RESEARCH REPORT

External Research Program

Planning and Managing Traffic Noise on Urban Roads: International and Canadian Experience

Canada

CMHC SCHL

HOME TO CANADIANS

CMHC—HOME TO CANADIANS

Canada Mortgage and Housing Corporation (CMHC) has been Canada's national housing agency for more than 60 years.

Together with other housing stakeholders, we help ensure that Canada maintains one of the best housing systems in the world. We are committed to helping Canadians access a wide choice of quality, affordable homes, while making vibrant, healthy communities and cities a reality across the country.

For more information, visit our website at **www.cmhc.ca**

You can also reach us by phone at 1-800-668-2642 or by fax at 1-800-245-9274.

Outside Canada call 613-748-2003 or fax to 613-748-2016.

Canada Mortgage and Housing Corporation supports the Government of Canada policy on access to information for people with disabilities. If you wish to obtain this publication in alternative formats, call 1-800-668-2642.

PLANNING AND MANAGING TRAFFIC NOISE ON URBAN ROADS: INTERNATIONAL AND CANADIAN EXPERIENCE

By: Margaret Eberle
Eberle Planning and Research

December 1997

CMHC Project Officer: Paula Archer

This project was carried out with the assistance of a grant from Canada Mortgage and Housing Corporation under the terms of the External Research Program (CMHC File 6585-E027). The views expressed are those of the author and do not represent the official views of the Corporation.

Planning and Managing Traffic Noise on Urban Roads:

International Examples

Eberle Planning and Research **December 1997**

Acknowledgments

The author would like to thank Paula Archer, CMHC Project Officer for her insights and assistance. I am also grateful to Eric Ancich, New South Wales Roads and Traffic Authority, Sydney, Australia, and Martyn Vanden Berg, Ministry of Housing, Spatial Planning and the Environment, The Hague, Netherlands who were both generous of their time in answering my email questions and generally pointing me in the right direction. And, finally, I would like to acknowledge Heather Evans, research assistant, for her research assistance and linguistic skills.

Abstract

Traffic noise on major roads in urban areas is viewed as an environmental issue with serious quality of life impacts in Europe, Australia and elsewhere. The paucity of current Canadian literature on the subject would suggest that Canada has little experience with this issue. This research identifies and describes fifteen planning and management approaches used in other countries to minimize the effects of traffic noise on residents living near arterial streets. These range from public education campaigns to low noise road surfaces, and are categorized by type of measure. Canadians should be aware of the existence of these options for addressing urban traffic noise issues. A brief survey of Canadian municipal and provincial officials reveals a general concern with traffic noise, and a range of arterial road traffic noise policies and practises, from none at all to quite comprehensive. Recommendations for further research are offered focusing on basic data gathering, current federal road and rail noise guidelines, and information dissemination.

Executive Summary

Citizens in many countries view road traffic noise, including arterial road traffic noise, as an urban environmental issue with serious quality of life impacts. Consequently, there is a considerable amount of research, planning, management and implementation activity dedicated to reducing its effects on urban populations around the world, particularly in Europe, Australia and Japan.

In large metropolitan areas of Canada today, the planning philosophy is to increase residential densities in existing areas, often concentrated at main streets or along arterials. This approach is meant to promote transit use and satisfy NIMBY forces. While urban environments are ultimately more transit friendly, they are also noisier. The noise attenuation solutions advocated for highways in an earlier era no longer apply or are more difficult to realize along existing roadways in established areas. Canada has little experience with this urban traffic noise issue.

The purpose of this research project is to investigate an emerging planning and housing issue, namely urban arterial street traffic noise, to identify planning and management approaches used elsewhere to minimize its impact on residents of both new and existing housing, and to document current Canadian policy and practise. Two research methods were employed: a literature search and review; and key informant interviews. These are explained in Section 1.

Section 2 briefly summarizes the existing literature on the subjects of noise exposure and annoyance, trends, and the impacts of traffic noise.

Section 3 contains fifteen "fact sheets" describing existing international traffic noise planning and management activities, ranging from public education campaigns, to noise mapping, to quiet town schemes, and low noise road surfaces. Where possible, illustrative examples from several jurisdictions are included. Information is presented under the headings: location, objective, description, date, impetus, responsible agency, implementation, costs, results, and problems. The source(s) of information is also included. The measures are classified as one of the following types: education, planning, design, policy, economic instruments, infrastructure, and comprehensive programs.

A brief review of Canadian provincial and municipal practise is presented in Section 4. Interviews with individuals representing five provinces and five municipalities within those provinces revealed information about the extent and nature of the issue in their jurisdiction, traffic noise measurement, policies for new roads and existing roads, mitigation practises, and general concerns.

Section 5 contains conclusions and recommendations. Canadians generally appear to be concerned with urban traffic noise, although the issue receives relatively little attention in practise. Two provinces are the exception: Alberta and Quebec. There either the municipality or the province in question have developed policies and programs to address the worst traffic noise situations and to prevent new development from occurring in exposed areas. Ontario has a strong land use planning approach and Burnaby, BC takes action when possible. Recommendations for further research are put forward based on this investigation of international experience and comments from key informants. They are focused on basic data gathering, the status of current CMHC noise guidelines, and information dissemination.

Résumé

Dans de nombreux pays on considère que le bruit de la circulation routière, notamment des grandes artères, est une question environnementale urbaine ayant de graves répercussions sur la qualité de vie. Quantité d'activités de recherche, de planification, de gestion et de mise en vigueur ont donc été entreprises afin de réduire l'effet du bruit sur les populations urbaines dans le monde, notamment en Europe, en Australie et au Japon.

Dans les grandes agglomérations urbaines canadiennes, la méthode de planification consiste à augmenter la densité résidentielle dans les secteurs existants, souvent concentrés dans les rues principales ou le long des grandes voies de circulation. Cette méthode préconise l'utilisation des transports publics et favorise le principe PDMC (Pas-dans-ma-cour). Même si, en fin de compte, la circulation est facilitée dans les milieux urbains, le bruit y est beaucoup plus élevé. Les solutions de réduction du bruit, préconisées à une époque antérieure pour les autoroutes, ne sont plus applicables ou sont plus difficiles à mettre en oeuvre le long des voies d'accès dans les secteurs établis. Le Canada connaît mal le dossier du bruit de la circulation routière.

Ce projet de recherche a pour but d'étudier une question tangible de planification et d'habitation, soit le bruit de la circulation routière dans les grandes artères, afin de déterminer les méthodes de planification et de gestion que l'on utilise ailleurs pour réduire son effet sur les résidents des logements neufs et existants et documenter les pratiques et la politique canadiennes actuelles. On a eu recours à deux méthodes de recherche expliquées à la section 1 : une recherche et un examen documentaires et des entrevues avec des personnes clés.

On donne dans la section 2 un bref résumé de la documentation existante au sujet de l'exposition au bruit et de la nuisance, des tendances et des répercussions du bruit de la circulation.

Dans la section 3, on trouve quinze feuillets documentaires rédigés au sujet des activités de planification et de gestion du bruit de la circulation sur la scène internationale, dont les thèmes sont aussi bien les campagnes de sensibilisation du public et le mappage du bruit, que les plans visant l'élimination du bruit, dans les villes et les revêtements spéciaux des chaussées. On y trouve, lorsque c'est possible, des exemples illustrés de plusieurs compétences. Les grands titres de cette information sont les suivants : emplacement, objectif, description, date, principe moteur, agence responsable, mise en vigueur, coûts, résultats et problèmes. On inclut aussi la provenance de cette information. Les mesures sont classées sous les rubriques suivantes : éducation, planification, conception, politique, instruments économiques, infrastructure et programmes détaillés.

La section 4 donne un bref aperçu des pratiques canadiennes, provinciales et municipales. Les entrevues de personnes représentant cinq provinces et cinq municipalités au sein de ces provinces a permis d'obtenir de l'information sur la portée et la nature de cette question dans leur juridiction, la mesure du bruit de la circulation, les politiques concernant les routes nouvelles et existantes, les pratiques d'atténuation du bruit et les préoccupations générales.

Les conclusions et les recommandations figurent à la section 5. Les Canadiens semblent généralement se préoccuper du bruit de la circulation dans les régions urbaines, bien qu'en pratique les provinces s'occupent peu de cette question, à l'exception de l'Alberta et du Québec. Dans ces

provinces, la municipalité ou la province en question a mis au point des politiques et des programmes pour régler les pires cas de bruit de la circulation et mettre un frein aux nouveaux aménagements dans les secteurs touchés. L'Ontario applique une solide méthode de planification de l'utilisation des terrains et Burnaby, C.-B. prend des mesures lorsque c'est possible. On présente des recommandations pour effectuer d'autres recherches d'après l'expérience recueillie sur la scène internationale et les observations recueillies auprès des personnes clés interviewées. Ces recommandations concernent la collecte de données de base, la situation relative aux directives de la SCHL sur le bruit et la diffusion de l'information.

National Office
700 Montreal Road
Ottawa ON K1A 0P7
Telephone: (613) 748-2000

Bureau national
700 chemin de Montréal
Ottawa ON K1A 0P7
Téléphone : (613) 748-2000

Puisqu'on prévoit une demande restreinte pour ce document de recherche, seul le résumé a été traduit.

La SCHL fera traduire le document si la demande le justifie.

Pour nous aider à déterminer si la demande justifie que ce rapport soit traduit en français, veuillez remplir la partie ci-dessous et la retourner à l'adresse suivante :

Centre canadien de documentation sur l'habitation
Société canadienne d'hypothèques et de logement
700, chemin Montréal, bureau C1-200
Ottawa (Ontario)
K1A 0P7

Titre du rapport: _____

_____

Je préférerais que ce rapport soit disponible en français.

NOM _____

ADRESSE _____
rue App.

_____
ville province Code postal

No de téléphone ( ) _____

Table of Contents

1.0 Introduction

Background

Whether it is the constant hum of a busy road which is so loud it limits normal conversation, or the piercing sound of a mufflerless motorcycle traveling through a residential street in the small hours of the morning, traffic noise is everywhere. It is the most pervasive and chronic source of noise in our cities. Evidence suggests that traffic noise is a widely shared annoyance worldwide and that efforts to deal with the problem to date are not always effective.

In the 1970s, North American planning and housing literature was preoccupied with the issue of highway traffic noise and its impacts. Consequently, there is a plethora of material and ideas concerning noise attenuation in connection with freeway construction and new subdivision development. The advocated solutions included separation of land uses, site planning and the erection of barriers.

Today's context is different. Urban freeway construction is limited and while suburban development still occurs, the planning issue today in many urban and regional municipalities is how to use existing land and infrastructure more sustainably to reduce urban sprawl and servicing requirements. Growth management strategies are directing residential development towards the inner suburbs and away from the quieter, formerly rural areas. The frequently advocated solution is to increase residential densities in established areas, often concentrated at main streets, along arterial roads, and above all, near public transit. Examples include Toronto's Main Streets Initiative and the City of Vancouver's Housing Above Shops zoning.[1] This approach is meant to promote transit use, and at the same time, satisfy the NIMBY forces. While urban environments are ultimately more transit friendly, they are also noisier.

In the meantime, automobile traffic continues to grow. Transportation planners promote a number of approaches to deal with this problem such as: increased reliance on transit, bicycling and walking; transportation demand management measures; and others. While laudable, these measures are yet to be effective in encouraging alternative modes of travel and it is unclear when, or if, our collective affair with the automobile will end.

The noise attenuation solutions advocated in an earlier era no longer apply or are more difficult to realise along existing roadways in established areas. Mixed use developments are becoming more prevalent. In these areas, the ability of site planning to mitigate traffic noise is constrained by the existing streetscape. It appears that those building and approving new housing projects in these areas rely primarily on acoustical construction

[1] Another avenue is to redevelop formerly industrial lands for housing or permit residential development in industrial lands, a policy not without noise implications.

techniques to block the noise. Sound proofed wall and window systems provide occupants some relief, but what of open windows in the summer time? How usable are outdoor balconies? Playspace? One of the attractions of suburban living is peace and quiet. Are residents willing to trade location and proximity to urban amenities for increased noise pollution? If not, are we planning quality residential communities despite the traffic noise? What options for managing or attenuating traffic noise can be employed in these situations? Are they being used?

The cumulative impact of traffic growth is also beginning to affect the quality of life of residents living along roadways in existing housing. Arterial roads are supporting more traffic than ever imagined. Measured noise levels are approaching that of freeways. This situation poses different challenges than for new housing built along existing roads. What planning measures can be employed? Are they being used? Are they adequate? What design or construction techniques can be employed to rehabilitate this existing housing stock? How successful are they? What is the cost and who should pay?

Purpose and Objectives

The purpose of this research project is to investigate an emerging planning and housing issue, namely urban arterial street traffic noise; to identify planning and management approaches used elsewhere to minimize its impact on residents of both new and existing housing; and to briefly examine current Canadian policy and practise.

The objectives of this research project are to:

1) investigate and summarize current research on how traffic noise affects residents living on or adjacent to arterial roads;

2) identify and describe innovative planning and management measures used in Europe, Australia, and the U.S. including urban policies, programs, educational initiatives, siting, design, construction, and mitigation approaches to protect residents from excessive traffic noise annoyance, both in new housing developments and in established areas;

3) document implementation issues such as: responsible agency(ies), costs and funding, results, and problems;

4) briefly review current traffic noise planning, policy and practise in Canada at the municipal and provincial level; and

5) develop recommendations for further research.

Scope

This research emphasizes planning and management options for traffic noise (which affect transmission and reception) as opposed to vehicle-based options for noise reduction such as vehicle noise emissions and transportation demand management (which focus on the noise source). While the latter are important components of an overall noise reduction policy, they are beyond the scope of this study. The research on current Canadian practise consequently is focused on the municipal and provincial levels, as in Canada and elsewhere, the federal government is responsible for vehicle-based measures through statutory vehicle emission limits. The situation on urban arterial streets is the main focus here, as opposed to highway related issues and approaches. The definition of noise employed is the most common one: sound that is unwanted by the recipient (CMHC, 1981).

Method

Two research methods were employed: a literature search and review; and key informant interviews.

The literature search concentrated on the following specific areas of inquiry:

a) the extent of noise exposure and annoyance in urban areas and future trends;
b) the impact of traffic noise, particularly arterial street traffic noise, on residential quality of life, health, property values and other areas;
c) what actions are being taken to plan for, design, site, manage or mitigate traffic noise along existing roadways, both for existing and new housing?
d) what are the practical considerations involved in implementing traffic noise management schemes along existing roads, for both new and existing housing?

The literature search was limited to English language material published in the last ten years in Europe, the U.S. and Australia as well as the limited Canadian literature. It was anticipated that most planning-oriented traffic noise initiatives would be undertaken at the local or municipal level, but that reports of such activities would be hard to obtain or only available in another language. The review is not meant to be exhaustive rather its purpose is to be instructive of the range of existing approaches to managing traffic noise on urban arterial streets to promote residential quality of life.

Several approaches to literature identification were used. International material was first sought from Canadian library sources. Searches were conducted of library catalogues of provincial ministries of transportation and/or environment (BC, Ontario, Alberta), universities (SFU, UBC, U of T), Canada Mortgage and Housing Corporation (CMHC), Transportation Association of Canada, Intergovernmental Committee on Urban and Regional Research (ICURR), and the National Library of Canada. Following that, international sources were contacted, including the National Transportation Library in the US, Washington State Department of Transportation (WSDOT), Organization for

Economic Cooperation and Development (OECD), and the European Union (EU). The TRANSPORT database provided many useful references.

After known sources were exhausted, two unique Internet capabilities were employed. Internet searches using the phrase "road traffic noise" located numerous web sites around the world with an interest in the topic: acoustical societies, universities, and community groups. Postings on pertinent Internet newsgroups resulted in contact with government officials in the Netherlands and Australia. They helpfully provided access to up to date material on several initiatives in their countries. Initial contact was made by email and material received either as downloaded files or through the postal system.

Reasonable success was achieved in obtaining pertinent information, through inter-library loan and other means. National and multinational bodies such as the OECD and European Union provided the main sources, although some national and local material was obtained. In some cases it was difficult to distinguish publications referring to highway noise or arterial street noise. The literature review served two purposes: to describe the traffic noise situation in Canada and elsewhere, future trends, and the effects of traffic noise; and to identify innovative approaches to planning and managing traffic noise used elsewhere, culminating in the preparation of fifteen "fact sheets".

A key informant survey of Canadian provincial and municipal officials in relevant departments such as transportation, municipal affairs, engineering or planning was conducted as part of the review of current Canadian practise. Five provinces were selected: Alberta, British Columbia, Ontario, Quebec and New Brunswick. In each province, one municipality was selected. Eleven interviews were completed by telephone: four with representatives of provincial ministries of transportation, one with the provincial ministry of the environment, one with an acoustical consultant in Alberta (where there is no provincial role), and five with municipal staff including transportation planners, a city administrator, and engineers, each with responsibility for the subject area. This limited sample is useful only for conveying preliminary information about the current situation in Canada. See Appendix A for a list of persons interviewed.

A phone call was made to each interview candidate. If desired, these persons were faxed a précis of the study and a copy of the interview questions, in advance, and arrangements were made to complete the interview at a later date. Others indicated a desire for an immediate discussion. The interview guide was translated into French and interviews with Quebec respondents were conducted in French. A copy of the interview questions is provided in Appendix B.

The information garnered from the survey was analysed by examining the extent of the issue, measurement, existence of surface transportation noise policies for new and upgraded roads, and for existing roads, use of mitigation measures, comments and issues, and in some cases, requirements for further research[2].

[2] Only three respondents were asked to identify requirements for further research.

2.0 Traffic Noise, Future Trends and the Effects of Noise

This section briefly summarizes existing literature on the subjects of noise annoyance and exposure, trends in traffic noise, and the impacts of traffic noise. For the most part, sources are overview studies rather than primary sources.

Noise Annoyance and Exposure

Compared to data collected to measure other environmental problems, data on noise annoyance and exposure is relatively poor. There are two different types of measurements of noise nuisance: annoyance from noise and noise exposure. The former is a subjective measure, obtained by interviewing people living in proximity to a noise source and asking them to rank their level of annoyance from traffic noise. The second, noise exposure, is an objective measure obtained by using a decibel meter, usually measured in dB(A), indoors or outdoors, and represents the level of noise over a certain period of time.[3] Alternately, the noise level may be estimated using information on traffic volumes, composition of vehicular traffic, road surface etc. Findings may be plotted, and a noise map produced for a city or region.

Techniques to measure community reaction to traffic noise usually involve both, called dose-response relationships. Interviews are conducted with people exposed to various levels of noise to determine level of annoyance. Their responses are the quantified on a scale ranging from highly annoyed to not bothered at all. These reactions are then plotted against the measured traffic noise levels to which the respondents are exposed. In the literature on dose-response relationships, there is a consistent observation that annoyance increases with noise level. However, a number of parameters affects the relation. These include the noise source, the time and location, community behavioural patterns and attitude toward the noise source. Some argue that these latter variables account for more variation in response than noise exposure (NSW Roads and Traffic Authority, 1991).

Following is a review of the most recent available noise annoyance and exposure data from various countries. In some cases, data refers to ambient noise levels from all sources, others measure transportation-induced noise, and still others measure road traffic noise alone.

---

[3] Traffic noise is commonly described in terms of decibels, a unit of measure using a logarithmic scale which places the quietest detectable sound at one end of the range (0dB) and noise such as a jet engine at around 140 dB, the threshold of pain. A doubling in *perceived* noise level occurs when the dB level shifts by 10 units. The A-weighted sound level or dB(A) is the frequency weighting most commonly used. Measurements using dB(A) alone give no idea of noise impact or duration, only peak level. The most commonly employed measure for traffic noise is Leq, which states the equivalent continuous sound level over a stated period, usually 24 hours.

There is no national noise exposure data for Canada reported in *Road and Rail Noise: Effects on Housing (1981)*. The most recent Canadian annoyance type data comes from Vancouver. In a telephone survey of 1000 Vancouver residents undertaken in 1996 for the City of Vancouver's Urban Noise Task Force, the majority of residents felt that the city was noisier today than five years earlier. Even more of those people living in the downtown areas of the City felt this way. Overall 55 % of respondents said they were bothered by noise some of the time. Traffic and vehicular noise was identified as the most common noise source by over 50% of respondents (City of Vancouver, 1997). A recent study conducted for the Ministry of Health in the province of Quebec found that environmental noise, including traffic noise, ranked as one of people's top concerns in urban areas of the province (MTQ, 1997).

At what level does annoyance with noise begin? Most jurisdictions note that public annoyance rises rapidly when noise exceeds 55dB(A) Leq (Alberta Transportation, 1977). The World Health Organization has suggested a standard value for average outdoor noise level of 55 dB(A) during daytime to prevent interference with normal day to day activities (1996). More specific values are suggested for certain environments with different noise levels for daytime and nighttime. Research has shown that when one percent of the population make formal complaints to the authorities about noise, 17 to 20 percent of the population are highly annoyed (CEST, 1993). Measurements of annoyance in Europe exhibit similar results. Road traffic noise seems to annoy between 20 to 25% of the population in four European countries: Germany, France, Netherlands and the United Kingdom (European Commission, 1997).

A number of early social surveys to determine the exposure to road traffic noise were undertaken in Canada in the 1970s.[4] The Alberta Surface Transportation Noise and Attenuation Study (1977) reported on data collected in a number of Canadian communities including: London, Ontario in 1973, Calgary in 1973 and Edmonton in 1972. The Calgary noise study found eleven sites with values greater than 75 dB(A) for over 50 percent of the measuring time. The Community Noise Survey of Greater Vancouver in 1971 found the noise climate in residentially zoned areas of the region to be 64 $dB(A)_{L10}$ daytime, and 53 $dB(A)_{L10}$ night-time, and that traffic noise was the dominant noise source (Price, 1972). This was comparable to other North American cities at the time.

The most comprehensive data on noise exposure in Europe includes data from 14 countries and dates from 1993. It estimated that between 17 and 22% of the European Union's population, or 80 million people, endure transport-induced noise levels that scientists and health experts consider unacceptable (over 65dB(A)). An additional 170 million people live in the so-called gray areas (between 55 and 65dB(A)) where noise

[4] The 1970s in Canada was a period of marked interest in road traffic noise and the mitigation of its effects. For example, several CMHC demonstration projects, such as LeBreton Flats and the St. Lawrence neighbourhood, incorporated noise mitigation features, and their effectiveness was monitored through resident satisfaction studies. See Environics Research Group Ltd., 1984; and National Office Support Centre, 1983.

levels annoy people during the daytime. Road transport noise is the dominant noise source accounting for over 90% of the exposure over 65dB(A) (European Commission, 1997).

In Japan the situation is much worse. There 80% of the population is exposed to sound levels above the recommended World Health Organization guidelines of 55 dB(A). In the US, the percent of population exposed to sound levels over 55 Leq_{24} outdoors was 37% in the early 1980s (CEST, 1993). Table 1 summarizes the exposure to road traffic noise for most European countries, Japan and the US.

Table 1
National Population Exposure to Road Transport Noise, Selected Countries, Early 1980s

Country	% Acceptable Leq<55	% Gray Area Leq 55-65	% Black Spot Leq>65
Austria	50	34	16
France	56	31	13
Germany	66	26	8
Japan	20	49	31
Netherlands	60	34	6
Norway	82	13	5
Spain	26	51	23
Sweden	62	27	11
Switzerland	46	43	11
United Kingdom	50	39	11
United States	63	30	7

Note: measured outdoors
Source: OECD data, reprinted in CEST, 1993.

Trends

Trends in Europe over the past 15 years do not show a marked improvement in noise exposure. Any improvements due to source reduction have been offset by greater traffic volumes. Some data show a reduction in the number of people acutely affected by traffic noise due to successful measure aimed at the worst areas, known as "blackspot" initiatives, and an increase in the number of people living in "gray zones" (European Commission, 1997). According to a recent British examination of the traffic noise situation, there are a number of trends in motor vehicle use which should be considered in the development of future traffic noise policies (CEST, 1993).

- the number of vehicle miles and number of vehicles is increasing;

- areas previously unaffected by traffic noise in both urban and rural areas are becoming affected;
- in urban areas, traffic noise peaks are not increasing but the period of noise impact is lengthening. The night-time period is now becoming noisier. This is a problem because increases in road traffic at night have a relatively greater impact in terms of noticeable noise levels. A few extra vehicles at night is all that is needed to increase the noise level by 3 dB(A), thereby doubling the sound energy (due to the logarithmic nature of the noise measurement scale);
- noise levels by vehicle type show buses and trucks are far louder individually than cars by 10-12 dB(A), and are responsible for noise peaks;
- the relative contribution of passenger cars to noise is likely to remain the same or decrease, as passenger cars are replaced more rapidly than trucks; and
- a high growth rate of freight movement in Heavy Goods Vehicles in UK and EC has occurred in the recent past and is expected in the future.

A review of these trends does not suggest a natural abatement of the problem. Comparable trends likely exist in Canada and the US.

Impacts

The major impacts of traffic noise reported in the literature are sleep disturbance, interference with speech, property value reduction and some psycho-physiological/health impacts, such as stress. Salient aspects of the recent literature are briefly reviewed here. The two most important effects of traffic noise on human behaviour centre around two activities: sleeping and speech. Evidence is not conclusive on other aspects of traffic noise impacts, particularly on the physiological/health aspects of chronic exposure. Intensive research is ongoing.

Generally speaking the effects of noise are viewed as less important than other sources of pollution, like air and water pollution, which are cumulative and have direct health impacts. Rather traffic noise affects quality of life which often has a lower policy priority than direct health and environmental risks (CEST, 1993).

Sleep disturbance

A study used by the Environmental Protection Agency in the US to prepare its original noise levels document, showed that sleep was the most frequently cited activity disrupted by surface vehicle noise (Suter, 1991). Traffic noise may disturb sleep at two levels: it may hinder the onset of sleep or affect the quality of sleep once an individual is sleeping, without awakening him or her. This effect starts at noise levels of 30 dB(A) for steady state continuous noise. The most important noise exposure parameter for sleep disturbance is the maximum peak level which means trucks are a particular nuisance at night. To ensure undisturbed sleep, the maximum level indoors should not exceed 45dB(A) (European Commission, 1997).

Impairment of sleep quality reduces the effectiveness of sleep for the body's regenerative processes and for mental well-being, although this is difficult to measure. Studies show deterioration in mood or symptoms such as tiredness, headache and nervous stomach where heavy traffic occurs at night and recommended values are exceeded (European Commission, 1997; CEST, 1993). Physiological tests show that people do not habituate to night-time noise, even after five years, although this is a common assumption (Suter, 1991).

There is no conclusive evidence that sleep disturbance may lead to direct long-term health risks, but because such research is laboratory based, there may be effects on mental health, general well-being, efficiency at work and other effects which have not been researched.

Interference with speech communication

Noise can mask important sounds and disrupt communication between individuals in a variety of settings, including face to face communication and enjoyment of radio and television in the home. It is generally accepted that noise levels inside the home should not exceed 40 - 45 dB(A) for ease of communication (European Commission, 1997; CMHC, 1981). Where noise exceeds these levels, speech interference may affect work, school or other daily activities. One study concluded that New York school children exposed to traffic noise in classrooms may have impaired academic performance because of the speech interference. The study found that children with classes on lower floors, which were exposed to more traffic noise, showed lower reading achievement than children with classes on higher floors and less traffic noise exposure (CEST, 1993).

People with impaired hearing are especially vulnerable to speech communication difficulties caused by traffic noise. As hearing impairment is a natural process of aging, demographic trends would suggest a worsening of traffic noise-induced communication difficulties. Another factor to consider is the type of hearing loss experienced by older people. Hearing acuity remains relatively intact for low frequency sound, produced more by trucks than cars. Low frequency vehicle noise competes with and masks the higher frequency sounds people wish to hear, such as speech (CEST, 1993).

Economic impacts

In Europe, the estimated costs of transportation-induced noise pollution vary between 0.2% and 2% of GDP. There are several measures of economic impact, the most common being property values. The decrease in housing value attributable to road traffic noise over the past 25 years depends on the period of time in question. In the 1980s, European studies estimated that the average rate of depreciation was approximately 1% per dB(A) if the noise exceeds 55 dB(A). Similarly, studies showed a property price reduction rate of 0.3 to 0.8% per dB(A) in the 1970s. Using these values to estimate impacts in France, the total cost was estimated to be 800 million ECU per year (European Commission, 1997). A review of nine empirical studies conducted in the 1970s covering 14 housing sites in Canada and the US found noise discounts in the range of .16 to .63% per decibel, with a mean of .40% per decibel (Nelson, 1982 reported in Kamerud and von

Buseck, 1985). These estimates of property value effects can be used to generate cost-benefit analyses of noise mitigation measures.

There are other measures of the costs of noise. Recent work in British Columbia recommends the use of $0.06 per vehicle km traveled as the unit environmental cost of automobile noise (Bein, Litman and Johnson, 1994). German studies of costs in terms of abatement cost and lost productivity estimate that noise effects cost 24 billion DM/year (CEST, 1993).

Psycho-physiological /health

Work in the Netherlands on the long term health effects of noise exposure has classified the most common effects into three categories, those for which there is: sufficient evidence, limited evidence, and lack of evidence (Health Council of the Netherlands, 1994). Falling within the first category is hearing damage, hypertension, heart disease, annoyance, awakening, sleep stages, self-reported sleep quality, and school performance each occurring above a unique threshold level of noise. The most easily measured physical effect, noise induced hearing loss, is not relevant for noise levels generated by traffic[5]. Others are not convinced by the data of the direct relation between environmental noise, like traffic noise, and increased blood pressure (WHO, 1992). There seems to be agreement that stress resulting from traffic noise is a stressor to health, and thereby a contributory factor in increased blood pressure, which in turn leads to heart and circulation disorders. Ultimately, noise reduction, to the degree that it reduces stress, is viewed as a worthwhile preventative health measure (CEST,1993). The World Health Organization generally embraces the principle that noise above certain levels is damaging to public health and the quality of life. German studies estimate that the annual cost of noise on public health is in the order of 500 to 1900 million ECU per annum for road noise (European Commission, 1997).

[5] Loss of hearing is typically the result of continuous exposure to high noise levels of 85 dB(A) and over for a period of years.

3.0 International Experience in Planning and Managing Traffic Noise

This section contains fifteen "fact sheets" describing types of measures used to plan for and manage traffic noise on arterial streets in other jurisdictions. Each fact sheet refers to a generic type of initiative, with examples provided from various countries, where applicable. They represent a range of options for non-vehicle based noise control measures used over the past 15 years. They are derived from experiences in Europe (particularly the Netherlands and Germany), Australia and the U.S, and to a limited extent, Japan. Information is presented under the headings: location, objective, description, date, impetus, responsible agency, implementation, costs, results, and problems. The source(s) of information is also included. Where information is not available, N/A is used.

The fact sheets are categorized according to the type of initiative they represent. The categories employed are:

Education	production and dissemination of information, public and staff education, advertising
Planning	land use planning, transportation planning, site planning, zoning
Design	use of design principles, construction materials and techniques, when applied to exposed buildings help to mitigate traffic noise. Can be applied to both new construction or renovation.
Policy	directions or actions taken by government to achieve a goal or target
Economic Instruments	a fee or charge on noise produced, grants to purchase low noise products or compensation to individuals to alleviate un-mitigatible noise
Infrastructure	capital improvements such as barriers, berms, road surfaces and insulation to reduce the transmission of noise
Comprehensive Program	municipal, state, provincial and/or private initiatives which consist of several of the categories of actions described here to achieve a stated goal

Public Education Campaigns

Category: Education and awareness

Location: Australia, Netherlands, France, Germany, Japan, Switzerland.

Objective: Initiatives which aim to encourage low-noise behaviour, stimulate the production, purchase and use of quiet vehicles, and promote awareness of noise issues in planning and policy-making and among the public.

Description: Targets are usually the general public or elected representatives, and technical staff.

Four general types of measures: training of technical staff and elected representatives, educating the public, local pilot projects and promotion of low noise products.

Activities include: anti-noise education campaigns, environmental education in schools, noise surveys, product labeling, certificates of acoustic quality, noise abatement organizations/councils/brigades, local pilot projects i.e. quiet towns in France combining education with regulation; encouraging drivers to buy smaller, lightest, low powered vehicles, creation of public information materials including guides, exhibitions, films, etc.

In all countries campaigns to educate the public are seen as an essential policy instrument and a vital part of policy implementation.

Date: N/A

Impetus: Increased awareness helps to make regulations acceptable and comprehensible to public. People who are conscious of a problem are more likely to accept regulations and less likely to register opposition. An essential adjunct to policy implementation and enforcement of regulations.

Responsible Agency: Private or non-profit associations undertaking this role are often more favourably received than public bodies. For example, in the Netherlands, anti-noise campaigns and the provision of public information on noise problems is an important task of the Dutch Noise Abatement Foundation, a private non-profit organization. Various levels of government have been involved in various countries.

Implementation: In Australia leaflets aim to increase driver awareness of noisy driving behaviour and the importance of car maintenance. In many countries, campaigns urge drivers to drive considerately, use gears efficiently and avoid using horns at night. The most successful have been targeted campaigns aimed at fleets of commercial drivers. In Switzerland, the image of a black cat on wheels has been used to promote quiet driving. In Germany, driving schools must include demonstration and testing of driving behaviour which reduces noise. In the Netherlands, the Dept. of Environment initiated a course on noise abatement management for technical and administrative staff of provincial and municipal governments, in connection with the introduction and implementation of the Dutch Noise Abatement Act.

Labeling low noise products acts to inform consumers and persuade them to change their purchasing behaviour. These are similar to labels for products which respect the environment. Often used in combination with time-space restrictions, for example, only low noise trucks bearing a certain sign can travel at night or on noise sensitive routes.

Costs: Measures are less expensive than alternatives: enforcing regulations or infrastructure investments.

Results: The experience of several countries suggests that it is better to organize ongoing campaigns of limited scope rather than major but short-lived national campaigns. Experience in countries such as Japan and Switzerland

has shown that local campaigns are more effective than national campaigns.

In Scandinavia, low noise driving has been shown to be compatible with fuel conservation (through better gear use etc.) and therefore conveys economic benefits to operators.

Problems: N/A

Source: OECD. *Noise Abatement in the Netherlands*. OECD- N-01, 1988.

OECD. *Fighting Noise in the 1990s*. Paris, 1991.

Australia Environment Council. *Strategies for the Control of Road Traffic Noise using non-vehicle Based Methods*. 1988

January 6, 1998

Quiet House

Category: Education and Awareness

Location: Sydney, Australia

Objective: The main objectives of the Quiet House project were to:

- promote awareness of the problem of traffic noise
- provide design techniques and information to architects, designers, builders, homeowners and industry on cost effective ways of reducing traffic noise in the home
- challenge conventional thinking about housing design in busy traffic areas
- provide a long term education facility for architecture and building students.

Description: The Quiet House is a single family dwelling located on a busy street in Sydney, which was designed and built using sound-proofing techniques. It is open to the public as a demonstration of these concepts and techniques.

Some essential noise reducing features of the Quiet House are: no line of sight, solid core front door, barrier facades, door seals, sealants around windows, laundry, bathrooms and kitchen placed on noisy side of house, air conditioning, hallway door near bedrooms, wall returns, roof insulation, double brick wall facade, no windows at the front, interior courtyard, and a concrete slab floor.

Date: The design competition was launched in April 1983. The building opened to public in November 1988.

Impetus: In the early 1980s, research into traffic noise in suburban areas of Sydney showed that new houses were being designed without any regard for their environment.

Responsible Agency: Design competition managed by Environment Protection Authority (formerly the State Pollution Control Commission). Environmental Protection Authority (EPA), the RTA, and Department of Housing together with a large number of private sector organizations sponsored the construction of the Quiet House. It is operated by NSW Roads and Traffic Authority.

Implementation: The Quiet House Design Award Competition launched the project. The conditions of the competition required that the designs use commonly available building materials and rely on design as the main noise control element. It attracted over 100 entries from all over Australia. Designs were judged by a panel of well-known architects and representatives of various sectors of the building industry. Prize money was donated by a private company. Sydney architect Geoffrey Le Sueur designed the award winning Quiet House. The Minister of the Environment presented prizes at a special event which attracted a lot of media attention.

Three years later, sponsors were organized to build the winning design to be used as a display home. The house was opened for inspection in 1989 by three Ministers.

In the first year of exhibition, the house was visited by over 15,000 people (in about 4 months). Between 30,000 and 40,000 people have been through the house during its life.

Costs: Land was provided by government, Dept. of Housing paid for labour, and companies provided the materials. The cost of the winning design was assessed to be not more than 10% more than conventional design.

Results:. The competition created widespread discussion of the issue both within the professions and the media with minimal cost to the government.

Proves that better design and construction can greatly improve living environments in busy cities. Noise measurement tests were conducted by the University of NSW according to Australian standards. Tests concluded that noise levels within the bedrooms exceeded the standard by 5-10 dB.

Problems: There is some concern that the building technology employed in the Quiet House has not been enthusiastically taken up by the wider community. In recent years, the RTA has considered selling it. It may consider a Mark 2 version Quiet House.

Source: NSW Roads and Traffic Authority, *Road Traffic Noise: Interim Policy and Guidelines*. September, 1992.

RTA Sydney Region, The Quiet House brochure.

Ancich, Eric. RTA Sydney region. Personal communication, Nov 5, 1997.

McLachlan, Stuart. Personal communication, Nov. 11, 1997.

January 6, 1998

Reducing Traffic Noise, A Guide for Homeowners, Designers and Builders

Category: Education and Awareness

Location: New South Wales, Australia

Objective: To provide practical advice to homeowners, designers and builders on how to design and insulate buildings to reduce traffic noise impacts.

Description: A 23 page publication with photographs, diagrams, and appendices. Practical approaches for designing or renovating a single family home with noise abatement properties are presented under the following headings: site planning, noise barriers, housing design and building techniques. Some ideas apply to new housing, some to existing housing and some apply to both.

For example, the guide points out that the type of double glazing used for thermal insulation (with an airspace of around 20-25 mm between panes) is not suitable for noise insulation. For noise insulation the air space between panes must be at least 50 to 100 mm or more.

The guide recommends the homeowner seek professional advice before undertaking acoustical design or renovation. Available from the NSW Roads and Traffic Authority.

Date: Published August 1991.

Impetus: There is only so much that government can do to combat the effects of traffic noise in urban areas. Private housing located near busy roads often needs modification to better withstand the realities of a noisy urban environment.

Responsible Agency(s): NSW Roads and Traffic Authority, State Pollution Control Commission, and Department of Housing.

Implementation: N/A

Costs: The cost is $2.00 Australian per copy.

Results: N/A

Problems: N/A

Source: State Pollution Control Commission, Road and Traffic Authority, and Department of Housing, *Reducing Traffic Noise A Guide for Homeowners, Designers and Builders.* August 1991.

January 6, 1998

Noise Mapping

Category: Planning

Location: Netherlands, Germany, Denmark.

Objective: Can be used in decision making regarding new transport infrastructure and in planning new residential areas. In existing areas, maps can be used for developing noise targets and for monitoring achievements in noise mitigation.

Description: Noise maps present ranges of noise exposure for a particular area in, for example, 5 dB(A) increments. Quiet and noisy areas can be shown in different colours. They make it easy to recognize the noise exposure and thereby identify areas where action is required, and other quiet areas where exposure should not increase. They are useful aids for visualizing noise levels.

Early noise maps utilized actual noise measurements. Today, computers and digital mapping facilitate prediction of noise levels using average number of vehicles, speed, and street surfacing. Noise prediction rather than noise measurement should be the basis when mapping noise levels because accurate and representative noise measurements are much too expensive. Noise mapping can be used to show future noise levels as well.

Various types of noise maps are in use. Some show detailed information at the level of every city street, other more simplified versions show only noise levels for main streets. They can show the number of exposed dwellings, residents or even windows. In order to depict the effects of noise mitigation measures, models need to incorporate all factors influencing noise exposure such as speeds and road surface material.

The European Commission believes that noise mapping has the potential to be an effective and relatively inexpensive method for the assessment of noise, for presentation of noise information to the public and to serve as a basic planning tool and has recommended harmonization of methods.

Date: First noise maps in Germany were compiled in 1968. Since 1992, noise maps have been prepared for 32 towns and communities in the federal state of Saxony-Anhalt, Germany. They were first prepared in Denmark in 1974.

Impetus: Without good information it is impossible to know where noise problems occur and to evaluate the impact of noise reduction measures.

Responsible Agency: Local governments are generally responsible for developing maps, sometimes with financial or other assistance from other levels of government.

Implementation: The European Commission is considering proposing legislation in the form of a directive to establish a framework for improving noise data, its comparability, monitoring, and provision of information to the public. Uniform noise exposure mapping would be a key component.

The Netherlands, Denmark and Germany have considerable experience in creating and using noise maps. Subsidies to all communities over 50,000 inhabitants provide the impetus and means to generate a map showing road and rail traffic noise for each community. Zones for airports and industrial areas are already known, so for practical purposes the noise load is known for about half the population. Furthermore, there is detailed information on every dwelling with a noise load over 65dB(A) due to road or rail transport.

The Netherlands has also undertaken combined mapping of noise and odour from traffic.

In Denmark, a nationwide mapping or road traffic noise exposure was carried out in 1991. Data from approximately 35 towns was included in the database and the results were extrapolated for the whole country.

Costs: Relatively inexpensive. In the Netherlands, the costs for setting up the maps is estimated at around FL3 per inhabitant. Costs are dependent on the extent to which a City possesses digital information regarding streets, dwellings and traffic intensities. Costs of maintenance are not known.

In Germany, costs estimated at 2 DM per inhabitant for cities with more than 100,000 people.

Results: Should be able to measure changes in traffic noise levels resulting from noise mitigation measures.

Problems: N/A

Source: Danish Environmental Protection Agency for the European Environment Agency. *Danish experience in monitoring noise exposure, and necessary steps towards procuring data for a uniform European mapping of environmental noise.* Copenhagen, January 1997.

European Community. *Green Paper on Future Noise Policy.* November 1997.

Dr. Christian Beckert, Ministry of Regional Planning, Agriculture and the Environment of the Federal State of Saxony-Anhalt. *Noise maps for cities and towns of Saxony-Anhalt.* Presentation at Conference on European Union Future Noise Policy. May 21/22, 1997

January 6, 1998

Land Use and Transportation Planning

Category: Planning

Location: Japan, Netherlands, Australia, France, U.S, Italy, Germany

Objective: To separate noise sensitive land uses from noise generating land uses in order to avoid future conflict through local government's regulatory powers.

Description: There are three major approaches:

a) channeling the noise generator, such as arterial road traffic, onto suitable corridors

b) classifying land uses as noise sensitive or noise tolerant, and using noise tolerant land uses or buffers to distance intervening land forms.

c) a system for laying down preferred and maximum permissible noise levels for dwellings adjacent to noisy roads and specifying performance standards for new buildings (see noise limits).

The basic requirement for successful planning and zoning is that planning authorities be able to produce maps visualizing noise alongside roads and railways. In addition, a model for calculating noise impacts on specific buildings or areas is necessary.

Date: 1970s

Impetus: Much more effective and cost effective to reduce noise transmission through planning than to reduce receptor noise.

Responsible Agency: Local and provincial/state governments responsible for regulating land use and controlling the development of land.

Implementation: In Italy, the new roads code (1992) requires an urban traffic plan for all towns over 30,000 people, with reduction of pollution (including noise pollution) as one of the objectives. Similar provisions exist in the German Federal Immission Protection Act, concerning Noise Abatement Plans. These plans would typically lay out numerous strategies for reducing traffic noise impacts.

In Japan and the Netherlands, special zoning alongside roads is now required in all major road developments.

Japan has tried to implement a green belt adjacent to major new roads and wherever the availability of land allows, on existing roads. Cities, towns and villages have had access to interest free loans to purchase land for buffer zones adjacent to major noise sources. Also used in France. In Finland, existing houses in newly established buffer zones are acquired and removed, but these buffer zones seldom exceed 40 metres in width.

In the Netherlands, the Noise Abatement Act requires that special zones alongside roads must meet acoustic requirements. Extra attention must be given to the planning of new dwellings and improvement of the acoustic environment of existing dwellings. The size of the zone is specified in the Act, the width depending on the number of traffic lanes, and can vary between 200 and 600 metres on either side of the road. Within this zone, when establishing or revising a land use plan, municipal councils must observe the maximum permissible noise load for dwellings - 50dB(A). In existing situations, the permissible noise level is 55dB(A). Improvement measures are sometimes necessary.

Other jurisdictions have favoured reflecting noise by constructing non-sensitive buildings as noise barriers adjacent to roads. This is considered effective in towns with limited space for siting warehouses and depots. Noise sensitive buildings placed strategically can reduce the size of the buffer zone. A number of countries have

found a continuous row of garages effective buffer zones.

In Indiana and Mississippi, some communities have been making zoning changes from residential to commercial near busy roads.

In NSW Australia, there is a proposal to establish noise sensitivity criteria based on the characteristics of existing land use and the nature of structures currently in place. This would include building materials and design. Such information would enable identification of desirable mixes of design, materials and building location.

In Denmark, road traffic noise is an active criterion in local planning decisions. No house built after 1980 is subjected to a noise level exceeding the current limits.

Costs: Less costly than many other types of noise measures. In the Netherlands, planning requirements are funded by means of the gasoline tax.

Results: Land use and transportation planning can have significant effects in reducing the impact of traffic noise in newly developing areas. However, in existing areas, the difficulties in modifying existing uses to more noise tolerant activities limits the impact of planning measures.

Problems: Sometimes, the shortage of land for residential development within a city has meant that residential development has been permitted in areas of severe noise impact, subject to the building meeting indoor noise performance standards.

Unless there is a widespread demand for noise tolerant land uses along noisy roads, the strategy will not be effective.

In France, there has been a reluctance to restrict land use based upon noise criteria because it is seen as an infringement of property rights.

Few of those locally responsible for planning policies have any training or awareness of the noise problems and few officials have technical knowledge to implement noise abatement policies effectively. Few towns can claim to have made proper allowance for noise in preparing traffic or transportation plans.

Source: Australian Environment Council. *Strategies for the Control of Road Traffic Noise Using Non-vehicle Based Methods*. 1988.

Bowlby, William et al. *Comprehensive System Level Noise Reduction Strategies*. Washington State Dept. of Transportation, 1991.

OECD. *Roadside Noise Abatement*. Road Transport Research. Paris, 1995.

OECD. *Fighting Noise in the 1990s*. Paris, 1991.

Waller, Herman. *Exchange of Information on Noise Abatement Policies*. Case Study on the Netherlands. OECD, 1988.

January 6, 1998

Building Siting, Design and Construction

Category: Design

Location: Australia.

Objective: To achieve acceptable acoustic environments, both inside and outside, in noisy locations through the use of sensitive siting, design and building techniques and materials.

Description: It is not always possible to use buildings affected by traffic or sites located close to busy streets for non-noise sensitive uses. Appropriate siting, design and construction can be effective in controlling traffic noise from large volume traffic flows. The most important considerations are: the location of the house, house design, building materials, quality of construction, and shielding of exterior living space.

Siting considerations include: distance, exploit existing natural features, use non-sensitive uses and building such as garages to shield house from noise, use the house to shield outdoor living areas such as courtyards.

Design features include: changes in room use, limiting the number or size of windows on noisy side of house, and single story construction.

Sound absorbing and insulating materials include: solid core doors, noise insulating windows, and sound dampened mechanical ventilation.

Outside protection can be achieved through orientation of buildings to create a courtyard, barrier walls, and return walls.

Date: 1980s

Impetus: Public action cannot always ameliorate traffic noise.

Responsible Agency: Local or municipal government usually regulates the development process. Building professionals design and construct.

Implementation: Implementation can occur through regulation, education or both. Generally, implementation of these concepts is not widespread. Australia seems to be most advanced in considering the application of building design to noise.

The average Australian house is designed for a quiet cul-de-sac and does not provide adequate protection against traffic noise. The Australian "Quiet House" demonstration project provides an actual example of siting design and construction techniques for minimizing indoor and outdoor noise.

When it is necessary to build or upgrade an existing dwelling capable of significantly reducing the impact of road traffic noise, there are a number of steps which can be taken, in a particular order. For existing buildings, changing internal room usage and sound-proofing the facade are usually the first options. Specific recommendations are contained in: NSW Roads and Traffic Authority's *Reducing Traffic Noise: A Guide for Homeowners, Designers and Builders,* 1991.

Costs: If these features are incorporated at pre-design stage of new construction, then the additional cost is minimal. The cost of retrofitting an existing building is more expensive, estimated at $4,000-10,000 Australian.

Experience in Australia has shown that small changes can produce significant reductions in traffic noise while expensive measures, when not properly designed and installed, can have disappointing results.

Results: Design approaches minimise the need for the removal of valuable residential land from residential use due to noise considerations.

Most effective in indoor situations. Less effective outdoors.

Problems: Difficult to protect upper stories of multi-level buildings.

Outside noise levels may be unsatisfactory unless some suitable screening is arranged.

Protecting existing housing more difficult and thus more expensive.

Source: Australian Environment Council. *Strategies for the Control of Road Traffic Noise using non-vehicle Based Methods*. 1988

NSW Roads and Traffic Authority, *Reducing Traffic Noise: A Guide for Homeowners, Designers and Builders,* 1991.

January 6, 1998

Road Traffic Noise: Interim Policy and Guidelines

Category: Policy

Location: New South Wales, Australia

Objective: To develop and implement policies to reduce road traffic noise.

Description: A comprehensive road traffic noise policy developed by the New South Wales Road Traffic Authority. Includes policies (or actions in the case of areas outside the RTA's sphere of responsibility), guidelines and actions to assist staff to implement these policies.

Recommendations address: managing noise impacts of RTA road projects (including new road and bridge projects and major road upgrading and traffic management projects); traffic noise level objectives (which are the noise level the RTA aims to achieve in different areas to determine application of policy); monitoring of noise levels; loudspot treatment; consultation and information sharing; research and development; reducing noise at vehicle source; separating people and noise; traffic management and monitoring of the effectiveness of policies.

Among the specific policies is a policy to assess and manage noise impacts of RTA road related projects, Policy 1.2:

"Appropriate measures will be implemented to reduce noise levels caused by major RTA road upgrading and traffic management projects when

a) the appropriate noise level objective has been exceeded
b) there is an appreciable noise increase and
c) it can be demonstrated that such measures to reduce traffic noise are cost-effective and practical."

Date: September 1992

Impetus: N/A

Responsible Agency: New South Wales Roads and Traffic Authority, Traffic Noise Steering Committee

Implementation: Road and Traffic Authority staff involved in designing new road projects, and staff involved in planning matters.

The RTA reviewed the Interim Traffic Noise Policy in 1995/96 working closely with the Environmental Protection Authority. Revisions will be the subject of community consultation prior to policy being finalized.

Costs: Development of policy and eventual implementation. No cost data.

Results: N/A

Problems: N/A

Source: NSW Roads and Traffic Authority, Community Relations Branch, *Road Traffic Noise Interim Policy and Guidelines.* September 1992.

January 6, 1998

Noise Limits

Category: Policy

Location: Most European countries have adopted limits. Also Australia, Canada, and some U.S. states.

Objective: Noise level standards aim to establish a maximum target for noise levels or noise increases produced by new roads or upgrading of existing roads, or in some cases, existing situations. If exceeded, noise abatement measures are required, usually subject to economic practicality and community input.

Description: Noise exposure limits, also called immission limits, or ambient noise targets, are maximum noise levels set for an area or type of land use, established by government, with the aim of protecting noise sensitive areas. They provide a standard against which projected increases in road traffic noise can be evaluated. Road development authorities are generally required to meet noise limits for new or upgrading projects subject to practicality and cost-effectiveness. Limits may be either mandatory or advisory.

A large degree of international consensus has emerged over the years as to what constitutes unacceptable levels of noise exposure. Different immission limits are generally applied to daytime and night-time periods, although definitions of night and day vary. Sometimes the evening is added as a third period as it is an extremely sensitive period for residents. Apart from time periods, limits depend on the sensitivity of where they apply, typical categories being: residential, hospitals, schools, commercial and industrial. Difference of 10 to 15 dB(A) are frequently found in limits between the most and least sensitive areas. The limits generally apply to ultimate predicted traffic flow or traffic flow 10 years after project construction. Different limits may also apply to new sources of noise, or existing noise levels.

Date: National regulations initially developed in the 1970s and 80s in northern Europe and somewhat later in southern Europe.

Impetus: Overall guidance needed as to acceptable and unacceptable community noise levels.

Responsible Agency: Limits usually adopted by national government or provincial/state level of government. Used by local governments in land use planning and state/provincial roads, land use and/or housing authorities. International bodies also have a role. OECD and WHO collect data and have developed guideline values for noise exposure.

Implementation: In EU member states the daytime limits ranged between 58 to 62 dB(A) and the night-time range for zones in residential areas is 48-55. Different limits are also commonly employed for new development and along existing roadways.

Limits generally apply to new roads and major modification to existing roads. A few countries have adopted measures to improve critical noise problems along existing roads.

Limits may act as a trigger for improvement programs involving: barrier construction, subsidies for insulation or for compensation.

In the Netherlands, immission standards are established in the Dutch Noise Abatement Act.

Noise immission standards for new developments near roads are normally set by local authorities as part of planning policy and are used as a reference in environmental impact assessments. They serve as a means of ensuring that appropriate measures are taken to minimise the noise impact of a site. Planning permission may be refused or action may be required to improve insulation from the noise source.

California has noise level standards that developers must meet, leading to many

miles of developer built noise barriers along roads.

Some countries set targets for achievement of limits i.e. reduce # dwellings exposed to 65dB(A) or greater by 50% within a certain time period.

Costs/Funding: Improvement programs associated with new projects and existing noisy areas are expensive.

Results: Some jurisdictions successfully ensuring that no new development exceeds standards.

Problems: Improvement programs expensive.

Unreliable implementation of limits at local level.

Source: OECD. *Green paper on future noise policy*. 1997

January 6, 1998

Subsidies and Charges

Category: Economic instruments

Location: Germany, Netherlands

Objective: To provide an economic incentive to promote the use and production of low-noise vehicles, to change behaviour and to finance noise abatement programs. Consistent with the "polluter pays" principle.

Description: Refers to charging or imposing a tax on noisy vehicles or those which do not meet "low noise" criteria and subsidies to those vehicles meeting or exceeding standards. Also called incentive measures, subsidies and charges are used to create an incentive to use quiet products. Another form of economic incentive is compensation. Instead of subsidizing a reduction in noise pollution, compensation could be given to those it affects.

Date: In the Netherlands, since 1981.

Impetus: For many journeys, there is a significant mismatch between prices paid by individual users and the costs they cause. This situation is both inequitable and inefficient. When economic incentives are combined with regulation, regulations are much more effective. Price based policies give citizens and businesses incentives to find solutions to problems. Charges may also be used to finance noise mitigation measures.

Responsible Agency: In the Netherlands, the Ministry of Housing, Physical Planning and Environment.

Implementation: Little experience with this tool in OECD countries to date - there is more experience with subsidies, less with noise charges.

For a period of about 10 years, the Netherlands implemented a subsidy program where operators of heavy goods vehicles were offered subsidies of 7.5 and 5% for noise reductions of 6 and 3dB(A) respectively. The costs of the quieting measures were borne by the operators.

In France a subsidy is available for a sound proofing kit for in-service city buses for only 50% of the cost. This measure has prompted the insulation of many buses, over a short period of time. This subsidy, by its nature, is transitional.

A recent EU Green Paper on road transport pricing advocates the use of electronic road pricing in the long run. In the meantime, the possibilities for taxing noisy vehicles include: a tax on new vehicles dependent on their noise category or an annual tax dependent on noise category. A third possibility is a charge on noisy vehicles when they are used in an environmentally sensitive area. Where in-use vehicles are noise tested, as in Australia and Japan, it would be possible to levy an annual discretionary noise tax. A definition of low noise would have to be developed. This could be applied using a sliding scale for noisier types of new vehicles and would have an incentive effect on manufacturers.

The Netherlands proposed a noise charge system that was never implemented. Instead, the Netherlands operates an indirect noise charge for vehicles through levying additional taxes on fuel. This levy is based on the rationale that old, probably noisy vehicles use more fuel and would therefore bear the brunt of the tax. This tax funds the Dutch Noise Abatement Program.

Austria planned to implement a road user charge in 1986 that differentiates according to the noise and emissions of vehicles.

According to the Green Paper, compensation for house price depreciation caused by noise or other environmental impacts is a well established policy in some countries. An important aspect of compensation is that, in some

circumstances, the polluter, or the authority making decision about pollution, may have to pay the compensation themselves. This is particularly so in the planning of new roads where projected compensation payments may be an incentive to reduce or mitigate impacts.

Costs: Average bus hush kit cost $1200 AU.

In the Netherlands, plans for 1990-2010 include a subsidy program for low noise and clean trucks and buses to an amount of 90 million Gld. Noise charges could cross-subsidize subsidies.

Contacts with manufacturers suggest that low-noise technology may increase capital costs of vehicles by between 2 - 10 percent of the purchase price.

Results: Where subsidies are available, maximum levels of cooperation are received from manufacturers, for whom the subsidies are a stimulus to introduce noise abatement measures into their standard production models. In the Netherlands, an evaluation of the subsidy scheme described above carried out in 1988 called it successful. More than 60 percent of trucks now in use in the Netherlands have noise levels 5 dB(A) below current standards.

Problems: The cost of subsidies can be prohibitive.

Source: European Union. *Towards Fair and Efficient Pricing in Transport*. Nd.

OECD. *Fighting Noise in the 1990s*. 1991.

Australian Environment Council. *Strategies for the Control of Road Traffic Noise using non-vehicle Based Methods*. 1988

January 6, 1998

Roadside Barriers

Category: Infrastructure

Location: France, Japan, Austria, Australia, U.S., Germany.

Objective: To reduce noise behind the barrier. The barrier interferes with the propagation of sound waves from the road to the receiver.

Description: May be constructed of earth (called a berm), timber, concrete or metal. Effective noise barriers can reduce noise levels by 10 to as much as 25 dB(A). A 10 decibel reduction cuts the perceived loudness of traffic noise in half.

Some barriers are designed simply to act as barriers to noise while others have absorption qualities to reduce the possibility of multiple reflections of noise. Absorptive barriers are now foremost in barrier design. Greatest attenuation is achieved when the barrier is close to the source, or close to the receiver.

Natural berms are usually earthberms planted with vegetation. Mixed barriers can be obtained by constructing an artificial screen on top of an earth berm. Artificial barriers are the most typical noise barrier, usually combined with some landscaping.

Vegetation provides negligible attenuation of traffic noise. It is typically incorporated into barrier designs for aesthetic purposes only.

Date: Beginning in the 1970s on highways, more recently on arterial roads.

Impetus: Where road design treatments are not effective or feasible.

Responsible Agency: Varies. Usually the agency responsible for construction and maintenance of roads. Developers of new housing in noisy areas. State/provincial/municipal authorities in black spot areas. Private property owners sometimes.

Implementation: In Japan, where roadside barriers have been used since the 1970s, about 200 km of barriers are built each year. In Germany, more than 1200 km of barriers have been erected along highways and streets. In Austria, artistic design of noise protection barriers meets needs of residents in towns. In Denmark great emphasis has been put on visual quality of barriers for both residents and motorists. Colors, transparent materials, and vegetation have been used.

In the U.S., the most notable trend in highway traffic noise barrier construction has been the dramatic increase in the amount of construction recently, 1988 and 89 (two most recent years of reporting). Expenditures for these two years almost tripled the average yearly expenditures of the earlier 15 years. Phoenix, Arizona has been experimenting with public art on noise barriers in since 1987.

In Australia, barriers have been installed in all states except Tasmania and the Northern Territory. Height is usually 2 metres, they are usually of the reflective type, and constructed of timber material. Some installations include cantilevered barriers to protect the upper levels of multistory buildings. They are installed on highways and arterial roads.

In the U.S. quite a few states have installed noise barriers on non-limited access facilities. This is possible if curb cuts are few. Homeowners have shared the cost of installing barriers off the right-of-way in a number of states.

Costs: The following costs per sq. meter, $US 1995 represent averages compiled by the OECD. Costs vary from site to site.

earthberms	$50 - 80
wood	60 -260
concrete	75 -300
aluminum or steel	110 -240

Absorptive barriers are more expensive.

In Australia, it is estimated that installation of a barrier increases total road construction costs by 1.5%.

Results: In the UK, noise reductions of between 8 to 12 dB(A) on average have been achieved. Barriers in Australia typically provide 4 to 6 dB(A) attenuation.

Problems: There are many considerations in implementing a noise barrier: visual impacts, safety, and maintenance. They are also expensive. Barriers are less effective where heavy vehicles use the road because of high vertical exhausts.

Freeways which were constructed without barriers usually have sufficient space available to construct a barrier. However, existing urban roads pose greater challenges. Smaller right-of-ways, problems with jurisdiction or who should pay, and site constraints affect possible noise control options. In some cases, private landowners have erected barrier fences on the property line.

Barriers are not as effective in attenuating noise affecting upper stories of multi-story buildings.

Source: Centre for Exploitation of Science and Technology. The UK Environmental Foresight Project. Volume 3. *The Future Road Transport Noise Agenda in the U.K.* London, 1993

OECD. *Roadside Noise Abatement*. 1995.

OECD. *Fighting Noise in the 1990s*. 1991.

Australian Environment Council. *Strategies for the Control of Road Traffic using Non-Vehicle-based Methods*. December 1988.

January 6, 1998

Insulation Programs

Category: Infrastructure

Location: Japan, France, Austria, Australia, Netherlands, Germany, Switzerland, Norway, UK, US.

Objective: Where it is not possible to re-plan room layout in existing buildings, or build noise barriers, insulation of frontages of homes is a quick and highly effective method of reducing serious noise impact in buildings located adjacent to major roads and in circumstances where it is not usual to have windows open.

Description: Consists of replacing windows, insulating walls and installing ventilation. This method is used when no other measures to reduce noise are possible in built-up areas in many countries. In Europe, both residences and institutions obtain noise insulation.

Provisions for insulation vary among countries where different thresholds of noise in existing housing or other sensitive buildings act as a trigger for insulation subsidies from the state. Another common approach is to require insulation in new dwellings along noisy roads to achieve certain indoor noise levels.

Usually employed in "loudspots" or where other measures have failed.

Date: 1973 in UK.

Impetus: This method is used when no other measures to reduce noise are possible.

Responsible Agency: In most countries, road authorities invest in these measures. Several urban councils have assisted by offering partial financial aid. In France, Ministry of Housing; in Netherlands, Ministry of Housing; in Germany, Ministry of Transport; in Australia, local councils implement building regulations, developers absorb cost of insulation.

Implementation: Property owners are often given grants or refunds on their investments. Outdoor trigger sound levels range from 50 dB(A) in Australia with windows and doors open to 70 dB(A) in France.

In 1973 UK introduced regulations governing grants for insulation of residential properties subject to increased noise levels from new roads or motorways. These regulations stipulate that where properties are within 300 yards of a new or substantially improved road and the resulting noise exceeds 68 dB(A), then the householder may receive an insulation grant if the increased traffic noise is at least 1 dB(A).

Most countries recommend an internal noise level of 35 to 40 dB(A) after insulation.

In the U.S. insulation of public buildings along highways, especially schools, is common. California has had a major school noise abatement program with 116 schools treated at a cost of $23 million.

In Japan, over 31,000 dwellings had been sound insulated by 1986.

In Berlin, the Federal Ministry of Traffic has paid for sound proof windows or erected sound walls along 100 kms of major roads where noise levels exceed 70 dB(A) daytime.

An amendment to the Housing Act in the Netherlands requires municipal councils to include sound insulation standards in their building codes.

Costs: Many European countries have invested large sums in such improvements. Usually the authority assumes partial financial responsibility for the cost in insulating, with the property owner paying part of the cost. Residents benefit in other ways from the measure,

such as better heat insulation and increased property values.

In the Netherlands, from 1987 to 1988 the Ministry of Housing spent $US 6.15 million on insulating 4000 new dwellings. It was found that the average cost to insulate houses at the initial building stage is $US 615 compared to insulating existing dwellings ($US 1400 - 2800).

The UK spent about £830,000 in grants paid to insulate homes in 1990/91.

Results: By replacing windows with noise-reducing windows, the noise level can be reduced to as much as 44 dB(A). Adding 100 mm of fiberglass roof insulation can reduce the sound level by 5 dB(A).

In some areas, insulation provisions act to discourage builders from building in noisy areas.

By 1986, 85% of Dutch municipalities had amended their building bylaws to the standards required by the Housing Act. However, a 1987 survey showed that less than 70 percent of new buildings required by regulation to incorporate top-quality soundproofing complied with the regulations and only 50 percent complied where average soundproofing was necessary

Insulation measures can reduce both noise and energy consumption. It is worthwhile to consider noise and energy consumption together when designing new buildings or refurbishing existing buildings.

Problems: Only indoor areas are protected from noise source.

Soundproofing regulations for new buildings along noisy roads are usually satisfactory from a technical standpoint. However, effective implementation is hindered by lack of training and awareness of those involved in the building process.

Window attenuation is not as effective for low frequency noise produced by heavy vehicles.

If all dwellings exposed to traffic noise were insulated, the cost would be enormous.

Source: Bowlby, William et al. *Comprehensive System Level Noise Reduction Strategies*. Washington State Department of Transportation, Olympia, WA: 1991.

Centre for Exploitation of Science and Technology. The UK Environmental Foresight Project. Volume 3. *The Future Road Transport Noise Agenda in the U.K.* London, 1993.

OECD. *Fighting Noise in the 90s.* 1991.

OECD. *Roadside Noise Abatement.* 1995

RTA. *Reducing Traffic Noise: A Guide for Homeowners, Designers and Builders.* Surrey Hills, NSW, 1991.

Waller, Herman. *Exchange of Information on Noise Abatement Policies.* Case Study on the Netherlands. OECD, 1988.

Mage, David and Olivier Zali (eds). *Motor Vehicle Air Pollution: Public Health Impact and Control Measures.* World Health Organization,1992.

January 6, 1998

Low Noise Road Surface

Category: Infrastructure

Location: Various European countries particularly the Netherlands, Italy, Austria, UK, Australia, Norway, and Japan.

Objective: To reduce tire/road noise through the use of low noise road pavement design, materials and application techniques.

Description: Tire/road noise is currently the principal noise emitted by all classes of vehicles even at moderate speeds. Tire/road noise is 2-4 dB(A) greater than the other noises produced by light vehicle traffic cruising at speeds over 50 Km/h.

Adoption in practically all OECD countries since mid-1980s. Much research has been conducted, some experimentation with different varieties of road pavements, and some implementation. Many countries did comparative analysis of noise generated by various types of existing pavements.

Porous asphalt pavements seem to offer the best noise mitigation qualities. It is an open textured smooth asphalt with an internal structure similar to honeycomb. Porous asphalt reduces both the generation and propagation of noise. Also called "whisper pavement".

Date: Developed in the 1950s as a solution to aquaplaning problems on airport runways. Implemented on road surfaces in mid-1980s for noise abatement properties.

Impetus: As motor vehicle noise emission limits have been progressively reduced, tire noise has become a more significant component of road traffic noise, and with new EC limits (1996) tire noise will be the main auto noise source at speeds above 50 km/h.

In the Netherlands, the Ministry of Environment persuaded the national highway authority to compensate for the rise in noise levels (about 2dB(A)) attributable to a rise in maximum velocity on highways from 100 to 120 km/hr. They did this by promising to cover national roadways with a volume of greater than 35,000 vehicles per day with porous asphalt. Local communities followed slowly afterward to implement.

Responsible Agency: In the Netherlands, the national highway authority is implementing and funding the use of porous asphalt on highways. Local government is implementing on roads in their jurisdiction.

Implementation: Italy and Japan lead the way in implementing use of this product. In Italy, sound absorbing pavement covers more than 10 million m2 of motorway. In Japan, there has been a movement to favour construction of porous asphalt surfaces so as to limit the high cost of noise abatement barriers.

In Japan, porous pavements are used to reduce water runoff during rain storms and improve water balance in urban areas. As these uses are not intended for noise reduction, their effects have not been measured.

In Austria, the use of porous asphalt amounted to over 6.5 million square meters in 1992. This is primarily due to pressure from local communities to reduce noise.

In the Netherlands, the national highway authority started almost 10 years ago to begin to cover all national roads with porous asphalt. Most of the highway network, about 3000 kms, are affected. On urban arterial roads this material has been applied on only a few experimental stretches.

In the UK, a 1992 policy to reduce noise from road surfaces includes preparation of specifications for porous asphalt. It is to be used in urban areas and other noise sensitive areas.

The 1997 European Community green paper on *Future Noise Policy* suggests

reducing road tire noise through low noise pavements would be a significant component of any action plan. It also proposes that the Commission promote the use of low noise pavements for road projects in sensitive areas receiving EC funding, where feasible and cost-effective.

In Australia, sections of major arterial roads have been provided with open grade asphalt road surface.

Costs: Higher than conventional surfaces, around 4.5 ECU per m2 for resurfacing. For new roads, the increased cost is marginal. Costs relative to conventional materials vary by country. In the Netherlands, costs are estimated at 20% higher than regular asphalt for resurfacing. This is largely offset by the advantages: less accidents in rainy weather and less noise. The Swedish Road Administration uses a rough rule of 50% higher costs, while Austrian experience reports increased costs of 30 - 100 %.

Results: The application and effectiveness is dependent on local conditions. In general, porous asphalt is beneficial at high traffic speeds, moderate speeds and also when traffic is at a standstill. It has also been found useful on sidewalks and parking areas due to noise absorption properties.

The UK has monitored noise reduction of porous surfaces longer than anywhere else. Long-term monitoring in the United Kingdom shows the following results: compared to equivalent non-porous road surfaces, noise reduction of 3-6 dB(A) is obtained for the first year, and 4 dB(A) for the next 4 yrs, falling to 3dB(A) at 5-6 yrs. These results apply to situations where traffic is predominantly passenger cars (less than 10% trucks).

Results in the Netherlands are quite satisfactory and still improving. On highways the maximum noise attenuation is 3dB and on urban roads much higher attenuations are attainable (up to 7 dB has been measured).

There is some evidence that the decrease of noise reduction with age may be a winter climate effect. Such deterioration has not been found in Denmark, England and Hong Kong.

A Norwegian study reports noise reduction of between 1.5 to 4.5 dB(A) in urban areas with 50 km/h posted speed and a Danish study reports a 4dB(A) reduction on a city street.

Local governments find its use attractive as it permits housing to be located closer to roads.

In a couple of instances where public reaction to installation of quiet road surfaces was measured, there was overwhelming support for this type of initiative, better than expected based upon objective noise measurements. It is likely that these surfaces are much more acceptable to the public than noise barriers.

Problems: Material is less durable than conventional road surfaces. However, improvements are being made to durability. Noise reduction is reduced over time, due to clogging. The experience in the Netherlands has found that freshly laid porous asphalt pavements possess longer braking distances; this is resolved by placing warning signs for a few weeks after installation. De-icing has a tendency to sink directly into the surface; this problem is resolved by using different deicing materials and procedures.

Source: Centre for Exploitation of Science and Technology. *The Future Road Transport Noise Agenda in the U.K.* The UK Environmental Foresight Project. Volume 3. London, 1993.

EEC. *Future Noise Policy.* European Commission Green Paper, Nov 7, 1997.

OECD. *Roadside Noise Abatement.* Road Transport Research. OECD: Paris, 1995.

Personal communication, Martin van den Berg, Ministry of Housing, Spatial Planning

and the Environment, Netherlands, May 24, 1997.

Sandberg, Ulf. "Low Noise Road Surfaces: A State of the Art Review." In *Eurosymposium*, Nantes, France. May 1992.

January 6, 1998

Loudspot Treatment

Category: Infrastructure

Location: Nearly all European countries and Australia.

Objective: To protect sensitive land uses from traffic noise at the worst locations. Loudspots are lengths of (usually existing) roads where traffic noise levels are high, considered unsafe from a public health standpoint, and generally inappropriate to the adjacent land use.

Description: Also called blackspots. Refer to areas with noise levels over 65 or 70 dB(A). Policies to address blackspots are also called catch-up policies.

There are three major ways to address existing loudspots: road side noise barriers, sound insulation of dwellings and improved road-tire interface.

Date: Not available.

Impetus: In France, the urban population exposed to noise black areas over 65 dB(A) constituted 6 million people in 1985. In the Netherlands, people claiming serious noise disturbance due to road traffic consists of 20 percent of the population.

Responsible Agency: In Switzerland, funds are made available by the federal government. It is difficult for local governments to undertake treatment alone due to costs.

Implementation: Requires knowledge of noise levels. Time horizons vary greatly. Prospects for alleviation of blackspots in some countries could take 40 years while Switzerland has set its goal at 15 years. In France, elimination of blackspots will take several decades given present budget allocations.

In Australia, initial plans for a loudspot treatment program are outlined in the NSW Traffic Noise Policy and Guidelines. Criteria under consideration for loudspot identification include:

- exceedence of noise level objectives (immission standards)
- number of people affected
- sensitive land use (school or hospital)
- likely effectiveness of treatment
- cost of treatment compared to benefits
- equity
- number of complaints

Costs: In some countries, such programs account for a considerable share or even the major portion of noise abatement funds. In France, they account for 35 percent of noise abatement expenditures by government departments. In the Netherlands, 60 % of the Environment Ministry's budget is devoted to road traffic noise abatement.

Results: There is evidence that the proportion of the population exposed to noise in black areas (over 65dB(A)) remained the same in France (from 1975 to 1985) and the Netherlands (from 1977 to 1987). This corresponds with an increase in "gray areas". In the absence of regular detailed surveys in most countries it is difficult to measure exactly to what extent previously existing black spots have or have not been dealt with.

Problems: It is very costly to mitigate noise in existing developed areas and options are limited.

Source: New South Wales Roads and Traffic Authority. *Road Traffic Noise: Interim Policy and Guidelines.* Sydney, 1992.

OECD. *Fighting Noise in the 1990s.* Paris, 1991

January 6, 1998

Quiet Town Schemes

Category: Comprehensive program

Location: France, also Darlington, UK, and Zurich, Switzerland, Japan.

Objective: To raise awareness of traffic and other types of noise and reduce noise levels in participating towns through changes in behaviour.

Description: Three year projects in 24 French towns where municipal authorities aimed to reduce noise by implementing a number of different measures including: educating the public; dealing with noise complaints; incorporating noise in urban policy and planning; soundproofing public buildings; traffic management; and providing out of town facilities for noisy sports.

Date: Beginning in 1980.

Impetus: Not available.

Responsible Agency: Municipal authorities in cooperation with the French Ministry of the Environment.

Implementation: Towns were awarded three year contracts, which made them eligible for a 50% state subsidy on all noise related spending.

In Japan, a "quiet town" program mainly consists of limiting business operating hours.

In Zurich, Switzerland, an integrated traffic noise management program was in place from 1979 to 1994. It was designed to reduce city noise levels from 70 to 65 dB(A). Specific measures include: porous asphalt road surfaces, traffic management through speed reductions to 30kph and re-routing of traffic, noise barriers, and insulation.

Costs: The total budget for the French scheme was 72.5 million FF or U.S. $12 million, half of which was provided by state subsidy. The budgets for individual towns vary considerably, from a few hundred thousand francs to several million.

In Zurich, the entire programme cost £38 million.

Results: There was little evaluation of the French scheme as of 1991. Certain public buildings were made quieter; public awareness improved; some land use planning measures were implemented, for example a 200 m buffer zone by highways and ring roads; and a rise in public awareness as evidenced by a larger number of noise related complaints. In some city centres, such as Audincourt, truck bans effectively reduced noise by 18%.

Problems: In France, the number of authorities responsible for dealing with noise has risen, causing inefficiencies and delays; noise maps have not been used in land use planning; public awareness techniques have not had the desired effect, i.e. huge noise meters on display were regarded as a "noise game"; and without continued state subsidy, towns do not have resources to continue.

Source: OECD. *Fighting Noise in the 1990s*. OECD: Paris, 1991.

Centre for Exploitation of Science and Technology. *The Future Road Transport Noise Agenda in the U.K.* The UK Environmental Foresight Project. Volume 3. London, 1993

January 6, 1998

Low Noise Heavy Traffic Program

Category: Comprehensive Program

Location: Heidelberg, Germany. Also Bad Reichenhall, Germany and London.

Objective: To reduce annoyance caused by excessive truck noise, to diminish resident noise complaints, to improve the image of public and private users of low-noise vehicles, to encourage the production of low noise vehicles, to promote the purchase of low noise trucks which exceed legal requirements, and to increase noise protection for drivers.

Description: In Heidelberg, a four year pilot project consisting of: a financing scheme for the purchase of low-noise vehicles combined with special access regulations to benefit users of private low-noise vehicles; municipal low-noise vehicle purchase; and education.

Date: Began September 1994. In Bad Reichenhall, Germany, since 1954.

Impetus: Noise emissions are not homogenous between different vehicle types. Trucks are the noisiest, the difference between passenger cars and trucks averaging 12 dB(A) or more than twice as noisy. In Heidelberg, in the early 1990s, low noise trucks were purchased very rarely. Of 100 to 150 trucks registered annually in Heidelberg, in 1996, about 60% were available as low-noise models. However, only a few were in use.

Responsible Agency: City of Heidelberg, Department for Environmental Protection, with the German Federal Environmental Protection Agency, and the Institute for Future Studies and Technology Assessment. In London, the Greater London Council and now, individual boroughs.

Implementation: The City, in cooperation with the Environmental Protection Agency of the State of Baden-Wurttemberg, provides a subsidy of up to 50% of the extra costs incurred for the purchase of a noise reduction package for privately-owned and operated trucks, not to exceed a maximum of 4500 DM.

The municipality first bought low-noise garbage trucks, regular trucks and sweeping machines in 1987. A bus transport provider also made the change to low-noise vehicle types over the past several years. Also municipal contracting procedures were amended so that low-noise vehicles can be included in specs.

Vehicles can bear a sign indicating "Low Noise Lorry" which is intended to make the low-noise vehicle a positive concept.

Low-noise trucks are granted special access privileges between the hours of 23:00 to 07:00 to the following zones: mixed residential commercial areas where truck traffic disturbs residents, sensitive areas like hospitals, schools, seniors homes etc., and roads with traffic restrictions for legal or town planning reasons.

Noise protection zones were established in phases. Zones established in 2 central areas in 1991; expanded to all 10 central areas in 1994, and to all areas with speed limits of 30km/h by 1996 planned.

Public education campaign implemented with truck owners consisting of lectures, display of low-noise trucks etc. and with residents of noise protection zones.

In Bad Reichenhall, low-noise trucks are exempted from a 1954 ban on heavy vehicles in certain areas of the town. Noisy trucks may be granted short-term permits to enter the zone in return for payment of a fee.

In London, a night time and weekend ban on heavy goods vehicles was implemented in some boroughs in the early 80s. The ban operates from 2100 hrs to 0700 hrs each night and from 1300 hours on Saturdays. Trucks which are exempt, either because they meet stringent noise criteria or carry

essential goods, must carry an Exemption Plate and a permit on the window.

Costs: Preliminary budget for four year Heidelberg project DM 120,000.00. Will help to reduce future expenses for passive noise protection measures such as barriers and window upgrading.

Results: Today more than 30% of Heidelberg municipal fleet is low-noise type. Noise reduction of 30% already achieved in noise protection zones. Out of 87 buses, 79 are equipped with special noise protection. By 1998, all remaining buses to be replaced by low-noise models. The economic benefit of exemption from traffic restriction helps to offset the extra costs of low-noise vehicles. Found the public relations and educational aspect of the project crucial for successful implementation of the plan.

Problems: Difficult to monitor and enforce traffic restriction regulations.

Source: Centre for Exploitation of Science and Technology. *The Future Road Transport Noise Agenda in the U.K.* The UK Environmental Foresight Project. Volume 3. London, 1993.

OECD. *Fighting Noise in the 1990s.* 1991.

Wurzner, Eckart (1996) *The Heidelberg "Low-noise Heavy Traffic Programme,"* Euronet/ICLEI Consortium.

January 6, 1998

4.0 Current Practise in Canada

Canadian noise policy and standards are briefly described below followed by an overview of provincial and municipal policies based on the survey of current practise.

Canadian Policy

CMHC's general policy with respect to road noise is as follows:

> *Canada Mortgage and Housing Corporation wishes to draw attention to problems associated with noise from road and rail traffic; to support methods which seek to protect residential areas from the effects of such noise; to encourage the cooperation of all levels of government to develop ways of alleviating the problems associated with such noise; to discourage the construction of new residential development on sites which are exposed to high levels of noise; and to introduce sound insulation in residential development on sites subject to lower levels of noise (CMHC, 1977).*

In 1977, CMHC established noise standards in its "Road and Rail Noise" publication. These standards were *recommended* for all new development, and were *mandatory* for new social housing projects where CMHC provided direct financing or subsidies. Three types of zones were identified:

1. the upper zone, where outdoor noise levels exceed 75dB, is unsuitable for housing;
2. the intermediate zone, where the noise level is between 55 and 75 dB, is unsuitable for housing unless adequate sound insulation is provided; and
3. the lower zone, where the noise level is below 55 dB, housing construction which meets typical standards will provide adequate sound insulation.

In addition, CMHC set the following recommended maximum acceptable levels of road and rail traffic noise inside new dwellings as follows:

bedroom	35 dB
living, dining, recreation rooms	40 dB
kitchens, baths, halls, utility room	45 dB
outdoor recreation areas	55 dB

Since the federal government no longer funds new social housing projects, the guidelines are no longer mandatory in any situation, only recommended. There is no monitoring of the use of the guidelines in situations where it is advisory; it appears that some provinces

and municipalities use these or their own standards; some don't use them at all; and others implement them in some situations.

Provincial and Municipal Policy and Practise

Table 2 summarizes the findings of eleven interviews with representatives of provincial ministries of transportation, and/or environment, acoustical consultants, and municipal planners, engineers, and/or administrators on the subject of traffic noise planning and management within their jurisdiction. The findings are not necessarily representative of the national picture, and should be viewed as preliminary. They are a snapshot based on a selection of provinces with the largest cities, and a fairly random selection of municipalities within each province. Other municipalities are known to have adopted policies or programs which are not represented here. A list of persons interviewed is contained in Appendix A, and copy of the interview guide in Appendix B. A brief discussion of the findings follows.

In some respects, the responses reflect the question of jurisdiction. In most of the provinces included in this review, provincial transportation departments are responsible for provincial roads, usually highways. The provincial role in arterial street traffic noise management may be limited to land use planning standards or policies, which may be implemented at the municipal level. Municipalities generally have jurisdiction over land use and the arterial roads within their boundaries.

Issue

Most respondents felt that arterial street traffic noise is a problem in their province or municipality, but most felt it is not a growing problem, rather a stable one. British Columbia and Quebec were the two exceptions, where it was felt to be of growing concern among residents. In Quebec a recent survey identified traffic noise concerns as a major health issue for urban residents. The source of the problem is viewed as general purpose traffic, although several respondents focused on trucks and truck routes as the greatest noise source. Traffic noise is primarily a concern in the larger urban centres, in particular, areas near: truck routes, construction sites, or major roads.

Measurement

Quebec is the only province in this review to assume a role in measuring arterial street traffic noise. The province uses mapping tools to estimate noise levels on an ongoing basis. At the municipal level, Toronto, maintains an ongoing program of measurement of ambient noise levels (mostly traffic), while Calgary and Burnaby conduct noise tests on a complaint basis.

Policies - New or upgraded arterial roads

Two of the five provinces have policies or criteria in place to control the noise impacts of new or upgraded arterial roads on neighbouring land uses, where there is predicted to be a noticeable noise impact. At the municipal level most cities have similar policies, or implement provincial policies, or in the case of Burnaby, adopt an informal approach.

Such a policy usually requires the road developer to ensure that adjacent land uses are not exposed to an unacceptable noise level. This may be achieved a number of ways, through siting, design, or abatement measures paid for by the road authority.

Policies - Existing roads

Developers of new homes, apartments or condominiums or other sensitive uses adjacent to existing arterial streets may be required to ensure that noise levels outside or inside the building do not exceed certain specified standards as a condition of development approval. Ontario has developed noise assessment criteria for land use planning which are applied in these situations. Most municipalities attempt to control indoor or outdoor noise levels in new developments adjacent to a traffic noise source by requiring the developer to ensure municipal or provincial criteria or standards are met. This type of policy may or may not apply to all types of development, for example infill type redevelopment of single family lots. Again planning, design or mitigation measures may be required as a condition of approval and would be paid for by the developer. In Ontario, warning clauses may be used in some cases where noise exceeds limits.

Retrofit policies for existing roads in established areas are less common. These refer to situations where the traffic noise on an existing arterial road has grown to be a problem for residents over time, due to volume increases only. Abatement measures are then retrofitted. Once a certain, usually quite high, outdoor noise level has been reached, mitigation measures are deemed necessary. One province (Quebec) and two out of the five cities contacted for this review have either a formal policy (Calgary) or informal policy (Burnaby) to help alleviate the worst traffic noise problem areas. As this type of initiative takes place in established areas, where roads and dwellings are in place, the options for mitigation are limited. In single family areas, barriers are the frequent solution. In Quebec, a pilot project is underway to examine the most effective way of attenuating traffic noise for residents of multistory buildings.

Mitigation

Again the provincial role in mitigation of arterial street traffic noise is limited - only Quebec assumes shared responsibility in retrofitting with its municipalities. Two cities undertake some form of traffic noise abatement in connection with new road construction or upgrading, or retrofitting existing neighbourhoods: Calgary and Burnaby. Measures include noise barriers, earth berms, site planning, building orientation, increased setbacks or buffer areas, acoustical construction techniques, enhanced insulation and air conditioning.

Comments/ Issues/ Research Needs

Respondents made the following comments reflecting their experiences or opinions on urban traffic noise, and expressed these concerns and ideas for further research on the subject.

- truck and bus noise most annoying
- arterial street retrofitting a challenge
- difficult to abate noise for multistory buildings

- people need to conduct more research when home buying
- many house designs unsuitable for noise
- air conditioning a solution for indoor noise and a problem for outdoor noise
- need barrier performance/standards to ensure long life
- need examples/models of techniques used elsewhere
- must consider residents needs, lifestyles, cultural differences through participation
- need an integrated approach to environmental impacts: air pollution, noise pollution and energy conservation
- must consider impact of mitigation measures on housing affordability

Table 2 - Summary of Canadian Current Practise
Arterial Street Traffic Noise Planning and Management

Location	Issue	Measurement	Policies - new or upgraded road	Policies - existing roads	Mitigation	Concerns/Issues/Research Needs
Alberta	yes	no	no arterial policies	no arterial policies	no	many Alta municipalities with noise policies - Calgary, Red Deer, Edmonton, Canmore people need to do more research on property before buying unsuitable house designs health effects of traffic induced air pollution e.g. asthma, latex allergies
City of Calgary, Alta.	yes, on major arterial streets, fairly stable	yes, on complaint basis	Surface Transportation Noise Policy, 1988 City provides noise attenuation to achieve Design Noise Level -60 dB(A)	Surface Transportation Noise Policy, 1988 residential redev req. developer mitigation and/or design/insulation measures to meet design noise level Noise Barrier Retrofit Program - existing problem locations placed on candidate list, priorities and funding as available	yes, noise barriers, site planning techniques new dev requires design or insulation measures	trucks most annoying policy amended in 1996 to address truck noise peaking, rear deck use and short life span of developer built barriers on truck routes limited funding for retrofit program seasonal nature of complaints

Location	Issue	Measurement	Policies - new or upgraded road	Policies - existing roads	Mitigation	Concerns/Issues/Research Needs
British Columbia	yes, in Lower Mainland, growing concern in some areas	no	no arterial policies	no arterial policies	no	province responsible for highways only difficult and expensive to implement noise retrofit on arterial streets second story pose challenge for mitigation
City of Burnaby, B.C.	yes, in specific locations, part. truck and bus routes near construction sites	measure for specific complaints	no specific policy, but general approach, if noise is City generated i.e. road widening, City will take measures to ensure no noise increase, subject to public input	new dev require 40' setback on arterials in addition to normal front yard requirement and meet noise standards in specific problem areas, city considers retrofit	yes, barriers new projects, developer required to mitigate noise	truck noise hard to deal with because stacked
New Brunswick	not an issue	no	no arterial policies	no arterial policies	no	problem with noise standards not being implemented when devel occurring nr highway because fear increased costs drive developer out of city boundaries
City of Fredericton	only in one area of city	no	no arterial policies	no arterial policies	no	volume and speed more of issue than noise generally truck noise specific issue

Location	Issue	Measurement	Policies - new or upgraded roads	Policies - existing roads	Mitigation	Concerns/Issues/Research Needs
Ontario	yes, in major metro areas and traffic corridors highway noise a serious issue for 20 yrs	no	Prov noise assessment criteria apply	new development nr highways or arterials must meet provincial noise assessment criteria - 55 dB(A) outside, also indoor criteria no retrofit policy	when noise impact exceeds criteria, warning clauses and mitigation meas. may be nec. by developer	ever increasing traffic volume in GTA, more 6-7 lane arterials sub-standard barriers erected by developers now deteriorating in new subdivisions where air conditioning required to achieve suitable indoor noise levels, now outdoor noise from A/C a problem
City of Toronto	noise a growing concern, but not traffic noise, people don't complain, accept ambient level except for localized activities like construction	ongoing noise measurement program of representative land uses, began 1975, not just traffic but ambient is mostly traffic	Prov noise assessment criteria apply	new development must meet provincial noise assessment criteria no retrofitting policy	req'd by developer	traffic volumes seem to be the issue, not noise per se. more arterial noise policy in suburban areas of Metro Toronto
Quebec	yes, a major issue in most urbanized areas, growing in last 3-4 years recent Min of Health survey found noise a major environmental problem	yes, province uses mapping tools to measure noise level (in Db) by area high noise areas tested on ongoing basis	Interim Policy on Road Noise - for new or upgraded roads MTQ must put into place attenuation measures if the noise impact is significant	no policy for new development, regional responsibility Interim Policy on Road Noise - will retrofit existing roads where noise is greater than 65dB(A) on a case by case basis (if meet certain criteria and if will reduce noise by 7dB(A)	noise screens, buffer zones, vegetation, road surface materials, road layout, traffic patterns, insulation pilot project for multi-story bldgs mun/prov. funding	public participation important difficult to abate noise for multi-storey buildings but can't ignore looking at successful European models for noise mitigation focus on indoor noise levels due to cold climate sustainable development approach important - noise, energy conservation and indoor air quality

Location	Issue	Measurement	Policies - new or upgraded roads	Policies - existing roads	Mitigation	Concerns/Issues/Research Needs
Quebec City, Que	yes, identified as "significant urban problem" in surveys, studies particularly in some areas near busy arterials and autoroutes constant problem	no municipal noise measurements, province does	yes, roads must maintain a certain setback from res areas and/or install noise barriers (paid for by province) to achieve noise levels under 55 dB(A)	no retrofit policy	no municipal abatement, just MTQ	nd further research to identify how noise can be reduced trucks and buses are significant noise problem, possible strategy to restrict buses and trucks need to look to other cultures for strategies like Europe and Japan automobile here to stay, need to mitigate its impact

5.0 Conclusions and Recommendations

International Experience

Citizens in many countries view road traffic noise, including arterial road traffic noise, as an urban environmental issue with serious quality of life impacts. Consequently, there is a considerable amount of research, planning, management and implementation activity dedicated to reducing its effects on urban populations around the world, particularly in Europe, Japan, and Australia. This research barely scratches the surface to reveal some examples of the types of creative approaches used to plan and manage traffic noise around the world. There is a whole range of initiatives, from relatively inexpensive ideas like public information campaigns to costly measures like home insulation programs and barrier construction.

Clearly, successful noise reduction policy should not rely on any one of these 15 types of measures alone, but on a mix of all or several, depending on the local situation, policy goals, perceived noise trends, technical development and public pressure. According to the Centre for Exploitation of Science and Technology in Britain (1993), an integrated approach is often necessary but rarely conceived and implemented.

Some observations follow based on the information contained in the fifteen fact sheets.

- Local conditions are important in determining the nature and extent of the problem, as well as potential solutions.
- Differences in culture and priorities are evident in the nature and extent of programs and policies, and approaches taken in different countries.
- In the examples presented here, local governments are working with or supported by policies and/or funding from state and/or provincial and/or national levels of government. Although the nature of the problem varies from city to city, the solution is not viewed solely as a local responsibility.
- Most European countries have a basic set of non-vehicle based programs or policies beginning with immission limits and land use planning provisions.
- Highways get the bulk of the noise mitigation attention, major arterials, less so; but the latter are definitely the subject of policy and action.
- There is typically a distinction made between policies affecting new or upgraded roads and those for existing roads. The latter may not be protected at all by noise policy, or they are subject to higher noise limits.
- In terms of economic measures, taxes and charges are not as well used as incentive measures and the "polluter pays" principle is the generally accepted approach.
- Funding sources are often higher levels of government. Only the Netherlands appears to have a dedicated source of noise abatement funds with its fuel tax.
- Problems encountered in implementing the measures vary: regulations can be confounded by lack of enforcement; technical problems arise; measures are costly;

and staff and others expected to implement measures may be uneducated about traffic noise.

- In some jurisdictions, most notably Japan, all the impacts of traffic are considered together, for example, air pollution, noise pollution and barrier effects. Programs and policies are designed to address all.

How relevant are these international examples for Canada? In those jurisdictions where traffic noise is identified as an issue, there is clearly scope for lessons to be learned from international experience. To the extent that the public and professionals view traffic noise as inevitable, and assume that nothing can be done about it, the examples here should prove otherwise. At the very least, Canadian planners, engineers, politicians and community leaders should be aware of the existence of these options for addressing a serious urban quality of life issue.

Canadian Experience

Canadians generally appear to be concerned with urban traffic noise although the issue receives less attention by provincial and municipal policymakers than elsewhere. Local differences are evident. In some jurisdictions, arterial street traffic noise is viewed as a serious issue, and/or of growing concern, and in others, not at all. And there is considerable variation in the scope of provincial and municipal roles in Canada, from virtually no role to quite sophisticated policies and programs. In Alberta, the municipality of Calgary, and in Quebec, the province, have developed policies and programs to address the worst traffic noise situations, and to prevent new construction or upgraded roads from worsening the situation. Ontario has a strong land use planning approach and Burnaby, BC generally tries to ameliorate the worst situations and prevent new roads and upgrading projects from worsening the noise environment. In terms of measures employed, the most common are land use planning and the construction of noise barriers. Overall, the province of Quebec appears to be the most active at the current time. There the Ministry of Transportation has recently developed an interim road noise policy, is undertaking a pilot project to protect a multi-family neighbourhood, and has conducted research on the subject.

Recommendations

The following recommendations for further research are made based on this investigation of international experience and comments from key informants. It is a preliminary list as there has been no discussion in the literature of the need for further Canadian research, planning and/or policy making in this area.

1. Research should examine existing residential development (and other sensitive land uses) located on or near arterial streets to determine resident satisfaction with respect to traffic noise and/or all noise concerns. This could be accomplished through a review of resident satisfaction literature or case studies or both. Social housing

projects and market housing should be examined, as should single storey and multi-storey buildings, where possible. Projects with noise attenuation features should be included to determine their efficacy.

2. Consider further basic information gathering. There is no noise exposure data for Canada. Computer programs now exist which estimate traffic noise based on several variables; these might successfully be used for this purpose. A revised edition of CMHC *Road and Rail Noise* could usefully contain some basic data.

3. The extent and nature of the arterial street traffic noise issue in Canadian municipalities is unknown, as is the extent to which they have developed municipal noise policies and their experiences with them. Only a limited survey of five municipalities is reported on here. Other cities are known to have adopted policies, and possibly other provinces. A comprehensive survey of Canada's largest municipalities is recommended.

4. There is no responsibility for monitoring provincial and municipal adherence to the CMHC *Road and Rail Noise* guidelines. Neither CMHC nor the National Research Council are charged with this task, and there is no available information on the subject. Municipalities and provinces could be surveyed regarding their use of the guidelines. This could be a component of item 3 above.

5. As CMHC is no longer providing direct social housing financing or subsidies for new projects, the *Road and Rail Noise* guidelines are not mandatory anywhere. Given CMHC's stated policy towards residential noise it would seem reasonable to expect a continued interest in the application of the guidelines. It is recommended that CMHC re-consider the advisory status of the guidelines. A panel of urban planners and politicians, housing officials and acoustic specialists could be convened to assist in these deliberations.

6. Expand CMHC's role in promoting awareness of residential noise issues. Consider an information dissemination and educational role for CMHC in producing or assisting in the preparation and distribution of a design guide for residential construction (and renovation) promoting noise sensitive design and construction. The audience should be cast as widely as possible to include the general public as well as building professionals. A "sustainable house guide" could be produced describing design and construction techniques which would enable individuals to protect their homes from urban noise and improve energy efficiency and indoor air quality.

7. Consider instituting a research project to describe various transportation demand management (TDM) measures in use and examine the utility and impacts of these measures on quality of life in urban residential areas.

8. Transmit this report to the Transportation Association of Canada, the National Research Council, Federation of Canadian Municipalities, Canadian Institute of

Planners, provincial ministries of housing, environment, planning and transportation, the Canadian Acoustical Association and the Institute of Transportation Engineers.

Bibliography

International Experience

Alberta Transportation (1977) *Alberta Surface Transportation Noise and Attenuation Study, A State of the Art Literature Review.*

Australian Environment Council (1988) *Strategies for the Control of Road Traffic Noise Using Non-Vehicle Based Methods.*

Beckert, Christian (1997) "Noise maps for cities and towns of Saxony-Anhalt", Paper presented at *Conference on European Union Future Noise Policy,* May 21/22, 1997.

Bein, Peter, Todd Litman and Chris Johnson (1994) *Units Costs of Environmental Impacts Report,* (DRAFT) BC Ministry of Transportation and Highways, Planning Services Branch, November 1994.

Bendtsen, Hans (1992) "Noise and Traffic Planning in Towns the Danish Example," *Eurosymposium: The Mitigation of Traffic Noise in Urban Areas*, Nantes, France 12 - 15 May 1992.

Bowlby, William and Thomas O'Grady, R. Clay Patton and Lloyd A. Herman (1991) *Comprehensive System-Level Noise Reduction Strategies*, Olympia: Washington State Department of Transportation.

Centre for Exploitation of Science and Technology (CEST) (1993) *The Future Road Transport Noise Agenda in the U.K.*, The UK Environmental Foresight Project, Vol 3. London:CEST.

City of Vancouver (1997) *City Noise*, Report of the Urban Noise Task Force, Vancouver.

Danish Environmental Protection Agency (1997) *Danish Experience in Monitoring Noise Exposure, and Necessary Steps Towards Procuring Data for a Uniform European Mapping of Environmental Noise,* Copenhagen: Danish Environmental Protection Agency.

European Commission (1997) *Green Paper on Future Noise Policy,* European Commission Green Paper, Brussels: European Commission.

European Commission n.d. *Towards Fair and Efficient Pricing in Transport,* European Commission Green Paper, Brussels: European Commission.

Grondahl, Olaf (1997) *The Berlin Traffic Noise Inventory.* Berlin.

Health Council of the Netherlands (1994) *Noise and Health.*

Kamerud, Dana B and Calvin R. von Busesk (1985) "The Effects of Traffic Sound and its Reduction on House Prices" *Transportation Research Record,* 1033.

Organization for Economic Cooperation and Development (1995) *Roadside Noise Abatement*, Paris: OECD.

OECD (1991) *Fighting Noise in the 1990s,* Paris: OECD.

OECD (1988) *Exchange of Information on Noise Abatement Policies : Case Study on the Netherlands,* Paris: OECD.

OECD (1980) *Conference on Noise Abatement Policies 7 - 9 May*, 1980, Paris: OECD.

Mage, David and Olivier Zali (eds) (1992) *Motor Vehicle Air Pollution: Public Health Impact and Control Measures,* Geneva: World Health Organization.

McLachlin, Stuart and Stephen Samuels (1988*) Road Traffic Noise Control into the Nineties,* Australian Acoustical Society 1988 Conference.

Nielsen, G. and S. Solberg (1988) "Costs and Effects of Traffic Noise Abatement Measures: Basis for a National Programme," *Applied Acoustics*, Vol 25, pp. 149-168.

Nishiokia, Shuzo (1989) "Traffic Pollution: Control Policy and Research Trend" *Transportation Research*, Vol 23A, No. 1, pp. 73-81.

NSW Roads and Traffic Authority (1992) *Road Traffic Noise Interim Policy and Guidelines*, Sydney, NSW: RTA.

Pendakur, V. Setty and Bonita Pyplacz (1984) "Urban Traffic Noise Abatement" *Transportation Quarterly*, Vol 38, No 3, pp.471- 486.

Price, A.J. (1972) Community Noise Survey of Greater Vancouver, *The Journal of the Acoustical Society of America*, Vol 52, No. 2, pp. 488-492.

Sandberg, Ulf (1992) "Low Noise Road Surfaces A State of the Art Review", *Eurosymposium: The Mitigation of Traffic Noise in Urban Areas*, Nantes, France 12 - 15 May 1992.

Schreiber, Ludwig (1992) "Mitigation of Traffic Noise by Urban Planning and Building Design," *Eurosymposium: The Mitigation of Traffic Noise in Urban Areas*, Nantes, France 12 - 15 May 1992.

State Pollution Control Commission et al. (1991) *Reducing Traffic Noise A Guide for Homeowners, Designers and Builders*, Surrey Hills, NSW: Roads and Traffic Authority.

Suter, Alice H. (1991) *Noise and its Effects*, Administrative Conference of the United States.

Van den Berg, Martin (1997) *Conclusions of the Conference on EU Future Noise Policy.* May 21-22, 1997.

Wurzner, Eckart (1996) *The Heidelberg "Low-noise Heavy Traffic Programme,"* Euronet/ICLEI Consortium.

Canadian Practise

Andre, P., Gagne, J.P. (1997) Attenuation du bruit routier en milieu residential dense. Revue et analyse de la litterature (rapport final), (Noise Attenuation in Dense Residential Areas: Review and Analysis of the Literature, Final Report), Rapport de recherche produit pour le compte du ministere des Transport du Quebec.

BC Ministry of Transportation and Highways, *Revised Policy for Mitigating the Effects of Traffic Noise from Freeways and Expressways*, November 1993.

Canada Mortgage and Housing Corporation (1981) *Road and Rail Noise: Effects on Housing*, Ottawa: CMHC.

City of Calgary, *Surface Transportation Noise Policy for the City of Calgary*, Transportation Department, April 1988.

City of Calgary, *Noise Issues Relating to Designated Truck Routes - Supplementary Report*, October 1996.

New Brunswick. Department of Transportation, *Highway Noise Policy and Highway Noise Mitigation Guidelines*, revised March 1995.

Ontario. Ministry of the Environment and Energy. *Noise Assessment Criteria in Land Use Planning,* Publication LU 131, revised October 1997.

Ontario. Ministry of the Environment and Energy. *Noise Assessment Criteria in land Use Planning: Requirements, Procedures and Implementation,* September, 1996.

Province of Quebec. *Combattre le Bruit: Techniques d'amenagement et intervention municipales*, (Fighting Against Traffic Noise: Management Techniques and Municipal Interventions), Sainte-Foy: Les Publications du Quebec, 1996.

Quebec Ministry of Transport, *Politique sur le Bruit Routier, version provisoire,* (Policy on Road Noise, Draft) January 1997.

Appendix A - List of Persons Interviewed

Chris Andrews, City of Toronto, City Works Services

Chris Blaney, Ministry of Transportation and Communication, Ontario

M. Jean-Michel Boisvert, Ministère de Transports Quebec

Jay Cunningham, Department of Transportation, New Brunswick

Greg Czernick, Ministry of Transportation and Highways, B.C.

Bob Glover, Transportation Planner, City of Burnaby

Krajewski, C.A., Engineering Specialist - Acoustics, Ontario Ministry of the Environment.

Richard Patching, Patching Associates Acoustical Consultants, Calgary

Mme. Jacqueline Prudhomme, Directrice du Service de L'urbanisme, Ville de Quebec

Paul Stapleton, City of Fredricton, City Administrator

Bruce Swanson, Transportation Planning Department, City of Calgary

Appendix B - Interview Guide

Planning for Residential Quality of Life in the face of Increasing Traffic Noise

A CMHC External Research Project by Margaret Eberle

Today, urban growth management strategies are advocating increased residential densities in existing areas, frequently concentrated at main streets or along arterials. The question is, can the quality of residential life be maintained in housing built in close proximity to one of the major sources of urban noise? The purpose of this research project is to investigate an emerging planning and housing issue, namely urban traffic noise, and to identify approaches used elsewhere for minimizing its impact on residents of both new and existing housing. The study will examine current research on the impacts of traffic noise along arterial streets; investigate and describe non-vehicle-based noise management measures used by other jurisdictions, specifically Europe, Australia and the U.S.; and obtain a sample of current practise in Canada.

Interview questions

The following are a series of questions you will be asked to answer as part of this research study. The purpose of these questions is to assess the state of current practise in Canada with respect to arterial street traffic noise management.

1. In your opinion, is urban traffic noise an issue in your province/municipality? If so, where? If so, is there a particularly annoying source of traffic noise?

2. Have residents living along arterial streets identified traffic noise as an issue in your jurisdiction? If yes, please describe. If yes, in the last 10 yrs, would you describe it as a growing concern/ no change/less of a concern?

3. Has your province/city ever measured traffic noise in urban locations? If yes, who was responsible and when did this occur? If yes, does your province/city measure urban traffic noise on an ongoing basis?

4. Does your province/city have policies addressing the effects of traffic noise on people living and working along arterial streets? If yes, please describe. If yes, are they implemented or enforced?

5. Does your province/city undertake urban arterial traffic noise mitigation or abatement:
   - when building new arterial roads or upgrading existing roads?
   - on existing roads where noise is a growing annoyance?

   If yes, please describe (criteria/type/who pays).

6. Are there any specific issues related to arterial street traffic noise that are of concern to you? Areas where further research required?

7. May we have copies of pertinent arterial street noise policies or program descriptions?