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NOISE AND VIBRATION ANALYSIS

FOR

METRO RAIL PROJECT

CORE STUDY

Submitted to:

METRO RAIL TRANSIT CONSULTANTS

FINAL REPORT

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1. INTRODUCTION

This report presents the results of a study of the noise and vibration characteristics to be expected from Metro Rail System operations along five final alternative alignments which comprise the "CORE" Study. The five candidate alignments are designated 1 through 5, and are described in the memorandum of December 23, 1986, "CORE Study Final Candidate Alignments" (Ref. 1). Each of the alignments consist of a northerly branch and a westerly branch which connect to the subway section through downtown and part of Wilshire Boulevard (MOS-1) and with the proposed subway alignment in the San Fernando Valley. This study covers the alternative alignments between Wilshire/Vermont Station and the North Hollywood Station as well as all westerly branches. Projections of ground-borne noise and vibration for the portions of the alignment not included in this report are contained in References 2, 3, and 4.

This report includes the projection of the expected ground-borne noise and vibration levels from train operations in the subway sections, and the projection of expected airborne noise levels produced by trains operating on the aerial structure sections. Also included are brief discussions of the noise expected from fan and vent shafts, ancillary facilities, and construction activities. An assessment of what the projections mean in terms of long- and short-term disturbance and a description of the recommended provisions to be included in the design of each alternative to reduce noise and vibration has been presented.

Projecting the level of noise expected from Metro Rail train operations requires consideration of the design features which will be included as part of the Metro Rail System. In making the projections of the expected noise and vibration levels, the procedure used has been to determine the expected levels with "standard" Metro Rail system facilities and compare the results with the design criteria for maximum allowable levels. The procedure then is to determine the expected noise and vibration levels with special design features for reduction of the noise and vibration, where needed to comply with the design criteria for maximum allowable levels.

Although a number of specific design features and exact locations of facilities have not yet been determined, certain general assumptions have been made as to the type of structures and facilities that will be used. For the subway alignments, structures and facilities similar to that for MOS-1 have been assumed, while for the aerial alignments, an all-concrete aerial structure has been assumed.

Note that the standard design features proposed for the Metro Rail System include many provisions which result in much lower noise and vibration levels than traditionally expected for a rail system. These features include such items as continuous welded rail, resilient (rubber) rail fasteners, use of wheel and rail grinding or truing machines to maintain the smoothness of the wheels and rail, use of vehicles with lightweight trucks which provide minimum unsprung weight, and the use of noise and vibration limits in the specifications and contract documents. All of these result in baseline noise and vibration levels for the system that are considerably reduced compared to experience with older systems.

Evaluation of the typical noise and vibration levels and type of occupancy in each community area provides a basis for selecting the appropriate maximum noise and vibration level criterion which should be applied. Comparison of the expected performance with the criterion provides a means for determining those areas where special design features are needed to reduce the noise and vibration to levels below those for standard design facilities.

No measurements of the existing environmental noise and vibration were undertaken for the alignments under consideration. However, environmental noise and vibration measurements were made along Wilshire Boulevard in 1981 and a short section of Lankershim Boulevard in 1982, and are reported in Reference 5. Thus, except for portions of the alignment along Wilshire Boulevard and a short section of Lankershim Boulevard, selection of appropriate criteria is based on the type of occupancy of each building and estimated existing noise and vibration levels.

The Metro Rail System has established strict criteria for maximum noise and vibration levels from the new transit system facilities and equipment (Ref. 6). This is because with a new transit system it is desirable both to provide a favorable environment for patrons of the system and to minimize transmission of noise and vibration to adjacent communities, buildings and structures. Acoustical impact is a very important factor influencing community and patron acceptance of any new transportation system and, particularly, the acceptance of a new rail transit system. The procedures and facilities used for noise and vibration reduction, e.g., the use of acoustical absorption materials, sound barrier walls, "soft" fasteners, resiliently supported ties and floating slab trackbeds, depend upon the need for these features as evaluated by determining projected noise levels in comparison with the criteria for acceptable or appropriate noise levels in the community where the transit system facilities are placed. Thus, the impact of each alternative alignment should be and has been evaluated in terms of facilities and operations incorporating the design features recommended herein for control and reduction of noise and vibration.

The evaluation presented, therefore, indirectly determines any special provisions needed to minimize environmental impact due to noise and vibration. The assessment of the projections of transit system noise and vibration includes a discussion of the expected noise and vibration levels in terms of their audibility and comparison with the estimated existing noise and vibration levels in the study area and in comparison with criteria for reasonable and acceptable noise level in the communities and buildings along the proposed alignments.

All alignments except Alignment 1 include both subway and aerial structure sections, thus analyses of the expected ground-borne noise and vibration from train operations in subway and airborne noise from train operations on aerial structures have been performed. A direct comparison of the potential noise and vibration impact of an aerial structure alignment to a subway alignment cannot be made for the following reasons.

The character of noise from transit trains traveling on aerial structure is different than the character of noise which arises from transit trains operating in subway. The noise from trains traveling on aerial structure is airborne and can be perceived by individuals outside of a building or inside of a building at an attenuated level after the noise has passed through the windows, doors or walls of the building. The noise from trains traveling in subway is ground-borne and can be perceived only when an individual is inside a building near the subway; outdoors the ground-borne noise is not audible. A train operating in subway creates vibration at the wheel/rail interface which is transmitted to the subway structure where it is then radiated in the form of a low-frequency noise which can be heard and sometimes felt as mechanical vibration only inside buildings near the subway. Trains operating on aerial structure will produce vibration levels in the ground which are generally low enough in level that they will not be felt by occupants of nearby buildings, while the vibration levels produced by trains operating in subway can in some situations be high enough in level that they can be felt by occupants of nearby buildings. As for ground-borne noise, vibration from train operations in subway can only cause impact to people or special equipment inside buildings.

Table 1-1 summarizes the preceeding discussion for convenience. Examination of Table 1-1 indicates that in order to undertake a meaningful direct comparison of the potential noise and vibration impact from subway and aerial structure train operations, the comparison must be done for occupants inside buildings adjacent to the alignment. Some of the necessary information includes size of the building structure, building construction materials and assemblies, number of doors, operable and inoperable windows facing the alignment, etc. Thus, in order to undertake a general review of the potential community noise and vibration impact from transit train operations in either subway or on aerial structure, we have compared the expected noise levels from train operations with appropriate acceptability criteria for the community.

TABLE 1-1 POSSIBILITY FOR NOISE AND VIBRATION IMPACT DUE TO TRANSIT TRAIN OPERATIONS

Type of Structure	Outside	Inside
Subway	None	Possible - due to ground-borne noise and/or ground-borne vibration
Aerial	Possible - due to airborne noise	Possible - due to airborne noise transmitted through building walls

2. GROUND-BORNE NOISE AND VIBRATION FROM SUBWAY OPERATIONS

Underground operations of rail rapid transit systems do result in ground-borne vibration and noise which is transmitted from the subway structure to adjacent buildings via the intervening geologic strata. The ground-borne vibration originates at the wheel/rail interface and is due to vibration and noise generated by the wheels rolling on the rails. The level of this vibration at the source is influenced by the degree of roughness or smoothness of the wheels and rails, the speed of the train, and by the type of subway structure and geologic strata in which the structure is founded.

As previously indicated, the ground-borne noise and vibration which results from the operation of transit trains in subway is only potentially perceptible inside buildings adjacent to the subway. The level of ground-borne noise and vibration which reaches the nearby buildings is dependent on the source level, the intervening medium between the subway tunnel and building foundation, and the response of the building to the ground-borne vibration. To an individual inside a nearby building, the passage of a train is perceived by the actual physical motion of the floor or objects (ground-borne vibration) or by a low frequency rumbling noise (ground-borne noise) which is due to the radiation of noise from the vibrating floor and sometimes walls.

It should be noted that the vibration is of such a low level that there is no possibility or potential for structural damage due to the ground-borne vibration transmitted to buildings near the subways. It should also be noted that trains operating on aerial structure will produce vibration levels which will be low enough in level that they will generally not be felt by nearby occupants of buildings. This is due primarily to the fact that the airborne noise from trains traveling on aerial structure generally overpowers the perception of ground-borne noise and vibration if there is a perception of the train passby.

In order to ensure that ground-borne noise and vibration from the operation of Metro Rail trains will be acceptable, but not necessarily imperceptible, inside buildings adjacent to the alignment, criteria for acceptable levels of ground-borne noise and vibration have been adopted and applied to the buildings along the alternative alignments. Sections 7.4.2 and 7.4.3 of the Metro Rail Design Criteria present the appropriate criteria for acceptable levels of ground-borne noise and vibration.

The basic vibration level and frequency content or spectrum at the source are based on subway measurements at BART and at-grade measurements of the BRRT (Baltimore) vehicle at the Transportation Test Center. From these measurements force density levels for BART and BRRT trains were developed. The force density level is

roughly analogous to the sound power level characteristic of a particular type of noise generating equipment. Both vehicles have Rockwell trucks which have stiff primary suspensions. The Metro Rail vehicle specification indicates that the transit vehicle will have a truck with a primary suspension resonance of less than 12 Hz. This reduces the force density level in the 12 to 25 Hz frequency range. In this analysis we have assumed that the Metro Rail transit vehicle will have a low stiffness primary suspension. It is extremely important to note here that if the vehicle does not have a low stiffness primary suspension then the ground-borne noise and vibration predictions will be invalid. Vehicles with a stiff primary suspension will produce higher levels of ground-borne noise and vibration, and consequently, greater extent of mitigation measures will be required in the subway.

The properties of vibration propagation are highly dependent on a number of different factors, especially on the soil types that intervene between the subway and adjacent buildings. Due to the dependency on soil types, we have performed two studies which have attempted to obtain detailed information about the properties of vibration propagation along the previously adopted Metro Rail alignment. The first study was the so-called "Pilot Study" where tests were performed at 5 locations in December 1982. The "Pilot Study" was sponsored through a research contract with the U.S. Department of Transportation/Transportation Systems Center. Test procedures and results have been reported in our Technical Memoranda "Use of Impact Method for Prediction of Groundborne Vibration along the SCRTD Metro Rail Route" of August 22, 1983 (Ref. 7) and "Projected Levels of Groundborne Vibration along the SCRTD Metro Rail Route" of September 7, 1983 (Ref. 8).

WIA performed a second study in December 1983. This was designed to obtain detailed information about the properties of vibration propagation in the siltstone of the bedrock formation referred to as the Fernando Formation. The measurement procedures and results were presented in our report, "Ground-Borne Vibration Propagation Investigation - Fernando Formation Bedrock" of April 1984 (Ref. 9).

For the alternative alignments under study, the subway alignments will be founded in either alluvium, the Puente Formation or the San Pedro Formation. For vibration propagation purposes, the Fernando Formation has similar properties to that of the Puente and San Pedro Formations. Thus, we have used vibration propagation characteristics determined from the two sets of tests described in References 7 and 9. While these vibration propagation tests are somewhat limited, they do provide a general indication of the vibration propagation characteristics which are an important factor in our prediction procedure. Although these tests do provide general vibration propagation characteristics, the actual vibration propagation characteristics at any specific location may be different due to such things as a sudden change in soil strata, large boulders, etc.

After the vibration has passed from the source and through the intervening soil, the vibration is transmitted into the building foundation. Field measurements inside a variety of building structures along existing subways indicate that building structures respond differently to ground vibration depending on such things as the type of foundation, type of framing (i.e., wood, steel, masonry), size of structure, etc. For this analysis, much of this information is not known and generalized adjustments have been made as to the type of building structure based on the aerial photographs supplied by MRTC.

The ground-borne noise and vibration has been predicted to the ground floor of the buildings which are nearest the subway structure. For each prediction the propagation distance is assumed to be the diagonal distance from the top-of-rail at track centerline to the ground floor of the building.

The basic analysis is based on 6-car Metro Rail trains traveling on track with resilient direct fixation (D.F.) fasteners at a maximum train speed of 70 mph for line sections and 45 mph at stations. Maximum train speeds have been adjusted for lower limits where indicated by MRTC. Speed changes are based on an acceleration and deceleration rate of 3 MPHPS. We have used the alignment plan and profile with aerial photographs which were developed for the "CORE" Study. Building uses and the number of building structures located adjacent to the subway have been estimated based on the aerial photographs, supplemented by a separate indication of potentially sensitive structures provided on the aerial photographs by MRTC and by information previously provided to us for earlier studies along portions of Wilshire Boulevard, Sunset Boulevard and Lankershim Boulevard. Thus, the building use identification is most refined along Wilshire Boulevard, portions of Sunset Boulevard, and Lankershim Boulevard.

The prediction procedures used for this analysis have been developed over the last several years. Although this prediction procedure is new and refinements are still being made, the procedure is a considerable improvement over the prediction procedures used during the alternative analysis of 1982 (Ref. 4).

The evaluation of ground-borne noise and vibration from subway operations have indicated mitigation measures where the projected levels for trains operating on standard D.F. fasteners exceed the criteria. The effectiveness of the candidate mitigation measures is based on a number of factors, including actual measured effectiveness at other systems with similar soil conditions and the estimated effectiveness where measured conditions are somewhat different than those expected for the Metro Rail System. The three types of mitigation measures are 1) a resiliently supported tie system, such as the RS-STEDEF system; 2) a very "soft" direct fixation fastener, such as one made by the Lord Corporation or one with a different design but with similar performance known as the

Cologne Egg; and 3) a floating slab trackbed, where the entire trackbed is resiliently isolated from the subway structure. Each of these mitigation measures provide a certain degree of vibration reduction which is frequency dependent. The floating slab trackbed is the most effective mitigation measure, but also the most expensive. The "soft" fasteners and resiliently supported ties provide an intermediate level of vibration reduction. Although both provide an intermediate level of vibration reduction, since their effectiveness is frequency dependent, a particular system may be recommended due to specific soil conditions or building structure type.

Appendices I through V (for Alignments 1 through 5 respectively) present a summary of the results of calculations of the expected maximum ground-borne noise and vibration levels from Metro Rail transit train operations along the subway sections of each of the alternatives under consideration. The data include the location along the alignment by civil station number, structure use, the depth of the top-of-rail below grade, the distance from the near track centerline to the buildings under consideration, and the maximum train speed for the area. Using these data in conjunction with the data and techniques which have been developed for computing expected ground-borne noise and vibration, the levels shown were calculated. If the expected ground-borne noise and vibration levels are significantly below the criterion for acceptable levels with the use of resilient direct fixation fasteners, then the predicted noise and vibration levels with mitigation measures are not shown, since these track fixation methods will reduce the levels even further below the criterion. If a mitigation measure is needed to achieve criteria compliance, then the expected maximum ground-borne noise and vibration levels are shown for the recommended mitigation measure.

Since the calculations are done for each frequency range on a one-third octave band basis, the expected ground-borne noise and vibration level is first determined in terms of one-third octave band levels. The one-third octave band analyses of the expected levels have been converted to an equivalent A-weighted noise level and an overall vibration velocity level.

Review of the expected levels indicated in the Appendices shows that there are locations along each alternative where mitigation measures will be needed to reduce the levels of ground-borne noise and vibration from subway operations. For virtually all locations along each alternative, one of the three mitigation measures will reduce the ground-borne noise and vibration to acceptable levels. Other mitigation measures which can be used on a site-specific basis include such measures as minor alignment relocation, crossover relocation, subway structure modification, and train speed modification.

The analyses also assumes that the track switches in the subway will use standard gapped-frogs. Trains traversing these switches will produce higher levels of noise and vibration by approximately 10 dB due to the impact at the frog. If a movable point switch frog or a spring loaded switch frog is utilized, then there will be no impact during normal operations and consequently no increase in the wayside noise and vibration levels.

In terms of impact assessment, if the maximum expected ground-borne noise and vibration levels are within 2 dB of the appropriate criterion, then in most cases we have considered the expected levels to be within substantial compliance with the criterion and thus no impact. If the maximum predicted levels are 3 dB or more above the criterion, then we have assumed that some degree of impact can be expected. Since a range of expected ground-borne noise and vibration has been predicted, then even when the expected maximum levels are within 2 dB of the criterion, there is a good possibility of criterion compliance unless the trains always produce the maximum ground-borne noise and vibration levels predicted.

Table 2-1 summarizes the anticipated impact of ground-borne noise and vibration from Metro Rail trains operating in subway. In addition this table indicates the approximate length of mitigation measures recommended for each alignment. A discussion of the ground-borne noise and vibration for transit train operations along each alignment follows:

Alignment 1

Alignment 1 is the only alignment which is entirely in subway. It is also the only alignment which includes a subway along Wilshire Boulevard west of the Wilshire/Crenshaw Station. Although the subway is relatively shallow with cut-and-cover construction, there is only one section on the western portion of the Wilshire Boulevard alignment (affecting two residences) where the noise and vibration from train operations with standard D.F. fasteners will be unacceptable. There are several factors contributing to the acceptability of noise and vibration along this portion of the alignment. These include: (1) few single-family residences adjacent to the alignment; (2) few non-residential noise and vibration sensitive building uses such as recording/TV studios, churches, schools, etc.; (3) soils which do not propagate vibration "efficiently" as determined by the bore-hole tests at Wilshire Boulevard/Hudson Avenue; and (4) an alignment which passes directly under very few buildings.

For the entire Wilshire Branch, without the recommended mitigation measures, impact is anticipated at 8 commercial/office buildings, 1 church and 2 single-family residential buildings. For the Wilshire Branch of Alignment 1, the approximate length of recommended mitigation measures for both tunnel bores is 600 ft of resiliently supported ties and 3,650 ft of "soft" fasteners.

The Vermont/Hollywood Branch of Alignment 1 is adjacent to numerous commercial/office buildings with uses which are, in general, not as sensitive to ground-borne noise and vibration as are residential buildings. However, the alignment does pass directly under a number of apartment and single-family residential buildings south of the Hollywood Bowl.

The Lankershim Branch is common to all of the alignments, and although the uses of buildings on Lankershim are primarily non-residential, there are several recording studios, two theaters and a church where the ground-borne noise and vibration from train operations will be excessive without mitigation measures.

For the northerly branch of Alignment 1, impact is anticipated at 1 commercial/office building, 8 apartment buildings, 41 residences, 1 church, 2 school buildings, 2 hospital buildings, 2 theaters and 4 recording studios. The approximate length of recommended mitigation measures for both tunnel bores is 6,200 ft of "soft" fasteners and 6,100 ft of floating slab trackbed.

Alignment 2

The Wilshire Branch of this alignment is primarily aerial with a relatively short subway section, extending from the Wilshire/Vermont Station to just beyond the Wilshire/Western Station. Without the recommended mitigation measures, impact is expected at 8 commercial/office buildings. The approximate length of recommended mitigation measures for both tunnel bores is 3,100 ft of "soft" fasteners.

The Vermont Subway Branch is also relatively short, extending from the Wilshire/Vermont Station to a point south of the Vermont/Beverly Station. Without the recommended mitigation measures, impact is expected at 6 apartment buildings. The approximate length of recommended mitigation measures for both tunnel bores is 800 ft of "soft" fasteners.

The Hollywood Subway Branch connects with the aerial structure just west of the Hollywood Freeway before turning north towards the San Fernando Valley. Without the recommended mitigation measures, impact is expected at 21 residences, 2 apartment buildings and 1 theater. For the Hollywood Subway

Branch of Alignment 2, the approximate length of recommended mitigation measures for both tunnel bores is 500 ft of "soft" fasteners and 3,800 ft of floating slab trackbed.

As previously indicated, the Lankershim Branch is common to all of the alignments. Without the recommended mitigation measures, impact is expected at 20 residences, 1 church, 2 theaters and 4 recording studios. The approximate length of recommended mitigation measures for both tunnel bores is 4,000 ft of "soft" fasteners and 1,500 ft of floating slab trackbed.

Alignment 3

Alignment 3 is the only alignment with a westerly branch which does not extend along Wilshire Boulevard after Crenshaw Boulevard. The Wilshire/Crenshaw/San Vicente Branch of this alignment has a western terminus at the San Vicente/Pico Station. Once this branch leaves Wilshire Boulevard, the alignment continues adjacent to numerous homes and apartments. At the proposed subway depth there are many locations where the ground-borne noise and vibration from train operations should be reduced.

Without the recommended mitigation measures, impact is expected at 1 church, 122 residential buildings, and 33 apartments. For this westerly branch of Alignment 3, the approximate length of recommended mitigation measures for both tunnel bores is 10,200 ft of "soft" fasteners and 7,700 ft of floating slab trackbed.

The Vermont Subway and Lankershim branches of Alignment 3 are identical to that of Alignment 2 and reference is made to the discussion of these branches for that alignment.

Like Alignment 2, the Hollywood Subway Branch of Alignment 3 connects with the aerial structure just west of the Hollywood Freeway; however, the subway portion extends further west along Hollywood Boulevard before turning north towards the San Fernando Valley. Without the recommended mitigation measures, impact is anticipated at 11 apartment buildings and 1 theater. The approximate length of recommended mitigation measures for both tunnel bores is 3,500 ft of "soft" fasteners.

Alignment 4

The Wilshire, Vermont and Lankershim Subway Branches for this alignment are identical to these branches of Alignment 2, and reference is made to the discussion for that alignment.

The Sunset Subway Branch connects with the aerial structure at El Centro Avenue, just east of the Sunset/Vine Station. The alignment turns north along Highland Avenue and extends into the San Fernando Valley. Without the recommended mitigation measures, impact is anticipated at 2 commercial/office buildings, 38 residences and 4 television/recording studios. A pocket track with connecting switches is located just west of the Sunset/Vine Station. Even with the recommended mitigation measures, impact is still expected at two recording studios between civil station 552+50 and 554+00 due to switches for the pocket track. It is recommended that the switches be relocated or that the switches use spring-loaded switch frogs in order to reduce or eliminate the adverse impact in these studios.

For the Sunset Subway Branch of Alignment 3, the approximate length of recommended mitigation measures for both tunnel bores is 400 ft of resiliently supported ties, 1,000 ft of "soft" fasteners, and 3,000 ft of floating slab trackbed.

Alignment 5

This alignment is primarily subway, except for the western part of the Wilshire alignment, which is an aerial configuration, the same as that for Alignments 2 and 4. The northerly branch is all subway and extends up Western Avenue and west along Sunset Boulevard. West of the pocket track along Sunset Boulevard, Alignment 5 is identical to Alignment 4 and reference is made to the discussion for that alignment for structures past civil station 554+00.

The Wilshire Subway Branch is different than all of the other alignments due to the change in the configurations of the Wilshire/Vermont and Wilshire/Normandie Stations, and the relocation of the crossover west of the Wilshire/Western Stations. These changes are due to the northerly branch extending up Western Avenue rather than Vermont Avenue. Without the recommended mitigation measures, impact is expected at 10 commercial/office buildings, 6 apartment buildings and 1 church. For this westerly branch of Alignment 5, the approximate length of recommended mitigation measures for both tunnel bores is 2,600 ft of "soft" fasteners and 2,350 ft of floating slab trackbed.

For the Western/Sunset Branch between civil station 350+00 and 554+00, impact is anticipated at 7 commercial/office buildings, 36 apartment buildings, 7 residences, 2 motel/hotel buildings, 3 churches, 3 television/recording studios and 2 theaters without the recommended mitigation measures. For this portion of Alignment 5, the approximate length of recommended mitigation measures is 800 ft of resiliently supported ties, 7,900 ft of "soft" fasteners and 1,800 ft of floating slab trackbed.

TABLE 2-1 SUMMARY OF ANTICIPATED IMPACT OF GROUND-BORNE NOISE AND VIBRATION FROM METRO RAIL OPERATIONS IN SUBWAY

A. Impacts without recommended mitigation measures

	Alignment				
Structure Type	1	2	3	4	5
Commercial/Office	9	8	8	10	17
Apartments	8	8	50	6	42
Residential	43	41	142	58	67
Motel	--	--	--	--	2
Church	2	1	2	1	5
School	2	--	--	--	--
Hospital	2	--	--	--	--
Theater	2	3	3	2	4
Rec/TV Studio	4	4	4	8	8

B. Impacts with recommended mitigation measures

	Alignment				
Structure Type	1	2	3	4	5
Rec/TV Studio	--	--	--	2	--

C. Approximate Length of Recommended Mitigation Measures for Both Tunnel Bores

	Alignment				
Rec. Mitigation	1	2	3	4	5
Resiliently supported ties	600'	--	--	400'	1,200'
"Soft" fasteners	9,850'	8,400'	18,500'	8,900'	16,300'
Floating slab trackbed	6,100'	5,300'	9,200'	4,500'	7,750'

3. FAN AND VENT SHAFT NOISE LEVELS

Transit system facilities or operations which can create noise intrusion or annoyance include fan and vent shafts. At ventilation shafts the train noise transmitted to the surface gratings and thence to the surrounding community areas depend on the speed of the transit trains and the presence or absence of sound absorption material in the shafts or in the tunnels in the area near the vent shaft. At fan shafts the main noise is from the fans, but the noise from the transit trains can also transmit through the shafts. It has been found that the attenuation required for the fan noise provides more than adequate attenuation for the transit train noise. In general, the noise from the fan shafts is dependent upon the number of fans required in the shaft, i.e., the total volume of air to be handled by the shaft. The noise from the subway ventilation fan units is limited by a specification requiring certified maximum sound power levels which is included in the contract documents. This specification of maximum sound power level from the fans determines the maximum noise level which can be expected from operation of fans at each fan shaft in the absence of any attenuation treatment.

In the absence of acoustical treatment in the shafts, both measurements and calculations or estimates of the sound transmission through the various configurations of fan and vent shaft show that there will be very little attenuation of the transit train noise or the fan noise as it is transmitted through the ducts to the surface. This is because the shafts are of concrete, which has a negligible sound absorption coefficient, and because the shafts are of large cross-sectional area.

Reduction of the noise from the transit trains and from the ventilation fans can be achieved through: 1) the use of sound absorption treatment applied to the wall and ceiling surfaces of the shafts, and 2) the use of sound attenuators on the ventilation fans. In general, the sound absorption treatment applied to vent shaft walls and ceilings is a 2" to 4" nominal thickness panel material of expanded cellular glass or mineral fiber. The sound absorption coefficient will be at least 0.75 in the middle frequency range (the range included in the 500 Hz and 1000 Hz octaves) where the maximum reduction of noise is needed to give appropriate noise reduction to reduce the noise in accordance with the requirements of the design criteria.

At this time the exact locations of the fan and vent shafts have not been determined, thus a general discussion follows which indicates the design criteria which will be applied to achieve noise levels which are comparable to or less than the existing typical ambient noise levels and, therefore, will not contribute significantly to the noise environment.

The design criteria for fan and vent shafts is given in Table 7.7.1 of the Design Criteria document (Ref. 6) and is repeated here for convenience as Table 3-1. As with other aspects of the design criteria, the appropriate noise level design goal limit depends on the activities of occupants as well as the background noise in the area. The acceptable levels of noise from vent shafts and fan shafts are different. This is because the noise from a vent shaft is transient in nature while that from a fan shaft is continuous. Transient noises are acceptable at higher levels than continuous noises. Thus the transient noise design goals apply to the train passby noise transmitted from vent shaft openings and the continuous noise design goals apply to the fan noise from fan shaft openings.

TABLE 3-1 DESIGN CRITERIA FOR NOISE FROM TRANSIT SYSTEM FAN AND VENT SHAFTS

	Community Area Category	Maximum Noise Level, dBA	
		Vent Shaft	Fan Shaft
I	Low Density Residential	50	40
II	Average Residential	55	45
III	High Density Residential	60	50
IV	Commercial	65	55
V	Industrial/Highway	75	65

The criteria shall be applied at a distance of 50 ft from the shaft outlet or shall be applied at the setback line of the nearest building or occupied area, whichever is closer.

4. ANCILLARY FACILITY NOISE

As with the location of fan and vent shafts, the location of ancillary facilities has not been defined at the time of this study, however a general discussion of the noise from ancillary facilities follows. As with the noise from fan and vent shaft openings, the noise from ancillary facilities is subject to the Metro Rail design criteria for maximum permissible noise levels.

Ancillary facilities include such items as power sub-stations, emergency power generation equipment and chiller plants. The criteria for noise from these ancillary facilities is essentially the same as that shown for fan shafts in Table 3-1, except that sub-station and emergency power generation noise shall be limited to 5 dBA less sound level than given in Table 3-1. This is due to the fact that transformer noise and continuous noise with tonal components can be more obtrusive due to their tonal nature, which is accounted for by making the criteria more restrictive.

The specification of a maximum permissible noise level from ancillary facilities is intended to control the level of sound to minimize or eliminate annoyance due to noise from the facilities. The design of each facility is required to incorporate noise reduction features sufficient to achieve the appropriate noise level for the site. The noise reduction features of typical facilities include sound barrier walls surrounding the noise sources; complete enclosures around the noise sources; sound attenuators on fans, blowers or cooling towers; and the use of sound absorption material, both inside enclosures and on the noise source side of sound barriers.

The net effect of the provisions in the Metro Rail design procedures for reducing noise generated by these facilities is that, regardless of the final location chosen for the ancillary facilities, the noise generated will be compatible with the ambient noise of the surrounding area. In most cases the noise will be comparable to the pre-existing background noise. In some cases the noise will be audible but will not be intrusive nor will it be of a higher level than is appropriate for the land use and type of buildings nearby. The criteria is generally a more severe requirement than is placed on typical residential air conditioning systems and other mechanical equipment found in residential and semi-residential/commercial areas.

5. NOISE LEVELS FROM AERIAL STRUCTURE OPERATIONS

To provide a basis for evaluating the expected acoustical impact of the Metro Rail transit trains operating on the aerial structure, levels of the expected wayside noise from the train operations have been determined. The background information providing the basis for the expected performance is based on measured data for a variety of conditions at several operating systems: Bay Area Rapid Transit District (BART), Washington Metropolitan Area Transit Authority (WMATA), Metropolitan Atlanta Rapid transit Authority (MARTA), and Toronto Transit Commission (TTC). The predictions, therefore, are based on the information available from the latest advancements in technology, from data obtained from the newest systems, and available information from research studies on wheel/rail noise and aerial structure noise.

In the evaluation and control of wayside noise created by steel wheel/rail rapid transit system operations, for surface and aerial way structures, the use of low sound barrier walls at the side of the way structure has been found to be an effective means for reducing wayside noise exposure due to the transit train operations. Evaluations which have been made at several of the newest systems indicate that a substantial noise reduction, typically on the order of 9 to 10 dBA, can be achieved with sound barrier walls. The predictions which are included as part of Appendices present the determination of the expected wayside noise level performance with the inclusion of sound barrier walls where necessary as part of the transit system facilities.

The predictions of wayside noise levels to be expected from the transit trains take into account the operational characteristics such as train length, speed, auxiliary equipment noise and other features which can affect the wayside noise. It has been assumed that solid wheels with either steel or aluminum hubs will be used on all the vehicles and that the maximum operational speed will be 70 mph. It should also be noted that rail transit train noise is strictly a function of speed. There is no variation in the noise produced for different operating modes, i.e., acceleration, deceleration, coasting, or constant speed.

One of the most important design features of the Metro Rail System, which contributes to quieter operation than may be expected based on experience with older steel wheel/rail systems, is the use of continuous welded rail. With the continuous welded rail eliminating the rail joints, which are one of the major sources of noise in a steel wheel/rail system, and considering all of the features included on the transit cars for noise reduction, the overall result is a considerably lower wayside noise level than for older systems which have noisier or jointed rail and which have vehicle equipment that generates higher noise levels.

One of the noisiest modes of operation of rail rapid transit systems in the past has been operation on elevated or aerial structures. The lightweight steel structures of the Chicago and New York elevated, with direct or rigidly attached rails, produce very intense noise due to mechanical vibration of the structure as the transit trains pass by. This noise has resulted in considerable impact on the neighboring areas and buildings and is one of the factors which has resulted in the general public view that rail rapid transit systems are noisy. The noise generated by the steel aerial structure also results in high noise levels in the transit car, decreasing the quality of the environment presented to the transit system patrons.

For many years it has been known that concrete deck and all-concrete aerial structures result in much less structure radiated wayside noise and in-car noise for aerial structure operations. On many occasions there have been recommendations that the old steel structures be replaced with concrete structure or at least have concrete decks added. Economic considerations have always ruled out these changes. With the construction of new transit systems the opportunity for use of all-concrete structures is presented and these systems mainly use all-concrete aerial structure girders.

At BART, WMATA Metro and MARTA, the use of concrete aerial structures with resilient direct fixation rail fasteners has been demonstrated to be very effective in reducing wayside and in-car noise. The noise radiated by the mechanical vibration of the concrete aerial structure is less than the noise radiated by the car and the noise produced during aerial structure operations is primarily due to the characteristics of the car. The concrete structure is so effective, in fact, that it is possible to use a sound barrier wall for further reduction of the wayside noise since the noise is primarily radiated from the transit car and rails. With a sound barrier wall it is possible to reduce the wayside noise to levels 9 to 12 dBA less than the levels produced by the car alone, thus further reducing the noise of aerial structure operations on the neighboring communities (without significantly affecting car interior noise).

With a concrete aerial structure there is a small increase in the wayside and in-car noise compared to ballast and tie operations, however, this increase is primarily due to the sound reflective characteristics of the concrete trackbed compared to the absorptive characteristics of the ballast and tie trackbed. The wayside noise for operation on an all-concrete aerial structure is only 2 to 4 dB greater than for operation on ballast and tie tracks. Similarly, the in-car noise is about 3 dBA greater on concrete aerial structure than for ballast and tie track. These higher noise levels on the concrete aerial structure are primarily due to the reflection of the middle frequency range sound from the concrete trackbed and are not due to mechanical vibration of the aerial structure.

In contrast to this performance of the all-concrete aerial structure it is typical for the noise radiated by a steel aerial structure, for systems such as the Chicago Transit Authority, to cause the car interior noise to be 8 to 10 dBA greater for aerial structure operations compared to ballast and tie operations. In fact, in Chicago it is found that the car interior noise levels for aerial structure operations are essentially the same as for operation in the highly reverberant round tunnels - indicating very intense noise levels under the car on the elevated structure due to noise radiated by structural vibration.

With steel aerial structures the noise radiated from the structure is greater than the noise from the transit cars and wayside sound levels of 100 to 110 dBA are typical at distances of about 50 ft from the track centerline. With a concrete aerial structure, levels of 80 to 88 dBA at 50 ft are typical for even higher speed operation than is characteristic of the systems using steel aerial structures. With sound barrier walls the levels can be further reduced to the range of 70 to 78 dBA at 50 ft for concrete aerial structures whereas the noise from a steel structure cannot be reduced at all with a simple sound barrier.

Figure 5-1 indicates the expected wayside noise level at 50 ft from track centerline as a function of train speed for Metro Rail trains operating on aerial structure. The continuous welded and ground rail is of considerable benefit in reducing the wayside noise expected from the aerial structure. Further, where the trackbed is concrete as on an aerial structure, the use of resilient direct fixation rail fasteners of the same type as used in subways contributes to the lowering of vibration and noise levels. These rail fasteners are to be used on the Metro Rail aerial structures.

In regions where special trackwork is included, such as at crossovers, the wheel impact against the frogs, switch points or other discontinuities can significantly increase the radiated noise levels. As such, a correction factor must be added to Figure 5-1 in order to project the maximum train operations. A correction factor of +6 dBA has been added to account for the added wheel/rail noise at the discontinuities at special trackwork sections. The wheel impacts occur with every train passby regardless of train direction or switch position. A switch with a moveable point switch frog or with a spring loaded frog which is normally closed would eliminate the increase in wayside noise. However most transit authorities have rejected the use of either of these switch types due to potential maintenance problems. Our analysis which is indicated "x-over" assumes that a standard switch will be used at the crossover. If there is no gap at the switch frog, then the wayside noise will be the same as that for train operations on standard trackwork.

To derive the community noise impact from the wayside noise level data given on Figure 5-1 it is necessary to provide information on the decrease of the noise level with distance away from the track centerline. Figure 5-2 indicates the maximum wayside noise levels as a function of distance from track centerline for locations perpendicular to the center of the train as the train passes by, assuming open level terrain. The chart is plotted in a manner to give a correction factor to be applied to the levels on Figure 5-1 for different distances from track centerline and for different lengths of trains.

The curves of decreasing sound level with distance on Figure 5-2 are for application to operations in open terrain. If there are rows of buildings along the transit structure alignment, the sound levels at large distances from the track may be somewhat less than given by Figure 5-2. At those locations along an aerial structure where the first row of buildings is of 2 stories or more height, additional attenuation of the train noise will be provided behind these buildings for locations which are lower than the building closest to the transit alignment. Having the aerial structure at high elevation relative to grade in order to traverse the Hollywood Freeway will be essentially the same as for a standard height aerial structure at an equivalent distance. The only potential difference would be the lack of shielding that would normally be provided behind tall buildings adjacent to the structure.

A basic and effective procedure available for abatement of the transit system wayside noise in critical areas is the use of a sound barrier wall such as that shown on Figure 5-3 for an aerial structure installation on a MARTA concrete aerial structure. A low sound barrier or shadow wall located at the side of the way structure is in an ideal location to shield all of the sound sources present on a transit car and, thus, can be used as a very effective means of producing extra sound abatement in critical areas. All of the noise generated by a transit car in operation originates in the area beneath the car. The main sources are the noise radiated by vibration of the wheels and rails due to wheel/rail interaction and the noise radiated by the propulsion system. The auxiliary equipment and vibration of other undercar components also contribute to the noise, but aerodynamic noise and vibration of the upper parts of the car body do not contribute significantly to the wayside noise. Therefore, a sound barrier wall shielding or shadowing the noise from beneath the car is a very effective noise abatement technique.

One of the most important features of the barrier wall design is the height of the wall relative to the transit car wheels and side skirt. Another important feature is that the wall must have no holes or slots which would allow transmission of sound through the wall. In special cases, the provision of sound absorbing material, on the interior face of the wall can be considered for maximizing the efficiency of the wall as a noise reduction element.

Figure 5-1 includes the expected wayside noise level as a function of speed for operations on aerial structure with a typical non-absorptive sound barrier wall in place. A sound barrier wall with absorption can be used in the most critical areas to obtain 2 to 3 dBA more reduction. However, for most areas the sound barrier without absorption will give adequate noise reduction to give satisfactory results.

As with other aspects of the Metro Rail System, strict design criteria have been adopted for wayside airborne noise from transit train operations (Section 7.4 of Reference 6). The tables in the appendices indicate a comparison of the expected wayside noise levels from 6-car transit train passbys with the criteria. These comparisons indicate where sound barrier walls should be used to reduce the noise to the appropriate level and are based on the simple concept of single event passby noise. The data shown on these tables provide information on the noise levels of an individual passby but do not account for the duration of each passby or the number of events per hour or day. These factors are, however, accounted for when evaluating the noise exposure levels for the transit trains utilizing the energy equivalent noise level, L_{eq}.

The aerial sections occur along Wilshire Boulevard on the westerly branch of Alignments 2, 4 and 5; along Vermont Avenue and Hollywood Boulevard on the northerly branch of Alignments 2 and 3; and along Vermont Avenue and Sunset Boulevard on the northerly branch of Alignment 4. The trains will travel at the maximum speed of 70 mph along much of these branches except at curves and in the vicinity of stations. For evaluation of potential impact, projections of the maximum expected wayside noise at a number of buildings along the alignment have been determined. The predicted noise levels have been calculated using the procedures and techniques previously described for determination of maximum wayside noise levels and determination of the areas where sound barrier walls are needed.

The data presented in the tables include the location along the alignments by civil station number and direction from the alignment, the building structure use, the distance from the near track centerline to the nearest buildings under consideration, the maximum train speed for the area, the criteria for allowable levels and the expected maximum wayside noise levels with and without sound barrier wall for 6-car trains. The noise levels for 6-car trains are used since the majority of Metro Rail train operations will be with 6-car trains.

As discussed in the Introduction, noise and vibration surveys along the alternative alignments were not performed as part of this study, thus the determination of the appropriate criteria is based on the identification of land usage and estimated community noise levels. However for the Wilshire Boulevard branch, a noise

and vibration survey was performed in 1981. Thus for this branch the data from the noise and vibration survey (Ref. 5) in conjunction with the identification of land usage are used to determine the appropriate criteria for the maximum airborne noise from transit train operations.

Table 7.4.1 of the Criteria document (Ref. 6) gives the criteria for maximum airborne noise from Metro Rail train operations. Without repeating the specific criteria for all situations, the basic criteria are that the maximum airborne noise from transit train operations should not exceed 75 dBA at single-family residences, 80 dBA at multi-family residences and 85 dBA at commercial buildings. In addition, the criteria indicate that the maximum airborne noise from transit train operations should not exceed 75 dBA at any Churches, Theaters, Schools, Hospitals, Museums or Libraries.

Review of the appropriate tables indicates that virtually the entire length of the aerial alignments will require the use of sound barrier walls to reduce the noise level to less than that required by the criterion. At some locations an absorptive barrier wall could be considered to further reduce the wayside passby noise. The following summarizes the projections for the aerial alignments and are based on the maximum wayside passby noise levels with typical non-absorptive barrier wall.

For the Wilshire Branch, common to Alignments 2, 4 and 5, the maximum airborne noise criteria are exceeded at approximately 8 single-family residences, 5 apartment buildings, 1 hotel and 1 theater by up to 2 dBA with an average exceedance of approximately 1 dBA. An average exceedance of 2 dBA or less is not considered a serious impact. The maximum airborne noise criteria are exceeded at 2 churches, 1 theater and 4 museum buildings by up to 6 dBA with an average exceedance of approximately 5 dBA. An average exceedance of 5 dBA or more is considered a serious impact, and the use of absorptive barrier walls or a reduction of train speed near these buildings is recommended.

For the Vermont/Hollywood Branch, common to Alignments 2 and 3, the maximum airborne noise criteria are exceeded at 1 theater, 3 hospital buildings and 3 museum buildings by up to 3 dBA with an average exceedance of approximately 2 dBA. Again, an average exceedance of 2 dBA or less is not considered a serious impact, although effort should be made to reduce these levels during subsequent design. The maximum airborne noise criteria are exceeded at 4 school buildings and 1 hospital building by up to 7 dBA with an average exceedance of approximately 5 dBA. As with the Wilshire Branch, an average exceedance of 5 dBA or more is considered a serious impact, and the use of absorptive barrier walls or a reduction of train speed near these buildings is recommended.

The maximum airborne noise criteria of 70 dBA for a "Quiet" Recreational Area is exceeded by up to 8 dBA at Barnsdall Park. However, this Park does not appear to warrant the designation as a "Quiet" Recreational Area due to its location near the intersection of Vermont Avenue and Hollywood Boulevard. Noise measurements along with information on the Park's use are needed in order to accurately determine the appropriate criterion for this Park.

For the Vermont/Sunset Branch, part of Alignment 4, the maximum airborne noise criteria are exceeded at 1 theater and 4 hospital buildings by up to 3 dBA with an average exceedance of approximately 2 dBA, which is not considered a serious impact, although effort should be made to reduce these levels during subsequent design. The maximum airborne noise criteria are exceeded at 4 school buildings and 10 residences by up to 7 dBA with an average exceedance of approximately 4 dBA. This is considered a serious impact and the use of absorptive barrier walls or a reduction of train speed near these buildings is recommended. Of particular concern are the maximum wayside noise levels at the CBS Studios (10 dBA above the criterion) and the KWHY Television Studios (8 dBA above the criterion). These noise levels could constitute a very serious noise impact. However, since these buildings already front on a relatively noisy street (Sunset Boulevard) and have noise sensitive uses inside, the noise reduction of the structure may already be sufficient to reduce the transit train noise to an acceptable level. If this is not the case, then additional acoustical insulation at these buildings may be necessary to achieve adequate interior noise levels.

The single-event passby noise does not account for the cumulative effect of noise since the noise level from an individual passby does not account for the duration of each passby or the number of events per hour or day. This is because a loud noise occurring very seldom may be less annoying or intrusive than a moderate noise occurring many times.

At this time the full operational schedule over a 24-hour period has not been determined, thus the noise exposure due to transit train operations on aerial structure over a full 24-hour period cannot be calculated. It is known that during rush hour periods, the transit trains will be operating at 3-minute headways. The noise exposure during the rush hour periods due to transit train operations on aerial structure with a non-absorptive sound barrier wall is presented in Table 5-1 in terms of the energy equivalent level (L_{eq}) for two train speeds and at distances of 50 and 100 ft. This measure allows an assessment of the noise exposure individuals near the transit route will experience during the rush hour periods without taking into account the effects of the existing community noise. This estimate of peak hour noise exposure is based on the passby sound levels, the duration of the

sound and the number of passbys per hour. Comparison of the transit train noise exposure with the existing noise exposure (where known) indicates the degree to which the transit train operations will affect the noise exposure levels during the rush hour periods.

Community noise measurements made in 1981 (Ref. 5) along Wilshire Boulevard between Western and Fairfax Avenues, indicate that the rush hour L_{eq} is in the range of 65 to 72 dBA, with an average of 69 dBA. Comparison of the data presented in Tables 5-1 with these measured levels indicates that the noise exposure during the rush hour for transit train operations on aerial structure with sound barrier wall is compatible with the existing environment.

The noise impact using this noise exposure analysis is considered generally not significant when using the general guidelines of UMTA (Urban Mass Transportation Agency). UMTA's general guidelines for evaluating the significance of noise impacts are contained in "Guidelines for Preparing Environmental Assessments," UMTA C5620.1 (Ref. 10). These guidelines indicate that noise impacts are generally not significant (1) if no noise-sensitive sites are located in the project area, and (2) if increases in the equivalent noise levels (L_{eq}) with implementation of the project are expected to be $\leq$3 dBA at noise sensitive locations and the proposed project would not result in violations of noise ordinances or standards. Noise impacts are possibly significant if increases in equivalent noise levels (L_{eq}) with implementation of the project are expected to be no greater than 5 dBA. Determination of significance must consider existing noise levels and the presence of noise-sensitive sites. Noise impacts are generally significant if the proposed project would cause (1) noise standards or ordinances to be exceeded, (2) an increase in the equivalent noise level (L_{eq}) of 6 to 10 dBA in built-up areas, and (3) an increase in the equivalent noise level (L_{eq}) of 10 dBA.

TABLE 5-1 ESTIMATED AIRBORNE NOISE EXPOSURE LEVELS DURING RUSH HOUR FOR TRANSIT TRAIN OPERATIONS ON AERIAL STRUCTURE WITH SOUND BARRIER WALL - L_{EQ} IN dBA

Train Speed	Distance From Near Track Centerline	
	50 ft	100 ft
50 mph	63 dBA	60 dBA
70 mph	67 dBA	64 dBA

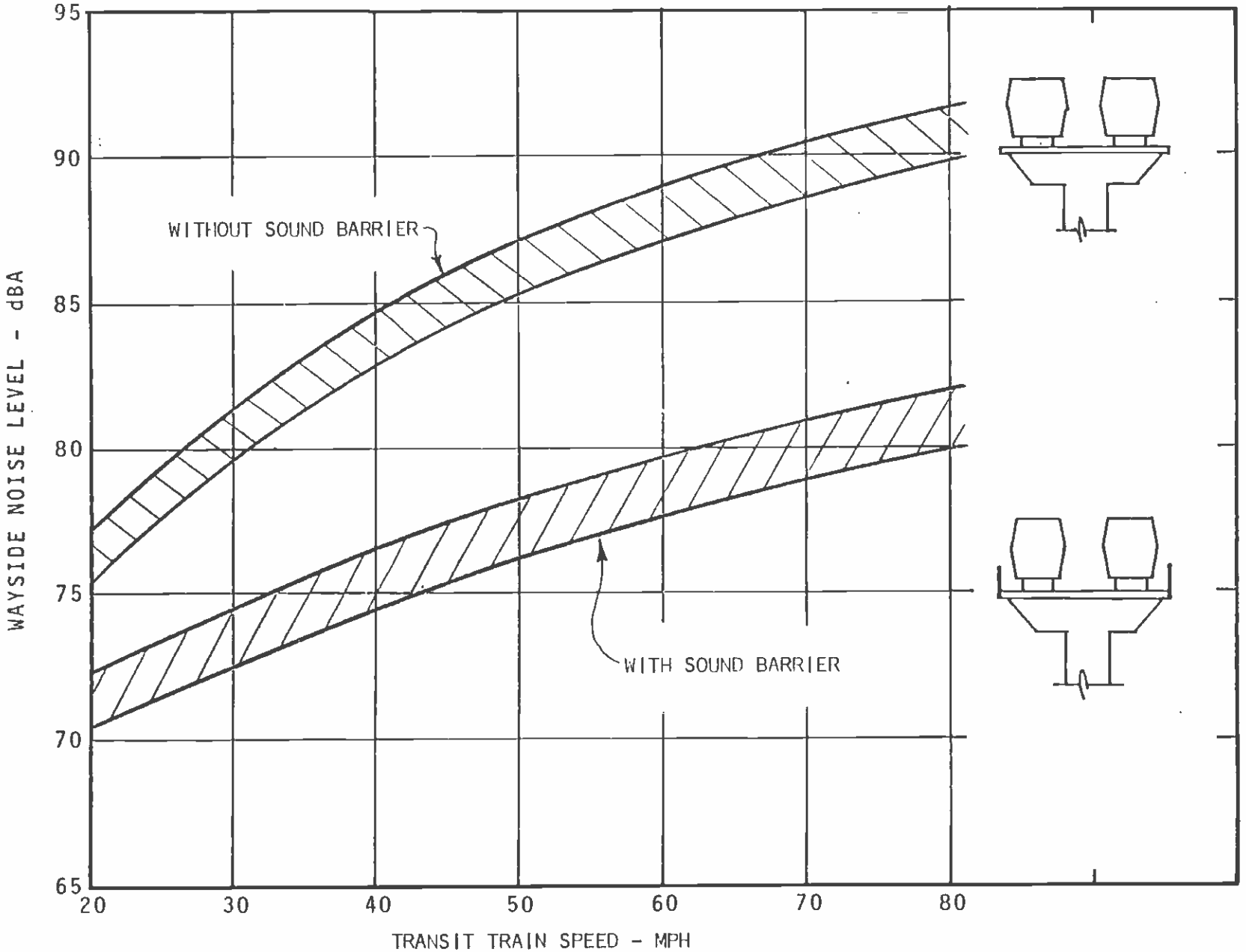

FIGURE 5-1 MAXIMUM WAYSIDE PASSBY NOISE LEVELS EXPECTED AT 50 FT FROM TRACK CENTERLINE FOR 6-CAR METRO TRAINS OPERATING ON CONCRETE AERIAL STRUCTURE WITH AND WITHOUT SOUND BARRIER WALLS

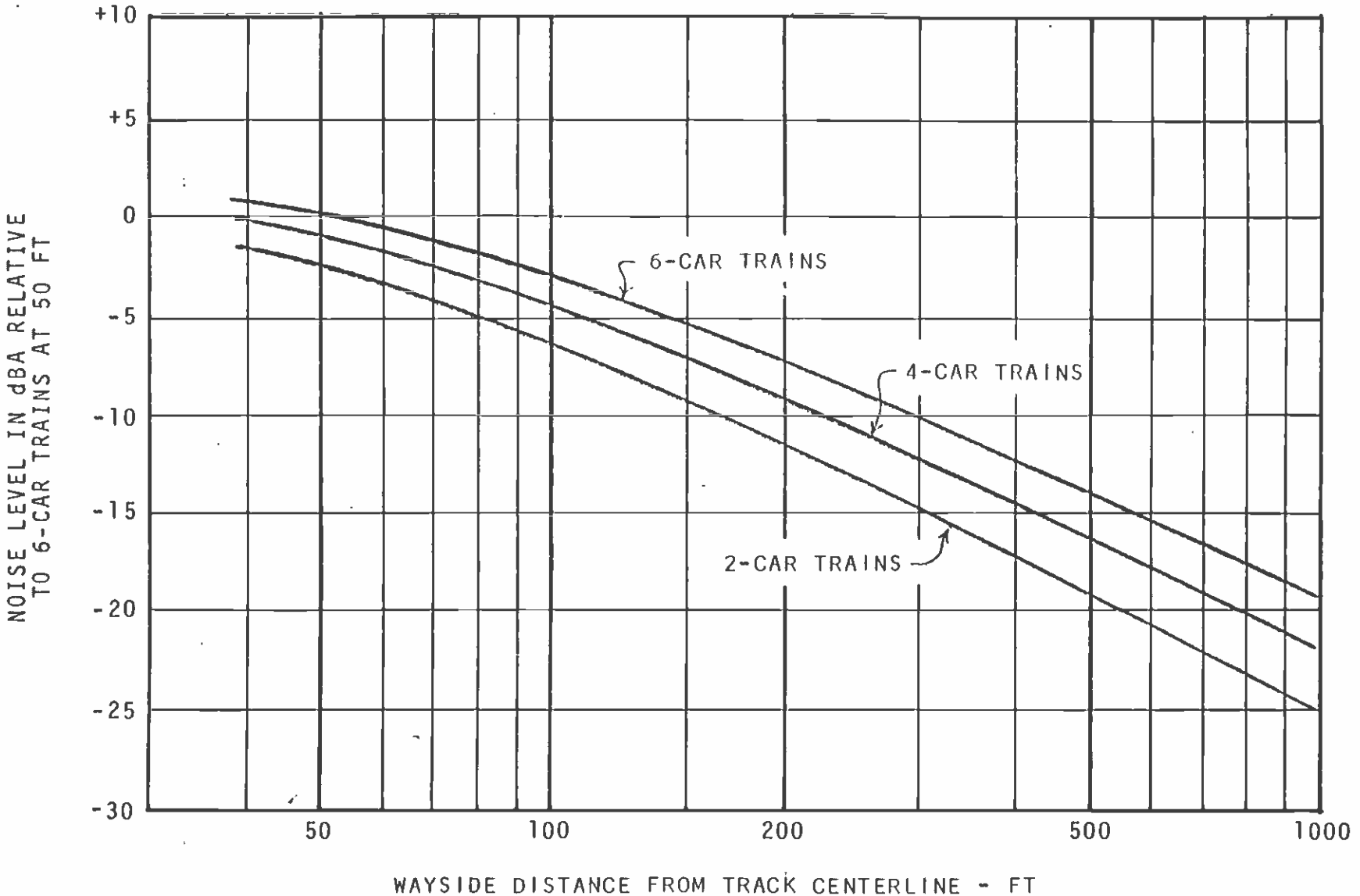

FIGURE 5-2 MAXIMUM WAYSIDE NOISE LEVELS AS A FUNCTION OF DISTANCE FROM TRACK CENTERLINE FOR OPEN LEVEL TERRAIN - METRO TRANSIT TRAINS OPERATING ON AERIAL STRUCTURE OR BALLAST AND TIE TRACK

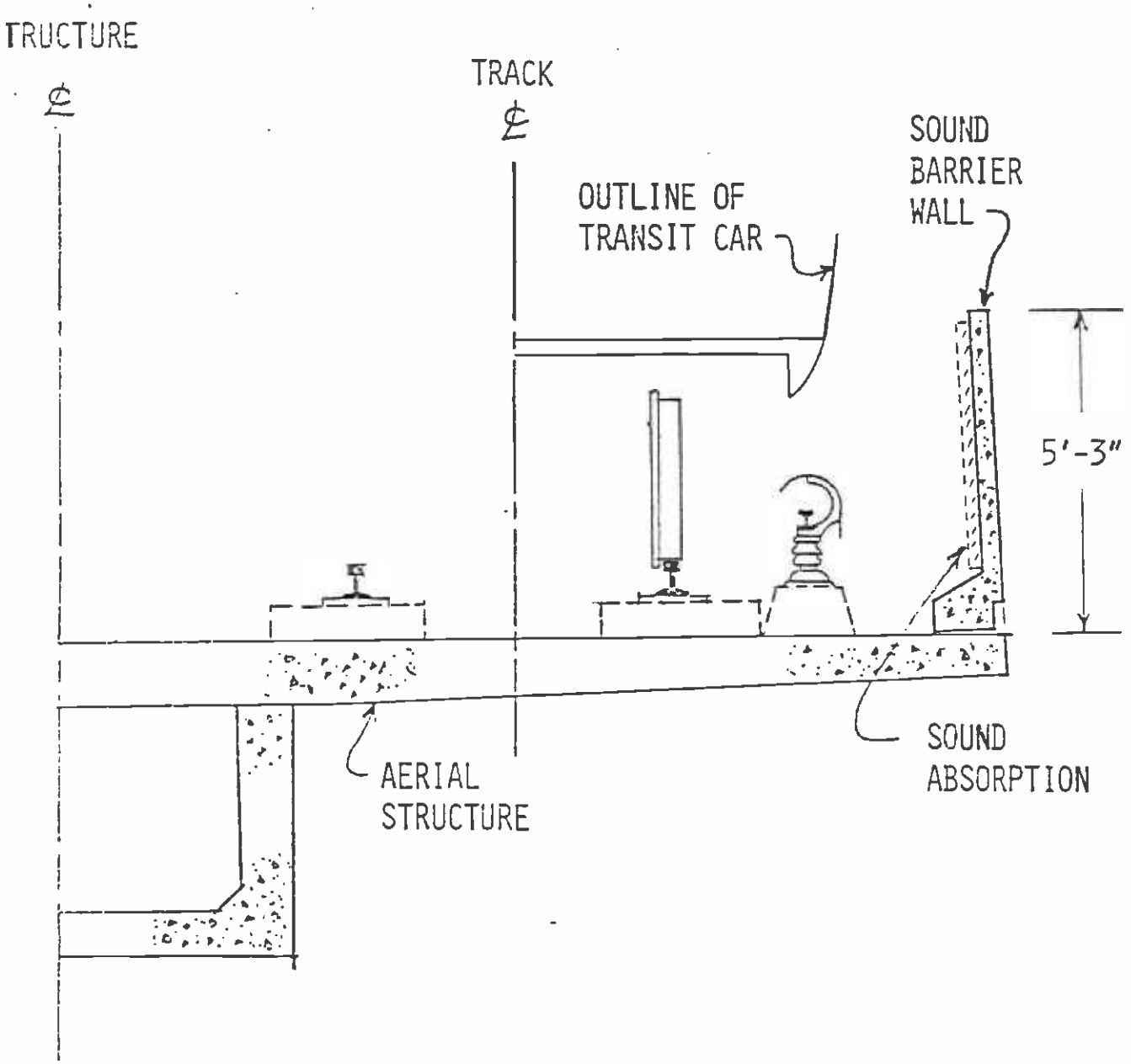

FIGURE 5-3 CROSS-SECTION OF MARTA AERIAL STRUCTURE SHOWING THE CONFIGURATION FOR SOUND BARRIER WALLS

6. CONSTRUCTION NOISE LEVELS

One of the impacts associated with a rail rapid transit system project is the short-term noise and vibration impact of construction activities. As with any large project, the construction of a rapid transit system involves the use of machines and procedures which, in the past, have resulted in intense noise levels and, occasionally, high vibration levels in and around the construction site. The Metro Rail transit system way structures may include subway, and aerial structure configurations. The construction activities include demolition, clearing, grading, excavating, pile driving, drilling, materials handling and placement, erection and finish work and will involve the use of all the various kinds of machines and procedures which are associated with these activities.

In recent years considerable progress has been made in the reduction and control of construction noise through modifications of the equipment to reduce noise generated at the source, through modifications of construction procedures and by selection of those construction procedure alternates which are less noisy. Also, in many areas and for many types of construction projects there have been noise limits or noise standards included in the construction contracts or applied by governmental agencies in order to limit the noise impact form the construction. These efforts at reducing construction noise have produced considerable success and with new construction projects the work can be and is accomplished with considerably less noise impact than is traditionally expected.

The two general configurations of transit way structures proposed, aerial and at-grade have different construction techniques involved and, hence, produce somewhat different noise and vibration.

For the aerial structure configuration the activities will include demolition; ground clearing and grading; erection of foundations including, possibly, pile driving; construction of the aerial structure columns; erection of girders and the finishing.

For subway construction the acoustical impacts can be of two different characters. In the areas where tunneling is used the only impact due to the construction activities (except at access shafts) will be the ground-borne vibration due to the excavation process, either the tunnel boring machine or blasting. Also, there may be some ground-borne vibration due to the vehicles used to remove material. For cut-and-cover subway there will be impacts due to ground clearing, excavation, erection and finishing activities.

Construction Equipment Noise Levels

There is considerable information available on the typical noise levels created by modern construction equipment and there is a growing body of information on lower noise levels which can be achieved with modified equipment or equipment which is designed with noise reduction and control as one of the design parameters.

Measurements made at transit system construction project sites provide the best information relative to expected noise levels from the type of construction activities which are associated with the Metro Rail system. Table 6-1 presents a series of noise levels observed for various types of machines and activities associated with the WMATA Metro construction project. These data are for early construction activities using standard present day equipment without noise control or noise reduction modifications to the equipment. The data were obtained before noise restrictions and limits had been applied to the construction activities on the Metro project.

Typical noise levels at construction sites, as indicated by Table 6-1, do result in substantial acoustic impact on neighboring communities and in new and future projects such noise levels are considered unacceptable. There are many techniques available for reducing the noise, some of which involve little or no cost and some of which involve considerable cost. In some instances modifications of procedures or use of different procedures and equipment can result in much lower noise levels and impact. For the Metro Rail project one of the procedures, a very effective procedure, will be to include noise limit specifications in the construction contracts in order to reduce or limit acoustic impact due to construction activities.

Ground-Borne Vibration from Construction

Because of the nature of some construction activities, high amplitudes of ground-borne vibration may result in some impact in neighboring community areas. Blasting and impact pile driving are two types of activities traditionally associated with high levels of ground-borne vibration. It is also possible that some types of heavy vehicles and excavation activities can generate sufficient ground-borne vibration levels to be perceptible or noticeable in nearby buildings.

The vibration levels created by the normal movement of vehicles including graders, loaders, dozers, scrapers and trucks generally are of the same order of magnitude as the ground-borne vibration created by heavy vehicles running on streets and highways. Large trucks and buses operating on city streets and on highways generate ground-borne vibration due to wheel/roadway interaction and particularly high vibration levels can be associated with

truck and bus operations on rough or pock-marked streets. In general, the ground-borne vibration from vehicle operations on streets, even very rough streets, is not sufficient to create noticeable impact on adjacent community areas. This vibration is of a level that is generally imperceptible or barely perceptible and is considered acceptable, producing little or no impact. Thus, it can be expected that the normal vehicle activities at the construction sites will not generate sufficient ground-borne vibration to result in significant impact.

Blasting, drilling and excavation procedures for cut-and-cover subways can result in ground-borne vibration levels which are perceptible or noticeable in adjacent community areas. The amplitudes of vibration from such activities are limited for safety reasons by procedural techniques. For example, through the use of time delay charges in blasting the maximum amplitude of the ground-borne vibration is limited to a level well below the criteria for structural damage to adjacent facilities. Impact pile drivers, which create considerable noise and vibration, also produce vibration levels which are well below the intensity required for structural damage to adjacent buildings and other facilities.

Tunnel boring machines also create ground-borne vibration and noise, however, experience to date indicates that the vibration from the use of such machines is considerably less in intensity than that from blasting or pile driving and that it is not significantly greater than the vibration created by heavy trucks traveling on city streets.

For the subway sections, a possible method of excavation is with the use of a tunnel boring machine (TBM). With the use of a TBM the potential noise and vibration impact is considerably lower than if traditional blasting techniques are used. Blasting can have a considerable noise and vibration impact on a community. As for transit trains operating in subway, the possibility of noise and vibration impact from the operation of a TBM is to occupants inside buildings adjacent to the new subway alignment. Outside of a building, there is no possibility of noise or vibration impact from TBM operation.

Use of a TBM will create vibration levels which are generally imperceptible at distances greater than 75 to 100 ft from the operating TBM. Even at a distance of 50 ft, the operation of the TBM will create vibration levels which are just perceptible. As stated above, the possibility of noise impact from the TBM will be to occupants inside of buildings, similar to the possible noise impact from operations of transit trains in subway. When the tunnel is approximately 35 ft below grade, then there is some possibility that the ground-borne noise would be noticed by building occupants at buildings which are approximately 100 ft in horizontal distance from the alignment. The relative noise levels

would depend on the type of building structure, and type of activities in the building. However, the ground-borne noise and vibration from tunnel boring machines is of very short duration since the machine passes by an area in, at most, a few days, so that there will be no significant impact.

Construction Noise Specifications

There are numerous procedures available for reducing the noise generated by construction equipment and activities. One of the most effective methods of assuring controlled noise and minimum acoustic impact is the inclusion of noise limit specifications in the construction contract documents. Recent construction projects of the New York City Transit Authority, the WMATA Metro, MARTA and NFTA systems have included noise restrictions in the contract specifications. The experience with these noise limit specifications and with the contractors working with the requirements is that considerable success in the reduction of construction noise has been realized.

For each design section of the Metro Rail system the construction contracts will include a section on permissible noise limits. In many instances noise standards or limitations applied to construction or other noisy type activities have been based on average conditions in a community or, alternatively, on the most severe or critical conditions. The noise limit law or standard has then been written with one set of restrictions which apply to every area. This procedure is not consistent with best economy or best benefit to the community. In many instances this results in either excessive noise in quiet residential areas or excessive cost for noise reduction in commercial or industrial areas where there is no benefit to be gained from the noise reduction. The noise limitation specifications for the Metro Rail project will be based on the character of development and land use in each area where construction is to be accomplish. Thus, the noise limits applied will be consistent with the type of community area in which the construction takes place.

Table 6-2 indicates construction noise and vibration level limitations from the Metro Rail project design criteria and provides an indication of the degree of noise impact expected from the Metro Rail system construction activities.

TABLE 6-1 TYPICAL NOISE LEVELS OBSERVED AT RAIL TRANSIT SYSTEM CONSTRUCTON PROJECTS

Equipment or Process	Distance	Noise Levels
Air Hammer Cutting concrete	50 ft	85-90 dBA
Crane & Pile Drilling Rig	50	
Moving Drill		90
Emptying Auger		86
Idling		82
Drilling		83-88
Placing Pile		74
Setting Pile		88
Concrete Mix Truck Placing Concrete	50	81-85
Diesel Hammer Pile Driver	24	95-106
Compressor	24	83-90
Hydraulic Cranes	24	88-90
Derrick Crane	50	88
Tamper	50	88
Scraper	50	88
Rock Drill	50	98
Trucks	50	85-91
Paver	50	89

TABLE 6-2 NOISE AND VIBRATION LEVEL RESTRICTIONS

I. NOISE LEVEL RESTRICTIONS

A. NOISE LEVEL RESTRICTIONS IN ALL AREAS

In no case expose the public to construction noise levels exceeding 90 dBA (slow) or to impulsive noise levels with a peak sound pressure level exceeding 140 dB as measured on an impulse sound level meter or 125 dBC maximum transient level as measured on a general purpose sound level meter on "fast" meter response.

B. NOISE LEVEL RESTRICTIONS AT AFFECTED STRUCTURES

Conduct construction activities in such a manner that the noise levels 200 feet from the Construction Limits or at the nearest affected building, whichever is closer, do not exceed the levels listed in the following schedules:

1. Continuous Noise: Prevent noises from stationary sources, parked mobile sources or any source or combination of sources producing repetitive or long-term noise lasting more than a few hours from exceeding the following limits.

* * *

LIMITS FOR CONTINUOUS CONSTRUCTION NOISE

Affected Structure or Area	Maximum Allowable Continuous Noise Level, dBA	
Residential	Daytime	Nighttime
single family residence	60	50
along an arterial or in multi-family residential areas, including hospitals	65	55
in semi-residential/commercial areas, including hotels	70	60
Commercial	At All Times	
in semi-residential/commercial areas, including schools	70	
in commercial areas with no nighttime residency	75	
Industrial		
all locations	80	

* * *

2. Intermittent Noise: Prevent noises from non-stationary mobile equipment operated by a driver or from any source of non-scheduled, intermittent, non-repetitive, short-term noises not lasting more than a few hours from exceeding the following limits.

* * *

LIMITS FOR INTERMITTENT CONSTRUCTION NOISE

Affected Structure or Area	Maximum Allowable Intermittent Noise Level, dBA	
Residential	Daytime	Nighttime
Single family residence areas	75	60
along an arterial or in multi-family residential areas, including hospitals	80	65
in semi-residential/commercial areas, including hotels	85	70
Commercial	At All Times	
in semi-residential/commercial areas, including schools	85	
in commercial areas with no nighttime residency	85	
Industrial		
all locations	90	

* * *

C. SPECIAL ZONE OR SPECIAL CONSTRUCTION SITE

In areas outside of Construction Limits but for which the Contractor has obtained designation as a Special Zone or Special Construction Site from the agency having jurisdiction, the noise limitations for buildings in industrial areas apply.

In zones designated by the local agency having jurisdiction as a special zone or special premise or special facilities, such as hospital zones, the noise level and working time restrictions imposed by the agency shall apply. These zones and work hour restrictions shall be obtained by the Contractor from the local agency.

D. MORE THAN ONE LIMIT APPLICABLE

Where more than one noise limit is applicable, use the more restrictive requirement for determining compliance.

E. NOISE EMISSION RESTRICTIONS

Use only equipment meeting the noise emission limits listed below, as measured at a distance of 50 feet from the equipment in substantial conformity with the provisions of the latest revisions of SAE J366b, SAE J88, and SAE J952b or in accordance with the measurement procedures specified herein.

* * *

NOISE EMISSION LIMITS ON CONSTRUCTION NOISE

TYPE OF EQUIPMENT	MAXIMUM NOISE LIMIT	
	Date Equipment Acquired	
	Before 1-1-1983	On or After 1-1-1983
All equipment other than highway trucks; including hand tools and heavy equipment	90 dBA	85 dBA

	Date Equipment Acquired	
	Before 1-1-1983	On or After 1-1-1983
Highway trucks in any operating mode or location	83 dBA	80 dBA

Peak levels due to impact pile drivers may exceed the above noise emission limits by 10 dBA.

* * *

- Line or cover hoppers, storage bins and chutes with sound deadening material.

- Do not use air or gasoline driven saws.

- Conduct truck loading, unloading and hauling operations so that noise and vibration is kept to a minimum.

- Route construction equipment and vehicles carrying spoil, concrete or other materials over streets and routes that will cause the least disturbance to residents in the vicinity of the work. Advise the Engineer in writing of the proposed haul routes prior to securing a permit from the local government.

- Site stationary equipment to minimize noise and vibration impact on the community, subject to approval of the Engineer.

- Use vibratory pile drivers or augering for setting piles in lieu of impact pile drivers. If impact pile drivers must be used, their use is restricted to the hours from 8:00 a.m. to 5:00 p.m. weekdays in residential and in semi-residential/commercial areas.

7. NOISE LEVEL CHANGES DUE TO CHANGES IN ROAD TRAFFIC VOLUMES

The report, "Detailed Analysis of Candidate Alignments Traffic Impacts", prepared by the traffic consultants to MRTC (Ref. 11), presents extensive data on changes in road traffic patterns associated with the implementation of one of the "CORE" Study Alternatives.

The study's findings include an estimated overall reduction of 1.6% in auto trips in the "core area". This percentage reduction was considered insignificant. However, the report also indicates some significant traffic increases at a number of critical intersections near the proposed stations. Access traffic generated by the Metro Rail stations, including park-and-ride and kiss-and-ride auto traffic and feeder and line-haul buses, will with all alignment candidates result in increases in critical traffic volumes of up to 50%. The corresponding increases in noise levels will, however, be less than 2 dBA.

In terms of subjective response, increases in noise level of 1 or 2 dBA are difficult to detect. Thus, in spite of the significantly higher traffic volumes at some intersections near the proposed Metro Rail stations, there should be minimal increase in traffic noise in these areas. We conclude that changes in road traffic patterns associated with the implementation of any of the Metro Rail system candidate alignments should cause no significant environmental noise impact.

8. SUMMARY OF NOISE AND VIBRATION IMPACTS AND RECOMMENDATIONS

Evaluation of the short- and long-term impacts requires comparison of the expected or projected noise and vibration levels with existing noise and vibration levels (where known) and with criteria for reasonable and appropriate noise and vibration levels or with noise and vibration levels which are considered to create intrusion.

All of the possible noise and vibration disturbances from subway and aerial transit train operations, including the noise from ancillary facilities and vent and fan shafts, comprise the long-term noise and vibration impacts of each of the alternative alignments. The short-term noise and vibration impacts are due mainly to construction activities, affecting the community around the proposed alignment before the Metro Rail trains begin operations.

The noise and vibration induced from ground-borne vibration due to underground transit train operations is a factor which could create intrusion if mitigation measures are not used. The noise and vibration radiated inside buildings is due to ground-borne and structural vibration originating at the wheel/rail interface and transmitted to the building by the intervening ground. Thus, the noise and vibration are not attenuated by the walls or exterior boundaries of a building but rather must be attenuated at the source or by distance from the source to the building in order to achieve satisfactory results.

Considering the typical sound insulation provided by the homes and larger buildings along the subway portions of the Metro Rail alignment, in addition to the typical existing background noise, there will be transient noise of comparable or higher level transmitted into the buildings, primarily through windows and doors. This noise is due primarily to the street traffic. These fluctuations in the community noise will cause fluctuations in the interior noise in the building and will produce noise intrusion similar to that which can be caused by the transit train ground-borne noise. Typically, in most buildings, the transient sound levels due to airborne noise from outdoors will be greater in level or at least comparable in level to the noise created by transit trains even without the use of special noise reduction features in the subway structure.

Due to the location of the subway alignment alternatives, a number of buildings will experience rumbling noise from the transit trains of more than 40 dBA level with a standard invert and resilient direct fixation track fasteners. In some of the buildings, the noise levels from train passbys on a standard invert could be expected to be greater than 50 dBA which would be noticeable and could create intrusion, especially in the residential buildings located away from heavily traveled streets.

A number of buildings will also experience vibration velocity levels greater than 75 dB due to train passbys on standard invert. Vibration velocity levels greater than 75 dB are generally noticeable to people and would be considered excessive in a building with sleeping areas. Recording studios and hospitals with vibration sensitive medical equipment generally require a vibration environment with a maximum vibration velocity of less than 70 dB.

Since the projected levels do exceed the criteria for ground-borne noise and vibration at some buildings, the Metro Rail System design will include resiliently supported ties, "soft" fasteners or floating slab trackbeds to reduce the ground-borne noise and vibration. In most cases this will result in the transit trains causing comparable levels of noise and vibration to that caused by other pre-existing activities. Thus, the noise and vibration impact from subway train operations with the recommended mitigation measures is expected to be small for any of the candidate alternatives. For each alternative, a summary of the impact with and without these standard mitigation measures as well as the appropriate length of mitigation measures is included as Table 2-1.

Airborne noise from fan and vent shafts which are required for ventilation of the subway is another possible source of noise intrusion along the subway alternative alignments. The applicable criteria for transit train noise from vent shafts and fan noise from fan shafts is as shown on Table 3-1. With proper attenuation of the fan noise and acoustical absorption added to the shaft walls, the noise from the fan and vent shafts will not contribute significantly to the community noise environment wherever the shafts are located.

Noise from the ancillary facilities such as cooling towers, chiller plants and power substations is similar to the noise from fan shafts and the same criteria comments are applicable. The impact of noise from ancillary facilities is controlled by design and the limitations on maximum permissible noise level.

Airborne wayside noise from transit train operations on aerial structure is another factor which could create intrusion. This noise, as opposed to noise from ground-borne vibration, is attenuated by the walls or exterior boundaries of a building. Thus the noise level affecting the occupants inside a building is dependent not only on the external noise level, but also upon the amount of sound insulation or attenuation produced by the walls and windows of the structure. Since the interior noise levels from this external noise is dependent upon the amount of attenuation provided by the boundaries of a building (over which the Metro Rail System has no control) the noise criteria for maximum allowable wayside noise are specified as exterior levels in a particular community, as discussed in Chapter 5.

As with noise induced from ground-borne vibration and noise from vent shafts, the noise from aerial operations is transient, occurring only at the time of a transit train passby. Thus the projected maximum wayside noise levels can be compared with the L_{10} and L_1 noise levels measured along Wilshire Boulevard during the 1981 noise survey. Although a noise survey has not been performed, the community noise levels along Vermont Avenue, Hollywood Boulevard and Sunset Boulevard are estimated to be similar to those measured along Wilshire Boulevard.

At most of the areas where aerial alignments are proposed, the wayside noise from transit train passbys without sound barriers will exceed the observed or estimated L_{10} and L_1 levels. Also, the criteria for maximum wayside noise would be exceeded without the use of sound barrier walls. Thus, there are a number of locations where the use of sound barrier walls is needed to avoid significant acoustical intrusion.

With the use of typical non-absorptive sound barrier walls as indicated as necessary, the noise from transit train operations will be minimized to be consistent with the existing noise environment for most of the areas along the aerial alignments. However, there are some residences, schools, theaters, museum buildings and television/recording studios which will experience noise from transit train operations in excess of the criteria for maximum wayside noise, even with the addition of absorption to sound barrier walls. These areas are quite close to the alignment, often where train operations at 60 to 70 mph are expected. In several cases, small revisions in the proposed alignment may reduce the noise levels to be equal to or just greater than the appropriate criterion. In addition, speed reductions in some areas below the maximum permissible speed may be possible in order to reduce the noise to appropriate levels. A reduction of train speed by 10 to 15 mph in critical areas will reduce the noise levels by 2 to 3 dBA.

It should be noted that although there may be some noise intrusion due to transit train operations at these locations, the projections are for worst case noise levels with maximum train speeds and maximum train length. Under normal nighttime operating conditions, the transit trains will be shorter. Also, the maximum permissible speed is not always the programmed speed used under normal operating conditions.

The noise exposure analysis performed for the rush hour periods along Wilshire Boulevard shows that with the use of sound barrier walls, the energy equivalent levels (L_{eq}) in the community will be increased by an average of less than 1 dBA, which is insignificant.

Thus, while the transit trains will add some noise to the community areas along the aerial sections, the intrusion in most cases will be minor because of pre-existing noise levels, particularly along those sections located near major streets and freeways with a high volume of vehicular traffic.

A possible short-term impact could arise from noise during construction of the Metro Rail facilities. The typical noise levels observed at rail transit construction projects can be quite high. Thus, there is the potential for major short-term intrusion from the construction activities. However, if the construction activities meet the construction noise specifications indicated in Chapter 6, then the effect of the construction noise will usually be small. The noise will be noticeable but acceptable to the community in most instances.

REFERENCES

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4. S. L. Wolfe and R. A. Carman, Wilson, Ihrig & Associates, Inc., "Noise and Vibration Study - Alternative Route Alignments for the Metro Rail Project," Report prepared for the Southern California Rapid Transit District, November 1982.

5. S. L. Wolfe, Wilson, Ihrig & Associates, Inc., "Noise and Vibration Study for the Metro Rail Project," Report prepared for the Southern California Rapid Transit District, August 1983.

6. SCRTD Metro Rail System Design Criteria and Standards, Volume IV, Section 7, "Noise and Vibration", initial issue, September 1983.

7. H. J. Saurenman, Wilson, Ihrig & Associates, Inc., "Use of Impact Method for Predictions of Ground-Borne Vibration along the SCRTD Metro Rail Route," Technical Memorandum submitted to DOT/TSC, August 22, 1983.

8. H. J. Saurenman, Wilson, Ihrig & Associates, Inc., "Projected Levels of Groundborne Vibration along SCRTD Metro Route," Technical Memorandum submitted to DOT/TSC, September 7, 1983.

9. H. J. Saurenman, Wilson, Ihrig & Associates, Inc., "Ground-Borne Vibration Propagation Investigation - Fernando Formation Bedrock," Report prepared for Metro Rail Transit Consultants, April 1984.

10. "Guidelines for Preparing Environmental Assessments," Urban Mass Transportation Administration (UMTA), Publication C5620.1, October 16, 1979.

11. "Detailed Analysis of Candidate Alignments - Traffic Impacts," Report supplied to WIA from MRTC, May 16, 1986.

APPENDIX I

Candidate Alignment 1

Vermont/Hollywood Boulevard/Wilshire Subway

I-1 Wilshire Branch (Subway)

TABLE I-1 PROJECTED MAXIMUM GROUND-BORNE NOISE AND VIBRATION LEVELS FOR METRO RAIL OPERATIONS IN SUBWAY -- ALIGNMENT 1 -- WILSHIRE BRANCH

Location of Structure Adjacent to Alignment		Type of Structure (N)*	Depth to Top of Rail (ft)	Horiz. Dist. from Near Track ℄ (ft)	Operat'l Train Speed (mph)	Ground-Borne Noise: Criterion for Allowable Noise Level (dBA)	Ground-Borne Noise: Projected Maximum Noise Level With D.F. Fasteners (dBA)	Ground-Borne Noise: Projected Maximum Noise Level With Recommended Mitigation (dBA)	Ground-Borne Vibration: Criterion for Allowable Vibration Level (dB)*	Ground-Borne Vibration: Projected Maximum Vibration Veloc. Lvl. With D.F. Fasteners (dB)*	Ground-Borne Vibration: Projected Maximum Vibration Veloc. Lvl. With Recomm. Mitigation (dB)*
00+00 to 01+00	(AR)	Commercial/ Office (1)	75	0	45	45	36-41	--	75-80	64-69	--
00+00 to 01+00	(AL)	Commercial/ Office (1)	40	0	45	45	42-47	36-41[2]	75-80	67-72	66-71[2]
01+00 to 02+00	(AR)	Commercial/ Office (1)	75	75	45	45	32-37	--	75-80	60-65	--
01+00 to 02+00	(AL)	Commercial/ Office (1)	40	75	45	45	36-41	--	75-80	61-66	--
02+00 to 09+50	(AR)	Commercial/ Office (5)	75	0-10	45	45	36-41	--	75-80	64-69	--
02+00 to 09+50	(AL)	Commercial/ Office (5)	35	0-15	45	45	43-48	37-42[2]	75-80	67-72	66-71[2]
09+50 to 13+50	(AR)	Commercial/ Office (2)	80	0	45	45	35-40	--	75-80	61-66	--
09+50 to 13+50	(AL)	Commercial/ Office (2)	35-40	0	45	45	43-48	37-42[2]	75-80	67-72	66-71[2]
13+50 to 20+00	(AR)	Commercial/ Office (2)	100	0	45	45	33-38	--	75-80	60-65	--
13+50 to 20+00	(AL)	Commercial/ Office (3)	50-60	0	45	45	40-45	--	75-80	65-70	--

TABLE I-1 (CONTINUED)

Location of Structure Adjacent to Alignment		Type of Structure (N)*	Depth to Top of Rail (ft)	Horiz. Dist. from Near Track ℄ (ft)	Operat'l Train Speed (mph)	Ground-Borne Noise			Ground-Borne Vibration		
						Criterion for Allowable Noise Level (dBA)	Projected Maximum Noise Level With D.F. Fasteners (dBA)	Projected Maximum Noise Level With Recommended Mitigation (dBA)	Criterion for Allowable Vibration Level (dB)*	Projected Maximum Vibration Veloc. Lvl. With D.F. Fasteners (dB)*	Projected Maximum Vibration Veloc. Lvl. With Recomm. Mitigation (dB)*
20+00 to 22+50	(AL)	Apartments (1)	60	0	45	40	33-38	--	75	61-66	--
24+00 to 28+00	(AR)	Office (1)	70-85	70	45	40	27-32	--	75	54-59	--
28+00 to 29+80	(AR)	Office (1)	55-60	35	45	40	32-37	--	75	61-66	--
30+00 to 31+50	(AR)	Church (1)	60	35	45	35	29-34	--	75	64-69	--
24+00 to 31+50	(AL)	Office (4)	55-85	30-60	45	40	30-35	--	75	60-65	--
32+00 to 33+00	(AR)	Hyatt Conference Center (1)	55	25	45	35	28-33	--	70	63-68	--
33+00 to 35+00	(AR)	Hotel (2)	60	25-70	45	45	25-30	--	75	60-65	--
35+20 to 37+20	(AR)	Office (1)	60	25	45	40	28-32	--	75	60-65	--
31+50 to 36+00	(AL)	Office/ Bank (2)	60	25	45	40-45	20-25	--	75-80	60-65	--
36+00 to 46+50	(AL)	Commercial/ Office (6)	60	25	45	40-50	26-31	--	75-80	65-70	--

TABLE I-1 (CONTINUED)

Location of Structure Adjacent to Alignment		Type of Structure (N)*	Depth to Top of Rail (ft)	Horiz. Dist. from Near Track ℄ (ft)	Operat'l Train Speed (mph)	Ground-Borne Noise: Criterion for Allowable Noise Level (dBA)	Ground-Borne Noise: Projected Maximum Noise Level With D.F. Fasteners (dBA)	Ground-Borne Noise: Projected Maximum Noise Level With Recommended Mitigation (dBA)	Ground-Borne Vibration: Criterion for Allowable Vibration Level (dB)*	Ground-Borne Vibration: Projected Maximum Vibration Veloc. Lvl. With D.F. Fasteners (dB)*	Ground-Borne Vibration: Projected Maximum Vibration Veloc. Lvl. With Recomm. Mitigation (dB)*
37+50 to 38+50	(AR)	Restaurant (1)	60	25	45	50	35-39	--	80	66-71	--
39+50 to 46+50	(AR)	Church (2)	60	45	45	35	31-36	--	75	64-69	--
50+00 to 54+00	(AR)	Office (2)	50-55	35	45	40	34-39 (X-Over)	--	75	67-72 (X-Over)	--
54+00 to 57+00	(AR)	Commercial/ Office (2)	50	25	45	40-50	25-30	--	75-80	64-69	--
54+00 to 58+50	(AL)	Office/ Theater (3)	50	40	45	35-40	21-26	--	70-75	60-65	--
57+50 to 64+00	(AR)	Office (2)	50	25	55	40	31-36	--	75	62-67	--
65+00 to 66+70	(AR)	Church (1)	50	30	55	35	32-37	26-31[2]	75	65-70	64-69[2]
66+80 to 83+50	(AR)	Commercial/ Office (8)	50-55	25-40	55	40-50	37-42	--	75-80	68-72	--
60+00 to 70+50	(AL)	Commercial/ Office (8)	50-55	30-35	55	40-50	37-42	--	75-80	68-72	--
70+50 to 72+00	(AL)	Apartments (1)	55	40	55	45	33-38	--	75	64-69	--

TABLE I-1 (CONTINUED)

Location of Structure Adjacent to Alignment		Type of Structure (N)*	Depth to Top of Rail (ft)	Horiz. Dist. from Near Track ℄ (ft)	Operat'l Train Speed (mph)	Ground-Borne Noise			Ground-Borne Vibration		
						Criterion for Allowable Noise Level (dBA)	Projected Maximum Noise Level With D.F. Fasteners (dBA)	Projected Maximum Noise Level With Recommended Mitigation (dBA)	Criterion for Allowable Vibration Level (dB)*	Projected Maximum Vibration Veloc. Lvl. With D.F. Fasteners (dB)*	Projected Maximum Vibration Veloc. Lvl. With Recomm. Mitigation (dB)*
72+00 to 73+00	(AL)	Office (1)	55	30	55	40	35-40	--	75	68-73	--
74+00 to 75+50	(AL)	Commercial (2)	55	30	55	45	35-40	--	75	68-73	--
76+00 to 81+00	(AL)	Office (2)	55-60	25	55	40	35-40	--	75	68-73	--
81+50 to 82+50	(AR)	Commercial/ Office (1)	65	30	45	45	20-25	--	75-80	59-64	--
82+50 to 84+00	(AR)	Apartments (1)	70	30	45	40	<20	--	70	55-60	--
83+00 to 84+50	(AL)	Theater (1)	70	30	45	35-40	19-24	--	70-75	58-63	--
84+00 to 84+50	(AL)	Residential (1)	70	120	45	35	<20	--	70	55-60	--
87+50 to 91+00	(AL)	Commercial (2)	70	25	45	50	17-22	--	80	58-63	--
87+50 to 91+00	(AR)	Office (1)	70	30	45	45	<20	--	75	55-60	--
92+00 to 95+00	(AL/AR)	Office (5)	60	25	50	45	16-21	--	75	57-62	--

TABLE I-1 (CONTINUED)

Location of Structure Adjacent to Alignment		Type of Structure (N)*	Depth to Top of Rail (ft)	Horiz. Dist. from Near Track ℄ (ft)	Operat'l Train Speed (mph)	Ground-Borne Noise			Ground-Borne Vibration		
						Criterion for Allowable Noise Level (dBA)	Projected Maximum Noise Level With D.F. Fasteners (dBA)	Projected Maximum Noise Level With Recommended Mitigation (dBA)	Criterion for Allowable Vibration Level (dB)*	Projected Maximum Vibration Veloc. Lvl. With D.F. Fasteners (dB)*	Projected Maximum Vibration Veloc. Lvl. With Recomm. Mitigation (dB)*
96+50 to 99+50	(AL/AR)	Office (3)	55	35-50	55	45	16-21	--	75	57-62	--
97+00 to 98+00	(AL)	Motel (1)	55	35	55	40	21-26	--	70	61-66	--
100+50 to 104+00	(AL/AR)	Church (2)	50	40	60	35	21-26	--	70	61-66	--
104+00 to 106+00	(AL)	Theater (1)	50	40	65	40	22-27	--	70	62-67	--
105+00 to 109+00	(AR)	Office (2)	50	40	70	45	23-28	--	75	63-68	--
107+00 to 108+50	(AL)	Apartments (1)	50	35	70	40	23-28	--	70	63-68	--
109+00 to 111+50	(AL)	Apartments (1)	50	40	70	40	22-27	--	70	63-68	--
110+00 to 111+00	(AR)	Office (1)	50	40	70	45	20-25	--	75	62-67	--
111+00 to 113+50	(AR)	Apartments (1)	50	50	70	40	22-27	--	70	62-67	--
115+00 to 118+00	(AR/AL)	Office (5)	40	35	70	45	25-30	--	75	65-70	--

TABLE I-1 (CONTINUED)

Location of Structure Adjacent to Alignment	Type of Structure (N)*	Depth to Top of Rail (ft)	Horiz. Dist. from Near Track ℄ (ft)	Operat'l Train Speed (mph)	Ground-Borne Noise			Ground-Borne Vibration		
					Criterion for Allowable Noise Level (dBA)	Projected Maximum Noise Level With D.F. Fasteners (dBA)	Projected Maximum Noise Level With Recommended Mitigation (dBA)	Criterion for Allowable Vibration Level (dB)*	Projected Maximum Vibration Veloc. Lvl. With D.F. Fasteners (dB)*	Projected Maximum Vibration Veloc. Lvl. With Recomm. Mitigation (dB)*
118+00 to 119+50 (AR/AL)	Apartments (2)	35	50	70	40	23-28	--	70	63-68	--
120+00 to 128+00 (AR)	Residential (3)	40	100	70	35	19-24	--	70	61-66	--
124+00 to 125+50 (AL)	Office (1)	40	50	70	45	18-23	--	75	60-65	--
128+00 to 130+00 (AR)	Office (1)	40	40	70	45	20-25	--	75	61-66	--
132+00 to 139+00 (AR)	Residential (3)	35	150	70	35	<20	--	70	58-63	--
139+00 to 141+00 (AL)	Residential (2)	30	40	70	35	27-32	24-29[1]	70	68-73	62-67[1]
144+50 to 146+00 (AL)	Office (1)	30	70	70	45	21-26	--	75	62-67	--
145+50 to 147+00 (AR)	Office (1)	30	70	70	45	<20	--	75	56-61	--
147+50 to 151+00 (AL)	Commercial/ Office (4)	30	40	65	45-50	25-30	--	75-80	65-70	--
151+00 to 152+50 (AR)	Office (1)	35	40	60	45	22-27	--	75	63-68	--

TABLE I-1 (CONTINUED)

Location of Structure Adjacent to Alignment		Type of Structure (N)*	Depth to Top of Rail (ft)	Horiz. Dist. from Near Track ℄ (ft)	Operat'l Train Speed (mph)	Ground-Borne Noise			Ground-Borne Vibration		
						Criterion for Allowable Noise Level (dBA)	Projected Maximum Noise Level With D.F. Fasteners (dBA)	Projected Maximum Noise Level With Recommended Mitigation (dBA)	Criterion for Allowable Vibration Level (dB)*	Projected Maximum Vibration Veloc. Lvl. With D.F. Fasteners (dB)*	Projected Maximum Vibration Veloc. Lvl. With Recomm. Mitigation (dB)*
151+50 to 160+00	(AR/AL)	Commercial (5)	35	30	55	50	26-31	--	80	67-72	--
157+50 to 158+50	(AL)	Office (1)	40	40	50	45	17-22	--	75	58-63	--
160+50 to 166+00	(AR/AL)	Commercial/ Office (8)	40	25	45	45-50	23-28	--	75-80	65-70	--
167+00 to 172+00	(AR/AL)	Commercial (6)	45	25	55	50	23-28	--	80	62-67	--
170+50 to 174+00	(AR/AL)	Office (2)	45	40	60	45	20-25	--	75	62-67	--
174+00 to 179+50	(AR/AL)	Commercial/ Office (9)	40	40	70	45-50	24-29	--	75-80	64-69	--
177+50 to 180+00	(AL)	Commercial/ Office (1)	40	40	70	45-50	18-23	--	75-80	58-63	--
180+00 to 189+00	(AL/AR)	Commercial/ Office (9)	40	40	70	45-50	24-29	--	75-80	64-69	--
187+00 to 190+00	(AL)	Office (1)	40	60	70	45	20-25	--	75	62-67	--
189+50 to 195+00	(AR)	Commercial/ Office (1)	35	50	70	45-50	17-22	--	75-80	57-62	--

TABLE I-1 (CONTINUED)

Location of Structure Adjacent to Alignment	Type of Structure (N)*	Depth to Top of Rail (ft)	Horiz. Dist. from Near Track ℄ (ft)	Operat'l Train Speed (mph)	Ground-Borne Noise: Criterion for Allowable Noise Level (dBA)	Ground-Borne Noise: Projected Maximum Noise Level With D.F. Fasteners (dBA)	Ground-Borne Noise: Projected Maximum Noise Level With Recommended Mitigation (dBA)	Ground-Borne Vibration: Criterion for Allowable Vibration Level (dB)*	Ground-Borne Vibration: Projected Maximum Vibration Veloc. Lvl. With D.F. Fasteners (dB)*	Ground-Borne Vibration: Projected Maximum Vibration Veloc. Lvl. With Recomm. Mitigation (dB)*
192+00 to 201+00 (AL)	Commercial/ Office (7)	35	40	70	45-50	25-30	--	75-80	65-70	--
198+00 to 199+00 (AL)	Commercial/ Museum (1)	40	40	70	45-50	19-24	--	75-80	64-69	--
203+00 to 208+00 (AR)	Museum (3)	40	80	60	40	<20	--	75	56-61	--
206+00 to 209+50 (AL)	Office (3)	40	80	60	40	16-21	--	75	59-64	--
210+00 to 213+00 (AR/AL)	Commercial/ Office (4)	40	30	55	45-50	33-38 (X-over)	--	75-80	72-77 (X-over)	--
213+00 to 216+50 (AR/AL)	Commercial/ Office (2)	40	30	50	45-50	27-33 (X-over)	--	75-80	68-73 (X-over)	--
217+00 to 221+00 (AR/AL)	Commercial/ Office (6)	40	30	45	45-50	20-25	--	75-80	60-65	--
221+00 to 227+50 (AR/AL)	Commercial/ Office (9)	35 (when line is extended)	30	50	45-50	25-30	--	75-80	66-71	--

(N)* = Number of Buildings ±10%

* = Vibration Velocity re 10^{-6} in/sec

Mitigation Measures:

1 = RS-STEDEF or Tie in Rubber Boot System
2 = Cologne Egg or Soft Fastener

I-2 Vermont/Hollywood/Lankershim Branch (Subway)

TABLE I-2 PROJECTED MAXIMUM GROUND-BORNE NOISE AND VIBRATION LEVELS FOR METRO RAIL OPERATIONS IN SUBWAY - ALIGNMENT 1 -- VERMONT/HOLLYWOOD/LANKERSHIM BRANCH

Location of Structure Adjacent to Alignment		Type of Structure (N)*	Depth to Top of Rail (ft)	Horiz. Dist. from Near Track ℄ (ft)	Operat'l Train Speed (mph)	Ground-Borne Noise			Ground-Borne Vibration		
						Criterion for Allowable Noise Level (dBA)	Projected Maximum Noise Level With D.F. Fasteners (dBA)	Projected Maximum Noise Level With Recommended Mitigation (dBA)	Criterion for Allowable Vibration Level (dB)*	Projected Maximum Vibration Veloc. Lvl. With D.F. Fasteners (dB)*	Projected Maximum Vibration Veloc. Lvl. With Recomm. Mitigation (dB)*
320+00 to 323+00	(AR)	Commercial/ Office (1)	80	0	55	45	36-41	--	75-80	65-70	--
320+00 to 323+00	(AL)	Commercial/ Office (1)	45	0	55	45	43-48	37-42[2]	75-80	68-73	67-72[2]
323+00 to 326+00	(AR)	Apartments (3)	85	0-30	55	40	39-44	33-38[2]	75	67-72	66-71[2]
323+00 to 326+00	(AL)	Apartments (3)	50	0-50	55	40	42-47	35-40[2]	75	68-73	67-72[2]
325+00 to 327+00	(AR)	Commercial/ Office (2)	85	0-40	55	45	32-37	--	75-80	61-66	--
325+00 to 327+00	(AL)	Commercial/ Office (2)	50	0-50	55	45	35-40	--	75-80	63-68	--
326+00 to 328+50	(AR)	Apartments (3)	90	70	55	40	34-39	--	75	62-67	--
326+00 to 328+50	(AL)	Apartments (3)	55	90	55	40	35-40	--	75	62-67	--
327+00 to 330+00	(AR)	Commercial/ Office (3)	100	0	55	45	30-35	--	75-80	61-66	--
327+00 to 330+00	(AL)	Commercial/ Office (3)	60	0	55	45	34-39	--	75-80	62-67	--

TABLE I-2 (CONTINUED)

Location of Structure Adjacent to Alignment	Type of Structure (N)*	Depth to Top of Rail (ft)	Horiz. Dist. from Near Track ℄ (ft)	Operat'l Train Speed (mph)	Ground-Borne Noise			Ground-Borne Vibration		
					Criterion for Allowable Noise Level (dBA)	Projected Maximum Noise Level With D.F. Fasteners (dBA)	Projected Maximum Noise Level With Recommended Mitigation (dBA)	Criterion for Allowable Vibration Level (dB)*	Projected Maximum Vibration Veloc. Lvl. With D.F. Fasteners (dB)*	Projected Maximum Vibration Veloc. Lvl. With Recomm. Mitigation (dB)*
330+00 to 338+00 (AR)	Commercial/ Office (8)	110	0	55	45	27-33	--	75-80	62-67	--
330+00 to 340+00 (AL)	Commercial/ Office (9)	65	0	55	45	34-39	--	75-80	62-67	--
338+00 to 345+00 (AR)	Commercial/ Office (7)	100	60	55	45	28-33	--	75-80	66-71	--
340+00 to 350+00 (AL)	Commercial/ Office (10)	70	30	55	45	33-38	--	75-80	62-67	--
345+00 to 350+00 (AR)	Commercial/ Office (7)	90	60	55	45	29-34	--	75-80	61-66	--
350+00 to 354+00 (AL)	Commercial/ Office (6)	55	30	55	45	34-39	--	75-80	62-67	--
350+00 to 352+00 (AR)	Commercial/ Office (4)	75	60	55	45	30-35	--	75-80	61-66	--
352+00 to 354+00 (AR)	Commercial/ Office (2)	65	30	55	45	34-39	--	75-80	62-67	--
354+00 to 357+00 (AR)	Commercial/ Office (2)	55	60	55	45	32-37	--	75-80	62-67	--
354+00 to 365+00 (AL)	Commercial Office (7)	50	30	55	45	34-39	--	75-80	62-67	--

TABLE I-2 (CONTINUED)

Location of Structure Adjacent to Alignment		Type of Structure (N)*	Depth to Top of Rail (ft)	Horiz. Dist. from Near Track ℄ (ft)	Operat'l Train Speed (mph)	Ground-Borne Noise			Ground-Borne Vibration		
						Criterion for Allowable Noise Level (dBA)	Projected Maximum Noise Level With D.F. Fasteners (dBA)	Projected Maximum Noise Level With Recommended Mitigation (dBA)	Criterion for Allowable Vibration Level (dB)*	Projected Maximum Vibration Veloc. Lvl. With D.F. Fasteners (dB)*	Projected Maximum Vibration Veloc. Lvl. With Recomm. Mitigation (dB)*
357+00 to 360+00	(AR)	School (2)	55	50	55	40	37-42	32-37[2]	75	65-70	64-69[2]
360+00 to 365+00	(AR)	Commercial/ Office (2)	50	50	55	45	34-39	--	75-80	62-67	--
365+00 to 370+00	(AR/AL)	Commercial/ Office (10)	55	30	45	45	25-30	--	75-80	60-65	--
370+00 to 374+00	(AL)	Commercial/ Office (3)	60	30	70	45	36-41	--	75-80	64-69	--
370+00 to 372+00	(AR)	Commercial/ Office (2)	60	30	70	45	36-41	--	75-80	64-69	--
374+00 to 380+00	(AL)	Commercial/ Office (2)	75	70	70	45	32-37	--	75-80	63-68	--
372+00 to 374+00	(AR)	Commercial/ Office (1)	60	60	70	45	34-39	--	75-80	64-69	--
374+00 to 380+00	(AR)	Commercial/ Office (2)	65	120	70	45	27-32	--	75-80	62-67	--
385+00 to 402+00	(AL)	Commercial/ Office (12)	50	30	70	45	41-46	--	75-80	68-73	--
383+50 to 387+50	(AR)	Commercial/ Office (1)	60	30	70	45	36-41	--	75-80	64-69	--

TABLE I-2 (CONTINUED)

Location of Structure Adjacent to Alignment		Type of Structure (N)*	Depth to Top of Rail (ft)	Horiz. Dist. from Near Track C (ft)	Operat'l Train Speed (mph)	Ground-Borne Noise			Ground-Borne Vibration		
						Criterion for Allowable Noise Level (dBA)	Projected Maximum Noise Level With D.F. Fasteners (dBA)	Projected Maximum Noise Level With Recommended Mitigation (dBA)	Criterion for Allowable Vibration Level (dB)*	Projected Maximum Vibration Veloc. Lvl. With D.F. Fasteners (dB)*	Projected Maximum Vibration Veloc. Lvl. With Recomm. Mitigation (dB)*
387+50 to 398+00	(AR)	Commercial/ Office (8)	50	30	70	45	41-46	--	75-80	68-73	--
402+00 to 414+00	(AL)	L.A.City College (School) (2)	50	30	70	40	36-41	--	75	64-69	--
402+00 to 414+00	(AR)	Commercial/ Office (9)	50	30	70	45	36-41	--	75-80	64-69	--
414+00 to 418+00	(AR/AL)	Commercial/ Office (5)	50	30	45	45	23-28	--	75-80	60-65	--
418+00 to 420+00	(AR)	Theater (1)	55	30	45	35	28-33	--	75	63-68	--
418+00 to 420+00	(AL)	Commercial/ Office (2)	55	30	45	45	23-28	--	75-80	60-65	--
420+00 to 439+50	(AR/AL)	Commercial/ Office (22)	40-55	30	55	45	33-38	--	75-80	62-67	--
439+50 to 442+50	(AL)	Commercial/ Office (4)	45	30	50	45	38-43 (X-Over)	--	75-80	71-76 (X-Over)	--
439+50 to 442+50	(AR)	Hospital (2)	50	30	50	40	37-42 (X-Over)	22-27[3]	60-70[A] 75	71-76 (X-Over)	61-66[3]
443+00 to 449+00	(AR/AL)	Hospital (2)	55	25	45	40	32-37	--	60-70[A] 75	56-61	--

TABLE I-2 (CONTINUED)

Location of Structure Adjacent to Alignment		Type of Structure (N)*	Depth to Top of Rail (ft)	Horiz. Dist. from Near Track ℄ (ft)	Operat'l Train Speed (mph)	Ground-Borne Noise			Ground-Borne Vibration		
						Criterion for Allowable Noise Level (dBA)	Projected Maximum Noise Level With D.F. Fasteners (dBA)	Projected Maximum Noise Level With Recommended Mitigation (dBA)	Criterion for Allowable Vibration Level (dB)*	Projected Maximum Vibration Veloc. Lvl. With D.F. Fasteners (dB)*	Projected Maximum Vibration Veloc. Lvl. With Recomm. Mitigation (dB)*
456+00 to 457+00	(AR/AL)	Museum (3)	50	0	45	40	36-41	--	75	59-64	--
459+00 to 506+00	(AR/AL)	Commercial/ Office (61)	45	25	70	45-50	38-43	--	75-80	68-73	--
501+50 to 503+50	(AL)	Motel (1)	45	25	55	45	39-44	--	75	68-73	--
506+00 to 512+00	(AR/AL)	Commercial/ Office (11)	45	25	45	45-50	27-32	--	75-80	64-69	--
510+50 to 511+00	(AR)	Hotel (1)	45	25	45	45	21-26	--	75	58-63	--
512+00 to 555+50	(AR/AL)	Commercial/ Office (50)	45	25	70	45-50	39-44	--	75-80	68-73	--
555+50 to 560+00	(AR/AL)	Commercial/ Office (5)	45	30	70	45	29-34	--	75-80	68-73	--
560+00 to 565+50	(AR/AL)	Commercial/ Office (12)	55	30	45	45	22-27	--	75-80	63-68	--
565+50 to 567+00	(AR/AL)	Commercial/ Office (5)	55	30	55	45	35-40 (X-Over)	--	75-80	75-80 (X-Over)	--
567+00 to 574+50	(AR/AL)	Commercial/ Office (15)	55	30	55	45	25-30	--	75-80	65-70	--

TABLE I-2 (CONTINUED)

Location of Structure Adjacent to Alignment		Type of Structure (N)*	Depth to Top of Rail (ft)	Horiz. Dist. from Near Track ℄ (ft)	Operat'l Train Speed (mph)	Ground-Borne Noise			Ground-Borne Vibration		
						Criterion for Allowable Noise Level (dBA)	Projected Maximum Noise Level With D.F. Fasteners (dBA)	Projected Maximum Noise Level With Recommended Mitigation (dBA)	Criterion for Allowable Vibration Level (dB)*	Projected Maximum Vibration Veloc. Lvl. With D.F. Fasteners (dB)*	Projected Maximum Vibration Veloc. Lvl. With Recomm. Mitigation (dB)*
571+00 to 573+00	(AR)	Theater (1)	55	30	55	35	25-30	--	75	65-70	--
574+50 to 576+50	(AR/AL)	Commercial/ Office (4)	55	30	55	45	35-40 (X-Over)	--	75-80	75-80 (X-Over)	--
576+50 to 582+00	(AR/AL)	Commercial/ Office (13)	55	30	55	45	30-35	--	75-80	65-70	--
582+00 to 584+50	(AL)	Commercial/ Office (5)	45	30-50	55	45	31-36	--	75-80	65-70	--
582+00 to 584+50	(AR)	Commercial/ Office (2)	45	0	55	45	29-34	--	75-80	71-76	--
584+50 to 599+00	(AR/AL)	Commercial/ Office (12)	45	0	55	45	29-34	--	75-80	71-76	--
599+00 to 609+00	(AR/AL)	Commercial/ Office (7)	40-60	40	55	45	35-40	--	75-80	69-74	--
599+00 to 609+00	(AR/AL)	Residential (6)	40-60	40	55	35	38-43	23-28[3]	70	71-76	64-69[3]
609+00 to 612+00	(AR/AL)	Apartments (2)	40	0	55	40	42-47	25-30[3]	75	73-78	66-71[3]
612+00 to 617+00	(AR/AL)	Residential (15)	40	0	55	35	42-47	25-30[3]	70	73-78	66-71[3]

TABLE I-2 (CONTINUED)

Location of Structure Adjacent to Alignment		Type of Structure (N)*	Depth to Top of Rail (ft)	Horiz. Dist. from Near Track ℄ (ft)	Operat'l Train Speed (mph)	Ground-Borne Noise			Ground-Borne Vibration		
						Criterion for Allowable Noise Level (dBA)	Projected Maximum Noise Level With D.F. Fasteners (dBA)	Projected Maximum Noise Level With Recommended Mitigation (dBA)	Criterion for Allowable Vibration Level (dB)*	Projected Maximum Vibration Veloc. Lvl. With D.F. Fasteners (dB)*	Projected Maximum Vibration Veloc. Lvl. With Recomm. Mitigation (dB)*
622+00 to 628+00	(AR/AL)	Hollywood Bowl Band Shell	70	300	55	N/A	--	--	75	65-70	--
628+00 to 920+00	(AR/AL)	Residential (Approx 100)	≥120	0	70	35	≤35	--	70	≤65	--
Equation STA 644+50 BACK = STA 821+00 AHEAD											
920+00 to 927+50	(AR/AL)	Residential (10)	80	0	60	35	38-43	32-37[2]	70	67-72	66-71[2]
927+50 to 928+50	(AR/AL)	Commercial (2)	80	0	60	50	36-41	--	80	65-70	--
930+00 to 931+00	(AR)	Commercial/ Office (1)	75	30	50	45	30-35	--	75-80	57-62	--
931+00 to 936+50	(AR)	Campo de Cahuenga	70	95	45	35	22-27	--	75	56-61	--
936+00 to 937+00	(AL)	Residential (4)	70	120	45	35	26-31	--	70	56-61	--
943+00 to 947+00	(AL)	Residential (10)	50	20	50	35	39-44	32-37[2]	70	63-68	62-67[2]
943+00 to 946+00	(AR)	Commercial/ Office (2)	50	15	50	45	37-42	--	75-80	61-66	--
948+00 to 951+50	(AR/AL)	Commercial (3)	70	0	55	50	30-35	--	80	59-64	--

TABLE I-2 (CONTINUED)

Location of Structure Adjacent to Alignment		Type of Structure (N)*	Depth to Top of Rail (ft)	Horiz. Dist. from Near Track ℄ (ft)	Operat'l Train Speed (mph)	Ground-Borne Noise			Ground-Borne Vibration		
						Criterion for Allowable Noise Level (dBA)	Projected Maximum Noise Level With D.F. Fasteners (dBA)	Projected Maximum Noise Level With Recommended Mitigation (dBA)	Criterion for Allowable Vibration Level (dB)*	Projected Maximum Vibration Veloc. Lvl. With D.F. Fasteners (dB)*	Projected Maximum Vibration Veloc. Lvl. With Recomm. Mitigation (dB)*
949+00 to 951+50	(AL)	Residential (4)	70	80-120	55	35	31-36	--	70	59-64	--
950+50 to 951+50	(AR/AL)	Office (1)	75	0	55	40	30-35	--	75	63-68	--
952+00 to 954+00	(AR/AL)	Commercial/ Office (3)	80	0	60	45	31-36	--	75-80	59-64	--
954+00 to 962+00	(AR/AL)	Office (9) School (1)	80	30	70	40	31-36	--	75	65-70	--
962+00 to 969+50	(AR/AL)	Commercial/ Office (7)	80	30	70	45	31-36	--	75-80	65-70	--
969+50 to 971+00	(AL)	Apartments (2)	85	40	70	40	31-36	--	75	60-65	--
970+00 to 976+00	(AR/AL)	Commercial/ Office (8)	85	30	70	45	30-35	--	75-80	59-64	--
974+00 to 976+50	(AL)	St. Charles Borromeo Church	85	40	70	35	35-40	29-34[2]	75	64-69	63-68[2]
977+00 to 982+00	(AR/AL)	Commercial/ Office (6)	90	30	70	45	29-34	--	75-80	58-63	--
979+00 to 980+00	(AL)	Recording Studio (1)	90	30	70	25	26-31	20-25[2]	65	57-62	56-61[2]

TABLE I-2 (CONTINUED)

Location of Structure Adjacent to Alignment		Type of Structure (N)*	Depth to Top of Rail (ft)	Horiz. Dist. from Near Track ℄ (ft)	Operat'l Train Speed (mph)	Ground-Borne Noise			Ground-Borne Vibration		
						Criterion for Allowable Noise Level (dBA)	Projected Maximum Noise Level With D.F. Fasteners (dBA)	Projected Maximum Noise Level With Recommended Mitigation (dBA)	Criterion for Allowable Vibration Level (dB)*	Projected Maximum Vibration Veloc. Lvl. With D.F. Fasteners (dB)*	Projected Maximum Vibration Veloc. Lvl. With Recomm. Mitigation (dB)*
982+50 to 995+50	(AR/AL)	Office (3)	90	30	70	40	23-28	--	75	58-63	--
985+00 to 997+50	(AR/AL)	Commercial (4)	90	30	70	45	29-34	--	80	58-63	--
995+75 to 996+25	(AR)	Precision Die Engravers	90	30	70	40	35-40	--	70	64-69	--
996+25 to 997+50	(AR)	Office (1)	90	30	70	40	35-40	--	75	64-69	--
998+00 to 1004+00	(AR/AL)	Commercial/ Office (14)	90	30	70	45	29-34	--	75-80	58-63	--
1008+00 to 1014+00	(AR/AL)	Commercial (13)	80	30	70	45	31-36	--	80	59-64	--
1014+00 to 1016+00	(AR/AL)	Commercial/ Office (5)	80	30	70	45	31-36	--	75-80	59-64	--
1015+50 to 1016+50	(AL)	Recording Studio (1)	80	30	70	25	31-36	15-20[3]	65	59-64	50-55[3]
1016+00 to 1026+00	(AR/AL)	Commercial/ Office (25)	70	30	70	45	33-38	--	75-80	60-65	--
1026+00 to 1026+50	(AR)	Recording Studio (1)	70	30	70	25	33-38	16-21[3]	65	60-65	50-55[3]

TABLE I-2 (CONTINUED)

Location of Structure Adjacent to Alignment		Type of Structure (N)*	Depth to Top of Rail (ft)	Horiz. Dist. from Near Track ℄ (ft)	Operat'l Train Speed (mph)	Ground-Borne Noise: Criterion for Allowable Noise Level (dBA)	Ground-Borne Noise: Projected Maximum Noise Level With D.F. Fasteners (dBA)	Ground-Borne Noise: Projected Maximum Noise Level With Recommended Mitigation (dBA)	Ground-Borne Vibration: Criterion for Allowable Vibration Level (dB)*	Ground-Borne Vibration: Projected Maximum Vibration Veloc. Lvl. With D.F. Fasteners (dB)*	Ground-Borne Vibration: Projected Maximum Vibration Veloc. Lvl. With Recomm. Mitigation (dB)*
1026+50 to 1028+00	(AL)	Office (1)	60	35	70	40	28-33	--	75	66-71	--
1027+50 to 1043+50	(AR/AL)	Commercial/ Office (37)	50	30	70	45	36-41	--	75-80	67-72	--
1033+00 to 1034+00	(AL)	Guild Theatre	50	30	70	35	36-41	30-35[2]	75	67-72	66-71[2]
1041+50 to 1042+00	(AL)	Recording Studio (1)	50	30	60	25	35-40	19-24[3]	65	66-71	56-61[3]
1043+00 to 1044+00	(AL)	El Portal Theater	50	30	55	35	40-45 (X-Over)	25-30[3]	75	75-80 (X-Over)	65-70[3]
1044+00 to 1048+00	(AR/AL)	Commercial (10)	50	30	55	45	40-45 (X-Over)	--	80	75-80 (X-Over)	--
1048+00 to 1052+50	(AR/AL)	Commercial (5)	50	30	45	45	27-32	--	80	64-69	--
1052+50 to 1057+64	(AR/AL)	Commercial (5)	50	30	55 (When line is extended)	45	30-35	--	80	64-69	--

(N)* = Number of Buildings ±10%

* = Vibration Velocity re 10^{-6} in/sec

Mitigation Measures:

[2] = Cologne Egg or Soft Fastener
[3] = Floating Slab Trackbed

[A] = If building has vibration sensitive medical equipment

APPENDIX II

Candidate Alignment 2

Vermont/Hollywood Boulevard/Wilshire Aerial

II-1 Wilshire Branch (Subway)

TABLE II-1 PROJECTED MAXIMUM GROUND-BORNE NOISE AND VIBRATION LEVELS FOR METRO RAIL OPERATIONS IN SUBWAY -- ALIGNMENT 2 -- WILSHIRE BRANCH

Location of Structure Adjacent to Alignment		Type of Structure (N)*	Depth to Top of Rail (ft)	Horiz. Dist. from Near Track ℄ (ft)	Operat'l Train Speed (mph)	Ground-Borne Noise			Ground-Borne Vibration		
						Criterion for Allowable Noise Level (dBA)	Projected Maximum Noise Level With D.F. Fasteners (dBA)	Projected Maximum Noise Level With Recommended Mitigation (dBA)	Criterion for Allowable Vibration Level (dB)*	Projected Maximum Vibration Veloc. Lvl. With D.F. Fasteners (dB)*	Projected Maximum Vibration Veloc. Lvl. With Recomm. Mitigation (dB)*
00+00 to 01+00	(AR)	Commercial/ Office (1)	75	0	45	45	36-41	--	75-80	64-69	--
00+00 to 01+00	(AL)	Commercial/ Office (1)	40	0	45	45	42-47	36-41[2]	75-80	67-72	66-71[2]
01+00 to 02+00	(AR)	Commercial/ Office (1)	75	75	45	45	32-37	--	75-80	60-65	--
01+00 to 02+00	(AL)	Commercial/ Office (1)	40	75	45	45	36-41	--	75-80	61-66	--
02+00 to 09+50	(AR)	Commercial/ Office (5)	75	0-10	45	45	36-41	--	75-80	64-69	--
02+00 to 09+50	(AL)	Commercial/ Office (5)	35	0-15	45	45	43-48	37-42[2]	75-80	67-72	66-71[2]
09+50 to 13+50	(AR)	Commercial/ Office (2)	80	0	45	45	35-40	--	75-80	61-66	--
09+50 to 13+50	(AL)	Commercial/ Office (2)	35-40	0	45	45	43-48	37-42[2]	75-80	67-72	66-71[2]
13+50 to 20+00	(AR)	Commercial/ Office (2)	100	0	45	45	33-38	--	75-80	60-65	--
13+50 to 20+00	(AL)	Commercial/ Office (3)	50-60	0	45	45	40-45	--	75-80	65-70	--
20+00 to 22+50	(AL)	Apartments (1)	60	0	45	40	33-38	--	75	61-66	--

TABLE II-1 (CONTINUED)

Location of Structure Adjacent to Alignment		Type of Structure (N)*	Depth to Top of Rail (ft)	Horiz. Dist. from Near Track ℄ (ft)	Operat'l Train Speed (mph)	Ground-Borne Noise			Ground-Borne Vibration		
						Criterion for Allowable Noise Level (dBA)	Projected Maximum Noise Level With D.F. Fasteners (dBA)	Projected Maximum Noise Level With Recommended Mitigation (dBA)	Criterion for Allowable Vibration Level (dB)*	Projected Maximum Vibration Veloc. Lvl. With D.F. Fasteners (dB)*	Projected Maximum Vibration Veloc. Lvl. With Recomm. Mitigation (dB)*
24+00 to 28+00	(AR)	Office (1)	70-85	70	45	40	27-32	--	75	54-59	--
28+00 to 29+80	(AR)	Office (1)	55-60	35	45	40	32-37	--	75	61-66	--
30+00 to 31+50	(AR)	Church (1)	60	35	45	35	29-34	--	75	64-69	--
24+00 to 31+50	(AL)	Office (4)	55-85	30-60	45	40	30-35	--	75	60-65	--
32+00 to 33+00	(AR)	Hyatt Conference Center (1)	55	25	45	35	28-33	--	70	63-68	--
33+00 to 35+00	(AR)	Hotel (2)	60	25-70	45	45	25-30	--	75	60-65	--
35+20 to 37+20	(AR)	Office (1)	60	25	45	40	28-32	--	75	60-65	--
31+50 to 36+00	(AL)	Office/ Bank (2)	60	25	45	40-45	20-25	--	75-80	60-65	--
36+00 to 46+50	(AL)	Commercial/ Office (6)	60	25	45	40-50	26-31	--	75-80	65-70	--
37+50 to 38+50	(AR)	Restaurant (1)	60	25	45	50	35-39	--	80	66-71	--
39+50 to 46+50	(AR)	Church (2)	60	45	45	35	31-36	--	75	64-69	--

TABLE II-1 (CONTINUED)

Location of Structure Adjacent to Alignment		Type of Structure (N)*	Depth to Top of Rail (ft)	Horiz. Dist. from Near Track ℄ (ft)	Operat'l Train Speed (mph)	Ground-Borne Noise: Criterion for Allowable Noise Level (dBA)	Ground-Borne Noise: Projected Maximum Noise Level With D.F. Fasteners (dBA)	Ground-Borne Noise: Projected Maximum Noise Level With Recommended Mitigation (dBA)	Ground-Borne Vibration: Criterion for Allowable Vibration Level (dB)*	Ground-Borne Vibration: Projected Maximum Vibration Veloc. Lvl. With D.F. Fasteners (dB)*	Ground-Borne Vibration: Projected Maximum Vibration Veloc. Lvl. With Recomm. Mitigation (dB)*
50+00 to 54+00	(AR)	Office (2)	50-55	35	45	40	34-39 (X-Over)	--	75	67-72 (X-Over)	--
54+00 to 57+00	(AR)	Commercial/ Office (2)	50	25	45	40-50	25-30	--	75-80	64-69	--
54+00 to 58+50	(AL)	Office/ Theater (3)	50	40	45	35-40	21-26	--	70-75	60-65	--
57+50 to 64+00	(AR)	Office (2)	50	25	55	40	31-36	--	75	62-67	--
65+00 to 66+70	(AR)	Church (1)	50	30	45	35	30-35	--	70	63-68	--
66+80 to 77+00	(AR)	Commercial/ Office (5)	20	30	45	45	38-43	--	75-80	66-71	--
60+00 to 70+50	(AL)	Commercial/ Office (8)	40	30	45	45	37-42	--	75-80	66-71	--
70+50 to 72+00	(AL)	Apartments (1)	30	40	45	40	32-37	--	75	66-71	--
72+00 to 77+00	(AL)	Commercial/ Office (4)	20	30	45	45	38-43	--	75	67-72	--

(N)* = Number of Buildings ±10%

* = Vibration Velocity re 10^{-6} in/sec

Mitigation Measures:

2 = Cologne Egg or Soft Fastener

II-2 Wilshire Branch (Aerial)

TABLE II-2 PROJECTED MAXIMUM AIRBORNE NOISE LEVELS FOR METRO RAIL OPERATIONS ON AERIAL STRUCTURE ALIGNMENT 2 -- WILSHIRE BRANCH

Station Number and Direction from Alignment	Type of Structure (N)*	Distance Near Track to Nearest Building (ft)	Maximum Train Speed (mph)	Criterion for Allowable Levels (dBA)	No Sound Barrier Wall		Sound Barrier Wall	
					Predicted Maximum Noise 6-car Train (dBA)	Required Distance for Criterion Compliance (ft)	Predicted Maximum Noise 6-car Train (dBA)	Required Distance for Criterion Compliance (ft)
77+00 to 82+50 (AR)	Commercial (5)	40	45	85	85-87	70	76-78	--
77+00 to 83+00 (AL)	Commercial (2)	30	45	85	85-87	70	76-78	--
82+50 to 84+50 (AR)	Apartments (1)	50	45	80	84-86	160	75-77	--
83+00 to 85+00 (AL)	Theater (1)	50	45	75	84-86	320	75-77	70
84+50 to 88+50 (AR)	Commercial (1)	40	45	85	85-87	70	76-78	--
85+00 to 88+50 (AL)	Commercial (1)	40	45	85	85-87	70	76-78	--
88+50 to 90+00 (AL/AR)	Commercial (1)	40	45	85	85-87	70	76-78	--
90+00 to 93+00 (AL/AR)	Commercial (1)	40	45	85	85-87	300	76-78	--
93+00 to 95+00 (AR)	Residential (2)	330	70	80	76-78	--	--	--
93+00 to 96+00 (AL)	Commercial (4)	40	70	85	89-91	150	80-82	--
95+00 to 100+00 (AR)	Commercial (3)	50	70	85	88-90	150	79-81	--

TABLE II-2 (CONTINUED)

Station Number and Direction from Alignment	Type of Structure (N)*	Distance Near Track to Nearest Building (ft)	Maximum Train Speed (mph)	Criterion for Allowable Levels (dBA)	No Sound Barrier Wall: Predicted Maximum Noise 6-car Train (dBA)	No Sound Barrier Wall: Required Distance for Criterion Compliance (ft)	Sound Barrier Wall: Predicted Maximum Noise 6-car Train (dBA)	Sound Barrier Wall: Required Distance for Criterion Compliance (ft)
96+00 to 98+00 (AL)	Hotel (1)	40	70	80	89-91	300	80-82	60
98+00 to 100+00 (AL)	Commercial (1)	40	70	85	89-91	150	80-82	--
100+00 to 103+00 (AL)	Church (1)	50	70	75	88-90	580	79-81	160
100+00 to 104+50 (AR)	Church (1)	50	70	75	88-90	580	79-81	160
103+00 to 106+00 (AL)	Theater (1)	50	70	75	88-90	580	79-81	160
104+50 to 111+00 (AR)	Commercial (2)	40	70	85	89-91	150	80-82	--
106+00 to 114+00 (AL)	Apartments (2)	40	70	80	89-91	300	80-82	60
111+00 to 114+00 (AR)	Apartments (1)	50	70	80	88-90	300	79-81	60
114+00 to 117+00 (AL/AR)	Commercial (4)	50	70	85	88-90	150	79-81	--
117+00 to 120+00 (AR)	Apartments (1)	50	70	80	88-90	300	79-81	60
117+00 to 118+00 (AL)	Apartments (1)	50	70	80	88-90	300	79-81	60

TABLE II-2 (CONTINUED)

Station Number and Direction from Alignment	Type of Structure (N)*	Distance Near Track to Nearest Building (ft)	Maximum Train Speed (mph)	Criterion for Allowable Levels (dBA)	No Sound Barrier Wall		Sound Barrier Wall	
					Predicted Maximum Noise 6-car Train (dBA)	Required Distance for Criterion Compliance (ft)	Predicted Maximum Noise 6-car Train (dBA)	Required Distance for Criterion Compliance (ft)
118+00 to 124+00 (AL)	Commercial (1)	250	70	85	79-81	--	--	--
120+00 to 128+00 (AR)	Residential (3)	120	70	75	84-86	580	75-77	160
124+00 to 127+00 (AL)	Commercial (1)	50	70	85	88-90	250	79-81	--
127+00 to 138+00 (AL)	Residential (5)	230	70	75	79-81	580	70-72	--
128+00 to 130+00 (AR)	Commercial (1)	40	70	85	89-91	150	80-82	--
130+00 to 140+00 (AR)	Residential (3)	140	70	75	83-85	580	74-76	160
138+00 to 142+00 (AL)	Residential (2)	50	70	80	88-90	300	79-81	60
140+00 to 163+00 (AR)	Commercial (7)	40	70	85	89-91	150	80-82	--
142+00 to 163+00 (AL)	Commercial (11)	40	70	85	89-91	150	80-82	--
163+00 to 169+00 (AL/AR)	Commercial (8)	40	45	85	85-87	60	76-78	--
169+00 to 198+00 (AL)	Commercial (15)	40	70	85	89-91	150	80-82	--

TABLE II-2 (CONTINUED)

Station Number and Direction from Alignment	Type of Structure (N)*	Distance Near Track to Nearest Building (ft)	Maximum Train Speed (mph)	Criterion for Allowable Levels (dBA)	No Sound Barrier Wall: Predicted Maximum Noise 6-car Train (dBA)	No Sound Barrier Wall: Required Distance for Criterion Compliance (ft)	Sound Barrier Wall: Predicted Maximum Noise 6-car Train (dBA)	Sound Barrier Wall: Required Distance for Criterion Compliance (ft)
169+00 to 203+00 (AR)	Commercial (17)	40	70	85	89-91	150	80-82	--
198+00 to 199+00 (AL)	Museum (1)	50	70	75	88-90	580	79-81	160
199+00 to 214+00 (AL)	Commercial (8)	40	70	85	89-91	150	80-82	--
203+00 to 209+00 (AR)	Museum (3)	100	70	75	83-87	580	76-78	160
209+00 to 214+00 (AR)	Commercial (2)	40	70	85	89-91	150	80-82	--
214+00 to 215+50 (AR)	Commercial (1)	40	50	85	92-94 (X-Over)	220	83-85	--
214+00 to 215+50 (AL)	Commercial (1)	50	50	85	91-93 (X-Over)	220	82-84	--
215+50 to 227+50 (AR)	Commercial (8)	40	45	85	85-87	60	76-78	--
215+50 to 227+50 (AL)	Commercial (7)	50	45	85	84-86	60	75-77	--

(N)* = Number of buildings ±10%

II-3 Vermont Branch (Subway)

TABLE II-3 PROJECTED MAXIMUM GROUND-BORNE NOISE AND VIBRATION LEVELS FOR METRO RAIL OPERATIONS IN SUBWAY -- ALIGNMENT 2 -- VERMONT BRANCH

Location of Structure Adjacent to Alignment		Type of Structure (N)*	Depth to Top of Rail (ft)	Horiz. Dist. from Near Track ℄ (ft)	Operat'l Train Speed (mph)	Ground-Borne Noise: Criterion for Allowable Noise Level (dBA)	Ground-Borne Noise: Projected Maximum Noise Level With D.F. Fasteners (dBA)	Ground-Borne Noise: Projected Maximum Noise Level With Recommended Mitigation (dBA)	Ground-Borne Vibration: Criterion for Allowable Vibration Level (dB)*	Ground-Borne Vibration: Projected Maximum Vibration Veloc. Lvl. With D.F. Fasteners (dB)*	Ground-Borne Vibration: Projected Maximum Vibration Veloc. Lvl. With Recomm. Mitigation (dB)*
320+00 to 323+00	(AR)	Commercial/ Office (1)	75	0	45	45	29-34	--	75-80	59-64	--
320+00 to 323+00	(AL)	Commercial/ Office (1)	40	0	45	45	40-45	--	75-80	64-69	--
323+00 to 326+00	(AR)	Apartments (3)	70	0-30	45	40	37-42	31-36[2]	75	65-70	64-69[2]
323+00 to 326+00	(AL)	Apartments (3)	40	0-50	45	40	45-50	37-42[2]	75	68-73	67-72[2]
325+00 to 327+00	(AR)	Commercial/ Office (2)	65	0-40	45	45	32-37	--	75-80	61-66	--
325+00 to 327+00	(AL)	Commercial/ Office (2)	40	0-50	45	45	38-43	--	75-80	63-68	--
326+00 to 328+50	(AR)	Apartments (3)	55	70	45	40	35-40	--	75	67-72	--
326+00 to 328+50	(AL)	Apartments (3)	45	90	45	40	33-38	--	75	67-72	--
327+00 to 330+00	(AR)	Commercial/ Office (3)	55	0	45	45	36-41	--	75-80	63-68	--
327+00 to 330+00	(AL)	Commercial/ Office (3)	45	0	45	45	37-42	--	75-80	63-68	--

TABLE II-3 (CONTINUED)

Location of Structure Adjacent to Alignment		Type of Structure (N)*	Depth to Top of Rail (ft)	Horiz. Dist. from Near Track ℄ (ft)	Operat'l Train Speed (mph)	Ground-Borne Noise: Criterion for Allowable Noise Level (dBA)	Ground-Borne Noise: Projected Maximum Noise Level With D.F. Fasteners (dBA)	Ground-Borne Noise: Projected Maximum Noise Level With Recommended Mitigation (dBA)	Ground-Borne Vibration: Criterion for Allowable Vibration Level (dB)*	Ground-Borne Vibration: Projected Maximum Vibration Veloc. Lvl. With D.F. Fasteners (dB)*	Ground-Borne Vibration: Projected Maximum Vibration Veloc. Lvl. With Recomm. Mitigation (dB)*
330+00 to 338+00	(AR)	Commercial/ Office (8)	35	0	45	45	38-43	--	75-80	63-68	--
330+00 to 340+00	(AL)	Commercial/ Office (9)	25	0	45	45	40-45	--	75-80	64-69	--
330+00 to 342+00	(AR)	Commercial/ Office (1)	20	60	45	45	40-45	--	75-80	66-71	--
340+00 to 342+00	(AL)	Commercial/ Office (4)	20	30	45	45	40-45	--	75-80	66-71	--

(N)* = Number of Buildings ±10%

* = Vibration Velocity re 10^{-6} in/sec

Mitigation Measures:

2 = Cologne Egg or Soft Fastener

II-4 Vermont/Hollywood Branch (Aerial)

TABLE II-4 PROJECTED MAXIMUM AIRBORNE NOISE LEVELS FOR METRO RAIL OPERATIONS ON AERIAL STRUCTURE ALIGNMENT 2 -- VERMONT/HOLLYWOOD BRANCH

Station Number and Direction from Alignment	Type of Structure (N)*	Distance Near Track to Nearest Building (ft)	Maximum Train Speed (mph)	Criterion for Allowable Levels (dBA)	No Sound Barrier Wall: Predicted Maximum Noise 6-car Train (dBA)	No Sound Barrier Wall: Required Distance for Criterion Compliance (ft)	Sound Barrier Wall: Predicted Maximum Noise 6-car Train (dBA)	Sound Barrier Wall: Required Distance for Criterion Compliance (ft)
342+00 to 349+00 (AL)	Commercial (8)	30	60	85	74-76	--	--	--
342+00 to 349+00 (AR)	Commercial (4)	100	60	85	70-72	--	--	--
349+00 to 365+00 (AL)	Commercial (18)	30	60	85	88-90	130	79-81	--
349+00 to 356+00 (AR)	Commercial (3)	50	60	85	87-89	120	78-80	--
356+00 to 360+00 (AR)	School (2)	50	60	75	87-89	510	78-80	140
360+00 to 365+00 (AR)	Commercial (4)	50	60	85	87-89	130	78-80	--
365+00 to 370+00 (AL/AR)	Commercial (10)	30	45	85	85-87	60	76-78	--
370+00 to 374+00 (AL)	Commercial (2)	40	70	85	85-91	150	80-82	--
370+00 to 373+00 (AR)	Commercial (1)	30	70	85	89-91	150	80-82	--
374+00 to 378+00 (AL)	Commercial (2)	90	70	85	85-87	110	77-79	--

TABLE II-4 (CONTINUED)

Station Number and Direction from Alignment	Type of Structure (N)*	Distance Near Track to Nearest Building (ft)	Maximum Train Speed (mph)	Criterion for Allowable Levels (dBA)	No Sound Barrier Wall: Predicted Maximum Noise 6-car Train (dBA)	No Sound Barrier Wall: Required Distance for Criterion Compliance (ft)	Sound Barrier Wall: Predicted Maximum Noise 6-car Train (dBA)	Sound Barrier Wall: Required Distance for Criterion Compliance (ft)
382+00 to 414+00 (AR)	Commercial (18)	30	70	85	89-91	150	80-82	--
384+00 to 402+00 (AL)	Commercial (12)	30	70	85	89-91	150	80-82	--
402+00 to 414+00 (AL)	School (2)	40	70	75	89-91	590	80-82	160
414+00 to 417+00 (AR)	Commercial (3)	30	45	85	85-87	60	76-78	--
414+00 to 446+00 (AL)	Commercial (24)	40	45	85	85-87	60	76-78	--
417+00 to 418+00 (AR)	Theater (1)	40	45	75	85-87	310	76-78	70
422+00 to 434+00 (AR)	Commercial (10)	30	45	85	85-87	60	76-78	--
434+00 to 438+00 (AR/AL)	Commercial (3)	30	45	85	91-93 (X-Over)	150	83-85 (X-Over)	--
438+00 to 440+00 (AR)	Hospital (1)	120	45	75	86-88 (X-Over)	580	78-80 (X-Over)	225
440+00 to 446+00 (AR)	Hospital (2)	30	45	75	85-87	310	76-78	70
446+00 to 449+00 (AL)	Hospital (1)	40	45	75	85-87	310	76-78	70

TABLE II-4 (CONTINUED)

Station Number and Direction from Alignment	Type of Structure (N)*	Distance Near Track to Nearest Building (ft)	Maximum Train Speed (mph)	Criterion for Allowable Levels (dBA)	No Sound Barrier Wall: Predicted Maximum Noise 6-car Train (dBA)	No Sound Barrier Wall: Required Distance for Criterion Compliance (ft)	Sound Barrier Wall: Predicted Maximum Noise 6-car Train (dBA)	Sound Barrier Wall: Required Distance for Criterion Compliance (ft)
446+00 to 450+00 (AR)	Commercial (4)	30	45	85	85-87	60	76-78	--
446+00 to 457+00 (AL)	Museum (3)	60	45	75	83-85	310	74-76	75
457+00 to 464+00 (AL)	Park	50	50	70**	85-87	700	76-78	220
459+00 to 506+00 (AR)	Commercial (30)	30	70	85	89-91	150	80-82	--
464+00 to 506+00 (AL)	Commercial (32)	30	70	85	89-91	150	80-82	--
506+00 to 512+00 (AL/AR)	Commercial (12)	30	45	85	85-87	60	76-78	--
512+00 to 540+00 (AL/AR)	Commercial (40)	30	70	85	89-91	150	80-82	--
540+00 to 546+00 (AL)	Commercial (3)	60	70	85	74-76	--	--	--
540+00 to 546+00 (AR)	Commercial (7)	40	70	85	76-78	--	--	--

(N)* = Number of buildings ±10%

** = Assumes park used for "quiet" outdoor recreation

II-5 Hollywood/Lankershim Branch (Subway)

TABLE II-5 PROJECTED MAXIMUM GROUND-BORNE NOISE AND VIBRATION LEVELS FOR METRO RAIL OPERATIONS IN SUBWAY -- ALIGNMENT 2 -- HOLLYWOOD/LANKERSHIM BRANCH

Location of Structure Adjacent to Alignment		Type of Structure (N)*	Depth to Top of Rail (ft)	Horiz. Dist. from Near Track ℄ (ft)	Operat'l Train Speed (mph)	Ground-Borne Noise			Ground-Borne Vibration		
						Criterion for Allowable Noise Level (dBA)	Projected Maximum Noise Level With D.F. Fasteners (dBA)	Projected Maximum Noise Level With Recommended Mitigation (dBA)	Criterion for Allowable Vibration Level (dB)*	Projected Maximum Vibration Veloc. Lvl. With D.F. Fasteners (dB)*	Projected Maximum Vibration Veloc. Lvl. With Recomm. Mitigation (dB)*
547+00 to 555+50	(AR/AL)	Commercial/ Office (12)	25-45	40	70	45	36-41	--	75-80	72-77	--
552+00 to 553+50	(AR)	Pantages Theater (1)	40	40	70	35	33-38	29-34[2]	75	71-76	70-75[2]
555+50 to 560+00	(AR/AL)	Commercial/ Office (5)	45	30	70	45	29-34	--	75-80	68-73	--
560+00 to 565+50	(AR/AL)	Commercial/ Office (12)	55	30	45	45	22-27	--	75-80	63-68	--
565+50 to 567+00	(AR/AL)	Commercial/ Office (5)	55	30	55	45	35-40 (X-Over)	--	75-80	75-80 (X-Over)	--
567+00 to 574+50	(AR/AL)	Commercial/ Office (15)	55	30	55	45	25-30	--	75-80	65-70	--
571+00 to 573+00	(AR)	Warner Theater (1)	55	30	55	35	25-30	--	75	65-70	--
574+50 to 576+50	(AR/AL)	Commercial/ Office (4)	55	30	55	45	35-40 (X-Over)	--	75-80	75-80 (X-Over)	--
576+50 to 582+00	(AR/AL)	Commercial/ Office (13)	55	30	55	45	30-35	--	75-80	65-70	--
582+00 to 584+50	(AL)	Commercial/ Office (5)	45	30-50	55	45	31-36	--	75-80	65-70	--
582+00 to 584+50	(AR)	Commercial/ Office (2)	45	0	55	45	29-34	--	75-80	71-76	--

TABLE II-5 (CONTINUED)

Location of Structure Adjacent to Alignment		Type of Structure (N)*	Depth to Top of Rail. (ft)	Horiz. Dist. from Near Track ℄ (ft)	Operat'l Train Speed (mph)	Ground-Borne Noise: Criterion for Allowable Noise Level (dBA)	Ground-Borne Noise: Projected Maximum Noise Level With D.F. Fasteners (dBA)	Ground-Borne Noise: Projected Maximum Noise Level With Recommended Mitigation (dBA)	Ground-Borne Vibration: Criterion for Allowable Vibration Level (dB)*	Ground-Borne Vibration: Projected Maximum Vibration Veloc. Lvl. With D.F. Fasteners (dB)*	Ground-Borne Vibration: Projected Maximum Vibration Veloc. Lvl. With Recomm. Mitigation (dB)*
584+50 to 599+00	(AR/AL)	Commercial/ Office (12)	45	0	55	45	29-34	--	75-80	71-76	--
599+00 to 609+00	(AR/AL)	Commercial/ Office (7)	40-60	40	55	45	35-40	--	75-80	69-74	--
599+00 to 609+00	(AR/AL)	Residential (6)	40-60	40	55	35	38-43	23-28[3]	70	71-76	64-69[3]
609+00 to 612+00	(AR/AL)	Apartments (2)	40	0	55	40	42-47	25-30[3]	75	73-78	66-71[3]
612+00 to 617+00	(AR/AL)	Residential (15)	40	0	55	35	42-47	25-30[3]	70	73-78	66-71[3]
622+00 to 628+00	(AR/AL)	Hollywood Bowl Band Shell	70	300	55	NA	--	--	75	65-70	--
628+00 to 920+00	(AR/AL)	Residential (Approx. 100)	≥120	0	70	35	≤35	--	70	≤65	--
Equation STA 644+50 BACK = STA 821+00 AHEAD											
920+00 to 927+50	(AR/AL)	Residential (10)	80	0	60	35	38-43	32-37[2]	70	67-72	66-71[2]
927+50 to 928+50	(AR/AL)	Commercial (2)	80	0	60	50	36-41	--	80	65-70	--

TABLE II-5 (CONTINUED)

Location of Structure Adjacent to Alignment		Type of Structure (N)*	Depth to Top of Rail (ft)	Horiz. Dist. from Near Track ℄ (ft)	Operat'l Train Speed (mph)	Ground-Borne Noise			Ground-Borne Vibration		
						Criterion for Allowable Noise Level (dBA)	Projected Maximum Noise Level With D.F. Fasteners (dBA)	Projected Maximum Noise Level With Recommended Mitigation (dBA)	Criterion for Allowable Vibration Level (dB)*	Projected Maximum Vibration Veloc. Lvl. With D.F. Fasteners (dB)*	Projected Maximum Vibration Veloc. Lvl. With Recomm. Mitigation (dB)*
930+00 to 931+00	(AR)	Commercial/ Office (1)	75	30	50	45	30-35	--	75-80	57-62	--
931+00 to 936+50	(AR)	Campo de Cahuenga	70	95	45	35	22-27	--	75	56-61	--
936+00 to 937+00	(AL)	Residential (4)	70	120	45	35	26-31	--	70	56-61	--
943+00 to 947+00	(AL	Residential (10)	50	20	50	35	39-44	32-37[2]	70	63-68	62-67[2]
943+00 to 946+00	(AR)	Commercial/ Office (2)	50	15	50	45	37-42	--	75-80	61-66	--
948+00 to 951+50	(AR/AL)	Commercial (3)	70	0	55	50	30-35	--	80	59-64	--
949+00 to 951+50	(AL)	Residential (4)	70	80-120	55	35	31-36	--	70	59-64	--
950+50 to 951+50	(AR/AL)	Office (1)	75	0	55	40	30-35	--	75	63-68	--
952+00 to 954+00	(AR/AL)	Commercial/ Office (3)	80	0	60	45	31-36	--	75-80	59-64	--

TABLE II-5 (CONTINUED)

Location of Structure Adjacent to Alignment		Type of Structure (N)*	Depth to Top of Rail (ft)	Horiz. Dist. from Near Track ℄ (ft)	Operat'l Train Speed (mph)	Ground-Borne Noise: Criterion for Allowable Noise Level (dBA)	Ground-Borne Noise: Projected Maximum Noise Level With D.F. Fasteners (dBA)	Ground-Borne Noise: Projected Maximum Noise Level With Recommended Mitigation (dBA)	Ground-Borne Vibration: Criterion for Allowable Vibration Level (dB)*	Ground-Borne Vibration: Projected Maximum Vibration Veloc. Lvl. With D.F. Fasteners (dB)*	Ground-Borne Vibration: Projected Maximum Vibration Veloc. Lvl. With Recomm. Mitigation (dB)*
954+00 to 962+00	(AR/AL)	Office (9) School (1)	80	30	70	40	31-36	--	75	65-70	--
962+00 to 969+50	(AR/AL)	Commercial/ Office (7)	80	30	70	45	31-36	--	75-80	65-70	--
969+50 to 971+00	(AL)	Apartments (2)	85	40	70	40	31-36	--	75	60-65	--
970+00 to 976+00	(AR/AL)	Commercial/ Office (8)	85	30	70	45	30-35	--	75-80	59-64	--
974+00 to 976+50	(AL)	St. Charles Borromeo Church	85	40	70	35	35-40	29-34[2]	75	64-69	63-68[2]
977+00 to 982+00	(AR/AL)	Commercial/ Office (6)	90	30	70	45	29-34	--	75-80	58-63	--
979+00 to 980+00	(AL)	Recording Studio (1)	90	30	70	25	26-31	20-25[2]	65	57-62	56-61[2]
982+50 to 995+50	(AR/AL)	Office (3)	90	30	70	40	23-28	--	75	58-63	--
985+00 to 997+50	(AR/AL)	Commercial (4)	90	30	70	45	29-34	--	80	58-63	--
995+75 to 996+25	(AR)	Precision Die Engravers	90	30	70	40	35-40	--	70	64-69	--

TABLE II-5 (CONTINUED)

Location of Structure Adjacent to Alignment		Type of Structure (N)*	Depth to Top of Rail (ft)	Horiz. Dist. from Near Track ℄ (ft)	Operat'l Train Speed (mph)	Ground-Borne Noise			Ground-Borne Vibration		
						Criterion for Allowable Noise Level (dBA)	Projected Maximum Noise Level With D.F. Fasteners (dBA)	Projected Maximum Noise Level With Recommended Mitigation (dBA)	Criterion for Allowable Vibration Level (dB)*	Projected Maximum Vibration Veloc. Lvl. With D.F. Fasteners (dB)*	Projected Maximum Vibration Veloc. Lvl. With Recomm. Mitigation (dB)*
996+25 to 997+50	(AR)	Office (1)	90	30	70	40	35-40	--	75	64-69	--
998+00 to 1004+00	(AR/AL)	Commercial/ Office (14)	90	30	70	45	29-34	--	75-80	58-63	--
1008+00 to 1014+00	(AR/AL)	Commercial (13)	80	30	70	45	31-36	--	80	59-64	--
1014+00 to 1016+00	(AR/AL)	Commercial/ Office (5)	80	30	70	45	31-36	--	75-80	59-64	--
1015+50 to 1016+50	(AL)	Recording Studio (1)	80	30	70	25	31-36	15-20[3]	65	59-64	50-55[3]
1016+00 to 1026+00	(AR/AL)	Commercial/ Office (25)	70	30	70	45	33-38	--	75-80	60-65	--
1026+00 to 1026+50	(AR)	Recording Studio (1)	70	30	70	25	33-38	16-21[3]	65	60-65	50-55[3]
1026+50 to 1028+00	(AL)	Office (1)	60	35	70	40	28-33	--	75	66-71	--
1027+50 to 1043+50	(AR/AL)	Commercial/ Office (37)	50	30	70	45	36-41	--	75-80	67-72	--
1033+00 to 1034+00	(AL)	Guild Theatre	50	30	70	35	36-41	30-35[2]	75	67-72	66-71[2]

TABLE II-5 (CONTINUED)

Location of Structure Adjacent to Alignment		Type of Structure (N)*	Depth to Top of Rail (ft)	Horiz. Dist. from Near Track ℄ (ft)	Operat'l Train Speed (mph)	Ground-Borne Noise: Criterion for Allowable Noise Level (dBA)	Ground-Borne Noise: Projected Maximum Noise Level With D.F. Fasteners (dBA)	Ground-Borne Noise: Projected Maximum Noise Level With Recommended Mitigation (dBA)	Ground-Borne Vibration: Criterion for Allowable Vibration Level (dB)*	Ground-Borne Vibration: Projected Maximum Vibration Veloc. Lvl. With D.F. Fasteners (dB)*	Ground-Borne Vibration: Projected Maximum Vibration Veloc. Lvl. With Recomm. Mitigation (dB)*
1041+50 to 1042+00	(AL)	Recording Studio (1)	50	30	60	25	35-40	19-24[3]	65	66-71	56-61[3]
1043+00 to 1044+00	(AL)	El Portal Theater	50	30	55	35	40-45 (X-Over)	25-30[3]	75	75-80 (X-Over)	65-70[3]
1044+00 to 1048+00	(AR/AL)	Commercial (10)	50	30	55	45	40-45 (X-Over)	--	80	75-80 (X-Over)	--
1048+00 to 1052+50	(AR/AL)	Commercial (5)	50	30	45	45	27-32	--	80	64-69	--
1052+50 to 1057+64	(AR/AL)	Commercial (5)	50	30	55 (When line is extended)	45	30-35	--	80	64-69	--

(N)* = Number of Buildings ±10%

* = Vibration Velocity re 10^{-6} in/sec

Mitigation Measures:

[2] = Cologne Egg or Soft Fastener

[3] = Floating Slab Trackbed

APPENDIX III

Candidate Alignment 3

Vermont/Hollywood Aerial, Pico/San Vicente Subway

III-1 Wilshire/Crenshaw/San Vicente Branch

TABLE III-1 PROJECTED MAXIMUM GROUND-BORNE NOISE AND VIBRATION LEVELS FOR METRO RAIL OPERATIONS IN SUBWAY -- ALIGNMENT 3 -- WILSHIRE/CRENSHAW/SAN VICENTE BRANCH

Location of Structure Adjacent to Alignment		Type of Structure (N)*	Depth to Top of Rail (ft)	Horiz. Dist. from Near Track ℄ (ft)	Operat'l Train Speed (mph)	Ground-Borne Noise			Ground-Borne Vibration		
						Criterion for Allowable Noise Level (dBA)	Projected Maximum Noise Level With D.F. Fasteners (dBA)	Projected Maximum Noise Level With Recommended Mitigation (dBA)	Criterion for Allowable Vibration Level (dB)*	Projected Maximum Vibration Veloc. Lvl. With D.F. Fasteners (dB)*	Projected Maximum Vibration Veloc. Lvl. With Recomm. Mitigation (dB)*
00+00 to 01+00	(AR)	Commercial/ Office (1)	75	0	45	45	36-41	--	75-80	64-69	--
00+00 to 01+00	(AL)	Commercial/ Office (1)	40	0	45	45	42-47	36-41[2]	75-80	67-72	66-71[2]
01+00 to 02+00	(AR)	Commercial/ Office (1)	75	75	45	45	32-37	--	75-80	60-65	--
01+00 to 02+00	(AL)	Commercial/ Office (1)	40	75	45	45	36-41	--	75-80	61-66	--
02+00 to 09+50	(AR)	Commercial/ Office (5)	75	0-10	45	45	36-41	--	75-80	64-69	--
02+00 to 09+50	(AL)	Commercial/ Office (5)	35	0-15	45	45	43-48	37-42[2]	75-80	67-72	66-71[2]
09+50 to 13+50	(AR)	Commercial/ Office (2)	80	0	45	45	35-40	--	75-80	61-66	--
09+50 to 13+50	(AL)	Commercial/ Office (2)	35-40	0	45	45	43-48	37-42[2]	75-80	67-72	66-71[2]
13+50 to 20+00	(AR)	Commercial/ Office (2)	100	0	45	45	33-38	--	75-80	60-65	--
13+50 to 20+00	(AL)	Commercial/ Office (3)	50-60	0	45	45	40-45	--	75-80	65-70	--

TABLE III-1 (CONTINUED)

Location of Structure Adjacent to Alignment		Type of Structure (N)*	Depth to Top of Rail (ft)	Horiz. Dist. from Near Track ℄ (ft)	Operat'l Train Speed (mph)	Ground-Borne Noise			Ground-Borne Vibration		
						Criterion for Allowable Noise Level (dBA)	Projected Maximum Noise Level With D.F. Fasteners (dBA)	Projected Maximum Noise Level With Recommended Mitigation (dBA)	Criterion for Allowable Vibration Level (dB)*	Projected Maximum Vibration Veloc. Lvl. With D.F. Fasteners (dB)*	Projected Maximum Vibration Veloc. Lvl. With Recomm. Mitigation (dB)*
20+00 to 22+50	(AL)	Apartments (1)	60	0	45	40	33-38	--	75	61-66	--
24+00 to 28+00	(AR)	Office (1)	70-85	70	45	40	27-32	--	75	54-59	--
28+00 to 29+80	(AR)	Office (1)	55-60	35	45	40	32-37	--	75	61-66	--
30+00 to 31+50	(AR)	Church (1)	60	35	45	35	29-34	--	75	64-69	--
24+00 to 31+50	(AL)	Office (4)	55-85	30-60	45	40	30-35	--	75	60-65	--
32+00 to 33+00	(AR)	Hyatt Conference Center (1)	55	25	45	35	28-33	--	70	63-68	--
33+00 to 35+00	(AR)	Hotel (2)	60	25-70	45	45	25-30	--	75	60-65	--
35+20 to 37+20	(AR)	Office (1)	60	25	45	40	28-32	--	75	60-65	--
31+50 to 36+00	(AL)	Office/ Bank (2)	60	25	45	40-45	20-25	--	75-80	60-65	--
36+00 to 46+50	(AL)	Commercial/ Office (6)	60	25	45	40-50	26-31	--	75-80	65-70	--

TABLE III-1 (CONTINUED)

Location of Structure Adjacent to Alignment		Type of Structure (N)*	Depth to Top of Rail (ft)	Horiz. Dist. from Near Track ℄ (ft)	Operat'l Train Speed (mph)	Ground-Borne Noise: Criterion for Allowable Noise Level (dBA)	Ground-Borne Noise: Projected Maximum Noise Level With D.F. Fasteners (dBA)	Ground-Borne Noise: Projected Maximum Noise Level With Recommended Mitigation (dBA)	Ground-Borne Vibration: Criterion for Allowable Vibration Level (dB)*	Ground-Borne Vibration: Projected Maximum Vibration Veloc. Lvl. With D.F. Fasteners (dB)*	Ground-Borne Vibration: Projected Maximum Vibration Veloc. Lvl. With Recomm. Mitigation (dB)*
37+50 to 38+50	(AR)	Restaurant (1)	60	25	45	50	35-39	--	80	66-71	--
39+50 to 46+50	(AR)	Church (2)	60	45	45	35	31-36	--	75	64-69	--
50+00 to 54+00	(AR)	Office (2)	50-55	35	45	40	34-39 (X-Over)	--	75	67-72 (X-Over)	--
54+00 to 57+00	(AR)	Commercial/ Office (2)	50	25	45	40-50	25-30	--	75-80	64-69	--
54+00 to 58+50	(AL)	Office/ Theater (3)	50	40	45	35-40	21-26	--	70-75	60-65	--
57+50 to 64+00	(AR)	Office (2)	50	25	55	40	31-36	--	75	62-67	--
65+00 to 66+70	(AR)	Church (1)	50	30	55	35	32-37	26-31[2]	75	65-70	64-69[2]
66+80 to 83+50	(AR)	Commercial/ Office (8)	50-55	25-40	55	40-50	37-42	--	75-80	68-72	--
60+00 to 70+50	(AL)	Commercial/ Office (8)	50-55	30-35	55	40-50	37-42	--	75-80	68-72	--
70+50 to 72+00	(AL)	Apartments (1)	55	40	55	45	33-38	--	75	64-69	--

TABLE III-1 (CONTINUED)

Location of Structure Adjacent to Alignment		Type of Structure (N)*	Depth to Top of Rail (ft)	Horiz. Dist. from Near Track C (ft)	Operat'l Train Speed (mph)	Ground-Borne Noise			Ground-Borne Vibration		
						Criterion for Allowable Noise Level (dBA)	Projected Maximum Noise Level With D.F. Fasteners (dBA)	Projected Maximum Noise Level With Recommended Mitigation (dBA)	Criterion for Allowable Vibration Level (dB)*	Projected Maximum Vibration Veloc. Lvl. With D.F. Fasteners (dB)*	Projected Maximum Vibration Veloc. Lvl. With Recomm. Mitigation (dB)*
72+00 to 73+00	(AL)	Office (1)	55	30	55	40	35-40	--	75	68-73	--
74+00 to 75+50	(AL)	Commercial (2)	55	30	55	45	35-40	--	75	68-73	--
76+00 to 81+00	(AL)	Office (2)	55-60	25	55	40	35-40	--	75	68-73	--
81+00 to 108+00	(AL)	Residences (30) and Apartments (6)	70-80	0-40	55	35 (Res) 40 (Apt)	40-45	24-29[3]	70 (Res) 75 (Apt)	65-70	58-63[3]
86+00 to 108+00	(AR)	Residences (26) and Apartments (8)	70-80	0-40	55	35 (Res) 40 (Apt)	40-45	24-29[3]	70 (Res) 75 (Apt)	65-70	58-63[3]
108+00 to 114+30	(AL)	Residences (11)	50-60	20-40	55	35	44-49	27-32[3]	70	70-75	63-68[3]
108+00 to 114+30	(AR)	Residences (3) and Apartments (3)	50	30-50	55	35 (Res) 40 (Apt)	44-49	27-32[3]	70	70-75	63-68[3]
114+30 to 118+50	(AL)	Commercial (1)	50	10	45	50	35-40	--	80	68-72	--
114+30 to 118+50	(AR)	Commercial (5)	50	15-50	45	50	35-40	--	80	68-72	--
118+50 to 124+50	(AR)	Commercial (4)	45	20-30	45	50	43-48	--	80	67-72	--

TABLE III-1 (CONTINUED)

Location of Structure Adjacent to Alignment		Type of Structure (N)*	Depth to Top of Rail (ft)	Horiz. Dist. from Near Track ℄ (ft)	Operat'l Train Speed (mph)	Ground-Borne Noise			Ground-Borne Vibration		
						Criterion for Allowable Noise Level (dBA)	Projected Maximum Noise Level With D.F. Fasteners (dBA)	Projected Maximum Noise Level With Recommended Mitigation (dBA)	Criterion for Allowable Vibration Level (dB)*	Projected Maximum Vibration Veloc. Lvl. With D.F. Fasteners (dB)*	Projected Maximum Vibration Veloc. Lvl. With Recomm. Mitigation (dB)*
118+50 to 124+50	(AL)	Commercial (6)	45	20-40	45	50	43-48	--	80	68-72	--
124+50 to 127+40	(AR)	Apartments (4)	45	20-60	45	40	43-48	37-42[2]	75	67-72	66-71[2]
124+50 to 127+50	(AL)	Apartments (3)	45	15	45	40	43-48	26-31[3]	75	68-72	57-63[3]
127+40 to 135+00	(AR)	Residences (13) and Apartments (1)	70	20-40	45	35 (Res) 40 (Apt)	36-41	30-35[2]	70 (Res) 75 (Apt)	65-70	64-69[2]
127+50 to 135+00	(AL)	Residences (9) and Apartments (2)	70	30-50	45	35 (Res) 40 (Apt)	37-43	22-27[3]	70 (Res) 75 (Apt)	67-72	60-65[3]
135+00 to 147+50	(AR)	Residences (16)	70-75	0	45	35	37-42	31-36[2]	70	65-70	64-69[2]
135+00 to 147+00	(AL)	Residences (14)	70-75	0	45	35	37-42	31-36[2]	70	65-70	64-69[2]
147+00 to 162+00	(AL)	Apartments (14)	80	0-60	45	40	35-41	--	75	65-70	--
147+50 to 157+70	(AR)	Apartments (9)	80	10-40	45	40	35-41	--	75	65-70	--
162+00 to 168+00	(AR/AL)	Commercial (12)	60-80	0-50	45	50	38-43	--	80	66-71	--

TABLE III-1 (CONTINUED)

Location of Structure Adjacent to Alignment		Type of Structure (N)*	Depth to Top of Rail (ft)	Horiz. Dist. from Near Track ℄ (ft)	Operat'l Train Speed (mph)	Ground-Borne Noise: Criterion for Allowable Noise Level (dBA)	Ground-Borne Noise: Projected Maximum Noise Level With D.F. Fasteners (dBA)	Ground-Borne Noise: Projected Maximum Noise Level With Recommended Mitigation (dBA)	Ground-Borne Vibration: Criterion for Allowable Vibration Level (dB)*	Ground-Borne Vibration: Projected Maximum Vibration Veloc. Lvl. With D.F. Fasteners (dB)*	Ground-Borne Vibration: Projected Maximum Vibration Veloc. Lvl. With Recomm. Mitigation (dB)*
157+70 to 161+00	(AR)	Apartment (3)	80	0-100	45	40	35-41	--	75	65-70	--
168+00 To 172+50	(AR/AL)	Commercial (4)	60-80	50	45	50	40-45 (X-Over)	--	80	71-76 (X-Over)	--
172+50 to 177+00	(AR/AL)	Commercial (1)	50	0	45	50	35-40	--	80	69-74	--
177+00 to 190+00	(AL)	Apartments (6)	75-100	0-60	45	40	38-43 (when line is extended)	32-37[2]	75	66-71	65-70[2]
177+00 to 190+00	(AR)	Apartments (16)	75-100	50-150	45	40	36-41 (when line is extended)	--	75	65-70	--

(N)* = Number of Buildings ±10%

* = Vibration Velocity re 10^{-6} in/sec

Mitigation Measures:

2 = Cologne Egg or Soft Fastener

3 = Floating Slab Trackbed

III-2 Vermont Branch (Subway)

TABLE III-2 PROJECTED MAXIMUM GROUND-BORNE NOISE AND VIBRATION LEVELS FOR METRO RAIL OPERATIONS IN SUBWAY -- ALIGNMENT 3 -- VERMONT BRANCH

Location of Structure Adjacent to Alignment		Type of Structure (N)*	Depth to Top of Rail (ft)	Horiz. Dist. from Near Track ℄ (ft)	Operat'l Train Speed (mph)	Ground-Borne Noise			Ground-Borne Vibration		
						Criterion for Allowable Noise Level (dBA)	Projected Maximum Noise Level With D.F. Fasteners (dBA)	Projected Maximum Noise Level With Recommended Mitigation (dBA)	Criterion for Allowable Vibration Level (dB)*	Projected Maximum Vibration Veloc. Lvl. With D.F. Fasteners (dB)*	Projected Maximum Vibration Veloc. Lvl. With Recomm. Mitigation (dB)*
320+00 to 323+00	(AR)	Commercial/ Office (1)	75	0	45	45	29-34	--	75-80	59-64	--
320+00 to 323+00	(AL)	Commercial/ Office (1)	40	0	45	45	40-45	--	75-80	64-69	--
323+00 to 326+00	(AR)	Apartments (3)	70	0-30	45	40	37-42	31-36[2]	75	65-70	64-69[2]
323+00 to 326+00	(AL)	Apartments (3)	40	0-50	45	40	45-50	37-42[2]	75	68-73	67-72[2]
325+00 to 327+00	(AR)	Commercial/ Office (2)	65	0-40	45	45	32-37	--	75-80	61-66	--
325+00 to 327+00	(AL)	Commercial/ Office (2)	40	0-50	45	45	38-43	--	75-80	63-68	--
326+00 to 328+50	(AR)	Apartments (3)	55	70	45	40	35-40	--	75	67-72	--
326+00 to 328+50	(AL)	Apartments (3)	45	90	45	40	33-38	--	75	67-72	--
327+00 to 330+00	(AR)	Commercial/ Office (3)	55	0	45	45	36-41	--	75-80	63-68	--
327+00 to 330+00	(AL)	Commercial/ Office (3)	45	0	45	45	37-42	--	75-80	63-68	--

TABLE III-2 (CONTINUED)

Location of Structure Adjacent to Alignment		Type of Structure (N)*	Depth to Top of Rail (ft)	Horiz. Dist. from Near Track ℄ (ft)	Operat'l Train Speed (mph)	Ground-Borne Noise: Criterion for Allowable Noise Level (dBA)	Ground-Borne Noise: Projected Maximum Noise Level With D.F. Fasteners (dBA)	Ground-Borne Noise: Projected Maximum Noise Level With Recommended Mitigation (dBA)	Ground-Borne Vibration: Criterion for Allowable Vibration Level (dB)*	Ground-Borne Vibration: Projected Maximum Vibration Veloc. Lvl. With D.F. Fasteners (dB)*	Ground-Borne Vibration: Projected Maximum Vibration Veloc. Lvl. With Recomm. Mitigation (dB)*
330+00 to 338+00	(AR)	Commercial/ Office (8)	35	0	45	45	38-43	--	75-80	63-68	--
330+00 to 340+00	(AL)	Commercial/ Office (9)	25	0	45	45	40-45	--	75-80	64-69	--
330+00 to 342+00	(AR)	Commercial/ Office (1)	20	60	45	45	40-45	--	75-80	66-71	--
340+00 to 342+00	(AL)	Commercial/ Office (4)	20	30	45	45	40-45	--	75-80	66-71	--

(N)* = Number of Buildings ±10%

* = Vibration Velocity re 10^{-6} in/sec

Mitigation Measures:

2 -- = Cologne Egg or Soft Fastener

III-3 Vermont/Hollywood Branch (Aerial)

TABLE III-3 PROJECTED MAXIMUM AIRBORNE NOISE LEVELS FOR METRO RAIL OPERATIONS ON AERIAL STRUCTURE
ALIGNMENT 3 -- VERMONT/HOLLYWOOD BRANCH

Station Number and Direction from Alignment		Type of Structure (N)*	Distance Near Track to Nearest Building (ft)	Maximum Train Speed (mph)	Criterion for Allowable Levels (dBA)	No Sound Barrier Wall		Sound Barrier Wall	
						Predicted Maximum Noise 6-car Train (dBA)	Required Distance for Criterion Compliance (ft)	Predicted Maximum Noise 6-car Train (dBA)	Required Distance for Criterion Compliance (ft)
342+00 to 349+00	(AL)	Commercial (8)	30	60	85	74-76	--	--	--
342+00 to 349+00	(AR)	Commercial (4)	100	60	85	70-72	--	--	--
349+00 to 365+00	(AL)	Commercial (18)	30	60	85	88-90	130	79-81	--
349+00 to 356+00	(AR)	Commercial (3)	50	60	85	87-89	120	78-80	--
356+00 to 360+00	(AR)	School (2)	50	60	75	87-89	510	78-80	140
360+00 to 365+00	(AR)	Commercial (4)	50	60	85	87-89	130	78-80	--
365+00 to 370+00	(AL/AR)	Commercial (10)	30	45	85	85-87	60	76-78	--
370+00 to 374+00	(AL)	Commercial (2)	40	70	85	85-91	150	80-82	--
370+00 to 373+00	(AR)	Commercial (1)	30	70	85	89-91	150	80-82	--
374+00 to 378+00	(AL)	Commercial (2)	90	70	85	85-87	110	77-79	--

TABLE III-3 (CONTINUED)

Station Number and Direction from Alignment		Type of Structure (N)*	Distance Near Track to Nearest Building (ft)	Maximum Train Speed (mph)	Criterion for Allowable Levels (dBA)	No Sound Barrier Wall		Sound Barrier Wall	
						Predicted Maximum Noise 6-car Train (dBA)	Required Distance for Criterion Compliance (ft)	Predicted Maximum Noise 6-car Train (dBA)	Required Distance for Criterion Compliance (ft)
382+00 to 414+00	(AR)	Commercial (18)	30	70	85	89-91	150	80-82	--
384+00 to 402+00	(AL)	Commercial (12)	30	70	85	89-91	150	80-82	--
402+00 to 414+00	(AL)	School (2)	40	70	75	89-91	590	80-82	160
414+00 to 417+00	(AR)	Commercial (3)	30	45	85	85-87	60	76-78	--
414+00 to 446+00	(AL)	Commercial (24)	40	45	85	85-87	60	76-78	--
417+00 to 418+00	(AR)	Theater (1)	40	45	75	85-87	310	76-78	70
422+00 to 434+00	(AR)	Commercial (10)	30	45	85	85-87	60	76-78	--
434+00 to 438+00	(AR/AL)	Commercial (3)	30	45	85	91-93 (X-Over)	150	83-85 (X-Over)	--
438+00 to 440+00	(AR)	Hospital (1)	120	45	75	86-88 (X-Over)	580	78-80 (X-Over)	225
440+00 to 446+00	(AR)	Hospital (2)	30	45	75	85-87	310	76-78	70
446+00 to 449+00	(AL)	Hospital (1)	40	45	75	85-87	310	76-78	70

TABLE III-3 (CONTINUED)

Station Number and Direction from Alignment		Type of Structure (N)*	Distance Near Track to Nearest Building (ft)	Maximum Train Speed (mph)	Criterion for Allowable Levels (dBA)	No Sound Barrier Wall		Sound Barrier Wall	
						Predicted Maximum Noise 6-car Train (dBA)	Required Distance for Criterion Compliance (ft)	Predicted Maximum Noise 6-car Train (dBA)	Required Distance for Criterion Compliance (ft)
446+00 to 450+00	(AR)	Commercial (4)	30	45	85	85-87	60	76-78	--
446+00 to 457+00	(AL)	Museum (3)	60	45	75	83-85	310	74-76	75
457+00 to 464+00	(AL)	Park	50	50	70**	85-87	700	76-78	220
459+00 to 506+00	(AR)	Commercial (3)	30	70	85	89-91	150	80-82	--
464+00 to 506+00	(AL)	Commercial (32)	30	70	85	89-91	150	80-82	--
506+00 to 512+00	(AL/AR)	Commercial (12)	30	45	85	85-87	60	76-78	--
512+00 to 540+00	(AL/AR)	Commercial (4)	30	70	85	89-91	150	80-82	--
540+00 to 546+00	(AL)	Commercial (3)	60	70	85	74-76	--	--	--
540+00 to 546+00	(AR)	Commercial (7)	40	70	85	76-78	--	--	--

(N)* = Number of buildings ±10%

** = Assumes park used for "quiet" outdoor recreation

III-4 Hollywood/Lankershim Branch (Subway)

TABLE III-4 PROJECTED MAXIMUM GROUND-BORNE NOISE AND VIBRATION LEVELS FOR METRO RAIL OPERATIONS IN SUBWAY -- ALIGNMENT 3 -- HOLLYWOOD/LANKERSHIM BRANCH

Location of Structure Adjacent to Alignment		Type of Structure (N)*	Depth to Top of Rail (ft)	Horiz. Dist. from Near Track ℄ (ft)	Operat'l Train Speed (mph)	Ground-Borne Noise			Ground-Borne Vibration		
						Criterion for Allowable Noise Level (dBA)	Projected Maximum Noise Level With D.F. Fasteners (dBA)	Projected Maximum Noise Level With Recommended Mitigation (dBA)	Criterion for Allowable Vibration Level (dB)*	Projected Maximum Vibration Veloc. Lvl. With D.F. Fasteners (dB)*	Projected Maximum Vibration Veloc. Lvl. With Recomm. Mitigation (dB)*
547+00 to 555+50	(AR/AL)	Commercial/ Office (12)	25-45	40	70	45	36-41	--	75-80	72-77	--
552+00 to 553+50	(AR)	Theater (1)	40	40	70	35	33-38	29-34[2]	75	71-76	70-75[2]
555+50 to 560+00	(AR/AL)	Commercial/ Office (5)	45	30	70	45	29-34	--	75-80	68-73	--
560+00 to 565+50	(AR/AL)	Commercial/ Office (12)	55	30	45	45	22-27	--	75-80	63-68	--
565+50 to 567+00	(AR/AL)	Commercial/ Office (5)	55	30	55	45	35-40 (X-Over)	--	75-80	75-80 (X-Over)	--
567+00 to 574+50	(AR/AL)	Commercial/ Office (15)	55	30	55	45	25-30	--	75-80	65-70	--
571+00 to 573+00	(AR)	Theater (1)	55	30	55	35	25-30	--	75	65-70	--
574+50 to 576+50	(AR/AL)	Commercial/ Office (4)	55	30	55	45	35-40 (X-Over)	--	75-80	75-80 (X-Over)	--
576+50 to 580+00	(AR/AL)	Commercial/ Office (10)	55	30	55	45	30-35	--	75-80	65-70	--
580+00 to 585+00	(AR/AL)	Commercial/ Office (16)	45	25	55	45	33-38	--	75-80	62-67	--

TABLE III-4 (CONTINUED)

Location of Structure Adjacent to Alignment		Type of Structure (N)*	Depth to Top of Rail (ft)	Horiz. Dist. from Near Track ℄ (ft)	Operat'l Train Speed (mph)	Ground-Borne Noise: Criterion for Allowable Noise Level (dBA)	Ground-Borne Noise: Projected Maximum Noise Level With D.F. Fasteners (dBA)	Ground-Borne Noise: Projected Maximum Noise Level With Recommended Mitigation (dBA)	Ground-Borne Vibration: Criterion for Allowable Vibration Level (dB)*	Ground-Borne Vibration: Projected Maximum Vibration Veloc. Lvl. With D.F. Fasteners (dB)*	Ground-Borne Vibration: Projected Maximum Vibration Veloc. Lvl. With Recomm. Mitigation (dB)*
585+00 to 593+50	(AR/AL)	Commercial/ Office (24)	40	25	55	45	33-38	--	75-80	62-67	--
593+50 to 599+50	(AR/AL)	Commercial/ Office (6)	40	25	45	45	23-28	--	75-80	60-65	--
594+00 to 594+50	(AL)	Theater (1)	40	25	45	35	28-33	--	75	64-69	--
599+50 to 606+00	(AR/AL)	Commercial/ Office (7)	40	25	50	45	32-37	--	75-80	61-66	--
606+00 to 620+00	(AR/AL)	Apartments (11)	55-70	0	50	40	37-42	30-35[2]	75	61-66	60-65[2]
620+00 to 625+00	(AR/AL)	Apartments (4)	70-100	0	55	40	36-41	--	75	61-66	--
625+00 to 753+76	(AR/AL)	Residential (approx. 100)	≥120	0	70	35	≤35	--	70	≤65	--
Equation STA 753+76 BACK = STA 922+00 AHEAD											
922+00 to 926+00	(AR/AL)	Residential (8)	80	0	60	35	38-43	32-37[2]	70	67-72	66-71[2]
926+00 to 927+00	(AR/AL)	Commercial (2)	80	0	60	50	36-41	--	80	65-70	--
930+00 to 931+00	(AR)	Commercial/ Office (1)	75	30	50	45	30-35	--	75-80	57-62	--

TABLE III-4 (CONTINUED)

Location of Structure Adjacent to Alignment		Type of Structure (N)*	Depth to Top of Rail. (ft)	Horiz. Dist. from Near Track ℄ (ft)	Operat'l Train Speed (mph)	Ground-Borne Noise			Ground-Borne Vibration		
						Criterion for Allowable Noise Level (dBA)	Projected Maximum Noise Level With D.F. Fasteners (dBA)	Projected Maximum Noise Level With Recommended Mitigation (dBA)	Criterion for Allowable Vibration Level (dB)*	Projected Maximum Vibration Veloc. Lvl. With D.F. Fasteners (dB)*	Projected Maximum Vibration Veloc. Lvl. With Recomm. Mitigation (dB)*
931+00 to 936+50	(AR)	Campo de Cahuenga	70	95	45	35	22-27	--	75	56-61	--
936+00 to 937+00	(AL)	Residential (4)	70	120	45	35	26-31	--	70	56-61	--
943+00 to 947+00	(AL	Residential (10)	50	20	50	35	39-44	32-37[2]	70	63-68	62-67[2]
943+00 to 946+00	(AR)	Commercial/ Office (2)	50	15	50	45	37-42	--	75-80	61-66	--
948+00 to 951+50	(AR/AL)	Commercial (3)	70	0	55	50	30-35	--	80	59-64	--
949+00 to 951+50	(AL)	Residential (4)	70	80-120	55	35	31-36	--	70	59-64	--
950+50 to 951+50	(AR/AL)	Office (1)	75	0	55	40	30-35	--	75	63-68	--
952+00 to 954+00	(AR/AL)	Commercial/ Office (3)	80	0	60	45	31-36	--	75-80	59-64	--
954+00 to 962+00	(AR/AL)	Office (9) School (1)	80	30	70	40	31-36	--	75	65-70	--
962+00 to 969+50	(AR/AL)	Commercial/ Office (7)	80	30	70	45	31-36	--	75-80	65-70	--

TABLE III-4 (CONTINUED)

Location of Structure Adjacent to Alignment		Type of Structure (N)*	Depth to Top of Rail (ft)	Horiz. Dist. from Near Track ℄ (ft)	Operat'l Train Speed (mph)	Ground-Borne Noise			Ground-Borne Vibration		
						Criterion for Allowable Noise Level (dBA)	Projected Maximum Noise Level With D.F. Fasteners (dBA)	Projected Maximum Noise Level With Recommended Mitigation (dBA)	Criterion for Allowable Vibration Level (dB)*	Projected Maximum Vibration Veloc. Lvl. With D.F. Fasteners (dB)*	Projected Maximum Vibration Veloc. Lvl. With Recomm. Mitigation (dB)*
969+50 to 971+00	(AL)	Apartments (2)	85	40	70	40	31-36	--	75	60-65	--
970+00 to 976+00	(AR/AL)	Commercial/ Office (8)	85	30	70	45	30-35	--	75-80	59-64	--
974+00 to 976+50	(AL)	St. Charles Borromeo Church	85	40	70	35	35-40	29-34[2]	75	64-69	63-68[2]
977+00 to 982+00	(AR/AL)	Commercial/ Office (6)	90	30	70	45	29-34	--	75-80	58-63	--
979+00 to 980+00	(AL)	Recording Studio (1)	90	30	70	25	26-31	20-25[2]	65	57-62	56-61[2]
982+50 to 995+50	(AR/AL)	Office (3)	90	30	70	40	23-28	--	75	58-63	--
985+00 to 997+50	(AR/AL)	Commercial (4)	90	30	70	45	29-34	--	80	58-63	--
995+75 to 996+25	(AR)	Precision Die Engravers	90	30	70	40	35-40	--	70	64-69	--
996+25 to 997+50	(AR)	Office (1)	90	30	70	40	35-40	--	75	64-69	--
998+00 to 1004+00	(AR/AL)	Commercial/ Office (14)	90	30	70	45	29-34	--	75-80	58-63	--

TABLE III-4 (CONTINUED)

Location of Structure Adjacent to Alignment		Type of Structure (N)*	Depth to Top of Rail (ft)	Horiz. Dist. from Near Track ℄ (ft)	Operat'l Train Speed (mph)	Ground-Borne Noise: Criterion for Allowable Noise Level (dBA)	Ground-Borne Noise: Projected Maximum Noise Level With D.F. Fasteners (dBA)	Ground-Borne Noise: Projected Maximum Noise Level With Recommended Mitigation (dBA)	Ground-Borne Vibration: Criterion for Allowable Vibration Level (dB)*	Ground-Borne Vibration: Projected Maximum Vibration Veloc. Lvl. With D.F. Fasteners (dB)*	Ground-Borne Vibration: Projected Maximum Vibration Veloc. Lvl. With Recomm. Mitigation (dB)*
1008+00 to 1014+00	(AR/AL)	Commercial (13)	80	30	70	45	31-36	--	80	59-64	--
1014+00 to 1016+00	(AR/AL)	Commercial/ Office (5)	80	30	70	45	31-36	--	75-80	59-64	--
1015+50 to 1016+50	(AL)	Recording Studio (1)	80	30	70	25	31-36	15-20[3]	65	59-64	50-55[3]
1016+00 to 1026+00	(AR/AL)	Commercial/ Office (25)	70	30	70	45	33-38	--	75-80	60-65	--
1026+00 to 1026+50	(AR)	Recording Studio (1)	70	30	70	25	33-38	16-21[3]	65	60-65	50-55[3]
1026+50 to 1028+00	(AL)	Office (1)	60	35	70	40	28-33	--	75	66-71	--
1027+50 to 1043+50	(AR/AL)	Commercial/ Office (37)	50	30	70	45	36-41	--	75-80	67-72	--
1033+00 to 1034+00	(AL)	Guild Theatre	50	30	70	35	36-41	30-35[2]	75	67-72	66-71[2]
1041+50 to 1042+00	(AL)	Recording Studio (1)	50	30	60	25	35-40	19-24[3]	65	66-71	56-61[3]
1043+00 to 1044+00	(AL)	El Portal Theater	50	30	55	35	40-45 (X-Over)	25-30[3]	75	75-80 (X-Over)	65-70[3]

TABLE III-4 (CONTINUED)

Location of Structure Adjacent to Alignment		Type of Structure (N)*	Depth to Top of Rail (ft)	Horiz. Dist. from Near Track ℄ (ft)	Operat'l Train Speed (mph)	Ground-Borne Noise: Criterion for Allowable Noise Level (dBA)	Ground-Borne Noise: Projected Maximum Noise Level With D.F. Fasteners (dBA)	Ground-Borne Noise: Projected Maximum Noise Level With Recommended Mitigation (dBA)	Ground-Borne Vibration: Criterion for Allowable Vibration Level (dB)*	Ground-Borne Vibration: Projected Maximum Vibration Veloc. Lvl. With D.F. Fasteners (dB)*	Ground-Borne Vibration: Projected Maximum Vibration Veloc. Lvl. With Recomm. Mitigation (dB)*
1044+00 to 1048+00	(AR/AL)	Commercial (10)	50	30	55	45	40-45 (X-Over)	--	80	75-80 (X-Over)	--
1048+00 to 1052+50	(AR/AL)	Commercial (5)	50	30	45	45	27-32	--	80	64-69	--
1052+50 to 1057+64	(AR/AL)	Commercial (5)	50	30	55 (When line is extended)	45	30-35	--	80	64-69	--

(N)* = Number of Buildings ±10%

* = Vibration Velocity re 10^{-6} in/sec

Mitigation Measures:

2 = Cologne Egg or Soft Fastener

3 = Floating Slab Trackbed

APPENDIX IV

Candidate Alignment 4

Vermont/Sunset/Wilshire Aerial

IV-1 Wilshire Branch (Subway)

TABLE IV-1 PROJECTED MAXIMUM GROUND-BORNE NOISE AND VIBRATION LEVELS FOR METRO RAIL OPERATIONS IN SUBWAY -- ALIGNMENT 4 -- WILSHIRE BRANCH

Location of Structure Adjacent to Alignment		Type of Structure (N)*	Depth to Top of Rail (ft)	Horiz. Dist. from Near Track ℄ (ft)	Operat'l Train Speed (mph)	Ground-Borne Noise: Criterion for Allowable Noise Level (dBA)	Ground-Borne Noise: Projected Maximum Noise Level With D.F. Fasteners (dBA)	Ground-Borne Noise: Projected Maximum Noise Level With Recommended Mitigation (dBA)	Ground-Borne Vibration: Criterion for Allowable Vibration Level (dB)*	Ground-Borne Vibration: Projected Maximum Vibration Veloc. Lvl. With D.F. Fasteners (dB)*	Ground-Borne Vibration: Projected Maximum Vibration Veloc. Lvl. With Recomm. Mitigation (dB)*
00+00 to 01+00	(AR)	Commercial/ Office (1)	75	0	45	45	36-41	--	75-80	64-69	--
00+00 to 01+00	(AL)	Commercial/ Office (1)	40	0	45	45	42-47	36-41[2]	75-80	67-72	66-71[2]
01+00 to 02+00	(AR)	Commercial/ Office (1)	75	75	45	45	32-37	--	75-80	60-65	--
01+00 to 02+00	(AL)	Commercial/ Office (1)	40	75	45	45	36-41	--	75-80	61-66	--
02+00 to 09+50	(AR)	Commercial/ Office (5)	75	0-10	45	45	36-41	--	75-80	64-69	--
02+00 to 09+50	(AL)	Commercial/ Office (5)	35	0-15	45	45	43-48	37-42[2]	75-80	67-72	66-71[2]
09+50 to 13+50	(AR)	Commercial/ Office (2)	80	0	45	45	35-40	--	75-80	61-66	--
09+50 to 13+50	(AL)	Commercial/ Office (2)	35-40	0	45	45	43-48	37-42[2]	75-80	67-72	66-71[2]
13+50 to 20+00	(AR)	Commercial/ Office (2)	100	0	45	45	33-38	--	75-80	60-65	--
13+50 to 20+00	(AL)	Commercial/ Office (3)	50-60	0	45	45	40-45	--	75-80	65-70	--
20+00 to 22+50	(AL)	Apartments (1)	60	0	45	40	33-38	--	75	61-66	--

TABLE IV-1 (CONTINUED)

Location of Structure Adjacent to Alignment		Type of Structure (N)*	Depth to Top of Rail (ft)	Horiz. Dist. from Near Track ℄ (ft)	Operat'l Train Speed (mph)	Ground-Borne Noise: Criterion for Allowable Noise Level (dBA)	Ground-Borne Noise: Projected Maximum Noise Level With D.F. Fasteners (dBA)	Ground-Borne Noise: Projected Maximum Noise Level With Recommended Mitigation (dBA)	Ground-Borne Vibration: Criterion for Allowable Vibration Level (dB)*	Ground-Borne Vibration: Projected Maximum Vibration Veloc. Lvl. With D.F. Fasteners (dB)*	Ground-Borne Vibration: Projected Maximum Vibration Veloc. Lvl. With Recomm. Mitigation (dB)*
24+00 to 28+00	(AR)	Office (1)	70-85	70	45	40	27-32	--	75	54-59	--
28+00 to 29+80	(AR)	Office (1)	55-60	35	45	40	32-37	--	75	61-66	--
30+00 to 31+50	(AR)	Church (1)	60	35	45	35	29-34	--	75	64-69	--
24+00 to 31+50	(AL)	Office (4)	55-85	30-60	45	40	30-35	--	75	60-65	--
32+00 to 33+00	(AR)	Hyatt Conference Center (1)	55	25	45	35	28-33	--	70	63-68	--
33+00 to 35+00	(AR)	Hotel (2)	60	25-70	45	45	25-30	--	75	60-65	--
35+20 to 37+20	(AR)	Office (1)	60	25	45	40	28-32	--	75	60-65	--
31+50 to 36+00	(AL)	Office/ Bank (2)	60	25	45	40-45	20-25	--	75-80	60-65	--
36+00 to 46+50	(AL)	Commercial/ Office (6)	60	25	45	40-50	26-31	--	75-80	65-70	--
37+50 to 38+50	(AR)	Restaurant (1)	60	25	45	50	35-39	--	80	66-71	--
39+50 to 46+50	(AR)	Church (2)	60	45	45	35	31-36	--	75	64-69	--

TABLE IV-1 (CONTINUED)

Location of Structure Adjacent to Alignment		Type of Structure (N)*	Depth to Top of Rail (ft)	Horiz. Dist. from Near Track ℄ (ft)	Operat'l Train Speed (mph)	Ground-Borne Noise: Criterion for Allowable Noise Level (dBA)	Ground-Borne Noise: Projected Maximum Noise Level With D.F. Fasteners (dBA)	Ground-Borne Noise: Projected Maximum Noise Level With Recommended Mitigation (dBA)	Ground-Borne Vibration: Criterion for Allowable Vibration Level (dB)*	Ground-Borne Vibration: Projected Maximum Vibration Veloc. Lvl. With D.F. Fasteners (dB)*	Ground-Borne Vibration: Projected Maximum Vibration Veloc. Lvl. With Recomm. Mitigation (dB)*
50+00 to 54+00	(AR)	Office (2)	50-55	35	45	40	34-39 (X-Over)	--	75	67-72 (X-Over)	--
54+00 to 57+00	(AR)	Commercial/ Office (2)	50	25	45	40-50	25-30	--	75-80	64-69	--
54+00 to 58+50	(AL)	Office/ Theater (3)	50	40	45	35-40	21-26	--	70-75	60-65	--
57+50 to 64+00	(AR)	Office (2)	50	25	55	40	31-36	--	75	62-67	--
65+00 to 66+70	(AR)	Church (1)	50	30	45	35	30-35	--	70	63-68	--
66+80 to 77+00	(AR)	Commercial/ Office (5)	20	30	45	45	38-43	--	75-80	66-71	--
60+00 to 70+50	(AL)	Commercial/ Office (8)	40	30	45	45	37-42	--	75-80	66-71	--
70+50 to 72+00	(AL)	Apartments (1)	30	40	45	40	32-37	--	75	66-71	--
72+00 to 77+00	(AL)	Commercial/ Office (4)	20	30	45	45	38-43	--	75	67-72	--

(N)* = Number of Buildings ±10%

* = Vibration Velocity re 10^{-6} in/sec

Mitigation Measures:

2 = Cologne Egg or Soft Fastener

IV-2 Wilshire Branch (Aerial)

TABLE IV-2 PROJECTED MAXIMUM AIRBORNE NOISE LEVELS FOR METRO RAIL OPERATIONS ON AERIAL STRUCTURE ALIGNMENT 4 -- WILSHIRE BRANCH

Station Number and Direction from Alignment	Type of Structure (N)*	Distance Near Track to Nearest Building (ft)	Maximum Train Speed (mph)	Criterion for Allowable Levels (dBA)	No Sound Barrier Wall		Sound Barrier Wall	
					Predicted Maximum Noise 6-car Train (dBA)	Required Distance for Criterion Compliance (ft)	Predicted Maximum Noise 6-car Train (dBA)	Required Distance for Criterion Compliance (ft)
77+00 to 82+50 (AR)	Commercial (5)	40	45	85	85-87	70	76-78	--
77+00 to 83+00 (AL)	Commercial (2)	30	45	85	85-87	70	76-78	--
82+50 to 84+50 (AR)	Apartments (1)	50	45	80	84-86	160	75-77	--
83+00 to 85+00 (AL)	Theater (1)	50	45	75	84-86	320	75-77	70
84+50 to 88+50 (AR)	Commercial (1)	40	45	85	85-87	70	76-78	--
85+00 to 88+50 (AL)	Commercial (1)	40	45	85	85-87	70	76-78	--
88+50 to 90+00 (AL/AR)	Commercial (1)	40	45	85	85-87	70	76-78	--
90+00 to 93+00 (AL/AR)	Commercial (1)	40	45	85	85-87	300	76-78	--
93+00 to 95+00 (AR)	Residential (2)	330	70	80	76-78	--	--	--
93+00 to 96+00 (AL)	Commercial (4)	40	70	85	89-91	150	80-82	--
95+00 to 100+00 (AR)	Commercial (3)	50	70	85	88-90	150	79-81	--

TABLE IV-2 (CONTINUED)

Station Number and Direction from Alignment		Type of Structure (N)*	Distance Near Track to Nearest Building (ft)	Maximum Train Speed (mph)	Criterion for Allowable Levels (dBA)	No Sound Barrier Wall		Sound Barrier Wall	
						Predicted Maximum Noise 6-car Train (dBA)	Required Distance for Criterion Compliance (ft)	Predicted Maximum Noise 6-car Train (dBA)	Required Distance for Criterion Compliance (ft)
96+00 to 98+00	(AL)	Hotel (1)	40	70	80	89-91	300	80-82	60
98+00 to 100+00	(AL)	Commercial (1)	40	70	85	89-91	150	80-82	--
100+00 to 103+00	(AL)	Church (1)	50	70	75	88-90	580	79-81	160
100+00 to 104+50	(AR)	Church (1)	50	70	75	88-90	580	79-81	160
103+00 to 106+00	(AL)	Theater (1)	50	70	75	88-90	580	79-81	160
104+50 to 111+00	(AR)	Commercial (2)	40	70	85	89-91	150	80-82	--
106+00 to 114+00	(AL)	Apartments (2)	40	70	80	89-91	300	80-82	60
111+00 to 114+00	(AR)	Apartments (1)	50	70	80	88-90	300	79-81	60
114+00 to 117+00	(AL/AR)	Commercial (4)	50	70	85	88-90	150	79-81	--
117+00 to 120+00	(AR)	Apartments (2)	50	70	80	88-90	300	79-81	60
117+00 to 118+00	(AL)	Apartments (1)	50	70	80	88-90	300	79-81	60

TABLE IV-2 (CONTINUED)

Station Number and Direction from Alignment		Type of Structure (N)*	Distance Near Track to Nearest Building (ft)	Maximum Train Speed (mph)	Criterion for Allowable Levels (dBA)	No Sound Barrier Wall: Predicted Maximum Noise 6-car Train (dBA)	No Sound Barrier Wall: Required Distance for Criterion Compliance (ft)	Sound Barrier Wall: Predicted Maximum Noise 6-car Train (dBA)	Sound Barrier Wall: Required Distance for Criterion Compliance (ft)
118+00 to 124+00	(AL)	Commercial (1)	250	70	85	79-81	--	--	--
120+00 to 128+00	(AR)	Residential (3)	120	70	75	84-86	580	75-77	160
124+00 to 127+00	(AL)	Commercial (1)	50	70	85	88-90	250	79-81	--
127+00 to 138+00	(AL)	Residential (5)	230	70	75	79-81	580	70-72	--
128+00 to 130+00	(AR)	Commercial (1)	40	70	85	89-91	150	80-82	--
130+00 to 140+00	(AR)	Residential (3)	140	70	75	83-85	580	74-76	160
138+00 to 142+00	(AL)	Residential (2)	50	70	80	88-90	300	79-81	60
140+00 to 163+00	(AR)	Commercial (7)	40	70	85	89-91	150	80-82	--
142+00 to 163+00	(AL)	Commercial (11)	40	70	85	89-91	150	80-82	--
163+00 to 169+00	(AL/AR)	Commercial (8)	40	45	85	85-87	60	76-78	--
169+00 to 198+00	(AL)	Commercial (15)	40	70	85	89-91	150	80-82	--

TABLE IV-2 (CONTINUED)

Station Number and Direction from Alignment		Type of Structure (N)*	Distance Near Track to Nearest Building (ft)	Maximum Train Speed (mph)	Criterion for Allowable Levels (dBA)	No Sound Barrier Wall		Sound Barrier Wall	
						Predicted Maximum Noise 6-car Train (dBA)	Required Distance for Criterion Compliance (ft)	Predicted Maximum Noise 6-car Train (dBA)	Required Distance for Criterion Compliance (ft)
169+00 to 203+00	(AR)	Commercial (17)	40	70	85	89-91	150	80-82	--
198+00 to 199+00	(AL)	Museum (1)	50	70	75	88-90	580	79-81	160
199+00 to 214+00	(AL)	Commercial (8)	40	70	85	89-91	150	80-82	--
203+00 to 209+00	(AR)	Museum (3)	100	70	75	83-87	580	76-78	160
209+00 to 214+00	(AR)	Commercial (2)	40	70	85	89-91	150	80-82	--
214+00 to 215+50	(AR)	Commercial (1)	40	50	85	92-94 (X-Over)	220	83-85	--
214+00 to 215+50	(AL)	Commercial (1)	50	50	85	91-93 (X-Over)	220	82-84	--
215+50 to 227+50	(AR)	Commercial (8)	40	45	85	85-87	60	76-78	--
215+50 to 227+50	(AL)	Commercial (7)	50	45	85	84-86	60	75-77	--

(N)* = Number of buildings ±10%

IV-3 Vermont Branch (Subway)

TABLE IV-3 PROJECTED MAXIMUM GROUND-BORNE NOISE AND VIBRATION LEVELS FOR METRO RAIL OPERATIONS IN SUBWAY -- ALIGNMENT 4 -- VERMONT BRANCH

Location of Structure Adjacent to Alignment		Type of Structure (N)*	Depth to Top of Rail (ft)	Horiz. Dist. from Near Track ℄ (ft)	Operat'l Train Speed (mph)	Ground-Borne Noise			Ground-Borne Vibration		
						Criterion for Allowable Noise Level (dBA)	Projected Maximum Noise Level With D.F. Fasteners (dBA)	Projected Maximum Noise Level With Recommended Mitigation (dBA)	Criterion for Allowable Vibration Level (dB)*	Projected Maximum Vibration Veloc. Lvl. With D.F. Fasteners (dB)*	Projected Maximum Vibration Veloc. Lvl. With Recomm. Mitigation (dB)*
320+00 to 323+00	(AR)	Commercial/ Office (1)	75	0	45	45	29-34	--	75-80	59-64	--
320+00 to 323+00	(AL)	Commercial/ Office (1)	40	0	45	45	40-45	--	75-80	64-69	--
323+00 to 326+00	(AR)	Apartments (3)	70	0-30	45	40	37-42	31-36[2]	75	65-70	64-69[2]
323+00 to 326+00	(AL)	Apartments (3)	40	0-50	45	40	45-50	37-42[2]	75	68-73	67-72[2]
325+00 to 327+00	(AR)	Commercial/ Office (2)	65	0-40	45	45	32-37	--	75-80	61-66	--
325+00 to 327+00	(AL)	Commercial/ Office (2)	40	0-50	45	45	38-43	--	75-80	63-68	--
326+00 to 328+50	(AR)	Apartments (3)	55	70	45	40	35-40	--	75	67-72	--
326+00 to 328+50	(AL)	Apartments (3)	45	90	45	40	33-38	--	75	67-72	--
327+00 to 330+00	(AR)	Commercial/ Office (3)	55	0	45	45	36-41	--	75-80	63-68	--
327+00 to 330+00	(AL)	Commercial/ Office (3)	45	0	45	45	37-42	--	75-80	63-68	--

TABLE IV-3 (CONTINUED)

Location of Structure Adjacent to Alignment		Type of Structure (N)*	Depth to Top of Rail (ft)	Horiz. Dist. from Near Track ℄ (ft)	Operat'l Train Speed (mph)	Ground-Borne Noise: Criterion for Allowable Noise Level (dBA)	Ground-Borne Noise: Projected Maximum Noise Level With D.F. Fasteners (dBA)	Ground-Borne Noise: Projected Maximum Noise Level With Recommended Mitigation (dBA)	Ground-Borne Vibration: Criterion for Allowable Vibration Level (dB)*	Ground-Borne Vibration: Projected Maximum Vibration Veloc. Lvl. With D.F. Fasteners (dB)*	Ground-Borne Vibration: Projected Maximum Vibration Veloc. Lvl. With Recomm. Mitigation (dB)*
330+00 to 338+00	(AR)	Commercial/ Office (8)	35	0	45	45	38-43	--	75-80	63-68	--
330+00 to 340+00	(AL)	Commercial/ Office (9)	25	0	45	45	40-45	--	75-80	64-69	--
330+00 to 342+00	(AR)	Commercial/ Office (1)	20	60	45	45	40-45	--	75-80	66-71	--
340+00 to 342+00	(AL)	Commercial/ Office (4)	20	30	45	45	40-45	--	75-80	66-71	--

(N)* = Number of Buildings ±10%

*- = Vibration Velocity re 10^{-6} in/sec

Mitigation Measures:

2 = Cologne Egg or Soft Fastener

IV-4 Vermont/Sunset Branch (Aerial)

TABLE IV-4 PROJECTED MAXIMUM AIRBORNE NOISE LEVELS FOR METRO RAIL OPERATIONS ON AERIAL STRUCTURE
ALIGNMENT 4 -- VERMONT/SUNSET BRANCH

Station Number and Direction from Alignment		Type of Structure (N)*	Distance Near Track to Nearest Building (ft)	Maximum Train Speed (mph)	Criterion for Allowable Levels (dBA)	No Sound Barrier Wall		Sound Barrier Wall	
						Predicted Maximum Noise 6-car Train (dBA)	Required Distance for Criterion Compliance (ft)	Predicted Maximum Noise 6-car Train (dBA)	Required Distance for Criterion Compliance (ft)
342+00 to 349+00	(AL)	Commercial (8)	30	60	85	74-76	--	--	--
342+00 to 349+00	(AR)	Commercial (4)	100	60	85	70-72	--	--	--
349+00 to 365+00	(AL)	Commercial (18)	30	60	85	88-90	130	79-81	--
349+00 to 356+00	(AR)	Commercial (3)	50	60	85	87-89	120	78-80	--
356+00 to 360+00	(AR)	School (2)	50	60	75	87-89	510	78-80	140
360+00 to 365+00	(AR)	Commercial (4)	50	60	85	87-89	130	78-80	--
365+00 to 370+00	(AL/AR)	Commercial (10)	30	45	85	85-87	60	76-78	--
370+00 to 374+00	(AL)	Commercial (2)	40	70	85	85-91	150	80-82	--
370+00 to 373+00	(AR)	Commercial (1)	30	70	85	89-91	150	80-82	--
374+00 to 378+00	(AL)	Commercial (2)	90	70	85	85-87	110	77-79	--

TABLE IV-4 (CONTINUED)

Station Number and Direction from Alignment		Type of Structure (N)*	Distance Near Track to Nearest Building (ft)	Maximum Train Speed (mph)	Criterion for Allowable Levels (dBA)	No Sound Barrier Wall		Sound Barrier Wall	
						Predicted Maximum Noise 6-car Train (dBA)	Required Distance for Criterion Compliance (ft)	Predicted Maximum Noise 6-car Train (dBA)	Required Distance for Criterion Compliance (ft)
382+00 to 414+00	(AR)	Commercial (18)	30	70	85	89-91	150	80-82	--
384+00 to 402+00	(AL)	Commercial (12)	30	70	85	89-91	150	80-82	--
402+00 to 414+00	(AL)	School (2)	40	70	75	89-91	590	80-82	160
414+00 to 417+00	(AR)	Commercial (3)	30	45	85	85-87	60	76-78	--
414+00 to 446+00	(AL)	Commercial (24)	40	45	85	85-87	60	76-78	--
417+00 to 418+00	(AR)	Theater (1)	40	45	75	85-87	310	76-78	70
422+00 to 438+00	(AR)	Commercial (12)	30	45	85	85-87	60	76-78	--
437+00 to 440+00	(AR)	Hollywood Presbyterian Hospital (2)	180	45	75	77-79	300	70-72	--
437+00 to 440+00	(AL)	Commercial/ Office (3)	25	45	85	87-89	50	78-80	--

TABLE IV-4 (CONTINUED)

Station Number and Direction from Alignment		Type of Structure (N)*	Distance Near Track to Nearest Building (ft)	Maximum Train Speed (mph)	Criterion for Allowable Levels (dBA)	No Sound Barrier Wall: Predicted Maximum Noise 6-car Train (dBA)	No Sound Barrier Wall: Required Distance for Criterion Compliance (ft)	Sound Barrier Wall: Predicted Maximum Noise 6-car Train (dBA)	Sound Barrier Wall: Required Distance for Criterion Compliance (ft)
440+00 to 448+00	(AR/AL)	Commercial/ Office (5)	25	45	85	87-89	50	78-80	--
440+00 to 448+00	(AL)	Apartments (6)	100	45	80	81-83	150	72-74	--
453+00 to 455+00	(AR/AL)	Commercial/ Office (4)	30	45	85	86-88	50	77-79	--
455+00 to 462+00	(AR/AL)	Kaiser Permanente Hospital and Annex (4)	40	45	75	85-87	300	76-78	70
455+00 to 462+00	(AR/AL)	Commercial/ Office (4)	40	45	85	85-87	50	76-78	--
462+00 to 465+00	(AL)	Residential (5)	40	50	75	86-88	325	77-79	80
462+00 to 468+00	(AR/AL)	Commercial/ Office (8)	40	50	85	86-88	70	77-79	--
468+50 to 471+00	(AL)	Apartments (4)	40	55	80	87-89	200	78-80	--
468+50 to 476+50	(AR/AL)	Commercial/ Office (8)	40	55	85	87-89	80	78-80	--
473+50 to 476+50	(AR)	Residential (6)	50	55	75	86-88	375	77-79	90

TABLE IV-4 (CONTINUED)

Station Number and Direction from Alignment		Type of Structure (N)*	Distance Near Track to Nearest Building (ft)	Maximum Train Speed (mph)	Criterion for Allowable Levels (dBA)	No Sound Barrier Wall: Predicted Maximum Noise 6-car Train (dBA)	No Sound Barrier Wall: Required Distance for Criterion Compliance (ft)	Sound Barrier Wall: Predicted Maximum Noise 6-car Train (dBA)	Sound Barrier Wall: Required Distance for Criterion Compliance (ft)
477+00 to 483+50	(AR/AL)	Commercial/ Office (10)	40	55	85	87-89	80	78-80	--
484+00 to 488+00	(AR/AL)	Apartments (11)	40	55	80	87-89	200	78-80	--
488+00 to 495+00	(AR/AL)	Commercial (7)	40	50	85	86-88	70	77-79	--
498+50 to 501+50	(AR)	KWHY Television Studios	40	45	70	85-87	580	76-78	160
500+00 to 508+00	(AR/AL)	Commercial (9)	40	55	85	87-89	80	78-80	--
512+00 to 530+00	(AR/AL)	Commercial/ Office (11)	40	55	85	87-89	80	78-80	--
Equation STA 530+00 BACK = STA 516+20 AHEAD									
516+20 to 520+70	(AR/AL)	Commercial/ Office (4)	40	55	85	87-89	80	78-80	--
517+00 to 518+00	(AR)	Motel (1)	40	55	80	87-89	200	78-80	--
518+00 to 524+50	(AR)	CBS Studios	40	55	70	87-89	750	78-80	230

(N)* = Number of buildings ±10%

IV-5 Sunset/Lankershim Branch (Subway)

TABLE IV-5 PROJECTED MAXIMUM GROUND-BORNE NOISE AND VIBRATION LEVELS FOR METRO RAIL OPERATIONS IN SUBWAY -- ALIGNMENT 4 -- SUNSET/LANKERSHIM BRANCH

Location of Structure Adjacent to Alignment		Type of Structure (N)*	Depth to Top of Rail (ft)	Horiz. Dist. from Near Track ℄ (ft)	Operat'l Train Speed (mph)	Ground-Borne Noise			Ground-Borne Vibration		
						Criterion for Allowable Noise Level (dBA)	Projected Maximum Noise Level With D.F. Fasteners (dBA)	Projected Maximum Noise Level With Recommended Mitigation (dBA)	Criterion for Allowable Vibration Level (dB)*	Projected Maximum Vibration Veloc. Lvl. With D.F. Fasteners (dB)*	Projected Maximum Vibration Veloc. Lvl. With Recomm. Mitigation (dB)*
521+00 to 524+50	(AR)	CBS Studios	0	70	55	25	23-28	11-16[3]	65	55-60	50-55[3]
521+00 to 530+50	(AR/AL)	Commercial/ Office (3)	0-20	30	55	45	33-38	--	75-80	70-75	--
525+00 to 528+00	(AR)	Hollywood Theater-Paladium	0	70	55	35	21-26	--	75	52-57	--
530+50 to 536+50	(AR/AL)	Commercial (5)	30-40	25	50	50	31-36	--	80	69-73	--
537+50 to 539+00	(AL)	Cinerama Theater	45	25	45	35	22-27	--	75	62-67	--
540+00 to 542+00	(AR/AL)	Commercial (2)	45	25	45	50	39-44 (At Switch)	35-40[1]	80	77-83 (At Switch)	74-79[1]
542+00 to 546+50	(AR/AL)	Commercial (3)	45	25	45	50	29-34	--	80	68-73	--
543+00 to 544+00	(AL)	Office (1)	45	25	45	45	25-30	--	75-80	68-73	--
547+00 to 548+00	(AR)	Hotel (1)	45	25	45	45	25-30	--	75	65-70	--
547+00 to 551+00	(AR)	Commercial (3)	45	25	45	50	25-30	--	80	65-70	--

TABLE IV-5 (CONTINUED)

Location of Structure Adjacent to Alignment		Type of Structure (N)*	Depth to Top of Rail (ft)	Horiz. Dist. from Near Track ℄ (ft)	Operat'l Train Speed (mph)	Ground-Borne Noise			Ground-Borne Vibration		
						Criterion for Allowable Noise Level (dBA)	Projected Maximum Noise Level With D.F. Fasteners (dBA)	Projected Maximum Noise Level With Recommended Mitigation (dBA)	Criterion for Allowable Vibration Level (dB)*	Projected Maximum Vibration Veloc. Lvl. With D.F. Fasteners (dB)*	Projected Maximum Vibration Veloc. Lvl. With Recomm. Mitigation (dB)*
549+00 to 550+00	(AL)	Motel (1)	45	25	45	45	32-37	--	75	70-75	--
549+50 to 550+50	(AR)	Hotel (1)	45	25	45	45	25-30	--	75	65-70	--
551+00 to 553+00	(AR/AL)	Commercial (3)	40	25	45	50	26-31	--	80	65-70	--
552+50 to 554+00	(AR/AL)	Recording Studios (2)	40	25	45	25	40-45 (At Switch)	28-33[3]	65	79-84 (At Switch)	69-74[3]
553+50 to 557+00	(AR/AL)	Commercial/ Office (7)	40	25	45	45	26-31	--	75-80	68-73	--
557+00 to 558+00	(AR)	School (1)	40	25	45	35	26-31	--	75	68-73	--
558+00 to 559+50	(AR)	Church (1)	35	25	45	35	19-24	--	75	62-67	--
561+00 to 574+00	(AR/AL)	Commercial/ Office (13)	25	0	45	45	33-38	--	75-80	72-77	--
570+00 to 571+00	(AR/AL)	Recording Studio	25	0	45	25	33-38	22-27[3]	65	72-77	62-67[3]
574+00 to 578+00	(AR/AL)	Commercial/ Office (7)	30	25	45	45	33-38	--	75-80	66-71	--

TABLE IV-5 (CONTINUED)

Location of Structure Adjacent to Alignment		Type of Structure (N)*	Depth to Top of Rail (ft)	Horiz. Dist. from Near Track C (ft)	Operat'l Train Speed (mph)	Ground-Borne Noise: Criterion for Allowable Noise Level (dBA)	Ground-Borne Noise: Projected Maximum Noise Level With D.F. Fasteners (dBA)	Ground-Borne Noise: Projected Maximum Noise Level With Recommended Mitigation (dBA)	Ground-Borne Vibration: Criterion for Allowable Vibration Level (dB)*	Ground-Borne Vibration: Projected Maximum Vibration Veloc. Lvl. With D.F. Fasteners (dB)*	Ground-Borne Vibration: Projected Maximum Vibration Veloc. Lvl. With Recomm. Mitigation (dB)*
578+00 to 582+50	(AR/AL)	Commercial/ Office (5)	40	25	45	45	25-30	--	75-80	65-70	--
582+00 to 588+00	(AR/AL)	Commercial/ Office (8)	45	30	45	45	31-36	--	75-80	56-61	--
589+00 to 590+00	(AL)	Church (1)	50	0	50	35	30-35	--	75	55-60	--
591+00 to 595+00	(AR/AL)	Residential (10)	60-70	0	50	35	38-43	32-37[2]	70	62-67	61-66[2]
595+00 to 604+00	(AR/AL)	Apartments (6)	30	0	50	40	35-40	--	75	66-71	--
604+00 to 609+00	(AR/AL)	Residential (28)	30-55	0	50	35	37-42	26-31[3]	70	68-73	58-63[3]
Equation STA 622+50 BACK = 630+00 AHEAD											
630+00 to 632+00	(AL)	Hollywood Bowl Band Shell	80	300	50	N/A	--	--	75	55-60	--
Equation STA 644+50 BACK = 821+00 AHEAD											
821+00 to 920+00	(AR/AL)	Residential (approx. 100)	120	0	70	35	35	--	70	65	--
920+00 to 926+00	(AR/AL)	Residential (8)	80	0	60	35	38-43	32-37[2]	70	67-72	66-71[2]
926+00 to 927+00	(AR/AL)	Commercial (2)	80	0	60	50	36-41	--	80	65-70	--

TABLE IV-5 (CONTINUED)

Location of Structure Adjacent to Alignment		Type of Structure (N)*	Depth to Top of Rail (ft)	Horiz. Dist. from Near Track ℄ (ft)	Operat'l Train Speed (mph)	Ground-Borne Noise: Criterion for Allowable Noise Level (dBA)	Ground-Borne Noise: Projected Maximum Noise Level With D.F. Fasteners (dBA)	Ground-Borne Noise: Projected Maximum Noise Level With Recommended Mitigation (dBA)	Ground-Borne Vibration: Criterion for Allowable Vibration Level (dB)*	Ground-Borne Vibration: Projected Maximum Vibration Veloc. Lvl. With D.F. Fasteners (dB)*	Ground-Borne Vibration: Projected Maximum Vibration Veloc. Lvl. With Recomm. Mitigation (dB)*
930+00 to 931+00	(AR)	Commercial/ Office (1)	75	30	50	45	30-35	--	75-80	57-62	--
931+00 to 936+50	(AR)	Campo de Cahuenga	70	95	45	35	22-27	--	75	56-61	--
936+00 to 937+00	(AL)	Residential (4)	70	120	45	35	26-31	--	70	56-61	--
943+00 to 947+00	(AL	Residential (10)	50	20	50	35	39-44	32-37[2]	70	63-68	62-67[2]
943+00 to 946+00	(AR)	Commercial/ Office (2)	50	15	50	45	37-42	--	75-80	61-66	--
948+00 to 951+50	(AR/AL)	Commercial (3)	70	0	55	50	30-35	--	80	59-64	--
949+00 to 951+50	(AL)	Residential (4)	70	80-120	55	35	31-36	--	70	59-64	--
950+50 to 951+50	(AR/AL)	Office (1)	75	0	55	40	30-35	--	75	63-68	--
952+00 to 954+00	(AR/AL)	Commercial/ Office (3)	80	0	60	45	31-36	--	75-80	59-64	--
954+00 to 962+00	(AR/AL)	Office (9) School (1)	80	30	70	40	31-36	--	75	65-70	--

TABLE IV-5 (CONTINUED)

Location of Structure Adjacent to Alignment		Type of Structure (N)*	Depth to Top of Rail (ft)	Horiz. Dist. from Near Track ℄ (ft)	Operat'l Train Speed (mph)	Ground-Borne Noise: Criterion for Allowable Noise Level (dBA)	Ground-Borne Noise: Projected Maximum Noise Level With D.F. Fasteners (dBA)	Ground-Borne Noise: Projected Maximum Noise Level With Recommended Mitigation (dBA)	Ground-Borne Vibration: Criterion for Allowable Vibration Level (dB)*	Ground-Borne Vibration: Projected Maximum Vibration Veloc. Lvl. With D.F. Fasteners (dB)*	Ground-Borne Vibration: Projected Maximum Vibration Veloc. Lvl. With Recomm. Mitigation (dB)*
962+00 to 969+50	(AR/AL)	Commercial/ Office (7)	80	30	70	45	31-36	--	75-80	65-70	--
969+50 to 971+00	(AL)	Apartments (2)	85	40	70	40	31-36	--	75	60-65	--
970+00 to 976+00	(AR/AL)	Commercial/ Office (8)	85	30	70	45	30-35	--	75-80	59-64	--
974+00 to 976+50	(AL)	St. Charles Borromeo Church	85	40	70	35	35-40	29-34[2]	75	64-69	63-68[2]
977+00 to 982+00	(AR/AL)	Commercial/ Office (6)	90	30	70	45	29-34	--	75-80	58-63	--
979+00 to 980+00	(AL)	Recording Studio (1)	90	30	70	25	26-31	20-25[2]	65	57-62	56-61[2]
982+50 to 995+50	(AR/AL)	Office (3)	90	30	70	40	23-28	--	75	58-63	--
985+00 to 997+50	(AR/AL)	Commercial (4)	90	30	70	45	29-34	--	80	58-63	--
995+75 to 996+25	(AR)	Precision Die Engravers	90	30	70	40	35-40	--	70	64-69	--
996+25 to 997+50	(AR)	Office (1)	90	30	70	40	35-40	--	75	64-69	--

TABLE IV-5 (CONTINUED)

Location of Structure Adjacent to Alignment		Type of Structure (N)*	Depth to Top of Rail (ft)	Horiz. Dist. from Near Track ℄ (ft)	Operat'l Train Speed (mph)	Ground-Borne Noise			Ground-Borne Vibration		
						Criterion for Allowable Noise Level (dBA)	Projected Maximum Noise Level With D.F. Fasteners (dBA)	Projected Maximum Noise Level With Recommended Mitigation (dBA)	Criterion for Allowable Vibration Level (dB)*	Projected Maximum Vibration Veloc. Lvl. With D.F. Fasteners (dB)*	Projected Maximum Vibration Veloc. Lvl. With Recomm. Mitigation (dB)*
998+00 to 1004+00	(AR/AL)	Commercial/ Office (14)	90	30	70	45	29-34	--	75-80	58-63	--
1008+00 to 1014+00	(AR/AL)	Commercial (13)	80	30	70	45	31-36	--	80	59-64	--
1014+00 to 1016+00	(AR/AL)	Commercial/ Office (5)	80	30	70	45	31-36	--	75-80	59-64	--
1015+50 to 1016+60	(AL)	Recording Studio (1)	80	30	70	25	31-36	15-20[3]	65	59-64	50-55[3]
1016+00 to 1026+00	(AR/AL)	Commercial/ Office (25)	70	30	70	45	33-38	--	75-80	60-65	--
1026+00 to 1026+50	(AR)	Recording Studio (1)	70	30	70	25	33-38	16-21[3]	65	60-65	50-55[3]
1026+50 to 1028+00	(AL)	Office (1)	60	35	70	40	28-33	--	75	66-71	--
1027+50 to 1043+50	(AR/AL)	Commercial/ Office (37)	50	30	70	45	36-41	--	75-80	67-72	--
1033+00 to 1034+00	(AL)	Guild Theatre	50	30	70	35	36-41	30-35[2]	75	67-72	66-71[2]
1041+50 to 1042+00	(AL)	Recording Studio (1)	50	30	60	25	35-40	19-24[3]	65	66-71	56-61[3]

TABLE IV-5 (CONTINUED)

Location of Structure Adjacent to Alignment		Type of Structure (N)*	Depth to Top of Rail (ft)	Horiz. Dist. from Near Track ℄ (ft)	Operat'l Train Speed (mph)	Ground-Borne Noise			Ground-Borne Vibration		
						Criterion for Allowable Noise Level (dBA)	Projected Maximum Noise Level With D.F. Fasteners (dBA)	Projected Maximum Noise Level With Recommended Mitigation (dBA)	Criterion for Allowable Vibration Level (dB)*	Projected Maximum Vibration Veloc. Lvl. With D.F. Fasteners (dB)*	Projected Maximum Vibration Veloc. Lvl. With Recomm. Mitigation (dB)*
1043+00 to 1044+00	(AL)	El Portal Theater	50	30	55	35	40-45 (X-Over)	25-30[3]	75	75-80 (X-Over)	65-70[3]
1044+00 to 1048+00	(AR/AL)	Commercial (10)	50	30	55	45	40-45 (X-Over)	--	80	75-80 (X-Over)	--
1048+00 to 1052+50	(AR/AL)	Commercial (5)	50	30	45	45	27-32	--	80	64-69	--
1052+50 to 1057+64	(AR/AL)	Commercial (5)	50	30	55 (When line is extended)	45	30-35	--	80	64-69	--

(N)* = Number of Buildings ±10%

* = Vibration Velocity re 10^{-6} in/sec

Mitigation Measures:

1 = RS-STEDEF or Tie in Rubber Boot System

2 = Cologne Egg or Soft Fastener

3 = Floating Slab Trackbed

APPENDIX V

Candidate Alignment 5

Western/Sunset Subway, Wilshire Aerial

V-1 Wilshire Branch (Subway)

TABLE V-1 PROJECTED MAXIMUM GROUND-BORNE NOISE AND VIBRATION LEVELS FOR METRO RAIL OPERATIONS IN SUBWAY -- ALIGNMENT 5 -- WILSHIRE BRANCH

Location of Structure Adjacent to Alignment		Type of Structure (N)*	Depth to Top of Rail (ft)	Horiz. Dist. from Near Track ℄ (ft)	Operat'l Train Speed (mph)	Ground-Borne Noise: Criterion for Allowable Noise Level (dBA)	Ground-Borne Noise: Projected Maximum Noise Level With D.F. Fasteners (dBA)	Ground-Borne Noise: Projected Maximum Noise Level With Recommended Mitigation (dBA)	Ground-Borne Vibration: Criterion for Allowable Vibration Level (dB)*	Ground-Borne Vibration: Projected Maximum Vibration Veloc. Lvl. With D.F. Fasteners (dB)*	Ground-Borne Vibration: Projected Maximum Vibration Veloc. Lvl. With Recomm. Mitigation (dB)*
319+50 to 320+50	(AR)	Apartments (1)	50	10	45	40	43-48	37-42[2]	75	68-73	67-72[2]
321+50 to 323+00	(AR/AL)	Office (2)	50	0	45	45	40-45	--	75-80	66-71	--
323+00 to 333+00	(AR/AL)	Apartments (5)	50	0	45	40	43-48	37-42[2]	75	68-73	67-72[2]
334+00 to 336+00	(AL)	Apartments (1)	60	0	45	40	31-36	--	75	64-69	--
338+00 to 344+00	(AL)	Offices (6)	55	30	45	45	31-36	--	75-80	64-69	--
338+00 to 344+00	(AR)	Offices (6)	85	30	45	45	26-31	--	75-80	63-68	--
343+00 to 344+50	(AL)	Church (1)	55	70	45	35	29-34	--	75	60-65	--
343+00 to 344+50	(AR)	Church (1)	85	30	45	35	29-34	--	75	60-65	--
345+00 to 347+50	(AL)	Hotel and Conference Center (1)	55	70	45	35	23-28	--	70	60-65	--
345+00 to 347+50	(AR)	Hotel and Conference Center (1)	85	30	45	35	23-28	--	70	60-65	--

TABLE V-1 (CONTINUED)

Location of Structure Adjacent to Alignment		Type of Structure (N)*	Depth to Top of Rail (ft)	Horiz. Dist. from Near Track ℄ (ft)	Operat'l Train Speed (mph)	Ground-Borne Noise: Criterion for Allowable Noise Level (dBA)	Ground-Borne Noise: Projected Maximum Noise Level With D.F. Fasteners (dBA)	Ground-Borne Noise: Projected Maximum Noise Level With Recommended Mitigation (dBA)	Ground-Borne Vibration: Criterion for Allowable Vibration Level (dB)*	Ground-Borne Vibration: Projected Maximum Vibration Veloc. Lvl. With D.F. Fasteners (dB)*	Ground-Borne Vibration: Projected Maximum Vibration Veloc. Lvl. With Recomm. Mitigation (dB)*
349+00 to 351+00	(AL)	Office (1)	55	70	45	45	23-28	--	75-80	63-68	--
349+00 to 351+00	(AR)	Office (1)	85	30	45	45	23-28	--	75-80	63-68	--
350+00 to 352+00	(AL)	Office (3)	55	70	45	45	35-40 (At Switch)	--	75-80	73-78 (At Switch)	--
350+00 to 352+00	(AR)	Dffice (3)	85	30	45	45	35-40 (At Switch)	--	75-80	73-78 (At Switch)	--
EQUATION STA 350+94.90 BACK = STA 37+44.97 AHEAD											
40+00 to 48+50	(AL)	Office (3)	50	40	45	45	27-32	--	75-80	63-68	--
40+00 to 41+50	(AR)	Church (1)	80	40	45	35	25-30	--	75	59-64	--
45+00 to 46+50	(AR)	Church (1)	65	45	45	35	27-32	--	75	60-65	--
50+00 to 54+00	(AR/AL)	Office (3)	50	40	45	45	28-33	--	75-80	60-65	--
54+00 to 57+00	(AR)	Commercial/ Office (2)	50	25	45	40-50	25-30	--	75-80	64-69	--
54+00 to 58+50	(AL)	Office/ Theater (3)	50	40	45	35-40	21-26	--	70-75	60-65	--

TABLE V-1 (CONTINUED)

Location of Structure Adjacent to Alignment		Type of Structure (N)*	Depth to Top of Rail (ft)	Horiz. Dist. from Near Track ℄ (ft)	Operat'l Train Speed (mph)	Ground-Borne Noise: Criterion for Allowable Noise Level (dBA)	Ground-Borne Noise: Projected Maximum Noise Level With D.F. Fasteners (dBA)	Ground-Borne Noise: Projected Maximum Noise Level With Recommended Mitigation (dBA)	Ground-Borne Vibration: Criterion for Allowable Vibration Level (dB)*	Ground-Borne Vibration: Projected Maximum Vibration Veloc. Lvl. With D.F. Fasteners (dB)*	Ground-Borne Vibration: Projected Maximum Vibration Veloc. Lvl. With Recomm. Mitigation (dB)*
59+50 to 64+00	(AR)	Office (2)	50	25	45	40	39-44 (X-Over)	23-28[3]	75	70-75 (X-Over)	60-65[3]
65+00 to 66+70	(AR)	Church (1)	50	30	45	35	40-45 (X-Over)	24-29[3]	75	72-77 (X-Over)	62-67[3]
66+80 to 77+00	(AR)	Commercial/ Office (5)	20	30	45	45	38-43	--	75-80	66-71	--
60+00 to 70+50	(AL)	Commercial/ Office (8)	40	30	45	45	46-51 (X-Over)	30-35[3]	75-80	76-81 (X-Over)	66-71[3]
70+50 to 72+00	(AL)	Apartments (1)	30	40	45	40	32-37	--	75	63-68	--
72+00 to 77+00	(AL)	Commercial/ Office (4)	20	30	45	45	38-43	--	75	67-72	--

(N)* = Number of Buildings ±10%

* = Vibration Velocity re 10^{-6} in/sec

Mitigation Measures:

[2] = Cologne Egg or Soft Fastener

[3] = Floating Slab Trackbed

V-2 Wilshire Branch (Aerial)

TABLE V-2 PROJECTED MAXIMUM AIRBORNE NOISE LEVELS FOR METRO RAIL OPERATIONS ON AERIAL STRUCTURE
ALIGNMENT 5 -- WILSHIRE BRANCH

Station Number and Direction from Alignment	Type of Structure (N)*	Distance Near Track to Nearest Building (ft)	Maximum Train Speed (mph)	Criterion for Allowable Levels (dBA)	No Sound Barrier Wall		Sound Barrier Wall	
					Predicted Maximum Noise 6-car Train (dBA)	Required Distance for Criterion Compliance (ft)	Predicted Maximum Noise 6-car Train (dBA)	Required Distance for Criterion Compliance (ft)
77+00 to 82+50 (AR)	Commercial (5)	40	45	85	85-87	70	76-78	--
77+00 to 83+00 (AL)	Commercial (2)	30	45	85	85-87	70	76-78	--
82+50 to 84+50 (AR)	Apartments (1)	50	45	80	84-86	160	75-77	--
83+00 to 85+00 (AL)	Theater (1)	50	45	75	84-86	320	75-77	70
84+50 to 88+50 (AR)	Commercial (1)	40	45	85	85-87	70	76-78	--
85+00 to 88+50 (AL)	Commercial (1)	40	45	85	85-87	70	76-78	--
88+50 to 90+00 (AL/AR)	Commercial (1)	40	45	85	85-87	70	76-78	--
90+00 to 93+00 (AL/AR)	Commercial (1)	40	45	85	85-87	300	76-78	--
93+00 to 95+00 (AR)	Residential (2)	330	70	80	76-78	--	--	--
93+00 to 96+00 (AL)	Commercial (4)	40	70	85	89-91	150	80-82	--
95+00 to 100+00 (AR)	Commercial (3)	50	70	85	88-90	150	79-81	--

TABLE V-2 (CONTINUED)

Station Number and Direction from Alignment		Type of Structure (N)*	Distance Near Track to Nearest Building (ft)	Maximum Train Speed (mph)	Criterion for Allowable Levels (dBA)	No Sound Barrier Wall		Sound Barrier Wall	
						Predicted Maximum Noise 6-car Train (dBA)	Required Distance for Criterion Compliance (ft)	Predicted Maximum Noise 6-car Train (dBA)	Required Distance for Criterion Compliance (ft)
96+00 to 98+00	(AL)	Hotel (1)	40	70	80	89-91	300	80-82	60
98+00 to 100+00	(AL)	Commercial (1)	40	70	85	89-91	150	80-82	--
100+00 to 103+00	(AL)	Church (1)	50	70	75	88-90	580	79-81	160
100+00 to 104+50	(AR)	Church (1)	50	70	75	88-90	580	79-81	160
103+00 to 106+00	(AL)	Theater (1)	50	70	75	88-90	580	79-81	160
104+50 to 111+00	(AR)	Commercial (2)	40	70	85	89-91	150	80-82	--
106+00 to 114+00	(AL)	Apartments (2)	40	70	80	89-91	300	80-82	60
111+00 to 114+00	(AR)	Apartments (1)	50	70	80	88-90	300	79-81	60
114+00 to 117+00	(AL/AR)	Commercial (4)	50	70	85	88-90	150	79-81	--
117+00 to 120+00	(AR)	Apartments (1)	50	70	80	88-90	300	79-81	60
117+00 to 118+00	(AL)	Apartments (1)	50	70	80	88-90	300	79-81	60

TABLE V-2 (CONTINUED)

Station Number and Direction from Alignment		Type of Structure (N)*	Distance Near Track to Nearest Building (ft)	Maximum Train Speed (mph)	Criterion for Allowable Levels (dBA)	No Sound Barrier Wall: Predicted Maximum Noise 6-car Train (dBA)	No Sound Barrier Wall: Required Distance for Criterion Compliance (ft)	Sound Barrier Wall: Predicted Maximum Noise 6-car Train (dBA)	Sound Barrier Wall: Required Distance for Criterion Compliance (ft)
118+00 to 124+00	(AL)	Commercial (1)	250	70	85	79-81	--	--	--
120+00 to 128+00	(AR)	Residential (3)	120	70	75	84-86	580	75-77	160
124+00 to 127+00	(AL)	Commercial (1)	50	70	85	88-90	250	79-81	--
127+00 to 138+00	(AL)	Residential (5)	230	70	75	79-81	580	70-72	--
128+00 to 130+00	(AR)	Commercial (1)	40	70	85	89-91	150	80-82	--
130+00 to 140+00	(AR)	Residential (3)	140	70	75	83-85	580	74-76	160
138+00 to 142+00	(AL)	Residential (2)	50	70	80	88-90	300	79-81	60
140+00 to 163+00	(AR)	Commercial (7)	40	70	85	89-91	150	80-82	--
142+00 to 163+00	(AL)	Commercial (11)	40	70	85	89-91	150	80-82	--
163+00 to 169+00	(AL/AR)	Commercial (8)	40	45	85	85-87	60	76-78	--
169+00 to 198+00	(AL)	Commercial (15)	40	70	85	89-91	150	80-82	--

TABLE V-2 (CONTINUED)

Station Number and Direction from Alignment		Type of Structure (N)*	Distance Near Track to Nearest Building (ft)	Maximum Train Speed (mph)	Criterion for Allowable Levels (dBA)	No Sound Barrier Wall		Sound Barrier Wall	
						Predicted Maximum Noise 6-car Train (dBA)	Required Distance for Criterion Compliance (ft)	Predicted Maximum Noise 6-car Train (dBA)	Required Distance for Criterion Compliance (ft)
169+00 to 203+00	(AR)	Commercial (17)	40	70	85	89-91	150	80-82	--
198+00 to 199+00	(AL)	Museum (1)	50	70	75	88-90	580	79-81	160
199+00 to 214+00	(AL)	Commercial (8)	40	70	85	89-91	150	80-82	--
203+00 to 209+00	(AR)	Museum (3)	100	70	75	83-87	580	76-78	160
209+00 to 214+00	(AR)	Commercial (2)	40	70	85	89-91	150	80-82	--
214+00 to 215+50	(AR)	Commercial (1)	40	50	85	92-94 (X-Over)	220	83-85	--
214+00 to 215+50	(AL)	Commercial (1)	50	50	85	91-93 (X-Over)	220	82-84	--
215+50 to 227+50	(AR)	Commercial (8)	40	45	85	85-87	60	76-78	--
215+50 to 227+50	(AL)	Commercial (7)	50	45	85	84-86	60	75-77	--

(N)* = Number of buildings ±10%

V-3 Western/Sunset/Lankershim Branch (Subway)

TABLE V-3 PROJECTED MAXIMUM GROUND-BORNE NOISE AND VIBRATION LEVELS FOR METRO RAIL OPERATIONS IN SUBWAY -- ALIGNMENT 5 -- WESTERN/SUNSET/LANKERSHIM BRANCH

Location of Structure Adjacent to Alignment		Type of Structure (N)*	Depth to Top of Rail (ft)	Horiz. Dist. from Near Track ℄ (ft)	Operat'l Train Speed (mph)	Ground-Borne Noise			Ground-Borne Vibration		
						Criterion for Allowable Noise Level (dBA)	Projected Maximum Noise Level With D.F. Fasteners (dBA)	Projected Maximum Noise Level With Recommended Mitigation (dBA)	Criterion for Allowable Vibration Level (dB)*	Projected Maximum Vibration Veloc. Lvl. With D.F. Fasteners (dB)*	Projected Maximum Vibration Veloc. Lvl. With Recomm. Mitigation (dB)*
350+00 to 354+00	(AL)	Office (3)	55	70	45	45	35-40 (At Switch)	--	75-80	73-78 (At Switch)	--
350+00 to 354+00	(AR)	Office (3)	85	30	45	45	35-40 (At Switch)	--	75-80	73-78 (At Switch)	--
352+50 to 354+00	(AL)	Church (1)	55	50	45	35	27-32	--	75	61-66	--
352+50 to 354+00	(AR)	Church (1)	85	10	45	35	26-31	--	75	61-66	--
358+00 to 360+50	(AL)	Church (1)	50	0	50	35	34-39	28-33[2]	75	63-68	62-67[2]
358+00 to 360+50	(AR)	Church (1)	80	0	50	35	32-37	26-31[2]	75	62-67	61-66[2]
361+00 to 364+00	(AL)	Apartments (6)	55	0	50	40	40-45	35-40[2]	75	69-74	68-73[2]
361+00 to 364+00	(AR)	Apartments (6)	75	0	50	40	39-44	33-38[2]	75	67-72	66-71[2]
366+00 to 375+00	(AR/AL)	Offices & Apartments (8)	60	0	55	40	34-39	--	75	63-68	--
375+00 to 381+00	(AR/AL)	Commercial/ Office (2)	60	0	55	45	32-37	--	75-80	60-65	--

TABLE V-3 (CONTINUED)

Location of Structure Adjacent to Alignment		Type of Structure (N)*	Depth to Top of Rail (ft)	Horiz. Dist. from Near Track ℄ (ft)	Operat'l Train Speed (mph)	Ground-Borne Noise			Ground-Borne Vibration		
						Criterion for Allowable Noise Level (dBA)	Projected Maximum Noise Level With D.F. Fasteners (dBA)	Projected Maximum Noise Level With Recommended Mitigation (dBA)	Criterion for Allowable Vibration Level (dB)*	Projected Maximum Vibration Veloc. Lvl. With D.F. Fasteners (dB)*	Projected Maximum Vibration Veloc. Lvl. With Recomm. Mitigation (dB)*
381+00 to 387+50	(AR/AL)	Commercial/ Office (12)	60	30	70	45	36-41	--	75-80	64-69	--
388+00 to 390+00	(AL)	Church (1)	60	30	70	35	35-40	30-35[2]	75	64-69	63-68[2]
388+00 to 395+50	(AR/AL)	Commercial/ Office (8)	60	30	70	45	36-41	--	75-80	64-69	--
395+50 to 405+00	(AR/AL)	Commercial/ Office (23)	55	30	70	45	36-41	--	75-80	64-69	--
405+00 to 407+00	(AL)	Commercial/ Office (2)	50	30	65	45	36-41	--	75-80	64-69	--
406+50 to 408+00	(AR)	Commercial (1)	50	30	65	50	31-36	--	80	63-68	--
407+00 to 412+00	(AR/AL)	Commercial/ Office (7)	50	30	60	45	42-47 (X-Over)	38-43[1]	75-80 (X-Over)	74-79	70-75[1]
412+00 to 413+50	(AR)	Hotel (1)	50	30	45	45	26-31	--	75	64-69	--
412+00 to 416+50	(AR/AL)	Commercial (6)	50	30	45	50	27-32	--	80	61-66	--
416+50 to 423+50	(AL/AR)	Commercial (5)	50	30	70	50	38-43	--	80	65-70	--

TABLE V-3 (CONTINUED)

Location of Structure Adjacent to Alignment		Type of Structure (N)*	Depth to Top of Rail (ft)	Horiz. Dist. from Near Track ℄ (ft)	Operat'l Train Speed (mph)	Ground-Borne Noise			Ground-Borne Vibration		
						Criterion for Allowable Noise Level (dBA)	Projected Maximum Noise Level With D.F. Fasteners (dBA)	Projected Maximum Noise Level With Recommended Mitigation (dBA)	Criterion for Allowable Vibration Level (dB)*	Projected Maximum Vibration Veloc. Lvl. With D.F. Fasteners (dB)*	Projected Maximum Vibration Veloc. Lvl. With Recomm. Mitigation (dB)*
422+50 to 425+00	(AL)	Apartments/ Offices (3)	55	30	70	40	39-44	33-38[2]	75	66-71	65-70[2]
423+50 to 430+00	(AR/AL)	Commercial/ Office (9)	55	30	70	45	39-44	--	75-80	66-71	--
430+00 to 440+50	(AR/AL)	Commercial/ Office (26)	60	30	70	45	38-43	--	75-80	65-70	--
431+00 to 432+00	(AL)	Residential (3)	60	30	70	40	41-46	35-40[2]	70	67-72	66-71[2]
440+50 to 448+00	(AR/AL)	Commercial/ Office (12)	60	30	70	45	38-43	--	75-80	65-70	--
448+00 to 449+50	(AL)	Residential (2)	60	30	70	40	41-46	35-40[2]	70	67-72	66-71[2]
448+00 to 452+50	(AR/AL)	Commercial/ Office (5)	55	30	70	45	40-45	--	75-80	67-72	--
452+50 to 458+00	(AR)	Apartments (10)	50	60	70	40	40-45	35-40[2]	75	68-73	67-72[2]
454+00 to 462+00	(AR/AL)	Commercial (7)	50	30	70	50	38-43	--	80	65-70	--
462+00 to 466+50	(AR/AL)	Commercial (8)	50	30	45	50	27-32	--	80	61-66	--

TABLE V-3 (CONTINUED)

Location of Structure Adjacent to Alignment		Type of Structure (N)*	Depth to Top of Rail (ft)	Horiz. Dist. from Near Track ℄ (ft)	Operat'l Train Speed (mph)	Ground-Borne Noise			Ground-Borne Vibration		
						Criterion for Allowable Noise Level (dBA)	Projected Maximum Noise Level With D.F. Fasteners (dBA)	Projected Maximum Noise Level With Recommended Mitigation (dBA)	Criterion for Allowable Vibration Level (dB)*	Projected Maximum Vibration Veloc. Lvl. With D.F. Fasteners (dB)*	Projected Maximum Vibration Veloc. Lvl. With Recomm. Mitigation (dB)*
466+50 to 473+00	(AR/AL)	Commercial (7)	60	0	55	50	34-39	--	80	61-66	--
473+00 to 480+00	(AR/AL)	Apartments (7)	50	0	55	40	41-46	35-40[2]	75	71-76	70-75[2]
480+00 to 483+50	(AR/AL)	Apartments (4)	60	0	70	45	43-48	38-43[2]	75	71-76	70-75[2]
485+00 to 487+00	(AR/AL)	Residential (4)	60	0	70	40	43-48	38-43[2]	75	71-76	70-75[2]
488+50 to 490+50	(AR/AL)	Office (1)	60	0	70	45	37-42	--	75-80	65-70	--
492+50 to 497+00	(AR/AL)	Office (2)	60	0	60	45	30-35	--	75-80	69-74	--
497+00 to 507+00	(AR/AL)	Office (4)	70	0	50	45	26-31	--	75-80	67-72	--
507+00 to 510+00	(AR/AL)	Commercial/ Office (3)	60	30	60	45	30-35	--	75-80	66-71	--
510+00 to 513+00	(AR/AL)	Commercial (3)	60	30	70	50	31-36	--	80	67-71	--
513+00 to 520+00	(AR/AL)	Commercial/ Office (5)	50	30	70	45	33-38	--	75-80	66-73	--

TABLE V-3 (CONTINUED)

Location of Structure Adjacent to Alignment		Type of Structure (N)*	Depth to Top of Rail (ft)	Horiz. Dist. from Near Track ℄ (ft)	Operat'l Train Speed (mph)	Ground-Borne Noise			Ground-Borne Vibration		
						Criterion for Allowable Noise Level (dBA)	Projected Maximum Noise Level With D.F. Fasteners (dBA)	Projected Maximum Noise Level With Recommended Mitigation (dBA)	Criterion for Allowable Vibration Level (dB)*	Projected Maximum Vibration Veloc. Lvl. With D.F. Fasteners (dB)*	Projected Maximum Vibration Veloc. Lvl. With Recomm. Mitigation (dB)*
516+50 to 517+50	(AR)	Motel (1)	55	30	70	45	39-44	35-40[1]	75	73-78	68-73[1]
521+00 to 524+50	(AR)	CBS Studios	45	30	70	25	33-38	19-24[3]	65	68-73	61-66[3]
521+00 to 530+50	(AR/AL)	Commercial/ Office (3)	45	30	70	45	33-38	--	75-80	68-73	--
525+00 to 528+00	(AR)	Hollywood Theater - Paladium	45	30	65	35	33-38	27-32[2]	75	67-72	66-71[2]
530+50 to 536+50	(AR/AL)	Commercial (5)	45	30	45	50	21-26	--	80	61-66	--
537+50 to 539+00	(AL)	Cinerama Theater	45	25	45	35	33-38 (At Switch)	21-26[3]	75	72-77 (At Switch)	62-67[3]
540+00 to 542+00	(AR/AL)	Commercial (2)	45	25	45	50	29-34	--	80	68-73	--
542+00 to 546+50	(AR/AL)	Commercial (3)	45	25	45	50	29-34	--	80	68-73	--
543+00 to 544+00	(AL)	Office (1)	45	25	45	45	25-30	--	75-80	68-73	--
547+00 to 548+00	(AR)	Hotel (1)	45	25	45	45	35-40 (At Switch)	23-28[3]	75	75-80 (At Switch)	65-70[3]

TABLE V-3 (CONTINUED)

Location of Structure Adjacent to Alignment		Type of Structure (N)*	Depth to Top of Rail (ft)	Horiz. Dist. from Near Track ℄ (ft)	Operat'l Train Speed (mph)	Ground-Borne Noise: Criterion for Allowable Noise Level (dBA)	Ground-Borne Noise: Projected Maximum Noise Level With D.F. Fasteners (dBA)	Ground-Borne Noise: Projected Maximum Noise Level With Recommended Mitigation (dBA)	Ground-Borne Vibration: Criterion for Allowable Vibration Level (dB)*	Ground-Borne Vibration: Projected Maximum Vibration Veloc. Lvl. With D.F. Fasteners (dB)*	Ground-Borne Vibration: Projected Maximum Vibration Veloc. Lvl. With Recomm. Mitigation (dB)*
547+00 to 551+00	(AR/AL)	Commercial (3)	45	25	45	50	31-36	--	80	65-70	--
549+00 to 550+00	(AL)	Motel (1)	45	25	45	45	38-43	--	75	70-75	--
549+50 to 550+50	(AR)	Hotel (1)	45	25	45	45	31-36	--	75	65-70	--
551+00 to 553+00	(AR/AL)	Commercial (3)	40	25	45	50	32-37	--	80	65-70	--
552+50 to 554+00	(AR/AL)	Recording Studios (2)	40	25	45	25	36-41	21-26[3]	65	69-74	59-64[3]
553+50 to 557+00	(AR/AL)	Commercial/ Office (7)	40	25	45	45	26-31	--	75-80	68-73	--
557+00 to 558+00	(AR)	School (1)	40	25	45	35	26-31	--	75	68-73	--
558+00 to 559+50	(AR)	Church (1)	35	25	45	35	19-24	--	75	62-67	--
561+00 to 574+00	(AR/AL)	Commercial/ Office (13)	25	0	45	45	33-38	--	75-80	72-77	--
570+00 to 571+00	(AR/AL)	Recording Studio	25	0	45	25	33-38	22-27[3]	65	72-77	62-67[3]

TABLE V-3 (CONTINUED)

Location of Structure Adjacent to Alignment		Type of Structure (N)*	Depth to Top of Rail (ft)	Horiz. Dist. from Near Track C (ft)	Operat'l Train Speed (mph)	Ground-Borne Noise: Criterion for Allowable Noise Level (dBA)	Ground-Borne Noise: Projected Maximum Noise Level With D.F. Fasteners (dBA)	Ground-Borne Noise: Projected Maximum Noise Level With Recommended Mitigation (dBA)	Ground-Borne Vibration: Criterion for Allowable Vibration Level (dB)*	Ground-Borne Vibration: Projected Maximum Vibration Veloc. Lvl. With D.F. Fasteners (dB)*	Ground-Borne Vibration: Projected Maximum Vibration Veloc. Lvl. With Recomm. Mitigation (dB)*
574+00 to 578+00	(AR/AL)	Commercial/ Office (7)	30	25	45	45	33-38	--	75-80	66-71	--
578+00 to 582+50	(AR/AL)	Commercial/ Office (5)	40	25	45	45	25-30	--	75-80	65-70	--
582+00 to 588+00	(AR/AL)	Commercial/ Office (8)	45	30	45	45	31-36	--	75-80	56-61	--
589+00 to 590+00	(AL)	Church (1)	50	0	50	35	30-35	--	75	55-60	--
591+00 to 595+00	(AR/AL)	Residential (10)	60-70	0	50	35	38-43	32-37[2]	70	62-67	61-66[2]
595+00 to 604+00	(AR/AL)	Apartments (6)	30	0	50	40	35-40	--	75	66-71	--
604+00 to 609+00	(AR/AL)	Residential (28)	30-55	0	50	35	37-42	26-31[3]	70	68-73	58-63[3]
Equation STA 622+50 BACK = 630+00 AHEAD											
630+00 to 632+00	(AL)	Hollywood Bowl Band Shell	80	300	50	N/A	--	--	75	55-60	--
Equation STA 644+50 BACK = 821+00 AHEAD											
821+00 to 920+00	(AR/AL)	Residential (approx. 100)	120	0	70	35	35	--	70	65	--
920+00 to 926+00	(AR/AL)	Residential (8)	80	0	60	35	38-43	32-37[2]	70	67-72	66-71[2]

TABLE V-3 (CONTINUED)

Location of Structure Adjacent to Alignment		Type of Structure (N)*	Depth to Top of Rail (ft)	Horiz. Dist. from Near Track ℄ (ft)	Operat'l Train Speed (mph)	Ground-Borne Noise			Ground-Borne Vibration		
						Criterion for Allowable Noise Level (dBA)	Projected Maximum Noise Level With D.F. Fasteners (dBA)	Projected Maximum Noise Level With Recommended Mitigation (dBA)	Criterion for Allowable Vibration Level (dB)*	Projected Maximum Vibration Veloc. Lvl. With D.F. Fasteners (dB)*	Projected Maximum Vibration Veloc. Lvl. With Recomm. Mitigation (dB)*
926+00 to 927+00	(AR/AL)	Commercial (2)	80	0	60	50	36-41	--	80	65-70	--
930+00 to 931+00	(AR)	Commercial/ Office (1)	75	30	50	45	30-35	--	75-80	57-62	--
931+00 to 936+50	(AR)	Campo de Cahuenga	70	95	45	35	22-27	--	75	56-61	--
936+00 to 937+00	(AL)	Residential (4)	70	120	45	35	26-31	--	70	56-61	--
943+00 to 947+00	(AL	Residential (10)	50	20	50	35	39-44	32-37[2]	70	63-68	62-67[2]
943+00 to 946+00	(AR)	Commercial/ Office (2)	50	15	50	45	37-42	--	75-80	61-66	--
948+00 to 951+50	(AR/AL)	Commercial (3)	70	0	55	50	30-35	--	80	59-64	--
949+00 to 951+50	(AL)	Residential (4)	70	80-120	55	35	31-36	--	70	59-64	--
950+50 to 951+50	(AR/AL)	Office (1)	75	0	55	40	30-35	--	75	63-68	--
952+00 to 954+00	(AR/AL)	Commercial/ Office (3)	80	0	60	45	31-36	--	75-80	59-64	--

TABLE V-3 (CONTINUED)

Location of Structure Adjacent to Alignment		Type of Structure (N)*	Depth to Top of Rail (ft)	Horiz. Dist. from Near Track ℄ (ft)	Operat'l Train Speed (mph)	Ground-Borne Noise			Ground-Borne Vibration		
						Criterion for Allowable Noise Level (dBA)	Projected Maximum Noise Level With D.F. Fasteners (dBA)	Projected Maximum Noise Level With Recommended Mitigation (dBA)	Criterion for Allowable Vibration Level (dB)*	Projected Maximum Vibration Veloc. Lvl. With D.F. Fasteners (dB)*	Projected Maximum Vibration Veloc. Lvl. With Recomm. Mitigation (dB)*
954+00 to 962+00	(AR/AL)	Office (9) School (1)	80	30	70	40	31-36	--	75	65-70	--
962+00 to 969+50	(AR/AL)	Commercial/ Office (7)	80	30	70	45	31-36	--	75-80	65-70	--
969+50 to 971+00	(AL)	Apartments (2)	85	40	70	40	31-36	--	75	60-65	--
970+00 to 976+00	(AR/AL)	Commercial/ Office (8)	85	30	70	45	30-35	--	75-80	59-64	--
974+00 to 976+50	(AL)	St. Charles Borromeo Church	85	40	70	35	35-40	29-34[2]	75	64-69	63-68[2]
977+00 to 982+00	(AR/AL)	Commercial/ Office (6)	90	30	70	45	29-34	--	75-80	58-63	--
979+00 to 980+00	(AL)	Recording Studio (1)	90	30	70	25	26-31	20-25[2]	65	57-62	56-61[2]
982+50 to 995+50	(AR/AL)	Office (3)	90	30	70	40	23-28	--	75	58-63	--
985+00 to 997+50	(AR/AL)	Commercial (4)	90	30	70	45	29-34	--	80	58-63	--
995+75 to 996+25	(AR)	Precision Die Engravers	90	30	70	40	35-40	--	70	64-69	--

TABLE V-3 (CONTINUED)

Location of Structure Adjacent to Alignment		Type of Structure (N)*	Depth to Top of Rail (ft)	Horiz. Dist. from Near Track ℄ (ft)	Operat'l Train Speed (mph)	Ground-Borne Noise			Ground-Borne Vibration		
						Criterion for Allowable Noise Level (dBA)	Projected Maximum Noise Level With D.F. Fasteners (dBA)	Projected Maximum Noise Level With Recommended Mitigation (dBA)	Criterion for Allowable Vibration Level (dB)*	Projected Maximum Vibration Veloc. Lvl. With D.F. Fasteners (dB)*	Projected Maximum Vibration Veloc. Lvl. With Recomm. Mitigation (dB)*
996+25 to 997+50	(AR)	Office (1)	90	30	70	40	35-40	--	75	64-69	--
998+00 to 1004+00	(AR/AL)	Commercial/ Office (14)	90	30	70	45	29-34	--	75-80	58-63	--
1008+00 to 1014+00	(AR/AL)	Commercial (13)	80	30	70	45	31-36	--	80	59-64	--
1014+00 to 1016+00	(AR/AL)	Commercial/ Office (5)	80	30	70	45	31-36	--	75-80	59-64	--
1015+50 to 1016+60	(AL)	Recording Studio (1)	80	30	70	25	31-36	15-20[3]	65	59-64	50-55[3]
1016+00 to 1026+00	(AR/AL)	Commercial/ Office (25)	70	30	70	45	33-38	--	75-80	60-65	--
1026+00 to 1026+50	(AR)	Recording Studio (1)	70	30	70	25	33-38	16-21[3]	65	60-65	50-55[3]
1026+50 to 1028+00	(AL)	Office (1)	60	35	70	40	28-33	--	75	66-71	--
1027+50 to 1043+50	(AR/AL)	Commercial/ Office (37)	50	30	70	45	36-41	--	75-80	67-72	--
1033+00 to 1034+00	(AL)	Guild Theatre	50	30	70	35	36-41	30-35[2]	75	67-72	66-71[2]

TABLE V-3 (CONTINUED)

Location of Structure Adjacent to Alignment		Type of Structure (N)*	Depth to Top of Rail (ft)	Horiz. Dist. from Near Track ℄ (ft)	Operat'l Train Speed (mph)	Ground-Borne Noise			Ground-Borne Vibration		
						Criterion for Allowable Noise Level (dBA)	Projected Maximum Noise Level With D.F. Fasteners (dBA)	Projected Maximum Noise Level With Recommended Mitigation (dBA)	Criterion for Allowable Vibration Level (dB)*	Projected Maximum Vibration Veloc. Lvl. With D.F. Fasteners (dB)*	Projected Maximum Vibration Veloc. Lvl. With Recomm. Mitigation (dB)*
1041+50 to 1042+00	(AL)	Recording Studio (1)	50	30	60	25	35-40	19-24[3]	65	66-71	56-61[3]
1043+00 to 1044+00	(AL)	El Portal Theater	50	30	55	35	40-45 (X-Over)	25-30[3]	75	75-80 (X-Over)	65-70[3]
1044+00 to 1048+00	(AR/AL)	Commercial (10)	50	30	55	45	40-45 (X-Over)	--	80	75-80 (X-Over)	--
1048+00 to 1052+50	(AR/AL)	Commercial (5)	50	30	45	45	27-32	--	80	64-69	--
1052+50 to 1057+64	(AR/AL)	Commercial (5)	50	30	55 (When line is extended)	45	30-35	--	80	64-69	--

(N)* = Number of Buildings ±10%

* = Vibration Velocity re 10^{-6} in/sec

Mitigation Measures:

1 = RS-STEDEF or Tie in Rubber Boot System
2 = Cologne Egg or Soft Fastener
3 = Floating Slab Trackbed

APPENDIX VI

GLOSSARY AND SIGNIFICANCE OF ACOUSTICAL TERMS

1. Glossary of Terms

A-WEIGHTED SOUND LEVEL (dBA):
The sound pressure level in decibels as measured on a sound level meter using the internationally standardized A-weighting filter or as computed from sound spectral data to which A-weighting adjustments have been made. A-weighting de-emphasizes the low and very high frequency components of the sound in a manner similar to the response of the average human ear. A-weighted sound levels correlate well with subjective reactions of people to noise and are universally used for community noise evaluations.

ACCELEROMETER:
A vibration sensitive transducer that responds to the vibration acceleration of a surface to which it is attached. The electronic signal generated by an accelerometer is directly proportional to the surface acceleration.

ACCELERATION LEVEL:
Also referred to as "vibration acceleration level." Vibration acceleration is the rate of change of speed and direction of a vibration. An accelerometer generates an electronic signal that is proportional to the vibration acceleration of the surface to which it is attached. The acceleration level is 20 times the logarithm to the base 10 of the ratio of the RMS value of the acceleration to a reference acceleration. The generally accepted reference vibration acceleration is 10^{-6} g (10^{-5} m/sec).

AMBIENT NOISE:
The prevailing general noise existing at a location or in a space, which usually consists of a composite of sounds from many sources near and far.

BACKGROUND NOISE:
Noise from all sources other than the source of interest. Generally background noise consists of a large number of distant noise sources and can be characterized by L_{90} or L_{99}.

C-WEIGHTED SOUND LEVEL (dBC)
The sound pressure level in decibels as measured on a sound level meter using the internationally standardized C-weighting filter or as computed from sound spectral data to which C-weighting adjustments have been made. The C-weighting network weights the frequencies between 70 Hz and 4000 Hz uniformly, but below and above these frequency limits the sound is discriminated against. Generally, C-weighted frequencies are essentially the same as overall sound pressure levels, which require no discrimination at any frequency.

COMMUNITY NOISE EQUIVALENT LEVEL (CNEL):
The L_{eq} of the A-weighted noise level over a 24-hour period with a 5 dB penalty applied to noise levels between 7 p.m. and 10 p.m. and a 10 dB penalty applied to noise levels between 10 p.m. and 7 a.m.

DAY-NIGHT SOUND LEVEL (L_{dn}):
The L_{eq} of the A-weighted noise level over a 24-hour period with a 10 dB penalty applied to noise levels between 10 p.m. and 7 a.m.

DECIBEL (dB):
The decibel is a measure on a logarithmic scale of the magnitude of a particular quantity (such as sound pressure, sound power, intensity) with respect to a standardized reference quantity.

ENERGY EQUIVALENT LEVEL (L_{eq}):
The level of a steady noise which would have the same energy as the fluctuating noise level of interest integrated over the time period of interest. L_{eq} is widely used as a single-number descriptor of environmental noise. L_{eq} is based on the logarithmic or energy summation and it places more emphasis on high noise level periods than does L_{50} or a straight arithmetic average of noise level over time. This energy average is not the same as the average of sound pressure levels over the period of interest, but must be computed by a rather complex procedure involving logarithms and integrals. Taken into account are the total times for which various noise levels are exceeded, thus the actual or assumed time history of the noise level must be known.

FREQUENCY (Hz):
The number of oscillations per second of a periodic noise (or vibration) expressed in Hertz (abbreviated Hz). Frequency in Hertz is the same as cycles per second.

L_1, L_{10}, L_{50}, L_{90} AND L_{99}:
The noise (or vibration) levels that are exceeded for 1%, 10%, 50%, 90% and 99% of a specified time period, respectively. Environmental noise and vibration data are often described in these terms. See section A-2 for a more detailed discussion of the statistical distribution terms.

NOISE REDUCTION COEFFICIENT (NRC):
Noise reduction coefficient is a measure of the acoustical absorption performance of a material, calculated by averaging its sound absorption coefficients at 250 Hz, 500 Hz, 1000 Hz and 2000 Hz.

OCTAVE BAND - 1/3 Octave Band
One octave is an interval between two sound frequencies that have a ratio of two. For example, the frequency range of 200 Hz to 400 Hz is one octave, as is the frequency range of 2000 Hz to 4000 Hz. An octave band is a frequency range that is one octave wide. A standard series of octaves is used in acoustics, and they are specified by their center frequencies. In acoustics, to increase resolution, the frequency content of a sound or vibration is often analyzed in terms of 1/3 octave bands, where each octave is divided into three 1/3 octave bands.

REVERBERENT FIELD:
The region in a room where the reflected sound dominates, as opposed to the region close to the noise source, where the direct sound dominates.

REVERBERATION:
The continuation of sound reflections within an enclosed space after the sound source has stopped.

REVERBERATION TIME (RT):
The time taken for the sound-pressure level in a room to decrease to one-millionth (60 dB) of its steady state value when the source of sound energy is suddenly interrupted. It is a measure of the persistence of a sound in a room and of the amount of acoustical absorption present inside the room.

SOUND ABSORPTION COEFFICIENT ( ):
The absorption coefficient of a material is the ratio of the sound absorbed by the material to that absorbed by an equivalent area of an open window. The absorption coefficient of a perfectly absorbing surface would be 1.0 and for marble slate is approximately 0.01.

SOUND PRESSURE LEVEL (SPL):
The sound pressure level of a sound in decibels is 20 times the logarithm to the base of 10 of the ratio of the RMS value of the sound pressure to the RMS value of a reference sound pressure. The generally accepted reference sound pressure is 20 micro-pascals.

VELOCITY LEVEL:
Also referred to as the "vibration velocity level." Vibration velocity is the rate of change of displacement of a vibration. The velocity level is 20 times the logarithm to the base 10 of the ratio of the RMS value of the velocity to the reference velocity. In this report the reported vibration velocity levels are all referenced to 10^{-6} in/sec. The vibration velocity of a surface is generally measured by integrating the output from an accelerometer. Above approximately 10 Hz, human responses to a vibration is more closely correlated to the velocity level than the acceleration level.

WEIGHTED VELOCITY LEVEL:
The vibration velocity level to which a weighting factor has been added. The weighting de-emphasizes the low frequencies in a manner similar to human response to vibration. The weighting used in this report is based on that proposed in Reference 10, however, there is no internationally recognized velocity weighting filter.

2. Statistical Distribution Terms

L_{99} and L_{90} are descriptors of the typical minimum or "residual" background noise (or vibration) levels observed during a measurement period, normally made up of the summation of a large number of sound sources distant from the measurement position and not usually recognizable as individual noise sources. The most prevalent source of this residual noise is distant street traffic. L_{99} and L_{90} are not strongly influenced by occasional local motor vehicle pass-bys. However they can be influenced by stationary sources such as air conditioning equipment.

L_{50} represents a long-term statistical median noise level over the measurement period and does reveal the long-term influence of local traffic.

L_{10} describes the average of the peaks or maximum noise levels occurring, for example, during nearby pass-bys of trucks, buses, automobiles, trains, or airplanes. Thus, while L_{10} does not describe the typical maximum noise levels observed at a point, it is strongly influenced by the momentary maximum noise level occurring during vehicle pass-bys.

L_1, the noise level exceeded for 1% of the times is representative of the occasional, isolated maximum or peak level which occurs in an area. L_1 is usually strongy influenced by occasional isolated short-duration noise events such as aircraft or vehicle passbys.