AECOM

# Noise Impact Assessment

Phillips 66 Ltd

Permit Number: EPR/UP3230LR Humber Refinery

Project number: 60712174
v1

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## Quality information

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## Revision History

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# 1. Synopsis

1.1 This Noise Impact Assessment (NIA) has been prepared by AECOM on behalf of Phillips 66 Limited (Phillips 66) to support an Environmental Permit variation application (Permit number: EPR/UP3230LR) for the Humber Refinery to enable the installation of a Post-combustion Carbon Capture (PCC) plant and associated facilities.

1.2 The Environmental Permit variation application and consequently this NIA is being carried out prior to completion of detailed design of the proposed PCC plant, in order to fit in with the timelines for the Final Investment Decision for the project to proceed. Accordingly, some worst-case assumptions have been applied to the assessment, which may lead to an over-prediction of the potential impacts. At the detailed design stage, opportunities to reduce the predicted specific sound levels further will be explored and Phillips 66 will continue to ensure that Best Available Techniques (BAT) is applied to the proposed PCC plant design. Following detailed design, it is proposed that this NIA be reviewed and that this is provided to the Environment Agency through a Pre-operational condition to be included in the Environmental Permit.

1.3 The NIA has been prepared following the Environment Agency's Noise and Vibration Management: Environmental Permits Guidance[1].

1.4 The focus of the NIA is on operational sound level impacts upon the nearest residential Noise Sensitive Receptors (NSR) to the Humber Refinery.

1.5 Previous noise assessments and weekly community noise monitoring have been reviewed to determine the representative background sound level without contribution of the existing noise from the Humber Refinery and the specific sound level of the current site operations based on an existing noise model of the whole site. The ambient and background sound levels from the surveys undertaken in 2022 by AECOM have also been used in the assessment.

1.6 The noise assessment comprises the following items:

- Review of previous noise assessments and baseline surveys.
- *BS 4142:2014+A1:2019* '*Methods for rating and assessing industrial and commercial sound'* (BS 4142)[2] assessment of the existing Humber Refinery operations, the proposed PCC plant and then the combined existing and proposed PCC plant.
- Proposal of options to prevent or reduce noise impact, in line with BAT or appropriate measures.

1.7 A sound propagation model has been created using the noise modelling software SoundPLAN to provide a 3D representation of the proposed PCC plant.

1.8 In accordance with BS 4142, the representative background sound levels at the NSRs have been compared against the operational rating levels (the predicted specific sound levels plus any adjustment of characteristic features of the sound). The assessment includes two representative background sound levels, one without contribution from the existing operations at the Humber Refinery (based on community noise surveys in 2015 during the last full shut down of the site) and one which includes the existing operations, as this is considered more representative of what is experienced at the NSRs. The Humber Refinery operates continuously and has been in use for over 50 years, so is part of the established baseline in the locality.

1.9 Two scenarios have been considered in this assessment - the existing specific noise levels based on the 2022 surveys at NSRs (Scenario 1) and the existing specific noise levels based on the existing operational noise model for the full Humber Refinery site (Scenario 2).

1.10 The initial BS 4142 assessment before context considerations for the existing operations for both Scenarios 1 and 2 indicate that an adverse to significant adverse impact is likely due to the excess of rating level over

[1] Noise and vibration management: environmental permits - GOV.UK (www.gov.uk)
[2] British Standards Institution (2014c) BS 4142:2014+A1:2019 – Methods for rating and assessing industrial and commercial sound

the background sound levels (both with and without contribution from existing operations at Humber Refinery). However as stated above, the Humber Refinery and other industrial/ commercial operations (including the adjacent Lindsey Oil Refinery, which has also been operational for over 50 years) have been operating in the area for many years and are considered part of the existing sound climate. Phillips 66 receive a limited number of complaints relating to noise at the Humber Refinery, which are due to transient events such as equipment requiring maintenance, flares or system safety valves lifting. These types of events are managed as part of the site process and condition monitoring systems and have been resolved quickly. There are no complaints regarding the general day to day operations of the site, indicating that the residents are accustomed to the existing noise climate.

1.11 Considering the noise levels from the proposed PCC plant alone, the initial BS 4142 assessment for the proposed PCC plant show a potential for significant adverse impacts at NSR 1 and a potential adverse impact at NSRs 2 and 3 when the rating level is compared to the background sound level without contribution from Phillips 66. However, when predicted rating level for the proposed PCC plant alone is compared to the existing background sound levels (which includes contributions from Phillips 66), there is no excess of rating level over background sound level at NSRs 1, 2 and 3 during the daytime, during the night-time the excess is 1 dB at NSRs 1 and 2, and no excess at NSR 2. This is less than the level above which adverse impacts are likely to be indicated in accordance with BS 4142.

1.12 Considering the noise levels from the combined existing operations and proposed PCC plant, Scenario 1 (based on 2022 ambient noise surveys) shows there would be up to 2 dB increase in the excess of rating level over background sound level, when the existing and proposed operations are combined compared to only the existing operations for NSRs 1 and 3, during the night-time and 1 dB increase at NSRs 1,2 and 3 during the daytime. For Scenario 2 (based on 2006 noise model predictions) there would be up to 1 dB increase in the excess of rating level over background sound level, when the existing and proposed operations are combined compared to only the BS 4142 assessment for the existing operations at NSR 1 and no change at NSRs 2 and 3. These increases are not expected to be perceptible at the NSRs, given the existing sound climate and the proposed PCC plant predictions are a worst case scenario, with all plant, including cooling fans and water cooling tower operating at maximum capacity for respective day and night periods during periods of hot weather. For the majority of the time, especially during winter months, not all the cooling fans will be in use, therefore reducing the overall sound emissions from the proposed PCC plant.

1.13 The context of the existing industrial and commercial operations in the area, which all contribute to the overall acoustic environment is also taken into consideration. The addition of the proposed PCC plant will only lead to a 1 to2 dB difference in the excess of the Rating level over background sound level between the existing and combined existing and proposed PCC plant. Therefore, the introduction of the proposed PPC plant is unlikely to be noticeable by the NSRs given very small difference in the excess of the rating level and the context of area.

1.14 Overall, considering the BS 4142 assessment outcomes and the context of the existing sound environment, it is considered that the addition of the proposed PCC plant would have a low impact on NSRs.

1.15 However, at the detailed design stage, opportunities to reduce the predicted specific sound levels further will be undertaken. Phillips 66 will continue to follow appropriate BAT as part of the existing Environmental Management System in place at the site.

1.16 This NIA has been used to develop a Noise Management Plan (NMP) for the Humber Refinery Installation.

# 2. Introduction

## Background

2.1 AECOM have been commissioned by Phillips 66 Limited (Phillips 66) to undertake the Noise Impact Assessment (NIA) to support the Environmental Permit variation application (Permit number: EPR/UP3230LR) for the Humber Refinery to enable the installation of a Post-Combustion Carbon Capture (PCC) plant and associated facilities.

2.2 This report presents the results of the NIA for the proposed PCC development and a BS 4142 assessment at nearest noise sensitive receptors (NSRs).

2.3 Phillips 66 intend to retrofit a Post-Combustion Carbon Capture (PCC) plant treating the flue gas emitted from the Installation's existing Fludised Catalytic Cracker (FCC) unit, to remove the carbon dioxide ($CO_2$) for subsequent compression and storage. The PCC plant could capture up to 0.5 million tonnes of $CO_2$ per year from the flue gases from the Installation thereby contributing towards the UK Government's legally binding target to reach net zero by 2050.

2.4 The Phillips 66 PCC plant comprise part of the wider Humber Zero Project (HZP), which consists of two Proposed Developments to install PCC plants and associated facilities located at the Phillips 66's Humber Refinery and the adjacent VPI Immingham CHP Power Plant. The Humber is the largest industrial cluster in the UK in terms of existing $CO_2$ emissions, emitting approximately 20 million tonnes of $CO_2$ per year.

2.5 The Phillips 66 PCC plant will remove approximately 95% of $CO_2$ from the flue gases from the FCC unit during normal operation. The FCC is the largest $CO_2$ emitter at the Installation and therefore is considered to be the logical first step to moving towards decarbonisation for the Installation.

2.6 Due to the critical project timelines, long Environment Agency (EA) permit determination periods and the need to demonstrate that a permit is in place to enable the project to reach Final Investment Decision, this Environmental Permit variation is being made before detailed project design has been completed. As such, it is recognised, that further information may need to be provided to the EA following completion of the detailed design process, in order to reflect design changes that may have occurred after this variation application has been submitted. Where possible, conservative or worst-case assumptions have been used in this variation application.

## Proposed PCC Plant

2.7 Phillips 66 own and operate the Humber Refinery at Eastfield Road, South Killingholme. The Humber Refinery is a highly integrated, energy efficient refinery which manufactures both fuels and specialist products.

2.8 The proposed PCC plant will prevent the emission of up to 0.5 million tonnes per annum carbon dioxide ($CO_2$) via the PCC retrofit to the FCC stack at the Humber Refinery.

2.9 The PCC plant will include the following components:

- FCC flue gas waste heat exchanger for energy recovery;
- ducting (including ducting over an existing internal access road) to connect the FCC unit to the PCC plant;
- flue gas pre-treatment using Selective Catalytic Reduction (SCR), a wet gas scrubber and wet electrostatic precipitator with associated air-cooled heat exchangers;
- one PCC unit with associated absorber, stack, stripper/ regenerator, thermal reclaimer unit and air-cooled heat exchangers
- a $CO_2$ vent stack for use during start up, shut down and emergencies only;
- $CO_2$ compression facility with associated air-cooled heat exchangers
- Water cooling tower

- oxygen removal and dehydration facilities;
- $CO_2$ metering and a pipeline connecting the PCC plant and compression facilities to the $CO_2$ gathering network interface (Viking CCS), including a pipeline crossing of the Phillips 66 railway sidings and Network Rail railway line;
- on-site electrical substation;
- caustic, solvent and other chemical offloading and storage facilities; and
- utilities (including chillers, steam turbine generator and air compressors);

2.10 The facilities will be designed to operate 24 hours per day, 7 days per week, with programmed offline periods for maintenance approximately every 6 years.

# Existing Site Operations

2.11 The existing Humber Refinery is operated under an Environmental Permit (permit number EPR/UP3230LR). Production at the Humber Refinery commenced in 1969 and has expanded over the intervening years. The refinery is divided into a number of process departments and process blocks. The dominant noise sources within the site vary depending on the proximity to the receiver location, in general pumps, air fin coolers and compressors are the plant types making the greatest contributions to the existing sound climate. The existing refinery operates 24 hours per day, 7 days per week.

2.12 Phillips 66 has an Environmental Management System (EMS) in place, which includes requirements for regular noise monitoring, a complaint handling procedure and an acoustic model of the current operations. Routine noise generating transient events, such as alarm and safety valve testing, are undertaken during the daytime when the ambient noise levels around the site are higher and also include road traffic noise. Phillips 66 has a community hotline number which is updated and maintained during abnormal events and keeps the local community informed.

2.13 Phillips 66 investigate noise complaints received and keep a log of complaints and any actions taken. All complaints received, either directly by the company or via other channels, are logged and kept open as action items until they have been satisfactorily resolved. Resolution of noise complaints involves investigation of the origin of the noise and implementation of the appropriate action.

2.14 A review of recent noise complaints shows that most are related to transient events such as equipment requiring maintenance, flares or system safety valves lifting. These types of events are managed as part of the site process and condition monitoring systems and have been resolved quickly. The Refinery has had a significant reduction of complaints in 2022 with improved management of tip steam on #3 flare and subsequent replacement of the flare tip. There has only been one noise complaint as a result of a compressor trip.

2.15 Noise levels have been measured at various points on the site boundary and at residential locations on a weekly basis for a number of years. The measurements are made by Phillips 66 staff who note the overall A-weighted noise level along with the weather conditions and other observations. The results and observations are trended and used to identify any significant changes in site noise emissions. Over the years this monitoring has identified some issues including maintenance of equipment. As a result, any issues identified have been resolved before complaints were received from residents.

2.16 Phillips 66 is not subject to any planning permission noise limits.

# Scope of Assessment

2.17 The assessment comprises the following items:

- Review of previous noise assessments for the Humber Refinery and weekly community noise monitoring.
- Review of baseline surveys undertaken as part of the Environmental Impact Assessment (EIA) to support the Town and Country Planning Application (TCPA) for the proposed PCC plant.
- Review of baseline surveys at proxy locations.

- BS 4142 assessment of the existing refinery operations, the proposed PCC plant and the combined existing and proposed PCC plant.
- Proposal of options to prevent or reduce noise impact, in line with Best Available Techniques (BAT) or appropriate measures.
- Provision of a report detailing baseline sound measurements, acoustic modelling, calculations and assessment work, suitable for submission to the Environment Agency as part of the Environmental Permit Variation.

# 3. Assessment Locations

3.1 The Humber Refinery is approximately 1 km north of Immingham town and 2 km west of the Humber Estuary and is located within the administrative boundary of North Lincolnshire Council (NLC), in the ward of Ferry. The proposed PCC plant area and the Installation site boundary is shown in Figure A1 in Appendix A along with details regarding the monitoring locations.

3.2 The PCC plant area comprises 15.68 hectares of land, largely within with the operational Humber Refinery, accessed from Eastfield Road, but also includes land to the east of the Refinery for pipeline and cable connections, including a crossing of the Network Rail railway line between the Port of Immingham and Ulceby which will need to be crossed by pipelines and cables.

3.3 The Humber Refinery is situated in a heavily industrialised area. The nearest residential settlements are the villages of South Killingholme (approximately 0.5 km west of the Phillips 66 Site) and North Killingholme (approximately 0.75 km north-west of the Phillips 66 site and approximately 0.45km west of Lindsey Oil Refinery). The closest noise sensitive receptors (NSR) are located to the west of the Humber Refinery on Staple Road, and north west of the Humber Refinery on Clarks Road and Church Lane, these NSRs are represented by NSRs 1, 2 and 3. There is also a single residential property on Marsh Lane (NSR 4). These NSRs and surrounding industrial/ commercial operations are shown on Figure A1 in Appendix A.

3.4 The identified NSRs are listed in Table 3.1

**Table 3.1. Identified nearest NSRs**

| NSR ID | Location | Approx. distance to site boundary (metres)* |
|---|---|---|
| NSR 1 | Staple Road | 519 |
| NSR 2 | Clarks Road | 790 |
| NSR 3 | Church Lane | 770 |
| NSR 4 | Hazel Dene, Marsh Lane | 1651 |

* The distance from the closest point to the Phillips 66 boundary is reported.

3.5 NSRs 1, 2 and 3 are the closest residential properties to the Humber Refinery and therefore are the main NSRs considered in this NIA. The existing noise climate consists of noise from the Phillips 66 site, other similar industrial/ commercial operations and road traffic noise. Industrial and commercial operations in the vicinity include:

- Lindsey Oil Refinery,
- VPI Immingham Combined Heat and Power plant,
- DFDS,
- DVS,
- Scangrit,
- Killingholme power station,
- Port of Immingham; and
- Killingholme Ro-Ro.

3.6 The ground between NSRs 1,2 and 3 and Phillips 66 is open space and fields, apart from local roads and the A160 to the south of the NSRs.

3.7 The baseline sound surveys carried out for the EIA which was produced to accompany the TCPA for the proposed PCC plant were completed in April and May 2022 at the NSRs listed in Table 3.1. These surveys were undertaken whilst the existing Phillips 66 plant was operating.

3.8 The BS 4142 assessments carried for the Environmental Permit variation require a background sound level without the existing Phillips 66 site. The Phillips 66 Humber Refinery operates continuously 24 hours a day, 7 days a week and there is no planned shutdown of the full site within the timeframes of the Environmental Permit application.

3.9 Additional site visit and surveys in the area by AECOM in August 2023 were undertaken to try to identify suitable proxy locations which had similar sound climate to the original NSR 1, 2 and 3 monitoring locations without the presence of sound from Phillips 66. It is acknowledged that finding appropriate proxy locations is difficult as they still need to include the sound contribution from the other industrial/ commercial operations and road traffic noise.

3.10 During the additional survey the original monitoring locations were visited again and it was noted that at NSR 1 and NSR 2 sound from Phillips 66 was audible. At NSR 1 and NSR 2 alternative locations were used (NSR 1 Proxy and NSR 2 Proxy), which had similar sound climates to the original monitoring locations but without the presence of sound from Phillips 66.

3.11 At NSR 3, neither Phillips 66 nor VPI was audible. Due to access reasons the exact location used originally was not used for the additional survey, but a publicly accessible location (NSR 3a) close to original location was used instead to represent NSR 3.

3.12 The Phillips 66 weekly community noise monitoring is undertaken on Staple Road, which is representative of NSR 1.

3.13 The location of the NSRs and the proxy monitoring locations are shown on Figure A1 in Appendix A.

# 4. Methodology

## Noise Surveys

4.1 A range of noise surveys were undertaken as part of the EIA carried out to support the TCPA for the proposed PCC plant at locations representative of the nearest NSRs. Sound level monitoring was undertaken to the requirements of *BS 7445 1: 2003 'Description and measurement of environmental noise. Guide to quantities and procedures'*[3], in particular regarding instrumentation and monitoring methodology. This comprised unattended measurements with observations made on set up and collection of equipment and weather data recorded using a weather station located at NSR 2.

4.2 All measurements were taken at approximately 1.5 m above ground level, and were positioned at least 3.5m from any reflecting surface, other than the ground (i.e., free-field measurements). Each sound level meter was set to log the $L_{AF10,15mins}$, $L_{Aeq,15mins}$, $L_{AF9015mins}$ and $L_{AFmax}$ parameters. The weather conditions during the survey periods were all within the parameters set out in the relevant guidance documents including BS 7445 and BS 4142.

4.3 AECOM have undertaken additional attended background sound measurements during the daytime and the night-time on 24th - 25th August 2023 (the "additional survey") at proxy locations.

4.4 At locations NSR 1 Proxy, NSR 2 Proxy and NSR 3a attended measurements were undertaken for a period of 1 hour in the daytime and 30 minutes during the night-time. Subjective descriptions of the audible sound were noted. All measurements were taken at approximately 1.5 m above ground level, and were positioned at least 3.5 m from any reflecting surface, other than the ground (i.e., free-field measurements). Each sound level meter was set to record the $L_{AF10T}$, $L_{AeqT}$, $L_{AF90T}$ and $L_{AFmax}$ parameters. The weather conditions during the survey periods were all within the parameters set out in the relevant guidance documents including BS 7445 and BS 4142.

4.5 Historical data from weekly night-time community sound surveys that Phillips 66 undertake as part of their current Environmental Permit have also been reviewed. The last full refinery shut down was in June 2015, with readings taken on 6th and 14th of June during the shut-down period.

## Operational Noise Prediction and Assessment

4.6 The assessment of operational sound levels has been based upon calculations taking account of plant proposed for the PCC plant and equipment sound power levels ($L_w$) relating to the proposed plant, distance between the proposed plant and NSRs and the acoustic screening offered by existing topography and existing and proposed new buildings. The proposed plant sound power levels, and the assumptions applied to the prediction methodology are detailed in Appendix B.

4.7 Three-dimensional sound propagation models have been developed using the modelling software SoundPLAN Version 8.2 to assess the current layout options for the PCC plant. SoundPLAN implements the prediction method *ISO 9613-2: 1996 'Attenuation of sound during propagation outdoors'*[4], which has been employed to calculate sound levels at surrounding NSRs due to the proposed PCC plant at Phillips 66.

4.8 Topographical features and buildings that may influence the transmission of sound from the proposed PCC plant to NSRs are included in the model. A digital terrain model created using publicly available ground elevation spot height data have been used to position buildings and other noise sources at the proposed heights relative to ground. Areas of acoustically soft (e.g. vegetation) and hard (e.g. concrete) ground have been identified from the Ordnance Survey MasterMap Topographic Layer and modelled accordingly.

[3] British Standards Institute (2003) BS 7445-1 – Description and measurement of environmental noise. Guide to quantities and procedures

[4] International Organization for Standardization (1996) ISO 9613 Acoustics - Attenuation of sound during propagation outdoors.

4.9 The following sources of information that define the proposed PCC plant have been reviewed and form the basis of the assessment:

- Indicative Layout 3D Model and Block Plan for the proposed Phillips 66 PCC plant as provided by Phillips 66's design team;
- Items of plant including sound power level data for the PCC plant as provided by Phillips 66's design team;
- Ordnance Survey (OS) MasterMap mapping, topographical data (LiDAR data) and aerial photography of the proposed PCC plant and surrounding area

4.10 The prediction method assumes that the prevailing wind direction is always from source to receiver, which is likely to overestimate sound from the proposed PCC plant for much of the time for the vast majority of NSRs, given the predominant wind direction in the UK is from the south-west. Based upon the predicted sound levels from the model, an assessment of potential impacts at nearby NSR has been undertaken using the guidance in BS 4142. Wind roses from Humberside Airport are included in Appendix A to show the prevailing wind direction.

4.11 A key aspect of the BS 4142 assessment procedure is a comparison between the '*background sound level'* in the vicinity of residential locations and the 'rating level' of the sound source under consideration. The relevant parameters in this instance are as follows:

- *background sound level* – $L_{A90,T}$ – defined in the Standard as the "A-weighted sound pressure level that is exceeded by the residual sound for 90% of a given time interval, T, measured using time weighting F and quoted to the nearest whole number of decibels";
- *specific sound level* – *L*s ($L_{Aeq,Tr}$) – the "equivalent continuous A-weighted sound pressure level produced by the specific sound source at the assessment location over a given reference time interval, Tr"; and
- *rating level* – $L_{Ar,Tr}$ – the "specific sound level plus any adjustment made for the characteristic features of the sound".

4.12 BS 4142 requires that a one-hour assessment period is considered during the day (07:00 to 23:00) and a 15-minute assessment period at night (23:00 to 07:00). It also allows for corrections to be applied based upon the presence or expected presence of the following at the receptor location:

- tonality: up to +6 dB penalty;
- impulsivity: up to +9 dB penalty (this can be summed with tonality penalty); and
- other sound characteristics (neither tonal nor impulsive but still distinctive): +3 dB penalty.

4.13 Once any adjustments have been made, the background sound level and the rating level are compared. The standard states that:

*"Typically, the greater the difference, the greater the magnitude of impact. A difference of around +10 dB or more is likely to be an indication of a significant adverse impact, depending on the context. A difference of around +5 dB is likely to be an indication of an adverse impact, depending on the context. The lower the rating level is relative to the measured background sound level, the less likely it is that the specific sound will have an adverse impact or a significant adverse impact. Where the rating level does not exceed the background sound level, this is an indication of the specific sound source having a low impact, depending on the context."*

4.14 BS 4142 (BSI, 2019) requires that the rating level of the sound source under assessment be considered in the context of the environment when determining the overall significance of the impact.

# 5. Noise Monitoring Data, Equipment, Meteorology and Predictions

## Noise Monitoring Data

5.1 Further details of the baseline surveys including the equipment used can be found in Appendix A.

5.2 The sound level meters and associated microphones were field calibrated at the beginning and calibration checked at end of their respective measurement periods in accordance with recommended practice. No drift in calibration occurred. The accuracy of the calibrator can be traced to the National Physical Laboratory Standards.

5.3 Section 8.1.1 of BS 4142 states that background sound level should be determined in “weather conditions that are representative or comparable to the weather conditions when the specific sound occurs”. The propagation of sound from outdoor sources is significantly influenced by the weather. In particular the propagation down wind of a source can be 10 to 15 dB greater than that upwind. The prediction methodology used to derive the specific sound level for all noise sources (based on ISO 9613 (ISO 1996)) assumes downwind conditions to the receptor. Therefore, the predicted specific sound levels will only occur when the receptor is downwind of the source. Representative background sound levels must then also be measured in similar conditions. The dataset was therefore filtered so that only measurement sessions where the average wind direction was within a 120 degree arc (60 degrees each side) of the downwind condition were included for further analysis. Over the 10 day monitoring period in April/ May 2022, the wind direction was within a 120 degree arc of downwind conditions for 34% of the 15 minute monitoring periods at NSR 1, 43% at NSR 2 and 35% at NSR 3.

5.4 Section 8.1.4 of BS 4142 states that to obtain a representative value the dataset should be analysed statistically and then a judgment made. It clearly states that the lowest measured level should not be taken as representative. Therefore, after filtering for wind direction as described above the remaining levels were analysed and a representative value was selected.

5.5 The results from the baseline sound surveys are provided in Table 5.1 and include the contribution from the existing Humber Refinery.

**Table 5.1. Baseline Sound Monitoring Results**

| Location | Survey | Daytime $L_{Aeq,T}$ dB | Night-time $L_{Aeq,T}$ dB | Daytime $L_{A90,T}$ dB | Night-time $L_{A90,T}$ dB |
|---|---|---|---|---|---|
| NSR 1 – Staple Road | April/May 2022 | 54* | 52* | 49* | 48* |
| NSR 1 Proxy | August 2023 | 52 | 49 | 41 | 36 |
| NSR 2 – Clarkes Road | April/May 2022 | 52* | 50* | 46* | 45* |
| NSR 2 Proxy | August 2023 | 73 | 60 | 53 | 35 |
| NSR 3 – Church Lane | April/May 2022 | 52* | 49* | 46* | 45* |
| NSR 3a | August 2023 | 61 | 40 | 40 | 35 |
| NSR 4 – Hazel Dene | April/May 2022 | 55* | 55* | 50* | 51* |

* The $L_{Aeq}$ values combine all measurements taken in each time period (e.g., day/ night), whilst the $L_{AF90}$ values presented are the ‘representative’ BS 4142 background sound levels, determined from analysis of the measured values.

Historical data from weekly night-time sound surveys Phillips 66 undertake as part of their current Environmental Permit has also been reviewed, the last full shut down for the site was 6th and 14th June 2015. The data recorded for the monitoring location on Staple Road (representative of NSR 1) was 41.2 dB and 38.6 dB $L_{A90}$. These are slightly higher than the NSR 1 proxy location night-time results as shown in Table 5.1.

# Representative Background Sound Levels

Based on the additional surveys and historical data, Table 5.2 presents the representative background sound levels without contribution from the existing Phillips 66 operations for the assessment NSRs, along with justification for the selection.

**Table 5.2. Representative Background Sound Levels**

| Location | Proposed Daytime $L_{A90,T}$ dB | Proposed Night-time $L_{A90,T}$ dB | Justification |
|---|---|---|---|
| NSR 1 | 42 | 41 | The proposed representative background sound level is based on the level recorded during the community noise surveys when the Phillips 66 plant was shutdown in June 2015, as the measurements were taken near the NSR 1 and would still include contribution from Lindsey Oil Refinery. The community noise surveys are undertaken during the night-time period. Based on the review of the surveys undertaken in April/May 2022 and August 2023 there is a slight increase in the daytime noise levels compared to the night-time levels, therefore the proposed daytime representative background level is 1 dB higher than the night-time level. The NSR 1 Proxy location is also further away from Lindsey Oil Refinery, therefore results in a lower background noise level which is not representative. Lindsey Oil Refinery is in constant operation and there is unlikely to be a scenario where both Phillips 66 and Lindsey Oil Refinery are both not in operation. |
| NSR 2 | 42 | 41 | Although the community noise surveys are undertaken on Staple Road (NSR 1) they will still be representative of NSR 2. Review of the of the surveys undertaken in April/May 2022 and August 2023 show the sound levels at NSR 1, NSR 2 and NSR 3 are similar and are also approximately the same distance to the west of Phillips 66 and Lindsey Oil Refinery. Therefore, based on the justification for NSR 1, the same representative background sound levels are proposed for NSR 2. |
| NSR 3 | 42 | 41 | Although the community noise surveys are undertaken on Staple Road (NSR 1) they will still be representative of NSR 3. Review of the of the surveys undertaken in April/ May 2022 and August 2023 show the sound levels at NSR 1, NSR 2 and NSR 3 are similar and are also approximately the same distance to the west of Phillips 66 and Lindsey Oil Refinery. Therefore, based on the justification for NSR 1, the same representative background sound levels are proposed for NSR 3. |

5.6 The Environment Agency and BS 4142 guidance require the background noise levels without contribution from the existing Phillips 66 operations. However, as stated in Chapter 2, as Phillips 66 has been operational for over 50 years, the sound emissions from the site are part of the existing ambient and background sound climate. Therefore, the BS 4142 assessments include both the representative background sound level without contribution from Phillips 66 (see Table 5.2) and with Phillips 66 operational (see Table 5.1).

# Existing Specific Noise Levels

5.7 The Environment Agency require the assessment to consider the existing operations at Phillips 66, as well as the existing and proposed operations combined. Phillips 66 have been operating 24 hours 7 days a week for over 50 years. At NSRs 1, 2 and 3 Phillips 66 is the dominant sound source.

5.8 Phillips 66 have previously had a noise model built to predict the noise levels from the operation of the current site. The environmental noise report to accompany the IPPC application in 2006[5] (Bureau Veritas, 2006), states the predicted Humber Refinery level is 56.8 dB at Staple Road. A copy of this report is included in Appendix A. It is assumed that this level is also representative of the level at NSRs 2 and 3 due to the close proximity of the NSRs. As the site is operational 24 hours a day, 7 days a week the same specific noise level is used for both day and night-time assessment periods.

[5] Bureau Veritas (2006) ConocoPhillips Humber Refinery Report on Environmental Noise to Accompany IPPC Application

5.9 The ambient noise levels at NSRs 1, 2 and 3 for both the daytime and night-time periods in Table 5.1 are therefore lower than the predicted noise level of 56.8 dB from the existing operations of Phillips 66. This is because the operational model predicts downwind conditions and assumes that all the plant is operating at the same time, therefore a worst-case scenario.

5.10 Therefore, two scenarios have been considered in Chapter 6, with the existing specific noise levels based on the 2022 surveys at NSRs and the other based on the operational noise model for the full Phillips 66 site.

# Predicted PCC Plant Operational Noise Levels

5.11 The predictions of operational sound from the proposed PCC plant have been based on information provided by Worley (the Applicants' engineering design team). This information has included sound power levels for the major sound sources and details of the acoustic performance of noise mitigation measures already embedded into the designs, such as siting of equipment away from the site boundary and NSRs. As part of the ongoing design process, Worley have reviewed the noise input data and provided revised input for the assessment of the worst case continuous operational noise and also provided 'an overnight' operational noise assessment scenario as set out in the document 'AECOM/ ARUP Noise Assessment Source Data' in Appendix B. The proposed PCC plant will use air cooled heat exchangers (aka fin fan coolers) and water cooling tower to maintain the required temperatures at various point in the process hence a sufficient number of fin fans needs to be installed to achieve the required cooling duty during periods of higher ambient temperatures (e.g. peak day time temperature). Whereas during periods of lower ambient temperature, fewer fin fan air coolers need to be in operation to achieve the same cooling duty (e.g. overnight, cooler months). Therefore, it will be infrequent when all of the fin fans are in operation at the same time.

5.12 The daytime assessment is based on 58 fin fans required to be in operation based on 26.7°C ambient temperature and the night-time assessment is based on 38 fin fans required to be in operation based on 21.1°C ambient temperature. The 21.1°C ambient temperature during the night-time period is considered to be conservative. Therefore, a worst-case scenario has been modelled for day and night-time periods, and in reality the operational noise levels will be lower, especially during periods of lower ambient temperatures.

5.13 During detailed design stage, where necessary, industrial sound will be mitigated as discussed in Chapter 7.

5.14 In accordance with BS 4142 the daytime assessment considers a 1-hour period, and the night-time assessment considers a 15-minute period. When in operation the sound produced by the PCC plant will be constant in nature, therefore no on-time correction is applicable due to the continuous nature of the operation. The free-field operational specific sound levels at the NSRs have been predicted at the ground floor during the daytime and at the upper floor for the night-time.

5.15 The potential for sound of a tonal, impulsive or intermittent nature will be designed out of the proposed PCC plant during the detailed design phase by the selection of appropriate plant, building cladding, louvres and silencers/ attenuators as necessary. It is considered that the proposed PCC plant is very unlikely to present distinctive sound at the NSRs due to the existing industrial and commercial sound climate in the area. Therefore, no character correction has been applied to the specific sound.

5.16 The predicted free-field operational specific sound levels at the NSR around the PCC plant are presented in Table 5.3

**Table 5.3. Predicted Operational Sound Levels**

| Receptor | Daytime specific sound level $L_{Aeq,Tr}$ dB | Night-time specific sound level $L_{Aeq,Tr}$ dB |
|---|---|---|
| NSR 1 | 49 | 49 |
| NSR 2 | 45 | 45 |
| NSR 3 | 46 | 46 |
| NSR 4 | 40 | 37 |

# 6. Noise Impact Assessment

6.1 The Environment Agency guidance requires the existing operations at Humber Refinery to be considered as well as the proposed variation operations – the existing and proposed PCC plant operations are to be presented individually and then combined to form an overall site operation (specific) sound level.

6.2 As previously discussed, the Environment Agency requires the background sound levels not to include the existing operations from Phillips 66 for the BS 4142 assessment. However, as stated in Chapter 2, Phillips 66 has been operational for over 50 years, the sound emissions from the site are part of the existing ambient and background sound climate. Therefore, the BS 4142 assessments include both the representative background sound level without contribution from Phillips 66 and with Phillips 66 operational.

6.3 The representative background sound level without contribution from Phillips 66 and the specific sound levels for the existing Phillips 66 operations and proposed PCC plant are stated in Chapter 5.

6.4 NSRs 1-3 are the closest to Phillips 66 and therefore the BS 4142 assessment focuses on these NSRs.

6.5 As stated in Chapter 5, two scenarios for the existing operations have been selected, one based on the operational noise model for the full Phillips 66 site and the other based on the 2022 surveys at NSRs.

- Scenario 1: Specific sound level for existing sites based on ambient noise surveys undertaken in April and May 2022.
- Scenario 2: Specific sound level for existing sites based existing model from Phillips 66 for Staple Road (NSR 1). It is assumed NSR 1 is representative of NSR 2 and NSR 3. It is assumed that the existing specific sound level is the same for day and night.

6.6 Tables 6.1 – 6.3 present the BS 4142 assessment summary for the daytime and night-time for NSRs 1-3 for Scenarios 1 and 2. The full BS 4142 assessment tables for each scenario including the background sound levels both with and without Phillips 66 operational can be found in Appendix C. The predicted specific sound level is rounded to whole decibels. The assessment is based on the difference between the representative background sound level and the predicted rating level, $L_{Ar,Tr}$ dB (i.e. the specific sound level $L_{Aeq,Tr}$ plus any character correction) at the NSR. Positive values in the tables indicate an excess of the rating level over the background sound level.

6.7 As stated in Chapter 4, the context of the area and existing sound climate should be taken into consideration when determining the overall impact. Phillips 66 are already a continuously operating industrial source in the study area, and there are other industrial/ commercial activities around the Sites. This is likely to mean that residents at all NSRs are already accustomed to industrial sources.

6.8 A rating level excess over the background sound level of +5 dB is considered the level around which adverse effects may occur, depending upon context.

## Existing Operations

6.9 Table 6.1 shows the summary initial BS 4142 assessment for the existing Humber Refinery operation for Scenarios 1 and 2.

**Table 6.1. BS 4142 Summary Assessment Existing Operations**

| Receptor | NSR 1 Daytime | NSR 1 Night-time | NSR 2 Daytime | NSR 2 Night-time | NSR 3 Daytime | NSR 3 Night-time |
|---|---|---|---|---|---|---|
| **Existing Operations – Scenario 1 (background levels without contribution from Phillips 66)** | | | | | | |
| Excess of *rating level* over *background sound level* ($L_{Ar,Tr}$ - $L_{A90,T}$), dB | 12 | 11 | 10 | 9 | 10 | 8 |
| BS 4142:2014 impact category | An indication of a significant adverse impact, depending on the context. | An indication of a significant adverse impact, depending on the context. | An indication of a significant adverse impact, depending on the context. | An indication of a significant adverse impact, depending on the context. | An indication of a significant adverse impact, depending on the context. | An indication of a significant adverse impact, depending on the context. |
| **Existing Operations – Scenario 1 (background levels with contribution from Phillips 66)** | | | | | | |
| Excess of *rating level* over *background sound level* ($L_{Ar,Tr}$ - $L_{A90,T}$), dB | 5 | 4 | 6 | 4 | 6 | 4 |
| BS 4142:2014 impact category | An indication of an adverse impact, depending on the context. | An indication of an adverse impact, depending on the context. | An indication of an adverse impact, depending on the context. | An indication of an adverse impact, depending on the context. | An indication of an adverse impact, depending on the context. | An indication of an adverse impact, depending on the context. |
| **Existing Operations – Scenario 2 (background levels without contribution from Phillips 66)** | | | | | | |
| Excess of *rating level* over *background sound level* ($L_{Ar,Tr}$ - $L_{A90,T}$), dB | 15 | 16 | 15 | 16 | 10 | 16 |
| BS 4142:2014 impact category | An indication of a significant adverse impact, depending on the context. | An indication of a significant adverse impact, depending on the context. | An indication of a significant adverse impact, depending on the context. | An indication of a significant adverse impact, depending on the context. | An indication of a significant adverse impact, depending on the context. | An indication of a significant adverse impact, depending on the context. |
| **Existing Operations – Scenario 2 (background levels with contribution from Phillips 66)** | | | | | | |
| Excess of *rating level* over *background sound level* ($L_{Ar,Tr}$ - $L_{A90,T}$), dB | 8 | 9 | 9 | 12 | 6 | 12 |
| BS 4142:2014 impact category | An indication of a significant adverse impact, depending on the context. | An indication of a significant adverse impact, depending on the context. | An indication of a significant adverse impact, depending on the context. | An indication of a significant adverse impact, depending on the context. | An indication of an adverse impact, depending on the context. | An indication of a significant adverse impact, depending on the context. |

6.10 The results in Table 6.1 for the existing operations for both Scenarios 1 and 2 indicate that there is an adverse to significant adverse impact due to the excess of rating level over the background sound level. However as stated above, Phillips 66 and other industrial/ commercial operations have been operational for many years and are considered part of the existing sound climate. Also as stated in Chapter 2, Phillips 66 receive very few complaints relating to noise, which are due to transient events such as equipment requiring maintenance, flares or system safety valves lifting. These types of events are managed as part of the site process and condition monitoring systems and have been resolved quickly. There are no complaints regarding the general day to day operations of the site, indicating that the residents are accustomed to the existing noise climate.

# Proposed PCC Plant

6.11 Table 6.2 shows the summary of the initial BS 4142 assessment for the proposed PCC plant.

**Table 6.2. Initial BS 4142 Assessment for Proposed PCC plant**

| | NSR 1 | | NSR 2 | | NSR 3 | |
|---|---|---|---|---|---|---|
| **Receptor** | **Daytime** | **Night-time** | **Daytime** | **Night-time** | **Daytime** | **Night-time** |
| Proposed PCC plant (Background Sound without contribution from Phillips 66) | | | | | | |
| Excess of *rating level* over *background sound level* ($L_{Ar,Tr}$ - $L_{A90,T}$), dB | 7 | 8 | 3 | 4 | 4 | 5 |
| BS 4142:2014 impact category | An indication of a significant adverse impact, depending on the context | An indication of a significant adverse impact, depending on the context | An indication of a minor adverse impact depending on the context | An indication of an adverse impact, depending on the context | An indication of an adverse impact, depending on the context | An indication of an adverse impact, depending on the context |
| Proposed PCC plant (Background Sound with contribution from Phillips 66) | | | | | | |
| Excess of *rating level* over *background sound level* ($L_{Ar,Tr}$ - $L_{A90,T}$), dB | 0 | 1 | -1 | 0 | 0 | 1 |
| BS 4142:2014 impact category | An indication of low impact, depending on the context | An indication of a low impact, depending on the context | An indication of low impact depending on the context | An indication of low impact, depending on the context | An indication of a low impact, depending on the context | An indication of a low impact, depending on the context |

6.12 The results in Table 6.2 for the proposed PCC plant show a potential for significant adverse impacts at NSR 1 and a potential adverse impact at NSRs 2 and 3 when the rating level is compared to the background sound level without contribution from Phillips 66. However, as Phillips 66 operates 24 hours a day, 7 days week and has done for over 50 years with a constant noise source the low background levels will not occur on a regular basis. When the predicted rating level for the proposed PCC plant alone, is compared to the existing background sound levels (with contributions from Phillips 66), there is no excess of rating level over background sound level at NSRs 1, 2 and 3 during the daytime, during the night-time the excess is 1 dB at NSRs 1 and 2, and no excess at NSR 2. This is less than the level above which adverse impacts are indicated to be likely in accordance with BS 4142.

# Existing and Proposed PCC Plant Combined

6.13 Table 6.3 shows the initial BS 4142 assessment for the existing and proposed PCC plant operation combined for Scenarios 1 and 2.

**Table 6.3. Initial BS 4142 Assessment for Existing and Proposed PCC plant combined-**

| | NSR 1 | | NSR 2 | | NSR 3 | |
|---|---|---|---|---|---|---|
| **Receptor** | **Daytime** | **Night-time** | **Daytime** | **Night-time** | **Daytime** | **Night-time** |
| **Existing Operations and Propose Development Combined – Scenario 1 (background levels without contribution from Phillips 66)** | | | | | | |
| Excess of *rating level* over *background sound level* ($L_{Ar,Tr}$ - $L_{A90,T}$), dB | 13 | 13 | 11 | 10 | 11 | 10 |
| BS 4142:2014 impact category | An indication of a significant adverse impact, depending on the context | An indication of a significant adverse impact, depending on the context. | An indication of a significant adverse impact, depending on the context. | An indication of a significant adverse impact, depending on the context | An indication of a significant adverse impact, depending on the context | An indication of a significant adverse impact, depending on the context. |

| Receptor | NSR 1 Daytime | NSR 1 Night-time | NSR 2 Daytime | NSR 2 Night-time | NSR 3 Daytime | NSR 3 Night-time |
|---|---|---|---|---|---|---|
| **Existing Operations and Propose Development Combined – Scenario 1 (background levels with contribution from Phillips 66)** | | | | | | |
| Excess of *rating level* over *background sound level* ($L_{Ar,Tr}$ - $L_{A90,T}$), dB | 6 | 6 | 7 | 6 | 7 | 6 |
| BS 4142:2014 impact category | An indication of an adverse impact, depending on the context. | An indication of an adverse impact, depending on the context. | An indication of an adverse impact, depending on the context. | An indication of an adverse impact, depending on the context. | An indication of an adverse impact, depending on the context. | An indication of an adverse impact, depending on the context. |
| **Existing Operations and Propose Development Combined – Scenario 2 (background levels without contribution from Phillips 66)** | | | | | | |
| Excess of *rating level* over *background sound level* ($L_{Ar,Tr}$ - $L_{A90,T}$), dB | 16 | 17 | 15 | 16 | 15 | 16 |
| BS 4142:2014 impact category | An indication of a significant adverse impact, depending on the context. | An indication of a significant adverse impact, depending on the context. | An indication of a significant adverse impact, depending on the context. | An indication of a significant adverse impact, depending on the context. | An indication of a significant adverse impact, depending on the context. | An indication of a significant adverse impact, depending on the context. |
| **Existing Operations and Propose Development Combined – Scenario 2 (background levels with contribution from Phillips 66)** | | | | | | |
| Excess of *rating level* over *background sound level* ($L_{Ar,Tr}$ - $L_{A90,T}$), dB | 9 | 10 | 11 | 12 | 11 | 12 |
| BS 4142:2014 impact category | An indication of a significant adverse impact, depending on the context. | An indication of a significant adverse impact, depending on the context. | An indication of a significant adverse impact, depending on the context. | An indication of a significant adverse impact, depending on the context. | An indication of a significant adverse impact, depending on the context. | An indication of a significant adverse impact, depending on the context. |

6.14 Table 6.4 shows the excess of rating level over background sound level when the existing and proposed operations are combined compared to only the existing operations for NSRs 1, 2 and 3.

**Table 6.4. Difference in Excess of Rating level Over Background Sound Level between the Existing and Combined Existing and Proposed**

| Scenario | NSR 1 Daytime | NSR 1 Night-time | NSR 2 Daytime | NSR 2 Night-time | NSR 3 Daytime | NSR 3 Night-time |
|---|---|---|---|---|---|---|
| Scenario 1 | 1 | 2 | 1 | 1 | 1 | 2 |
| Scenario 2 | 1 | 1 | 0 | 0 | 0 | 0 |

6.15 Table 6.4 shows for Scenario 1 (based on 2022 ambient noise surveys) there would be up to 2 dB increase in the excess of rating level over background sound level, when the existing and proposed operations are combined, compared to only the BS 4142 assessment for the existing operations for NSRs 1, 2 and 3. For Scenario 2 (based on 2006 noise model predictions) there would be up to 1 dB increase in the excess of rating level over background sound level, when the existing and proposed operations are combined compared to only the BS 4142 assessment for the existing operations at NSR 1 and no change at NSRs 2 and 3. These increases are close to the point at which there is an indication of the sound source having a low impact, given the existing sound climate and the proposed PCC plant predictions are a worst case scenario. with all plant, including cooling fans operating at maximum capacity for the respective daytime and night-time period. For the majority of the time, especially during winter months, not all the cooling fans will be in use, therefore reducing the overall sound emissions from the proposed PCC plant.

# Overall Context and Conclusions

6.16 As stated in Chapter 3, the Humber Refinery is situated in a heavily industrialised area. The existing noise climate consists of noise from the Phillips 66 site, other similar industrial operations at the Lindsey Oil Refinery and the VPI Immingham Combined Heat and Power plant and other commercial operations such as DFDS, DVS, Scangrit, Killingholme power station, Port of Immingham and Killingholme Ro-Ro and road traffic noise. Immingham docks and Killingholme Ro-Ro contribute to significant HGV movements on the road network both day and night based on ship arrival / sail times. Therefore, the NSRs are used to hearing industrial/ commercial noise as part of the normal acoustic soundscape during the day and night-time periods.

6.17 This is shown in the existing ambient noise levels at the NSRs during the daytime and night-time periods. The predicted specific noise levels from the proposed PCC plant are lower than the existing day and night-time ambient levels. When the predicted PCC plant noise levels are combined with the existing ambient noise levels, there would be up to 1 dB increase during the daytime and up to 2 dB increase during the night-time periods at the closest NSRs. These increases are unlikely to be noticeable given the existing acoustic climate and context of the area.

6.18 As stated in Chapter 5, the predicted noise levels for the proposed PCC plant are worst case scenarios, with the number of cooling fin fans in operation based on 26.7°C ambient temperature in the daytime and the night-time assessment is on 21.1°C ambient temperature. These ambient temperatures are considered conservative and in reality, the operational noise levels will be lower, since the majority of the time the ambient temperatures will be lower.

6.19 Therefore, overall, considering the BS 4142 assessment outcomes and the context of the existing sound environment, it is considered that the addition of the proposed PCC plant would have a low impact on nearby NSRs.

6.20 At the detailed design stage, opportunities to reduce the predicted specific sound levels for the proposed PCC plant and review of the existing noise emissions further will be explored and are discussed in Chapter 7.

# 7. Noise Control

7.1 AECOM have modelled the proposed PCC plant based on plant data from the project designers. The initial assessment indicated the potential for significant adverse noise impacts. Therefore, mitigation and attenuation options were discussed and agreed. The proposed noise sources were ranked from highest to lowest based on the level of impact at NSRs 1, 2 and 3. The attenuation shown in Table 7.1 was applied to the key noise emitting plant to minimise the impact. The predicted specific sound levels in Table 5.3 (Chapter 5) include these proposed reductions.

**Table 7.1. Attenuation Required (dB from individual plant items)**

| Plant Ref (see Appendix B for plant details) | Attenuation (dB) |
|---|---|
| P66-13, P66-33, P66-37, P66-34, P66-35, P66-36P66-58 | -10 |
| P66-3, P66-25, P66-39, | -5 |

7.2 These reductions could be achieved for the proposed PCC plant either through reduction of sound power levels at source or by application of BAT and general principals include, but are not limited to the following hierarchy of controls as set out the document ‘AECOM/ARUP Noise Assessment Source Data’ in Appendix B and summarised in Table 7.2.

**Table 7.2. Best Available Techniques**

| Technique | Description | Applicability |
|---|---|---|
| Eliminate | Review proposed plant and design and where possible remove unnecessary items from the scope of the design | Review of the design has resulted in the routing of flue gas from fired heaters H3401 and H3630 to the new Carbon Capture Plant being removed from scope. Operational noise will reduce with the elimination of two large flue gas fans. The reduction in overall flue gas flow rate to the PCC plant also reduces the overall compression, cooling and pumping duties. The front end loading stage 2 (FEL2) design assumed two separate $CO_2$ compressors for Low Pressure (LP) and High Pressure (HP) compression. It is anticipated that both LP and HP stages will be achieved using a common compressor that has multiple compressor stages. The overall noise emissions associated with $CO_2$ compression is expected to be less for one common compressor versus two separate compressors. |
| Reduction | Where possible reduce the number of fin fans and /or selecting plant with reduced noise levels<br>Review height of fin fans and lower where practicable | For the same cooling duty, a Cooling Tower requires less fan power versus that of the equivalent bank of fin fan air coolers. Studies have been undertaken to reduce the number of fin fan air coolers by partially transferring cooling duty to a cooling tower. Note, whilst this will have the benefit of reduced fin fan air cooler noise there are penalties including increased water consumption.<br>A new waste heat exchanger recovers heat from the FCC flue gas before it is cooled further by the wet gas scrubber. The wet gas scrubber uses cooled slurry to reduce the flue gas temperature. Slurry is cooled by fin fan air coolers and a heat exchanger that uses cooling water from a cooling tower. The optimization of the amount of heat that can be recovered from the FCC flue gas by the waste heat exchanger during normal operation will in turn minimise the cooling duty by wet gas scrubber. This will provide flexibility on the number of fin fan air coolers that need to be in operation.<br>The standard specification for items of equipment includes a figure for operating noise. Where a choice exists between different equipment makes/ models, operating noise will be taken into consideration when determining the make /model selected for installation. For example, quieter Fin Fan Air Coolers may be available for particular cooling duties but could result in the requirement for more Fin Fan Air Cooler units. Quieter fin fan air cooler designs are often achieved at the penalty of a lower maximum cooling duty per cooler.<br>Plot restrictions necessitate the requirement for fin fan air coolers to be installed on top of pipe racks for space |

| Technique | Description | Applicability |
| --- | --- | --- |
| | | conservation. The location of fin fan air coolers at elevation potentially increases offsite noise levels as there is less opportunity for attenuation by structures and other equipment. Where not prohibitive due to maintaining overhead clearances, the benefit of reducing the elevation of fin fan air cooler banks shall be assessed in the next phase of the project |
| Engineering Control | Use of full or partial acoustic enclosures, acoustic barriers and sound absorbing surfaces | Engineering control measures required to achieve further reduction in operational noise will be determined when further equipment information is available |

7.3 During the detailed design of the proposed PCC plant it may be desirable or more practical to apply higher attenuation to some plant items/ buildings than listed in Table 7.1 in order to reduce the attenuation applied to other plant items/ buildings and still achieve the same level of overall reduction.

7.4 The operational assessment has assumed that potential sound of a tonal, impulsive or intermittent nature (according to BS 4142:2014) will be designed out of the proposed PCC plant during the detailed design phase through the selection of appropriate plant, building cladding, louvres and silencers/ attenuators as necessary.

7.5 The existing site is laid out with the highest noise levels concentrated at the centre. These blocks are well shielded from the surrounding environment by the less noisy blocks surrounding them. Some of the low-level equipment around the edge of the main site and in the tank farm is screened by containment bunds, tanks and other equipment.

7.6 The principal noise control tool used by Phillips 66 has been procurement controls. Previous noise assessments have indicated that this has been successful in that the new plant installation at the site has produced no increase in overall emission levels. In addition, occupational noise exposure monitoring is undertaken, and actions are taken to reduce occupational noise levels, as necessary, which can have a benefit on environmental noise.

7.7 Phillips 66 already has a well-developed Environmental Noise Management system in place. The system includes regular noise monitoring, an enquiries and complaint handling procedure and the computer based acoustic model. Routine noise generating transient events such as alarm and safety valve testing are undertaken during the daytime when ambient noise levels around the site are dominated by road noise and high transient noise levels from passing road vehicles are common. The refinery has a freephone information line onto which events of this nature are recorded in advance. Records are kept of plant operation conditions so that any unscheduled system safety valve lifts can be explained if they occur. Phillips 66 will continue with the weekly community noise monitoring.

7.8 An updated noise management plan has been prepared to cover the Phillips 66 site and is submitted with environmental permit variation.

# 8. Uncertainty

8.1 As outlined previously, the operational noise is assessed against the background sound levels obtained during the night-time surveys undertaken during Phillips 66 last full site shutdown in 2015. There are uncertainties involved with the use of this data as there would be with any background sound measurement; other sources of noise may have changed in the intervening period. However, in view of the nature of the area these uncertainties are no greater than those which would be associated with a single occasion survey undertaken specifically for this assessment. The assessment has also included the background sound levels with Phillips 66 operational, which is more representative of the typical background sound levels experienced at the NSRs as the site operates continuously and has been part of the acoustic climate for over 50 years.

8.2 Predictions of sound pressure levels according to ISO 9613 are based on an assumption of moderate downwind propagation, and hence could be considered as a worst-case calculation. However, the standard also indicates an estimated accuracy of ±3 dB in predicted levels at the heights and distances relevant to this assessment.

8.3 Although the proposed PCC plant will operate 24 hours a day, 7 days a week, not all the plant will operate all the time as it is due to demand and ambient temperatures. For example, the main source of noise is the large number of air coolers, which would only all be in operation in the highest anticipated ambient air temperatures and with higher than average FCC processing rates. Therefore, the daytime and night-time scenarios assessed are very worst-case scenarios and operational noise levels will be lower as maximum cooling is only required during periods of warm/ hot weather. It is considered that the assumptions made during the noise modelling and assessment of the proposed PCC plant have led to a conservative (‘worst case’) assessment.

# 9. Conclusions

9.1 This noise assessment has been prepared by AECOM on behalf of Phillips 66 to support the environmental permit variation (Permit number EPR/UP3230LR Humber Refinery) for the proposed Post-combustion Carbon Capture (PCC) development and associated facilities at Phillips 66 Ltd Humber Refinery.

9.2 The focus of the assessment has been on operational sound level impacts upon the nearest residential NSRs to the Humber Refinery.

9.3 Previous noise assessments and weekly community noise monitoring have been reviewed to determine the representative background sound level without contribution of the existing noise from Phillips 66 and the specific sound level of the current site operations based on an existing noise model of the whole site. The ambient and background sound levels from the surveys undertaken in 2022 by AECOM have also been used in the assessment.

9.4 A sound propagation model has been created using the noise modelling software SoundPLAN to provide a 3D representation of the proposed PCC plant for the daytime and night-time operations. Two scenarios have been considered in this assessment - the existing specific noise levels based on the 2022 surveys at NSRs (Scenario 1) and the existing specific noise levels based on the existing operational noise model for the full Humber Refinery site (Scenario 2).

9.5 In accordance with BS 4142, the representative background sound levels at the NSRs have been compared against the predicted operational rating levels (the specific sound levels with character correction). The assessment has included two representative background sound levels, one without contribution from the existing operations at Phillips 66 (based on community noise surveys in 2015 during the last full shut down of the site) and one which includes the existing operations, as this is considered more representative of what is experienced at the NSRs. Phillips 66 operates continuously and had been in use for over 50 years, so is part of the established baseline in the locality.

9.6 BS 4142 assessments have been undertaken for the existing Humber Refinery operations, the proposed PCC plant, and the combined existing operations and proposed PCC plant.

9.7 Scenario 1 (based on 2022 ambient noise surveys) there would be up to 2 dB increase in the excess of rating level over background sound level, when the existing and proposed operations are combined, compared to only the BS 4142 assessment for the existing operations, for NSRs 1, 2 and 3. For Scenario 2 (based on 2006 noise model predictions) there would be up to 1 dB increase in the excess of rating level over background sound level, when the existing and proposed operations are combined compared to only the BS 4142 assessment for the existing operations at NSR 1 and no change at NSRs 2 and 3. These increases are close to the point at which there is an indication of the sound source having a low impact, given the existing sound climate and the proposed PCC plant predictions are a worst case scenario, with all plant, including cooling fans operating at maximum capacity for the respective daytime and night-time period. For the majority of the time, especially during winter months, not all the cooling fans will be in use, therefore reducing the overall sound emissions from the proposed PCC plant.

9.8 Therefore, overall, considering the BS 4142 assessment outcomes and the context of the existing sound environment, it is considered that the noise impacts from the operation proposed PCC plant in combination with the existing Humber Refinery operations on the nearest NSRs would have a low impact on nearby NSRs.

9.9 However, at the detailed design stage, opportunities to reduce the predicted specific sound levels further will be undertaken and opportunities to reduce the existing emissions from the site will also be explored. Phillips 66 will continue to follow appropriate.

# Appendix A Baseline Monitoring Locations and Survey Data

## Monitoring Locations

The monitoring and assessment locations are shown on Figure A1

Revision: 1 Drawn: ER Checked: LC Approved: DP Date: 2023-12-01

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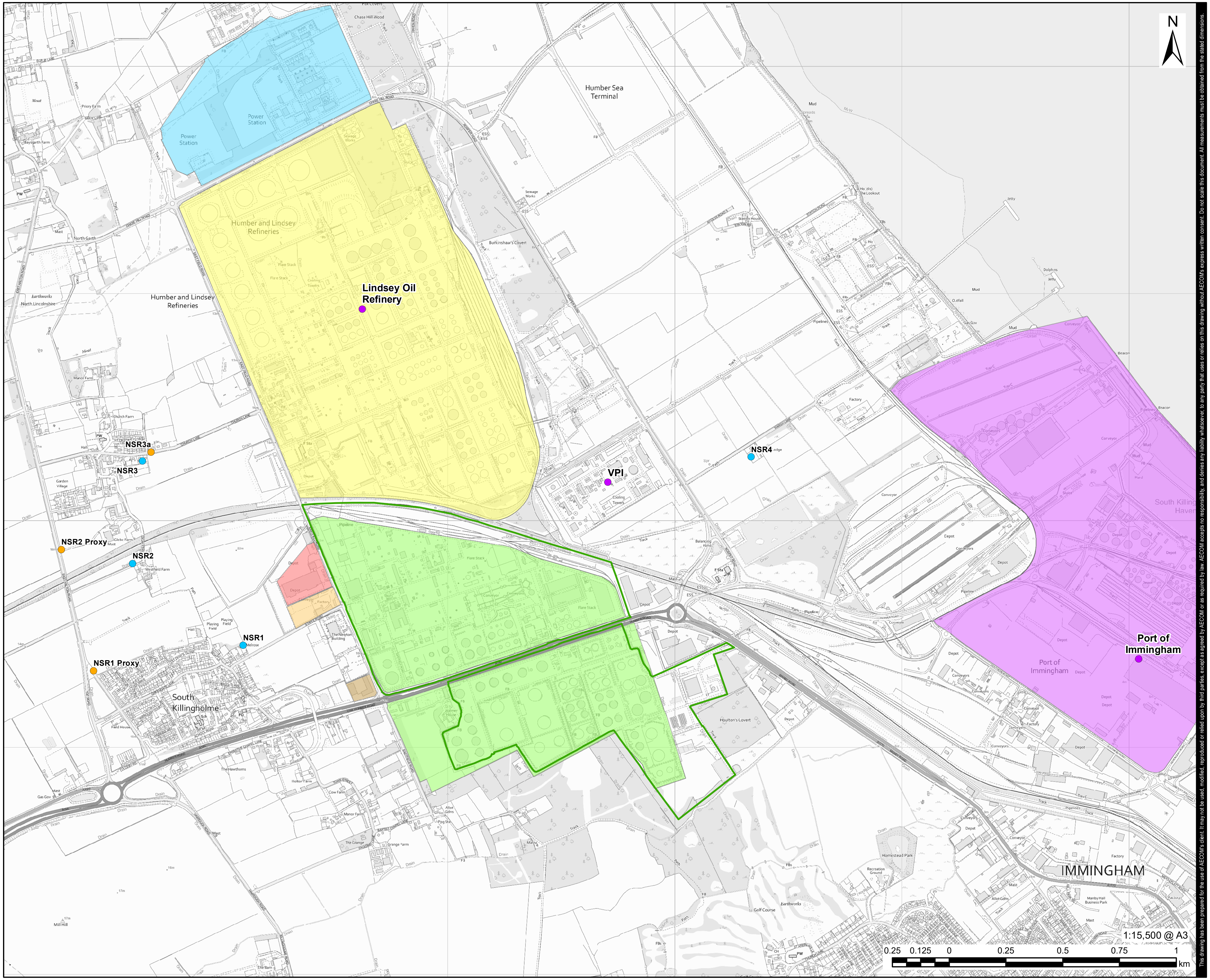


AECOM

**PROJECT**

Humber Zero

**CLIENT**

Phillips 66 Ltd

**CONSULTANT**

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**LEGEND**

- Installation Site Boundary

**Industrial Areas**

- DFDS Logistics
- DSV Road
- Killingholme Power Station
- Lindsey Oil
- Phillips 66 Ltd
- Port of Immingham
- Scangrit
- Noise Monitoring Location
- Proxy Noise Monitoring Location
- Surrounding Industry Location

**NOTES**

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**ISSUE PURPOSE**

FINAL

**PROJECT NUMBER**

60712174

**FIGURE TITLE**

Phillips 66 Installation Boundary with Noise Monitoring and Industry Locations

**FIGURE NUMBER**

Figure A.1

# Survey Data/ Reports

The following reports have been used to determine the background and existing specific sound levels.

1. Bureau Veritas (2006) ConocoPhillips Humber Refinery Report on Environmental Noise to Accompany IPPC Application. This document states the predicted Humber Refinery specific noise level based on a noise model of the site is 56.8 dB on Page 24 of the document.

2. AECOM (2022) environmental Statement Chapter 7 Noise & Vibration and Appendix 7A Sound Survey Information. Baseline survey information reviewed and concluded there was very little variation in the ambient sound levels during the day and night-time periods.

3. Phillips 66 Community Noise Survey- covering period of last full factory shutdown in 2015. (Provided as separate zipped file)

# Proxy Survey Information (August 2023)

**NSR 1 Proxy**

Table 9.1 below provides information on the survey location and conditions for NSR 1 Proxy, with Plate 1 below showing a photograph of the monitoring location.

**Table 9.1. Location NSR 1 Proxy survey location details**

| Location NSR 1 Proxy | Description |
|---|---|
| Location description and OS grid reference (Easting/Northing) | Top Road, South Killingholme<br>///pile.selection.thrones<br>514440, 416339 |
| Monitoring date and time | 24/08/2023 12:25 - 25/08/2023 00:26 |
| Monitoring height above ground | 1.5 m |
| Distance to nearest building facade | Greater than 3.5 m |
| Average wind speeds (m/s) | 1.4 m/s on set up |
| Wind direction | SE on set up |
| Temperature (°C) | 22°C on set up |
| Cloud coverage | 8/8 on set up |
| Sound Level Meter and Serial No. | Rion NL-52 00710387 calibrated 11 October 2021 |
| Field Calibrator and Serial No. | B&K 4231 3005464 calibrated 9 December 2022 |
| Description of the sound climate | Dominated by East Holton Road Traffic Noise and Crickets. VPI/P66 Inaudible. |

Plate 1: Location NSR 1 Proxy at Top Road looking towards Phillips 66

### NSR 2 Proxy

Table 9.2 provides information on the survey location and conditions for NSR 2 Proxy and Plate 2 below shows a photograph of the monitoring location.

**Table 9.2. Location NSR 2 Proxy survey location details**

| Location NSR 2Proxy | Description |
|---|---|
| Location description and OS grid reference (Easting/Northing) | East Halton Road, North Killingholme<br>///glorified.briefer.clock<br>514298, 416873 |
| Monitoring date and time | 24/08/2023 14:45 – 25/08/2023 01:03 |
| Monitoring height above ground | 1.5 m |
| Distance to nearest building facade | Greater than 3.5 m |
| Average wind speeds (m/s) | 4.7 m/s on set up |
| Wind direction | SE on set up |
| Temperature (°C) | 22°C on set up |
| Cloud coverage | 8/8 on set up |
| Sound Level Meter and Serial No. | Rion NL-52 00710387 calibrated 11 October 2021 |
| Field Calibrator and Serial No. | B&K 4231 3005464 calibrated 9 December 2022 |
| Description of the sound climate | Dominated by East Holton Road Traffic Noise and Crickets. VPI/P66 Inaudible. |

**Plate 2: Location NSR 2 Proxy at East Halton Road looking towards East Halton Road**

### NSR 3a

Table 9.3 provides information on the survey location and conditions for NSR 3a and Plate 3 below shows a photograph of the monitoring location.

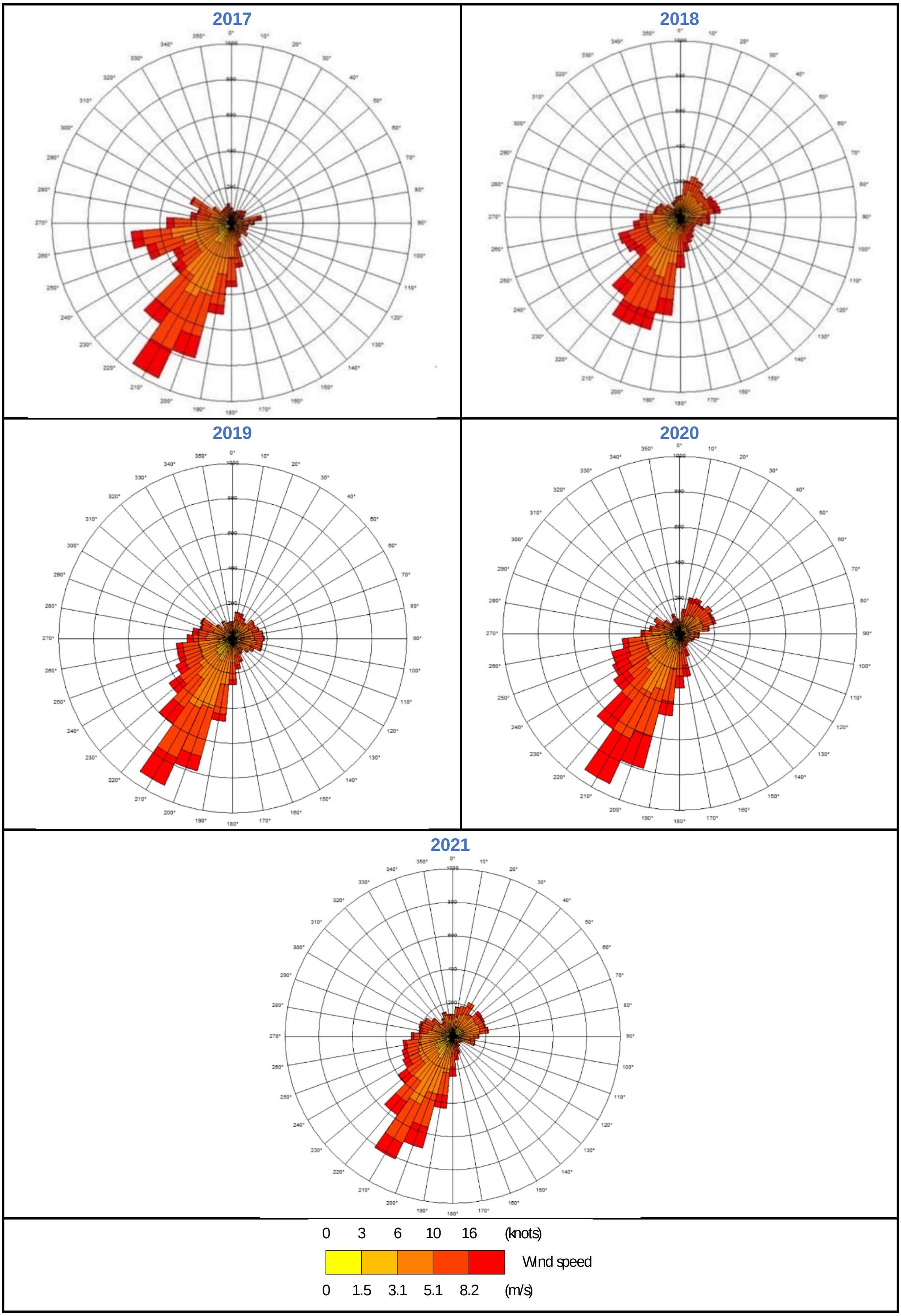
**Table 9.3. Location NSR 3a survey location details**

| Location NSR 3a | Description |
|---|---|
| Location description and OS grid reference (Easting/Northing) | Church Lane, North Killingholme<br>///glare.uniform.developed<br>514694, 417302 |
| Monitoring date and time | 24/08/2023 16:02 – 25/08/2023 01:39 |
| Monitoring height above ground | 1.5 m |
| Distance to nearest building facade | Greater than 3.5 m |
| Average wind speeds (m/s) | 5.0 m/s on set up |
| Wind direction | SE on set up |
| Temperature (°C) | 22°C on set up |
| Cloud coverage | 8/8 on set up |
| Sound Level Meter and Serial No. | Rion NL-52 00710387 calibrated 11 October 2021 |
| Field Calibrator and Serial No. | B&K 4231 3005464 calibrated 9 December 2022 |
| Description of the sound climate | Dominated by Church Lane Road Traffic Noise and Breeze in Trees. VPI/P66 Inaudible. |

**Plate 3: Location NSR 3a looking down Church Lane**

# Wind Roses

The wind roses below from Humberside Airport show the prevailing wind is from the south west.



Acoustics and Vibration Group

# ConocoPhillips Humber Refinery

## *Report on Environmental Noise to Accompany IPPC Application*

Technical Report 681649/1 Rev1
7th August 2006

**Technical Report:** 681649/1 Rev 1
**Date:** 7th August 2006

| | |
|---|---|
| **Title:** | ConocoPhilllips Humber Refinery<br>Report on Environmental Noise<br>to Accompany IPPC Application |
| **Submitted to:** | ConocoPhillips Ltd<br>Humber Refinery<br>Eastfield Road<br>South Killingholme<br>South Humberside<br>DN40 3DW |
| **Attention:** | Mr Steve Danter |
| **Submitted by:** | Acoustics and Vibration Group<br>Bureau Veritas UK & Ireland<br>Parklands<br>825a Wilmslow Road<br>Didsbury<br>Manchester, M2O 2RE |
| **Prepared by:** | Mike Hewett<br>Principal Consulting Engineer |
| **Approved by:** | Bernard Postlethwaite<br>Technical Director |

***Project Quality Assurance:***
This Project has been undertaken in accordance with the Company's Quality Management System registered by BSI Management Systems to BS EN ISO 9001: 2000. (Certificate No. FS34143 in the name of the BV Group, of which the Acoustics and Vibration Group forms part of the UK organisation).

# Document Control Sheet

**Client:** ConocoPhillips

**Document no:** 681649/1

## Document Status and Approval Schedule

| Issue | Status | Description | Prepared by | Approved by |
|---|---|---|---|---|
| 20/4/6 | Draft | Draft for review by client | | |
| 10/7/6 | Final | Issued to Client | | |
| 7/7/6 | Revised | Minor changes to plant names | | |
| | | | | |

# Report Summary

The ConocoPhillips Humber Refinery is a crude oil processing facility located near Immingham in North Lincolnshire.

This report, prepared by Bureau Veritas on behalf of ConocoPhillips, is issued in support of the IPPC application for the installation. It reviews the existing environmental noise emissions from the site, assesses the environmental noise impact of those emissions and identifies the noise control and management measures being implemented. By reference to Environment Agency Horizontal Guidance Notes H3, Parts 1 and 2 it assess how the Refinery has applied BAT (Best Available Techniques).

The site was found to operate an effective environmental noise management system including regular monitoring, documented complaint responses, management of transient noise events and plant change planning using a computer based noise model. The noise model has been reviewed and updated to reflect the current status of the site. The predicted noise levels have been compared with levels measured at the nearest residential receptors and found to correlate adequately.

It was concluded that, with reference to the IPPC Horizontal Guidance and the specific conditions of the area, the noise emissions from the Refinery are satisfactory and that the site environmental noise management system represents the application of BAT.

# Contents

# 1 Introduction

1.1 The ConocoPhillips Humber Refinery is a crude oil processing facility located near Immingham, North Lincolnshire. Bureau Veritas (BV) was requested by ConocoPhillips to prepare a report on noise emissions from the facility as part of the IPPC permit application process

1.2 The purpose of the investigation described in this report was to provide a review of the noise emissions from the site in relation to the requirements of IPPC. As such, the investigation was based on a detailed survey of the site and previous work undertaken at the site by BV (previously Acoustic Technology Limited) and ConocoPhillips.

1.3 The investigation involved measurements close to the plant, the modification of the existing site predictive noise model and verification measurements at the nearest residences. The noise levels produced by the plant were compared with appropriate current guidance. The effects of the existing design and layout of the plant on noise emissions were examined and compared with BAT (Best Available Techniques).

1.4 In undertaking this review, due cognisance has been taken of Environment Agency (EA) documents IPPC H3, "Horizontal Guidance for Noise, Part 1 – Regulation and Permitting" and "Horizontal Guidance for Noise, Part 2 – Noise Assessment and Control".

1.5 The management of environmental noise emissions for the Refinery is already well developed. A regular noise monitoring programme has been in place for a number of years and a detailed acoustic model of the site has been in use since 1999.

1.6 This report describes: the relevant background information gathered during the investigation; the procedure and results of the community and on-plant noise surveys and the assessment of BAT.

# 2 Description of Site and Surroundings

2.1 The ConocoPhillips Humber Refinery is located in South Killingholme on the Humber Estuary, close to the east coast ports of Grimsby and Immingham. Lindsey Oil Refinery is located to the immediate north-west of the site. Immingham CHP Power Station is located immediately to the east-north-east.

2.2 The Refinery processes crude oil and other feedstocks producing a wide range of products including petrol and diesel fuels, gas, fuel oil, and aviation fuel. Unlike other UK refineries, it also produces petroleum coke for use in steel and aluminium smelting.

2.3 The Refinery site is divided into two parts separated by the A160 Humber Road dual carriageway. The process parts of the plant are all located to the north of the road along with part of the tank farm (the North Tank Farm). The rest of the tank farm (the South Tank Farm) is to the south of the road.

2.4 Residential properties are located in South Killingholme village to the west of the refinery. The nearest of these to the refinery are located in Staple Road. A cluster of properties is located to the south of the refinery around East End Farm (although East End Farm itself no longer includes any buildings as these have recently been demolished). Residential properties are also located to the east of the refinery on Rosper Road and on Marsh Lane.

2.5 Historically, three residential locations have been used in conjunction with ConocoPhillips to serve as 'control' points for acoustic models and community noise monitoring. In recent years two of these locations have ceased to be in residential use. As a result a fourth location has been added for use in the assessment presented in this report. The four locations used are therefore as follows:

1. Melrose, Staple Road, South Killingholme;
2. East End Farm House, south of the refinery (demolished);
3. Myrtle Villas, Rosper Road, east of the refinery (demolished).
4. Hazeldene, Marsh Lane, east of the refinery (new location)

2.6 The locations of the refinery and the residential receptors are shown seen on Figure 2.1.

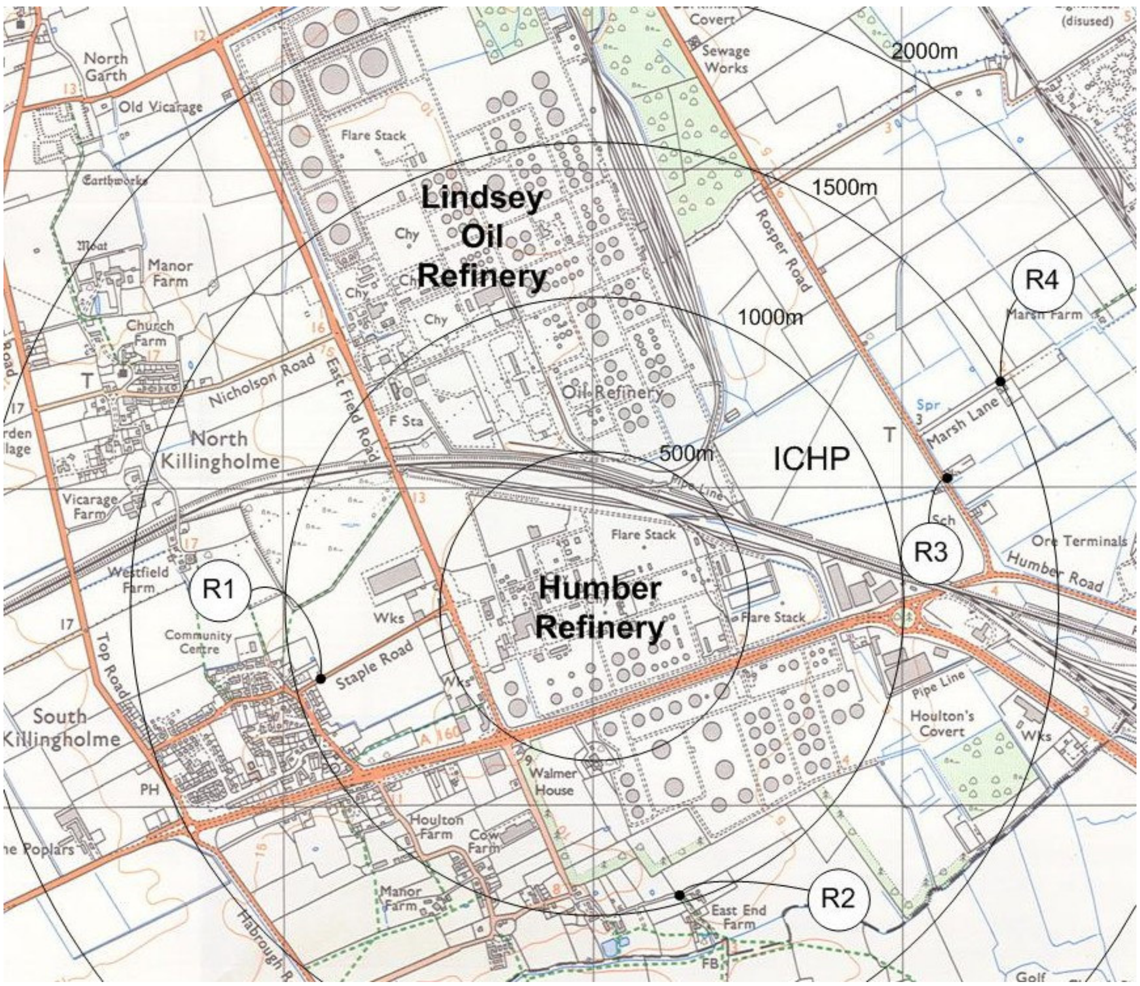



**Figure 2.1** Location of Humber Refinery and Residential Locations

2.7 The Refinery is divided into a number of process departments and process blocks. Figure 2.2 shows the layout of the main refinery site and the locations of the different process blocks within it. Figure 2.2 does not show the South Tank Farm, which does contain some noise sources such as pump bays.

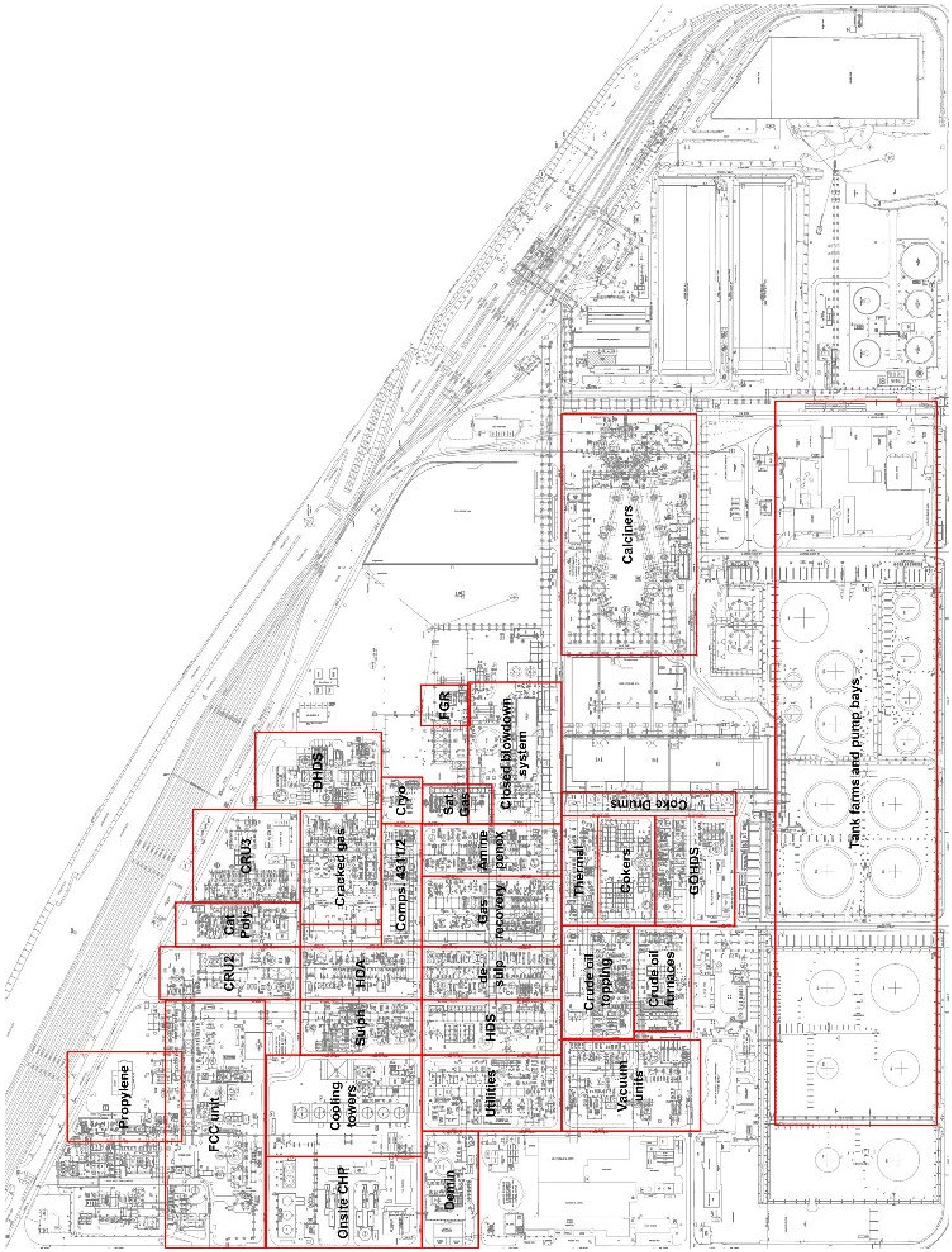



**Figure 2.2** Layout of the Humber Refinery

2.8 The main process blocks in the Refinery are as follows:

| Area | Block | Comments |
|---|---|---|
| Aromatics | Aromatics & HDA | |
| Aromatics | Control Room Area | |
| Aromatics | No2 Reformer | |
| Aromatics | Sulphur Plant | |
| Calciners | Calciners | |
| Cokers | Coke Drums | |
| Cokers | Coker & Cracker Furnaces | |
| Cokers | Gas Oil Hydrodesulphurisation | |
| Cokers | Closed Blowdown System | |
| Cokers | No3 Sub Area | |
| Cokers | Thermal Crackers | |
| Aromatics | CRU3 | Constructed ~2004 |
| Crutilities | Crude Topping Units | |
| Crutilities | Demin Plant | |
| OM&S | Effluent Treatment | |
| Crutilities | No.1 Vacuum Dist Unit | |
| Crutilities | No.2 & 3 Vacuum Dist Unit | |
| Crutilities | Onsite CHP | |
| Crutilities | Utilities | |
| FCC | Alkylation | |
| FCC | DME Unit | |
| FCC | FCC | |
| FCC | Propylene Unit | |
| Flare | Flares No.1 & 3 | |
| OM&S | OM&S | |
| OM&S | Pump Bays | |
| White Oils | Amine/Penex Unit | |
| White Oils | Cracked Gas & PSA Unit | |
| White Oils | Desulph Area | |
| White Oils | DHDS | Constructed ~2002 |
| White Oils | Gas Recovery | |
| White Oils | HDS | |
| White Oils | Saturated Gas & Cryogenic Plant | Reconstructed ~2004 |

**Table 2.1** Refinery Process Blocks

2.9 Other significant sources of noise in the area are the Lindsey Oil Refinery, the Immingham CHP Power Station and the A180 Road. At night the impact of road noise on the measured $L_{Aeq}$ is minimal and on the measured $L_{A90}$ , negligible..

# 3 Assessment Methodology

3.1 Integrated Pollution Prevention and Control (IPPC) is a regulatory system that employs an integrated approach to control the environmental impacts of certain industrial activities. It involves determining the appropriate controls for industry to protect the environment through a single permitting process. To gain a Permit, operators will have to show that they have systematically developed proposals to apply BAT and meet certain other requirements, taking account of relevant local factors.

3.2 Guidance Note IPPC H3 Part 1 outlines the main considerations relating to the regulation and permitting of noise, and is aimed primarily at the information needs of regulators. Guidance Note IPPC H3 Part 2, describes the principles of noise measurement and prediction and the control of noise by design, by operational and management techniques and by abatement technologies. It forms a background to Part 1, and is intended to assist in determining BAT for a given installation. It is aimed equally at regulators and at operators.

3.3 The Regulations require installations to be operated in such a way that “all the appropriate preventative measures are taken against pollution, in particular through the application of BAT”. The definition of pollution includes “emissions which may be harmful to human health or the quality of the environment, cause offence to any human senses or impair or interfere with amenities and other legitimate uses of the environment”. The guidance states that BAT is therefore likely to be similar, in practice, to the requirements of the Statutory Nuisance legislation which requires the use of “best practicable means” to prevent or minimise noise nuisance. It goes on to say that in the case of noise, “offence to any human senses” may be judged by the likelihood of complaints. However a lack of complaints should not necessarily imply the absence of a noise problem and it may be possible, and desirable, to reduce noise emissions still further at reasonable cost. This may, therefore be BAT, for noise emissions.

3.4 The guidance summarises the aim of BAT as achieving the following:

- Underpinning of good practice, a basic level of which the operator should employ for controlling noise, including adequate maintenance of plant whose deterioration may cause increases in noise;
- Noise levels should not be loud enough to give reasonable cause for annoyance to persons in the vicinity (this is a more appropriate standard than that of Statutory Nuisance);
- Prevention of creeping ambient (creeping background), which is the gradual increase in ambient sound levels as industry expands and areas develop.

3.5 To apply for an IPPC permit, the operator must provide information relating to:

- the techniques employed to control noise;
- the emission of noise from the installation;
- an assessment of the impact of those emissions on the environmental receptors.

3.6 The application needs to identify the main sources of noise that fall within the IPPC installation, stating: whether noise is continuous or intermittent; the type of emission and any associated characteristics; the hours of operation; its contribution to the overall site noise emission; and the location of the installation. Information is also required on infrequent sources of noise (such as alarm testing). The noise sensitive receptors need to be identified, with details of the ambient noise environment, details of any relevant planning conditions and details of any complaints about noise within the previous three years. The application should also contain details of any noise modelling work, describe the proposed position with respect to the techniques and technologies for noise measurement and control, as contained in IPPC H3 Part 2, and demonstrate that the proposals are BAT by confirming compliance with the indicative requirements given in section 2.2.1 of IPPC H3 Part 1.

3.7 In order to meet these requirements the procedure used for this assessment was as follows.

3.8 Environmental noise surveys were undertaken at the identified residential receptors. The measurements were conducted at night-time as this was the most critical period in terms of noise impact and the most useful for acoustics model validation.

3.9 The measured noise levels were compared to

(i) any existing planning noise limits;

(ii) the indicative noise limits given in Horizontal Guidance Note IPPC H3.

3.10 The existing Environmental Noise Model for the site was audited and verified to assess its relevance to the current plant configuration. There had been a number of significant plant changes and additions since the model was originally prepared. These modified and added areas were surveyed to assess their current noise emissions and the information was added to the model. The status of the rest of the plant was assessed by a series of spot measurements that were compared against similar measurements made in 1998 and 2002. Any areas where the spot measurements had changed significantly were investigated in more detail and the appropriate changes made.

3.11 The output of the ENM was reviewed and compared to the measured environmental noise levels. The dominant areas of the refinery, contributing to environmental noise levels at the nearest noise sensitive locations, were identified.

3.12 Noise control features incorporated specifically for environmental or for noise at work purposes were reviewed.

3.13 Existing installation or company-wide procedures in relation to environmental noise management, including training of personnel were also reviewed.

3.14 Based on the findings of the review and the specific conditions of the site and surroundings a view was given on the current application of Best Available Techniques (BAT) at the Refinery.

# 4 Community Noise Levels

4.1 The noise levels at the residential receptors were measured to validate the predictions of the noise model.

4.2 The acoustic model predicts the noise at the receptor in light downwind conditions. Therefore two sets of wind conditions will be necessary for the community measurements. Receptor 1 needs to be measured in a light ENE wind (± 60º). Receptor 2 needs to be measured in a light NNE wind (± 60º). Receptors 3 and 4 will need to be measured in a light WSW wind (± 60º). However the noise at receptors 3 and 4 includes significant contributions from Lindsey Oil Refinery and Immingham CHP. Therefore the critical receptor for validation of the Humber Refinery model is 1 and the critical wind direction is ENE (± 60º).

4.3 An environmental noise survey was conducted in the early hours of the morning on 4$^{th}$ May 2006. The survey was conducted according to the principles of BS 4142:1997 “Method for rating industrial noise affecting mixed industrial and residential areas”. The measurements were made using a Brüel & Kjær type 2260 real time analyser sound level meter. (s/n 2520445)

4.4 The wind direction through out the survey was from the SE/ESE direction, which is within the parameters for valid measurement at Receptor 1. Measurements were made at all four Receptors for reference purposes but only those made at Receptor 1 were used for model validation.

4.5 The full results of the measurements are given in Appendix 2 and summarised in Table 4.1 below.

| Receptor | Representative Measured Ambient Noise Level dB $L_{Aeq}$ | Comments |
|---|---|---|
| 1 | 56 | Wind from ideal direction |
| 2 | 51 | Wind not ideal, dogs barking |
| 3 | not located | no longer in existence |
| 4 | 53 | Wind direction inappropriate |

**Table 4.1** Summary of Noise Measurements

4.6 The normal operational noise from the site audible at the receptors did not feature any significant tonal or impulsive characteristics.

# 5 Noise Model

5.1 Bureau Veritas originally prepared an environmental noise model of the refinery in 1999 as part of the development of the site environmental noise management (ENM) system. The model details the sound power levels of all significant noise sources on the refinery and quantifies the impact of those sources at the residential receptors. The model demonstrates good correlation between noise levels measured at selected residential properties and those predicted.

5.2 The model was based on the EEMUA 140 calculation methodology (ref). It was designed to predict the ambient levels at the receptor points and as such includes the Lindsey Oil Refinery as the other significant source in the area.

5.3 This system can be used to track any changes in noise emissions from the refinery and will also provide information to assist in the setting of suitable noise limits for new developments. It can also be used to assess the benefits of any proposed noise control measures. Use of the system will enable noise to be managed in a similar way to other environmental emissions.

5.4 There have been a number of changes to the plant since the model was originally constructed. The model has been used in each case to assist in the specification of the new and modified plant. Details of these changes were obtained from ConocoPhillips.

5.5 ConocoPhillips had modified the acoustic model for each of the major plant changes. These modifications were based on manufacturers' data for source sound power levels. However there was no single model reflecting the current status of the entire site.

5.6 For the IPPC application, Bureau Veritas has prepared a new model using the original 1999 model as a basis but incorporating all of the subsequent plant changes. This exercise involved measurements to determine the actual sound power of the new and modified sources and identify any other parts of the plant where noise levels had changed significantly.

5.7 Since the original model was prepared, the Immingham CHP Power Station has been constructed. It was therefore appropriate to incorporate the Power Station into the model in a similar way that Lindsey Oil Refinery is included.

5.8 Also since the original model was prepared, two of the residential receptors (no 2, East End Farm House and no 3, Mrytle Villas, Rosper Road) have been demolished. For continuity, receptors 2 and 3 have been retained in the calculations but a fourth location has been added at Hazeldene on Marsh Lane (which is now the nearest residence to the east of the site).

### Major Plant Modifications Included In Model Revision

5.9 Plant changes that have occurred since the original model were provided by ConocoPhillips and incorporated into the current version of the model.

5.10 Not all sources were present in the original model as individual items. This is because their size, location and sound power levels made it more practical to include them in a group with other sources. Similarly many of the new sources are best grouped together for the purposes of the model revision surveys.

### Sound Power Survey Methodology

5.11 The purpose of the on-site survey was to determine the sound power levels of each significant noise source. It was not feasible to survey every possible noise source on the refinery, (there are many "spare" items which were not operational), so equipment items were measured as found. It was ensured however, that all major equipment items were operating in the relevant block at the time of the survey.

5.12 Sound power is the amount of energy given off by a noise source and is independent of the environment surrounding the source. Three different measurement techniques were used in determining the sound power levels of plant items on the refinery. These were (i) measurement of sound intensity levels integrated over assumed radiating areas, (ii) measurement of sound pressure levels integrated over assumed radiating areas, and (iii) the use of surface vibration velocity measurements on pipework, ductwork and heater bodies together with assumed radiation efficiency factors and assumed radiating areas.

5.13 Where possible, sound intensity levels from individual noise sources were measured. Sound intensity measures the flow of acoustic energy from a noise source. It is a vector quantity giving the energy flow per unit area in a given direction. The sound intensity probe was used to scan over the radiating surface area of the noise source of interest. Alternatively, sound intensity levels were measured at discrete points. A correction for the radiating surface area of the source was then applied to the measured levels to give the sound power of the noise source.

5.14 For noise radiated from heater bodies, ductwork and pipework, surface vibration velocity measurements were also carried out. The measured surface vibration velocity levels were then converted to surface sound pressure levels taking into account the assumed radiation efficiency of the surface.

5.15 Where a noise source was isolated from other sources, global sound pressure and sound intensity level measurements were carried out to determine the overall sound power level for the source.

5.16 As far as possible, all significant noise sources were measured, however, there were physical limitations to this. Some equipment items were located in high noise areas where no appropriate measurement could be made in some octave bands and, for some items, in any octave band. However, it is considered that this will not have resulted in a significant number of sources being omitted from the model.

5.17 The purpose of the spot sound pressure measurements was to determine whether the sound levels emitted by any of the remaining plant in the Refinery had changed since the original model was prepared. This was done by repeating the on-plant noise measurement at 1752 points conducted in 1998 and 2002. The measured levels were averaged for each process block and the averages compared.

## Survey Schedule

5.18 The sound power level and spot measurement surveys took place between 16th and 26th January 2006 with additional measurements on the 16th March 2006

5.19 Each block was operating normally during the measurements as stated by the control room operators.

## Measurement and Sound Power Determination Methodology

***Pumps***

5.20 Generally, discrete sound intensity measurements were made at locations around pump units at a distance of 0.5 m. Judgement was made by the surveyor regarding the dominant source of noise within the pump unit e.g. electric motor/steam turbine and/or pump and only the significant portion was measured. In some other cases, where pumps were well isolated from any other noise source, global sound pressure levels at distances of a few meters from the unit were made. Where pumps were steam turbine driven, steam vents associated with the turbine were measured and included in the overall sound power level for that pump.

5.21 Physical dimensions of pumps were measured and the elevation of the acoustic centre was noted. This allowed the radiating surface area to be determined and used in conjunction with the sound intensity or sound pressure levels to calculate the sound power level of the pump.

***Air Fin Coolers***

5.22 Generally, access to air fin coolers was obtained via walkways which run adjacent to the tops of banks of air fin coolers and also to the sides of the air coolers, either from ground level or from walkways under the fans themselves. A pole and extension lead arrangement was used to measure sound intensity over the surface of the tube bundles. Where possible, physical measurements of air cooler dimensions and elevations were made, however, this was supplemented by information obtained from drawings supplied by ConocoPhillips. Corrections were made to intensity levels measured across tube bundles to allow for the additional sound radiating from the fan side.

***Pipework / Ductwork***

5.23 Pipework was reviewed on the refinery to determine which lines were likely to be potentially significant noise sources. Where possible, pipework noise was measured by sound intensity, however, most noisy sections of pipework were located in areas of high noise and therefore surface vibration velocity measurements were conducted on most pipework included in the study. The measured vibration levels were then corrected taking into account the transducer mounting resonance, assumed radiation efficiency of the pipe and the assumed radiating surface area, to determine the sound power level of each section of pipe.

5.24 Due to the large amount of pipework on the refinery and the limited survey time, it was not feasible to measure all pipework. Corrections were therefore made to allow for additional piping noise sources that were not accounted for by direct measurement.

5.25 Vibration velocity measurements were also carried out on most ductwork systems considered and also on large drums.

***Heaters***

5.26 For natural draft heaters, sound intensity was measured around open areas underneath the heater body. Where possible, sound intensity levels were measured close to the body of the heater, however, noise levels from heater bodies were generally measured using surface vibration velocity as levels were quite low.

5.27 Air intakes, fans and ductwork associated with forced draft heaters were also measured. Sound intensity levels were measured at discrete locations around fans and corrections were made for radiating surface areas. Intensity scans were made over open areas of air intakes. Ductwork was measured, where possible, by sound intensity but usually by surface vibration velocity.

5.28 Dimensions of the different elements were measured where possible, and augmented with information obtained from drawings supplied by ConocoPhillips.

***Other Plant***

5.29 Steam leaks were measured by sound intensity at discrete points usually 0.5 m or 1 m from the leak.

5.30 Where a complete source included a number of different elements, e.g. gas turbines, then a combination of the techniques described above was used to determine the overall sound power level.

***Global Measurements***

5.31 Global sound pressure measurements were made around the new plant installed since the previous assessment: CRU3, DHDS, Saturated Gas Plant, Cryogenic Plant and Flare Gas Recovery Unit. The results were used to confirm the total block sound power emission levels from the individual source measurements.

5.32 The sound power levels included in the model for the Lindsey Oil Refinery and Immingham CHP power station were based on global measurements. The Lindsey Oil measurements were made at the time of the original model preparation. The Immingham CHP power station data was based on BV library measurements.

### *Flares*

5.33 Flare noise was addressed in the original model and not revisited for this exercise. Sound power levels for both flares have been included in the acoustic model for two different conditions. The first condition is with steam rates at the flare alarm level. This level has been set by ConocoPhillips as the level at which they expect noise complaints to occur. The second condition was when steam rates were reduced to the minimum level possible without the flare becoming ‘dirty’.

## Spot Measurements

5.34 The results of the spot measurements are summarised in Table 5.1

| Block | 2002 Avg $L_A$ | 2006 Avg $L_A$ | Difference |
|---|---|---|---|
| Cryogenic unit | na | 91.6 | na |
| Saturated gas plant | na | 86.0 | na |
| Closed blowdown system | na | 83.9 | na |
| Flare gas recovery | na | 92.8 | na |
| CRU3 | na | 88.6 | na |
| PB No 8 | 75.1 | 87.1 | 12.0 |

| Block | 2002 Avg $L_A$ | 2006 Avg $L_A$ | Difference |
|---|---|---|---|
| PB No 11B | 80.7 | 87.6 | 6.8 |
| Cat poly | 78.5 | 82.8 | 4.3 |
| PB No 5 | 82.8 | 85.8 | 3.0 |
| Vacuum unit No 1 | 86.8 | 89.7 | 2.9 |
| FCC unit | 84..8 | 87.7 | 2.9 |
| Utilities – cooling towers | 87.4 | 90.2 | 2.8 |
| Calciners | 79.5 | 81.6 | 2.1 |
| No 2 Coker & Thermal Cracker | 91.7 | 93.5 | 1.8 |
| PB No 11B | 78.0 | 79.1 | 1.1 |
| No 2 Reformer | 84.7 | 85.7 | 1.0 |
| Aromatic / HDA | 84.5 | 85.3 | 1.0 |
| DHDS | 81.4 | 82.2 | 0.8 |
| Demin unit | 81.5 | 82.1 | 0.6 |
| Crude unit furnaces | 87.9 | 88.5 | 0.6 |
| Vacuum unit No 3 | 84.4 | 84.5 | 0.1 |
| PB No 9 | 87.7 | 87.7 | 0.0 |
| de sulphur cat reformer | 93.8 | 93.7 | -0.1 |
| PB No 1 | 85.6 | 85.4 | -0.2 |
| PB No 2b | 90.5 | 89.8 | -0.7 |
| Cokers | 88.2 | 87.4 | -0.8 |
| Vacuum unit No 2 | 84.5 | 83.6 | -0.9 |
| Calciners | 80.6 | 79.5 | -1.1 |
| PB No 10 | 83.8 | 82.6 | -1.2 |
| Crude topping unit | 89.2 | 87.8 | -1.4 |
| Amine | 91.6 | 90.2 | -1.4 |
| Coke drums | 89.6 | 88.1 | -1.5 |
| PB No 7 | 89.5 | 91.5 | -1.5 |
| Sulphur plant | 91.5 | 89.7 | -1.8 |
| Propylene unit | 85.9 | 83.8 | -2.2 |
| C4311/C5302 | 89.4 | 86.5 | -2.9 |
| Utilities | 94.7 | 91.7 | -3.0 |
| Cokers GOHDS | 90.9 | 87.8 | -3.2 |
| Cracked gas Plant/PSA | 91.4 | 87.4 | -4.1 |
| Effluent | 85.4 | 81.2 | -4.3 |
| Utilities - cooling towers | 89.5 | 83.6 | -5.8 |
| PB No 3 | 85.7 | 79.8 | -5.9 |
| Closed blowdown system | 89.9 | 81.2 | -6.8 |
| HDS | 95.0 | 83.1 | -11.9 |
| Gas recovery | 100.2 | 88.1 | -12.0 |
| Blending | 83.5 | 67.2 | -16.3 |
| **Overall** | **91.2** | **88.3** | **-2.8** |

**Table 5.1** Comparison of Average Sound Pressure Levels

5.35 Where significant differences between the 2002 and 2006 assessments were apparent, further investigations were conducted and adjustments made to the sound power levels input into the acoustic model. These modifications included:

a Several steam leaks were removed from or switched off in the model;

b the sound power levels for certain pipework and valve areas were altered to reflect the current situation (e.g. the levels around fuel gas receiver D701 were reduced to reflect the reduced fuel gas flow noise);

c the changes in the pump bays were mostly due to different measurement locations and the overall pump bay average remained fairly constant.

## Overview of Calculation Methodology

5.36 The basis of an acoustic model is to convert a source sound power level in dB re 10pW to a resultant community sound pressure level in dB re 20µPa, as follows:

Resultant $L_p = L_W$ + directivity - $\Sigma$(attenuation factors)

5.37 The attenuation factors considered are:

(i) geometrical divergence of sound energy;

(ii) ground interaction effects;

(iii) absorption directly by the atmosphere;

(iv) effect of screening by barriers.

5.38 The first factor relates to the way in which sound energy dissipates with distance in a geometrical fashion, very much like the way the ripples on a pond spread after a stone is thrown into it. In general, sound decays at a rate of 6 dB per doubling of distance from a "point" source although this factor is modified close to the source by the physical source size. Other factors may also temper this generalised rate of attenuation with distance.

5.39 The ground interaction effect is a phase cancellation phenomenon caused by the destructive interference of "direct" rays and rays reflected from the ground. This effect is significant for a broad range of frequencies over acoustically soft ground (e.g. grassland, ploughed fields etc.) but is less significant, and more frequency selective, if the ground is acoustically hard (e.g. concrete). The actual ground profile between source and receiver may also modify this phenomenon.

5.40 Wind and temperature gradients in the atmosphere play a very important part in modifying sound attenuation characteristics. A positive vertical temperature gradient causes sound to be refracted downwards which enhances sound propagation. During the day, if it is sunny, a negative vertical temperature gradient occurs in the atmosphere and sound is refracted upwards. If it is cloudy, the cloud acts as a blanket and the temperature gradient tends to be more neutral. In reality, vertical temperature gradients in the atmosphere can be complex and change from positive to negative or vice versa, giving rise to more complex sound propagation conditions.

5.41 Sound is also refracted downwards, in a downwind direction, and upwards in an upwind direction. The combination of wind and temperature gradients may lead to shadow zones upwind of a noise source, where the source of noise may be seen, but not heard. In a downwind direction, downwards sound refraction may modify the ground interaction phenomenon, and also, at longer distances, give rise to sound focusing effects. Generalised models of sound propagation cannot take into account the detailed structure of the atmosphere on a day to day basis, therefore some differences between measurements and predictions must always be expected. The most stable sound propagation direction is downwind of a source, and typically within a distance of about 1 km. It is for this condition and for this range that the best correlation with standard sound propagation models would be expected to occur.

5.42 Sound absorption by the atmosphere involves a “real” loss mechanism in that a direct transfer of energy occurs between the acoustic wave and the constituents of the atmosphere. There are a number of different attenuation mechanisms involved concerning thermal and viscous losses and transfer of energy to nitrogen and oxygen molecules. The main factors influencing atmospheric sound absorption are temperature and relative humidity.

5.43 Buildings, large equipment items and topographical features can act as barriers to sound and increase the attenuation of sound to outlying areas. In a process plant, there are many reflecting surfaces, therefore care has to be taken in assuming barrier effects for noise sources, as sound can easily be reflected back again in the direction in which the barrier is thought to be effective. For plant items in the centre of densely packed process areas, screening effects will be significant.

5.44 Some of the attenuation factors highlighted above are frequency dependent. For example the absorption of sound directly by the atmosphere is a high frequency phenomenon, whereas the increased attenuation caused by interaction with the ground is generally more significant at mid frequencies. Screening is also more effective at high frequencies.

5.45 The directivity factor describes the way in which sound energy may propagate more strongly in one direction than another, or how the location of the source in the presence of a reflective surface affects the radiation properties. For example, if a noise source is located directly in front of a building, the building may act as a reflective surface and cause sound to be radiated more strongly in the direction normal to the facade of the building.

5.46 The acoustic model used in the Environmental Noise Management (ENM) system for the Humber Refinery is based on EEMUA 140 with the ground attenuation factors calibrated to suit the propagation characteristics between the refinery and the receiver control points. The model has been extended to consider distances greater than 1 km although the accuracy can be expected to decrease over greater propagation distances. The 31.5 Hz octave band has been included and has been assumed to have the same characteristics as the 63 Hz octave band.

5.47 The model includes all significant noise sources which were operating during the survey period. The most significant intermittent sources have been included i.e. coke drums during drilling and flare noise, however, these would not be continuous normal operations. For the analysis given in this report, it has been assumed that these intermittent sources are not operating.

5.48 The sound power level schedule included in the model and used as a basis for the following analysis for the significant sources only can be seen in Appendix 3. Information on other sources is available at the installation.

### Validation Against Community Measurements

5.49 The results of the model were validated against the results of the community noise measurements at Receptor 1. No suitable measured data was available for Receptors 2 and 4. The noise at Receptor 4 includes significant contributions from the Immingham CHP power station and the Lindsey Oil Refinery. It is therefore of limited use in validating the Humber Refinery model. Receptor 3 is no longer in existence. It is therefore considered that validation against high quality measurements at Receptor 1 is adequate to confirm the output of the model. Further validation of the model based on measurements at Receptor 2 would be desirable when they become available.

5.50 In terms of overall dB $L_A$ and octave band spectral levels, the correlation at Receptor 1 was found to be good with predicted and measured levels within 1dB $L_A$.

## Rank Ordering of Noise Sources

***By Overall Resultant Sound Pressure Level***

5.51 Having developed an acoustic model, which gives reasonable correlation with the measured levels, it is possible to rank order the significance of individual noise sources to the selected community locations.

5.52 The following tables show the most significant individual noise sources at each location. These lists of sources given overleaf give an indication of some of the more significant noise sources on the refinery and how, in a downwind situation, they are likely to contribute to the total community noise levels. There are many other noise sources on the refinery complex, which when added together will also contribute to the overall noise levels.

## Melrose, Staple Road

| Line | Site Area | Area Description | Plant Type | Tag number | dB $L_A$ |
|---|---|---|---|---|---|
| 16 | Crutilities | Onsite CHP | Pump | P7701 | 49.9 |
| 38 | Crutilities | Onsite CHP | Valve/Pipework | PRC440V | 44.8 |
| 469 | Lindsey | Lindsey Oil Refinery | Lindsey | Lindsey | 43.5 |
| 264 | White Oils | Amine/Penex Unit | Valve/Pipework | | 42.8 |
| 304 | FCC | FCC | Valve/Pipework | | 41.2 |
| 37 | Crutilities | Onsite CHP | Valve/Pipework | | 41.0 |
| 561 | Aromatics | CRU3 | Fin fans | X6003/4/5/6 | 40.8 |
| 223 | White Oils | Desulph | Air Fin Cooler | X311 | 40.4 |
| 310 | FCC | FCC | Building | | 40.4 |
| 39 | Crutilities | Onsite CHP | Valve/Pipework | | 40.3 |
| 40 | Crutilities | Crude Topping Units | Air Fin Cooler | X111 | 40.0 |
| 221 | White Oils | Desulph | Air Fin Cooler | X309 | 39.9 |
| 24 | Crutilities | Onsite CHP | Cooling Tower | CT5701 | 39.6 |
| 343 | Aromatics | Aromatics & HDA | Air Fin Cooler | X538 | 39.5 |
| 229 | White Oils | Desulph | Valve/Pipework | FRC370 | 38.5 |
| 98 | Crutilities | No.2 & 3 Vacuum Dist Unit | Ductwork | | 38.5 |
| 198 | White Oils | Cracked Gas Plant & PSA Unit | Drum | D4001 | 38.4 |
| 194 | White Oils | Cracked Gas Plant & PSA Unit | Air Fin Cooler | X4009 | 38.2 |
| 110 | Crutilities | Utilities | Pump | P716 | 37.7 |
| 20 | Crutilities | Onsite CHP | Pump | P714 | 37.6 |
| 567 | Aromatics | CRU3 | Pipework | | 37.6 |
| 463 | Calciners | Calciners | Global | | 37.2 |
| 197 | White Oils | Cracked Gas Plant & PSA Unit | Valve/Pipework | | 37.0 |
| 92 | Crutilities | No.2 & 3 Vacuum Dist Unit | Ductwork | | 36.7 |
| 23 | Crutilities | Onsite CHP | Cooling Tower | CT710 | 36.1 |
| 375 | Aromatics | Sulphur Plant | Heater | H571 | 35.8 |
| 263 | White Oils | Amine/Penex Unit | Drum | D7730 | 35.5 |
| 330 | Aromatics | No2 Reformer | Air Fin Cooler | X6304 | 35.3 |
| 303 | FCC | FCC | Air Fin Cooler | X3403 | 35.2 |
| 122 | Crutilities | Utilities | Air Fin Cooler | X722 | 35.1 |
| 19 | Crutilities | Onsite CHP | Pump | P705 | 35.1 |
| 90 | Crutilities | No.2 & 3 Vacuum Dist Unit | Fan | F101 | 35.0 |
| 103 | Crutilities | No.2 & 3 Vacuum Dist Unit | Fan | F4104 | 34.7 |
| 342 | Aromatics | Aromatics & HDA | Air Fin Cooler | X531 | 34.5 |
| 30 | Crutilities | Onsite CHP | Ductwork | | 34.2 |
| 422 | Cokers | Gas Oil Hydrodesulph. | Heater | H151 | 34.1 |
| 222 | White Oils | Desulph | Air Fin Cooler | X323 | 34.0 |
| 29 | Crutilities | Onsite CHP | Ductwork | | 33.9 |
| 41 | Crutilities | Crude Topping Units | Air Fin Cooler | X144 | 33.8 |
| 32 | Crutilities | Onsite CHP | Ductwork | | 33.7 |

| Line | Site Area | Area Description | Plant Type | Tag number | dB $L_A$ |
|---|---|---|---|---|---|
| 364 | Aromatics | Sulphur Plant | Compressor | C4501 | 33.7 |
| 267 | White Oils | HDS | Heater | H301 | 33.4 |
| 472 | Power Station | Immingham CHP Power Station | Plant | | 33.4 |
| | | **Sub total of above sources** | | | **55.9** |
| | | **Total for all sources** | | | **57.0** |

**Table 5.2** Noise Source Sound Pressure Contributions at Receptor 1

5.53 It can be seen that Pump P7701 in the Crutilities area makes the largest contribution to noise levels at Melrose with various valves and sections of pipework making significant contributions. Lindsey Oil Refinery is also significant.

## East End Farm

| Line | Site Area | Area Description | Plant Type | Tag number | dB $L_A$ |
|---|---|---|---|---|---|
| 16 | Crutilities | Onsite CHP | Pump | P7701 | 41.7 |
| 264 | White Oils | Amine/Penex Unit | Valve/Pipework | | 40.2 |
| 463 | Calciners | Calciners | Global | | 39.3 |
| 155 | OM&S | Pump Bays | Pump | P820 | 38.8 |
| 156 | OM&S | Pump Bays | Pump | P854 | 38.4 |
| 422 | Cokers | Gas Oil Hydrodesulph. | Heater | H151 | 37.4 |
| 40 | Crutilities | Crude Topping Units | Air Fin Cooler | X111 | 36.9 |
| 98 | Crutilities | No.2 & 3 Vacuum Dist Unit | Ductwork | | 36.7 |
| 469 | Lindsey | Lindsey Oil Refinery | Lindsey | Lindsey | 36.4 |
| 157 | OM&S | Pump Bays | Pump | P4803 | 36.3 |
| 221 | White Oils | Desulph & Cat Reformer | Air Fin Cooler | X309 | 36.3 |
| 223 | White Oils | Desulph | Air Fin Cooler | X311 | 36.3 |
| 561 | Aromatics | CRU3 | Fin fans | X6003/4/5/6 | 35.3 |
| 92 | Crutilities | No.2 & 3 Vacuum Dist Unit | Ductwork | | 35.2 |
| 194 | White Oils | Cracked Gas & PSA Unit | Air Fin Cooler | X4009 | 35.0 |
| 472 | Power Station | Immingham CHP Power Station | Plant | | 34.6 |
| 343 | Aromatics | Aromatics & HDA | Air Fin Cooler | X538 | 34.4 |
| 38 | Crutilities | Onsite CHP | Valve/Pipework | PRC440V | 34.4 |
| 198 | White Oils | Cracked Gas & PSA Unit | Drum | D4001 | 34.3 |
| 229 | White Oils | Desulph | Valve/Pipework | FRC370 | 34.1 |
| 152 | OM&S | Pump Bays | Pump | P825 | 33.7 |
| 304 | FCC | FCC | Valve/Pipework | | 33.5 |
| 90 | Crutilities | No.2 & 3 Vacuum Dist Unit | Fan | F101 | 33.4 |
| 167 | OM&S | Pump Bays | Pump | P837 | 33.2 |
| 263 | White Oils | Amine/Penex Unit | Drum | D7730 | 33.2 |
| 197 | White Oils | Cracked Gas & PSA Unit | Valve/Pipework | | 32.9 |
| 567 | Aromatics | CRU3 | Pipework | | 32.7 |
| 103 | Crutilities | No.2 & 3 Vacuum Dist Unit | Fan | F4104 | 32.3 |
| 424 | Cokers | Gas Oil Hydrodesulph. | Air Fin Cooler | X127 | 32.3 |
| 41 | Crutilities | Crude Topping Units | Air Fin Cooler | X144 | 31.7 |
| 168 | OM&S | Pump Bays | Pump | P828 | 30.8 |
| 470 | White Oils | Flare Gas Rec. | Compressor | C781/2 | 30.8 |
| 222 | White Oils | Desulph | Air Fin Cooler | X323 | 30.6 |
| 37 | Crutilities | Onsite CHP | Valve/Pipework | | 30.5 |
| 153 | OM&S | Pump Bays | Pump | P827 | 30.4 |
| 24 | Crutilities | Onsite CHP | Cooling Tower | CT5701 | 30.2 |
| 146 | OM&S | Pump Bays | Pump | P807 | 30.1 |
| 154 | OM&S | Pump Bays | Pump | P818 | 30.1 |
| 147 | OM&S | Pump Bays | Pump | P879 | 29.9 |
| 330 | Aromatics | No2 Reformer | Air Fin Cooler | X6304 | 29.8 |
| 342 | Aromatics | Aromatics &HDA | Air Fin Cooler | X531 | 29.8 |

| Line | Site Area | Area Description | Plant Type | Tag number | dB $L_A$ |
|---|---|---|---|---|---|
| 83 | Crutilities | No.2 & 3 Vacuum Dist Unit | Pump | P4158 | 29.8 |
| 110 | Crutilities | Utilities | Pump | P716 | 29.7 |
| 20 | Crutilities | Onsite CHP | Pump | P714 | 29.7 |
| | | **Sub total of above sources** | | | **51.4** |
| | | **Total for all sources** | | | **52.9** |

**Table 5.3** Noise Source Sound Pressure Contributions at Receptor 2

5.54 Crutilites pump P7701 makes the largest contribution to noise levels at East End Farm with White Oils valve/pipework systems and pumps in pump bays also of significance. The contribution of the eastern area of the calciners is also important.

### Myrtle Villas, Rosper Road

| Line | Site Area | Area Description | Plant Type | Tag number | dB $L_A$ |
|---|---|---|---|---|---|
| 463 | Calciners | Calciners | Global | | 44.8 |
| 472 | Power Station | Immingham CHP Power Station | Plant | | 44.7 |
| 16 | Crutilities | Onsite CHP | Pump | P7701 | 39.4 |
| 469 | Lindsey | Lindsey Oil Refinery | Lindsey | Lindsey | 39.3 |
| 264 | White Oils | Amine/Penex Unit | Valve/Pipework | | 38.5 |
| 198 | White Oils | Cracked Gas & PSA Unit | Drum | D4001 | 37.1 |
| 561 | Aromatics | CRU3 | Fin fans | X6003/4/5/6 | 36.3 |
| 567 | Aromatics | CRU3 | Pipework | | 36.2 |
| 197 | White Oils | Cracked Gas & PSA Unit | Valve/Pipework | | 35.5 |
| 194 | White Oils | Cracked Gas & PSA Unit | Air Fin Cooler | X4009 | 35.3 |
| 470 | White Oils | Flare Gas Rec. | Compressor | C781/2 | 35.0 |
| 223 | White Oils | Desulph | Air Fin Cooler | X311 | 34.5 |
| 498 | White Oils | DHDS | Pipework/valves | | 34.0 |
| 221 | White Oils | Desulph | Air Fin Cooler | X309 | 33.9 |
| 40 | Crutilities | Crude Topping Units | Air Fin Cooler | X111 | 33.8 |
| 343 | Aromatics | Aromatics & HDA | Air Fin Cooler | X538 | 33.6 |
| 304 | FCC | FCC | Valve/Pipework | | 33.5 |
| 229 | White Oils | Desulph | Valve/Pipework | FRC370 | 32.4 |
| 247 | White Oils | Saturated Gas & Cryogenic Plant | Pipework | | 32.1 |
| 310 | FCC | FCC | Building | | 32.1 |
| 38 | Crutilities | Onsite CHP | Valve/Pipework | PRC440V | 32.0 |
| 155 | OM&S | Pump Bays | Pump | P820 | 31.9 |
| 263 | White Oils | Amine/Penex Unit | Drum | D7730 | 31.7 |
| 383 | Cokers | Closed Blowdown system | Pump | P1748 | 31.6 |
| 422 | Cokers | Gas Oil Hydrodesulph. | Heater | H151 | 30.5 |
| 462 | Calciners | Calciners | Air Fin Cooler | VC5601 | 30.5 |
| 98 | Crutilities | No.2 & 3 Vacuum Dist Unit | Ductwork | | 30.0 |
| 330 | Aromatics | No2 Reformer | Air Fin Cooler | X6304 | 29.6 |
| 424 | Cokers | Gas Oil Hydrodesulph. | Air Fin Cooler | X127 | 29.5 |
| 195 | White Oils | Cracked Gas & PSA Unit | Air Fin Cooler | X4001 | 29.4 |
| 196 | White Oils | Cracked Gas & PSA Unit | Building | | 29.3 |
| 459 | Calciners | Calciners | Fan | F5602 | 29.0 |
| 342 | Aromatics | Aromatics & HDA | Air Fin Cooler | X531 | 28.8 |
| 375 | Aromatics | Sulphur Plant | Heater | H571 | 28.8 |
| 24 | Crutilities | Onsite CHP | Cooling Tower | CT5701 | 28.7 |
| 41 | Crutilities | Crude Topping Units | Air Fin Cooler | X144 | 28.7 |
| 152 | OM&S | Pump Bays | Pump | P825 | 28.5 |
| 389 | Cokers | Closed Blowdown System | Ductwork | | 28.2 |
| 92 | Crutilities | No.2 & 3 Vacuum Dist Unit | Ductwork | | 28.2 |
| 222 | White Oils | Desulph | Air Fin Cooler | X323 | 28.0 |
| 37 | Crutilities | Onsite CHP | Valve/Pipework | | 28.0 |

| Line | Site Area | Area Description | Plant Type | Tag number | dB $L_A$ |
|---|---|---|---|---|---|
| 502 | White Oils | DHDS | Air Fin Coolers | | 27.9 |
| 562 | Aromatics | CRU3 | FFC Pipework | | 27.9 |
| 303 | FCC | FCC | Air Fin Cooler | X3403 | 27.7 |
| | | **Sub total of above sources** | | | **51.7** |
| | | **Total for all sources** | | | **52.6** |

**Table 5.4** Noise Source Sound Pressure Contributions at Receptor 3

5.55 The eastern area of the calciners is an important noise source at Myrtle Villas but includes a large number of individual sources. Pumps and valve/pipework systems in White Oils are important as is Crutilities pump P7701. The Power Station and Lindsey Oil Refinery also make significant contributions to noise levels at this location.

### Hazeldene, Marsh Lane

| Line | Site Area | Area Description | Plant Type | Tag number | dB $L_A$ |
|---|---|---|---|---|---|
| 472 | Power Station | Immingham CHP Power Station | Plant | | 41.7 |
| 463 | Calciners | Calciners | Global | | 41.6 |
| 469 | Lindsey | Lindsey Oil Refinery | Lindsey | Lindsey | 38.9 |
| 16 | Crutilities | Onsite CHP | Pump | P7701 | 36.7 |
| 264 | White Oils | Amine/Penex Unit | Valve/Pipework | | 35.3 |
| 198 | White Oils | Cracked Gas & PSA Unit | Drum | D4001 | 34.6 |
| 567 | Aromatics | CRU3 | Pipework | | 34.0 |
| 561 | Aromatics | CRU3 | Fin fans | X6003/4/5/6 | 33.6 |
| 194 | White Oils | Cracked Gas & PSA Unit | Air Fin Cooler | X4009 | 33.1 |
| 197 | White Oils | Cracked Gas & PSA Unit | Valve/Pipework | | 32.8 |
| 223 | White Oils | Desulph | Air Fin Cooler | X311 | 32.4 |
| 470 | White Oils | Flare Gas Rec. | Compressor | C781/2 | 32.3 |
| 498 | White Oils | DHDS | Pipework/valves | | 32.1 |
| 343 | Aromatics | Aromatics & HDA | Air Fin Cooler | X538 | 31.6 |
| 221 | White Oils | Desulph | Air Fin Cooler | X309 | 31.5 |
| 40 | Crutilities | Crude Topping Units | Air Fin Cooler | X111 | 31.5 |
| 304 | FCC | FCC | Valve/Pipework | | 31.3 |
| 310 | FCC | FCC | Building | | 29.9 |
| 229 | White Oils | Desulph | Valve/Pipework | FRC370 | 29.7 |
| 38 | Crutilities | Onsite CHP | Valve/Pipework | PRC440V | 29.6 |
| 263 | White Oils | Amine/Penex Unit | Drum | D7730 | 28.9 |
| 383 | Cokers | Closed Blowdown System | Pump | P1748 | 28.9 |
| 247 | White Oils | Saturated Gas & Cryogenic Plant | Pipework | | 28.6 |
| 422 | Cokers | Gas Oil Hydrodesulph. | Heater | H151 | 28.3 |
| 155 | OM&S | Pump Bays | Pump | P820 | 28.0 |
| 98 | Crutilities | No.2 & 3 Vacuum Dist Unit | Ductwork | | 28.0 |
| 330 | Aromatics | No2 Reformer | Air Fin Cooler | X6304 | 27.7 |
| 462 | Calciners | Calciners | Air Fin Cooler | VC5601 | 27.6 |
| 195 | White Oils | Cracked Gas & PSA Unit | Air Fin Cooler | X4001 | 27.1 |
| 24 | Crutilities | Onsite CHP | Cooling Tower | CT5701 | 27.0 |
| 375 | Aromatics | Sulphur Plant | Heater | H571 | 27.0 |
| 342 | Aromatics | Aromatics & HDA | Air Fin Cooler | X531 | 26.9 |
| 424 | Cokers | Gas Oil Hydrodesulph | Air Fin Cooler | X127 | 26.9 |
| 196 | White Oils | Cracked Gas & PSA Unit | Building | | 26.7 |
| 41 | Crutilities | Crude Topping Units | Air Fin Cooler | X144 | 26.4 |
| 303 | FCC | FCC | Air Fin Cooler | X3403 | 26.1 |
| 92 | Crutilities | No.2 & 3 Vacuum Dist Unit | Ductwork | | 26.1 |
| 389 | Cokers | Closed Blowdown System | Ductwork | | 26.0 |
| 270 | White Oils | HDS & No.1 Reformer | Valve/Pipework | ESD3327 | 25.8 |
| 415 | Cokers | Thermal Crackers | Air Fin Cooler | X216 | 25.4 |

| Line | Site Area | Area Description | Plant Type | Tag number | dB $L_A$ |
|---|---|---|---|---|---|
| 222 | White Oils | Desulph | Air Fin Cooler | X323 | 25.3 |
| 459 | Calciners | Calciners | Fan | F5602 | 25.3 |
| 502 | White Oils | DHDS | Air Fin Coolers | | 25.3 |
| 37 | Crutilities | Onsite CHP | Valve/Pipework | | 25.2 |
| | | **Sub total of above sources** | | | **49.2** |
| | | **Total for all sources** | | | **50.0** |

**Table 5.5** Noise Source Sound Pressure Contributions at Receptor 4

5.56 The Power Station, calciners and Lindsey Oil Refinery are the major noise sources affecting receptor 4.

***By Block***

5.57 A rank ordering has been undertaken of the radiated noise levels from each block on the refinery to the selected community control points. The following tables show the contribution of each of the major blocks on the refinery along with the contribution from Lindsey Oil Refinery at each property.

## Melrose, Staple Road

| Site Area | Block | dB $L_A$ |
|---|---|---|
| Crutilities | Onsite CHP | 52.9 |
| White Oils | Desulph Area | 45.9 |
| FCC | FCC | 45.5 |
| Crutilities | No.2 & 3 Vacuum Dist Unit | 45.3 |
| White Oils | Amine/Penex Unit | 44.1 |
| Lindsey | Lindsey Oil Refinery | 43.5 |
| White Oils | Cracked Gas & PSA Unit | 43.5 |
| Aromatics | CRU3 | 43.0 |
| Crutilities | Crude Topping Units | 42.5 |
| Crutilities | Utilities | 41.8 |
| Aromatics | Aromatics & HDA | 40.9 |
| Aromatics | Sulphur Plant | 39.2 |
| OM&S | Pump Bays | 38.4 |
| Cokers | Gas Oil Hydrodesulpherisation | 37.9 |
| Calciners | Calciners | 37.8 |
| Cokers | Thermal Crackers | 37.5 |
| Aromatics | No2 Reformer | 37.2 |
| White Oils | HDS & No.1 Reformer | 36.8 |
| White Oils | Gas Recovery | 36.2 |
| White Oils | DHDS | 33.6 |
| FCC | Propylene Unit | 33.6 |
| Power Station | Immingham CHP Power Station | 33.4 |
| White Oils | Flare Gas Rec. | 32.1 |
| White Oils | Saturated Gas & Cryogenic Plant | 32.0 |
| Cokers | Closed Blowdown System | 32.0 |
| Crutilities | No.1 Vacuum Dist Unit | 31.6 |
| Cokers | No3 Sub Area | 30.0 |
| OM&S | OM&S | 29.7 |
| Cokers | Coker & Cracker Furnaces | 29.7 |
| Cokers | Coke Drums | 28.8 |
| Aromatics | Control Room Area | 27.8 |
| FCC | Alkylation | 25.5 |

| Site Area | Block | dB $L_A$ |
|---|---|---|
| FCC | DME Unit | 25.4 |
| Crutilities | Demin Plant | 25.0 |
| OM&S | Effluent Treatment | 22.0 |

**Table 5.6** Block Sound Pressure Contributions at Receptor 1

5.58 At Melrose, Staple Road in South Killingholme, the Crutilities block results in the largest contribution followed by White Oils and FCC. Aromatics, Lindsey Oil Refinery and the Cokers also make significant contributions

## 5.59 East End Farm

| Site Area | Block | dB $L_A$ |
|---|---|---|
| OM&S | Pump Bays | 45.3 |
| Crutilities | Onsite CHP | 44.1 |
| Crutilities | No.2 & 3 Vacuum Dist Unit | 43.1 |
| White Oils | Desulph | 41.9 |
| White Oils | Amine/Penex Unit | 41.5 |
| Cokers | Gas Oil Hydrodesulphurisation | 40.2 |
| Calciners | Calciners | 39.9 |
| White Oils | Cracked Gas & PSA Unit | 39.7 |
| Crutilities | Crude Topping Units | 39.5 |
| Aromatics | CRU3 | 37.7 |
| FCC | FCC | 36.6 |
| Lindsey | Lindsey oil refinery | 36.4 |
| Aromatics | Aromatics & HDA | 35.9 |
| Cokers | Thermal Crackers | 35.6 |
| Power Station | Immingham CHP Power Station | 34.6 |
| Crutilities | Utilities | 34.4 |
| White Oils | Gas Recovery | 33.2 |
| Aromatics | Sulphur Plant | 33.1 |
| Cokers | No3 Sub Area | 33.1 |
| White Oils | HDS | 32.7 |
| Aromatics | No2 Reformer | 31.5 |
| White Oils | DHDS | 31.1 |
| OM&S | Flare Gas Rec. | 30.8 |
| OM&S | OM&S | 30.8 |
| Cokers | Closed Blowdown System | 30.8 |
| Cokers | Coke Drums | 29.0 |
| White Oils | Saturated Gas & Cryogenic Plant | 28.7 |
| Cokers | Coker & Cracker Furnaces | 28.5 |
| Crutilities | No.1 Vacuum Dist Unit | 27.7 |
| Crutilities | Effluent Treatment | 26.2 |
| FCC | Propylene Unit | 26.1 |
| Aromatics | Control Room Area | 24.7 |
| Crutilities | Demin Plant | 17.9 |
| FCC | DME Unit | 14.5 |
| FCC | Alkylation | 12.1 |

**Table 5.7** Block Sound Pressure Contributions at Receptor 2

5.60 At East End Farm, the Crutilities and White Oils blocks make the largest contributions. With OM&S and the Cokers also significant.

## Myrtle Villas, Rosper Road

| Site Area | Block | dB $L_A$ |
|---|---|---|
| Calciners | Calciners | 45.3 |
| Power Station | Immingham CHP Power Station | 44.7 |
| Crutilities | Onsite CHP | 41.9 |
| White Oils | Cracked Gas & PSA Unit | 41.5 |
| White Oils | Amine/Penex Unit | 40.0 |
| White Oils | Desulph | 39.9 |
| Aromatics | CRU3 | 39.8 |
| Lindsey | Lindsey Oil Refinery | 39.3 |
| OM&S | Pump Bays | 38.0 |
| FCC | FCC | 37.7 |
| Crutilities | No.2 & 3 Vacuum Dist Unit | 36.4 |
| Crutilities | Crude Topping Units | 36.3 |
| White Oils | DHDS | 35.4 |
| Aromatics | Aromatics & HDA | 35.0 |
| OM&S | Flare Gas Rec. | 35.0 |
| Cokers | Gas Oil Hydrodesulphurisation | 34.7 |
| Cokers | Closed Blowdown System | 34.0 |
| Cokers | Thermal Crackers | 33.6 |
| Aromatics | No2 Reformer | 32.7 |
| White Oils | Saturated Gas & Cryogenic Plant | 32.5 |
| Crutilities | Utilities | 32.1 |
| Aromatics | Sulphur Plant | 32.0 |
| White Oils | Gas Recovery | 31.9 |
| OM&S | Effluent Treatment | 30.8 |
| White Oils | HDS | 30.4 |
| Cokers | Coke Drums | 28.0 |
| Cokers | No3 Sub Area | 26.9 |
| Cokers | Coker & Cracker Furnaces | 26.5 |
| FCC | Propylene Unit | 25.9 |
| OM&S | OM&S | 25.0 |
| Aromatics | Control Room Area | 24.5 |
| Crutilities | No.1 Vacuum Dist Unit | 24.2 |
| FCC | DME Unit | 13.2 |
| Crutilities | Demin Plant | 11.4 |
| FCC | Alkylation | 10.7 |

**Table 5.8** Block Sound Pressure Contributions at Receptor 3

5.61 The Calciners and the power station are the most significant sources at this location

## Hazeldene, Marsh Lane

| Site Area | Block | dB $L_A$ |
|---|---|---|
| Calciners | Calciners | 42.1 |
| Power Station | Immingham CHP Power Station | 41.7 |
| Crutilities | Onsite CHP | 39.5 |
| White Oils | Cracked Gas & PSA Unit | 39.1 |
| Lindsey | Lindsey Oil Refinery | 38.9 |
| White Oils | Desulph Area | 37.5 |
| Aromatics | CRU3 | 37.4 |
| White Oils | Amine/Penex Unit | 36.9 |

| Site Area | Block | dB $L_A$ |
|---|---|---|
| FCC | FCC | 35.6 |
| Crutilities | No.2 & 3 Vacuum Dist Unit | 34.2 |
| OM&S | Pump Bays | 34.1 |
| Crutilities | Crude Topping Units | 33.9 |
| White Oils | DHDS | 33.3 |
| Aromatics | Aromatics & HDA | 33.0 |
| OM&S | Flare Gas Rec. | 32.3 |
| Cokers | Gas Oil Hydrodesulphurisation | 32.2 |
| Cokers | Closed Blowdown System | 31.5 |
| Cokers | Thermal Crackers | 31.0 |
| Aromatics | No2 Reformer | 30.6 |
| Aromatics | Sulphur Plant | 30.0 |
| White Oils | Gas Recovery | 29.4 |
| Crutilities | Utilities | 29.3 |
| White Oils | Saturated Gas & Cryogenic Plant | 29.0 |
| White Oils | HDS | 28.5 |
| OM&S | Effluent Treatment | 26.5 |
| Cokers | Coke Drums | 24.7 |
| Cokers | No3 Sub Area | 24.5 |
| Cokers | Coker & Cracker Furnaces | 24.5 |
| FCC | Propylene Unit | 24.4 |
| Aromatics | Control Room Area | 22.1 |
| Crutilities | No.1 Vacuum Dist Unit | 22.0 |
| OM&S | OM&S | 21.4 |
| FCC | DME Unit | 11.6 |
| Crutilities | Demin Plant | 9.1 |
| FCC | Alkylation | 8.7 |

**Table 5.9** Block Sound Pressure Contributions at Receptor 4

5.62 The Calciners and the power station are the most significant sources at this location

## Conclusions

5.63 The site acoustic model of the refinery has been revised to reflect the current plant configuration and the addition of the Immingham CHP power station.

5.64 The dominant noise sources vary somewhat depending on proximity to the receiver location. In general, pumps, air fin coolers and valve/pipework systems were the plant types making the greatest contributions to community noise levels.

5.65 It is clear that no one noise source or even one block dominates the environmental noise emissions from the Humber Refinery. However, the information provided by the model will allow certain areas or types of equipment to be targeted for noise reduction plans and for specifying low noise equipment for future developments. The effects of any changes to the environmental noise emissions from the refinery can be quantified at design stage.

5.66 The predictions given above do not include noise from the flares or drilling out of the coke drums. The operation of both flares (in the high flow condition) increases the predicted levels at Receptors 1 and 4 by 0.3 dB and 1.7 dB respectively. Simultaneous drilling out of two of the eight coke drums increases the predicted levels at Receptors 1 and 4 by 0.3 dB and 0.7 dB respectively.

# 6 Noise Management Procedures

6.1 The ConocoPhillips Humber Refinery already has a well developed Environmental Noise Management system in place. The system includes regular noise monitoring, a complaints handling procedure and the computer based acoustic model.

6.2 Routine noise generating transient events such as alarm and safety valve testing are undertaken during the daytime when ambient noise levels around the site are dominated by road noise and high transient noise levels from passing road vehicles are common. The refinery has a free phone information line onto which events of this nature are recorded in advance.

6.3 Records are kept of plant operation conditions so that any unscheduled system safety valve lifts can be explained if they occur.

### Noise Monitoring

6.4 Noise levels have been measured at various points on the site boundary and at residential locations on a weekly basis for number of years. The measurements are made by ConocoPhillips staff who note the overall A-weighted noise level along with the weather conditions and other observations.

6.5 The results and observations are trended and used to identify any significant changes in site noise emissions.

6.6 Over the years this monitoring has identified some issues including maintenance of equipment. As a result these have been resolved before complaints were received from residents.

### Handling of Noise Complaints

6.7 ConocoPhillips operates a formal complaints management procedure. This procedure forms part of the ISO 14001 certified management system for the site and is constantly developing.

6.8 All complaints received, either directly by the company or via other channels, are logged and kept open as action items until they have been satisfactorily resolved.

6.9 Resolution of noise complaints involves investigation of the origin of the noise and implementation of the appropriate action. Investigations are usually conducted by ConocoPhillips but sometimes external consultants are used.

6.10 The log shows an average of about five complaints a year and a review of recent complaints shows that most are related to transient events such as equipment requiring maintenance or system safety valves lifting. These types of events are managed as part of the site process and condition monitoring systems and have been resolved quickly.

6.11 Since the completion of Immingham CHP power station a number of complaints have been received by the Refinery that were due to Immingham CHP power station generated noise.

### Use of Acoustic Model

6.12 ConocoPhillips has used the acoustic model as a tool to support the management of environmental noise at the refinery. The model has been used as part of the process to specify or predict noise emissions from new and modified plant. As a result the modifications to the site over the last six years have resulted in a slight decrease in predicted noise levels.

# 7 Assessment of BAT

### Environment Agency Guidance

7.1 In para 2.5.6 of IPPC H3 Part 1 the use of numerical limits is discussed. It suggests that the starting point for setting numerical limits should be a free field rating level ($L_{Ar,Tr}$) of 50 dB by day and a facade rating level of 45 dB by night. The rating level is defined in BS 4142: 1997 (Reference 3). This is the noise due to the proposed development expressed as an equivalent continuous sound pressure level, averaged over a time period of 1 hour during the daytime or 5 minutes at night, and corrected (where appropriate) for any distinguishable tonal or impulsive characteristics, or if the noise is sufficiently irregular to attract attention. A correction of 5 dB applies if one or more of these characteristics exist. The guidance also suggests that the night-time maximum instantaneous noise level outside a residence should be limited to 60 dB $L_{AFmax}$.

7.2 IPPC H3 Part1 goes on to state that there is evidence that the setting of absolute levels can lead to difficulties. Consequently the setting of levels linked to the background, with an overriding safeguard on absolute levels to ensure a baseline of good practice, is considered to be most appropriate by the EA. Section 2.5.6 of IPPC H3 Part 1 also states that, to have a high degree of confidence that there is no reasonable cause for annoyance, the rating level of the noise from the installation should be the same as the background level (expressed as $L_{A90,\ T}$). EA advice is that the aim should be to set the rating level from the installation at the numerical value of the background sound level.

7.3 IPPC H3 Part1 states that there is sometimes concern over the need to prevent a “creeping background” although this is likely to arise when there is a general redevelopment of an area where a number of sources are likely to raise the background level over a wide area. However, the concept of having an overriding absolute noise limit places a restriction on the extent of any creep in background noise level that may occur.

### Planning Noise Limits

7.4 The Humber Refinery is not subject to any planning consent noise limits.

### Assessment

7.5 The noise environment around the Refinery is dominated by industrial noise from the two Refineries and the Immingham CHP Power Station. This has been the case for a number of years. The three sites are grouped together in the centre with the residential properties around in all directions. Noise propagation is influenced greatly by the wind. The noise level at an equivalent distance upwind and downwind of a noise source can differ by 20 dB or more. Therefore the noise level in each residential area will be highly dependant on wind direction with whichever area happens to be downwind at any given time receiving the highest noise levels.

7.6 If the two refineries and the Immingham CHP power station were all removed the noise levels in the area would be very much lower. However, as all three are constant sources, this condition never occurs. Therefore comparison of the industrial noise to a notional background noise level is of limited validity.

7.7 The majority of the residences close to the Refinery are to the west and southwest in Killingholme. Figure 7.1 shows a wind rose for the east coast of England. The wind rose shows that these residences will be upwind of the site for approximately 70% of the time.

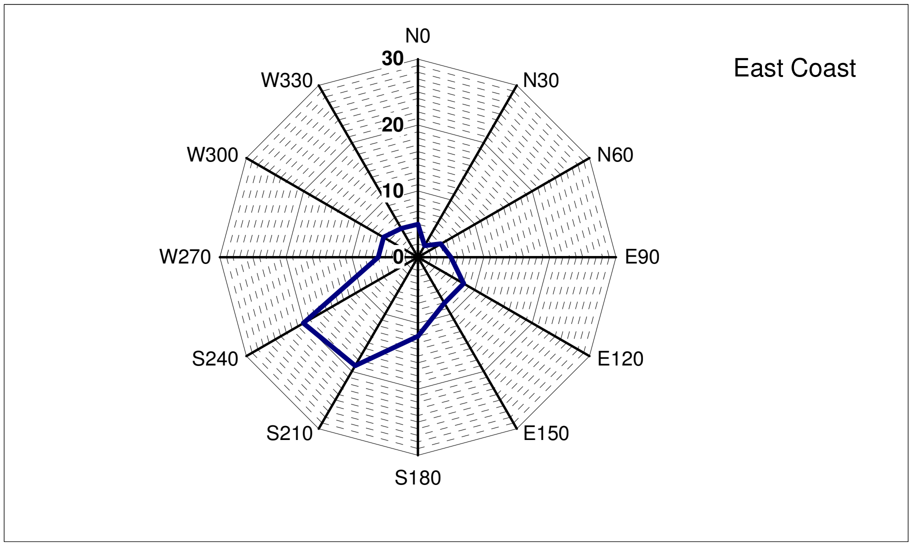



**Figure 7.1** Wind Rose for Eastern England

7.8 Table 7.1 shows the environmental noise model predictions for Ambient Noise (including contributions from all three facilities) and Refinery only noise

| Receptor | Predicted Ambient Noise Level | Predicted Humber Refinery Level |
|---|---|---|
| 1 | 57.0 | 56.8 |
| 2 | 52.9 | 52.7 |
| 3 | 52.6 | 51.6 |
| 4 | 50.0 | 48.9 |

**Table 7.1** Predicted Ambient and Refinery Noise Levels $L_{Aeq}$

7.9 All of the levels in Table 7.1 are above the IPPC night-time indicative limit of 45dB $L_A$. However, it should be noted that the predictions in Table 7.1 are based on downwind conditions. The noise levels at each location in upwind conditions will be significantly lower than these values. Therefore, as the four receptors are in different directions from the site. The levels in Table 7.1 would never all occur at the same time.

7.10 The levels given in Table 7.1 are for constant normal operation sources. None of the levels exceeds the 60 dB $L_{AFmax}$ limit. The flares and drilling out of the coke drums cause a small increase in overall site noise emissions but would not cause the overall level to exceed 60 dB $L_{AFmax}$. The only sources at the Refinery that could produce levels above 60 dB $L_{AFmax}$ at the nearest residences are the site alarms and safety valve vents. Routine tests on these are done during the daytime. It is possible that in emergency situations the alarms could sound or safety valves could lift during the night-time. However, these occurrences are rare, thoroughly investigated and recorded within the Refinery management systems. They are also an essential part of the safe operation of the plant in emergency situations.

7.11 Previous survey work by BV and routine monitoring by ConocoPhillips indicates that levels in the mid 40s dB $L_A$ are common at Receptor 1 in light south-westerly conditions. In stronger wind conditions, noise levels rise significantly due to local wind effects. Therefore noise from the Refinery is likely to have the most potential for a significant impact on the area around Receptor 1 in light north-easterly conditions (±60$^o$). This condition is only likely to occur for a very small proportion of the time.

7.12 Receptor 2 is no longer in existence as a residence, but there are other residences to the south of the site so it is still important to assess impact at a location to the south. As historical information is available for Receptor 2 it is the most appropriate assessment location.

7.13 Receptor 3 is no longer in existence as a residence and therefore receptor 4 is the nearest residence to the east of the site.

7.14 The Refinery has received a number of complaints each year about noise. Most of these relate to transient events or noises caused by maintenance issues with items of plant. These events have been resolved or explained to the complainants' satisfaction. Very few complaints have been related to "normal" plant operational noise and none of these has been a persistent complaint.

7.15 It therefore appears that, although the predicted downwind levels are above 45 dB $L_A$, the community reaction appears not to have been as adverse as might be expected. This will be due to a combination of factors including the prevailing wind direction and people habituating to the nature of the area.

7.16 The overall emissions from the Humber Refinery have decreased slightly in the last six years. Therefore IPPC requirement to avoid "creeping background" has been met.

7.17 The principle noise control tool used by ConocoPhillips has been procurement controls. This has been successful in that the new plant installation at the site has produced no increase in overall emission levels. In addition occupational noise exposure monitoring is undertaken and actions are taken to reduce occupational noise levels, as necessary, which can have a benefit on environmental noise.

7.18 The results of the noise model show that the noise at each receptor includes significant contributions from a range of diverse sources. Therefore significant reductions in noise at the receptors could only be achieved by treating many sources at once.

7.19 The site is laid out with the highest noise levels concentrated at the centre. These blocks are well shielded from the surrounding environment by the less noisy blocks surrounding them. Some of the low level equipment around the edge of the main site and in the tank farm is screened by containment bunds, tanks and other equipment. Very little proprietary noise control such as acoustic enclosures or lagging is used on site (the power generation gas turbines are one exception).

7.20 Any additional noise control introduced must take into consideration the potential for introduction of additional hazards. For example, no significant reduction in environmental noise emissions could be achieved without reducing noise radiation from several miles of pipework on the site. It may be possible to reduce some of this radiation by process changes but it is likely that large reductions could only be achieved by lagging. Acoustic lagging on pipes can introduce problems of concealed corrosion.

7.21 The Environmental Noise Management system in place at Humber Refinery has been effective in monitoring emissions, acting on the results of monitoring, dealing with complaints and specifying plant changes to reduce noise impact. The noise levels produced by the site, though above the IPPC indicative levels are equivalent to the neighbouring Lindsey Oil Refinery site and have not produced extensive adverse community reaction.

7.22 Therefore it can be concluded that the noise emissions from the Humber Refinery do not constitute a cause for reasonable annoyance and the Environmental Noise Management system represents BAT.

# 8 Conclusions

8.1 The environmental noise emissions from ConocoPhillips Humber Refinery have been managed to ensure that the resultant community noise levels are satisfactory. This report has demonstrated that BAT has been applied to matters of noise radiation.

8.2 An Environmental Noise Model has been operated for the site since 1999. This report describes how the model was reviewed and modified to accurately reflect the current status of the site. The plant was surveyed to identify any significant changes and determine the sound power of new and modified equipment. These new values were inserted into the model and the sound power levels for certain redundant plant items were removed.

8.3 At the nearest residential properties, predicted noise levels from the Humber Refinery range from 49 to 57 dB $L_A$. These predicted noise levels assume light downwind conditions from site to receptor. In light upwind conditions noise levels in the mid 40s dB $L_A$ are common at the four receptors. In high wind speeds the ambient noise levels in the area rise due to wind generated noise as a result the impact of the Refinery is reduced. These levels have been present at the site for many years and have not increased in the last six years. The noise complaints received by the refinery have tended to relate to transient noise events such as safety valves lifting rather than normal operation. The noise produced by the Humber refinery is similar to the adjacent Lindsey Oil Refinery and the normal operational noise from the two sites constitutes the background noise in the area. It was therefore concluded that, with reference to the IPPC Horizontal Guidance on Noise and the specific conditions of the area, these noise emissions are satisfactory.

# References

1 Bureau Veritas/Acoustic Technology Technical Report 4409/1 Rev 0 “Environmental Noise Modelling of the Conoco Humber Refinery” 22nd April 1999

2 Bureau Veritas/Acoustic Technology Technical Report 5260/1 Rev 0 “Environmental Noise Monitoring at Conoco’s Humber Refinery” 2nd May 2002

3 Bureau Veritas/Acoustic Technology Technical Report 5260/2 Rev 0 “Update of Environmental Noise Model at Conoco’s Humber Refinery” 9th May 2002

4 Bureau Veritas/Acoustic Technology Technical Report 5278/1 Rev 0 “Ambient Noise Survey for Immingham CHP Power Station Development” 5th August 2002

5 Bureau Veritas/Acoustic Technology Technical Report 480361/7 Rev 0 “Immingham CHP Residential Night-Time Noise Survey” 14th January 2005

6 Sound insulation and noise reduction for buildings – Code of practice. British Standard BS 8233: 1999.

7 Method for rating industrial noise affecting mixed industrial and residential areas. British Standard BS 4142: 1997.

8 The Engineering Equipment and Materials Users Association “Noise Procedure Specification, Publication No. EEMUA 140” (formerly OCMA Specification No. NWG 1, Revision 2).

9 Guidelines for community noise. World Health Organization 1999, edited by Berglund, Lindvall and Schwela.

10 Environment Agency Horizontal Guidance Note IPPC H3 Part 1 “Horizontal Guidance for Noise Part 1 Regulation and Permitting”

11 Environment Agency Horizontal Guidance Note IPPC H3 Part 2 “Horizontal Guidance for Noise Part 2 Noise Assessment and Control”

12 Environment Agency Horizontal Guidance Note IPPC H1 “Environmental Assessment and Appraisal of BAT”

# Appendix 1

An Introduction to Acoustic Terminology

# A Description of Noise Characteristics

**Sound Pressure Level and the decibel (dB)**

A sound wave is a small fluctuation of atmospheric pressure. The human ear responds to these variations in pressure, producing the sensation of hearing. The ear can detect a very wide range of pressure variations. In order to cope with this wide range of pressure variations, a logarithmic scale is used to convert the values into manageable numbers. Although it might seem unusual to use a logarithmic scale to measure a physical phenomenon, it has been found that human hearing also responds to sound in an approximately logarithmic fashion.

The dB (decibel) is a logarithmic unit used to describe any physical quantity. Decibel units are ratios comparing the measured quantity with a reference level. For Sound Pressure Level, $L_p$, the reference is 20μPa RMS sound pressure.

The usual range of sound pressure levels is from 0 dB $L_p$ (threshold of hearing) to 120 dB $L_p$ (threshold of pain).

Due to the logarithmic nature of decibels, when two noises of the same level are combined together, the total noise level is (under normal circumstances) 3 dB higher than each of the individual noise levels e.g. 60 dB combined with 60 dB = 63 dB.

In terms of perceived 'loudness' a 3 dB variation in noise level is a relatively small (but nevertheless just noticeable) change. An increase in noise level of 10 dB generally corresponds to a doubling of perceived loudness. Likewise, a reduction in noise level of 10 dB generally corresponds to a halving of perceived loudness.

**Sound Power Level, $L_W$**

The Sound Power Level of a noise source is the total amount of sound energy emitted by the source per second. The usual decibel reference for Sound Power Level is 1pW.

**Frequency and Hertz (Hz)**

As well as the loudness of a sound, the frequency content of a sound is also very important. Frequency is a measure of the rate of fluctuation of a sound wave. The unit used is cycles per second, or hertz (Hz). Sometimes large frequency values are written as kilohertz (kHz), where 1 kHz = 1000 Hz.

Young people with normal hearing can hear frequencies in the range 20 Hz to 20,000 Hz (20 kHz). However, the upper frequency limit gradually reduces as a person gets older.

A single frequency is perceived as having an identifiable 'pitch' the higher the frequency the 'higher' the perceived pitch. Most sounds are made up of many different frequencies, each with different (and often varying) loudness. It is the relative proportions of each frequency (and how they change with time) that gives a sound its perceived 'character'. This is how the human ear distinguishes between the sound of a bass drum (mainly low frequencies) and a cymbal (mainly high frequencies) for example, or between a ventilation fan and traffic noise.

The behaviour of sound waves is not the same at all frequencies. For example: noise at high frequencies is easily absorbed by soft materials or stopped by light partitions, whereas low frequencies are much harder to control.

**A-weighting**

The ear is not equally sensitive to sound at all frequencies. It is less sensitive to sound at low and very high frequencies, compared with the frequencies in between. Therefore, when measuring a sound made up of different frequencies, it is often useful to 'weight' each frequency appropriately, so that the measurement correlates better with what a person would actually hear. This is usually achieved by using an electronic filter called the 'A' weighting, which is built into sound level meters. Sound pressure levels measured using the 'A' weighting are denoted $L_{pA}$ or $L_A$. A-weighted sound power levels are denoted $L_{WA}$.

The use of the old style dB(A) is no longer encouraged as it can cause confusion with other SI units. Therefore all noise units whether sound pressure level, sound power level, A-weighted or otherwise are given in dB, e.g.

The $L_{WA}$ of the fan was 106 dB.

The measured noise level was 84 dB $L_A$.

There are other weightings called B, C and D, which have specialist uses. The unit name protocol is the as for A-weighting (e.g. $L_B$ etc.)

**Frequency Analysis**

Rather than just using a single decibel figure to measure the loudness of sound, sometimes it is useful to compare the loudness the different frequency components of the sound. This is achieved by dividing the audible range into a number of adjacent 'bands'.

The most commonly used band is the octave band. There are ten octave bands in the audible frequency range. Each octave band covers a unique frequency range, the upper frequency of which is twice the lower frequency (just like the octaves used in music). For example, the octave band centred at 1000 Hz has an upper limit of 1414 Hz and a lower limit of 707 Hz. This logarithmic arrangement correlates best with the way we perceive the 'pitch' of a sound. The sound pressure levels within each octave band are called the octave band levels.

Where more detailed information is required, one-third octave bands can be used. There are three one octave bands in each octave band, and thirty one-third octave bands in the audible frequency range. Sometimes, if a particular tone is causing a problem (e.g., from a fan) 'narrow band' frequency analysis is required in order to identify the precise frequency.

Frequency analysis spectra are often un-weighted (i.e. $L_p$ or $L_W$) but can also be A, B, C etc weighted if necessary (ie $L_A$ , $L_{WA}$ etc.).

**Noise Rating, NR, Values**

Noise Rating values, NR, give a single figure representation of the overall loudness of a noise spectrum. The NR system uses a family of octave band spectra -plotted on a chart. The value of each NR curve is determined by its magnitude at 1kHz.

The NR value of a noise is determined by plotting an un-weighted octave band spectrum on the chart, the NR value of the noise is the highest curve touched. NR values are not expressed in dB

It is not possible to convert directly between NR and $L_A$ without additional data. For a noise spectrum completely dominated by noise in one octave band the NR and $L_A$ will be almost the same. For a broad band noise the $L_A$ can be as much as 10 higher than the NR.

The Noise Criterion or NC is an American system that works on the same principle.

# B Description of Noise Indicators

When a noise level is constant and does not fluctuate over time, it can be described adequately by measuring the dB level. However, when the noise level varies with time, the measured dB level will vary as well. In this case, it is therefore not possible to represent the noise climate with a simple dB value. In order to describe noise where the level is continuously varying, a number of other indices, including statistical parameters, are used. The indicators used in this report are described below.

$L_{Aeq,T}$ This is the A-weighted ‘equivalent continuous noise level’ which is an average of the total sound energy measured over a specified time period T. In other words, $L_{Aeq}$ is the level of a continuous noise which has the same total (A-weighted) energy as the real fluctuating noise, measured over the same time period. It is increasingly being used as the preferred parameter for all forms of environmental noise. T can be in seconds, minutes or hours (e.g. 10sec, 5min, 1hr). The inclusion of the time period in the unit name subscript is optional.

$L_{AE}$ This is the ‘single event level’, which is an average of the total sound energy of a single noise event, ‘compressed’ into 1 second. $L_{AE}$ is thus the level of a continuous noise lasting 1 second, which as the same total (A-weighted) energy as the entire real fluctuating noise event. It is usually used to measure short duration single events, such as trains passing by.

$L_{AFmax}$ This is the maximum A-weighted noise level with a Fast time constant that was recorded during the monitoring period. (The maximum A-weighted level with a slow time constant would be donated $L_{ASmax}$)

$L_{AFmin}$ This is the minimum A-weighted noise level with a Fast time constant that was recorded during the monitoring period.

$L_{AF10,T}$ This is the A-weighted noise level with a Fast time constant exceeded for 10% of the specified time period. $L_{A10}$ is an indication of the louder noise levels. It is sometimes used as a measure of road traffic noise. T can be in seconds, minutes or hours (eg. 10sec, 5min, 1hr). The inclusion of the time period in the unit name subscript is optional.

$L_{AF90,T}$ This is the A-weighted noise level with a Fast time constant exceeded for 90% of the time period. $L_{A90}$ is used as a measure of background noise or to measure the level of a constant noise in a variable noise environment. T can be in seconds, minutes or hours (eg. 10sec, 5min, 1hr). The inclusion of the time period in the unit name subscript is optional.

# Appendix 2

Noise Monitoring Results

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| Location | Date | Time | Measurement point weather: Average Wind Speed m/s | Wind Direction | Cloud Direction | Temperature ( °C) | Humidity % | Cloud/8 | Tone Frequency (Hz) | EEMUA Tonality | Subjective audibility (1-4): Refinery | Road traffic | Other industry | ICHP | Birdsong | Dog barking | | Noise Indicator: $L_{Aeq,5min}$ | $L_{AFmax}$ | $L_{AF5}$ | $L_{AF50}$ | $L_{AF90}$ | Comments: Refineries in typical operation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 4-May | 01:28 | <0.5 | SE | na | 10 | 80 | 0 | na | | 4 | 2 | | | | | | **53** | 57 | 55 | 52 | **51** | Road traffic constant |
| 1 | 4-May | 01:35 | <0.5 | SE | na | 10 | 80 | 0 | na | | 4 | 2 | | | | | | **52** | 58 | 55 | 52 | **50** | |
| 1 | 4-May | 01:40 | <0.5 | SE | na | 10 | 80 | 0 | na | | 4 | 2 | | | | | | **53** | 58 | 55 | 52 | **51** | |
| 1 | 4-May | 01:46 | <0.5 | SE | na | 10 | 80 | 0 | na | | 4 | 2 | | | | | | **54** | 60 | 56 | 53 | **52** | |
| 2 | 4-May | 02:01 | ~0 | SE | na | 10 | 80 | 0 | na | | 2 | 3 | 1 | | | 4 | | **55** | 77 | 53 | 42 | **41** | Dogs barking only affecting $L_{Aeq}$ |
| 2 | 4-May | 02:07 | ~0 | SE | na | 10 | 80 | 0 | na | | 2 | 3 | 1 | | | 4 | | **57** | 77 | 58 | 42 | **40** | |
| 2 | 4-May | 02:13 | ~0 | SE | na | 10 | 80 | 0 | na | | 2 | 3 | 1 | | | 3 | | **51** | 75 | 44 | 41 | **39** | |
| 4 | 4-May | 02:34 | <0.5 | S | na | 10 | 80 | 0 | 3.15k | <0 | 3 | 1 | | 4 | | | | **53** | 57 | 54 | 53 | **52** | Difficult to differentiate between Refinery, LOR and ICHP contributions |
| 4 | 4-May | 02:40 | ~0 | SE | na | 10 | 80 | 0 | 3.15k | <0 | 3 | 1 | 1 | 4 | | | | **54** | 56 | 55 | 53 | **53** | |
| 4 | 4-May | 02:45 | <0.5 | SE | na | 10 | 80 | 0 | 3.15k | <0 | 3 | 1 | 1 | 4 | | | | **51** | 57 | 54 | 50 | **49** | |
| 1 | 4-May | 03:07 | 0.5 | ESE | na | 10 | 80 | 1 | na | | 4 | 1 | | | 1 | | | **55** | 60 | 56 | 55 | **54** | Refinery seems louder, road noise reduced. Slight wind shift. Birdsong only affecting $L_{Aeq}$ |
| 1 | 4-May | 03:13 | 0.5 | ESE | na | 10 | 80 | 2 | na | | 4 | 1 | | | 1 | | | **56** | 60 | 57 | 55 | **54** | |
| 1 | 4-May | 03:18 | 0.5 | ESE | na | 10 | 80 | 4 | na | | 4 | 1 | | | 1 | | | **56** | 60 | 57 | 55 | **54** | |

**Table A2.1 Results of Environmental Noise Measurements Around ConocoPhilips Humber Refinery 04/05/06**

| Location | Date | Time | Period | un-weighted octave bands (centre frequency in Hz) | | | | | | | | | | | Overall A |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 16 | 31.5 | 63 | 125 | 250 | 500 | 1k | 2k | 4k | 8k | 16k | |
| 1 | 4-May | 01:28 | 300 | 62 | 64 | 62 | 53 | 51 | 49 | 50 | 44 | 34 | 24 | 21 | 52.7 |
| 1 | 4-May | 01:35 | 300 | 62 | 65 | 60 | 53 | 50 | 49 | 49 | 44 | 33 | 23 | 20 | 52.4 |
| 1 | 4-May | 01:40 | 300 | 63 | 64 | 59 | 54 | 51 | 50 | 50 | 44 | 34 | 20 | 17 | 52.9 |
| 1 | 4-May | 01:46 | 300 | 63 | 63 | 61 | 55 | 52 | 50 | 50 | 46 | 35 | 23 | 21 | 53.7 |
| 2 | 4-May | 02:01 | 300 | 57 | 58 | 55 | 46 | 48 | 50 | 53 | 45 | 26 | 21 | 14 | 54.9 |
| 2 | 4-May | 02:07 | 300 | 58 | 59 | 56 | 47 | 46 | 50 | 55 | 48 | 30 | 25 | 17 | 56.7 |
| 2 | 4-May | 02:13 | 300 | 58 | 58 | 55 | 45 | 44 | 47 | 49 | 42 | 26 | 21 | 17 | 51.1 |
| 4 | 4-May | 02:34 | 300 | 67 | 66 | 64 | 55 | 51 | 51 | 49 | 43 | 30 | 19 | 17 | 52.9 |
| 4 | 4-May | 02:40 | 300 | 67 | 66 | 65 | 55 | 51 | 52 | 50 | 43 | 30 | 20 | 17 | 53.6 |
| 4 | 4-May | 02:45 | 300 | 66 | 66 | 62 | 53 | 49 | 49 | 47 | 41 | 29 | 21 | 19 | 51.0 |
| 1 | 4-May | 03:07 | 300 | 63 | 64 | 61 | 58 | 54 | 51 | 51 | 47 | 38 | 23 | 18 | 55.0 |
| 1 | 4-May | 03:13 | 300 | 63 | 65 | 63 | 58 | 54 | 52 | 51 | 48 | 38 | 22 | 18 | 55.5 |
| 1 | 4-May | 03:18 | 300 | 63 | 64 | 61 | 58 | 54 | 52 | 52 | 48 | 39 | 23 | 17 | 55.6 |

**Table A2.2 Octave Band $L_{Eq}$ Spectra Measured 04/05/06**

| Location | Date | Time | Period | un-weighted octave bands (centre frequency in Hz) | | | | | | | | | | | Overall A |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 16 | 31.5 | 63 | 125 | 250 | 500 | 1k | 2k | 4k | 8k | 16k | |
| 1 | 4-May | 01:28 | 300 | 60 | 61 | 57 | 51 | 49 | 46 | 47 | 42 | 32 | 15 | 14 | 50.8 |
| 1 | 4-May | 01:35 | 300 | 60 | 63 | 56 | 51 | 48 | 46 | 46 | 42 | 31 | 14 | 13 | 50.2 |
| 1 | 4-May | 01:40 | 300 | 60 | 61 | 56 | 52 | 49 | 46 | 47 | 43 | 31 | 14 | 13 | 51.2 |
| 1 | 4-May | 01:46 | 300 | 60 | 61 | 57 | 53 | 50 | 47 | 48 | 44 | 33 | 15 | 13 | 52.0 |
| 2 | 4-May | 02:01 | 300 | 55 | 56 | 53 | 43 | 36 | 39 | 35 | 27 | 17 | 12 | 13 | 40.6 |
| 2 | 4-May | 02:07 | 300 | 56 | 56 | 53 | 44 | 36 | 39 | 35 | 27 | 16 | 12 | 13 | 40.2 |
| 2 | 4-May | 02:13 | 300 | 56 | 56 | 52 | 43 | 35 | 38 | 33 | 27 | 17 | 12 | 13 | 39.4 |
| 4 | 4-May | 02:34 | 300 | 64 | 64 | 62 | 53 | 49 | 49 | 47 | 42 | 28 | 12 | 13 | 52.0 |
| 4 | 4-May | 02:40 | 300 | 65 | 64 | 62 | 53 | 49 | 50 | 48 | 42 | 28 | 13 | 13 | 52.6 |
| 4 | 4-May | 02:45 | 300 | 64 | 63 | 59 | 50 | 47 | 47 | 44 | 39 | 25 | 12 | 13 | 49.2 |
| 1 | 4-May | 03:07 | 300 | 61 | 62 | 58 | 56 | 52 | 49 | 49 | 46 | 36 | 16 | 12 | 54.0 |
| 1 | 4-May | 03:13 | 300 | 61 | 62 | 59 | 56 | 52 | 50 | 50 | 46 | 36 | 16 | 12 | 54.4 |
| 1 | 4-May | 03:18 | 300 | 60 | 61 | 59 | 56 | 52 | 50 | 50 | 46 | 37 | 16 | 12 | 54.4 |

**Table A2.3 Octave Band $L_{90}$ Spectra Measured 04/05/06**

# Appendix 3

Acoustic Model Input Source Data

| Site Area | Area Descriptions | Plant Type | Tag No. | Assoc Tag No. | Source Lw - dB(lin) Octave Band Centre Frequency Hz | | | | | | | | | Equipment Location | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 31.5 | 63 | 125 | 250 | 500 | 1k | 2k | 4k | 8k | E | N | EL |
| Aromatics | Aromatics & HDA | Air Fin Cooler | X538 | | 117.7 | 116.5 | 116.4 | 114.2 | 109.4 | 104.7 | | | | 1792 | 4636 | 14 |
| Aromatics | Aromatics & HDA | Air Fin Cooler | X531 | | 113.1 | 112.8 | 110.6 | 110.1 | 104.7 | 99.9 | | | | 1792 | 4501 | 12 |
| Aromatics | Aromatics & HDA | Steam Leak | | | | | | 87.0 | 83.5 | 92.5 | 91.4 | 96.6 | 95.8 | 1750 | 4619 | 1.8 |
| Aromatics | Control Room Area | Air Fin Cooler | X5322/25 | | 104.0 | 103.1 | 98.5 | 95.7 | 93.6 | 89.2 | 82.8 | 75.7 | 73.7 | 2116 | 4487 | 15 |
| Aromatics | Control Room Area | Building | | C4311/2 | | | 100.0 | 101.2 | 103.5 | 93.5 | | 95.5 | 92.5 | 2082 | 4503 | 2.3 |
| Aromatics | Control Room Area | Valve/Pipework | | PSV4366 | | | | | 86.8 | 93.1 | 97.8 | 102.4 | 95.6 | 2124 | 4537 | 4 |
| Aromatics | No2 Reformer | Air Fin Cooler | X6304 | | 116.3 | 117.1 | 112.4 | 108.9 | 105.3 | 100.8 | 95.6 | 88.5 | 83.9 | 1792 | 4823 | 14 |
| Aromatics | No2 Reformer | Building | | C6301 | | | | 83.1 | 95.8 | 94.7 | 95.3 | 94.0 | 92.7 | 1756 | 4815 | 3 |
| Aromatics | No2 Reformer | Heater | H6301 | | 118.2 | 110.8 | 108.0 | 105.5 | 102.7 | 97.6 | 95.3 | 89.6 | 79.3 | 1823 | 4973 | 8 |
| Aromatics | No2 Reformer | Pump | P6313 | | | | | 95.2 | 95.4 | 93.8 | 91.2 | 84.8 | | 1823 | 4888 | 0.9 |
| Aromatics | No2 Reformer | Steam Leak | | | | | | | 88.1 | 97.9 | 105.7 | 109.7 | 112.5 | 1795 | 4880 | 1.5 |
| Aromatics | No2 Reformer | Steam Leak | | D6307 | | | | 81.1 | 90.3 | 95.8 | 97.4 | 104.8 | 108.6 | 1806 | 4888 | 6 |
| Aromatics | No2 Reformer | Steam Leak | | H6305 | | | | 75.4 | 81.8 | 85.7 | 93.8 | 96.4 | 99.0 | 1801 | 5032 | 10 |
| Aromatics | No2 Reformer | Valve/Pipework | FRC6302 | | | | | 76.9 | 76.7 | 80.4 | 87.8 | 97.7 | 94.2 | 1761 | 4905 | 1.5 |
| Aromatics | Sulphur Plant | Air Fin Cooler | X7055 | | 111.5 | 105.6 | 103.7 | 99.0 | 94.3 | 88.9 | | | | 1682 | 4630 | 12 |
| Aromatics | Sulphur Plant | Compressor | C4501 | | | | | 95.9 | 103.8 | 104.8 | 108.4 | 111.3 | 109.8 | 1682 | 4675 | 1.3 |
| Aromatics | Sulphur Plant | Ductwork | | H4405 | 99.3 | 96.0 | 103.2 | 93.0 | 82.1 | 83.0 | 81.4 | 71.8 | 68.6 | 1631 | 4481 | 8 |
| Aromatics | Sulphur Plant | Heater | H571 | | 104.1 | 102.9 | 108.3 | 115.1 | 111.2 | 101.7 | 92.6 | 82.6 | 68.5 | 1648 | 4734 | 10 |
| Aromatics | Sulphur Plant | Heater | H4405 | | 89.9 | 94.8 | 100.3 | 102.8 | 101.0 | 93.9 | 86.7 | 76.2 | 65.7 | 1648 | 4473 | 2 |
| Aromatics | Sulphur Plant | Pump | P4710 | | | | | 88.7 | 101.3 | 99.4 | 97.9 | 86.0 | 76.3 | 1685 | 4518 | 0.6 |
| Aromatics | Sulphur Plant | Pump | P7050 | | | | | 87.2 | 95.3 | 95.8 | 92.8 | 85.9 | 77.4 | 1707 | 4633 | 0.9 |
| Aromatics | Sulphur Plant | Steam Leak | | | | | | 78.6 | | 89.1 | 98.3 | 98.4 | 100.7 | 1640 | 4546 | 0.8 |
| Aromatics | Sulphur Plant | Steam Leak | | | | | | 87.3 | 81.0 | | 82.7 | 95.3 | 99.7 | 1694 | 4636 | 10 |
| Aromatics | Sulphur Plant | Valve/Pipework | | C4502 | | | | 90.5 | 103.6 | 93.5 | 88.2 | 94.0 | 84.0 | 1668 | 4534 | 1.8 |
| Calciners | Calciners | Air Fin Cooler | VC5601 | | 111.6 | 108.3 | 108.7 | 105.8 | 103.0 | 99.0 | 91.0 | 83.1 | 81.0 | 3006 | 3793 | 3 |
| Calciners | Calciners | Fan | F5604 | | 106.6 | 103.0 | 105.0 | 101.8 | 97.0 | 94.7 | 88.6 | | | 2846 | 3781 | 1 |
| Calciners | Calciners | Fan | F622 | | 103.5 | 103.1 | 99.2 | 97.4 | 99.2 | 98.4 | 84.3 | 66.0 | | 2810 | 4018 | 1.5 |
| Calciners | Calciners | Fan | F5602 | | | | | | | 102.5 | 96.3 | 83.5 | 77.0 | 3023 | 3750 | 1.2 |
| Calciners | Calciners | Fan | F6602 | | | | | 92.8 | 87.6 | 90.6 | 96.8 | 92.4 | 82.7 | 2714 | 3926 | 1.5 |
| Calciners | Calciners | Global | | | | 120.7 | 121.6 | 119.2 | 115.2 | 114.2 | 110.0 | 103.7 | 93.8 | 3128 | 3905 | 5 |
| Calciners | Calciners | Heater | I5601 | | 103.5 | 102.5 | 105.8 | 97.7 | 85.0 | 78.1 | | | | 2866 | 3759 | 5 |
| Calciners | Calciners | Pump | | SC608 | | | | | 95.9 | 96.0 | 95.6 | 91.4 | 88.7 | 2855 | 3989 | 1 |
| Cokers | Closed Blowdown System | Air Fin Cooler | X5781 | | 109.1 | 107.5 | 102.7 | 96.1 | 89.8 | 86.9 | | | | 2403 | 4395 | 13 |
| Cokers | Closed Blowdown System | Ductwork | | H5261 | 89.1 | 101.2 | 109.9 | 106.2 | 104.5 | 97.1 | 87.7 | 77.4 | 70.4 | 2211 | 4198 | 2.5 |
| Cokers | Closed Blowdown System | Heat Exchanger | X233 | | 91.4 | 88.2 | 93.4 | 96.3 | 91.5 | 86.9 | 84.0 | 79.2 | 70.1 | 2234 | 4206 | 2 |
| Cokers | Closed Blowdown System | Heater | H501 | | 90.9 | 93.9 | 92.2 | 98.0 | 98.7 | 93.8 | 58.7 | 60.4 | 63.0 | 2223 | 4162 | 4 |
| Cokers | Closed Blowdown System | Heater | H203 | | 98.0 | 99.0 | 91.0 | | | | | | | 2149 | 3953 | 5 |
| Cokers | Closed Blowdown System | Pump | P1748 | | 99.5 | 91.7 | 100.2 | 108.3 | 105.0 | 104.3 | 102.3 | 98.0 | 94.5 | 2464 | 4265 | 1.1 |
| Cokers | Closed Blowdown System | Steam Leak | | | | | | 80.7 | 85.3 | 86.7 | 95.0 | 95.4 | 98.3 | 2293 | 4128 | 1.5 |
| Cokers | Coke Drums | Drum | D125 | | 129.1 | 122.6 | 117.5 | 113.1 | 115.2 | 116.5 | 116.2 | 111.7 | 102.9 | 2250 | 3640 | 15 |
| Cokers | Coke Drums | Drum | D126 | | 129.1 | 122.6 | 117.5 | 113.1 | 115.2 | 116.5 | 116.2 | 111.7 | 102.9 | 2250 | 3663 | 15 |
| Cokers | Coke Drums | Drum | D5161 | | 129.1 | 122.6 | 117.5 | 113.1 | 115.2 | 116.5 | 116.2 | 111.7 | 102.9 | 2250 | 3747 | 15 |
| Cokers | Coke Drums | Drum | D5162 | | 129.1 | 122.6 | 117.5 | 113.1 | 115.2 | 116.5 | 116.2 | 111.7 | 102.9 | 2250 | 3773 | 15 |
| Cokers | Coke Drums | Drum | D103 | | 129.1 | 122.6 | 117.5 | 113.1 | 115.2 | 116.5 | 116.2 | 111.7 | 102.9 | 2250 | 3809 | 15 |
| Cokers | Coke Drums | Drum | D104 | | 129.1 | 122.6 | 117.5 | 113.1 | 115.2 | 116.5 | 116.2 | 111.7 | 102.9 | 2250 | 3835 | 15 |
| Cokers | Coke Drums | Drum | D201 | | 129.1 | 122.6 | 117.5 | 113.1 | 115.2 | 116.5 | 116.2 | 111.7 | 102.9 | 2250 | 3975 | 15 |
| Cokers | Coke Drums | Drum | D202 | | 129.1 | 122.6 | 117.5 | 113.1 | 115.2 | 116.5 | 116.2 | 111.7 | 102.9 | 2250 | 3998 | 15 |
| Cokers | Coke Drums | Pump | P128 | | | | | | | 85.2 | 97.6 | 98.4 | 100.0 | 2253 | 3902 | 2 |
| Cokers | Coke Drums | Pump | P248 | | | | | 97.4 | 97.9 | 97.1 | 93.2 | 79.3 | | 2242 | 4046 | 2 |
| Cokers | Coke Drums | Pump | P1017 | | | | | 94.4 | 97.8 | 97.1 | 90.8 | 79.5 | 71.3 | 2222 | 3857 | 0.8 |
| Cokers | Coke Drums | Steam Leak | | | | | | 80.2 | 85.1 | 90.5 | 100.5 | 103.7 | 99.3 | 2250 | 3677 | 20 |
| Cokers | Coker & Cracker Furnaces | Ductwork | | H103 | 100.0 | 91.2 | 84.7 | 82.9 | 76.3 | 63.1 | 62.8 | 65.7 | 68.5 | 2137 | 3891 | 10 |
| Cokers | Coker & Cracker Furnaces | Heater | H201 | | 107.9 | 113.8 | 112.2 | 111.0 | 104.1 | 90.5 | 79.4 | 78.8 | 76.4 | 2000 | 3922 | 4.5 |
| Cokers | Coker & Cracker Furnaces | Heater | H103 | | 108.3 | 108.8 | 105.4 | 101.3 | 95.0 | 83.0 | 70.9 | 76.1 | 75.3 | 2151 | 3908 | 4 |
| Cokers | Coker & Cracker Furnaces | Heater | H104 | | 104.8 | 106.2 | 101.4 | 94.3 | 80.3 | 75.3 | 82.5 | 84.1 | 73.2 | 2000 | 3855 | 8.8 |
| Cokers | Coker & Cracker Furnaces | Steam Leak | | | | | | 83.0 | 86.9 | 88.8 | 94.4 | 96.6 | 99.1 | 2168 | 3849 | 1.5 |
| Cokers | Gas Oil Hydrodesulpherisation | Air Fin Cooler | X127 | | 118.7 | 117.2 | 109.8 | 107.2 | 103.6 | 100.4 | | | | 2123 | 3771 | 14 |
| Cokers | Gas Oil Hydrodesulpherisation | Air Fin Cooler | X152 | | 109.0 | 100.3 | 96.7 | 96.4 | 94.0 | 87.5 | | | | 2025 | 3808 | 7 |
| Cokers | Gas Oil Hydrodesulpherisation | Heater | H151 | | 106.9 | 104.9 | 112.3 | 117.8 | 110.3 | 101.5 | | | | 1966 | 3799 | 6 |
| Cokers | Gas Oil Hydrodesulpherisation | Pump | P1120 | | | | | 98.9 | 100.2 | 100.8 | 94.9 | 83.8 | 69.5 | 2194 | 3813 | 1.2 |
| Cokers | Gas Oil Hydrodesulpherisation | Pump | P154 | | | | 92.1 | 96.1 | 101.1 | 95.8 | 96.2 | 96.9 | 89.7 | 2104 | 3785 | 0.8 |
| Cokers | Gas Oil Hydrodesulpherisation | Pump | P1039 | | | | 87.0 | 94.1 | 103.7 | 88.7 | 91.9 | 80.7 | 63.7 | 2098 | 3816 | 1.1 |
| Cokers | Gas Oil Hydrodesulpherisation | Pump | P223 | | | | | 94.4 | 98.4 | 99.7 | 95.9 | 88.1 | 80.2 | 2078 | 3816 | 0.9 |
| Cokers | Gas Oil Hydrodesulpherisation | Pump | P1151 | | | | | 94.7 | 96.8 | 91.9 | 92.3 | 80.4 | | 2042 | 3774 | 1.3 |
| Cokers | Gas Oil Hydrodesulpherisation | Pump | P1007 | | | | 91.9 | 94.8 | 92.9 | 85.4 | 94.2 | 85.0 | 72.8 | 2180 | 3774 | 1 |
| Cokers | Gas Oil Hydrodesulpherisation | Steam Leak | | | | | | 80.8 | 81.8 | 86.0 | 93.7 | 99.8 | 99.6 | 2132 | 3802 | 2 |
| Cokers | Gas Oil Hydrodesulpherisation | Valve/Pipework | FRC112 | | | | | 81.7 | 97.3 | 102.1 | 98.5 | 99.2 | 92.1 | 2171 | 3771 | 13 |
| Cokers | No3 Sub Area | Air Fin Cooler | X816 | | 104.7 | 105.6 | 107.0 | 105.7 | 100.2 | 96.0 | | | | 2042 | 3598 | 5 |
| Cokers | No3 Sub Area | Air Fin Cooler | X814 | | 104.6 | 106.3 | 104.7 | 102.4 | 96.2 | 94.6 | | | | 1960 | 3598 | 5 |
| Cokers | No3 Sub Area | Fan | F109 | | 124.3 | 113.6 | 98.0 | 98.3 | 100.0 | 99.0 | 88.1 | 81.8 | 76.0 | 2132 | 3657 | 1.6 |
| Cokers | No3 Sub Area | Heater | H106 | | 110.1 | 106.3 | 93.5 | 84.8 | 78.7 | 75.6 | 73.7 | 75.4 | 74.7 | 2163 | 3682 | 6 |
| Cokers | No3 Sub Area | Pump | P1029 | | | | | 91.9 | 90.1 | 88.6 | 98.3 | 87.9 | 73.1 | 2014 | 3712 | 1.5 |
| Cokers | Thermal Crackers | Air Fin Cooler | X216 | | 119.5 | 116.4 | 109.2 | 106.3 | 101.1 | 96.6 | | | | 2135 | 4047 | 13 |
| Cokers | Thermal Crackers | Air Fin Cooler | X226 | | 118.2 | 114.3 | 107.4 | 103.7 | 99.1 | 96.1 | | | | 2028 | 4047 | 13 |
| Cokers | Thermal Crackers | Pump | P241 | | | | 84.3 | 91.0 | 102.7 | 99.6 | 96.7 | 87.9 | 80.9 | 2026 | 4046 | 1.4 |
| Cokers | Thermal Crackers | Pump | P217 | | | | | 93.7 | 99.0 | 98.5 | 97.6 | 89.9 | 82.3 | 2109 | 4046 | 0.9 |
| Cokers | Thermal Crackers | Pump | P228 | | | | | 82.9 | 92.4 | 96.7 | 96.8 | 100.4 | 82.9 | 2087 | 4013 | 1.8 |
| Cokers | Thermal Crackers | Pump | P215 | | | | | 88.7 | 96.7 | 99.5 | 98.9 | 83.6 | 76.7 | 2132 | 4046 | 0.9 |
| Cokers | Thermal Crackers | Pump | P206 | | | | | 98.2 | 98.2 | 97.3 | 94.3 | 87.5 | 80.8 | 2059 | 4046 | 1.1 |
| Cokers | Thermal Crackers | Pump | P237 | | | | | 93.5 | 99.9 | 95.7 | 95.7 | 89.1 | 77.6 | 2188 | 4001 | 1.2 |
| Cokers | Thermal Crackers | Pump | P209 | | | | | 92.0 | 94.1 | 94.9 | 89.6 | 90.2 | 83.8 | 2000 | 4041 | 1.2 |
| Cokers | Thermal Crackers | Steam Leak | | | | | | 86.0 | 96.9 | 103.8 | 104.9 | 108.9 | 108.0 | 1960 | 4008 | 10 |
| Cokers | Thermal Crackers | Steam Leak | | | | | | 80.3 | 90.3 | 99.9 | 105.1 | 104.3 | 103.8 | 2056 | 4016 | 10 |

| Site Area | Area Descriptions | Plant Type | Tag No. | Assoc Tag No. | Source Lw - dB(lin) | | | | | | | | | Equipment Location | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Octave Band Centre Frequency Hz | | | | | | | | | E | N | EL |
| | | | | | 31.5 | 63 | 125 | 250 | 500 | 1k | 2k | 4k | 8k | | | |
| Cokers | Thermal Crackers | Steam Leak | | | | | | | 81.7 | 78.0 | 94.8 | 94.1 | 95.7 | 2087 | 4019 | 1.5 |
| Cokers | Thermal Crackers | Valve/Pipework | FRC203 | | | | | 75.0 | 82.6 | 74.3 | 88.1 | 101.8 | 104.8 | 2115 | 4030 | 1.5 |
| Cokers | Thermal Crackers | Valve/Pipework | FRC260 | | | | | | 88.4 | 98.6 | 95.2 | 95.0 | 92.8 | 2188 | 4033 | 1.5 |
| Crutilities | CRU3 | Compressor | C6002/3 | | | 106.0 | 105.0 | 95.0 | 94.0 | 95.0 | 88.0 | 85.0 | 79.0 | 2011 | 4997 | 4 |
| Crutilities | CRU3 | Compressor | C6001 | | 95.0 | | 96.0 | 94.0 | 103.0 | 102.0 | 103.0 | 95.0 | 82.0 | 2011 | 4915 | 4 |
| Crutilities | CRU3 | Fin fans | X6003/4/5/6 | | 113.0 | 108.0 | 104.0 | 100.0 | 95.0 | 110.0 | 113.0 | 102.0 | 87.0 | 2051 | 4921 | 20 |
| Crutilities | CRU3 | Furnace | H6001/2/3 | | 105.0 | 103.0 | 97.0 | 101.0 | 94.0 | 90.0 | 84.0 | | | 2149 | 4921 | 10 |
| Crutilities | CRU3 | Pipework | | | | 120.2 | 116.9 | 109.5 | 109.3 | 111.0 | 111.2 | 105.5 | | 2008 | 4884 | 10 |
| Crutilities | CRU3 | Pipework beneath FFC | | X6003/4/5/6 | | 109.0 | 105.0 | 98.0 | 96.0 | 102.0 | 108.0 | 96.0 | 85.0 | 2051 | 4921 | 10 |
| Crutilities | CRU3 | Pipework to pumps | | P6005/6 | 101.4 | 96.2 | 92.1 | 91.5 | 84.4 | 83.9 | 87.1 | 88.3 | 80.5 | 2102 | 4878 | 3 |
| Crutilities | CRU3 | Reactor | | | 118.0 | 106.0 | 8.0 | | | 89.0 | 96.0 | 95.0 | 88.0 | 2093 | 4921 | 20 |
| Crutilities | Crude Topping Units | Air Fin Cooler | X111 | | 121.1 | 118.8 | 116.1 | 113.8 | 108.9 | 106.2 | 93.2 | 86.7 | 79.6 | 1765 | 3983 | 14 |
| Crutilities | Crude Topping Units | Air Fin Cooler | X144 | | 112.7 | 113.0 | 111.5 | 108.7 | 104.1 | 98.6 | | | | 1887 | 3920 | 14 |
| Crutilities | Crude Topping Units | Pump | P1101 | | | | | 97.6 | 97.7 | 105.1 | 100.4 | 96.7 | 91.1 | 1818 | 3977 | 1.3 |
| Crutilities | Crude Topping Units | Pump | P102 | | | | | 95.4 | 98.0 | 100.6 | 100.7 | 94.8 | 86.6 | 1803 | 3977 | 1.1 |
| Crutilities | Crude Topping Units | Pump | P4152 | | | | 83.7 | 91.8 | 102.3 | 94.3 | 90.7 | 84.4 | 70.4 | 1715 | 3974 | 1.1 |
| Crutilities | Crude Topping Units | Pump | P1104 | | | | 101.5 | 93.9 | 90.4 | 88.7 | 88.6 | 82.0 | | 1811 | 3908 | 0.9 |
| Crutilities | Crude Topping Units | Pump | P1020 | | | | 83.3 | 90.5 | 100.6 | 91.0 | 95.3 | 89.6 | 82.5 | 1704 | 3977 | 1 |
| Crutilities | Crude Topping Units | Pump | P4153 | | | | | 90.5 | 101.1 | 92.8 | 90.4 | 84.7 | 78.3 | 1726 | 3974 | 1.1 |
| Crutilities | Crude Topping Units | Pump | P4150 | | | | 88.5 | 94.1 | 98.5 | 91.6 | 92.0 | 83.1 | 75.1 | 1709 | 3918 | 1.1 |
| Crutilities | Crude Topping Units | Pump | P1105 | | | | 99.0 | 92.6 | 90.3 | 89.0 | 88.2 | 82.7 | | 1811 | 3918 | 0.9 |
| Crutilities | Crude Topping Units | Steam Leak | | P106 | | | | 79.7 | 85.4 | 88.7 | 96.3 | 99.9 | 98.1 | 1825 | 3946 | 2 |
| Crutilities | Crude Topping Units | Valve/Pipework | | | | | | 93.4 | 96.2 | 105.8 | 103.2 | 97.9 | 90.5 | 1681 | 3912 | 1.5 |
| Crutilities | Effluent Treatment | Building | P7777 | | | | | 94.0 | 96.7 | 96.5 | 92.7 | 83.7 | 77.2 | 3440 | 3648 | 1.2 |
| Crutilities | No.1 Vacuum Dist Unit | Air Fin Cooler | X4103 | | 111.0 | 104.8 | 101.0 | 98.4 | 94.5 | 88.6 | 80.1 | | | 1625 | 3984 | 13 |
| Crutilities | No.1 Vacuum Dist Unit | Pump | P4148 | | | | 88.9 | 102.8 | 99.3 | 90.0 | 89.7 | 87.4 | 85.6 | 1605 | 4050 | 1 |
| Crutilities | No.1 Vacuum Dist Unit | Pump | P4145 | | | | 87.0 | 94.5 | 99.3 | 93.6 | 90.9 | 90.0 | 82.4 | 1605 | 4024 | 1 |
| Crutilities | No.1 Vacuum Dist Unit | Pump | P4102 | | | | | 90.2 | 97.1 | 98.4 | 92.0 | 89.7 | 88.9 | 1602 | 3989 | 1.3 |
| Crutilities | No.1 Vacuum Dist Unit | Pump | P4111 | | | | 93.7 | 96.8 | 90.6 | 90.7 | 89.5 | 86.9 | 78.7 | 1602 | 3913 | 1 |
| Crutilities | No.2 & 3 Vacuum Dist Unit | Air Fin Cooler | X316 | | 117.4 | 111.4 | 107.1 | 104.5 | 100.2 | 89.8 | | | | 1887 | 3824 | 13.5 |
| Crutilities | No.2 & 3 Vacuum Dist Unit | Air Fin Cooler | X4179 | | 105.5 | 101.9 | 94.0 | 91.9 | 99.1 | 94.6 | 97.6 | | | 1536 | 3765 | 15.5 |
| Crutilities | No.2 & 3 Vacuum Dist Unit | Air Fin Cooler | X4127 | | 106.2 | 100.0 | 98.4 | 94.9 | 93.0 | 89.0 | | | | 1505 | 3950 | 13.5 |
| Crutilities | No.2 & 3 Vacuum Dist Unit | Ductwork | | F108 | 98.3 | 119.7 | 118.0 | 114.8 | 108.6 | 101.5 | 98.1 | 84.8 | 72.2 | 1738 | 3802 | 2.5 |
| Crutilities | No.2 & 3 Vacuum Dist Unit | Ductwork | | F101 | 98.8 | 112.8 | 115.2 | 112.8 | 108.9 | 99.6 | 92.4 | 80.6 | 66.7 | 1783 | 3763 | 2.5 |
| Crutilities | No.2 & 3 Vacuum Dist Unit | Ductwork | | F4104 | 115.9 | 110.5 | 98.0 | 85.8 | 84.6 | 73.2 | 65.0 | 65.4 | 68.4 | 1662 | 3785 | 2.5 |
| Crutilities | No.2 & 3 Vacuum Dist Unit | Ductwork | | F107 | 85.3 | 97.6 | 95.3 | 95.2 | 90.6 | 81.0 | 75.5 | 68.6 | 61.7 | 1738 | 3765 | 2.5 |
| Crutilities | No.2 & 3 Vacuum Dist Unit | Fan | F101 | | 95.1 | 113.3 | 108.3 | 110.4 | 106.8 | 101.7 | 97.1 | 88.8 | 82.8 | 1783 | 3756 | 1.3 |
| Crutilities | No.2 & 3 Vacuum Dist Unit | Fan | F4104 | | 111.5 | 110.7 | 105.0 | 106.4 | 106.9 | 101.7 | 94.7 | 86.8 | 76.6 | 1654 | 3793 | 1.6 |
| Crutilities | No.2 & 3 Vacuum Dist Unit | Fan | F107 | | 100.0 | 103.6 | 107.6 | 106.3 | 101.5 | 96.1 | 91.5 | 87.6 | 84.4 | 1738 | 3760 | 1.5 |
| Crutilities | No.2 & 3 Vacuum Dist Unit | Fan | F4105 | | 96.1 | 105.1 | 99.0 | 91.1 | 91.5 | 91.8 | 84.4 | 85.9 | 76.2 | 1648 | 3774 | 1.9 |
| Crutilities | No.2 & 3 Vacuum Dist Unit | Fan | F102 | | 91.6 | 98.4 | 95.8 | 94.8 | 89.9 | 91.9 | 92.1 | 88.8 | 77.2 | 1783 | 3796 | 1.7 |
| Crutilities | No.2 & 3 Vacuum Dist Unit | Fan | F108 | | 96.4 | 99.2 | 94.4 | 86.3 | 90.3 | 93.9 | 85.7 | 80.0 | 75.2 | 1741 | 3793 | 1.6 |
| Crutilities | No.2 & 3 Vacuum Dist Unit | Fan | F4102 | | 98.9 | 93.9 | 91.3 | 76.5 | 70.7 | 66.6 | | | | 1415 | 3847 | 4.5 |
| Crutilities | No.2 & 3 Vacuum Dist Unit | Heater | H101 | | 112.2 | 113.6 | 111.9 | 108.5 | 98.6 | 91.6 | 82.7 | 85.6 | 77.5 | 1800 | 3810 | 8 |
| Crutilities | No.2 & 3 Vacuum Dist Unit | Heater | H4103 | | 115.3 | 106.1 | 97.4 | 100.3 | 88.6 | 88.4 | 80.1 | 77.6 | 78.8 | 1685 | 3808 | 7.5 |
| Crutilities | No.2 & 3 Vacuum Dist Unit | Heater | H4101 | | 112.6 | 110.7 | 103.3 | 104.5 | 97.6 | 88.4 | 70.8 | 70.4 | 72.6 | 1645 | 3824 | 7 |
| Crutilities | No.2 & 3 Vacuum Dist Unit | Heater | H102 | | 104.7 | 102.8 | 97.3 | 103.3 | 99.0 | 90.9 | 72.0 | 68.3 | 70.0 | 1721 | 3827 | 7 |
| Crutilities | No.2 & 3 Vacuum Dist Unit | Heater | H4102 | | 105.7 | 99.6 | 92.0 | 86.1 | 81.6 | 77.5 | 67.1 | 69.2 | 71.8 | 1454 | 3864 | 8.5 |
| Crutilities | No.2 & 3 Vacuum Dist Unit | Pump | P4158 | | | | 86.5 | 95.2 | 105.6 | 99.0 | 96.8 | 90.1 | 80.6 | 1517 | 3836 | 0.9 |
| Crutilities | No.2 & 3 Vacuum Dist Unit | Pump | P4156 | | | | 91.5 | 97.3 | 102.5 | 93.1 | 95.1 | 94.3 | 83.5 | 1517 | 3853 | 1.1 |
| Crutilities | No.2 & 3 Vacuum Dist Unit | Pump | P4132 | | | | 91.6 | 96.5 | 102.7 | 92.7 | 93.9 | 90.2 | 84.5 | 1482 | 3956 | 1.3 |
| Crutilities | No.2 & 3 Vacuum Dist Unit | Pump | P4159 | | | | 85.6 | 95.8 | 101.8 | 97.5 | 95.3 | 91.3 | 82.6 | 1517 | 3826 | 0.9 |
| Crutilities | No.2 & 3 Vacuum Dist Unit | Pump | P4157 | | | | 92.0 | 95.5 | 100.4 | 91.9 | 95.0 | 93.6 | 84.2 | 1517 | 3844 | 1.1 |
| Crutilities | No.2 & 3 Vacuum Dist Unit | Pump | P4134 | | | | 84.8 | 91.3 | 102.7 | 88.4 | 91.1 | 86.3 | 84.8 | 1485 | 3991 | 0.9 |
| Crutilities | No.2 & 3 Vacuum Dist Unit | Pump | P4133 | | | | 93.1 | 97.6 | 98.0 | 91.4 | 92.9 | 90.2 | 84.5 | 1482 | 3951 | 1.3 |
| Crutilities | No.2 & 3 Vacuum Dist Unit | Pump | P4167 | | | | 86.9 | 88.8 | 95.7 | 97.0 | 92.7 | 89.9 | 80.1 | 1517 | 3748 | 0.8 |
| Crutilities | No.2 & 3 Vacuum Dist Unit | Pump | P4166 | | | | 87.1 | 89.3 | 96.7 | 95.5 | 92.6 | 85.8 | 79.5 | 1517 | 3767 | 0.8 |
| Crutilities | Onsite CHP | Cooling Tower | CT5701 | | 117.7 | 115.0 | 119.7 | 111.1 | 107.7 | 103.8 | 98.8 | 98.6 | 97.2 | 1428 | 4641 | 8 |
| Crutilities | Onsite CHP | Cooling Tower | CT710 | | 114.4 | 113.7 | 112.1 | 106.5 | 105.6 | 101.0 | 92.0 | 90.5 | 87.4 | 1259 | 4793 | 6 |
| Crutilities | Onsite CHP | Cooling Tower | CT3631 | | | 97.2 | 96.6 | 93.6 | 93.5 | 97.7 | 98.9 | 99.0 | 96.7 | 1158 | 4804 | 7 |
| Crutilities | Onsite CHP | Ductwork | | GTA711 | 127.6 | 123.2 | 105.2 | 104.0 | 90.5 | 86.8 | 62.8 | 61.2 | 60.2 | 1183 | 4679 | 2 |
| Crutilities | Onsite CHP | Ductwork | | GTA714 | 125.9 | 123.2 | 105.7 | 92.5 | 92.3 | 92.0 | 61.3 | 61.5 | 63.1 | 1183 | 4579 | 2 |
| Crutilities | Onsite CHP | Ductwork | | GTA712 | 125.2 | 123.9 | 108.9 | 98.9 | 89.2 | 83.2 | 77.4 | 60.9 | 62.5 | 1183 | 4651 | 2 |
| Crutilities | Onsite CHP | Ductwork | | GTA713 | 124.1 | 119.7 | 105.1 | 99.0 | 88.8 | 83.5 | 61.5 | 61.3 | 62.5 | 1183 | 4609 | 2 |
| Crutilities | Onsite CHP | Gas Turbine | GTA712 | | 91.7 | 87.9 | 89.9 | 99.2 | 100.2 | 95.9 | 92.2 | | | 1194 | 4665 | 2 |
| Crutilities | Onsite CHP | Gas Turbine | GTA711 | | 80.8 | 83.5 | 85.8 | 94.8 | 98.7 | 96.5 | 91.8 | | | 1194 | 4695 | 2 |
| Crutilities | Onsite CHP | Gas Turbine | GTA713 | | 89.0 | 84.4 | 85.8 | 97.2 | 97.3 | 94.5 | | | | 1194 | 4598 | 2 |
| Crutilities | Onsite CHP | Heater | H714 | | 112.6 | 103.1 | 81.5 | 71.3 | 70.5 | 71.3 | 67.3 | 69.6 | 72.4 | 1147 | 4579 | 7.5 |
| Crutilities | Onsite CHP | Heater | H713 | | 112.3 | 104.5 | 83.3 | 75.6 | 70.0 | 70.6 | 67.4 | 71.0 | 72.5 | 1147 | 4609 | 7.5 |
| Crutilities | Onsite CHP | Heater | H711 | | 106.1 | 105.6 | 87.8 | 75.4 | 71.5 | 68.4 | 68.5 | 69.8 | 72.5 | 1147 | 4679 | 7.5 |
| Crutilities | Onsite CHP | Heater | H712 | | 107.0 | 99.2 | 83.3 | 70.4 | 70.4 | 69.0 | 66.6 | 69.5 | 72.4 | 1147 | 4651 | 7.5 |
| Crutilities | Onsite CHP | Pump | P7701 | | | | | 107.0 | 114.7 | 119.5 | 124.0 | 128.2 | 123.7 | 1495 | 4585 | 2.1 |
| Crutilities | Onsite CHP | Pump | P705 | | | | 102.2 | 108.6 | 109.0 | 104.3 | 103.6 | 98.4 | | 1460 | 4560 | 1 |
| Crutilities | Onsite CHP | Pump | P714 | | | | | 96.3 | 102.5 | 108.1 | 111.2 | 97.6 | 88.4 | 1460 | 4568 | 1 |
| Crutilities | Onsite CHP | Pump | P704 | | | | 95.5 | 98.0 | 101.9 | 99.6 | 102.8 | 102.6 | 102.0 | 1460 | 4547 | 1 |
| Crutilities | Onsite CHP | Pump | P5701 | | | | 101.1 | 104.3 | 101.2 | 100.3 | 95.3 | 87.6 | 79.1 | 1398 | 4526 | 1.2 |
| Crutilities | Onsite CHP | Pump | P703 | | | | 101.4 | 97.8 | 96.3 | 102.9 | 99.3 | 93.4 | 91.7 | 1460 | 4532 | 1 |
| Crutilities | Onsite CHP | Pump | P3662 | | | | | 83.9 | 92.1 | 98.1 | 103.2 | 98.2 | 92.8 | 1207 | 4553 | 1.5 |
| Crutilities | Onsite CHP | Pump | P717 | | | | 90.2 | 95.8 | 94.1 | 97.2 | | 87.6 | 74.6 | 1477 | 4575 | 1.3 |
| Crutilities | Onsite CHP | Valve/Pipework | PRC440V | | 104.4 | 106.5 | 102.3 | 106.2 | 105.2 | 114.2 | 111.1 | 106.3 | 94.7 | 1361 | 4585 | 2.5 |
| Crutilities | Onsite CHP | Valve/Pipework | | PRC440V | | | | | 95.8 | 106.3 | 111.1 | 111.7 | 107.6 | 1361 | 4450 | 4 |
| Crutilities | Onsite CHP | Valve/Pipework | | VC701 | | | | 93.6 | 101.2 | 108.3 | 112.7 | 108.6 | 99.5 | 1485 | 4518 | 3 |
| Crutilities | Utilities | Air Fin Cooler | X722 | | 108.1 | 105.0 | 104.9 | 105.0 | 102.9 | 103.8 | 88.8 | 81.7 | 79.1 | 1482 | 4153 | 9 |

| Site Area | Area Descriptions | Plant Type | Tag No. | Assoc Tag No. | Source Lw - dB(lin) Octave Band Centre Frequency Hz 31.5 | 63 | 125 | 250 | 500 | 1k | 2k | 4k | 8k | Equipment Location E | N | EL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Crutilities | Utilities | Building | | C703 | | | | 77.7 | 93.3 | 88.4 | 89.8 | 93.4 | 96.5 | 1434 | 4391 | 2 |
| Crutilities | Utilities | Ductwork | | | 117.2 | 117.9 | 108.5 | 96.5 | 83.6 | 70.9 | 69.3 | 72.2 | 75.2 | 1556 | 4344 | 9 |
| Crutilities | Utilities | Fan | F703 | | 113.5 | 113.5 | 106.6 | 100.0 | 94.4 | 88.0 | 82.4 | 85.5 | 80.7 | 1561 | 4352 | 1.2 |
| Crutilities | Utilities | Fan | F4704 | | 107.5 | 107.6 | 104.5 | 101.4 | 98.0 | 96.5 | 95.6 | 84.2 | 77.4 | 1541 | 4402 | 1.5 |
| Crutilities | Utilities | Fan | F702 | | 102.0 | 103.6 | 99.6 | 97.9 | 90.4 | 96.6 | 85.5 | 81.3 | 75.8 | 1561 | 4302 | 1.2 |
| Crutilities | Utilities | Gas Turbine | GTA706 | | 109.1 | 102.4 | 113.6 | 98.3 | 100.3 | 94.6 | 91.0 | 91.9 | 92.8 | 1558 | 4223 | 2 |
| Crutilities | Utilities | Heater | H703 | | 102.5 | 110.7 | 107.1 | 98.4 | 89.0 | 85.6 | | | | 1513 | 4366 | 5 |
| Crutilities | Utilities | Heater | H702 | | 98.9 | 108.2 | 105.9 | 90.8 | 83.0 | 81.4 | | | | 1513 | 4316 | 5 |
| Crutilities | Utilities | Pump | P716 | | | | 101.0 | 102.6 | 107.2 | 106.3 | 101.4 | 93.7 | 80.6 | 1496 | 4150 | 1 |
| Crutilities | Utilities | Pump | P746 | | | | 95.9 | 99.4 | 100.7 | 98.6 | 91.9 | 85.4 | 80.7 | 1455 | 4157 | 1 |
| Crutilities | Utilities | Pump | P718 | | | | 81.9 | 83.1 | 89.2 | 92.8 | 102.6 | 93.8 | 89.7 | 1523 | 4148 | 1.1 |
| Crutilities | Utilities | Pump | P7069 | | | | 91.4 | 94.7 | 93.6 | 96.3 | 95.4 | 96.1 | 91.8 | 1509 | 4111 | 1.4 |
| FCC & Alkylation | Alkylation | Pump | P3631/2 | | | | 88.8 | 93.9 | 91.1 | 91.8 | 92.9 | 96.2 | 97.3 | 1138 | 5108 | 1 |
| FCC & Alkylation | DME Unit | Air Fin Cooler | X6509 | | 100.8 | 99.4 | 97.4 | 95.9 | 93.0 | 89.1 | | | | 1197 | 4883 | 4 |
| FCC & Alkylation | DME Unit | Heater | H3401 | | 94.8 | 89.9 | 101.5 | 95.5 | 84.1 | 81.4 | 78.1 | 70.0 | 69.3 | 1307 | 4978 | 7 |
| FCC & Alkylation | FCC | Air Fin Cooler | X3403 | | 121.4 | 116.7 | 111.9 | 107.5 | 104.1 | 99.1 | | | | 1542 | 5065 | 15 |
| FCC & Alkylation | FCC | Building | | C3401 | | | | 101.3 | 109.1 | 108.7 | 110.7 | 103.0 | 91.9 | 1528 | 4944 | 4 |
| FCC & Alkylation | FCC | Building | | TX3470 | 89.8 | 94.6 | 104.6 | 93.7 | 93.2 | 96.0 | 90.9 | 88.2 | 90.0 | 1403 | 4953 | 2 |
| FCC & Alkylation | FCC | Building | | C3402 | | | | 85.5 | 94.0 | 93.5 | 96.3 | 91.0 | 82.7 | 1517 | 5130 | 1.5 |
| FCC & Alkylation | FCC | Building | | C3402 | | | | 85.5 | 94.0 | 93.5 | 96.3 | 91.0 | 82.7 | 1517 | 5130 | 3 |
| FCC & Alkylation | FCC | Drum | D3407 | | 104.1 | 100.2 | 95.9 | 93.5 | 88.9 | 85.3 | 77.8 | 65.1 | 58.3 | 1542 | 5119 | 6 |
| FCC & Alkylation | FCC | Generator | TXEG3470 | | 94.5 | 95.7 | 103.6 | 94.9 | 94.4 | 95.1 | 90.6 | 79.8 | 43.6 | 1403 | 4939 | 4 |
| FCC & Alkylation | FCC | Pump | P3406 | | | | | 83.3 | 86.1 | 88.4 | 106.6 | 98.0 | 94.0 | 1565 | 5034 | 1.2 |
| FCC & Alkylation | FCC | Pump | P3401 | | | | | 101.1 | 104.0 | 99.4 | 96.9 | 91.5 | 81.3 | 1643 | 5034 | 0.9 |
| FCC & Alkylation | FCC | Pump | P3458 | | | | | 96.1 | 101.8 | 92.5 | 90.2 | 83.4 | 82.8 | 1660 | 5034 | 1.2 |
| FCC & Alkylation | FCC | Pump | P3407 | | | | | 95.5 | 98.5 | 95.5 | 95.1 | 88.9 | 88.0 | 1579 | 5029 | 1.2 |
| FCC & Alkylation | FCC | Pump | P3413 | | | | | 92.0 | 100.5 | 88.1 | 90.4 | 86.4 | 85.7 | 1621 | 5034 | 1.1 |
| FCC & Alkylation | FCC | Pump | P3420 | | | | | 86.9 | 95.7 | 94.8 | 96.4 | 88.8 | 79.2 | 1590 | 5085 | 1.6 |
| FCC & Alkylation | FCC | Pump | P3417 | | | | | 92.1 | 97.9 | 94.3 | 88.2 | 86.9 | 75.2 | 1573 | 5085 | 1 |
| FCC & Alkylation | FCC | Pump | P3425 | | | | 88.7 | 90.9 | 89.9 | 93.5 | 94.2 | 88.8 | 85.4 | 1646 | 5085 | 0.9 |
| FCC & Alkylation | FCC | Valve/Pipework | | X3428 | | | | 103.2 | 110.1 | 110.5 | 107.9 | 104.1 | 98.4 | 1655 | 5085 | 15 |
| FCC & Alkylation | FCC | Valve/Pipework | | TX3470 | 102.9 | 102.7 | 106.2 | 98.6 | 97.4 | 88.5 | 82.3 | 76.3 | 75.8 | 1406 | 4978 | 12 |
| FCC & Alkylation | Propylene Unit | Air Fin Cooler | X3610 | | 112.9 | 113.5 | 106.9 | 101.7 | 97.1 | 93.6 | | | | 1355 | 5153 | 18 |
| Flare | Flare No.1 | Flare | Flare No.1 | | 135.0 | 130.0 | 124.0 | 118.0 | | | | | | 3890 | 3362 | 91 |
| Flare | Flare No.1 | Flare | Flare No.1 | | 115.8 | 111.6 | 113.2 | 117.3 | | | | | | 3890 | 3362 | 91 |
| Flare | Flare No.3 | Flare | Flare No.3 | | 139.3 | 135.3 | 121.7 | 120.0 | 107.1 | | | | | 2702 | 4412 | 137 |
| Flare | Flare No.3 | Flare | Flare No.3 | | 128.2 | 124.6 | 116.2 | 117.7 | 102.8 | | | | | 2702 | 4412 | 137 |
| Lindsey | Lindsey | Lindsey | Lindsey | | 133.9 | 130.5 | 122.1 | 119.1 | 120.4 | 120.1 | 117.8 | 110.0 | 109.5 | 1378 | 8308 | 2 |
| OM&S | OM&S | Air Fin Cooler | X815 | | 110.9 | 106.6 | 100.9 | 99.5 | 95.8 | 94.0 | 90.7 | | | 3751 | 2488 | 5.3 |
| OM&S | OM&S | Pump | P846 | | | | | 88.9 | 95.6 | 97.8 | 97.0 | 83.0 | 73.6 | 1842 | 3618 | 1.6 |
| OM&S | OM&S | Pump | P8042 | | | | | 91.9 | 94.6 | 96.6 | 95.9 | 90.7 | 86.1 | 1839 | 3626 | 0.8 |
| OM&S | Pump Bays | Air Fin Cooler | X817 | | 102.7 | 99.1 | 93.3 | 93.0 | 88.6 | 86.8 | | | | 1870 | 3644 | 7 |
| OM&S | Pump Bays | Pump | P820 | | | | 100.1 | 106.4 | 108.7 | 104.6 | 104.4 | 96.4 | 88.6 | 3370 | 2484 | 1.1 |
| OM&S | Pump Bays | Pump | P825 | | | | | 104.1 | 103.8 | 100.1 | 101.3 | 94.4 | 85.4 | 3626 | 2484 | 1 |
| OM&S | Pump Bays | Pump | P837 | | | | | 101.4 | 104.5 | 102.2 | 98.5 | 90.9 | 83.6 | 2872 | 3151 | 0.8 |
| OM&S | Pump Bays | Pump | P854 | | | | | 100.7 | 103.8 | 101.0 | 99.3 | 93.6 | 88.1 | 2518 | 2180 | 1.1 |
| OM&S | Pump Bays | Pump | P4803 | | | | 96.9 | 102.0 | 102.4 | 99.2 | 92.4 | 86.2 | 75.1 | 2518 | 2194 | 1.3 |
| OM&S | Pump Bays | Pump | P828 | | | | | 98.9 | 102.7 | 101.3 | 98.1 | 90.0 | 83.0 | 2872 | 3401 | 0.9 |
| OM&S | Pump Bays | Pump | P4804 | | | | | 102.2 | 101.2 | 98.8 | 92.8 | 86.4 | 77.0 | 2132 | 3601 | 1.1 |
| OM&S | Pump Bays | Pump | P830 | | | | | 96.3 | 102.6 | 98.5 | 97.1 | 92.1 | 89.1 | 2163 | 3601 | 1 |
| OM&S | Pump Bays | Pump | P827 | | | | | 99.4 | 98.3 | 96.5 | 101.0 | 92.2 | 83.6 | 3642 | 2484 | 1 |
| OM&S | Pump Bays | Pump | P807 | | | | | 100.9 | 100.3 | 98.7 | 94.3 | 87.0 | 80.3 | 4457 | 1483 | 0.8 |
| OM&S | Pump Bays | Pump | P886 | | | | | 93.3 | 99.4 | 97.2 | 96.1 | 90.3 | 82.7 | 2872 | 3480 | 1.4 |
| OM&S | Pump Bays | Pump | P818 | | | | 83.0 | 90.0 | 94.9 | 98.8 | 96.4 | 90.8 | 87.1 | 3386 | 2484 | 0.8 |
| OM&S | Pump Bays | Pump | P879 | | | | | 96.1 | 96.5 | 97.7 | 94.0 | 88.5 | 81.6 | 4083 | 1480 | 0.9 |
| OM&S | Pump Bays | Pump | P872 | | | | | 97.1 | 94.6 | 96.3 | 93.9 | 86.6 | 77.9 | 1749 | 3607 | 0.8 |
| OM&S | Pump Bays | Pump | P873 | | | | | 90.2 | 96.4 | 97.7 | 92.1 | 83.0 | 73.1 | 1744 | 3607 | 0.6 |
| OM&S | Pump Bays | Pump | P862 | | | | | 95.2 | 95.7 | 95.4 | 89.1 | 85.1 | 78.0 | 4248 | 2707 | 1.8 |
| OM&S | Pump Bays | Pump | P899 | | | | | 89.1 | 94.1 | 96.0 | 93.0 | 88.1 | 79.9 | 4160 | 2484 | 0.8 |
| Power Station | Power Station | Plant | | | 124.3 | 123.7 | 119.3 | 123.5 | 105.6 | 103.7 | 100.6 | 99.5 | 96.7 | 3700 | 4412 | 5 |
| White Oils | Amine/Penex Unit | Air Fin Cooler | X508 | | 112.8 | 110.5 | 106.9 | 104.2 | 101.1 | 99.2 | 92.7 | | | 2118 | 4209 | 14 |
| White Oils | Amine/Penex Unit | Air Fin Cooler | X406 | | 104.6 | 103.6 | 103.0 | 100.9 | 98.6 | 95.8 | 88.1 | | | 2118 | 4308 | 14 |
| White Oils | Amine/Penex Unit | Air Fin Cooler | X4401 | | 102.3 | 103.2 | 99.1 | 93.4 | 87.3 | 77.6 | | | | 2118 | 4401 | 12 |
| White Oils | Amine/Penex Unit | Building | | C502 | 97.0 | 98.6 | 100.1 | 97.0 | 94.2 | 93.2 | 95.0 | 93.7 | 86.6 | 2071 | 4283 | 1.5 |
| White Oils | Amine/Penex Unit | Drum | D7730 | | 98.9 | 95.3 | 98.0 | 107.7 | 108.7 | 109.9 | 108.9 | 105.1 | 91.2 | 2079 | 4176 | 3 |
| White Oils | Amine/Penex Unit | Pump | P406 | | | | | 103.5 | 101.0 | 98.5 | 92.8 | 84.9 | 79.5 | 2109 | 4300 | 0.8 |
| White Oils | Amine/Penex Unit | Pump | P504 | | | | | 90.0 | 101.7 | 99.8 | 93.9 | 84.0 | 74.2 | 2127 | 4300 | 0.7 |
| White Oils | Amine/Penex Unit | Pump | P409 | | | | 91.8 | 99.4 | 98.7 | 95.4 | 93.7 | 90.5 | 81.0 | 2109 | 4329 | 0.9 |
| White Oils | Amine/Penex Unit | Pump | P4401 | | | | | 97.9 | 97.2 | 97.4 | 94.8 | 91.1 | 84.6 | 2127 | 4421 | 0.9 |
| White Oils | Amine/Penex Unit | Pump | P510 | | | | | 97.5 | 92.6 | 94.2 | 95.0 | 88.3 | 78.8 | 2110 | 4163 | 0.9 |
| White Oils | Amine/Penex Unit | Valve/Pipework | | D7730 | 101.1 | 92.6 | 93.3 | 103.2 | 109.1 | 116.2 | 121.0 | 111.6 | 105.2 | 2079 | 4176 | 5 |
| White Oils | Cracked Gas & PSA Unit | Air Fin Cooler | X4009 | | 119.7 | 115.9 | 112.2 | 107.8 | 104.9 | 106.8 | 102.2 | | | 2125 | 4658 | 18 |
| White Oils | Cracked Gas & PSA Unit | Air Fin Cooler | X4001 | | 107.8 | 106.2 | 103.6 | 99.6 | 100.0 | 101.6 | 100.0 | 91.4 | 80.7 | 2071 | 4537 | 18 |
| White Oils | Cracked Gas & PSA Unit | Building | | C4001 | | | | 95.4 | 104.7 | 104.2 | 105.0 | 97.2 | 85.4 | 2012 | 4596 | 1.5 |
| White Oils | Cracked Gas & PSA Unit | Drum | D4001 | | 95.4 | 91.9 | 91.0 | 96.3 | 109.0 | 113.8 | 110.3 | 105.0 | 98.0 | 2049 | 4622 | 6 |
| White Oils | Cracked Gas & PSA Unit | Pump | P4021 | | | | 89.0 | 100.2 | 99.1 | 91.4 | 95.9 | | 62.3 | 2088 | 4647 | 1.1 |
| White Oils | Cracked Gas & PSA Unit | Pump | P4020 | C4001 | | | 92.6 | | 87.4 | 94.2 | 98.1 | 92.6 | 84.9 | 2049 | 4579 | 1.3 |
| White Oils | Cracked Gas & PSA Unit | Valve/Pipework | | C4001 | 97.9 | 96.2 | 92.5 | 96.2 | 104.5 | 112.3 | 111.0 | 103.8 | 98.1 | 2037 | 4599 | 9 |
| White Oils | Desulph & Cat Reformer Area | Air Fin Cooler | X311 | | 118.0 | 120.9 | 116.4 | 113.9 | 110.8 | 105.4 | | | | 1795 | 4316 | 14 |
| White Oils | Desulph & Cat Reformer Area | Air Fin Cooler | X309 | | 118.7 | 117.2 | 115.0 | 113.8 | 110.9 | 102.1 | | | | 1795 | 4150 | 15 |
| White Oils | Desulph & Cat Reformer Area | Air Fin Cooler | X363 | | 118.5 | 115.9 | 113.6 | 111.6 | 107.1 | 100.4 | | | | 1835 | 4344 | 14 |
| White Oils | Desulph & Cat Reformer Area | Air Fin Cooler | X323 | | 117.3 | 113.7 | 108.2 | 103.8 | 100.6 | 102.9 | 100.7 | 92.3 | 83.2 | 1837 | 4114 | 15 |
| White Oils | Desulph & Cat Reformer Area | Air Fin Cooler | X6301 | | 111.4 | 111.5 | 103.9 | 99.6 | 95.5 | 90.0 | | | | 1880 | 4260 | 15 |

| Site Area | Area Descriptions | Plant Type | Tag No. | Assoc Tag No. | Source Lw - dB(lin) Octave Band Centre Frequency Hz 31.5 | 63 | 125 | 250 | 500 | 1k | 2k | 4k | 8k | Equipment Location E | N | EL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| White Oils | Desulph & Cat Reformer Area | Air Fin Cooler | X6312 | | 104.7 | 113.4 | 103.1 | 99.9 | 93.5 | 88.3 | | | | 1795 | 4436 | 15 |
| White Oils | Desulph & Cat Reformer Area | Air Fin Cooler | X6319 | | 109.7 | 109.7 | 102.9 | 99.7 | 96.2 | 92.4 | | | | 1835 | 4428 | 15 |
| White Oils | Desulph & Cat Reformer Area | Air Fin Cooler | X375 | | 106.4 | 100.4 | 99.4 | 99.3 | 89.9 | 74.1 | | | | 1837 | 4260 | 14 |
| White Oils | Desulph & Cat Reformer Area | Pump | P366 | | | | 92.3 | 99.5 | 107.0 | 103.5 | 103.7 | 96.0 | 85.9 | 1761 | 4223 | 1.1 |
| White Oils | Desulph & Cat Reformer Area | Pump | P6310 | | | | 103.1 | 103.5 | 105.1 | 99.8 | 96.9 | 93.2 | 84.1 | 1783 | 4411 | 1.2 |
| White Oils | Desulph & Cat Reformer Area | Pump | P303 | | | | 97.6 | 100.5 | 104.0 | 101.8 | 100.1 | 96.3 | 85.8 | 1785 | 4166 | 1.2 |
| White Oils | Desulph & Cat Reformer Area | Pump | P368 | | | | | 103.4 | 100.4 | 102.5 | 102.6 | 91.1 | 83.5 | 1756 | 4118 | 1.7 |
| White Oils | Desulph & Cat Reformer Area | Pump | P310 | | | | | | 83.6 | 89.5 | 101.2 | 102.3 | 101.6 | 1787 | 4135 | 1.3 |
| White Oils | Desulph & Cat Reformer Area | Pump | P301 | | | | | | 94.1 | 96.1 | 102.3 | 99.2 | 98.2 | 1787 | 4145 | 1.3 |
| White Oils | Desulph & Cat Reformer Area | Pump | P6308 | | | | 97.2 | 100.5 | 96.6 | 92.0 | 89.6 | 91.9 | 81.1 | 1785 | 4236 | 1.4 |
| White Oils | Desulph & Cat Reformer Area | Pump | P3309 | | | | 89.7 | 89.8 | 102.3 | 90.3 | 94.5 | 81.4 | 78.1 | 1787 | 4219 | 1.1 |
| White Oils | Desulph & Cat Reformer Area | Pump | P302B | | | | 92.2 | 96.9 | 98.3 | 96.9 | 92.7 | 70.9 | 78.9 | 1785 | 4176 | 1.2 |
| White Oils | Desulph & Cat Reformer Area | Pump | P6314 | | | | | 93.4 | 96.7 | 98.0 | 96.0 | 86.5 | 77.9 | 1804 | 4428 | 1 |
| White Oils | Desulph & Cat Reformer Area | Pump | P302A | | | | 94.3 | 96.7 | 96.4 | 92.3 | 90.6 | 77.2 | | 1785 | 4182 | 1.2 |
| White Oils | Desulph & Cat Reformer Area | Steam Leak | | P301 | | | | | | 65.0 | 96.0 | 96.9 | 96.2 | 1787 | 4145 | 0.3 |
| White Oils | Desulph & Cat Reformer Area | Valve/Pipework | FRC334 | | 105.7 | 109.1 | 112.6 | 103.7 | 100.6 | 90.8 | 94.7 | 99.1 | 98.9 | 1747 | 4407 | 1.5 |
| White Oils | Desulph & Cat Reformer Area | Valve/Pipework | FRC370 | | | | | 91.2 | 87.5 | 113.5 | 106.0 | 106.0 | 96.1 | 1823 | 4384 | 1.5 |
| White Oils | DHDS | Air Fin Coolers | | | 118.5 | 110.9 | 105.5 | 103.6 | 99.0 | 99.3 | 105.0 | 102.2 | 90.4 | 2313 | 4659 | 10 |
| White Oils | DHDS | Compressor | | | 102.3 | 97.1 | 104.5 | 100.0 | 95.7 | 93.4 | 86.3 | 93.5 | 85.1 | 2382 | 4603 | 3 |
| White Oils | DHDS | Pipework/valves | | | 123.1 | 117.9 | 115.8 | 112.5 | 108.5 | 104.1 | | | 88.4 | 2313 | 4734 | 6 |
| White Oils | DHDS | Pump | P3502 | | 95.9 | 91.2 | 91.3 | 94.2 | 92.8 | 91.4 | 98.1 | 89.9 | 81.0 | 2375 | 4659 | 1 |
| White Oils | Flare Gas Rec. | Compressor | C781/2 | | | 85.8 | 98.9 | 107.5 | 108.8 | 107.9 | 106.6 | 97.4 | 84.9 | 2516 | 4380 | 2 |
| White Oils | Gas Recovery | Air Fin Cooler | X7405 | | 112.0 | 112.0 | 108.9 | 104.6 | 98.2 | 95.5 | | | | 2023 | 4114 | 13.5 |
| White Oils | Gas Recovery | Air Fin Cooler | X4444 | | 108.2 | 106.7 | 105.5 | 102.8 | 96.2 | 90.1 | | | | 1976 | 4181 | 13.5 |
| White Oils | Gas Recovery | Air Fin Cooler | X374 | | 104.2 | 100.9 | 101.4 | 97.0 | 92.7 | 86.3 | | | | 1976 | 4294 | 13.5 |
| White Oils | Gas Recovery | Building | | C301 | | | 102.7 | 101.8 | 104.9 | 102.4 | 103.9 | 94.9 | 92.4 | 1925 | 4353 | 3 |
| White Oils | Gas Recovery | Pump | P4445 | | | | 86.5 | 94.7 | 100.5 | 103.5 | 99.1 | 88.9 | 82.9 | 2035 | 4383 | 0.7 |
| White Oils | Gas Recovery | Pump | P4446 | | | | 85.6 | 94.3 | 100.6 | 103.2 | 98.8 | 88.9 | 82.3 | 2035 | 4376 | 0.7 |
| White Oils | Gas Recovery | Pump | P4443 | | | | | 90.6 | 95.5 | 99.0 | 99.9 | 97.2 | 87.7 | 1986 | 4339 | 1 |
| White Oils | Gas Recovery | Pump | P7402 | | | | 94.5 | 96.2 | 93.4 | 89.9 | 86.7 | 89.3 | 82.9 | 2033 | 4343 | 1 |
| White Oils | Gas Recovery | Valve/Pipework | D701 | | 115.9 | 111.3 | 124.6 | 108.2 | 110.0 | 108.1 | 93.7 | 91.0 | 77.1 | 2017 | 4283 | 2.6 |
| White Oils | Gas Recovery | Valve/Pipework | | D701 | 110.7 | 106.4 | 102.2 | 98.1 | 94.7 | 100.7 | 106.8 | 92.3 | 91.2 | 2017 | 4283 | 6 |
| White Oils | HDS & No.1 Reformer | Heater | H306 | | 105.7 | 109.7 | 115.6 | 121.5 | 116.6 | 108.0 | 65.8 | 64.4 | 73.2 | 1634 | 4350 | 7 |
| White Oils | HDS & No.1 Reformer | Heater | H304 | | 115.8 | 108.2 | 104.9 | 93.6 | 81.7 | 79.4 | 71.5 | 63.3 | 68.1 | 1646 | 4198 | 15 |
| White Oils | HDS & No.1 Reformer | Heater | H302 | | 114.1 | 111.1 | 103.9 | 96.4 | 77.3 | 70.7 | 76.3 | 71.8 | 70.9 | 1645 | 4238 | 15 |
| White Oils | HDS & No.1 Reformer | Heater | H301 | | 102.0 | 104.7 | 104.4 | 107.4 | 100.5 | 100.0 | 63.2 | 61.3 | 69.3 | 1646 | 4164 | 15 |
| White Oils | HDS & No.1 Reformer | Heater | H4441 | | 103.9 | 95.2 | 96.6 | 100.9 | 97.8 | 92.8 | 56.9 | 55.1 | 62.2 | 1632 | 4409 | 8 |
| White Oils | HDS & No.1 Reformer | Valve/Pipework | ESD3327 | | 125.5 | 120.6 | 115.0 | 109.4 | 103.7 | 98.6 | 89.9 | 91.5 | 86.6 | 1662 | 4232 | 1.5 |
| White Oils | Sat Gas & Cryo Plant | Pipework | | | 103.9 | | | | 99.1 | 104.0 | 111.8 | 115.7 | 105.6 | 2260 | 4495 | 0.8 |
| White Oils | Sat Gas & Cryo Plant | Valve/Pipework | ESD642 | | 89.8 | 81.1 | 66.7 | | 85.0 | 92.6 | 101.7 | 102.8 | 89.8 | 2270 | 4488 | 0.9 |

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## Tables

# 7. Noise and Vibration

## 7.1 Introduction

7.1.1 This chapter of the Environmental Statement (ES) addresses the potential noise and vibration impacts of Post Combustion Carbon Capture (PCC) developments at the VPI Combined Heat and Power (CHP) plant (Proposed VPI Development) and the Phillips 66 Humber Refinery (Proposed Phillips 66 Development) on local Noise Sensitive Receptors (NSRs). The impacts and effects of the Proposed VPI Development and Phillips 66 Development are considered separately and for both developments together (the Proposed Developments).

7.1.2 Impacts during the construction, operation (including maintenance) and decommissioning of the Proposed Developments are assessed. In particular, the assessment considers:

- existing and future baseline conditions;
- the effects of construction of the Proposed Developments on NSRs during the site clearance and construction works, including predicted changes in road traffic noise levels on the local road network during construction;
- the effects of noise and vibration resulting from operation of the Proposed Developments; and
- the effects of noise and vibration resulting from decommissioning of the Proposed Developments.

7.1.3 The cumulative effects of noise associated with the Proposed Developments and other committed developments in the vicinity are described in Chapter 18: Cumulative and Combined Effects (ES Volume I).

7.1.4 This chapter is supported by Figures 7.1 – 7.4, provided in ES Volume III, and Appendix 7A: Noise Surveys, Appendix 7B: Construction Sound Levels and Assumptions, and Appendix 7C: Operational Sound Levels and Assumptions, provided in ES Volume II.

7.1.5 This chapter assesses the impact of noise on residential and other human receptors. The assessment of noise impacts on relevant ecological receptors is presented in Chapter 13: Ecology and Nature Conservation (ES Volume I).

## 7.2 Legislation and Planning Policy Context

7.2.1 This section discusses the legislation, planning policy context and standards relevant to assessing the impacts of noise and vibration on residential and other human receptors.

### Legislation

#### Environmental Protection Act 1990

7.2.2 The Environmental Protection Act (EPA) 1990 Part 3 identifies that noise (and vibration) emitted from premises (including land) can, at certain levels, be prejudicial to health or give rise to statutory nuisance.

7.2.3 Local Authorities are required to investigate any public complaints of noise and if they are satisfied that a statutory nuisance exists, or is likely to occur or recur, they must serve a noise abatement notice. A notice is served on the person responsible for the nuisance. It requires either the abatement of the nuisance or works to abate the nuisance to be undertaken, or it prohibits or restricts the relevant activity. Contravention of a notice without reasonable excuse is an offence. Right of appeal to the Magistrates Court exists within 21 days of the service of a noise abatement notice.

7.2.4 In determining if a noise complaint amounts to a statutory nuisance, the Local Authority can take account of various guidance documents and existing case law; however, no statutory noise limits exist. Demonstrating the use of 'Best Practicable Means' (BPM) to minimise noise levels is an accepted defence against a noise abatement notice.

### Control of Pollution Act 1974

7.2.5 Sections 60 and 61 of the Control of Pollution Act 1974 (CoPA) provide the main legislation regarding demolition and construction site noise and vibration. If noise complaints are received, a Section 60 notice may be issued by the local planning authority with instructions to cease work until specific conditions to reduce noise have been adopted.

7.2.6 Section 61 of the CoPA provides a means for applying for prior consent to undertake noise generating activities during construction. Once prior consent has been agreed under Section 61, a Section 60 notice cannot be served provided the agreed conditions are maintained on-site.

7.2.7 The CoPA requires that BPM (as defined in Section 72 of CoPA) be adopted for construction noise on any given site. CoPA makes reference to British Standard 5228 (British Standards Institute (BSI), 2014a and b) (herein referred to as 'BS 5228) which provides guidance on mitigation measures.

### Environmental Permitting Regulations 2016 (as amended)

7.2.8 The Environmental Permitting (England and Wales) Regulations 2016 (EPR) require the application of Best Available Techniques (BAT) to activities performed within installations regulated by the legislation in order to manage the impact of these operations on the surrounding environment. The Environmental Permit applies only to the operational and decommissioning phase, not to the construction phase. The Proposed Developments will require variations to the existing permits.

7.2.9 In terms of noise specifically, the selection of BAT will have to be considered and balanced with releases to different environmental media (air, land and water) and to give due consideration to issues such as usage of energy and raw materials. Noise, therefore, cannot be considered in isolation from other impacts on the environment.

7.2.10 The definition of pollution in regulation 2 of the EPR includes *"emissions which may be harmful to human health or the quality of the environment, cause offence to human senses or impair or interfere with amenities and other legitimate uses of the environment"*. BAT is therefore likely to be similar, in practice, to the requirements of the Statutory Nuisance legislation which requires the use of BPM to prevent or minimise noise nuisance. In the case of noise, 'offence of any human senses' may be judged by the likelihood of complaints. However, the lack of complaint should not necessarily imply the absence of a noise problem. In some cases, it may be possible, and desirable, to reduce noise emissions still further at reasonable costs and this may therefore be BAT for the control of noise emissions from an installation. Consequently, the aim of BAT should be to ensure that there is no reasonable cause for annoyance to persons beyond the installation boundary.

7.2.11 Guidance regarding Environmental Permitting and noise is available in the Environment Agency's Integrated Pollution Prevention and Control (IPPC) H3 document 'Horizontal Guidance for Noise Part 2 - Noise assessment and Control' (Environment Agency, 2002a). However, 'Horizontal Guidance for Noise Part 1 – Regulation and Permitting' (Environment Agency, 2002b), which provided useful guidance relating to noise limits from industrial installations in terms of absolute *rating levels* and *rating levels* relative to *background sound levels* (as defined in BS 4142:1997 (now superseded)) was withdrawn in February 2016. Therefore, industry wide noise limits no longer apply.

## National Policy

7.2.12 While National Policy Statements (NPS) apply to Nationally Significant Projects (NSIPs) rather than local planning applications, they can, however, have points of relevance in the determination of local planning applications.

7.2.13 Section 5.11 of the Overarching National Policy Statement (NPS) for Energy (EN-1) (Department of Energy & Climate Change (DECC) 2011) refers to the Government's policy on noise within the Noise Policy Statement for England (NPSE) (discussed further below).

7.2.14 With regards to decision making, NPS EN-1 states:

> *"The project should demonstrate good design through selection of the quietest cost-effective plant available; containment of noise within buildings wherever possible; optimisation of plant layout to minimise noise emissions; and, where possible, the use of landscaping, bunds or noise barriers to reduce noise transmission.*" (paragraph 5.11.8)

7.2.15 Section 7.5 of this chapter describes the impact avoidance measures identified as relevant to the Proposed Developments.

7.2.16 The NPS for Fossil Fuel Electricity Generating Infrastructure (EN-2) (DECC, 2011b) sets out policy specific to fossil fuel power stations such as the VPI Immingham CHP Plant. In paragraph 2.7.1, specific sources of noise are identified. Those that are relevant to the Proposed VPI Development include *"the gas and steam turbines that operate continuously during normal operation"*. It then reiterates the point made in NPS EN-1, stating that:

> *"The primary mitigation for noise from fossil fuel generating stations is through good design, including enclosure of plant and machinery in noise-reducing buildings wherever possible and to minimise the potential for operations to create noise'.* It goes on to state that *"Noise from gas turbines should be mitigated by attenuation of exhausts to reduce any risk of low-frequency noise transmission."* (paragraph 2.7.5)

7.2.17 Table 7.1 provides a summary of the NPS advice regarding noise and vibration and how each has been considered in this chapter.

**Table 7.1: Summary of relevant NPS advice regarding noise and vibration**

| Summary of NPS | Consideration within chapter |
|---|---|
| **NPS EN-1** | |
| Paragraph 5.11.4 states: *"Where noise* impacts *are likely to arise from the proposed development, the applicant should include the following in the noise assessment:*<br>• *A description of the noise generating aspects of the development proposal leading to noise impacts, including the identification of any distinctive, tonal, impulsive or low frequency characteristics of the noise;*<br>• *Identification of noise sensitive premises and noise sensitive areas that may be affected;*<br>• *The characteristics of the existing noise environment;*<br>• *A prediction of how the noise environment will change with the proposed development;*<br>• *In the shorter term such as during the construction period;*<br>• *In the longer term during the operating life of the infrastructure;*<br>• *At particular times of the day, evening and night as appropriate;*<br>• *An assessment of the effect of predicted changes in the noise; and*<br>• *Measures to be employed in mitigation noise.* | Descriptions of noise generating aspects of the Proposed Developments, together with an assessment of construction, operational and decommissioning noise and vibration impacts are presented in Section 7.6 of this chapter.<br>NSRs including proximity of any Noise Important Areas (NIA) are identified.<br>Information relating to the existing noise environment is presented in Section 7.4 of this chapter.<br>The mitigation of construction and operational noise is discussed in Section 7.5 and 7.7 of this chapter. |

| Summary of NPS | Consideration within chapter |
|---|---|
| **NPS EN-1** | |
| *The nature and extent of the noise assessment should be proportionate to the likely noise impact."* | |
| Paragraph 5.11.5 states: *"The noise impact of ancillary activities associated with the development, such as increased road and rail traffic movements, or other forms of transportation, should also be considered."* | Potential construction related traffic noise effects on human NSRs have been assessed in Section 7.6 of this chapter. |
| Paragraph 5.11.6 states: *"Operational noise, with respect to human receptors, should be assessed using the principles of the relevant British Standards and other guidance. Further information on assessment of particular noise sources may be contained in the technology-specific NPSs. In particular, for…electricity networks (EN-5) there is assessment guidance for specific features of those technologies. For the prediction, assessment and management of construction noise, reference should be made to any relevant British Standards and other guidance which also give examples of mitigation strategies."* | Potential operational noise effects on human NSRs are presented in Section 7.6 of this chapter. |
| Paragraph 5.11.7 states: *"The applicant should consult EA and Natural England (NE), as necessary and in particular with regard to assessment of noise on protected species or other wildlife. The results of any noise surveys and predictions may inform the ecological assessment. The seasonality of potentially affected species in nearby sites may also need to be taken into account."* | Potential effects of noise on biodiversity and nature conservation are considered in Chapter 13: Ecology and Nature Conservation (ES Volume I) and the Habitat Regulations Assessment Reports submitted with each planning application. |
| Paragraph 5.11.8 states *"The project should demonstrate good design through selection of the quietest cost-effective plant available; containment of noise within buildings wherever possible; optimisation of plant layout to minimise noise emissions; and, where possible, the use of landscaping, bunds or noise barriers to reduce noise transmission."* | Section 7.5 of this chapter describes the impact avoidance measures identified as relevant to the Proposed Developments. |
| **NPS-EN1** | |
| Paragraph 2.7.2 states: *"The ES should include a noise assessment as described in Section 5.11 in EN-1."* | A noise assessment is included within this chapter. |

## National Planning Policy Framework

7.2.18 The National Planning Policy Framework (NPPF) (Ministry of Housing, Communities and Local Government (MHCLG), 2021) sets out that planning should make sufficient provision for *"conservation and enhancement of the natural, built and historic environment"* (Paragraph 20d). Consequently, the aim is to prevent both new and existing development from contributing to, being put at unacceptable risk from, or being adversely affected by, unacceptable levels of noise pollution.

7.2.19 Paragraph 174 of the NPPF states that:

> *"planning policies and decisions should contribute to and enhance the natural and local environment by:*

*……preventing new and existing development from contributing to, being put at unacceptable risk from, or being adversely affected by, unacceptable levels of soil, air, water or noise pollution or land instability. Development should, wherever possible, help to improve local environmental conditions such as air and water quality, taking into account relevant information such as river basin management plans."*

7.2.20 Paragraph 185 states that:

*"Planning policies and decisions should also ensure that new development is appropriate for its location taking into account the likely effects (including cumulative effects) of pollution on health, living conditions and the natural environment, as well as the potential sensitivity of the site or the wider area to impacts that could arise from the development. In doing so they should:*

- *mitigate and reduce to a minimum potential adverse impacts resulting from noise from new development - and avoid noise giving rise to significant adverse impacts on health and the quality of life;…* [and]
- *identify and protect tranquil areas which have remained relatively undisturbed by noise and are prized for their recreational and amenity value for this reason".*

7.2.21 With regards to 'adverse effects' and 'significant adverse effects' the NPPF refers to the Noise Policy Statement for England Explanatory Note (NPSE) (Department for Environment, Food and Rural Affairs (Defra), 2010), which is described in the sub-section below.

## Noise Policy Statement for England

7.2.22 The NPSE (Defra, 2010) seeks to clarify the underlying principles and aims in existing policy documents, legislation and guidance that relate to noise. The NPSE (Defra, 2010) applies to all forms of noise, including environmental noise, neighbour noise and neighbourhood noise.

7.2.23 The statement sets out the long-term vision of the government's noise policy, which is to:

*"promote good health and a good quality of life through the effective management of noise within the context of policy on sustainable development".*

7.2.24 This long-term vision is supported by three aims:

- *"avoid significant adverse impacts on health and quality of life;*
- *mitigate and minimise adverse impacts on health and quality of life; and*
- *where possible, contribute to the improvements of health and quality of life."*

7.2.25 The long-term policy vision and aims are designed to enable decisions to be made regarding what is an acceptable noise burden to place on society.

7.2.26 The 'Explanatory Note' within the NPSE (Defra, 2010) provides further guidance on defining 'significant adverse effects' and 'adverse effects' using the concepts:

- No Observed Effect Level (NOEL) - the level below which no effect can be detected. Below this level no detectable effect on health and quality of life due to noise can be established;
- Lowest Observed Adverse Effect Level (LOAEL) - the level above which adverse effects on health and quality of life can be detected; and
- Significant Observed Adverse Effect Level (SOAEL) - the level above which significant adverse effects on health and quality of life occur.

7.2.27 The three aims can therefore be interpreted as follows:

- the first aim is to avoid noise levels above the SOAEL;
- the second aim considers situations where noise levels are between the LOAEL and SOAEL. In such circumstances, all reasonable steps should be taken to mitigate and

minimise the effects. However, this does not mean that such adverse effects cannot occur; and

- the third aim seeks, where possible, to positively improve the health and quality of life through the pro-active management of noise whilst also taking account of the guiding principles of sustainable development. It is considered that the protection of quiet places and quiet times as well as the enhancement of the acoustic environment will assist with delivering this aim.

7.2.28 The NPSE (Defra, 2010) recognises that it is not possible to have uniform objective noise-based measures that define the SOAEL, LOAEL and NOEL that are applicable to all sources of noise in all situations. The levels are likely to be different for different noise sources, receptors and times of the day.

### Planning Practice Guidance – Noise

7.2.29 The Planning Practice Guidance (PPG) (MHCLG, 2019) was first published on 6th March 2014 to provide a web-based resource with more in-depth guidance to the NPPF (MHCLG, 2021). The PPG aims to make planning guidance more accessible, and to ensure that the guidance is kept up to date. The PPG was last updated for noise in July 2021.

7.2.30 The guidance advises that local planning authorities should take account of the acoustic environment and consider:

- whether or not a significant adverse effect is occurring or likely to occur,
- whether or not an adverse effect is occurring or likely to occur, and
- whether or not a good standard of amenity can be achieved.

7.2.31 This guidance introduced the additional concepts of No Observed Adverse Effect Level (NOAEL), and Unacceptable Adverse Effect Level (UAEL). Full details of the PPG guidance on effects are provided in Table 7.2.

**Table 7.2: Planning Practice Guidance noise advice**

| Perception | Examples of outcomes | Effect level | Action |
|---|---|---|---|
| Not present | No effect | No Observed Effect | No specific measures required |
| Present and not intrusive | Noise can be heard but does not cause any change in behaviour, attitude or other physiological response. Can slightly affect the acoustic character of the area but not such that there is a perceived change in the quality of life. | No Observed Adverse Effect | No specific measures required |
| **Lowest Observed Adverse Effect Level (LOAEL)** | | | |
| Present and intrusive | Noise can be heard and causes small changes in behaviour, attitude or other physiological response, e.g. turning up volume of television; speaking more loudly; where there is no alternative ventilation, having to close windows for some of the time because of the noise. Potential for some reported sleep disturbance. Affects the acoustic character of the area such that there is a small actual or perceived change in the quality of life. | Observed Adverse Effect | Mitigate and reduce to a minimum |
| **Significant Observed Adverse Effect Level (SOAEL)** | | | |

| Perception | Examples of outcomes | Effect level | Action |
|---|---|---|---|
| Present and disruptive | The noise causes a material change in behaviour, attitude or other physiological response, e.g. avoiding certain activities during periods of intrusion; where there is no alternative ventilation, having to keep windows closed most of the time because of the noise. Potential for sleep disturbance resulting in difficulty in getting to sleep, premature awakening and difficulty in getting back to sleep. Quality of life diminished due to change in acoustic character of the area. | Significant Observed Adverse Effect | Avoid |
| Present and very disruptive | Extensive and regular changes in behaviour, attitude or other physiological response and/or an inability to mitigate effect of noise leading to psychological stress or physiological stress, e.g. regular sleep deprivation/awakening; loss of appetite, significant, medically definable harm, e.g. auditory and non-auditory. | Unacceptable Adverse Effect | Prevent |

7.2.32 Factors to be considered in determining if noise is a concern are identified including the absolute noise level of the source, the existing ambient noise climate, time of day, frequency of occurrence, duration, character of the noise and cumulative impacts.

## Local Policy

7.2.33 The Development Plan for North Lincolnshire comprises the North Lincolnshire Local Development Framework (LDF) and the 'Saved Policies' of the North Lincolnshire Local Plan (NLC, 2007). The LDF includes the Core Strategy (adopted June 2011) (NLC, 2011).

7.2.34 North Lincolnshire Council does not have a specific policy relating to noise. However, the Council adopted its Core Strategy in June 2011 (NLC, 2011) as part of the Local Development Framework which has a Supplementary Planning Document entitled Planning for Health and Wellbeing that was published in November 2016 (NLC, 2016). It recognises that noise is an issue that can have an effect on physical and mental health.

7.2.35 Policy 3 of Planning for Health and Wellbeing - "Well Designed Places" - states:

> *"When considering the detail of development, proposals should:*
> *Seek to reduce noise and air pollution through ensuring planning applications include a Noise Impact Assessment…… in areas of concern."*

7.2.36 Paragraph 4.15 states "*the design of places also needs to take account of transport which has a direct impact on health and safety. Air pollution, noise, traffic and congestion all have a negative impact on people's ability to enjoy their environment."*

7.2.37 The 'Saved' policies of the Local Plan (NLC, 2007) that it is considered may be relevant to the determination of the planning applications include DS 1 General Requirements and DS 11.

7.2.38 Policy DS 1 General Requirements states:

> *"A high standard of design is expected in all developments in both built-up areas and the countryside and proposals for poorly designed development will be refused. All proposals will be considered against the criteria set out below:*
>
> *Amenity: iii) No acceptable loss of amenity to neighbouring land uses should result in terms of noise, smell, fumes, dust or tother nuisance, or through the effects of overlooking or overshadowing."*

7.2.39 Policy DS 11 Polluting Activities states:

> *"Planning permission for development, including extensions to existing premises and changes of use, will only be permitted where it can be demonstrated that the levels of potentially polluting emissions, including effluent, leachates, smoke, fumes, gases, dust, steam, smell or noise do not pose a danger by way of toxic release; result in land contamination; pose a threat to current and future surface or underground water resources; or create adverse environmental conditions likely to affect nearby developments and adjacent* areas*."*

## Other Guidance

### British Standard 7445-1:2003 and 7445-2:1991

7.2.40 BS 7445 'Description and measurement of environmental noise' (BSI, 1991 and 2003) defines parameters, procedures and instrumentation required for noise measurement and analysis.

### British Standard 5228:2009+A1:2014

7.2.41 BS 5228-1 'Code of practice for noise and vibration control on construction and open sites. Noise' (BSI, 2014a) provides a 'best practice' guide for noise control and includes sound power level ($L_{Aw}$) data for individual plant as well as a calculation method for noise from construction activities. BS 5228-2 'Code of practice provides a 'best practice' guide for noise and vibration control on construction and open sites. Vibration' (BSI, 2014b) provides comparable 'best practice' for vibration control, including guidance on the human response to vibration.

### British Standard 6472:2008

7.2.42 BS 6472-1 'Guide to evaluation of human exposure to vibration in buildings Part 1: Vibration sources other than blasting' (BSI, 2008), presents recommended frequency weighted vibration spectra (for continuous vibration) and vibration dose values (VDV) (for intermittent vibration), above which adverse comment is likely to occur in residential properties.

### British Standard 7385:1993

7.2.43 BS 7385-2 'Evaluation and measurement for vibration in buildings. Guide to damage levels from ground borne vibration' (BSI, 1993) presents guide values for transient and continuous vibration, above which there is a likelihood of cosmetic damage. The standard establishes the basic principles for carrying out vibration measurements and processing the data, with regard to evaluating vibration effects on buildings.

### International Organization for Standardization (ISO) 4866:2010

7.2.44 ISO 4866:2010 'Mechanical Vibration and Shock – Vibration of Fixed Structures – Guidelines for the Measurement of Vibrations and Evaluation of Their Effects on Structures' (ISO, 2010) establishes the principles for carrying out vibration measurement and processing data with regard to evaluating vibration effects on structures.

### British Standard 4142:2014+A1:2019

7.2.45 BS 4142 'Methods for rating and assessing industrial and commercial sound' (BSI, 2014c) can be used for assessing the effect of noise of an industrial nature, including mechanical services plant noise. The method compares the difference between '*rating level*' of the industrial sound, with the '*background sound level*' at the receptor position.

### British Standard 8233:2014

7.2.46 BS 8233 'Guidance on sound insulation and noise reduction for buildings' (BSI, 2014d) defines criteria for noise levels in and around buildings.

### ISO 9613-2:1996: Attenuation of Sound during Propagation Outdoors

7.2.47 ISO 9613-2:1996 'Attenuation of Sound during Propagation Outdoors, Part 2: General Method of Calculation' (ISO, 1996) specifies an engineering method for calculating the attenuation of sound during propagation outdoors in order to predict the levels of environmental noise at a distance from a variety of sources.

### Calculation of Road Traffic Noise

7.2.48 Department for Transport (DfT)/ Welsh Office Memorandum 'Calculation of Road Traffic Noise' (CRTN) (DfT/ Welsh Office, 1988) describes procedures for traffic noise calculation and measurement and is suitable for environmental assessments of schemes where road traffic noise may have an effect.

### Design Manual for Road and Bridges

7.2.49 The Highways England 'Design Manual for Road and Bridges LA 111 (Revision 2) Noise and Vibration' (DMRB) (Highways England, 2020) provides guidance on the appropriate approach to be taken when assessing the noise and vibration effects arising from all road projects, including new construction, improvements and maintenance. The guidance is also useful for assessing changes in traffic noise levels as a result of non-road projects such as this.

### World Health Organization

7.2.50 The World Health Organization's (WHO) 'Environmental Noise Guidelines for the European Region' (WHO, 2018) provides recommendations to protect human health from noise from transportation, wind turbines and leisure. These guidelines do not cover industrial noise, however, recommend that 'Guidelines for Community Noise' (WHO, 1999) should remain valid. This recommends external daytime and evening environmental noise limits, and internal night-time limits to avoid sleep disturbance.

7.2.51 The WHO 'Night Noise Guidelines for Europe' (WHO, 2009) recommended updated guidelines on night-time noise limits to avoid sleep disturbance.

# 7.3 Assessment Methodology and Significance Criteria

## Study Area

7.3.1 The extent of the study area has been defined to include the closest NSRs and communities in each direction from Proposed Developments. Study areas have also been informed by changes in road traffic flows predicted during the construction phase of the Proposed Developments. The extent of the study areas are shown in Figures 7.2a-c: Construction Noise Level Predictions, Figures 7.3a-c: Operational Noise Level Predictions (Daytime Unmitigated Scenario) and Figures 7.4a-c: Operational Noise Level Predictions (Night-time Unmitigated Scenario), found in ES Volume III.

## Assessment Methodology

7.3.2 To facilitate the impact assessment process and ensure consistency in the terminology used, a defined assessment methodology has been applied. This methodology has been developed from a range of sources, including the guidance documents listed above in paragraphs 7.2.40 to 7.2.51.

7.3.3 An understanding of the existing sound climate in the vicinity of the Proposed Developments has been obtained through baseline sound measurement surveys, traffic count data for the local highway network and a review of details of the current uses on the Proposed Developments' sites (referred to as 'the Phillips 66 Site' and 'the VPI Site', and collectively 'the Sites'). This baseline information has been used to assess the effects of noise associated with construction, construction traffic, operational and decommissioning noise arising from the Proposed Developments.

## Determining Baseline Conditions and Noise and Vibration Sensitive Receptors

7.3.4 The location of potential NSRs in proximity to the Phillips 66 Site and the VPI Site has been considered when assessing the effects associated with noise and vibration levels from the construction, operational (including maintenance) and decommissioning phases of the Proposed Developments.

7.3.5 The NSR locations selected are considered representative of the nearest and potentially most sensitive existing receptors to the Phillips 66 Site and the VPI Site. It is considered that if noise and vibration levels are suitably controlled at the selected receptors identified, then noise and vibration levels will be suitably controlled at other sensitive receptors in the surrounding area. The NSRs are shown in Table 7.3 and illustrated on Figure 7.1: Noise and Vibration Sensitive Receptors (ES Volume III).

**Table 7.3: Potential noise sensitive receptors**

| Receptor | Sensitivity/ value of receptors | Direction from Phillips 66 Site | Distance from Phillips 66 Site boundary (m)* | Direction from VPI Site | Distance from VPI Site boundary (m)* |
|---|---|---|---|---|---|
| NSR 1 – Staple Road | High | West | 519 | West | 1542 |
| NSR 2 – Clarkes Road | High | North-west | 790 | West | 1930 |
| NSR 3 – Church Lane | High | North-west | 770 | North-west | 1944 |
| NSR 4 – Hazel Dene | High | North-east | 1651 | East | 340 |

*Distance from the closest point to the Phillips 66 Site and VPI Site boundaries reported

7.3.6 The nearest NIA is located in Great Coates on the A1136. This is approximately 9 km away from the Sites, therefore noise impacts from the Proposed Developments at this location are unlikely and no further assessment is required.

7.3.7 A description of the study areas for ecological receptors are presented in Chapter 13: Ecology and Nature Conservation. Further assessment is provided in the Habitats Regulations Assessment Report.

## Baseline Sound Surveys

7.3.8 Baseline sound monitoring to inform the assessment was undertaken at the four key residential NSRs identified in Table 7.3. This comprised unattended measurements with observations made on set up and collection of equipment and weather data recorded using a weather station located at NSR 2. Further details of the baseline sound surveys can be found in Appendix 7A (ES Volume II). The results of the baseline sound monitoring are summarised in Table 7.12 in Section 7.4 of this chapter.

## Construction Phase Impacts

7.3.9 To determine the temporary noise and vibration impacts that may arise during the construction phase the following matters have been considered:

- noise and vibration caused by construction site activities; and
- noise caused by increases in traffic on existing roads as a result of construction traffic.

## Assessment of Construction and Decommissioning Noise

7.3.10 At this stage in the Proposed Developments' design development, before the appointment of a construction contractor, site specific details regarding the construction activities, programme and numbers and types of construction plant are not fully available. Therefore, detailed construction noise predictions have not been undertaken. Nevertheless, indicative construction noise predictions have been undertaken using the calculation methods set out in BS 5228 (BSI, 2014a), based upon construction information from similar projects and confirmed/ updated by Phillips 66 and VPI. Further details of the proposed construction plant can be found in Appendix 7B (ES Volume II). At this stage it is assumed the decommissioning works will be similar to the construction works.

7.3.11 The assessment involves the calculation of sound emissions from the construction site based on the sound power levels associated with the plant or equipment to be used, and the propagation of sound from the source to the NSR locations. Sound power levels are taken from manufacturers data and/or archive data given in BS 5228-1. The calculated levels are then compared to nominated criteria to determine whether an adverse impact is expected.

7.3.12 The calculation method provided in BS 5228 (2014a) also takes account of factors including the number and type of equipment operating, their modes of operation (% on-times within the working period), the distance to the NSR, and the effects of any intervening ground cover or barrier/ topographical screening. This allows the prediction of the magnitude of impact.

7.3.13 The subsequent assessment of construction noise impacts at residential NSR considers the guidance in 'example method 1 – the ABC method' as defined in BS 5228 (BSI, 2014a). Table 7.4 (reproduced from BS 5228-1) provides guidance in terms of appropriate threshold values for residential NSR, based upon existing ambient noise levels.

**Table 7.4: Construction noise threshold values at residential dwellings**

| Assessment category and threshold value period | Threshold value $L_{Aeq,T}$ dB | | |
|---|---|---|---|
| | Category A (a) | Category B (b) | Category C (c) |
| Daytime (07:00 – 19:00) and Saturdays (07:00 – 13:00) | 65 | 70 | 75 |
| Evenings and weekends (d) | 55 | 60 | 65 |
| Night-time (23:00 – 07:00) | 45 | 50 | 55 |

NOTE 1: A potential significant effect is indicated if the $L_{Aeq,T}$ noise level arising from the site exceeds the threshold level for the category appropriate to the ambient noise level.

NOTE 2: If the ambient noise level exceeds the Category C threshold values given in the table (i.e. the ambient noise level is higher than the above values), then a potential significant effect is indicated if the total $L_{Aeq,T}$ noise level for the period increases by more than 3 dB due to site noise.

NOTE 3: Applies to residential receptors only.

(a) Category A: Threshold values to use when ambient noise levels (when rounded to the nearest 5 dB) are less than these values.

(b) Category B: Threshold values to use when ambient noise levels (when rounded to the nearest 5 dB) are the same as Category A value.

(c) Category C: Threshold values to use when ambient noise levels (when rounded to the nearest 5 dB) are higher than Category A values.

(d) 19:00 – 23:00 weekdays, 13:00 – 23:00 Saturdays, 07:00 – 23:00 Sundays.

7.3.14 For the appropriate period (day, evening, night etc.), the ambient noise level is determined and rounded to the nearest 5 dB and the appropriate threshold value is then derived. The predicted construction noise level is then compared with this noise threshold value.

7.3.15 Based upon the BS 5228 ABC method (BSI, 2014a), the criterion adopted in this assessment for the determination of potentially significant effects is the exceedance of the $L_{Aeq,T}$ threshold level for the category appropriate to the ambient noise level at each NSR. This is considered to be equivalent to the SOAEL, although as stated in BS 5228, other project-specific factors, such as the number of NSR affected and the duration and character of the impact, should also be considered by the assessor when determining if there is a potentially significant effect.

7.3.16 For residential receptors and other high sensitivity human receptors, the criterion for the LOAEL is a predicted construction noise level equal to the existing ambient noise level at each NSR i.e. resulting in a 3 dB increase in noise level when combined with the existing ambient noise level.

7.3.17 It is noted that the criteria for the LOAEL and SOAEL relate to residential NSR only, in line with the ABC method.

7.3.18 In accordance with the NPPF (MHCLG, 2021) and NPSE (Defra, 2010), it is important to avoid significant adverse effects (at or above the SOAEL) and also mitigate and minimise other adverse effects (above the LOAEL), where possible.

7.3.19 Based upon the above, the magnitude of the impact of construction noise is classified in accordance with the descriptors in Table 7.5.

**Table 7.5: Magnitude of construction noise impacts**

| Magnitude of Impact | Comparison with Threshold Value $L_{Aeq,T}$ dB |
|---|---|
| High | Exceedance of ABC Threshold Value by ≥+5 dB |
| Medium | Exceedance of ABC Threshold Value by up to +5 dB |
| Low | Equal to or below the ABC Threshold Value by up to 5 dB |
| Negligible | Below the ABC Threshold Value by ≥-5 dB |

## Assessment of Construction Works Traffic on the Public Highway

7.3.20 The Proposed Developments will affect traffic flows on existing roads in the area within and surrounding the Proposed Development Sites during construction. The assessment focuses on the impact at NSRs located alongside the local road network.

7.3.21 Construction traffic noise has been assessed by considering the increase in traffic flows during the construction works, following the guidance of CRTN (DfT/ Welsh Office, 1988) and DMRB (Highways England, 2020).

7.3.22 18-hour (06:00 – 24:00) Annual Average Weekday Traffic (AAWT) data have been obtained for the year 2026 ‘with’ and ‘without’ construction traffic during the peak construction period, in order to determine if any existing roads are predicted to be subject to a potentially significant change in 18-hour traffic flows. CRTN Basic Noise Level (BNL) calculations have been undertaken to predict the change in noise level between the ‘with’ and ‘without’ scenarios.

7.3.23 The criteria for the assessment of traffic noise changes arising from construction works have been taken from Table 3.17 of DMRB (Highways England, 2020) and are provided in Table 7.6 below. The magnitude descriptors in parenthesis are provided to align with the descriptors used in this assessment.

**Table 7.6: Construction traffic noise criteria**

| Magnitude of Impact | Change in traffic noise level $L_{A10,18h}$ dB |
|---|---|
| Major (High) | ≥ 5 |
| Moderate (Medium) | 3 to <5 |

| Magnitude of Impact | Change in traffic noise level $L_{A10,18h}$ dB |
|---|---|
| Minor (Low) | 1 to <3 |
| Negligible (Very Low) | <1 |

7.3.24 DMRB advises that an increase in road traffic flows of 25% (where the traffic speed and composition remain consistent) equates to an approximate increase in road traffic noise of 1 dB $L_{A10,18hr}$. A doubling in traffic flow would be required for an approximate increase of 3 dB $L_{A10,18hr}$.

7.3.25 The criteria are based on the current guidance on short-term changes in traffic noise levels in DMRB. It is generally accepted that changes in noise levels of 1 dB $L_A$ or less are imperceptible, and changes of 1 to 3 dB $L_A$ are not widely perceptible. Therefore, the SOAEL is set at a change in traffic noise of ≥3 dB and the LOAEL at ≥1 dB.

## Assessment of Construction Vibration

### *Impacts on Humans - Annoyance*

7.3.26 Due to distances between the construction works and the NSRs, significant adverse effects are unlikely, however general information and criteria are provided below.

7.3.27 The transmission of ground-borne vibration is highly dependent on the nature of the intervening ground between the source and receptor and the activities being undertaken. BS 5228-2: 2009+A1:2014 'Code of Practice for Noise and Vibration Control on Construction and Open Sites - Vibration' (BSI, 2014b) provides data on measured levels of vibration for various construction works, with particular emphasis on piling.

7.3.28 Table 7.7 sets out Peak Particle Velocity (PPV) vibration levels and provides a semantic scale for the description of demolition and construction vibration impacts on human receptors, based on guidance contained in BS 5228-2 (BSI, 2014b).

**Table 7.7: Construction vibration thresholds at residential dwellings**

| Peak Particle Velocity (PPV) level | Description | Magnitude of impact |
|---|---|---|
| >= 10 mm/s | Vibration is likely to be intolerable for any more than a very brief exposure to this level. | High |
| 1.0 to < 10 mm/s | It is likely that vibration of this level in residential environments will cause complaint but can be tolerated if prior warning and explanation has been given to residents. | Medium |
| 0.3 to < 1.0 mm/s | Vibration might be just perceptible in residential environments. | Low |
| 0.14 to < 0.3 mm/s | Vibration might be just perceptible in the most sensitive situations for most vibration frequencies associated with construction. At lower frequencies, people are less sensitive to vibration. | Very low |

7.3.29 For residential receptors and other high sensitivity receptors, the LOAEL is defined as a PPV of 0.3 mm/s (millimetres per second); this being the point at which construction vibration is likely to become perceptible. The SOAEL is defined as a PPV of 1.0 mm/s, this being the level at which construction vibration could become significant with respect to human annoyance but can be tolerated with prior warning.

7.3.30 The nearest residential NSRs are approximately 340 m from the Proposed VPI Development and 545 m from the Proposed Phillips 66 Development. Given the distance between the residential NSRs and the Proposed Developments, no significant vibration effects (i.e. those associated with a medium or high magnitude impact) are expected to result from the proposed construction (or demolition) activities and therefore further assessment on residential NSRs has been scoped out.

### *Impacts on Buildings/ Existing Infrastructure*

7.3.31 In addition to human annoyance, building structures may be damaged by high levels of vibration. The levels of vibration that may cause building damage are far in excess of those that may cause annoyance. Consequently, if vibration levels are controlled to those relating to annoyance (i.e. 1.0 mm/s), then it is highly unlikely that buildings will be damaged by demolition and construction vibration levels.

7.3.32 Given the distance to residential receptors, no significant vibration is expected to result from the proposed construction activities on such receptors and therefore further assessment of the effects of vibration on residential buildings is scoped out. However, if piling, heavy earthworks, vibratory rollers or other significant vibration producing operations are proposed in close proximity to any existing sensitive buildings/ structures, further consideration will be given to potential impacts, once the contractor is appointed and the construction methods and requirements are known.

7.3.33 With respect to existing buildings within the Phillips 66 Site and VPI Site, as both the construction of the Proposed Developments and the existing buildings are both within the control of the respective Applicant, any identified issues can be effectively managed by the Applicants and their contractors. Potential measures to ensure that appropriate mitigation is in place during the works are discussed in Section 7.5 and Section 7.7 of this chapter.

## Assessment of Operational Sound - Residential NSRs

7.3.34 The assessment of operational sound levels has been based upon calculations taking account of proposed plant and equipment (refer to Appendix 7C: Operational Noise Appendix in ES Volume II) sound power levels ($L_w$) relating to the proposed plant, distance between the proposed plant and NSRs and the acoustic screening offered by existing topography and existing and proposed new buildings.

7.3.35 Three-dimensional sound propagation models have been developed using the modelling software SoundPlan Version 8.2 to assess the current layout options for the Proposed Developments. SoundPlan implements the prediction method ISO 9613-2: 1996 'Attenuation of sound during propagation outdoors' (ISO, 1996), which has been employed to calculate sound levels at surrounding NSR due to proposed operations at the Sites.

7.3.36 Topographical features and buildings that may influence the transmission of sound from the Proposed Developments to NSR are included in the model. A digital terrain model created using publicly available ground elevation spot height data have been used to position buildings and other noise sources at the proposed heights relative to ground. Areas of acoustically soft (e.g. vegetation) and hard (e.g. concrete) ground have been identified from the Ordnance Survey MasterMap Topographic Layer and modelled accordingly.

7.3.37 The prediction method assumes that the prevailing wind direction is always from source to receiver, which is likely to overestimate sound from the Proposed Developments for much of the time for the vast majority of NSRs, given the predominant wind direction in the UK is from the south-west.

7.3.38 Based upon the predicted sound levels from the model, an assessment of potential impacts at nearby NSR has been undertaken using the guidance in BS 4142:2014+A1:2019 'Methods for rating and assessing industrial and commercial sound' (BSI, 2014c).

7.3.39 A key aspect of the BS 4142 (BSI, 2014c) assessment procedure is a comparison between the *'background sound level'* in the vicinity of residential locations and the *'rating level'* of the sound source under consideration. The relevant parameters in this instance are as follows:

- *background sound level* – $L_{A90,T}$ – defined in the Standard as the "*A-weighted sound pressure level that is exceeded by the residual sound for 90% of a given time interval, T, measured using time weighting F and quoted to the nearest whole number of decibels*";
- *specific sound level* – *L*s ($L_{Aeq,Tr}$) – the "*equivalent continuous A-weighted sound pressure level produced by the specific sound source at the assessment location over a given reference time interval, Tr*"; and
- *rating level* – $L_{Ar,Tr}$ – the "*specific sound level plus any adjustment made for the characteristic features of the sound*".

7.3.40 BS 4142 (BSI, 2014c) allows for corrections to be applied based upon the presence or expected presence of the following:

- tonality: up to +6 dB penalty;
- impulsivity: up to +9 dB penalty (this can be summed with tonality penalty); and
- other sound characteristics (neither tonal nor impulsive but still distinctive): +3 dB penalty.

7.3.41 Once any adjustments have been made, the *background sound level* and the *rating level* are compared. The standard states that:

> *"Typically, the greater the difference, the greater the magnitude of impact.*
>
> *A difference of around +10 dB or more is likely to be an indication of a significant adverse impact, depending on the context.*
>
> *A difference of around +5 dB is likely to be an indication of an adverse impact, depending on the context.*
>
> *The lower the rating level is relative to the measured background sound level, the less likely it is that the specific sound will have an adverse impact or a significant adverse impact. Where the rating level does not exceed the background sound level, this is an indication of the specific sound source having a low impact, depending on the context."*

7.3.42 Importantly, as suggested above, BS 4142 (BSI, 2014c) requires that the *rating level* of the sound source under assessment be considered in the context of the environment when defining the overall significance of the impact.

7.3.43 BS 4142 (BSI, 2014c) suggests that a one-hour assessment period is considered during the day and a 15-minute assessment period at night.

7.3.44 Table 7.8 illustrates the adopted magnitude of impact scale used in this assessment based upon the numerical level difference. For BS 4142 (BSI, 2014c) assessment purposes, the SOAEL is set at a *rating level* above the *background sound level* of +10 dB, and the LOAEL at +5 dB, although it should be remembered that the context assessment (including the absolute level of the sound under consideration) can vary the overall classification of effects.

**Table 7.8: Magnitude of impact for industrial sound**

| Magnitude of impact | BS 4142 descriptor | *Rating level* minus *background sound level* (dB) |
|---|---|---|
| High | No BS 4142 descriptor for this magnitude level | >15 |
| Medium | Indication of a significant adverse impact, depending upon context | +10 approx. |
| Low | Indication of an adverse impact, depending upon context | +5 approx. |

| Magnitude of impact | BS 4142 descriptor | *Rating level* minus *background sound level* (dB) |
|---|---|---|
| Very low | Indication of low impact, depending upon context | ≤ 0 |

7.3.45 It is intended for the Proposed Developments that the *rating level* will be limited to no greater than +5 dB above the *background sound level* in order to not exceed the LOAEL. Achieving no greater than the LOAEL would ensure that significant adverse effects are avoided, and that other adverse effects are minimised; primary and secondary aims of NPSE. However, both Phillips 66 and VPI are aiming to achieve a lower *rating level* of +3 dB above *background sound level* where practicable.

## Assessment of Road Traffic Noise During the Operational Phase

7.3.46 The traffic generation associated with the operational phase of the Proposed Developments is predicted to be limited and has been scoped out of the transport assessment as stated in ES Chapter 8: Traffic and Transport (ES Volume I) and therefore is not considered further in this chapter.

## Assessment of Operational Vibration Impacts

7.3.47 No significant sources of vibration are likely to be present due to the Proposed Developments and given the distances to the residential NSRs, it is not anticipated that vibration levels will be significant. Therefore, further assessment of operational vibration is scoped out of this assessment.

## Receptor Sensitivity

7.3.48 Effects are classified based on the magnitude of the impact (as outlined above for the various potential impacts during construction and operation) and the sensitivity or value of the affected receptor. A scale of receptor sensitivity is presented in Table 7.9.

**Table 7.9: Sensitivity/ value of receptors**

| Sensitivity/ value of receptor | Description | Examples of receptor usage |
|---|---|---|
| Very high | Receptors where noise or vibration will significantly affect the function of a receptor | Auditoria/ studios<br>Specialist medical/ teaching centres, or laboratories with highly sensitive equipment |
| High | Receptors where people or operations are particularly susceptible to noise or vibration | Residential<br>Quiet outdoor areas used for recreation<br>Conference facilities<br>Schools/ educational facilities in the daytime<br>Hospitals/ residential care homes<br>Libraries |
| Medium | Receptors moderately sensitive to noise or vibration where it may cause some distraction or disturbance | Offices<br>Restaurants/ retail<br>Sports grounds when spectators or noise is not a normal part of the event and where quiet conditions are necessary (e.g. tennis, golf) |
| Low | Receptors where distraction or disturbance of people | Residences and other buildings not occupied during working hours |

| Sensitivity/ value of receptor | Description | Examples of receptor usage |
|---|---|---|
| | from noise or vibration is minimal | Factories and working environments with existing high noise levels<br>Sports grounds when spectators or noise is a normal part of the event |

## Classification of Effects

7.3.49 Impacts are defined as changes arising from the Proposed Developments, and consideration of the result of these impacts on environmental receptors enables the identification of associated effects, and their classification (major, moderate, minor and negligible, and adverse, neutral or beneficial). Each effect has been classified both before and after mitigation measures have been applied.

7.3.50 The following terminology has been used in the assessment to define effects:

- adverse – detrimental or negative effects to an environmental resource or receptor;
- neutral – effects to an environmental resource or receptor that are neither adverse nor beneficial; or
- beneficial – advantageous or positive effect to an environmental resource or receptor.

7.3.51 The effect resulting from each individual potential impact type above is classified according to the magnitude of the impact and the sensitivity or value of the affected receptor using the matrix presented in Table 7.10 below, but where necessary also considering the context of the acoustic environment.

**Table 7.10: Significance of Effects Matrix**

| Magnitude of Impact | Sensitivity of Receptor | | | |
|---|---|---|---|---|
| | Low | Medium | High | Very High |
| High | Minor | Moderate | Major | Major |
| Medium | Minor | Minor | Moderate | Major |
| Low | Negligible | Negligible | Minor | Moderate |
| Very Low | Negligible | Negligible | Negligible | Minor |

7.3.52 Where adverse or beneficial effects have been identified, these have been assessed against the following significance scale, derived using the matrix presented in Table 7.10.

- negligible – imperceptible effect of no significant consequence;
- minor – slight, very short or highly localised effect of no significant consequence;
- moderate – limited effect (by extent, duration or magnitude), which may be considered significant; or
- major – considerable effect (by extent, duration or magnitude) of more than local significance or in breach of recognised acceptability, legislation, policy or standards.

7.3.53 For the purposes of this assessment, negligible and minor effects are considered to be not significant, whereas moderate and major effects are considered to be significant. Where necessary the context of the acoustic environment has also been considered in determining the classification of effect.

## Data Sources

7.3.54 The following sources of information that define the Proposed Developments have been reviewed and form the basis of the assessment of likely significant effects of sound, noise and vibration from the Proposed Developments:

- Chapter 3: Proposed Developments Description, Need and Alternatives Considered;
- Chapter 4: Construction Programme and Management;
- Indicative Layout 3D Model and Block Plan for the Proposed Phillips 66 Development as provided by Phillips 66's design team;
- Indicative Layout and Zoning Plan for the Proposed VPI Development as provided by VPI's design team;
- items of plant including sound power level data for the Proposed Phillips 66 Development as provided by Phillips 66's design team;
- items of plant including sound power level data for Proposed VPI Development as provided by VPI's design team ;
- AAWT traffic data from the Transport Assessment (TA) (Appendix 8A ES Volume II) for the construction phase of the Proposed Developments; and
- Ordnance Survey (OS) MasterMap mapping, topographical data (LiDAR data) and aerial photography of the Proposed Developments and surrounding area.

## Use of Rochdale Envelope

7.3.55 The assessment of sound, noise and vibration has been undertaken using the Rochdale Envelope approach having regard to the Planning Inspectorate (PINS) Advice Note 9 (PINS, 2018). The Rochdale Envelope is applicable where some of the details of a Proposed Developments are not able to be confirmed when an application is submitted and flexibility is needed to address design uncertainty. The three key principles an assessment should adopt are as follows:

- use a cautious worst-case approach;
- the level of information assessed should be sufficient to enable the likely significant effects of a proposed development to be assessed; and
- the allowance for flexibility should not be abused to provide inadequate descriptions of projects.

7.3.56 In line with these principles, the following approach has been taken for the construction stage:

- within each of the Sites, plant has been distributed across the development site and adjacent laydown areas;
- 24-hour construction is proposed at the Phillips 66 Site, with plant assumed to be in constant operation as a worst-case scenario (see Appendix 9A: Construction Noise Assessment Methodology (ES Volume II)); and
- construction activities and plant for the Proposed VPI Development have been assumed to be in constant operation through the 07:00 to 19:00 working day and Saturday 08:00 to 13:00 (see Appendix 9A: Construction Noise Assessment Methodology (ES Volume II)).

7.3.57 The following approach has been taken for the operational assessment:

- for each of the Sites a block/ zoning plan was used to identify approximate locations for each piece of plant. The closest location for the closest receptor in each block has been used for predicting worst-case sound levels at the NSRs.
- The free-field design criterion assumed for each piece of sound producing plant at each site is provided in Appendix 7C. There are different sound levels for equipment (e.g. fans) between the two developments due to differences in design, specification or size.

7.3.58 In relation to both construction noise and operational sound effects, mitigation, if considered necessary, would be integrated into the detailed design, in order to meet the limits to be agreed at the nearest NSR.

### Consultation

7.3.59 The EIA scoping opinion stated *'the general approach to the noise and vibration assessment is supported. The noise assessment which will accompany the ES will include the following:*

- *construction and decommissioning noise and vibration impacts (including impacts related to traffic on public roads);*
- *operational noise impacts from the Proposed Developments, including the potential air-cooling infrastructure; and*
- *operational noise impacts from road traffic on public roads'*.

7.3.60 The scoping opinion confirmed that operational traffic related noise impacts can be scoped out of the assessment if justification can be provided.

7.3.61 The scoping response also states '*the methodology and details regarding the assessment will be agreed in advance with North Lincolnshire Council'.*

7.3.62 During the public consultation, concerns were raised about the noise impacts on residential properties during construction and regarding operational traffic impacts (see the Consultation Report submitted to accompany the Applications).

7.3.63 The Environmental Protection Officer at North Lincolnshire Council has been contacted to confirm the assessment methodology adopted in the assessment.

## 7.4 Baseline Conditions

### Existing Baseline

7.4.1 The existing baseline sound climate in the vicinity of the Proposed Developments is dominated by sound from the industrial/ commercial operations at the Phillips 66 Humber Refinery and VPI Immingham CHP Plant and other nearby industrial operations as well as rail noise and road traffic noise from A160 and other local roads.

7.4.2 In order to help further define the existing sound conditions at NSRs, *ambient* and *background sound level* measurements have been undertaken at four representative residential locations (NSRs 1-4). The monitoring locations are shown on Figure 7.1 (ES Volume III).

7.4.3 Sound level monitoring was undertaken to the requirements of BS 7445 1: 2003 'Description and measurement of environmental noise. Guide to quantities and procedures' (BSI, 2003), in particular regarding instrumentation and monitoring methodology.

7.4.4 All measurements were taken at approximately 1.5 m above ground level, and were positioned at least 3.5 m from any reflecting surface, other than the ground (i.e. free-field measurements). Each sound level meter was set to log the $L_{AF10}$, $L_{Aeq}$, $L_{AF90}$ and $L_{AFmax}$ parameters.

7.4.5 The observations shown in Table 7.11 are the general baseline sound environment at each monitoring location recorded during the set-up and collection of the equipment.

**Table 7.11: Sound climate observations at receptors**

| Receptor | Sound Climate Observations |
|---|---|
| NSR 1 – Staple Road | Noise from Phillips 66 Humber Refinery, wind generated noise. |
| NSR 2 – Clarkes Road | Noise from Phillips 66 Humber Refinery, bird song and nearby railway. |

| Receptor | Sound Climate Observations |
|---|---|
| NSR 3 – Church Lane | Sound from Phillips 66 Humber Refinery, together with other sources including bird song, wind generated noise, power tools and local residents. |
| NSR 4 – Hazel Dene | Sound from VPI Immingham CHP Plant, together with other sources include bird song, distant road traffic, trains, industrial moving sounds e.g. cranes. |

7.4.6 The weather conditions during the survey periods were all within the parameters set out in the relevant guidance documents including BS 7445 (BSI, 2003) and BS 4142 (BSI, 2014c). The weather conditions are summarised for each location in Appendix 7A (ES Volume II).

7.4.7 The sound level meters and associated microphones were field calibrated at the beginning and end of their respective measurement periods in accordance with recommended practice. No significant drift in calibration was observed. The accuracy of the calibrator can be traced to the National Physical Laboratory Standards. Full details of the equipment used can be found in Appendix 7A (ES Volume II).

7.4.8 Section 8.1.1 of BS 4142 states that *background sound level* should be determined in *"weather conditions that are representative or comparable to the weather conditions when the specific sound occurs"*. The propagation of sound from outdoor sources is significantly influenced by the weather. In particular the propagation down wind of a source can be 10 to 15 dB greater than that upwind. The prediction methodology used to derive the *specific sound level* for all noise sources (based on ISO 9613 (ISO 1996)) assumes downwind conditions to the receptor. Therefore, the predicted *specific sound levels* will only occur when the receptor is downwind of the source. Representative *background sound levels* must therefore be measured in similar conditions. The dataset was therefore filtered so that only measurement sessions where the average wind direction was within a 120 degree arc (60 degrees each side) of the downwind condition were included for further analysis.

7.4.9 Section 8.1.4 of BS 4142 states that to obtain a representative value the dataset should be analysed statistically and then a judgment made. It clearly states that the lowest measured level should not be taken as representative. Therefore, after filtering for wind direction as described above the remaining levels were analysed and a representative value was selected.

7.4.10 The results from the baseline sound surveys are provided in Table 7.12. Surveys were undertaken during April and May 2022 during operational periods. The $L_{Aeq}$ values presented in Table 7.12 combine all measurements taken in each time period (e.g. day/ night), whilst the $L_{AF90}$ values presented are the 'representative' BS 4142 *background sound levels*, determined from analysis of the measured values.

**Table 7.12: Baseline sound levels**

| Receptor | Time Period | $L_{Aeq,T}$ dB | $L_{AF90,\ 15min}$ dB |
|---|---|---|---|
| NSR 1 – Staple Road | Daytime | 54 | 49 |
| | Night-time | 52 | 48 |
| NSR 2 – Clarkes Road | Daytime | 52 | 46 |
| | Night-time | 50 | 45 |
| NSR 3 – Church Lane | Daytime | 52 | 46 |
| | Night-time | 49 | 45 |
| NSR 4 – Hazel Dene | Daytime | 55 | 50 |
| | Night-time | 55 | 51 |

### Future Baseline

7.4.11 In the absence of the Proposed Developments, future baseline sound levels at NSRs will continue to be influenced by traffic flows on surrounding road and rail networks, operations at Phillips 66, VPI and other industrial/ commercial premises, plus any future developments in the area.

## 7.5 Development Design and Impact Avoidance

### Construction Noise

7.5.1 The proposed construction programme and working hours are described in Chapter 4: Construction Programme and Management (ES Volume I). However, it is likely that some construction works for the Proposed VPI Development may need to take place outside of the normal working hours and could be 24/7, although these would be limited to manage critical periods where required. Where on-site works are to be conducted outside the normal construction working hours, they will comply with any restrictions agreed with the local planning authority regarding control of noise. Normal construction working hours for the Proposed Phillips 66 Development could be 24/7 where required as per the existing Humber Refinery operating and maintenance working hours.

7.5.2 Measures to mitigate noise will be implemented during the construction phase of the Proposed Developments in order to minimise impacts at local NSRs and ecological receptors, particularly with respect to activities required outside of core working hours. Mitigation (included in the Outline CEMP) shall include, but not be limited to:

- abiding by agreed construction noise limits at locations to be agreed with NLC;
- ensuring that processes are in place to minimise noise before works begin and ensuring that BPM are being achieved throughout the construction programme, including the use of localised screening around significant noise producing plant and activities;
- ensuring that modern plant is used, complying with applicable UK noise emission requirements, and selection of inherently quiet plant where possible;
- use of hydraulic techniques for breaking, in preference to percussive techniques where reasonably practicable;
- use of lower noise piling (e.g. rotary bored or hydraulic jacking) rather than driven piling techniques, where reasonably practicable;
- off-site pre-fabrication for components of the Proposed Developments, where reasonably practicable;
- all plant and equipment being used for the works to be properly maintained, silenced where appropriate, operated to prevent excessive noise and switched off when not in use;
- all contractors to be made familiar with current legislation and the guidance in BS 5228 (Parts 1 and 2) (BSI, 2014a and b), which should form a prerequisite of their appointment;
- loading and unloading of vehicles, dismantling of site equipment such as scaffolding or moving equipment or materials within the Sites to be conducted in such a manner as to minimise noise generation, as far as reasonably practicable;
- appropriate routing of construction traffic on public roads and along access tracks, to reduce construction traffic noise, as far as reasonably practicable (see Chapter 8: Traffic and Transport ES Volume I);
- provision of information to NLC and local residents to advise of potential noisy works that are due to take place; and
- monitoring of any noise complaints and reporting to the Applicant for immediate investigation.

7.5.3 Method statements regarding construction management, traffic management, and overall site management will be prepared in accordance with best practice and relevant British Standards, to help to reduce the impacts of construction works. One of the key aims of such method statements will be to minimise noise disruption to local residents during the construction phase as far as reasonably practicable.

7.5.4 Regular communication with the local community throughout the construction period will also serve to publicise the works schedule, giving notification to residents regarding periods when higher levels of noise may occur during specific operations, and providing lines of communication where any complaints can be addressed.

7.5.5 The selected contractors for each of the Proposed Developments would be encouraged to be a member of the 'Considerate Constructors Scheme', which is an initiative open to all contractors undertaking building work.

7.5.6 As mentioned above, a Final CEMP will be prepared for each of the Proposed Developments which will set out provisions to ensure that the noise and vibration impacts relating to construction activities are reduced, as far as reasonably practicable, based on the measures outlined above. An Outline CEMP is provided as Appendix 4A (ES Volume II).

7.5.7 To assist in the preparation of the Final CEMP for each of the Proposed Developments, a detailed noise and vibration assessment will be undertaken for each of the Proposed Developments once the contractor is appointed and further details of construction methods are known, in order to identify specific mitigation measures for each of the Proposed Developments.

## Carbon Dioxide and Other Venting During Commissioning and Operation

7.5.8 A $CO_2$ venting system will be designed to collect and safely disperse abnormal $CO_2$ releases generated in the Proposed Developments and needing to be discharged during start up venting, emergency venting or for safety reasons, for example due to plant over-pressurisation situations or due to maintenance activities. This venting system will comprise:

- small individual vents for minor emissions from equipment e.g. during routine maintenance;
- larger vents sized to safely dispose of larger volume emissions in an emergency scenario. The sizing of these vents is subject to ongoing work and would be confirmed at detailed design stage; and
- venting of steam lines and traps.

7.5.9 No planned operational venting of $CO_2$ or steam lines is expected during normal operation of the Proposed Developments and it is considered that noise associated with minor $CO_2$ venting from the Proposed Developments would be not significant in the context of the prevailing acoustic environment and in any event would be controlled by the Environmental Permit.

7.5.10 Measures to mitigate noise associated with any $CO_2$ venting during commissioning will include those listed above for construction.

7.5.11 As $CO_2$ venting during operation would only take place during emergency scenarios, it is not considered that any further consideration of effects or potential mitigation is required within this noise assessment for this activity.

## Operational Noise

7.5.12 During the detailed design stage, potential significant residual effects of industrial sound will be mitigated by location and design. This will include appropriate stack design, use of cladding and shielding where appropriate and, where practical siting of equipment away from site boundaries and NSRs.

7.5.13 The Sites will be operated in accordance with Environmental Permits, issued and regulated by the Environment Agency. This will require operational noise to be controlled through the use of BAT, which will be determined through the Environmental Permit application.

### Decommissioning Noise and Vibration

7.5.14 Appropriate best practice mitigation measures will be applied during any decommissioning works and documented in a Decommissioning Environmental Management Plan (DEMP) for each of the Proposed Developments to control noise effects. This is proposed to be secured by planning condition. No additional mitigation for decommissioning of the Proposed Developments beyond such best practice is considered necessary at this stage. The predicted noise and vibration effects of eventual decommissioning of the Proposed Developments are considered to be comparable to, or less than, those assessed for construction activities.

## 7.6 Likely Impacts and Effects of the Proposed Developments

### Construction Phase Noise

7.6.1 Construction noise levels are likely to vary during the different construction phases, depending on the location of work sites and the proximity to NSRs.

7.6.2 Based upon the analysis and summary of the results of the free-field baseline ambient sound surveys undertaken, Table 7.13 sets out the BS 5228 'ABC' noise threshold categories and construction noise criteria (BSI, 2014a) at each NSR for the day, evening and night-time periods as set out in Table 7.4. A 3 dB correction has been added to measured free-field levels to present façade levels in the below table. These noise thresholds apply to both the Proposed Phillips 66 Development and Proposed VPI Development as well as the Proposed Developments together. Provided these construction noise criteria are not exceeded, the construction noise levels at NSRs will be below the SOAEL.

**Table 7.13: Façade $L_{Aeq,T}$ noise levels and associated "ABC" assessment category**

| Receptor | Time Period | $L_{Aeq,T}$ dB | ABC Category | Indicative Construction Noise Criteria / SOAEL values |
|---|---|---|---|---|
| NSR 1 – Staple Road | Daytime* | 57 | A | 65 |
| | Evening* | 54 | A | 55 |
| | Weekend* | 56 | B | 60 |
| | Night-time* | 55 | C | 55 |
| NSR 2 – Clarkes Road | Daytime | 55 | A | 65 |
| | Evening | 52 | A | 55 |
| | Weekend | 53 | A | 55 |
| | Night-time | 53 | C | 55 |
| NSR 3 – Church Lane | Daytime | 55 | A | 65 |
| | Evening | 52 | A | 55 |
| | Weekend | 54 | A | 55 |

| Receptor | Time Period | $L_{Aeq,T}$ dB | ABC Category | Indicative Construction Noise Criteria / SOAEL values |
|---|---|---|---|---|
| | Night-time | 52 | C | 55 |
| NSR 4 – Hazel Dene | Daytime | 58 | A | 65 |
| | Evening | 53 | A | 55 |
| | Weekend | 56 | B | 60 |
| | Night-time | 58 | C | 55 |

*Daytime is Monday to Friday 07:00 to 19:00 and Saturdays 07:00 to 13:00

Evening is Monday to Friday 19:00 to 23:00

Weekend is Saturday 13:00 to 23:00 and Sunday 07:00 to 23:00

Night is 23:00 to 07:00

## Construction Noise Predictions

7.6.3 The following have been identified as the main construction phases which have the potential to affect NSRs:

- Phase 1 Enabling and Earthworks;
- Phase 2 Foundations (including CFA piling); and
- Phase 3 Mechanical and Electrical works.

7.6.4 The noise levels that will be generated by construction activities and experienced by nearby NSRs, such as residential properties, will depend upon a number of variables, including:

- the noise generated by plant or equipment used on each of the Sites, generally expressed as sound power levels;
- the periods of use of the plant on each of the Sites, known as its 'on-time';
- the distance between the noise source and the NSR;
- the attenuation due to ground absorption, air absorption and any barrier effects; and
- the existing noise environment and noise levels at the time of the works.

7.6.5 The construction noise predictions reported in this assessment have been undertaken using noise data for items of plant and calculation methodologies from BS 5228-1. Predicted noise levels for construction of the Proposed Developments have been based on construction methods used for similar developments in the UK. This gives an indication of where, at what stage, and during which construction activities construction noise is at risk of leading to potentially adverse and significant adverse effects.

7.6.6 The predicted levels apply to weekday daytime (07:00 – 19:00) working, although these could also be applied to other time periods where working at the same rate and intensity is proposed. The predictions assume constant operation of equipment throughout the 07:00 – 19:00 period which is a conservative worst-case assumption. Details regarding the noise prediction methodology, including a full list of indicative construction plant and associated sound power levels ($L_{Aw}$) for each construction phase, together with assumptions made during the predictions, are presented in Appendix 7B (ES Volume II).

7.6.7 Predictions have been carried out assuming all of the plant for each phase is operating at the same time, therefore presenting a worst-case scenario, as not all of the plant will be operating all of the time.

7.6.8 Predictions have also been carried out assuming that the phases occur concurrently. The worst case predicted construction noise levels at the NSRs are provided individually for both the Proposed Phillips 66 Development and the Proposed VPI Development, as well as the combined noise levels of the construction of both the Proposed Developments taking place at the same time.

7.6.9 The daytime construction noise contours (Figures 7.2a-c) are free-field construction: noise levels at ground floor level (1.5 m above ground) using 20 m x 20 m grid and are provided for illustration purposes.

## Phillips 66 Construction Noise

7.6.10 For the Proposed Phillips 66 Development, 24-hour construction is proposed as work at Phillips 66 Humber Refinery already takes place 24 hours a day, 7 days per week. Therefore, the predicted façade construction noise levels during the daytime, evening, weekend and night-time periods have been included in Table 7.14.

7.6.11 The predicted daytime construction noise levels have been assumed, as a conservative approach, to be the equivalent to weekend daytime, evening and night-time levels. The daytime, evening and weekend construction noise levels have been predicted a ground floor level and the night-time construction noise levels have been predicted at first floor level (representative of bedrooms).

7.6.12 The predicted construction noise levels at NSRs are summarised in Table 7.14. The values in **bold** indicate where the construction noise threshold is exceeded.

**Table 7.14: Predicted façade construction noise levels, Proposed Phillips 66 Development**

| Receptor | Time Period | Predicted Construction Noise Levels $L_{Aeq,T}$, dB (façade) | | | | | |
|---|---|---|---|---|---|---|---|
| | | Phase 1 Enabling & Earthworks | Phase 2 Foundations | Phase 3 Mechanical & Electrical | Phase 1 & 2 | Phase 2 & 3 | All Phases |
| NSR 1 – Staple Road | Daytime | 58 | 60 | 56 | 62 | 61 | 63 |
| | Evening | **58** | **60** | **56** | **62** | **61** | **63** |
| | Weekend | 58 | 60 | 56 | **62** | **61** | **63** |
| | Night-time | **60** | **61** | **58** | **64** | **63** | **65** |
| NSR 2 – Clarkes Road | Daytime | 54 | 56 | 53 | 59 | 58 | 60 |
| | Evening | 54 | **56** | 53 | **59** | **58** | **60** |
| | Weekend | 54 | **56** | 53 | **59** | **58** | **60** |
| | Night-time | 55 | **57** | 54 | **59** | **58** | **60** |
| NSR 3 – Church Lane | Daytime | 55 | 57 | 54 | 59 | 59 | 61 |
| | Evening | 55 | **57** | 54 | **59** | **59** | **61** |
| | Weekend | 55 | **57** | 54 | **59** | **59** | **61** |
| | Night-time | **56** | **58** | 54 | **60** | **59** | **61** |
| NSR 4 – Hazel Dene | Daytime | 48 | 50 | 47 | 52 | 52 | 53 |
| | Evening | 48 | 50 | 47 | 52 | 52 | 53 |

| Receptor | Time Period | Predicted Construction Noise Levels $L_{Aeq,T,}$ dB (façade) | | | | | |
|---|---|---|---|---|---|---|---|
| | | Phase 1 Enabling & Earthworks | Phase 2 Foundations | Phase 3 Mechanical & Electrical | Phase 1 & 2 | Phase 2 & 3 | All Phases |
| | Weekend | 48 | 50 | 47 | 52 | 52 | 53 |
| | Night-time | 49 | 51 | 47 | 53 | 52 | 54 |

7.6.13 The effects of the predicted daytime construction noise levels (as presented in Table 7.14) have been compared against the absolute construction noise criteria in Table 7.13, and using the semantic scale in Table 7.5, the classification of effects is summarised in Table 7.15 below.

### Table 7.15: Construction noise effects – Proposed Phillips 66 Development

| Receptor | Time Period | Predicted Effect | | | | | |
|---|---|---|---|---|---|---|---|
| | | Phase 1 Enabling & Earthworks | Phase 2 Foundations | Phase 3 Mechanical & Electrical | Phase 1 & 2 | Phase 2 & 3 | All Phases |
| NSR 1 – Staple Road | Daytime | Negligible adverse (not significant) | Negligible adverse (not significant) | Negligible adverse (not significant) | Minor adverse (not significant) | Minor adverse (not significant) | Minor adverse (not significant) |
| | Evening | **Moderate adverse (significant)** | **Major adverse (significant)** | **Moderate adverse (significant)** | **Major adverse (significant)** | **Major adverse (significant)** | **Major adverse (significant)** |
| | Weekend | Minor adverse (not significant) | Minor adverse (not significant) | Minor adverse (not significant) | **Moderate adverse (significant)** | **Moderate adverse (significant)** | **Moderate adverse (significant)** |
| | Night-time | **Major adverse (significant)** | **Major adverse (significant)** | **Moderate adverse (significant)** | **Major adverse (significant)** | **Major adverse (significant)** | **Major adverse (significant)** |
| NSR 2 – Clarkes Road | Daytime | Negligible adverse (not significant) | Negligible adverse (not significant) | Negligible adverse (not significant) | Negligible adverse (not significant) | Negligible adverse (not significant) | Negligible adverse (not significant) |
| | Evening | Minor adverse (not significant) | **Moderate adverse (significant)** | Minor adverse (not significant) | **Moderate adverse (significant)** | **Moderate adverse (significant)** | **Major adverse (significant)** |
| | Weekend | Minor adverse (not significant) | **Moderate adverse (significant)** | Minor adverse (not significant) | **Moderate adverse (significant)** | **Moderate adverse (significant)** | **Major adverse (significant)** |
| | Night-time | Minor adverse (not significant) | **Moderate adverse (significant)** | Minor adverse (not significant) | **Moderate adverse (significant)** | **Moderate adverse (significant)** | **Major adverse (significant)** |
| NSR 3 – Church Lane | Daytime | Negligible adverse (not significant) | Negligible adverse (not significant) | Negligible adverse (not significant) | Negligible adverse (not significant) | Negligible adverse (not significant) | Minor adverse (not significant) |
| | Evening | Minor adverse (not significant) | **Moderate adverse (significant)** | Minor adverse (not significant) | **Moderate adverse (significant)** | **Moderate adverse (significant)** | **Major adverse (significant)** |

| Receptor | Time Period | Predicted Effect | | | | | |
|---|---|---|---|---|---|---|---|
| | | Phase 1 Enabling & Earthworks | Phase 2 Foundations | Phase 3 Mechanical & Electrical | Phase 1 & 2 | Phase 2 & 3 | All Phases |
| | Weekend | Minor adverse (not significant) | **Moderate adverse (significant)** | Minor adverse (not significant) | **Moderate adverse (significant)** | **Moderate adverse (significant)** | **Major adverse (significant)** |
| | Night-time | **Moderate adverse (significant)** | **Moderate adverse (significant)** | Minor adverse (not significant) | **Major adverse (significant)** | **Moderate adverse (significant)** | **Major adverse (significant)** |
| NSR 4 – Hazel Dene | Daytime | Negligible adverse (not significant) | Negligible adverse (not significant) | Negligible adverse (not significant) | Negligible adverse (not significant) | Negligible adverse (not significant) | Negligible adverse (not significant) |
| | Evening | Negligible adverse (not significant) | Negligible adverse (not significant) | Negligible adverse (not significant) | Minor adverse (not significant) | Minor adverse (not significant) | Minor adverse (not significant) |
| | Weekend | Negligible adverse (not significant) | Negligible adverse (not significant) | Negligible adverse (not significant) | Negligible adverse (not significant) | Negligible adverse (not significant) | Negligible adverse (not significant) |
| | Night-time | Negligible adverse (not significant) | Minor adverse (not significant) | Negligible adverse (not significant) | Minor adverse (not significant) | Minor adverse (not significant) | Minor adverse (not significant) |

7.6.14 Construction noise effects at the above NSRs during the daytime periods are predicted to be **negligible or minor adverse** (**not significant**). Phillips 66 has indicated that some construction works may take place during the evening, weekend and night-time periods.

7.6.15 At NSR 1, NSR 2 and NSR 3 there is the potential for **moderate and major adverse** (**significant**) effects during some of the phases of construction works during the evening weekend and night-time periods, especially when one or more phases may take place concurrently.

7.6.16 At NSR 4 there are no exceedances of the construction noise criteria during any assessment period, resulting in **negligible or minor adverse** (**not significant**) effects.

## VPI Construction Noise

7.6.17 For the VPI development 24-hour construction may be required for some construction activities. Therefore, the predicted façade construction noise levels during the daytime, evening, weekend and night-time periods have been predicted.

7.6.18 The predicted daytime construction noise levels have been assumed, as a conservative approach, to be the equivalent to weekend daytime, evening and night-time levels. The daytime, evening and weekend construction noise levels have been predicted a ground floor level and the night-time construction noise levels have been predicted at first floor level (representative of bedrooms).

7.6.19 The predicted construction noise levels at NSRs are summarised in Table 7.16. The values in bold indicate where the construction threshold is exceeded.

**Table 7.16: Predicted façade construction noise level – Proposed VPI Development**

| Receptor | Time Period | Predicted Construction Noise Levels $L_{Aeq,T}$, dB (façade) | | | | | |
|---|---|---|---|---|---|---|---|
| | | Phase 1 Enabling & Earthworks | Phase 2 Foundations | Phase 3 Mechanical & Electrical | Phase 1 & 2 | Phase 2 & 3 | All Phases |
| NSR 1 – Staple Road | Daytime | 49 | 48 | 48 | 51 | 51 | 53 |
| | Evening | 49 | 48 | 48 | 51 | 51 | 53 |
| | Weekend | 49 | 48 | 48 | 51 | 51 | 53 |
| | Night-time | 45 | 44 | 44 | 47 | 47 | 49 |
| NSR 2 – Clarkes Road | Daytime | 48 | 46 | 46 | 50 | 49 | 51 |
| | Evening | 48 | 46 | 46 | 50 | 49 | 51 |
| | Weekend | 48 | 46 | 46 | 50 | 49 | 51 |
| | Night-time | 48 | 47 | 47 | 50 | 50 | 52 |
| NSR 3 – Church Lane | Daytime | 48 | 47 | 48 | 51 | 50 | 52 |
| | Evening | 48 | 47 | 48 | 51 | 50 | 52 |
| | Weekend | 48 | 47 | 48 | 51 | 50 | 52 |

| Receptor | Time Period | Predicted Construction Noise Levels $L_{Aeq,T,}$ dB (façade) | | | | | |
|---|---|---|---|---|---|---|---|
| | | Phase 1 Enabling & Earthworks | Phase 2 Foundations | Phase 3 Mechanical & Electrical | Phase 1 & 2 | Phase 2 & 3 | All Phases |
| | Night-time | 49 | 47 | 48 | 51 | 50 | 52 |
| NSR 4 – Hazel Dene | Daytime | 61 | 59 | 60 | **63** | **63** | **65** |
| | Evening | **61** | **59** | **60** | **63** | **63** | **65** |
| | Weekend | **61** | 59 | 60 | **63** | **63** | **65** |
| | Night-time | **62** | **60** | **61** | **64** | **64** | **66** |

7.6.20 The effects of the predicted daytime construction noise levels (as presented in Table 7.16) have been compared against the absolute construction noise criteria in Table 7.13 and using the semantic scales in Table 7.5, the classification of effects is summarised in Table 7.17 below.

### Table 7.17: Predicted construction noise effects – Proposed VPI Development

| Receptor | Time Period | Predicted Effect | | | | | |
|---|---|---|---|---|---|---|---|
| | | Phase 1 Enabling & Earthworks | Phase 2 Foundations | Phase 3 Mechanical & Electrical | Phase 1 & 2 | Phase 2 & 3 | All Phases |
| NSR 1 – Staple Road | Daytime | Negligible adverse (not significant) | Negligible adverse (not significant) | Negligible adverse (not significant) | Negligible adverse (not significant) | Negligible adverse (not significant) | Negligible adverse (not significant) |
| | Evening | Negligible adverse (not significant) | Negligible adverse (not significant) | Negligible adverse (not significant) | Minor adverse (not significant) | Minor adverse (not significant) | Minor adverse (not significant) |
| | Weekend | Negligible adverse (not significant) | Negligible adverse (not significant) | Negligible adverse (not significant) | Negligible adverse (not significant) | Negligible adverse (not significant) | Negligible adverse (not significant) |
| | Night-time | Negligible adverse (not significant) | Negligible adverse (not significant) | Negligible adverse (not significant) | Negligible adverse (not significant) | Negligible adverse (not significant) | Negligible adverse (not significant) |
| NSR 2 – Clarkes Road | Daytime | Negligible adverse (not significant) | Negligible adverse (not significant) | Negligible adverse (not significant) | Negligible adverse (not significant) | Negligible adverse (not significant) | Negligible adverse (not significant) |
| | Evening | Negligible adverse (not significant) | Negligible adverse (not significant) | Negligible adverse (not significant) | Negligible adverse (not significant) | Negligible adverse (not significant) | Minor adverse (not significant) |
| | Weekend | Negligible adverse (not significant) | Negligible adverse (not significant) | Negligible adverse (not significant) | Negligible adverse (not significant) | Negligible adverse (not significant) | Minor adverse (not significant) |
| | Night-time | Negligible adverse (not significant) | Negligible adverse (not significant) | Negligible adverse (not significant) | Negligible adverse (not significant) | Negligible adverse (not significant) | Minor adverse (not significant) |
| NSR 3 – Church Lane | Daytime | Negligible adverse (not significant) | Negligible adverse (not significant) | Negligible adverse (not significant) | Negligible adverse (not significant) | Negligible (not significant) | Negligible adverse (not significant) |
| | Evening | Negligible adverse (not significant) | Negligible adverse (not significant) | Negligible adverse (not significant) | Minor adverse (not significant) | Negligible adverse (not significant) | Minor adverse (not significant) |
| | Weekend | Negligible adverse (not significant) | Negligible adverse (not significant) | Negligible adverse (not significant) | Minor adverse (not significant) | Negligible adverse (not significant) | Minor adverse (not significant) |

| Receptor | Time Period | Predicted Effect | | | | | |
|---|---|---|---|---|---|---|---|
| | | Phase 1 Enabling & Earthworks | Phase 2 Foundations | Phase 3 Mechanical & Electrical | Phase 1 & 2 | Phase 2 & 3 | All Phases |
| | Night-time | Negligible adverse (not significant) | Negligible adverse (not significant) | Negligible adverse (not significant) | Minor adverse (not significant) | Negligible adverse (not significant) | Minor adverse (not significant) |
| NSR 4 – Hazel Dene | Daytime | Minor adverse (not significant) | Negligible adverse (not significant) | Negligible adverse (not significant) | Minor adverse (not significant) | Minor adverse (not significant) | Minor adverse (not significant) |
| | Evening | **Major adverse (significant)** | **Moderate adverse (significant)** | **Major adverse (significant)** | **Major adverse (significant)** | **Major adverse (significant)** | **Major adverse (significant)** |
| | Weekend | **Moderate adverse (significant)** | Minor adverse (not significant) | Minor adverse (not significant) | **Moderate adverse (significant)** | **Moderate adverse (significant)** | **Major adverse (significant)** |
| | Night-time | **Major adverse (significant)** | **Major adverse (significant)** | **Major adverse (significant)** | **Major adverse (significant)** | **Major adverse (significant)** | **Major adverse (significant)** |

7.6.21 Construction noise effects at the above NSRs during the daytime periods are predicted to be **negligible or minor** (**not significant**).

7.6.22 At NSR 4 there is the potential for **moderate and major adverse** (**significant**) effects during some of the phases of construction works during the evening, weekend and night-time periods, especially when one or more phases may take place concurrently.

7.6.23 At NSR 1, NSR 2 and NSR 3 there are no exceedances of the construction noise criteria during any assessment period, resulting in **negligible or minor adverse** (**not significant**) effects.

## Combined Construction Noise of the Proposed Developments

7.6.24 The combined assessment of the construction works for both the Proposed Phillips 66 Development and the Proposed VPI Development occurring at the same time have been predicted.

7.6.25 The predicted daytime construction noise levels have been assumed, as a conservative approach, to be the equivalent to weekend daytime, evening and night-time levels. The daytime, evening and weekend construction noise levels have been predicted a ground floor level and the night-time construction noise levels have been predicted at first floor level (representative of bedrooms).

7.6.26 The predicted construction noise levels at NSRs are summarised in Table 7.18. The values in bold indicate where the construction threshold is exceeded.

**Table 7.18: Predicted façade construction noise levels –Proposed Developments**

| Receptor | Time Period | Predicted Construction Noise Levels $L_{Aeq,T}$, dB (façade) | | | | | |
|---|---|---|---|---|---|---|---|
| | | Phase 1 Enabling & Earthworks | Phase 2 Foundations | Phase 3 Mechanical & Electrical | Phase 1 & 2 | Phase 2 & 3 | All Phases |
| NSR 1 – Staple Road | Daytime | 58 | 60 | 57 | 62 | 62 | 63 |
| | Evening | **58** | **60** | **57** | **62** | **62** | **63** |
| | Weekend | 58 | 60 | 57 | **62** | **62** | **63** |
| | Night-time | **60** | **62** | **59** | **64** | **63** | **65** |
| NSR 2 – Clarkes Road | Daytime | 55 | 57 | 54 | 59 | 59 | 60 |
| | Evening | 55 | **57** | 54 | **59** | **59** | **60** |
| | Weekend | 55 | **57** | 54 | **59** | **59** | **60** |
| | Night-time | **56** | **57** | 54 | **59** | **59** | **61** |
| NSR 3 – Church Lane | Daytime | 56 | 58 | 55 | 60 | 60 | 61 |
| | Evening | **56** | **58** | 55 | **60** | **60** | **61** |
| | Weekend | **56** | **58** | 55 | **60** | **60** | **61** |
| | Night-time | **56** | **58** | 55 | **60** | **60** | **61** |
| | Daytime | 61 | 60 | 60 | 64 | 63 | 65 |

| Receptor | Time Period | Predicted Construction Noise Levels $L_{Aeq,T,}$ dB (façade) | | | | | |
|---|---|---|---|---|---|---|---|
| | | Phase 1 Enabling & Earthworks | Phase 2 Foundations | Phase 3 Mechanical & Electrical | Phase 1 & 2 | Phase 2 & 3 | All Phases |
| NSR 4 – Hazel Dene | Evening | **61** | **60** | **60** | **64** | **63** | **65** |
| | Weekend | **61** | 60 | 60 | **64** | **63** | **65** |
| | Night-time | **62** | **61** | **61** | **64** | **64** | **66** |

7.6.27 The effects of the predicted construction noise levels (as presented in Table 7.18) have been compared against the absolute construction noise criteria in Table 7.13, and using the semantic scales in Table 7.5, the classification of effects is summarised in Table 7.19 below.

HUMBERZERO

## Table 7.19: Predicted Construction noise effects – Proposed Developments

| Receptor | Time Period | Predicted Effect | | | | | |
|---|---|---|---|---|---|---|---|
| | | Phase 1 Enabling & Earthworks | Phase 2 Foundations | Phase 3 Mechanical & Electrical | Phase 1 & 2 | Phase 2 & 3 | All Phases |
| NSR 1 – Staple Road | Daytime | Negligible adverse (not significant) | Negligible adverse (not significant) | Negligible adverse (not significant) | Minor adverse (not significant) | Minor adverse (not significant) | Minor adverse (not significant) |
| | Evening | **Moderate adverse (significant)** | **Major adverse (significant)** | **Moderate adverse (significant)** | **Major adverse (significant)** | **Major adverse (significant)** | **Major adverse (significant)** |
| | Weekend | Minor adverse (not significant) | Minor adverse (not significant) | Minor adverse (not significant) | **Moderate adverse (significant)** | **Moderate adverse (significant)** | **Moderate adverse (significant)** |
| | Night-time | **Major adverse (significant)** | **Major adverse (significant)** | **Moderate adverse (significant)** | **Major adverse (significant)** | **Major adverse (significant)** | **Major adverse (significant)** |
| NSR 2 – Clarkes Road | Daytime | Negligible adverse (not significant) | Negligible adverse (not significant) | Negligible adverse (not significant) | Negligible adverse (not significant) | Negligible adverse (not significant) | Negligible adverse (not significant) |
| | Evening | Minor adverse (not significant) | **Moderate adverse (significant)** | Minor adverse (not significant) | **Moderate adverse (significant)** | **Moderate adverse (significant)** | **Major adverse (significant)** |
| | Weekend | Minor adverse (not significant) | **Moderate adverse (significant)** | Minor adverse (not significant) | **Moderate adverse (significant)** | **Moderate adverse (significant)** | **Major adverse (significant)** |
| | Night-time | **Moderate adverse (significant)** | **Moderate adverse (significant)** | Minor adverse (not significant) | **Moderate adverse (significant)** | **Moderate adverse (significant)** | **Major adverse (significant)** |

| Receptor | Time Period | Predicted Effect | | | | | |
|---|---|---|---|---|---|---|---|
| | | Phase 1 Enabling & Earthworks | Phase 2 Foundations | Phase 3 Mechanical & Electrical | Phase 1 & 2 | Phase 2 & 3 | All Phases |
| NSR 3 – Church Lane | Daytime | Negligible adverse (not significant) | Negligible adverse (not significant) | Negligible adverse (not significant) | Negligible adverse (not significant) | Negligible adverse (not significant) | Minor adverse (not significant) |
| | Evening | **Moderate adverse (significant)** | **Moderate adverse (significant)** | Minor adverse (not significant) | **Major adverse (significant)** | **Major adverse (significant)** | **Major adverse (significant)** |
| | Weekend | **Moderate adverse (significant)** | **Moderate adverse (significant)** | Minor adverse (not significant) | **Major adverse (significant)** | **Major adverse (significant)** | **Major adverse (significant)** |
| | Night-time | **Moderate adverse (significant)** | **Moderate adverse (significant)** | Minor adverse (not significant) | **Major adverse (significant)** | **Major adverse (significant)** | **Major adverse (significant)** |
| NSR 4 – Hazel Dene | Daytime | Minor adverse (not significant) | Negligible adverse (not significant) | Negligible adverse (not significant) | Minor adverse (not significant) | Minor adverse (not significant) | Minor adverse (not significant) |
| | Evening | **Major adverse (significant)** | **Major adverse (significant)** | **Major adverse (significant)** | **Major adverse (significant)** | **Major adverse (significant)** | **Major adverse (significant)** |
| | Weekend | **Moderate adverse (significant)** | Minor adverse (not significant) | Minor adverse (not significant) | **Moderate adverse (significant)** | **Moderate adverse (significant)** | **Major adverse (significant)** |
| | Night-time | **Major adverse (significant)** | **Major adverse (significant)** | **Major adverse (significant)** | **Major adverse (significant)** | **Major adverse (significant)** | **Major adverse (significant)** |

7.6.28 Construction noise effects at the above NSRs during the daytime periods are predicted to be **negligible or minor adverse** (**not significant**).

7.6.29 At all NSRs there is the potential for **moderate** and **major adverse** (**significant**) effects during some of the phases of construction works during the evening, weekend and night-time periods, especially when one or more phases may take place concurrently.

## Construction Traffic Noise for the Proposed Developments

7.6.30 As reported in Chapter 8 Traffic and Transport, the peak period for construction traffic is expected in 2025. The CRTN traffic noise BNL on nine local roads has been calculated 'with' and 'without' construction traffic, using 18 AAWT traffic data provide by the Transport Consultant from traffic models reported in Chapter 8: Traffic and Transport (ES Volume I).

7.6.31 It has been assumed as a worst-case approach that the traffic speeds will remain the same 'with' and 'without' the construction traffic. The difference between the 'with' and 'without' construction traffic BNL has been compared to the short-term change criteria in noise levels as shown in Table 7.6.

7.6.32 The potential changes in road traffic noise as result of the construction traffic from the Proposed Developments as a whole is presented in Table 7.20. The change in road traffic noise levels due to each development individually would be smaller, therefore the results presented are a worst case.

### Table 7.20: Changes in road traffic noise as a result of construction of the Proposed Developments

| Link | 'Without' the Proposed Developments construction flows (2025) | | | 'With' the Proposed Developments construction flows (2025) | | | Change in BNL, dB ('with'- 'without') | Magnitude of Impact |
|---|---|---|---|---|---|---|---|---|
| | AAWT | % HGV | Speed (km/h) | AAWT | % HGV | Speed (km/h) | | |
| Ropser Road | 4,657 | 30 | 64 | 4,801 | 29 | 64 | 0.1 | Negligible |
| Eastfield Road | 8,201 | 12 | 45 | 10,011 | 12 | 45 | 0.9 | Negligible |
| A160 Humber Road (near Killingholme Primary School) | 15,112 | 51 | 75 | 16,910 | 46 | 75 | 0.5 | Negligible |
| A180 (near Ulceby Skitter) | 31,190 | 37 | 99 | 32,727 | 36 | 99 | 0.2 | Negligible |
| A180 (near Immingham) | 13,203 | 16 | 87 | 13,427 | 16 | 87 | 0.1 | Negligible |
| A1173 Manby Road | 9,394 | 13 | 65 | 9,473 | 13 | 65 | 0.0 | Negligible |
| A160 Humber Road (south of Phillips 66 Site) | 12,569 | 52 | 83 | 12,812 | 52 | 83 | 0.1 | Negligible |
| Humber Road | 11,473 | 21 | 49 | 11,550 | 21 | 49 | 0.0 | Negligible |
| A15 | 25,284 | 9 | 88 | 26,031 | 9 | 88 | 0.1 | Negligible |

7.6.33 Table 7.20 shows that there is very small increase in road traffic noise due to construction traffic along the construction routes of the Proposed Developments during the peak construction phase. These will result in **negligible adverse** effects (**not significant**) at local residential NSRs. Based upon the above, no specific mitigation measures are required beyond those listed in Section 7.5.

## Construction Phase Vibration

7.6.34 There are no residential receptors in close proximity to the Proposed Developments which have the potential to be affected by construction vibration. However, there is the potential for some vibration impacts upon buildings/ structures within the existing Phillips 66 or VPI Sites. It is considered unlikely that most typical construction working routines would generate levels of vibration above which building damage, as set out in Section 7.3, would be a possibility.

7.6.35 If piling, heavy earthworks, vibratory rollers or other significant vibration producing operations are proposed in close proximity to any existing sensitive buildings, further consideration will be given to potential impacts, once the contractors are appointed and the construction methods and requirements are developed. As the construction of the Proposed Developments and the use of many of the existing buildings and structures within the Phillips 66 and VPI Sites are both within the control of the Applicants, any identified issues can be effectively managed by the Applicants and their contractor. Potential measures to ensure that appropriate mitigation is in place during the works are discussed in Section 7.5 and Section 7.7.

## Operation Phase

### Operational Sound Criteria

7.6.36 Using the representative *background sound levels* presented in Table 7.12 and following the approach proposed by the Applicants, operational sound criteria are set as the *rating level* at the NSRs. As stated in paragraph 7.3.45, *rating level* will be limited to no greater than +5 dB above the *background sound level* in order to not exceed the LOAEL.

7.6.37 Table 7.21 presents the operational sound criteria, in the form of a *rating level*, for each of the Proposed Developments.

**Table 7.21: Operational Sound Criteria (*Rating Levels*, $L_{Ar,Tr}$ dB)**

| Receptor | Time Period | Phillips 66: *Background Sound Level* + 5 dB | VPI: *Background Sound Level* + 5 dB |
|---|---|---|---|
| NSR 1 – Staple Road | Daytime | 54 | 54 |
| | Night-time | 53 | 53 |
| NSR 2 – Clarkes Road | Daytime | 51 | 51 |
| | Night-time | 50 | 50 |
| NSR 3 – Church Lane | Daytime | 51 | 51 |
| | Night-time | 50 | 50 |
| NSR 4 – Hazel Dene | Daytime | 55 | 55 |
| | Night-time | 56 | 56 |

## BS 4142 Assessment

7.6.38 The predictions of operational sound from the Proposed Developments have been based on information provided by the Applicants' engineering design teams. This information has included sound power levels for the major sound sources and details of the acoustic performance of noise mitigation measures already embedded into the designs. Using the Rochdale Envelope principle, reasonable worst-case operational sound impacts and effects are presented. The data are summarised in Appendix 7C (ES Volume II) which also lists the assumptions applied to the prediction methodology.

7.6.39 In accordance with BS 4142:2014 (BSI 2014c) the daytime assessment considers a 1-hour period, and the night-time assessment considers a 15-minute period. When in operation the sound produced by the plant will be constant in nature. As the plant may operate at any time of day or night the predicted *specific sound levels* will be the same for both day and night. No on-time correction is applicable due to the continuous nature of the operation. The predicted free-field operational *specific sound levels* at the NSRs during the daytime have been predicted at the ground floor and the night-time levels have been predicted at the upper floor.

7.6.40 The assessment has assumed that the potential sound of a tonal, impulsive or intermittent nature will be designed out of the Proposed Developments during the detailed design phase by the selection of appropriate plant, building cladding, louvres and silencers/ attenuators as necessary. However, a +3 dB correction for has been included at this stage to account for the potential, as a conservative approach, that NSRs might identify 'other distinctive character' in the new sound source in the future acoustic environment.

7.6.41 The daytime operational noise contours (Figures 7.3 a-c) present free-field operational sound levels at ground floor level (1.5 m above ground), and the night-time operational noise contours (Figures 7.4 a-c) present free-field operational sound levels at first floor (4 m above ground). All Figures use 20 m x 20 m grids and are provided for illustration purposes.

## Proposed Phillips 66 Development

7.6.42 In the absence of additional mitigation, the predicted free-field operational *specific sound levels* at the NSRs around the Proposed Phillips 66 Development are presented in Table 7.22 below.

**Table 7.22: Predicted Operational Sound Levels – Proposed Phillips 66 Development**

| Receptor | Daytime *specific sound level* $L_{Aeq,Tr}$ dB | Night-time *specific sound level* $L_{Aeq,Tr}$ dB |
|---|---|---|
| NSR 1 – Staple Road | 57 | 57 |
| NSR 2 – Clarkes Road | 53 | 54 |
| NSR 3 – Church Lane | 55 | 55 |
| NSR 4 – Hazel Dene | 42 | 45 |

**The daytime BS 4142 assessments are presented in Table 7.23 and the night-time BS 4142 assessments are presented in**

7.6.43 Table 7.24. The magnitude of impact and significance of effect classifications have been included in the tables, to provide context for the BS 4142 assessment outcomes, with reference to the semantic scales in Table 7.8, Table 7.9 and Table 7.10.

7.6.44 The values presented are the difference between the representative *background sound level* at each NSR (Table 7.12) and the predicted *rating level* (the *specific sound level* $L_{Aeq,Tr}$ presented in Table 7.22 plus the character correction). Positive values in the table indicate an excess of the *rating level* over the *background sound level*.

### Table 7.23: Daytime BS4142 assessment without additional mitigation – Proposed Phillips 66 Development

| Receptor | NSR 1 – Staple Road | NSR 2 – Clarkes Road | NSR 3 – Church Lane | NSR 4 – Hazel Dene |
|---|---|---|---|---|
| *Specific sound level* $L_s$ ($L_{Aeq,Tr}$), dB | 57 | 53 | 55 | 42 |
| Acoustic feature correction, dB | +3 | +3 | +3 | +3 |
| *Rating level* ($L_{Ar,Tr}$), dB | 60 | 56 | 58 | 45 |
| Representative *background sound level* ($L_{A90,T}$), dB | 49 | 46 | 46 | 50 |
| Excess of *rating level* over *background sound level* ($L_{Ar,Tr}$ - $L_{A90,T}$), dB | +11 | +10 | +12 | -5 |
| BS 4142:2014 impact category (assigned from Table 7.8) | Indication of a significant adverse impact, depending upon context | Indication of a significant adverse impact, depending upon context | Indication of a significant adverse impact, depending upon context | Indication of low impact |
| Magnitude of impact (assigned from Table 7.8) | Medium | Medium | Medium | Very low |
| Initial classification of effect (assigned from Table 7.10) | **Moderate adverse** (significant) | **Moderate adverse** (significant) | **Moderate adverse** (significant) | Negligible adverse (not significant) |

### Table 7.24: Night-time BS4142 assessment without additional mitigation – Proposed Phillips 66 Development

| Receptor | NSR 1 – Staple Road | NSR 2 – Clarkes Road | NSR 3 – Church Lane | NSR 4 – Hazel Dene |
|---|---|---|---|---|
| *Specific sound level* $L_s$ ($L_{Aeq,Tr}$), dB | 57 | 54 | 55 | 45 |
| Acoustic feature correction, dB | +3 | +3 | +3 | +3 |
| *Rating level* ($L_{Ar,Tr}$), dB | 60 | 57 | 58 | 48 |
| Representative *background sound level* ($L_{A90,T}$), dB | 48 | 45 | 45 | 51 |
| Excess of *rating level* over *background sound level* ($L_{Ar,Tr}$ - $L_{A90,T}$), dB | +12 | +12 | +13 | -3 |
| BS 4142:2014 impact category (assigned from Table 7.8) | Indication of a significant adverse impact, depending upon context | Indication of a significant adverse impact, depending upon context | Indication of a significant adverse impact, depending upon context | Indication of low impact |

| Receptor | NSR 1 – Staple Road | NSR 2 – Clarkes Road | NSR 3 – Church Lane | NSR 4 – Hazel Dene |
|---|---|---|---|---|
| Magnitude of impact (assigned from Table 7.8) | Medium | Medium | Medium | Very low |
| Initial classification of effect (assigned from Table 7.10) | **Moderate adverse** (significant) | **Moderate adverse** (significant) | **Moderate adverse** (significant) | Negligible adverse (not significant) |

7.6.45 In accordance with Table 7.10, the values in Table 7.23 and

7.6.46 Table 7.24 for the worst-case scenario produce a range of impact magnitudes from very low to medium adverse at the NSRs. This would result in effects between **negligible adverse (not significant)** to **moderate adverse (significant)**, subject to consideration of context.

7.6.47 Phillips 66 and VPI are already a continuously operating industrial source in the study area, and there are other industrial/ commercial activities around the Sites. This is likely to mean that residents at all NSR are already accustomed to industrial sources. Nevertheless, based upon the desire to reduce *rating levels* to +3 dB, or where not possible no greater than +5 dB, above the *background sound level* to achieve the operational sound criteria in Table 7.21, potential mitigation options to reduce sound levels have been considered and are discussed in Section 7.7.

## Proposed VPI Development

7.6.48 In the absence of additional mitigation, the predicted free-field operational *specific sound levels* at the NSR around the Proposed VPI Development are presented in Table 7.25 below.

**Table 7.25: Predicted Operational Sound Levels – Proposed VPI Development**

| Receptor | Daytime *specific sound level* $L_{Aeq,Tr}$ dB | Night-time *specific sound level* $L_{Aeq,Tr}$ dB |
|---|---|---|
| NSR 1 – Staple Road | 44 | 44 |
| NSR 2 – Clarkes Road | 41 | 41 |
| NSR 3 – Church Lane | 43 | 43 |
| NSR 4 – Hazel Dene | 56 | 56 |

7.6.49 The daytime BS 4142 assessments are presented in Table 7.26 and the night-time BS 4142 assessments are presented in Table 7.27. The magnitude of impact and significance of effect classifications have been included in the tables, to provide context for the BS 4142 assessment outcomes, with reference to the semantic scales in Table 7.8, Table 7.9 and Table 7.10.

7.6.50 The values presented are the difference between the representative *background sound level* at each NSR (Table 7.12) and the predicted *rating level* (the *specific sound level* $L_{Aeq,T}$ presented in Table 7.25 plus the character correction). Positive values in the table indicate an excess of the *rating level* over the *background sound level*.

**Table 7.26: Daytime BS4142 assessment without additional mitigation – Proposed VPI Development**

| Receptor | NSR 1 – Staple Road | NSR 2 – Clarkes Road | NSR 3 – Church Lane | NSR 4 – Hazel Dene |
|---|---|---|---|---|
| *Specific sound level* $L_s$ ($L_{Aeq,Tr}$), dB | 44 | 41 | 43 | 56 |

| Receptor | NSR 1 – Staple Road | NSR 2 – Clarkes Road | NSR 3 – Church Lane | NSR 4 – Hazel Dene |
|---|---|---|---|---|
| Acoustic feature correction, dB | +3 | +3 | +3 | +3 |
| *Rating level* ($L_{Ar,Tr}$), dB | 47 | 44 | 46 | 59 |
| Representative *background sound level* ($L_{A90,T}$), dB | 49 | 46 | 46 | 50 |
| Excess of *rating level* over *background sound level* ($L_{Ar,Tr}$ - $L_{A90,T}$), dB | -2 | -2 | +0 | +9 |
| BS 4142:2014 impact category (assigned from Table 7.8) | Indication of low impact | Indication of low impact | Indication of low impact | Indication of a significant adverse impact |
| Magnitude of impact (assigned from Table 7.8) | Very low | Very low | Very low | Medium |
| Initial classification of effect (assigned from Table 7.10) | Negligible adverse (not significant) | Negligible adverse (not significant) | Negligible adverse (not significant) | **Moderate adverse** (significant) |

### Table 7.27: Night-time BS4142 assessment without additional mitigation – Proposed VPI Development

| Receptor | NSR 1 – Staple Road | NSR 2 – Clarkes Road | NSR 3 – Church Lane | NSR 4 – Hazel Dene |
|---|---|---|---|---|
| *Specific sound level* $L_s$ ($L_{Aeq,Tr}$), dB | 44 | 41 | 43 | 56 |
| Acoustic feature correction, dB | +3 | +3 | +3 | +3 |
| *Rating level* ($L_{Ar,Tr}$), dB | 47 | 44 | 46 | 59 |
| Representative *background sound level* ($L_{A90,T}$), dB | 48 | 45 | 45 | 51 |
| Excess of *rating level* over *background sound level* ($L_{Ar,Tr}$ - $L_{A90,T}$), dB | -1 | -1 | +1 | +8 |
| BS 4142:2014 impact category (assigned from Table 7.8) | Indication of low impact | Indication of low impact | Indication of a low to adverse impact, depending upon context | Indication of an adverse to significant adverse impact, depending upon context |
| Magnitude of impact (assigned from Table 7.8) | Very low | Very low | Very Low/Low | Low/Medium |
| Initial classification of effect (assigned from Table 7.10) | Negligible adverse (not significant) | Negligible adverse (not significant) | Negligible/ Minor adverse (not significant) | **Minor/ Moderate adverse** (significant) |

7.6.51 In accordance with Table 7.10, the values in Table 7.26 and Table 7.27 for the worst-case scenario produce a range of impact magnitudes from very low to medium adverse at the NSRs. This would result in effects between **negligible adverse (not significant)** to **moderate adverse** (significant), subject to consideration of context.

7.6.52 Phillips 66 and VPI are already a continuously operating industrial source in the study area, and there are other industrial/ commercial activities around the Sites. This is likely to mean that residents at all NSR are already accustomed to industrial sources. Nevertheless, to achieve the operational noise criteria in Table 7.21, potential mitigation options to reduce sound levels have been considered and are discussed in Section 7.7.

## Combined Operational Sound from the Proposed Developments

7.6.53 In the absence of additional mitigation, the predicted free-field operational *specific sound levels* at the NSRs around the Proposed Developments as a whole are presented in Table 7.28 below.

**Table 7.28: Predicted Operational Sound Levels – Both Proposed Developments – Unmitigated**

| Receptor | Daytime *specific sound level* $L_{Aeq}$ dB | Night-time *specific sound level* $L_{Aeq}$ dB |
|---|---|---|
| NSR 1 – Staple Road | 57 | 57 |
| NSR 2 – Clarkes Road | 53 | 54 |
| NSR 3 – Church Lane | 55 | 55 |
| NSR 4 – Hazel Dene | 56 | 56 |

7.6.54 The daytime BS 4142 assessments are presented in Table 7.29 and the night-time BS 4142 assessments are presented in Table 7.30. The magnitude of impact and effect classification has been included in the tables, to provide context for the BS 4142 assessment outcomes, with reference to the semantic scales in Table 7.8, Table 7.9 and Table 7.10.

7.6.55 The values presented are the differences between the representative *background sound level* at each NSR (Table 7.12) and the predicted *rating level* (the *specific sound level* $L_{Aeq,T}$ presented in Table 7.25 plus the character correction). Positive values in the table indicate an excess of the *rating level* over the *background sound level*.

**Table 7.29: Daytime BS4142 assessment without additional mitigation – Both Proposed Developments**

| Receptor | NSR 1 – Staple Road | NSR 2 – Clarkes Road | NSR 3 – Church Lane | NSR 4 – Hazel Dene |
|---|---|---|---|---|
| *Specific sound level* $L_s$ ($L_{Aeq,Tr}$), dB | 57 | 53 | 55 | 56 |
| Acoustic feature correction, dB | +3 | +3 | +3 | +3 |
| *Rating level* ($L_{Ar,Tr}$), dB | 60 | 56 | 58 | 59 |
| Representative *background sound level* ($L_{A90,T}$), dB | 49 | 46 | 46 | 50 |
| Excess of *rating level* over *background sound level* ($L_{Ar,Tr}$ - $L_{A90,T}$), dB | +11 | +10 | +12 | +9 |

| Receptor | NSR 1 – Staple Road | NSR 2 – Clarkes Road | NSR 3 – Church Lane | NSR 4 – Hazel Dene |
|---|---|---|---|---|
| BS 4142:2014 impact category (assigned from Table 7.8) | Indication of a significant adverse impact, depending upon context | Indication of a significant adverse impact, depending upon context | Indication of a significant adverse impact, depending upon context | Indication of a significant adverse impact, , depending upon context |
| Magnitude of impact (assigned from Table 7.8) | Medium | Medium | Medium | Medium |
| Initial classification of effect (assigned from Table 7.10) | **Moderate adverse** (significant) | **Moderate adverse** (significant) | **Moderate adverse** (significant) | **Moderate adverse** (significant) |

### Table 7.30: Night-time BS4142 assessment without additional mitigation – Both Proposed Developments

| Receptor | NSR 1 – Staple Road | NSR 2 – Clarkes Road | NSR 3 – Church Lane | NSR 4 – Hazel Dene |
|---|---|---|---|---|
| *Specific sound level* $L_s$ ($L_{Aeq,Tr}$), dB | 57 | 54 | 55 | 56 |
| Acoustic feature correction, dB | +3 | +3 | +3 | +3 |
| *Rating level* ($L_{Ar,Tr}$), dB | 60 | 57 | 58 | 59 |
| Representative *background sound level* ($L_{A90,T}$), dB | 48 | 45 | 45 | 51 |
| Excess of *rating level* over *background sound level* ($L_{Ar,Tr}$ - $L_{A90,T}$), dB | +12 | +12 | +13 | +8 |
| BS 4142:2014 impact category (assigned from Table 7.8) | Indication of a significant adverse impact, depending upon context | Indication of a significant adverse impact, depending upon context | Indication of a significant adverse impact, depending upon context | Indication of an adverse to significant adverse impact, depending upon context |
| Magnitude of impact (assigned from Table 7.8) | Medium | Medium | Medium | Low/Medium |
| Initial classification of effect (assigned from Table 7.10) | **Moderate adverse** (significant) | **Moderate adverse** (significant) | **Moderate adverse** (significant) | **Minor/ Moderate adverse** (significant) |

7.6.56 In accordance with Table 7.10, the values in Table 7.29 and Table 7.30 for the worst-case scenario produces an impact magnitude of low/medium or medium at the NSRs. This would result in minor/moderate adverse or moderate adverse (significant) effects, subject to consideration of context.

7.6.57 Phillips 66 and VPI are already a continuously operating industrial source in the study area, and there are other industrial/ commercial activities around the Sites. This is likely to mean that residents at all NSR are already accustomed to industrial sources. Nevertheless, to achieve the operational noise criteria in Table 7.21, potential mitigation options to reduce sound levels have been considered and are discussed in Section 7.7.

### Decommissioning Phase

7.6.58 The potential impacts and effects would require further consideration at the decommissioning stage of the Proposed Developments, but potential measures to ensure that appropriate mitigation is in place during such works are detailed in Section 7.5.

7.6.59 The effects of eventual decommissioning are considered to be comparable to, or less than, those assessed for construction activities.

7.6.60 Decommissioning would require submission of a DEMP to the relevant planning authority for its approval, secured by a planning condition. Appropriate best practice mitigation measures will be applied during any decommissioning works, as described in section 7.5, and documented in a DEMP; no additional mitigation for decommissioning of the Proposed Developments beyond such best practice specified in BS 5228 and section 7.5 is considered necessary to specify at this stage.

## 7.7 Mitigation and Enhancement Measures

### Construction Phase

7.7.1 This assessment has identified no greater than negligible/ minor adverse (not significant) noise effects during construction works during core daytime and Saturday morning working hours, and up to moderate/ major adverse (significant) noise effects if Phillips 66 and/or VPI construction work were to take place at the same intensity during evenings/ night-time and/or weekend periods.

7.7.2 In the event that Phillips 66 and VPI construction activities are required during evening/ night-time periods, levels in excess of the SOAEL for night-time works could occur (depending on the nature of activities undertaken and the intensity of working). This could result in a moderate/ major adverse (significant) noise effect at NSRs in the absence of additional mitigation. Measures would therefore be put in place to control or restrict activities during evenings/ night-times so as to not exceed the SOAEL or relevant noise criteria at locations to be agreed with NLC. Control of construction noise and vibration, for example construction noise and vibration limits, is proposed to be secured by a planning condition. By timing construction works and avoiding noisier activities being undertaken during the evening, weekend and night, significant adverse effects can therefore be avoided.

7.7.3 The list of noise control measures presented within Section 7.5 of this chapter provides a detailed but not exhaustive list of construction noise management measures. The measures listed will be implemented and supplemented as necessary with further bespoke measures identified through further detailed assessment as part of the Final CEMP. With respect to reduction of noise levels, this may include, but is not limited to, use of temporary acoustic barriers and use of a partial enclosures around items of plant. The need for monitoring of noise and vibration levels during construction will also be determined through the detailed assessment to be undertaken.

7.7.4 Residual effects after mitigation is implemented are described in Section 7.8.

### Operation Phase

7.7.5 The operational assessment has assumed that potential sound of a tonal, impulsive or intermittent nature (according to BS4142: 2014) will be designed out of the Proposed Developments during the detailed design phase through the selection of appropriate plant, building cladding, louvres and silencers/ attenuators as necessary. However, a +3 dB correction for has been included at this stage to account for the potential, as a conservative approach, that NSRs might identify ‘other distinctive character’ in the new sound source in the future acoustic environment.

7.7.6 Based on the worst-case results presented in Section 7.6, further mitigation would be required to achieve the operational daytime and night-time LOAEL criterion of a *rating level* no greater than +5 dB above the defined representative *background sound level* at each NSR.

7.7.7 The potential mitigation measures and general principles to achieve this may include, but are not limited to, the following measures, depending upon the potential benefits achieved from such measures:

- reducing the breakout noise from plant through the use of enhanced enclosures, or potentially containing them within a building;
- reducing air inlet noise emissions by the addition of further in-line attenuation;
- reducing stack outlet noise emissions by the addition of silencers or sound proofing panels;
- reducing fin fan cooler noise emissions by screening, re-sizing, fitting low noise fans or attenuation;
- screening or enclosing the compressors or other equipment;
- use of screening or bunding to shield receptors from noise sources; or
- orientation of plant within the Site to provide screening of low-level noise sources by other buildings and structures, or orientating fans and the air inlets away from sensitive receptors.

## Proposed Phillips 66 Development

7.7.8 Table 7.31 outlines the overall attenuation required to achieve the daytime and night-time operational sound criteria i.e. the *rating level* to be no greater than +5 dB above the defined representative *background sound level* at each NSR.

**Table 7.31: Overall attenuation (dB) required to achieve operational sound criteria**

| Receptor | Required attenuation to achieve daytime +5 dB criterion | Required attenuation to achieve night-time +5 dB criterion |
|---|---|---|
| NSR 1 – Staple Road | 6 | 7 |
| NSR 2 – Clarkes Road | 5 | 7 |
| NSR 3 – Church Lane | 7 | 8 |
| NSR 4 – Hazel Dene | - | - |

7.7.9 The sound contribution at each NSR from each modelled sound source across the Proposed Phillips 66 Development has been ranked. The potential attenuation required from the source sound power levels of the key noise emitting plant in order to meet a *rating level* of no greater than +5 dB above the defined representative *background sound level* at each NSR is listed in Table 7.32. These reductions could be achieved either through reduction of sound power level at source or by application of the mitigation measures listed in paragraph 7.7.7 above.

**Table 7.32: Attenuation required (dB) from individual plant items – Proposed Phillips 66 Development**

| Plant Ref. (see Appendix 7C for plant details) | Attenuation required to achieve a *rating level* no greater than +5 dB above the defined *background sound level* |
|---|---|
| P66-33, P66-34, P66-35, P66-36, P66-37 | -11 |
| P66-13, P66-51, P66-52， P66-55, P66-58 | -10 |

| Plant Ref. (see Appendix 7C for plant details) | Attenuation required to achieve a *rating level* no greater than +5 dB above the defined *background sound level* |
|---|---|
| P66-39, P66-56, P66-57 | -9 |

7.7.10 During the detailed design of the Proposed Phillips 66 Development it may be desirable or more practical to apply higher attenuation to some plant items/ buildings than listed in Table 7.32 in order to reduce the attenuation applied to other plant items/ buildings and still achieve the +5 dB criterion.

7.7.11 The daytime and night-time BS 4142 assessment results for these mitigated predictions are presented in Table 7.33 and Table 7.34.

**Table 7.33: Daytime BS4142 assessment with additional mitigation (to achieve up to +5dB above the *background sound level*) – Proposed Phillips 66 Development**

| Receptor | NSR 1 – Staple Road | NSR 2 – Clarkes Road | NSR 3 – Church Lane | NSR 4 – Hazel Dene |
|---|---|---|---|---|
| *Specific sound level* $L_s$ ($L_{Aeq,Tr}$), dB | 50 | 45 | 47 | 36 |
| Acoustic feature correction, dB | +3 | +3 | +3 | +3 |
| *Rating level* ($L_{Ar,Tr}$), dB | 53 | 48 | 50 | 39 |
| Representative *background sound level* ($L_{A90,T}$), dB | 49 | 46 | 46 | 50 |
| Excess of *rating level* over *background sound level* ($L_{Ar,Tr}$ - $L_{A90,T}$), dB | +4 | +2 | +4 | -11 |
| BS 4142:2014 effect category (assigned from Table 7.8) | Indication of an adverse impact, depending upon context | Indication of a low to adverse impact, depending upon context | Indication of an adverse impact, depending upon context | Indication of a low impact |
| Magnitude of impact (assigned from Table 7.8) | Low | Very Low/ Low | Low | Very low |
| Initial classification of effect (assigned from Table 7.10) | Minor adverse (not significant) | Negligible/ minor adverse (not significant) | Minor adverse (not significant) | Negligible adverse (not significant) |

**Table 7.34: Night-time BS4142 assessment with additional mitigation (to achieve up to +5 dB above the *background sound level*) – Proposed Phillips 66 Development**

| Receptor | NSR 1 – Staple Road | NSR 2 – Clarkes Road | NSR 3 – Church Lane | NSR 4 – Hazel Dene |
|---|---|---|---|---|
| *Specific sound level* $L_s$ ($L_{Aeq,Tr}$), dB | 50 | 46 | 47 | 37 |
| Acoustic feature correction, dB | +3 | +3 | +3 | +3 |
| *Rating level* ($L_{Ar,Tr}$), dB | 53 | 49 | 50 | 40 |
| Representative *background sound level* ($L_{A90,T}$), dB | 48 | 45 | 45 | 51 |
| Excess of *rating level* over *background sound level* ($L_{Ar,Tr}$ - $L_{A90,T}$), dB | +5 | +4 | +5 | -11 |
| BS 4142:2014 impact category (assigned from Table 7.8) | Indication of an adverse impact, depending upon context | Indication of an adverse impact, depending upon context | Indication of an adverse impact, depending upon context | Indication of low impact |
| Magnitude of impact (assigned from Table 7.8) | Low | Low | Low | Very low |
| Initial classification of effect (assigned from Table 7.10) | Minor adverse (not significant) | Minor adverse (not significant) | Minor adverse (not significant) | Negligible adverse (not significant) |

7.7.12 Residual effects after mitigation has been implemented are described in Section 7.8.

## Proposed VPI Development

7.7.13 Based on the worst-case results presented in Table 7.26 and Table 7.27 mitigation would be required to achieve operational sound levels equal to the LOAEL, or lower, at each NSR. Table 7.35 outlines the overall attenuation required to achieve the daytime and night-time operational sound criteria i.e. the *rating level* to be no greater than +5 dB, above the defined representative *background sound level* at each NSR.

**Table 7.35: Overall attenuation (dB) required to achieve operational sound criteria – Proposed VPI Development**

| Receptor | Required attenuation to achieve daytime +5 dB criterion | Required attenuation to achieve night-time +5 dB criterion |
|---|---|---|
| NSR 1 – Staple Road | - | - |
| NSR 2 – Clarkes Road | - | - |
| NSR 3 – Church Lane | - | - |
| NSR 4 – Hazel Dene | -4 | -3 |

7.7.14 The sound contribution at each receptor from each modelled sound source across the Proposed VPI Development has been ranked. The potential attenuation required from the source sound power levels of the key noise emitting plant in order to meet the operational sound criteria of +5 dB above the *background sound level* is listed in Table 7.36. These reductions could be achieved either through reduction of sound power levels at source or by application of the mitigation measures listed in paragraph 7.7.7 above.

**Table 7.36: Attenuation required (dB) from individual plant items – Proposed VPI Development**

| Plant Ref. (See Appendix 7C for plant details) | Attenuation required to achieve a *rating level* no greater than +5 dB above the *background sound level* |
|---|---|
| VPI-19 | -5 |
| VPI-54 | -10 |
| VPI 99a-99d | -10 |
| VPI 70 | -9 |
| VPI-29-39 | -5 |
| VPI-46-48 | -5 |

7.7.15 During detailed design of the Proposed VPI Development it may be desirable or more practical to apply higher attenuation to some plant items/ buildings than listed in Table 7.32 in order to reduce the attenuation applied to other plant items/ buildings and still achieve the +5 dB.

7.7.16 The daytime and night-time BS 4142 assessment results for these mitigated predictions are presented in Table 7.37 and Table 7.38.

**Table 7.37: Daytime BS4142 assessment with additional mitigation to achieve +5dB above background – Proposed VPI Development**

| Receptor | NSR 1 – Staple Road | NSR 2 – Clarkes Road | NSR 3 – Church Lane | NSR 4 – Hazel Dene |
|---|---|---|---|---|
| *Specific sound level* $L_s$ ($L_{Aeq,Tr}$), dB | 42 | 39 | 41 | 52 |
| Acoustic feature correction, dB | +3 | +3 | +3 | +3 |
| *Rating level* ($L_{Ar,Tr}$), dB | 45 | 42 | 44 | 55 |
| Representative *background sound level* ($L_{A90,T}$), dB | 49 | 46 | 46 | 50 |
| Excess of *rating level* over *background sound level* ($L_{Ar,Tr}$ - $L_{A90,T}$), dB | -4 | -4 | -2 | +5 |
| BS 4142:2014 impact category (assigned from Table 7.8) | Indication of low impact | Indication of low impact | Indication of low impact | Indication of an adverse impact, depending upon context |
| Magnitude of impact (assigned from Table 7.8) | Very low | Very low | Very low | Low |

| Receptor | NSR 1 – Staple Road | NSR 2 – Clarkes Road | NSR 3 – Church Lane | NSR 4 – Hazel Dene |
|---|---|---|---|---|
| Initial classification of effect (assigned from Table 7.10) | Negligible adverse (not significant) | Negligible adverse (not significant) | Negligible adverse (not significant) | Minor adverse (not significant) |

**Table 7.38: Night-time BS4142 assessment with additional mitigation to achieve +3/+5dB above background – Proposed VPI Development**

| Receptor | NSR 1 – Staple Road | NSR 2 – Clarkes Road | NSR 3 – Church Lane | NSR 4 – Hazel Dene |
|---|---|---|---|---|
| *Specific sound level* $L_s$ ($L_{Aeq,Tr}$), dB | 42 | 39 | 41 | 53 |
| Acoustic feature correction, dB | +3 | +3 | +3 | +3 |
| *Rating level* ($L_{Ar,Tr}$), dB | 45 | 42 | 44 | 56 |
| Representative background sound level ($L_{A90,T}$), dB | 48 | 45 | 45 | 51 |
| Excess of *rating level* over *background sound level* ($L_{Ar,Tr}$ - $L_{A90,T}$), dB | -3 | -3 | -1 | +5 |
| BS 4142:2014 effect category (assigned from Table 7.8) | Indication of low effect | Indication of low effect | Indication of low effect | Indication of an adverse impact, depending upon context |
| Magnitude of impact (assigned from Table 7.8) | Very low | Very low | Very low | Low |
| Initial classification of effect (assigned from Table 7.10) | Negligible adverse (not significant) | Negligible adverse (not significant) | Negligible adverse (not significant) | Minor adverse (not significant) |

7.7.17 Residual effects after mitigation has been implemented are described in Section 7.8.

## Combined Proposed Developments

7.7.18 Based on the worst-case results presented in Table 7.29 and Table 7.30, mitigation would be required to achieve operational sound levels equal to the LOAEL at each NSR. Table 7.39 outlines the overall attenuation required to achieve the daytime and night-time operational sound criteria i.e. the *rating level* to be no greater than +5 dB, above the defined representative *background sound level* at each NSR.

**Table 7.39: Overall attenuation (dB) required to achieve operational sound criteria**

| Receptor | Required attenuation to achieve daytime (+5 dB) criterion | Required attenuation to achieve night-time (+5 dB) criterion |
|---|---|---|
| NSR 1 – Staple Road | 6 | 7 |
| NSR 2 – Clarkes Road | 5 | 7 |
| NSR 3 – Church Lane | 7 | 8 |

| Receptor | Required attenuation to achieve daytime (+5 dB) criterion | Required attenuation to achieve night-time (+5 dB) criterion |
|---|---|---|
| NSR 4 – Hazel Dene | 4 | 3 |

7.7.19 The sound contribution at each receptor from each modelled sound source across the Proposed Developments have been ranked. The potential attenuation required from the source sound power levels of the key noise emitting plant in order to meet the operational noise criterion of *rating level* +5 dB above the *background sound level* is listed in Table 7.40. These reductions could be achieved either through reduction of sound power level at source or by application of the mitigation measures listed in paragraph 7.7.7 above.

**Table 7.40: Attenuation required (dB) from individual plant items – Both Proposed Developments**

| Plant Item | Attenuation required to achieve a *rating level* no greater than +5 dB above the defined *background sound level* |
|---|---|
| P66-13, P66-33, P66-34, P66-35, P66-36, P66-37, P66-51, P66-52， P66-55, P66-58, P66-67 | -11 |
| P66-39, P66-56, P66-57 | -10 |
| P66-32 | -8 |
| VPI-19 | -5 |
| VPI-54 | -10 |
| VPI-99a-99d | -10 |
| VPI-70 | -9 |
| VPI-29-39 | -5 |
| VPI 46-48 | -5 |

7.7.20 During detailed design of the Proposed Developments it may be desirable or more practical to apply higher attenuation to some plant items/ buildings than listed in Table 7.32 in order to reduce the attenuation applied to other plant items/ buildings and still achieve the +5 dB criteria.

7.7.21 The daytime and night-time BS 4142 assessment results for these mitigated predictions are presented in Table 7.41 and Table 7.42.

**Table 7.41: Daytime BS4142 assessment with additional mitigation to achieve +5dB above the *background sound level* – Combined Proposed Developments**

| Receptor | NSR 1 – Staple Road | NSR 2 – Clarkes Road | NSR 3 – Church Lane | NSR 4 – Hazel Dene |
|---|---|---|---|---|
| *Specific sound level* $L_s$ ($L_{Aeq,Tr}$), dB | 50 | 45 | 47 | 52 |
| Acoustic feature correction, dB | +3 | +3 | +3 | +3 |
| *Rating level* ($L_{Ar,Tr}$), dB | 53 | 48 | 50 | 55 |

| Receptor | NSR 1 – Staple Road | NSR 2 – Clarkes Road | NSR 3 – Church Lane | NSR 4 – Hazel Dene |
|---|---|---|---|---|
| Representative *background sound level* ($L_{A90,T}$), dB | 49 | 46 | 46 | 50 |
| Excess of *rating level* over background sound level ($L_{Ar,Tr}$ - $L_{A90,T}$), dB | +4 | +2 | +4 | +5 |
| BS 4142:2014 effect category (assigned from Table 7.8) | Indication of an adverse impact, depending upon context | Indication of a low to adverse impact, depending upon context | Indication of an adverse impact, depending upon context | Indication of an adverse impact, depending upon context |
| Magnitude of impact (assigned from Table 7.8) | Low | Very Low/Low | Low | Low |
| Initial classification of effect (assigned from Table 7.10) | Minor adverse (not significant) | Negligible/ minor adverse (not significant) | Minor adverse (not significant) | Minor adverse (not significant) |

**Table 7.42: Night-time BS4142 assessment with additional mitigation to achieve +5dB above the *background sound level* – Combined Proposed Developments**

| Receptor | NSR 1 – Staple Road | NSR 2 – Clarkes Road | NSR 3 – Church Lane | NSR 4 – Hazel Dene |
|---|---|---|---|---|
| *Specific sound level* $L_s$ ($L_{Aeq,Tr}$), dB | 50 | 46 | 47 | 53 |
| Acoustic feature correction, dB | +3 | +3 | +3 | +3 |
| *Rating level* ($L_{Ar,Tr}$), dB | 53 | 49 | 50 | 56 |
| Representative *background sound level* ($L_{A90,T}$), dB | 48 | 45 | 45 | 51 |
| Excess of *rating level* over *background sound level* ($L_{Ar,Tr}$ - $L_{A90,T}$), dB | +5 | +4 | +5 | +5 |
| BS 4142:2014 effect category (assigned from Table 7.8) | Indication of an adverse impact, depending upon context | Indication of an adverse impact, depending upon context | Indication of an adverse impact, depending upon context | Indication of an adverse impact, depending upon context |
| Magnitude of impact (assigned from Table 7.8) | Low | Low | Low | Low |
| Initial classification of effect (assigned from Table 7.10) | Minor adverse (not significant) | Minor adverse (not significant) | Minor adverse (not significant) | Minor adverse (not significant) |

7.7.22 Residual effects after mitigation has been implemented are described in Section 7.8.

## Decommissioning Phase

7.7.23 Consistent with construction mitigation, it has been assumed that relevant best practice mitigation measures would be in place during any decommissioning works. No additional mitigation has been identified as necessary for the decommissioning phase of the Proposed Developments.

# 7.8 Residual Effects and Conclusions

A summary of the likely residual effects, following the implementation of appropriate mitigation to reduce sound, noise and vibration during construction, operation and decommissioning phases, is presented in Table 7.43 below.

### Table 7.43: Summary of effects

| Phase | Description of Effect | Time Period | Significance of Effect (Before Mitigation) | Mitigation Measures | Significance of Effect (After Mitigation) | Duration (short/ medium/ long term) and Reversibility |
|---|---|---|---|---|---|---|
| Construction | Noise effects on residential NSRs during construction of the Proposed Phillips 66 Development | Daytime | **Negligible/ minor adverse** (not significant) | Further detailed assessment and implementation of a CEMP once a contractor appointed and appropriate mitigation is employed such that the BS 5228 ABC noise criteria are met and the section 7.5 mitigation guidance is followed | **Up to minor adverse** (not significant) | Short term, reversible |
| | | Evening, Weekend, Night-time | **Negligible up to major adverse** (significant) | Further detailed assessment and implementation of a CEMP once a contractor appointed and appropriate mitigation is employed such that the BS 5228 ABC noise criteria are met and the section 7.5 mitigation guidance is followed | **Up to minor adverse** (not significant) | Short term, reversible |
| | Noise effects on residential NSRs during construction of the Proposed VPI Development | Daytime | **Negligible/ minor adverse** (not significant) | Further detailed assessment and implementation of a CEMP once a contractor appointed and appropriate mitigation is employed such that the BS 5228 ABC noise criteria are met and the section 7.5 mitigation guidance is followed | **Up to minor adverse** (not significant) | Short term, reversible |
| | | Evening, Weekend, Night-time | **Negligible up to major adverse** (significant) | Further detailed assessment and implementation of a CEMP once a contractor appointed and appropriate mitigation is employed such that the BS 5228 ABC noise criteria are met and the section 7.5 mitigation guidance is followed | **Up to minor adverse** (not significant) | Short term, reversible |

| Phase | Description of Effect | Time Period | Significance of Effect (Before Mitigation) | Mitigation Measures | Significance of Effect (After Mitigation) | Duration (short/ medium/ long term) and Reversibility |
|---|---|---|---|---|---|---|
| | Combined noise effects on residential NSR during construction of both Proposed Developments simultaneously | Daytime | **Negligible/ minor adverse** (not significant) | Further detailed assessment and implementation of a CEMP once a contractor appointed and appropriate mitigation is employed such that the BS 5228 ABC noise criteria are met and the section 7.5 mitigation guidance is followed | **Up to minor adverse** (not significant) | Short term, reversible |
| | | Evening, Weekend, Night-time | **Minor up to major adverse** (significant) | Further detailed assessment and implementation of a CEMP once a contractor appointed and appropriate mitigation is employed such that the BS 5228 ABC noise criteria are met and the section 7.5 mitigation guidance is followed | **Up to minor adverse** (not significant) | Short term, reversible |
| | Noise effects due to construction traffic | All time periods | **Negligible adverse** (not significant) | No further mitigation considered necessary, unless number of proposed construction vehicle movements changes. | **Negligible adverse** (not significant) | Short term, reversible |
| | Vibration effects on existing structures on site | All time periods | **Minor adverse or less** (not significant) | Further assessment once construction methods confirmed and appropriate mitigation implemented so as not to exceed the vibration SOAEL | **Minor adverse or less** (not significant) | Short term, reversible |
| Operation | Effects of operational sound on residential NSRs – Proposed Phillips 66 Development | Daytime and Night-time | **Negligible adverse** (not significant) to **moderate adverse** (significant) | Application of practical mitigation to reduce relevant sound at source to meet the operational sound criteria in Table 7.21 | **Negligible to minor adverse** (not significant) | Long-term, reversible |
| | Effects of operational sound on residential NSRs – Proposed VPI Development | Daytime and Night-time | **Negligible adverse** (not significant) to **moderate adverse** (significant) | Application of practical mitigation to reduce relevant sound at source to meet the operational sound criteria in Table 7.21 | **Negligible to minor adverse** (not significant) | Long-term, reversible |

| Phase | Description of Effect | Time Period | Significance of Effect (Before Mitigation) | Mitigation Measures | Significance of Effect (After Mitigation) | Duration (short/ medium/ long term) and Reversibility |
|---|---|---|---|---|---|---|
| | Combined effects of operational sound on residential NSRs – Both Proposed Developments | Daytime and Night-time | **Minor/ moderate to Moderate adverse** (significant) | Application of practical mitigation to reduce relevant sound at source to meet the operational sound criterion in Table 7.21 | **Minor adverse** (not significant) | Long-term, reversible |
| Decommissioning | Noise effects during decommissioning of the Proposed Phillips 66 Development | All time periods | As detailed above for construction effects. | Further detailed assessment and Decommissioning Environmental Management Plan (DEMP), particularly regarding working outside of daytime working hours. | Further assessment would need to confirm the potential level of effects at NSRs, although they would be expected to be similar or less than those during construction. | Short-term, reversible |
| | Noise effects during decommissioning of the Proposed VPI Development | All time periods | As detailed above for construction effects. | Further detailed assessment and Decommissioning Environmental Management Plan (DEMP), particularly regarding working outside of daytime working hours. | Further assessment would need to confirm the potential level of effects at NSRs, although they would be expected to be similar or less than those during construction. | Short-term, reversible |
| | Combined noise effects during decommissioning of the Both Proposed Developments simultaneously | All time periods | As detailed above for construction effects. | Further detailed assessment and Decommissioning Environmental Management Plan (DEMP), particularly regarding working outside of daytime working hours. | Further assessment would need to confirm the potential level of effects at NSRs, although they would be expected to be similar or less than those during construction. | Short-term, reversible |

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World Health Organisation (2018) *Environmental Noise Guidelines for the European Region.*

# Contents

# 7A. Noise Survey Information

## 7A.1 Monitoring Location 1 (M1) Staple Road

7A.1.1 Table 7A.1 below provides information on the survey location and conditions for M1.

**Table 7A.1: Location M1 survey location details**

| Location M1 | Description |
|---|---|
| Location description and OS grid reference (Easting/Northing) | Melrose, Staple Road, South Killingholme<br>///squaring.nips.rocker<br>515099, 416451 |
| Monitoring date and time | 22/04/2022 13:45 - 03/05/2022 10:56 |
| Monitoring height above ground | 1.5 m |
| Distance to nearest building facade | Greater than 3.5 m |
| Average wind speeds (m/s) | 19 mph on set up |
| Wind direction | NE on set up |
| Temperature (°C) | 14°C on set up |
| Cloud coverage | 0/8 on set up |
| Sound Level Meter and Serial No. | Rion NL-52 386766 calibrated 03 June 2020 |
| Field Calibrator and Serial No. | B&K 4321 2217877 calibrated 15 July 2021 |
| Description of the sound climate | Dominated by Phillips 66 refinery noise and wind |

7A.1.2 Plate 7A.1 below shows a photograph of the monitoring location.

**Plate 7A.1: Location M1 at Staple Road looking towards the receptor**

## 7A.2 Monitoring Location 2 (M2) Clarkes Road

7A.2.1 Table 7A.2 below provides information on the survey location and conditions for M2. A weather monitoring station recording the wind speed, wind direction and rainfall was also set up at M2 for the duration of the monitoring period.

**Table 7A.2: Location M2 survey location details**

| Location M2 | Description |
|---|---|
| Location description and OS grid reference (Easting/Northing) | Westfield Farm, Clarkes Road, North Killingholme<br>///pages.visions.arise<br>514612, 416811 |
| Monitoring date and time | 22/04/2022 15:45 – 03/05/2022 13:30 |
| Monitoring height above ground | 1.5 m |
| Distance to nearest building facade | Greater than 3.5 m |
| Average wind speeds (m/s) | 19 mph on set up |
| Wind direction | NE on set up |
| Temperature (°C) | 14°C on set up |
| Cloud coverage | 0/8 on set up |
| Sound Level Meter and Serial No. | Rion NL-52 386762 calibrated 14 July 2020 |
| Field Calibrator and Serial No. | B&K 4321 2217877 calibrated 15 July 2021 |
| Weather station and Serial No. | RS Hydro Vaisala Weather Transmitter WXT533<br>Serial no. P1540170 and<br>Outpost COBRA2 Series 3G logger<br>Serial no. OP46548 |
| Description of the sound climate | Dominated by Phillips 66 refinery noise. Other sound from nearby railway and birdsong |

7A.2.2 Plate 7A.2 below shows a photograph of the monitoring location.

**Plate 7A.2: Location M2 at Clarkes Road looking towards the receptor**

# 7A.3 Monitoring Location 3 (M3) Church Lane

7A.3.1 Table 7A.3 below provides information on the survey location and conditions for M3.

**Table 7A.3: Location M3 survey location details**

| Location M3 | Description |
|---|---|
| Location description and OS grid reference (Easting/Northing) | Church Lane, North Killingholme<br>///grocers.nips.influencing<br>514655, 417262 |
| Monitoring date and time | 22/04/2022 14:45-03/05/2022 13:55 |
| Monitoring height above ground | 1.5 m |
| Distance to nearest building facade | Greater than 3.5 m |
| Average wind speeds (m/s) | 19 mph on set up |
| Wind direction | NE on set up |
| Temperature (°C) | 14°C on set up |
| Cloud coverage | 0/8 on set up |
| Sound Level Meter and Serial No. | Rion NL-52 1021280 calibrated 13 April 2021 |
| Field Calibrator and Serial No. | B&K 4321 2217877 calibrated 15 July 2021 |
| Description of the sound climate | Dominated by Phillips 66 refinery. Other sound from power tools at nearby residential properties, birds and wind. |

7A.3.2 Plate 7A.3 below shows a photograph of the monitoring location.

**Plate 7A.3: Location M3 Church Lane looking away from receptor**

# 7A.4 Monitoring Location 4 (M4) Hazeldene

7A.4.1 Table 7A.4 below provides information on the survey location and conditions for M4.

**Table 7A.4: Location M4 survey location details**

| Location M4 | Description |
|---|---|
| Location description and OS grid reference (Easting/Northing) | Hazel Dene, Marsh Lane, South Killingholme<br>///sands.inert.shave<br>517336, 417280 |
| Monitoring date and time | 22/04/2022 16:32 – 03/05/2022 14:02 |
| Monitoring height above ground | 1.5 m |
| Distance to nearest building facade | Greater than 3.5 m |
| Average wind speeds (m/s) | 19 mph on set up |
| Wind direction | NE on set up |
| Temperature (°C) | 14°C on set up |
| Cloud coverage | 0/8 on set up |
| Sound Level Meter and Serial No. | Rion NL-52 1021278 Calibrated 20 May 2021 |
| Field Calibrator and Serial No. | B&K 4321 2217877 calibrated 15 July 2021 |
| Description of the sound climate | Dominated by industrial noise (unable to distinguish between VPI and Phillips 66 industrial noise). Other sources include birdsong, railway traffic, distant road traffic. |

7A.4.2 Plate 7A.4 below shows a photograph of the monitoring location.

**Plate 7.4: Location M4 Hazel Dene looking away from receptor**

# Appendix B Noise Modelling Data and Assumptions.

## Noise Model Settings

9.10 SoundPLAN (version 8.2) 3-dimensional acoustic modelling software has been used to predict the $L_{Aeq}$ noise levels from the on-site operational activities of the Phillips 66 PCC plant. Operational noise is predicted using the method described in ISO 9613-2:1996 'Acoustics — Attenuation of sound during propagation outdoors — Part 2: General method of calculation'.

9.11 The following noise modelling parameters, data and assumptions have been used:

- The 3D digital terrain model (DTM) has been created using LiDAR data from www.environment.data.gov.uk [Downloaded 27/05/22].
- Acoustically hard ground which includes roads, other areas of hardstanding and water have been modelled to reflect sound. Acoustically soft ground which includes areas covered in vegetation have been modelled to absorb sound.
- All existing building outlines were taken from the OS MasterMap provided by the client. Existing building heights have been determined using a combination of OS MasterMap Building Height Attribute dataset and a survey of images from Google Earth and Google 'Streetview'.
- The noise levels at the NSRs were at predicted 1.5 m above the ground during the day. For night-time levels were predicted at 4.0 m above ground, representative of first floor level, at Church Lane and Clarkes Road. Night-time predicted noise levels at Hazeldene were at 6.5m representative of third floor level.
- Operational noise from site activities has been modelled using spectral data to allow more accurate prediction of sound propagation. Spectral data have been estimated from the in-built SoundPLAN library, BS 5228 measured levels and measured levels from other AECOM projects. The overall sound pressure level at 1m for each source has been provided by the client for each item of plant.
- Where the location of equipment is unknown or uncertain, a worst-case position on the closest boundary of each "block" or "zone" to the closest receptor has been used.
- The proposed PCC plant stack exhaust has been modelled as an individual point source, located 0.1 m above the top of the stack.

## Phillips 66 Noise Modelling

9.12 The following noise modelling parameters, data and assumptions have been used:

- The layout of the PCC plant design is based upon drawing Project Model Annotation – Main Process Island Annotation (10th Aug 2022).pdf provided by the Worley design team.
- The heights of the proposed sources have been taken from the Navisworks model *'Phillips 66 Humber Zero Project Model – In Progress Model (AECOM – 10th Aug 2022).nwd'* provided by Worley. Some sources were not present on the model but dimensions of these have been provided by the Worley design team.
- Where there is a duty and standby item of plant, only the duty is included in the model.
- The cooling tower cells have been modelled in the same location as the fans they are replacing.
- The fin fans not operating during the night-time period are located furthest away from the NSRs as a worst-case scenario.

Details of source assumptions for the Phillips 66 Site are provided in Table 9.4

### Table 9.4. Noise Data input for the PCC plant

| Plant ref. | Equipment Description | Quantity | Noise Level at 1 m $L_{Aeq,T}$ dB | Dimensions of Source (width x length x height) | Source type | Spectrum reference |
|---|---|---|---|---|---|---|
| P66-3 | P66 H01 Selective Catalytic Reduction (SCR) Package | 1 | 80 | 4 m x 2 m x 6 m | Point source | BS 5228 Table C5.5 Compressor for hand-held pneumatic breaker |
| P66-4 | P66 H01 Ammonia Injection Package | 1 | 80 | 2 m x 2 m x 2 m | Point source | BS 5228 Table C5.5 Compressor for hand-held pneumatic breaker |
| P66-5 | P66 H01 CCU Condensate Spray Water Pump | 1 | 80 | 2 m x 2 m x 2 m | Point source | SoundPLAN library ref 160 Cooling Tower |
| P66-6 | P66 H01 Condensate Transfer Pump | 1 | 80 | 0.5 m x 1.6 m x 0.5 m | Point source | BS 5228 Table C2.45 Water pump |
| P66-7 | P66 H01 Recovered Water Return Pump | 1 | 80 | 0.5 m x 1.6 m x 0.5 m | Point source | BS 5228 Table C2.45 Water pump |
| P66-9 | P66 H01 600# Steam Waste Heat Exchanger | 1 | 80 | 8.7 m x 2.5 m x 1.6 m | Industrial Building | BS 5228 Table C5.5 Compressor for hand-held pneumatic breaker |
| P66-10 | P66 H01 BFW Preheat Economiser | 1 | 80 | 1.1 m x 4.5 m x 2.4 m | Point source | BS 5228 Table C5.5 Compressor for hand-held pneumatic breaker |
| P66-13 | P66 H02 – Piperack (E/W) B&W - Slurry Cooler | 16 fans | 82* | 3.3 m x 3.3 m x 0.85 m | Point source | SoundPLAN library ref 90 Axial flow fan |
| P66-14 | P66 H02 – PTU B&W - Oxidation Blower | 2 | 80 | 0.5 m x 1.7 m x 1 m | Point source | SoundPLAN library ref 90 Axial flow fan |
| P66-15 | P66 H02 – PTU B&W - Oxidation Recirculation Pump | 1 | 80 | 0.5 m x 1.6 m x 0.5 m | Point source | BS 5228 Table C2.45 Water pump |
| P66-16 | P66 H02 – PTU B&W - Treated Water Pump | 1 | 80 | 0.5 m x 1.6 m x 0.5 m | Point source | BS 5228 Table C2.45 Water pump |
| P66-18 | P66 H02 – PTU B&W - Clarifier Unit | 1 | 80 | 6.7 m x 6.7 m x 2.7 m | Industrial Building | BS 5228 Table C2.45 Water pump |
| P66-19 | P66 H02 – PTU B&W - Oxidation Unit | 1 | 80 | 4 m x 4 m x 6.8 m | Industrial Building | BS 5228 Table C2.45 Water pump |
| P66-20 | P66 H02 – PTU B&W - Coagulant Make-up and Dosing Package | 1 | 80 | 1 m x 1 m x 1.8 m | Point source | BS 5228 Table C2.45 Water pump |

| Plant ref. | Equipment Description | Quantity | Noise Level at 1 m $L_{Aeq,T}$ dB | Dimensions of Source (width x length x height) | Source type | Spectrum reference |
|---|---|---|---|---|---|---|
| P66-21 | P66 H02 – PTU<br>B&W - Flocculant Make-up and Dosing Package | 1 | 80 | 1.7 m x 1.7 m x 2 m | Point source | BS 5228 Table C2.45 Water pump |
| P66-23 | P66 H02 – WGS<br>B&W - Slurry Recirculation Pump | 1 | 80 | 0.5 m x 1.6 m x 0.5 m | Point source | BS 5228 Table C2.45 Water pump |
| P66-24 | P66 H02 – WGS<br>B&W - Wet Gas Scrubber Stack Exhaust | 1 | 80 | 2.6 m x 2.6 m x 16.6 m | Point source | SoundPLAN library ref 160 Cooling tower |
| P66-25 | P66 H02 – WGS<br>B&W - Wet Electrostatic Precipitator | 1 | 80 | 6 m x 6 m x 48 m | Industrial Building | SoundPLAN library ref 160 Cooling tower |
| P66-27 | P66 H03 – Abs<br>Shell - $CO_2$ Absorber Inter Cooler Pump | 1 | 80 | 0.5 m x 1.6 m x 0.5 m | Point source | BS 5228 Table C2.45 Water pump |
| P66-28 | P66 H03 – Abs<br>Shell - Wash Water Pump | 1 | 80 | 0.5 m x 1.6 m x 0.5 m | Point source | BS 5228 Table C2.45 Water pump |
| P66-30 | P66 H03 – Abs<br>Shell - $CO_2$ Absorber – Stack Exhaust | 1 | 80 | Point at 66.5 m | Point source | SoundPLAN library ref 160 Cooling tower |
| P66-32 | P66 H03 – Abs<br>Shell - $CO_2$ Absorber | 1 | 80 | 8.15 m x 8.15 m x 53.6 m | Industrial Building | SoundPLAN library ref 160 Cooling tower |
| P66-33 | P66 H03 – Piperack (E/W)<br>Shell - Lean Solvent Cooler | 6 fans | 82* | 3.3 m x 3.3 m x 0.85 m | Point source | SoundPLAN library ref 90 Axial flow fan |
| P66-34 | P66 H03 – Piperack (Main N/S)<br>Shell - $CO_2$ Absorber Inter Cooler | 16 fans | 82* | 3.3 m x 3.3 m x 0.85 m | Point source | SoundPLAN library ref 90 Axial flow fan |
| P66-35 | P66 H03 – Piperack (Main N/S)<br>Shell – Wash Water Cooler | 4 fans | 82* | 3.3 m x 3.3 m x 0.85 m | Point source | SoundPLAN library ref 90 Axial flow fan |

| Plant ref. | Equipment Description | Quantity | Noise Level at 1 m $L_{Aeq,T}$ dB | Dimensions of Source (width x length x height) | Source type | Spectrum reference |
|---|---|---|---|---|---|---|
| P66-36 | P66 H03 – Piperack (Main N/S) Shell – Lean Solvent Cooler | 10 fans | 82* | 3.3 m x 3.3 m x 0.85 m | Point source | SoundPLAN library ref 90 Axial flow fan |
| P66-37 | P66 H03 – Piperack (Small N/S)<br>Shell - Thermal Reclaimer Condenser | 2 fans | 82* | 3.3 m x 3.3 m x 0.85 m | Point source | SoundPlLAN library ref 90 Axial flow fan |
| P66-38 | P66 H03 – Solvent<br>Shell - Rich Solvent Pump | 1 | 80 | 0.5 m x 1.6 m x 0.5 m | Point source | BS 5228 Table C2.45 Water pump |
| P66-39 | P66 H03 – Strip<br>Shell - MVR Compressor | 1 | 90 | 5.4 m x 1.8 m x 4.9 m | Point source | BS 5228 Table C5.5 Compressor for hand-held pneumatic breaker |
| P66-40 | P66 H03 – Strip<br>Shell - Lean Solvent Pump | 1 | 80 | 0.5 m x 1.6 m x 0.5 m | Point source | BS 5228 Table C2.45 Water pump |
| P66-41 | P66 H03 – Strip<br>Shell - $CO_2$ Stripper Reflux Pump | 1 | 80 | 0.5 m x 1.6 m x 0.5 m | Point source | BS 5228 Table C2.45 Water pump |
| P66-42 | P66 H03 – Strip<br>Shell - Stripper Condensate Pump | 1 | 80 | 0.5 m x 1.6 m x 0.5 m | Point source | BS 5228 Table C2.45 Water pump |
| P66-43 | P66 H03 – Strip<br>Shell - $CO_2$ Stripper | 1 | 80 | 5.4 m x 5.4 m x 32 m | Industrial Building | SoundPLAN library ref 160 Cooling tower |
| P66-46 | P66 H03 – TRU<br>Shell - Thermal Reclaimer Vacuum Package | 1 | 80 | 1 m x 5.5 m x 1 m | Industrial Building | SoundPLAN library ref 892 Manure trailer - vacuum pump |
| P66-47 | P66 H03 – TRU<br>Shell - Thermal Reclaimer Reflux Pump | 1 | 80 | 0.5 m x 1.6 m x 0.5 m | Point source | BS 5228 Table C2.45 Water pump |
| P66-48 | P66 H03 – TRU<br>Shell - Thermal Reclaimer Bottom Pump | 1 | 80 | 0.5 m x 1.6 m x 0.5 m | Point source | BS 5228 Table C2.45 Water pump |
| P66-49 | P66 H03 – TRU | 1 | 80 | 0.5 m x 1.6 m x 0.5 m | Point source | BS 5228 Table C2.45 Water pump |

| Plant ref. | Equipment Description | Quantity | Noise Level at 1 m $L_{Aeq,T}$ dB | Dimensions of Source (width x length x height) | Source type | Spectrum reference |
|---|---|---|---|---|---|---|
| | Shell - Thermal Reclaimer Degraded Solvent Pump | | | | | |
| P66-50 | P66 H03 – TRU Shell - Thermal Reclaimer Column | 1 | 80 | 0.84 m x 0.84 m x 13.5 m | Industrial Building | BS 5228 Table C5.5 Compressor for hand-held pneumatic breaker |
| P66-51 | P66 H04 – Piperack (E/W) Shell - $CO_2$ Stripper Condenser | 4 fans | 82* | 3.3 m x 3.3 m x 0.85 m | Point source | SoundPLAN library ref 90 Axial flow fan |
| P66-53 | P66 H05 Recovered Water Distribution Pump | 1 | 80 | 0.5 m x 1.6 m x 0.5 m | Point source | BS 5228 Table C2.45 Water pump |
| P66-54 | P66 H05 Dehydration Unit | 1 | 80 | 2.1 m x 2.1 m x 7 m | Industrial Building | SoundPLAN library ref 11 Power station (boiler & coal mill room) |
| P66-57 | P66 H06 Common HP/LP Compression (Including Ancillaries) | 1 | 90 | 2.3 m x 1.7 m x 4.2 m | Point source | 5228 Table C5.5 Compressor for hand-held pneumatic breaker |
| P66-58 | P66 H06 – Piperack (N/S) Cooling Tower Cell | 4 fans | 80 | 3.3 m x 3.3 m x 0.85 m | Point source | SoundPLAN library ref 90 Axial flow fan |
| P66-59 | P66 H09 Pretreatment Caustic Feed Pump | 1 | 80 | 0.5 m x 1.6 m x 0.5 m | Point source | BS 5228 Table C2.45 Water pump |
| P66-60 | P66 H09 Caustic transfer pump | 1 | 80 | 0.5 m x 1.6 m x 0.5 m | Point source | BS 5228 Table C2.45 Water pump |
| P66-61 | P66 H09 Thermal Reclaimer Caustic Feed Pump | 1 | 80 | 0.5 m x 1.6 m x 0.5 m | Point source | BS 5228 Table C2.45 Water pump |
| P66-65 | P66 H11 Air Compressor | 1 | 80 | 2.3 m x 1.7 m x 4.2 m | Point source | BS 5228 Table C5.5 Compressor for hand-held pneumatic breaker |
| P66-66 | P66 H11 Chiller Package | 1 | 80 | 2.2 m x 6 m x 6.1 m | Point source | BS 5228 Table C5.5 Compressor for hand-held pneumatic breaker |

| Plant ref. | Equipment Description | Quantity | Noise Level at 1 m $L_{Aeq,T}$ dB | Dimensions of Source (width x length x height) | Source type | Spectrum reference |
|---|---|---|---|---|---|---|
| P66-67 | P66 H11<br>Closed Loop Cooling Water Air Cooler | 2 fans | 82* | 3.3 m x 3.3 m x 0.85 m | Point source | SoundPLAN library ref 90 Axial flow fan |
| P66-68 | P66 H11<br>Cooling Water Supply Pump | 1 | 80 | 0.5 m x 1.6 m x 0.5 m | Point source | BS 5228 Table C2.45 Water pump |
| P66-69 | P66 H11<br>Chilled Water Supply Pump | 1 | 80 | 0.5 m x 1.6 m x 0.5 m | Point source | BS 5228 Table C2.45 Water pump |
| P66-70 | P66 H11<br>Steam Electrical Generator | 1 | 90 | 2.2 m x 2.9 m x 7.2 m | Point source | SoundPLAN library ref 10 Power Station (generator turbine hall) |

* Each fan unit is 85 dBA at 1m and contains 2 fans per unit

# Appendix C BS 4142 Assessment Tables

9.13 The following tables present the BS 4142 assessment for the daytime and night-time for NSRs 1-3 for Scenarios 1 and 2. The predicted specific sound level is rounded to whole decibels. The assessment is based on the difference between the representative background sound level and the predicted rating level, $L_{Ar,Tr}$ dB (i.e. the specific sound level $L_{Aeq,Tr}$ plus any character correction) at the NSR. Positive values in the tables indicate an excess of the rating level over the background sound level.

**Table 9.5. Initial BS 4142 Assessment Existing Operations – Scenario 1 (Background sound levels without contribution from Phillips 66)**

| | NSR 1 | | NSR 2 | | NSR 3 | |
|---|---|---|---|---|---|---|
| **Receptor** | **Daytime** | **Night-time** | **Daytime** | **Night-time** | **Daytime** | **Night-time** |
| *Specific sound level* $L_s$ ($L_{Aeq,Tr}$), dB | 54 | 52 | 52 | 50 | 52 | 49 |
| Acoustic feature correction, dB | 0 | 0 | 0 | 0 | 0 | 0 |
| *Rating level* ($L_{Ar,Tr}$), dB | 54 | 52 | 52 | 50 | 52 | 49 |
| Representative *background sound level* ($L_{A90,T}$), dB | 42 | 41 | 42 | 41 | 42 | 41 |
| Excess of *rating level* over *background sound level* ($L_{Ar,Tr}$ - $L_{A90,T}$), dB | 12 | 11 | 10 | 9 | 10 | 8 |
| BS 4142:2014 impact category | An indication of a significant adverse impact, depending on the context | An indication of a significant adverse impact, depending on the context | An indication of a significant adverse impact, depending on the context | An indication of a significant adverse impact, depending on the context | An indication of a significant adverse impact, depending on the context | An indication of a significant adverse impact, depending on the context |

**Table 9.6. Initial BS 4142 Assessment Existing Operations – Scenario 1 (Background sound levels with contribution from Phillips 66)**

| | NSR 1 | | NSR 2 | | NSR 3 | |
|---|---|---|---|---|---|---|
| **Receptor** | **Daytime** | **Night-time** | **Daytime** | **Night-time** | **Daytime** | **Night-time** |
| *Specific sound level* $L_s$ ($L_{Aeq,Tr}$), dB | 54 | 52 | 52 | 50 | 52 | 49 |
| Acoustic feature correction, dB | 0 | 0 | 0 | 0 | 0 | 0 |
| *Rating level* ($L_{Ar,Tr}$), dB | 54 | 52 | 52 | 50 | 52 | 49 |
| Representative *background sound level* ($L_{A90,T}$), dB | 49 | 48 | 46 | 46 | 46 | 45 |
| Excess of *rating level* over *background sound level* ($L_{Ar,Tr}$ - $L_{A90,T}$), dB | 5 | 4 | 6 | 4 | 6 | 4 |
| BS 4142:2014 impact category | An indication of an adverse impact, depending on the context. | An indication of an adverse impact, depending on the context. | An indication of an adverse impact, depending on the context. | An indication of an adverse impact, depending on the context. | An indication of an adverse impact, depending on the context. | An indication of an adverse impact, depending on the context. |

**Table 9.7. Initial BS 4142 Assessment Existing Operations – Scenario 2 (Background sound levels without contribution from Phillips 66)**

| | NSR 1 | | NSR 2 | | NSR 3 | |
|---|---|---|---|---|---|---|
| **Receptor** | **Daytime** | **Night-time** | **Daytime** | **Night-time** | **Daytime** | **Night-time** |
| *Specific sound level* $L_s$ ($L_{Aeq,Tr}$), dB | 57 | 57 | 57 | 57 | 57 | 57 |
| Acoustic feature correction, dB | 0 | 0 | 0 | 0 | 0 | 0 |
| *Rating level* ($L_{Ar,Tr}$), dB | 57 | 57 | 57 | 57 | 57 | 57 |
| Representative *background sound level* ($L_{A90,T}$), dB | 42 | 41 | 42 | 41 | 42 | 41 |
| Excess of *rating level* over *background sound level* ($L_{Ar,Tr}$ - $L_{A90,T}$), dB | 15 | 16 | 15 | 16 | 10 | 16 |
| BS 4142:2014 impact category | An indication of a significant adverse impact, depending on the context. | An indication of a significant adverse impact, depending on the context. | An indication of a significant adverse impact, depending on the context. | An indication of a significant adverse impact, depending on the context. | An indication of a significant adverse impact, depending on the context. | An indication of a significant adverse impact, depending on the context. |

**Table 9.8. Initial BS 4142 Assessment Existing Operations – Scenario 2 (Background sound levels with contribution from Phillips 66)**

| | NSR 1 | | NSR 2 | | NSR 3 | |
|---|---|---|---|---|---|---|
| **Receptor** | **Daytime** | **Night-time** | **Daytime** | **Night-time** | **Daytime** | **Night-time** |
| *Specific sound level* $L_s$ ($L_{Aeq,Tr}$), dB | 57 | 57 | 57 | 57 | 57 | 57 |
| Acoustic feature correction, dB | 0 | 0 | 0 | 0 | 0 | 0 |
| *Rating level* ($L_{Ar,Tr}$), dB | 57 | 57 | 57 | 57 | 57 | 57 |
| Representative *background sound level* ($L_{A90,T}$), dB | 49 | 48 | 46 | 46 | 46 | 45 |
| Excess of *rating level* over *background sound level* ($L_{Ar,Tr}$ - $L_{A90,T}$), dB | 8 | 9 | 9 | 12 | 6 | 12 |
| BS 4142:2014 impact category | An indication of a significant adverse impact, depending on the context. | An indication of a significant adverse impact, depending on the context. | An indication of a significant adverse impact, depending on the context. | An indication of a significant adverse impact, depending on the context. | An indication of a significant adverse impact, depending on the context. | An indication of a significant adverse impact, depending on the context. |

### Table 9.9. Initial BS 4142 Assessment for Proposed PCC plant (Background sound levels without contribution from Phillips 66)

| | NSR 1 | | NSR 2 | | NSR 3 | |
|---|---|---|---|---|---|---|
| **Receptor** | **Daytime** | **Night-time** | **Daytime** | **Night-time** | **Daytime** | **Night-time** |
| *Specific sound level* $L_s$ ($L_{Aeq,Tr}$), dB | 49 | 49 | 45 | 45 | 46 | 46 |
| Acoustic feature correction, dB | 0 | 0 | 0 | 0 | 0 | 0 |
| *Rating level* ($L_{Ar,Tr}$), dB | 49 | 49 | 45 | 45 | 46 | 46 |
| Representative *background sound level* ($L_{A90,T}$), dB | 42 | 41 | 42 | 41 | 42 | 41 |
| Excess of *rating level* over *background sound level* ($L_{Ar,Tr}$ - $L_{A90,T}$), dB | 7 | 8 | 3 | 4 | 4 | 5 |
| BS 4142:2014 impact category | An indication of a significant adverse impact, depending on the context | An indication of a significant adverse impact, depending on the context | An indication of a minor adverse impact depending on the context | An indication of an adverse impact, depending on the context | An indication of an adverse impact, depending on the context | An indication of an adverse impact, depending on the context |

### Table 9.10. Initial BS 4142 Assessment for Proposed PCC plant (Background sound levels with contribution from Phillips 66)

| | NSR 1 | | NSR 2 | | NSR 3 | |
|---|---|---|---|---|---|---|
| **Receptor** | **Daytime** | **Night-time** | **Daytime** | **Night-time** | **Daytime** | **Night-time** |
| *Specific sound level* $L_s$ ($L_{Aeq,Tr}$), dB | 49 | 49 | 45 | 45 | 46 | 46 |
| Acoustic feature correction, dB | 0 | 0 | 0 | 0 | 0 | 0 |
| *Rating level* ($L_{Ar,Tr}$), dB | 49 | 49 | 45 | 45 | 46 | 46 |
| Representative *background sound level* ($L_{A90,T}$), dB | 49 | 48 | 46 | 46 | 46 | 45 |
| Excess of *rating level* over *background sound level* ($L_{Ar,Tr}$ - $L_{A90,T}$), dB | 0 | 1 | -1 | 0 | 0 | 1 |
| BS 4142:2014 impact category | An indication of low impact, depending on the context | An indication of a low impact, depending on the context | An indication of low impact depending on the context | An indication of low impact, depending on the context | An indication of a low impact, depending on the context | An indication of a low impact, depending on the context |

### Table 9.11. Initial BS 4142 Assessment for Existing and Proposed PCC plant combined- Scenario 1 (Background sound levels without contribution from Phillips 66)

| | NSR 1 | | NSR 2 | | NSR 3 | |
|---|---|---|---|---|---|---|
| Receptor | Daytime | Night-time | Daytime | Night-time | Daytime | Night-time |
| *Specific sound level* $L_s$ ($L_{Aeq,Tr}$), dB | 55 | 54 | 53 | 51 | 53 | 51 |
| Acoustic feature correction, dB | 0 | 0 | 0 | 0 | 0 | 0 |
| *Rating level* ($L_{Ar,Tr}$), dB | 55 | 54 | 53 | 51 | 53 | 51 |
| Representative *background sound level* ($L_{A90,T}$), dB | 42 | 41 | 42 | 41 | 42 | 41 |
| Excess of *rating level* over *background sound level* ($L_{Ar,Tr}$ - $L_{A90,T}$), dB | 13 | 13 | 11 | 10 | 11 | 10 |
| BS 4142:2014 impact category | An indication of a significant adverse impact, depending on the context | An indication of a significant adverse impact, depending on the context. | An indication of a significant adverse impact, depending on the context. | An indication of a significant adverse impact, depending on the context | An indication of a significant adverse impact, depending on the context. | An indication of a significant adverse impact, depending on the context. |

### Table 9.12. Initial BS 4142 Assessment for Existing and Proposed PCC plant combined- Scenario 1 Background sound levels with contribution from Phillips 66)

| | NSR 1 | | NSR 2 | | NSR 3 | |
|---|---|---|---|---|---|---|
| Receptor | Daytime | Night-time | Daytime | Night-time | Daytime | Night-time |
| *Specific sound level* $L_s$ ($L_{Aeq,Tr}$), dB | 55 | 54 | 53 | 51 | 53 | 51 |
| Acoustic feature correction, dB | 0 | 0 | 0 | 0 | 0 | 0 |
| *Rating level* ($L_{Ar,Tr}$), dB | 55 | 54 | 53 | 51 | 53 | 51 |
| Representative *background sound level* ($L_{A90,T}$), dB | 49 | 48 | 46 | 46 | 46 | 45 |
| Excess of *rating level* over *background sound level* ($L_{Ar,Tr}$ - $L_{A90,T}$), dB | 6 | 6 | 7 | 6 | 7 | 5 |
| BS 4142:2014 impact category | An indication of an adverse impact, depending on the context. | An indication of an adverse impact, depending on the context. | An indication of an adverse impact, depending on the context. | An indication of an adverse impact, depending on the context. | An indication of an adverse impact, depending on the context. | An indication of an adverse impact, depending on the context. |

### Table 9.13. Initial BS 4142 Assessment for Existing and Proposed PCC plant combined- Scenario 2 (Background sound levels without contribution from Phillips 66)

| | NSR 1 | | NSR 2 | | NSR 3 | |
|---|---|---|---|---|---|---|
| **Receptor** | **Daytime** | **Night-time** | **Daytime** | **Night-time** | **Daytime** | **Night-time** |
| *Specific sound level* $L_s$ ($L_{Aeq,Tr}$), dB | 58 | 58 | 57 | 57 | 57 | 57 |
| Acoustic feature correction, dB | 0 | 0 | 0 | 0 | 0 | 0 |
| *Rating level* ($L_{Ar,Tr}$), dB | 58 | 58 | 57 | 57 | 57 | 57 |
| Representative *background sound level* ($L_{A90,T}$), dB | 42 | 41 | 42 | 41 | 42 | 41 |
| Excess of *rating level* over *background sound level* ($L_{Ar,Tr}$ - $L_{A90,T}$), dB | 16 | 17 | 15 | 16 | 15 | 16 |
| BS 4142:2014 impact category | An indication of a significant adverse impact, depending on the context. | An indication of a significant adverse impact, depending on the context. | An indication of a significant adverse impact, depending on the context. | An indication of a significant adverse impact, depending on the context. | An indication of a significant adverse impact, depending on the context. | An indication of a significant adverse impact, depending on the context. |

### Table 9.14. Initial BS 4142 Assessment for Existing and Proposed PCC plant combined- Scenario 2 (Background sound levels with contribution from Phillips 66)

| | NSR 1 | | NSR 2 | | NSR 3 | |
|---|---|---|---|---|---|---|
| **Receptor** | **Daytime** | **Night-time** | **Daytime** | **Night-time** | **Daytime** | **Night-time** |
| *Specific sound level* $L_s$ ($L_{Aeq,Tr}$), dB | 58 | 58 | 57 | 57 | 57 | 57 |
| Acoustic feature correction, dB | 0 | 0 | 0 | 0 | 0 | 0 |
| *Rating level* ($L_{Ar,Tr}$), dB | 58 | 58 | 57 | 57 | 57 | 57 |
| Representative *background sound level* ($L_{A90,T}$), dB | 49 | 48 | 46 | 46 | 46 | 45 |
| Excess of *rating level* over *background sound level* ($L_{Ar,Tr}$ - $L_{A90,T}$), dB | 9 | 10 | 11 | 12 | 11 | 12 |
| BS 4142:2014 impact category | An indication of a significant adverse impact, depending on the context. | An indication of a significant adverse impact, depending on the context. | An indication of a significant adverse impact, depending on the context. | An indication of a significant adverse impact, depending on the context. | An indication of a significant adverse impact, depending on the context. | An indication of a significant adverse impact, depending on the context. |

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