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NOISE MODEL DEVELOPMENT REPORT

FOR

WAGERUP 3 EXPANSION PROJECT

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1 INTRODUCTION

This report describes the methodology and assumptions used in developing the noise model for the Wagerup 3 expansion project.

The expansion model has been based on the model developed for the existing refinery by Herring Storer Associates (HSA). So the same topographical information, ground types, and building (barrier) locations have been used. The same noise modelling software (SoundPlan) has also been used for consistency. The most recent update of the existing refinery model (December 2004) was supplied by HSA. Validation of the existing model has been undertaken by HSA and their report ref 4373-2-05029-4-2-8 describing the validation process is duplicated in Appendix F. In modelling the expansion project, SVT has simply added new sound sources to represent additional plant associated with the expansion and, where appropriate, modified existing sources where these will be affected by the expansion.

In the first instance, no specific noise control measures were assumed, and, therefore, the "Base Case" model represents a worst-case situation where all new or upgraded equipment emits similar noise to existing equipment. The results from this model were then used to determine the noise reductions required to achieve Alcoa's environmental noise level objective, and the model was revised by applying noise reductions to relevant noise sources. This "Attenuated Base Case" model was then used to demonstrate that the noise reductions would be effective. The noise reductions have mostly been applied to new plant associated with the expansion. However, in order to achieve Alcoa's environmental noise level objective it was also necessary to apply noise reductions to existing sources at the refinery. A series of site visits was undertaken to review the practicality of achieving these noise reductions.

The design of the expansion is in the early stages of development and consequently there are many areas where there is limited information available on the equipment to be installed. Therefore, the current model of the expansion is not intended to represent the final as-built situation but serves as a tool to develop a "noise emission budget" for the expansion. As the design of the expansion develops the model should be continuously updated to represent the latest available information.

The model has been used to provide preliminary noise predictions at seven noise sensitive locations surrounding the refinery and the results are presented in this report.

A separate version of the model has been used to investigate noise impacts from the overland conveying system. This version of the model includes only those noise sources associated with the overland conveying system and excludes refinery sources. The model has been used to provide preliminary noise predictions at two noise sensitive locations to the south of overland conveyor #371.

2 METHODOLOGY

Noise modelling was undertaken using the SoundPlan noise modelling software (version 6.2) developed by Bruanstein & Berndt GmbH. The software allows a choice of noise prediction algorithms. The CONCAWE algorithms were adopted for this study since these algorithms were also used by HSA for the model of the existing refinery.

Topographical information was provided with the model supplied by HSA and was originally obtained from the Department of Land Information as 5m ground contours.

The noise level predictions produced by the model represent sound propagation under worst-case meteorological conditions, i.e. 3m/s wind blowing from the source to the receiver combined with a thermal inversion. The noise contours represent the worst-case envelope – i.e. worst-case propagation in all directions simultaneously.

3 NOISE SOURCES – BASE CASE

A sound power summary table is provided in Appendix A, which lists the overall sound power levels for each new or amended noise source that SVT has introduced into the noise model. Appendix B provides spectral noise data for these sound sources. The following section of this report provides a discussion on the noise emission levels assumed for each new or amended source in the noise model. Changes to plant areas not described in the following sections are assumed to have no noise impacts or are not sufficiently defined at the present time to be included in the noise model. Appendix C provides a site plan for the proposed expansion and a map showing the proposed extension of the overland conveyor system.

3.1 Overland Conveyor

3.1.1 Overland Conveyor 371 (1st 150 modules)

The 1st 150 modules of conveyor 371 (approx 1.1 km) have been considered for the model of the refinery. (The overland conveyor in its entirety has been modelled separately – see section 3.1.3.) The following has been assumed:

- Conveyor speed will increase from 5.5 m/s to 5.9 m/s.
- Belt width will increase from 915 mm to 1050 mm.
- Current 152mm diameter idlers will be changed as a consequence of the belt width increase to the most successful design of idlers as established by an ongoing trial program in order to ensure that an acceptable noise level is achieved.
- Effective belt cleaning stations (either belt washes or turnovers) will be installed to ensure that noise level reductions can be sustained.

Based on noise measurements recorded for the Huntly overland conveyor, the increase in speed is likely to result in a 1.5 dB increase in noise level.

The increase in noise level due to belt width has been calculated at 0.6 dB based on the difference in the sound radiating area (i.e. 10Log(1050/915)).

A 2 dB reduction in noise has been assumed for changing out the idlers. Tests performed by Alcoa on the Huntly conveyor have shown that reductions up to 4 dB are possible but this is only achieved when the idlers are clean. Note that for particularly dirty idlers noise levels can actually increase, and, therefore, it is very important to keep the idlers clean if the 2 dB reduction is to be maintained.

The modifications result in no net change in the noise level for the refinery end of the conveyor.

The sound power data for the model is derived from the Dec 2004 HSA model: The 1st 150 modules are split into 3 groups: 0-50, 50-100, 100-150. The overall SWLs are 86.7, 81.3, and 83 dB(A) respectively. The sound power levels of the section between modules 100-150 has been used for all 150 modules in the base case model.

3.1.2 Conveyor 371 Head Drive

This drive is new for the expansion and has been included in the noise model in the vicinity of the existing transfer station at a height of 15m above ground. As a starting point, noise emission levels have been based on those in the Dec 2004 HSA model for conveyor 371 Bancel drive station. (Note that the sound power levels for this drive were developed in May 03 and the drive enclosures have subsequently been upgraded.) The new drive will actually be more like the drive for Huntly 274 conveyor but no noise data is available for this drive. It is recommended, therefore, that sound power assessments be undertaken for both Bancel drives and Huntly 274 drives to get a better understanding of existing and potential sound power levels for the proposed 371 head drive.

3.1.3 Willowdale Mine Ore Handling System

The current conveying system comprises conveyor 372 (from the Orion crushing station to the Arundel drive station) and conveyor 371 (from the Arundel drive station to the Refinery.)

The proposed conveying system involves transporting of ore from a new crushing station (Larego) situated some 5 km to the south east of the Arundel drive station. It is planned to construct a curved extension of the existing 371 conveyor system.

Appendix C shows the proposed ore transportation system.

The following has been assumed:

- Conveyor 371 speed will increase from 5.5m/s to 5.9m/s
- Belt width will increase from 915mm to 1050mm
- The existing tail end drive for conveyor 371 will be relocated from Arundel to the Bancel drive station

Based on noise measurements recorded for the Huntly overland conveyor, the increase in speed is likely to result in a 1.5 dB increase in noise level. The increase in noise level due to belt width has been calculated at 0.6 dB based on the difference in the sound radiating area (i.e. 10Log(1050/915)). Therefore, it has been assumed that noise levels from conveyor 371 will increase by approximately 2 dB.

The sound power for new conveyor sections has been based on the average sound power level for the section of the existing 371 conveyor between modules 850 and 1140, but increased by 2 dB to account for the increase in conveyor speed and belt width. This section of conveyor is currently fitted with 127mm diameter, machined and balanced idlers.

No changes are proposed for the existing 372 conveyor system.

3.2 Stockpile Area (15)

3.2.1 Transfer Station

A 3dB increase in overall emission levels from the transfer station has been assumed based on the increased capacity of conveyor 371, and an expected increase in drop height. (The transfer station also includes sample plant #380 and apron feeder #396.) For the expansion noise model the sound power level of the source representing the existing transfer station in the Dec 2004 HSA model has been increased by 3dB.

3.2.2 Conveyor 395 (from transfer station to stacker)

The conveyor speed is to be maintained at its current speed of 3.5 m/s and modifications to the idler configuration will allow the belt to carry more ore. Noise from the conveyor is related to conveyor speed. Therefore, for the expansion noise model the sound power level of the source representing the existing conveyor in the Dec 2004 HSA model has been maintained at its current level.

3.2.3 Stacker

The stacker is to be upgraded from 110 kW to 150 kW and the boom belt speed increased from 3.5m/s to 4.5m/s. Based on the increase in power it is assumed that noise levels would increase by approximately 1 dB (i.e. 10Log(150/110)). For the expansion noise model the sound power level of the source representing the existing stacker in the Dec 2004 HSA model has been increased by 1 dB.

3.2.4 Reclaimers

The existing reclaimer is to be upgraded from a capacity of 1700 tph to 2400 tph. Therefore, the sound power level of the point source in the Dec 2004 HSA model has been increased proportionally (by 2 dB) to represent the upgraded reclaimer.

There will also be a new reclaimer for the expansion with a capacity of 3000 tph. This has been included in the noise model as a point source with a sound power level 3 dB greater than the existing reclaimer in the Dec 2004 HSA model.

The existing and new reclaimers have been located at opposite ends of the stockpiles in the noise model since they will only operate simultaneously at these locations. (Note that although both reclaimers will only operate simultaneously for short periods when changing between stockpiles, the noise model represents this operating condition because noise impacts will be greatest.)

3.2.5 Conveyor B100

The capacity of this conveyor is expected to increase from 1700 tph to 2400 tph. The conveyor speed, however, is to be maintained at its current value of 3.5 m/s. Modifications to the idler configuration will allow the belt to carry more ore. Noise from the conveyor is related to conveyor speed. Therefore, for the expansion noise model the sound power level of the source representing the existing conveyor in the Dec 2004 HSA model has been maintained at its current level.

3.2.6 Conveyor B100 Drive

Noise from the conveyor drive station is dominated by impact noise from the transfer hopper. Based on the conveyor's increase in capacity (from 1700 tph to 2400 tph), it has been assumed that the overall noise level for the drive will increase by 2 dB (i.e. 10Log(2400/1700)). For the expansion noise model the sound power level of the source representing the existing drive station in the Dec 2004 HSA model has been increased by 2 dB.

3.2.7 Conveyor B200

The capacity of this conveyor is expected to increase from 1700 tph to 3000 tph. The conveyor speed, however, is to be maintained at its current value of 3.5 m/s. Modifications to the idler configuration will allow the belt to carry more ore. Noise from the conveyor is related to conveyor speed. Therefore, for the expansion noise model the sound power level of the source representing the existing conveyor in the Dec 2004 HSA model has been maintained at its current level.

Note that conveyors B100 & B200 will operate simultaneously for short periods when changing between stockpiles and the noise model represents this operating condition because noise impacts will be greatest when this occurs.

3.2.8 Conveyor B200 Drive

Noise from the conveyor drive station is dominated by impact noise from the transfer hopper. Based on the conveyor's increase in capacity (from 1700 tph to 3000 tph), it has been assumed that the overall noise level for the drive will increase by 3 dB (i.e. 10Log(3000/1700)). For the expansion noise model the sound power level of the source representing the existing drive station in the Dec 2004 HSA model has been increased by 3 dB.

Note that conveyors B100 & B200 will operate simultaneously for short periods when changing between stockpiles and the noise model represents this operating condition because noise impacts will be greatest when this occurs.

3.2.9 Conveyor C100

The capacity of this conveyor is expected to increase from 1700 tph to 2400 tph. The conveyor speed, however, is to be maintained at its current value of 3.5 m/s. Modifications to the idler configuration will allow the belt to carry more ore. Noise from the conveyor is related to conveyor speed. Therefore, for the expansion noise model the sound power level of the source representing the existing conveyor in the Dec 2004 HSA model has been maintained at its current level.

3.2.10 Conveyor C100 Drive

The capacity of the conveyor is to be upgraded from a capacity of 1700 tph to 2400 tph. Therefore, the sound power level of the point source in the Dec 2004 HSA model has been increased proportionally (by 2 dB).

3.2.11 Conveyor C200

This is a new conveyor. It is proposed that the conveyor will run at the same speed (3.5 m/s) as the C100 conveyor. For the purposes of the expansion noise model this conveyor is assumed to be equivalent to the existing C100 conveyor. A line source has been included in the model with the same sound power as the C100 conveyor in the Dec 2004 HSA model.

Note that conveyors C100 & C200 will operate simultaneously for short periods when changing between stockpiles and the noise model represents this operating condition because noise impacts will be greatest when this occurs.

3.2.12 Conveyor C200 Drive

This new drive has been represented in the noise model as a point source with a sound power level 3 dB greater than the existing C100 conveyor drive. The increase in sound power level is proportional to increase in capacity of the new C200 conveyor compared to the existing C100 conveyor (i.e. 10Log(3000/1700)).

Note that conveyors C100 & C200 will operate simultaneously for short periods when changing between stockpiles and the noise model represents this operating condition because noise impacts will be greatest when this occurs.

3.3 Mill Area (25)

3.3.1 SAG Mills

There are currently three SAG mills: #3, #4 and #5. Current refinery capacity requires that two mills operate all of the time. The expansion will require that all three SAG mills (and two new ball mills, see below) operate to meet the maximum bauxite demand. The mills will also operate at higher capacities. The capacity of mill #3 will increase from 550 tph to 1000 tph. The capacity of mills #4 and #5 will increase from 490 tph to 660 tph. These changes have been implemented in the noise model by increasing the number of operating mills from 2 to 3, and by increasing the sound power levels of the mills in proportion to the increase in their capacities.

3.3.2 Ball Mills

Two new ball mills are proposed for the expansion. SVT has developed sound power levels for these mills based on experience of similar installations. A single point source has been entered into the model representing the combined operation of the two ball mills. This source has been located to the north of the existing no. 3 SAG mill.

3.3.3 Bauxite Slurry Recirculation & BSD Pumps (25A)

HSA have estimated the sound power level of the existing equipment in this area as 104 dB(A) (report ref 0619-1-02029-4.2). Noise levels from the existing pumps are in the range 85 – 90 dB(A) at 1m (2004 occupational noise survey). It is assumed, therefore, that average sound power levels for individual pumps will be approximately 97dB(A), which is consistent with both HSA's estimate and noise levels recorded during the recent occupational noise survey. The expansion will include 7 new recirculation pumps and 4 new BSD pumps. This has been represented in the expansion noise model as a single point source with an overall sound power level of 107 dB(A) (= 97+10Log(11)).

3.4 Digestion (30)

A new unit is proposed for this area and it is assumed that noise will be similar to existing unit 2. The 2 existing units are represented by 3 sources in the Dec 2004 HSA model (east, west and south faces), each with similar sound power levels. The new unit is represented by a single point source in the expansion noise model with a sound power level equivalent to the sum of the sound power for the west face (since the expansion is to the west) and ½ the sound power for the south face from the HSA model.

3.4.1 Pumps at Digestion Test Tanks (30A)

Currently there are 3 pumps operating in this area. 2 further pumps are to be added for the expansion with a total of 4 out of 5 pumps operating at any given time, i.e. there will be 1 further pump operating due to the expansion. This has been included in the expansion noise model as a point source having a sound power level equivalent to 1/3, or 5dB less than that of equivalent sources in the Dec 2004 HSA model.

3.5 Heat Exchange (40)

A new unit is proposed for this area and it is assumed that noise will be similar to an existing unit (currently there are 2 units). Unit 40 is currently included in the Dec 2004 HSA model as 2 noise sources. The sound power for the new unit has been derived by summing the sound power levels from the HSA model sources and subtracting 3dB since there will be only 1 new unit. The new unit is included as a single point source in the expansion noise model.

3.6 Evaporation (42)

3.6.1 Buildings 42B and 42C

The expansion will involve new plant equivalent to duplication of the existing units 42C-3 and 42C-4. This has been represented in the acoustic model as a point noise source with a sound power level equivalent to sum of the sound power levels in the Dec 2004 HSA model for the existing units. The source has been located to the west of the existing plant.

3.6.2 Pumps at Evaporation Storage Tanks (42A)

There are currently 5 large pumps in this area with sound pressure levels in the range 85 – 90 dB(A) @ 1m. An increase in capacity of approximately 20 % is expected which is equivalent to adding one extra pump. A point source has been included in the expansion noise model with a sound power level 7 dB below that of the equivalent source in the Dec 2004 HSA noise model (i.e.10Log(1/5)).

3.7 Condensate Facilities (43)

There are currently several pumps in this area with sound pressure levels in the range 80 – 90 dB(A) @ 1m. An increase in capacity of approximately 20 % is expected. A point source has been included in the expansion noise model with a sound power level 7 dB below that of the equivalent source in the Dec 2004 HSA noise model (i.e.10Log(1/5)).

3.8 Clarification Area (35)

3.8.1 Pumps at Filtrate Tanks (35A)

The Dec 2004 HSA noise model does not include this source. However, the source is included in the model source library with a sound power level of 106 dB(A) for normal operating conditions, assumed to represent 4 operating pumps. The 4 existing 300 kW pumps are to replaced with 4 new 500 kW for the expansion. The expansion noise model includes a point source with a sound power level 108 dB(A) (i.e. 106 for existing source + 10Log(500/300)).

3.8.2 Pumps at Mud Washers (35C)

The expansion will see 15 new pumps directly associated with this area and 2 new pumps associated with the Oxalate removal process. There are no sources representing this area in the HSA Dec 2004 noise model. The expansion model includes a source with a sound power level of 109 dB(A) representing the 17 new pumps, which are assumed to have similar sound power levels to those in area 25A (i.e. 97 dB(A) per pump.)

3.8.3 Cyclone Building (35C)

A new cyclone building is proposed for area 35C comprising 6 clusters of 12 x 500mm cyclones. SVT has estimated a sound power level of 109 dB(A) for this building based on experience of similar installations. The building is represented by a point source to the north of tanks 35C-23 and 35C-24.

3.8.4 Pumps at Thickener Overflow Tanks (35D)

There are currently 2 pumps located between tanks 11 & 12 and 2 pumps located between tanks 21 & 22, with one pump operating and one pump on standby at each location. The expansion will include installation of an additional 3 pumps with 3 out of 7 pumps operating at any time (i.e. one extra pump operating). From the recent occupational noise survey, noise levels at these pumps are in the range 90 – 97 dB(A) at 1m and the average sound power level for a single pump has been estimated at 105 dB(A). It is assumed that 1 extra pump will be operating after the expansion and this has been represented by including a single point source with a sound power level of 105 dB(A). The source has been placed at the most exposed location (between tanks 21 & 22) to represent worst-case conditions.

3.8.5 Pumps at Mud Wash Water Tanks (35E)

The existing pumps are not included in the HSA noise model and so the sound power level has been estimated based on the noise levels recorded during the recent occupational noise survey. Noise levels exceed 85 dB(A) over an area of approximately 40 m^2 (3m x 4m x 2m high) which is equivalent to a sound power level of 101 dB(A) (i.e. 85+10log(40)). An increase in capacity of 20 % is expected. Therefore, the expansion noise model includes a point source with a sound power level 102 dB(A) (i.e. 101 for existing source + 10Log(1.2)).

3.8.6 Hose & Press Water Facilities (35G)

The Dec 2004 HSA noise model does not include this source. However, the source is included in the model source library with a sound power level of 106 dB(A) for normal operating conditions. An increase in capacity of 20 % is expected. Therefore, the expansion noise model includes a point source with a sound power level 107 dB(A) (i.e. 106 for existing source + 10Log(1.2)).

3.8.7 Mud Thickeners (35F)

The expansion will see 11 new pumps associated with this area. There are no sources representing this area in the HSA Dec 2004 noise model. The expansion model includes a source with a sound power level of 107 dB(A) representing the 11 new pumps, which are assumed to have similar sound power levels to those in area 25A (i.e. 97 dB(A) per pump.)

3.8.8 Cyclone Building (35F)

A new cyclone building is proposed for area 35F comprising 3 clusters of 10 x 500mm cyclones. SVT has estimated a sound power level of 106 dB(A) for this building based on experience of similar installations. The building is represented by a point source between tanks 35F-11 and 35F-31.

3.8.9 Mud Washers (35H)

This area is not included in the Dec 2004 HSA noise model. The existing sound power level has been estimated based on the noise levels recorded during the recent occupational noise survey. Noise levels exceed 85 dB(A) over an area of approximately 128 m^2 (8m x 8m x 2m high) which is equivalent to a sound power level of 106 dB(A) (i.e. 85+10log(128)). An increase in capacity of 20 % is expected. Therefore, the expansion noise model includes a point source with a sound power level 107 dB(A) (i.e. 106 for existing source + 10Log(1.2)).

3.8.10 Causticising Tanks Area (35J) and HEC (High Efficiency Causticisation)

Area 35J has been removed from the scope for the expansion, (i.e. the existing plant will be decommissioned) but is to be replaced with a HEC building located to the south of the existing digestion building. It is anticipated that the HEC building will comprise similar equipment to the existing building 40. Therefore, the HEC building has been included in the expansion noise model as a single point source with a sound power level equivalent to a single unit from building 40. (Refer section 3.5.) The existing source representing area 35J has been deleted from the expansion model.

3.9 Residue Dispoal Area (259)

3.9.1 Superthickener

A second superthickener has been proposed. The expansion noise model includes a point source with sound power levels equivalent to the existing superthickener and located adjacent to the existing unit.

3.9.2 Mud Pumping Station

A second mud pumping has been proposed. The expansion noise model includes a point source with sound power levels equivalent to the existing pumping station and located adjacent to the existing unit.

3.9.3 Sand Separation Plant

A new sand separation plant is to be installed in the residue disposal area. No data is available at this stage but the plant is expected to include similar equipment to the mud pumping station. Therefore, the expansion noise model includes a point source with sound power levels equivalent to the existing mud pumping station and located adjacent to the existing unit.

3.10 Precipitation (45)

The precipitation area is represented by several noise sources in the HSA model. These include the north, south and west sides of the precipitation area, green liquor valves and agitator gearboxes. The proposed expansion includes a new unit comprising 24 tanks to the south of the existing unit and a further row of 12 tanks to the east. There will also be filters on top of the 12 new tanks to the east with associated vacuum pumps at ground level. The following sound sources have been developed for the expansion noise model and are discussed in the following sections:

- Building faces;
- Agitator gearboxes;
- Green liquor valves; and
- Vacuum pumps.

3.10.1 Precipitation Building South & West Faces

The new unit to the south represents a 50 % increase for this area. The expansion noise model includes 2 point sources, each with a sound power level 3 dB below that of the equivalent source in the HSA noise model. (It is assumed that any noise emission from the northern face of the new unit will be shielded by the tanks in the existing unit and will not contribute to an increase in noise emissions.) The expansion model also includes the barrier effects of the new precipitator tanks since their location is well defined. (Concrete footings have already been laid.)

3.10.2 Agitator Gearboxes on top of Precipitator Tanks

The existing gearboxes are included individually in the Dec 2004 HSA noise model. The new unit to the south represents a 50 % increase for this area. In the expansion noise model the new agitator gearboxes are represented by a single point source with a sound power level 3 dB below that of the sum of the sources in the HSA noise model.

3.10.3 Green Liquor Valves

Noise emissions from the green liquor valves are represented by 4 point sources in the Dec 2004 HSA noise model. The 2 southern most valves will be removed and 2 new valves installed in the new unit. The expansion noise model includes a single point source representing the combined sound power level of 2 operating valves.

3.10.4 Vacuum Pumps

The filters to be employed atop the eastern row of tanks are to be similar to those in building 44.2 and it is assumed that the associated vacuum pumps will also be similar. A single point source is included in the expansion noise model with a sound power level equivalent to that in the HSA model representing noise from vacuum pumps at building 44.2. Note that noise from the filters should be insignificant since the filters are likely to be fully enclosed.

3.10.5 Air Fin Coolers

A large bank of air fin coolers is proposed for the precipitation unit. Currently it is anticipated that there will be 24 bays of 3 fans, i.e. a total of 72 fans. SVT has estimated sound power levels for the fans based on experience from similar installations. A sound power level of 94 dB(A) per fan has been assumed giving a total sound power level of 113 dB(A) for the coolers. The expansion model includes a point source with a sound power level of 113 dB(A) located where the operation stores yard is currently sited.

3.10.6 Building 45A

This area is not included in the Dec 2004 HSA noise model. The existing sound power level has been estimated based on the noise levels recorded during the recent occupational noise survey. Noise levels reach 92 dB(A) at 1m from the current pump units and the sound power level for a single pump has been estimated at 105dB(A). The expansion will include 2 new pumps and this is represented in the expansion noise model by a single source equivalent to the combined sound power level of 2 pumps, i.e. 108 dB(A).

3.11 Calciners (50)

Two new calciners are proposed for the expansion. It is anticipated that the new calciners will be very similar to the existing unit 4. Unit 4 is represented by 3 sources in the Dec 2004 HSA model: blower enclosure, blower inlet, and calciner building. The expansion noise model includes duplicates of these sources located to the south of the existing calciners.

3.12 Power Generation (110)

There are two options for power generation for the expansion: 2 new boilers similar to the existing units or 2 gas turbine generators (GT) with heat recovery steam generators. For the purpose of the expansion noise model, it has been assumed that the GT option will be chosen. The sound power levels have been based on the sound power levels for the GT at the Pinjarra refinery but with the noise from the GT enclosure has been reduced by 5 dB(A).

3.13 Oxalate Removal (47)

A new kiln is to be installed in the oxalate building. No noise data is currently available for the kiln, but it is anticipated that the noise emissions will originate from the fans and associated stack. Therefore, the expansion noise model includes two noise sources for the kiln: the stack and the fans. Sound power levels for the stack have been based on the HSA model sources representing the liquor burning kiln stacks but reduced by 5 dB since the new oxalate kiln includes a Regenerative Thermal Oxidizer (RTO) which is likely to provide significant attenuation. Sound power levels for the fans have been based on SVT's experience of similar fans.

4 NOISE REDUCTION REQUIREMENTS

Alcoa's objective for noise emissions from the expansion is for no increase in noise impacts at nearby residences. The following sections of this report describe the noise reduction requirements for new plant associated with the expansion, and, where necessary, for existing plant in order to satisfy the noise objective. Section 5.2 presents the results of noise modelling assuming that these noise reductions can be realised. At this stage, the noise reductions are assumed to apply equally across all frequencies since this approach ensures that the required noise reductions are achieved irrespective of the frequency content of the source. However, frequency dependent reductions should be reviewed during the detailed design phase of the expansion project.

4.1 Stockpile Conveyors and 1st 150 modules of Overland Conveyor

Noise emissions from the overland conveyor and stockpile conveyors should be limited to a sound power level of 83 dB(A) per metre. Tests performed by Alcoa on the Huntly conveyor have shown that this limit is achievable using large diameter, machined idlers and providing effective belt cleaning stations (either belt washers of turnovers). Further trials are continuing to establish the most successful design of idlers and the most effective means of sustainably maintaining the necessary noise levels.

4.2 Overland Conveyor Head Drive & Transfer Station

The new conveyor head drive is to be located at the existing transfer station. A noise reduction of 10 dB is required from these sources and this should be achievable by enclosing the entire drive / transfer station.

4.3 Willowdale Mine Ore Handling System

The table below provides the noise reductions required for various elements of the ore handling system.

Table 4-1 Noise reductions required for ore handling system

Element	**Noise Reduction**
Conveyor 371 modules 390 - 413	2 dB
Conveyor 371 modules 413 – 500	3 dB
Conveyor 371 modules 500 – 657	2 dB
Conveyor 371 modules 850 – 1140	7 dB
Conveyor 371 modules 1140 - 1160	10 dB
600m extension of conveyor 371 beyond Arundel*	7 dB

**Note that no specific noise controls are required beyond the 1st 600m of the extension of conveyor 371.*

These noise reductions can be achieved by selection of appropriate conveyor idlers.

4.4 Stackers and Reclaimers

It has been assumed that noise from the stacker will only increase marginally with the expansion and no noise reduction has been specified.

Noise from the reclaimers primarily originates from the transfer hopper to the stockyard conveyors. A noise reduction of 5 dB is required for the existing reclaimer, which should be achievable by modifications or enclosures/cladding to the hopper. The new reclaimer should incorporate similar noise mitigation measures to ensure that noise emissions are no greater than those for the existing (modified) reclaimer.

4.5 Conveyor B100 and B200 Drive Stations

Noise from the drive stations for conveyors B100 and B200 originates from the transfer hoppers to conveyor C100 and, to lesser extent, from the drive motors. A 5 dB reduction from these sources is required. This can be achieved by modifications to the transfer hoppers (e.g. by using non impact transfer chutes or enclosing the existing chutes) and by replacing the existing drives with low noise drives (e.g. employing 6 pole motors and low noise gearboxes).

4.6 Conveyor C100 and C200 Drive Stations

Noise here originates from the drive units. A 4 dB reduction is required for the existing C100 drive and a 5 dB reduction is required in the sound power level assumed for the C200 drive. This can be achieved by replacing existing noisy drives with quieter alternatives, specifying new equipment as low noise, or employing acoustic enclosures.

4.7 Ball Mills and SAG Mills

A noise reduction of 10dB is required from the ball and SAG mills. It is likely that this can only be achieved by housing the mills inside buildings.

4.7.1 Bauxite Slurry Recirculation & BSD Pumps (25A)

A 2 dB reduction is required for new pumps such that individual pump/drive units do not exceed a sound power level of 95 dB(A). This can be achieved by specification of low noise equipment or using acoustic enclosures over the pumps. Acoustic pipe lagging may also be required for large diameter discharge piping.

4.8 Digestion

The sound power level for the new digestion unit needs to be reduced by 5 dB compared to an existing unit. This can be achieved by specifying low noise pumps and low noise design (or acoustic lagging) for piping and valves.

4.8.1 Pumps at Digestion Test Tanks

Sound power levels for new pumps need to be reduced by 13 dB compared to existing pumps. (The sound power levels for the existing source in the HSA noise model are dominated by a sharp peak at a frequency of 4kHz – it is not clear what the cause of this peak is.) Individual pumps should not exceed a sound power level of 95 dB(A). This can be achieved by specification of low noise equipment or using acoustic enclosures over the pumps.

4.9 Heat Exchange

A noise reduction of 5 dB is required for the new heat exchange unit. This can be achieved by specifying low noise pumps and low noise design (or acoustic lagging) for piping and valves.

4.10 Evaporation

A noise reduction of 3 dB is required for the new evaporation units. This can be achieved by specifying low noise pumps and low noise design (or acoustic lagging) for piping and valves.

4.10.1 Pumps at Evaporation Storage Tanks

A 10 dB reduction is required for new pumps such that individual pump/drive units do not exceed a sound power level of 95 dB(A). This can be achieved by specification of low noise equipment or using acoustic enclosures.

4.11 Condensate Facilities

A 10 dB reduction is required for new pumps such that individual pump/drive units do not exceed a sound power level of 95 dB(A). This can be achieved by specification of low noise equipment or using acoustic enclosures.

4.12 Clarification

4.12.1 Pumps

There will be a significant increase in the number of pumps in the clarification area as described in section 3.8. New pumps should not exceed a maximum sound power level of 95 dB(A). This can be achieved by specification of low noise equipment or using acoustic enclosures. Acoustic lagging may also be required for larger diameter discharge piping.

4.12.2 Cyclone Buildings

A 5 dB reduction is required for the cyclone buildings in areas 35C and 35F. This can be achieved by housing the cyclones inside buildings.

4.13 High Efficiency Causticisation (HEC)

Area 35 J is to be decommissioned and replaced with a HEC unit which comprises similar equipment to building 40 (heat exchange). A noise reduction of 5 dB is required compared to an existing heat exchange unit.

4.14 Residue Disposal Area

Noise emissions at the superthickener are dominated by noise from the hydraulic drive which has a strong peak in the 500Hz octave band. A noise reduction of 10 dB at this frequency is required for both the new and existing superthickeners.

4.14.1 Mud pumping Station and Sand Separation Plant

A noise reduction of 5 dB is required for the new mud pumping station and sand separation plant. This can be achieved by specification of low noise equipment or using acoustic enclosures.

4.15 Precipitation

Noise from the south and west faces of the new precipitator need to be reduced by 5 dB. Noise from elevated sources such as agitator drives and green liquor valves need to be reduced by 10 dB. All equipment atop the precipitator tanks will have to be fully enclosed or lagged (either using individual enclosures / lagging or by fitting a roof over the building) to achieve the required noise reductions. Any ground level noise sources near the perimeter of the unit will also need to be enclosed.

Noise reductions will also be required for the existing agitator drives on top of the precipitation tanks. A 5 dB reduction will be required for all existing drives with a sound power level of 95 dB(A) or greater.

4.15.1 Pumps at 45A

A noise reduction of 10 dB(A) is required. This can be achieved by specification of low noise equipment or using acoustic enclosures.

4.15.2 Air-Fin Coolers

A noise reduction of 6 dB(A) is required such that the sound power level per fan does not exceed 88 dB(A). This can only be achieved using variable speed drives. Low noise drive motors will also be required.

4.16 Calcination

A 10 dB reduction is required from the blower inlets. This will require significant upgrades to the intake silencers and possible modifications to the blower to reduce noise at source.
A 5 dB reduction from other calciner noise sources is also required. This may be achieved by specification of low noise equipment and lagging of piping downstream of the blowers.

A noise reduction of 5 dB from the existing blower inlets will also be required.

4.17 Power Generation

Noise from the Gas Turbine Generator / HRSG packages will need to be reduced by 10 dB to 104 dB(A) per unit. This is a very onerous target and a major noise control review will be required to reduce noise from all associated sources such as air intakes and exhausts, turbine enclosures, pumps, burners etc.

Noise reductions from the existing power generation area will also be required. A 5 dB reduction is needed from the FD fan air intakes and discharges. This can be achieved by installing intake and discharge silencers.

4.18 Oxalate Removal

Noise from the oxalate kiln will need to be reduced by 5 dB. This can be achieved by acoustically lagging or enclosing the fan casings.

5 PRELIMINARY RESULTS

5.1 Base-Case – Refinery

Based on the assumptions described in section 3 of this report, noise levels for the expanded refinery were predicted for seven of the nearest noise sensitive residences surrounding the refinery. The results are presented in the table below. The table also provides the existing noise levels as predicted by HSA's current noise model and the potential change in noise levels.

Note that the predicted noise levels are based on duplication of existing equipment during the expansion with no allowance for new, quieter technologies or noise control measures. As such the results demonstrate the need to incorporate noise mitigation measures in the design of the expansion.

Table 5-1 Predicted noise levels for expanded refinery assuming no noise mitigation

Location	Existing Noise Level dB(A)	Noise Level after Expansion dB(A)	Noise Impact dB
R1	42.0	45.7	3.7
R2	45.6	49.5	3.9
R3	48.8	53.1	4.3
R4	47.8	51.4	3.6
R5	45.9	49.9	4.0
R6	47.2	50.9	3.7
R7	40.9	45.1	4.2

Figure B1 in appendix D presents the noise contours for the expansion assuming worst-case sound propagation conditions.

5.2 Attenuated Base-Case – Refinery

Based on the assumptions described in section 4 of this report, noise levels for the expanded refinery were predicted for seven of the nearest noise sensitive residences surrounding the refinery. The results are presented in the table below. The table also provides the existing noise levels as predicted by HSA's current noise model and the potential change in noise levels.

Note that the predicted noise levels are based on applying noise reductions to noise sources associated with the expansion and to some existing refinery noise sources. The model does not currently account for any barrier effects provided by new plant at the refinery (with the exception of the new precipitator tanks), and, therefore, it is possible that noise levels could be slightly lower. However, the design of the expansion is not sufficiently advanced to allow any such barrier effects to be included at this stage.

Table 5-2 Predicted noise levels for expanded refinery assuming implementation of noise control measures

Location	Existing Noise Level dB(A)	Noise Level after Expansion dB(A)	Noise Impact dB
R1	42.0	41.5	-0.5
R2	45.6	45.6	0
R3	48.8	48.7	-0.1
R4	47.8	48.3	0.5
R5	45.9	46.8	0.9
R6	47.2	46.8	-0.4
R7	40.9	41.5	0.6

Figure C1 in appendix D presents the noise contours for the expansion assuming worst-case sound propagation conditions.

5.2.1 Discussion of Noise Reduction Opportunities

The output from the noise model has been analysed to determine the contributions to overall noise levels from existing plant, upgraded plant and new plant.

- **Existing plant** includes all plant which is unaffected by the expansion. In order to achieve Alcoa's environmental noise level objective, it will be necessary to apply noise controls to some existing plant which would otherwise be unaffected by the expansion. These items, identified in Table 6-2, are also included in the definition of existing plant.
- **Upgraded plant** refers to existing plant within the refinery which will be modified during the expansion process. Examples include the stockyard conveyors and SAG mills. The expansion project provides the opportunity to implement noise reductions for upgraded plant which would otherwise not be practicable.
- **New plant** refers to any new equipment exclusively associated with the expansion. Examples include the new Calciners, Precipitation plant and air fin coolers. However, as discussed in section 3, several areas of the plant which are to be modified as part of the expansion were not included in the noise model of the existing refinery (because their contributions to received noise were considered insignificant). Since these areas are included as new sources in the expansion noise model, they are also included in the definition of new plant. This mainly applies to pump upgrades in the clarification area of the refinery.

The detailed analysis is provided in a spreadsheet in Appendix E. The analysis shows that the control measures discussed in section 4 provide reductions in the contributions to received noise of between 0.3 and 0.9 dB from existing plant and between 3.8 and 5.1 dB from upgraded plant. Considering the relative contributions from existing and upgraded plant this corresponds to an overall reduction of between 0.3 and 1.9 dB in noise received from the equipment associated with the current refinery, depending on the receiving location. The contribution from new plant is between 5.4 and 6.4 dB below what it would be if no noise attenuation measures were applied.

Because of the proximity of the nearest receivers to the refinery (approximately 1 km to 1.5 km) any new plant area with a sound power level greater than approximately 100 dB(A) would alone have the potential to cause an exceedance of the 35 dB(A) assigned noise level. New equipment associated with the expansion is represented by 43 noise sources in the noise model, which, in theory, reduces the maximum allowable sound power level to 84 dB(A) per source. In practice, not all of the new sources are significant contributors to the noise received at all locations and some sources will be shielded by existing structures at the refinery. Consequently the maximum allowable sound power level per source will be somewhat greater than 84 dB(A).

In any case, such low sound power levels are an order of magnitude below what is currently available for this sort of plant. As an example, a typical fan for an air fin cooler has a sound power level of the order of 94 dB(A). The air fin cooler proposed for the expansion project comprises 72 fans, which corresponds to an overall sound power level of 113 dB(A), and is represented by a single source in the noise model. Using the latest available technology it is possible to reduce the sound power level per fan to approximately 88 dB(A) (as assumed in the attenuated base-case noise model) corresponding to an overall sound power level of 106 dB(A) for the entire cooler. To satisfy a 35 dB(A) criterion for new plant would require further reductions of the order of 10 to 20 dB. (The exact reduction required varies depending on the location of the receiver.) This represents a further 10 fold to 100 fold reduction in the sound energy emitted by cooler.

For the attenuated base-case model, noise reductions up to 10 dB have been assumed for new plant compared to similar equipment already operating at the refinery (refer Table 6-1). It has been calculated that the contributions to overall noise levels from new plant are between 34.6 and 42.6 dB(A) at the seven receiving locations considered. To reduce the contributions from new plant to less than 35 dB at all locations would require substantial further reductions which, as discussed above, are not practical. Furthermore, the benefit of achieving such reductions would not be realized unless the contributions from all other existing and upgraded plant at the refinery were also similarly reduced. Previous assessments have demonstrated that such reductions for existing plant are not achievable (refer HSA report ref 9572-7-00029-4.2).

In summary, to achieve no increase in noise impacts from the expanded refinery requires all new plant to employ the latest available noise reduction technologies as well as significant noise reductions to many existing plant areas at the refinery.

5.3 Base-Case – Ore Transport System

Based on the assumptions described in section 3.1.3 of this report, noise levels for the upgraded ore transport system were predicted for the two noise sensitive residences nearest to the conveying system. The results are presented in the table below. The table also provides the existing noise levels as predicted by HSA's current noise model and the potential change in noise levels.

Note that the predicted noise levels are based on duplication of existing equipment during the expansion with no allowance for new, quieter technologies or noise control measures. As such the results demonstrate the need to incorporate noise mitigation measures in the design of the expansion.

Table 5-3 Predicted noise levels for ore transport system assuming no noise mitigation

Location	Existing Noise Level dB(A)	Noise Level after Expansion dB(A)	Noise Impact dB
RC1	32.8	34.2	1.4
RC2	37.3	38.7	1.4

Figure B2 in appendix D present the noise contours for the ore transport system options assuming worst-case sound propagation conditions.

5.4 Attenuated Base-Case – Ore Transport System

Based on the assumptions described in section 4.3 of this report, noise levels for the upgraded ore transport system were predicted for the two noise sensitive residences nearest to the conveying system. The results are presented in the table below. The table also provides the existing noise levels as predicted by HSA's current noise model and the potential change in noise levels.

Table 5-4 Predicted noise levels for ore transport system assuming implementation of noise control measures

Location	Existing Noise Level dB(A)	Noise Level after Expansion dB(A)	Noise Impact dB
RC1	32.8	32.1	-0.7
RC2	37.3	34.8	-2.5

Figure C2 in appendix D present the noise contours for the ore transport system options assuming worst-case sound propagation conditions.

6 Appendix A – Sound Power Summary Table

The table below presents the overall sound power levels for expansion noise sources assumed for both the base case noise model and the attenuated base case noise model.

Table 6-1 Overall Sound Power Levels

Building No.	Description	Un-attenuated Sound Power Level dB(A)	Attenuated Sound Power Level dB(A)	Noise Reduction dB
371	Overland Conveyor (1st 150 modules)	83/m	83/m	-
371	Overland Conveyor head drive	105	95	10
15	Transfer Station	115	105	10
15	Conveyor 395 (to stacker)	83/m	83/m	-
15	Stacker	104	104	-
15	Reclaimer	110	105	5
15	Reclaimer 2	111	105	6
15	B100 conveyor	88/m	83/m	5
15	B200 conveyor	83/m	83/m	-
15	B100 conveyor drive	114	110	4
15	B200 conveyor drive	115	110	5
15	Conveyor C100	86/m	83/m	3
15	Conveyor C100 drive	114	110	4
15	Conveyor C200	86/m	83/m	3
15	Conveyor C200 drive	115	110	5
25	Ball Mills (combined)	117	107	10
25	SAG Mill 3	117	107	10
25	SAG Mill 4	118	108	10
25	SAG Mill 5	118	108	10
25A	Bauxite slurry Recirc & BSD Pumps	107	105	2
30	Digestion	114	109	5
30A	Digestion test tanks	108	95	13
40	Heat exchange	111	106	5
42B	Evaporation	111	108	3
42A	Evaportation Storage Tanks	105	95	10
43	Condensate Facilities	108	98	10
35A	Filtrate tanks	108	108	-
35C	Washers	109	107	-
35C	Cyclones	109	104	5
35D	Thickner over flow tanks 21 & 22	105	95	10
35E	Mud wash water tank	102	102	-
35G	Hose & press water facilities	107	107	-
35F	Thickeners	107	105	2
35F	Cyclones	106	101	5
35H	Mud washers	107	107	-
HEC	HEC	111	106	5
259	Superthickener 2 - drive	109	100	9
259	Superthickener - mud pumping station	105	102	3

Building No.	Description	Un-attenuated Sound Power Level dB(A)	Attenuated Sound Power Level dB(A)	Noise Reduction dB
259	Sand separation plant	105	102	3
45	Precipitator building south face	100	95	5
45	Precipitator building west face	104	99	5
45	Agitator gearboxes	110	100	10
45	Green liquor valves	106	96	10
45	Vacuum pumps	99	99	-
45A	Pumps at ground level	108	98	10
50	Calciner blower enclosure (stage 1)	107	102	5
50	Calciner blower inlet (stage 1)	115	105	10
50	Calciner building (stage 1)	112	107	5
50	Calciner blower enclosure (stage 2)	107	102	5
50	Calciner blower inlet (stage 2)	115	105	10
50	Calciner building (stage 2)	112	107	5
110	GT 1	114	104	10
110	GT 2	114	104	10
47	Oxalate kiln stack	90	90	-
47	Oxalate kiln fan	105	100	5
45	Air fin coolers	113	107	6
Ore Transport System*				
371	Conveyor 371 modules 390 - 413	84/m	82/m	2
371	Conveyor 371 modules 413 – 500	83/m	80/m	3
371	Conveyor 371 modules 500 – 657	83/m	81/m	2
371	Conveyor 371 modules 850 – 1140	89.5/m	83/m	6.5
371	Conveyor 371 modules 1140 - 1160	94/m	84/m	10
371	600m extension of conveyor 371 beyond Arundel	89.5/m	83/m	6.5
371	Remainder of conveyor 371 to Larego	89.5/m	89.5/m	-

** Only new conveyor sections and those sections of the existing conveyor system that will require noise reductions are listed. All other sections of conveyor 371 have the same sound power levels as in the original HSA noise model but increased by 2 dB to account for the proposed increase in conveyor speed.*

Note that for the attenuated base case the following noise reductions have also been applied to existing sources at the refinery:

Table 6-2 Noise Reductions applied to existing sources

Building No.	Description	Reduction dB
110	Power Station FD fan intakes	5
110	Power Station exhaust stack (FD fan discharges)	5
50	Calciner blower intakes	5
259	Superthickener hydraulic drive	9
45	Agitator drives (13 noisiest)	5

7 Appendix B – Source Details

7.1 Base Case

Table 7-1 Octave Band Noise Levels – dB(A) for Base Case Model

Building No	Description	31.5	63	125	250	500	1k	2k	4k	8k	Sum dB(A)	
371	Overland Conveyor (1st 150 modules)		55	70	72	77	77	77	72	64	83	/m
371	Overland Conveyor head drive	78	80	89	94	100	100	95	93	83	105	
15	Transfer Station	74	87	97	105	112	108	106	99	91	115	
15	Conveyor 395 (to stacker)	36	52	66	77	78	78	74	67	57	83	/m
15	Stacker	63	76	86	94	98	100	97	91	82	104	
15	Reclaimer	64	85	91	98	106	105	102	100	97	110	
15	Reclaimer 2	65	86	92	99	107	106	103	101	98	111	
15	B100 conveyor	46	58	67	75	83	85	81	74	63	88	/m
15	B200 conveyor	36	52	66	77	78	78	74	67	57	83	/m
15	B100 conveyor drive		81	90	101	109	110	108	101	93	114	
15	B200 conveyor drive	71	83	97	100	110	112	108	102	92	115	
15	Conveyor C100	46	64	72	77	83	80	77	70	59	86	/m
15	Conveyor C100 drive		86	95	102	111	108	105	99	89	114	
15	Conveyor C200	43	64	72	77	83	80	77	70	59	86	/m
15	Conveyor C200 drive		87	96	103	112	109	106	100	90	115	
25	Ball Mills (combined)	80	95	100	107	111	112	110	105	95	117	
25	SAG Mill 3	69	84	95	104	109	112	110	109	104	117	
25	SAG Mill 4	71	90	99	106	111	114	113	107		118	
25	SAG Mill 5	71	90	99	106	111	114	113	107		118	
25A	Bauxite slurry Recirc & BSD Pumps		68	81	90	99	102	102	97	87	107	
30	Digestion		84	98	101	105	108	110	106	97	114	
30A	Digestion test tanks		81	94	94	96	99	99	105	99	108	
40	Heat exchange		80	92	97	105	106	104	100	89	111	
42B	Evaporation		77	88	96	101	106	106	105	99	111	
42A	Evaportation Storage Tanks		76	90	93	96	100	99	95	87	105	
43	Condensate Facilities		71	87	94	102	102	102	99	90	108	
35A	Filtrate tanks	68	80	91	99	104	102	101	96	87	108	
35C	Washers		70	83	92	101	104	104	99	89	109	
35C	Cyclones		64	77	90	101	104	104	101	93	109	
35D	Thickner over flow tanks 21 & 22	56	71	83	90	96	99	100	97	88	105	
35E	Mud wash water tank	50	63	76	85	94	97	97	92	82	102	
35G	Hose & press water facilities	60	74	90	94	102	102	101	97	89	107	
35F	Thickeners		68	81	90	99	102	102	97	87	107	
35F	Cyclones		61	74	87	98	101	101	98	90	106	
35H	Mud washers	55	68	81	90	99	102	102	97	87	107	
HEC	HEC		80	92	97	105	106	104	100	89	111	
259	Superthickener 2 - drive		67	71	82	109	94	85	73		109	
259	Superthickener - mud pumping station		74	88	86	94	102	101	94		105	

Building No	Description	31.5	63	125	250	500	1k	2k	4k	8k	Sum dB(A)	
259	Sand separation plant		74	88	86	94	102	101	94		105	
45	Precipitator building south face		81	88	91	95	94	90	87	81	100	
45	Precipitator building west face		76	87	94	100	99	95	90	79	104	
45	Agitator gearboxes	69	76	89	96	102	108	100	93	85	110	
45	Green liquor valves		74	81	89	96	102	100	98	91	106	
45	Vacuum pumps		74	88	96	89	91	88	88	85	99	
45A	Pumps at ground level	56	69	82	91	100	103	103	98	88	108	
50	Calciner blower enclosure (stage 1)		70	79	90	101	103	103	93	86	107	
50	Calciner blower inlet (stage 1)		88	96	102	108	110	109	103	89	115	
50	Calciner building (stage 1)		80	83	92	102	107	107	107	98	112	
50	Calciner blower enclosure (stage 2)		70	79	90	101	103	103	93	86	107	
50	Calciner blower inlet (stage 2)		88	96	102	108	110	109	103	89	115	
50	Calciner building (stage 2)		80	83	92	102	107	107	107	98	112	
110	GT 1		99	105	103	106	109	108	104	98	114	
110	GT 2		99	105	103	106	109	108	104	98	114	
47	Oxalate kiln stack		75	77	82	87	84	78	72	63	90	
47	Oxalate kiln fan	65	76	83	94	103	100	93	88	80	105	
45	Air fin coolers		96	103	103	104	107	107	101	89	113	
Ore Transport System												
371	Conveyor 371 modules 390 - 413		56	63	69	79	79	78	74	66	84	/m
371	Conveyor 371 modules 413 – 500			68	72	77	77	78	72	69	83	/m
371	Conveyor 371 modules 500 – 657			68	72	77	77	78	72	69	83	/m
371	Conveyor 371 modules 850 – 1140		58	71	73	83	86	83	77	66	90	/m
371	Conveyor 371 modules 1140 - 1160		67	82	80	90	89	87	81	68	94	/m
371	600m extension of conveyor 371 beyond Arundel		58	71	73	83	86	83	77	66	90	/m
373	Remainder of conveyor 371 to Larego		58	71	73	83	86	83	77	66	90	/m

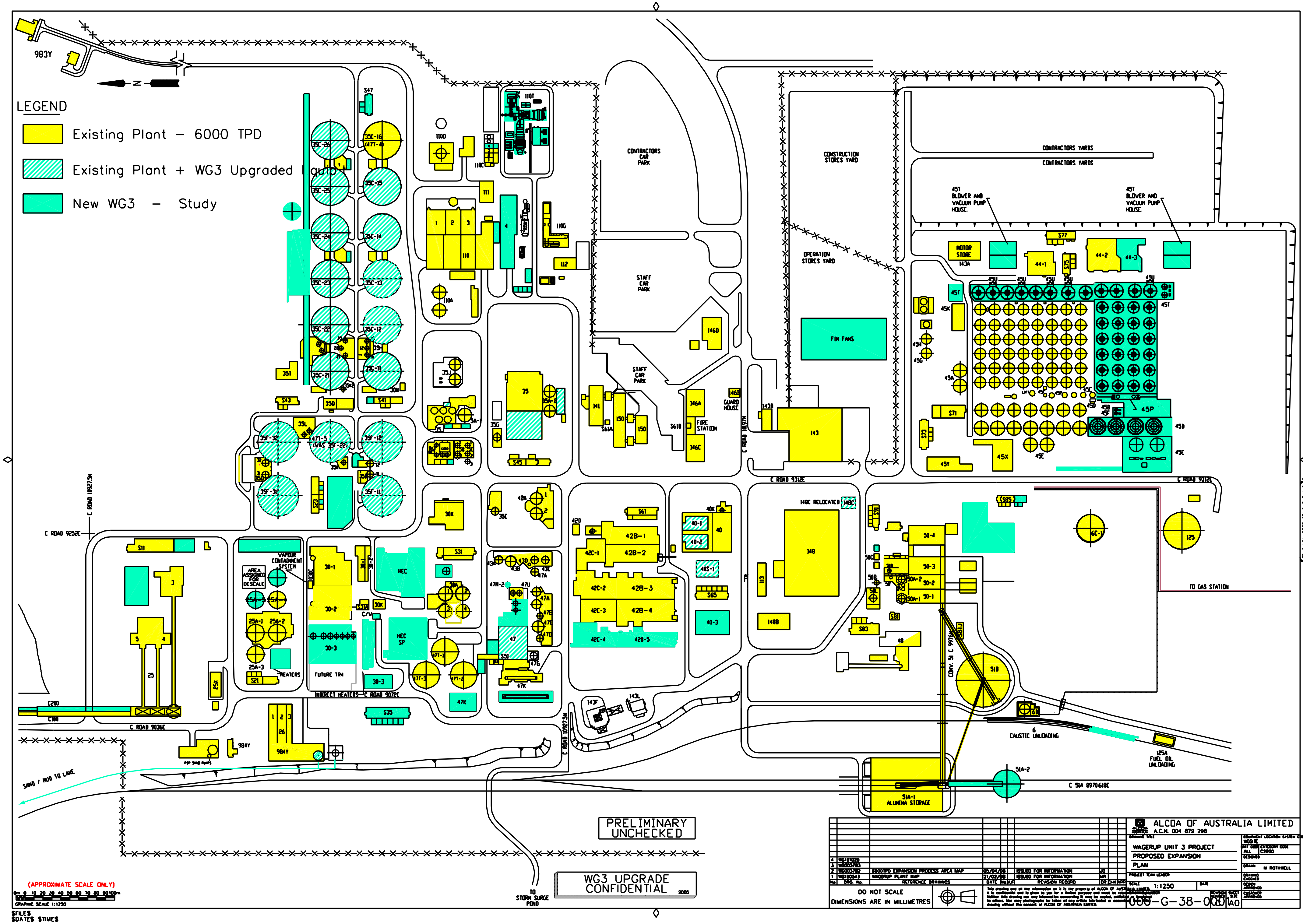
7.2 Attenuated Base Case

Table 7-2 Octave Band Noise Levels – dB(A) for Attenuated Base Case Model

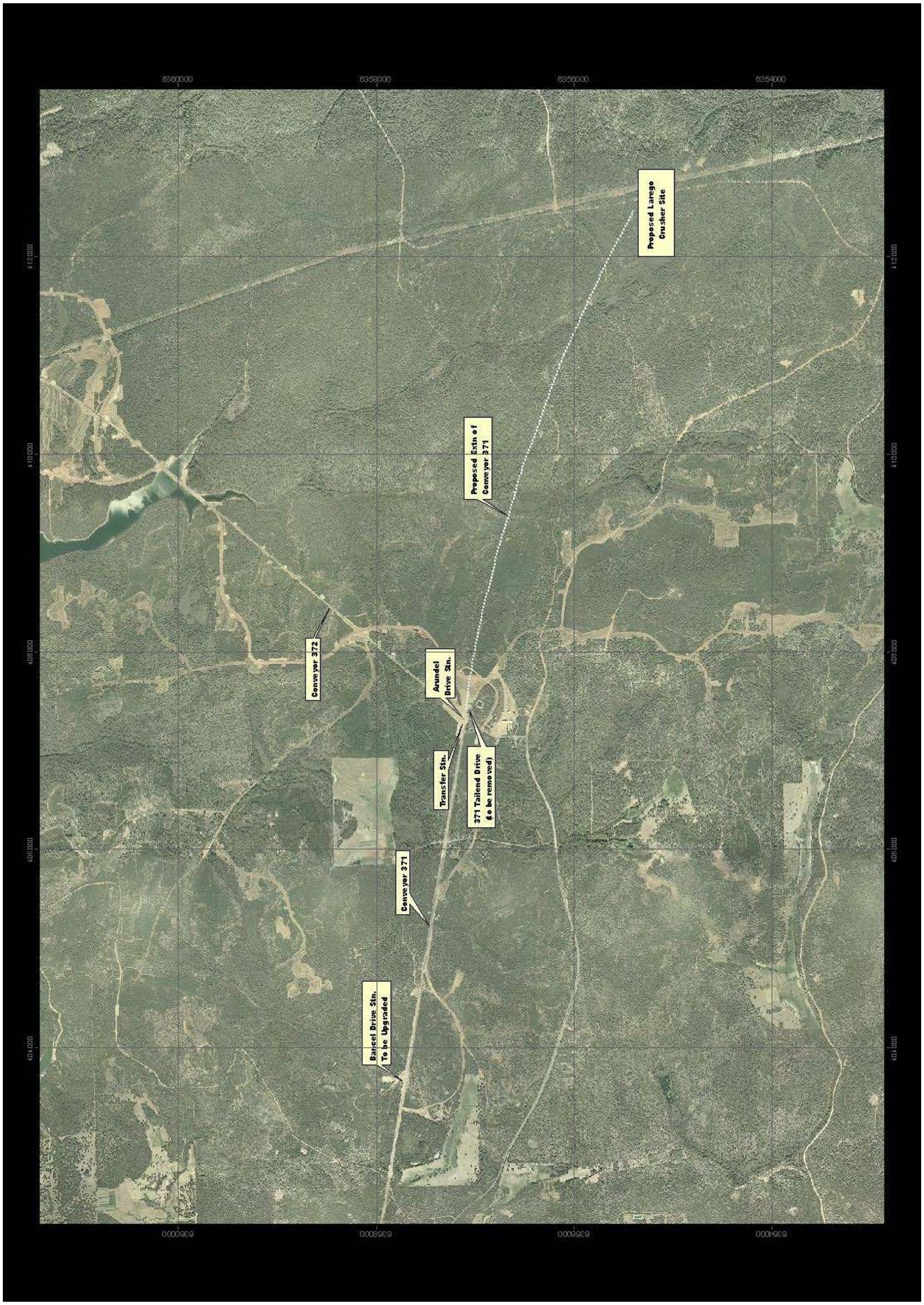
Building No	Description	31.5	63	125	250	500	1k	2k	4k	8k	Sum dB(A)	
371	Overland Conveyor (1st 150 modules)		55	70	72	77	77	77	72	64	83	/m
371	Overland Conveyor head drive	68	70	79	84	90	90	85	83	73	95	
15	Transfer Station	64	77	87	95	102	98	96	89	81	105	
15	Conveyor 395 (to stacker)	36	52	66	77	78	78	74	67	57	83	/m
15	Stacker	63	76	86	94	98	100	97	91	82	104	
15	Reclaimer	59	80	86	93	101	100	97	95	92	105	
15	Reclaimer 2	59	80	86	93	101	100	97	95	92	105	
15	B100 conveyor	41	53	62	70	78	80	76	69	58	83	/m
15	B200 conveyor	36	52	66	76	78	78	74	67	57	83	/m
15	B100 conveyor drive		77	86	97	105	106	104	97	89	110	
15	B200 conveyor drive	66	78	92	95	105	107	103	97	87	110	
15	Conveyor C100	40	61	69	74	80	77	74	67	56	83	/m
15	Conveyor C100 drive		82	91	98	107	104	101	95	85	110	
15	Conveyor C200	40	61	69	74	80	77	74	67	56	83	/m
15	Conveyor C200 drive		82	91	98	107	104	101	95	85	110	
25	Ball Mills	70	85	90	97	101	102	100	95	85	107	
25	SAG Mill 3	59	74	85	94	99	102	100	99	94	107	
25	SAG Mill 4	61	80	89	96	101	104	103	97		108	
25	SAG Mill 5	61	80	89	96	101	104	103	97		108	
25A	Bauxite slurry Recirc & BSD Pumps		66	79	88	97	100	100	95	85	105	
30	Digestion		79	93	96	100	103	105	101	92	109	
30A	Digestion test tanks		56	69	78	87	90	90	85	75	95	
40	Heat exchange		75	87	92	100	101	99	95	84	106	
42B	Evaporation		74	85	93	98	103	103	102	96	108	
42A	Evaportation Storage Tanks		66	80	83	86	90	89	85	77	95	
43	Condensate Facilities		61	77	84	92	92	92	89	80	98	
35A	Filtrate tanks	68	80	91	99	104	102	101	96	87	108	
35C	Washers		68	81	90	99	102	102	97	87	107	
35C	Cyclones		59	72	85	96	99	99	96	88	104	
35D	Thickner over flow tanks 21 & 22	46	61	73	80	86	89	90	87	78	95	
35E	Mud wash water tank	50	63	76	85	94	97	97	92	82	102	
35G	Hose & press water facilities	60	74	90	94	102	102	101	97	89	107	
35F	Thickeners		66	79	88	97	100	100	95	85	105	
35F	Cyclones		56	69	82	93	96	96	93	85	101	
35H	Mud washers	55	68	81	90	99	102	102	97	87	107	
35J	Flash tanks		75	87	92	100	101	99	95	84	106	
259	Superthickener 2 – drive		67	71	82	99	94	85	73		100	
259	Superthickener - mud pumping station		71	85	83	91	99	98	91		102	
259	Sand separation plant		71	85	83	91	99	98	91		102	
45	Precipitator building south face		76	83	86	90	89	85	82	76	95	

Building No	Description	31.5	63	125	250	500	1k	2k	4k	8k	Sum dB(A)	
45	Precipitator building west face		71	82	89	95	94	90	85	74	99	
45	Agitator gearboxes	59	66	79	86	92	98	90	83	75	100	
45	Green liquor valves		64	71	79	86	92	90	88	81	96	
45	Vacuum pumps		74	88	96	89	91	88	88	85	99	
45A	Pumps at ground level	46	59	72	81	90	93	93	88	78	98	
50	Calciner blower enclosure (stage 1)		65	74	85	96	98	98	88	81	102	
50	Calciner blower inlet (stage 1)		78	86	92	98	100	99	93	79	105	
50	Calciner building (stage 1)		75	78	87	97	102	102	102	93	107	
50	Calciner blower enclosure (stage 2)		65	74	85	96	98	98	88	81	102	
50	Calciner blower inlet (stage 2)		78	86	92	98	100	99	93	79	105	
50	Calciner building (stage 2)		75	78	87	97	102	102	102	93	107	
110	GT 1		89	95	93	96	99	98	94	88	104	
110	GT 2		89	95	93	96	99	98	94	88	104	
47	Oxalate kiln stack		75	77	82	87	84	78	72	63	90	
47	Oxalate kiln fan	60	71	78	89	98	95	88	83	75	100	
45	Air fin coolers		90	97	97	98	101	101	95	83	107	
Ore Transport System												
371	Conveyor 371 modules 390 - 413		54	61	67	77	77	76	72	64	82	/m
371	Conveyor 371 modules 413 – 500			65	69	74	74	75	69	66	80	/m
371	Conveyor 371 modules 500 – 657			66	70	75	75	76	70	67	81	/m
371	Conveyor 371 modules 850 – 1140		51	64	66	76	79	76	70	59	83	/m
371	Conveyor 371 modules 1140 - 1160		57	72	70	80	79	77	71	58	84	/m
371	600m extension of conveyor 371 beyond Arundel (Options A & C)		51	64	66	76	79	76	70	59	83	/m
373	Remainder of conveyor 371 to Larego		58	71	73	83	86	83	77	66	90	/m

8 Appendix C – Expansion Plot Plan and Willowdale Mine Ore Transportation System



LEGEND
Existing Plant – 6000 TPD
Existing Plant + WG3 Upgraded
New WG3 – Study
PRELIMINARY UNCHECKED
WG3 UPGRADE CONFIDENTIAL
CONTRACTORS CAR PARK
CONSTRUCTION STORES YARD
CONTRACTORS YARDS
OPERATION STORES YARD
STAFF CAR PARK
FIN FANS
MOTOR STORE
45T BLOWER AND VACUUM PUMP HOUSE
GUARD HOUSE
FIRE STATION
148C RELOCATED
TO GAS STATION
CAUSTIC UNLOADING
FUEL OIL UNLOADING
ALUMINA STORAGE
VAPOUR CONTAINMENT SYSTEM
AREA ASSIGNED FOR DESCALE
INDIRECT HEATERS
FUTURE TR4
SAND / MUD TO LAKE
TO STORM SURGE POND
C ROAD 9312E
C ROAD 10927N
C ROAD 9252E
C ROAD 9036E
C ROAD 9072E
C 51A 8970.618E
(APPROXIMATE SCALE ONLY)
COMPUTER PRODUCED DRAWING ORIGINAL STORED ELECTRONICALLY
ALCOA OF AUSTRALIA LIMITED
A.C.N. 004 879 298
WAGERUP UNIT 3 PROJECT
PROPOSED EXPANSION
PLAN
SCALE 1:1250
DO NOT SCALE
DIMENSIONS ARE IN MILLIMETRES
6000TPD EXPANSION PROCESS AREA MAP
WAGERUP PLANT MAP
ISSUED FOR INFORMATION
05/04/06
21/02/06
REFERENCE DRAWINGS
REVISION RECORD
000-G-38-0001
A0


Proposed Larego Crusher Site
Proposed Extn of Conveyor 371
Conveyor 372
Arundel Drive Stn.
Transfer Stn.
371 Tailend Drive (to be removed)
Conveyor 371
Bancel Drive Stn. To be Upgraded

9 Appendix D – Noise Contours

Figure A1 – Noise Contours for Existing Refinery
Figure A2 – Noise Contours for Existing Conveyor System

Figure B1 – Noise Contours for Expanded Refinery – WITHOUT Noise Control
Figure B2 – Noise Contours for Expanded Conveyor System – WITHOUT Noise Control

Figure C1 – Noise Contours for Expanded Refinery – WITH Noise Control
Figure C2 – Noise Contours for Expanded Conveyor System – WITH Noise Control

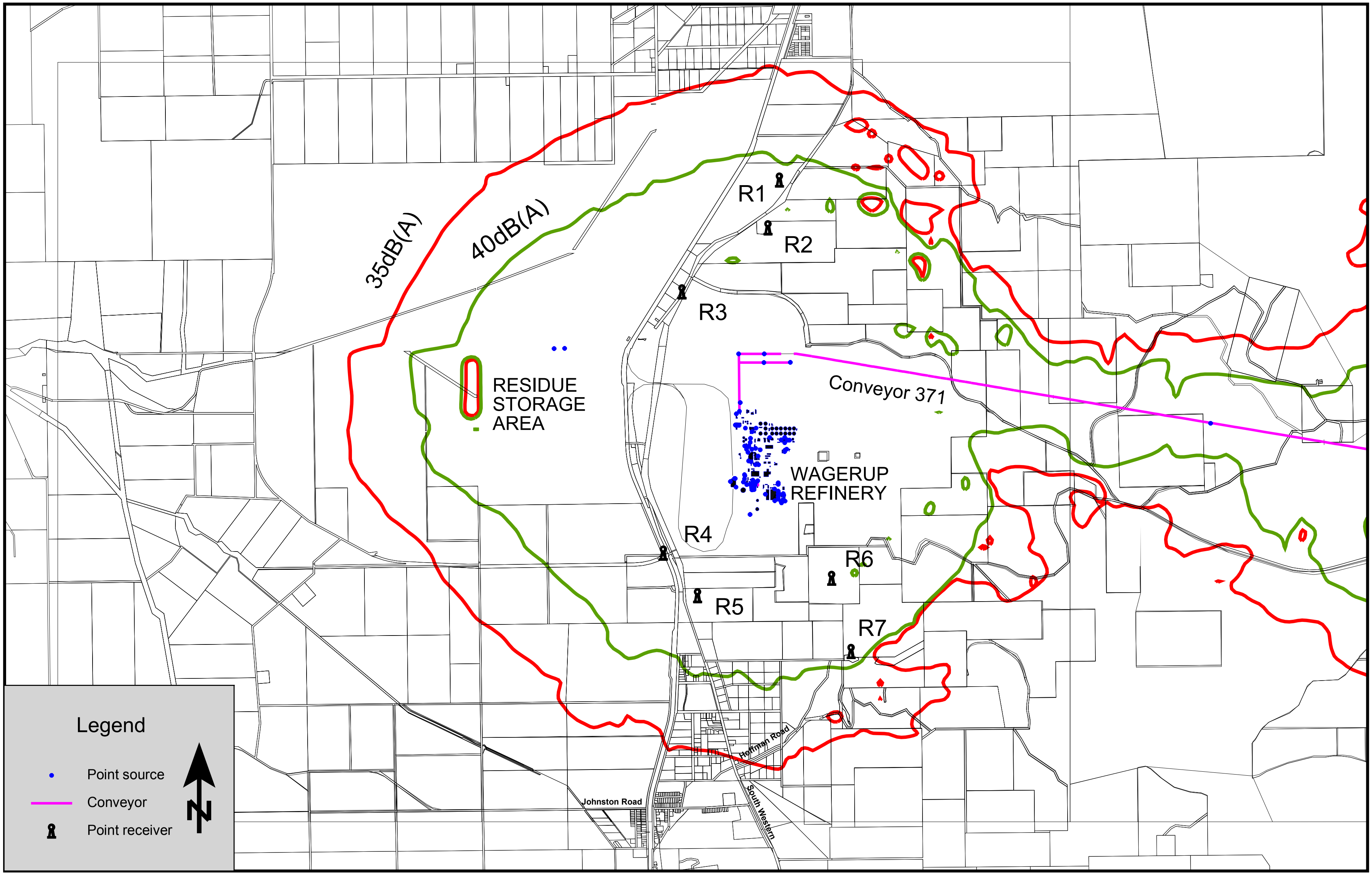


Figure A1. Noise Contours for Existing Refinery

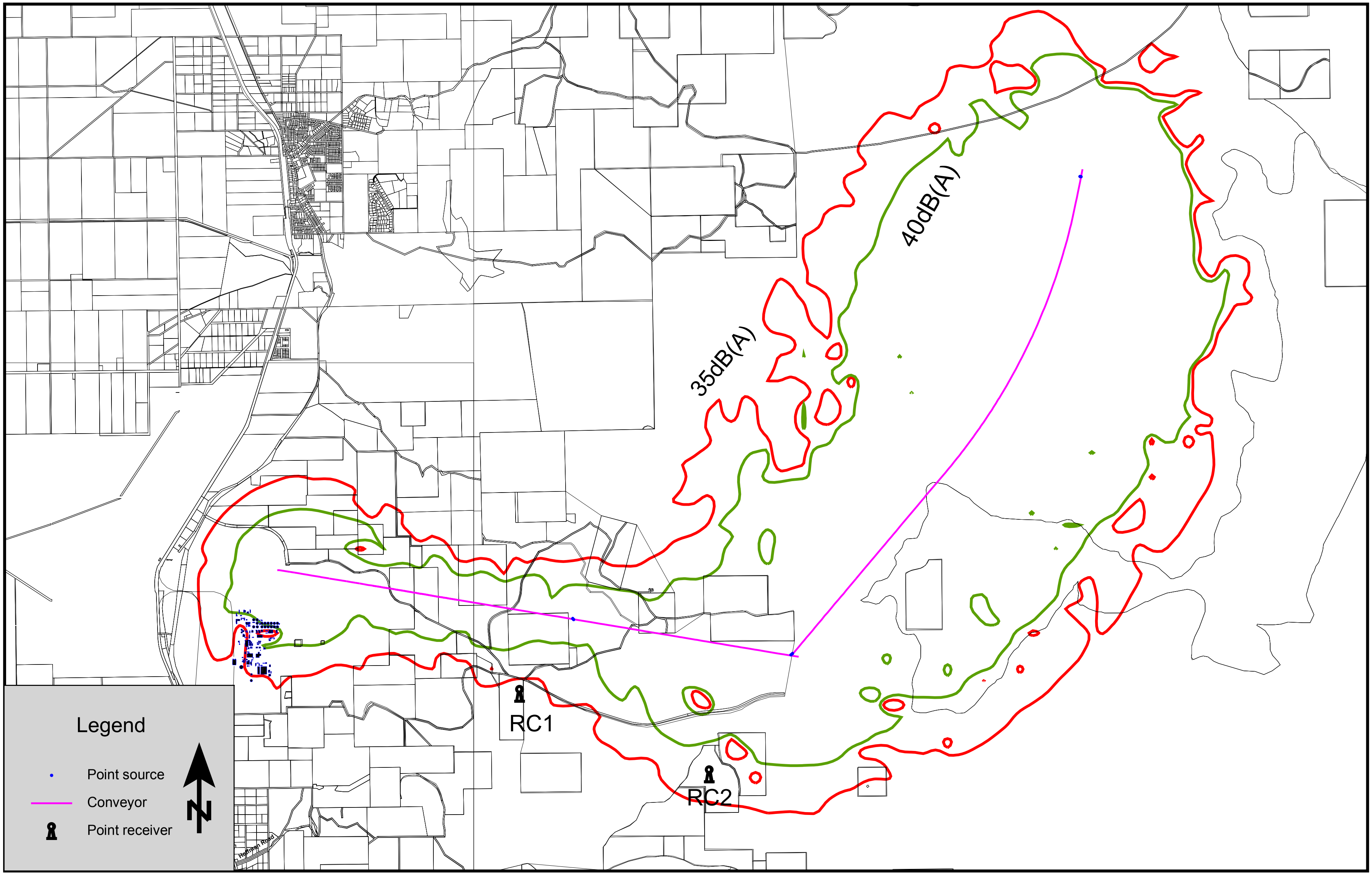


Figure A2. Noise Contours for Existing Overland Conveyors.

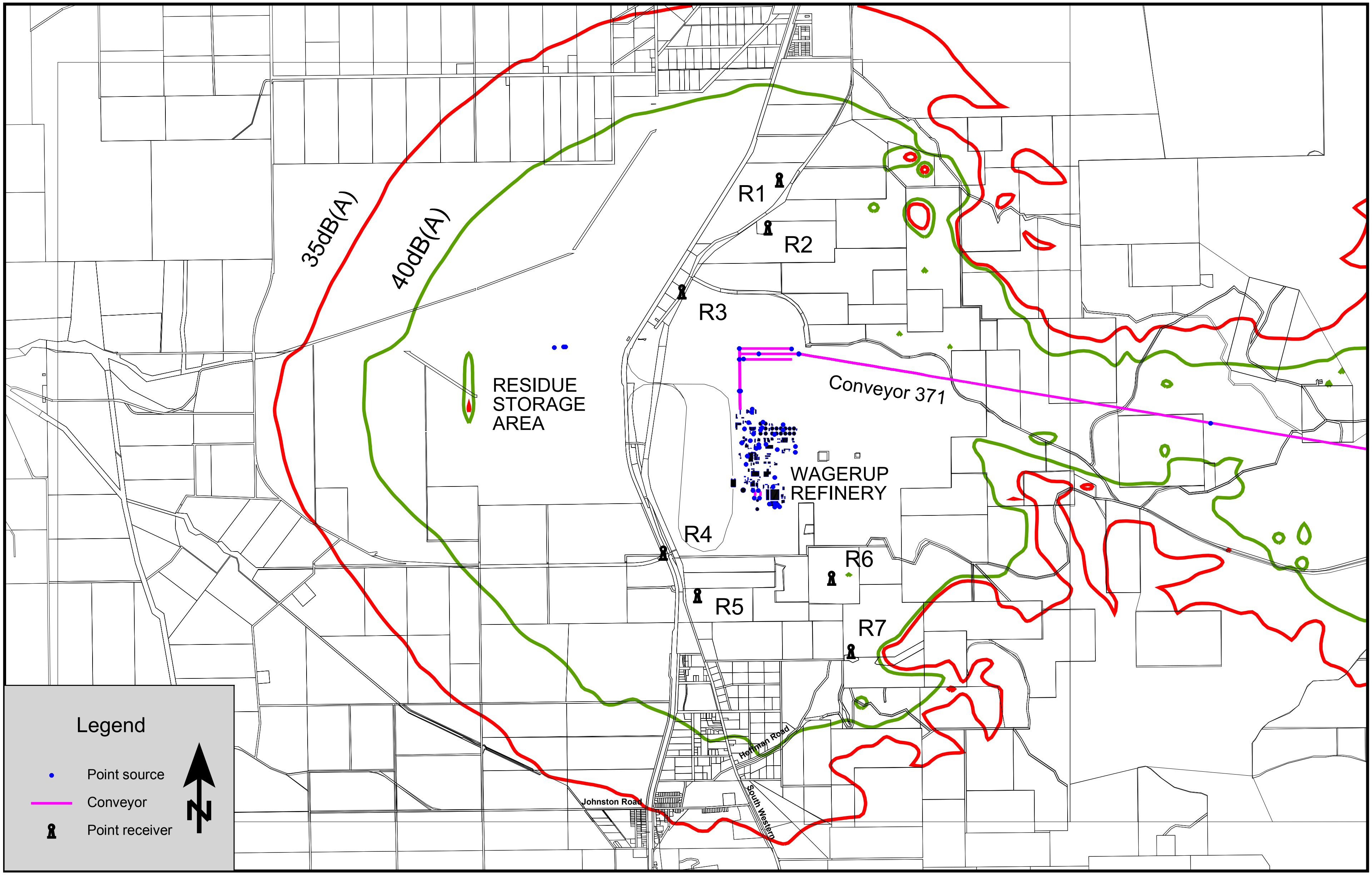


Figure B1. Noise Contours for Expanded Refinery - Without Noise Control.

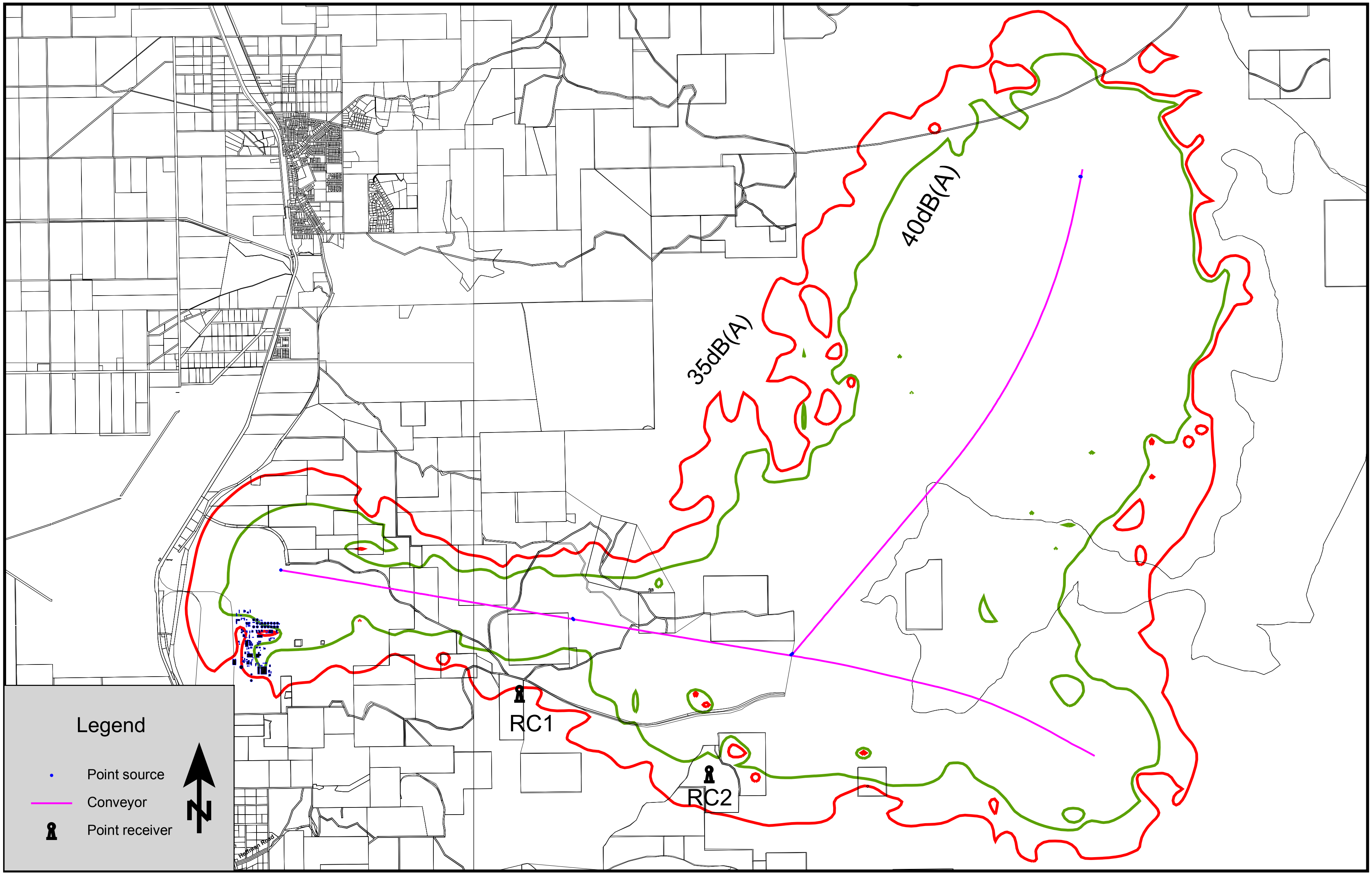


Figure B2. Noise Contours for Expanded Overland Conveyors - Without Noise Control.

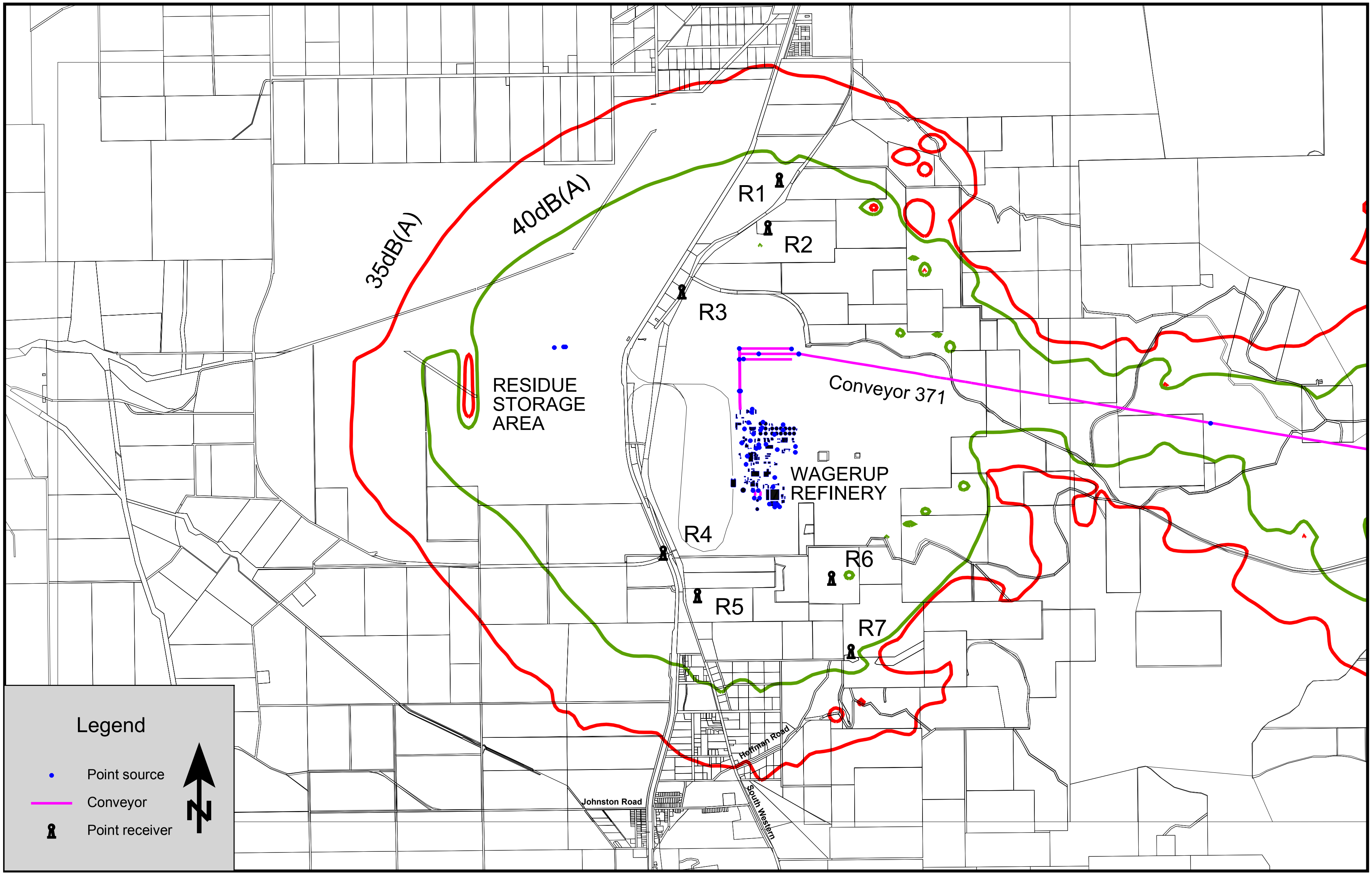


Figure C1. Noise Contours for Expanded Refinery - With Noise Control.

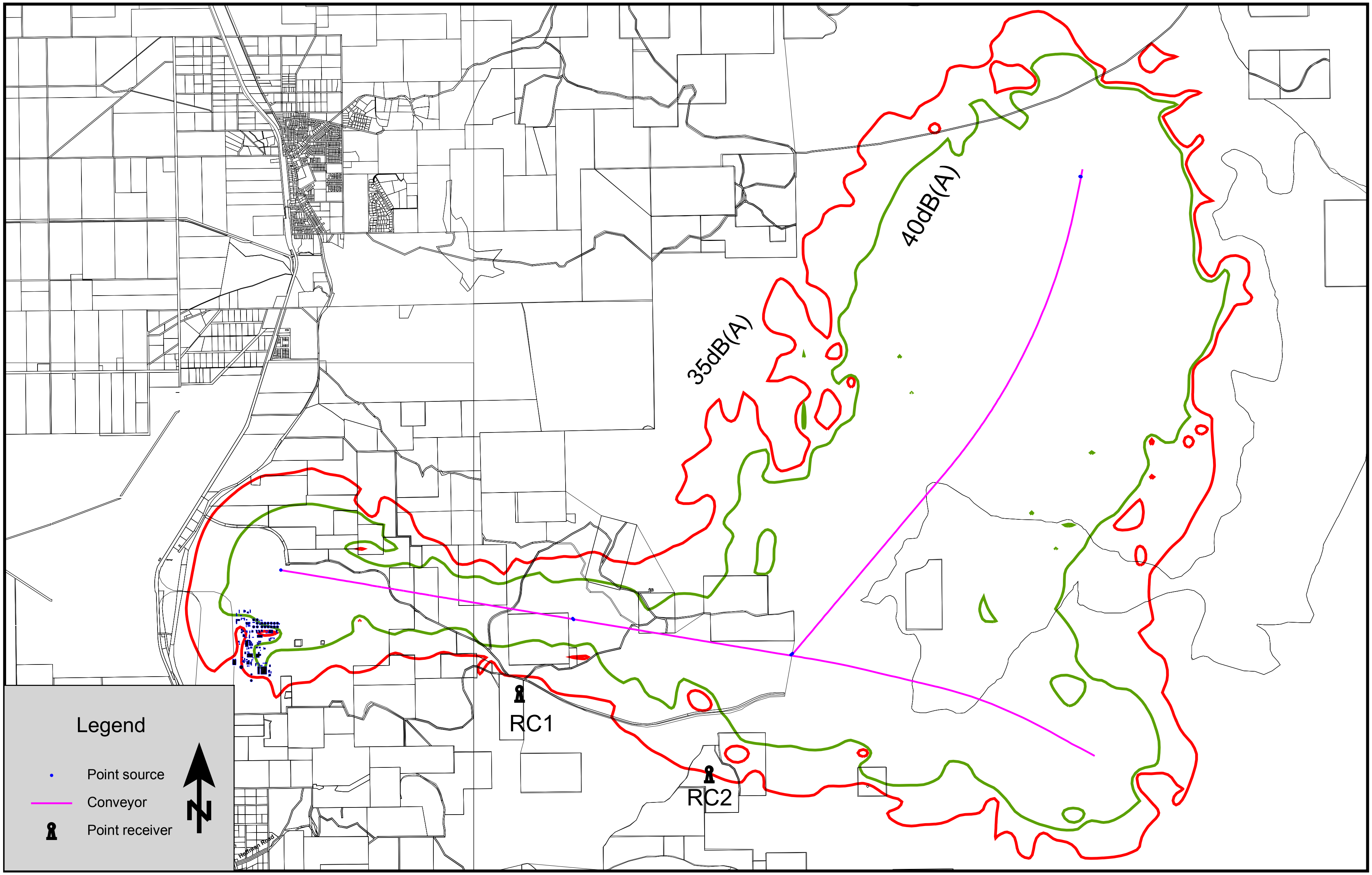


Figure C2. Noise Contours for Expanded Overland Conveyors - With Noise Control.

10 Appendix E – Analysis of Source Contributions and Potential Noise Reductions

Summary of Source Contributions and Reductions

		Source Contributions for Unattenuated Expansion					Source Contributions for Attenuated Expansion					Potential Reductions for Attenuated Expansion					
Receiving Location	Current Refinery Noise Level	Existing Plant	Upgraded Plant	Existing Plus Upgraded	New Plant	Total	Existing Plant	Upgraded Plant	Existing Plus Upgraded	New Plant	Total	Existing	Upgraded	Existing Plus Upgraded v Current	New Plant	Attenuated v Unattenuated	Attenuated v Current
R1	42.0	36.5	43.3	44.1	40.4	45.7	36.0	38.9	40.7	34.6	41.5	0.5	4.4	1.3	5.8	4.2	0.5
R2	45.6	40.2	47.4	48.2	43.9	49.5	39.9	43.0	44.7	38.5	45.6	0.3	4.4	0.9	5.4	3.9	0.0
R3	48.8	41.5	51.3	51.7	47.7	53.1	40.7	46.7	47.7	42.2	48.7	0.8	4.6	1.1	5.5	4.4	0.1
R4	47.8	46.6	43.4	48.3	48.5	51.4	46.3	38.3	46.9	42.6	48.3	0.3	5.1	0.9	5.9	3.1	-0.5
R5	45.9	45.2	41.0	46.6	47.2	49.9	44.9	37.0	45.6	41.1	46.8	0.3	4.0	0.3	6.1	3.1	-0.9
R6	47.2	45.1	43.7	47.5	48.2	50.9	44.2	38.8	45.3	41.8	46.8	0.9	4.9	1.9	6.4	4.1	0.4
R7	40.9	39.8	37.4	41.8	42.3	45.1	39.2	33.6	40.3	36.0	41.5	0.6	3.8	0.6	6.3	3.6	-0.6

Existing plant includes all plant which is unaffected by the expansion. In order to achieve Alcoa's environmental noise level objective, it will be necessary to apply noise controls to some existing plant which would otherwise be unaffected by the expansion. These items are also included in the definition of existing plant.

Upgraded plant refers to existing plant within the refinery which will be modified during the expansion process. Examples include the stockyard conveyors and SAG mills. The expansion project provides the opportunity to implement noise reductions for upgraded plant which would otherwise not be practicable.

New plant refers to any new equipment exclusively associated with the expansion. Examples include the new Calciners, Precipitation plant and air fin coolers.

Source contributions are determined from the output of the expansion noise model.

The overall reductions in existing plant are achieved by implementing the individual reductions listed in table 6.2 and discussed in the relevant paragraphs of section 4.

The overall reductions in upgraded and new plant can be achieved by implementing the individual reductions listed in table 6.1 and discussed in the relevant paragraphs of section 4.

The attenuated v unattenuated reductions represent the difference in potential noise impacts for the expansion with and without the noise controls discussed in section 4.

The attenuated v current reductions represent the difference between current refinery emissions and those after completion of the expansion assuming the noise control discussed in section 4 are successfully implemented.

11 Appendix F – Model Validation Report

Summary of Wagerup Noise Propagation Model Validation Process

1.0 INTRODUCTION

This document outlines the generic process used to validate the Wagerup Refinery Acoustic model.

Extensive measurements in 2000 to assess the Wagerup refinery noise immission levels, indicated refinery noise could not be accurately measured at distances of greater than around 1000m from the refinery.

The extensive measurements were undertaken using hand held meter recordings and observations as well as automatic data loggers deployed specifically for the task. The measurements were conducted over varying weather conditions throughout the year.

Computer modelling was employed in an attempt to define refinery noise in far field locations where actual measurements were precluded due to background noise.

Initially the computer program ENM was utilised but there were difficulties in aligning predictions with recorded levels. The then new SoundPlan program was trialled and found to be more consistent with measurements particularly over distances of up to 1700m. Little adjustment of the SoundPlan model was required to align the predicted levels with the measured levels and only some variations of the ground type algorithms were required.

The SoundPlan model has been used from this time onwards to predict the refinery contribution to the neighbourhood noise levels. The model is updated with source information as new measurements are taken relative to any process changes or if any equipment is modified or installed. The validation of the model is a continuous process.

Apart from more accurately predicting refinery noise at distances, the computer model is used to understand the contribution of various components of the Refinery to the overall environmental noise levels.

2.0 VALIDATION PROCESS

The process of validating the computer model was essentially to align the predicted data with the measured data at locations where refinery noise could be delineated from background noise. This is somewhat limited to data recorded within 1000m of Refinery, however some data obtained at Boundary Road (1700m south of Refinery) under maximum propagation conditions was also useful in the validation process.

Most validation work was done south and north of the Refinery as this is the direction where most noise sensitive premises are located. There are distant residences located to the East of the refinery and only a few residences located to the West where the presence of road and rail traffic noise limit any accurate measurements of refinery noise.

Hand held recordings and observations are the most reliable method of ascertaining refinery noise contribution at a location of interest. However, even this method cannot accurately ascertain the parameters required by Regulatory criteria (L_{Amax}, L_{A1} and L_{A10} over a minimum of 15 minute periods), due to the significant influence of background noise, even at close locations. Accordingly short term levels (typically measured over 10 seconds) were recorded when the refinery noise was obvious and background noise minimal.

Ongoing model validation has occurred using spot checks to the south, north, east and west, generally along the 45 to 50 dB(A) contour locations where refinery noise is the dominant source. Recent samples of data collected in 2004 are shown in Table 1, indicating the good correlation of predicted and measured noise levels in the relatively near field of the refinery.

TABLE 1 - EXAMPLE OF SPOT VALIDATION MEASUREMENTS

Direction from Refinery	Sample Month	Location Description	Recorded Level (Short Term)	Predicted Level
South	June 04	Boundary Rd, near Logger 3	40 dB(A)	41 dB(A)
East	June 04	Escarpment near communications tower	50 dB(A	53 dB(A
North	July 04	Access Rd, near Logger 1	49 dB(A	50 dB(A
West	July 04	Between rail and SW Hwy in line with ROWS pond & to south of old Post office	48 dB(A	49 dB(A

NOTE: Measurements are scheduled to coincide with maximum propagation conditions in the direction of interest.

The model is continually updated with any changes in Refinery emission levels, due to plant modifications. The changes are continually validated using the methods described above. Different model inputs are shown in Table 2 for two refinery sources.

TABLE 2 - EXAMPLE OF MODEL UPDATES (Source Updates)

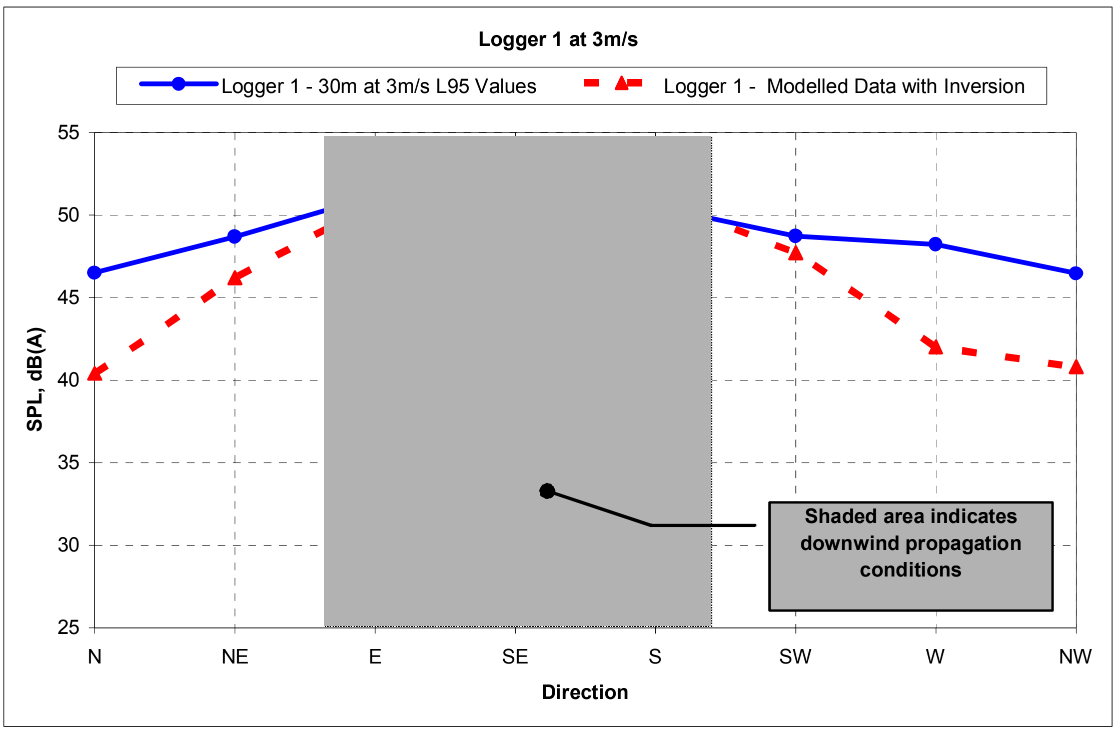
Source	Sound Power Level, dB Octave Band Centre Frequency (Hz)							dB(A)	Predicted	
	63	125	250	500	1k	2k	4k		Source Contribution dB(A)	Overall Refinery dB(A)
Building 44-2 East										
Original 2000	92	97	98	88	89	86	79	94	15[A]	41[A]
Update 2002	101	100	94	89	87	83	81	93	14[A]	41[A]
Update 2004	117	107	98	88	89	86	79	97	19[A]	41[A]
Building 50-3 Inlet										
Original 2000	118	101	85	83	76	91	103	107	18[B]	41[B]
Update 2002	104	81	70	69	70	68	64	80	4[B]	41[B]
Update 2004	Measurements were taken in 2004 following changes to the source but are not available at this time.									

[A] Predicted contribution and overall level at Boundary Road East
[B] Predicted contribution and overall level at Boundary Road (Logger 3)

As a further check, continuous logger data from the fixed monitors located at the access road (Logger 1) to the north and Bancell and Boundary Roads (Loggers 2 and 3) to the south of the refinery are also used to assist with model validation. Based on the hand held meter recordings, it was determined that under down wind (near worst case) conditions at loggers 1 and 2 the L_{A95} value was a reasonably true indication of the refinery L_{A10} value for most periods of the year. The actual L_{A10} value at these logger locations is heavily influenced by background noise and generally do not represent refinery noise contribution. For logger 3, the only parameter that can be used to reasonably indicate the refinery L_{A10} value is the L_{A99} value under downwind conditions. Accordingly these parameters have been used to validate model predictions by comparing these to the predicted L_{A10} levels over time.

A summary of the predicted versus recorded refinery noise levels is shown in Figures 1 to 3. These plots compare the highest 10 percentile value of all the L_{A95} values for the period 2002 to 2005 for various wind directions at logger 1 and 2 and the highest 10 percentile value of all the L_{A99} values for Logger 3, against the predicted refinery L_{A10} values under the same meteorological conditions. This data shows the consistency of the measured versus predicted levels under down wind conditions[1]. At other than down wind conditions the predicted levels do not correlate with the measured levels, as background noise is the dominant source.

Figure 1: Northern Monitor (Logger 1 Access Rd) Measured v Predicted SPL's



[1] For Logger 1 down wind conditions are generally southerly winds. For Loggers 2 and 3 down wind conditions are generally northerly winds.

Figure 2: Southern Monitor (Logger 2 Bancell Rd) Measured v Predicted SPL's

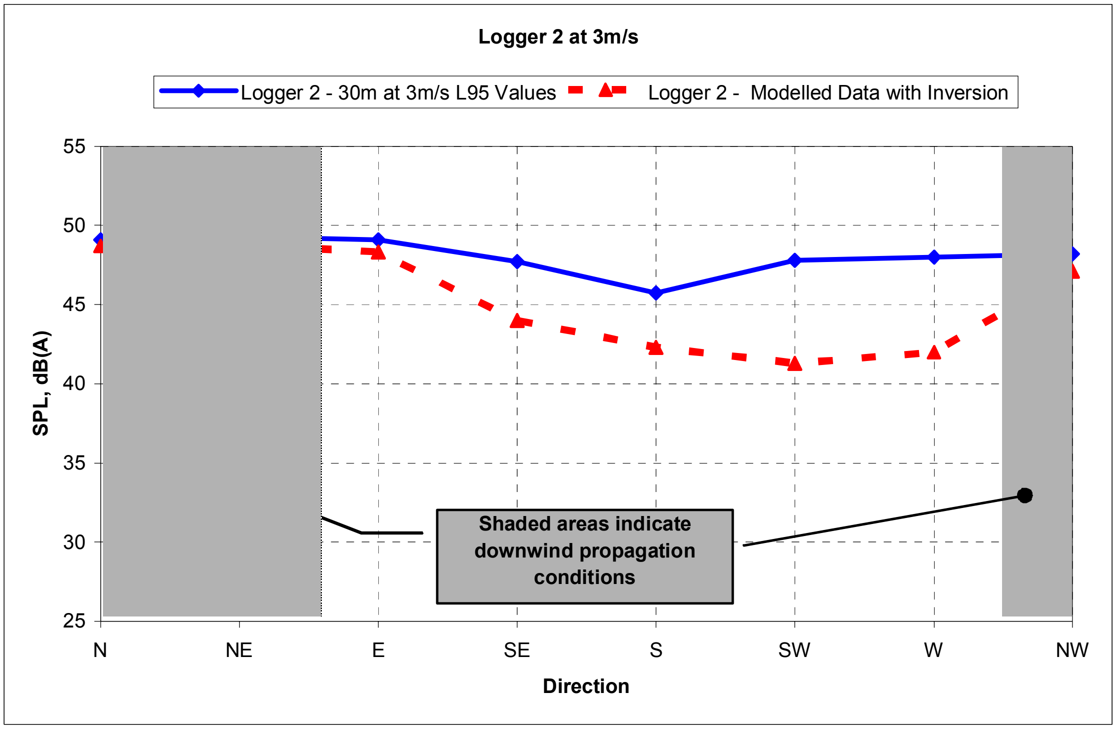
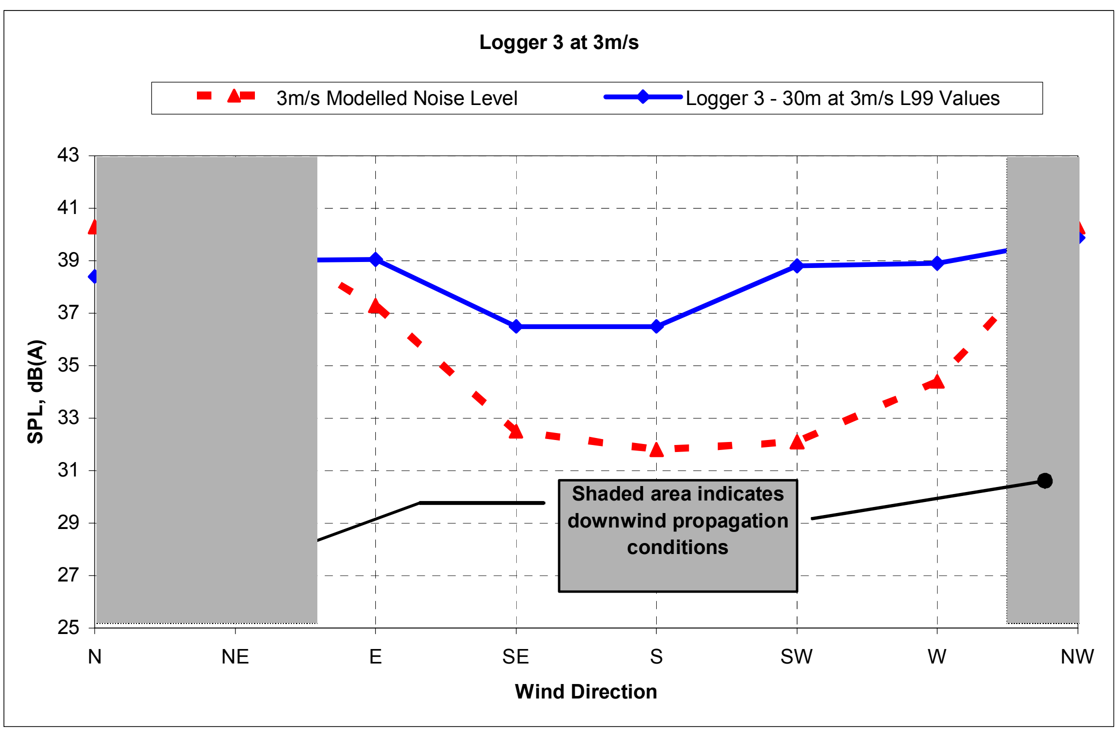


Figure 3: Southern Monitor (Logger 3 Boundary Rd) Measured v Predicted SPL's



3.0 Conclusion

The validation to date shows good correlation of predicted to measured levels with a deviation no greater than + or – 3dB(A. This is within the expected accuracy of predictive modelling.