SPECIALIST STUDY INTO
THE POTENTIAL IMPACT OF NOISE OF THE PROPOSED N2
WILD COAST TOLL HIGHWAY

PREPARED FOR
CCA ENVIRONMENTAL (PTY) LTD
ON BEHALF OF THE
N2 WILD COAST CONSORTIUM

DECEMBER 2007
EXECUTIVE SUMMARY

A Noise Impact Investigation was conducted into the proposed N2 Wild Coast Toll Highway Project in accordance with the National Environmental Management Act. The Investigation included sections of the Toll Highway Project consisting of the construction of new roads, changes to existing roads, as well as the proposed location of new mainline and ramp toll plazas.

The impact of noise from a new road on surrounding land, even with only little traffic, is very much larger than the impact of even a substantial increase in traffic flow on an existing road. The proposed construction of a new road between Ndwalane and the Mtamvuna River was expected to cause a significant increase in noise levels on land extending up to approximately 700 m on either side of the road within the concession period with the daytime rating level, $L_{Req,d}$, of noise exceeding 65dBA within 50m from the road edge. The actual distance would be dependent on the topography of the land. In terms of the Noise Control Regulations (NCR) noise mitigation measures would be required to be implemented to ensure that the 65dBA legal limit would no be exceeded.

Road traffic on the existing N2 between Amanzimtoti and the Isipingo interchange causes the current $L_{Req,d}$ on adjacent land to significantly exceed the 65 dBA maximum limit stipulated by the NCR for all noise sensitive land excluding land zoned for industrial use. The addition of a third lane in each direction was expected to result in a further increase in the $L_{Req,d}$. The N2 passes through residential suburbs along this section of the road with residential and educational land extending up to the road reserve. In terms of the NCR, noise mitigation measures along this section of the road would be required to be implemented to reduce the $L_{Req,d}$ to 65 dBA on all land zoned for residential, educational, hospital and office use.

Two alternative noise mitigation measures were studied regarding noise emanating from free-flowing road traffic, namely, the use of a low-noise, porous road surface, and the erection of noise barriers close to the edge of the road. Where noise mitigation measures were expected to be required to be implemented, the relative effectiveness of each alternative in reducing noise along the particular section of the road was presented.

Neither the NCR, nor SANS 10328 contains procedures to assess the impact of noise emanating from toll plazas. The expected impact of proposed mainline toll plazas was assessed and noise mitigation procedures recommended based on the results of previous investigations. These do not, however, follow standardised procedures and should be considered as a guide based on best available knowledge.

The existing $L_{Req,d}$ on land flanking the alternative R102 route, such as Kingsway, is unacceptably high. Although the predicted increase in $L_{Req,d}$ over the subsequent 10 and 15 years is barely significant, with or without tolling of the N2, any increase will exacerbate an already unacceptably high exposure to road traffic noise on residential land in this suburb. As a consequence of inadequate planning, technical noise mitigation alternatives cannot be practically implemented on residential land directly flanking the R102. It is thus recommended that serious consideration be given to attracting through-traffic away from the R102 onto the N2. This would imply that the section of the N2 Highway skirting the residential suburbs south of Durban not be tolled.

The intensity of impact of noise during construction of new roads through rural areas is expected to range between very high on land within approximately 150 m of construction work to medium at approximately 400 m distance. In order to minimise the significance of the impact it is recommended that machinery with the lowest noise emission be used and that a well planned and co-ordinated “fast track” procedure be implemented to complete the construction process in any area in the shortest possible time.
It has been stressed throughout the report that implementation of noise mitigation procedures in order to comply with the legal limit of 65 dBA imposed by the NCR on land adjacent to the road, could still result in the intensity of noise impact on large areas of land still being high due to the $L_{Req,d}$ exceeding the acceptable levels contained in SANS 10103 and exceeding the levels recommended by WHO. It is recommended that adequate noise mitigation procedures be implemented to ensure an $L_{Req,d} = 55$ dBA not be exceeded on residential and other noise sensitive land.

EXPERTISE OF INDEPENDENT NOISE IMPACT ASSESSMENT CONSULTANT

The author of this report, A.W.D. Jongens, M.Sc. (Elec.) Engineering, UCT, has since 1971 conducted numerous studies and submitted reports and recommendations to government departments, defence institutions, local authorities, local & international industries and private bodies relating to noise & vibration control, building and architectural acoustics, community noise, environmental noise and transportation noise throughout sub-Saharan Africa. The following is an abridged list of previous contracts relating to the present study.

Proposed Kirstenbosch Freeway, Cape Peninsula;
Proposed South Road Extension between William Nicol Drive & Rivonia Road, Johannesburg;
Impact of road noise on Morningside Wedge, Johannesburg;
Access Roads to the Victoria & Alfred Waterfront Development, Cape Town;
N2 Freeway Raapenberg Interchange, Cape Peninsula;
Jan Smuts Drive proposed widening, Pinelands;
Ottery to Blue Route proposed arterial Road, Cape Peninsula;
Blaauwberg Road & bridge widening;
Stanhope Road widening & interchange, Claremont, Cape Peninsula;
Platinum Toll Road (N4) between Pretoria and Botswana;
N1, N2 Winelands Toll Roads, Western Cape
GrangerBay Boulevard, Cape Town;
Robert Mugabe Extension, Windhoek, Namibia;
Foreshore Freeway, Cape Town;
Huguenot Tunnel Toll Plaza, Paarl;
Frans Conradie Road Extension, Cape Town;
Eastern Bypass, Worcester;
R60 between Worcester & Robertson, Western Cape;
Harbour arterial road, East London;
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SPECIALIST STUDY INTO THE POTENTIAL IMPACT OF NOISE OF THE PROPOSED N2 WILD COAST TOLL HIGHWAY.

1 INTRODUCTION

1.1 Background and brief

This report presents a description and results of a Noise Impact Assessment (referred to as NIA) of a proposal to upgrade, construct, maintain and toll sections of the N2 National Route between East London in the Eastern Cape and Durban in KwaZulu-Natal. It reviews the effect of road traffic noise on humans; identifies noise sensitive land and assesses the potential impact of road traffic noise on the identified land along the various sections of the proposed Toll Road. Various noise mitigation alternatives are explained and the change in noise impact these would have when applied along respective sections of the Toll Road.

1.2 Description of study area

The proposed N2 Wild Coast Toll Highway is proposed to extend over a total distance of approximately 560 km from the Gonubie Interchange, near East London (Eastern Cape) to the Isipingo Interchange south of Durban (KwaZulu-Natal). The proposed project includes the upgrading of existing road sections (of the N2 and R61), new road construction within the greenfields sections, the upgrading and/or construction of road interchanges, and the construction of associated structures (such as toll plazas and bridges).
2 IDENTIFICATION OF RISK SOURCES

2.1 Effects of road traffic noise

Road traffic noise has been identified as one of the greatest pollutants in the world. However, it has persisted for so long and is so wide spread that it is accepted part of one's environment. Most people are exposed to it from birth and contribute themselves to it as they commute to and from their place of work or recreation so are not consciously aware of it or of its insidious effects on the individual unless a particularly loud vehicle passes by. With the rapid increase in general vehicular traffic in and around cities and increased number of inter-city truck movements through rural areas an increasing number of residents, not only in suburban and urban areas, but also in rural areas are consciously or unconsciously becoming disturbed by traffic noise. It affects the enjoyment of their property during the day and affects their sleep during night time.

The levels of noise emissions from road traffic utilised in SANS 10210 for the prediction of road traffic noise are a function of:
- The number of vehicles passing in a time period (determined for each hour);
- The mean speed of the vehicles;
- The percentage heavy-duty vehicles;
- The road surface texture;
- The road gradient;
- The road worthiness of the vehicles.
- Distance between road and receiver;
- Intervening topography and structures that may shield the noise from the receiver;
- Meteorological effects.

The SANS 10210 road noise prediction model is accurate and has been adopted by other countries. However it does not encompass all sources of noise. An intrusive source prevalent in South Africa is the high level of low-frequency, throbbing noise emanating from Jacobs assisted braking systems on many heavy-duty vehicles in this country and that can be heard over distances well over 1 km. Because of this, these braking systems have been prohibited in many countries. It is recommended that this be addressed at the time of revision of provincial Noise Control Regulations.

The predominant effect to road traffic noise is sleep disturbance comprising difficulty in falling asleep; awakenings; alteration in depth of sleep; increased blood pressure; increased heart rate; changes in respiration; cardiac arrhythmia and an increase in body movement. This, in turn induces secondary effects during the day that include reduced perceived sleep quality; increased fatigue; depressed mood or well-being; and decreased performance. Studies have indicated that habituation may reduce the number of awakenings but not the other described effects [WHO, 3].

Sleep disturbance can be caused by relatively continuous levels of road traffic noise characteristic of urban areas and the difference in levels between noise of sporadic passing of vehicles compared to low background noise levels characteristic of rural areas.

In general, the greatest noise impact of any development occurs where there has been no development initially. Thus, the impact of a new road, even with only little traffic, is very much larger than the impact of even a substantial increase in traffic flow on an existing road.

The question of the influence of noise on wildlife is often raised. There remains inadequate quantitative information to suggest that noise that humans label as disturbing, or any other noise generated by humans, has any effect on wildlife other than exercising their primary instincts to avoid being in the
immediate vicinity of humans or vehicles moving on the roads. The physical clearance of land and construction of the roads is likely to have a greater impact on wildlife in the vicinity of the road reserve than any noise associated with such activities.

2.2 National Standards and Regulations relating to road traffic noise

Two procedures exist for assessing the impact of road traffic noise and for controlling road traffic noise:


- The procedures contained in the National Noise Control Regulations (NCR) promulgated under sections 25 and 28 of the Environment Conservation Act (Act No 73 of 1989) (ECA) and published in Government Notice No. R 896 of 27 April 1990. The NCR were revised under Government Notice Number R. 55 of 14 January 1994 to make it obligatory for all authorities to apply the regulations. Subsequently, in terms of Schedule 5 of the Constitution of South Africa of 1996 legislative responsibility for administering the NCR was devolved to provincial and local authorities. Provincial Noise Control Regulations exist in the Free State, Western Cape and Gauteng provinces but have not been promulgated in the Eastern Cape and KwaZulu-Natal. In these provinces the regulations put in place under the old dispensation still apply until such time as these provinces pass their own Provincial Noise Control Regulations [Glazewski, 2000].

The procedures, described in greater detail in Chapters 2.3 through 2.5 of this report, may be summarised as follows:

SANS 10328 contains procedures to be followed to quantify the predicted impact that noise emanating from a proposed development will have on surrounding land based on scientific principles. The predicted impact is assessed in accordance with SANS 10103, *The measurement and rating of environmental noise with respect to land use, health, annoyance and to speech communication* by determining whether the level of the predicted noise will exceed the residual (background) noise level on that land and/or the acceptable level of noise pertaining to the use of that land and relating this excess to the probable response of a community to the noise.

In terms of the National Noise Control Regulations, if the predicted level of noise emanating from road traffic on a newly constructed road, or after changes are made to an existing road, is likely to cause the noise levels on surrounding land to exceed 65 dBA, noise mitigation measures are required to be implemented to ensure that the noise levels on the affected land are reduced so as not to exceed 65 dBA.

This report attempts to distinguish between the assessment of noise impact in accordance with SANS and noise mitigation measures required to comply with legal limit of the Noise Control Regulations.

2.3 Impact assessment in accordance with SANS 10328 and SANS 10103

A glossary of terms used in the measurement and assessment of sound is contained in the Appendix.

In accordance with Section 7.3.1.4 of SANS 10328, the rating level of noise emanating from road traffic is determined in accordance with SANS 10210, *Calculating and predicting road traffic noise*. The rating level so determined is compared with the acceptable outdoor rating level for the particular district under investigation as recorded in Table 2 of SANS 10103 or with the rating level of residual noise in the area.
under investigation. SANS 10103 contains procedures for the measurement and assessment of noise in various districts and on human activities with respect to possible annoyance. Section 4.6.4 of SANS 10103 states that it is highly probable that the noise is annoying or otherwise intrusive to a community, or a group of persons, if the rating level, \( L_{\text{REQ,T}} \), of the ambient noise (including the noise under investigation) exceeds the acceptable level as indicated in Table 2 of SANS 10103 or exceeds the \( L_{\text{REQ,T}} \) of residual noise (in the absence of the noise under investigation). The acceptable levels in Table 2 of SANS 10103 are in line with the recommendations of the World Health Organisation (WHO) considered in Chapter 2.4. In accordance with Section 7.5 of SANS 10328, the assessment of the estimated road traffic noise impact is established by determining the probable community response from Table 5 of SANS 10103. Tables 2 and 5 of SANS 10103 are reproduced hereunder.

**SANS 10103, Table 2 — Acceptable rating levels for noise in districts**

<table>
<thead>
<tr>
<th>Type of district</th>
<th>Equivalent continuous rating level ( (L_{\text{REQ,T}}) ) for noise, dBA</th>
<th>Outdoors</th>
<th>Indoors, with open windows</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Day-night ( L_{\text{R,dn}} )</td>
<td>Day-time ( L_{\text{R,d}} )</td>
<td>Night-time ( L_{\text{R,n}} )</td>
</tr>
<tr>
<td>RESIDENTIAL DISTRICTS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a) Rural districts</td>
<td>45</td>
<td>45</td>
<td>35</td>
</tr>
<tr>
<td>b) Suburban districts with little road traffic</td>
<td>50</td>
<td>50</td>
<td>40</td>
</tr>
<tr>
<td>c) Urban districts</td>
<td>55</td>
<td>55</td>
<td>45</td>
</tr>
<tr>
<td>NON RESIDENTIAL DISTRICTS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>d) Urban districts with some workshops, with business premises, and with main roads</td>
<td>60</td>
<td>60</td>
<td>50</td>
</tr>
<tr>
<td>e) Central business districts</td>
<td>65</td>
<td>65</td>
<td>55</td>
</tr>
<tr>
<td>f) Industrial districts</td>
<td>70</td>
<td>70</td>
<td>60</td>
</tr>
</tbody>
</table>

**NOTE 1** If the measurement or calculation time interval is considerably shorter than the reference time intervals, significant deviations from the values given in the table may result.

**NOTE 2** If the spectrum of the sound contains significant low frequency components, or when an unbalanced spectrum towards the low frequencies is suspected, special precautions should be taken, and specialist attention is required. In this case the indoor sound levels may significantly differ from the values given in columns 5 to 7. See also annex B.

**NOTE 3** Residential buildings, e.g. dormitories, hotel accommodation, residences etc. may only be allowed in non-residential districts on condition that the calculated or anticipated indoor \( L_{\text{R,dn}} \) values given in column 3 of table 1 are not exceeded.

a The values given in columns 2 and 5 are equivalent continuous rating levels and include corrections for tonal character, impulsiveness of the noise and the time of day.

b The values given in columns 3, 4, 6 and 7 are equivalent continuous rating levels and include corrections for tonal character and impulsiveness of the noise.
SANS 10103, Table 5 — Categories of community/group response

<table>
<thead>
<tr>
<th>Excess $\Delta L_{req,T}$ dBA</th>
<th>Category</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 – 10</td>
<td>Little</td>
<td>Sporadic complaints</td>
</tr>
<tr>
<td>5 – 15</td>
<td>Medium</td>
<td>Widespread complaints</td>
</tr>
<tr>
<td>10 – 20</td>
<td>Strong</td>
<td>Threats of community/group action</td>
</tr>
<tr>
<td>&gt;15</td>
<td>Very strong</td>
<td>Vigorous community/group action</td>
</tr>
</tbody>
</table>

Calculate $\Delta L_{req,T}$ from the appropriate of the following:

1) $\Delta L_{req,T} = L_{req,T}$ of ambient noise under investigation MINUS the residual noise (determined in the absence of the specific noise under investigation).

2) $\Delta L_{req,T} = L_{req,T}$ of ambient noise under investigation MINUS the maximum rating level for the ambient noise given in table 1.

3) $\Delta L_{req,T} = L_{req,T}$ of ambient noise under investigation MINUS the acceptable rating level for the applicable district as determined from table 2.

4) $\Delta L_{req,T} = \text{Expected increase in } L_{req,T}$ of ambient noise in an area because of a proposed development under investigation.

NOTE: Overlapping ranges for the excess values are given because a spread in the community reaction may be anticipated.

2.4 World Best Practice

The World Health Organisation (WHO) together with the Organisation for Economic Co-operation and Development (OECD) are the main international bodies that have collected data and developed assessments on the effects of exposure to environmental noise. This has provided the following summary of thresholds for noise nuisance in terms of outdoor daytime LAeq in residential districts:

At 55-60 dBA noise creates annoyance.

At 60-65 dBA annoyance increases considerably.

Above 65 dBA constrained behaviour patterns, symptomatic of serious damage caused by noise arise.

The World Health Organisation recommends a maximum outdoor daytime LAeq of 55 dBA in residential areas and schools “in order to prevent significant interference with normal activities of local communities”. It further recommends a maximum night-time LAeq of 45 dBA outside dwellings [WHO, 4]. No distinction is made as to whether the noise originates from road traffic, from industry, or any other noise source.

These recommended maximum levels correspond to the acceptable rating levels for ambient noise in an urban residential district referred to in Table 2 of SANS 10103. Much of the land adjacent to the N2 Wild Coast Toll Road is rural in nature. The corresponding acceptable outdoor rating levels for ambient noise are 45 dBA during the day and 35 dBA during night time.

2.5 Noise Control Regulations

2.5.1 Definition

In terms of Schedule 1 of the Noise Control Regulations:

**controlled area** means a piece of land designated by a local authority where, in the case of –
(a) road transport noise directly adjacent to a road –

(i) the reading on an integrating impulse sound level meter, taken outdoors at the end of a period extending from 06:00 to 24:00 while such meter is in operation, exceeds 65 dBA; or

(ii) the equivalent continuous "A"-weighted sound pressure level at a height of at least 1,2 m. but not more than 1,4 m. above the ground for a period extending from 06:00 to 24:00, as calculated in accordance with SABS 0210, and projected for a period of 15 years following the date on which the local authority makes such designation, exceeds 65 dBA:"

SABS 0210 has been superseded by SANS 10210

2.5.2 Noise control procedure

In terms of Schedule 3(d) of the Noise Control Regulations:

“No person shall build a road or change an existing road, or alter the speed limit on a road, if it shall in the opinion of the local authority concerned cause an increase in noise in or near residential areas, or office, church, hospital or educational buildings, unless noise control measures have been taken in consultation with the local authority concerned to ensure that the land in the vicinity of such road shall not be designated as a controlled area.”

Therefore, in areas where the predicted noise levels associated with a road exceed 65 dBA, legislation requires that noise mitigation measures be implemented in order to ensure that the noise levels on affected land will not exceed 65 dBA.

2.6 Distinction between SANS and Noise Control Regulations

Certain terms used in the NCR and in the SANS 10103 have similar sounding but not equal meanings. The following require particular clarification:

<table>
<thead>
<tr>
<th>Noise Control Regulations:</th>
<th>SANS 10103:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ambient sound level</td>
<td>is similar to Rating level of residual noise</td>
</tr>
<tr>
<td>Noise level</td>
<td>is similar to Rating level of ambient noise</td>
</tr>
</tbody>
</table>

The present study into the anticipated impact of noise from the proposed N2 Wild Coast Toll Road and recommending noise mitigation procedures, where applicable, is made complex by the fact that two disparate procedures are to be implemented in the assessment and in the control of noise.

In accordance with procedures contained in SANS 10328, the predicted impact that the noise emanating from the proposed development will have on occupants of surrounding land is assessed in accordance with SANS 10103 by determining whether the rating level of the predicted noise will exceed the rating level of the acceptable and/or the residual level of noise on that land and relating this excess to the probable response of a community to the noise. SANS 10103 thereby enables the noise during daytime as well as the sensitive night time periods to be assessed as a function of the land use. This is in line with international best practice and with WHO recommendations [WHO, 4]. However, a National Standard cannot stipulate a maximum legal limit.

In contrast, the NCR specify a maximum allowable level of 65 dBA on noise sensitive land adjacent to a road occurring during the combined day and evening time period of 18 hours. No consideration is given to night time road traffic. The Regulations stipulate that, where the predicted noise level exceeds 65 dBA, noise mitigation measures are required to be implemented to ensure that this level is not exceeded. However, the NCR do not consider the land use and zoning of the adjacent land such as residential,
educational, hospitals and places of worship. Furthermore the NCR does not consider those situations where the introduction of a new road into a rural or residential area may cause a significant increase in the prevailing ambient level. Thus, an increase from 45 or 50 dBA, respectively, to 65 dBA would impose a very high noise impact on residents near to the new road, although the noise levels would still be legal in terms of the NCR.

It is considered important to note that the 65 dBA limit specified in the Noise Control Regulations exceeds by a significant 10 dB the maximum $L_{Aeq}$ of 55 dBA recommended by the WHO and that considered acceptable in an urban residential district by SANS 10103.

Schedule 1 (ii) of the NCR refers to an 18-hour period extending from 06:00 to 24:00. This was originally in line with the daytime and evening time periods contained in South African Bureau of Standards (SABS) Code of Practice 0103. SABS 0103 has been superseded by SANS 10103 in which the 16-hour daytime time period extends from 06:00 to 22:00 and the 8-hour night time period extends from 22:00 to 06:00. Practical experience has shown that, whether considering the 18-hour period extending from 06:00 to 24:00 in accordance with the NCR or the 16-hour daytime time period extending from 06:00 to 22:00 in accordance with SANS 10103, the numerical value of the rating levels for each period differs by less than 1dB. In this report the daytime rating level, $L_{req,d}$, is considered and assessed in accordance with current usage and incorporates the NCR 18-hour period where applicable.

Section 5.2.4.12 of the independent review of the original N2 Toll Road EIA [Berrisford et al] states “no consideration has been given to the forthcoming noise regulations that have been in draft form for the last 3 years in which maximum ambient day-night noise levels in rural areas will be 45 dBA as opposed to the maximum level of 65 dB(A) which is the current limit stated in the National Noise Control Regulations and used in this report. It is possible that the new regulations might be passed before the road comes into operation and therefore it would have been more realistic to adopt the precautionary principle in this report and apply the proposed new noise limits in the rural areas.”

In response, in Chapter 2.2 it has been indicated that regulations for the control of noise is no longer a national function but a function of the provinces. No revision of the National NCR can therefore be expected.

Various shortcomings experienced in implementing the Noise Control Regulations of the Province of the Western Cape, including those referred to in this Chapter, has resulted in the Provincial NCR of the Western Cape being extensively revised by the Department of Environmental Affairs and Development Planning of the Province of the Western Cape to bring the provincial NCR in line with SANS 10103 and WHO recommendations. In the revised form of the NCR the 65 dBA limit for road traffic noise is removed and replaced by the SANS 10103 acceptable limit for the particular affected land.

It is anticipated that the revised provincial NCR will soon be promulgated by the Province of the Western Cape and that this might be the stimulus for other provinces to follow suite. However, until such time as the Eastern Cape and KwaZulu-Natal provinces pass their own provincial NCR, the original National Noise Control Regulations remain in force in these provinces [Glazewski, 2000].

The original as well as the present Noise Impact Study presents the complexity of needing to consider two disparate procedures contained in the National Standards and in the Noise Control Regulations. In the assessment of the predicted noise levels for the various Toll Road sections clear distinction was and is made between the potential impacts of the noise in terms of SANS and whether the levels comply with the NCR – with and without noise mitigation. That is the requirement of this Noise Study. It is the task of the decision makers to determine whether to apply the legal limit of the NCR or the more stringent criteria contained in SANS 10103.
3 STUDY APPROACH

3.1 Procedure

The potential impact of noise is measured or calculated and assessed entirely according to objective, quantitative procedures in the absence of any subjectivity in accordance with the SANS 10328, *Methods for environmental noise impact assessments* as stipulated by the ECA and subsequently NEMA.

The following procedure was followed:

- Noise sensitive land that could potentially be affected along proposed new road sections or changes to existing roads along the route was identified.
- The estimated Rating Level of future noise due to road traffic on the proposed route passing through or near each identified noise sensitive area was determined in accordance with Section 7.3.1.4 of SANS 10328 by means of procedures contained in SANS 10210.
- The estimated noise impact on each identified area was determined by calculating the difference between the estimated rating level of future ambient noise and the acceptable rating level in Table 2 of SANS 10103.
- The assessment of the estimated noise impact was established in accordance with Section 7.5 of the SANS 10328 by determining the probable community response from Table 5 of SANS 10103; in terms of the NCR; and in terms of the WHO guidelines [WHO, 4].
- The effect of mitigation measures was quantified for each identified noise sensitive area using the road traffic noise prediction methods contained in SANS 10210 as specified by the NIA process in SANS 10328.
- The algorithms used to calculate the $L_{Aeq,T}$, the influence of noise barriers and the data used to determine the influence of porous asphalt road surfaces were derived from SANS 10210. The $L_{Aeq,T}$ values are validated up to a range of 300 m from a road. The accuracy of the calculated $L_{Aeq,T}$ for distances beyond 300 m was not defined.

In terms of SANS 10328 the impact of road traffic noise is to be assessed in accordance with Table 5 of SANS 10103 as stipulated by the Environment Conservation Act. For the purpose of this investigation the intensity of a predicted noise impact is qualified as follows:

<table>
<thead>
<tr>
<th>Intensity</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Negligible</td>
<td>Predicted $L_r$ does not exceed the acceptable or residual $L_r$</td>
</tr>
<tr>
<td>Low</td>
<td>Predicted $L_r$ exceeds the acceptable, or residual, $L_r$ by between 0 &amp; 5 dB</td>
</tr>
<tr>
<td>Medium</td>
<td>Predicted $L_r$ exceeds the acceptable, or residual, $L_r$ by between 5 &amp; 10 dB</td>
</tr>
<tr>
<td>High</td>
<td>Predicted $L_r$ exceeds the acceptable, or residual, $L_r$ by between 10 &amp; 15 dB</td>
</tr>
<tr>
<td>Very High</td>
<td>Predicted $L_r$ exceeds the acceptable, or residual, $L_r$ by more than 15 dB</td>
</tr>
</tbody>
</table>

The intensity of impacts is thereby determined by means of a quantitative, objective procedure.

The predicted impact of particular types of noise associated with toll plazas is assessed by means of a different procedure. This is described in Chapters 3.3 and 3.4.

3.1.1 Assumptions

The following assumptions were made and utilised in the prediction model for the NIA:
• The surface of the proposed road would consist of conventional smooth dense asphalt.
• The design speeds of the various road sections, as provided by the technical team, were correct and valid.
• The current and predicted traffic volumes for the various road sections, as provided by the technical team, were correct and valid.

3.1.2 Sections of the route included in the study

In terms of the NCR only areas in which new road sections are to be constructed and where changes to an existing road are likely to cause an increase in noise exposure on adjacent land are required to be considered in terms of noise impacts. The potential noise impact of the proposed new road through the Greenfields, sections 4 and 6, is included in this investigation. Upgrading of an existing road within its present width is excluded. The construction of an additional lane along an entire section of the route is considered likely to cause an increase in traffic volume and/or speed. Both traffic volume and speed result in increased levels of noise and, therefore, the addition of a lane falls within the scope of the noise assessment. The construction of an additional, third lane in each direction between Amanzimtoti and Isipingo has been proposed and the potential noise impact is included in this investigation.

The impact of the construction of new toll plazas present areas of potential noise impact and are, therefore, included in the assessment.

3.2 Mitigation of road traffic noise

Chapters 4.4 through 4.19 formulate the assessment of the potential impact of noise from changes in road traffic, the construction of new toll plazas and/or road widening, where applicable, to that section of the route.

All noise problems contain three elements: the noise source(s), the sound propagation path and the receiver(s) of the noise. Chapters 3.2.1 through 3.2.4 present the general principles of noise mitigation alternatives. These principles are applied, where relevant, to noise mitigation procedures in each of Chapters 4.4 through 4.19.

The effect of specific alternative mitigation measures is quantified for each identified noise sensitive area using procedures contained in SANS 10210 as specified by the NIA process in SANS 10328. The algorithms used to calculate the influence of noise barriers and the data used to determine the influence of porous asphalt road surfaces as applied in the investigation of each noise sensitive area in this report are derived from SANS 10210.

The term “porous asphalt” appearing in the discussions of mitigation measures in this report refers to “porous road surfaces such as open grade bitumen rubber” contained in SANS 10210. In calculating the Lreq,d, SANS 10210 applies a constant correction of –3.5 dB, irrespective of vehicle speed, if the road surface is “porous”. This constant correction has been applied in all predictions contained in this report.

However, experience and published literature (Jongens, 1995; Jongens & van Blokland, 1999) has shown that this value is not constant. It is, in fact, dependent on vehicle speed and is highly dependent on surface texture. Use of modern low-noise, porous asphalt surfaces can result in a reduction of between 5 dB and more than 8 dB compared to smooth dense asphalt at freeway speeds. This should be borne in mind when considering the different noise mitigation alternatives.
3.2.1 Road surface texture

Tyre/road interaction noise accounts for over 90% of the total noise generated by light vehicular traffic (de Graaff & van Blokland, 1997). The level of engine noise of modern cars exceeds tyre/road noise only during the brief period when a vehicle accelerates from rest or when negotiating a steep gradient.

The noise produced by the interaction of a tyre with the road is due to no single process but the combined effect of several different mechanisms (Jongens, 1995). However, the greatest influence on the noise produced is due to the road surface texture and porosity. The tyre acts like a drum that is set into vibration by interaction with the road surface texture as it rotates. The more irregular the surface within the contact area of the tyre the more the tyre is set into vibration. This is then radiated as noise. The most essential component of a low-noise road surface is a well rolled, smooth and porous upper layer comprising aggregate less than 8 mm in size.

Compared to a smooth dense asphalt road surface, a reduction in sound level of between 5 dB at 50 km/hr to more than 8 dB at 120 km/hr can be achieved using a two-layer, porous, bitumen-rubber pavement (Jongens, 1995). The upper 2.5 cm thick layer consists of between 4 and 8 mm aggregate overlaying a 4.5 cm layer of between 11 and 16 mm stone with a 5% / 4.2% rubber-bitumen binder and a porosity of 23%. The finer structure of the upper layer minimises the generation of tyre noise and acts as a sieve preventing larger particles, which cause clogging, from becoming lodged in the pores while the lower layer provides good water drainage. Due to its low noise properties and increased safety during wet weather this road pavement is used on all inter-city freeways in the Netherlands.

Although somewhat less effective, good low-noise generation properties can also be achieved by what is termed Ultra-Thin Friction courses of between 2 and 3 cm thick using between 4 and 8 mm aggregate, rubber/bitumen binder and approximately 14% porosity. Information recently obtained from a road builder and a major supplier of road material in the Western Cape [PC 2007] indicated that there would be no difference in cost between laying a conventional and a low-noise ultra-thin friction course on a base course. In addition the cost would likely reduce with more widespread use of rubber/bitumen binder. This dispels the often held misconception that low-noise road surfaces are more costly than conventional road surfaces. There are additional benefits:

- A road surface with rubber/bitumen binder is more durable than conventional binders.
- The rubber is obtained from recycling of disused motor vehicle tyres thereby enabling the reduction of the environmental pollution caused by discarded tyres.
- At the time of rehabilitation of the road surface only the upper surface needs to be removed and can be reused. The base layer remains intact.

At the other end of the scale, deep grooved cement concrete and chip seal surfaces, typically used on many road surfaces in South Africa, are the noisiest surfaces producing up to 10 dB higher sound levels compared to smooth asphalt surfaces (Jongens, 1995). Many complaints regarding road noise have been due to chip seal road surfaces and surfaces containing large aggregates such as Cape Seal. The perceived cost benefits of using chip seal surfaces should therefore be weighed against the potentially high social cost of the noise impact on a community. It is, therefore, strongly recommended that these surfaces not be used on roads within 1 km of residential areas, academic institutes, offices, recreation and parkland, or other noise sensitive areas.
3.2.2 Noise barriers

Noise barriers are often perceived as the primary means of reducing noise from road traffic. However, their effectiveness is limited to the immediate vicinity of the barrier. A noise barrier is any continuous object, without apertures. In order to provide sufficient sound insulation the barrier must have a minimum mass of 24 kilogram per square metre of surface area. Typical barriers include earth berms; brick walls; buildings; metal or heavy Perspex sheeting; glass; or any combination of these. In many countries throughout the world, where busy roads traverse densely populated areas, extensive use is made of noise barriers that are typically 5 to 7 m high and even 11 m high along some routes. These tall barriers are used in combination with low-noise road surfaces in order to achieve sufficient road noise mitigation on noise sensitive land close to the road.

Barriers are only effective against road traffic if their effective height is at least 2 m and they are positioned close to the noise source. “Effective” height is the vertical distance between where the line-of-sight joining noise source and receiver intersects a barrier and the top of the barrier. This is illustrated in Figure 1. The source height for passenger vehicles is assumed to be 0.5 m above the road surface. However, the outlet of the exhaust of some heavy-duty vehicles is located some 2m above road level.

Figure 1a. illustrates that for a road in cut, the ground floor of the dwelling is in the acoustic “shadow” of the barrier thereby benefitting from the barrier. However, the barrier provides no attenuation to the upper floor because the top of the window is in line of sight of traffic on the furthest lane.

Figure 1b. illustrates the benefit of raising a road above the height of the receiver. Here a relatively low wall at the edge of the elevated road screens both ground floor and upper floor of the dwelling. The wall is normally closer to the road edge and hence closer to the noise sources compared to a road at ground level or in cut.

Figure 1c. illustrates the limited effectiveness of the physical barrier height for a road at grade. This represents the least effective use of a noise barrier.

The noise emanating from a road raised on a viaduct, or traversing along the top of a ridge, can therefore be readily reduced at noise sensitive land close to the viaduct. The latter is illustrated in Figure 9a of Chapter 4.2. However, at larger receiver distances there is less benefit compared to a road at level due to the lack of intervening buildings and topography that may act as partial noise barriers.

A road in cut is visually the most acceptable and can provide significant sound reduction. However, in practice the angle of the sides of a cutting are often such that the top of the noise barrier is far removed from the noise sources thereby offsetting the benefits of a road in cut. Furthermore, sound diffracts, or “spills”, over the top of a barrier. Dwellings located further away from a barrier benefit increasingly more from the reduction of noise with increased separation distance from the road and less from the barrier. In addition, under certain meteorological conditions, sound propagating in the atmosphere “bends” down towards the earth as illustrated in Figure 2. This condition generally prevails during wind-still conditions just before sunrise and after sunset and for light winds blowing from source to receiver direction.

The impact of road noise is greatest for dwellings flanking the road. Although less intense, the noise impact can still be significant for dwellings located several hundred metres from a busy road. Hence the “roar” of road traffic that can be heard on the outskirts of cities.

Trees and shrubs provide no meaningful reduction of sound from road traffic noise. They do, however, provide a psychological benefit by reducing the visual distraction of passing traffic.
FIGURE 1. The effective height of a noise barrier for a road located:

a. Below the receiver
b. Above the receiver
c. On the same level as the receiver

FIGURE 2. Refraction of sound through the atmosphere reduces effectiveness of a barrier.
### 3.2.3 Reduction in vehicle speed

For a constant number of vehicles per hour a reduction in mean traffic speed from 120 to 60 km/hr causes a reduction in $L_{Aeq,T}$ of 6 dB at receiver location for traffic containing up to 3% heavy-duty vehicles and a reduction of 5 dB for traffic containing between 4 and 14% heavy-duty vehicles. These both represent significant differences in $L_{Aeq,T}$ and substantiate the need to implement and enforce the 60 km/hr speed limit on roads traversing suburban areas.

### 3.2.4 Sound insulation of dwelling facades

The installation of “double glazing” is often suggested as a noise mitigation option. Such double glazing, with small separation between panes, is primarily utilised for thermal insulation in colder climatic regions, and is less tenable in the warm South African climate where windows are traditionally left open. Noise reduction would require thick, laminated glass in sealed frames accompanied by the installation of costly fresh-air ventilation systems with appropriate noise attenuation. In addition, sound insulation of buildings will not resolve the problem of noise intruding into private gardens and outdoor educational spaces of affected properties.

### 3.2.5 Distance

Sound radiating from a single source of sound, such as a single vehicle, reduces in sound level by 6 dB for every doubling of distance from the source. However, the collective sound radiating from many vehicles on a road is physically different. Traffic on a road consists of many single sources (vehicles), together forming a line of sources. Sound radiating from a line of sources reduces in sound level by only 3 dB for every doubling of distance from the line(road). Therefore, doubling the distance between a road and a listener results in a 3 dB reduction in noise level. Doubling the new distance results in a further 3 dB reduction in noise level. Thus, if possible, a road should be constructed away from noise sensitive areas, such as residences.

However, the use of distance, alone, in achieving acceptable noise levels may be very costly in terms of land use. Consideration should be given to applying commercial or other less noise sensitive zoning adjacent to a road thereby creating noise buffer zones and noise screening for noise sensitive land further removed from the road.

### 3.2.6 Resettlement of people

It has been proposed that resettlement of people should be considered as a noise mitigation option [Berrisford et al]. It would seem logical that those settlements – formal or informal - situated within the proposed road reserve will need to be relocated. South Africa comprises large tracts of rural land where it appears difficult for any authority to control the ordered settlement of people in those areas. Thus, even if it was decided to resettle people in informal settlements in the vicinity of the proposed Toll Road there appears to be no effective mechanism in place that will ensure that new informal settlements will not sprout in the immediate vicinity of the new road. It is therefore questioned whether the resettlement proposal in rural areas – outside of the road reserve - is practically viable.

In the vicinity of the various cities one expects there to be greater control of activities within the respective land use zones. It is clarified in the NCR that it is incumbent on the developer of a new road or changes to an existing road to ensure compliance with the noise limits contained in the NCR. There is such a premium on land in the vicinity of cities that this would render the resettlement proposal nonviable. The
implementation of noise mitigation procedures described in Chapters 3.2.1 and 3.2.2 has enabled many densely populated residential suburbs to be located adjacent to busy freeways throughout the world with full compliance of the outdoor, day-night noise limit of 55dBA within the suburbs.

### 3.2.7 Passing lanes

Additional passing lanes or climbing lanes are proposed along parts of various sections of the route. These are relatively short sections of a route that do not result in an increase in traffic volume and hence no increase in traffic noise emission along the route. They reduce congested traffic flow by enabling passenger vehicles to pass slow moving trucks thereby resulting in more uniform traffic flow and more constant levels of road noise emission along the route.

Due to the dramatic reduction of engine noise emissions of passenger vehicles in the last decades there is an insignificant increase in noise emission of these vehicles as they accelerate relatively gently past slow moving traffic on the passing lanes compared to the average level of tyre/road noise prevalent at these speeds. This author has observed that passing lanes are an effective calming measure on most drivers who generally wait patiently for the next passing lane. By contrast where traffic congestion occurs on roads without passing lanes, there is an increased display of impatience, more erratic behaviour and a more significant increase in levels of engine noise as more power is used during more rapid acceleration. Passing lanes therefore present a positive noise impact where they are included along the Toll Highway.

### 3.2.8 Summary

The most effective means of reducing the spread of road traffic noise over large areas, including areas close to a road, is reducing the noise at source. Namely, by utilising low-noise road surfaces (Jongens, 1995). The cost benefit far exceeds that of noise barriers when considering the total area of land and number of people impacted upon by road noise. In the light of recent information it is anticipated that there would be no cost penalty when using low-noise ultra-thin-friction courses [PC 2007].

A 3 dB reduction in noise at source when using a low-noise road surface is equivalent to doubling the distance of a listener from the road using conventional dense graded asphalt. Modern, low-noise road surfaces reduce the noise at source by more than 6 dB at freeway speeds. This is equivalent to more than an apparent fourfold increase in distance between road and listener.

A further significant reduction of road traffic noise at source is obtained by the reduction of the mean traffic speed from freeway speeds of 120 km/hr to the suburban speed limit of 60 km/hr.

Unfortunately, in addition to a low-noise road surface, noise barriers are still needed to screen noise sensitive land areas located adjacent to busy freeways. Depending on the distance separating a noise barrier from the road and/or single-storey residential dwelling, a 2 m high barrier may provide sufficient sound insulation to reduce the noise levels at the nearest residences in order to comply with the Noise Control Regulations but will be insufficient to meet SANS and WHO criteria. The effective barrier height needs to be significantly greater than 2 m to benefit upper storeys of nearest dwellings. The effectiveness of barriers is significantly reduced, if not negated, in hilly terrain if the elevation of the road is lower than the noise sensitive areas.

The effectiveness of noise barriers decreases with increasing distance of the barrier from either the source or the receiver of noise. Beyond several tens of metres the reduction of noise is increasingly due to the increased distance and less due to the barrier. This is shown in Figure 11 of Chapter 4.2.
3.3 Noise impact of toll plazas

The prediction of noise emanating from toll plazas is not straightforward due to the combination of different types of noise associated with such infrastructures. These comprise the noise from deceleration and acceleration of vehicles through the toll plaza plus sporadic impulsive types of noise emanating from individual vehicles when stopping at the tollbooths and subsequently accelerating away from the tollbooths. Experience has shown that these types of noise can be the dominant source of noise impact from a toll plaza. The standard procedures used to predict the noise from free-flowing traffic on freeways are inadequate to predict the total impact of noise from toll plazas. Neither the National Standards, nor the Noise Control Regulations, nor any other international standards contain procedures to predict or assess the impact of this type of noise. Procedures are proposed in this investigation for predicting the combined noise emanating from the different sources that is perceived at distances from a toll plaza. Chapter 3.4 characterises the different types of noise that may be produced at toll plazas arising out of investigations conducted at three typical toll plazas in South Africa (Jongens Keet Associates, May 2002).

3.4 Characteristics of noise emanating from toll plazas

3.4.1 Mainline toll plazas

Jongens Keet Associates (Jongens Keet Associates, May 2002) previously undertook studies of the conditions that produce noise at three mainline toll plazas in the country. These are the Machado Toll Plaza and the Middelburg Toll Plaza in Gauteng and the Huguenot Tunnel Toll Plaza in the Western Cape. The Machado Plaza is located on a section of the N4 freeway immediately east of, but outside the developed area of Machadodorp. The Middelburg Plaza is located on a section of the N4 freeway immediately south of, but outside the developed area of Middelburg. The Huguenot Toll Plaza is located on the N1 at the foot of the Du Toit’s Kloof Mountains, close to the town of Paarl.

The area around all three toll plazas is farmland with no residential or other development in the area that would be sensitive to noise from the toll plazas other than housing provided for toll plaza personnel.

The noise emanating from a toll plaza is associated with a mixture of several sound sources. The sources identified at one or more of the three mainline toll plazas studied include:

- General traffic operation sounds under stop-start (interrupted flow) conditions as vehicles pass through the toll plaza.
- These normal sounds are, however, interspersed with sporadic, very loud and more intrusive sounds from some vehicles, including:
  - Vehicles with overly noisy engines and exhaust systems.
  - Vehicles decelerating and accelerating excessively loudly. This includes respectively, Jacobs assisted brakes of heavy-duty vehicles that produce high levels of low-frequency throbbing noise; the “squeal” of brakes from some light- and heavy-duty vehicles as well as the sudden, loud, high frequency “hiss” accompanying compressed air release of brakes on many heavy-duty vehicles; and the loud revving of engines by some vehicles prior to accelerating away from the tollbooths.
  - Rattling of badly maintained vehicles and badly loaded freight.
  - Vehicles hooting.
  - Radios in some vehicles being played very loudly.
The noise produced by the tyres and suspension of a vehicle during interaction with the rumble strips on approaches to some of the plaza. The instantaneous, high impulse sound levels render this noise particularly noticeable at night when the ambient noise level is low.

- Intermittent sounding of a siren at the weighbridge indicating an overload of a heavy-duty vehicle.

The one-hour $L_{Aeq}$ values, measured 3.5 m from the tollbooths and 2 m from the nearest operating lane, varied between 72 and 78 dBA, depending on the number of vehicles per hour, percentage heavy-duty vehicles, the driving conditions of individual vehicles and the number of adjacent lanes operating.

However, these slowly varying sound levels were frequently interspersed with short duration levels of sound often exceeding 100 dBA.

The noise in the vicinity of a toll plaza is characterized by two distinct types of noise:

- Noise that fluctuates relatively little and slowly in level (loudness) and frequency content (tone) over a period of several seconds or minutes due to the collective noise of vehicles passing through the toll plaza.

- Sporadic, abrupt emission of noise from single events occurring infrequently resulting in brief but significant changes in level and/or frequency of the ambient noise in close proximity to the tollbooths. Examples of the latter noise sources are, compressed air release, siren, hooting, squeal of brakes and brief but rapid acceleration.

The significance of this distinction is that the subjective response to noise by a human listener is determined not only by the level of the noise but, to a greater extent, on the variability of the level and frequency content of the noise with time. The more constant the noise, the more readily a human listener becomes accustomed to the noise and the less conscious the listener is of the noise. In contrast, the more rapidly the noise changes with time, the more the listener is aware of the noise and the greater the probability of the noise intruding on the activity of the listener be it work or rest.

The first type of noise produced at a toll plaza can be predicted with a medium to high level of confidence by applying the same procedures used for free-flowing freeway traffic contained in the SANS 10210 Calculating and predicting road traffic noise. This is based on the average energy of sound received by the listener over a period of time. However, the impact of noise due to unpredictable occurrences of sporadic, high levels of sound cannot be assessed on the basis of the average energy received over a period of time. Instead, the maximum A-weighted sound level, $L_{Amax}$, measured with the sound level meter set to fast response, is generally accepted as the preferred descriptor on which to base an assessment of sporadic impulsive types of sound [WHO, 4].

The results of our studies indicate that the major impact of toll plazas is that due to the more intrusive, impulsive types of noise compared to noise from free-flowing traffic and that the assessment and mitigation of toll plaza noise should be based on determining the $L_{Amax}$ values of the impulse types of noise in addition to the $L_{Aeq,d}$ descriptor used for free-flowing traffic.

A further type of noise is that produced by rumble strips. Rumble strips are often utilised on the approach lanes of toll plazas in an attempt to alert drivers to reduce speed although experience at the Huguenot Tunnel Toll Plaza has shown that their use has not produced the desired result of slowing traffic. The impulsive type of noise produced by the impact of vehicle tyres with the rumble strips has been found to be highly intrusive (Jongens Keet Associates, May 2002). Due to the high levels of broad frequency band sound energy produced, this noise travels over large distances. The low frequency components of this
noise readily penetrate the windows and walls of buildings, thereby rendering the noise even more intrusive, particularly during evening and night-time periods.

The noise from rumble strips is distinct from that occurring from occasional vehicles stopping and starting in the immediate vicinity of the tollbooths in that it occurs for each vehicle passing along an extended section of the approach lanes to the tollbooths (e.g. an approximate 300 m at the Hugeunot Tunnel Toll Plaza).

Due to their ineffectiveness as a traffic calming procedure, coupled with the highly intrusive noise produced, it is strongly recommended that no rumble strips be constructed on approach lanes of toll plazas. On the assumption that rumble strips will not be employed at toll plazas on the proposed N2 Wild Coast Toll Road route, these will not be considered further in this study.

Additional sources of noise that have resulted in complaints, particularly during the night, is that of operators talking loudly to each other and sometimes background music. Even for low levels of noise ($L_{Aeq,T}$), the particular attributes of speech and music render such sounds more noticeable than other sounds, particular during the night.

### 3.4.2 Ramp toll plazas

A quantitative study has not yet been conducted on ramp toll plazas. However, the following observations have been made:

- There is minimal effect of a ramp toll plaza on the flow of vehicles on a ramp compared to conventional ramps whether considering deceleration on off-ramps or acceleration on on-ramps. So also any noise associated with braking or accelerating.

- The number of vehicles per hour on a ramp is considerably less than that on the freeway. The contribution of traffic noise from a ramp to the combined ramp plus freeway noise level is insignificant at a receiver located more than, approximately 100 m from the ramp. Where residences are located in close proximity to a ramp the (usually) elevated ramp screens the residences from traffic noise on the freeway thereby rendering noise on the ramp more noticeable.

It is estimated that at receiver distances greater than approximately 100 m from the ramp there is no additional effect of a ramp toll plaza due to road traffic noise. Any impact in close proximity to a ramp toll plaza is generally due to the noise produced by the operators.

### 3.5 Noise mitigation relating to toll plazas

#### 3.5.1 Separation distance required between toll plazas and noise sensitive land

Methods for predicting the erratic but brief occurrence of high levels of sound do not appear in any national or international standard procedures for predicting road traffic noise. For minimal impact of the noise at a receiver location it is generally accepted that the $L_{Amax}$ at the receiver location must not exceed the acceptable or residual rating level (whichever is relevant) of ambient noise for the area by 10 dB. In this investigation, the noise level at a distance from impulsive types of noise produced in the immediate vicinity of the tollbooths was determined by assuming the propagation of sound from a point source (refer to Chapter 3.2.5) producing a brief, maximum A-weighted sound level, $L_{Amax}$, of 100 dBA at 2 m from the source of noise.
The study conducted on noise from mainline toll plazas (Jongens Keet Associates, May 2002) showed that impulsive type of sounds emanating from toll plazas have the greatest impact on people during night-time and that the noise impact of toll plazas should therefore be assessed for night-time conditions. With reference to the acceptable rating levels of ambient noise reproduced from SANS 10103 in Chapter 3.2 of this report, the $L_{A_{\text{max}}}$ of an impulsive sound during night-time at a receiver location must not exceed 45 dBA in a rural district and 50 dBA in a suburban district with little road traffic for there to be no response to the noise from communities in the respective districts. In order for this to occur in the absence of any other noise mitigation measures, it has been calculated that the separation distance between a tollbooth and nearest receiver location in each district should be no less than 950 m and 630 m, respectively.

3.5.2 Noise barriers

Where the separation distance is likely to be less than the distances given in the previous paragraph, noise mitigation measures may be required. The only practical alternative noise mitigation measure for noise produced in the vicinity of mainline tollbooths is a noise barrier extending on either side of the tollbooths. With reference to Chapter 3.2.2, in order for a noise barrier to be effective the required height of a noise barrier is dependent on the horizontal distance between the noise source and the top of the barrier. Thus, for an earth berm with the highest point located some distance from the nearest lane, the height would need to be greater than a vertical wall located close to the nearest lane. Typically, for a mainline toll plaza, the minimum height required would be 3 m.

The typical length of the barrier required would be 100 m extending on either side of the tollbooths. A noise barrier, as described, will only be beneficial if the land to be protected from noise is located behind the barrier. In instances such as at Candu (refer to Chapter 4.5.3) the residential suburbs are directly in line with the approach lanes to the tollbooths of the proposed toll plaza. A noise barrier placed parallel to the approach lanes will serve no purpose in this case.

Although the same quantitative data is not available for ramp toll plazas, it is estimated that a 2 m high noise barrier extending approximately 20 m on either side of the toll booth(s) would provide adequate screening of noise at the toll booth(s) from noise sensitive land located less than 100 m from the toll booth. This applies for situations where the elevation of the toll booth location on the ramp is higher than the adjacent land.

As previously discussed in this Chapter, the assessment and mitigation of noise from proposed toll plazas appearing in Chapters 4.4 through 4.11 do not follow standard procedures in the Noise Control Regulations nor SANS 10328 and SANS 10103. They should, therefore, be seen as a guide for the assessment and mitigation of noise from such sources, based on best available knowledge.

4 IMPACT DESCRIPTION AND ASSESSMENT

The predicted exposure to road traffic noise on the most densely populated land adjacent to Sections 5 and 6 of the proposed N2 Toll Highway east of Lusikisiki, was modelled and the results displayed in the form of noise contours overlaid on ortho-photos of the land without and with the implementation of alternative noise mitigation procedures. The area modelled included a variation of topography to be found throughout Sections 5 and 6 of the proposed N2 Toll Highway. The results could therefore be extrapolated throughout these Sections including the various alternative road alignments. Chapter 4.1 describes the modelling procedure while Chapter 4.2 contains the results of the modelling.

The modelling of existing and future noise exposure along Section 7 is contained in Chapter 4.11.8 through 4.11.10.
Although only a number of specific noise mitigation measures have been modelled, they are included in order to illustrate their effectiveness, or otherwise. Other noise mitigation measures such as addressing the noise at source via reduced speed (refer to Chapter 3.2.3), or the separation of source and receiver (refer to Chapter 3.2.5) may, however, also be considered in terms of efficiency and cost effectiveness. These examples are included to show what may be achieved through addressing road surface design and noise barrier design throughout the study area.

4.1 Prediction of Road Traffic Noise on the proposed N2 east of Lusikisiki

The levels of road traffic noise on land adjacent to the section of the proposed road extending from Lusikisiki in the west to approximately 2 km before the Fraser Falls intersection in the east were calculated in accordance with SANS 10210 *Calculating and predicting road traffic noise* as required by the Noise Control Regulations and SANS 10328. The results were used in Chapters 4.10 and 4.11 to predict the intensity of noise impact on the land and to determine the effects of alternative noise mitigation measures. The prediction model used has been validated up to a range of 300 m from a road. Beyond this range the results may still be reported, but the accuracy of the prediction model is reduced.

The midday hourly traffic flow was determined from traffic data obtained from the Wild Coast Consortium and estimated for fifteen years after completion of construction in accordance with the Noise Control Regulations. It has been found in numerous similar studies that the 16-hour $L_{REQ}$ for the period 06:00 hrs to 22:00 hrs is approximately equal to the 1-hour $L_{Aeq}$ using the 1-hour traffic count at “mid trough” between morning and afternoon peak traffic flows. The error in using this approximation has been found to be less than 1 dB for typical daily traffic flow distributions. The results generated by the computer program have been validated on numerous occasions by comparing measured 1-hours $L_{Aeq}$ together with simultaneous traffic counts and mean speed of light and heavy-duty traffic travelling on single and multiple roads at ranges varying from 10 m to 200 m. Measured and calculated results in all instances correlated to within 1 dB providing confidence in the prediction model and computer program.

Digital terrain data of the topography of the study area was obtained from the Wild Coast Consortium and incorporated into a computer program together with alignments and elevations of the proposed road to calculate and generate contours of $L_{REQ}$ at receivers located 1.4 m above local ground level. The noise contours, at 5 dBA intervals, were then superimposed on ortho-photos of the area.

4.2 Results of traffic noise predictions

Bearing in mind the fact that several mitigation measures may be considered, the results of specifically considering effects of road surface and barrier design are included below. To exhaustively model and predict all conceivable mitigation options would serve no useful purpose. Instead, final detail design should form part of the Environmental Management Plan to incorporate the required noise mitigation illustrated in the following pages.

The $L_{REQ}$ was calculated from Lusikisiki in the west to approximately 2 km before the Fraser Falls intersection in the east for three road surface conditions. These were:

- Conventional smooth dense asphalt surface;
- Low-noise, porous asphalt surface using the $–3.5$ dB correction contained in SANS 10210;
- Two-layer, low-noise, bitumen-rubber porous asphalt surface.
The results are displayed along five overlapping sections of the route in Figures 4 through 8. The colours between the 5 dB noise contour intervals are defined by a colour bar included in each Figure. Thus, yellow indicates land exposed to $L_{\text{Req,d}}$ values equal to and exceeding 65 dBA but less than 70 dBA. Figure 9 is a 3-dimensional representation of the western half of the area in Figure 8, and provides an indication of the influence of topography on sound distribution. The areas encompassed by each Figure are displayed in the key map in Figure 3.

![Figure 3: Key to Figures presenting results of predicted noise levels on land adjacent to the proposed N2 route east of Lusikisiki without and with alternative noise mitigation measures](image)

The figures thereby enable a comparison to be made of the noise emanating from a conventional road, without noise mitigation, and two alternative noise mitigation measures, namely, two types of low-noise road surface. These two alternative noise mitigation measures are further compared with the effect of erecting a noise barrier of, respectively, 2- and 3- m height, located 20 m from the nearest road edge. The results are displayed in Figures 10 and 11 of an enlarged portion of the route. Figure 11a is identical to Figure 10a. It is included to facilitate comparison.

In studying the influence of noise barrier heights in Figure 11, cognisance must be taken of the fact that the barrier shown is of finite length of approximately 820 m. The intention is to illustrate that land near the ends of the barrier is only partially screened by the barrier and is still exposed to road traffic noise beyond the barrier. The reduced noise screening effect at the end of the barrier, and therefore the need to extend the barrier well beyond the land to be protected from noise, is thereby indicated. The Figure indicates that for the full benefit of the barrier this would need to extend more than 200 m beyond the land to be protected. The area covered by the figures, includes land that is most densely populated by rural settlements along the greenfields section of the proposed N2 route.
FIGURE 4 Proposed N2 route at Lusikisiki showing different levels of noise due to alternative road surfaces.

a. No mitigation; conventional dense asphalt road surface.

b. –3.5 dB; single layer, porous asphalt road surface.

c. –6 dB; two-layer, porous asphalt road surface.

1-hr $L_{Aeq}$

- 70 dBA
- 65 dBA
- 60 dBA
- 55 dBA
- 50 dBA
FIGURE 5 Proposed N2 between Lusikisiki and the Magwa intersection showing different levels of noise due to alternative road surfaces.

a. No mitigation; conventional dense asphalt road surface.

b. –3,5 dB; single layer, porous asphalt road surface.

c. –6 dB; two-layer, porous asphalt road surface.

1-hr $L_{Aeq}$

70 dBA

65 dBA

60 dBA

55 dBA

50 dBA
FIGURE 6 Proposed N2 in the vicinity of the Magwa intersection showing different levels of noise due to alternative road surfaces.

a. No mitigation. Dense graded asphalt

b. Single layer porous road surface providing 3.5 dB reduction in noise level

c. Two-layer porous road surface providing 6 dB reduction in noise level
FIGURE 7 Proposed N2 east of the Magwa intersection showing different levels of noise due to alternative road surfaces.

a. No mitigation; conventional dense asphalt road surface.
b. −3.5 dB; single layer, porous asphalt road surface.
c. −6 dB; two-layer, porous asphalt road surface.

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FIGURE 7

Proposed N2 east of the Magwa intersection showing different levels of noise due to alternative road surfaces.

a. No mitigation; conventional dense asphalt road surface.
b. −3.5 dB; single layer, porous asphalt road surface.
c. −6 dB; two-layer, porous asphalt road surface.
FIGURE 8 Proposed N2 west of the Fraser Falls intersection showing different levels of noise due to alternative road surfaces.

a. No mitigation; conventional dense asphalt road surface.
b. $-3.5\,\text{dB}$; single layer, porous asphalt road surface.
c. $-6\,\text{dB}$; two-layer, porous asphalt road surface.

- 1-hr $L_{\text{Aeq}}$
  - 70 dBA
  - 65 dBA
  - 60 dBA
  - 55 dBA
  - 50 dBA
FIGURE 9: L$_{Aeq}$ contours overlaid on 3-D view of terrain east of Lusikisiki for different road surfaces. Mean traffic speed: 120 kph.

a. Conventional dense asphalt road surface

b. Low-noise road surface with 3.5 dB reduction in L$_{Aeq}$

c. Low-noise, two layer road surface with 6 dB reduction in L$_{Aeq}$
FIGURE 10 Enlarged portion of proposed N2 route east of Lusikisiki showing influence of different road surfaces on levels of noise on affected land areas

a. No mitigation. Dense graded asphalt
b. Porous road surface providing 3.5 dB reduction in L_{Aeq}
c. Porous road surface providing 6 dB reduction in L_{Aeq}

Traffic flow: 1000 veh/hr total
Means speed: 100 kph
% Heavy-duty: 0.5%
FIGURE 11. Enlarged portion of proposed N2 route east of Lusikisiki showing influence of different noise barrier heights on levels of noise on affected land areas.

a. No mitigation. Conventional dense graded asphalt
b. 2m high wall
c. 3m high wall

Traffic flow: 1000 veh/hr total
Mean speed: 100 kph
% Heavy-duty: 0.5%
Noise barrier/wall; 820 metres long, 20 metres from road edge

1-hr $L_{Aeq}$

- 70 dBA
- 65 dBA
- 60 dBA
- 55 dBA
- 50 dBA