AIR QUALITY IMPACT OF ASPHALT PLANT
CLASHEEN, KILLARNEY
CO. KERRY

ROADSTONE LTD.
CLASHEEN,
KILLARNEY, CO. KERRY

Client	SLR Consulting Ltd.
Address	Dundrum Business Park, Dublin 14
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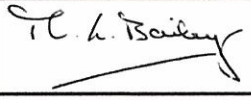
Circulation	Peter Kinghan
Author	Michael Bailey, M.Sc., B.Sc., Dip. Env. Eng
Company	Envirocon Ltd, Old Road, Kilcarn Bridge, Navan Co. Meath e-mail: info@envirocon.ie, Tel: 046-9074135/086 8071314
	
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ENVIROCON
Air Pollution
and Environmental Consultancy
Kilcarn Bridge
Navan, Co. Meath
Tel: 046-74135, Fax: 046-74055

1.0 INTRODUCTION

Roadstone Ltd. are proposing to install an asphalt plant at their sand and gravel pit at Clasheen, near Killarney Co. Kerry and are applying to Kerry County Council for an air pollution licence.

Planning permission for the installation of a mobile blacktop plant at the existing pit was granted by Kerry County Council in February 2011 (Plan File Ref. No. 10/1163). An extension of duration of the planning permission, under Section 42 of the Planning and Development Act 2000 (as amended), was granted by Kerry County Council on the 16th May 2016 and extends the appropriate period of 5 years to the 16th February 2021 (Plan File Ref. No. 10/91163).

A previous air emissions licence was granted for the proposed blacktop plant by Kerry County Council on the 22nd February 2011 (Ref. No. AP10-01). A first party appeal was made to An Bord Plenala to amend a condition of the licence and a decision by the board was made on the 29th July 2011. On the 21st December 2018 Kerry County Council environment section wrote to the applicant informing them that as no atmospheric emissions had occurred to date at the site the licence shall cease to have effect. As such there is a requirement for a new air emission licence for the proposed blacktop plant.

The proposed asphalt plant will be as per the plant proposed under Plan File Ref. No. 10/1163, or similar.

In order to evaluate the impact on local air quality due to emissions from the plant exhaust stack, an air quality modelling assessment study was undertaken. Predicted ground level concentrations for Sulphur Dioxide (SO_2), Nitrogen Oxides (NO_x), Nitrogen Dioxide (NO_2) and Particulates (as PM_{10}) were compared with the short-term and annual National Air Quality Standards (NAQS) (SI No 180 of 2011).

2.0 LOCATION OF ASPHALT PLANT SITE

The Roadstone sand and gravel pit is situated in Clasheen Townland near Minish, approximately 3km south east of Killarney (Figure 1). The site is accessed directly from the N22 that runs between Killarney and Cork. The existing extraction area of the pit extends from the road boundary eastwards for 1km with the proposed asphalt plant site on the pit floor within the eastern section of the active extraction area. The width of the pit floor near the proposed asphalt plant site is about 150m from north to south with the faces extending 8-10m above the floor on both sides.

The surrounding topography is gently undulating within 3km of the site with elevations of 50-80m O.D. within 3km to the west of the N22. At the eastern end of the pit the ground surface is at about 90m O.D. with the terrain increasing to 120-150m O.D. within 4km north of the eastern boundary. The land use in the surrounding area is mainly fields for arable farming and pasture land with isolated areas of bog-land. There is an extensive area of mature woodland bordering the NE boundary and extending along the eastern end of the pit.

There are 2 areas of housing within 1km of the sand and gravel pit, each with a small number of detached houses. The housing development at Minish East is to the south

of the pit boundary and comprises about 30 detached houses within 750m of the boundary with the nearest property 150m to the SW of the proposed site for the asphalt plant. The other area is a small development of detached houses at Lios Na Greine, which is located approximately 600m to the NW of the plant site.

3.0 EMISSION SOURCE CHARACTERISTICS

The proposed base of the asphalt plant exhaust stack is at an elevation of 78.25 m O.D. (refer to Drawing LE10-001-01-004 enclosed with this application) and is located within the eastern part of the sand and gravel pit floor. The principal emission characteristics for the exhaust stack of the macadam/asphalt plant that were used in the air quality model are presented in Table 1, with the maximum emission limit values and emission rates for Sulphur Dioxide (SO_2), Nitrogen Oxides (NO_x as NO_2) and Particulates (PM) given in Table 2. An exit velocity of 22.4 m/s was calculated for a maximum flow rate of 56,000 Nm^3/h (normal cubic metres per hour) as discharged, equivalent to an actual exhaust volume of 21.2 m^3/s.

Table 1: Characteristics of the exhaust stack

Parameter	Stack Ht (m)	Diameter (m)	Exhaust Vol (Ref) (Nm^3/h)[(i)]	Exhaust vol (Nm^3/h)[(ii)]	Actual vol (m^3/h)[(iii)]	Exit T. (°C)	Exit Vel (m/s)
Exhaust Stack	15.0	1.1	49,000	56,000	76,520	100	22.4

Note: (i) Reference Condition (Dry/17%O_2), based on Moisture Content 12.5%; (ii) As discharged at STP Reference T=0°C) (Nm^3/h); (iii) Actual exhaust volume (m^3/h).

Table 2: Emission Limits and Maximum Rates

Parameter	Emission Limit Value (mg/Nm^3)	Emission (kg/h)	Emission (g/s)
Nitrogen Oxides (as NO_2)	450	22.1	6.1
Sulphur Dioxide (SO_2)	350	17.2	4.8
Particulates	50	2.5	0.68

Note: Emission Limit Value (Reference Dry/17% O_2)

It is proposed that the normal operation of the asphalt plant will be from 04:00-19:00 Monday to Saturday with no production taking place on Sundays or Bank Holidays.

4.0 MODEL REQUIREMENTS

4.1 Model Overview

The ADMS5 (Atmospheric Dispersion Modelling System (Version 5.2, November 2017) model was used to predict ambient air pollutant concentrations in the locality. The ADMS software has been developed by CERC (Cambridge Environmental Research Consultants) over the past 20 years. It includes methods for predicting NO_2 concentrations as the plume disperses downwind from the exhaust stack using a plume chemistry reaction approach, effect of changes in terrain and downwash effects from nearby buildings on the plume dispersion pattern. It has been widely used in air pollution studies throughout Ireland over the past 2 decades for a wide range of

industrial activities and power plants and is approved by the Environmental Protection Agency.

The air quality impact assessment for the proposed asphalt plant was undertaken in accordance with the Air Dispersion Modelling Guidance Note AG4 published by the EPA.

4.2 Model Input Requirements

4.2.1 Emission source characteristics

Information relating the stack exit velocity and temperature and mass emission rates of the various pollutants to be modelled was calculated based on maximum emissions operating at the limits specified in Table 2. To allow for this weekly emission pattern in the ADMS5 model, the exhaust stack emission rates for SO_2, NO_x and PM were set at maximum with the plant in full production during the hours of 04:00-19:00 hours Monday- Saturday. For the remaining hours the emission rate was set at zero. This approach to modelling the air quality impact of the asphalt plant assumes a 'worst-case' emission scenario with maximum emissions taking place during the operational period of the day for each pollutant parameter. No variation in asphalt production from week to week was included in the modelling so from Monday-Saturday it assumed full production is taking place.

4.2.2 Climatological data

Sequential hourly climatological data from the meteorological station at Cork Airport (68km to SE) of the sand pit at Clasheen were used in predicting the ground level pollutant concentrations in the locality of the proposed asphalt plant location. Hourly climatological datasets for the years, 2015-2018, that give measurements of wind speed, wind direction, air temperature and cloud cover were processed. The year-to-year variations in wind speed and direction were taken into account in the modelling by using these datasets instead of relying on predicted concentrations based only on one year of climatological data.

The climatological data recorded at Cork Airport is likely to be representative of conditions experienced in the Killarney area. The overall pattern of wind speed and direction annual occurrence in the area is also likely to be similar to that experienced at the airport as the general W-E alignment of the River Flesk valley near Minish that tends to produce a strong prevailing SW-Westerly wind field in the area. The alternative location where hourly measurements of wind speed and direction are available is at Cahirciveen meteorological station (54km to the SW). This station is within 15km of the Atlantic coast and so measurements are strongly affected by local coastal wind-flow and would not be appropriate for locations over 50km east of the nearest coast-line.

Input parameters for wind speed, direction, cloud cover and air temperature provide values to enable the degree of atmospheric turbulence, or instability within the lower air layers to be calculated. Atmospheric instability occurs due to heating of the ground by solar radiation and this is related to the amount of cloud cover, coupled with the solar inclination, which is a function of the time of year. The hourly stability parameters

were computed by the ADMS5 from the wind, temperature and cloud cover input data. Five annual data-sets of hourly climatological data for Cork Airport for the years 2015-2019 were generated and wind roses that show the frequency of certain wind direction sectors and frequency of wind speed categories for each year are given in Figure 2.

4.2.3 Surface Roughness

The vertical wind profile above the ground is an important parameter in determining the structure of the atmospheric boundary layer near the ground. The Monin-Obukhov length provides a measure of the relative importance of buoyancy generated by heating of the ground and mechanical mixing generated by the frictional effect of the earth's surface. This frictional effect is related both to the surface roughness length and wind speed. The former parameter is used in the ADMS5 model and can vary from 0.001m over open sea to 1.5m in urban areas. It is used to calculate the boundary layer structure, which determines the rate of dispersion of an emission plume both in the horizontal and vertical plane as the plume travels downwind from the stack. A roughness length value of 0.3m, which approximates to farmland/pasture areas, was included in the dispersion model to represent surface roughness conditions within the surrounding area.

4.2.4 Receptor Grid

A grid was used with a regular spacing of 4225 receptor points (65x65 points). The grid covered an area centred on the application site. The grid covered an area of 2.6 x 2.5 km (6.5 km^2) around the site with National Grid coordinates of 500320E, 587575N for the SW corner and extending to 503120E, 590175N at the NE corner of the grid. Preliminary modelling to assess the extent of the area of the likely maximum ground level impact indicated that the highest levels of emissions from the stack will occur within about 350m of the plant site.

4.2.5 NO_x and NO_2 modelling

As the emission plume from the asphalt plant exhaust stack travels through the air the nitric oxide (NO) component in the exhaust from the aggregate dryer burner is partially converted to NO_2. The rate at which this conversion takes place varies with the degree of solar insolation present and atmospheric stability conditions and so changes throughout the day and the year. The conversion rate of NO to NO_2 is generally limited by the level of ozone present. This is normally at a maximum during the summer, with strong sunshine forming convective cells near the ground resulting in unstable conditions.

The ADMS5 model incorporates the reactions between ozone (O_3), NO and NO_2 using the simple generic reaction scheme, which simplifies the complicated series of reactions in the photochemical model. This scheme takes account of the photo-chemical reactions, in the conversion process of NO to NO_2 within the emission plume, based on solar radiation and travel time of the pollutant between the emission source and receptor locations. Background concentrations of NO_x, NO_2 and O_3 are necessary to initialise the chemistry scheme process in the ADMS5. An annual average level for NO_x of 4 $\mu g/m^3$ and 3 $\mu g/m^3$ for NO_2 was used as background concentrations in the

Minish area. These values were derived from annual average concentrations obtained from rural locations in Ireland published in the annual air quality reports for the years 2017-2019 by the EPA. An annual average O_3 concentration of 69 µg/m^3 measured at Cahirciveen for the years 2017-2019 was also obtained from these reports. This location was considered appropriate for providing a long-term value for O_3 representative of regional ground level concentrations for County Kerry.

4.3 Background Air Quality

EU Legislation on Air Quality requires Member States to divide their country into 4 zones (A-D), for the purpose of air quality monitoring, reporting, assessment and management. Dublin conurbation is in Zone A and Cork City in Zone B with large urban areas with populations greater than 15,000 in Zone C. The remainder of the country is classified as the Zone D air quality zone. Killarney and the surrounding area is within the Zone D (small town/rural) air quality zone classification.

4.4 Predicted Environmental Concentration (PEC)

The total environmental loading in terms of air quality impact on the surrounding air quality is referred to as the Predicted Environmental Concentration (PEC). This parameter is the total impact of emissions from the asphalt plant exhaust stack, (Process Contribution or PC) combined with the long-term background concentrations, so that the cumulative or total air quality impact can be compared with the NAQS values.

There are no other significant industrial emission sources nearby, and so background levels in the surrounding area are well below the NAQS values. The Ambient ground level concentrations will be comparable to background locations measured elsewhere in Ireland. Results published by the EPA on ambient air quality during 2017-19 at rural monitoring locations give annual average SO_2 levels in the order of 2-3 µg/m^3. For evaluating the total impact on local air quality the hourly and daily PEC values were calculated by adding double the background value of 3 µg/m^3 to the predicted short-term PC concentrations.

The daily average PM_{10} PEC value was calculated based on the annual average concentrations obtained at Zone D monitoring sites published in the EPA reports for 2017-19 of 8-12 µg/m^3. A background annual average beyond the quarry boundary of 12 µg/m^3 was used for calculating the daily and annual PM_{10} PEC value by adding this concentration to the predicted level due to the stack emissions.

The plume chemistry method used in the ADMS5 (refer Section 4.2.5) incorporates background concentrations of NO_x and NO_2 in calculating predicted levels and so the values for the 99.8 percentile hourly and annual average concentrations generated by the model are interpreted as the total or Predicted Environmental Concentration (PEC) NO_2 air quality impact.

5.0 RESULTS OF MODELLING STUDY

5.1 Introduction

Predicted ground level concentrations were compared with the National Air Quality Standards (NAQS) contained in the Air Quality Standards Regulations 2011 (SI: No 180 of 2011) (Table 3) for the various pollutants emitted from the exhaust stack. The predicted concentrations are based on the emissions from the plant operating at the maximum emission concentration in the exhaust gases, as given in Table 2. In other words, the modelling is based on the 'worst-case' maximum emission scenario operating continuously during the operational period of the day (Ref Section 3.2.1). In relation to dust/particulate emissions, it is assumed that it is of the size fraction defined as PM_{10} (particulates with a mean diameter of <10 µm) for the purpose of comparison with the NAQS values.

Actual emission concentrations measured in the flue gases from the plant exhaust stack are likely to be substantially below the emission limit values with efficient operation of the asphalt plant. This is especially the case for SO_2 emissions with the measured concentrations in the flue being less than 10% of the emission limit value with the use of gas oil for firing the burner in the aggregate drier.

Table 3: National Air Quality Standards (SI No 180 of 2011)

Pollutant	Criteria	(µg/m³)
SO_2	Hourly – 99.7% (not to be exceeded more than 24 times per year)	350
	Daily – 99.2% (not to be exceeded more than 3 times per year)	125
	Annual – annual average	20
NO_2	Hourly – 99.8% (not to be exceeded more than 18 times per year)	200
	Annual average	40
PM_{10}	Daily – 90.4% (not to be exceeded more than 35 times per year	50
	Annual average	40

5.2 Maximum impact beyond the quarry boundary

The predicted short-term (hourly/daily) average concentrations for NO_2, SO_2 and PM_{10} are shown as concentration contour plots in Figures 3-10. These contours are based on the maximum predicted percentile concentration for these 3 pollutants at each point modelled in the receptor grid over each of the 5 years of hourly climatological data-sets (2015-2019).

The results in the contour plots are the Predicted Environmental Concentration (PEC), which is the combined impact on local air quality due to the asphalt plant stack emissions and the inclusion of a background concentration. The PEC value is the 'total' impact or environmental loading on the local air quality and these levels can be compared with the NAQS limit values. Table 4 gives the percentage compliance of the

maximum short-term and annual average Process Contribution (PC) beyond the quarry boundary, due to the asphalt plant emissions, and the PEC values as a percentage compliance with the NAQS. Also included with this table are the PC and PEC NO_x annual average values as these can be compared with the annual NAQS for the protection of ecosystems.

The results indicate the maximum predicted concentrations for NO_2, SO_2 and PM_{10} are substantially below the relevant NAQS, based on maximum emissions concentrations at the limit values. The maximum 99.7 percentile PEC hourly SO_2 values beyond the boundary is predicted to be 97 µg/m^3 or 28 % of the NAQS limit value of 350 µg/m^3 and this occurs 250-350m to the south-east of the plant site (Figure 3). Beyond about 300m from the quarry boundary, the predicted 99.7 percentile of hourly SO_2 levels decreases to below 80 µg/m^3 or 23% of the hourly NAQS.

Table 4: Maximum predicted ground level concentrations downwind of the quarry site boundary (µg/m^3)

Parameter	NAQS Limit Value	Max Conc	% of NAQS
Sulphur Dioxide (SO_2)			
(i) Hourly	350 (99.7percentile)	91(97)	26(28)
(ii) Daily	125 (99.2 percentile)	53(59)	42(47)
(iii)Annual[(a)]	20 (annual average)	7.5(10.5)	38(53)
Nitrogen Dioxide (NO_2)			
(i)Hourly	200 (99.8percentile)	43(46)	22(23)
(ii)*Annual*	40 (annual average)	3(6)	8(15)
NOx Annual average[(a)]	30 (Annual average)	10(14)	33(47)
Particulates (as PM_{10})			
(i) Daily	50 (90.4 percentile)	4(16)	8(32)
(ii)Annual	40 (annual average)	1(13)	<3(33)

Note: (a) NAQS for protection of ecosystems; Process Contribution (PC), Predicted Environmental Concentration (PEC) [PC+ Background]

The corresponding maximum daily PEC SO_2 value, as a 99.2 percentile, is 59 µg/m^3 or 47% of the NAQS and this also is found to occur within 250m to the south of the plant site (Figure 4). Predicted daily levels are below 40 µg/m^3, or 32% of the NAQS, beyond 350m from the asphalt plant site.

The PEC maximum hourly NO_2 PEC values are predicted to be 23% of the hourly NAQS and 15% of the annual limit value and these levels occur within 450-550m of the plant location (Figures 5 and 6). Finally, the PEC daily PM_{10} downwind of the pit boundary are below 34% of both the daily (Figure 7) and annual average NAQS limit values (Figure 8).These maximum PEC values include the background PM_{10} level of 12 µg/m^3 and as shown in Table 4 the actual contribution due to PM/Dust emissions from the asphalt plant stack (PC) is 8% of the daily and less than 3% of the annual NAQS.

5.3 Impact at Nearest Houses

The maximum predicted concentrations at the nearest houses are given in Table 5. Predicted ambient concentrations for each of the air pollutants at locations are well below the relevant NAQS limit values. The highest predicted concentrations occur at the nearest houses SW of the planned site for the asphalt plant. The predicted short-term PEC SO_2 values are below 25% and 33% of the hourly and daily NAQS, respectively. Hourly NO_2 values are below 19% of the NAQS, with the maximum predicted at house H5, which is 250m to SW of the plant stack. The corresponding PM_{10} maximum daily PEC values at the nearest houses are 27% of the daily NAQS. The contribution of PM_{10} emissions from the asphalt plant stack is minor and is predicted to contribute <1 $\mu g/m^3$ as a daily average at the nearest houses.

Table 5: Predicted short-term PEC values at the nearest houses to the application site

	Map Coordinates		NO_2	SO_2		PM_{10}
House ID	Easting	Northing	Hourly 99.8%	Hourly 99.7%	Daily 99.2%	Daily 90.4%
H1	501127	588617	30	45	21	12.3
H2	501120	588554	31	43	23	12.3
H3	501052	588643	30	41	19	12.2
H4	501327	588712	36	80	42	12.7
H5	501413	588685	37	86	32	12.6
H6	501534	588516	33	59	24	12.8
H7	501807	588539	35	56	30	13.5
H8	501935	588533	31	44	23	13.0
H9	502055	588843	31	42	19	12.9
H10	501010	589428	25	29	16	12.5
H11	501037	589194	27	36	18	12.6
H12	500831	588967	27	32	17	12.5
H13	500734	588891	24	28	15	12.4
H14	500665	588846	21	23	12	12.4
H15	500911	588600	26	32	15	12.2
H16	500784	588590	23	27	14	12.1
H17	500896	589764	20	21	11	12.3
H18	501486	589602	25	30	15	12.6
H19	502236	589627	23	24	13	12.6
Maximum			37	86	42	13.5

Note: Refer to Figure 11 for locations of houses

5.4 Impact at Ecological Sensitive Receptors

Annual average SO_2 and NO_x ground level concentrations were predicted with the ADMS5 at areas of ecological importance within a radius of 15km of the proposed asphalt plant site and compared with the annual NAQS for these 2 air pollutants. The areas assessed in terms of potential long-term air quality impacts from the operation of the asphalt were those designated Special Areas of Conservation (SAC) and Special

Protection Areas (SPA). The predicted maximum annual concentrations were compared with the annual NAQS for the protection of the ecosystem (Table 6), which are 20 µg/m^3 and 30 µg/m^3 for SO_2 and NO_x, respectively. This provides an indication of potential air quality impacts on the ecology within the area.

From a review of the information available on the National Parks and Wildlife Service web-site, 3 SAC/SPAs were identified as within 15km of the asphalt plant. The nearest is the River Flesk that is part of the Killarney National Park, Macgillycuddy Reeks and Caragh River Catchment SAC (SAC Site Code No 000365). This river flows northwards to the west of the Roadstone pit and passes within 0.75km to the south and 1.5km to the west of the plant site. The second closest site is a small area of bog at Sheree situated 3km to the west of the sand and gravel pit. The third site is at Curraglass Wood that is located 9.7km south of the asphalt plant.

The results of the model for the area within 1km of the asphalt plant site demonstrate that the annual average SO_2 PEC values with maximum emissions from the asphalt plant are below 4 µg/m^3, or 20% of the annual NAQS of 20 µg/m^3 beyond 0.5km from the southern and western boundary and 1-1.4km from the northern and eastern boundaries of the Roadstone pit (Figure 9). A similar pattern for the annual NO_x PEC levels also occurs with very low NO_x levels beyond 1-1.2km from the pit boundary (Figure 10). The long-term contribution from the asphalt plant is very small at <1 µg/m^3 for both annual SO_2 and NO_x concentrations at this distance beyond the quarry site.

The annual average NO_x and SO_2 concentrations were also predicted at the River Flesk and the other 2 SACs within 15km of the asphalt plant (Table 7). The contribution of the asphalt plant emissions to SO_2 and NO_x long-term PEC values at the 3 ecologically sensitive sites are very low. Predicted long-term concentrations of SO2 and NOx are <0.5 µg/m^3 and <0.6 µg/m^3, based on continuous emissions from the asphalt plant (Table 6). It evident that the potential air quality impact of emissions from the asphalt plant will be imperceptible at the 3 sites examined.

Table 6: Predicted long-term air quality impact values at SAC/SPA sites within 15km of the asphalt plant

	Distance/Direction from asphalt plant (km)	Map Coordinates		SO_2	NO_x
SAC/SPA		**X**	**Y**	**Annual Average**	**Annual Average**
River Flesk	0.75 to South	501270	588105	(0.4) 3.4	(0.5) 4.5
River Flesk	1.5 to West	500100	588510	(0.2) 3.2	(0.2) 4.2
Sheheree Bog	3.0 to West	498525	588711	(0.1) 3.1	(0.1) 4.1
Curraglass Wood	9.7 to South	504412	579705	(<0.1) 3.0	(<0.1)4.1
NAQS				**20**	**30**

Note Stack contribution (Process Contribution PC) in (), PEC = PC + background concentration

6.0 CONCLUSION

An air dispersion modelling study was carried out to evaluate the impact on local air quality of emissions from the exhaust stack of the proposed asphalt plant within the Roadstone quarry at Clasheen Woods, Killarney. The predicted ground level concentrations were compared with the National Air Quality Standards to assess

compliance with the values designed to protect the environment and public health. The air quality assessment assumed a 'worst-case' emission scenario with the plant operating at full production during the proposed working hours at the site with no seasonal variation in output.

The emission limit values used in the modelling study are those commonly included in Air Emission Licences in Ireland and are based on the German TA Luft emission limit values for this type of industrial activity. However, emission measurements obtained from numerous asphalt plants in Ireland in recent years demonstrate that the SO_2 and NO_x emission concentrations in the plant stack exhaust are generally well below 100 mg/Nm^3. This 'actual' measured maximum emission concentration is less than 30% of the emission limit value used in the impact assessment of the operation of the proposed asphalt plant. With the installation of high efficiency bag-houses as the industry standard for particulate abatement for asphalt plants, measured emissions of PM are normally well below 50 mg/Nm^3.

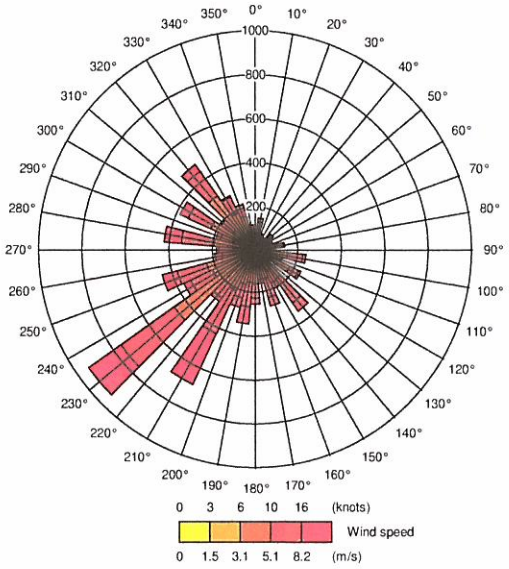
With the plant operating at maximum production and concentrations of NO_2, SO_2 and particulates in the stack exhaust gas also at maximum emission levels, the predicted ground level concentrations in the locality are substantially below the NAQS values. The impact of emissions from the exhaust stack combined with background ambient concentrations of NO_2, SO_2 and PM_{10} for the locality will also result in cumulative impacts that are well below the NAQS. The air quality impact at the 3 ecologically sensitive sites identified within 15km of the plant location will be imperceptible.

With efficient management of the asphalt plant and actual emissions substantially below the emission limit values used in the air quality modelling study no significant impact on the local environment or health of the local community is predicted.

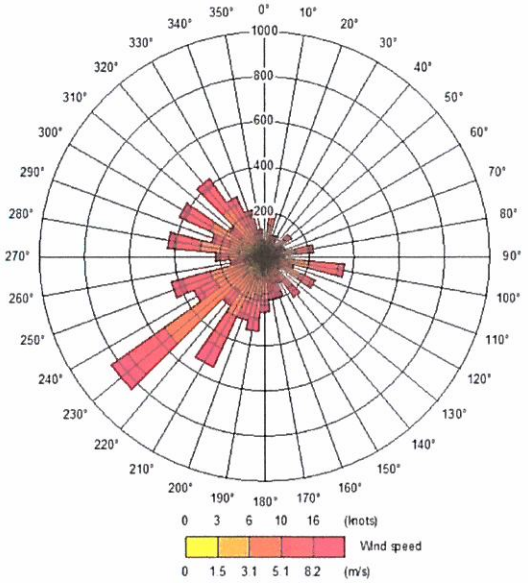
APPENDIX

FIGURES 1-11
ASPHALT PLANT SITE LOCATION
WIND ROSES
GROUND LEVEL CONCENTRATION
CONTOUR PLOTS
AND
NEAREST SENSITIVE RECEPTORS

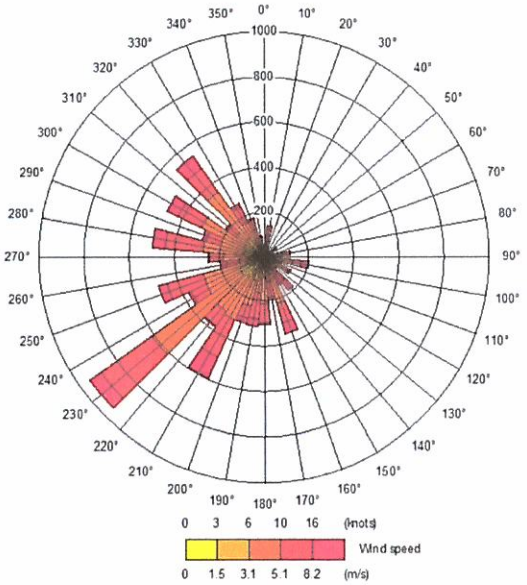
FIGURE 1: LOCATION OF ASPHALT PLANT SITE



2015



2016



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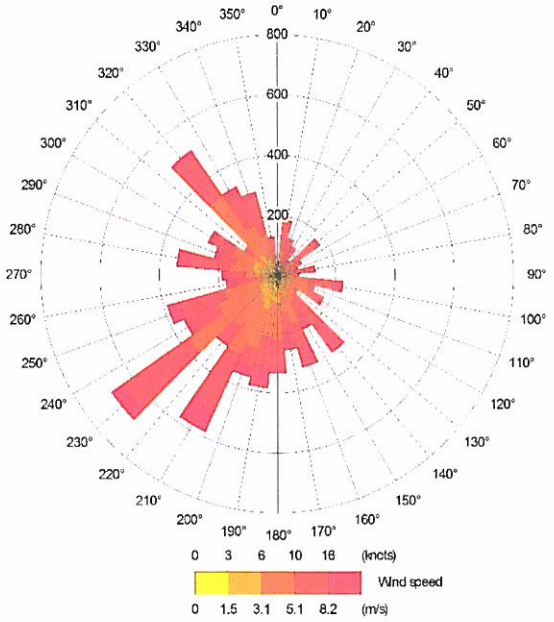
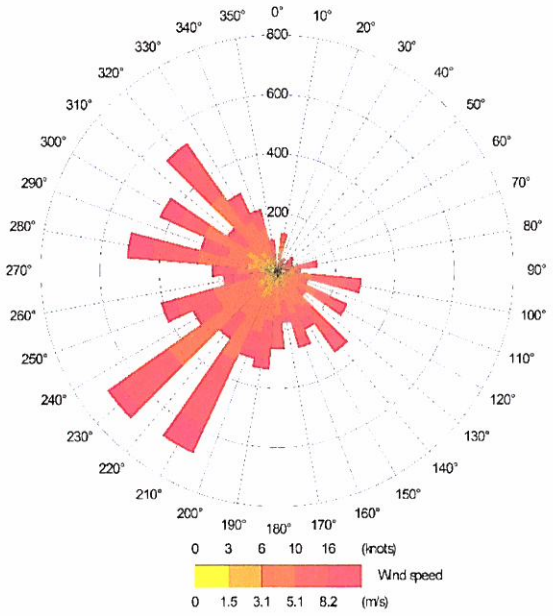


2018



2019

FIGURE 2: WIND ROSES FOR 2015-19 – CORK AIRPORT
Source: www.met.ie hourly raw data

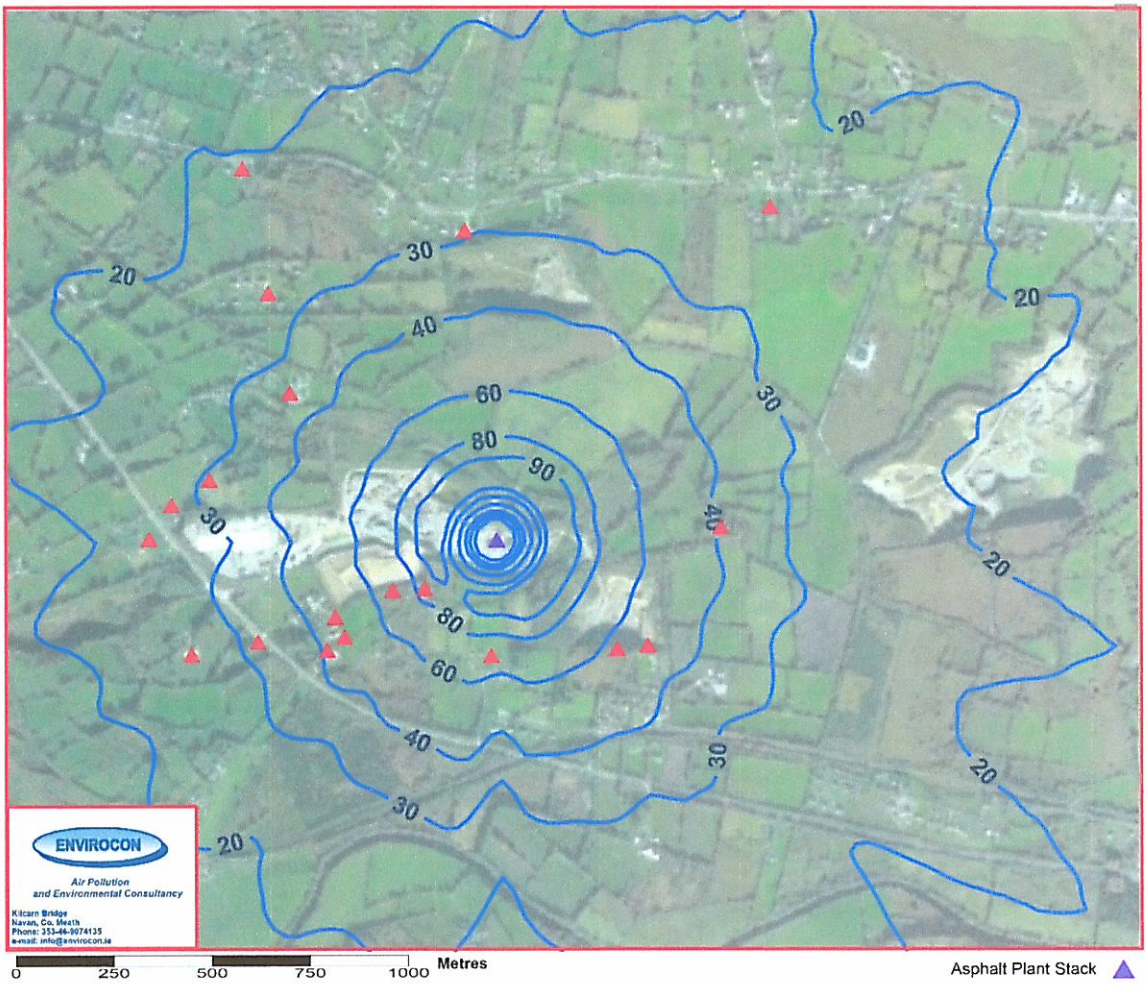


FIGURE 3: 99.7 PERCENTILE OF HOURLY SO_2 PEC DUE TO EMISSIONS FROM ASPHALT PLANT EXHAUST STACK (µg/m^3)

PEC: Predicted Environmental Concentration – Process contribution (asphalt plant stack) + Background concentration.

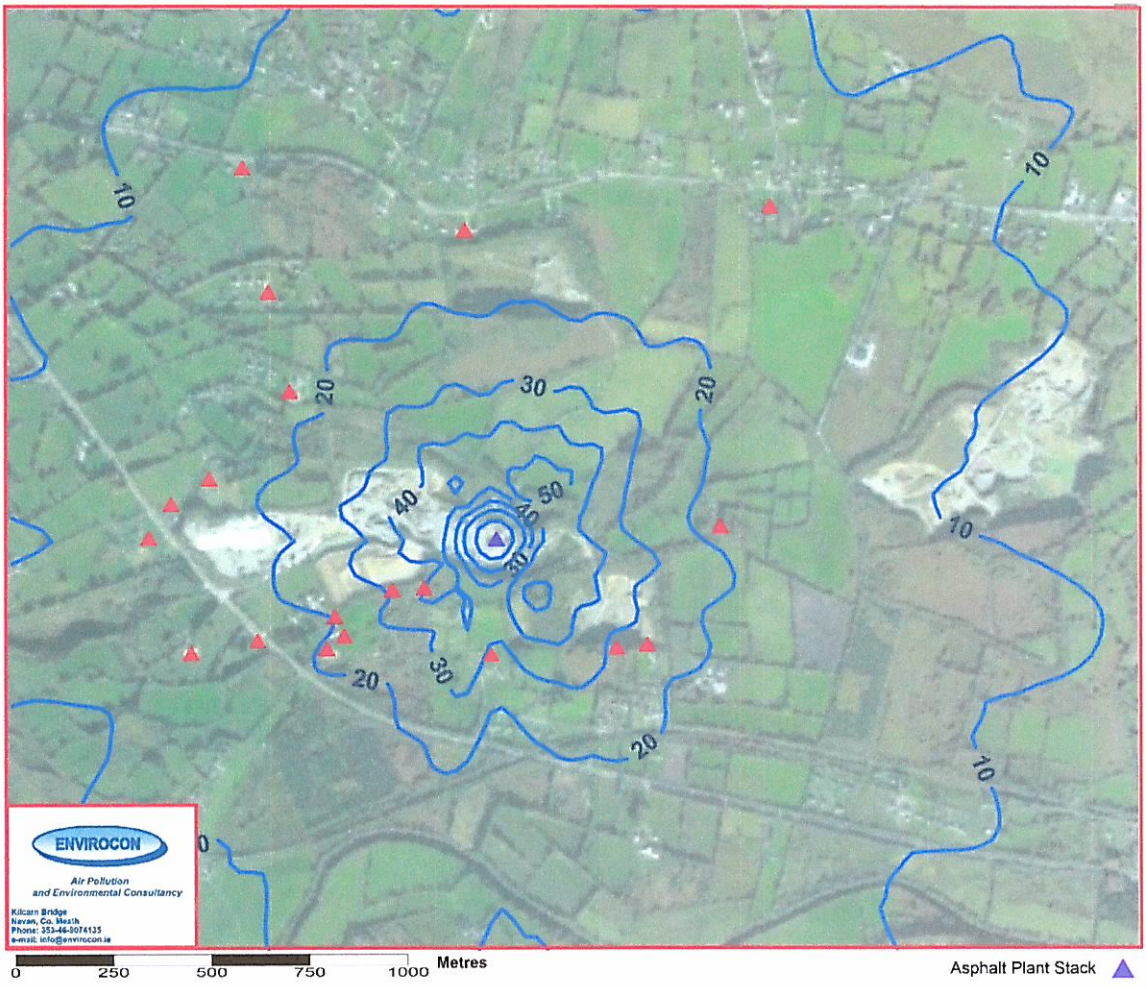


FIGURE 4: 99.2 PERCENTILE OF HOURLY SO_2 PEC DUE TO EMISSIONS FROM ASPHALT PLANT EXHAUST STACK (µg/m^3)

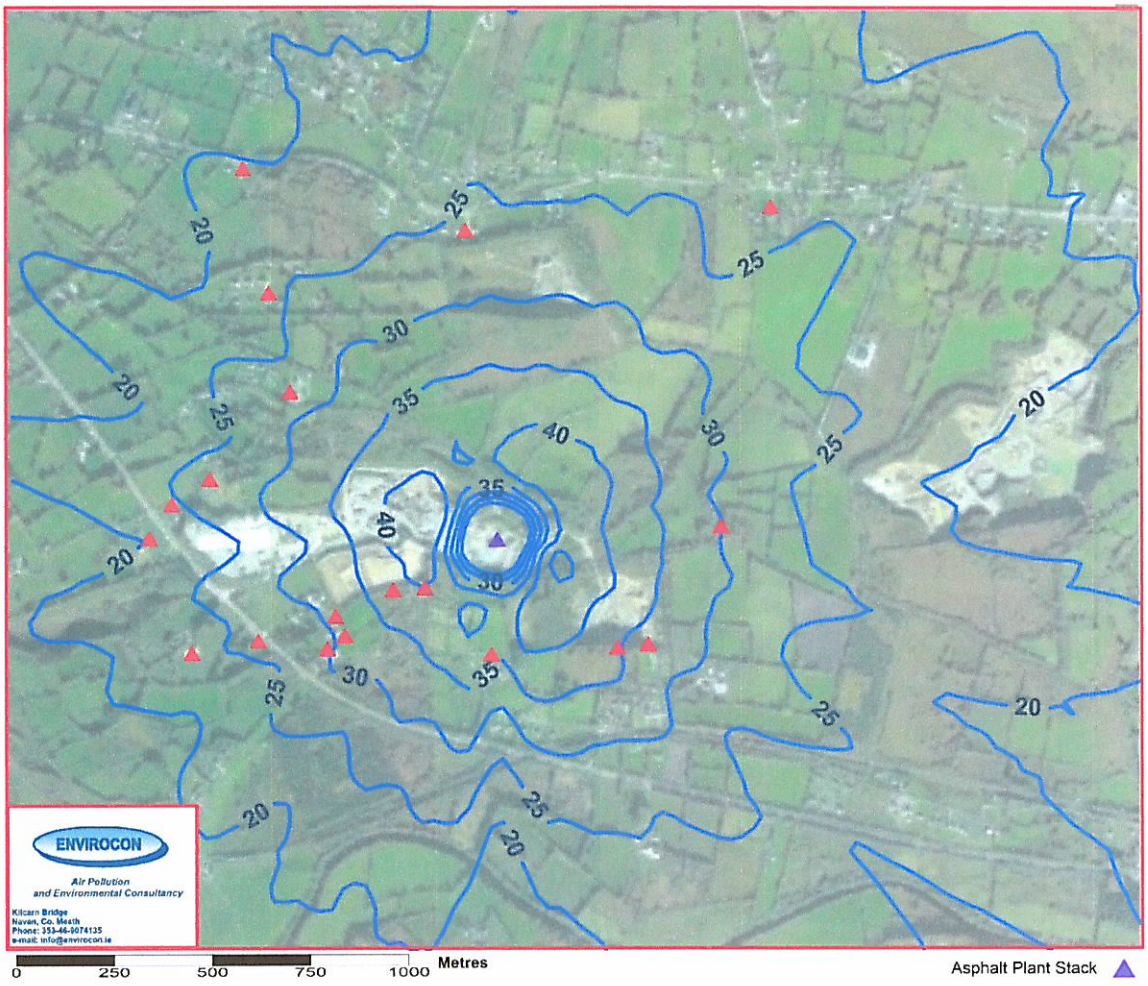


FIGURE 5: 99.8 PERCENTILE OF HOURLY NO_2 PEC DUE TO EMISSIONS FROM ASPHALT PLANT EXHAUST STACK ($\mu g/m^3$)

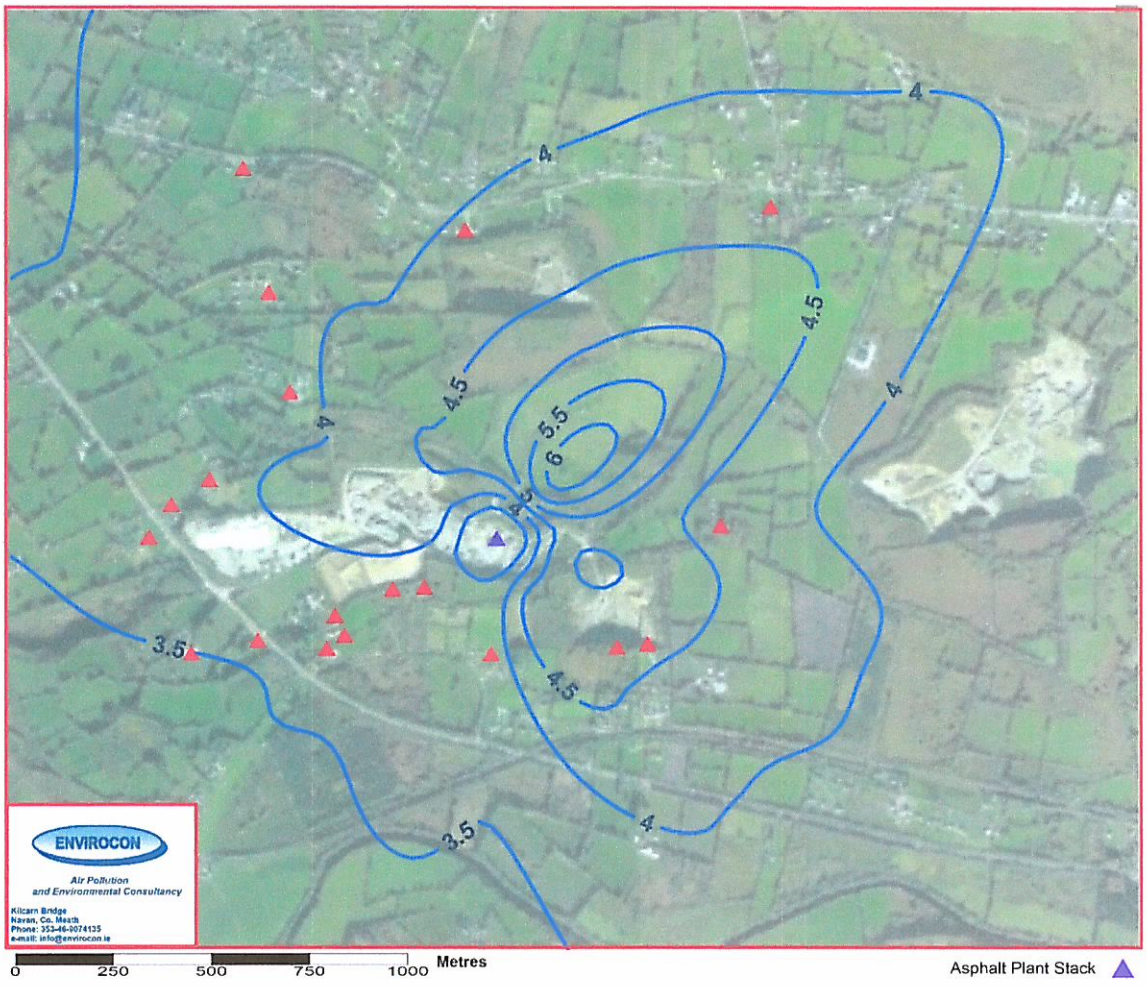


FIGURE 6: ANNUAL AVERAGE NO_2 PEC DUE TO EMISSIONS FROM ASPHALT PLANT EXHAUST STACK ($\mu g/m^3$)

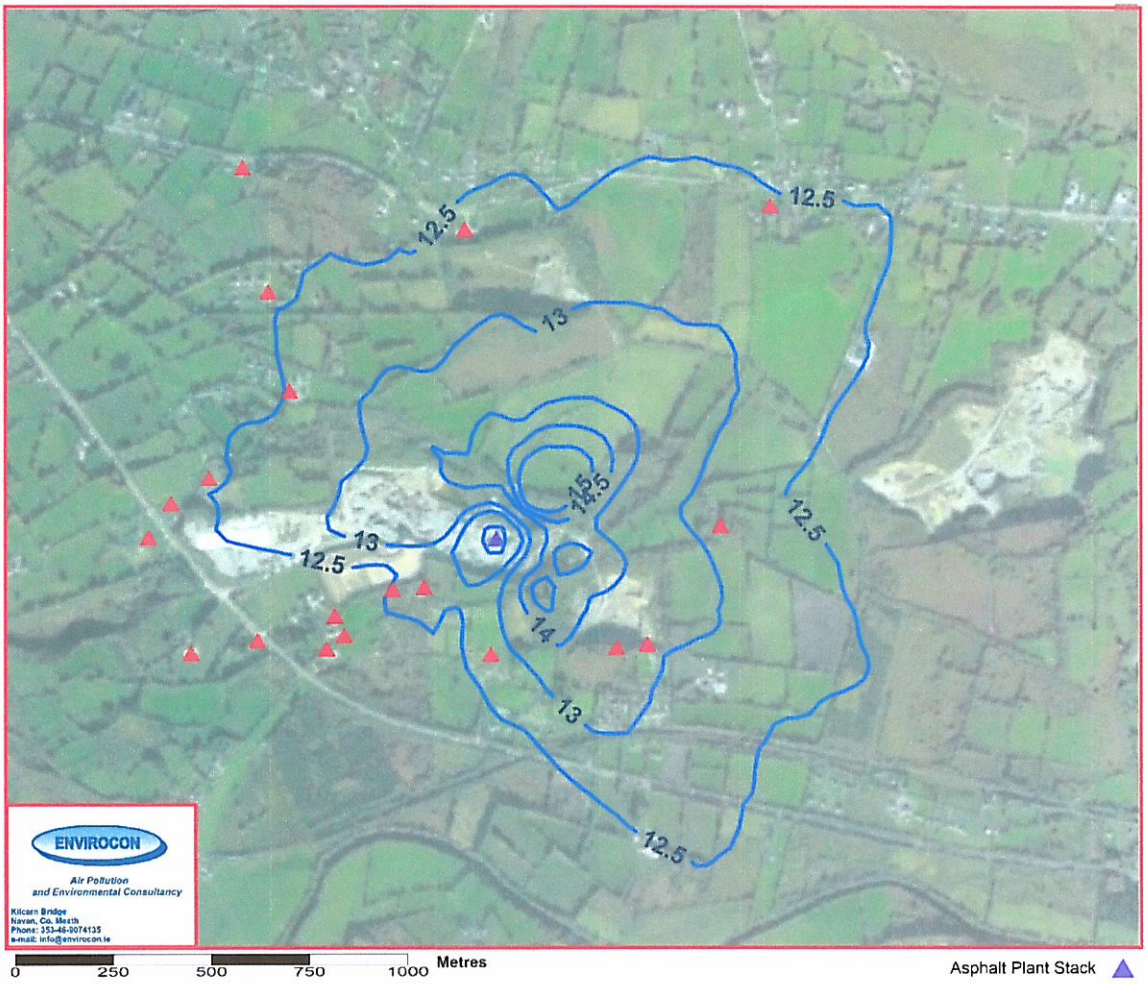


FIGURE 7: 90.4 PERCENTILE OF DAILY PM_{10} PEC CONCENTRATIONS DUE TO EMISSIONS FROM ASPHALT PLANT EXHAUST STACK ($\mu g/m^3$)

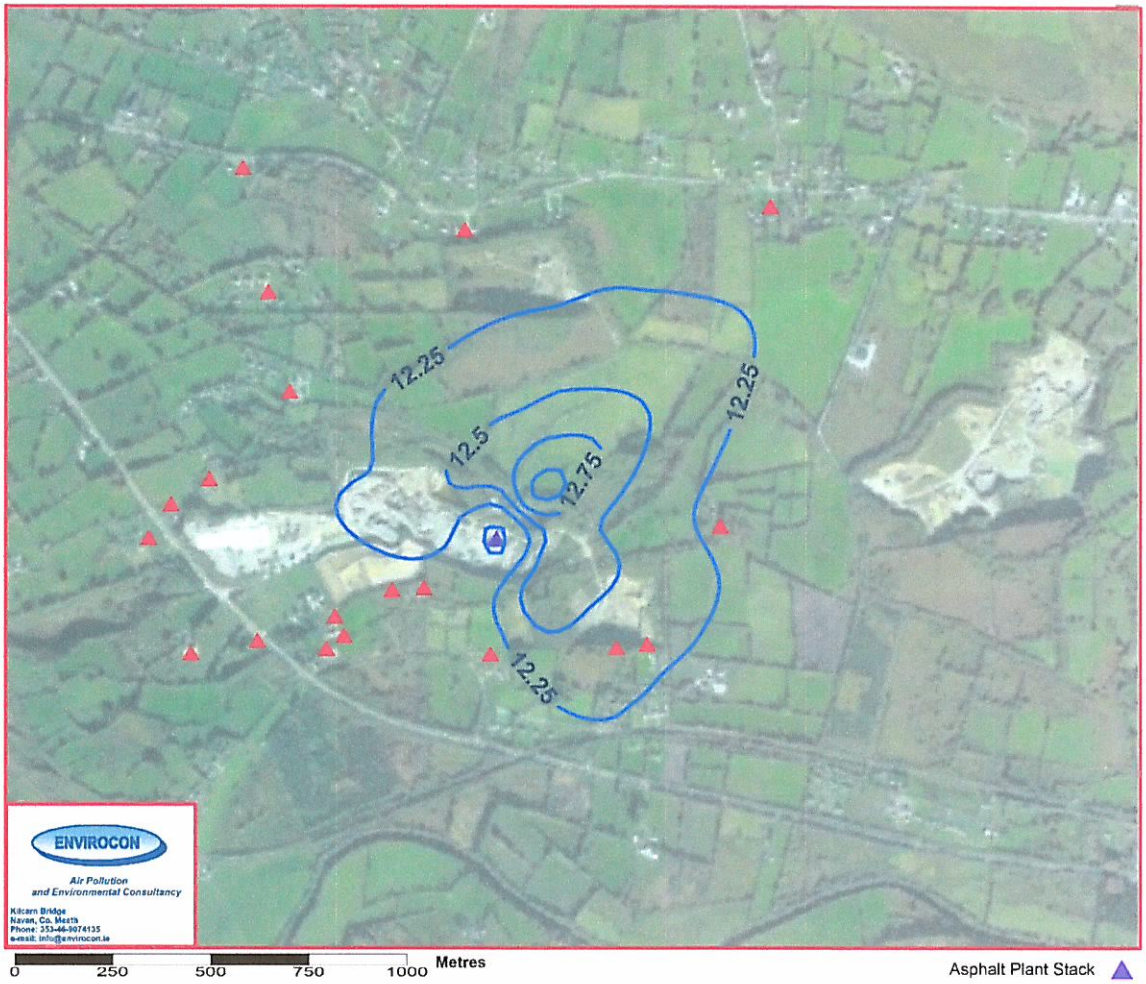


FIGURE 8: ANNUAL AVERAGE PM_{10} PEC DUE TO EMISSIONS FROM ASPHALT PLANT EXHAUST STACK ($\mu g/m^3$)

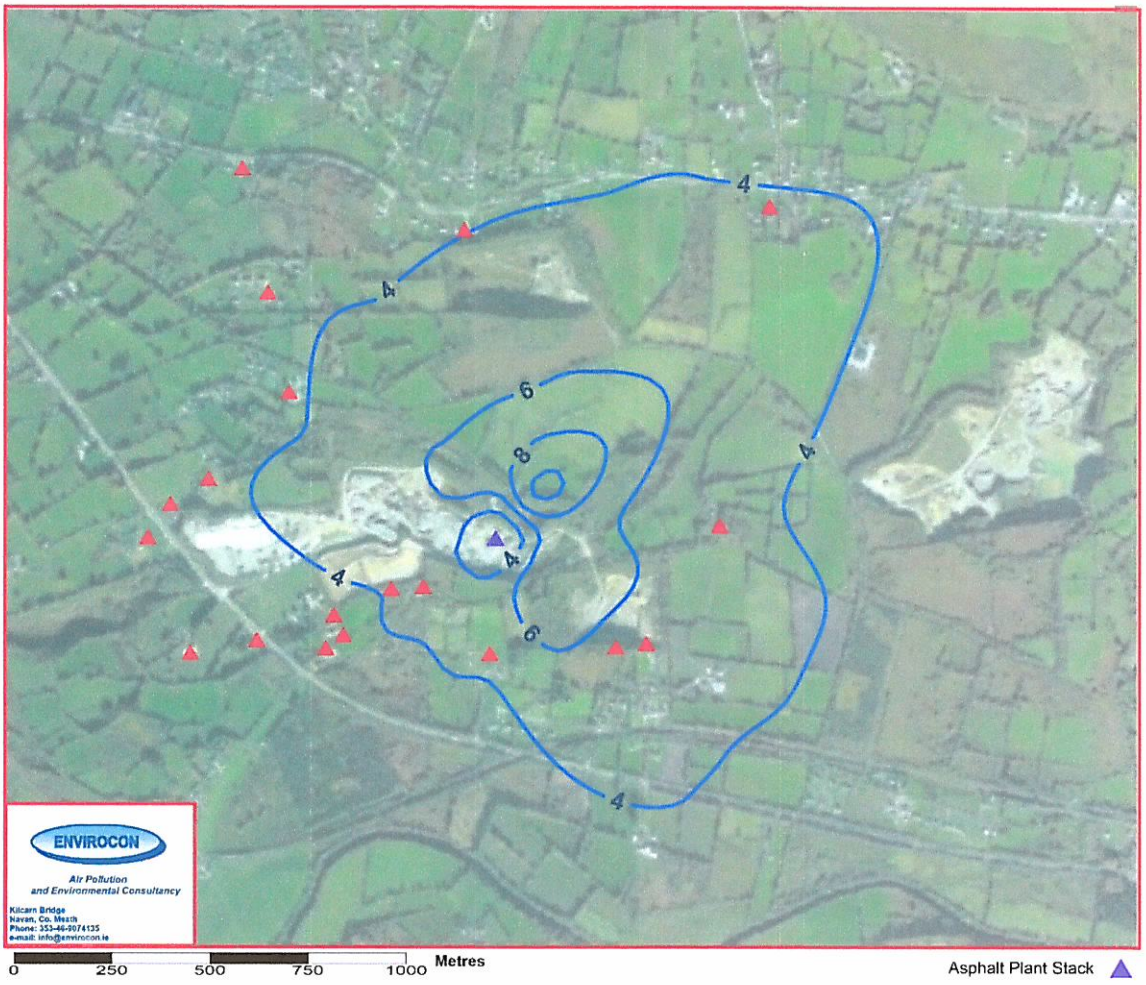


FIGURE 9: ANNUAL AVERAGE SO_2 PEC DUE TO EMISSIONS FROM ASPHALT PLANT EXHAUST STACK ($\mu g/m^3$)

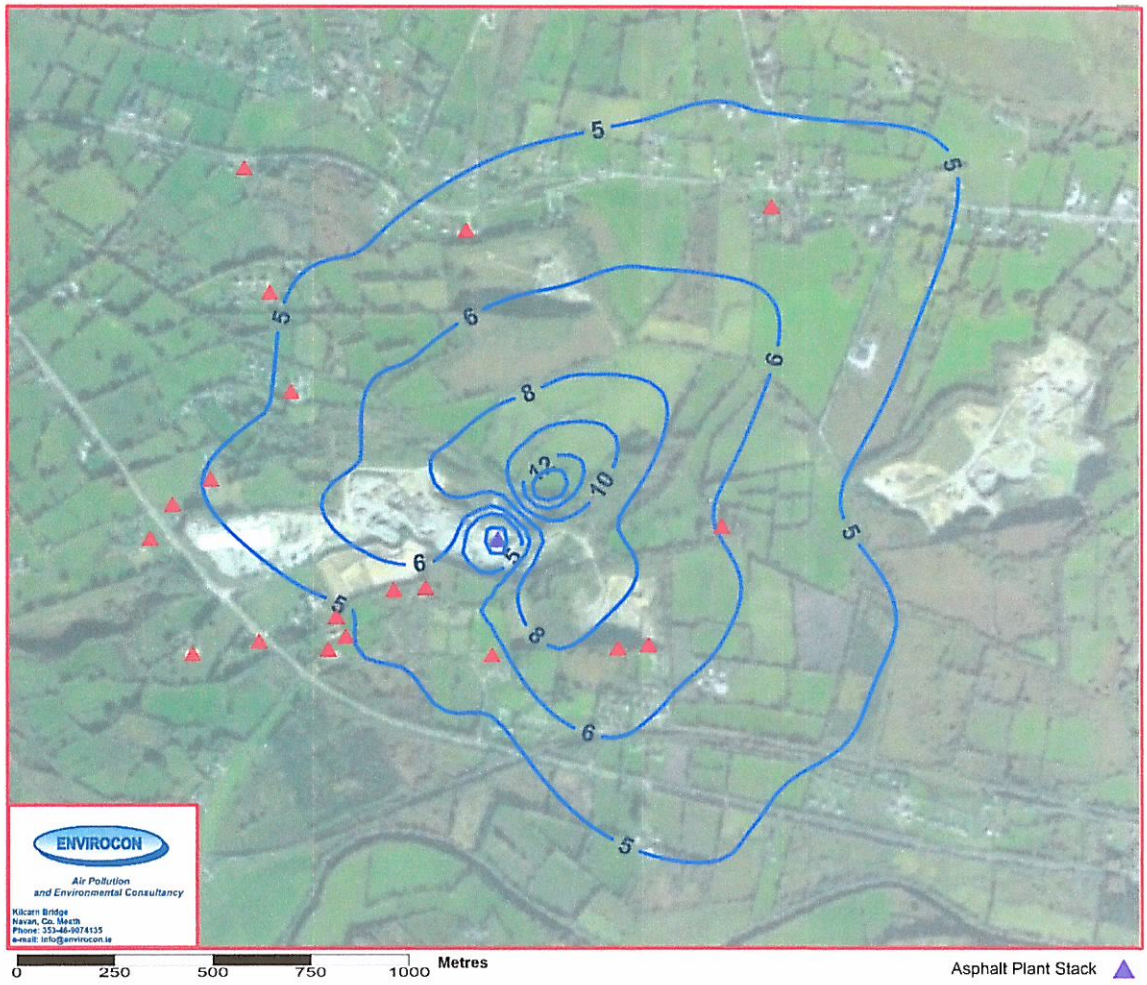


FIGURE 10: ANNUAL AVERAGE NO_X PEC DUE TO EMISSIONS FROM ASPHALT PLANT EXHAUST STACK ($\mu g/m^3$)

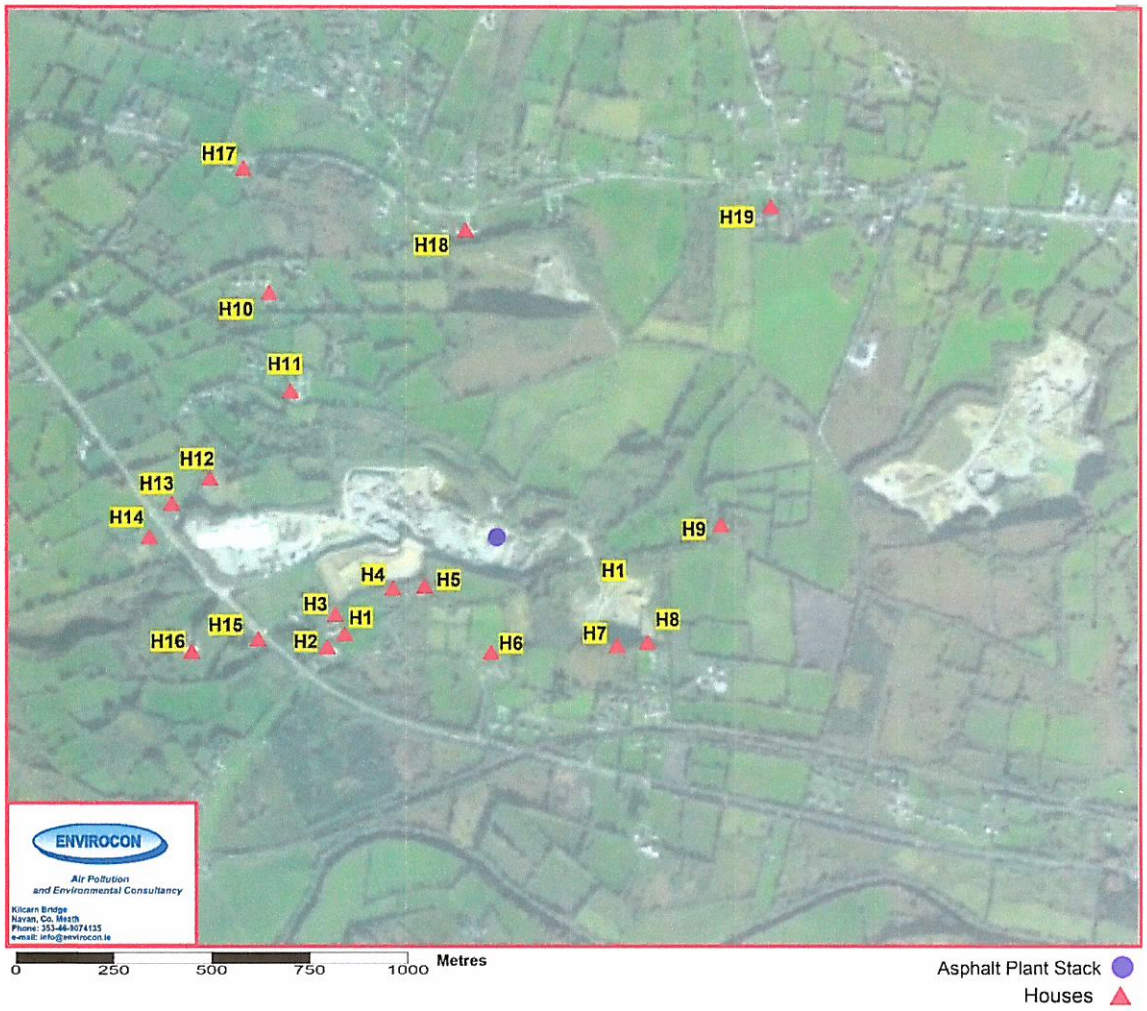


FIGURE 11: NEAREST HOUSES TO ASPHALT PLANT SITE