OHIO

HUDSON

COMMUNITY DEVELOPMENT • 115 Executive Parkway, Suite 400 • Hudson, Ohio 44236 • (330) 342-1790

MEMORANDUM

Date: July 10, 2015

To: Board of Zoning and Building Appeals Board Members

Cc: Aimee Lane

From: Kris McMaster

Re: 2015-03 2 High Street

Attached is information the property owner submitted regarding their variance request for a 6' foot fence in the side yard at 2 High Street.

- Traffic Noise Study and Impacts
- Photographs of the new 6' fence installed in the rear yard.

3. FUNDAMENTALS OF HIGHWAY TRAFFIC NOISE

As discussed in the introduction, 23 CFR, Part 772 identifies several noise abatement measures that may be available to reduce anticipated traffic-noise impacts associated with existing and proposed highway projects. The scope of this effort included an evaluation of any "non traditional" noise mitigation techniques that may be available for use in the state of Ohio as an alternate to traditional sound barriers. The study focused on those items identified in 23 CFR, Part 772, as well as any other options that have been identified through the review process.

In order to understand the types of noise mitigation options that may be available, it is first important to understand the principals of highway traffic noise generation, analysis and mitigation.

3.1. Background on Sound

Sound is vibratory disturbance created by a moving or vibrating source. The movement of objects causes vibrations in air molecules that move the surrounding air in a manner similar to waves on water. When these vibrations reach our ears, we hear what we call sound. Noise meters are used to measure or quantify the intensity of sound, which is described in terms of decibels. The decibel (dB) is a logarithmic unit which expresses the ratio of sound pressure being measured to a standard reference level.

Most environmental sounds are complex and comprised of multiple frequencies or tones. Many of the frequencies associated with environmental noise are within the range of human hearing (i.e., audible sound) while many are above or below the range of typical human hearing, referred to as ultrasound and infrasound, respectively. Additionally, the human ear does not respond to all frequencies (within the range of audible sound) the same way. To account for these tonal differences, researchers have developed the "A-weighted scale" which places an adjustment on high and low-pitched sounds to best approximate the way the average person hears sounds. Sound pressure levels measured on the A-weighted scale are presented in A-weighted decibels, abbreviated dBA. The A-weighted decibel is the unit of measure applied to transportation noise studies [1].

Using the A-weighted decibel scale (dBA), noise levels can range from 0 dBA, a level which is barely audible to about 120 dBA, a level at which pain is felt by the listener [2]. **Table 1** provides a summary of the typical range of environmental sounds. Referencing this scale, the typical range of human speech communication is in the mid-60 dBA range. Quiet suburban environments are often in the 40 to 50 dBA range, with loud urban environments approaching the 70-75 dBA range.

Table 1: TYPICAL RANGE OF SOUND

Common Outdoor Activities	Noise Level dBA	Common Indoor Activities
Jet Fly-over at 300 m (1000 ft)	--110--	Rock Band
Gas Lawn Mower at 1 m (3 ft)	--100--	
Diesel Truck at 15 m (50 ft), at 80 km/hr (50 mph)	--90--	Food Blender at 1 m (3 ft)
Noisy Urban Area, Daytime	--80--	Garbage Disposal at 1 m (3 ft)
Gas Lawn Mower, 30 m (100 ft)	--70--	Vacuum Cleaner at 3 m (10 ft)
Commercial Area	--60--	Normal Speech at 1 m (3 ft)
Heavy Traffic at 90 m (300 ft)	--50--	Large Business Office Dishwasher Next Room
Quiet Urban Daytime	--40--	Theater, Large Conference Room (Background)
Quiet Urban Nighttime	--30--	Library
Quiet Suburban Nighttime	--20--	Bedroom at Night, Concert Hall (Background)
Quiet Rural Nighttime	--10--	Broadcast/ Recording Studio
Lowest Threshold of Human Hearing	--0--	Lowest Threshold Human Hearing

Source: CALTRANS Technical Noise Supplement, 1998

While much of this research effort will attempt to quantify sound levels and potential noise level reductions, it is important to understand the differences between how sound is quantified and how sound is perceived. A sound's loudness is a subjective, rather than an objective description of noise. This may vary from person to person and from sound-source to sound-source. As a result of extensive human testing, researchers have developed a correlation between objective differences in measured sound levels to the subjective response of listeners. **Table 2** provides a summary of measurable changes in sound levels and a description of the perceived change sensed by the listener. As shown, a 3 dBA change in sound is considered barely perceptible, and changes of less than 3 dBA are often imperceptible. A 5 dBA change is considered readily perceptible by most individuals. A 10 dBA increase in sound levels is typically perceived as a doubling of sound, and a 20 dBA increase in sound level is typically perceived as being 4-times as loud as the original level.

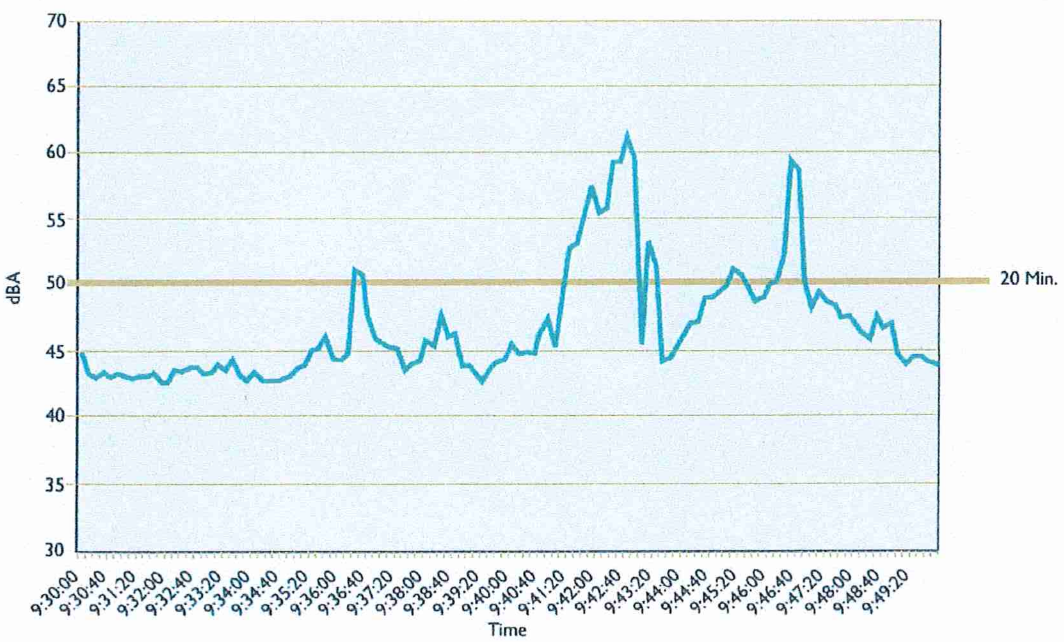
Table 2:

Actual Sound Level Change (dBA)	Perceived Change in Sound Level
+ 20	Four times as loud
+10 dBA	Twice as loud
+5 dBA	Readily perceptible increase
+3 dBA	Barely perceptible increase
0 dBA	Reference level
-3 dBA	Barely perceptible reduction
-5 dBA	Readily perceptible reduction
-10 dBA	Half as loud
-20 dBA	One quarter as loud

Source: Acoustics and your Environment. The Basis of Sound and Highway Traffic Noise. Final Report. 1999.

In addition to noise varying in frequency (or tone), noise intensity also fluctuates with time. Highway traffic noise is never constant. The instantaneous noise level at a given location is constantly changing, based on the volume, speed, and composition of vehicles using a given roadway at a given time. To address the fluctuation of noise over time, highway-related noise assessments use the equivalent (energy-averaged) sound levels (or Leq) as the appropriate "descriptor" to evaluate existing and future noise levels. Leq is defined as the constant, steady-state sound level which, in a given period of time, contains the same acoustical energy as the time-varying level during that same period. Leq is essentially an average noise level over a given period of time, recognizing that the decibel is derived logarithmically. **Figure 1** provides a summary of how Leq is established at a given location. In **Figure 1** noise levels were monitored in a 20-minute period. As shown, instantaneous noise levels during this test ranged from approximately 42 to 61 dBA, with the 20-minute $Leq(_{20min})$ established at approximately 50 dBA. For ODOT and FHWA purposes, all evaluations are performed to represent the average "worst-case" one-hour periods in a given 24-hour day, represented Leq(h). All levels are reported in A-weighted decibels (dBA). The use of this descriptor is appropriate to ensure that all noise level assessments are performed to address average "worst-case" conditions. These assessments are typically performed to evaluate "rush-hour" travel conditions, a period when peak-hour traffic volumes are traveling at "worst-case" speeds, producing worst-case hourly equivalent noise levels (Leq(h)).

Figure 1: LEQ. BASED ON 20 MINUTE MONITORING



Source: McCormick Taylor, 2006

3.2. CAUSES OF HIGHWAY TRAFFIC NOISE

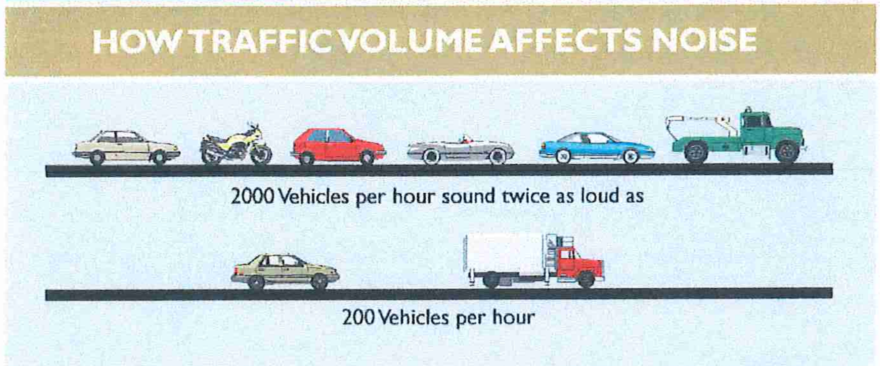
Obviously, noise produced by a highway source is not produced directly by the highway itself, but rather by the individual vehicles using the highway. The principal noise sources of highway vehicles are the engine, the exhaust system, and the tires. Mechanical and aerodynamic noise sources are also present, but generally overshadow the principal noise sources identified above. Generally speaking, exhaust noise is typically controlled by vehicle mufflers, assuming that they are used and functioning properly. Engine noise, as well as most mechanical noise sources can only be controlled by vehicle manufacturers and by proper maintenance, factors that are typically beyond the control of ODOT and FHWA. Tire noise is generated by the interaction between each vehicle's tires with the roadway surface. Currently, considerable research is ongoing related to noise levels associated with the tire/pavement interaction. Pavement type and texture is one factor that is within the control of ODOT and FHWA, and will be explored throughout the next sections of this report.

When considering the total noise produced by vehicles on a given roadway, engine and exhaust noise are usually louder than tire noise at vehicle speeds under 30 miles per hour (mph). At speeds greater than 30 mph, tire noise often becomes the dominant noise source from individual vehicles. Applying this rationale, highways and other arterial roadways are typically dominated by tire noise, while local roadways are typically dominated by engine and exhaust noise.

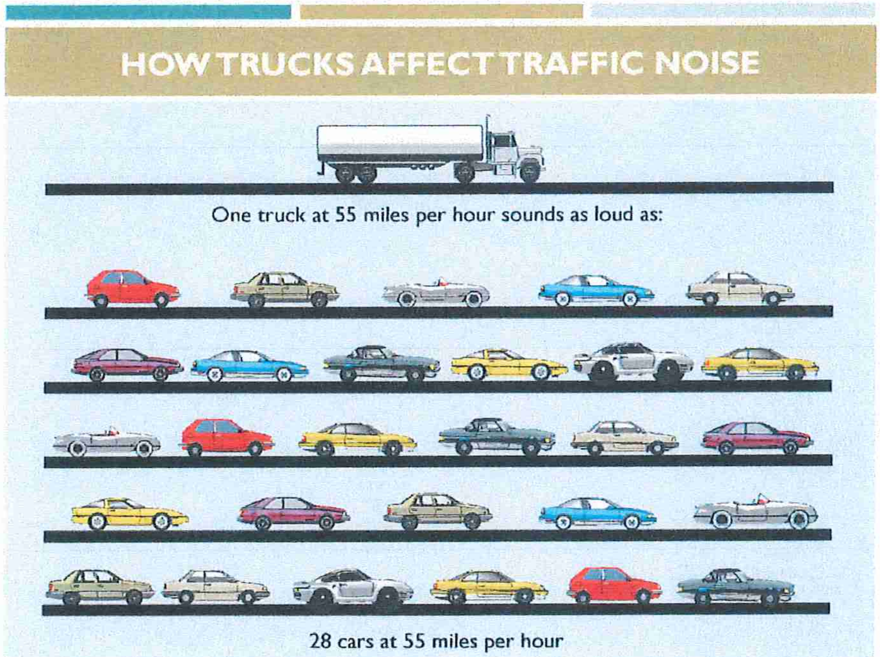
The overall noise level generated by a highway system depends on some additional factors, including the number of vehicles using the roadway, the speeds of the vehicles using the roadway, and the types of vehicles using the roadway. Generally, the loudness of traffic noise is increased by heavier traffic volume, higher speeds, and greater numbers of medium and heavy trucks. There are also many environmental and geographic factors that can influence the actual noise level at a given location adjacent to a roadway corridor. Any condition, such as steep roadway grades, that causes heavy laboring of motor vehicle engines will also increase traffic noise levels at a given location.

Figure 2 provides some general information related to how operational factors such as vehicle volume, speed, and composition can affect noise levels at a given location. As shown, a 10-fold increase in vehicle volume equates to a noise level increase of approximately 10 dBA, or a perceptible doubling in volume. Similarly, FHWA estimates that an increase in speed from 30 to 65 mph would also equate to a noise level increase of approximately 10 dBA, or a perceptible doubling in noise level (or volume). Related to the affects of vehicle composition, as shown in **Figure 2**, one heavy truck at 55 mph contains about the same acoustic energy as approximately 28 cars at that same speed. Given this comparison it is clear that composition of traffic (i.e., the percentages of heavy truck volumes) can have as much (or more) of an effect on final noise levels than volume or speed of traffic.

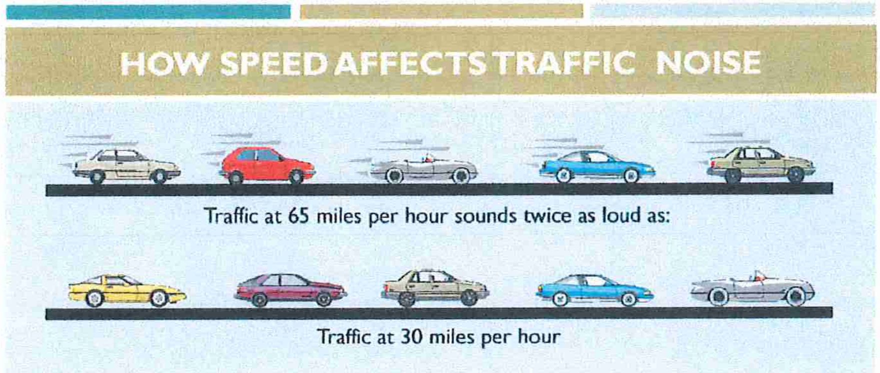
Figure 2: HOW TRAFFIC CHARACTERISTICS AFFECT NOISE LEVELS



Source: Making Sound Decisions About Highway Noise Abatement, Pennsylvania Department of Transportation, 1999



Source: Making Sound Decisions About Highway Noise Abatement, Pennsylvania Department of Transportation, 1999



Source: Making Sound Decisions About Highway Noise Abatement, Pennsylvania Department of Transportation, 1999

Sound propagation is another factor that should be discussed. The travel (or propagation) of traffic noise depends mainly on three factors: Atmospheric effects, ground effects, and spreading effects. Atmospheric conditions are constantly changing, and these conditions can continually affect how sound propagates from source to receiver. Considerable research is currently ongoing related to atmospheric effects on sound propagation. Generally, atmospheric affects are of greater concern when considering propagation over greater distances, with less impact to propagation directly adjacent to roadway corridors. While atmospheric effects can influence actual noise levels at a given location (and can change those levels from day to day), this factor is not currently considered overly significant at locations directly adjacent to a given roadway. These factors are also beyond the control of ODOT/FHWA, and generally outside of the scope of this study.

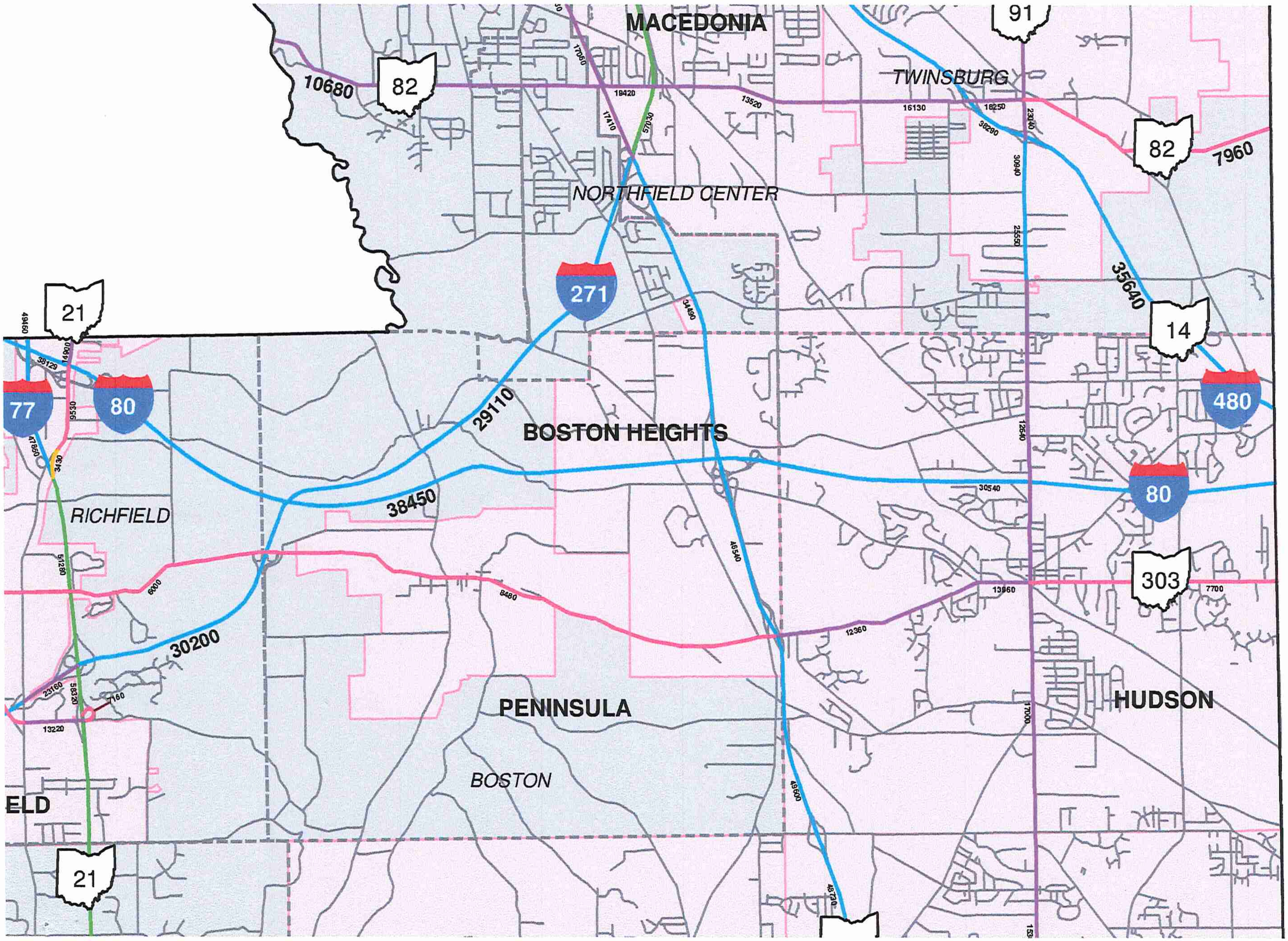
Ground conditions can also affect sound propagation. Sound will travel further over "hard", reflective surfaces than over "soft" surfaces covered by vegetation. This is generally due to sound absorption and scattering which occurs when sound travels over absorptive surfaces such as grassy fields or wooded areas. Finally, sound propagation is also affected by "spreading" effects, which diminish sound at a constant rate as the sound travels away from the source. Sound from a line-source (such as a highway) decreases at a rate of approximately 3 dBA per doubling of distance, when no other factors such as absorption are considered. Given this theory, noise levels of 65 dBA at 100 feet from the roadway would drop to 62 dBA at 200 feet (a doubling of distance); to 59 dBA at 400 feet (another doubling of distance); and to 56 dBA at 800 feet (another doubling of distance).

Other geographic factors can help to reduce noise levels at a given location. The presence of intervening terrain (or roadway cut-slopes) can shield the receiver from the source and ultimately reduce noise levels, when compared to areas with clear lines-of-sight to that same roadway. Based on a combination of all of the factors discussed above, as a person moves further away from a given roadway, traffic noise levels are typically reduced by distance, terrain, vegetation, and "shielding" provided by natural and manmade objects.

3.3. EFFECTS OF HIGHWAY TRAFFIC NOISE

Federal and state participation in highway noise studies is driven out of concern for the safety, health and welfare of people who are exposed to highway noise, including those who live, work, go to school, worship, or participate in active or passive recreation activities adjacent to highway corridors. Perhaps one of the most obvious concerns and one often questioned by the public, is the potential for physical hearing damage resulting from continued exposure to highway noise. Fortunately, transportation-related noise levels experienced along highway corridors are typically well below thresholds necessary to produce hearing damage [1]. Other effects of noise exposure include interference with certain activities, including sleeping, relaxation, conversation, study, or recreation activities [3]. Most of the effects of highway traffic noise can be classified as an annoyance or inconvenience; however, impacts associated with highway noise have also been blamed for depreciating property values and impacting the general quality of life adjacent to highway corridors.

Less obvious, but documented, is research suggesting the stress effects of noise. There is ample evidence that noise can cause stress, and thus may be a contributor to stress-related diseases, including anxiety and heart disease [1]. Given these social, personal, financial, and health concerns, FHWA and ODOT actively participate in a program to evaluate and mitigate for noise impacts associated with transportation improvement projects.


MACEDONIA
TWINSBURG
NORTHFIELD CENTER
BOSTON HEIGHTS
RICHFIELD
PENINSULA
BOSTON
HUDSON
ELD
91
82
82
21
21
14
303
271
77
80
80
480
10680
7960
35640
29110
38450
30200
19420
13520
16130
18250
23040
30940
25550
12640
30540
13960
7700
12360
17000
46540
49600
48730
8480
6000
51280
58320
13220
23160
7160
9530
14900
38129
47850
3430
49460
17060
17410
57030
36290
34490

2013 SUMMIT COUNTY 4
AVERAGE 24-HR TRAFFIC VOLUME

	SECT. BEGINS	TRAFFIC SECTION	SECT. LENGTH	PASS & A COM'L	B & C COM'L	TOTAL VEH.
		IR-77 (Cont'd)				
	23.21	SR 18	1.51	49970	4030	54000
	24.72	C-98 (GHENT RD.)/ATR #147 AT 28.43	4.91	51410	3910	55320
	29.63	SR 176	.55	53950	4370	58320
	30.18	IR 271	1.96	46990	4290	51280
	32.14	SR 21	1.33	43870	3980	47850
U	33.47	OHIO TURNPIKE IN RICHFIELD	.15	46150	3310	49460
	33.62	EQUALS STA. 0.00 IN CUYAHOGA CO.	.00			
		SR-82				
	00.00	CUYAHOGA CO. LINE	3.50	10320	360	10680
U	03.50	SR 8 (AKRON-CLEVELAND) IN MACEDONIA	.50	18650	770	19420
U	04.00	IR 271	2.20	12900	620	13520
U	06.20	CHAMBERLIN RD.IN TWINSBURG	1.04	15390	740	16130
U	07.24	IR 480	.60	17410	840	18250
U	07.84	SR 91 (DARROW RD.)	2.74	7600	360	7960
	10.58	EQUALS STA. 0.00 IN PORTAGE CO.	.00			
		SR-91				
	00.00	US 224	1.81	17870	1290	19160
U	01.81	SR 18 (MARKET ST.) IN AKRON	.50	10410	750	11160
U	02.31	MOGADORE RD.	.21	16610	1200	17810
U	02.52	GILCHRIST RD.	.45	20430	1480	21910
U	02.97	NEWTON ST.	.92	12590	910	13500
U	03.89	S. CORP. TALLMADGE	1.12	11510	830	12340
U	05.01	SR 91DA ENTER CIRCLE	.09	21480	1560	23040
U	05.10	SR 261 (NORTHEAST AVE.)	.02	21680	1570	23250
U	05.12	SR 91DA ENTER NORTH AVE.	1.13	8260	580	8840
U	06.25	HOWE RD.	1.44	12770	660	13430
U	07.69	MUNROE FALLS RD.IN MUNROE FALLS	1.41	13360	1030	14390
U	09.10	SR 59 (KENT RD.)IN STOW	.49	19020	1470	20490
U	09.59	GRAHAM RD.	.15	21920	1690	23610
U	09.74	STOW RD.	2.21	14270	1030	15300
U	11.95	FISH CREEK RD.	2.72	16380	620	17000
U	14.67	SR 303 (STREETSBORO ST.)IN HUDSON	3.08	11680	960	12640
U	17.75	OLD MILL RD. IN TWINSBURG	.90	23640	1910	25550
U	18.65	HIGHLAND RD.	.53	28850	2090	30940
U	19.18	IR 480	.42	21790	1250	23040
U	19.60	SR 82 (AURORA RD.)	2.61	10840	620	11460
	22.21	EQUALS STA. 0.00 IN CUYAHOGA CO.	.00			

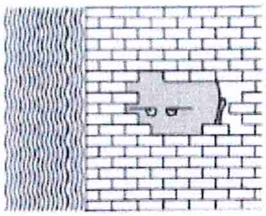
2013 SUMMIT COUNTY 5
AVERAGE 24-HR TRAFFIC VOLUME

	SECT. BEGINS	TRAFFIC SECTION	SECT. LENGTH	PASS & A COM'L	B & C COM'L	TOTAL VEH.
		SR-91 DIRECTIONAL ALTERNATE				
U	00.00	SR 91 ENTER CIRCLE IN TALLMADGE	.10	21880	1580	23460
U	00.10	SR 261 (WEST AVE.)	.09	20450	1480	21930
	00.19	ROUTE ENDS AT SR 91 IN TALLMADGE	.00			
		SR-93				
U	00.00	STARK CO. LINE S. CORP. NEW FRANKLIN	.36	7840	290	8130
U	00.36	SR 236	1.54	7280	410	7690
U	01.90	MIMISILA RD.	1.02	8650	310	8960
U	02.92	CENTER RD.	2.23	11280	280	11560
U	05.15	SR 619 (TURKEYFOOT LAKE RD.)	1.58	8910	650	9560
	06.73	C-75 (PORTAGE LAKES RD.)	.33	13250	860	14110
	07.06	C-54 (ROBINSON AVE.)	.57	19450	1260	20710
	07.63	C-233 (CORMANY RD.)	.76	22990	1490	24480
U	08.39	IR 277 IN AKRON	.11	25250	1040	26290
U	08.50	WATERLOO RD.	.63	10920	450	11370
U	09.13	SR 764 (WILBETH RD.)	.26	10460	430	10890
U	09.39	MARYLAND RD.	.45	3410	70	3480
U	09.84	LAKEVIEW AVE.	1.32	4740	180	4920
U	11.16	MANCHESTER RD. ENTER EAST AVE.	.24	6700	260	6960
	11.40	ROUTE ENDS AT SR 261 IN AKRON	.00			
		SR-162				
	00.00	MEDINA CO. LINE C-2 (MEDINA LINE RD.)	1.67	4100	110	4210
	01.67	SR 21	.67	6210	420	6630
	02.34	SR 162DA	.08	2910	50	2960
	02.42	SR 162DA	1.36	5500	230	5730
	03.78	C-205 (JACOBY RD.)	1.84	5860	240	6100
U	05.62	W. CORP. AKRON COLLIER RD.	.49	7660	320	7980
U	06.11	IR 77	2.25	12120	500	12620
U	08.36	EXCHANGE ST.	.47	5310	220	5530
U	08.83	MAPLE ST. ENTER GLENDALE AVE.	.37	1710	80	1790
U	09.20	RAND AVE.	.06	4570	120	4690
	09.26	ROUTE ENDS AT SR 18 IN AKRON	.00			
		SR-162 DIRECTIONAL ALTERNATE				
	00.00	SR 162	.08	2880	120	3000
	00.08	ROUTE ENDS AT SR 162	.00			

Highway Traffic Noise

The Audible Landscape

4 Physical Techniques to Reduce Noise Impacts



This section describes some of the physical methods which architects, developers and builders can employ to reduce noise impacts. There are four major actions which can be taken to improve noise compatibility for any type of land use or activity. These are site planning, architectural design, construction methods, and barrier construction.

Acoustical site design uses the arrangement of buildings on a tract of land to minimize noise impacts by capitalizing on the site's natural shape and contours. Open space, nonresidential land uses, and barrier buildings can be arranged to shield residential areas or other noise sensitive activities from noise, and residences can be oriented away from noise.

Acoustical architectural design incorporates noise reducing concepts in the details of individual buildings. The areas of architectural concern include building height, room arrangement, window placement, and balcony and courtyard design.

Acoustical construction involves the use of building materials and techniques to reduce noise transmission through walls, windows, doors, ceilings, and floors. This area includes many of the new and traditional "soundproofing" concepts

Noise barriers can be erected between noise sources and noise-sensitive areas. Barrier types include berms made of sloping mounds of earth, walls and fences constructed of a variety of materials, thick plantings of trees and shrubs, and combinations of these materials.

These physical techniques vary widely in their noise reduction characteristics, their costs, and especially, in their applicability to specific locations and conditions. This section is not designed to provide complete criteria for selecting a solution to particular noise problems and is not intended as a substitute for acoustical design. Rather, its purpose is to illustrate the wide range of possible alternatives which could be considered in the architectural and engineering planning process. Knowledgeable municipal officials can provide valuable assistance to designers, developers, and builders who may not be familiar with sound attenuation techniques that are most applicable locally.

4.1 Acoustical Site Planning

The arrangement of buildings on a site can be used to minimize noise impacts. If incompatible land uses already exist, or if a noise sensitive activity is planned, acoustical site planning often provides a successful technique for noise impact reduction.

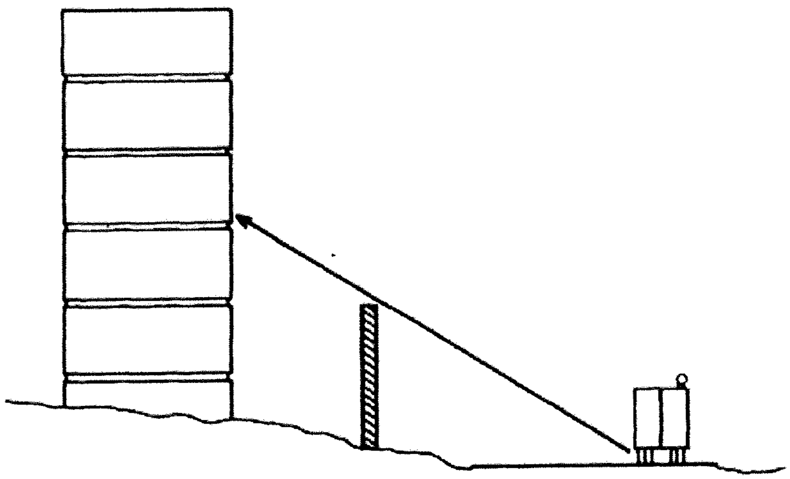
Many site planning techniques can be employed to shield a residential development from noise. These can include:

1. increasing the distance between the noise source and the receiver;
2. placing nonresidential land uses such as parking lots, maintenance facilities, and utility areas between the source and the receiver;
3. locating barrier-type buildings parallel to the noise source or the highway; and
4. orienting the residences away from the noise.

The implementation of many of the above site planning techniques can be combined through the use of cluster and planned unit development techniques.

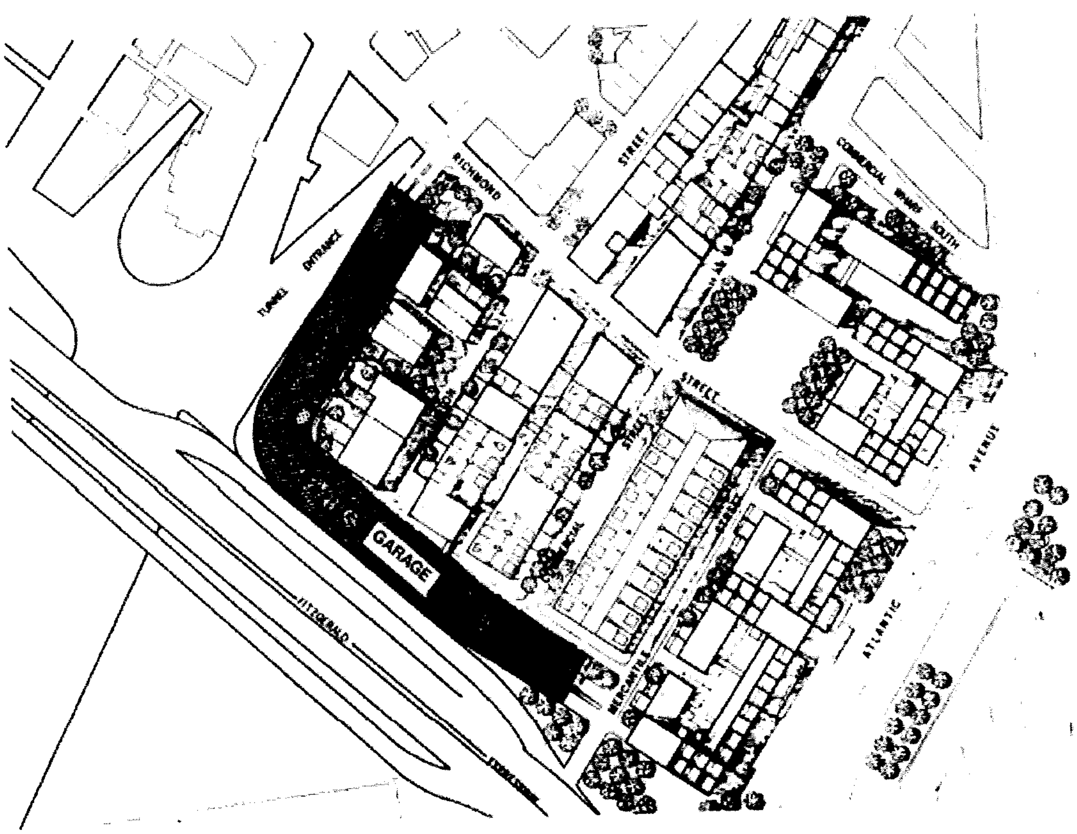
Distance Noise can be effectively reduced by increasing the distance between a residential building and a highway. Distance itself reduces sound: doubling the distance from a noise source can reduce its intensity.

Distance itself reduces sound: doubling the distance from a noise source can reduce its intensity by as much as 6 dBA. In the case of high rise buildings, distance may be the only means, besides acoustical design and construction, of reducing noise impacts. This is because it is nearly impossible to provide physical shielding for the higher stories from adjacent noise. (See Figure 4.1.)



4.1 Noise barriers can shield only the lowest floors of a building.

Noise Compatible Land Uses as Buffers Noise protection can be achieved by locating noise-compatible land uses between the highway and residential units. Whenever possible, compatible uses should be nearest the noise source. Figure 4.2 which follows shows a proposed parking garage along two sides of a development in Boston. Both the Fitzgerald Expressway and the entrance to the Callahan Tunnel which are shown on the site plan are major and noisy traffic routes.



4.2 Parking Garage to shield residential area.

In addition to protecting the residential development from the noise and dirt of highway traffic, the parking garage provides needed facilities for the residents

Buildings as Noise Shields Additional noise protection can be achieved by arranging the site plan to use buildings as noise barriers. A long building, or a row of buildings parallel to a highway can shield other more distant structures or open areas from noise. One study shows that a two-story building can reduce noise levels on the side of the building away from the noise source by about 13dBA.[1]

If the use of the barrier building is sensitive to highway noise, the building can be soundproofed. This technique was used in a housing project under construction in England where a 3,900 foot long, 18 foot wide and 45-70 foot high wall (depending on the terrain) serves as both residence and a sound shield.[2]

The wall/building will contain 387 apartments in which the kitchens and bathrooms are placed towards the noise, and the bedrooms and living rooms face away from the highway. The wall facing the highway will be soundproofed and windows, when they exist, are sealed. Substantial noise reductions are expected.

Orientation The orientation of buildings or activities on a site affects the impact of noise, and the building or activity area may be oriented in such a way as to reduce this impact.

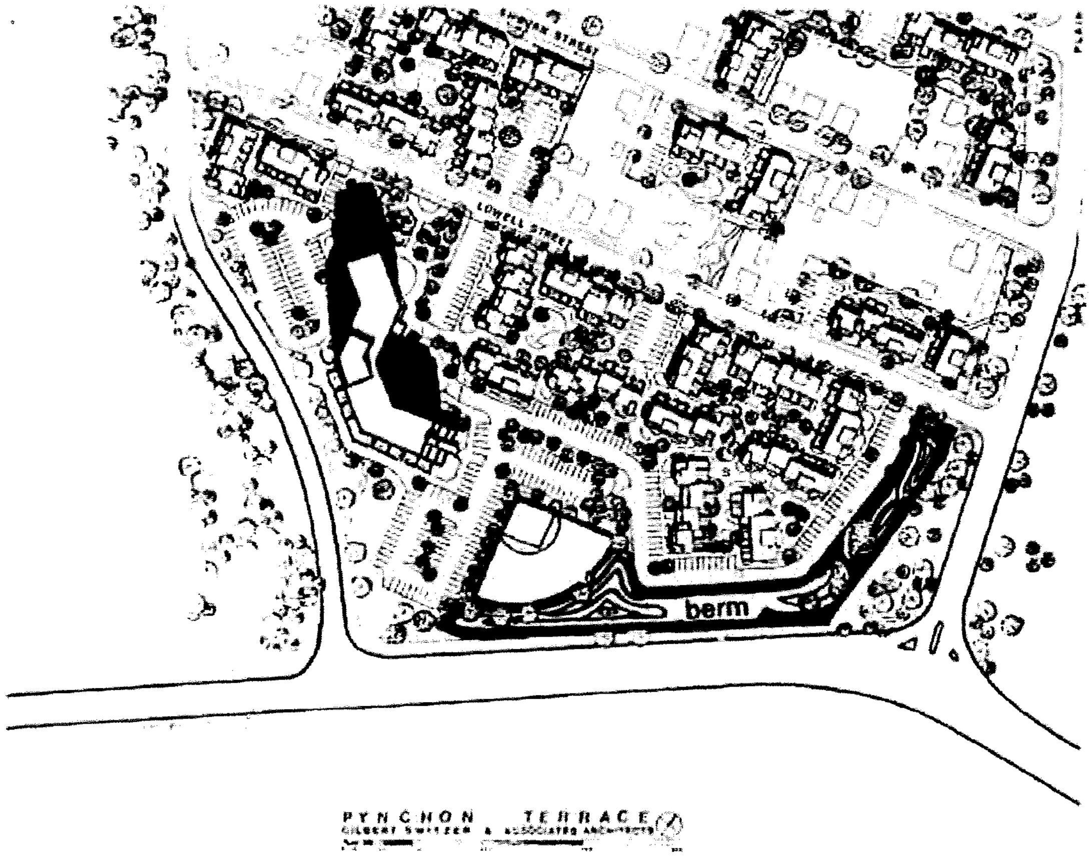
Noise impacts can be severe for rooms facing the roadway since they are closest to the noise source. The noise impact may also be great for rooms perpendicular to the roadway because a) the noise pattern can be more annoying in perpendicular rooms and b) windows on perpendicular walls do not reduce noise as effectively as those on parallel walls because of the angle of the sound. Road noise can be more annoying in perpendicular rooms because it is more extreme when it suddenly comes in and out of earshot as the traffic passes around the side of the building, rather than rising and falling in a continuous sound, as it would if the room were parallel to passing vehicles.

Whether the noise impact is greater on the perpendicular or the parallel wall will depend on the specific individual conditions. Once the most severely impacted wall or walls are determined, noise impacts may be minimized by reducing or eliminating windows from these walls.

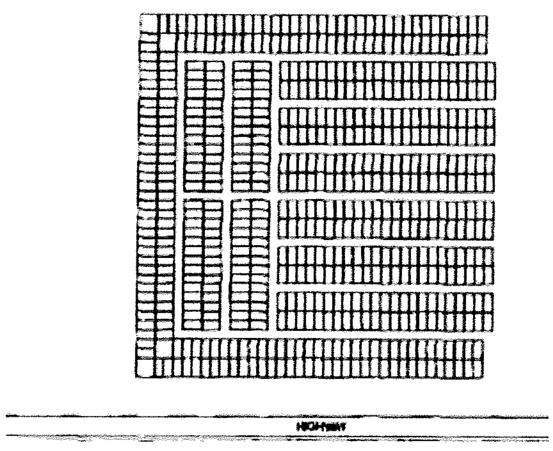
Buildings can also be oriented on a site in such a way as to exploit the site's natural features. With reference to noise, natural topography can be exploited and buildings placed in low noise pockets if they exist. If no natural noise pockets exist, it is possible to create them by excavating pockets for buildings and piling up earth mounds between them and the noise. Such a structure would obstruct the sound paths and reduce the noise impacts on the residences.

Cluster and Planned Unit Development A cluster subdivision is one in which the densities prescribed by the zoning ordinance are adhered to but instead of applying to each individual parcel, they are aggregated over the entire site, and the land is developed as a single entity. A planned unit development, or P.U.D., is similar but changes in land use are included, such as apartments and commercial facilities in what would otherwise be a single-family district. Examples of grid, cluster and P.U.D. subdivisions follow in Figures 4.4, 4.5, and 4.6.

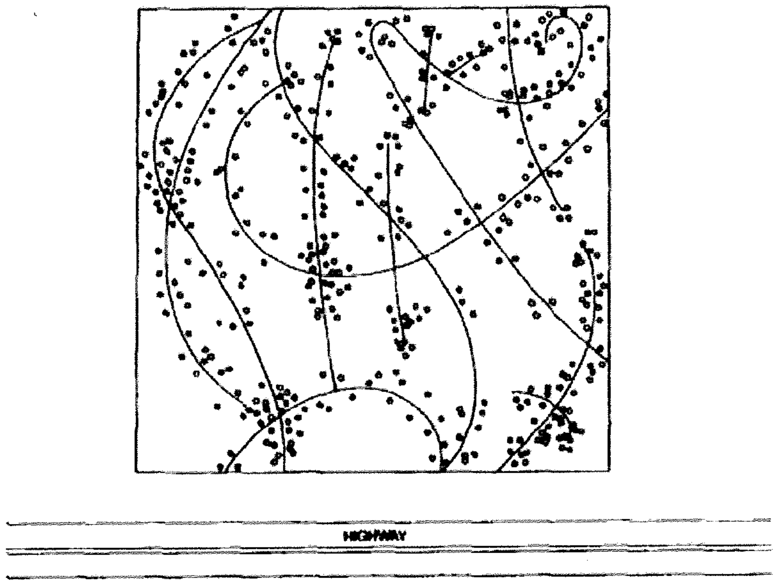
Figure 4.3 provides another example of locating noise-compatible uses near a highway (West Street) in Springfield, Massachusetts. From the plan, one can see that parking spaces, ends of buildings, and a baseball diamond are near the highway.



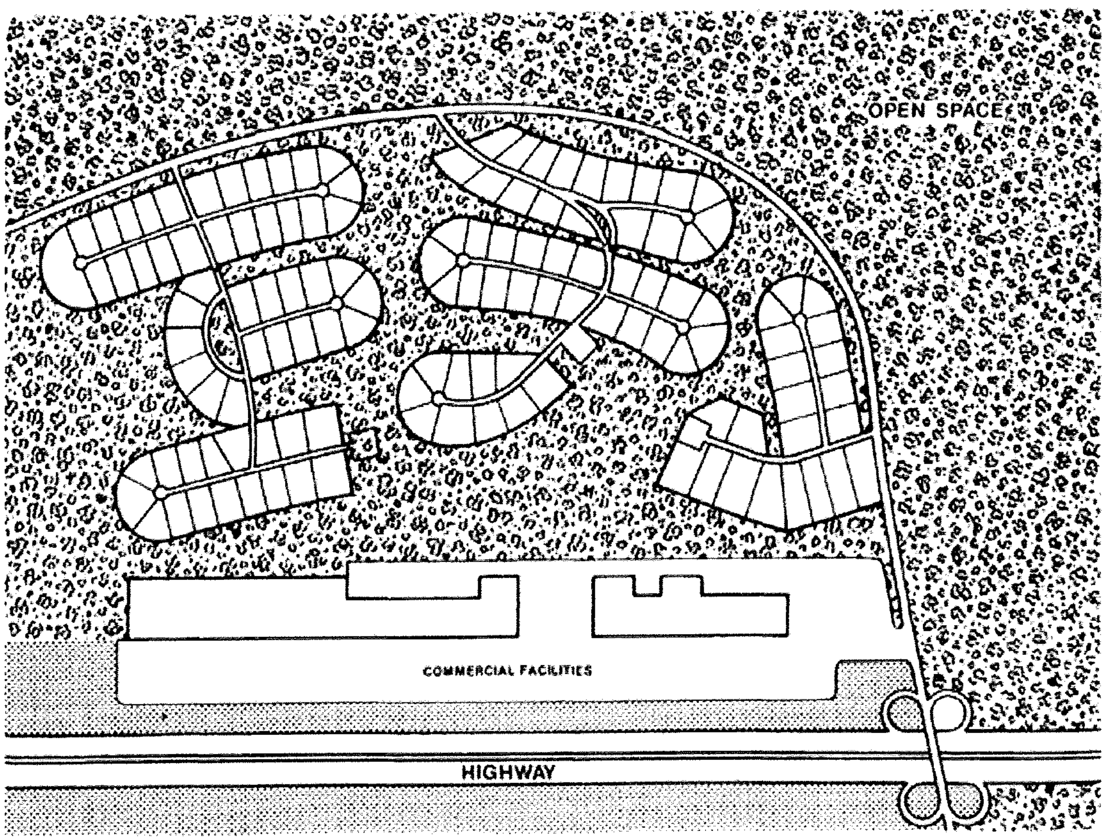
4.3 Parking spaces, end of buildings, and a baseball diamond are placed near the highway. A berm is constructed and trees are planted to shield residences from traffic noise.



4.4 Conventional Grid Subdivision

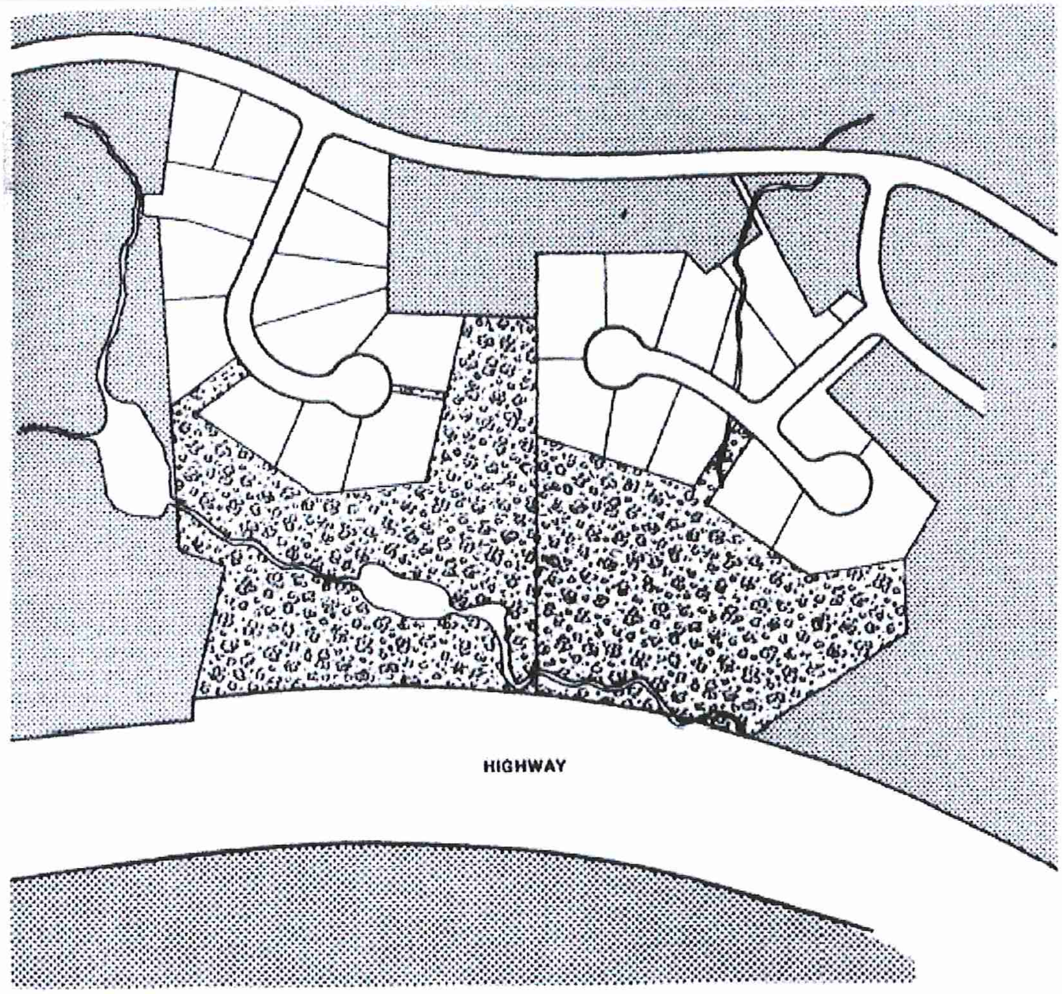


4.5 Cluster Subdivision



4.6 Placement of noise compatible land uses near highway in Planned Unit Development

From Figure 4.4 it can be seen how the conventional grid subdivision affords no noise protection from the adjacent highway. The first row of houses bears the full impact of the noise. In contrast, the cluster and P.U.D. techniques enable commercial uses and open space respectively to serve as noise buffers. Examples of this are shown in Figures 4.6 and 4.7.



4.7 In cluster development, open space can be placed near the highway to reduce noise impacts on residences

A word of caution is necessary: in a cluster development, the required open space can be located near the highway to minimize noise to the residences. However, many recreation uses are noise sensitive, and when one takes advantage of the flexibility of cluster development to minimize noise, care must be taken not to use all of the available open space in buffer strips, thus depriving the development of a significant open space area. Where high noise levels exist, a combination of buffer strips and other techniques (such as berms and acoustical sound proofing) can be employed.

The flexibility of the cluster and planned unit development techniques allows many of the above site planning techniques to be realized and effective noise reduction achieved.

[1] Hans Bernard Reichow, "Town Planning and Noise Abatement," Architect's Journal, 137-7 (February 13, 1963) pp. 357-360.

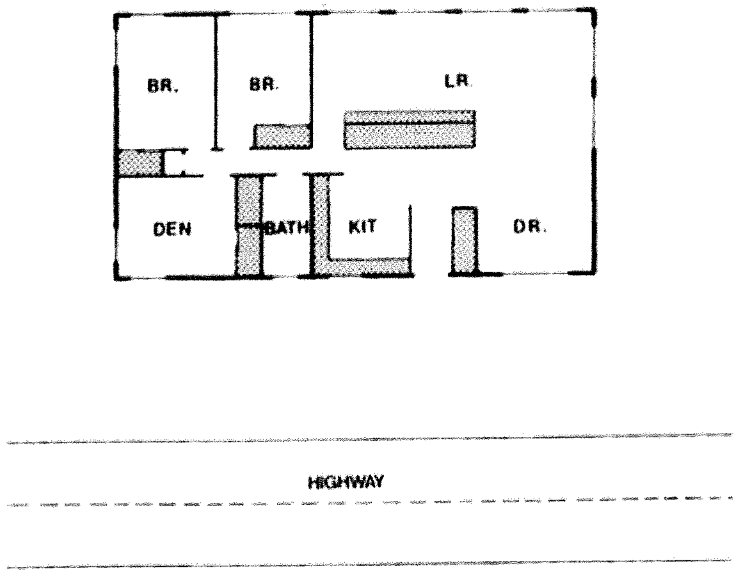
[2]"Live-in Wall, 3,900 Feet Long, is Also a Sound Shield," Engineering Record, (September 6,1973).

4.2 Acoustical Architectural Design

Noise can be controlled in a building with proper architectural design. By giving attention to acoustical considerations in the planning of room arrangement, placement of windows, building height, balconies, and courtyards, the architect may achieve significant noise impact reduction, without the need for costly acoustical construction.

Room Arrangement Noise impacts can be substantially reduced by separating more noise sensitive rooms from less noise sensitive rooms; and placing the former in the part of the building which is furthest away from the noise source. The less sensitive rooms should then be placed closest to the noise source where they can act as noise buffers for the more sensitive rooms.

Whether or not a room is noise sensitive depends on its use. Bedrooms, livingrooms, and dining rooms are usually noise sensitive, while kitchens, bathrooms, and playrooms are less so. Figure 4.8 shows a layout designed to reduce the impact of highway noise. This technique was used extensively in England in a 100 acre residential development adjacent to a planned expressway.[1] Kitchens and bathrooms were placed on the expressway side of the building, and bedrooms and living rooms were placed on the shielded side. In addition, the wall facing the expressway is sound insulated.

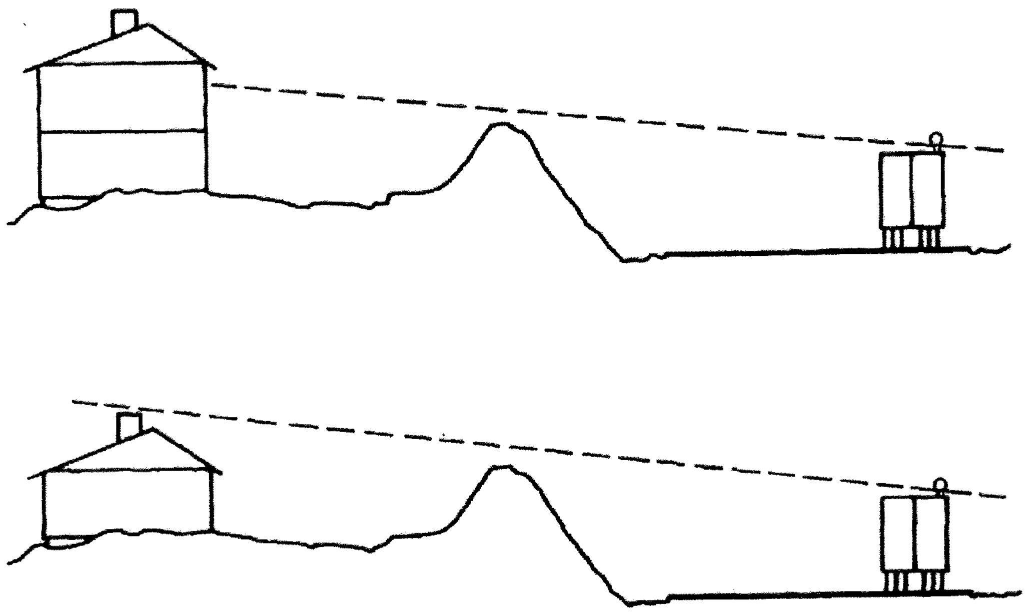


4.8 Use of acoustical architectural design to reduce noise impacts on more noise sensitive living spaces

[1]"Live-In Wall is Also Sound Shield", Engineering News-Record, September 6,1973.

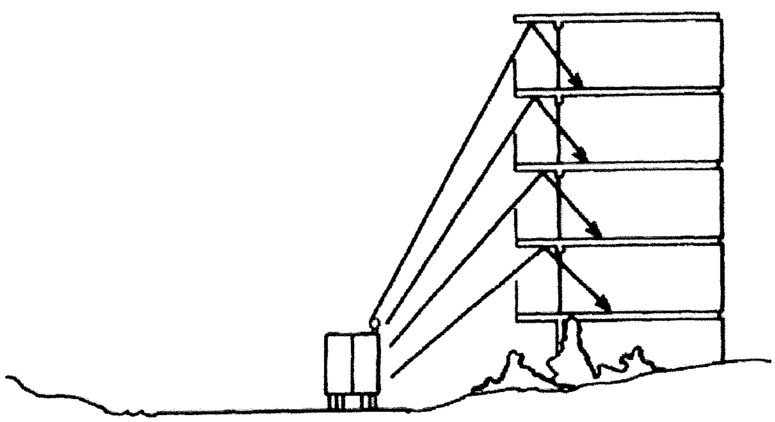
Solid Walls Noise can be reduced by eliminating windows and other openings from the walls of a building close to noise sources. The solid wall can then have the effect of a sound barrier for the rest of the building. As previously discussed in Figure 4.1, walls directly adjacent, and those perpendicular to the noise source can be the most severely impacted. When a solid wall is impractical, illegal, or highly undesirable; the same effect can be achieved by reducing window size and sealing windows airtight. This technique is used in the housing project described above.[1]

One Story Houses In cases where either the house or the highway is slightly recessed or a barrier has been placed in the sound path, the noise impact may be further reduced if the house has only one story[2] (See Figure 4.9). If the single story design is inefficient, the split level design may be effective. In any case the path of the sound waves should be assessed before the building design is drawn.



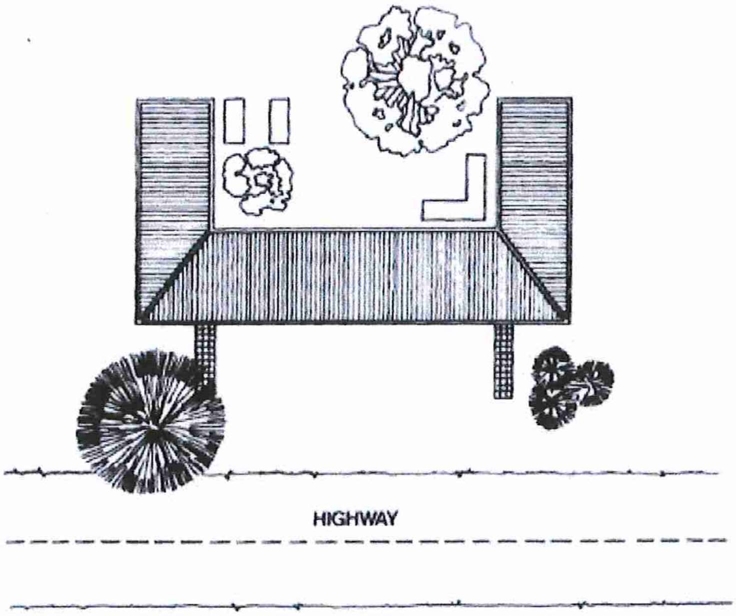
4.9 Noise impacts can be reduced by use of single story houses.

Balconies If balconies are desired they should be given acoustical consideration. The standard jutting balcony, facing the road, may reflect traffic noise directly into the interior of the building in the manner illustrated in Figure 4.10. In addition to reflecting noise into the building, the balcony may be rendered unusable due to the high noise levels. This problem is particularly applicable to high rise apartment buildings where balconies are common. If balconies are desired, the architect may avoid unpleasant noise impacts by placing them on the shielded side of the buildings.



4.10 The standard jutting balcony facing the road may reflect traffic noise directly into the interior of the building.

Courtyards Proper architectural design may also provide for noise reduction in an area outside of the building. The court garden and patio houses can provide outdoor acoustical privacy. (See Figure 4.11). Schools, rest homes, hotels, and multi-family apartment dwellings can also have exterior spaces with reduced noise by means of court yards.



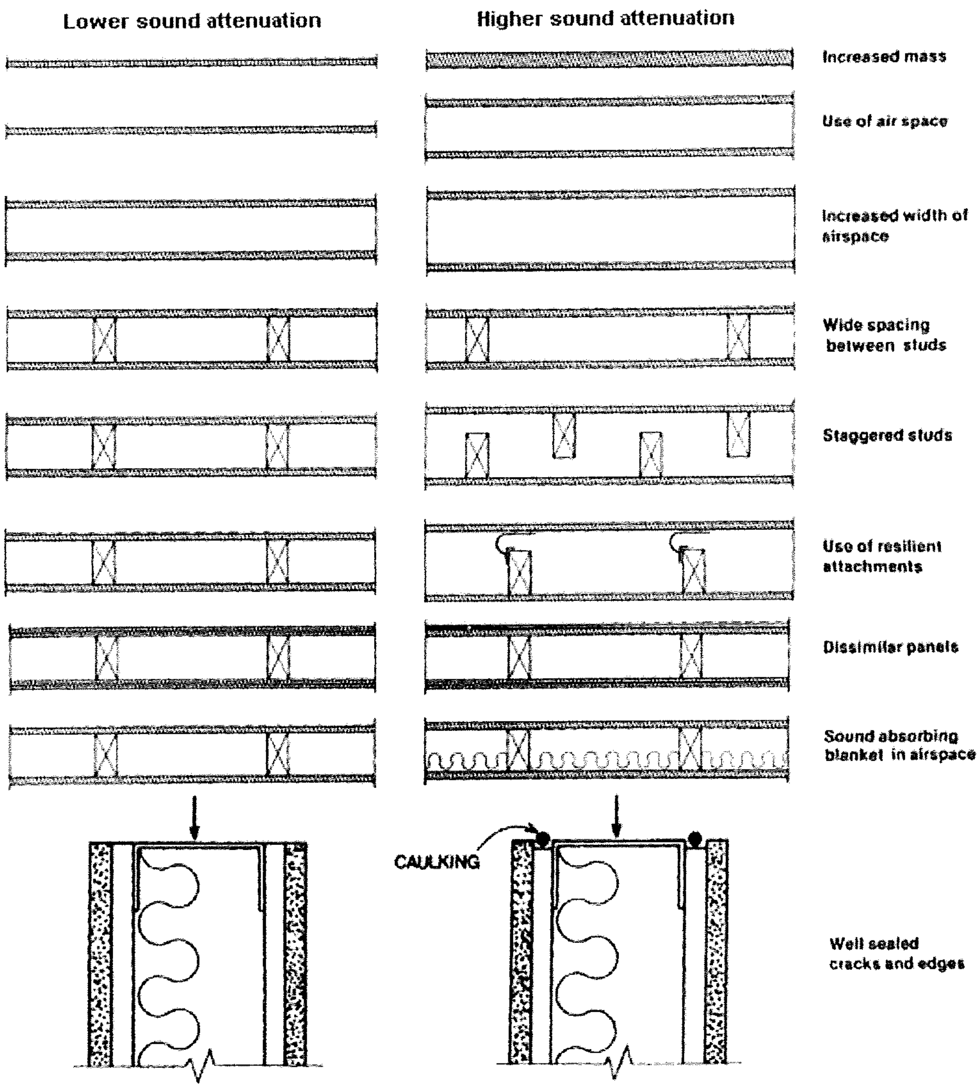
4.11 Use of courtyard house to obtain quite outdoor environment

4.3 Acoustical Construction

Noise can be intercepted as it passes through the walls, floors, windows, ceilings, and doors of a building. Examples of noise reducing materials and construction techniques are described in the pages that follow.

To compare the insulation performance of alternative constructions, the sound transmission class (STC) is used as a measure of a material's ability to reduce sound. Sound Transmission Class is equal to the number of decibels a sound is reduced as it passes through a material. Thus, a high STC rating indicates a good insulating material. It takes into account the influence of different frequencies on sound transmission, but essentially it is the difference between the sound levels on the side of the partition where the noise originates and the side where it is received. For example, if the external noise level is 85 dB and the desired internal level is 45 dB, a partition of 40 STC is required. The Sound Transmission Class rating is the official rating endorsed by the American Society of Testing and Measurement. It can be used as a guide in determining what type of construction is needed to reduce noise.

A. Walls provide building occupants with the most protection from exterior noise. Different wall materials and designs vary greatly in their sound insulating properties. Figure 4.12 provides a visual summary of some ways in which the acoustical properties can be improved:



4.12 Factors which influence sound attenuation of walls

B.

- Increase the mass and stiffness of the wall.

  In general, the denser the wall material, the more it will reduce noise. Thus, concrete walls are better insulators than wood walls of equal thickness. Increasing the thickness of a wall is another way to increase mass and improve sound insulation. Doubling the thickness of a partition can result in as much as a 6 dB reduction in sound.[3] However, the costs of construction tend to limit the feasibility of large increases in wall mass. The relative stiffness of the wall material can influence its sound attenuation value. Care must be taken to avoid wall constructions that can vibrate at audible frequencies and transmit exterior sounds.

- Use cavity partitions

  A cavity wall is composed of two or more layers separated by an airspace. The airspace makes a more effective sound insulator than a single wall of equal weight, leading to cost savings.

- Increase the width of the airspace.

  A three inch airspace provides significant noise reduction, but increasing the spacing to six inches can reduce noise levels by an additional 5 dBA. Extremely wide air spaces are difficult to design.

- Increase the spacing between studs.

  In a single stud wall, 24 inch stud spacing gives a 2-5 dB increase in STC over the common 16 inch spacing.[4]

- Use staggered studs.

Sound transmission can be reduced by attaching each stud to only one panel and alternating between the two panels.

- Use resilient materials to hold the studs and panels together.

  Nails severely reduce the wall's ability to reduce noise. Resilient layers such as fiber board and glass fiber board, resilient clips, and semi-resilient attachments are relatively inexpensive, simple to insert, and can raise the STC rating from 2-5 dB.1

- Use dissimilar leaves.

  If the leaves are made of different materials and/or thickness, the sound reduction qualities of the wall are improved.[2]

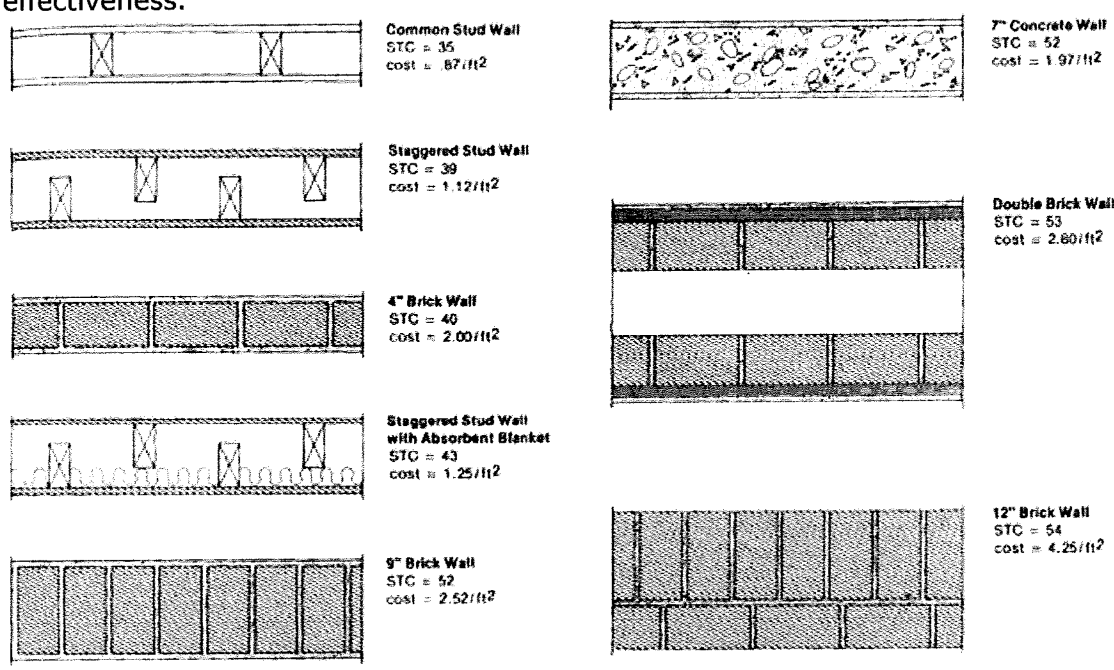
- Add acoustical blankets.

  Also known as isolation blankets, these can increase sound attenuation when placed in the airspace. Made from sound absorbing materials such as mineral or rock wool, fiberglass, hair felt or wood fibers, these can attenuate noise as much as 10 dB.[3]They are mainly effective in relatively lightweight construction.

- Seal cracks and edges.

  If the sound insulation of a high performance wall is ever to be realized, the wall must be well sealed at the perimeter. Small holes and cracks can be devastating to the insulation of a wall. A one-inch square hole or a 1/16 inch crack 16 inches long will reduce a 50 STC wall to 40.[4]

Figure 4.13 shows a sample of wall types ranging from the lowest to the highest sound insulation values. The cost of these walls in dollars per square foot is given for comparison of cost effectiveness.[5]



4.13 Wall Types with STC Rating and Approximate Cost.

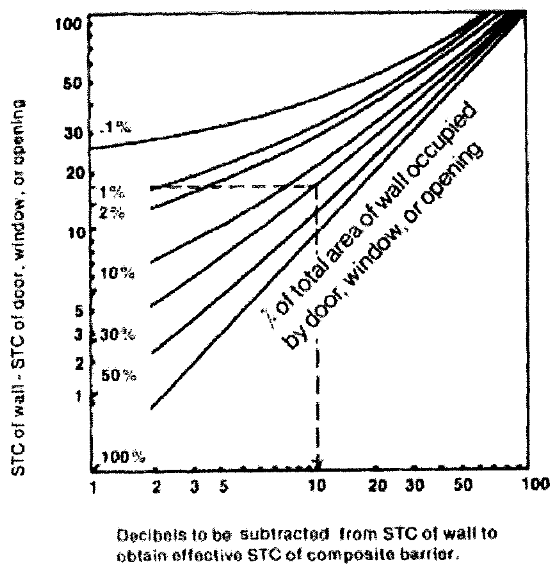
[1] "Live-in Wall. . ."

[2]This technique is used extensively in Cerritos, California.

[3]R.K. Cook and P. Chrzanowski, "Transmission of Noise Through Walls and Floors," Cyril Harris, ed., Handbook of Noise Control, McGraw-Hill Book Company, Inc. (New York, 1957).

[4]T. Doelle, Environmental Acoustics, (New York, McGraw-Hill Book Company, 1972), pp. 232-233.

C. Windows Sound enters a building through its acoustically weakest points, and windows are one of the weakest parts of a wall. An open or weak window will severely negate the effect of a very strong wall. Whenever windows are going to be a part of the building design, they should be given acoustical consideration. Figure 4.14 illustrates the effects of windows on the sound transmission of walls. For example, if a wall with an STC rating of 45 contains a window with an STC rating of 26 covering only 20% of its area, the overall STC of the composite partition will be 33, a reduction of 12 dB.



4.14 Graph for calculating STC of composite barriers.

The following is a discussion of techniques that can be used to reduce noise in a building by means of its windows. These techniques range from a blocking of the principal paths of noise entry to a blocking of the most indirect paths.

- **Close windows** The first step in reducing unwanted sound is to close and seal the windows. The greatest amount of sound insulation can be achieved if windows are permanently sealed. However, openable acoustical windows have been developed which are fairly effective in reducing sound.6 Whether or not the sealing is permanent, keeping windows closed necessitates the installation of an air-conditioning system. The air conditioning system may in addition provide some masking of noise. (Masking is discussed below). If windows must be openable, special seals are available which allow windows to be opened.[7]
- **Reduce window size**The smaller the windows, the greater the transmission loss of the total partition of which the window is a part. Reducing the window size is a technique that is used because (a) it precludes the cost of expensive acoustical windows, and (b) it saves money by cutting down the use of glass. The problems with this technique are (a) it is not every effective in reducing noise; e.g., reducing the proportion of window to wall size from 50% to 20% reduces noise by only 3 decibels; and (b) many building codes require a minimum window to wall size ratio.
- **Increase glass thickness**If ordinary windows are insufficient in reducing noise impacts in spite of sealing techniques, then thicker glass can be in stalled. In addition, this glass can be laminated with a tough transparent plastic which is both noise and shatter resistant. Glass reduces noise by the mass principle; that is, the thicker the glass, the more noise resistant it will be. A 1/2-inch thick glass has a maximum STC rating of 35 dB compared to a 25 dB rating for ordinary 3/16 inch glass.

However, glass thickness are only practical up to a certain point, when STC increases become too insignificant to justify the cost. For example, a 1/2 inch thick glass can have an STC of 35; increasing the thickness to 3/4 inch only raises the STC to 37. However, a double glass acoustical window consisting of two 3/16 inch thick panes separated by an airspace will have an STC of 51 and can cost less than either solid window

In addition to thickness, proper sealing is crucial to the success of the window. To prevent sound leaks, single windows can be mounted in resilient material such as rubber, cork, or felt.

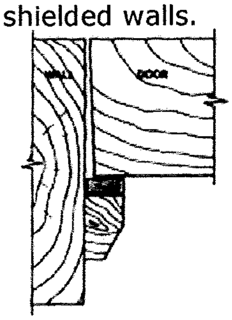
Install Double-Glazed Windows Double-glazed windows are paired panes separated by an airspace or hung in a special frame. Generally, the performance of the double-glazed window may be increased with:

a. increased airspace width
b. increased glass thickness
c. proper use of sealing
d. slightly dissimilar thickness of the panes

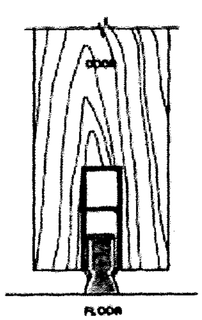
e. slightly non-parallel panes

In general the airspace between the panes should not be less than 2-4 inches if an STC above 40 is desired. If this is not possible, a heavy single-glazed window can be used. The use of slightly non-parallel panes is a technique employed when extremely high sound insulation is required, such as in control rooms of television studios.
The thickness of double-glazed panes may vary from 1 /8 to 1 /4 inch or more per pane. Although thickness is important, the factors which most determine the noise resistance of the window is the use of sealant and the width of the airspace.
As in the case of all windows, proper sealing is extremely important. To achieve an STC above 43, double-glazed windows should be sealed permanently. If the windows must be openable, there are available special frames and sealers for openable windows which allow a maximum STC of 43.1
Permanently sealed double-glazed windows often require an air pressure control system to maintain a constant air pressure and minimal moisture in the airspace. Without this system, the panes may deflect, and, in extremely severe cases, pop out of the frames.
To further insure isolation of noise between double-glazed panes, the panes could be of different thicknesses, different weights, and slightly non-parallel to each other. This prevents acoustical coupling and resonance of sound waves.

D. Doors Acoustically,doors are even weaker than windows, and more difficult to treat. Any door will reduce the insulation value of the surrounding wall. The common, hollow core door has an STC rating of 17 dB. Taking up about 20% of the wall, this door will reduce a 48 STC wall to 24 STC. To strengthen a door against noise, the hollow core door can be replaced by a heavier solid core door that is well sealed[2] and is relatively inexpensive. A solid core door with vinyl seal around the edges and carpeting on the floor will reduce the same 48 STC wall to only 33dB[3]. An increased sound insulation value can be achieved if gasketed stops or drop bar threshold closers are installed at the bottom edge of the door. (See Figure 4.15) The alternative solution to doors is to eliminate them whenever possible from the severely impacted walls and place them in more shielded walls.



Gasketed door stop



Drop bar threshold closer

4.15 Increased sound insulation can be achieved with gasketed door stops or drop bar threshold closers.

E. Ceilings Acoustical treatment of ceilings is not usually necessary unless the noise is extremely severe or the noise source is passing over the building. The ordinary plaster ceiling should provide adequate sound insulation except in extremely severe cases. An acoustically weak ceiling which is likely to require treatment is the beamed ceiling.4 Beamed ceilings may be modified by the addition of a layer of fiberglass or some other noise resistant material. Suspended ceilings are the most effective noise reducers but they are also the most expensive.

F. Floors In the case of highway noise, floors would only require acoustical treatment if the highway were passing under the building. In this case, flooring would have to provide protection against structural vibrations as well as airborne sound.

G. Two ways to insulate a floor from noise are to install a solid concrete slab at least 6 inches thick or install a floating floor. In general, the floating floor gives the greatest amount of sound and vibration insulation; however, it is extremely expensive. Basically, a floating floor consists of a wood or concrete slab placed over the structural slab, but separated by a resilient material. The resilient material isolates the surface slab from the structural slab and the surrounding walls.

H. Interior Design Overall interior noise levels can be reduced by the extensive use of thick, heavy carpeting, drapes, wall hangings, and acoustical ceiling tiles. These materials absorb sound. They cannot prevent noise from coming through the walls, but they can reduce overall sound levels by reducing sound reverberations.

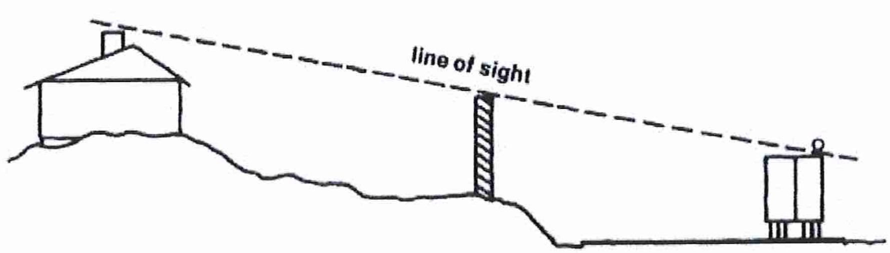
I. Masking Another way of coping with noise is to drown it out with background noise. This technique is known as masking. It can be very effective in reducing noise fluctuations which are often the most annoying aspects of noise. Masking can be produced by air conditioning and heating systems, soft music, or electronic devices.

4.4 Barriers

A noise barrier is an obstacle placed between a noise source and a receiver which interrupts the path of the noise. They can be made out of many different substances:

a. sloping mounds of earth, called berms
b. walls and fences made of various materials including concrete, wood, metal,plastic, and stucco
c. regions of dense plantings of shrubs and trees
d. combinations of the above techniques

The choice of a particular alternative depends upon considerations of space, cost, safety and aesthetics, as well as the desired level of sound reduction. The effectiveness of the barrier is dependent on the mass and height of the barrier, and its distance from the noise source and the receiver. To be effective a barrier must block the "line of sight" between the highest point of a noise source, such as a truck's exhaust stack, and the highest part of the receiver. This is illustrated in Figure 4.16.

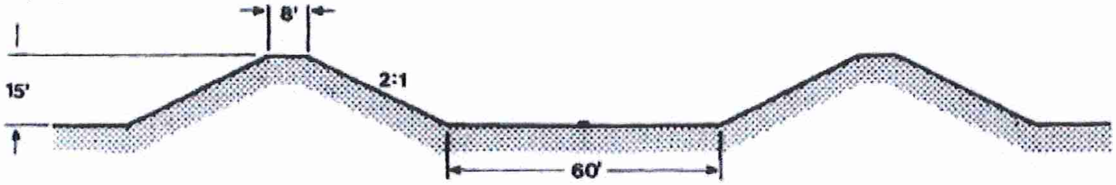


4.16 To be effective, a barrier must block the "line of sight" between the highest point of a noise source and the highest part of a receiver.

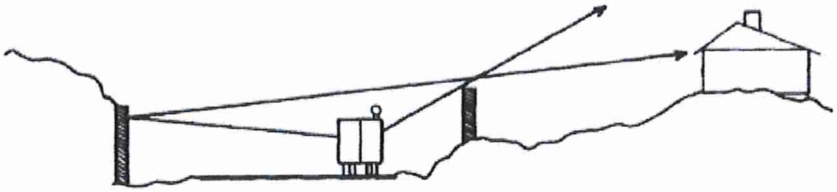
To be most effective, a barrier must be long and continuous to prevent sounds from passing around the ends. It must also be solid, with few, if any, holes, cracks or openings. It must also be strong and flexible enough to withstand wind pressure.

Safety is another important consideration in barrier construction. These may include such requirements as slope, the distance from the roadway, the use of a guard rail, and discontinuation of barriers at intersections. Aesthetic design is also important. A barrier constructed without regard for aesthetic considerations could easily be an eyesore. A well designed berm or fence can aesthetically improve an area from viewpoints of both the motorist and the users of nearby land.

A. **Earth Berms** An earth berm, a long mound of earth running parallel to the highway, is one of the most frequently used barriers. Figure 4.17 shows a cross-section of a berm. Berms can range from five to fifty feet in height. The higher the berm, the more land is required for its construction. Because of the amount of land required, a berm is not always the most practical solution to highway noise. Different techniques must be applied in urban as distinct from rural settings. A berm can provide noise attenuation of up to 15 dBA if it is several feet higher than the "line of sight" between the noise source and the receiver. This is comparable to the noise reduction of various walls and fences which are used as barriers. However, earth berms possess an added advantage: instead of reflecting noise from one side of the highway to another, as walls do,1 and thus increasing the noise heard on the opposite side, they deflect sound upwards. Figure 4.18 illustrates this phenomenon. The cost of building a berm varies with the area of the country and the nature of the project. In California, the statewide average for building a berm is about $1 per cubic yard when the earth is at the site.2 In planning a berm, one must include seeding and planting in figuring cost. Also to be included are land costs and maintenance in relation to erosion, drainage, snowplowing, mowing, and perhaps future seeding. It costs approximately $1,000 per acre per year to maintain a berm which is accessible to maintenance equipment.3



4.17 Cross section of a berm



4.18 Wall barriers may reflect sound from one side of the highway to the other.

B. Walls and Fences as Barriers In addition to the more usual function of keeping people, animals and vehicles from entering the highway right of way at undesired locations, a properly designed fence or wall can also provide visual and acoustical separation between highway noise sources and adjacent land areas. This method can reduce noise as much as 15 dBA.4 The vertical construction and minimal width of walls and fences makes installation possible when space is severely limited. This is especially important when land costs are high, and where buildings are already adjacent to the highway. The advantages and disadvantages of wall and fence barriers are summarized in Figure 4.19. The number of design variations for fence and wall barriers is virtually unlimited. Acoustically, any solid continuous structure will suffice, provided that it is high enough, and provided that the barrier is of adequate mass and density. The cost of a fence or wall type barrier can vary considerably according to the type of construction, the material used, local availability of materials and skills, and the barrier's dimensions. Not all types of barriers are suited for all climates, and local conditions may cause significant differences in the maintenance cost of the various barrier types. The cost questions must be evaluated on a local basis. Some of the frequently used materials for fence and wall construction are masonry, precast concrete, and wood. Masonry noise barriers can be made of concrete blocks, brick or stone. A concrete block barrier might range in cost from $10a linear foot for a 6-ft. high wall, to $75 a linear foot for a 12-ft. high wall. This latter figure includes a safety railing. In general, a concrete block wall would cost $50 to $60 a linear foot.1 To alleviate the monotony of a long run of wall, pilasters can be used: a 20 ft. high concrete wall with pilasters might cost $300 per linear foot.2 Brick and stone are extremely expensive and should only be used for special aesthetic considerations.3 Precast concrete panels offer opportunities for cost reduction. A 13' 4" high wall in Fairfield, California constructed of precast concrete panels cost only $29.50 per linear foot Wood noise barriers are another possibility. They tend to be less expensive than other methods but are not as durable. An estimated cost for a 6' high 5/8" plywood fence is $5.00 per linear foot.[4]

C. Plantings Plants absorb and scatter sound waves. However, the effectiveness of trees, shrubs, and other plantings as noise reducers is the subject of some debate. Some conclusions can, however, be drawn:

- Plantings in a buffer strip, high, dense,and thick enough to be visually opaque, will provide more attenuation than that provided by the mere distance which the buffer strip represents. A reduction of 3-5 dBA per 100 feet can be expected. Shrubs or other ground cover are necessary in this respect to provide the required density near the ground.

- The principal effect of plantings is psychological. By removing the noise source from view, plantings can reduce human annoyance to noise. The fact that people cannot see the highway can reduce their awareness of it, even though the noise remains.
- Time must be allowed for trees and shrubs to attain their desired height.
- Because they lose their leaves, deciduous trees do not provide year-round noise protection.

In general, plantings by themselves do not provide much sound attenuation. It is more effective, therefore, to use plantings in conjunction with other noise reduction techniques and for aesthetic enhancement. The cost of plantings varies with the species selected, the section of the country, the climate, and the width of the buffer strip. For deciduous trees and evergreens, costs range from $10 to $50 a linear foot. The width of such a strip would be approximately 40 feet for deciduous trees and 20 feet for evergreens. Planting shrubs between the trees so as to form a dense ground cover would double the price.

D. Combinations of Various Barrier Designs Often, the most economical, acoustically acceptable, and aesthetically pleasing barrier is some combination of the barrier types previously discussed. For example, the Milwaukee County Expressway and Transportation Commission feels that barriers constructed of precast concrete on top of an earth berm provide maximum benefit for the cost.5 They estimate that such a combination costs $51 per linear foot. In addition to cost advantages, an earth berm with a barrier wall on top of it possesses several other advantages over both a wall or a berm alone: 1) it is more visually pleasing than a wall of equivalent height; 2) the berm portion of this combination is less dangerous for a motorist leaving the roadway; 3) the non-vertical construction of the berm does not reflect noise back to the opposite side of the highway the way a wall does; 4) the combination requires less land than would be required for a berm of equivalent height and slope; and 5) the wall provides a fencing function not provided by a berm. Another combination to be considered is that of plantings in combination with a barrier. Not only do plantings and ground cover provide some additional noise attenuation, but they also increase visual appeal.

[1] Reflection of noise from one side of the highway to another can increase sound levels by 3 dBA. Scholes, Salvidge, and Sargent, "Barriers and Traffic Noise Peaks,"Applied Acoustics, 5:3 (July 1972) p. 217.

[2]This estimate was provided by the California Highway Department.

[3] Ibid.

[4] California Division of Highways, Highway Noise Control, A Value Engineering Study, (October 1972).

4.5 Conclusion

Figure 4.19 provides a summary of the physical techniques which can be used by designers, builders, and developers to reduce highway noise impacts. Some conclusions follow which may be useful in getting them implemented.

Figure 4.19

Physical Technique	Potential Effectiveness	Situations Where Most Effective	Cost	Relevant Administrative Technique	Comments
Acoustical Site Planning	Good-excellent: depends on size of lot and natural terrain.	Before building construction, before subdivision development	Low. only costs are fees of acoustical consultant and site planner.	Building code* Health code	Fairly inexpensive but requires space which may be unavailable. Has limited sound reduction. Positive aesthetic impacts.
Acoustical Architectural Design	Fair	Before building construction.	Low: only cost is that of acoustical consultant	Building code* Health code	Low cost but limited effectiveness.
Acoustical construction.	Excellent for interior, poor for exterior.	During building construction best. Most costly after construction.	Varies with amount of noise reduction desired but generally high especially after construction.	Building code* Health code	Most effective noise reduction for interiors

Barriers	Fair-excellent, depends on height and mass	Varies with type of barrier	Moderate-high: varies with type of barrier, see below.	Zoning, subdivision rules, health code	High noise reduction and potentially low cost. Achieves exterior noise reduction. Can have adverse aesthetic impacts.
Earth Berms	Good-excellent	Best during road construction when earth is available. Costly after road construction. Impractical in densely populated areas where land is scarce.	Moderate-high: depends on availability of earth.		Good noise reduction properties and aesthetic appeal, but requires space and requires maintenance.
Walls and Fences	Poor-excellent, depends on height and mass	Any time	Low-high: depends on height and thickness.		Requires little space and no maintenance, but may be aesthetically unappealing and can reflect noise to other side of road.
Plantings	Poor	After road construction. After building construction.	Moderate high: depends on size of buffer strip.		Poor noise reduction but often necessary for aesthetic appeal. Best used in combination with other techniques.
Combinations	Good-excellent.	Depends on particular combination.	Moderate-high: depends on type of barrier used		Potentially high noise reduction and aesthetic appeal.

4.19 Summary of Physical Techniques to Reduce Noise Impacts

As is indicated by the chart below, five factors which must be considered in the selection of noise reduction measures include the following:

1. Noise reduction desired
2. Situation where the physical technique would be most effective
3. Cost
4. Relevant administrative techniques
5. Aesthetics

Noise Reduction The physical techniques discussed vary in their noise reduction capabilities. For example, the effectiveness of the less expensive techniques, such as site planning and acoustical architectural design, is limited to situations where there is some distance between the buildings and the noise source. If the noise source is nearby and significant noise reduction is desired regardless of the expense, then more expensive measures, such as acoustical soundproofing and barrier construction, may be necessary.

Situation where a technique is most applicable The applicability of a technique is determined by the population density of an area and the point in the development process at which the technique is to be used, i.e., its timing. In a densely populated area, site planning (perhaps in conjunction with construction of a berm and a region of plantings) can often solve the noise problem. In a high density area where land is scarce and expensive, a better alternative would be barrier construction and acoustical soundproofing of the buildings.

*Administrative techniques which can achieve any physical technique are health codes, occupancy permit procedures, architectural review boards, and municipal design services.

The timing of a technique also determines whether or not it is applicable. There are three points at which physical noise reduction measures can be used: in the planning phase; during building construction; and after construction. Techniques applicable during the planning phase Include acoustical site planning and acoustical architectural design. During the construction phase, those techniques most applicable for highways are berms and barriers, since building materials are available at the site; and during building construction the most appropriate measure is acoustical soundproofing. It is possible to undertake noise reduction measures after construction, but costs are much higher.

Cost Cost is a very important consideration in the selection of a physical noise reduction technique. Generally, cost is determined by the amount of noise reduction desired and whether the noise measure is a preventative or ameliorative one.

The most effective noise reduction measures are often the most expensive. These include barrier construction and acoustical soundproofing. However, if action is taken as a preventative measure in the planning stage, there is often no need for the more expensive techniques.

Relevant administrative techniques All these physical techniques depend upon administrative actions for implementation. It is possible that physical measures to reduce noise would be taken without local government action, but since they involve extra expense, it is unlikely that they would be adopted on any significant scale. Many administrative means exist to achieve each physical noise reduction technique. For example, a noise impacted area can be zoned to specify details of development design or construction. In such an area, buffer strips (acoustical site planning), acoustical arrangement of living spaces (acoustical architectural design), building insulation (acoustical construction techniques), and barrier construction could be required. Similar requirements could be included in the subdivision laws. Building and health codes, enforced by withholding an occupancy permit, are effective ways to bring about acoustical soundproofing. As explained in the section on Building Codes, particular acoustical construction materials can be required or specific performance standards established.

Aesthetics Aesthetic and quality of life considerations are another important area of concern. They depend largely on local preferences and climate, and opinions of what is aesthetically pleasing will vary among communities.

Whatever the aesthetic judgement, aesthetic considerations must be incorporated into the planning and construction process to insure that the solution which results is not offensive to the community. This can save a great deal of time and money in the long run.

Finally, it should be stressed that no single technique or combination of techniques is best for all situations, and that technique which is best will depend on the nature of the project. The factors which are discussed above (i.e., noise reduction, cost, applicability, and aesthetics) must be balanced against each other to determine which technique or combination of techniques will be most effective in a given situation.


State Route 91


State Route 91

Board of Zoning and Building Appeals
Area/Size Variance Worksheet

Application for property located at:____

Applicant:____

After reviewing the application, the hearing of evidence under oath, reviewing all documentary submissions of interested parties, and by taking into consideration the personal knowledge of the property in question, the Board of Zoning and Building Appeals finds and concludes:

1. The property in question (will / will not) yield a reasonable return and there (can / cannot) be a beneficial use of the property without the variance because
____
____
____
____.

2. The variance is (substantial/insubstantial) because____________________
____
____
____
____.

3. The essential character of the neighborhood (would / would not) be substantially altered or adjoining properties (would / would not) suffer a substantial detriment as a result of the variance because__________________________________
____
____
____.

4, The variance (would / would not) adversely affect the delivery of governmental services, (e.g. water, sewer, garbage).

5. The applicant purchased the property (with / without) knowledge of the zoning restriction.

6. The applicant's predicament feasibly (can / cannot) be resolved through some method other than a variance.

7. The spirit and intent behind the zoning requirement (would / would not) be observed and substantial justice (done / not done) by granting the variance because____
____
____
____

For all of the above reasons, I move that the variance be (granted / denied) (granted with the following conditions):
____
____
____
____

7/6/2015

Brian & Mairin Mancino
20 High St.
Hudson, OH 44236

City of Hudson
Community Development
115 Executive Parkway
Suite 400
Hudson, OH 44236

To the Zoning & Variance Committee:

We are writing to express our support for the variance requested by Kim and Rick Nickerson on their property located at 2 High Street (BZBA CASE NO. 2015-03 VARIANCE). We own the parcel of property contiguous to the Nickerson's property at 2 High St, and we believe their requested variance would provide a benefit to the use and enjoyment of our property as well.

Thank you for your consideration.

Regards,

Brian & Mairin Mancino
20 High St.

20 High St.