raised background concentration' with a character 'similar to that' of natural (and not disagreeable) sources'.

Concerning the other significant odour source at the works, i.e. the sludge storage skip, it is suggested that covering of same will substantially reduce the odour emissions therein.

Whilst the Danish and Dutch guidelines suggest odour concentration norms for residential areas of 0.6-1.2ou/m^3 as a 99th percentile (1-hour averaging period) and 3ou/m^3 as a 98th percentile, respectively, it is generally perceived that outside the laboratory environment the recognition threshold is generally about 5 times this concentration range (5ou/m^3). Moreover, it is generally accepted that odour concentrations of between 5 and 10ou/m^3 give rise to a faint odour only, and that only a distinct odour (concentration greater than 10ou/m^3) gives rise to a nuisance. Therefore, an increase of greater than 10ou/m^3 above baseline as a result of on-site activity has the potential to create a persistent nuisance.

The results of modelling Scenario I demonstrate that the odour emissions from the existing sewage treatment works will result in ground level odour concentrations less than 10ou/m^3 (98 Percentile) above baseline anywhere along the boundary, and more importantly less than 3ou/m^3 (98 Percentile) above baseline at the nearest sensitive location.

In summary, on comparison with the relevant Dutch guidelines on immission concentrations for wastewater treatment plants (Table 6.1.1) the 98 percentile value is within the recommended guideline.

*Assessment of odour emissions from sewage treatment plants. T. Graafland and Associates.

6.2 Assessment of the Proposed Improvement Works

Table 5.2 in Section 5.0 presents the results of the impact assessment of odour emissions from the sewage treatment works following the expansion and improvement works. Figures 6 to 8 represent the 99.5, 99 and 98 percentile analysis respectively, of the 1-hourly average ground level odour emissions for Scenario II. Examination of each plot demonstrates the following approximate maximum odour concentrations at the boundary and nearest residences:

Table 6.2.1: Maximum Ground level Odour Concentrations at the Boundary and Nearest Residences

Percentile	Maximum Odour Concentrations at the:				
	Northern Boundary	Western Boundary	Southern Boundary	Eastern Boundary	Nearest Residences
99.5 Percentile	10.5	6.5	12.0	8.0	5.0
99 Percentile	8.0	5.0	10.5	5.0	3.0
98 Percentile	5.5	2.5	7.6	2.6	1.4
Dutch 98 Percentile Guideline Value		-	-	-	*1*

On comparison with the baseline assessment (Table 6.1.1), it is clearly evident that the proposed works are predicted to reduce odours experienced at both the northern and eastern site boundaries by approximately 40 – 60%. For example, the reduction on the eastern side is predicted to be from 6.0ou/m^3 to 2.6ou/m^3 (98 percentile of the 1-hour average odour concentration). This is a direct result of an overall increase in efficiency at the works, together with the introduction of odour abatement systems, particularly in relation to the sludge skips. On comparison with the baseline assessment the impact from the sludge skips has been reduced significantly.

Again, the main contributors to the ground level concentrations are the aeration and settlement tanks due to their large surface areas. Due to a twofold increase in the number of these tanks there may be an increase in the predicted odour concentrations at the western side of the boundary. However, notwithstanding this increase it is noted that the concentrations are insignificant (i.e. less than 3.0ou/m^3 as a 98 percentile of the 1-hour average odour concentration) and are unlikely to create a nuisance.

Furthermore, as alluded to previously, the odour emission rates are well within the typical ranges and are indicative of these components working efficiently. In any event, this odour, in practice, is not experienced as unpleasant, in comparison to the odours arising from the sludge.

In summary, on review of Table 6.1.2 above it is evident that predicted ground level odour concentrations of 8ou/m^3 (98 Percentile) above baseline may occur anywhere along the boundary and more importantly predicted ground level concentrations of 1.4ou/m^3 (98 percentile) may occur at the nearest odour sensitive location. However, taking into consideration the previous discussion in relation to character of odour particularly from the aeration and settlement tanks, it is contended that odour emissions generated at the proposed Mallow STW's are unlikely to result in odour nuisance.

Finally, on comparison with the baseline assessment, it is clearly evident that the proposed upgrading and expansion of the Mallow STW's will improve the air quality around the works, and the resulting odour concentrations will not have an adverse effect on the surrounding environment.

Appendix 1

Site Location Map and Receptor Grid

FIGURE 1

MALLOW SEWAGE TREATMENT WORKS

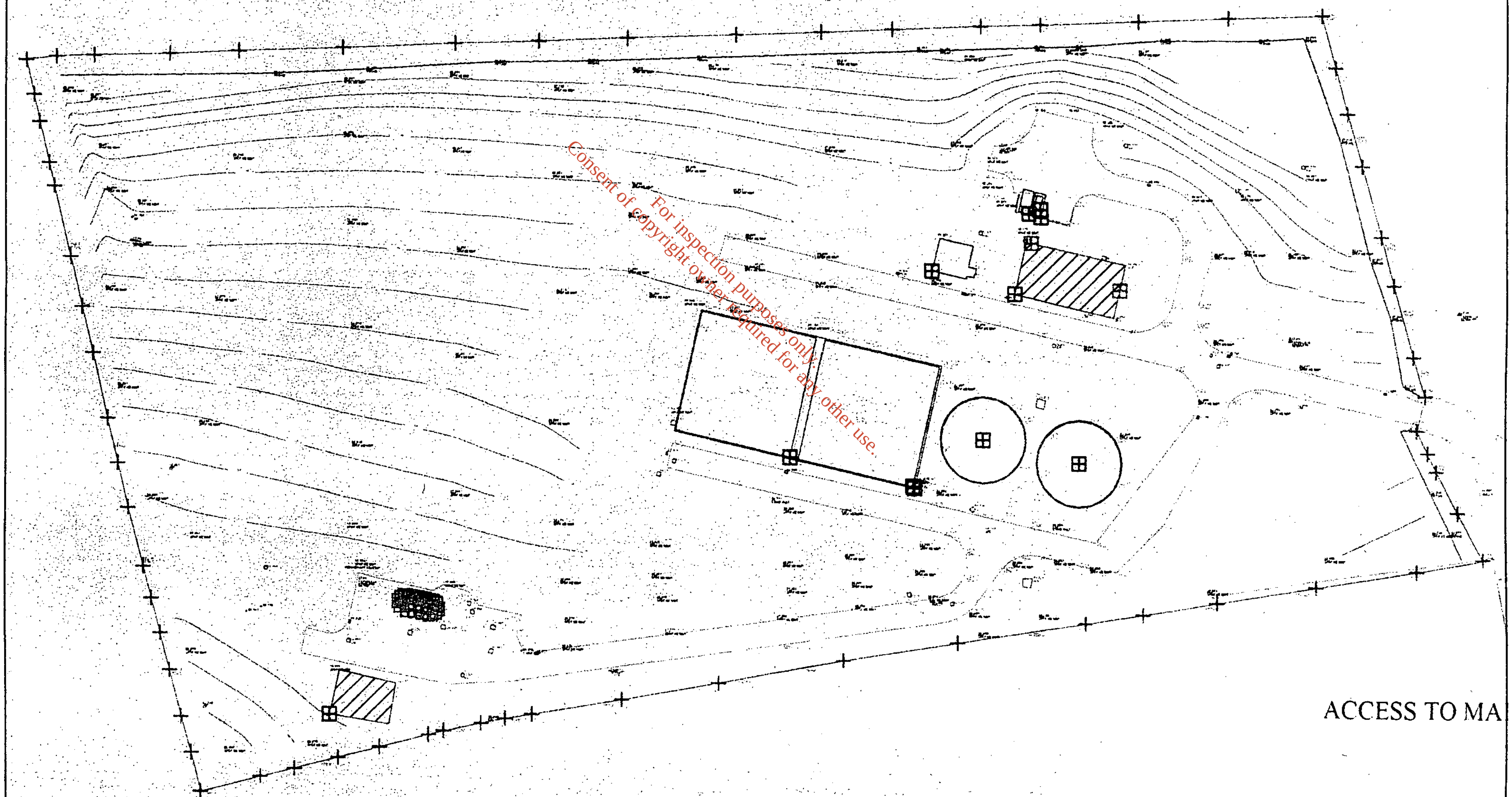
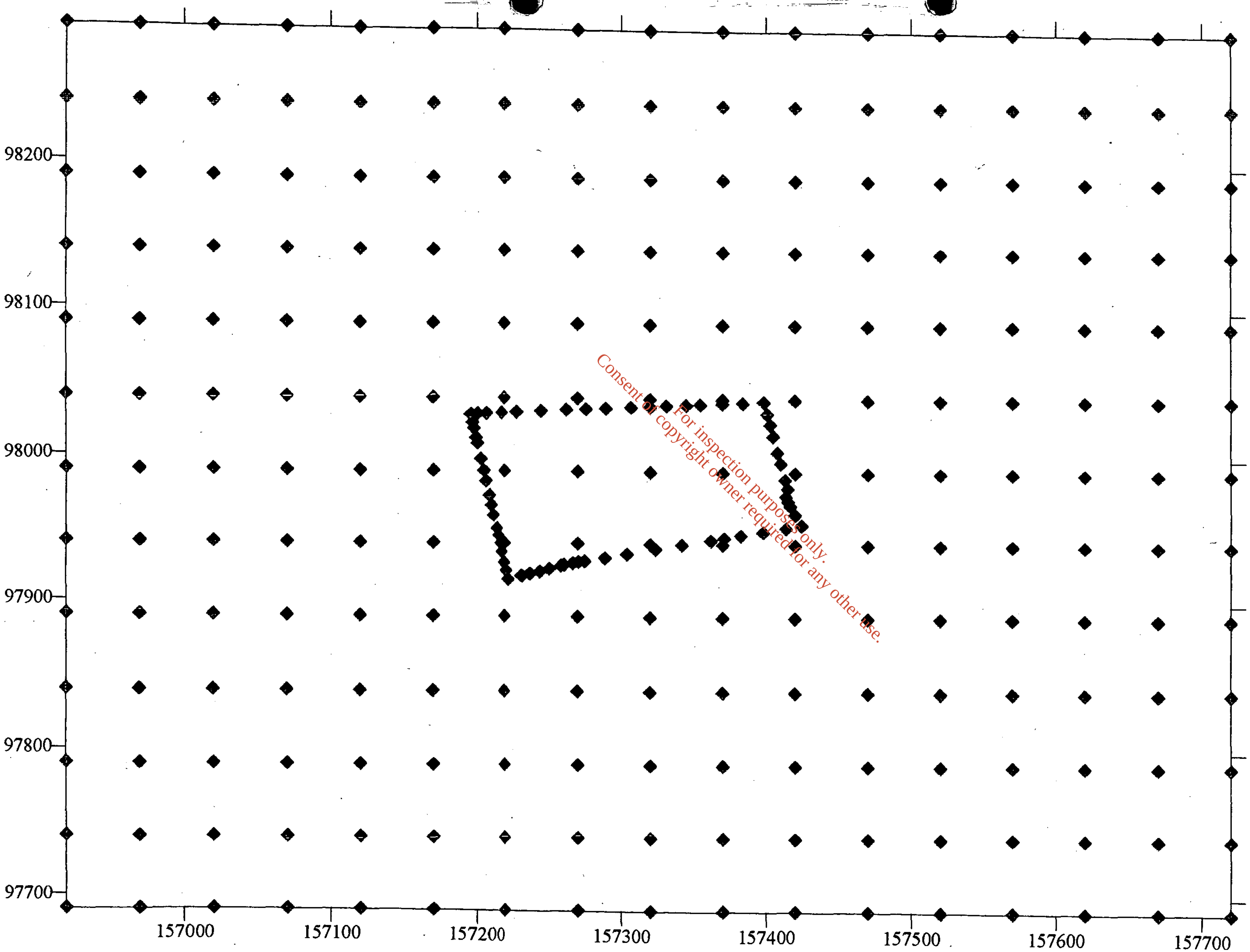


FIGURE 2: MALLOW STW'S RECEPTOR LOCATIONS



Appendix 2

Isopleth Plots

Rural PLACE Map

Revised 1932
Lev... 1932

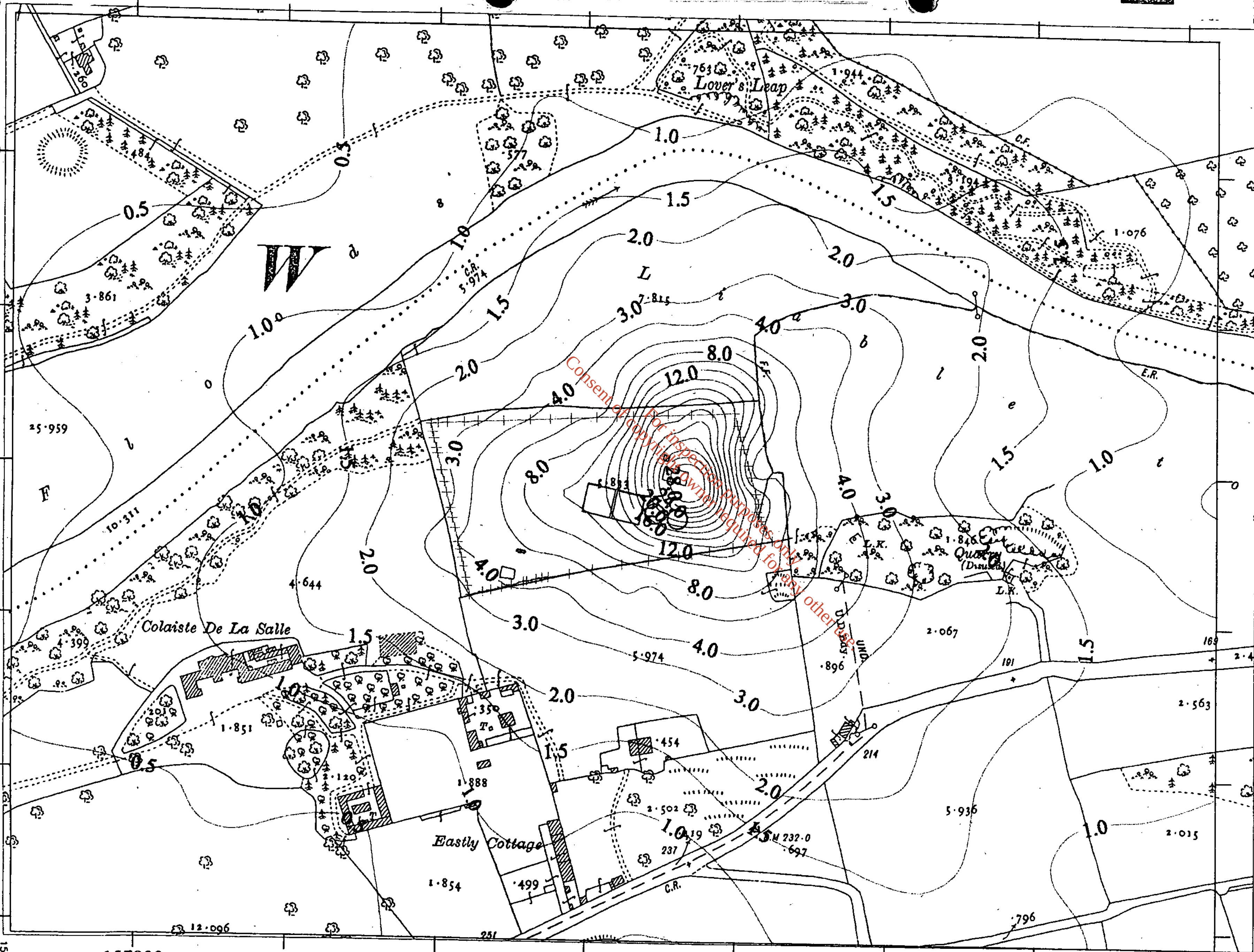


Figure 3:

99.5 Percentile Analysis of the 1-Hrly Average Ground Level Odour Conc's as a Result of the Emissions from the Existing Mallow STW's. (ou/m**3)

DESCRIPTION

ORDNANCE SURVEY IRELAND ©

MAP SCALES

25inch
CK033-06

Ordnance Survey Ireland

Suirbhéireacht Ordanáis Éireann, Páirc an Fhionnuisce, Baile Átha Cliath a thiomsaigh, a chuir i gcló agus a d'fhoilsigh.

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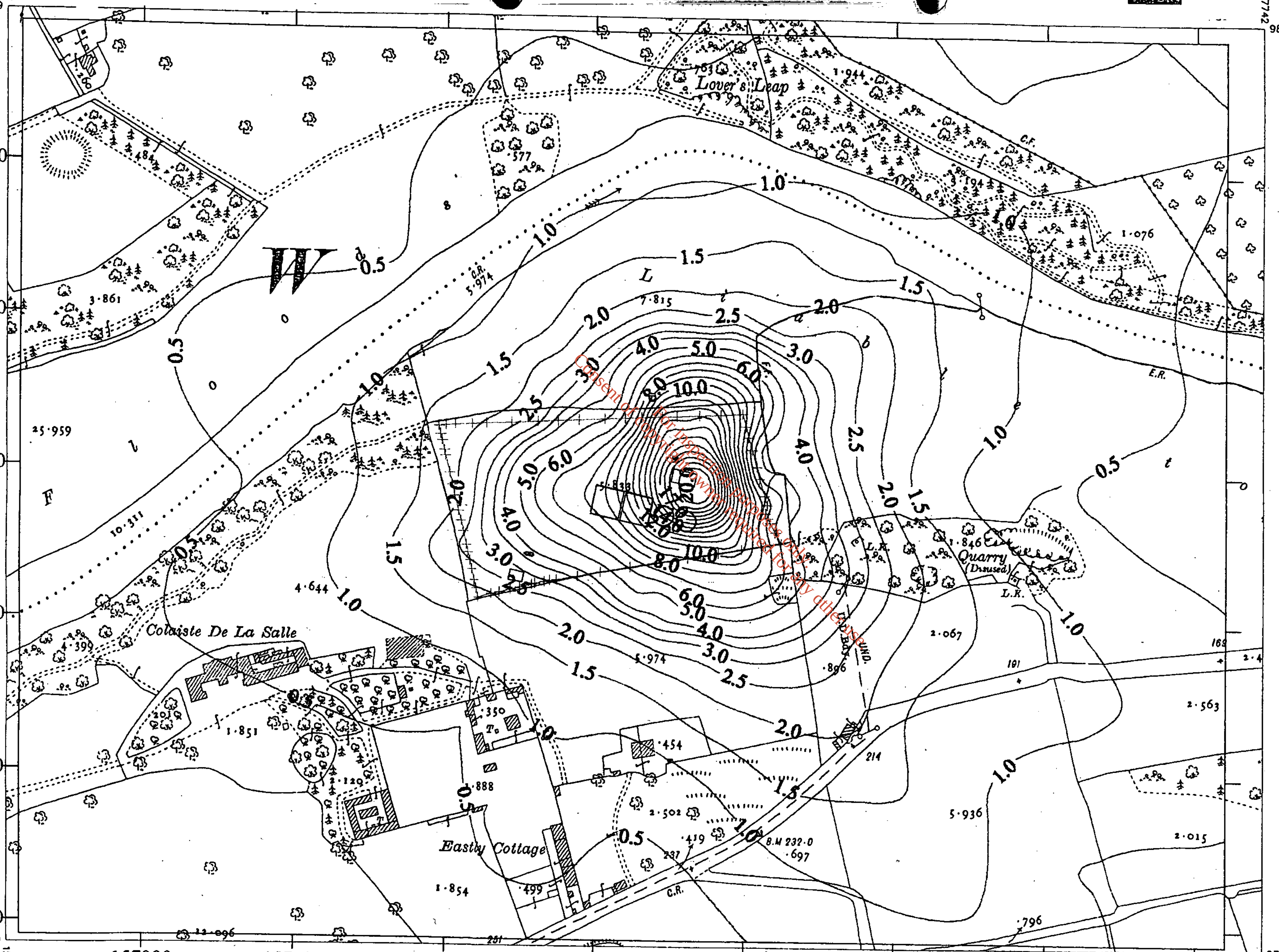
Scale:- 1:2500
Scála:- 1:2500

Plot Ref. No. 13236870_5
Plot Date 04-FEB-2000

Rural PLACE Map

Revised 1932
Level[illegible] 1932



25inch
CK033-06

Figure 4:

99 Percentile Analysis of the 1-Hrly Average Ground Level Odour Conc.'s as a Result of the Emissions from the Existing Mallow STW's. (ou/m**3)

Ordnance Survey Ireland

Scale:- 1:2500
Scála:- 1:2500

Plot Ref. No. 132368_1_5
Plot Date 04-FEB-2000

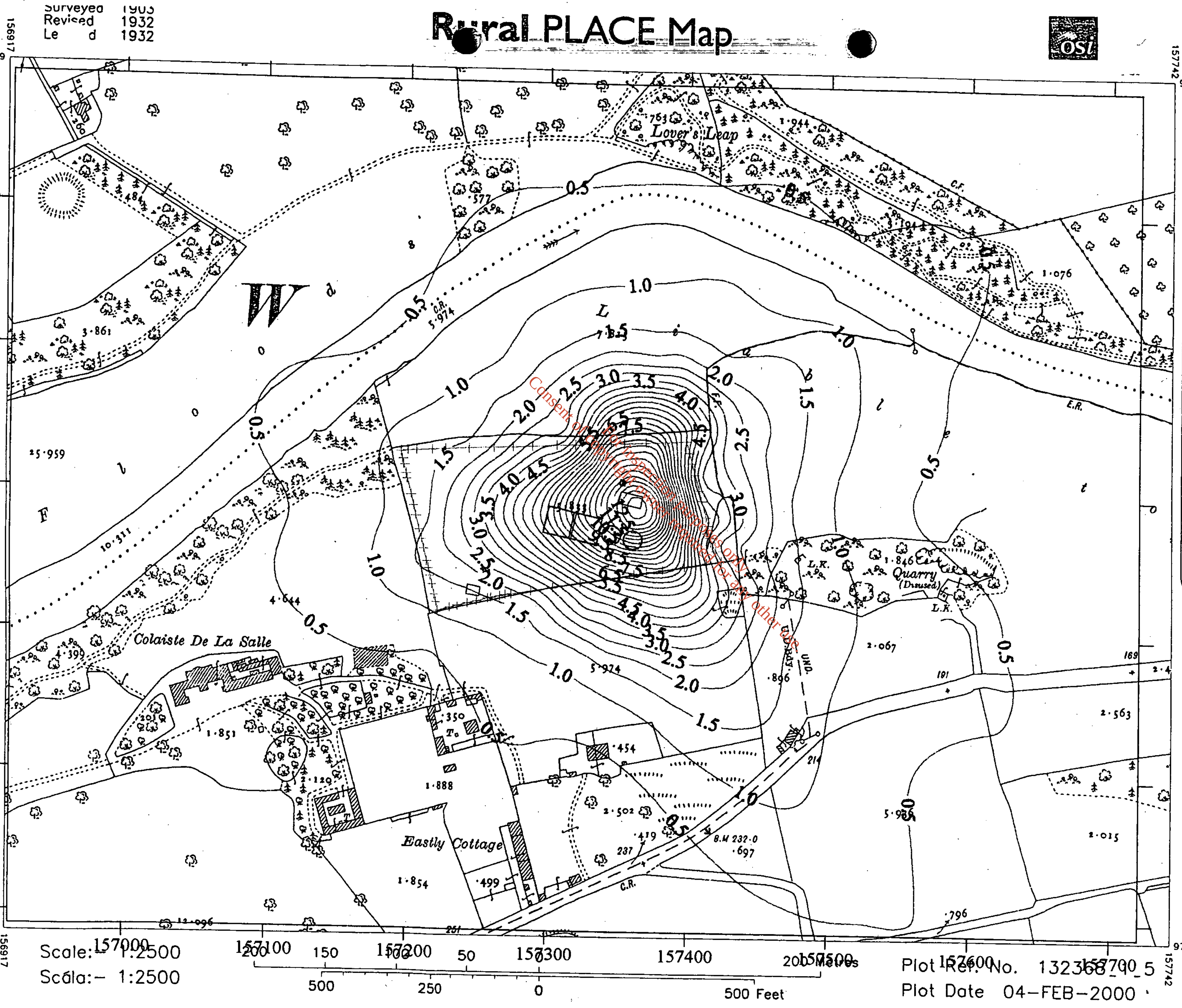


Figure 5:

98 Percentile Analysis of the 1-Hrly Average Ground Level Odour Conc.'s as a Result of the Emissions from the Existing Mallow STW's. (ou/m**3)

DESCRIPTION

ORDNANCE SURVEY IRELAND ©

MAP SCALES

25inch
CK033-06

Ordnance Survey Ireland

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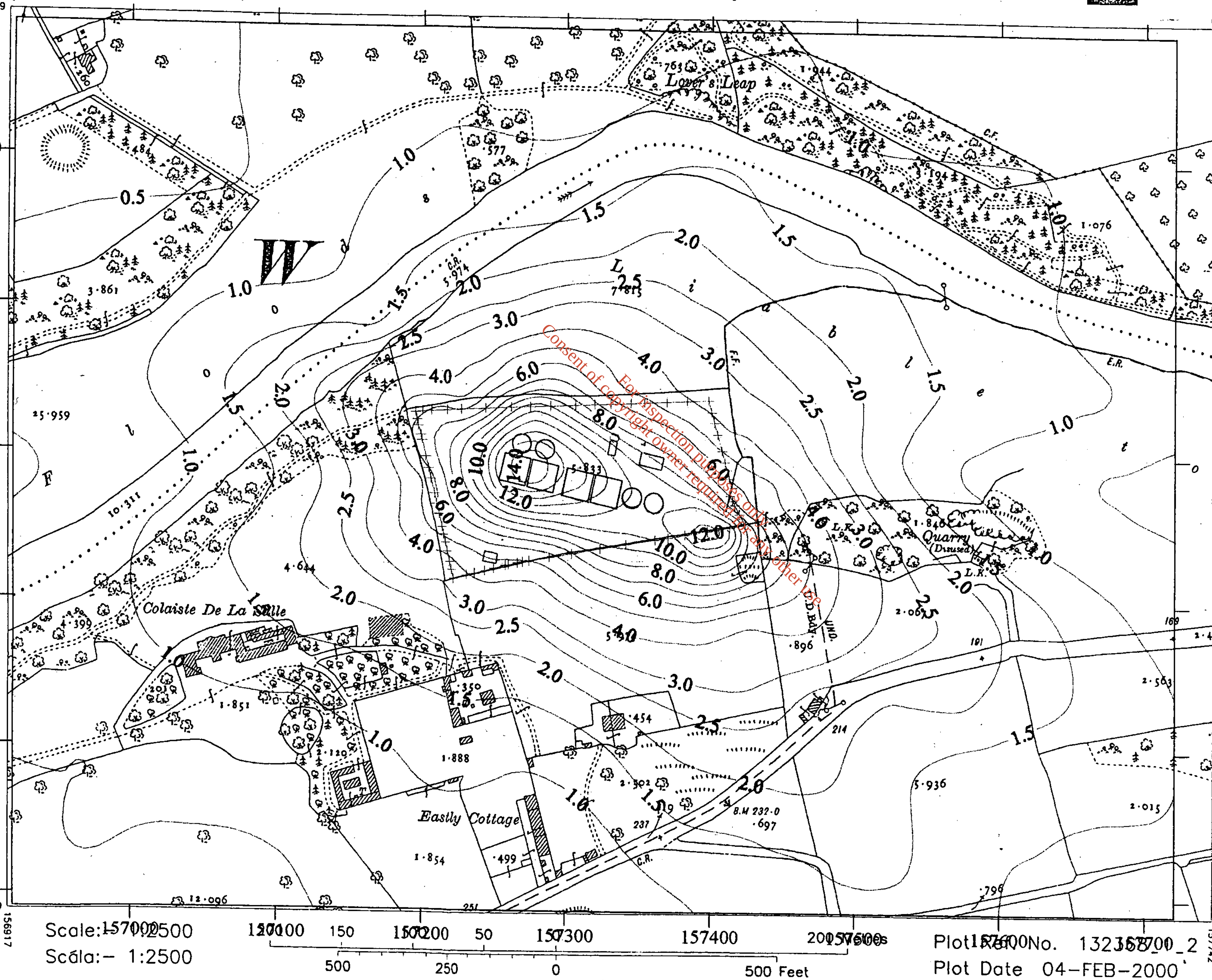
Surveyed 1903
Re..ed 1932
L...ed 1932

Rural PLACE Map



25inch
CK033-06

Figure 6:

99.5 Percentile Analysis of the 1-Hrly Average Ground Level Odour Conc's as a Result of the Emissions from the Proposed Mallow STW's. (ou/m**3)

Ordnance Survey Ireland

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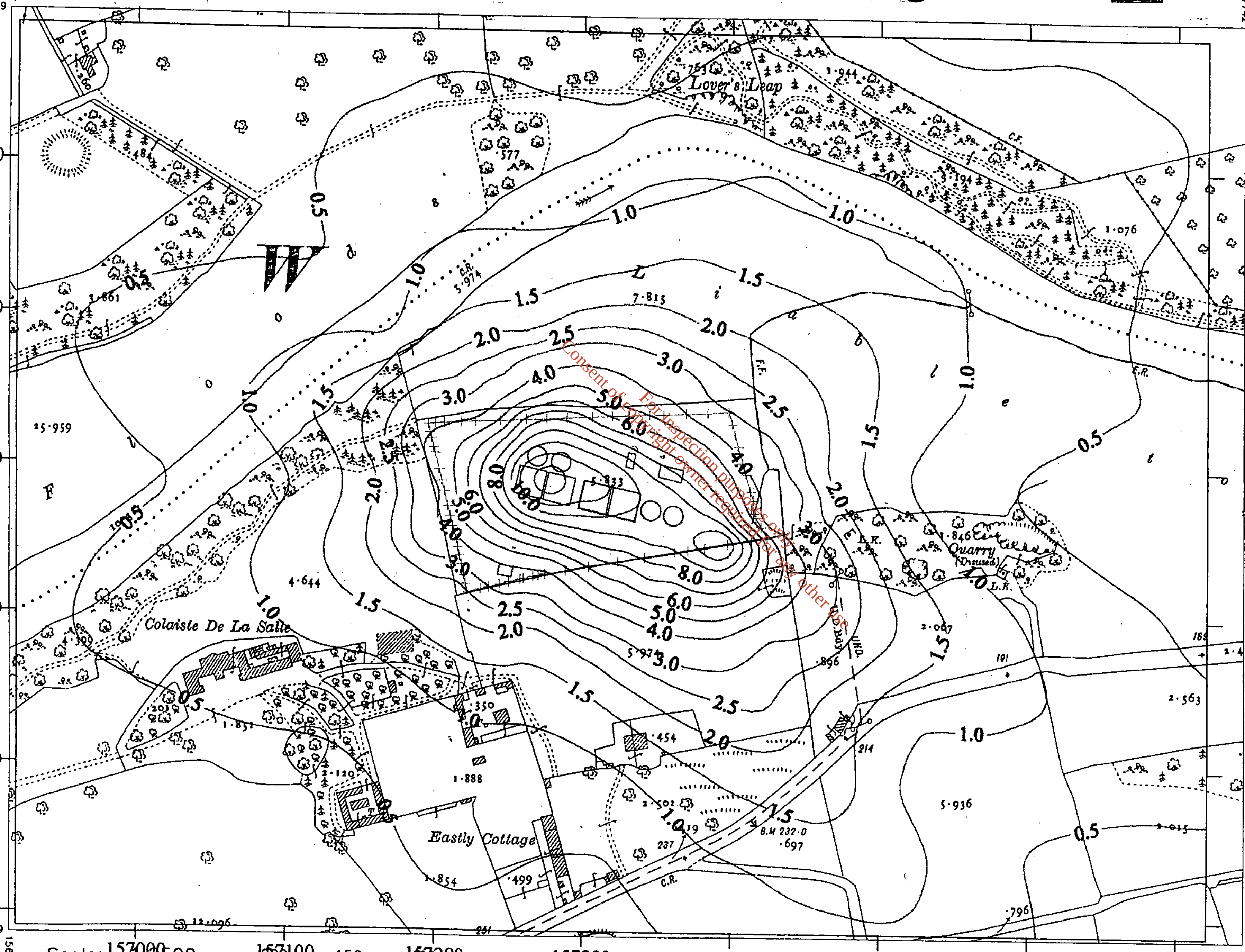
Scale:- 1:2500
Scála:- 1:2500

Plot Ref No. 132358700_2
Plot Date 04-FEB-2000

Rural PLACE Map

Surveyed 1903
Revised 1932
Levelled 1932



DESCRIPTION

ORDNANCE SURVEY IRELAND ©

MAP SCALES

25inch
CK033-06

Figure 7:

99 Percentile Analysis of the 1-Hrly Average Ground Level Odour Conc's as a Result of the Emissions from the Proposed Mallow STW's. (ou/m**3)

Ordnance Survey Ireland

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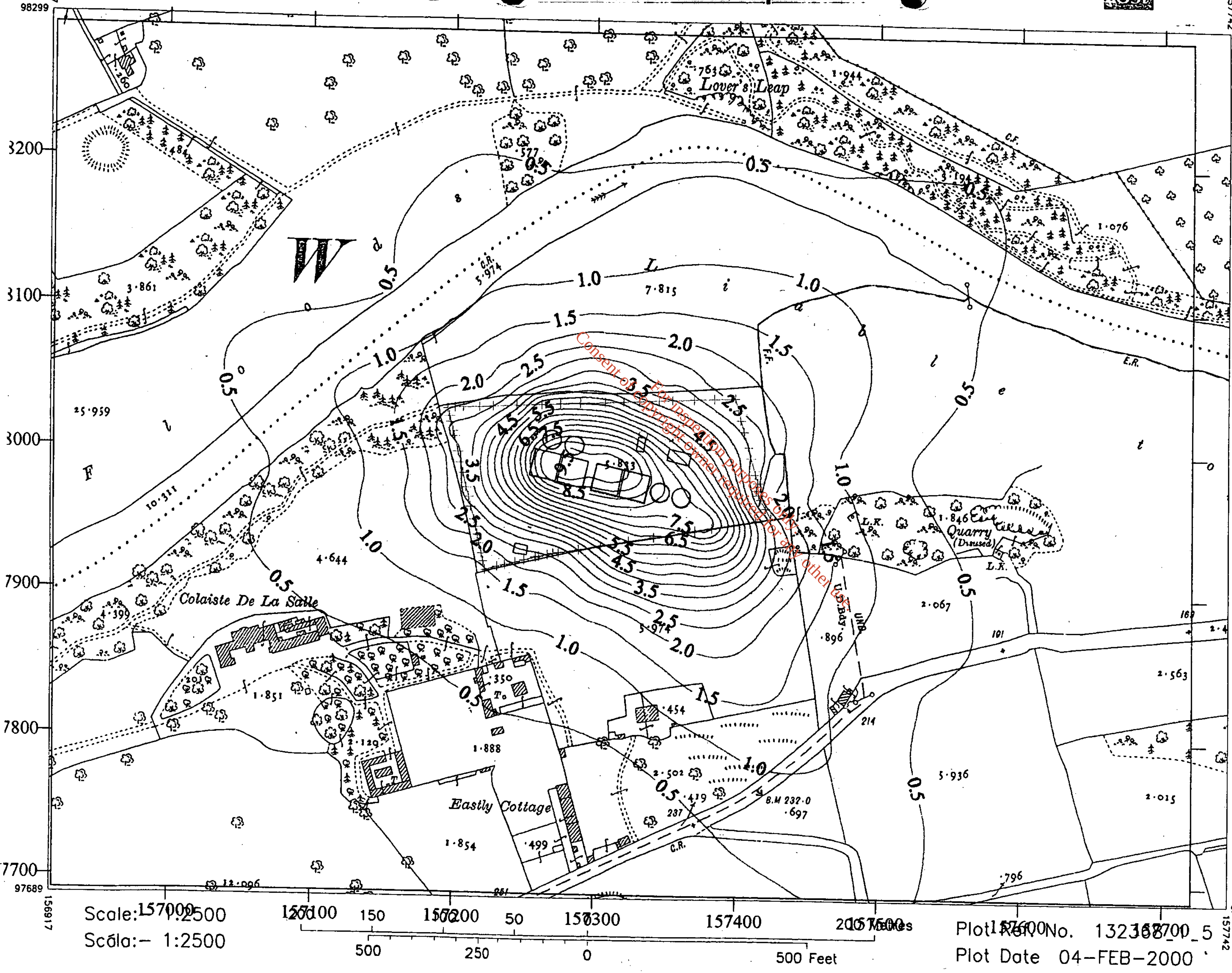
Scale:- 1:2500
Scála:- 1:2500

Plot Ref. No. 1323687_1_5
Plot Date 04-FEB-2000

Rural PLACE Map

Surveyed 1905
Revised 1932
Levelled 1932



DESCRIPTION

ORDNANCE SURVEY IRELAND ©

MAP SCALE

25inch
CK033-06

Figure 8:

98 Percentile Analysis of the 1-Hrly Average Ground Level Odour Conc.'s as a Result of the Emissions from the Proposed Mallow STW's. (ou/m**3)

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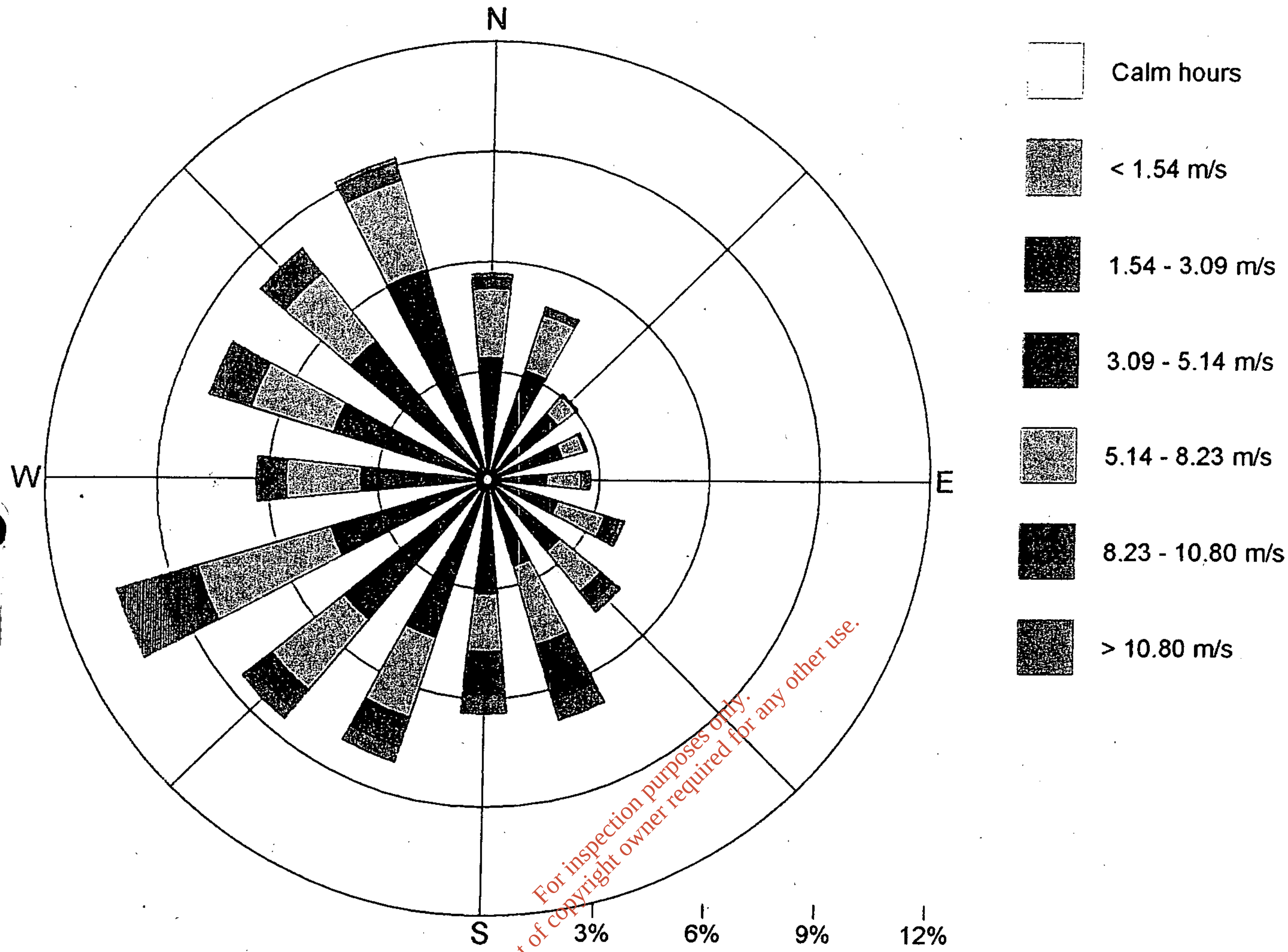
Scale:- 1:2500
Scála:- 1:2500

Plot Ref. No. 132368_1_5
Plot Date 04-FEB-2000

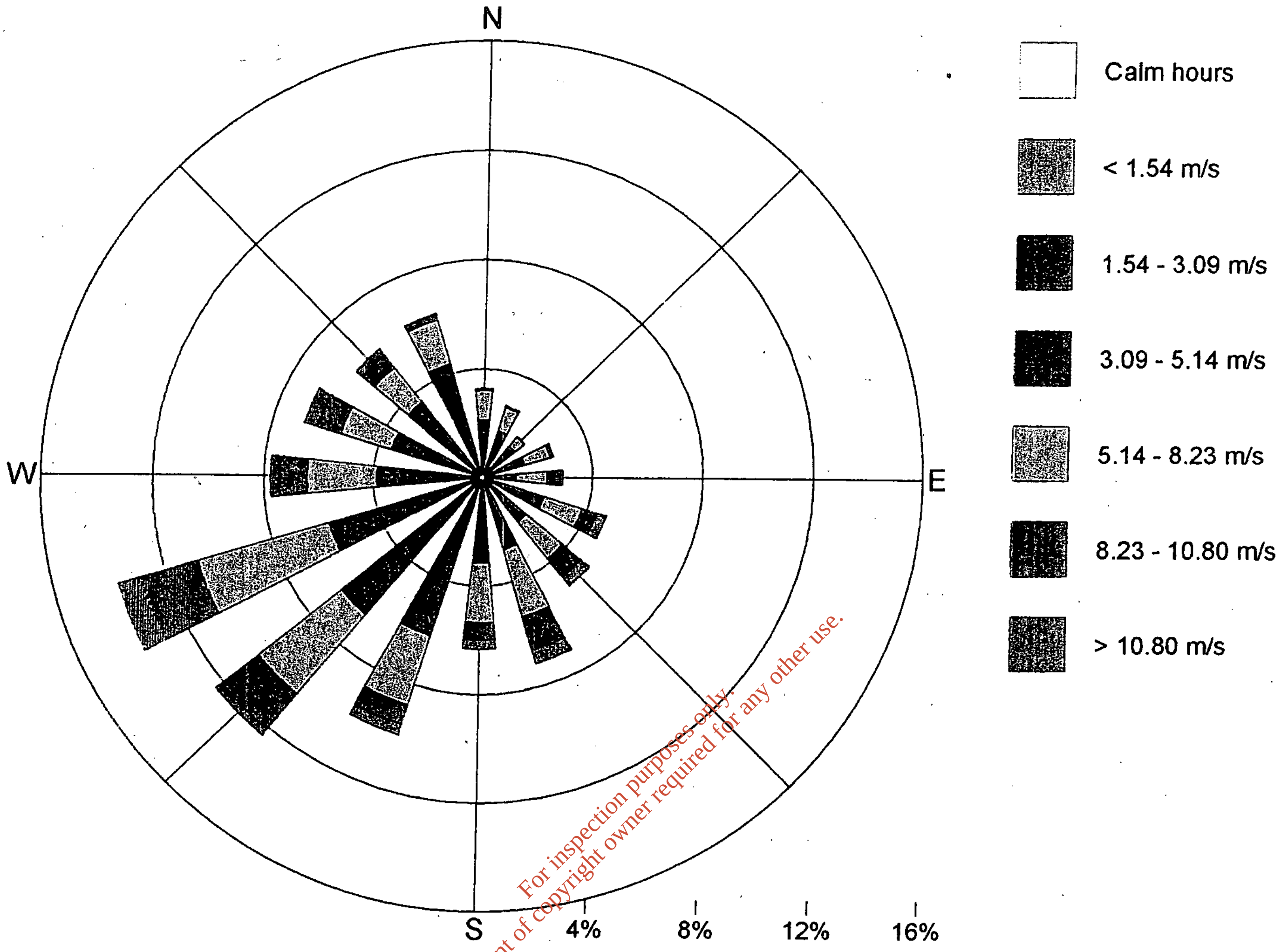
Appendix 3

Windroses for Cork Meteorological Station 1993-1997

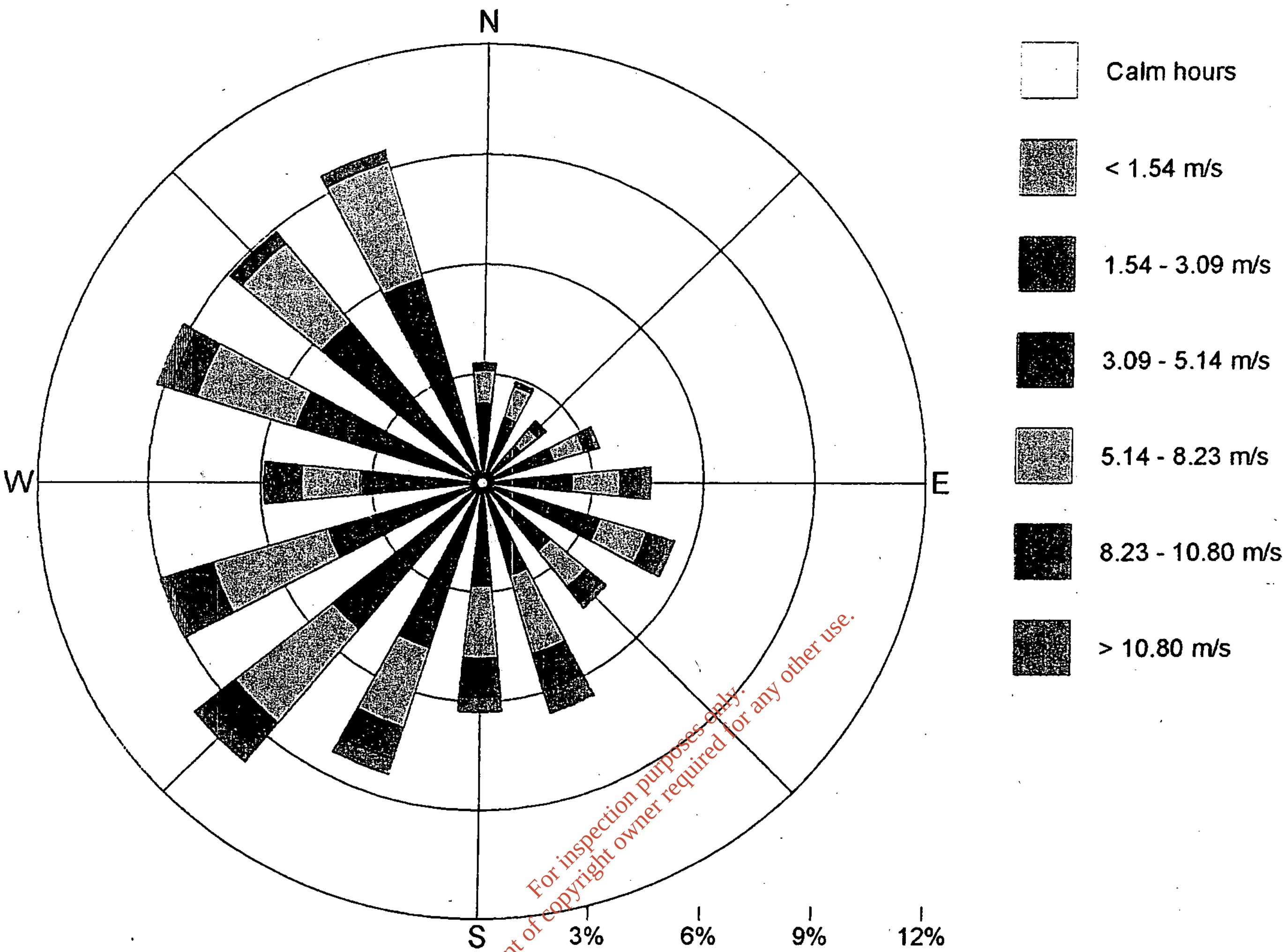
Windrose for Cork Airport Met. Station (1993)



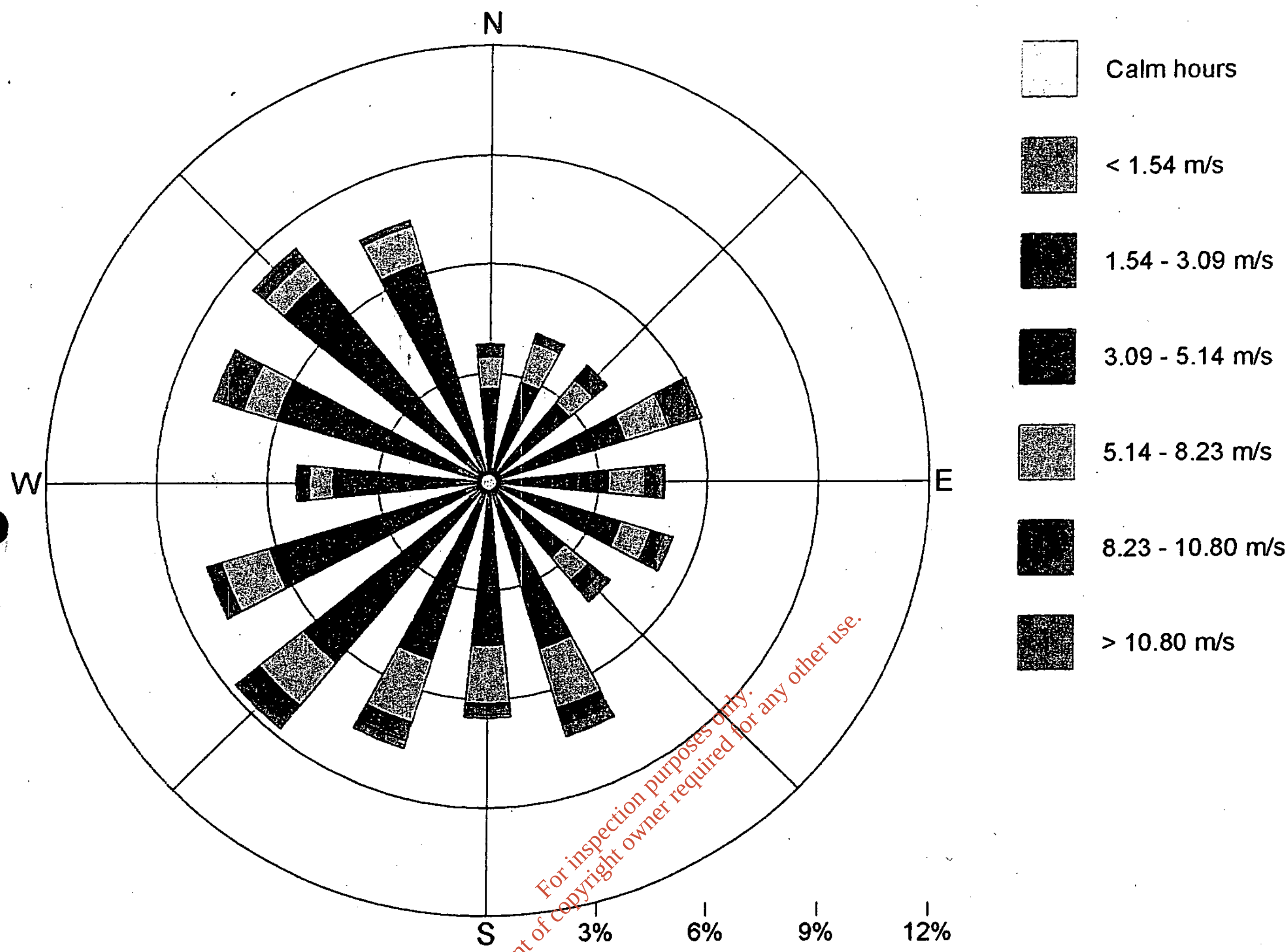
Windrose for Cork Airport Met. Station (1994)



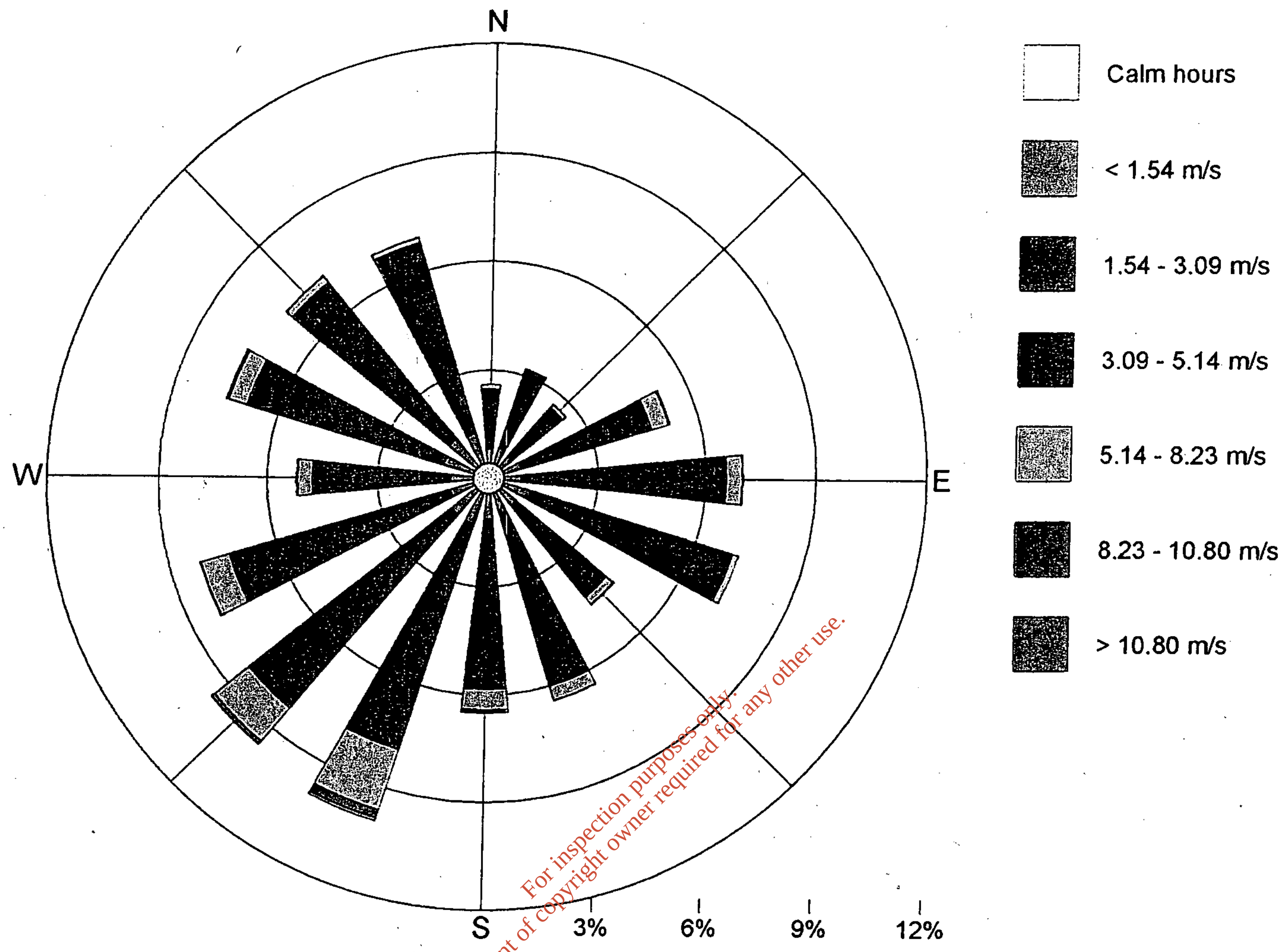
Windrose for Cork Airport Met. Station (1995)



Windrose for Cork Airport Met. Station (1996)



Windrose for Cork Airport Met. Station (1997)



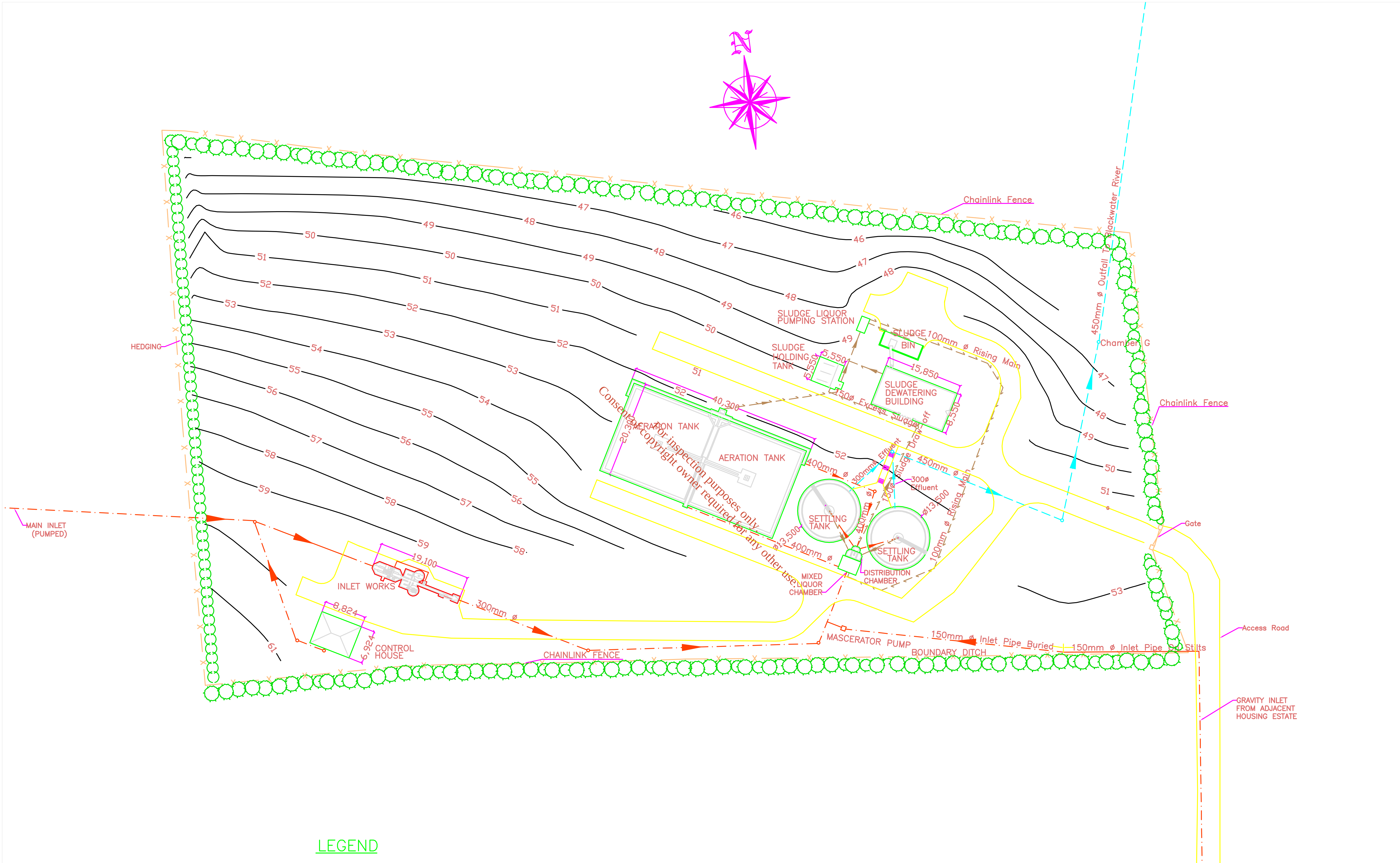
APPENDIX 3

Drawings

L3 Mallow Sewage Treatment Works - Location Map

E3 Mallow Sewage Treatment Works – Existing Site Layout

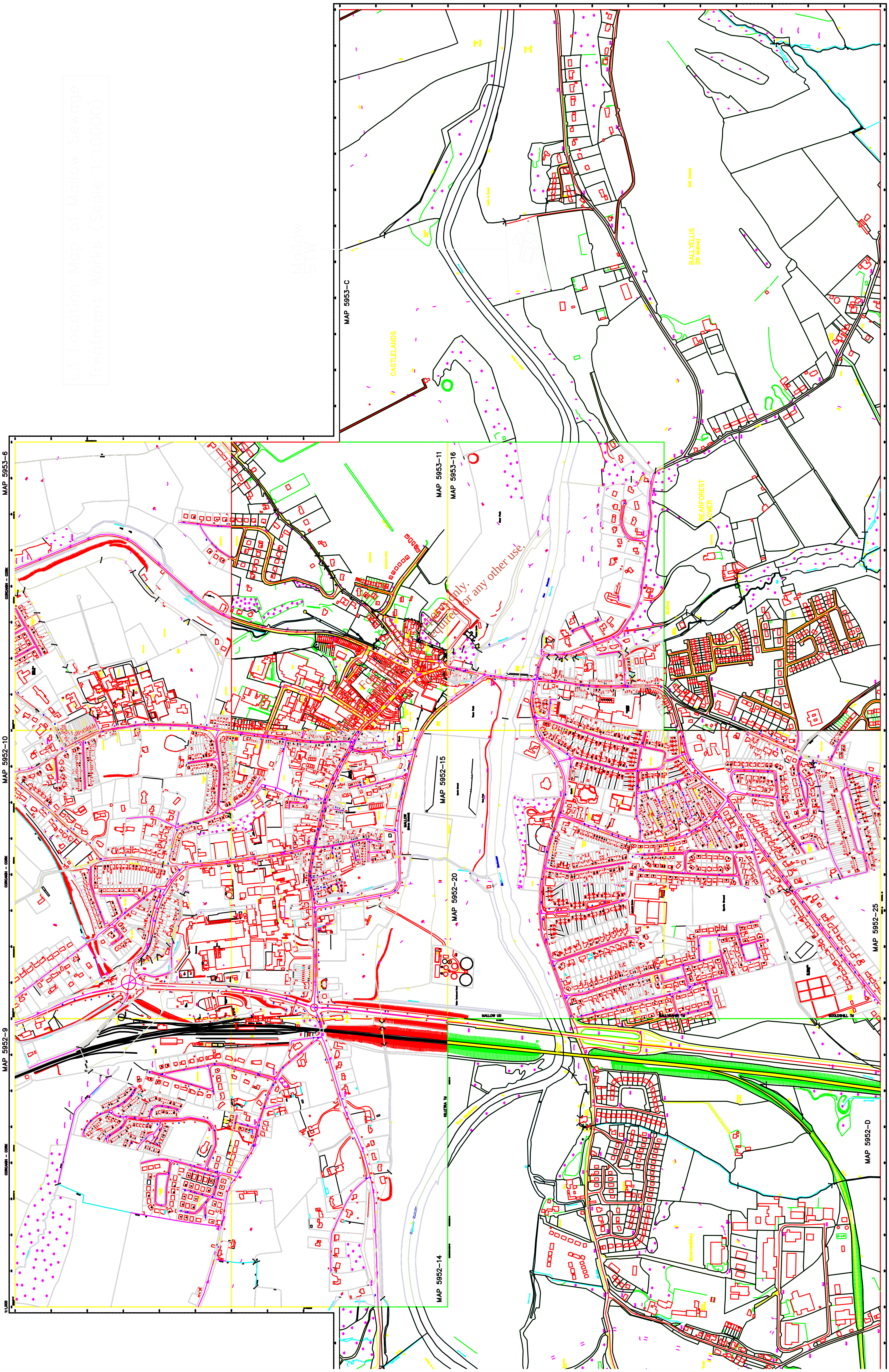
P3 Mallow Sewage Treatment Works – Proposed Site Layout

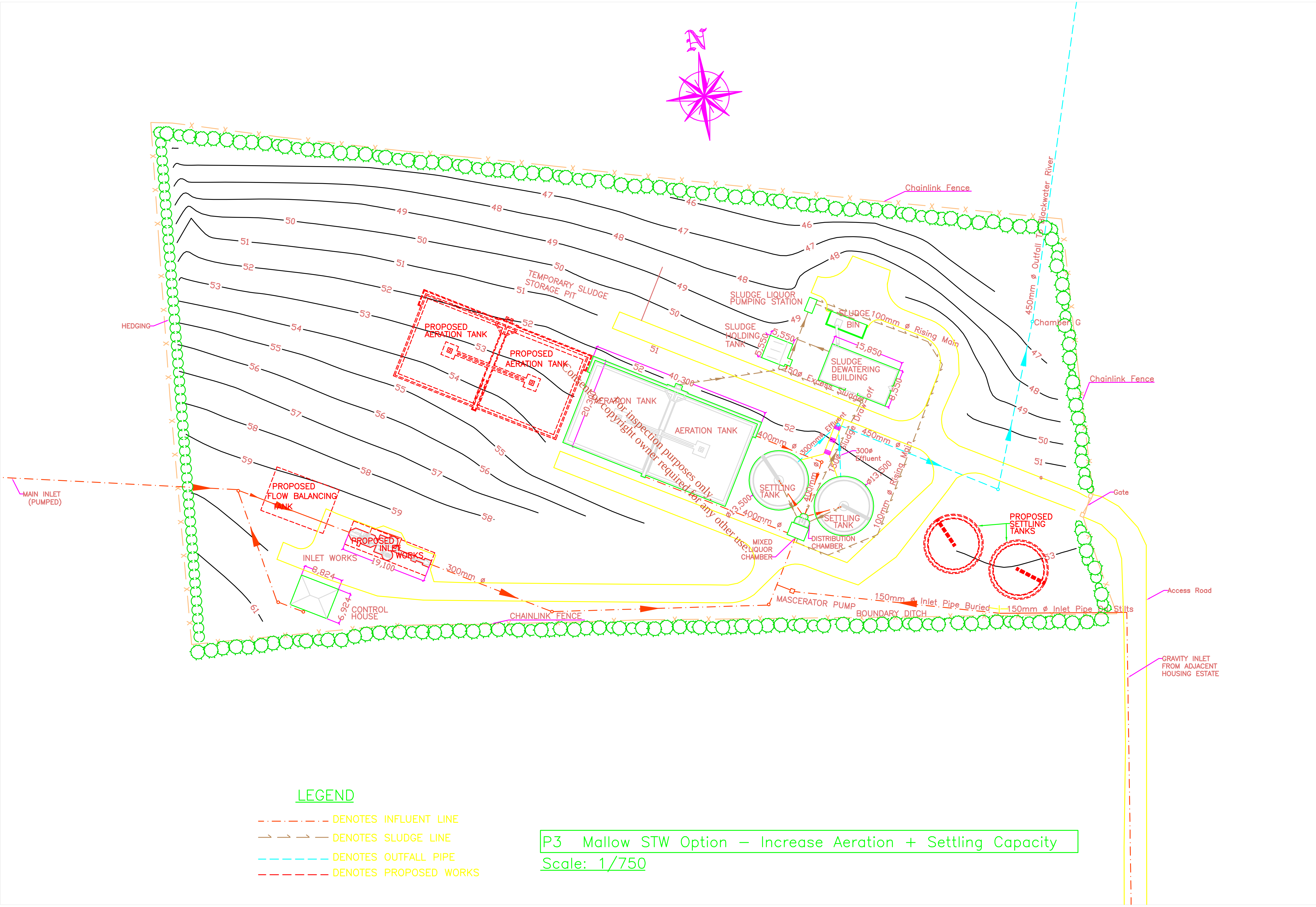


E3 Mallow Sewage Treatment Works – Existing Site Layout

Scale: 1/750

L3 Location Map at Mallow Sewage Treatment Works (Scale 1:10000)



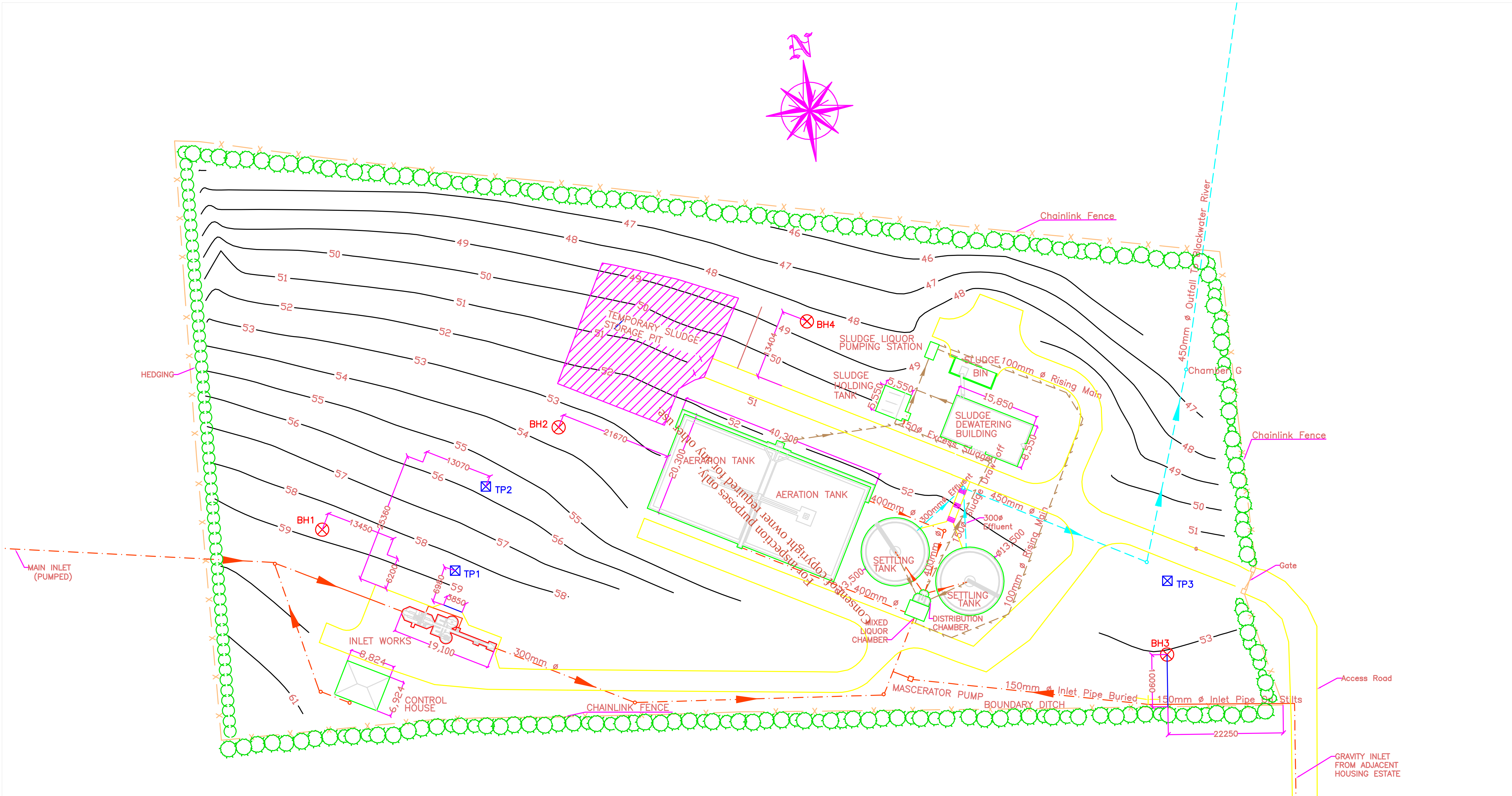


LEGEND

- DENOTES INFLUENT LINE
- DENOTES SLUDGE LINE
- DENOTES OUTFALL PIPE
- DENOTES PROPOSED WORKS

P3 Mallow STW Option – Increase Aeration + Settling Capacity

Scale: 1/750



LEGEND

- DENOTES INFLUENT LINE
- DENOTES SLUDGE LINE
- DENOTES OUTFALL PIPE
- DENOTES TRIAL PIT
- DENOTES BOREHOLE

SI 3 Mallow Sewage Treatment Works – Site Investigation Layout

Scale: 1/750

LEGEND

DENOTES INFLUENT LINE
DENOTES SLUDGE LINE
DENOTES OUTFALL PIPE

Mallow Sewage Treatment Works – Proposed Site Layout
Scale: 1/250