9.10. What is an odour unit?

The odour concentration of a gaseous sample of odourant is determined by presenting a panel of selected screened human panellists with a sample of odourous air and varying the concentration by diluting with odourless gas, in order to determine the dilution factor at the 50% detection threshold. The Z_{50} value (threshold concentration) is expressed in odour units (Ou_E m^{-3}).

SIMPLY, ONE ODOUR UNIT IS THE CONCENTRATION OF AN ODOURANT, WHICH INDUCES AN ODOUR SENSATION TO 50% OF A SCREEN PANEL

Although odour concentration is a dimensionless number, by analogy, it is expressed as a concentration in odour units per cubic metre (Ou_E m^{-3}), a term which simplifies the calculation of odour emission rate. The European odour unit is that amount of odourant(s) that, when evaporated into one cubic metre of neutral gas (nitrogen), at standard conditions elicits a physiological response from a panel (detection threshold) equivalent to that elicited by one European Reference Odour Mass (EROM) evaporated in one cubic meter of neutral gas at standard conditions. One EROM is that mass of a substance (n-butanol) that will elicit the Z_{50} physiological response assessed by an odour panel in accordance with this standard. *n*-Butanol is one such reference standard and is equivalent to 123ug of n-butanol evaporated in one cubic meter of neutral gas at standard conditions (CEN, 2003).

Typically domestic sewage sludge contains 3-6 mg L^{-1} organic sulphur, mainly arising from proteinaceous material, approximately 4 mg L^{-1} from sulphonates contained in household detergents and 30-60 mg L^{-1} inorganic sulphur (as sulphonates) (Burgess et al. 2001).

9.11. General overview of proposed drainage scheme design

A description of the general specimen design of the drainage scheme is contained else where in the EIS.

9.12. Containment and ventilation/extraction of odours – Standard Practice

The containment and ventilation/extraction of odour from WWTP's should consider the following as a minimum:

9.12.1. Covers

Covers should consider the following design notes before been installed.

- Covers should be sealed as far as possible. Inspection /access hatches should be sufficiently durable so that they continue to be effectively sealed for the design life of a piece of plant. Considerable care and attention to detailed design is required to provide adequate sealing of covers, particularly if passive ventilation to odour treatment is to be effective
- For tank surfaces the recently developed floating covers can be considered. These are produced from sections of hard foam material or fitted using soft foam that hardens in situ. Such covers can accommodate moving equipment, and can be replaced on a regular basis. Such covers do not require extraction and treatment.
- Overflow and discharge pipes should be designed and constructed to prevent a route for air under covers being discharged to the atmosphere.
- Design should withstand wind loadings, static loads due to snow or ice accumulation
- Equipment should be located in a small area to which suitable platform access is provided. Facilities to allow access of personnel onto covers should not be provided, and warning notices posted.

- Materials for covers and supports, and any equipment below the cover should be resistant to corrosion. Reinforced thermoplastic-based covers should have been considered at a minimum as very aggressive atmospheres may develop below the covers.
- Where possible, design should be such that equipment needed below covers can be easily and quickly removed to minimise time when covers need to be opened.
- To prevent the displacement of highly odorous air through gaps or hatches in the cover and ensure that all air is vented through odour treatment. Badly sealed or broken hatches will act as significant points of odour emission. Even small openings, such as the openings around cable-duct entry points, have been observed as significant sources of odour emission from tanks.
- Air displaced during filling will take the route of least resistance and may not pass through odour treatment systems, unless ventilated to maintain a negative pressure. Therefore, if any passive based odour treatment technology is to be used the cover must be 100% effectively sealed. The application of negative ventilation will also prevent significant odour emissions during cover opening.

9.12.2. Ventilation

Ventilation should consider the following design notes before been installed.

- All buildings containing sewage or sludge processes will need some form of ventilation. It should be assumed that this ventilation air will require odour treatment.
- The effective local encapsulation and extraction of process equipment, with the aim to reduce emissions to the atmosphere of the containment building, improves the indoor air quality. The odour concentration in the general indoor air can be improved using this approach to the point where odour treatment of the general air is not required. Treating a more limited flow from the local extraction system is a favoured and more economical option.
- Odour releasing units (such as screens Grit removal and rags removal) within a building should be locally enclosed, and a proportion of the required ventilation air drawn from the body of the building towards the odorous unit to ensure odours do not escape into the body of the building.
- Ventilation of a building should maintain a slight negative pressure. This negative ventilation will depend on the effectiveness of sealing of processes. Typically 6 to 10 AC/Hr are required with good sealing around odourous processes. This is required to provide a safe working environment in accordance with published occupational exposure limits, and to prevent an odour problem. By enclosing processes the emissions of aerosols and odours area minimised into the main body of the building where it could affect working conditions
- It may be advantageous to have two streams of ventilation air: one of low-volume and high-odour, drawn from the odour producing unit which can be pre-treated prior to mixing with the other stream of remaining ventilation air (high volume and low or no, odour), with possible provision of 'polishing' to reduce odours to a minimum.
- In buildings, ventilation systems and zoning of areas are designed to avoid development of potentially hazardous (explosive or toxic) atmospheres. There are no firm guidelines and rates vary widely across the Europe. Typical rates are 3 – 6 air changes per hour for a screening building, 10 air changes per hour for a sludge building.
- Design of the ventilation and odour control system may need to take in to account the handling of potentially hazardous gases, and the zone requirements of the area in which it is installed. This will avoid risks associated with hazardous gases and to provide equipment suitable for the zone requirement.
- In a covered process tank, ventilation is required only to contain and collect odours and should be kept to a minimum, whilst maintaining a slight negative pressure. Ventilation rates in this case are typically three to four air changes per hour of the volume of the headspace of the tank, and should be no less than the maximum filling rate. Smaller pump sumps which are subjected to turbulent liquid flows and instantaneously pump flows should consider at least 10 to 12 AC/Hr and should be no less than the maximum filling rate. Do not over-design the air-extraction rate. Odour removal processes tend to work more effectively at lower flow-rates

- The sitting of emergency vents, and initiation of emergency ventilation should be carefully considered, particularly if triggered by the presence of excessive concentrations of hydrogen sulphide. If likely to be a frequent occurrence, upstream treatment of the sewage/sludge or odour treatment on the emergency vent may be required.

9.13. Odour Scrubbing Systems

The following technologies may be considered as best available techniques not exceeding excessive cost for odour abatement during any upgrade or amendments to the WWTW design:

- Biotrickling filtration with carbon polishing system;
- Two stage biofiltration system;
- Two stage Chemical scrubbing system.

All the above odour abatement system have been shown to obtain >90% efficiency if proper engineering design parameters and operational parameters are implemented. It is recommended to locate the exhaust of any odour abatement systems higher (at least 3 to 5 metres) than the surrounding buildings in order to enhance dispersion and reduce building wake effects. Engineering and operational design are outside the scope of this document. Due to site complexity four separate odour abatement systems should be incorporated to treat odourous air from the negatively ventilated processes. The volumetric airflow required to be treated from all process will depend on the final design of the WWTP/Pumping stations and implemented odour abatement strategy. Biological abatement techniques are most cost effective. Ventilation rates for odour control should consider the guidance provided within this document and be refined when the final design has been agreed. The odour impact associated with the final design should be reassessed if overall odour emissions from the final designed WWTP and Pumping stations are higher that those contained in *Section 4.2* of this document

9.14. General rules for reduction of odour emissions for wastewater treatment works operation by design.

- Avoid turbulence at the inlet works, weirs and when handling sludge's and return liquors.
- Sewage discharged from a rising main is more likely to be anaerobic (i.e. odourous), particularly during hot weather. Inlet covering and chemical dosing may be necessary.
- Minimise the retention of sewage under anaerobic conditions, especially in anoxic zones and balancing tanks to prevent the formation of odourous compounds.
- Avoid accumulation of floating debris and persistent sediments in channels and holding tanks by design.
- Maintain minimal sludge delay in handling and treatment stages by design. Avoid exposure of untreated sludge to the atmosphere.
- Enclosed units should be sealed and vented to odour abatement systems. Provide storage provisions on site for odour prevention medium and chemicals.
- Ensure clear and concise odour management plans are produced for plant operation and abatement systems (i.e. system operation and maintenance manuals) (Sheridan, 2002).

9.15. Precise odour abatement strategies reduces complaints and cost

Prevent the displacement of highly odorous air through gaps or hatches in the cover and ensure that all air is vented through the odour abatement system. Badly sealed or broken hatches will act as significant points of odour emission. Even small openings, such as the openings around cable-duct and piping entry points, have been observed as significant sources of odour emission from raw-sludge storage tanks.

In a covered storage tank, ventilation is required only to contain and collect odours and should be kept to a minimum by maintaining a slight negative pressure. Ventilation rates in this case are typically half to one air change per hour of the volume of the empty tank, and should be no less than the maximum filling rate. If the tank is normally operated full, the ventilation rate could be reduced to 1 air change per hour for the air space, or the maximum filling rate. Odour abatement equipment tends to work more efficiently at lower flow-rates (i.e. biofilters and biotrickling filters).

Design odour abatement systems together, so that an odour abatement system (perhaps providing two stages of treatment) can treat extracted air from more than one facility. When an odour abatement system is provided, the outlet stack should be sited away from the boundary and any potential complainants and at an elevated height in order to reduce building wake effects and increase dispersion. Optimise the exit velocity of the outlet of the odour abatement system to increase dispersion effects. (Sheridan, 2002).

10. References

1. Callan, B.T., (1993). Noses Knows Best. In malodour measurement and control. Proceedings of the International Tydnall School, September. 134-145.
2. CEN, (2003). EN13725-Air-quality-Determination of odour concentration by dynamic olfactometry. Brussels, Belgium.
3. DOE, (1993). Report by the Inspector on a Public Inquiry into the Appeal by Northumbrian Water Limited for Additional Sewage treatment facilities on land adjacent to Spitial Burns, Newbriggin-by-the-Sea, Northumberland in March 1993. DoE ref APP/F2930/A/92/206240.
4. Dravniek, A., (1986). Atlas of odor character profiles. ASTM Committee on sensory evaluation of materials and products, ASTM data series. Baltimore, MD, USA.
5. EPA, (2001). Odour impacts and odour emission control measures for intensive agriculture. Commissioned by the Environmental Protection Agency (Ireland). OdourNet UK Ltd.
6. Longhurst, P., (1998). Odour impact assessment of an extension to the Brogborough landfill site. IREC, Cranfield University, England.
7. McIntyre, A., (2000). Application of dispersion modelling to odour assessment; a practical tool or a complex trap. Water Science and Technology, 41 (6). 81-88.
8. Sheridan, B.A. (2002). In house odour intensity and hedonic tone profile data of different odourous sources. Unpublished.
9. Sheridan, B.A., (2001). Controlling atmospheric emissions-BAT Note Development, UCD Environmental Engineering Group, Department of Agricultural and Food Engineering, UCD, Dublin 2.
10. Sheridan, B.A., Hayes, E.T., Curran, T.P., Dodd, V.A., (2003). A dispersion modelling approach to determining the odour impact of intensive pig production units in Ireland. Bioresource Technology. Published.

Appendix 5C

Climate Change Report

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POSSIBLE IMPLICATIONS OF CLIMATE CHANGE FOR CONSIDERATION IN THE DESIGN OF A WASTE WATER TREATMENT PLANT IN CORK LOWER HARBOUR, COUNTY CORK.

PERFORMED BY ODOUR MONITORING IRELAND ON BEHALF OF MOTT MCDONALD PETTIT CONSULTING ENGINEERING, CORK.

REFERENCE NUMBER:	2007.A343 (1)
ATTENTION:	Ms. Orla Freyne
PREPARED BY:	Dr. John Casey
DATE:	30th October 2007
DOCUMENT VERSION:	Document Ver.001
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1. Climate in Ireland

Climate is constantly changing. The signal that indicates that the changes are occurring can be evaluated over a range of temporal and spatial scales. We can consider climate to be an integration of complex weather conditions averaged over a significant area of the earth (typically in the region of 100 km2 or more), expressed in terms of both the *mean* of weather expressed by properties such as temperature, radiation, atmospheric pressure, wind, humidity, rainfall and cloudiness (amongst others) and the *distribution*, or range of variation, of these properties, usually calculated over a period of 30 years. As the frequency and magnitude of seemingly unremarkable events change, such as rainstorms, the mean and distribution that characterise a particular climate will start to change. Thus climate, as we define it, is influenced by events occurring over periods of hours, through to global processes taking centuries.

Over the millennia natural processes have driven changes in climate, and these mechanisms continue to cause change. "Climate change" as a term in common usage over much of the world is now taken to mean *anthropogenically* driven change in climate.
Evidence for an anthropogenic influence on climate change is now stronger than ever before, with the Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report assertion that 'It is very likely that anthropogenic greenhouse gas increases caused most of the observed increase in globally averaged temperatures since the mid-20th century' (IPCC, 2007a). Global average temperature has increased by 0.74°C over the past 100 years with the rate of warming almost doubling over the last 50 years. Precipitation patterns have also changed with an increase in the number of heavy precipitation events being observed globally. Sweeney *et al* (2003) summed up the evidence of our changing climate with the following key points.

* Global average temperature has increased by 0.6°C ±0.2°C since 1860 with accelerated warming apparent in the latter decades of the 20th century. A further increase of 1.5-6.0°C from 1990 to 2100 is projected, depending on how emissions of greenhouse gases increase over the period.

* The last century was the warmest of the last millennium in the Northern Hemisphere, with the 1990s being the warmest decade and 1998 being the warmest year. Warming has been more pronounced at night than during the day.

* Reductions in the extent of snow cover of 10% have occurred in the past 40 years concurrent with a widespread retreat of mountain glaciers outside the Polar Regions. Sea-ice thickness in the Arctic has declined by about 40% during late summer/early autumn, though no comparable reduction has taken place in winter. These trends are considered likely to continue. In the Antarctic, no similar trends have been observed. One of the most serious impacts on global sea level could occur from a catastrophic failure of grounded ice in West Antarctica. This is, however, considered unlikely over the coming century.

* Global sea level has risen by 0.1-0.2m over the past century, an order of magnitude larger than the average rate over the past three millennia. A rise of approximately 0.5m is considered likely during the period 1990-2100.

* Precipitation has increased over the landmasses of the temperate regions by 0.5-1.0% per decade. Frequencies of more intense rainfall events appear to be increasing also in the Northern Hemisphere. In contrast, decreases in rainfall over the tropics have been observed, though this trend has weakened in recent years. More frequent warm phase El Niño events are occurring in the Pacific Basin. Precipitation increases are projected, particularly for winter, for northern middle and high latitudes and for Antarctica.

* No significant trends in the tropical cyclone climatology have been detected.
As a mid latitude country, these global trends have implications for the future course of Irish climate, and for a range of impacts which it is judicious to anticipate (Sweeney et al 2003).

A recent report published by the EPA (McElwain and Sweeney, 2007) summarised the indicators of climate change in Ireland and summarised the changes in climate over recent years.

- Ireland's mean annual temperature has increased by 0.7°C between 1890 and 2004.
- The average rate of increase is 0.06°C per decade. However, as Ireland experiences considerable climate variability, the trend is not linear. The highest decadal rate of increase has occurred since 1980, with a warming rate of 0.42°C per decade.
- The warmest year on record was 1945, although 6 of the 10 warmest years have occurred since 1990.
- An alteration of the temperature distribution has occurred, with a differential warming rate between maximum and minimum temperatures. Minimum temperatures are increasing more than maximum temperatures in spring, summer and autumn, while maximum temperatures are increasing more than minimum temperatures in winter.
- There has been a reduction in the number of frost days and a shortening of the frost season length.
- The annual precipitation has increased on the north and west coasts, with decreases or small increases in the south and east.
- The wetter conditions on the west and north coastal regions appear due to increases in rainfall intensity and persistence.
- There is an increase in precipitation events over 10 mm on the west coast with decreases on the east coast, there is an increase in the amount of rain per rain day on the west coast, and a greater increase in number of events greater than the 90th percentile also on the west coast.

The increases in intensity and frequency of extreme precipitation events provide a cause for concern as they may have a greater impact upon the environment, society and the economy. The precipitation series however require further analysis as there is large spatial and temporal variability associated with extreme precipitation events.

2. Expected Climate Change in Ireland.

Current research on climate change in Ireland and Britain is in broad agreement. The climate scenarios suggest that, by the middle of the present century, mean winter temperatures will have increased by approximately 1.5°C (*see Figure 2.1*), bringing the mild conditions currently associated with the far south-west coast to almost all parts of the island. Commensurate changes in secondary parameters such as frost frequency and growing season can be expected. Summer temperature increases of approximately 2°C are suggested, with the greatest increases away from south and west coasts. Precipitation changes (*see Figure 2.2*) will perhaps have the greatest impact. Studies indicate increases during the winter months, predominantly in the northwest, of over 10%. Of greater importance, however, are projected decreases of approximately 25% in amounts of summer receipts. Geographically, these are most significant in the southeast where decreases of summer rainfall amounts in excess of 40% are anticipated over the next five decades. Coupled with increased evaporation amounts, such changes would significantly impact on a number of key sectors. Blenkinsop and Fowler (2007) predicted an increase in short summer drought frequency in all areas of the British Isles except Scotland and Northern Ireland suggesting that in future, engineers may have to plan for more intense short-term droughts, but may experience fewer long term events. The current trend of increase in frequency of extreme precipitation events is expected to continue. McGrath et al., (2005) found that the frequency of very intense cyclones/storms with core pressures less than 950 hPa is set to show a 15% increase in the future simulations with even stronger increases in winter and spring seasons.

It is expected that the main features of climate change to be experienced in the Cork Harbour region will be higher mean temperatures, milder winters, lower precipitation in summer, and an increase in storm frequency.

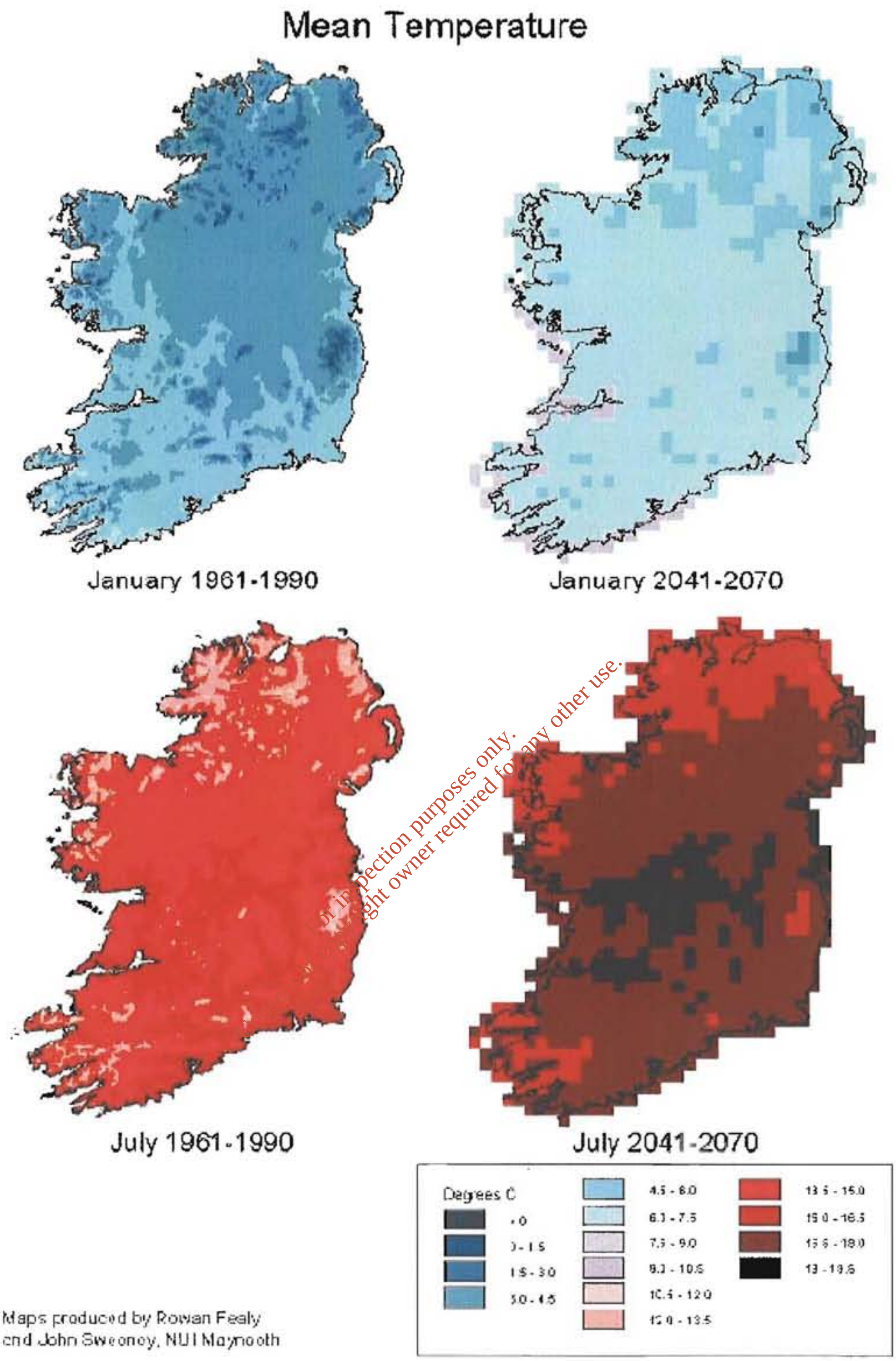

Figure 2.1. Downscaled mean temperature scenarios for the period 2061-2090 at a resolution of 10 km2. This approximates to the period around 2075. (Sweeney and Fealy, 2003)

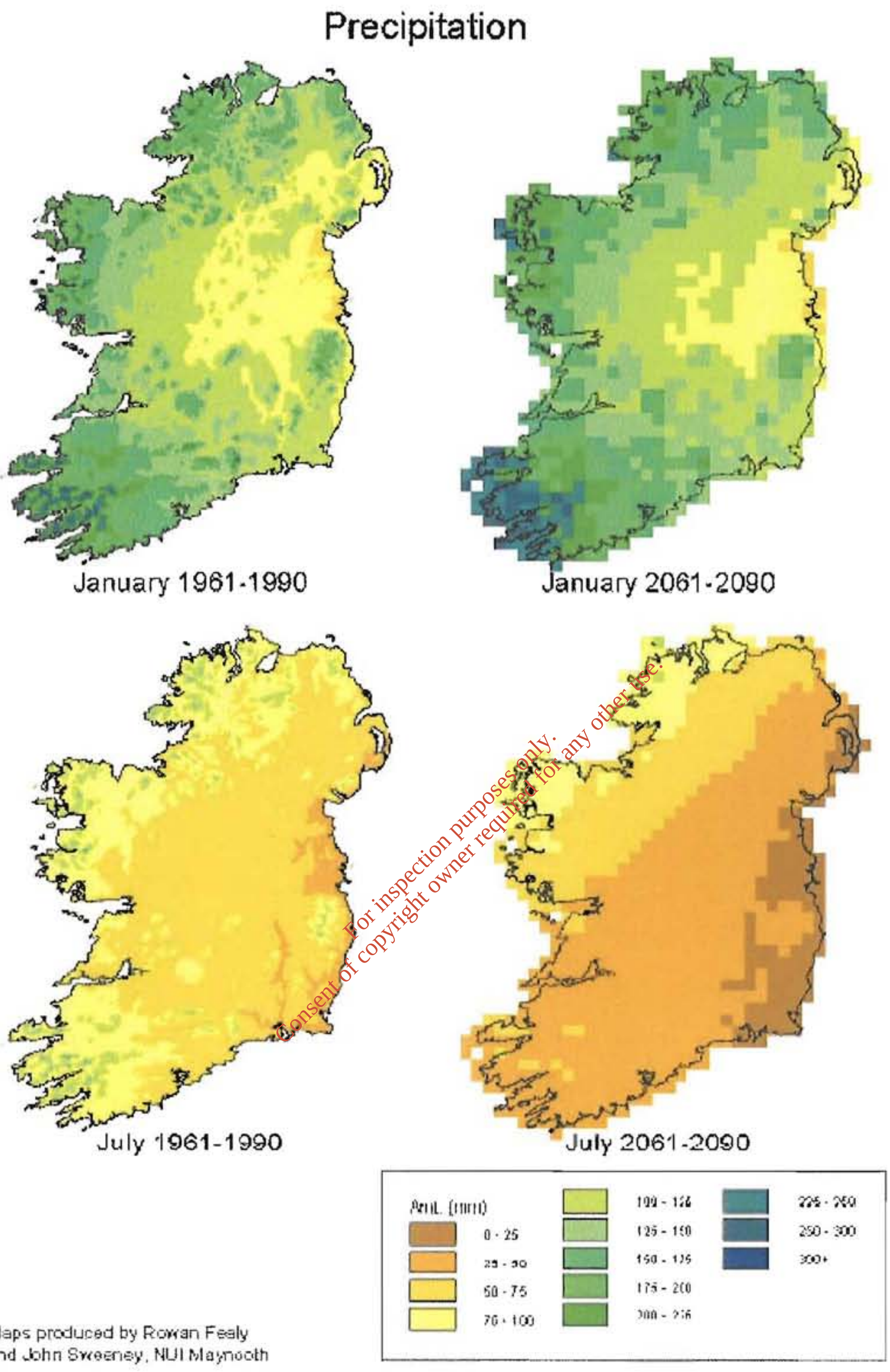

Figure 2.2. Downscaled precipitation scenarios for Ireland for the period 2061-2090 at a resolution of 10 km2. This approximates to the period around 2075. (Sweeney and Fealy, 2003)

3. The impact of climate change on hydrology.

Future changes in Irish climate are likely to have significant impacts on its hydrology. These may influence the annual and seasonal availability of water resources, with particular impacts being felt in terms of water resource management, water quality management and approaches to coping with flood/drought/storm hazards.

Ireland is relatively well endowed with water resources, however regional shortages can occur at times, especially in the east and southeast of the country, areas, which also experience the greatest population density. The rapid expansion associated with recent economic conditions of cities such as Cork and Dublin, is putting and increasing strain on the water supply infrastructure. Low flows are becoming more frequent in some areas and it is likely that future climate change will exacerbate these effects. At the same time, increases in winter precipitation particularly over the western part of the island are likely to increase the magnitude and frequency of flood events and increase the duration of seasonal flooding. Most of Ireland's present water supply comes from surface water, approximately 25% coming from groundwater. Characteristics such as soil permeability, geology and topography determine an area's response to precipitation.

Shorthouse and Arnell (1999) found that precipitation is strongly correlated with the North Atlantic Oscillation index (NAO). Increased rainfall caused by strengthened westerlies (positive NAO) has been observed for northern and western Europe, while at the same time southern Europe has experienced drying. An increase in winter storminess has also been observed by a number of authors for Ireland (Houghton and Cinneide, 1976; Sweeney, 1985; Sweeney and O'Hare, 1992; Kiely, 1999. Kiely (1999) associated the change that occurred in the North Atlantic Oscillation around 1975 with an increased westerly air-flow circulation in the northeast Atlantic which is correlated with wetter climate in Ireland. Future changes in climate are likely to have major impacts on regional and local runoff patterns. This may influence the annual and seasonal availability of water resources with significant implications for water resource use, water quality management and strategies, as well as flood/drought hazard indices in Ireland. Charlton *et al* (2006) performed a study assessing the impacts of climate change on water supply and flood hazard in Ireland. Further catchment-based research which includes analysis of climate change impacts on the hydrology of the River Blackwater is due to be published in 2007, however comprehensive data is currently unavailable. Murphy and Charlton (2006) performed an analysis of climate change impact on catchment hydrology and water resources for selected catchments, with detailed analyses of the Boyne and Suir catchments. Each of these two catchments showed a progressively increasing stream flow in January, February and March by the 2020's, 2050's and 2080s where February stream flow had increased by 25%. In contrast summer stream flows decreased markedly. The Boyne catchment showed a 50% decrease in stream flow in August in the 2080s, whereas the Suir showed the greatest decrease of around 35% in the Month of October by 2080 (Murphy and Charlton, 2006). Overall it is expected that all areas will see a significant decrease in annual runoff, which may result on long-term deficits in soil moisture, aquifers, lakes and reservoirs.
Murphy and Charlton, 2006 also analysed the impact of climate change on the magnitude of flood events. Their work gave a consistent indication that the magnitude of future flood events particularly those of a high return period (50 years) would increase significantly in the majority of catchments with little regional variation. This work may be understated as the use of ensemble GCMs and scenarios, while useful for analysis of day-to-day conditions, are less useful in capturing meteorological extremes.

These figures can be used as an indication of the potential issues facing Cork Harbour and surrounding areas in future years from a water supply perspective.

4. The impact of climate change on sea level and storm surge frequency and severity.

Global sea level rise is a major threat to the coastal environment and it is expected to accelerate with global warming (Church et al., 2001). Since 1993, sea level has been rising rapidly (Cabanes et al 2001) a fact that coincides with the warmest decade recorded (Hulme et al 2002). The increase in global temperatures is likely to have a huge impact on glaciers and glacier melts water during the course of the present century resulting in significant contributions to sea level rise (Fealy and Sweeney, 2005).

Sea Surface Temperature (SST) has also been showing a warming trend: Since the mid-1980s a warming trend is detectable in all seasons. In most time series this period of warming is unprecedented; 25 of the 30 time series display temperatures in this period that exceed all measurements since 1861 when the earliest of these records began. It is estimated that since 1990 there has been around a 50% chance that any given winter or summer has had a temperature in the warmest 10% of all measurements since at least 1880. In the same period, the probability of colder temperatures has decreased by around 10%. It is expected that this will lead to thermal expansion, which will continue long after 2100. Although inundation by increases in mean sea level over the 21st century and beyond will be a problem for unprotected low-lying areas, the most devastating impacts are likely to be associated with changes in extreme sea levels resulting from the passage of storms. (IPCC, 2007b).

There has been little research performed on sea level rise around the Irish coast. Projections for sea level changes around the UK have been developed using regional climate change models. In addition to the regional rise in mean sea level, changes in wind and wave climate also affect the vulnerability of various coastlines to global change. Storm surges and set-up associated with waves contribute to the sea level in coastal waters and especially at the coast. Wave heights in the northeast Atlantic have increased since the 1960s (Bacon & Carter 1993; Woolf *et al.* 2002.). It is not clear whether climate change will affect the global distribution of waves.

The severity of the impact of sea-level rise at any location will depend on whether the land is locally lifting or subsiding, and on changes in wind and wave factors. The relative importance of the various forcing mechanisms varies from site to site. In order to assess the impact of global climate change on a particular coastal environment therefore, it is important to identify and estimate the contribution of regional climatic changes.

The IPCC estimates a global sea level rise of between 0.1 and 0.9 metres in the period 1990-2100 from the full range of emissions scenarios (IPCC 2001). Their calculated sea level change is due mainly to thermal expansion of ocean water, melting of glaciers and ice caps, with little change in ice sheet volume. The consequences of sea level rise are severe and long lasting with serious implications for coastal communities, loss of land and coastal erosion (McElwain and Sweeney, 2006). The century scale rise in average sea level may threaten some low-lying unprotected coastal areas, yet it is the extremes of sea level – storm surges and large waves- that will cause most damage. The modelling of future changes in extreme sea levels is therefore of high importance, although the uncertainties in modelling such changes remain very large. A surge is generated when meteorological variables, such as barometric pressure and wind, depart substantially from average conditions. This can produce negative or positive surge conditions. The effects of a storm surge as it moves onshore are dependant on a number of factors. These include strength and direction of an onshore wind, local topographical features, occurrence with a spring or neap tide, and location of the tidal bulge. The elevation of a storm surge can also be greatly enhanced if it becomes coupled with wind waves. The duration of the surge event also contributes to its damage potential. At present, a storm surge of 2.6m has a return period of 100 years, but Orford (1988) expects this to decrease to a return period of 1-2 years by 2100. Hulme *et al* (2002) found that the largest increases in surge heights would occur off the southeast coast of the UK. They estimated that there would be an increase of 0.3 m in height of storm surges of a 50-year return period using a medium emissions scenario. The UK CIP project also found for a high emissions scenario, that by 2100, a storm with a current 50-year return period would occur more than once a year. It is important to note however, that the uncertainties associated with modelling storm surges are very large however as these are the most potentially damaging effects of climate change, these predictions should not be discounted on account of uncertainty. An increase in the incidence of extreme events has already been noted and it is expected that this trend will continue.

Fealy (2003) identified harbours that may be susceptible to inundation over the next 100 years, including the Carrigaline region of Cork Harbour. A 5-10% probability of inundation was identified in some areas of Carrigaline with a sea level rise of 0.48 m (*see Figure 4.1*). This increased to a 10-20% probability with a sea level rise of 0.88 m (*see Figure 4.2*). A 2.6 metre storm surge coupled with a sea level rise of 0.48 m showed all areas of Carrigaline at risk of inundation (*see Figure 4.3*).

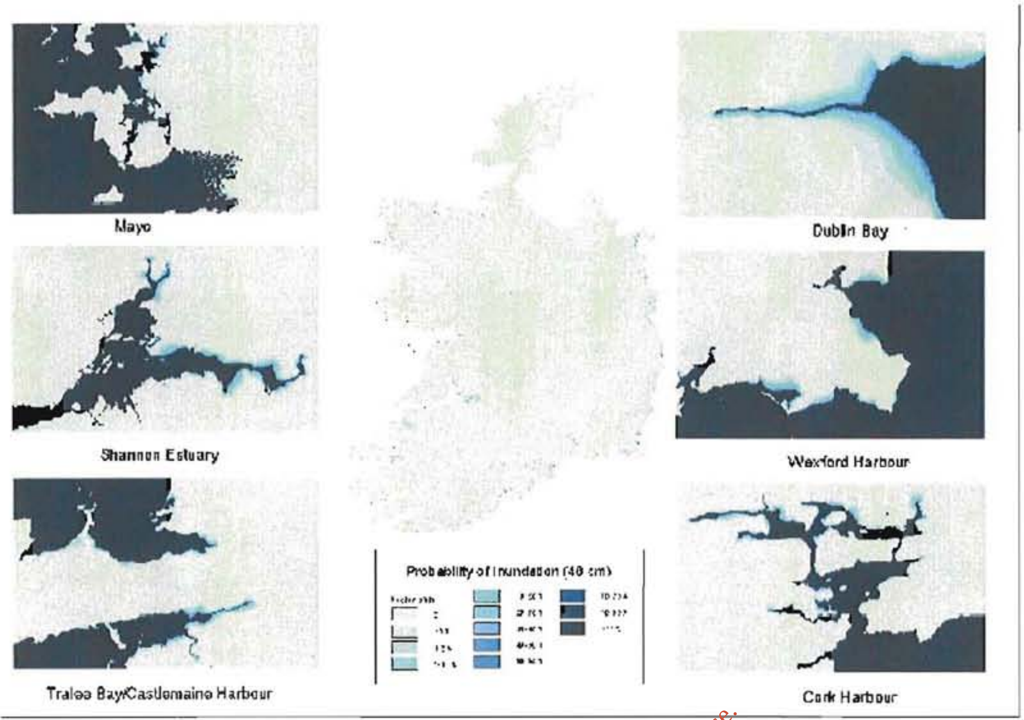

Figure 4.1. Possibility of inundation with a sea level rise of 0.48m (Fealy, 2003)

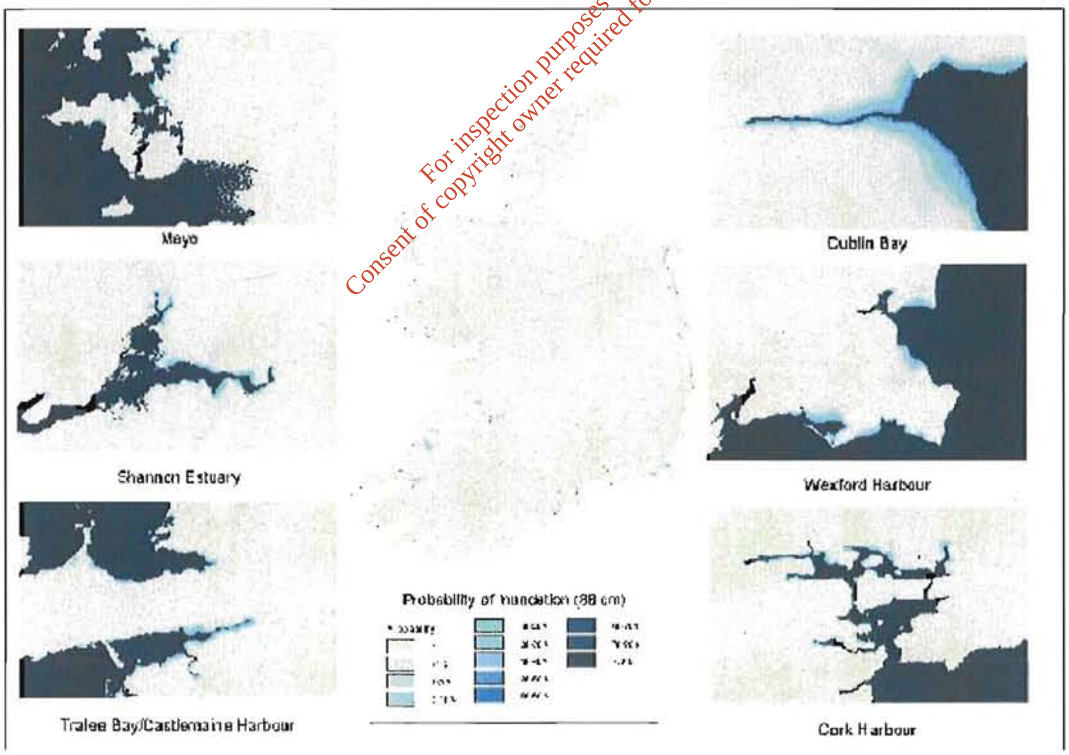

Figure 4.2. Possibility of inundation with a sea level rise of 0.88m (Fealy, 2003)

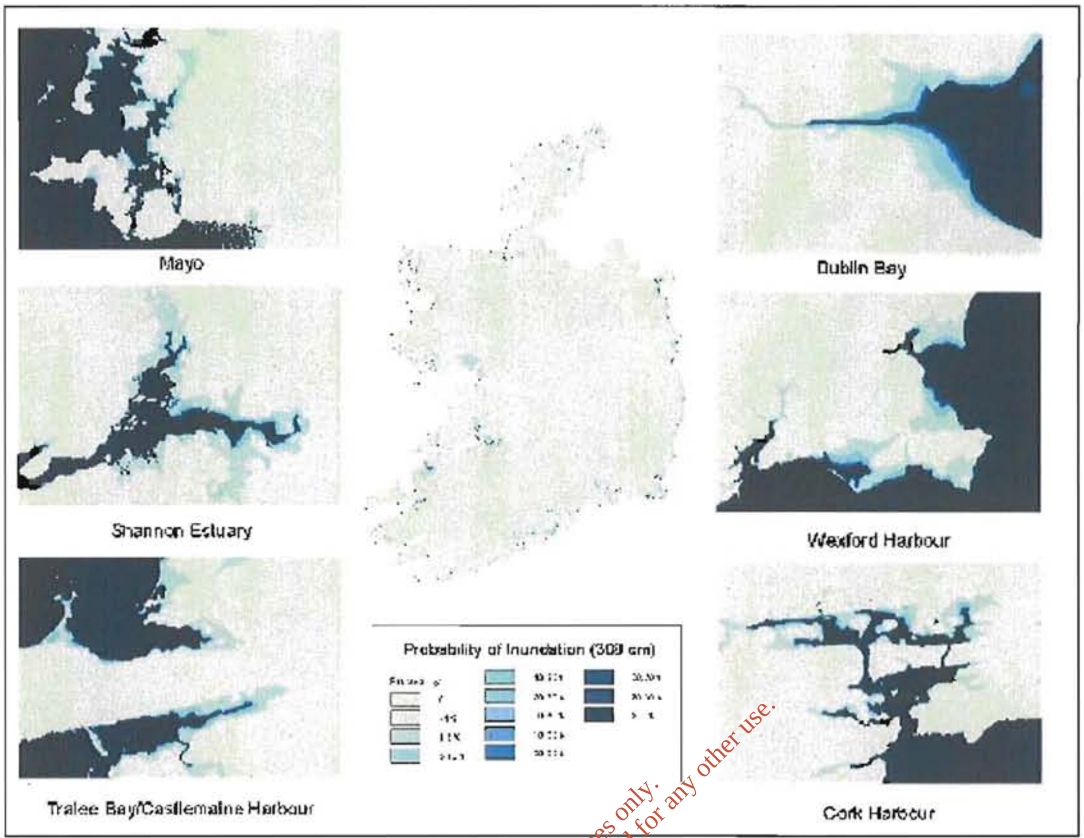

Figure 4.3. Storm surge coupled with a sea level rise of 0.48 m. (Fealy, 2003)

5. Summary

This report has outlined the main factors to be considered in the engineering design of a WWTP in Cork Harbour. To summarise:

- There will be a significant decrease in summer precipitation, which will lead to decreases in runoff, river stream flow and water availability. This could possibly lead to long-term depletions of groundwater storage and deficits in soil moisture, aquifers and lakes and reservoirs.
- Mean sea level is expected to increase by up to 0.9m, but significantly, storm surges, which currently have a return period of 50 years, could occur more than once yearly by 2100 resulting in many areas of Cork Harbour being at risk from inundation.
- The frequency of extreme precipitation events is expected to increase.

The impact of climate change on coastal societies depends both on the physical characteristics of the coasts and on whether the local economy relies strongly on sectors vulnerable to sea-level rise and extreme weather/wave conditions. Thus, in addition to physical processes, socio-economic factors need to be considered in deciding the management of vulnerable coastal areas. Therefore the following points should be considered in the planning of any coastal development.

- Coastal erosion
- Susceptibility to storm surges
- Effects of summer water shortages
- Effects of high amounts of precipitation and flood water during cyclonic events.
- Impact of sea level rise on the local population (displacement), tourism and businesses.

6. References

1. Bacon, S. and Carter, D.J.T. 1993. A connection between mean wave height and atmospheric pressure gradient in the north Atlantic. International Journal of Climatology 13, 423-436.
2. Blenkinsop, S. & Fowler, H.J. 2007. Changes in drought frequency, severity
3. and duration for the British Isles projected by the PRUDENCE regional climate
4. models. Journal of Hydrology 342: 50-71.
5. Charlton, R., Fealy, R., Moore, S., Sweeney, J. and Murphy, C. 2006. Assessing the impact of climate change on water supply and flood hazard in Ireland using statistical downscaling and hydrological modelling techniques. Climatic Change 74: 475-491
6. Church, J.A., Gregory, J.M., Huybrechts, P., Kuhn, M., Lambeck, K., Nhuan, M.T., Qin, D. and Woodworth, P.L. 2001. Changes in sea level. Intergovernmental Panel on Climate Change Third Assessment Report. Cambridge: Cambridge University Press, ch.11, pp 639-694.
7. Cabanes, C., Cazenave, A. and Le Provost, C. 2001. Sea level rise during the past 40 years determined from satellite and in situ observations. Science 294, 840-842.
8. Fealy, R., 2003. The impacts of climate change on sea level and the Irish coast. In: Sweeney et al. (eds) Climate Change: Scenarios and Impacts for Ireland. Environmental Protection Agency, Wexford
9. Fealy, R. and Sweeney J. 2005. Detection of a possible change point in atmospheric variability in the north atlantic and its effect on Scandinavian glacier mass balance. International Journal of Climatology 25, 1819-1833.
10. Houghton, J. and Cinneide, M.O., 1976. Distribution and synoptic origin of selected heavy precipitation storms over Ireland. Irish Geography 9, 1-8.
11. Hulme, M., Jenkins, G.J., Lu, X., turnpenny, J.R., Mitchell, T.D., Jones, R.G., Lowe, J., Murphy, J.M., Hassell, D., Boorman, P., McDonald, R. and Hill, S. (2002). Climate Change Scenarios for the United Kingdom: the UKCIP02 Scientific Report, Tyndall Centre for Climate Change Research, School of Environmental Sciences, University of East Anglia, Norwich, UK. 120pp.

12. Intergovernmental Panel on Climate Change (IPCC), 2001. Climate Change 2001: The Scientific Basis. Contribution of Working Group 1 to the Third Assessment Report of the Intergovernmental Panel on Climate Change. (Houghton, J.T., Ding, Y., Griggs, D.J., Noguer, M., van der Linden, P.J., Dai, X., Maskell, K. and Johnson, C.A. (eds)). Cambridge University Press, UK. 944pp.
13. Intergovernmental Panel on Climate Change (IPCC) (2007a) Climate Change 2007: The Physical Science Basis. Contribution of Working Group 1 to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, UK. (In Press).
14. Intergovernmental Panel on Climate Change (IPCC) (2007b) Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, UK. (In Press).
15. Kiely, G., 1999. Climate change in Ireland from precipitation and streamflow observations. Advances in water resources 23 141-151.
16. Lowe, J.A. and Gregory, J.M., 2005. The effects of climate change on storm surges around the United Kingdom. Phil. Trans. R. Soc. A 363, 1313-1328.
17. Mackenzie, B.R. & Schiedek, D. 2007. Daily ocean monitoring since the
18. 1860s shows record warming of northern European seas. Global Change Biology 13:1335-1347.
19. McGrath, R., Nishimura, E., Nolan, P., Semmler, T., Sweeney, C. and Wang, S. 2005. Climate Change: Regional Climate Model Predictions for Ireland Co Wexford, Ireland: Environmental Protection Agency, pp 45.
20. McElwain, L., and Sweeney J. 2006. Implications of the EU Climate Protection Target for Ireland. Co Wexford, Ireland: Environmental Protection Agency, pp 33.
21. Murphy, C. and Charlton R., 2006. Climate change impact on catchment hydrology and water resources for selected catchments in Ireland. Proceedings of the National Hydrology Seminar 2006: Water Resources in Ireland and Climate Change Available online at http://www.ria.ie/committees/pdfs/hydrology/Murphy.pdf (last accessed 23-08-2007)
22. Orford, J.D., 1988. Alternative interpretation of man-induced shoreline changes in Rosslare Bay, southeast Ireland. Transactions of the Institute of British Geographers 13 65-78.
23. Shorthouse, C. and Arnell, N., 1999. The effects of climate variability on spatial characteristics of European river flows. Physics and Chemistry of the Earth 24, 7-13.
24. Sweeney, J., 1985. The changing synoptic origins of Irish precipitation. Transactions of the Institute of British Geographers 10, 467-480.
25. Sweeney, J. and O'Hare, G., 1992. Geographical variations on precipitation yields and circulation types in Britain and Ireland. Transactions of the Institute of British Geographers 17, 448-463.
26. Sweeney, J., 2003. Climate change: scenarios and impacts for Ireland. Co Wexford, Ireland: Environmental Protection Agency, pp 229
27. Tsimplis, M.N., Woolf, D.K., Osborn, T.J., Wakelin, S., Wolf, J., Flather, R., Shaw, A.G.P., Woodworth, P., Challenor, P., Blackman, D., Pert, F., Yan, Z. and Jevrejeva, S. 2005. Towards a vulnerability assessment of the UK and northern European coasts: the role of regional climate variability.
28. Woolf, D. K., Challenor, P.G. and Cotton, P.D. 2002. The variability and predictability of North Atlantic wave climate. Journal of Geophysical Research. 107, 3145.

Appendix 6A

Noise and Vibration Report

Mott MacDonald

Cork Lower Harbour Main Drainage Scheme

Noise and Vibration Impact Assessment

August 2007

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Cork Lower Harbour Main Drainage Scheme
Noise and Vibration Impact Assessment

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Cork Lower Harbour Main Drainage Scheme
Noise and Vibration Impact Assessment

1 INTRODUCTION

The noise and vibration impact of the proposed Cork Lower Harbour Drainage scheme was assessed. The proposed scheme will include construction of a new wastewater treatment plant (WWTP) at Shanbally, including access roads, installation of a network of sewerage lines serving the lower harbour area, with associated pumping stations.

The proposed WWTP site is located in lands zoned for this purpose in the Shanbally area, to the northwest of Carrigaline. The current use of these lands is agricultural.

The potential noise impacts during the construction phase, and during the operational phase were considered.

During the construction phase there will be noise emissions from activities at the WWTP site, including earthmoving, excavations, and construction of facilities, with associated construction traffic on routes to the site.

There will also be noise impacts along the routes of the proposed sewer lines, and at the construction sites of the proposed pumping stations.

During the operational phase of the WWTP, there will be continuous process noise emissions during both daytime and nighttime. There are minor potential impacts in terms of noise from pumping stations, which are also considered in the report.

1.1 NOISE SENSITIVE LOCATIONS

The proposed WWTP site is in a rural area, with few dwellings visible from the site. The nearest existing noise-sensitive locations to the site are the houses at Upper Shanbally, approximately 260m to the east of the site boundary. There are also lands zoned for residential use approximately 130m to the east of the site, which are treated in this assessment as noise sensitive locations.

The nearest houses to the north are approximately 430m distant. The intervening lands are agricultural. The sports ground located 80m from the north-eastern corner of the site is moderately noise sensitive, as it is an outdoor recreational area.

The nearest house to the south is at a distance of approximately 570m.

There are no noise sensitive locations immediately to the west of the site. The ESB compound is located 160m to the west. A Bord Gáis facility is located 65m from the south-western corner of the site. There are commercial units located on the southern side of the entrance road to the site from Cogan's Road.

Houses in the vicinity of the proposed major pumping stations at Raffeen. Monkstown, Carrigaloe and West Beach Cobh, are also treated as noise sensitive locations. For houses in the vicinity of the minor pumping stations, there is lower potential for noise impact. However potential impacts at these locations are also considered.

Pipe laying will occur along the routes of the proposed new sewer lines. The associated construction works will therefore affect many houses in different areas, for limited periods during the construction phase. All of the houses along the proposed sewer routes are therefore considered as being noise sensitive locations during the construction phase.

1.2 METHODOLOGY

The existing noise environment was determined by means of baseline noise surveys at the site of the proposed WWTP and pumping stations in accordance with ISO 1996 "Description and measurement of environmental noise". The surveys were carried out in June 2007.

Noise propagation calculations in this report were made according to ISO 9613 "Attenuation of sound during propagation outdoors".

Calculation of noise due to construction plant and equipment was in accordance with BS 5228 "Noise and vibration control on open and construction sites", using standardised noise emission data for typical construction site equipment likely to be used for this development, and heavy vehicle noise levels.

Traffic noise was calculated based on the U.K. Calculation of Road Traffic Noise (CRTN), with results converted to daytime average noise levels (L_{Aeq}).

The WWTP is a Design-Build-Operate (DBO) project. One of the environmental parameters to be met by a successful bidder will be a maximum noise emission specification at the boundary of the WWTP site, and at a reference distance from the pumping stations. In this assessment report, an appropriate boundary noise criterion is proposed for the WWTP and the pumping stations. This was arrived at by first determining an appropriate noise assessment criterion at the nearest houses which would ensure negligible adverse impact. This assessment criterion noise level at the nearest house was then used to calculate back to the plant boundaries, to establish the appropriate design noise criterion at the boundaries. The validity of the noise impact assessment relies on the proposed design noise criteria being incorporated into the contracts for the projects, and implemented through appropriate equipment specifications during the detailed design stage.

The noise assessment criterion at the nearest noise sensitive locations was determined with reference to the EPA guideline noise limits, and also by considering the change in noise environment brought about by the development, based on the methodology of British Standard BS 4142 "Rating industrial noise affecting mixed residential and industrial areas", and the potential audibility of the noise.

All noise levels presented in the text of the report represent time-averaged noise levels over the appropriate reference periods ($L_{Aeq,}$), unless otherwise indicated. An explanation of acoustics terminology is provided in Appendix A.

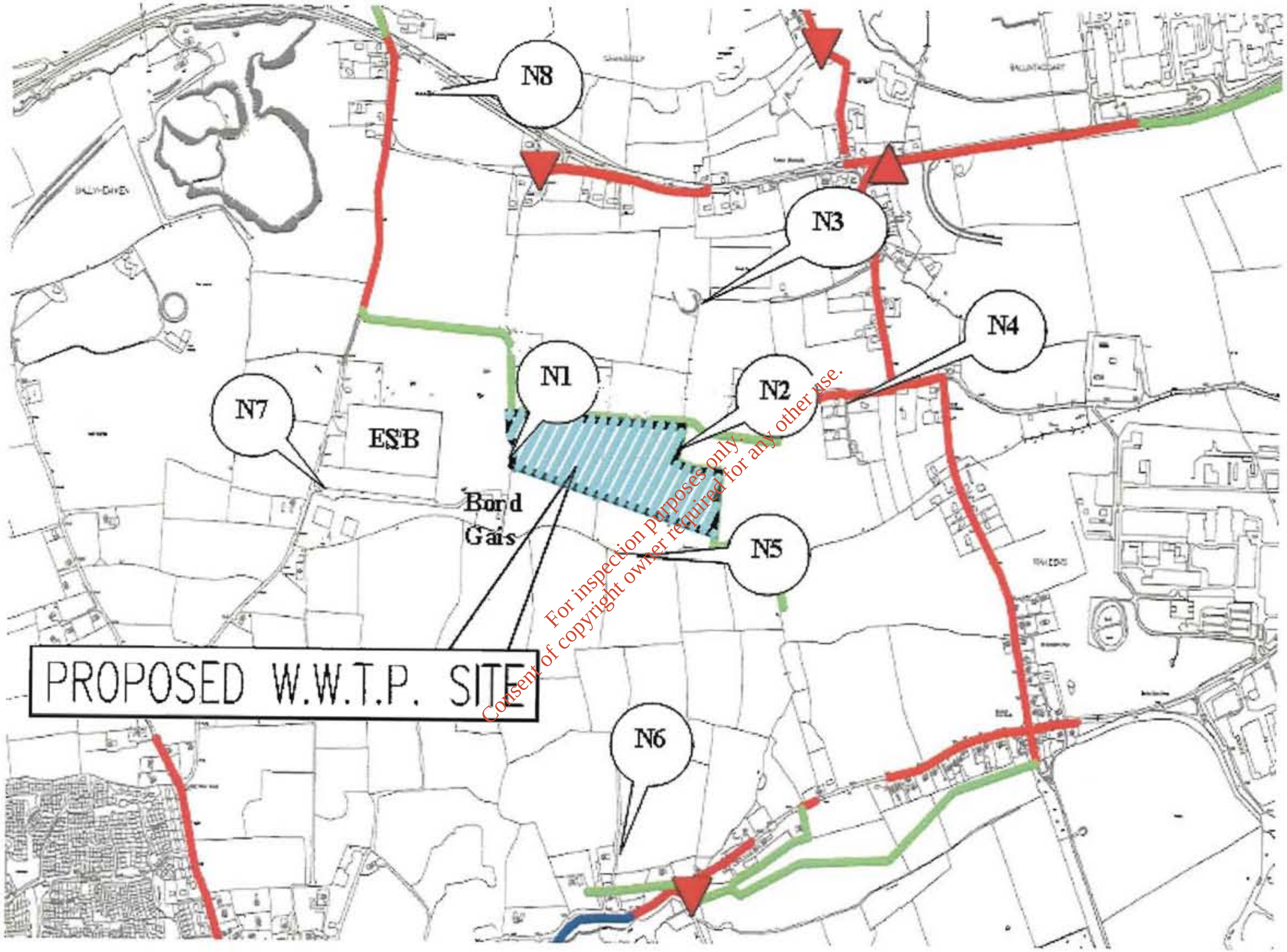

Figure 1. Location of proposed WWTP site, and baseline noise survey locations N1 to N8

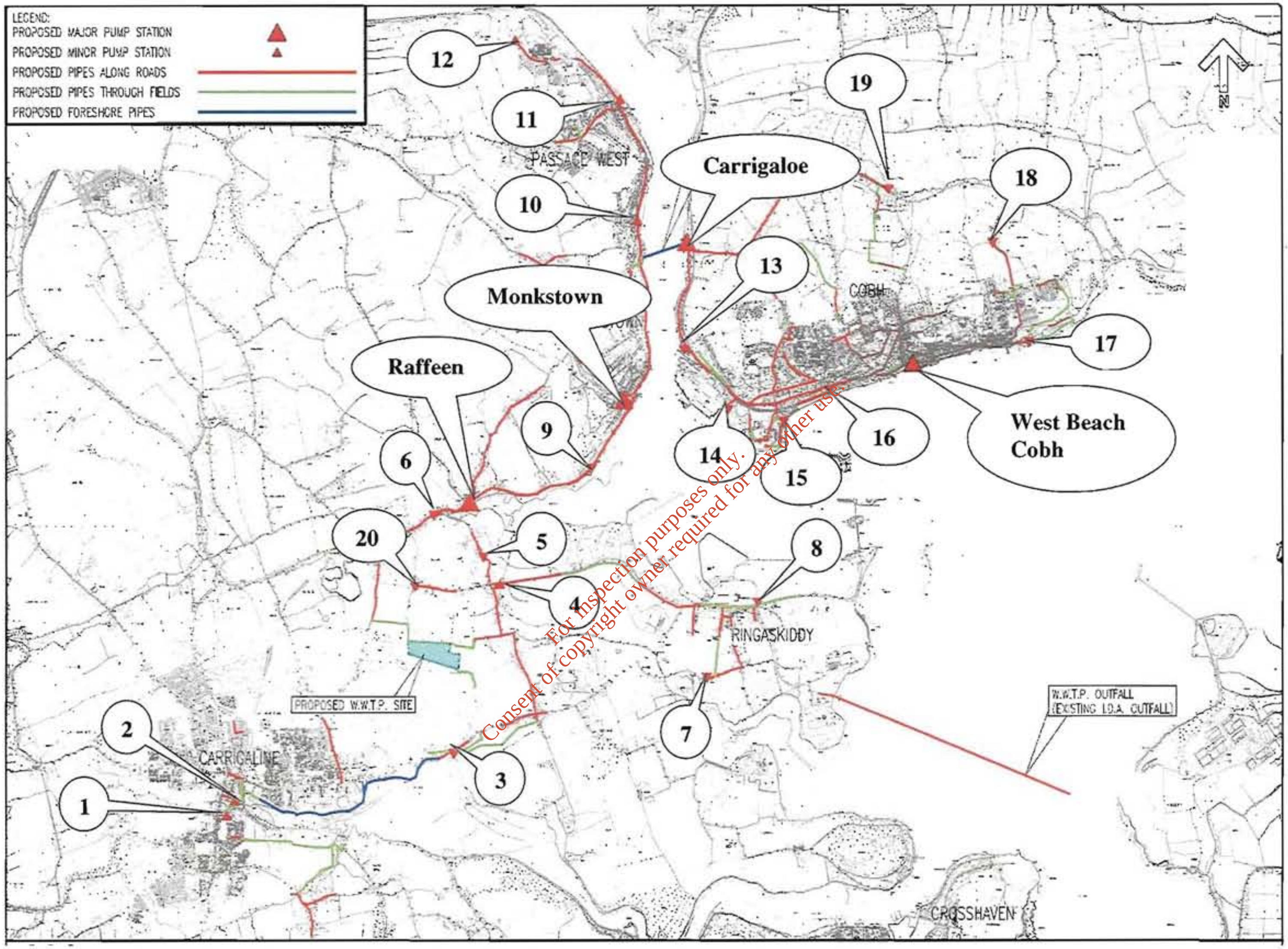

Figure 2. Layout of Cork Lower Harbour Main Drainage Scheme, showing sewerage network, and major pumping station locations at Raffeen, Monkstown, Carrigaloe, and West Beach where detailed noise surveys were carried out. Also shown are the minor pumping station locations 1 to 20, where short-duration noise surveys were carried out

2 EXISTING ENVIRONMENT

2.1 RECEIVING NOISE ENVIRONMENT

The proposed WWTP site is located within a predominantly rural area, with a low density of housing.

The main contribution to the existing ambient noise level is from the distant traffic noise on the N28, located 490m to the north of the site. There is a lower component of noise from distant agricultural machinery, aircraft, and natural noise sources such as wind noise, birds and animals. Along the entrance road to the site from Cogan's Road, there is audible electrical hum from the ESB compound, and occasional work activity noise from the Brown & Gilmer premises at the entrance from Cogan's Road.

The overall noise environment in the vicinity of the proposed WWTP site can be described as quiet rural.

2.2 BASELINE NOISE SURVEYS

2.2.1 DESCRIPTION OF MEASUREMENT LOCATIONS

Noise surveys over 24-hour periods were carried out at three locations in the vicinity of the WWTP site, denoted N1, N2 and N3 in Figure 1.

Surveys of three hours duration during daytime and nighttime were conducted at five additional representative positions, including nearest noise sensitive locations, in the Carrigaline East/Shanbally areas, denoted N4 to N8 in Figure 1.

N1: Western boundary of proposed site, beside electricity pylon
N2: Eastern boundary of proposed site, adjacent gate
N3: 200 m to the north of site, southwest corner of sports ground
N4: Upper Shanbally, at entrance to playing field
N5: 70 m south of proposed site
N6: Nearest house to south of site, at approximately 570m
N7: Entrance to Bord Gais, 20m from roadway
N8: At 12 m from N28 Ringaskiddy Road

Surveys of three hours duration during daytime and nighttime were also conducted at the proposed sites of the four major pumping stations at Raffeen, Monkstown, Carrigaloe, and West Beach Cobh, the locations of which are shown in Figure 2.

Short orientation noise measurements were carried out during daytime and nighttime at the sites of twenty proposed minor pumping stations, as indicated in Figure 2.

2.2.2 Weather Conditions:

Date	Measurement Period	Description of weather conditions
25/06/2007	Daytime	Light SW breeze, overcast, showers.
	Nighttime	Showers, light SW breeze.
26/06/2007	Daytime	Moderate SW breeze, overcast, warm, dry.
	Nighttime	Moderate breeze - calm, cool, clear night.
27/06/2007	Daytime	Light SW Breeze, dry, overcast, warm.
	Nighttime	Calm, clear, cool.
28/06/2007	Daytime	Heavy showers, moderate SW with gusts, warm.
	Nighttime	Showery, moderate SW breeze, cool.
29/06/2007	Daytime	Showers, light SW breeze

Table 1. Summary of weather conditions during noise surveys

2.2.3 Personnel

The baseline surveys were carried out by Kevin Downes B.Sc, and Alan Hanley B.Sc. of ANV Technology. The assessment was undertaken by Colin Doyle M.Sc. MIOA of ANV Technology.

2.2.4 INSTRUMENTATION

Manufacturer	Instrument	Calibrated Laboratory	Calibration reference	Last Laboratory Calibration
Brüel & Kjær	SLM 2260 (Type 1) serial no.1875380	Pennine Instruments	07062-1	20/01/06
Brüel & Kjær	SLM 2250-L Class1 serial no. 2579999	Bruel & Kjaer	Certificate of conformance 2579999	19/3/2007
Svantek	SLM 949 (Type 1)	Svantek	No. 8183	27/09/05
Brüel & Kjær	Calibrator 4231 serial no. 1859044	AV Calibration	0611490	7/11/06
Castle	Calibrator GA 607 serial no. 040520	Castle Group	40520/ 45338	27/10/05

Table 2. Noise measurement instrumentation used during the surveys. Calibration checks were carried out before and after each survey period.

2.3 MEASURED EXISTING NOISE LEVELS

The results of the noise survey for the measurements positions in the vicinity of the WWTP site are presented in Table 3. At locations N1, N2, N3, the mean measured noise levels are averaged over continuous 24 hours measurement. At locations N4 to N8, the mean measured noise levels are derived from noise levels measured during a 3 hour period in daytime and in nighttime.

Time plots of the 24-hour measurements at N1, N2 and N3 are shown in Figure 3. The measured hourly noise levels for measurement positions N4 to N8 are presented in Tables 4 and 5 for daytime and nighttime periods respectively.

The results of the noise surveys at the sites of the proposed major pumping stations are presented in Tables 6 and 7 for daytime and nighttime periods respectively.

The results of the short-term orientation surveys at the sites of the proposed minor pumping stations are presented in Tables 8 and 9 for daytime and nighttime periods respectively.

2.3.1 EXISTING NOISE ENVIRONMENT IN VICINITY OF WWTP SITE

The noise environment in this area was determined primarily by distant traffic, agricultural machinery, wind noise, birds/ animals, with a contribution from aircraft noise during daytime.

Referring to Table 3, at the measurement locations N1 and N2 at the proposed WWTP site boundaries, the average daytime noise level was 44 and 47 dB(A) L_{Aeq} respectively. This reduced to 36 and 38 dB(A) L_{Aeq} respectively at nighttime. At N3, 230m to the north of the proposed site boundary, the mean daytime noise level was 47 dB(A) L_{Aeq}, reducing to 39 dB(A) L_{Aeq} at nighttime. The noise measurements at locations N2 and N3 represent the noise environment in the lands zoned residential to the east of the proposed site.

The L_{A90} parameter is the noise level exceeded for 90% of the measurement period. This represents the steady component of the underlying background noise. At locations N1 to N3, the mean L_{A90} value for the day/evening periods ranged from 39 to 41 dB(A). At nighttime this reduced to 30 to 31 dB(A) L_{A90}.

Measurements location N4 was at the nearest house to the proposed site, at a distance of 280m from the eastern site boundary. At this position, the average daytime noise level was 55 dB(A) L_{Aeq} due to local traffic, reducing to 50 dB(A) L_{Aeq} at nighttime. The steady underlying background noise at this location was 48 dB(A) L_{A90} during daytime, and 40 dB(A) L_{A90} at nighttime.

At location N5, 100m to the south of the site, the average daytime noise level was 45 dB(A) L_{Aeq}, reducing to 43 dB(A) L_{Aeq} at nighttime. The steady underlying background noise at this location was 41 dB(A) L_{A90} during daytime, and 39 dB(A) L_{A90} at nighttime.

Measurement location N6 was at the nearest house to the south of the proposed site, which is at a distance of approximately 600m. The average daytime noise level was 55dB(A) L_{Aeq}, reducing to 48 dB(A) L_{Aeq} at nighttime. The steady underlying background noise at this location was 42 dB(A) L_{A90} during daytime, and 31 dB(A) L_{A90} at nighttime.

Measurement location N7 was at Cogan's Road, and measurements from this position represent the existing noise exposures of houses along this road. The average daytime noise level was 54dB(A) L_{Aeq}, reducing to 46 dB(A) L_{Aeq} at nighttime. The steady underlying background noise at this location was 46 dB(A) L_{A90} during daytime, and 38 dB(A) L_{A90} at nighttime.

Measurement location N8 was at the N28, and measurements from this position represent the existing noise exposures of houses along this road. The average daytime noise level was 62dB(A) L_{Aeq}, reducing by 13 dB, to a level of 49 dB(A) L_{Aeq} at nighttime. The steady underlying background noise at this location was 53 dB(A) L_{A90} during daytime, and 35 dB(A) L_{A90} at nighttime.

2.3.2 EXISTING NOISE ENVIRONMENT AT SITES OF PROPOSED MAJOR PUMPING STATIONS

Referring to Tables 6 and 7, at Raffeen, the average daytime noise level was 57 dB(A) L_{Aeq}, due to local traffic, reducing to 46 dB(A) at nighttime. The steady underlying background noise at this location was 50 dB(A) L_{A90} during daytime, and 40 dB(A) L_{A90} at nighttime.

At Monkstown, the average daytime noise level was 55 dB(A) L_{Aeq}, due to local traffic and local activity noise, reducing to 42 dB(A) at nighttime. The steady underlying background noise at this location was 43 dB(A) L_{A90} during daytime, and 38 dB(A) L_{A90} at nighttime.

At West Beach Cobh, the average daytime noise level was 58 dB(A) L_{Aeq}, due to local traffic and local activity noise, and 57 dB(A) at nighttime, due to noise from a docked boat and local activity noise. The steady underlying background noise at this location was 50 dB(A) L_{A90} during daytime, and 47 dB(A) L_{A90} at nighttime.

At Carrigaloe, the average daytime noise level was 63dB(A) L_{Aeq}, due to local road traffic, ferry traffic, and noise from the ferry, and reduced to 57 dB(A) at nighttime. The steady underlying background noise at this location was 49 dB(A) L_{A90} during daytime, and 39 dB(A) L_{A90} at nighttime.

2.3.3 EXISTING NOISE ENVIRONMENT AT SITES OF MINOR PUMPING STATIONS

Referring to Tables 8 and 9, daytime noise levels at the sites of the proposed minor pumping stations ranged from 44 to 69 dB(A) L_{Aeq}, depending on the local traffic flows. The underlying background noise levels during daytime ranged from 38 to 53 dB(A) L_{A90}.

Nighttime noise levels ranged from 44 to 64 dB(A) L_{Aeq} , depending on the local traffic flows. The underlying background noise levels ranged from 27 to 49 dB(A) L_{A90}.

Location	Measured Noise Levels dB(A) (mean of measured values at 15-minute intervals)				Comment
	$L_{Aeq,15mins}$	L_{A90}	L_{A50}	L_{A10}	
Day/Evening (07.00 -23.00)					
N1	44	39	41	45	Distant traffic, tractors, aircraft, wind noise
N2	47	41	44	48	
N3	47	41	45	49	
N4	55	48	50	56	
N5	45	41	43	47	
N6	55	42	50	59	Light traffic, tractors, wind noise
N7	54	46	49	55	Noise form commercial unit, light traffic
N8	62	53	60	65	Traffic, wind noise
Night (23.00 -07.00)					
N1	36	31	34	37	Low-level distant traffic, aircraft, animals, wind noise
N2	38	30	33	40	
N3	39	30	34	42	
N4	50	40	44	51	
N5	43	39	41	42	
N6	48	31	34	44	Aircraft, occasional traffic
N7	46	38	39	42	Low-level noise from commercial unit, distant traffic
N8	49	35	39	49	Occasional traffic, wind noise
EU [1] noise descriptors for 24-hr locations N1 to N3 (power averaged noise levels)					
Location	L_{day} $L_{Aeq,}$ 07.00-19.00	$L_{evening}$ $L_{Aeq,}$ 19.00-23.00	L_{night} $L_{Aeq,}$ 23.00-07.00	L_{den}	
N1	45	46	39	48	
N2	50	44	42	50	
N3	48	44	48	54	

Table 3. Overview of measured noise levels.(see also plots of measured noise levels over 24 hrs at N1, N2 N3 Further details in Figure 3, and measured noise levels at N4 to N8 in Tables 4 and 5)

[1] The standard EU noise descriptors are L_{Aeq} values over the daytime, evening and nighttime periods. However in low noise areas such as this, the noise environment is more reliably described by the arithmetic mean of the measured noise levels at 15-minute intervals. In low noise areas, the EU noise descriptors are biased by short duration noise events, which may be of no significance (eg. animal/bird sounds near the meter). The description of noise environment is therefore based on the mean values rather than the EU descriptors.

Location	Date	Time	$L_{Aeq, 15mins}$	L_{A90}	L_{A50}	L_{A10}	Comment
Daytime Survey							
N4	25/06/2007	16.58	53	49	51	55	Very little Traffic. Wind moderate. Aircraft
		17.59	58	46	49	58	Church bells. Moderate breeze
		18.58	54	48	51	56	Gentle breeze
		mean	55	48	50	56	
N5	26/06/2007	14.56	44	40	42	47	Airplane. Moderate breeze
		17.2	45	42	44	47	Cattle in crush. Gentle breeze
		17.36	45	42	43	46	Moderate wind. Traffic.
		mean	45	41	43	47	
N6	26/06/2007	14.27	51	39	46	55	Moderate Breeze. Rustling of hedges and leaves. Very little traffic on road.
		16.25	57	44	53	62	Tractors
		17	57	45	52	60	Traffic
		mean	55	42	50	59	
N7	25/06/2007	16.13	56	49	52	58	Work at Brown & Gilmer Ltd. Very traffic on road.
		17.18	53	45	48	55	Door closing at Brown & Gilmer Ltd. Very little traffic on road.
		18.21	51	44	47	53	Dogs barking
		mean	54	46	49	55	20m from road edge
N8	25/06/2007	16.37	63	56	61	65	Traffic. Light breeze.
		17.41	61	51	59	64	Rustling of trees and hedges.
		18.4	61	51	59	65	Little traffic. Light breeze.
		mean	62	53	60	65	At 12m road edge

Table 4. Expanded details of daytime noise surveys at WWTP survey locations N4 to N8

Location	Date	Time	$L_{Aeq, 15mins}$	L_{A90}	L_{A50}	L_{A10}	Comment
Night Time Survey							
N4	25/06/2007	22.51	52	46	50	55	Moderate breeze. Rustling from leaves.
		23.51	54	38	43	50	Moderate breeze
		00.48	44	35	38	47	Light breeze
		mean	50	40	44	51	
N5	26/06/2007	00.09	45	40	41	43	Aircraft, cattle
		00.52	43	40	41	43	Distant traffic
		01.32	41	38	39	41	Distant traffic
		mean	43	39	41	42	
N6	26/06/2007	23.49	53	32	37	51	Aircraft
		00.32	51	31	34	45	Aircraft
		01.13	41	29	31	37	Very little traffic.
		mean	48	31	34	44	
N7	25/06/2007	23.30	44	41	43	43	Very little traffic. Rustling of leaves.
		00.30	45	38	39	43	Gentle hum coming from Brown & Gilmer Ltd.
		01.27	49	35	36	37	Gentle hum coming from Brown & Gilmer Ltd.
		mean	46	38	39	42	20m from road edge
N8	25/06/2007	23.12	53	42	47	55	Very little traffic
		00.11	46	32	35	43	Rustling leaves
		01.09	48	31	36	49	Calm
		mean	49	35	39	49	12m road edge

Table 5. Expanded details of nighttime noise surveys at WWTP survey locations N4 to N8

Location	Date	Time	$L_{Aeq, 15mins}$	L_{A90}	L_{A50}	L_{A10}	Comment
Daytime							
Raffeen	26/06/2007	16:24	56	50	54	59	Local traffic, distant construction noise from nearby reservoir site, flowing stream barely audible.
		17:10	57	51	55	60	Noise from local traffic, stream barely audible, distant intermittent construction works.
		mean	57	50	55	60	
Monkstown	26/06/2007	15:46	57	43	48	59	Noise from children in adjacent playground, intermittent local and distant traffic, tree movement in breeze, stream flowing barely audible (roadside position)
		16:45	52	41	46	54	Local traffic noise, children in playground, birdsong, distant traffic noise, tree movement in breeze.
		17:55	55	45	51	58	Local traffic noise, children playing, dogs barking, nearby lawnmower.
		mean	55	43	49	57	
West Beach	27/06/2007	13.15	57	49	55	60	People walking by. Traffic
		14.16	60	52	58	63	People walking by. Jetski's in water. Church bells ringing. Construction noise.
		15.05	58	50	55	60	Lots of people walking by. Church bells ringing. Construction noise
		mean	58	50	56	61	
Carrigaloe	27/07/2006	12.32	63	49	55	67	Traffic
		13.55	62	49	54	66	Traffic. Ferry crossing. Aircraft
		14.38	63	49	57	66	Traffic, wind freshening
		mean	63	49	56	67	

Table 6. Daytime noise surveys at the sites of the proposed major pumping stations

Location	Date	Time	$L_{Aeq, 15mins}$	L_{A90}	L_{A50}	L_{A10}	Comment
Nighttime							
Raffeen	26/06/2007	23:24	48	52	39	37	Trees in breeze, intermittent local traffic.
		00:30	47	34	37	47	Intermittent distant and local traffic (light), noise from trees in breeze and nearby stream.
		01:15	42	34	35	39	Noise from nearby stream, very quiet, occasional local car/distant car.
		mean	46	40	37	41	
Monkstown	26/06/2007	23:45	45	37	39	44	Noise from water flowing in nearby stream, distant and intermittent traffic noise, very calm, clear.
		00:53	40	38	38	40	Steady noise from nearby stream.
		00:00	41	39	39	42	Noise from running stream, light breeze, light tree movement, very quiet.
		mean	42	38	39	42	
West Beach Cobh	27/07/2006	23.27	56	48	50	58	Boat docked. Voices
		0.09	56	48	50	59	Boat docked.
		0.51	60	47	49	55	Boat Docked. Voices
		mean	57	47	50	57	
Carrigaloe	27/06/2007	22.3	57	43	49	62	Very Little traffic. Ferry crossing
		23.48	57	41	49	62	Ferry Crossing. Little traffic. No wind
		0.29	57	32	36	56	Ferry has stopped crossing
		mean	57	39	45	60	

Table 7. Nighttime noise surveys at the sites of the proposed major pumping stations

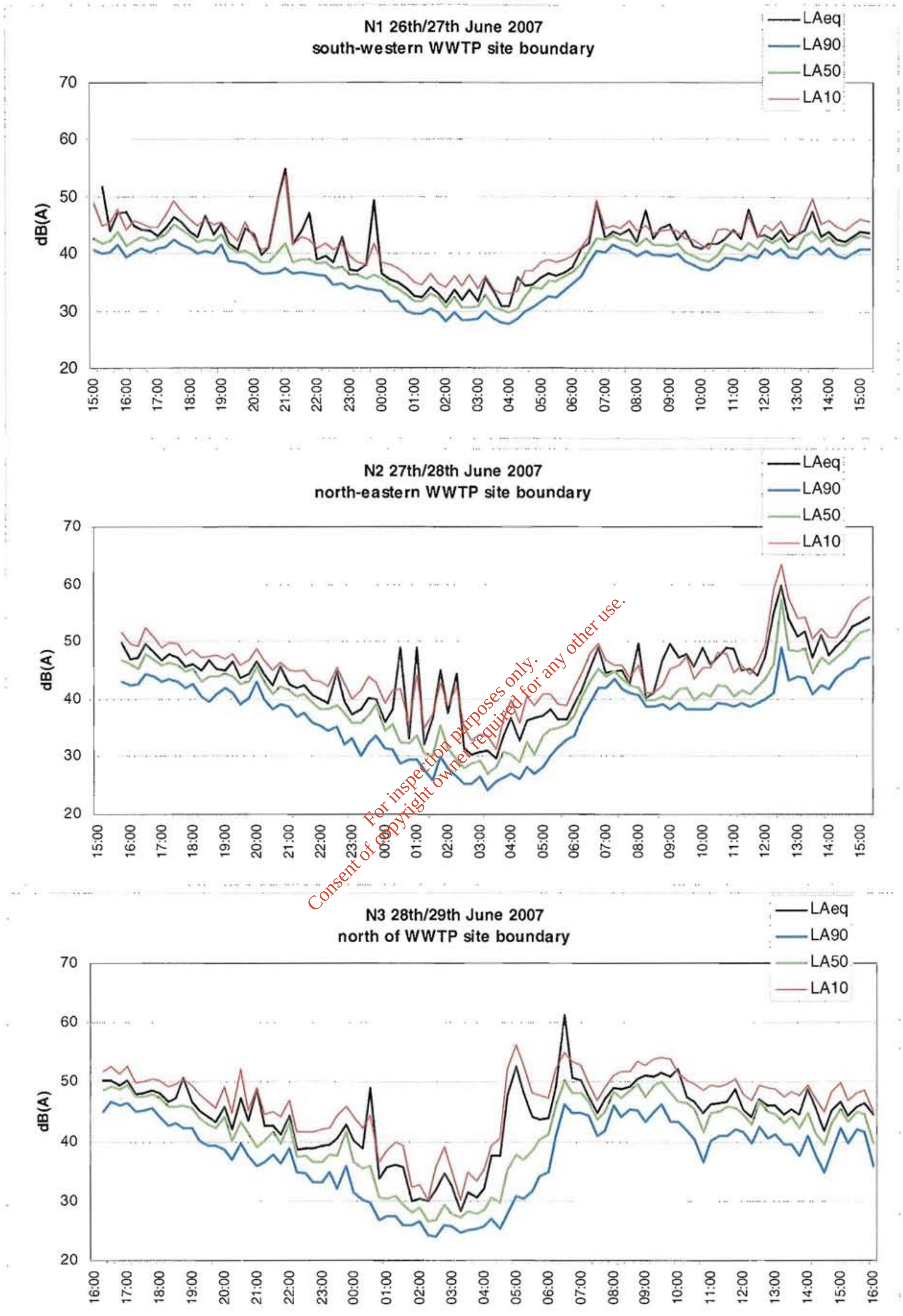

Figure 3 Plot of measured noise levels at 24-hour measurements positions at WWTP site

Daytime	Date	Time	$L_{Aeq,}$ $_{15mins}$	L_{A90}	L_{A50}	L_{A10}	Comment
1	26/06/2007	15.47	58	51	55	60	Significant traffic.
2	26/06/2007	16.05	64	53	60	67	Traffic, voices, horns beeping.
3	26/07/2007	16.42	57	44	52	61	Tractors.
4	26/06/2007	12:44	63	47	57	66	Local and distant traffic noise, distant motor noise on main road, nearby silage machinery, high % HGV's on road.
5	26/06/2007	13:43	44	38	42	45	Distant and local traffic noise, golf course mowers.
6	26/06/2007	18:15	61	44	55	65	Heavy local traffic noise, trees in breeze
7	27/06/2007	12:15	55	45	49	55	Local and distant traffic, tree movement in wind.
8	27/06/2007	11:32	62	47	51	61	Noise from nearby vehicle distribution centre, intermittent local traffic, distant trucks audible.
9	27/06/2007	17:33	64	41	53	67	Local traffic noise, trees in breeze.
10	27/06/2007	14:58	63	47	53	67	Noise from local and distant traffic, birds, water lapping against sea wall.
11	27/06/2007	16:55	62	49	55	61	Heavy local traffic, distant traffic noise, cars in car park, children playing in nearby playground.
12	27/06/2007	16:25	69	53	65	73	Heavy local traffic, roadside position 3-4 meters, trees moving in breeze.
13	27/06/2007	12.5	69	50	64	72	Traffic
14	28/06/2007	12:57	55	48	52	58	Noise from local traffic, trees in breeze, distant traffic. ~ 20m from roadside and water front.
15	28/06/2007	13:30	49	44	47	51	Distant traffic noise, birdsong, light rain, construction noise from island across the water, distant boat noise.
16	27/06/2007	13.36	66	46	58	71	Traffic
17	28/06/2007	13:55	58	50	52	57	Wind & water lapping against seashore (20m below), trees in breeze, distant traffic barely audible, light rain.
18	28/06/2007	14:24	47	41	44	50	Noise from nearby construction site, trees in breeze.
19	28/06/2007	14:46	54	40	43	54	Intermittent local traffic, birdsong - stopped due to rain after 10 minutes.
20	26/06/2007	13:15	59	49	55	62	Local traffic noise, high % HGV's on road, distant and local traffic.

Table 8. Short-term orientation noise surveys at the sites of the proposed minor pumping during daytime

Nighttime	Date	Time	$L_{Aeq, 15mins}$	L_{A90}	L_{A50}	L_{A10}	Comment
1	26/06/2007	22.5	53	47	48	56	Dry night. Little traffic on road. River running close to site.
2	26/06/2007	23.12	63	49	52	65	Road works being carried out 75m away
3	26/07/2007	23.33	47	33	36	45	Aircraft
4	26/06/2007	23:50	57	35	44	62	Intermittent local and distant traffic, low level distant plant noise audible in lulls. Calm & Clear
5	26/06/2007	00:35	45	29	31	38	Noise from airplanes, water flowing in nearby stream barely audible, distant low level plant noise barely audible.
6	26/06/2007	23:00	55	38	42	56	Distant traffic barely audible, intermittent local traffic, stream flowing nearby barely audible
7	27/06/2007	23:25	44	42	43	46	Low level distant plant noise, and distant traffic, trees in breeze.
8	27/06/2007	23:05	51	37	40	46	Intermittent traffic and distant traffic noise, low level rumble, boat?, tree movement in breeze.
9	27/06/2007	00:10	54	34	36	52	Intermittent local and distant traffic, low level plant noise across water from Pfizer barely audible, hedge growth/trees in breeze.
10	27/06/2007	00:57	54	27	34	51	Distant traffic barely audible, occasional car pass by.
12	27/06/2007	01:38	53	33	35	42	Intermittent distant and local traffic, low level plant noise across water audible. Calm, clear, cold night. Stream barely audible.
13	27/06/2007	22.5	64	38	53	70	Little traffic. Little or no breeze
16	27/06/2007	23.09	64	38	50	66	Traffic
20	28/06/2007	00:10	49	32	41	53	Intermittent local and distant traffic.

Table 9. Short-term orientation noise surveys at the sites of the proposed minor pumping stations during nighttime

2.4 Do-Minimum Scenario

In the do-minimum scenario, with no development at the site, it is expected that the environmental noise sources will remain essentially unchanged in terms of noise emission. However, the proposed realignment of the N28 will result in a change in noise environment at the proposed WWTP site.

The realigned road will be 100m from the northern boundary of the site at its closest approach. Based on published NRA traffic flow data for this road, it is calculated to generate a daytime traffic noise level of 52 dB(A) L_{Aeq} at the northern site boundary. The additional nighttime traffic noise level is expected to be approximately 39 dB(A) L_{Aeq} (calculated based on a 13 dB difference between daytime and nighttime noise levels as measured at the N28, measurement position N8). When added to the existing nighttime noise, of level 36 to 39 dB(A), this will increase the nighttime ambient noise to approximately 40 to 42 dB(A) L_{Aeq}.

As the steady underlying background noise is determined mainly by the distant traffic noise component, the realignment of the N28 is not expected to significantly alter the steady underlying background noise levels (L_{A90}) in the vicinity of the site, and is consequently not a consideration in setting design noise criteria for the WWTP site.

The noise environment is expected to remain unchanged at the locations of the proposed pumping stations.

3 NOISE IMPACTS OF THE DEVELOPMENT

3.1 Assessment Criteria

3.1.1 Construction Noise Criteria

Criteria for daytime construction noise are generally set at a level higher than for other permanent intrusive noise sources, because it is recognised that it is a short-term activity. For prolonged exposures above 70dB(A), the level of noise intrusion into houses may however prove unacceptable.

A level of 70 dB(A) is the construction noise limit proposed in the National Roads Authority guidelines for road construction projects, during normal daytime working hours, as shown in Table 10. (Guidelines for Treatment of Noise and Vibration in National Roads Schemes, published draft, NRA, 2004).

The National Road Authority guidelines for road construction projects do not include limits for works between the hours of 22:00 hrs. and 07:00 hrs. However for any essential nighttime works it would be reasonable to assign a limit of 45 dB(A) $L_{Aeq,1hr}$, which is the EPA guideline industrial nighttime noise limit.

Days & Times	**$L_{Aeq\ (1hr)}$ dB**	**L_{Amax} dB**
Monday to Friday 07.00 to 19.00	70	80
Monday to Friday 19.00 to 22.00	60	65
Saturday 08.00 to 16.30	65	75
Sundays and Bank Holidays 08.00 to 16.30	60	65
Vibration Limits: For protection of buildings 8 mm/s (vibration frequency <10Hz) 12.5mm/s (vibration frequency 10 to 50Hz) 20 mm/s (vibration frequency >50 Hz) Continuous piling: 2.5mm/s (tolerable level)		

$L_{Aeq(1hr)}$ is the one hour average noise level.
L_{Amax} is the measured maximum noise level.

Table10 Maximum permissible noise levels at the façade of dwellings during construction. Source: "Guidelines for the Treatment of Noise & Vibration in National Road Schemes", NRA, 2004

The NRA construction noise limits represent a reasonable compromise between the practical limitations of a construction project, and the need to ensure an acceptable ambient noise level for the residents. The degree of adverse impact depends on the construction noise level, and the duration of the construction project. The descriptive scale of adverse construction noise impacts used in this report is presented in Table 11.

Approximate Duration of Exposure	Construction Noise Level L_{Aeq} dB					
	<55	55-60	60-70	70-75	75-80	>80
Days	Negligible	Negligible	Negligible	Slight	Moderate	Significant
Weeks	Negligible	Negligible	Slight	Moderate	Significant	Severe
Months	Negligible	Slight	Moderate	Significant	Severe	Severe
Year	Negligible	moderate	Significant	Severe	Severe	Severe

Table 11. Gradation of adverse noise impact as function of construction noise level, and duration of noise exposure

3.1.2 OPERATIONAL PHASE NOISE IMPACT CRITERIA

As this is a Design-Build-Operate (DBO) project, there are no details at this planning stage on the exact equipment to be installed in the Waste Water Treatment Plant.

The project management team has requested that design noise criteria be specified at the plant boundary, in order to accommodate the contractual requirements of the DBO project. Since equipment at the plant will operate continuously, equipment noise emissions would need to be controlled to ensure that acceptable night-time noise levels are achieved at the nearest noise sensitive locations.

The approach taken in this report is to determine a suitably low assessment noise criterion at the nearest houses, such that the resulting noise impact of the proposed development will be negligible, and comfortably within acceptable guideline levels. This assessment noise criterion is then used to calculate back to the plant boundaries, to establish the appropriate design criteria at the plant boundaries.

The validity of the noise impact assessment relies on the final design noise criteria being incorporated into the contracts for the projects, and implemented through appropriate equipment specifications during the detailed design stage.

3.1.2.1 EPA NOISE LIMITS

The EPA (Environmental Protection Agency) guidelines, which set a nighttime limit of 45dB(A), and a daytime noise limit of 55 dB(A), at noise sensitive locations. The EPA guidelines should however be viewed as maximum tolerable levels rather than levels of negligible impact. Where existing background noise levels are low, a lower noise criterion would be required, as described below.

3.1.2.2 CONSIDERATION OF CHANGE IN NOISE ENVIRONMENT

In assessing the scale of an adverse noise impact, consideration is given to the change in noise environment brought about by a development. There are two aspects to be considered. The first is the increase in total noise level (L_{Aeq}) due to the development, which is termed the "sound emergence". The second is the degree to which the industrial noise exceeds the pre-existing background noise. In this context the background noise, which is quantified by the L_{A90} parameter, is the steady underlying component of the ambient noise.

BS 4142 provides guidelines on potential noise impacts by consideration of the level of the industrial noise relative to the background noise. An exceedence of 10 dB indicates clear audibility, with potential for complaints, and the impact needs to be carefully assessed. An increase of 5 dB is considered to be a marginal situation. When the industrial noise is equal to or less than the background noise, it is unlikely to be noticeable, and there is a low probability of complaint.

The mean daytime background noise level at measurement locations N1 to N3 in the vicinity of the proposed WWTP site were in the range 39 to 41 dB(A) L_{A90}, due to distant traffic noise. At the nearest house to the east, at position N4, the daytime background noise level was 48 dB(A) L_{A90}.

The mean nighttime background noise level at measurement locations N1 to N3 in the vicinity of the proposed WWTP site was in the range 30 to 31 dB(A) L_{A90}. During the quietest periods of the night from 02.00 to 05.00, background noise levels ranged between 24 and 30 dB(A) L_{A90}. At the nearest house to the east of the site at N4, the lowest background noise level detected was 35 dB(A) L_{A90}.

Noise Impact Descriptors

Neither EPA guidelines, nor BS 4142 provide criteria for assigning noise impact descriptors such as "negligible, slight, moderate, significant". However the principles of BS 4142 can be used in conjunction with the EPA guideline noise limits to arrive at a set of descriptors.

In the case where noise from a development is 10 dB higher than the existing background noise, and if the EPA guideline limit is also approached or exceeded, the adverse noise impact can be described as "significant".

If the noise from a development exceeds the background noise by 5 dB, the adverse impact can be described as: "slight" if the noise level is less than the EPA limit; "moderate" if the noise level is close to the EPA limit; and "significant" if the EPA limit is exceeded by more than 2 dB.

For "negligible" or "slight" impact, the additional noise from the development should be less than, or broadly comparable with the existing background noise. In these cases, if the absolute noise level is close to the EPA limit, , the impact can be described as "slight". If the absolute noise level is significantly less (10 dB less) than the EPA limit, the impact can be described as "negligible". When the noise from the development is significantly lower than the background noise (for example 10 dB lower), it is unlikely to be audible, and the noise impact can be described as negligible.

3.1.2.3 CONSIDERATION OF INDOOR NOISE LEVELS AT NIGHTTIME

It should be noted that BS 4142 was devised for mixed residential and industrial areas, already subject to a detectable level of industrial noise. It does not specifically address noise impacts in quiet rural areas where the background noise is less than 30 dB(A), as occurs on occasion in this area at nighttime.

In these cases of very low background noise, any new noise sources will always be in excess of the background noise level at certain times, especially at nighttime. In these cases, the level of the new noise source relative to the background noise is not the determining factor. Rather, the level of noise transmitted inside a house needs to be considered.

Acceptable indoor noise criteria are specified in British Standard 8233 " Sound insulation and noise reduction for buildings – Code of practice" (1999). BS 8233 specifies 30 to 40 dB(A) L_{Aeq} as representing a "good" to "reasonable" indoor noise environment for living rooms, and 30 to 35 dB(A) L_{Aeq} for bedrooms. In addition, noise maxima inside bedrooms should not normally exceed 45 dB(A) L_{AFmax} at nighttime. This is to ensure acceptable resting/sleeping conditions. These guidelines are also consistent with recommendations of the World Health Organisation. However from experience measuring indoor noise levels in Irish residences in rural areas, it is found that indoor noise levels at nighttime are generally below 30 dB(A), and would more typically be in the range 20 to 25 dB(A).

An external noise source of level 35 dB(A) would be attenuated by approximately 15 dB when transmitted into a house, through a partially opened window, or through an open ventilation grille. The resulting indoor noise level would therefore be approximately 20 dB(A). This would be at the lower range of typical indoor background noise levels, and provided the sound contains no tonal or impulsive components is unlikely to be noticeable. An indoor noise level of 20 dB(A) would be very comfortably within BS 8233 and WHO guideline levels. Noise impact at this level would be negligible.

3.1.3 PROPOSED BOUNDARY NOISE DESIGN CRITERIA

Criterion for Continuous Plant and Process Noise Emissions

Taking account of the EPA guideline limits, and the existing low background noise levels, and also the requirement that the WWTP noise should not be noticeable indoors at nighttime, it is considered that a design criterion of 35 dB(A) at nighttime at the nearest noise sensitive location is appropriate for this development. This would constitute a "negligible" noise impact, based on the noise impact criteria discussed in section 3.1.2 above. The nearest noise sensitive location is the land zoned residential, approximately 130m to the east of the proposed site boundary. There is currently no development on these lands. The nearest existing house is approximately 260m to the east.

The noise design criterion is best specified at a reference distance from the proposed boundary, rather than at the precise WWTP boundary. Specification at a position beyond the site boundary would take proper account of any noise screening which may be incorporated at the WWTP plant boundary, which would also have a benefit at the nearest noise sensitive receptor locations. A reasonable reference position would be at 20m from the boundary to the north, south, and east. The western boundary is not especially noise sensitive, due to the proximity of the ESB compound. It is therefore not necessary to apply a noise design criterion for the western boundary.

An ISO 9613 noise propagation model was developed for the proposed site. This was used to calculate the design criterion at the plant boundary, which would ensure that the resulting noise level at the zoned residential lands 130m to the east was less than 35 dB(A), which is the criterion for negligible noise impact in this rural area. The calculated design noise criterion is a noise level of 45 dB(A) at 20m from the plant boundaries. Based on experience measuring noise levels at existing wastewater treatment plants, this is considered to be technically achievable using current equipment technology, and through incorporation of boundary noise screening where required.

Criterion for Daytime Work Activity Noise Emissions

It should be noted that the above engineering design noise criterion applies to items of equipment and processes at the WWTP which operate on a 24-hour basis. The criterion was devised to ensure that there would be negligible noise impact at nighttime, which is the most sensitive period with respect to noise impact.

During normal operation of the WWTP there will also be daytime work activities, and movement of vehicles during daytime within the site, which would not be subject to the same criterion. The existing underlying background noise in the vicinity of the site was determined to be at least 10 dB higher than at nighttime. Consequently, a daytime design noise criterion 10dB higher than the nighttime criterion, i.e. 55 dB(A) at 20 m for the site boundary, would be considered appropriate to ensure negligible daytime noise impact at the nearest noise sensitive receptors. For a daytime noise criterion of 55 dB(A) at 20m from the boundary, the resulting noise level at the nearest noise sensitive location, approximately 130m to the east is calculated to be 45 dB(A).

3.2 CONSTRUCTION NOISE IMPACT

3.2.1 CONSTRUCTION OF WASTE WATER TREATMENT PLANT

The assessment in this report is based on general information available at the planning stage of the project. The analysis presented is considered indicative of the scale of potential noise impacts during the construction phase, based on noise emission data for construction equipment from BS 5228, and experience at similar sites. However this does not constitute a definitive estimate of construction noise levels. The detailed noise analysis can only be carried out when precise details of works are formulated in terms of equipment, processes, and exact timings of works. This detailed analysis will be the responsibility of contacting companies undertaking the work, in accordance with the applicable standards.

During construction of the treatment plant itself, the highest noise levels will be generated during the site clearance and excavation phase of the works. During the actual construction of the plant facilities and equipment installation, noise emissions will be considerably lower.

For site clearance activities, involving heavy earth moving and excavation equipment, the calculated construction noise level at the nearest house to the east is 51 dB(A) L_{Aeq} (based on an assumed sound power emission of 120 dB L_{WA} from plant and equipment operating on the site). This calculated noise level is very comfortably below the NRA construction noise criterion of 70 dB(A). It would be just noticeable above the existing ambient noise outdoors, but would not be intrusive. There would be no noticeable noise impact indoors. The resulting noise impact at the houses is negligible.

The construction noise level in the sports field to the northeast is expected to be in the range 50 to 55 dB(A), and will have negligible impact on outdoor activities in this area.

A noise map representing construction noise levels during the early construction phase of the WWTP is shown in Figure 4.

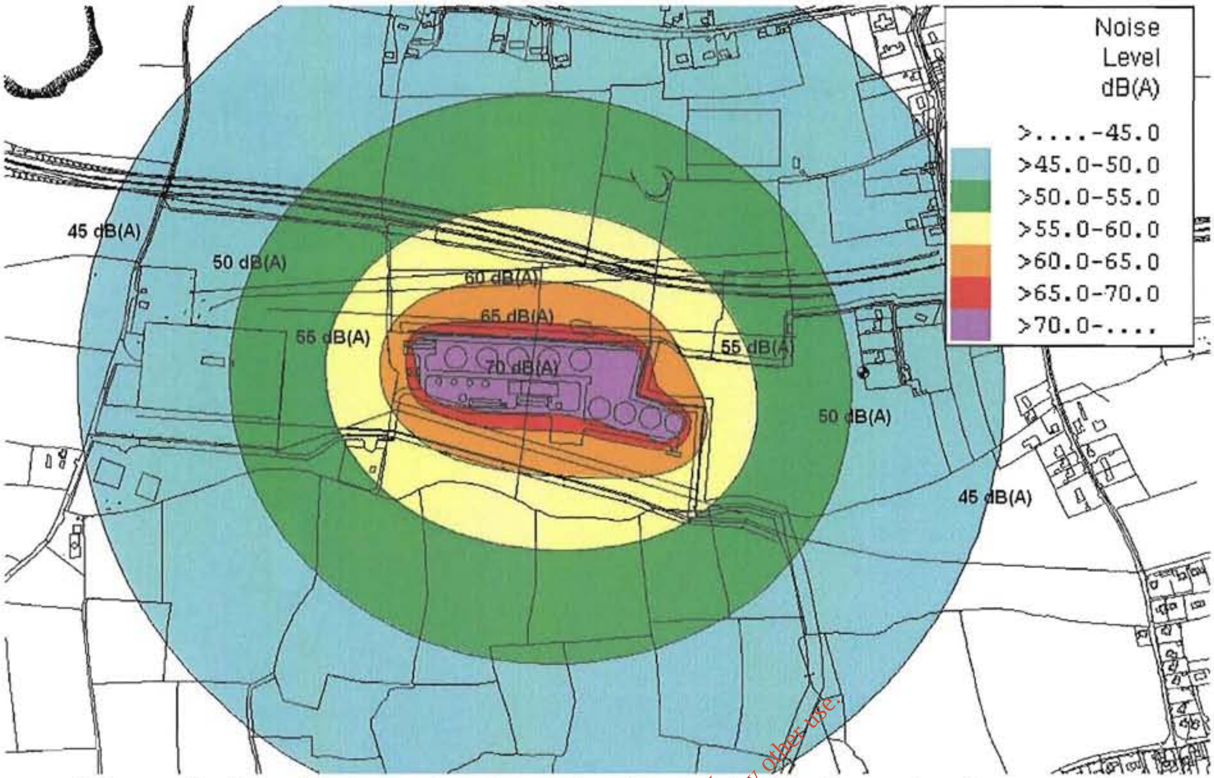

Figure 4. Calculated construction noise levels during the early site excavation and preparation phase when noise emissions are expected to be highest. The calculation are based on a total site sound power emission of 120 dB(A) L_{WA}, which is a reasonable allowance for a project of this scale

3.2.2 CONSTRUCTION WORKS AT PUMPING STATIONS

The construction works at the major pumping stations will be of a significantly reduced scale compared with the construction of the WWTP. The highest noise emissions will be produced during the site preparation and excavation phase. Based on a site equipment sound power emissions of 115 dB(A) L_{WA}, the resulting construction noise levels at the nearest houses are calculated to be approximately 70 dB(A) at the nearest houses at the Monkstown and West Beach sites, where it is considered that the standard guideline noise limit of 70 dB(A) can be complied with, subject to appropriate mitigation. There will be a slight adverse noise impact at these houses. At the Raffeen and Carrigaloe sites, the calculated noise levels are 58 and 57 dB(A) respectively, which are comfortably within the standard 70 dB(A) criterion, and noise impact will be negligible.

Construction noise levels at the minor pumping stations will be of a lower level and shorter duration than for the major pumping stations, and the adverse noise impact will be negligible to slight.

Location of Proposed Pumping Station	Calculated Construction Phase Noise Level at Nearest House to Pumping Station dB(A)
Rafeen	58
Monkstown	70
Carrigaloe	57
West Beach Cobh	69

Table 12. Calculated highest construction noise levels, during the early site preparation and excavation phases for the proposed major pumping stations (BS 5228 calculation based on site sound power emissions of 115 dB(A) L_{WA}, with allowance for noise screening by standard timber site hoardings).

3.2.3 EXCAVATION WORKS FOR SEWER LINES

The proposed sewer network will involve laying of sewer lines through populated areas of Cobh, Monkstown, Ringaskiddy, and Carrigaline, and in the vicinity of houses along rural sections of the network. The noise level at houses along the proposed sewer routes will vary depending on the proximity of the works, and the set-back distance of the houses from the line of the sewer. The expected construction noise levels at the houses along the routes of the sewer pipelines were calculated in accordance with BS 5228. The calculations are based on typical equipment noise emissions data (for excavator/breaker and truck) and allow for distance attenuation, and marginal screening at the house boundaries.

The highest expected noise level at any given house along the sewer route will be generated when excavations are in progress immediately adjacent to the house in question. The noise level at the house will depend on the distance of the house from the excavation works. Table 13 shows the calculated noise levels for houses at various distances from the line of the sewer line excavation works.

For houses set back 10 metres from the sewer line, the noise levels may exceed the 70 dB(A) construction noise criterion for the short period while works are in progress immediately adjacent to the house.

As works progress along the route, the noise level at any given house will vary depending on the location of the works along the road. The expected variation in noise level is shown in Figure 5. This shows that in general noise levels will be less than 65 dB(A). However, noise levels may exceed 70 dB(A) while works are in progress in the 20m stretch immediately in front of the houses. As works progress away from the house, the noise level falls off rapidly. Beyond 50 metres, the noise level would be less than 60 dB(A), and beyond 100 metres the noise levels would be less than 54 dB(A).

This construction noise will be audible above the existing ambient noise, but would not be considered intrusive in the context of the limited duration of the works.

Set-back distance of house from line of sewer excavations, metres	10	20	30	40	50
Noise level dB(A) $L_{Aeq,1hr}$	73	67	63	61	59

Table 13. Calculated noise levels at a house, due to excavation works at roadside adjacent to the house

(based on data from BS 5228, with an assumed sound power emission of 110 dB(A) from an excavation works, with average on-time of 50%, and assumed nominal screening allowance of 6 dB for boundary walls.)

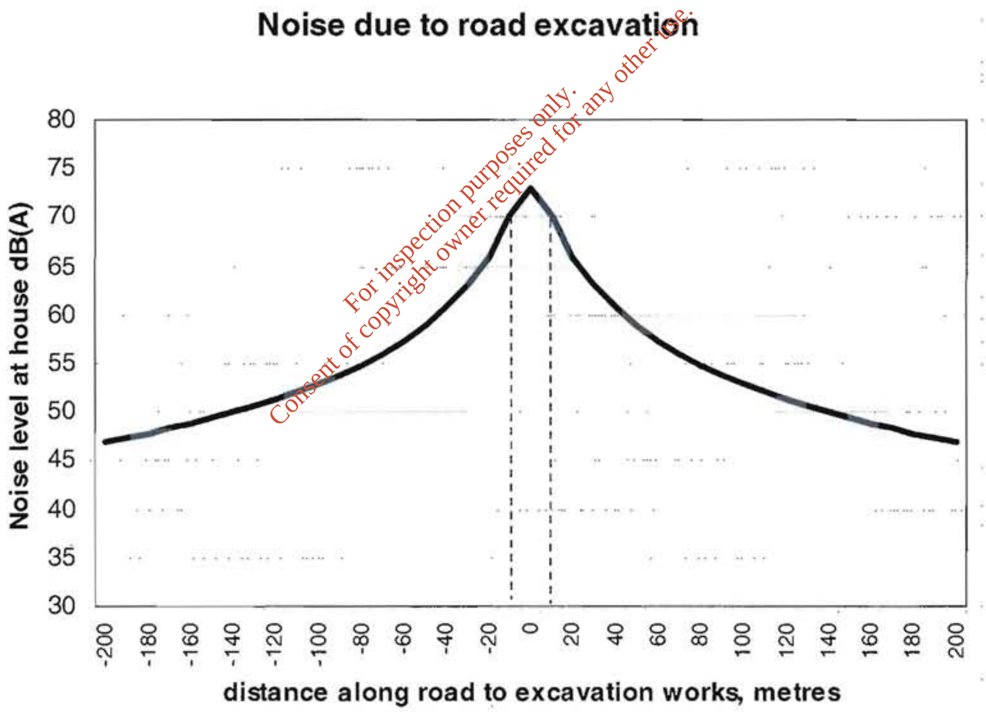

Figure 5. Variation of noise level at a given house, depending on distance of excavation works along the road from the house entrance. In the situation depicted, the house is 10m from the road. The 70dB(A) NRA criterion may be exceeded while works are in progress on the 20m stretch immediately in front of the house.

Channel Crossing at Carrigaloe