Noise Pollution

STUDY REPORT

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Central Mortgage and Housing Corporation

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I wish to submit herewith a report concerning the trends and problems related to noise pollution in the residential environment. The terms of reference for this report are as follows:-

1. Review the effect of noise on the environment and its recognition as a pollutant.
2. Determine the areas of concern.
3. Develop a rational for investigation and study where it is shown to be necessary.

The report is purported to be a reasonable reflection of present knowledge of the subject provided by the sources listed in the bibliography. Further detailed research with the aid of experts in various aspects of the problem can be expected to modify and refine our understanding of this pollutant.

It is hoped the recommendations contained herein will provide a framework for defining subsequent program priorities with respect to the Corporation's concern to preserve and improve the quality of the residential environment.

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The clear theme which emerges from this study is the need for involvement by all levels of government and the creation of public awareness of the noise problem. A simple corrective policy by one agency will lead to waste of available resources, inequality of standards and distortion of the solution. For example, a uniform noise abatement standard for vehicular traffic will greatly reduce the need and cost of installing acoustic insulation in nearby buildings.

The responsibility of the Corporation with regard to noise pollution is largely one of initiation and direction of the research for the noise problem solutions as they affect residential communities. At the Federal level this will involve close cooperation with the new Department for the Environment, the Ministry of Transport, Department of Industry and Commerce, the National Research Council and the National Health and Welfare Department.

The immediate specific interest of the Corporation is the improvement on a more factual basis the standards contained in the Site Planning Handbook and the improvement of the livability of the individual dwelling unit by revisions to the sound control requirements of the National Building Code.

NOISE POLLUTION

Of the many pollutants which are deteriorating the quality of urban life, noise is now recognized as an important problem. The annoyance caused by noise is also one of the most elusive to assess since there are no material substances to find, measure and remove.

Noise is caused by the release of energy in the form of vibration which impinges on the human senses via our hearing facilities. An example of the complexity of noise is experienced at a musical concert given by an orchestra, although in this case it is usually regarded as pleasurable. One of the latest corrective treatments has been to try to have the energy producing noise converted to heat instead of sound. Loud noise can be produced by a relatively small amount of energy.

The most common noise yardstick is the decibel (db) scale. The scale begins at zero db which is the weakest sound that can be picked up by the healthy human ear. There is general agreement that high pitched tones are more annoying and therefore should be given more weight than low tones. A weighted decibel "A" scale has been devised to represent the sound effect on people, written dbA. A comparative measure of noise loudness from various sources to which people may be exposed is noted in Appendix A.

At extremely high levels and for long periods of exposure noise may produce deafness but it is difficult to show a measurable effect on

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people exposed to the kind of noise which exists in towns at present.

On the basis of the investigations of the comparable rate of deafness between humans in developed and undeveloped countries some scientists have predicted mass deafness in affluent civilizations within 30 years unless the anti-noise laws are enacted which have power to regulate and control the pollutant.

The definition of the effect of noise on the human being at the present time is similar to the smoking hazards suspected by some members of the medical profession back in the 1920's. It was not until recent years that medical science established an undisputable link between smoking and health. The same time lag applies to noise. Noise damage to health is suspected but the nature of the damage is yet to be discovered.

Noise is intensifying as people concentrate in large urban centres. The products of technology which have freed us from problems of day-to-day manual chores and survival have been accompanied by noise as the price of progress. Increasing noise levels have been tolerated until only the most blatant violations have been recognized. The answer lies in establishing standards of environmental quality and a willingness to require the application of our technology.

NOISE SOURCE LOCATION

Transportation Noises

Airport The human environment has always had noise as the result of natural phenomena. The range of noises from rustling leaves to electrical storm thunderclaps is extensive and we can safely assume that the health and quality of environment remain relatively unaffected. A jetliner making a landing from 50 feet overhead produces a noise similar to a thunderclap but when it occurred frequently at civilian airports in various countries, the surrounding communities made strong public protests for the first time with regard to excessive noise. Subsequently, research to measure and regulate aircraft noise around airports was initiated.

If the latest aircraft developments SST and STOL proceed as intended the high noise levels at airports will be felt along fly-over routes. In the case of the SST a sonic boom may be felt as a continuous explosion over a belt up to 50 miles wide.

Large jetliners have only been in existence since early 1960 so that the study of noise pollution of the environment is in its infancy. The greatest progress has been made in the field of recording the extent of community complaint reaction to a combination of factors such as loudness, frequency of occurrence and time of day. When the details of air transportation are known at an airport, the type of community reaction may be predicted depending on its distance from the noise source.

The most promising solutions to the aircraft noise problem will come from a combination of actions in the areas of:-

- New or modified engine and airframe design.
- Special flight operation and procedures.
- Encouragement of alternative forms of less noisy forms of transportation.
- Planned land use around airports compatible with high aircraft noise levels.

Highway Although the noise levels are exceptionally high at airports and public reaction in recent years has been vigorous vehicular traffic on highways is the predominant source of noise annoyance in the city. Highways, collector roads and service streets penetrate every part of the residential community.

The generation and intensity of traffic noise is dependent upon:-

- the kind, time of day, number and speed of vehicles,
- the types of road surface,
- the design of the highway system.

The descending order of noise annoyance with respect to vehicles is trucks, buses, motorcycles, sports cars and passenger automobiles. A single truck travelling at 50 m.p.h. produces a noise level of 78 dbA at 100'. The noise sources of an individual vehicle are complex and can originate from the exhaust system, the engine, the transmission, brakes, horn, tires, loose chains, pins and cargo.

Truck transportation has increased with the decline of some forms of railway service. Expressway truck traffic is heavy during the night when other background noise levels are low and therefore appears louder.

To control traffic noise the following measures must be considered:-

- Reduction of the noise radiated by individual vehicles.
- Improvement of road surface design.
- Location of expressways and arteries to avoid residential communities and use of protective shielding.
- Traffic flow design and speed regulations to minimize acceleration, deceleration and braking at intersections.
- Planned compatible land use adjacent to highways and roads.

Railway The noise levels due to individual trains can be high, in the order of 85 dbA at 100 feet. These noise levels from railways have aroused comparatively few complaints. This may be due to the fact that the railway is probably the oldest established noise source. People have generally grown up with the noise and move to houses where they will hear trains. With the latest development of jet and turbine engine trains which will travel at greatly increased speeds, it is predictable that the additional noise will cause public reactions similar to those at airports.

In recent years the operation of the traditional railway system

has been uneconomic in certain areas and has lead to the curtailment of railway services. Passenger services are being eliminated. Truck transports have taken over some sectors of the railway freight operation. Marshalling yards on costly downtown properties are being transferred to less expensive land in the suburbs.

Many of the controls for highway noise apply to railways, i.e.,

- reduction of noise at the source,
- design of the railway track system to avoid residential communities and provide protective shielding where possible,
- planned compatible land use adjacent to railways.

Standards of acceptable railway noise for residential areas have not been explored thoroughly in the past and with the evolution of mass urban transit, the study of railway noise and its solution must be initiated soon in order to establish noise standards as part of the design criteria for the new systems.

Urban Noises

Although noise from transportation has been shown to be the major source of noise pollution, about 20 per cent may be attributed to other sources in the community. Little effort has been devoted to this area of study but it can make a significant addition to the increasing urban background noise. The problem of identifying the annoyance contribution of these sources is complicated by the fact

that as the background noise increases the degree of annoyance from a given individual noise source decreases.

Construction Building construction and demolition, road building and repair, installation of underground services and utilities are increasing at a phenomenal rate due to the urbanization of populations of the developed countries. The inconvenience these activities cause is largely unavoidable but the range of noise producing equipment is extensive, pneumatic drills, compressors, bulldozers, excavators, concrete mixers, pile drivers, jack hammers, rivetors, chain saws, cranes, conveyors, and dump trucks.

Corrective action is as follows:

- Anti-noise treatment of the equipment.
- Strict enforcement of the time of day when these operations can be performed.

Factory The pitch, duration, intermittency or impulsive characteristics of factory noise have often reduced the desirability of property ownership in the surrounding community. Each factory or industry has individual characteristics such as cooling and ventilation towers, stockpiling and fabrication which have to be examined on a specialized basis.

Service and Maintenance There are presently numerous pieces of city servicing and maintenance equipment which are sources of high noise levels. These levels may be of short duration at any one location but nevertheless contribute continuously to the total background

noise pollution. They may be listed as follows - garbage trucks, fuel trucks, street cleaning vehicles, snow plows and blowers.

There has been considerable development of equipment noted for its silent operation and it is possible to reduce these noise sources within acceptable limits.

Commercial and Residential There has been an increase in noise associated with healthy commercialism. Canned music blares at shopping centres and amusement parks. Power lawn mowers and motor boats represent action and affluence. The noise emanating from school playgrounds and sporting events can destroy the quiet of a pleasant neighbourhood. The racket of individual air conditioners in the summer ruins the amenity of private yards.

Noise abatement for these kinds of problems rests on a variety of approaches -

- effective local anti-noise ordinances,
- greater respect for the comfort and well being of neighbours,
- sound level controls to ensure efficient muffling of power equipment.

Noise Within Buildings

The noise annoyance within buildings has grown imperceptibly over the years. This has been due to the rising noise levels from within the building and the change from massive load bearing construction technique to modern lightweight structures.

The public attitude to noise made inside buildings varies. At

places of work the chief concerns have been loss of hearing due to high noise levels or loss of production efficiency due to noise interference with work concentration. Within multiple residential buildings the greatest noise annoyance is the invasion of privacy from adjoining dwelling units. The lack of freedom to make noise without upsetting the neighbours is also an important source of irritation or annoyance.

Buildings for specialized use such as the arts, institutions and industry receive specialized professional services which take account of a client's satisfaction with regard to the total building performance. In residential buildings consisting of many dwelling units the user client's requirements are varied and numerous. The resident of a dwelling unit has recently been able to assemble in his unit many pieces of equipment which produce airborne noise many times greater than originally contemplated by the building designers, which contribute to the increased noise level within the building. The noise racket in an American kitchen rises as high as 90 dbA.

Individual household noise sources		dbA at normal hearing distances
Laundry	- washing machine	
	- drying machines	
Kitchen	- dishwashers	68
	- mechanical mixers	87
	- refrigerators	45
	- knife sharpeners	80
Servicing	- vacuum cleaners	
	- air conditioners	
	- humidifiers	
	- exhaust fans	
	- power tools	

Servicing (cont'd)	- sewing machines - electric shavers	88 + 92
Recreation	- hi-fi - stereo - transistor radio - television - musical instruments	

Apart from airborne noise there is another classification, impact noise which results from falling objects, walking and play, etc. Some cognizance of this problem is shown by the popularity of wall to wall carpeting in both the private and public areas in the new apartment buildings using modern light concrete slab construction systems.

The control of noise pollution in buildings will depend upon the following:-

1. Noise abatement standards for all household equipment.
2. Noise abatement standards for common building servicing equipment -

   heating

   ventilation

   incineration

   elevators

   plumbing
3. Definition of an average normal noise level considered acceptable for the individual dwelling unit and particular use areas within the unit.
4. Revised noise resistance standards for the building divisions between units to allow preservation of the average noise level within the unit.

Independent research studies have already been undertaken to determine some of the standards required above. For example, a report "The Auditory Environment in the Home" prepared by the Environmental design department of the University of Wisconsin recommends a noise level of 75 dbA which should not be exceeded by kitchen appliances.

STUDY RECOMMENDATIONS

1. Aircraft Noise

The Corporation has restrictions on the financing of housing adjacent to airports in accordance with the requirements of the Site Planning Handbook (Appendix B). These requirements have been shown to be no longer relevant as a result of the recent CMHC study "New Housing and Airport Noise". Interior and exterior minimum aircraft noise standards have been recommended along with acoustic protection requirements for the exterior building envelope where required in new residential construction.

i) Extend the study "New Housing and Airport" to include existing housing.

ii) Prepare a study "The Effect of SST and STOL aircraft on Canadian Residential Urban Centres".

2. Vehicular Traffic Noise

The Corporation Site Planning Handbook has lending restrictions for residential development adjacent to highways and roads (Appendix C). These requirements require to be revised to take account of noise and its annoyance.

The building set back requirements from highways and roads were derived from past practise which was primarily concerned with future road widening.

A traffic annoyance rating system, called the Traffic Noise Index (TNI) similar to CNR for aircraft noise has been recently

developed by the Building Research Station 1968. There is every reason to believe that there is a high attainable accuracy of prediction.

i) Review traffic annoyance rating systems.

ii) Prepare a study "New Housing and Vehicular Traffic Noise" with the following terms of reference for inclusion in the Site Planning Handbook:-

- Establish acceptable traffic noise levels for the exterior and interior of a dwelling.
- Prepare advice with respect to acoustic design for traffic noise protection.

3. Train Noise

The requirements of the Corporation Site Planning Handbook (Appendix D) with regard to residential development have little scientific basis from the point of view of noise considerations. There is a wide divergence of acceptability between the opinions for building setbacks held by acoustic specialists and those used in practise. The Corporation requires a 90' minimum setback for a building less than four storeys from the railway right-of-way. Under the same circumstances Dr. Thiessen and Dr. Emblems of the National Research Council have recommended that for over one mile on either side of the railroad tracks is unsuitable for a "quiet residential area in an urban community".

The development of mass transportation systems would appear to be about to supersede many of the existing railway facilities.

Recent developments are the Turbo Service from Montreal to Toronto and the GO Service for commuters.

i) Determine the future characteristics of railway traffic and its development, i.e., Commuter services - GO trains - Inter-city service - Turbo trains.

ii) Review the noise potential from the existing railway system and these new developments.

iii) Devise revised setback distances for residential areas appropriate to each form of rail transportation based on noise annoyance data for inclusion in the Site Planning Handbook.

4. Exterior Residential Background Noise

As standards are established for all the different types of noise annoyance it becomes necessary to monitor the total accumulation of city noise known as background noise. The establishment of a limit on background noise would provide a standard within which all other standards from individual sources would require to conform and also provide a strong basis for local anti-noise ordinances.

Several attempts have been made to arrive at a common noise measurement for the total environment. (Appendix E). A study of this subject is required to devise a solution suited to the Canadian Urban Environment. The specific terms of reference which would be of interest to the Corporation are as follows:

i) Investigate the characteristics of urban background noise.

ii) Define the exterior acceptable background noise levels for urban, semi-urban and suburban residential areas for inclusion in the Site Planning Handbook.

5. Indoor Noise

Standards of acoustic insulation for walls, floors and ceilings are contained in the National Building Code (Appendix F). The standards are concerned with airborne noise. There is no guidance with respect to impact noise.

The FHA of America has minimum property standards for multi-family housing containing both airborne and impact sound criteria which were patterned after some of the European codes. While the criteria for airborne sound insulation are mandatory, those for impact sound insulation are merely recommended.

The terms of reference for a study entitled "Noise Control Within New Residential Buildings" are as follows:

i) Review existing codes and legislation with respect to noise control in buildings.

ii) Investigate noise sources with airborne and impact characteristics within the individual dwelling unit and establish average acceptable noise level standards.

iii) Establish new minimum standards for airborne and impact noise resistance for inclusion in the National Building Code.

iv) Recommend good design practise to alleviate noise problems within the dwelling unit and between units.

APPENDIX A

Comparison of sample noises at distances at which people are commonly exposed.

Noise Source	dbA Scale
Rustling leaves	20
Window air conditioner	55
Conversational speech	60
Private car	70
Heavy city traffic	80-90
Snowmobiles (at 15' distance)	90
Home lawn mower	98
Construction compressor 150 cu. ft.	100
Outboard motor	102
Motorcycle	110
Jet plane (500' overhead)	115
Rock music (high)	130
Special Values	
Beginning of hearing damage (if prolonged)	85
Human feeling threshold (hearing sensation replaced by one of feeling)	120
Human pain threshold (feeling sensation replaced by pain)	130-140
Laboratory rats died (prolonged exposure)	150
Saturn V moon rocket at launching pad	180

The scale increase is logarithmic. Apparent minor differences of one or two decibels may represent an enormous jump in noise intensity; 53 dbA for example is equivalent to double the sound pressure at 50 dbA.

APPENDIX B

Section E
CMHC Site Planning Handbook 1971
Housing Adjacent to Airports

Because of the detrimental effect of noise and vibrations in the vicinity of major airports, certain lending restrictions are imposed depending on the type of air traffic using the airport.

Restrictions on the location of housing adjacent to runways shall be as follows:

a) Airplane Runways Other Than For Jets - A zone 5,000 feet in length from both ends of the runway and laterally 1,000 feet on each side of the centre line of the runway or its projection, shall be denied financing under the National Housing Act.

b) Jet Runways - Research is being undertaken in many countries into the effects of jet aircraft noise. In Canada, the Federal Ministry of Transport has identified zones around airports, based upon noise ratings, within which it makes recommendations of appropriate land uses. Because the delineation of the noise zones depends upon the type, number and direction of aircraft movements, the area they encompass varies from airport to airport and from runway to runway.

   The advice of the local Corporation office shall be sought on the eligibility for assistance under the National Housing Act for any proposal for the development of land which is subject to the noise generated by jet aircraft arriving or leaving airports.

   Restrictions on the financing of housing will be made:

   (i) within a zone four miles in length measured from the end of the runway from which roll starts and laterally 2,000 feet on each side of the centre line of the runway and its projection, or

   (ii) in those zones where noise will seriously affect residential development. This restriction will apply to those airports where the recommendations of the Ministry of Transport have been adopted by the Corporation.

Section E
CMHC Site Planning Handbook 1971
Housing Adjacent to Roads

Not all types of roads are compatible with residential development. For the purpose of establishing the suitability of housing development adjacent to roads the general classification of roads given in Section C has been adopted.

The requirements for the distance of housing and the treatment of the site relative to various classes of roads are listed below. The Corporation may reduce these distances for housing adjacent to Class I and Class II roads where measures to improve soundproofing have been taken.

a) Class I and Class II Roads: Expressways and Major Highways

No access to individual housing shall be accepted. The minimum distance from the road allowance to the residential buildings shall be 90 feet. Where a road allowance varies over a short distance, the average distance to the wall of a residential building shall govern.

Where there is a high volume of traffic or traffic noise additional protective measures shall be provided in the form of screening or an increased set-back to a maximum of 150 feet. Where service roads are provided, the set-back requirements shall be as required for Class III or IV roads, depending upon anticipated traffic volumes.

b) Class III Roads: Major Collector Streets

Individual access is normally allowed except where prohibited by the local municipality. Buildings shall be set back a minimum of 30 feet from the road allowance. In urban core areas the Corporation may reduce this requirement.

c) Class IV Roads: Local Collector Streets

Individual vehicular access is allowed. Buildings shall be set back a minimum of 12 feet from the road allowance. This set-back may be increased where, in the opinion of the Corporation, the function of the road may change in the near future. In no case shall the set-back requirement exceed 30 feet. Approved screening to the rear yard of corner lots shall be required where considered necessary by the Corporation.

d) Class V Roads: Local Residential Streets

Individual vehicular access is allowed. Buildings shall be set back appropriate to the character of the housing. Approved screening to the rear yard of corner lots shall be required where considered necessary by the Corporation.

APPENDIX D

CMHC Site Planning Handbook 1971
Housing Adjacent to Railways

All forms of housing shall be screened from an adjacent railway right-of-way by a fence, wall or berm designed to minimize noise and visual nuisance. The distance from the nearest wall of a residential building to the railway right-of-way shall be determined according to the type of the proposed residential structure and the quality of the proposed screening as set out in the following paragraphs. The Corporation may reduce these distances for housing adjacent to railways where measures to improve soundproofing have been taken.

Where a berm, grade separation or structure creates a sound shadow, housing may be located on any part of the site provided the residential building falls entirely within the sound shadow and normal yard requirements are met. For these purposes the sound shadow is assumed to originate at the centre line of the track at track elevation.

Where no sound shadow is created the minimum distance from the boundary of the railway right-of-way to the nearest wall of a residential building, less than 4 storeys in height shall be 90 feet. This required distance may be increased by the Corporation to a maximum distance of 200 feet where railway grades are sufficient to cause engine labour; where there are long trains at frequent intervals; or where structures of 4 storeys and over are proposed. The proximity of marshalling yards or other high intensity railway uses will require special consideration and advice must be sought from the local Corporation office concerning eligibility under the National Housing Act.

APPENDIX E

The British Ministry of Technology Aeronautical Research Council issued a paper in 1970 entitled "An Outline Guide to Criteria for the Limitation of Urban Noise" by D. W. Robinson, N.P.L.

It provides a summary of present noise rating methods with special reference to transportation. An attempt has been made to arrive at a "common measure, termed noise pollution level" which summarizes the character of a complex noise environment. Suggestions for noise limits are included.

Since the final product is based on various rating systems which, in themselves, are projected approximations, the results for an overall rating system will be that more approximate. It would appear more reasonable to obtain actual data in some form of city grid on a continuous basis to substantiate the proposals.

The London Noise Survey

A general noise survey was conducted on a 500 yard grid for the Central London Area, U.K. in 1961-62 as the result of proposals to plan for helicopter stations. The London Noise Survey was intended to investigate in a general way -

a) the objective noise levels in the Greater London Area in terms of the variation with respect to place, time and kind of noise sources, and

b) the subjective effect of noise on people living in the area.

The results of the London Survey are not particularly applicable to American cities since public transportation is more acceptable in Europe. There is also a marked difference in the land use distribution and concentration between European and American examples.

APPENDIX F

Sound Control Requirements of the N.B.C. 1971

SUBSECTION 3.3.4. RESIDENTIAL OCCUPANCY

Sound Control	3.3.4.7. Walls and floors separating dwelling units shall be designed and constructed to restrict sound transmission in conformance with Part 9 of this By-law.

SECTION 9.11 SOUND CONTROL

SUBSECTION 9.11.1. SOUND TRANSMISSION CLASS RATING (AIRBORNE SOUND)

Test Method	9.11.1.1. Sound transmission class ratings for construction shall be determined in accordance with ASTM E-90-66T, "Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions".

SUBSECTION 9.11.2. REQUIRED SOUND CONTROL LOCATIONS (AIRBORNE SOUND)

Sound Trans-mission Rating	9.11.2.1. Construction shall provide a sound transmission class rating of not less than 45 between dwelling units in the same building and between a dwelling unit and any space common to two or more dwelling units.
	9.11.2.2. Every service room or space such as storage room, laundry, workshop or building maintenance room or garage serving more than one dwelling unit, shall be separated from the dwelling units by a construction providing a sound transmission class rating of not less than 45.
Airborne Sound Rating	9.11.2.3. Construction described in Tables I-A to I-C (see p.433) of this Part as having airborne sound ratings of I and II shall be deemed to satisfy the requirements of Articles 9.11.2.1. and 9.11.2.2.

NOTE 3 TABLES 1-A to 1-C FIRE AND SOUND RESISTANCE OF FLOORS, CEILINGS AND ROOFS

Rating I for airborne sound transmission signifies construction with a sound transmission class rating of 50 or more and is considered to provide good resistance to transmission of airborne sound.

Rating II for airborne sound transmission signifies constructions with a sound transmission class rating of 45 to 50 and is considered to provide fair resistance to airborne sound. This is the minimum rating that satisfies the requirements in Subsection 9.11.2.

Rating III for airborne sound transmission signifies constructions with a sound transmission class rating of less than 45 and is not acceptable where sound-resistant construction is required.

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