For the WWTP odour impact assessment, the 99.5th percentile of hourly averages is used to complement the 98th percentile of hourly averages to take account of predicted downwind odour concentrations during short time worst-case meteorological conditions thereby providing added protection to the public at large. This was not performed upon the pumping station odour impact assessment as the predicted plume spread as assessed using the 98th percentile assessment criterion concluded negligible odour impact.

Selection of Odour Annoyance Thresholds: Odours from WWTP's / pumping station operations arise mainly from the volatilisation of odorous gases from:

- The surfaces of non-quiescence processes including overflow weirs, returned pumped centrate/liquor above the working height of the tank/channel etc.
- Positive displacement of odours from tankage as a result of inlet waste water flow and pressure effects induced by wind flows
- Anaerobic decay of floating organic debris upon quiescence surfaces including organic matter attached to grit and rags, organic matter carryover to secondary tanks etc.
- Sludge handling operations including dewatering, thickening, digestion, drying, storage and transport of raw/processed sludge's offsite
- Anaerobic digestion processes and emissions of sour gas
- Turbulent processes within the inlet works and storage of screens (i.e. grit and rags removal)
- Inefficient odour control/abatement equipment operation and design including loose fitting covers, inefficient extraction and odour control unit failure

An odour impact criterion defines the odour threshold concentration limit value above baseline in ambient air, which will result in an odour stimulus capable of causing an odour complaint. There are a number of interlinked factor, which causes a nearby receptor (i.e. resident) to complain. These include:

- Odour threshold concentration, odour intensity and hedonic tone-defined measurable parameters at odour source
- Frequency of odour-how frequently the odour is present at the receptor location
- Duration of odour-how long the odour persists at the receptor location
- Physiological-previous experiences encountered by receptor etc.

By assessing these combined interlinked factors, the ability for a facility to cause odour complaint can be determined.

When utilising dispersion models for impact assessment, specific impact criterion (odour concentrations) need to be established at receptors. For odour assessment in general terms, this is called an odour impact criterion, which defines the maximum allowable ground level concentration (GLC) of odour at a receptor location for a particular exposure period (i.e. $\leq$1.50 Ou_E m^{-3} at the 98th percentile of hourly averages).

By abating the sources of offensive odours within the WWTP and pumping station, the odour limit value becomes less conservative as the odour emitted from the odour abatement technology is considered less offensive and therefore has a markedly lower potential risk of causing complaint. Taking into account these factors for the WWTP's and pumping stations, it is proposed that:

- All sensitive locations and areas of amenity should be located outside the 1.50 Ou_E m^{-3} at the 98th percentile of hourly averages over a meteorological year
- All sensitive locations and areas of amenity should be located outside the 3.0 Ou_E m^{-3} at the 99.5th percentile of hourly averages over a meteorological year
- The hedonic tone should not be considered unpleasant (scale greater than –2) as assessed in accordance with VDI 3882:1997, part 2; ('Determination of Hedonic) for all emission points
- Recent studies demonstrate trends where both mean ranking of dislike ability and hedonic scoring provide subjective ranking of odours and their respective ability to cause offensive/complaint. It would appear that when the hedonic tone of the odour reached a specific level, the odour hedonic tone decreases rapidly to small increases in odour threshold concentration (i.e. small increases in odour threshold concentrations will cause a large change in the perceived odour offensiveness). Such trends have been observed by OMI in a laboratory-based environment. It has been suggested that when an odour reached an odour intensity level of 3 (distinct) and a mean hedonic score of –2 (unpleasant), an odour will become offensive and cause odour complaint.
- These proposed odour impact criterion is considered by OMI as sufficiently conservative to provide protection to the community at large taking into account latest suggested odour impact criterion by environmental agencies in Ireland, UK and Netherlands.

(iii) Climate

The methodology for the description of the current climate in the region of the proposed development includes a desk study and literature review of published data available for Ireland and the Cork Harbour area, carried out by OMI. Possible implications of climate change are assessed for consideration in the design of the proposed development. A full description of this assessment is included in *Volume III, Appendix 5A and 5C*.

3.6.3 Existing Environment

(i) Air Quality

Benzene, Toluene, Ethyl Benzene and Ortho and Para Xylene (BTEX)

BTEX and other aromatic/alkanes are most likely derived from petrol driven vehicle exhausts. Heavier semi-volatile organic compounds are frequently derived from diesel-powered engines. Benzene is a known carcinogen, poisonous by inhalation and a severe eye and moderate skin irritant. At each of the five monitoring locations (A1 to A5; Table 3.6.1), the air quality was monitored for BTEX, over a 29-day period, using BTEX diffusion tubes.

Table 3.6.2: Baseline Air Quality - Average BTEX concentrations at each location as measured by passive diffusion tubes.

Location	Benzene ($\mu g/m^3$)	Toluene ($\mu g/m^3$)	Ethyl Benzene ($\mu g/m^3$)	P-Xylene ($\mu g/m^3$)	O-Xylene ($\mu g/m^3$)
A1	0.695	0.256	0.183	0.256	0.121
A2	0.143	0.361	0.428	0.312	0.224
A3	0.270	0.233	0.418	0.249	0.186
A4	-	-	-	-	-
A5	0.329	0.282	0.471	0.576	0.248
Old Station Rd. hourly median (EPA)[Note]	0.20	-	-	-	-
Limit Value	**5**	**4700**	**10,875**	**5525**	**5525**

Note - Old Station Road is located on the south side of the River Lee near City Hall, about 500m from Cork City centre.

The results illustrated in Table 3.6.2 for BTEX at A1 to A5 are all in compliance with Irish and EU limit values (i.e. SI 271 of 2002 and EU Directive 2000/69/EC) for Benzene. Average Benzene concentrations were up to 93% lower than the Irish and EU directive limit values. The rule of thumb for guidelines for ambient air quality of volatile organic compounds without legislative limit values is using 1/40th of the 8-hour Occupational Exposure Limit as stated in the National Authority for Occupational Safety and Health 2002 "Code of Practice for the Safety, Health and Welfare at Work (Chemical Agents) Regulations". Toluene, ethyl benzene and xylene isomers are well within their respective fractional exposure limit values.

Nitrogen Dioxides (NO_2)

When industrial metabolism releases nitrogen to the environment it is considered a "pollutant" because of its chemical form: NO, NO_2, and N_2O. These oxides of nitrogen can be toxic to humans, to biota, and they also perturb the chemistry of the global atmosphere. In the transportation sector, the NO_x emissions result from internal combustion engines.

At each of the five monitoring locations (A1 to A5; Table 3.6.1), levels of NO_2 were measured using diffusion tubes, which were left on site for a 29-day period. The results are presented in Table 3.6.3.

Table 3.6.3: Average NO_2 concentrations at each location as measured by passive diffusion tubes

Location	Sampling Period	Average No_2 Concentration ($\mu g/m^3$)
A1	July to Aug 2007	6.00
A2	July to Aug 2007	4.82
A3	July to Aug 2007	4.86
A4	July to Aug 2007	6.06
A5	July to Aug 2007	6.76
EPA value - Old Station Rd hourly max value	2006	111
EPA value - Old Station Rd Annual mean value	2006	26
Limit value - Annual average	**-**	**40**
Limit value - 1 hour average	**-**	**200**

The dominant source of NO_2 in the area appears to be from motor vehicle exhausts and the burners/boiler of space heating of local light industry and business units. The measured concentrations of NO_2 at all monitoring locations are within the Irish and EU Ambient Air Standards. Monitoring locations A1 to A5 are an average 83% lower than currently established Irish and European ambient air regulatory levels for annual averages.

Sulphur Dioxide (SO_2)

Sulphur dioxide is a colourless gas, about 2.5 times as heavy as air, with a suffocating faint sweet odour. At each of the five monitoring locations (A1 to A5; Table 3.6.1), levels of SO_2 were measured using diffusion tubes, which were left on site for a 29-day period. The results are presented in Table 3.6.4.

Table 3.6.4: Average SO_2 concentrations at each location as measured by passive diffusion tubes

Location	Sampling Period	Average So_2 Concentration ($\mu g/m^3$)
A1	July to Aug 2007	1.64
A2	July to Aug 2007	1.75
A3	July to Aug 2007	1.32
A4	July to Aug 2007	1.60
A5	July to Aug 2007	1.18
EPA value-Old Station Rd hourly max value	2006	58
EPA value-Old Station Rd daily max value	2006	24
EPA value-Old Station Rd annual mean value	2006	4
Limit value - Annual average	**-**	**20**
Limit value - Daily average	**-**	**125**
Limit value - Hourly average	**-**	**350**

The dominant source of SO_2 in the area appears to be from motor vehicle exhausts and the burners/boiler/solid fuel heating local single residences and industrial units. The measured concentrations of SO_2 at all monitoring locations are within the Irish and EU Ambient Air Standards. Monitoring locations A1 to A5 are an average 91% lower than currently established Irish and European ambient air regulatory annual levels.

Carbon Monoxide (CO)

Carbon monoxide is produced as a result of incomplete burning of carbon-containing fuels. It can be emitted by combustion sources such as un-vented kerosene and gas heaters, furnaces, woodstoves, gas stoves, fireplaces and water heaters, automobile exhaust from attached garages, and tobacco smoke. Due to power and equipment safety issues existing baseline monitoring data from EPA monitoring sites (*Air Quality Monitoring Report, 2006* - Old Station Rd.) was used for assessment of baseline Carbon monoxide air quality. The EPA monitoring location and results are presented in Table 3.6.5.

Table 3.6.5: Average ambient baseline CO concentrations for the proposed site development.

Location	Sampling Period	Ambient Co Concentration (mg/m^3)
EPA - Annual mean - Old Station Rd	2006	0.50
EPA - 8 hour median value - Old Station Rd	2006	0.40
EPA - Maximum 8 hourly value - Old Station Rd	2006	2.80
Limit value-8 hour average	-	**10**

CO monitoring is also very limited in Ireland. Data sets developed by the EPA indicate 8 hour running average CO levels of between 0.10 and 0.80mg m^{-3} for 8 hour rolling averages, respectively for urban areas in Ireland. The dominant source of CO in this area would appear to be vehicle emissions, boilers (i.e. home heating and industrial heating), industrial processes and construction activities. The CO emissions measured in Old Station Rd would be considered worst case in comparison to the proposed site location. CO emissions are on average 78% lower than Irish and EU ambient air limit values, which would be considered worst case in terms of exposure for the area

Particulate Matter (PM_{10})

PM_{10} (Particulate Matter 10) refers to particulate matter with an aerodynamically diameter of 10 µm. Generally, such particulate matter remains in the air due to low deposition rates. It is the main particulate matter of concern in Europe and has existing air quality limits. In order to obtain a baseline PM_{10} for the proposed work area, a PM_{10} analyser was used to monitor the PM_{10} ambient concentration levels at one location (A1) within the vicinity of the proposed works. Continuous monitoring was performed over a 2-day period. Results are presented in Table 3.6.6.

Table 3.6.6: Average ambient PM_{10} concentrations in the vicinity of the proposed development

Location	Sampling Period	Ambient m_{10} Concentration ($\mu g/m^3$)
A1-24 hour average	July 2007	22
A1-24 hour average	July 2007	31
EPA measured conc. – Old Station Rd, annual mean value	2006	16
Limit Value at 98.07th percentile	-	**50**
Limit Value - annual mean Stage 1	-	**40**
Limit value - annual mean Stage 2	-	**20**

PM_{10} monitoring in Ireland is limited to continuous monitoring stations operated by the Local Authorities and the Irish EPA, mainly in large urban centres. Average 24-hour ambient air concentrations monitored at Old Station Rd, Cork would be considered worst case in this area. The EPA measured an annual mean of 16 $\mu g\ m^{-3}$ at this monitoring station. The dominant source of PM_{10} in the area appears to be vehicle emissions, boilers (i.e. home heating and industrial heating), industrial processes and construction activities. The average ambient PM_{10} concentrations are higher than those monitored by the EPA (highlighting elevated levels in the existing environment). Maximum-recorded ambient PM_{10} concentrations were on average 38% lower than the Irish and EU 24-hour ambient air quality limit value (SI 271 of 2002 and 1999/30/EC).

Total Depositional Dust

Total dust deposition was measured at the site using Bergerhoff gauges specified in the German Engineering Institute VDI 2119 entitled "Measurement of Dustfall Using the Bergerhoff Instrument (Standard Method)." Samples were collected at five locations (i.e. A1 to A5) over a 30-day period. The purpose of these monitors is to assess the baseline total depositional dust impact in the vicinity of the current site. The results are presented in Table 3.6.7.

Table 3.6.7: Total depositional dust levels at each monitoring location

Sample Reference	Sampling Period	Total Dust Deposition (Summer Sampling Period) ($mg/m^2/day$)
A1	July to Aug 2007	66
A2	July to Aug 2007	78
A3	July to Aug 2007	94
A4	July to Aug 2007	62
A5	July to Aug 2007	87
EPA recommended Limit value	-	**350**

Currently in Ireland there are no statutory limits for dust deposition, however, EPA guidance suggest, "a soiling of $10mg/m^2$/hour is generally considered to pose a soiling nuisance" (TA Luft, 2002). This equates to $240mg/m^2$/day of Total Depositional Dust. The EPA recommend a maximum level of $350mg/m^2$day of dust deposition when measured according to TA Luft standard, which includes both soluble and insoluble matter (i.e. EPA compliance monitoring is based on the TA Luft Method). This value was not exceeded at any of the sample locations with all measured values at least 73% lower than the maximum recommended limit value.

Hydrogen Sulphide (H_2S)

H_2S is commonly associated with waste water handling operations. It is used as an indicator gas for the assessment of significant odour nuisance in the vicinity of waste water facilities. An ambient H_2S profile monitoring exercise was carried out in the vicinity of the proposed WWTP site and five pumping stations using a pre-calibrated H_2S analyser (Jerome metre). Samples were taken approximately 1.2 metres above ground level. The analyser is a real time analyser with a range of detection from 3 ppb to 50 ppm. Samples were collected at twelve locations (i.e. A1, to A12). In order to maintain clarity within the document all 5 individual monitoring locations in the vicinity of the pumping stations are presented as one value as the ambient H_2S concentration were below instrumental limits of detection. The purpose of this monitoring is to assess the baseline H_2S in the vicinity of the sites. The results are presented in Table 3.6.8.

Monitoring Location	Sampling Period	Ambient Air Concentration ($\mu g/m^3$)
A1-WWTP	July 2007	<4.50
A2-WWTP	July 2007	6.0
A3-WWTP	July 2007	6.0
A4-WWTP	July 2007	7.50
A5-WWTP	July 2007	<4.50
A6-WWTP	July 2007	<4.50
A7-WWTP	July 2007	<4.50
A8-Raffeen Pumping Station	July 2007	<4.50
A9-West Beach Pumping Station	July 2007	<4.50
A10-Monkstown Pumping Station	July 2007	<4.50
A11-Carrigaloe Pumping Station	July 2007	<4.50
A12-Church Rd Pumping Station (existing)	July 2007	<4.50
Recommended limit	-	**7.50**

Table 3.6.8: Hydrogen sulphide levels at each monitoring location

Currently in Ireland, there are no statutory limits for hydrogen sulphide concentrations in ambient air, however, guidance from the California Air Resources Board suggest an ambient air concentration level of less than 7.50 $\mu g/m^3$ to limit odour nuisance. This value was not exceeded at any of the sample locations. Elevated ambient concentrations above the lower limits of detection of the instrument method were detected at location A2, A3 and A4. There were no scheduled point emissions of Hydrogen sulphide in the vicinity of the site although; concentrations could be attributed to traffic movement on the nearby main road. Hydrogen sulphide is generated from side product reactions of exhaust emissions with the catalytic converter on diesel engines.

Speciated Volatile Organic Compounds (VOC's)

Speciated VOC's to include alkanes, mercaptans, organic acids, aromatics and nitrogen containing organics in ambient air at elevated concentrations can lead to the formation of odours. In order to ascertain the baseline levels of speciated VOC's in the vicinity of the proposed site location, ambient pumped sampling of VOC's was performed in order to ascertain the baseline profile of such compounds in order to generate a baseline profile during no operation of the WWTP. Samples were collected at two locations across the proposed WWTP site (i.e. A6 and A7), and at one location in the vicinity of each of the five pumping stations (i.e. A8 to A12). The results of the main VOC constituents are presented in Tables 3.6.9 to 3.6.15.

Table 3.6.9: Speciated VOC profile and concentrations in the vicinity of the proposed site location at monitoring location A6-WWTP

Compound Identity	Ambient Air Concentration (µg/m^3)
3-Butyn-1-ol	1.75
Benzaldehyde	0.58
Acetophenone	0.63
Nonanal	0.38
Decanal	0.40
Cyclododecane	0.56
Hexadecanal	0.99
Cyclohexadecane	13.20
Total VOC's	**26.02**

Table 3.6.10: Speciated VOC profile and concentrations in the vicinity of the proposed site location at monitoring location A7-WWTP

Compound Identity	Ambient Air Concentration (µg/m^3)
Benzaldehyde	0.65
Acetophenone	0.65
Nonanal	0.84
Decanal	0.66
Tetradecane	0.65
1-Hexadecene	0.57
Oxirane, tetradecyl-	1.49
Cyclohexadecane	4.09
Total VOC's	**25.64**

Table 3.6.11: Speciated VOC profile and concentrations in the vicinity of the proposed site location at monitoring location A8-Raffeen Pumping Station

Compound Identity	Ambient Air Concentration ($\mu g/m^3$)
2,5-Furandione, dihydro-3-methylene-	7.43
3(2H)-Thiophenone, dihydro-2-methyl-	1.02
2,2-Dichlorocyclopropanecarboxamide	6.05
Cyclohexan-1,4,5-triol-3-one-1-carboxylic acid	1.61
2,4-Diethyl-6-methyl-1,3,5-trioxane	12.20
1-Tetradecene	2.03
Cyclohexadecane	5.54
Oxirane, heptadecyl-	1.45
1-Nonadecene	16.90
Total VOC's	**74.03**

Table 3.6.12: Speciated VOC profile and concentrations in the vicinity of the proposed site location at monitoring location A9-West Beach Pumping Station

COMPOUND IDENTITY	AMBIENT AIR CONCENTRATION ($\mu g/m^3$)
2,5-Furandione, dihydro-3-methylene-	5.62
Formamide, N,N-dimethyl-	2.54
Ethanol, 2-butoxy-	2.19
Benzaldehyde	1.26
Acetophenone	0.82
Cyclotetradecane	1.03
1-Decanol, 2-hexyl-	19.44
1-Hexacosene	1.11
1-Heptadecanol	4.93
Total VOC's	**64.95**

Table 3.6.13: Speciated VOC profile and concentrations in the vicinity of the proposed site location at monitoring location A10-Monkstown Pumping Station

Compound Identity	Ambient Air Concentration ($\mu g/m^3$)
2,5-Furandione, dihydro-3-methylene-	4.23
Nonanal	3.32
Ethanol, 2-butoxy-	1.19
2-Propanol, 1-[2-(2-methoxy-1-methylethoxy)-1-methylethoxy]-	1.16
Acetophenone	1.25
Cyclotetradecane	1.20
1-Decanol, 2-hexyl-	6.89
2,4-Diethyl-6-methyl-1,3,5-trioxane	5.42
1-Heptadecanol	2.23
Total VOC's	**54.23**

Table 3.6.14: Speciated VOC profile and concentrations in the vicinity of the proposed site location at monitoring location A11-Carrigaloe Pumping Station

Compound Identity	Ambient Air Concentration ($\mu g/m^3$)
2,5-Furandione, dihydro-3-methylene-	5.42
2-Octanamine	0.66
Benzaldehyde	1.42
Acetophenone	1.22
2-Propanol, 1-[2-(2-methoxy-1-Methylethoxy)-1-methylethoxy]-	1.17
2,4-Diethyl-6-methyl-1,3,5-trioxane	2.43
Cyclohexadecane	5.05
1-Hexadecanol	2.38
Total VOC's	**36.78**

Table 3.15: Speciated VOC profile and concentrations in the vicinity of the proposed site location at monitoring location A12-Church Road Pumping Station (existing)

Compound Identity	Ambient Air Concentration ($\mu g/m^3$)
Propane, 1-(ethenylthio)-	0.72
Benzaldehyde	1.03
Acetophenone	0.84
Nonanal	1.11
Decanal	1.18
Cyclohexadecane	6.20
Hexadecanal	3.39
Cyclohexadecane	6.45
Eicosane	0.52
Total VOC's	**49.37**

Currently in Ireland, there are no statutory limits for total volatile organic compound concentrations in ambient air, however, research data gathered by Odour Monitoring Ireland suggest an ambient air concentration level of less than 250 $\mu g/m^3$ to limit odour impact. The compounds detected in ambient air would be typical of emissions detected close to busy roadways and in agricultural locations. No background concentrations of mercaptans or sulphur containing organics were detected and the absence of such compounds suggests in general that odour air quality is good in the vicinity of the site. The profiles can be compared with any additional profiles measured when the facilities are operational in order to ascertain any increases in ambient air concentrations of speciated VOC's. The overall background level of speciated VOC's as total VOC's is generally low in the vicinity of all site locations.

(ii) Odour

In terms of odour, the existing background will be dominated by the influence of the rural environment and to a lesser degree the coastal location. Currently the air quality is average to good with levels of criteria and baseline odour pollutants for traffic, industrial and residential derived pollution below the relevant Irish and European Union limits. No background concentrations of mercaptans or sulphur containing organics were detected and the absence of such compounds suggests in general that odour air quality is good in the vicinity of the site (detailed in *Volume III, Appendix 5A*).

As odour is not measurable in ambient air due to issues in sampling techniques, limit of detections for olfactometers and the inability to monitor continuously; therefore the existing odour is effectively omitted in the olfactometry assessment. Dispersion models become useful tools in odour impact assessments and odour risk analysis (as described in *Volume III, Appendix 5B* and the odour impact assessment in Section 3.6.4.2).

(iii) Climate

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 km^2 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, 2007). 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.

3.6.4 Impact Assessment

(i) Air

Construction Phase Impacts

There is the potential for a number of emissions to atmosphere during the construction of the development with wind blown dust being most significant. Wind blown dust emissions may arise during the construction phase of the proposed development, which may impact upon the surrounding environment. The deposition of dust and mud on the local roads is both unsightly and dangerous. Dust may be a particular problem during periods of dry windy weather.

Potential sources of dust from construction and operation include the following:

- Vehicles carrying dust on their wheels,
- Un-vegetated stockpiles of construction materials,
- The handling of construction materials for the construction phase of the development,
- The generation of dust from the recycling activities to be carried out indoors within the facility.

The construction and operation vehicles, generators, etc., will also give rise to petrol and diesel exhausts emissions, although this is of minor significance compared to dust.

Operational Phase Impacts

Regarding operations at the proposed development, the activities to be located in the development are waste water treatment activities. All equipment generating dust emissions will contain localised dust abatement equipment where necessary in order to prevent the release of dust to atmosphere.

'Do Nothing' Impact

The baseline survey results suggest that air quality in the vicinity of the proposed development is average/good and shows typical levels for a rural and suburban area with all pollutants within the relevant Irish and EU limits. The air quality may improve slightly in future years due to improvements in engine technology and greater controls on petrol, diesel, coal and gas composition and purity. If the proposed development were not to take place, the current air pollutant concentrations will remain unchanged followed by potential decreases in future years for the reasons outlined above. In relation to dust, non-development of the site would result in no movement of soils/sands and no construction activity and therefore no dust creation as a result of construction works. Other factors which may alter background dust concentrations is beyond the scope of this assessment.

'Worst Case Scenario' Impact

For traffic-derived pollutants, the "worst-case" scenario consists of gridlock conditions with large volumes of traffic on the road, simultaneously. This has been accounted for within the model whereby it is predicted that traffic movements will occur simultaneously on the road network. In addition gridlock is also assessed.

The DMRB predictive model employed (refer to *Volume III, Appendix 5A*) is a screening model that is used to generate worst-case scenario predictions for air quality. If this model indicates that pollutant levels will not breach the Irish and EU limits, then it can be assumed with some confidence that a project will not produce air pollution problems if none are identified by this method. There are no predicted breaches of Irish and EU legislation for DMRB design year and 2023. As a result of these model predictions it may be concluded that the worst-case impact of the traffic alterations associated with the proposed development are predicted to be a slight negative.

(ii) Odour

Construction Phase Impacts

During the construction phase, odour impacts are not predicted due to the nature of the activities.

Operational Phase Impacts

The contractor will be required to meet the following impact criteria for both the WWTP and pumping stations:

- All sensitive locations and areas of amenity should be located outside the 1.50 Ou_E m^{-3} at the 98th percentile of hourly averages over a meteorological year
- All sensitive locations and areas of amenity should be located outside the 3.0 Ou_E m^{-3} at the 99.5th percentile of hourly averages over a meteorological year
- The hedonic tone should not be considered unpleasant (scale greater than –2) as assessed in accordance with VDI 3882:1997, part 2; ('Determination of Hedonic) for all emission points

An odour modelling assessment has been carried out for the WWTP and pumping stations based on the specimen design (Indicative Design Nr. 1, refer to Section 2.5.5). A worst-case odour-modelling scenario was chosen to estimate worst-case odour impact from the proposed Cork Harbour Main Drainage Scheme WWTP and five pumping stations following the incorporation of odour management systems (i.e. five years of met data, predicted odour emission rate, etc.).

This will allow for the predictive analysis of any potential impact on the neighbouring sensitive locations while the WWTP and pumping stations are in operation. It will also allow the operators of the WWTP and pumping station site to assess the effectiveness of their suggested odour abatement/minimisation strategies. The intensity of the odour from two or more sources of the WWTP operation will depend on the strength of the initial odour threshold concentration from the sources and the distance downwind at which the prediction and/or measurement is being made. Where the odour emission plumes from a number of sources combine downwind, then the predicted odour concentrations may be higher than that resulting from an individual emission source. It is important to note that various odour sources have different odour characters. This is important when assessing those odour sources to minimise and/or abate. Although an odour source may have a high odour emission rate, the corresponding odour intensity (strength) may be low and therefore it is easily diluted. Those sources that express the same odour character, as an odour impact should be investigated first for abatement/minimisation before other sources are examined as these sources are the driving force behind the character of the perceived odour.

Dispersion Model: AERMOD Prime was used to determine the overall odour impact of the proposed Cork Harbour Main Drainage Scheme WWTP and pumping stations operation. The output data was analysed to calculate:

Scenario 1 - WWTP

- Predicted odour emission contribution of overall proposed WWTP operation to surrounding population, to odour plume dispersal at the 98th percentile for an odour concentration of less than or equal to 1.50 Ou_E m^{-3}

- Predicted odour emission contribution of overall proposed WWTP operation to surrounding population, to odour plume dispersal at the 99.5th percentile for an odour concentration of less than or equal to 3.0 $Ou_E\ m^{-3}$
- Predicted odour emissions contribution of individual grouped Odour Control Units to surrounding population, to odour plume dispersal at the 98th percentile for an odour concentration of less than or equal to 0.30 Ou_E/m^3
- Predicted odour emissions contribution of individual grouped Aeration, Secondary settlement and Storm water tankage sources to surrounding population, to odour plume dispersal at the 98th percentile for an odour concentration of less than or equal to 1.50 Ou_E/m^3

These odour impact criterions were chosen for the WWTP in order to ascertain the level of proposed impact to the surrounding residential and industrial population in the vicinity of the proposed WWTP.

The plotted odour concentrations of ≤ 1.50 $Ou_E\ m^{-3}$ for the 98th percentile and ≤ 3.0 $Ou_E\ m^{-3}$ for the 99.5th percentile for the proposed Cork Harbour Main Drainage Scheme WWTP specimen design operation are illustrated in *Figure 3.6.7 and Figure 3.6.8*, respectively. As can be observed for the 98th percentile contour, it is predicted that odour plume spread is small with a radial spread of 80 metres from the boundary of the facility in a northerly direction. In accordance with odour impact criterion and in keeping with currently recommended odour impact criterion in this country, no long-term odour impacts will be generated by receptors in the vicinity of the future proposed WWTP.

In terms of the 99.5th percentile of hourly averages over five years of meteorological data, the overall odour plume spread is similar with a radial spread of 75 metres in a northerly and easterly direction. In accordance with odour impact criterion and in keeping with currently recommended odour impact criterion in this country, no short-term odour impacts will be generated by receptors in the vicinity of the future proposed WWTP.

Figures 3.6.9 and 3.6.10 illustrates the odour plume spread for individual grouped odour sources to include odour control units (OCU 1 to 5) and tankage odour sources – aeration tankage, secondary settlement and storm water tankage. As can be observed, the main contributor of odour to the actual plume spread is the aeration, secondary settlement and storm water tankage. All other offensive odour sources will be covered, sealed and negatively ventilated and odorous air directed to odour control units (two stages of odour control if biological treatment is chosen as first stage). The maximum predicted ground level concentration for OCU 1 to 5 will be less than 0.41 Ou_E/m^3 at the 98th percentile of hourly averages over 5 years of meteorological data (odour threshold concentration of less than 300 Ou_E/m^3 for OCUs 1, 2, 4, and 5 and less than 500 Ou_E/m^3 for OCU 3; refer to Table 3.6.16). The overall stack heights of each OCU are 12 m high from ground level with an efflux velocity greater than 15 m/s.

It should be noted that in terms of the number of odour treatment units, the contractor will be required to ensure that odour emission rates do not exceed 2,314 $Ou_E\ s^{-1}$ whether 3, 4 or 5 OCUs are utilised within the design (i.e. must achieve the total odour emission of 6,611 Ou_E/s from the WWTP and also at minimum the total treatment volume 6.20 m^3/s and a total odour emission rate of less than or equal to 2,314 $Ou_E\ s^{-1}$ from the odour control units, refer to Table 3.6.16).

Scenario 2 - Pumping Stations

Based on the proposed design (Indicative Design Nr.1) plotted odour concentrations for the 98th of hourly averages were generated for the five major pumping stations (four proposed and one existing). Maximum ground level concentrations ranged from 0.15 to 0.34 Ou_E/m^3 for the 98th percentile. This is up to 77 - 90% lower than the odour impact criterion presented in Section 3.6.2. In accordance with odour impact criterion, no long-term odour impacts will be perceived in the vicinity of the pumping stations (refer to *Volume III, Appendix 5B*).

Minor pumping stations were not assessed as it was anticipated that impacts predicted for the major pumping stations would be greater than that for minor pumping stations.

The implementation of odour management systems at each pumping station will minimise the uncontrolled release of fugitive odour emissions. An odour management system (e.g. good design in terms of odour management, tight fitting covers, etc.) will be required to minimise the uncontrolled release of fugitive odour emissions and prevent complaints from the public at large.

The dispersion model incorporated odour emission rates identified in Table 3.6.17. Since the overall predicted odour emission rate from the five major pumping stations is low (due to the small nature and characteristics of the odour source). Taking this low impact into account, there is no requirement to perform risk analysis using the 99.5th percentile assessment criterion, as the predicted odour impact criterion will always be below this level.

Table 3.6.16: Predicted overall odour emission rate from proposed Cork Harbour Main Drainage Scheme WWTP specimen design with the incorporation of odour mitigation protocols

Source Identity	Area (M^2)	Odour Emission Flux ($ou_e/m^2/s$)	Volumetric Airflow Rate (m^3/s)	Odour Threshold Concentration (ou_e/m^3)	Odour Emission Rate (ou/s)	% Contribution
Inlet works - Primary treatment building	0	See OCU emission rate		-	0	0
Primary settlement tank 1	0	See OCU emission rate	-	-	0	0
Primary settlement tank 2	0	See OCU emission rate	-	-	0	0
Primary settlement tank 3	0	See OCU emission rate	-	-	0	0
Storm water tank 1	952.47	0.50		-	476	7.20
Storm water tank 2	952.47	0.50		-	476	7.20
Aeration tank	1200	1.20		-	1440	21.78
Secondary settlement tank 1	952.47	0.50		-	476	7.20
Secondary settlement tank 2	952.47	0.50		-	476	7.20
Secondary settlement tank 3	952.47	0.50		-	476	7.20
Secondary settlement tank 4	952.47	0.50		-	476	7.20
OCU 1 - Inlet works building OCU	-	-	1.0	300	300	4.54
OCU 2 - Primary settlement tanks/Flow splitting chambers OCU	-	-	0.93	300	279	4.22
OCU 3 - Sludge holding tanks/Digesters/Sludge drier OCU	-	-	2.27	500	1135	17.17
OCU 4 - Primary sludge storage OCU	-	-	1	300	300	4.54
OCU 5 - Secondary sludge treatment OCU	-	-	1	300	300	4.54
Total odour emission rate	**-**	**-**	**-**	**-**	**6,611**	**100**

Table 3.6.17: Predicted overall odour emission rate from the five major pumping stations with the incorporation of good design and odour management systems (i.e. tight fitting covers, etc.)

Source Identity	Odour Emission Rate (ou_e/s)
Raffeen PS OCU	90
West beach PS OCU	360
Monkstown PS OCU	120
Church Rd PS OCU	81
Carrigaloe PS OCU	51

'Do Nothing' Impact

If the development does not proceed, the odour environment of the area would continue to be subject to existing prevailing influences.

'Worst Case Scenario' Impact

It is considered that the "Worst-Case Scenario" Impact for the odour would arise from ineffective management of the plant and consequently the plant causing a significant odour impact.

(iii) Climate

Construction and Operational Phase Impacts

There is a potential for impacts to climate as a result of any development that requires fuel and energy. These impacts are the generation of greenhouse gas emissions (principally carbon dioxide and oxides of nitrogen) from traffic and electrical supply.

The potential effects of climate change on a global scale have been investigated by the Intergovernmental Panel on Climate Change (IPCC). The resulting impacts in Ireland are outlined in the National Climate Change Strategy and recently by the EPA and include the following:

- Significant increases in winter rainfall, of the order of 10% in the southeast, with a corresponding increase in the water levels in rivers, lakes and soils. Serious flooding more frequent than at present
- Lower summer rainfall, of the order of 10% in the southern half of the country. Less recharge of reservoirs in the summer leading to more regular and prolonged water shortages than at present. Loss of bog land due to regular water deficits
- Increased agricultural production, with new crops becoming more viable and potentially reduced agricultural costs. Grass growth could enjoy beneficial effects with an increase in 20% possible with higher temperatures and changes in rainfall patterns
- The development will be designed to take account of changes in rainfall intensity and mean sea level rise

These figures for climate change refer to year 2100. The specimen design is for up to the year 2030.

It is recognised that Ireland cannot, on its own, prevent or ameliorate the impacts of climate change. However, the National Climate Change Strategy states that Ireland must meet its responsibilities with regard to reducing CO_2 emissions in partnership with the EU and the global community. In terms of this specimen design, the generation of biogas and utilisation of generated biogas in a gas utilisation engine/boiler will offset CO_2 eq. emissions generated by the WWTP.

Road traffic and power usage would be expected to be the dominant sources of greenhouse gas emissions as a result of the proposed development. Vehicles and power used to operate the plant will give rise to CO_2 and NO_2 emissions as a result of the proposed development. For the purposes of this assessment, it is estimated that the number of vehicles accessing the site on a weekly basis (when operational) will be 12 vehicles for truck movements and approximately 60 vehicle movements per week for small vehicles such as passenger cars. This will lead to the emission of 139 tonnes of CO_2 per annum, which is equivalent to 0.00000175% of the National Emissions in Ireland in 2008 to 2012 (assuming a driving radius of 30km from the facility and a payload of 13 tonnes).

With reference to relevant evaluation criteria such as the Kyoto Protocol, which has set objectives to be achieved by 2008 – 2012, GHG emissions as a result of this proposal will be imperceptible.

'Do Nothing' Impact

If the development does not proceed, the general climate of the area would continue to be subject to existing prevailing influences.

'Worst Case Scenario' Impact

Due to the nature and scale of the development, it is considered that there are no impacts arising which could affect the general climate of the area, either regionally or locally.

3.6.5 Mitigation Measures

(i) Air

Construction Phase

Construction activities are likely to generate some dust emissions. The potential for dust to be emitted depends on the type of construction activity being carried out in conjunction with environmental factors including levels of rainfall, wind speed and wind direction. In order to ensure that no dust nuisance occurs, a series of measures will be implemented and incorporated into the Construction Environmental Plan (CEMP). Site roads shall be regularly cleaned and maintained as appropriate. Hard surface roads shall be swept to remove mud and aggregate materials from their surface as a result of the development. Any un-surfaced roads shall be restricted to essential site traffic only. Furthermore, any road in the vicinity of the development that has the potential to give rise to dust may be regularly watered, as appropriate, during extended dry and/or windy conditions.

A full traffic management plan and dust management plan will be implemented into the CEMP in order to minimise such emission as a result of the construction phase of the development. This will be generated specifically for the development when detailed design is completed.

Vehicles using site roads shall have their speed restricted, and this speed restriction must be enforced rigidly. On any un-surfaced site road and on hard surfaced roads that site management dictates speed shall be restricted to 20 km per hour.

Material handling systems and site stockpiling of materials shall be designed and laid out to minimise exposure to wind. Water misting or sprays shall be used as required if particularly dusty activities are necessary during dry or windy periods.

In relation to the completion of the proposed development, the hard standing surface, and all roads will be tarmacadamed/concreted. In periods of dry weather when dust emission would be greatest, a road sweeper, which would also dampen the road, may be employed in order to prevent the generation of dust.

It is envisaged that the proposed development will not have a significant impact on the surrounding air quality. However, as discussed previously a number of dust mitigation measures have been suggested. Moreover, dust monitoring could be carried out during the construction phase of the development if deemed necessary by the planning authority. If the level of dust is found to exceed 350mg/m^{2}day in the vicinity of the site (using Bergerhoff gauges), further mitigation measures will be incorporated into the construction of the proposed site.

Operational Phase

It is not anticipated that dust will be a significant problem during the operation of the development. All sources generating dust will operate dust management equipment as required.

Depositional dust monitoring will be carried out during the operation phase of the development if deemed necessary by the regulatory authority. If the level of dust is found to exceed 350mg/m^{2}day in the vicinity of the site, further mitigation measures will be incorporated into the operation of the proposed site.

Emissions of pollutants from road traffic can be controlled by either controlling the number of road users or by controlling the flow of traffic. For the majority of vehicle-generated pollutants, emissions rise as speed drops. Emissions are also higher under stop-start conditions when compared with steady speed driving. Since the development will generate only small volumes of traffic, emissions from such activities were predicted to be minimal.

It is envisaged that the proposed development will not have a significant impact on the surrounding air quality.

(ii) Odour

Construction Phase

Since the impact of the scheme during the construction phase in terms of odour is not significant, measures to mitigate odour impacts are not required.

Operational Phase

The following recommendations were developed during the study:

- Odour management, minimisation and mitigation procedures will be implemented at the proposed Cork Harbour Main Drainage Scheme WWTP and each pumping station in order to prevent any odour impact in the surrounding vicinity
- The maximum allowable odour emission rate from the overall proposed WWTP should not be greater than 6,611Ou_E s^{-1} (*refer to Table 3.6.16*) inclusive of the odour emission contribution from the abatement systems installed on the primary treatment, pumping and sludge handling processes. The maximum overall odour emission rate from the odour control units shall be no greater than 2,314 Ou_E s^{-1} (with an exhaust stack concentration of less than 300 Ou_E/m^3 for OCU 1, 2, 4 and 5 and less than 500 Ou_E/m^3 for OCU 3, respectively). The specimen design suggests the use of three OCUs. As long as the total odour emission rate for the WWTP (i.e. 6,611Ou_E s^{-1}) is achieved along with the total minimum odour treatment volume (i.e. 6.20 m^3/s) and a total odour emission rate from the OCUs of less than or equal to 2,314 Ou_E s^{-1} is similar, then the number of OCUs utilised onsite is not important. The hedonic tone of this odour should not be considered unpleasant (Scale greater than –2) as assessed in accordance with VDI 3882:1997, part 2; ('Determination of Hedonic) for all emission points
- The odour management systems to be installed upon Raffeen, Carrigaloe, West Beach, Monkstown and Church Road should be sufficient to prevent any uncontrolled fugitive odours escaping from the system. In addition any odour management system incorporated into the design and upgrade of the pumping stations (both minor and major) should be capable of achieving less than 1.5 Ou_E/m^3 at the 98th percentile and less than 3.0 Ou_E/m^3 at the 99.5th percentile of hourly averages
- Maintain good housekeeping practices (i.e. keep yard area clean, etc.), closed-door management strategy (i.e. to eliminate puff odour emissions from sludge dewatering building), maintain sludge storage within sealed airtight containers and to implement an odour management plan for the operators of the WWTP and all pumping station. All odorous processes such as inlet works, primary treatment, and thickening will be carried out indoors/enclosed tankage
- Avoid accumulation of floating debris and persistent sediments in channels and holding tanks by design (i.e. flow splitters and secondary sedimentation tanks, etc.). Techniques to eliminate such circumstances shall be employed
- Enclose and seal all primary treatment, wet wells and sludge handling processes
- Operate the proposed WWTP within specifications to eliminate overloading and under loading, which may increase septic conditions within the processes
- Odour scrubbing technologies employing will be implemented within the proposed Cork Harbour Main Drainage Scheme WWTP. An odour management system will be implemented upon each pumping station (both minor and major)
- When operational, it is recommended that the contractor should provide evidence through the use of dispersion modelling (AERMOD Prime) and olfactometry measurement (in accordance with EN13725:2003), that the as built WWTP and pumping stations are achieving the overall mass emission rate of odour and emission limit values for the installed odour management systems

(iii) Climate

All space heating and energy requirements for the proposed development should be designed in accordance with best practice. The Building Regulations 2002 "Technical Guidance Document Part L – Conservation of Fuel an Energy Dwellings" should be used as a reference for best practice in order to reduce the impact of the proposed development on greenhouse gas emissions.

Since it is envisaged that the proposed facility will have no impacts on the regional and local climate, no specific mitigation measures are deemed necessary.

3.6.6 Residual Impacts

(i) Air

Construction Phase

The effect of construction of the facility on air quality will not be significant following the implementation of the proposed mitigation measures. The main environmental nuisance associated with construction activities is dust. However, it is proposed to adhere to good working practices and dust mitigation measures to ensure that the levels of dust generated will be minimal and are unlikely to cause an environmental nuisance. A series of such good working practices and mitigation measures are outlined earlier in Section 3.6.5.

Operational Phase

The predicted increases in traffic volumes as a result of the development along the existing road network are expected to be very low. The information on traffic provided in the traffic section of the Statement has been used to identify whether any significant impact on sensitive receptors will occur. The traffic information has been input into the Design Manual for Roads and Bridges (DMRB), Volume 11 (February 2003) model. This model was prepared by the United Kingdom Department of Transport, the Scottish Office of Industrial Development, the Welsh Office and the Department of Environment for Northern Ireland as a screening tool to assess worst-case air quality impact associated with roads developments. The screening model uses a worst-case scenario in calculating emissions. The emission factors used for each pollutant are intentionally biased to overestimate the actual emission rate. It is assumed that a total of 4 AADT movements per day for HGVs and a maximum 12 AADT movements per day for LGV/cars (i.e. to and from the site).

The DMRB only assesses the potential impacts from traffic up to and including the year 2023. Even though the development design period goes beyond this date, this is not considered significant since impacts are expected to be even lower beyond this date due to improvements in engine technology etc. The impacts associated with the proposed development are well within the ground level impact concentrations in year 2023 (as predicted by the model). Using the model, concentrations of Carbon Monoxide, Benzene, Oxides of Nitrogen and PM_{10} (particulate matter with an average 10 µm aerodynamic diameter), have been determined for a receptor point road along the road L2490 (Fernhill Rd).

The computer model predictions indicate the following findings:

- Ambient concentrations will, in general, decrease due to legislation driven improvements in engine technology and fuel content. Any increases will be slight.
- There will be negligible increases in NO_2 and PM_{10} concentrations as the development phase is implemented.
- The net impact of the proposed development will be a slight negative for NO_2 and PM_{10} but will remain well within the Irish and EU legislative limit values.

(ii) Odour

A worst-case odour emission scenario was modelled using the atmospheric dispersion model AERMOD Prime with meteorology data representative of the study area. A worst-case odour emission data set was used to predict any potential odour impact in the vicinity of the proposed Cork Harbour Main Drainage Scheme WWTP and five pumping stations. Odour impact potential was discussed for proposed operations with the implementation of mitigation protocols. It was concluded that for Cork Harbour Main Drainage Scheme WWTP:

- In accordance with odour impact criterion, and in keeping with current recommended odour impact criterion in this country, no odour impact will be perceived by sensitive receptors in the vicinity of the proposed Cork Harbour Main Drainage Scheme WWTP following the installation of proposed odour management, minimisation and mitigation protocols assuming specimen design. As can be observed, the overall odour emission rate from the new proposed Cork Harbour Main Drainage Scheme WWTP will be no greater than 6,611 Ou_E/s based on the specimen design.
- All residents/industrial neighbours in the vicinity of the proposed Cork Harbour Main Drainage Scheme WWTP will perceive an odour concentration at or less than 1.50 Ou_E m^{-3} for the 98th percentile and less than 3.0 Ou_E/m^3 for the 99.5th percentile for five years of meteorological data (refer to Figures 3.6.7 and 3.6.8). Those odour sources considered most offensive (inlet works, primary treatment and holding tanks, centrate, filtrate, sludge, RAS/WAS pump sumps, flow splitting chambers and all sludge handling processes including tankage will be effectively contained and ventilated to an odour control system and therefore the overall risk of any resident/industrial neighbours detecting odour will be negligible since the major odour sources contributing to the remaining odour plume are considered low risk in term of odour. These sources include the aeration tankage, secondary settlement tankage and storm water tankage (refer to Figures 3.6.9 and 3.6.10).

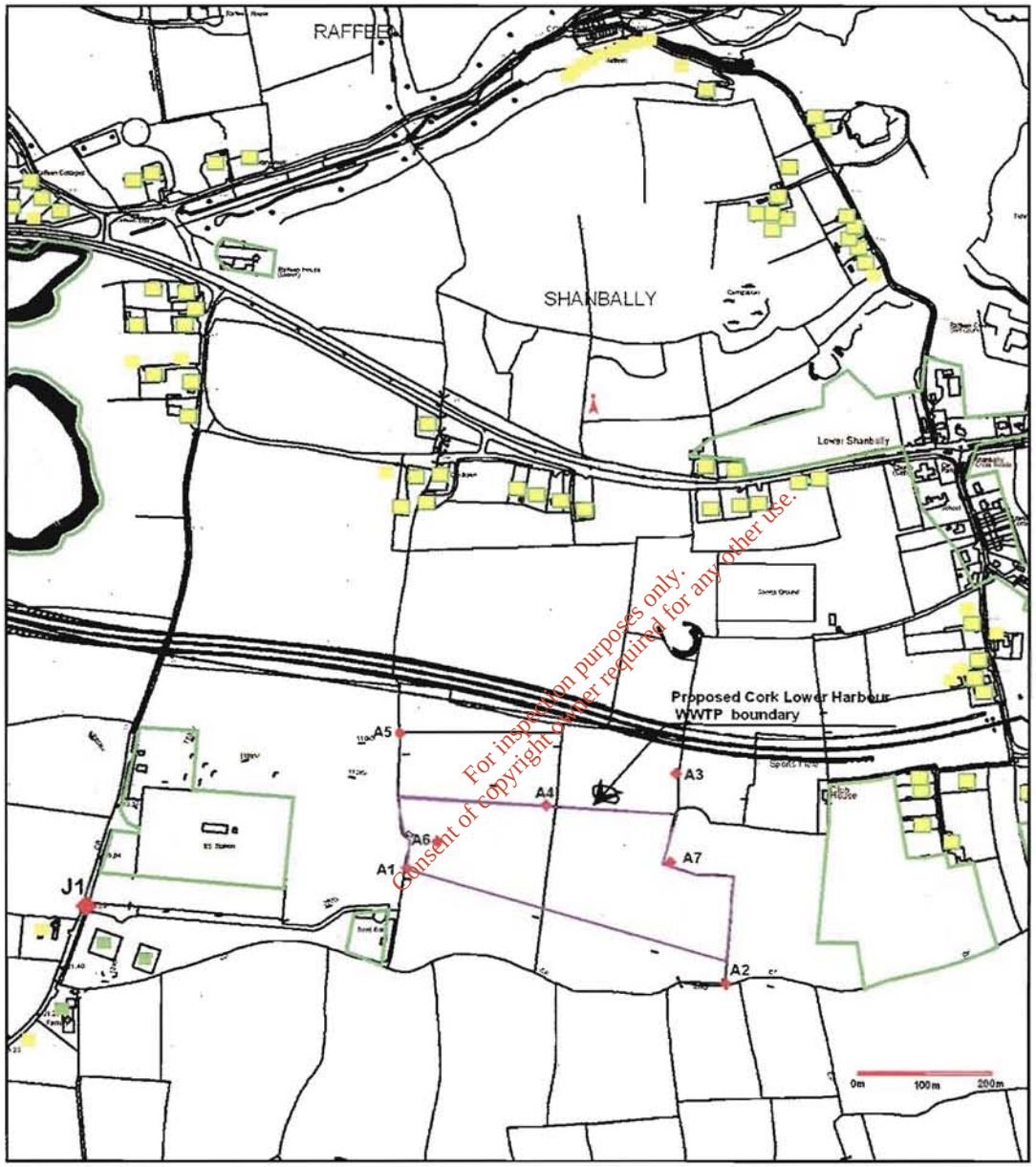
It was concluded that for Pumping Stations:

- In accordance with odour impact criterion, and in keeping with current recommended odour impact criterion in this country, no odour impact will be perceived by sensitive receptors in the vicinity of the major pumping stations Raffeen, West Beach, Monkstown, Church Road and Carrigaloe pumping stations following the implementation of good design in terms of odour management (e.g. tight fitting covers, etc.).
- All residents/industrial neighbours in the vicinity of the proposed pumping stations will perceive an odour concentration at or less than 1.50 Ou_E m^{-3} for the 98th percentile and less than 3.0 Ou_E/m^3 for the 99.5th percentile for five years of meteorological data (refer to *Volume III, Appendix 5B*). All pumping station (both minor and major) will incorporate the use of an odour management system (e.g. good design in terms of odour minimisation, tight fitting covers etc.) to ensure no fugitive release of odours from each pumping station. In addition, each pumping station will be regularly visited so as to ensure efficient operation of the odour management system.

- It is acknowledged that many of the pumping stations are located in populous areas. For this reason the design of the collection system will include best practice and adequate odour management systems to prevent odour complaint and impact.

(iii) Climate

No significant residual impacts are envisaged.



NOTE:
RECEPTOR LOCATION J1 WAS USED FOR ASSESSING THE MAXIMUM PREDICTED EMISSIONS ASSOCIATED WITH TRAFFIC GENERATION AS A RESULT OF THE WWTP OPERATION PHASE.

FIGURE 3.6.1 OVERVIEW OF MONITORING LOCATIONS A1 TO A7 AND RECEPTOR LOCATION J1 (SEE NOTE) IN THE VICINITY OF THE PROPOSED CORK HARBOUR MAIN DRAINAGE SCHEME WWTP

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CORK HARBOUR MAIN DRAINAGE SCHEME
ENVIRONMENTAL IMPACT STATEMENT
JOB NR. 234541
DRG NR. 5670FG178

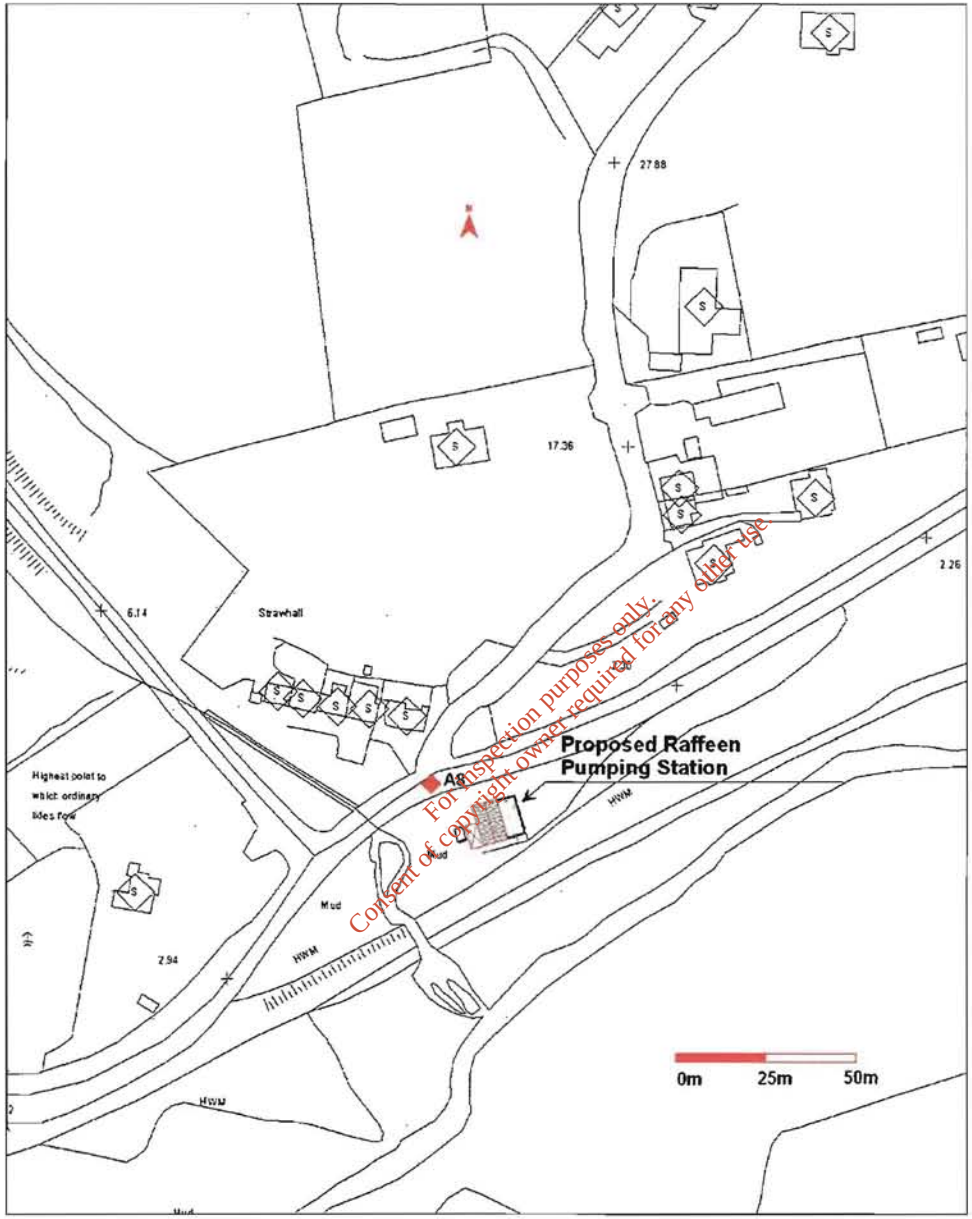

FIGURE 3.6.2 OVERVIEW OF MONITORING LOCATION A8 IN THE VICINITY OF THE PROPOSED RAFFEEN PUMPING STATION

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CORK HARBOUR MAIN DRAINAGE SCHEME
ENVIRONMENTAL IMPACT STATEMENT
JOB NR. 234541
DRG NR. 5670FG173

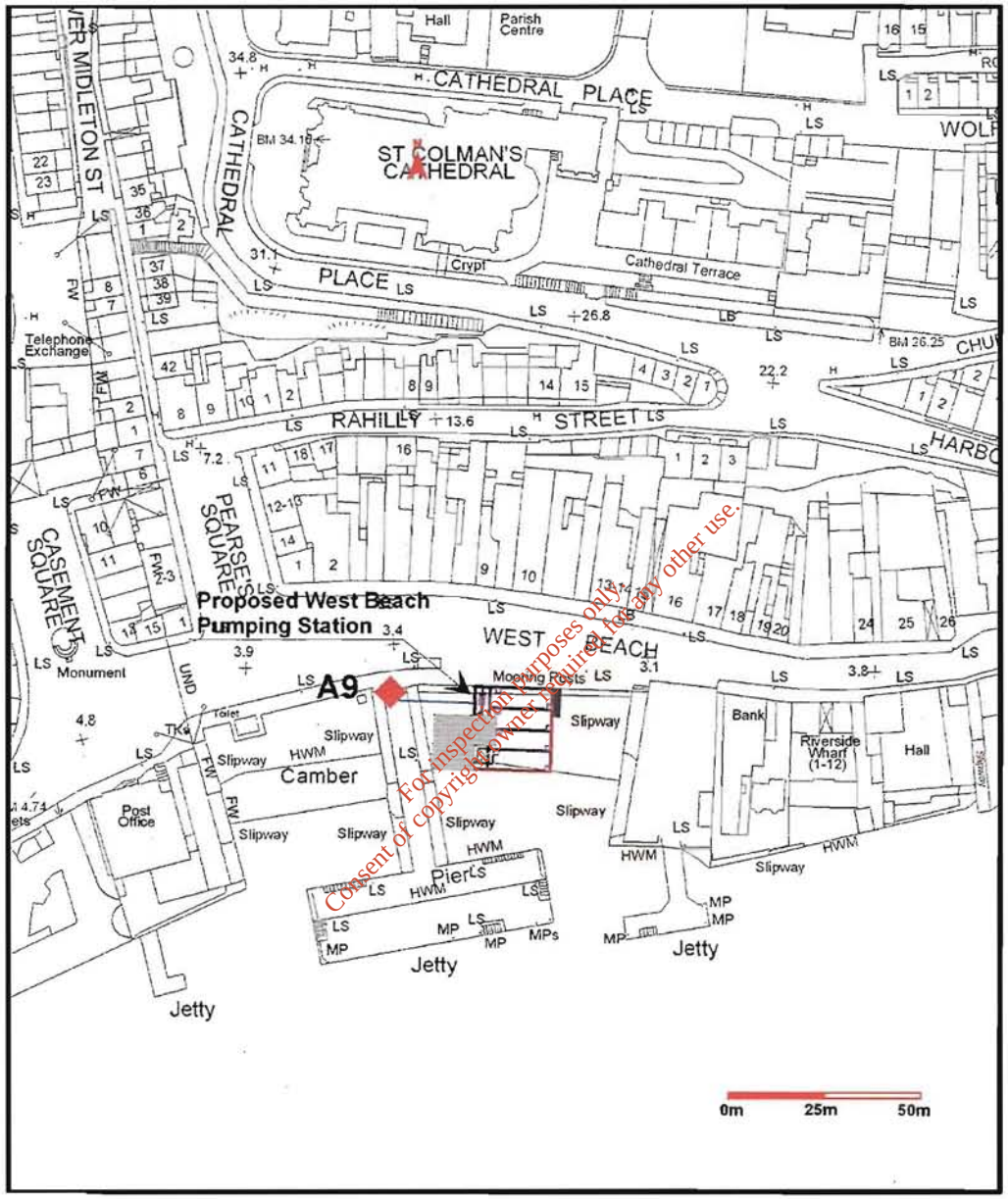

FIGURE 3.6.3 OVERVIEW OF MONITORING LOCATION A9 IN THE VICINITY OF THE PROPOSED WEST BEACH PUMPING STATION

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CORK HARBOUR MAIN DRAINAGE SCHEME
ENVIRONMENTAL IMPACT STATEMENT
JOB NR. 234541
DRG NR. 5670FG174

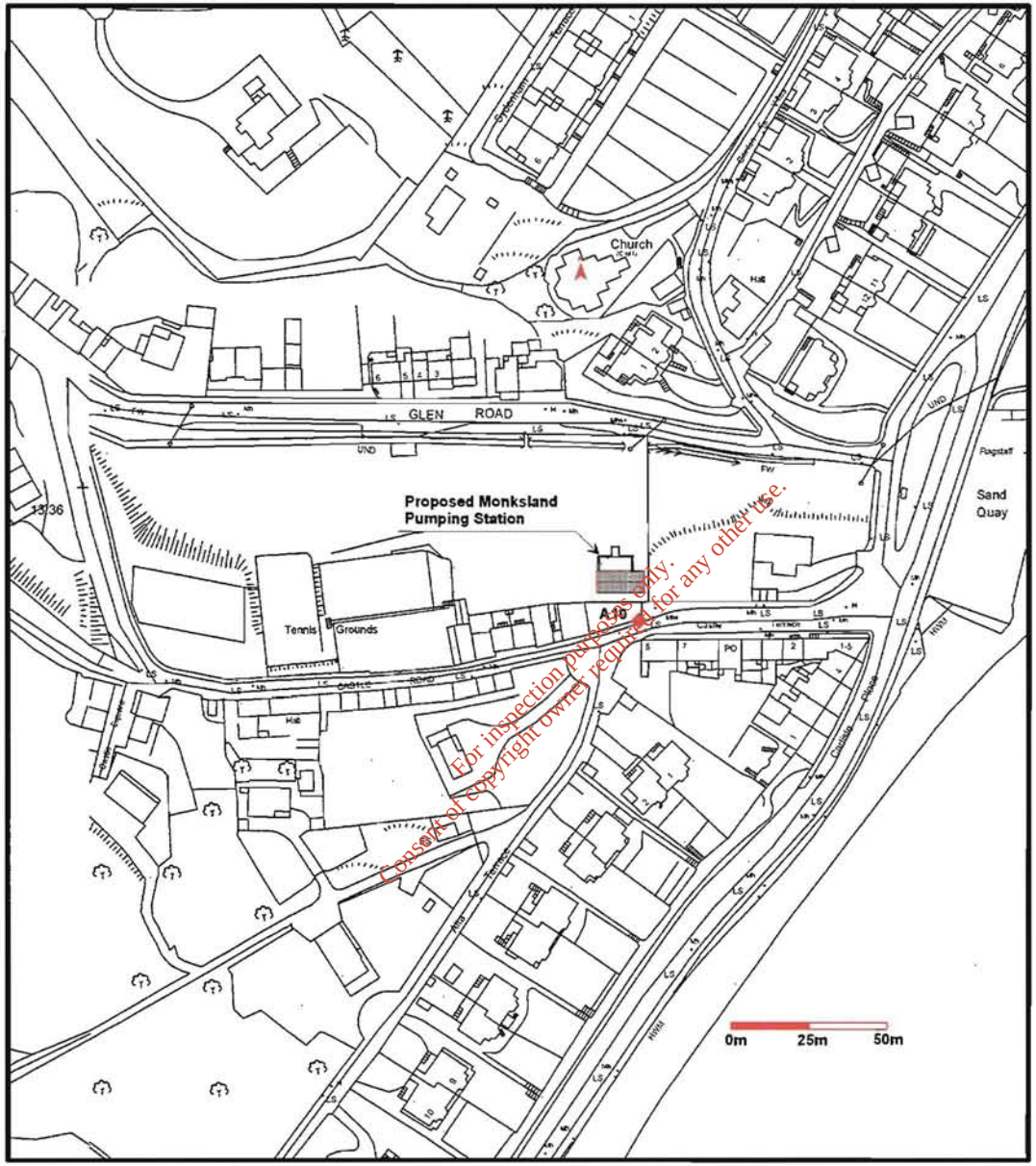

FIGURE 3.6.4 OVERVIEW OF MONITORING LOCATION A10 IN THE VICINITY OF THE PROPOSED MONKSTOWN PUMPING STATION

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CORK HARBOUR MAIN DRAINAGE SCHEME
ENVIRONMENTAL IMPACT STATEMENT
JOB NR. 234541
DRG NR. 5670FG175

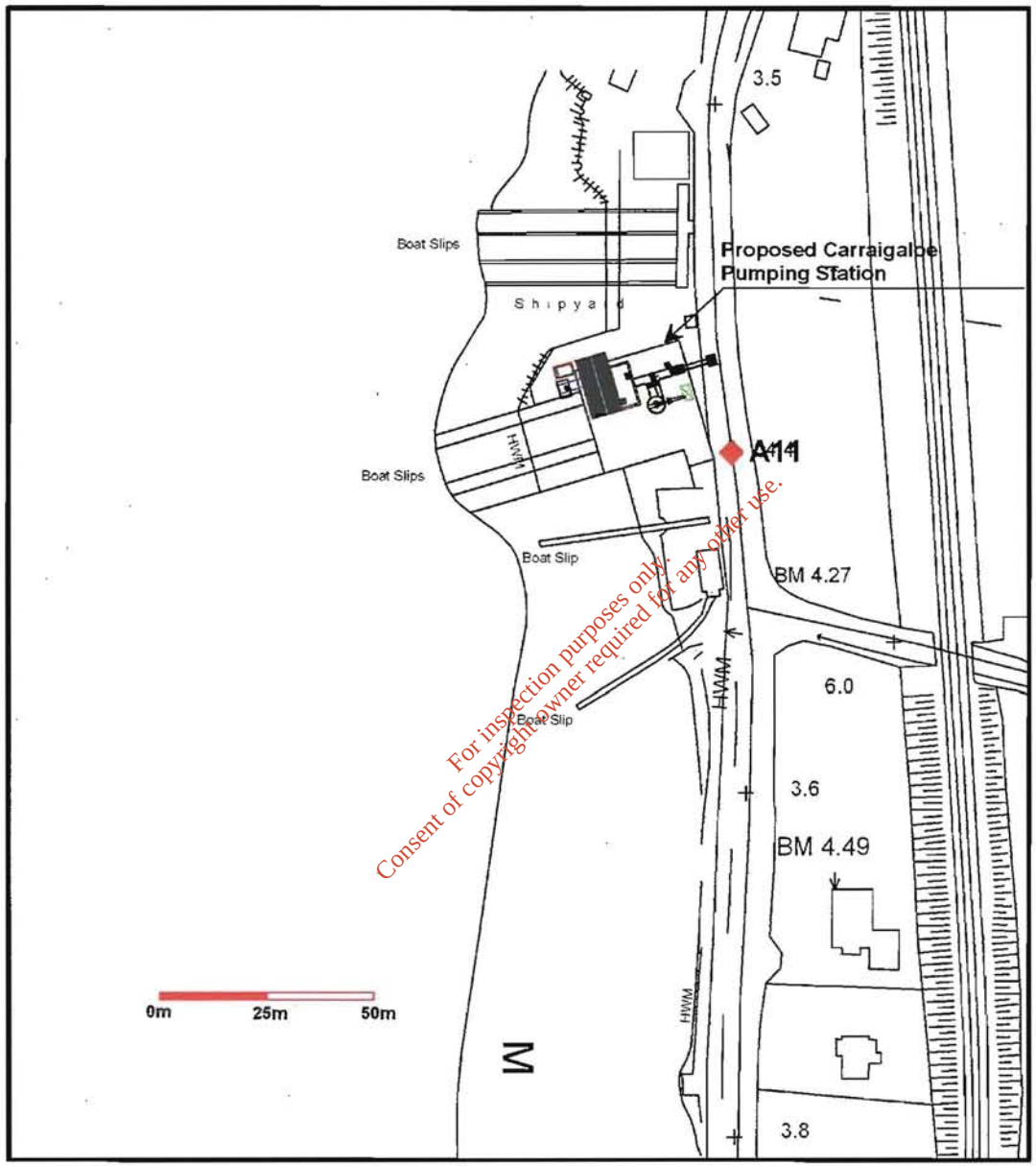

FIGURE 3.6.5 OVERVIEW OF MONITORING LOCATION A11 IN THE VICINITY OF THE PROPOSED CARRIGALOE PUMPING STATION

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CORK HARBOUR MAIN DRAINAGE SCHEME
ENVIRONMENTAL IMPACT STATEMENT
JOB NR. 234541
DRG NR. 5670FG176

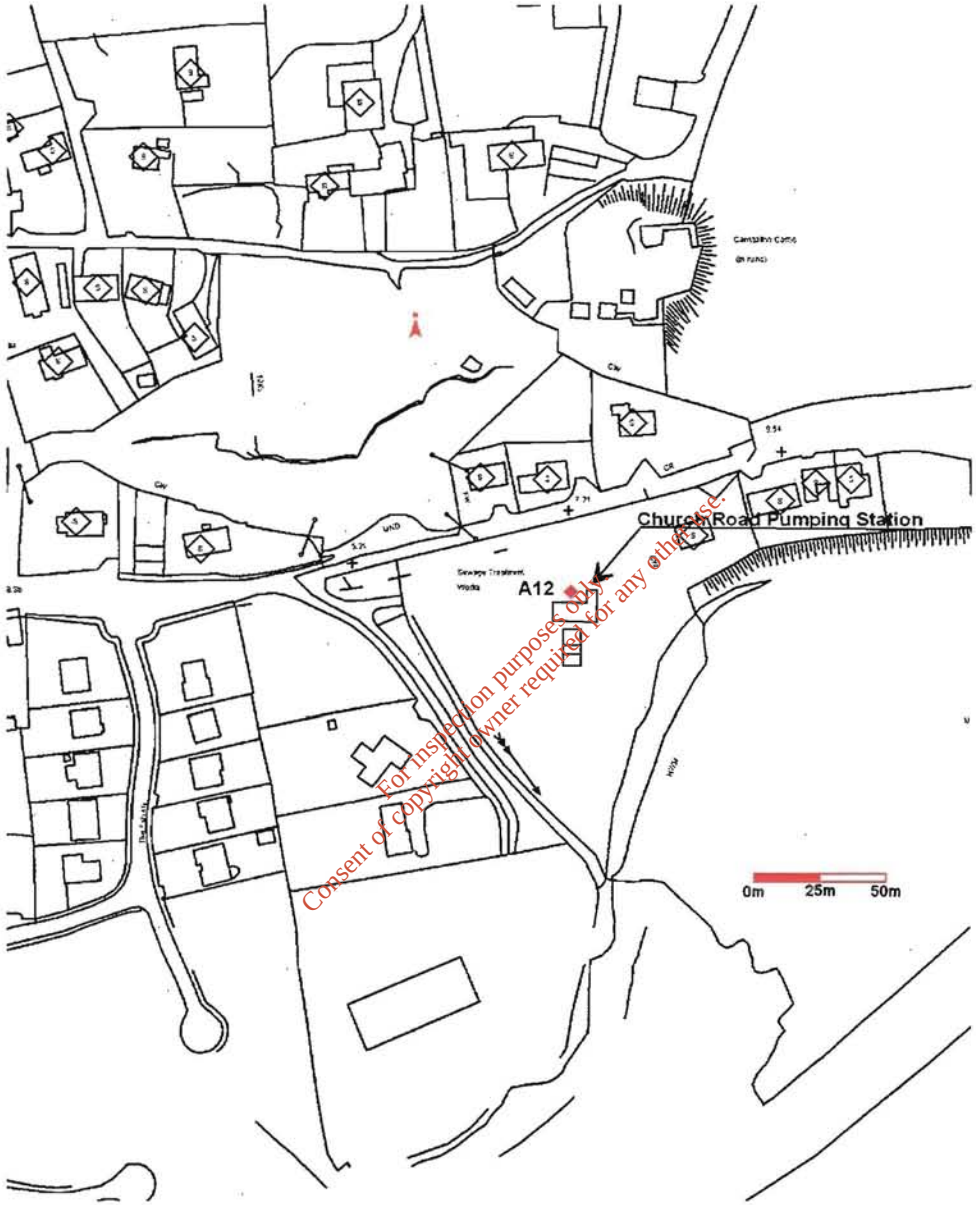

FIGURE 3.6.6 OVERVIEW OF MONITORING LOCATION A12 IN THE VICINITY OF THE PROPOSED CHURCH ROAD PUMPING STATION

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CORK HARBOUR MAIN DRAINAGE SCHEME
ENVIRONMENTAL IMPACT STATEMENT
JOB NR. 234541
DRG NR. 5670FG177

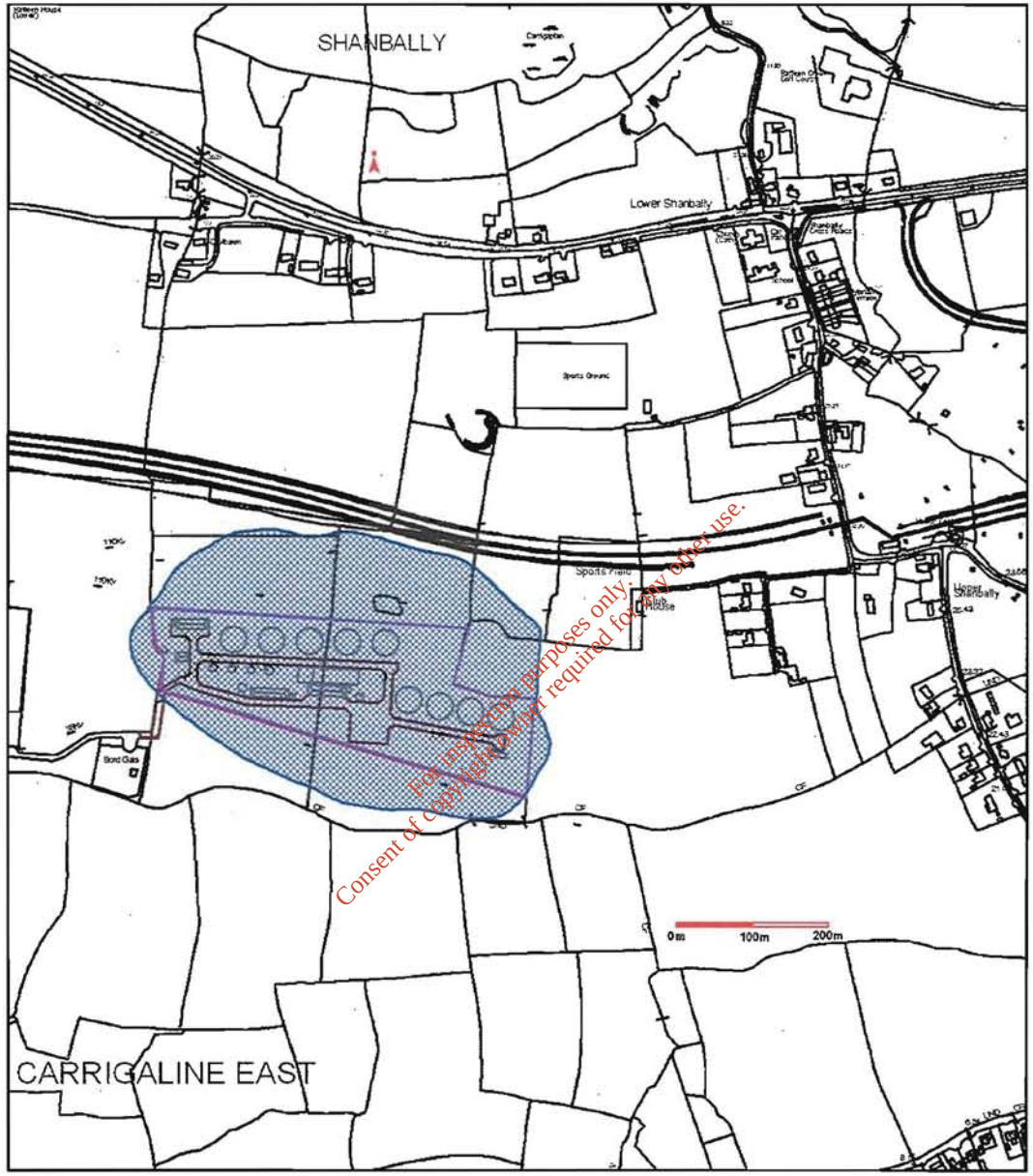


FIGURE 3.6.7 PREDICTED ODOUR EMISSION CONTRIBUTION WITH ODOUR ABATEMENT PROTOCOLS IMPLEMENTED AT THE 98th PERCENTILE FOR ODOUR CONCENTRATIONS ≤ 1.5 $O_{UE}\,m^{-3}$

Mott MacDonald

CORK HARBOUR MAIN DRAINAGE SCHEME
ENVIRONMENTAL IMPACT STATEMENT
JOB NR. 234541
DRG NR. 5670FG144

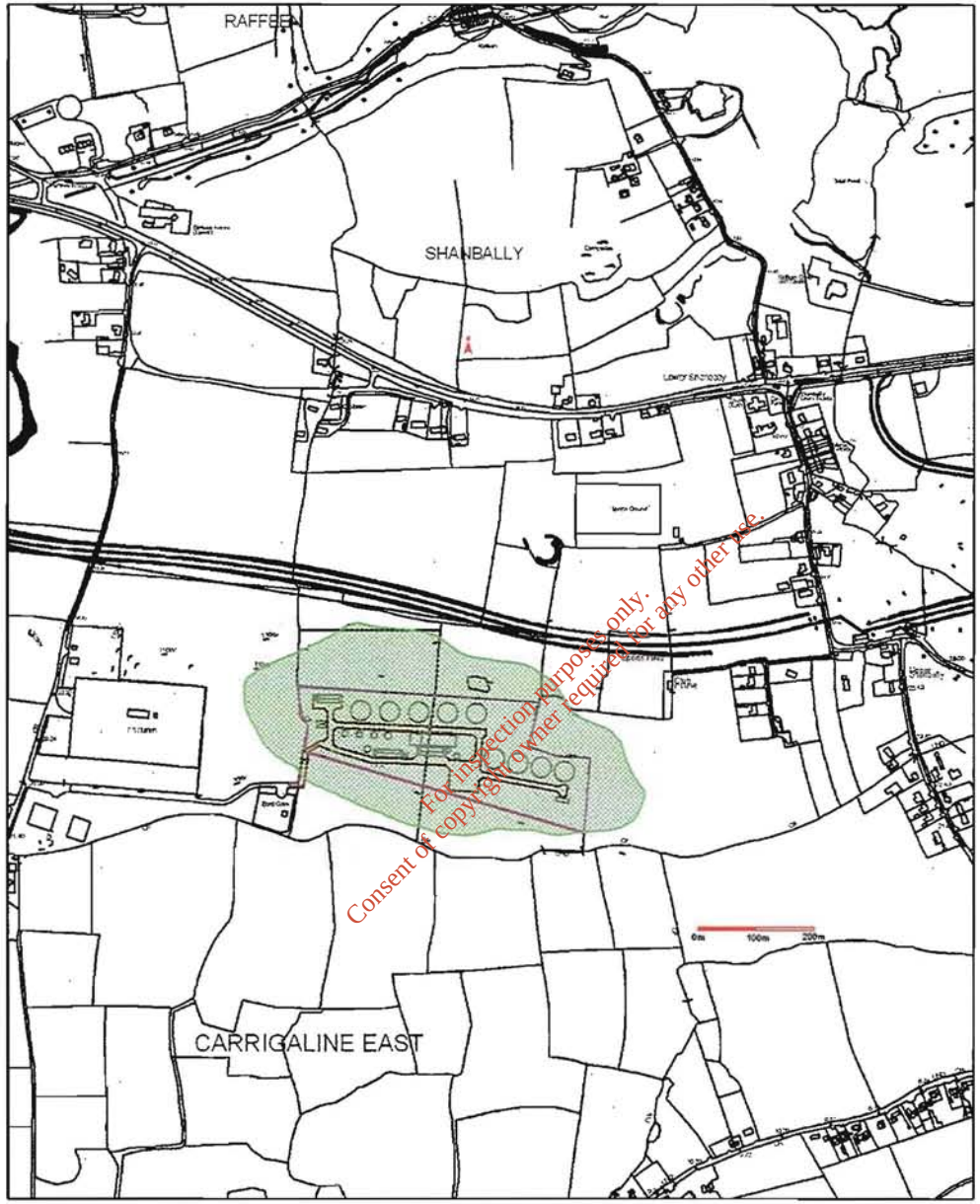
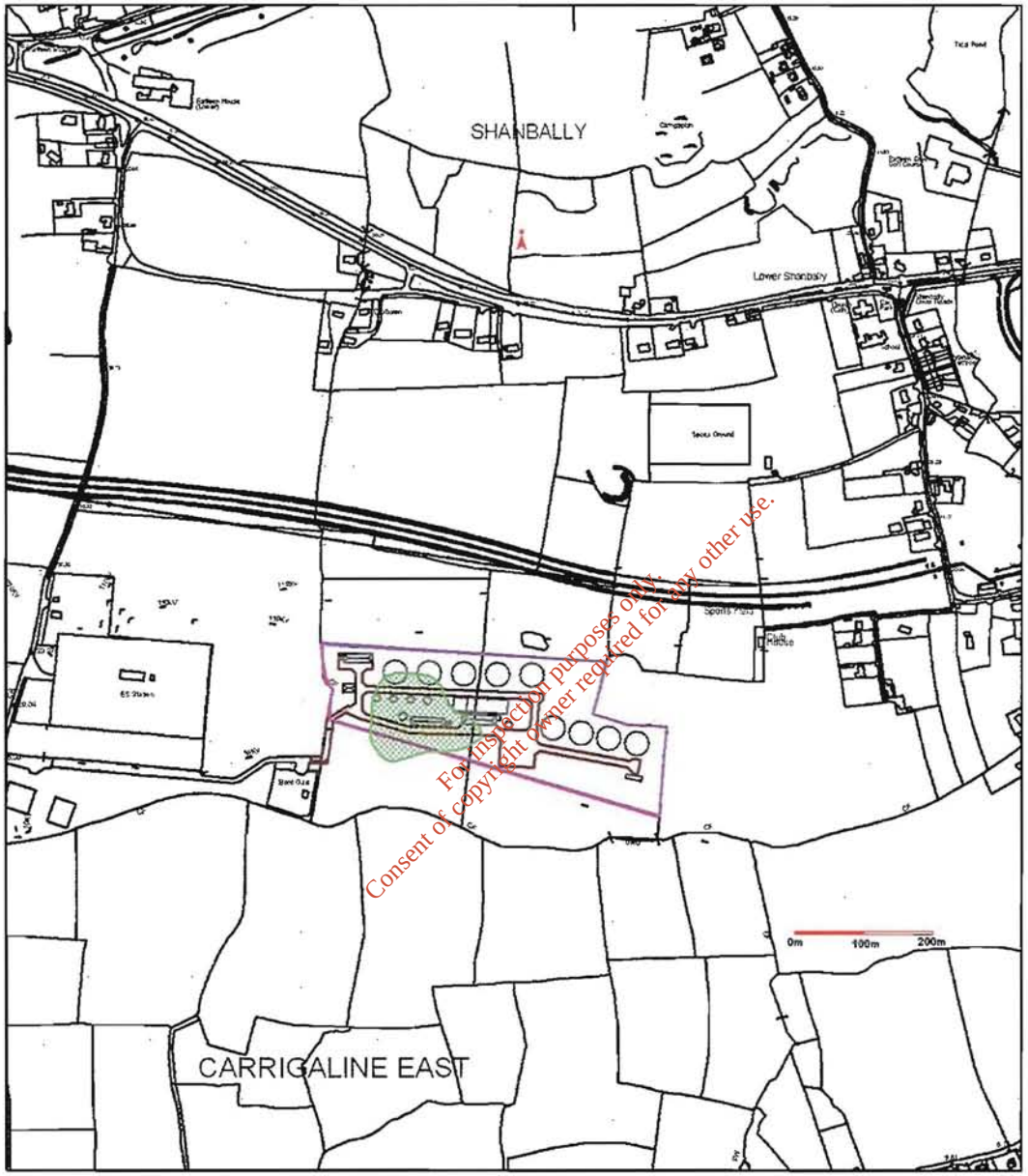


FIGURE 3.6.8 PREDICTED ODOUR EMISSION CONTRIBUTION WITH ODOUR ABATEMENT PROTOCOLS IMPLEMENTED AT THE 99.5th PERCENTILE FOR ODOUR CONCENTRATIONS ≤ 3.0 $Ou_E\ m^{-3}$

Mott MacDonald

CORK HARBOUR MAIN DRAINAGE SCHEME
ENVIRONMENTAL IMPACT STATEMENT
JOB NR. 234541
DRG NR. 5670FG145

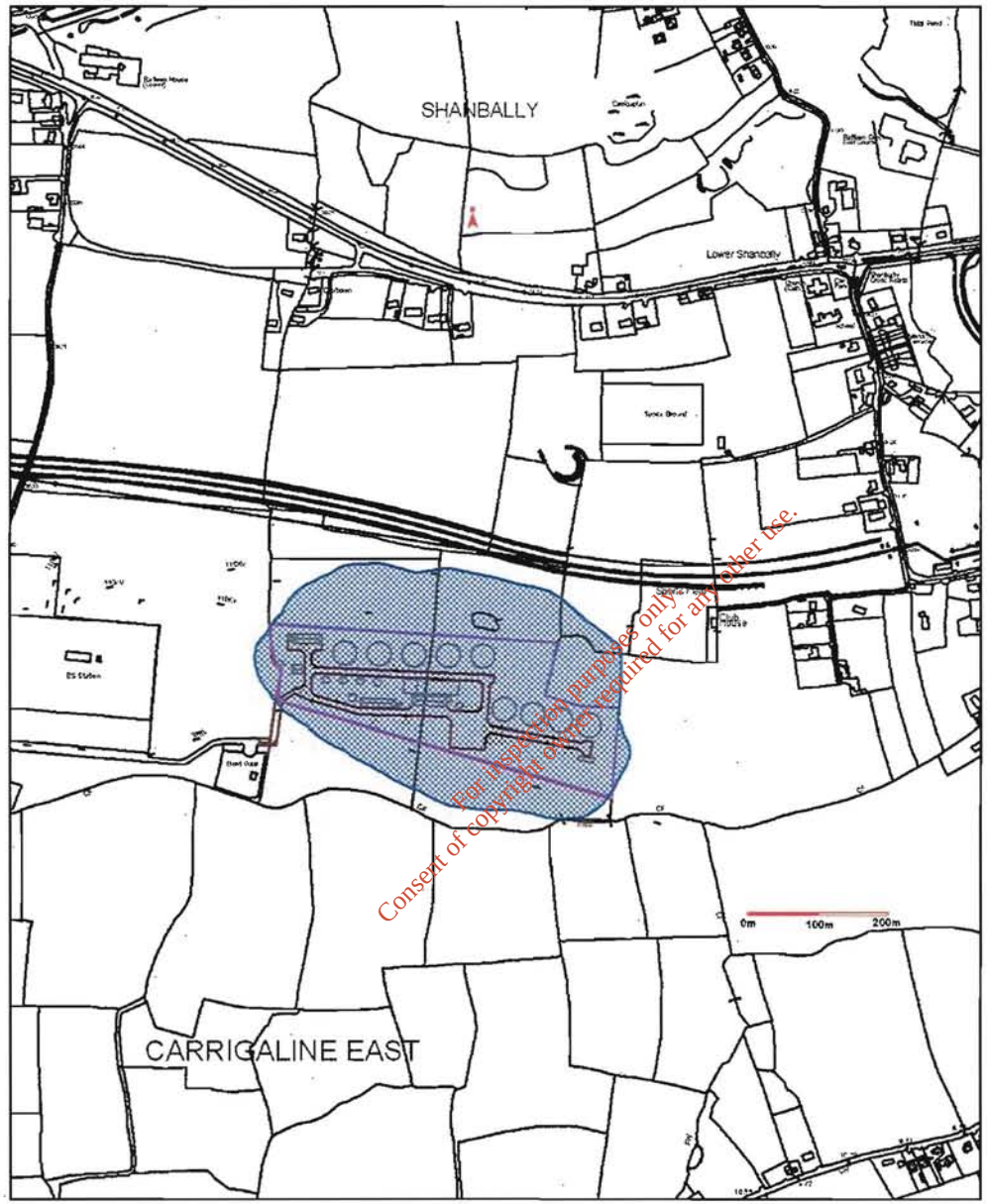


NOTE:
TOTAL OCUs – INDIVIDUAL GROUPED ODOUR CONTROL UNIT SOURCES.

FIGURE 3.6.9 PREDICTED ODOUR EMISSION CONTRIBUTION OF TOTAL OCUs (SEE NOTE) TO ODOUR PLUME DISPERSAL. ODOUR CONCENTRATION ≤ 0.3 $Ou_E\ m^{-3}$ AT THE 98th PERCENTILE

Mott MacDonald

CORK HARBOUR MAIN DRAINAGE SCHEME
ENVIRONMENTAL IMPACT STATEMENT
JOB NR. 234541
DRG NR. 5670FG146



NOTE:
THIS INCLUDES ODOUR CONTRIBUTIONS FROM THE AERATION TANKAGE, SECONDARY SETTLEMENT AND STORM WATER TANKAGE.

FIGURE 3.6.10 PREDICTED ODOUR EMISSION CONTRIBUTION (EXCLUDING OCUs) TO ODOUR PLUME DISPERSAL (SEE NOTE). ODOUR CONCENTRATION ≤ 1.5 $O_{UE}\,m^{-3}$ AT THE 98th PERCENTILE

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CORK HARBOUR MAIN DRAINAGE SCHEME
ENVIRONMENTAL IMPACT STATEMENT
JOB NR. 234541
DRG NR. 5670FG147

3.7 Noise and Vibration

3.7.1 Introduction

This noise and vibration assessment was completed by ANV Technology Limited on behalf of Mott MacDonald Pettit.

The purpose of this study is to evaluate the noise and vibration impacts associated with the proposed Cork Lower Harbour WWTP (Cork Harbour Main Drainage Scheme) at Shanbally, Co. Cork. In doing so, assessments are made regarding the likely impacts, the appropriate mitigation measure and any residual impacts associated with the development. A copy of the specialist report is included in *Volume III, Appendix 6A* of this statement.

3.7.2 Methodology

(i) Existing Environment

A baseline noise survey was carried out in June 2007 at the WWTP site and pumping station sites to establish the existing noise environment. This serves as a baseline against which the operational noise emissions during daytime and night-time from the WWTP and pumping stations can be assessed. The surveys were undertaken in accordance with ISO 1996 *Description and Measurement of Environmental Noise*.

Noise surveys over 24-hour periods were carried out at three locations in the vicinity of the WWTP site (N1, N2 and N3). Surveys of three hours duration during daytime and night-time were conducted at five additional representative positions, including nearest noise sensitive locations, in the Carrigaline East/Shanbally areas (N4 to N8). Surveys of three hours duration during daytime and night-time were also conducted at the proposed sites of the four major pumping stations at Raffeen, Monkstown, Carrigaloe, and West Beach, Cobh. Short orientation noise measurements were carried out during daytime and night-time at twenty of the proposed minor pumping stations. These measurements of daytime noise levels were also carried out to represent locations along the proposed sewer lines, to serve as a baseline for the assessment of construction noise impact. Refer to Figure 3.7.1 *Location of Proposed WWTP Site and Baseline Noise Survey Locations N1 to N8* and Figure 3.7.2 *Layout of Cork Harbour Main Drainage Scheme, Pumping Station Locations* for noise survey measurement locations.

Instrumentation used was Brüel & Kjær and Svantek Type 1 sound level meters. The calibration of the instrument was checked before and during the survey with a Brüel & Kjær and Castle calibrator.

(ii) Impact Assessment Methodology

Construction Phase

Noise propagation calculations 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}).

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 70dB(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 3.7.1. *Maximum Permissible Construction Noise Levels at the Façade of Dwellings during Construction (NRA, 2004).*

The NRA 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 night-time works it would be reasonable to assign a limit of 45dB(A) L_{Aeq},1hr , which is the EPA guideline industrial night-time noise limit.

Table 3.7.1: Maximum Permissible Construction Noise Levels at the Façade of Dwellings during Construction (NRA 2004)

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.

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 3.7.2 *Gradation of adverse noise impact as function of construction noise level, and duration of noise exposure.*

Table 3.7.2: Gradation of adverse noise impact as function of construction noise level, and duration of noise exposure

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

Operational Phase

The WWTP is a Design-Build-Operate (DBO) project. One of the environmental parameters to be met by the Contractor 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 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 potential noise impact during the operational phase was assessed with reference to the EPA guideline noise limits, and the assessment procedures of BS 4142, *Rating Industrial Noise Affecting Mixed Residential and Industrial Areas.* The potential audibility of sound at night-time was also considered.

A computer noise propagation model was developed for the proposed waste WWTP. The model is based on the calculation procedures of ISO 9613.

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.

EPA Noise Limits

The EPA guidelines set a night-time limit of 45dB(A), and a daytime noise limit of 55dB(A), at noise sensitive locations. However these should be viewed as maximum tolerable levels rather than levels of negligible impact.

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 LA90 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 exceedance of 10dB indicates clear audibility, with potential for complaints, and the impact needs to be carefully assessed. An increase of 5dB 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.

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 5dB, 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 2dB.

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 (10dB 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 10dB lower), it is unlikely to be audible, and the noise impact can be described as negligible.

Consideration of Indoor Noise Levels at Night-time

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 30dB(A), as occurs on occasion in this area at night-time.

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 night-time. In these cases, the level of the new noise source relative to the background noise is not the determining factor. Instead 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 40dB(A) L_{Aeq} as representing a "good" to "reasonable" indoor noise environment for living rooms, and 30 to 35dB(A) L_{Aeq} for bedrooms. In addition, noise maxima inside bedrooms should not normally exceed 45dB(A) L_{AFmax} at night-time. This is to ensure acceptable resting/sleeping conditions. These guidelines are also consistent with recommendations of the World Health Organisation. However based on ANV's experience measuring indoor noise levels in Irish residences in rural areas, it was found that indoor noise levels at night-time are generally below 30 dB(A), and would more typically be in the range 20 to 25dB(A).

An external noise source of level 35dB(A) would be attenuated by approximately 15dB 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 20dB(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 20dB(A) would be very comfortably within BS 8233 and WHO guideline levels. Noise impact at this level would be negligible.

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 night-time, it is considered that a design criterion of 35dB(A) at night-time at the nearest noise sensitive location is appropriate for this development. This would constitute a "negligible" noise impact, based on the noise impact criteria. The nearest noise sensitive location is the land zoned residential, approximately 134m 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 35dB(A), which is the criterion for negligible noise impact in this rural area. The calculated design noise criterion is a noise level of 45dB(A) at 20m from the plant boundaries.

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 night-time, 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 10dB higher than at night-time. Consequently, a daytime design noise criterion 10dB higher than the night-time criterion, i.e. 55dB(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 55dB(A) at 20m from the boundary, the resulting noise level at the nearest noise sensitive location, approximately 134m to the east is calculated to be 45dB(A).

3.7.3 Existing Environment

WWTP Site

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

Referring to Table 3.7.3 *Overview of measured noise levels at N1 to N8*, at the measurement locations N1 and N2 at the proposed WWTP site boundaries, the average daytime noise level was 44 and 47dB(A) L_{Aeq} respectively. This reduced to 36 and 38dB(A) L_{Aeq} respectively at night-time. At N3, 230m to the north of the proposed site boundary, the mean daytime noise level was 47 dB(A) L_{Aeq}, reducing to 39dB(A) L_{Aeq} at night-time. The noise measurements at locations N2 and N3 represent the noise environment in the lands zoned residential to the east of the proposed site. Plots of measured noise levels over the 24hr period at N1 to N3 are detailed in Figure 3.7.3 *Plot of measured noise levels at 24hr measurements, positioned at WWTP 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 41dB(A). At night-time this reduced to 30 to 31dB(A) L_{A90}.

Measurements location N4 was at the nearest house to the proposed site, at a distance of 260m from the eastern site boundary. At this position, the average daytime noise level was 55dB(A) L_{Aeq} due to local traffic, reducing to 50dB(A) L_{Aeq} at night-time. The steady underlying background noise at this location was 48dB(A) L_{A90} during daytime, and 40dB(A) L_{A90} at night-time.

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

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 night-time. The steady underlying background noise at this location was 42 dB(A) L_{A90} during daytime, and 31 dB(A) L_{A90} at night-time.

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 46dB(A) L_{Aeq} at night-time. The steady underlying background noise at this location was 46dB(A) L_{A90} during daytime, and 38dB(A) L_{A90} at night-time.

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 13dB, to a level of 49dB(A) L_{Aeq} at night-time. The steady underlying background noise at this location was 53dB(A) L_{A90} during daytime, and 35dB(A) L_{A90} at night-time.

Table 3.7.3: Overview of measured noise levels at N1 to N8.

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	

Major Pumping Stations

Referring to Tables 3.7.4 *Daytime and night-time noise surveys at the sites of the proposed major pumping stations* at Raffeen, the average daytime noise level was 57dB(A) L_{Aeq}, due to local traffic, reducing to 46dB(A) at night-time. The steady underlying background noise at this location was 50dB(A) L_{A90} during daytime, and 40dB(A) L_{A90} at night-time.

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

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

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 57dB(A) at night-time. The steady underlying background noise at this location was 49dB(A) L_{A90} during daytime, and 39dB(A) L_{A90} at night-time.

Table 3.7.4: Daytime and night-time noise surveys at the sites of the proposed major pumping stations

Location	Date	Time	L_{AEQ} 15 Mins	L_{A90}	L_{A50}	L_{A10}
Daytime						
Raffeen	26/06/2007	mean	57	50	55	60
Monkstown	26/06/2007	mean	55	43	49	57
West Beach	27/06/2007	mean	58	50	56	61
Carrigaloe	27/07/2006	mean	63	49	56	67
Night-time						
Raffeen	26/06/2007	mean	46	40	37	41
Monkstown	26/06/2007	mean	42	38	39	42
West Beach Cobh	27/07/2006	mean	57	47	50	57
Carrigaloe	27/06/2007	mean	57	39	45	60

Minor Pumping Stations

Daytime noise levels at the sites of the proposed minor pumping stations ranged from 44 to 69dB(A) L_{Aeq}, depending on the local traffic flows. The steady underlying background noise levels during daytime ranged from 38 to 53dB(A) L_{A90} (refer to Table 3.7.5 *Daytime short-term orientation noise surveys at 20 proposed minor pumping stations*).

Night-time noise levels ranged from 44 to 64dB(A) L_{Aeq}, depending on the local traffic flows. The steady underlying background noise levels ranged from 27 to 49dB(A) L_{A90} (refer to Table 3.7.6 *Night-time short-term orientation noise surveys at 20 minor pumping stations*).

Table 3.7.5: Daytime short-term orientation noise surveys at 20 proposed minor pumping stations

Day time	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 % HGVs 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	61	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 % HGVs on road, distant and local traffic.

Table 3.7.6: Night-time short-term orientation noise surveys at 20 minor pumping stations

Night-time	Date	Time	L_{Aeq}, 15 mins	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.

3.7.4 Impact Assessment

(i) Construction Phase Impacts

WWTP

During construction of the WWTP 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 51dB(A) L_{Aeq} (based on an assumed sound power emission of 120dB LWA from plant and equipment operating on the site). This calculated noise level is very comfortably below the NRA construction noise criterion of 70dB(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 55dB(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 3.7.4 *Calculated construction noise levels, during early site investigation and preparation phase when noise emissions are expected to be highest.*

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 3.7.7 *Calculated noise levels at a house, due to excavation works at roadside adjacent to the house* shows the calculated noise levels for houses at various distances from the line of the sewer line excavation works.

For houses set back 10m from the sewer line, the noise levels may exceed the 70dB(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 3.7.5 *Variation of noise levels at a given house, depending on distance of excavation works along the road from the house entrance.* This shows that in general noise levels will be less than 65dB(A). However, noise levels may exceed 70dB(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 50m, the noise level would be less than 60dB(A), and beyond 100 metres the noise levels would be less than 54dB(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.

Table 3.7.7: Calculated noise levels at a house, due to excavation works at roadside adjacent to the house

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

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

Channel Crossing at Carrigaloe

At this planning stage, final details are not available on the works on the channel crossing at Carrigaloe. The possible options include open cut and tunnelling. In either case, it can be assumed that there will be shore-based works, which will generate noise. In the case of the open cut option there would also be noise emitted from the works on floating platforms in the channel. An additional consideration is the question of tidal restrictions, which may require works to be carried out outside the normal daytime construction periods on occasions. Noise emissions form these works will be subject to the construction noise limits set out in Table 3.7.1 *Maximum Permissible Construction Noise Levels at the Façade of Dwellings during Construction (NRA 2004)* and the EPA guidelines.

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 115dB(A) LWA, the resulting construction noise levels at the nearest houses (refer to Table 3.7.8 *Calculated highest construction noise levels, during the early site preparation and excavation phases for the proposed major pumping stations*) are calculated to be approximately 70dB(A) at the nearest houses at the Monkstown and West Beach sites, where it is considered that the standard guideline noise limit of 70dB(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 57dB(A) respectively, which are comfortably within the standard 70dB(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.

Table 3.7.8: Calculated highest construction noise levels, during the early site preparation and excavation phases for the proposed major pumping stations.

Location of Proposed Pumping Station	Calculated Construction Phase Noise Level At Nearest House To Pumping Station DB(A)
Raffeen	58
Monkstown	70
Carrigaloe	57
West Beach Cobh	69

(BS 5228 calculation based on site sound power emissions of 115dB(A) LWA, with allowance for noise screening by standard timber site hoardings).

Vibration

Taking account of the nature of the likely excavation works for the sewerage pipes, such as excavation and rock-breaking, it is expected that the resulting vibration levels at nearby properties will be comfortably within the vibration limits for protection against cosmetic damage (as set out in Table 3.7.1 *Maximum Permissible Construction Noise Levels at the Façade of Dwellings during Construction (NRA 2004)*, and in terms of nuisance, are likely to be imperceptible.

Construction Traffic

Additional traffic noise can be expected on haul routes to the treatment plant site, and along the sewer pipeline routes. Based on a nominal assumption of 10 vehicles per hour travelling to/from the work sites, the additional traffic noise generated at a house at 10m from the road is expected to be approximately 55dB(A). This is a relatively low level of traffic noise, and would have only a slight impact.

(ii) Operational Phase Impacts

Noise Emissions from the WWTP

The calculated operational noise levels, and noise impact assessment for the daytime and night-time periods, are presented in Table 3.7.9 *Predicted noise levels from proposed WWTP, and noise impact assessment*. The calculated noise levels for the operational WWTP are illustrated as a noise map in Figures 3.7.6 *Calculated night-time noise levels due to operating WWTP* and 3.7.7 *Calculated daytime noise levels due to operating WWTP* for night-time and daytime operation respectively.

Daytime Noise Impact

For daytime operation of the WWTP, including daytime work activities and vehicle movements within the site, the projected additional noise levels due to the WWTP are in the range 34dB(A) to 45dB(A) at the noise sensitive locations considered. These additional noise levels are all comfortably below the EPA daytime noise limit of 55dB(A).

At the nearest lands zoned residential to the east of the site, the ambient noise level is calculated to increase by 2dB. This increase is not likely to be perceptible. The daytime activity noise and vehicle movement noise within the site is calculated to exceed the background noise by 4dB. The noise may therefore be just audible, but is unlikely to be clearly distinguishable from the existing distant traffic noise. The component of continuous noise from the plant and processes at the WWTP (excluding vehicles and daytime works activities) would be in the range 27 to 35dB(A) and would be inaudible. The noise impact at this location is considered to be negligible.

At the other noise sensitive locations, the additional noise from the WWTP, including daytime work activities and vehicle movements within the site, would not result in any change in the existing total ambient noise at the nearest noise sensitive locations, and would be lower than the existing background noise levels. There would be no adverse noise impact at these locations.

At the existing houses to the east, north, south and west, the calculated additional WWTP noise will be 8 to 14dB lower than the existing steady background noise level, and will be inaudible.

In the sports field to the north east of the site, the daytime noise level is expected to be in the range 40 to 45dB(A), and will have no noise impact on the amenity of this area.

Night-time Noise Impact

For night-time operations, noise emissions from the WWTP are the same as modelled for daytime conditions, and the calculated noise levels at the noise sensitive locations are in the range 24 to 35dB(A).

These additional noise levels are all in comfortable compliance with the EPA night-time noise limit of 45dB(A).

The additional noise at the noise sensitive locations would result in an increase of at most 1dB in night-time noise level at the nearest noise sensitive location, which is the land zoned residential 140m to the east. At this location, the WWTP noise would exceed the existing steady background noise by 5dB, and consequently the noise would be audible at a low level outdoors. Allowing for an attenuation of approximately 15dB through a partially opened window, the resulting indoor noise level would be 20dB(A). This is comfortably within the BS 8233 guidelines, and represents an extremely low noise level which is unlikely to be noticeable indoors. The adverse noise impact at this location is considered to be negligible.

At the existing houses to the east, north, south and west, the projected WWTP noise is very low, and in the range 24 to 30dB(A). The WWTP noise would be between 6 and 11dB lower than the existing background noise, and would not be audible outdoors or indoors. There would be no adverse noise impact at these houses.

Table 3.7.9: Predicted noise levels from proposed WWTP, and noise impact assessment

House Locations	Projected WWTP Plant Noise Level L_{AEQ} DB(A)	Existing Noise L_{AEQ} DB(A)	Projected Total Future Noise L_{AEQ} DB(A)	Projected Change, DB (Sound Emergence)	Within Epa Limits (55/45 DB(A) Day/Night)	Comparison With Mean Background Noise L_{A90} (Note 1)	Likely Audibility	Overall Adverse Noise Impact
Daytime								
Lands to east (zoned residential)	45	47	49	+2	yes	+ 4 dB	Daytime activities possibly audible at low level outdoors, inaudible indoors	Negligible
Houses to east	40	55	55	0	yes	-8 dB	Inaudible outdoors and indoors	None
Houses to north	39	62	62	0	yes	-14 dB		
Houses to south	34	55	55	0	yes	-8 dB		
Houses to west	37	54	54	0	yes	-9 dB		
Night-time								
Lands to east (zoned residential)	35	38	40	+2	yes	+5 dB	Audible at low level outdoors, not noticeable indoors	Negligible
Houses to east	30	50	50	0	yes	-10 dB	Inaudible outdoors and indoors	None
Houses to north	29	49	49	0	yes	-6 dB		
Houses to south	24	48	48	0	yes	-7 dB		
Houses to west	27	46	46	0	yes	-11 dB		

Note 1-differrence between projected WWTP noise, and the background noise at the assessment location (as given on Table 3.7.3).

Ground Vibration due to Operation of WWTP

Based on noise surveys carried out by ANV Technology Limited at other WWTPs (including Limerick, Ennis, Kilkenny, Athy, Greystones), it has been found that there is no perceptible ground vibration beyond the site boundaries associated with the operating equipment. At the proposed WWTP site, the nearest sensitive location is 134m to the east. There is unlikely to be any significant potential for audible ground-borne vibration over this distance.

Noise and Vibration Emissions from Pumping Stations

As the pumps and equipment in the major pumping stations will be enclosed within buildings, or located below ground level at the minor pumping stations, the noise sources will be effectively enclosed. In principle any desired degree of sound attenuation can be achieved.

Night-time background noise levels at the sites of the proposed pumping stations ranged from 32 to 47dB(A) L_{A90}. A reasonable criterion would be to ensure a noise level of less than 35dB(A) at the nearest houses, as was proposed for the noise sensitive locations near the WWTP site itself. For noise sensitive locations closest to the pumping stations at Monkstown and West Beach Cobh, this would correspond to a design noise criterion of 45dB(A) at 5m from the pumping stations.

Given the proximity of nearby residences to the pumping station at Monkstown and West Beach Cobh, it is prudent to consider the potential for generation of ground-borne vibration, in the audio frequency range, which could potentially give rise to a low pitched audible sound inside the nearby residences.

Such ground-borne hums could be generated by motors, pumps and any other equipment which is in mechanical contact with the ground near a building. Audible ground-borne vibration is readily prevented through incorporation of suitable vibration isolators in the equipment mountings.

Measurements at the existing Church Street pumping station in Carrigaline found that ground vibration levels at 1m from the wall of the pumping station were extremely low, and there was negligible potential for transmission of audible ground-borne vibration to nearby residences. The measured vibration level is presented in Figure 3.7.8 *Measured ground vibration at 1m from existing Church Road Pumping Station.*

Traffic Impact

Operational phase estimates of likely site traffic are relatively low. Using a nominal figure of 10 HGV movements per day along Cogan's Road to the site and light staff traffic, the operational phase will have negligible impact (Note - the number of HGV sludge movements used for this assessment is over estimated by a factor of approximately 2.5 for Indicative Design Nr.2 (2 HGVs daily for dewatered sludge) and a factor of 10 for Indicative Design Nr.1 (2-3 HGVs weekly for dried sludge)).

The calculated traffic noise level due to the heavy vehicle movements is 40dB(A) L_{Aeq} at a distance of 20m from the road. The existing measured traffic noise level was 54dB(A) L_{Aeq} . The additional traffic noise would not add detectibly to the average traffic noise level.

The noise generated by vehicles moving within the site is calculated to result in a noise level of less than 50dB(A) at 20m from the site boundary, and will be comfortably within the proposed daytime noise criterion of 55dB(A) at 20m from the site boundary.

(iii) 'Worst-Case Scenario' Impact

It is considered that the "Worst-Case Scenario" impact would arise from ineffective traffic and construction management and consequently the plant and equipment involved in haulage and construction activities causing a significant noise impact.

(iv) 'Do-Nothing' Impact

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 52dB(A) L_{Aeq} at the northern site boundary. The additional night-time traffic noise level is expected to be approximately 39dB(A) L_{Aeq} (calculated based on a 13 dB difference between daytime and night-time noise levels as measured at the N28, measurement position N8). When added to the existing night-time noise, of level 36 to 39dB(A), this will increase the night-time ambient noise to approximately 40 to 42dB(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.

3.7.5 Mitigation Measures

(i) Construction Phase

During the construction phase of the actual WWTP, the potential noise impact during daytime is slight, and no special mitigation measures are likely to be required.

During construction of the pumping stations and during excavation works for the sewer lines, there is potential for exceedance of the standard construction noise criterion of 70dB(A) on occasions. In accordance with best practice, the noise issues at the sites should be managed in accordance with the recommendations in BS 5228, which should be incorporated into the construction environmental management plan.

General guidelines for limiting the disturbance which may be applicable for these works are outlined below:

- Limit noisy construction works to 07.00 to 19.00 weekdays with Saturday working from 08.00 – 13.00 hours (relatively quiet construction activities could be carried out outside these hours, subject to strict controls).
- Essential night-time works, should be subject to a noise limit of 45dB(A), and carefully assessed and controlled to minimise impact
- Utilise solid timber site hoardings where required to screen sensitive properties; particularly where noise levels are anticipated to exceed 70dB(A).
- Use modern, silenced and well-maintained equipment conforming to applicable EU Directives.
- Shut down equipment when not in use, where practicable.
- Site semi-static equipment such as generators, mixers, and compressors as far away as possible from sensitive locations and ensure that the orientation is the optimum for low noise.
- Ensure that all workers are given training with respect to minimising noise and disturbance.
- Noise exposure aspects within the worksites will be managed in accordance with the requirements of *Safety, Health and Welfare at Work (General Application) Regulations* 2007, S.I. No. 299 of 2007.

(ii) Operational Phase

The assessment of noise impact during the operational phase of the development was based on a night-time design noise criterion of 45dB(A) at 20m from the northern, eastern and southern boundaries of the WWTP, and a design criterion of 45dB(A) at 5m from the pumping stations.

In addition, for the WWTP site, a daytime design noise criterion of less than 55dB(A) at 20m from the boundary is proposed to ensure negligible noise impact due to daytime work activities and vehicles operating within the site. These design noise criteria represent the specific noise emissions from continuous plant and processes, excluding residual noise from other sources such as traffic.

The achievement of these noise criteria will depend on the appropriate noise specifications and noise controls being incorporated into the detailed acoustic design of the plant. The principal mitigation measures required for the development therefore concern selection of equipment, sound containment, acoustic attenuators, and noise screening, in order to achieve the required design noise criteria.

Any mechanical equipment (such as motors) at the pumping stations, which is considered capable of transmitting significant ground borne vibration in the audio frequency range, should be adequately vibration isolated to ensure that they do not give rise to audible sound at the nearest houses.

Achieving the design criteria will be the responsibility of the developer's design team. The predicted noise levels, as outlined in this report are considered to be readily technically achievable using standard technology and noise control methods. The contractor will be required to demonstrate in advance of construction, using an appropriate methodology, that the design noise criteria will be achieved.

The design noise criteria referred to above, are for engineering design purposes only, and should not be confused with any noise conditions which may be set by the relevant authorities, which would typically be 55dB(A) during daytime, and 45dB(A) during night-time at noise sensitive locations (as opposed to boundaries).

3.7.6 Residual Impacts

On effective implementation of the specified mitigation measures, no significant residual impacts are envisaged.

The WWTP development with associated pumping stations is expected to have a negligible residual noise impact at the nearest houses during daytime and night-time operations. Noise will be comfortably within the EPA limits at all houses.

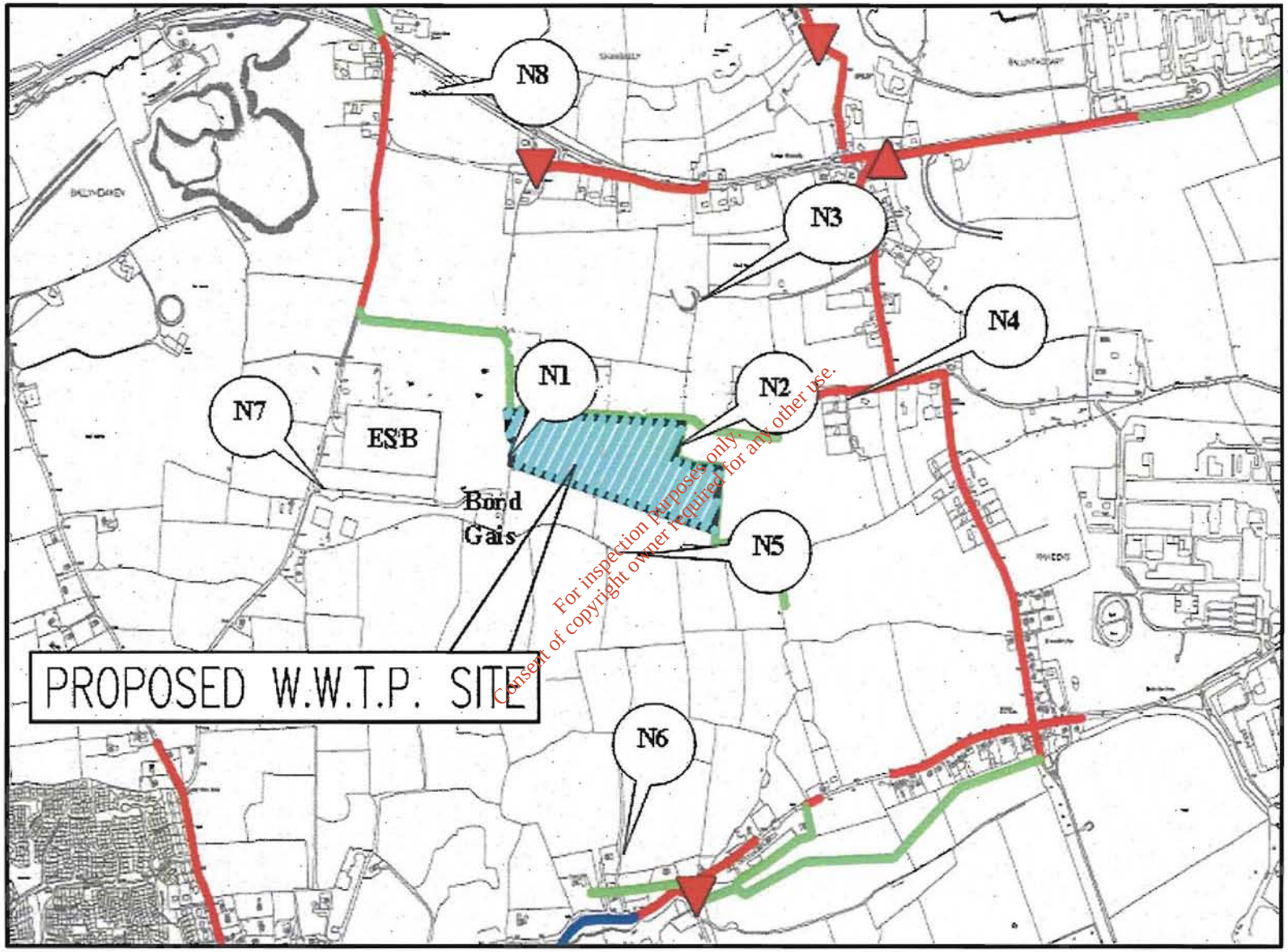

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FIGURE 3.7.1 LOCATION OF PROPOSED WWTP SITE, AND BASELINE NOISE SURVEY LOCATIONS N1 TO N8

CORK HARBOUR MAIN DRAINAGE SCHEME
ENVIRONMENTAL IMPACT STATEMENT
JOB NR. 234541
DRG NR. 5670FG126

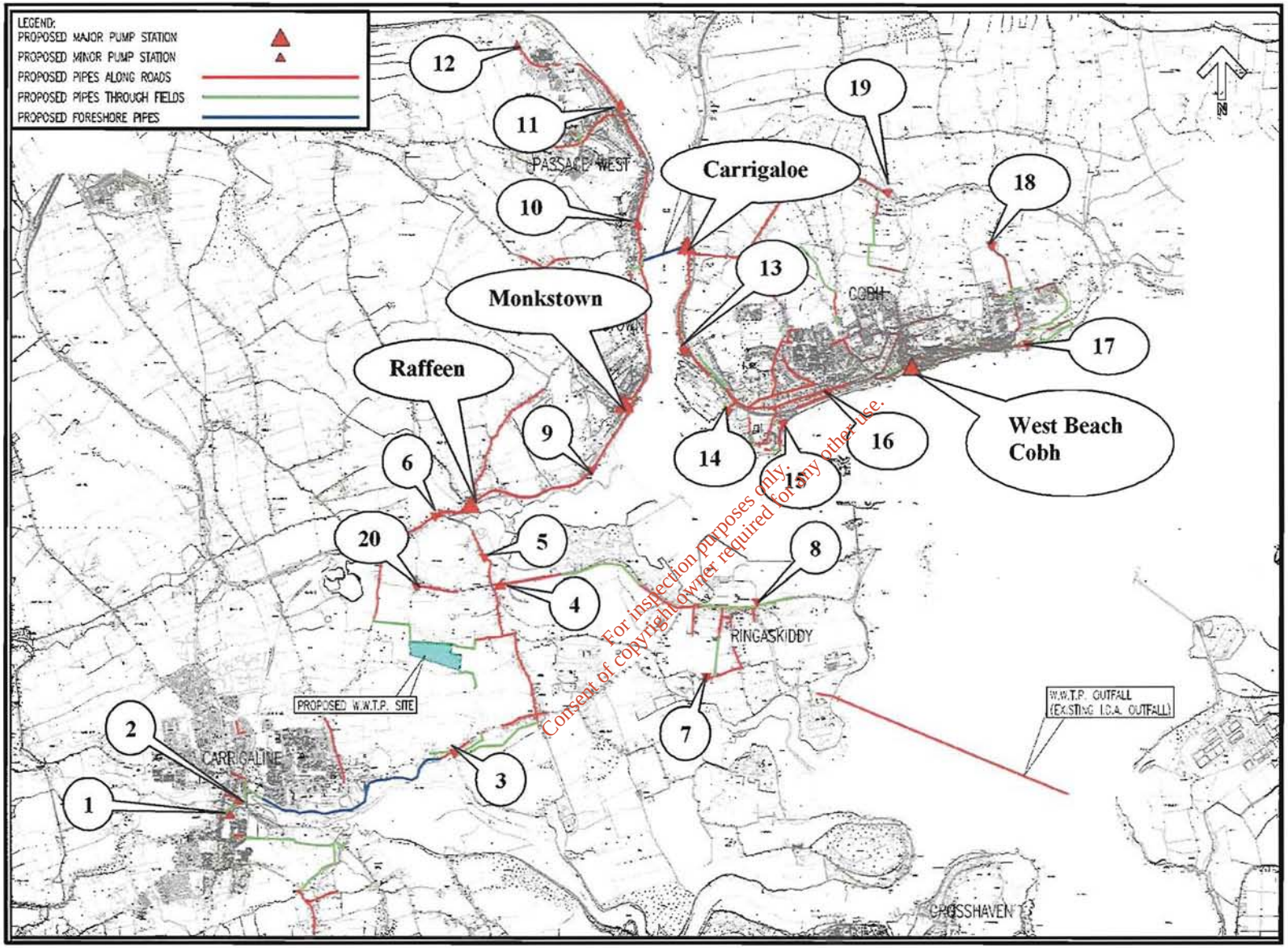

FIGURE 3.7.2 LAYOUT OF CORK HARBOUR MAIN DRAINAGE SCHEME, PUMPING STATION LOCATIONS

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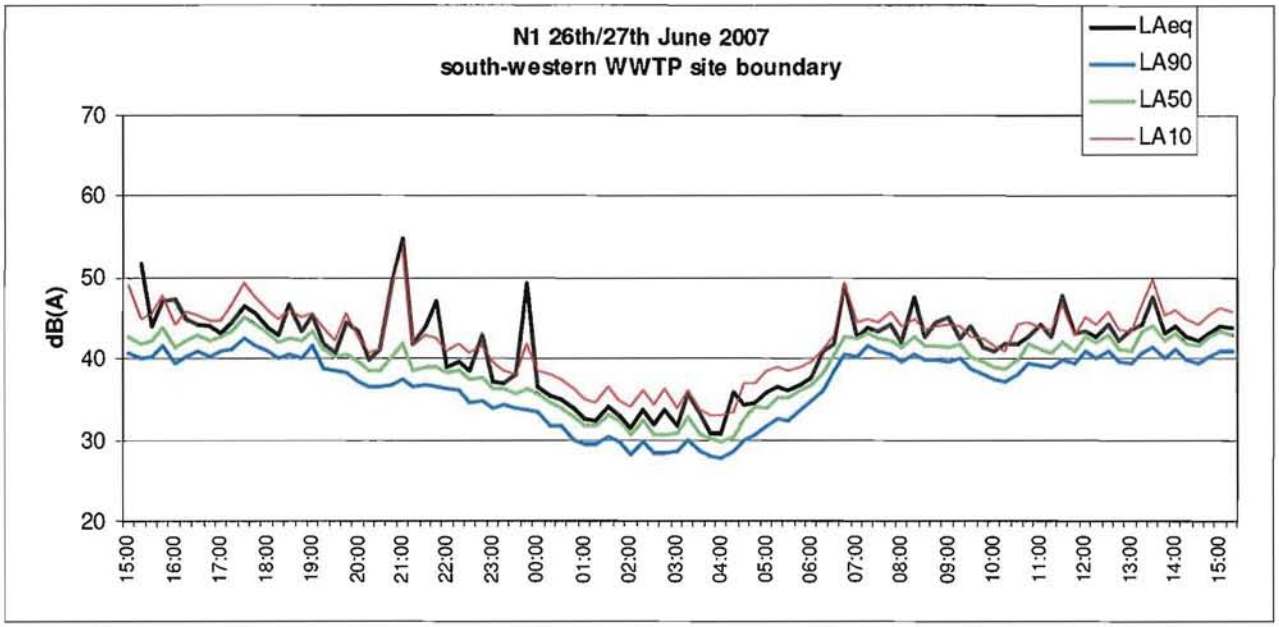
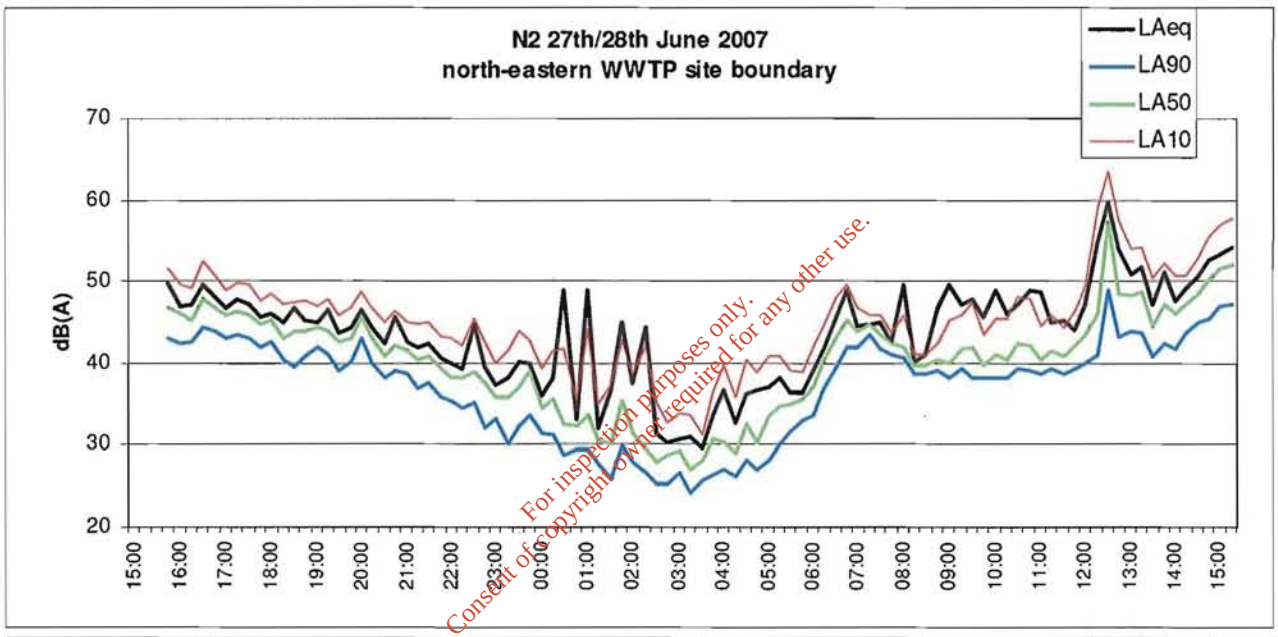
CORK HARBOUR MAIN DRAINAGE SCHEME
ENVIRONMENTAL IMPACT STATEMENT
JOB NR. 234541
DRG NR. 5670FG127





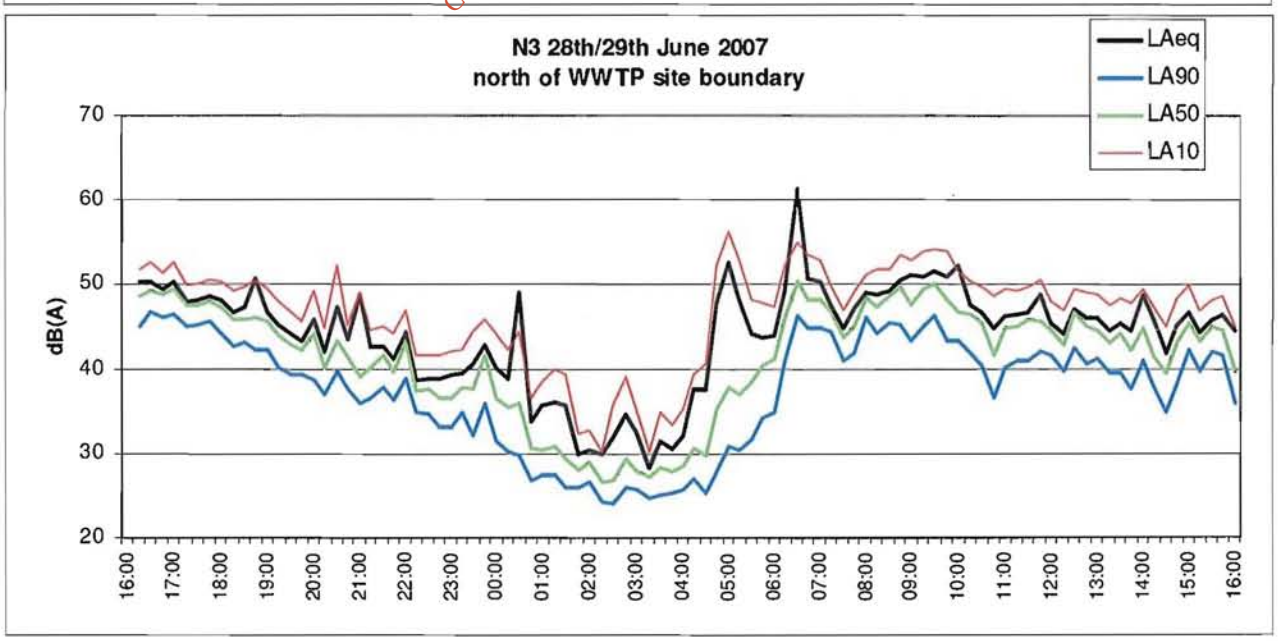


FIGURE 3.7.3 PLOT OF MEASURED NOISE LEVELS AT 24-HOUR MEASUREMENTS, POSITIONED AT WWTP SITE

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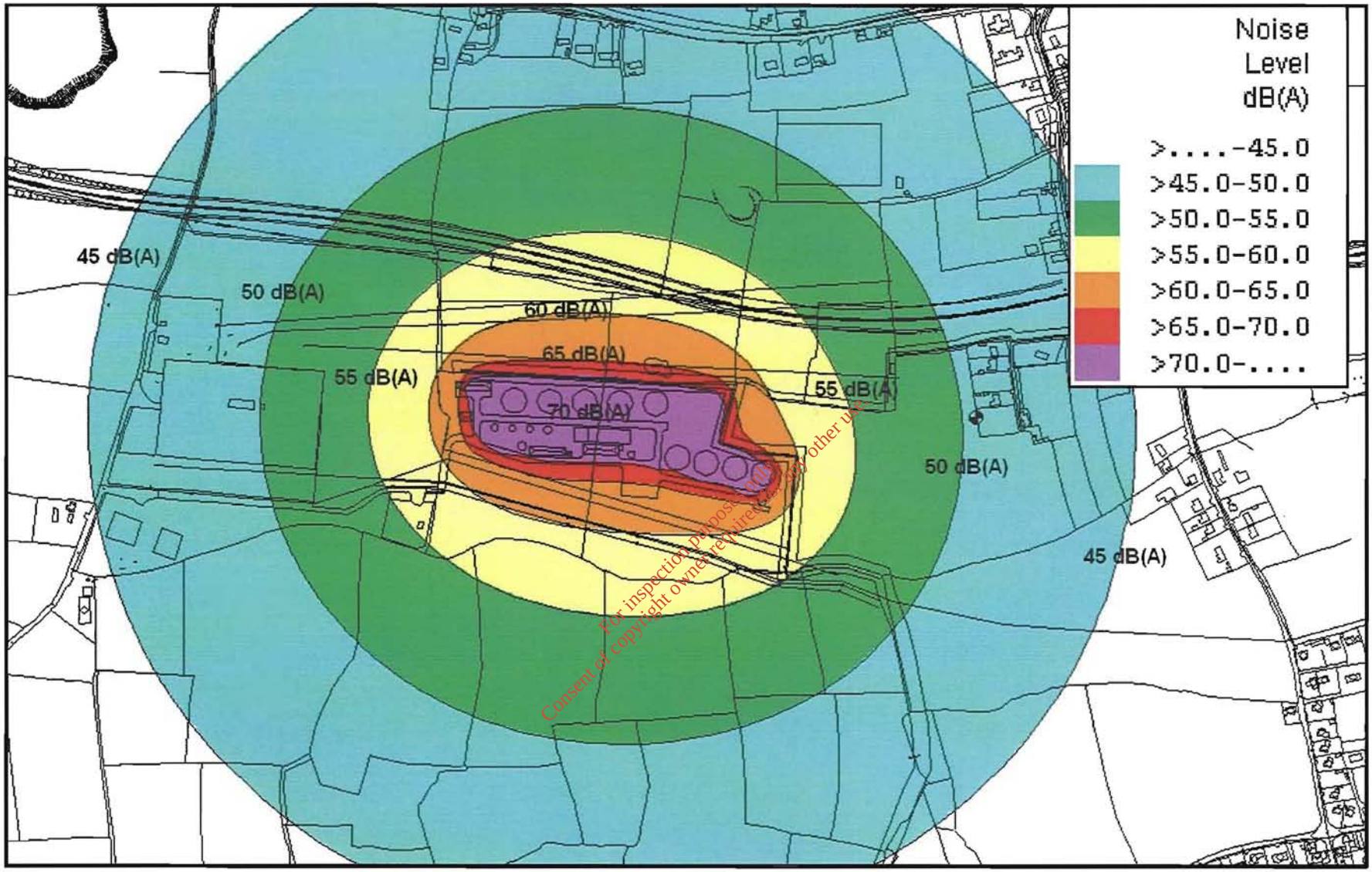
CORK HARBOUR MAIN DRAINAGE SCHEME
ENVIRONMENTAL IMPACT STATEMENT
JOB NR. 234541
DRG NR. 5670FG139



(The calculation are based on a total site sound power emission of 120 dB(A) LWA, which is a reasonable allowance for a project of this scale)

FIGURE 3.7.4 CALCULATED CONSTRUCTION NOISE LEVELS, DURING EARLY SITE EXCAVATION AND PREPARATION PHASE WHEN NOISE EMISSIONS ARE EXPECTED TO BE HIGHTEST

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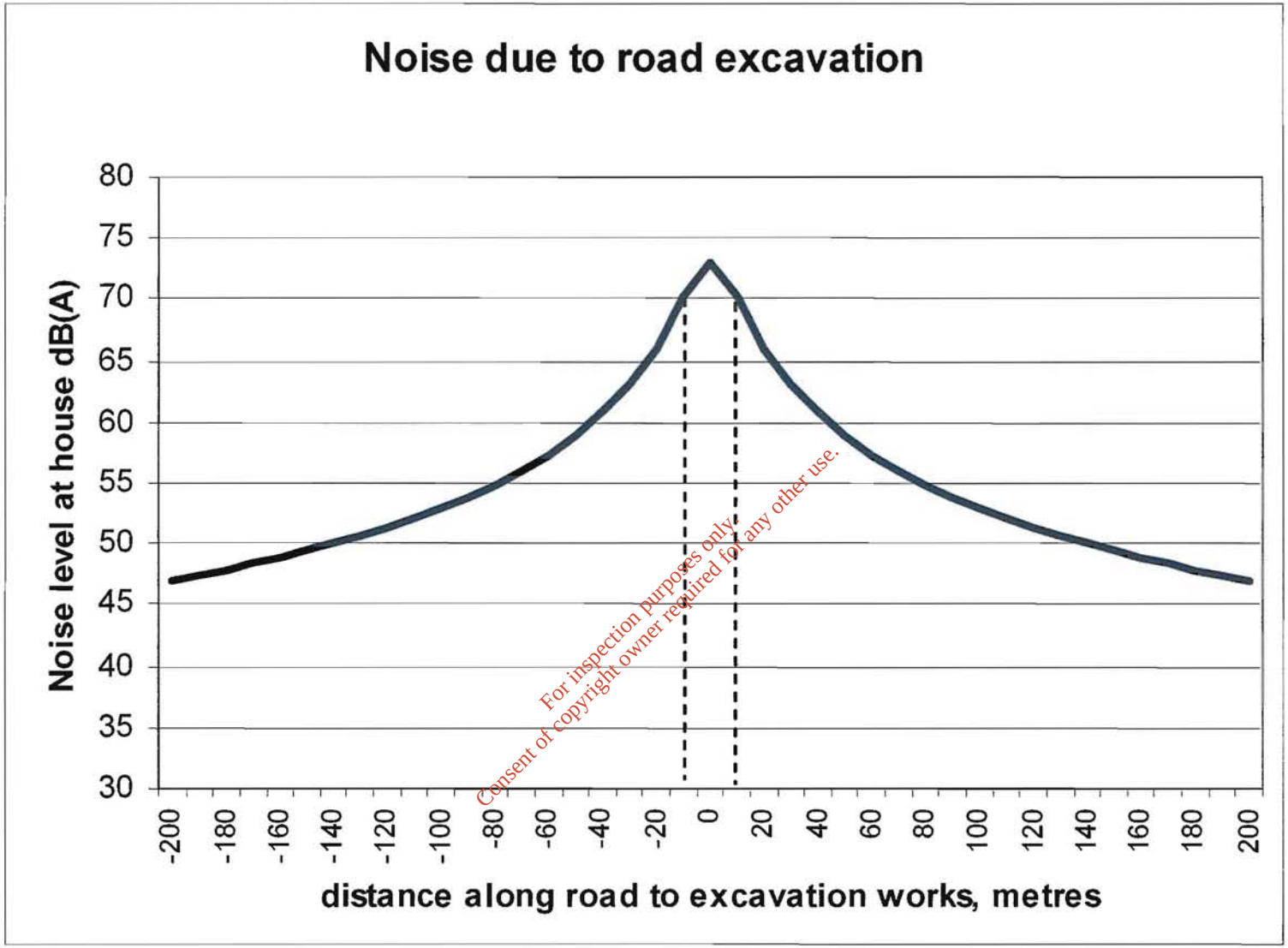
CORK HARBOUR MAIN DRAINAGE SCHEME
ENVIRONMENTAL IMPACT STATEMENT
JOB NR. 234541
DRG NR. 5670FG128



(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).

FIGURE 3.7.5 VARIATION OF NOISE LEVEL AT A GIVEN HOUSE, DEPENDING ON DISTANCE OF EXCAVATION WORKS ALONG THE ROAD FROM THE HOUSE ENTRANCE

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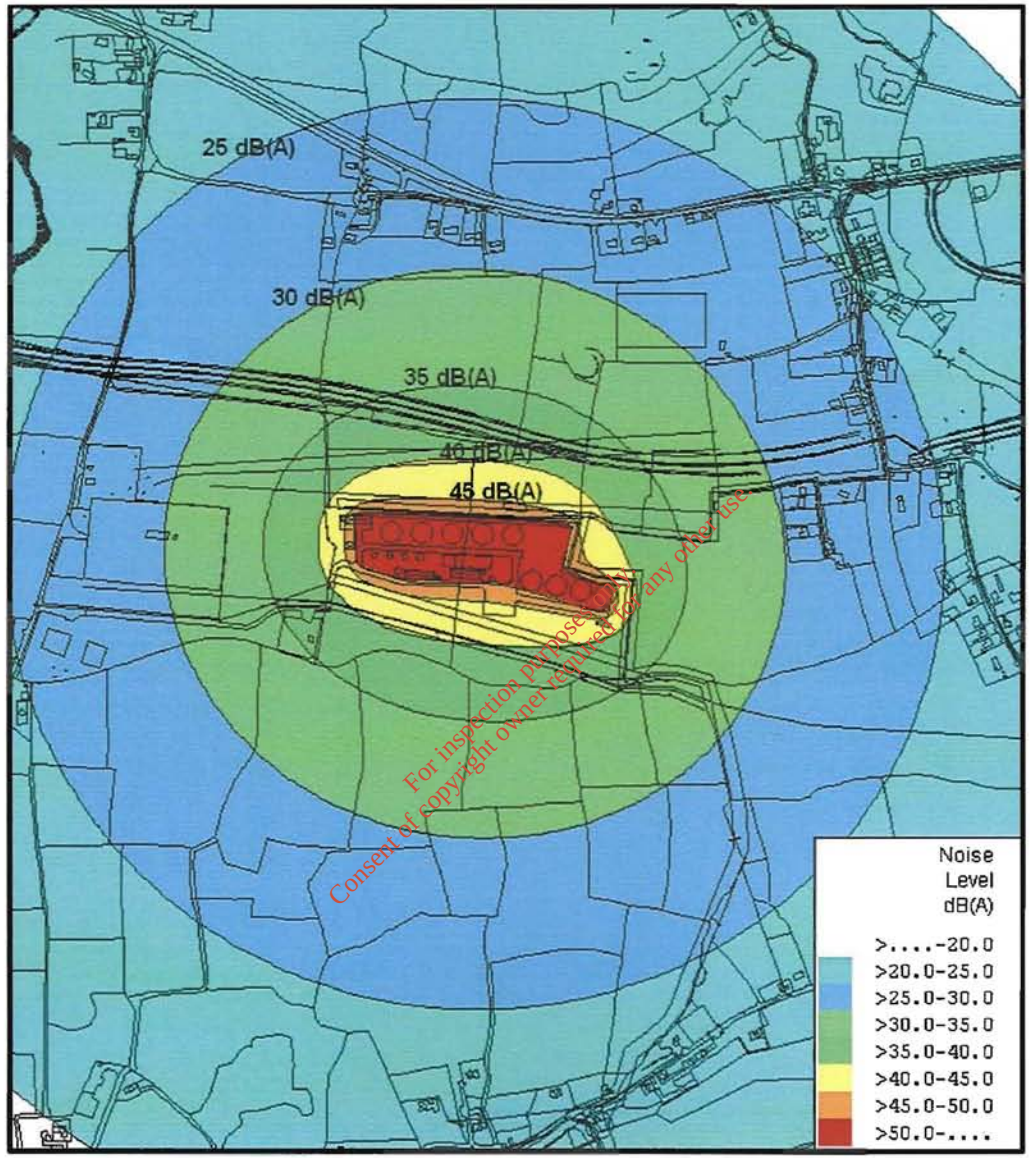
CORK HARBOUR MAIN DRAINAGE SCHEME
ENVIRONMENTAL IMPACT STATEMENT
JOB NR. 234541
DRG NR. 5670FG138



(This noise map was generated using an ISO 9613 noise propagation model, based on a nighttime design noise criterion of 45 dB(A) at 20m from the WWTP boundary. This noise map represents the continuous plant and process noise emissions from the operating WWTP)

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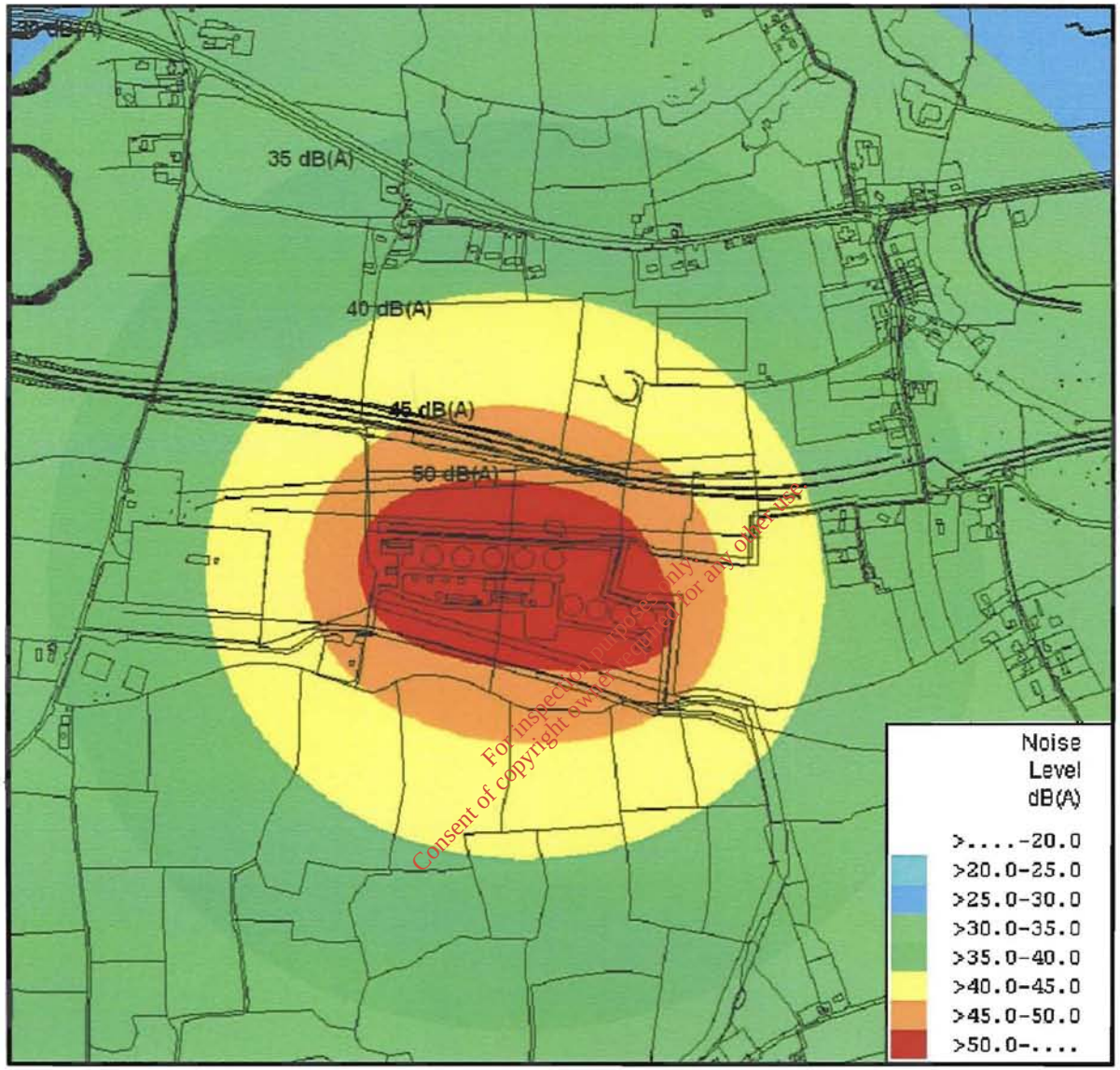
FIGURE 3.7.6 CALCULATED NIGHT-TIME NOISE LEVELS DUE TO OPERATING WWTP

CORK HARBOUR MAIN DRAINAGE SCHEME
ENVIRONMENTAL IMPACT STATEMENT
JOB NR. 234541
DRG NR. 5670FG129



(This noise map was generated using an ISO 9613 noise propagation model, based on a design noise criterion of 55 dB(A) at 20m from the WWTP boundary during daytime. This noise map represents the continuous plant and process noise emissions from the operating WWTP, and includes daytime work activities and traffic on site)

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FIGURE 3.7.7 CALCULATED DAYTIME NOISE LEVELS DUE TO OPERATING WWTP

CORK HARBOUR MAIN DRAINAGE SCHEME
ENVIRONMENTAL IMPACT STATEMENT
JOB NR. 234541
DRG NR. 5670FG130

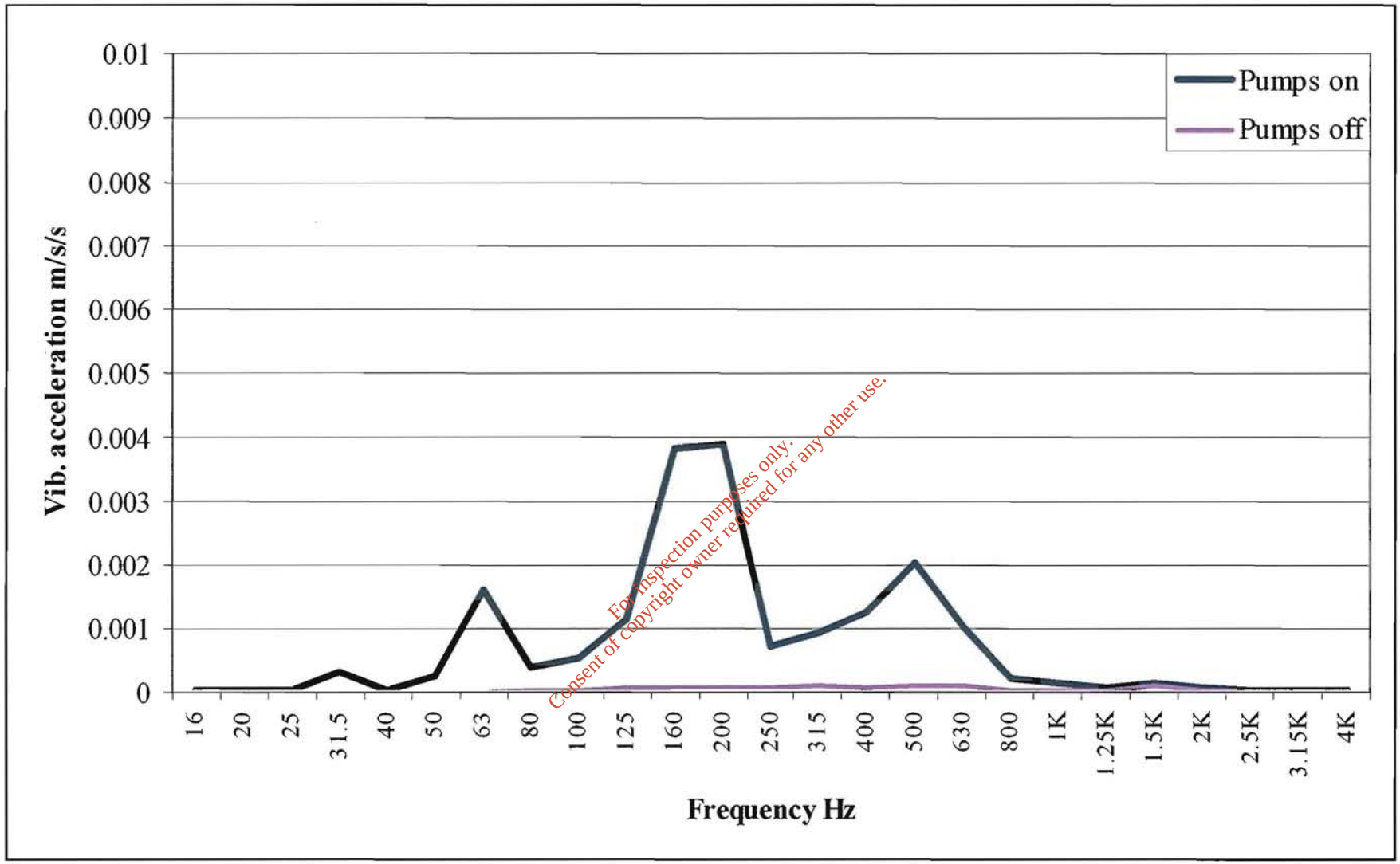

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FIGURE 3.7.8 MEASURED GROUND VIBRATION AT 1m FROM EXISTING CHURCH ROAD PUMPING STATION

CORK HARBOUR MAIN DRAINAGE SCHEME
ENVIRONMENTAL IMPACT STATEMENT
JOB NR. 234541
DRG NR. 5670FG160

3.8 Cultural Heritage

3.8.1 Introduction

This chapter of the EIS describes the Cultural Heritage in the existing environment surrounding the proposed development.

ÆGIS Archaeology Limited was commissioned to conduct a Cultural Heritage Assessment as part of the EIS for the proposed development in Cork Lower Harbour. The Archaeological Diving Company Limited was appointed by ÆGIS Archaeology to undertake the off-shore/inter-tidal assessment. The study included both the proposed development area and the collection system environs (on-shore and offshore). The objective of the assessment was to examine the potential impact on the archaeological, architectural and cultural heritage due to the proposed development and to identify mitigation measures where necessary. A copy of the specialist report is included in *Volume III, Appendix 7A* of this statement.

3.8.2 Methodology

General

The cultural heritage assessment comprised of a desk based study and a field assessment of the study area of the on-shore and off-shore elements of the proposed development.

On-Shore Assessment

The desk based study comprised of:

- A comprehensive review of published archaeological and cultural heritage work undertaken in the vicinity of the study area was undertaken (including Excavations Bulletins, searched on the online research database www.excavations.ie)
- The National Museum topographical files were consulted
- The Record of Monuments and Places (RMP) constraint maps and list were consulted
- The published archaeological inventory for the study area was consulted (*Archaeological Inventory of County Cork- Volume II: East and South Cork* (Power *et al.*, 1994)). This is an important resource for the archaeological heritage of Co. Cork
- *Cork County Development Plan* (Cork County Council, 2003), *Cobh Town Development Plan* (Cobh Town Council, 2005) and applicable local area plans were consulted for the locations of possible Protected Structures in the vicinity of the proposed development
- The National Inventory for Architectural Heritage (NIAH) was consulted. The NIAH has not yet undertaken the inventory for this area of Cork, but are beginning fieldwork presently
- A wide range of local historical and archaeological records relevant to the study area were consulted, including the OS First Edition six-inch map (c.1840)
- Suitable aerial photos, analysed for archaeological purposes were used in the study

The information from these sources has been tabularised as per the NRA published guidelines on constraints studies for both archaeological and architectural heritage.

The Archaeological Inventory of County Cork VOL II: East and South Cork (Power *et al.,* 1994), which is a publication of information held in the files of the Archaeological Survey of Ireland, held by the National Monuments Section, DEHLG (also known as the SMR) were also consulted. This inventory also records field work.

The National Museum of Ireland files, known as the Topographical Files were also checked to identify archaeological artefact sites that may be within the pipeline vicinity.

The yearly Excavations Bulletin, which summarises licensed archaeological work in the country, by county (Bennett, various dates) was checked for up-to-date information on recent archaeological discoveries the location of the study area. Excavation summaries for the years 1996-2003 inclusive were included.

The on-shore field assessment was carried out on 27th June, 10th July and the 16th September 2007 comprised of:

- An inspection of the proposed WWTP site
- Where the proposed pipeline corresponded with roadway or public areas these were visited and/or a windscreen survey was undertaken
- Where the proposed pipelines were on private lands aerial photos were used as a substitute and the areas were viewed from the roadsides or gateways

Off-Shore Assessment

An underwater dive assessment, including metal-detection survey, across the River Lee at Monkstown (c.390m wide crossing-point) and field-walking of the intertidal section of the proposed pipeline route (c.2.4km long corridor, Owenboy River near Carrigaline) was carried out on the 24th and 25th September 2007 (refer to Figures 3.8.1 *Location of Underwater and Intertidal Survey Areas*).

Marine Crossing

Visual inspection and magnetometry survey by hand-held metal-detection was employed to assess the archaeological potential of the seabed over an area that extended 12m upstream and 50m downstream of the proposed marine pipeline. The upstream survey area was restricted due to the presence of an active ferry service between Cobh and Passage West. Detailed descriptions were made of the seabed topography and bottom composition. Where possible, metal-detected anomalies were inspected and logged. A finds retrieval strategy dealing with conservation issues, cataloguing, and locational recording was in place to deal with any artefacts recovered during the survey. Maximum seabed coverage was obtained using a diver-towed survey methodology.

A very strong current of 5+ knots was noted during both the filing and the ebb tides. As such, the dive survey was undertaken during the tide-change, at which time the current fell to around 2 knots; the interaction between river and sea meant no 'slack-water' period was evident at this site. Due to the diving conditions present it was not possible to undertake a metal-detection survey across the central channel or the eastern side of the river. However, a band of reduced current was noted along the western limit of the survey and a metal-detection survey was undertaken across this area. A maximum water depth of 16.68m was recorded for the central channel. Visibility ranged between 1m-2m, depending on location within the channel. Diving operations were carried out to HSA/HSE standard using surface supplied equipment, supported with suitable boat cover and VHF communications to the relevant authorities.

Intertidal/Foreshore Pipelines

The proposed intertidal/ foreshore locations were field-walked to assess their archaeological potential and a photographic record was made. This was undertaken at low water to maximise survey coverage. A metal-detection survey was undertaken along a 50m stretch of foreshore to provide a sample target-ratio that would be representative of the rest of the foreshore survey area. A hand-held GPS unit was used to log any items of interest encountered as part of the survey.

3.8.3 Existing Environment

Historical Overview – Cork and the Lower Harbour

The following is a synopsis of the study area as it relates to the archaeology and history of the Lower Cork Harbour region. All Cultural Heritage (CH) features identified in this section are detailed in Tables 3.8.4 *Archaeological constraints Inventory of Recorded Monuments,* 3.8.5 Architectural *constraints inventory of Recorded Structures within study area* and 3.8.6 *Further potential Architectural Constraints within study area.*

Prehistory (Early Mesolithic 8000-5500BC, Later Mesolithic 5500-4000BC, Neolithic 4000-2500BC, Bronze Age 2500-500BC, Iron Age 500BC-AD500)

The earliest evidence for human settlement in Co. Cork now dates to the Early Mesolithic period (Woodman 1984, 1-11; 1989, 116-124). People living in the Mesolithic period ("middle stone age") were gatherers, hunters and fishers. It is thought they lived near the coastlines and along rivers, using flint and other suitable stones to make sharp tools (Anderson 1991, 35-8). Shell middens are refuse mounds or spreads of discarded sea-shells and can date from the Late Mesolithic, although the Cork Harbour oyster middens are quite recent (Power *et al.,* 1994). In addition Mesolithic people are found in the archaeological record by the material they left behind, usually in the form of stone tool-making waste ("debitage") and the tools themselves, and more rarely by habitation evidence such as house structures, pits and hearths. Burial evidence for this period is exceedingly rare with the latest evidence being located along the River Shannon, Co. Limerick (Collins and Coyne 2003; 2006). The Later Mesolithic period could be represented by the midden at Ringaskiddy CH12, although without datable material from this feature it is impossible to estimate its precise date of use (CO087-054---).

The Neolithic ("new stone age") saw the introduction of farming into Ireland. This change is seen in the archaeological evidence through domesticated plant and animal remains and a more sedentary lifestyle, although it is now thought that a certain amount of hunting and gathering would have continued (Waddell 1998). An important development in the Neolithic is the appearance of community burial places, megalithic tombs (of which there are 4 types), which took much time, effort and planning to construct (Twohig 1990). Evidence for Neolithic life in the archaeological record of Munster includes rectangular houses, farmsteads, pottery and megalithic tombs.

The Bronze Age marks the first introduction of widespread metal use into Ireland, firstly copper and then bronze. It is thought that society in this period became more hierarchical, with stress in community evidenced in the archaeological record by the disproportionate amount of weapons, particularly those which appear to be ritually deposited in watery places. Farming continued with houses being characterised in this period by circular structures, some in unenclosed or enclosed farmsteads. Burial at this time moves from the community rite of the Neolithic to singular burial in much smaller burial monuments such as barrows, ring ditches, cists and pits, sometimes grouped together into "cemeteries" (Waddell 1990; 1998). Pottery continues to be used in a domestic context and also new pottery shapes are seen, which are made especially for funerary purposes. Of the most common monument types in the archaeological record in Ireland, the burnt mound, or fulacht fiadh tends to date to this period (although both earlier and later dated examples have been found) (Buckley 1990; Monk 2007). Although no surface trace survives of CH19 is such an example. Ritual stone monuments such as standing stones, pairs, rows and circles, as well as rock art tend to date to the Bronze Age, which are particularly common in the Munster region, especially west Cork and Kerry (Ó Nualláin 1984).

An archaeological site dating to the Neolithic and Bronze Ages was excavated in advance of a golf course on Foaty Island excavated in 1992 (outside the study area), revealed a prehistoric complex of human occupation and possible burial pits.

The Iron Age in Ireland is more elusive than the previous periods, with no definite site type or burial tradition attributable to the period. The Iron Age has been discovered in Co. Cork, however, most recently at excavations at Cashel Hill and on the Beara peninsula by Prof. William O'Brien of UCC (O'Brien 2006).

Medieval (Early Medieval AD400-1100, Later Medieval AD1100-1600, Post Medieval AD1600-1700)

The early medieval period in Ireland is characterised by the introduction to Christianity to the country and history (i.e. writing, Edwards 1990; Sheehan and Monk 1998). Archaeological monuments attributable to this period include ringforts, cashels, (enclosed farmsteads) some hut sites, souterrains (underground chambers) and many monastic and ecclesiastical sites. These sites may occur in association in the landscape (Stout 1997). There are two ringforts located in the vicinity of the pipeline route CH1 & CH16, a ringfort and souterrain) and CH3 a ringfort in Parkgarriff. CH9 and CH10 are other probable examples of ringforts situated near the proposed location of the WWTP site. The end of the early medieval period in Ireland is marked by the arrival of the Vikings in AD795, firstly through raiding and later through trade and settlement. The Vikings are credited with establishing the first true towns in Ireland, at Cork, Dublin, Waterford and Limerick and smaller centres such as Wicklow and Arklow (Edwards 1990). There are no known early medieval archaeological remains in the immediate vicinity of the pipeline route. Other monuments represented within the study area which may be dated to the Medieval period are holy wells. The use of holy wells has continued from at least Early Medieval times until the present day (O'Sullivan and Sheehan 1996) and has its origins in pre-Christian Ireland although many of the sites are more recent in origin. The wells were usually visited for penitential purposes on saint's days and these pilgrimages followed a set pattern. During 19th century the Church became more and more disapproving of the trouble the patterns caused and the superstitious nature of the ritual associated with them, which has led to a decline in numbers in the recent past. Although CH2 in Ballywilliam is extant, the holy well at Ballyfouloo (CH4) has not been located.

The later medieval period begins historically with the invasion of the Anglo-Normans in AD1169 (Barry 1987; O'Keeffe 2002). Their presence can be seen in the archaeological record through the towns they established and re-organised. Archaeological monuments dating to this period include ringworks, hall houses, moated sites and tower houses.

The beginning of the post-medieval period was a turbulent time in Irish history. A new system of lordships emerged which eclipsed many of the earlier Anglo-Norman settlements. Irish lords came into conflict with the monarchy of England particularly Elizabeth I, when they tried to re-assert their control over the country, by establishing plantations, populated by settlers and by other means (Duffy *et al.* 2001; Robinson 1984). This resulted in the wars from 1560-1603.

Early Modern (AD1700-1900)

The 18th century was a time of general prosperity for the newly established protestant gentry. From 1691 until 1798 (the Rebellion) Ireland witnessed few dramatic events. By the end of the 18th century Cork Harbour was the lynch-pin of British naval operations in Ireland (Rynne 1993, 68). Defence was always a consideration, and with political changes on Continental Europe, and the threat of a French invasion of British-controlled lands, a series of defensive features, such as barracks, forts, batteries and Martello towers were built. The fort of Cove or Carrignafoy fort (CH18) was built between 1743 and 1749 and in 1804 it had three batteries (*ibid.* 70). Martello towers (so named after Mortello in Corsica where a similar type of gun tower had been used with success in 1794) and were built in Cork Harbour in 1813 and 1815 (Rynne 1993, 74; Rynne 2006, 204). The Cork Martello towers were placed strategically around the harbour on Haulbowline Island, at Monning, Belvelly and Rossleague on Great Island and Ringaskiddy (Rynne 1993, 74). None of the Martello towers or their zone of archaeological potential (ZAP) is predicted to be impacted, so they have not been included as CH features in this study.

Industrialisation occurred in Ireland in this period with many industries being established throughout the country. The limekilns at Monkstown and Shanbally, CH5 & CH8 are located within the pipeline route. The primary use of lime was agricultural but it was also used in the manufacture of mortar (Rynne 2006; 197). In addition, in Irish coastal towns and ports limekilns were also used for refining salt, which was imported as rock salt and used in the manufacture of butter (Rynne 1999, 29; 2006, 159). Cork was internationally famous for its butter and the trade in rock salt created the largest urban salt processing industry in Ireland (Rynne 2006, 302). CH22 is an unusual occurrence of a previously unrecorded limekiln. It is clearly an excellent example of the type and its location is marked on the OS six-inch first edition map with the characteristic "ring and dot" symbol which indicates a kiln.

Other features of industry dating to this period are mills (CH6 at Carrigaline). Running water was the main power source for the majority of flour mills built within the harbour area (Rynne 1993, 87). Traditional small-scale mills were gradually replaced by larger mills as mechanisation developed. Large scale milling could be undertaken on the quay sides where grain could be unloaded, reduced to flour and loaded to outgoing ships (Rynne 1999, 74). A similar mill complex was established in the eighteenth century at Raffeen. This is no longer extant and no trace of it could be found during the walkover. As the proposed development is only in its general vicinity it was not allocated a CH number on this occasion.

As part of this industrialisation the development of roads and railways became important in this part of Cork. Marked on the earlier OS maps as the Great Southern Railway the railway line that skirts the study area is also known as the Cork, Blackrock, and Passage Light Railway. It passed through the study area from Cork City through Passage West, Glenbrook, Monkstown, Raffeen, Carrigaline and onward to Crosshaven. The Great Southern and Western Railway travelled from Cork to Cobh (it is still operational) CH26. The railway servicing Crosshaven through Passage West to Carrigaline ceased functioning by the 30s (Rynne 2005, 196). Two remnants of this line are the embankments and small bridges which allow outflows of smaller creeks to the harbour and are CH features of the study area: CH23 near Raffeen in the townland of Ballyfouloo and CH25 in the townland of Kilnaglery. The latter now forms part of an amenity walk from Carrigaline to Crosshaven.

Townland and Barony Boundaries

Townland and barony boundaries may be the remnants of much earlier (early medieval or perhaps earlier) cultural divisions of the landscape, which have been maintained overtime, many to the present day. Boundaries in the vicinity of the Scheme are identified on Figures 3.8.2 to 3.8.6.

Current Townlands

The study area covers portions of 30Nr. existing townlands. These are detailed in Table 3.8.1 *Detail of Townlands within Study Area.*

Table 3.8.1: Detail of Townlands within Study Area

Townland	OS 6" Sheet No.	Parish	Barony
Ardmore	87	Marmullane	Kerrycurrihy
Ballybricken	87	Barnahely	Kerrycurrihy
Ballyfouloo	87	Monkstown	Kerrycurrihy
Ballyleary	87	Clonmel	Barrymore
Ballynoe	87	Clonmel	Barrymore
Ballintaggart	87	Carrigaline	Kerrycurrihy
Ballywilliam	87	Templerobin	Barrymore
Ballyvoloon	87	Clonmel	Barrymore
Barnahely	87	Barnahely	Kerrycurrihy
Carrigaline	87, 99	Carrigaline	Kerrycurrihy
Carrigaline Middle	87	Carrigaline	Kerrycurrihy
Carrigaline East	87	Carrigaline	Kerrycurrihy
Carrignafoy	87	Templerobin	Barrymore
Commeen	99	Carrigaline	Kerrycurrihy
Cuskinny	87	Templerobin	Barrymore
Dean & Chapter: Land of Cloyne	87	Clonmel	Barrymore
Kilgarvan	87	Templerobin	Barrymore
Lackaroe	87	Monkstown	Kerrycurrihy
Loughbeg	87	Barnahely	Kerrycurrihy
Maulbaun	75, 87	Monkstown	Kerrycurrihy
Monkstown	87	Monkstown	Kerrycurrihy
Raheens	87	Carrigaline	Kerrycurrihy
Rathanker	87	Monkstown	Kerrycurrihy
Ringaskiddy	87	Barnahely	Kerrycurrihy
Ringacoltig	87	Clonmel	Barrymore
Ringmeen	87	Clonmel	Barrymore
Shanbally	87	Carrigaline	Kerrycurrihy
Parkgarriff	87	Monkstown	Kerrycurrihy
Pembroke	75, 87	Marmullane	Kerrycurrihy
Passage West	75, 87	Marmullane & Monkstown	Kerrycurrihy

On-Shore Assessment

Field Assessment

An archaeological inspection was carried out on the study area. For ease of description the footprint was sub divided into 5Nr. Sections.

1. Passage West, Monkstown, Raffeen/Strawhill
2. Carrigaline
3. Shanbally (WWTP)
4. Ringaskiddy

5. Cobh and environs

These are described in terms of a) pipeline routes along existing roads, b) pipeline routes through 'green field' areas, c) pumping stations, and d) cultural heritage features. Full details of this assessment are included in *Volume III, Appendix 7A*.

The proposed WWTP site was inspected and field walked. Nothing new of an archaeological nature was noted as being present during the inspection. The proposed site is adjacent to two recorded archaeological monuments (CH9 & CH10, detailed on Table 3.8.4 *Archaeological constraints Inventory of Recorded Monuments*).

A number of the proposed pipelines in green field locations were located on private lands. Where these occurred, aerial photos (orthophotos) were consulted or, where possible, stretches were viewed from roads or gateways. Nothing of an archaeological nature was noted during this field assessment. However, there remains the potential for archaeological features to be present at a very low above ground register, which may not manifest on aerial photos. There remains the possibility that subsurface unrecorded archaeological remains may be impacted during the positioning of these pipes.

Desk-Based Assessment

The five sections of the study area (identified above) are described in terms of their archaeological and historical background. This is included in the specialist report in *Volume III, Appendix 7A*. A summary of archaeological monuments, architectural structures and further potential archaeological & architectural features which could be impacted by the Scheme are detailed on Tables 3.8.4 *Archaeological constraints Inventory of Recorded Monuments,* 3.5.8 *Architectural constraints inventory of Recorded Structures within study area* and 3.8.6 *Further potential Architectural Constraints within study area*.

A list of finds recovered from the townlands within and adjacent to the study area as per the National Museum of Ireland Topographical finds is detailed in Table 3.8.2 *List of finds from Townlands along the pipeline (National Museum of Ireland Topographical Files)*.

Table 3.8.2: List of finds from Townlands along the pipeline (National Museum of Ireland Topographical Files)

Townland	Find Description
Carrigaline	• Stone ball 1.5 inch diameter with projecting knob on one side • 2 amber beads
Near Carrigaline	• 1 polished stone axe-head: 6.3cm long width at cutting edge 4.25cm; width at butt 3.1cm
Carrigaline (Ravenswood)	• 1 stone axe-head • 6 bronze pins; 1 amber ball; 1 bronze armlet; 1 flat copper axe head
Pembroke	• Dug-out canoe, 1.70m long x 0.45m wide, round bottomed with pointed stem; sides damaged, washed ashore in the townland of Pembroke in 1964

Off-Shore/Intertidal Assessment

There are no archaeological sites listed in the Record of Monuments and Places for the immediate vicinity of the Marine Pipeline Crossing, the nearest sites lying 900m to the southeast of the proposed impact area; CO087:008: Possible Ringfort, and CO087:009: Graveyard(Figure 3.8.7 *RMP Sites within the Vicinity of the proposed Marine Crossing*). However, the history of maritime activity within this area is well established; an activity that is further attested to by the number of vessels listed in the Shipwreck Inventory for this stretch of coastline (refer to *Volume III, Appendix 7A*).

The proposed crossing lies within an extremely active stretch of waterway, approximately 800m from the mouth of the River Lee and the greater expanse of Cork Harbour (Plate 3.8.1 *North-facing view of the estuary mounth, River Lee survey area in distance,* Figure 3.8.8 *Survey Area and Seabed Observations at Site of Proposed Marine Pipeline Crossing*). The east side of the river is occupied by the site of a disused boatyard, currently under development, and a series of boat-moorings are located immediately upstream of the pipeline crossing (Plate 3.8.2 *East-facing view across Marine Pipeline Survey Area, River Lee Estuary*). The Cobh to Monkstown Car Ferry operates in close proximity to the pipeline crossing; leaving from a slipway 190m upstream of the eastern limit of the pipeline, and arriving at a slipway 60m upstream on the western limit of the pipeline.

The R610 roadway runs along the western side of the river, behind which, a series detached houses are located. A steep, wooded hill is located behind these residences (Plate 3.8.3 *West-facing view across Marine Pipeline Survey Area, River Lee Estuary*). The remains of the Royal Victoria Baths are located upon the waterfront, to the east of the roadway. The site is impacted by the pipeline corridor along its northern (upstream) side. The baths consisted of two wings, with an interlinking corridor, and provided separate bathing areas for both male and female patrons. A plunge pool and 150ft swimming area was located on the eastern side of this interlinking corridor, at the river's edge. The southern wing was one storey, while the northern wing was three stories high. The baths were extended in 1858 to include an entertainment area and Turkish bath. The northern wing was destroyed by a fire in 1859 and the baths were extensively refurbishment. The baths underwent a decline in popularity during the latter part of the nineteenth-century and by 1929 they were left in a derelict state. Shortly after the upstanding elements of the structure were demolished, the rubble being used to in-fill the swimming area. The foundations of both the north and south wings are still visible today and rise *c.*2.5m from the waters edge at Low Water (Plates 3.8.4 *West-facing view of downstream (southern wing) masonry façade from the remains of the Royal Victoria Baths* and 3.8.5 *North-west facing view of western side of survey area, adjacent to the remains of the Swimming area of Royal Victoria Baths*).

The Owenboy River rises in near Adamstown and runs eastwards, passing thorough Carrigaline to exit at Crosshaven. To the east of Carrigaline town, the river becomes tidal in nature and extensive mudflats flank the river at Low water. The remains of fish-traps, fish-weirs, wooden jetties/causeways, trackways, and submerged seasonal habitation sites are included among the more frequent archaeological sites/structures encountered within the intertidal zone. In addition, the possibility remains that mudflat sediments will retain isolated archaeological features, such as log boats (dug-out canoes) or other river/sea craft.

There are no known sites of archaeological or architectural interest located within the immediate vicinity of pipeline route (Figure 3.8.9 *RMP Sites within the Vicinity of the proposed Foreshore Pipeline Route)*. However, it is important to remember the high recovery potential for portable archaeological artefacts from riverine environments. The National Museum of Ireland's (NMI) topographic files attest to the large amount of archaeological material recovered from Ireland's waterways. No artefacts are listed in the National Museum of Ireland's Topographical Files for Owenboy River.

The Record of Monuments and Places lists six sites for the townlands surrounding the proposed foreshore pipeline corridor and these are tabulated below (Table 3.8.3 *List of RMP for the Foreshore Pipeline Corridor*).

Table 3.8.3: List of RMP for the Foreshore Pipeline Corridor

Rmp Number:	National Grid Reference:	Townland:	Site Type:	Distance From Pipeline:
CO087:036-01	17414E, 06259N	Carrigaline Middle	Graveyard	300m north
CO087:036-02	17414E, 06259N	Carrigaline Middle	Church	300m north
CO087:036-03	17414E, 06259N	Carrigaline Middle	Church of Ireland	300m north
CO087:037	17446E, 06275N	Carrigaline East	Castle	200m north
CO099:001	17543E, 06147N	Kilnaglery	Fulacht Fiadh	500m south
CO099:001-02	17542E, 06149N	Kilnaglery	Fulacht Fiadh	500m south

The underwater and intertidal assessments were comprehensive and extended beyond the site boundaries. The compact nature of the riverbed/seabed, coupled with high water velocities across of the central-channel and the eastern side of the river, provides an extremely poor holding content for archaeological material. A moderate to poor holding content can be ascribed to the western side of the river, where current is reduced and some sediment deposition is taking place. No archaeologically significant materials/structures were observed during the in-water assessment of the pipeline route. While the presence of masonry and other building material located along the western limit of the underwater survey area is of interest, most likely associated with the nineteenth century Royal Victoria Baths, it retains an historic rather than archaeological significance. However, whilst no surface archaeological material has been encountered, there always remains the possibility of buried, *in situ*, archaeology remains.

Likewise, a poor archaeological potential has been observed for the pipeline corridor at Owenboy River. It is evident that extensive modern alteration has taken place with the construction of flood protection measures and the presence of an existing pipeline running along the upper foreshore. This pipeline runs along approximately 70% of the survey area. In contrast, a good archaeological holding content can be ascribed to the inter-tidal mudflats, where the deep build up of silt and clay sediments provide ideal conditions for the preservation of archaeological material. No archaeologically significant material/structures were observed during the inter-tidal assessment of the pipeline route. Only two structures of note were encountered as part of the survey. These included the remains of two iron-trackways with associated boat-trolleys. However, while these structures provide a useful insight into the river-use in the early 1900s, they hold no inherent archaeological value.

3.8.4 Environmental Impacts

(i) Construction and Operational Phase Impacts

On-shore Impacts

All elements of the proposed WWTP will involve ground disturbance. Trenches will need to be dug for pipe-laying purposes, the construction of the pumping stations may require some excavation, while, construction of the WWTP itself will require that earth be removed from the area and reused on site where possible. There exists the potential to negatively impact upon any sub-surface archaeological features and/or artefacts that may as of yet be unidentified in the area. There are recorded archaeological monuments in the immediate vicinity of the WWTP. During the construction of the WWTP and collection system, vibration from nearby machinery may have a negative impact on nearby extant archaeological features, however, the impact will be imperceptible following the implementation of mitigation measures.

The proposed pipeline follows for the most part existing roadways and so will not impact on any townland or barony boundaries in those areas (excepting where the road may form this boundary). However, areas where there is green field piping will impact a number of townland and barony boundaries. Figures 3.8.2 to 3.8.6 show the townland boundaries, which will be impacted by the green-field routes for the piping. Townland boundaries, while not recorded archaeological monuments, do possess the potential to yield archaeological information on the enclosing of the landscape in the past.

Impacts to known sites of archaeological value are as follows:

- The digging of trenches within or adjacent to zones of archaeological potential (ZAP) for the RMP sites within the study area have the potential to cause a negative impact. Zones of archaeological potential which are predicted to be directly impacted by the development are CH9 and CH18. These are indicated on the map by a circle (this is for indication purposes only and may not actually delimit the site on the ground). The locations of these monuments are depicted on the aerial photo figures (Figures 3.8.10 to 3.8.14 *Aerial Photo showing CH Locations*). 17 Nr. sites and their ZAPs may be indirectly impacted by the proposed pipeline (as stated above the ZAP is indicative only). The impact on these sites is predicted to be significant and permanent in nature; where the pipelines are routed along existing roadways, which have already caused disturbance the predicted impact has a low certainty.

- The digging of trenches for the proposed development in greenfield areas where no recorded archaeology is located could potentially result in the permanent destruction of subsurface archaeological features and/or artefacts which might as of yet be un-recorded in the area. This would be a significantly negative impact.

Should no archaeological mitigation be put in place for the duration of these works, it is likely that unrecorded archaeological deposits and/or artefacts may be destroyed without proper archaeological recording taking place.

Landscape

It is clear from this study that the landscape of the proposed development is rich in cultural heritage elements from the earliest times to the present. Perhaps the most important of those is that of Cobh Town itself CH26. Due to its historic past and its protected structures (which are seen as individual elements) it was decided that in the case of this study it should be seen as a cohesive entity. This ethos is echoed in the town's Development Plan (Cobh Town Council 2005). Most of the proposed development is underground pipe work, so while it is predicted to be visible when construction is taking place, in the long term, the visual impact should not be permanent. Major pumping stations will have a visual impact, particularly the one proposed for West Beach Cobh. This should be designed sensitively with its central location borne in mind, among all the historic structures. The other stations might also be suitably screened and their construction either/or archaeologically test trenched or monitored.

Inventory of Recorded Monuments

The following are the archaeological monuments in the vicinity of the study area, which are likely to be impacted by the proposed development. There is a description of each monument as they appear in the *Archaeological Inventory of County Cork- Volume II: East and South Cork* (Power *et al.* 1994). Where possible these sites were visited in the field. Due to the scale of the development, only those recorded monuments whose ZAP are predicted to be impacted by the development have been included as CH sites. The recorded archaeological monuments predicted to be impacted by the proposed development are detailed below on Table 3.8.4 *Archaeological Constraints Inventory of Recorded Monuments.*

Architectural Inventory

The following features listed in Table 3.8.5 *Architectural constraints inventory of Recorded Structures within study area* are the list of all known recorded protected structures (RPS) within the study area (with the exception of Cobh Town; its elements have been grouped under CH26 see below due to its complexity). This study's code (Cultural Heritage, CH, features) is provided as well as the RPS county code for the structure. The importance/legal status of the structure is provided along with the name of the address in which the structure is situated. The site type is the classification designated to the structure in the list of Protected Structure in the *Cork County Development Plan* (2003). The source of the information provided in the table is given, along with the pertinent points of that source in the final column. The National Inventory of Architectural Heritage (NIAH) was contacted. They informed Aegis Archaeology that they have yet to survey the study area and its vicinity and as such have no records for the study area at present. It is important to point out that the NIAH's future work may have a bearing on this study.

Further Potential Archaeological & Architectural Constraints

Some wayside monuments were noted during the inspection of the study area (refer to Table 3.8.6 *Further potential Architectural Constraints within study area*). These are not formally protected. They might be regarded as being of local interest and so it is suggested that they be protected from inadvertent damage during the construction of the development. The potential architectural constraints have been included here (although they are not recorded structures at present). Potential architectural features were identified from the walkover inspection only. One "new" unrecorded existing archaeological monument was noted during the walkover CH22, a limekiln.

Table 3.8.4: Archaeological constraints Inventory of Recorded Monuments

Constraint Study Code	Reference Nos.	Legal Status	Townland	Monument Type	National Grid Reference	Information Source	Information Detail	Type of Impact Predicted	Suggested Mitigation Measure
CH1 (see CH16 also)	CO087-006--- Inventory 4614	Recorded monument	Rathanker	Ringfort	17590/06740	RMP Inventory	Indicated. In pasture, on south-facing slope. Roughly circular area (35.3m n-s; 32.5m E-W) defined by heavily overgrown earthen bank (H1.85m) SE to SW; low rise elsewhere, with slight depression externally to NW. Break in low rise to NW and E. Possible souterrain (5140) in interior.	Indirect: pipe impacting ZAP of monument	Monitoring of pipeline in vicinity of ZAP for monument
CH2	CO087-013--- Inventory 5193	Recorded monument	Ballywilliam	Holy Well	18127/06719	RMP Inventory	Indicated 'Tubberlaonann' Roadside. Enclosed by rectangular stonewall; roofed with slab. Surrounding area wet; overgrown; no longer in holy use.	Possible inadvertent damage when pipe trench is dug, due to proximity of monument to roadside	Securely fence off during pipe works (remove fencing when project complete). Monitoring of pipeline in vicinity of ZAP for monument
CH3	CO087-024--- Inventory 4973	Recorded monument	Parkgarriff	Ringfort	17599/06616--	RMP Inventory	Indicated. In pasture, on south-facing slope. Shown on 1842 OS map as circular enclosure (diameter c. 40m); as slight	None. Monument is no longer extant and obscured by modern	Monitoring of pipeline in vicinity of ZAP for monument

Constraint Study Code	Reference Nos.	Legal Status	Townland	Monument Type	National Grid Reference	Information Source	Information Detail	Type of Impact Predicted	Suggested Mitigation Measure
							curve in NNW-SSE field fence on 1902 and 1934 OS maps. Modern bungalow now occupies site. Field fence (h 1.2m) SW to NW, possibly retains original bank. Fosse (d 0.95m) outside bank.	construction	
CH4	CO087-025---Inventory 5186	Recorded monument	Ballyfouloo	Holy Well	17567/06574	RMP Inventory	Indicated 'Tobernadihy' In wooded area, beside road. Site not located. According to Hurse (1926, 90) well closed but 'rounds were made and votive gifts offered' and 'the old thorn bush or tree remains'.	Indirect: pipe impacting ZAP of monument	Monitoring of pipeline in vicinity of ZAP for monument
CH5	CO087-026---Inventory 6155	Recorded monument	Monkstown (Castlefarm)	Lime Kiln	17626/06533	RMP Inventory	Indicated. Built against natural slope. Front south-facing; heavily overgrown with arched recess (wth 2.6m; D 2.7m), front of recess partially infilled with rubble, stoking hole evident. Funnel infilled; rear of kiln collapsed.	Indirect: Possible inadvertent damage when pipe trench is dug, due to proximity of monument to roadside	Securely fence off during pipe works (remove fencing when project complete). Monitoring of pipeline in vicinity of ZAP for monument
CH6	CO087-033---Inventory 6293	Recorded monument and Protected	Carrigaline Middle	Mill	17307/06249	RMP Inventory	Indicated. Late 18th/early 19th century flour mill, in Carrigaline town. Shown	Indirect: pipe impacting ZAP of monument. Monument	Monitoring of pipeline in vicinity of ZAP for monument

Constraint Study Code	Reference Nos.	Legal Status	Townland	Monument Type	National Grid Reference	Information Source	Information Detail	Type of Impact Predicted	Suggested Mitigation Measure
		Structure 00579					as L-shaped structure on 1842 OS map. Rectangular 4-storey mill (long axis N-S), now used as a store. Roof double-half-hipped. Wooden floor intact; also remains of hoist system and winnower. Courtyard to North enclosed on three sides by additional buildings.	already renovated for modern use.	
CH7	CO087-036-01 CO087-036-02 CO087-036-03 Inventory 5698	Recorded monument and Protected Structure 00576	Carrigaline Middle	Graveyard Church Church of Ireland Church	17414/06259 17415/06259 17419/06259	RMP Inventory	On north shore Owenboy estuary, on south side of road; rectangular area (c. 50m E-W; c. 80m N-S) enclosed by stone wall; still in use, recent extension on west side. Inscribed headstones date from 1690, also a number of chest tombs; large gabled burial vault SE of church. Facing entrance to graveyard, SW of church, altar tomb of Lady Susanna Newenham, date 1754, set in vaulted shelter; burial place of Newenham family of Coolmore house. At centre, St. Mary's C of I church; nave and chancel	Indirect: pipe impacting ZAP of monument. Monument still in use as graveyard.	Monitoring of pipeline in vicinity of ZAP for monument

Constraint Study Code	Reference Nos.	Legal Status	Townland	Monument Type	National Grid Reference	Information Source	Information Detail	Type of Impact Predicted	Suggested Mitigation Measure
							with spired tower at west end; built in new-Gothic style in 1823 to design of Pain brothers, brass tablet above door. On site of ancient parish church of Carrigaline, described in 1700 as 'above 70 foot long… well slated and well furnished with seats' (Lunham 1909, 169-70); O'early notes 'detached stone' bearing inscription 'this church was rebuilt in the year of our Saviour Christ, 1723'; Smithe (1750, vo. 1 208) described it as 'in decent order'; no visible surface trace. Font dated 1637 inside church.		
CH8	CO087-038---Inventory 6163	Recorded monument	Shanbally	Lime Kiln	17555/06461	RMP Inventory	Indicated. In quarry, built against natural slope. Arched recess (H2.4m; wth 1.98m; D 3m), sloping slabs to rear, stoking hole evident; keystone inscribed 'G.P.B. 1837. Stone-lined funnel almost completely infilled. Not located during this survey (no access and very	Indirect: pipe impacting ZAP of monument.	Monitoring of pipeline in vicinity of ZAP for monument

Constraint Study Code	Reference Nos.	Legal Status	Townland	Monument Type	National Grid Reference	Information Source	Information Detail	Type of Impact Predicted	Suggested Mitigation Measure
							overgrown with vegetation).		
CH9	CO087-040---Inventory 5312	Recorded monument	Shanbally	Enclosure	17528/06387	RMP Inventory Aerial Photograph	Indicated. In pasture, on south-facing slope of E-W ridge overlooking Owenboy river. Depicted on 1842 OS map as hachured D-shaped enclosure; south part of site now levelled. Arc (NW to NE) formed by earthen bank (H 0.85m) with external fosse. Possible second earthen bank (H 0.75m) immediately outside fosse; heavily overgrown and incorporated into field fence system. Interior surface irregular, interfered with; open to south.	Indirect and direct Impact. ZAP impacted by WWTP site and pipeline at this location. Some of pipe route adjacent to extant bank now extant as field boundary	Creation of c.20m buffer zone around monument in order to protect it from inadvertent damage and to maintain integrity of monument in landscape. Berms, trees and fencing should respect buffer zone and be placed outside it. Pipeline to respect buffer zone and should not impinge it.
CH10	CO087-041---Inventory 6364	Recorded monument	Shanbally	Circular Enclosure	17547/06365	RMP Inventory	Not shown. In pasture, on south-facing slope. Aerial photograph (Bord Gáis) shows levelled circular enclosure. No visible surface trace. Due to the photographic evidence and the fact that this is in close proximity to another enclosure it is	Indirect: pipe impacting ZAP of monument. Adjacent to WWTP site.	Creation of c.20m buffer zone around monument in order to protect it from inadvertent damage and to maintain integrity of monument in landscape

Constraint Study Code	Reference Nos.	Legal Status	Townland	Monument Type	National Grid Reference	Information Source	Information Detail	Type of Impact Predicted	Suggested Mitigation Measure
							quite likely that its archaeological remains are subsurface.		Pipeline to respect buffer zone and should not impinge it. Berms, trees and fencing should respect buffer zone and be placed outside it.
CH11	CO087-049---Inventory Not included	Recorded monument	Ballybricken	Possible church	17705/06449	RMP	Not included in inventory. Site not located during inspection.	Indirect: pipe impacting ZAP of monument.	Monitoring of pipeline in vicinity of ZAP for monument
CH12	CO087-054---Inventory 4271	Recorded monument	Ringaskiddy	Shell midden	17908/00345	RMP Inventory	Not shown. On beach at Curlane Bank. Narrow layer of midden material extends for 30m n-s along shoreline just above high tide mark and measures 0.1m in thickness. Deposit contains cockles, limpets and winkles with some oyster and razor shells. Large scatter of shells (c. 100m e-w) on beach at low tide level.	No Impact of archaeological feature (shell midden) and its ZAP, as it is not intended to undertake intrusive works at this location at present.	Existing pipe wayleave. No works required at this time. Should work be required in future, suitable mitigation should be put in place.
CH13	CO087-077---	Recorded monument	Kilgarvan	Church	17975//06647	RMP Urban	Not included in inventory. No surface trace found	Indirect: pipe impacting ZAP	Monitoring of pipeline in vicinity

Constraint Study Code	Reference Nos.	Legal Status	Townland	Monument Type	National Grid Reference	Information Source	Information Detail	Type of Impact Predicted	Suggested Mitigation Measure
	Inventory Not included					Archaeology Survey County Cork	during walkover. Located close to harbour in centre of Cobh. No visible trace. Unlocated during walkover inspection.	of monument.	of ZAP for monument
CH14	CO087-078--- Not included	Recorded monument	Kilgarvan	Graveyard	17967/06684	RMP Urban Archaeology Survey County Cork	Not included in inventory. No surface trace found during walkover. Urban Survey records that it was uncovered in 19th century and its site is now occupied by Cove Male National School.	Indirect: pipe impacting ZAP of monument.	Monitoring of pipeline in vicinity of ZAP for monument
CH15	CO087-079--- Not included	Recorded monument	Kilgarvan	Graveyard	17975/06647	RMP Urban Archaeology Survey County Cork	Not included in inventory. No surface trace found during walkover. Urban Survey records site now occupied by Pearse Square and originally uncovered in 19th century and recorded by Coleman in 1894.	Indirect: pipe impacting ZAP of monument.	Monitoring of pipeline in vicinity of ZAP for monument
CH16	CO087-097--- Inventory 5140	Recorded monument	Rathanker	Possible Souterrain	17590/06740	RMP Inventory	Not shown. In ringfort (4614). According to Hurse ('subterranean passage or cave was to be seen between forty and fifty years ago. It is now covered with a large flat stone and the soil has	Indirect: pipe impacting ZAP of monument	Monitoring of pipeline in vicinity of ZAP for monument

Constraint Study Code	Reference Nos.	Legal Status	Townland	Monument Type	National Grid Reference	Information Source	Information Detail	Type of Impact Predicted	Suggested Mitigation Measure
							grown over it'. No visible surface trace.		
CH17	CO087-107---Inventory 6361	Recorded monument	Carrigaline East	Possible Souterrain	17506/06287	RMP Inventory	Not shown. Uncovered during building of house c.1977. According to local information consisted of 'stone-lined passage'. Destroyed by foundation trenches. (pers. comm. S. Lane). No trace found during inspection.	Indirect: pipe impacting ZAP of monument. Impact already occurred due to construction of house.	Monitoring of pipeline in vicinity of ZAP for monument
CH18	CO087-109---Inventory 5871	Recorded monument	Carrignafoy	Battery	18097/06667	RMP Inventory	Indicated. On steep s-facing shore of Great Island with commanding view of entrance to Cork harbour; remains of roughly star-shaped fort later enclosed within rectangular ordnance grounds; known as Cove Fort. Fort built 1743-9 (Brunicardi 1982,4)	Direct and Indirect: pipe impacting ZAP of monument and some stretches very close to extant portions of the monument.	Monitoring of pipeline in vicinity of ZAP for monument
CH19	CO099-072---Inventory 3941	Recorded monument	Commeen	Fulacht Fiadh (burnt mound)	17423/06108	RMP Inventory	Not shown. According to local information, fulacht fiadh discovered during reconstruction of rural water scheme. No visible surface trace. Well nearby	Indirect: pipe impacting ZAP of monument	Monitoring of pipeline in vicinity of ZAP for monument

Constraint Study Code	Reference Nos.	Legal Status	Townland	Monument Type	National Grid Reference	Information Source	Information Detail	Type of Impact Predicted	Suggested Mitigation Measure
CH27	CO087-010---inventory 5693 & 5894	Recorded Monument Protected Structure	Ballyvoloon	Church and Graveyard	17960/06785	RMP Inventory PS	Indicated. "Cobh Cemetery". Square graveyard, large collection of inscribed headstones, contains ruins of 17th church. Many headstones have maritime connection. Lusitania mass grave here in SW corner. Site of ancient parish church called Clonmel.	Indirect: pipe impacting ZAP of monument	Monitoring of pipeline in vicinity of ZAP for monument

Table 3.8.5: Architectural constraints inventory of Recorded Structures within study area

Constraint study code	Reference (RPS County Code)	Address	Location/ Coordinates	Site Type	Source	Importance/ Legal Status	Information Detail	Type of Impact Predicted	Suggested Mitigation Measure
CH6	00579	Carrigaline Middle	17307/06249	Mill	Cork County Development Plan (as varied)	Protected Structure (and recorded monument)	List of Protected Structures Also a recorded archaeological monument.	No impact on fabric of structure, pipeline in vicinity of structure.	none
CH7	00576	Carrigaline Middle	17415/06259	St Mary's Church	Cork County Development Plan (as varied)	Protected structure (and recorded monument)	List of Protected Structures. Also a recorded archaeological monument.	No impact on fabric of structure, pipeline in vicinity of structure.	none
CH27	00861	Ballyvoloon	17960/06785	Clonmel Church and graveyard	County Development Plan	Protected Structure and recorded monument	List of Protected Structures. Also a recorded archaeological monument.	No impact on fabric of structure, pipeline in vicinity of structure.	none

Table 3.8.6: Further potential Architectural Constraints within study area

Constraint Study Code	Ref. Nos	Address	Location/ Coordinates	Site Type	Source	Importance/ Legal Status	Information Detail	Type of Impact Predicted	Suggested Mitigation Measure
CH20	none	Ringaskiddy	Within study area, 177180/064360	Roadside memorial	Fieldwork	none	Memorial for a death near this location.	Direct Impact: May be inadvertently disturbed during construction.	Suitably protected and fenced off (temporarily) during construction works
CH21	none	Ringaskiddy	Within study area, 176970/064659	plaque	Fieldwork	none	Cork Harbour Commissioners commemorative plaque erected in 1980 and bearing the inscription 'This plaque acknowledges the assistance of the European Regional Development Fund in the development of the port of Cork. June 1980'. It is a 2.40m high brick structure.	Direct Impact: May be inadvertently disturbed during construction.	Suitably protected and fenced off (temporarily) during construction works
CH22	none	Ringmeen, (Whitepoint)	Within study area, 178520/065720	Limekiln	Fieldwork OS map analysis	None	Unusual occurrence of an unrecorded kiln in Co. Cork. Rynne in his publications does not note it. Associated with a local quarry to west of monument. Marked on the first edition 6" map with a limekiln symbol (circle/ring with dot). In	Indirect impact: adjacent to location of pipes	Suitably protected and fenced off (temporarily) during construction works Archaeological monitoring in vicinity of monument.

Constraint Study Code	Ref. Nos	Address	Location/ Coordinates	Site Type	Source	Importance/ Legal Status	Information Detail	Type of Impact Predicted	Suggested Mitigation Measure
							very good condition.		
CH23	None	Ballyfouloo "Strawhill"	075400/ 065100	Railway Embankment	Fieldwork OS map analysis	None	Railway embankment extant relating to the Great southern railway which ran from Carrigaline to Crosshaven. Closed in the 1930s. Low possibility that some remains of Raffeen Mills may be present subsurface at this location also.	Indirect: impact adjacent to pumping station	Archaeological monitoring of construction works (due to presence of modern fill at location of station).
CH24	None	Kilnaglery/Commeen	073525/ 061515	The Dandy Bridge	Fieldwork OS map analysis	None	Indicated as Ford and crossing point and bridge. Origin of name unknown. Bridge single span semi-circular headed arch in mortared stone. Parapets at either side of roadway, mortared stone. Very overgrown. Stone paving noted in water to north side of bridge, possible original fording paving. Modern pipes on northern side of bridge.	Direct and Indirect impact: adjacent to pipe location. Route of pipe may traverse bridge	Archaeological monitoring of construction works. Protection of bridge in case of inadvertent damage should it be required (sandbagging, scaffolding or suchlike).
CH25	None	Kilnaglery	074255/ 062100	Bridge/ Railway	Fieldwork OS map	None	Railway embankment extant relating to the	Indirect impact: adjacent to outfall of	Archaeological monitoring in

Constraint Study Code	Ref. Nos	Address	Location/ Coordinates	Site Type	Source	Importance/ Legal Status	Information Detail	Type of Impact Predicted	Suggested Mitigation Measure
				Embankment	analysis		Great southern railway which ran from Carrigaline to Crosshaven. Closed in the 1930s. Kilnaglery bridge to south. Marked on earlier editions of maps. Modern road now traverse bridge which appears modern (though may be older and repaired).	pipe	vicinity of monument
CH26	None	Historic Town	179750/066470	Historic Town	Fieldwork OS map and documentary analysis	None (as a historic entity)	Cobh town is a complex and very important cultural heritage location. It is not designated as an entity in its own right but for the purposes of this study has been allocated a CH number. This CH number incorporates the contents of the Cobh Development Plan (CTC 2005) including its PS list and so they have not been described individually. At the end of the 18th century Cobh was described as a small fishing village consisting of a few scattered houses. Its subsequent rise arose	Direct and indirect impact: Pumping stations and pipe locations in historic town	Archaeological monitoring of all pipe routes within Urban district of Cobh. Sympathetic design of major pumping station at West Beach. Suitable Screening of all works during construction phase so as not to detract from the historic integrity of the town until they are made good. Archaeological testing in advance of construction of

Constraint Study Code	Ref. Nos	Address	Location/ Coordinates	Site Type	Source	Importance/ Legal Status	Information Detail	Type of Impact Predicted	Suggested Mitigation Measure
							from its convenient island location for shipping in Cork Harbour. It also benefited from the erection of Camden and Carlisle forts and by the construction of an artillery barracks on Spike Island to the south. It was a British naval base until 1937 and was the principal American naval base in Europe during WW1. In 1838 the Sirius sailed from here- the first steamer to cross the Atlantic. In the 19th century Cobh was a "winter resort" and in 1894 Queen Victoria visited when it was temporarily called "Queenstown". The ill-fated Titanic stopped at Cobh before it continued its maiden voyage to America (Zajac et al, Urban Survey 1995)		pumping stations at Carrigaloe and West Beach.

Off-Shore Impacts

The insertion of the Marine Pipeline between Cobh and Monkstown will result in a direct and potentially significant negative impacts to the existing riverbed/seabed environment. While no archaeologically significant material/structures/deposits were encountered during the survey, the potential of impacting buried, in-situ, archaeological material still remains. In addition, the pipeline will impact the foundations of the northern wing of the Royal Victoria Baths. It is recommended that direct impacts to this structure be avoided, preserving the in-situ masonry foundations of the northern wing. It is recommended that the pipeline either be placed outside the site of the Royal Baths, or inserted between the north and south wings; originally the swimming pool area. No *in situ* remains are believed to remain within this intersection between the north and south wings.

Archaeological monitoring licensed to the DEHLG is recommended during all riverbed/seabed disturbances associated with insertion of the marine pipeline between Cobh and Monkstown, with the proviso for full excavation of any archaeologically significant material uncovered at this time. In addition, it is recommended that direct impacts to the site of the Royal Victoria Baths be avoided, preserving the *in situ* masonry foundations of the North and South Wings.

In contrast, the insertion of the pipeline along the upper foreshore of the Owenboy River does not represent a significant impact to the existing foreshore environment. The upper foreshore has already undergone extensive and successive modern alteration with the placement of flood protection measures and a concrete encased pipeline. Should the impact area remain limited to the pipeline corridor identified on the Figure 2.9 *Associated Development Works*, it is extremely unlikely that any archaeological material/structures/deposits will be impacted during the construction process.

(ii) 'Worst Case Scenario' Impact

In the unlikely event that no archaeological mitigation is implemented for the duration of the construction phase of the proposed development, it is considered likely that unrecorded archaeological deposits and/or artefacts may be destroyed without proper archaeological recording occurring.

(iii) 'Do-Nothing' Impact

In the event of the development not proceeding at the identified sites of Cork Lower Harbour and its environs, no RMP (known archaeological sites), potential sub-surface unrecorded archaeological features or artefacts will be disturbed.

3.8.5 Mitigation Measures

(i) Construction and Operational Phases

On-shore Mitigation Measures

Monitoring/testing mitigation measures identified in Tables 3.8.4 to 3.8.6 and Table 3.8.7 will be subjected to archaeological monitoring under licence by an archaeologist. In the event of archaeological deposits and/or artefacts being encountered during this monitoring the National Monuments Section of the DEHLG and the National Museum of Ireland (NMI) will be consulted to determine the requirements, if any, for further mitigation.

The pipeline routes along the existing roads that are not adjacent to/within any RMP will be inspected by an archaeologist, at a schedule which will be agreed prior to commencement of construction activities. The detailed design of the proposed development will ensure that the pipeline route does not impact directly on any RMP site.

It should be noted that it is the remit of the National Monuments Section and the NMI to legally recommend any one or a combination of the above specified measures, or indeed to make additional recommendations in respect of mitigation.

Table 3.8.7: Mitigation Measure Summary

General Predicted Impact Summary	Mitigation Measure Summary
Predicted impacts on specific CH sites 1-27	Refer to Tables 3.8.4 to 3.8.6 for suggested specific measures
Impact of green field pipe routes on unrecorded subsurface archaeology or cultural heritage	Field walking of all green field areas when accessible. Archaeological test trenching and/or monitoring of pipe routes
Impact of WWTP	Archaeological testing in advance of construction
Impact of pipe routes where it cuts boundaries such as barony/townland boundaries	Archaeological test trenching of locations where this occurs
Impact of pipe routes within zones for CH sites	Archaeological monitoring of these locations
Impact of pipe routes along roads outside zones for CH sites	Archaeological Inspections of works at these locations
Impact of major pumping station locations: Monkstown, Raffeen/Strawhill, West Beach and Carrigaloe	Archaeological testing and/or monitoring of these locations
Visual Impact of pipeline routes	Suitable screening during construction especially in CH26 (Cobh)
Visual Impact of major pumping stations	Suitable screening to minimise visual impact on cultural heritage. In particular, sensitive design of West Beach pumping station in line with provisions of Cobh Development Plan (CTC 2005), due to its highly visible location with the cultural heritage town of Cobh.
Scale of proposed development	Due to scale of proposed development it is suggested that a Project Archaeologist be appointed to the project to oversee and manage its cultural heritage dimension during construction by liaising directly with main contractor

Off-shore Mitigation Measures

Pre-construction Measures

No further ameliorative measures are recommended in advance of construction commencing.

Construction Phase Measures

Archaeological monitoring licensed to the DEHLG is recommended during all riverbed/seabed disturbances associated with insertion of the Marine Pipeline between Cobh and Monkstown, with the proviso for full excavation of any archaeologically significant material uncovered at this time. In addition, it is recommended that direct impacts to the site of the Royal Victoria Baths be avoided, preserving the *in situ* masonry foundations.

As impacts are not anticipated, no construction phase measures are recommended for the insertion of the upper foreshore pipeline along the northern side of Owenboy River.

An archaeologist should be retained for the duration of the relevant works.

The time scale for the construction phase should be made available to the archaeologist, with information on where and when ground disturbances and dredging will take place. It is essential for the developer to give sufficient notice to the archaeologist/s in advance of the construction works commencing. This will allow for prompt arrival on site to monitor the ground disturbances. As often happens, intervals may occur during the construction phase. In this case, it is also necessary to inform the archaeologist/s as to when ground disturbance works will recommence.

In the event of archaeological features or material being uncovered during the construction phase, it is crucial that any machine work cease in the immediate area to allow the archaeologist/s to inspect any such material.

Once the presence of archaeologically significant material is established, full archaeological recording of such material is recommended. If it is not possible for the construction works to avoid the material, full excavation would be recommended. The extent and duration of excavation would be a matter for discussion between the client and the licensing authorities.

It is recommended that the core of a suitable archaeological team be on standby to deal with any such rescue excavation. This would be complimented in the event of a full excavation.

Secure site offices and facilities should be provided on or near those sites where excavation is required. Fencing of any such areas would be necessary once discovered and during excavation.

Adequate funds to cover excavation, post-excavation analysis, and any testing or conservation work required should be made available.

Machinery traffic during construction must be restricted as to avoid any of the selected sites and their environs.

Spoil should not be dumped on any of the selected sites or their environs.

3.8.6 Residual Impacts

It is anticipated that in the event of the mitigation measures as specified above being implemented in accordance with the requirements of the National Monuments Section and the NMI, there will be no residual impacts of significance arising from the proposed development.

FIGURE 3.8.1 LOCATION OF UNDERWATER AND INTER-TIDAL SURVEY AREAS.

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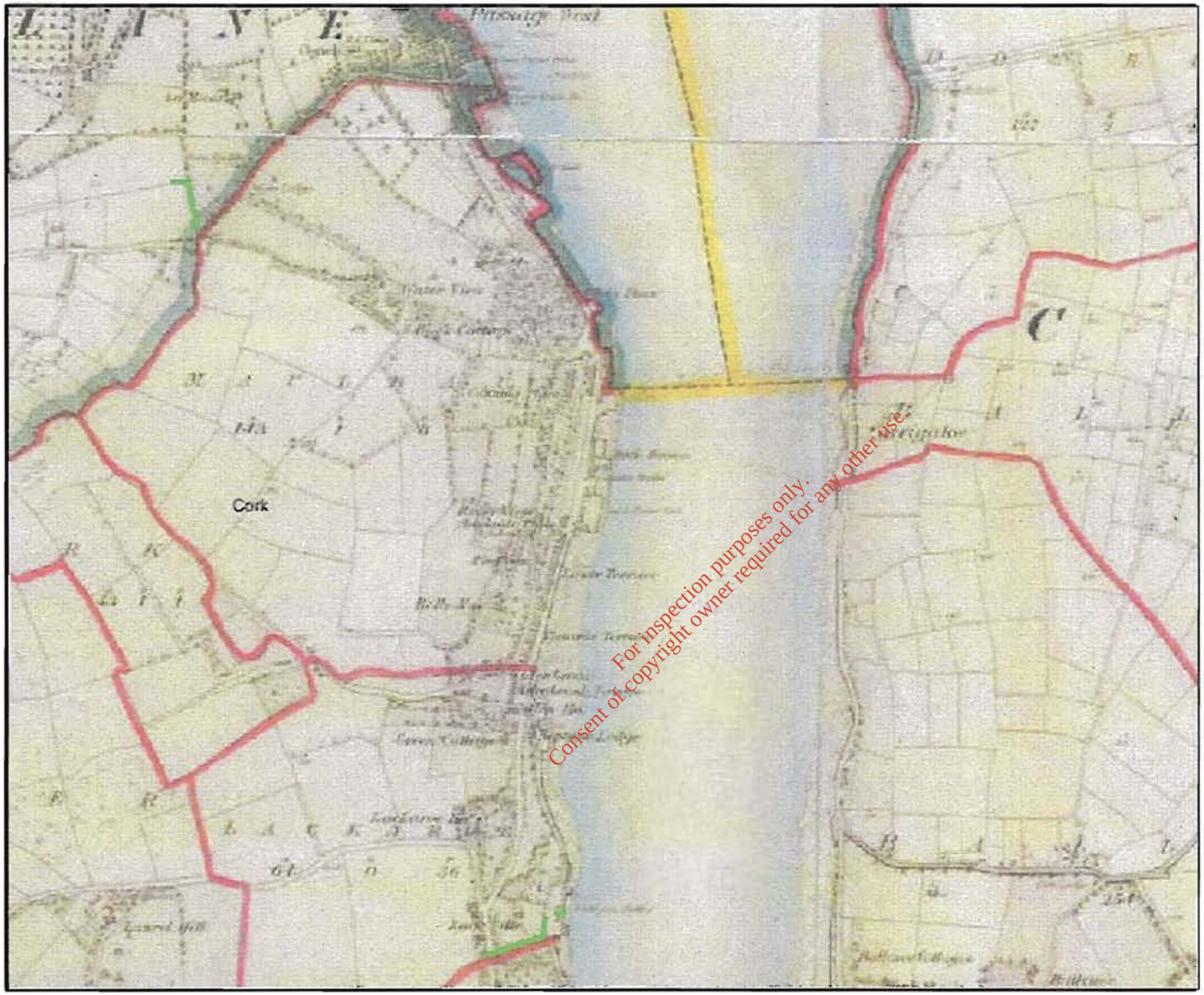
CORK HARBOUR MAIN DRAINAGE SCHEME
ENVIRONMENTAL IMPACT STATEMENT
JOB NR. 234541
DRG NR. 5670FG148



LEGEND:

TOWNLAND BOUNDARIES

GREEN FIELD PIPELINE

FIGURE 3.8.2 TOWNLAND BOUNDARIES IN THE PASSAGE WEST/MONKSTOWN AREA

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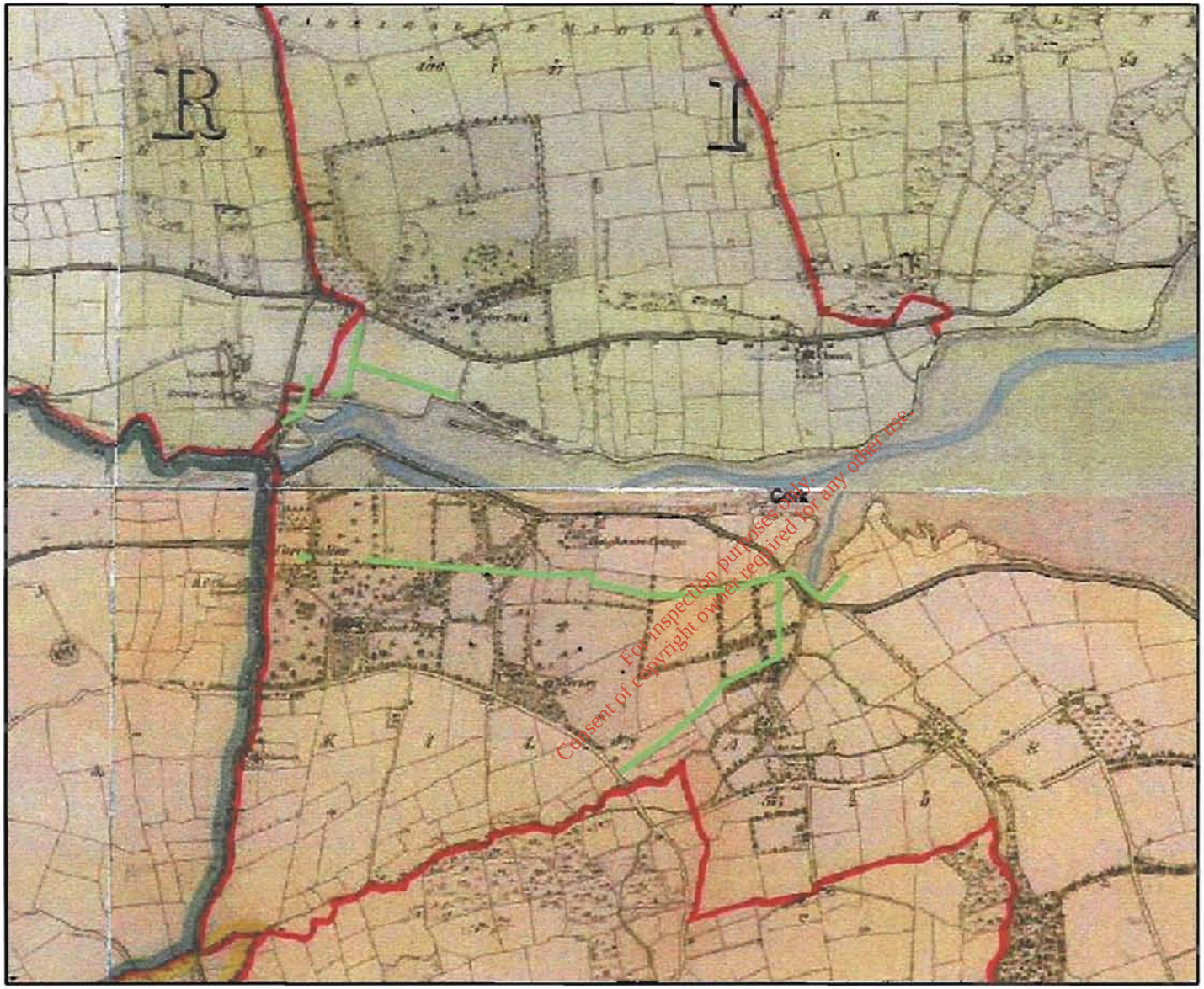
CORK HARBOUR MAIN DRAINAGE SCHEME
ENVIRONMENTAL IMPACT STATEMENT
JOB NR. 234541
DRG NR. 5670FG161



LEGEND:

TOWNLAND BOUNDARIES

GREEN FIELD PIPELINE

FIGURE 3.8.3 TOWNLAND BOUNDARIES IN THE CARRIGALINE AREA

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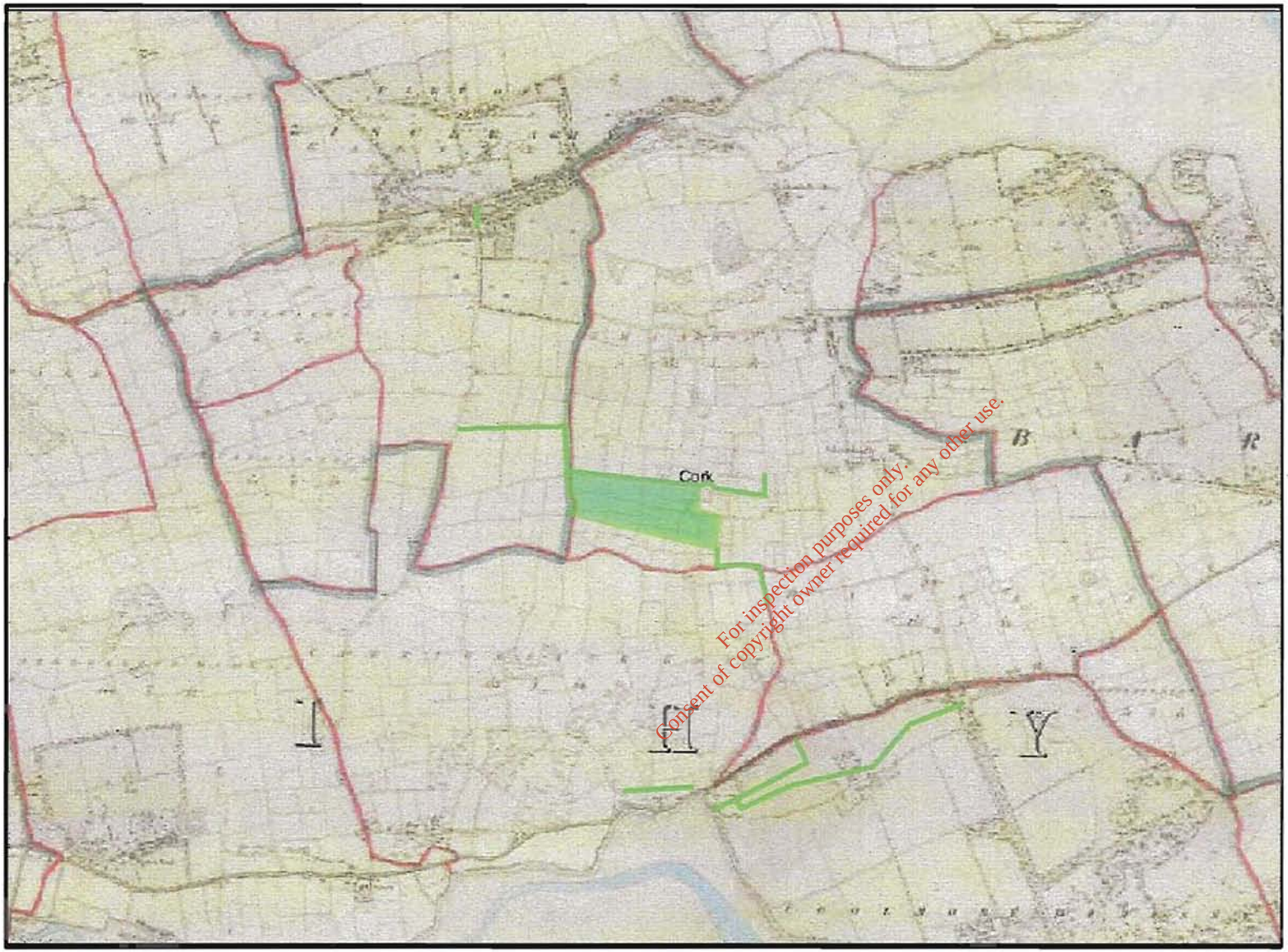
CORK HARBOUR MAIN DRAINAGE SCHEME
ENVIRONMENTAL IMPACT STATEMENT
JOB NR. 234541
DRG NR. 5670FG162



LEGEND:

TOWNLAND BOUNDARIES

GREEN FIELD PIPELINE

FIGURE 3.8.4 TOWNLAND BOUNDARIES IN THE SHANBALLY AREA

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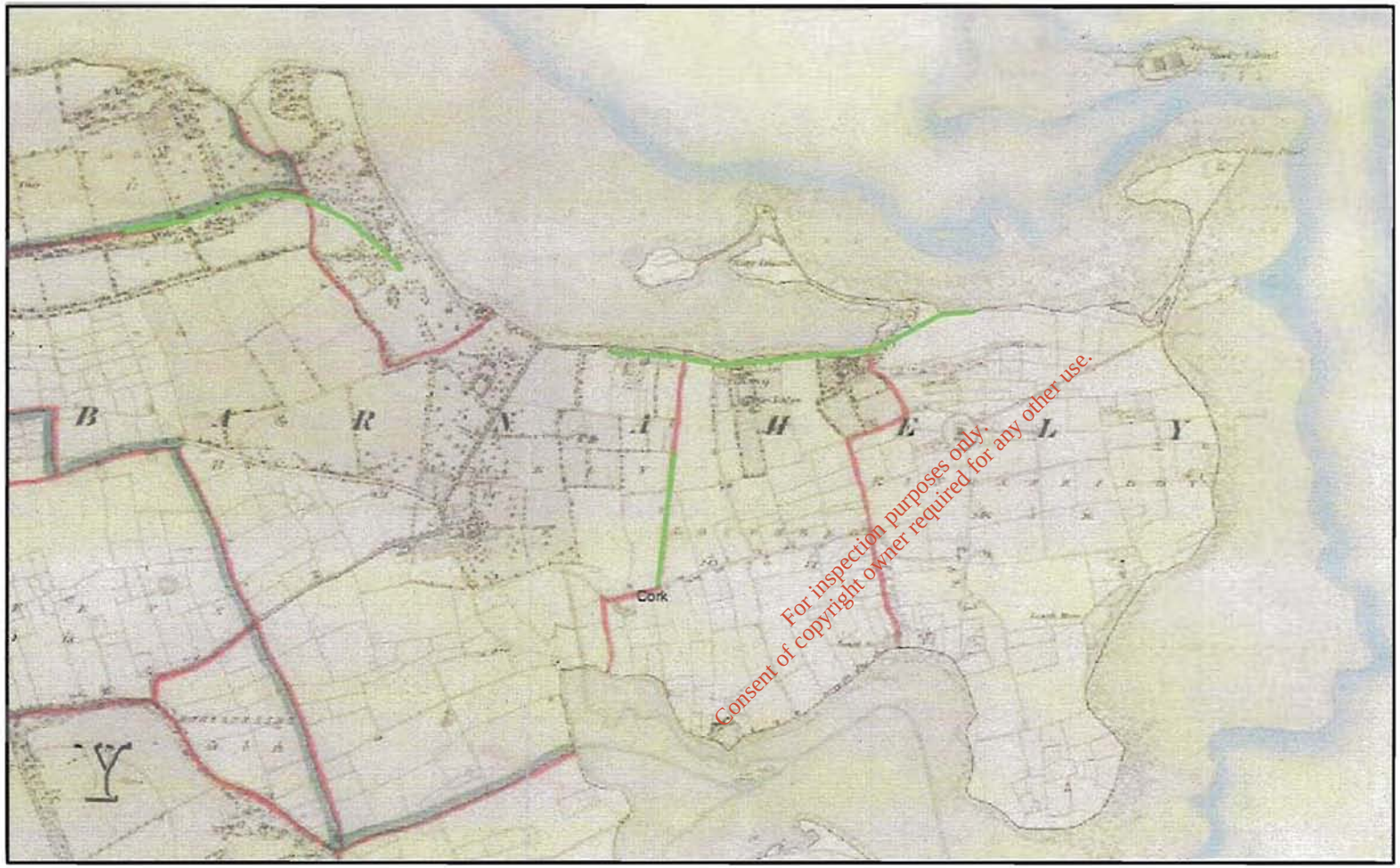
CORK HARBOUR MAIN DRAINAGE SCHEME
ENVIRONMENTAL IMPACT STATEMENT
JOB NR. 234541
DRG NR. 5670FG163



LEGEND:

TOWNLAND BOUNDARIES

GREEN FIELD PIPELINE

FIGURE 3.8.5 TOWNLAND BOUNDARIES IN THE RINGASKIDDY AREA

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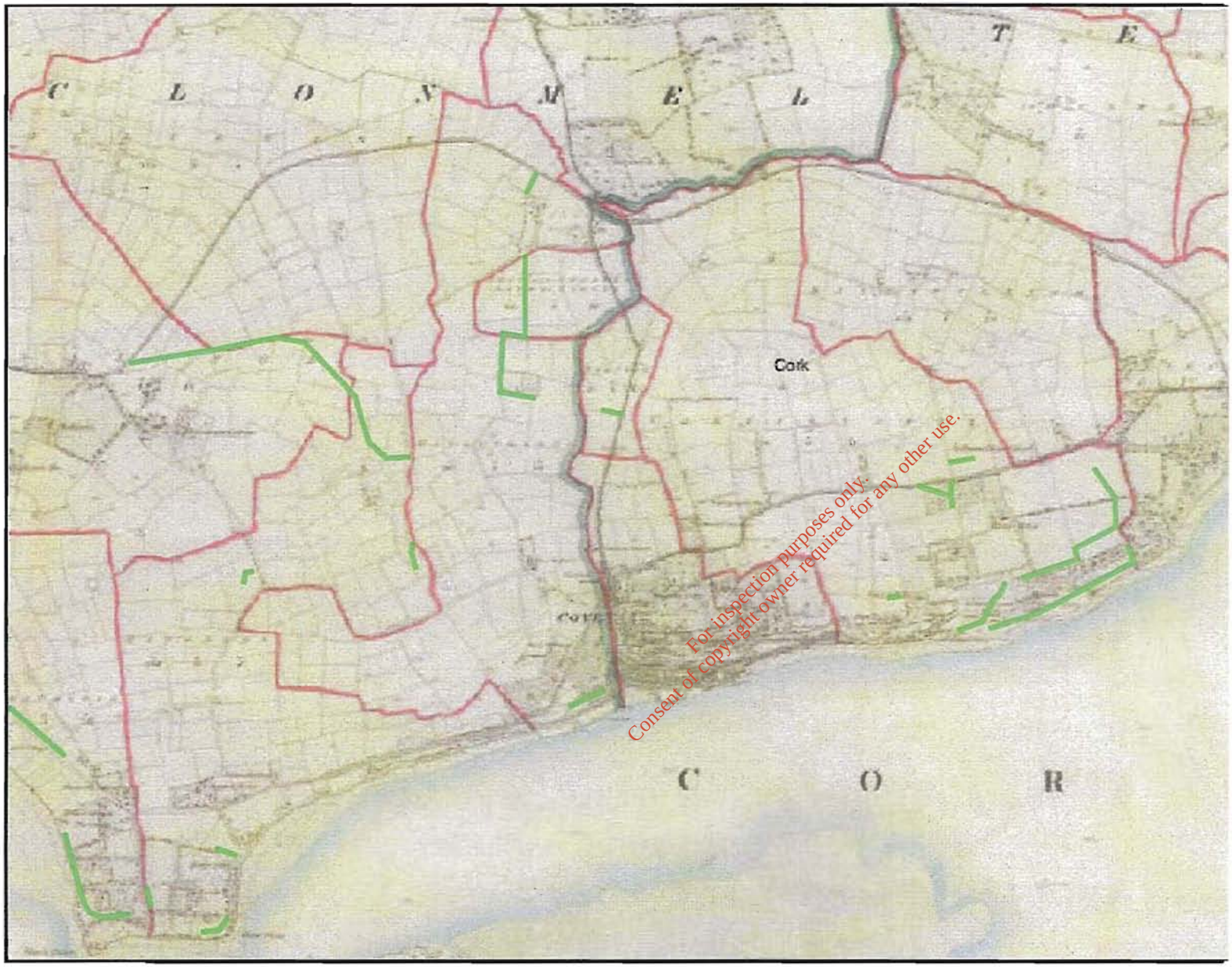
CORK HARBOUR MAIN DRAINAGE SCHEME
ENVIRONMENTAL IMPACT STATEMENT
JOB NR. 234541
DRG NR. 5670FG164



LEGEND:

TOWNLAND BOUNDARIES

GREEN FIELD PIPELINE

FIGURE 3.8.6 TOWNLAND BOUNDARIES IN THE COBH AREA

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CORK HARBOUR MAIN DRAINAGE SCHEME
ENVIRONMENTAL IMPACT STATEMENT
JOB NR. 234541
DRG NR. 5670FG165