



ACOUSTICAL ANALYSIS ASSOCIATES, INCORPORATED

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ASPHALT RUBBER OVERLAY NOISE STUDY UPDATE

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ASPHALT RUBBER OVERLAY NOISE STUDY UPDATE

1.0 INTRODUCTION

This report presents the results and findings of a noise survey conducted in July 1991, July 1992, and now updated in June 2002, along eight streets in the City of Thousand Oaks. Traffic noise measurements were gathered at six of the locations just prior to re-surfacing in the survey conducted in July 1991. Two other locations on streets recently re-surfaced with standard asphalt were selected for measurement at the same time to act as control sites. The measurements were repeated at all eight locations in July 1992, nine months to one year after re-surfacing at the first six sites using a new asphalt rubber overlay product. The measurements were again repeated ten years later in June 2002.

This report presents the results of the noise survey and data analysis in terms of the reduction in traffic noise levels experienced due to re-surfacing, regardless of type of material used. Also developed is a comparison of noise source levels between streets re-surfaced with the asphalt rubber overlay material and streets re-surfaced with standard asphalt.

Section 2 of this report describes the noise measurement sites, noise survey technique and equipment used, and the measured noise and traffic levels. Presented in Section 3 is the data analysis used to normalize the measured data to common conditions. The results of the analysis give the incremental noise reductions provided by re-surfacing and by use of the new asphalt rubber overlay material, and the change in noise reduction over a ten-year period.

2.0 NOISE MEASUREMENT SURVEYS

The sites used for noise measurement were selected by City staff, and are shown in Figure 1 and listed in Table 1. The same measurement locations were used in all three noise surveys. The streets chosen span a wide range of traffic flow and geometric conditions, from the six-lane arterial, Westlake Blvd., to the neighborhood street, Blue Mesa St. Some sites were located in commercial areas, with significant medium and even heavy truck traffic, while others in residential areas carry nearly no truck traffic.

Wherever possible, the microphone was placed 50 ft or more from the roadway centerline, with clear line-of-sight in both directions, and away from intersections. This was done to ensure accurate measurements and to enhance the roadway/tire noise source while reducing the

contribution of engine/exhaust noise (important during acceleration) to the total measured sound levels.

The condition of the streets was poor at sites 1 through 6 in July 1991, with many bumps, patches, and rough spots. The streets adjacent to sites 7 and 8 had recently been re-surfaced in July 1991 with standard asphalt and were in good condition. At the time of the July 1992 noise survey, all streets were in good condition.

Roadway traffic noise levels were measured using a Larson-Davis Model 870 precision integrating sound level meter. Equivalent Sound Levels (Leq) were gathered for a minimum of two 10-minute periods at each site during each survey, while counts of vehicle traffic were maintained. The vehicle counts were separated by direction of travel and type of vehicle (auto, medium truck, heavy truck). Average speed in each direction was estimated by driving by the site at the speed of the local traffic flow.

The results of the noise surveys are summarized in Table 2. The average measured sound levels obtained in each survey are compared in Figure 2. As shown, the noise levels measured in the 1991 survey were higher than in 1992 at every site except number 8 (Erbes Rd). By June 2002, noise levels were also higher than in 1992, roughly the same as in 1991. However, increased traffic volumes affected the measured noise levels, so further investigation is required to determine the effectiveness of the asphalt rubber overlay after 10 years.

Figure 3 shows the hourly numbers of vehicles passing by each site during the measurements, based on the 10-minute counts. Comparing the earlier two noise surveys, the numbers of vehicles were about the same or slightly higher during the 1991 survey at sites 1 through 6, while there were slightly more vehicles during the 1992 survey at sites 7 and 8 (Arboles E and Erbes). By 2002, there were more vehicles than either earlier noise survey at six of the eight sites, and significantly more at sites 2, 7, and 8 (Westlake, Arboles E, and Erbes).

3.0 DATA ANALYSIS

As described above, the noise data were obtained under different traffic conditions. As shown in Table 2, the numbers of autos counted in the three surveys varied, but more importantly, the numbers of medium and heavy trucks differed significantly at some sites. The algorithms and

procedures given in FHWA-RD-77-108 (the FHWA Highway Traffic Noise Prediction Model) were used to normalize the measured sound levels to common traffic flow conditions.

Traffic noise exposure levels vary according to the equivalent numbers of vehicles (N_E) passing by a location. This value is computed from:

$$N_E = N_A + 10 N_{MT} + 32 N_{HT}$$

where N_A = number of automobiles

N_{MT} = number of medium trucks

N_{HT} = number of heavy trucks

This relationship demonstrates the large influence relatively small numbers of trucks can have on roadway traffic noise levels.

Figure 4 shows the equivalent hourly numbers of vehicles at each site corresponding to traffic conditions during the three noise surveys. As shown, equivalent numbers of vehicles were higher during the 1991 survey or about the same at the first six sites, following the trend of total numbers of vehicles. However, at Arboles E (site 7), the equivalent numbers of vehicles was far less in the 1992 survey than in 1991, even though the total numbers were greater. By June 2002, the equivalent numbers of vehicles increased at five of the sites affected by residential developments.

The FHWA procedure was used to normalize the measured noise levels to a common equivalent number of vehicles at each site so that the actual change in traffic noise level could be obtained. The conditions chosen were the mix and numbers of vehicles counted in the 1992 survey. The resulting normalized sound levels are shown in Figure 5. By comparison with the measured sound levels in Figure 2, the only significant change is seen at Arboles E, where the difference between 1991 and 1992 conditions is much reduced after accounting for the numbers of heavy trucks. By 2002, normalized sound levels generally returned to 1991 levels, except at sites 2 and 4 (Westlake and Lynn).

The effect of re-surfacing on traffic noise levels at sites 1 through 6 can be determined by taking the difference between 1991 and 1992 normalized sound levels, and then the difference

between 1991 and 2002 normalized sound levels. The resulting noise reductions are shown in Figure 6.

The results indicate that traffic noise level reductions were between 3 and 7 dBA at the six sites when freshly re-surfaced with the asphalt rubber overlay in 1992. The noise reduction was greater at sites where speeds are higher (Lynn Rd and Westlake Blvd). By the time of the June 2002 survey, the estimated noise reduction provided by the overlay had declined to the 0 - 3 dB range. The reduction remains detectable (about 3 dB) at the Westlake and Lynn Rd sites where vehicle speeds are higher and free-flowing conditions generally exist, which emphasize the tire/pavement noise source.

It must be remembered that re-surfacing the streets at sites 1-6 with any material would reduce the traffic noise levels, considering the poor condition of the streets during the 1991 survey. Some portion of the total noise reductions shown in Figure 6 are due to the use of the new asphalt rubber overlay.

Although small noise reductions (less than 1 dB) are shown for control sites (7 and 8), this should be considered insignificant, since the accuracy of the FHWA noise model and procedures are ± 1.5 dBA. Therefore, the traffic noise levels measured at the two control sites are essentially unchanged, as expected, since these were not re-surfaced between noise surveys.

Finally, the traffic noise output from all 8 streets studied was compared by further normalizing the measured data to a standard distance (50 ft from roadway centerline), and common number of equivalent vehicles. The number chosen was the average equivalent number obtained at all sites, but is not crucial since we are interested in obtaining the difference in sound levels only.

The normalized sound levels are shown in Figure 7. The data seems to fall into two groups, sites 1-4 and sites 5-8. The levels shown for sites 7 and 8 represent the roadway noise output of a street surfaced with standard asphalt. The normalized levels for Triunfo and Blue Mesa (site 5 and 6) appear to be comparable. It should be recalled, however, that these data were measured at distances of less than 50 feet. The FHWA model becomes inaccurate when projecting data taken from less than 50 feet distance, so the final results after adjustment at these two locations should be neglected.

The difference in traffic noise levels between the two types of asphalt can be determined by comparing the normalized sound levels at sites 7 and 8 with sites 1-4. In 1992, the portion of total noise reduction attributable to the new asphalt rubber overlay was in the range of 2-5 dBA, depending on the average speed observed on the streets. The noise reduction was greatest along Westlake Blvd and Lynn Rd where speeds are highest. This result is consistent with the observation that roadway/tire noise was the dominant source during measurements at these sites.

By 2002, ten years after re-surfacing, roadway source noise levels increased at sites 1, 2, and 4 but not quite to the levels at the control sites 7 and 8, paved with standard materials. This is a further indicator that the rubber overlay still provided some noise reduction (1-2 dBA) at these test sites.

4.0 CONCLUSIONS

4.1 Initial Effect of Asphalt Rubber Overlay

The maximum noise reduction achieved by use of the rubber overlay can be computed by comparing the normalized equivalent sound levels from the 1992 and 1991 noise survey. The results of the comparison noise surveys indicate that the use of the new asphalt rubber overlay material to re-surface City streets can reduce traffic noise exposure levels by as much as 3 to 7 dBA (± 1.5 dB). The re-surfacing of any street which was in poor repair will reduce traffic noise levels. However, the additional noise reduction attributed to asphalt rubber overlay over that obtained by use of standard asphalt is 2 to 5 dBA (± 1.5 dB).

As stated above, the rubber overlay noise reduction was greatest along streets where the tire/roadway noise source is dominant. This is the case where speeds are relatively high, and truck traffic is relatively low, as along the sections of Westlake Blvd and Lynn Rd measured.

4.2 Eventual Effect of Asphalt Rubber Overlay

The study updated in 2002 showed that the amount of noise reduction provided by the asphalt rubber overlay degrades over time, but is still detectable at locations where auto speeds are relatively high, under free-flowing conditions, and with low percentages of truck traffic.

Noise levels along the study streets were higher in 2002 than in 1992, but traffic had increased significantly as well. When normalized for traffic flow conditions, noise levels for the streets resurfaced with the overlay were still 1 to 3 dBA lower than prior to re-surfacing in 1991-1992. When adjusted to 50 feet distance and compared to the control sites 7 and 8, the roadway noise source levels at sites 1, 2, and 4 show that the overlay still provides 1 to 2 dBA noise reduction along these streets. Again, these locations are those where traffic is free-flowing, vehicle speeds are relatively high, and truck traffic relatively low, all of which emphasize the tire/roadway noise source.



Figure 1. Asphalt Rubber Overlay Noise Measurement Locations

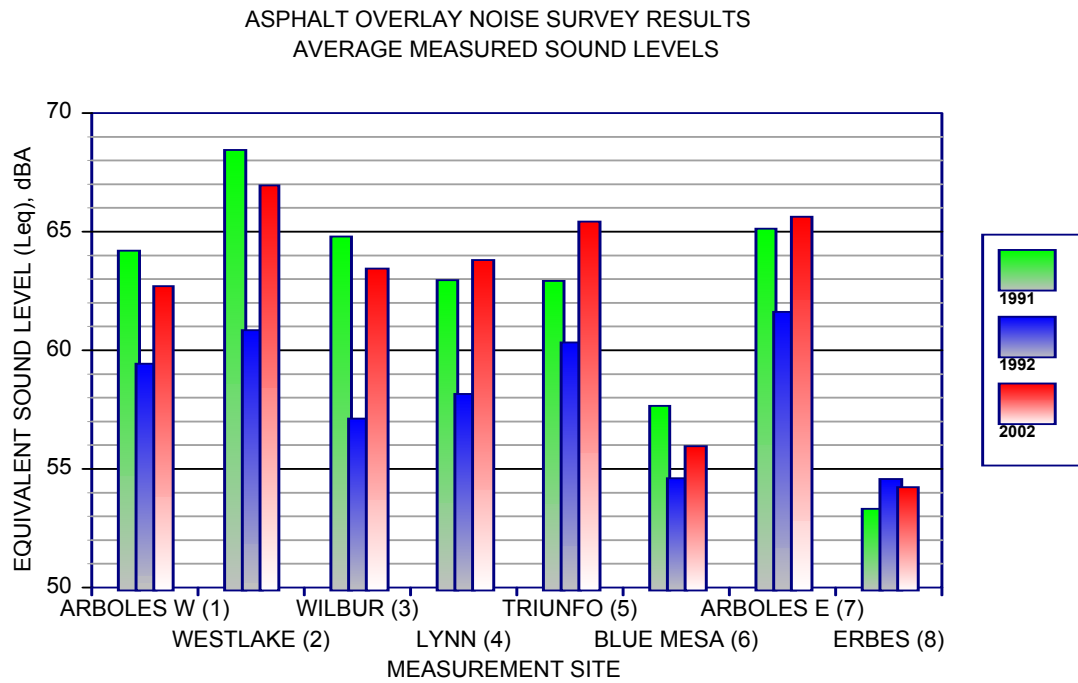


Figure 2. Comparison of Measured Sound Levels

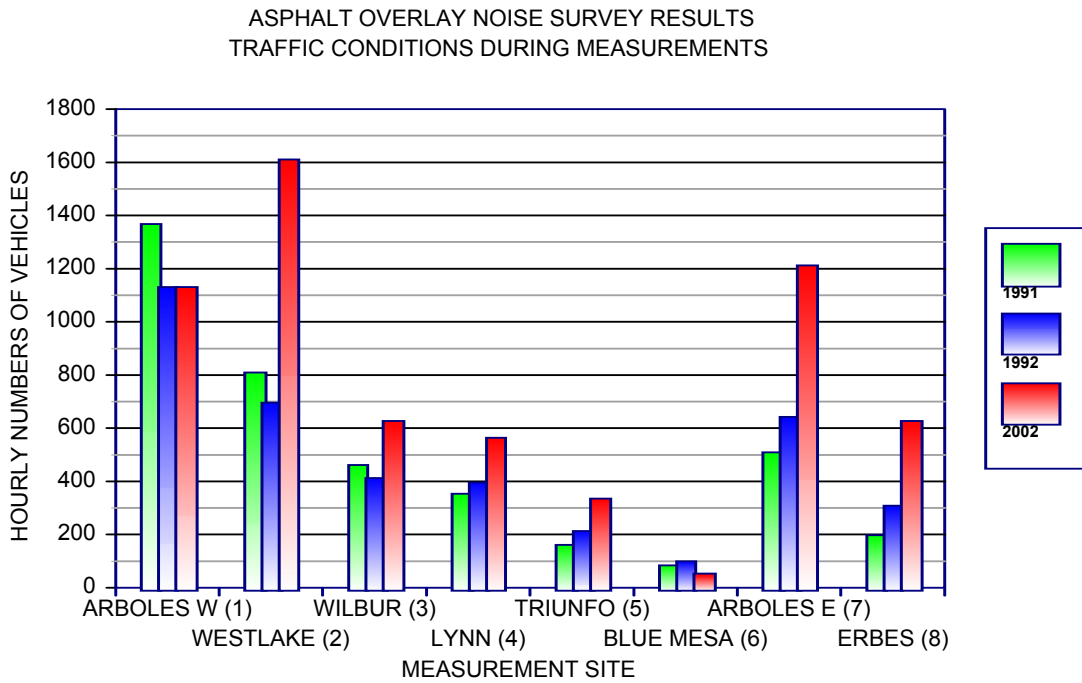


Figure 3. Comparison of Vehicles Counted

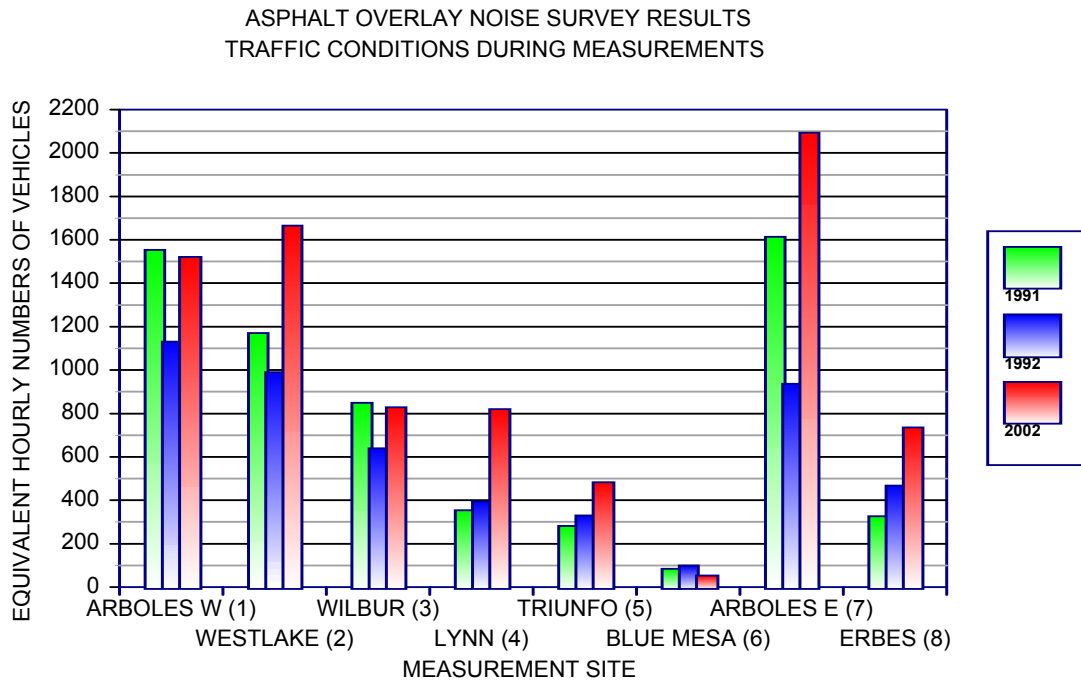


Figure 4. Comparison of Equivalent Numbers of Vehicles Counted

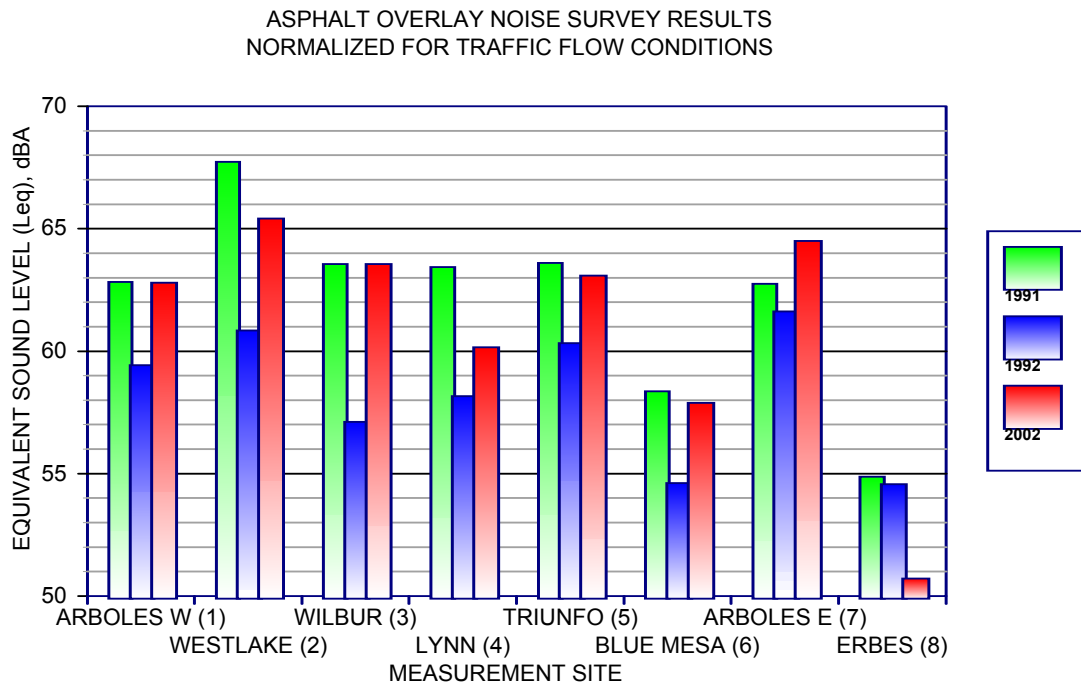


Figure 5. Comparison of Normalized Sound Levels

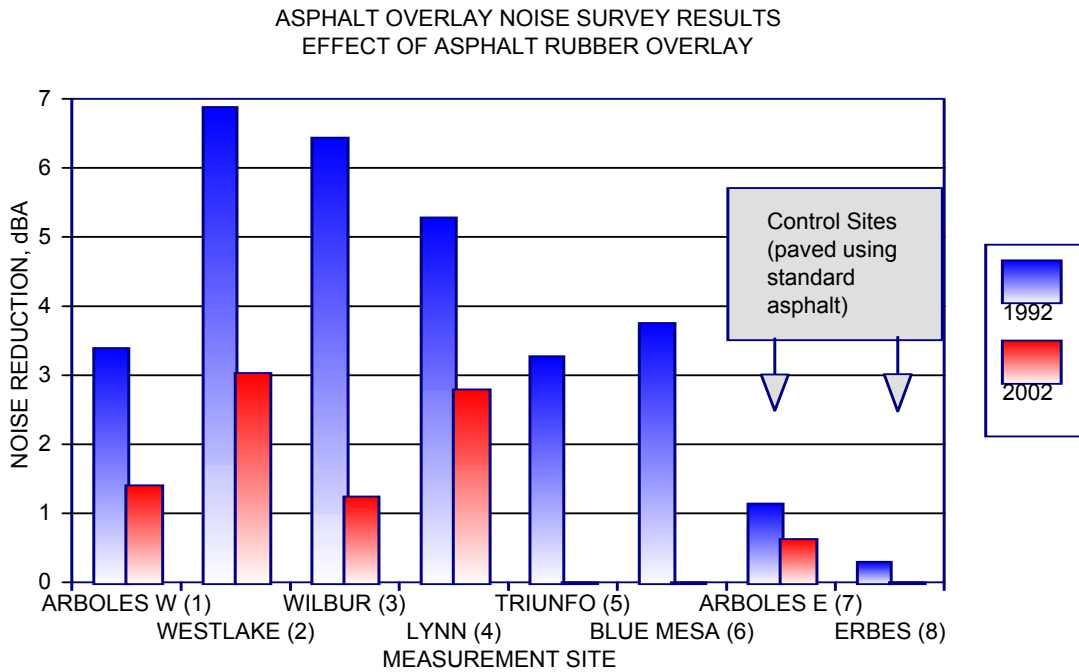


Figure 6. Effect of Asphalt Rubber Overlay

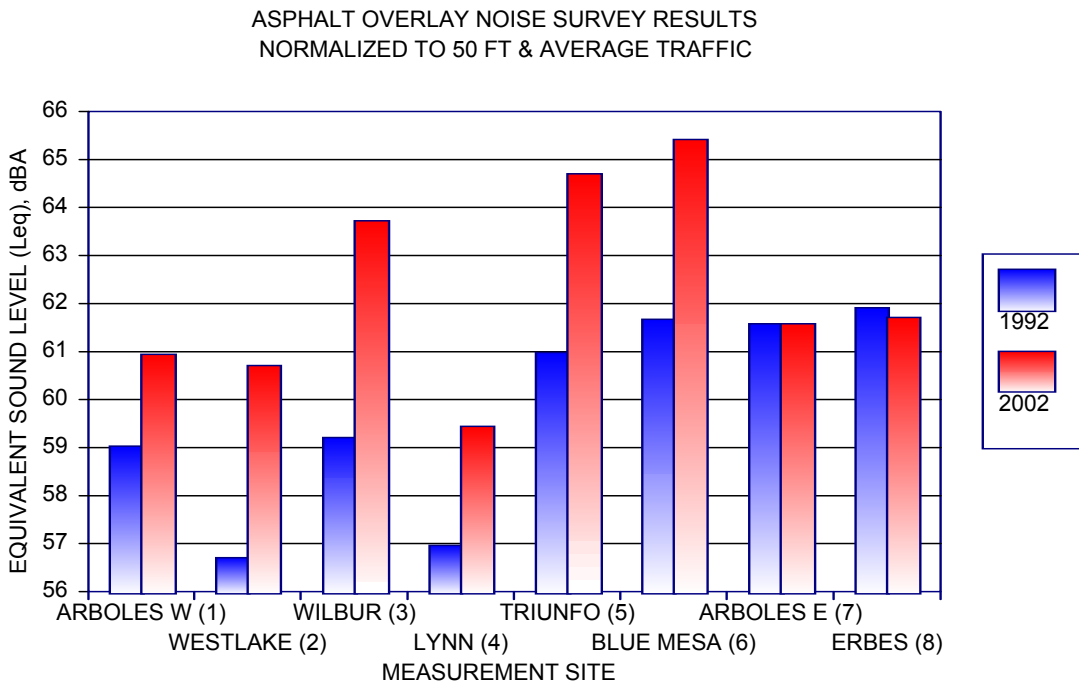


Figure 7. Comparison of Roadway Source Noise Levels

**Table 1. Asphalt Rubber Overlay Noise Survey
Noise Measurement Locations**

Site			Distance to Roadway
<u>No.</u>	<u>Street</u>	<u>Microphone Position</u>	<u>Centerline, feet</u>
1	Avenida de Los Arboles (west) between Calle Abeto and Olivo	50 ft north of N. curb	80
2	Westlake Blvd. (north) at Skelton Cyn. trailhead	30 ft east of E. curb	75
3	Wilbur Rd. at Oak Plaza	40 ft north of N. curb	70
4	Lynn Rd. west of Greenmeadow west of Laurie Ln.	20 ft south of S. curb	60
5	Triunfo Canyon Rd. between Waterby and Stonegate	3 ft north of S. curb	30
6	Blue Mesa St. between North Sierra and Blackhills	3 ft west of E. curb	28
7	Avenida de Los Arboles (east) behind Taco Bell	30 ft south of S. curb	75
8	Erbes Rd. south of Pederson	50 ft west of W. curb	80

Table 2. Asphalt Rubber Overlay Noise Survey

SITE	STREET AND DIRECTION	DISTANCE FROM C.L. TO MEAS. POINT, ft.	JULY 1991 NOISE SURVEY						JULY 1992 NOISE SURVEY						JUNE 2002 NOISE SURVEY					
			START TIME	NO. VEHICLES AUTO TRK HVY	AVG SPEED, mph	10-min Leq, dBA	START TIME	NO. VEHICLES AUTO TRK HVY	AVG SPEED, mph	10-min Leq, dBA	START TIME	NO. VEHICLES AUTO TRK HVY	AVG SPEED, mph	10-min Leq, dBA						
SITE 1	ARBOLES WEST	70	7:40	79	1	30	64.1	7:33	55	30	58.9	11:00	187	6	0	35	62.9			
	ARBOLES EAST	90	7:50	155	1	40	64.1	7:43	113	40	58.9	11:10	175	5	1	35	62.5			
SITE 2	ARBOLES WEST	70	7:50	69	1	30	64.3	11:02	96	30	59.9	7:40	240	2	0	50	66.8			
	ARBOLES EAST	90	12:37	151	3	50	68.5	11:12	113	40	59.9	7:50	295	0	0	50	67.1			
	WESTLAKE NO.	50	12:47	54	2	50	68.5	9:44	62	3	50	61.4	10:00	48	0	0	35	62.8		
	WESTLAKE SO.	100	10:36	70	1	30	66.2	9:55	53	1	50	61.4	10:10	67	0	0	35	64.0		
SITE 3	WILBUR WEST	60	10:46	36	1	35	62.7	10:17	47	5	30	57.5	9:10	88	2	1	50	63.8		
	WILBUR EAST	80	11:19	42	2	30	62.9	10:27	25	1	35	56.7	9:20	97	4	0	50	63.8		
	LYNN WEST	40	11:29	33	1	35	62.9	11:49	19	1	50	58.4	8:20	47	1	35	65.0			
	LYNN EAST	40	13:18	22	1	35	61.3	11:59	37	1	35	59.5	8:30	62	1	1	35	65.8		
SITE 5	TRIUNFO WEST	20	13:28	13	1	35	64.1	12:09	23	1	35	59.2								
	TRIUNFO EAST	40		11		35			13		35									
	TRIUNFO WEST	20		15	1	35			20	1	35									
	TRIUNFO EAST	40		13		35			20		35									
	TRIUNFO WEST	20		20		35			20	1	35									
	TRIUNFO EAST	40		22		50			14		35									
	TRIUNFO WEST	20		35		50			15	2	35									
	TRIUNFO EAST	40		29		63.0			12		35									
SITE 6	BLUE MESA NO.	15	7:21	13		30	58.3	6:48	13		30	58.9	7:10	7	0	0	35	55.6		
	BLUE MESA SO.	30		2		30			5		30									
	BLUE MESA NO.	15	7:31	15		30	59.1	7:08	8		30	53.5	7:20	11	0	0	35	56.3		
	BLUE MESA SO.	30		3		30			0		30									
	BLUE MESA NO.	15	7:41	12		30	58.1													
	BLUE MESA SO.	30		10		30														
	BLUE MESA NO.	15	8:01	6		30	55.4													
	BLUE MESA SO.	30		5		30	56.0													
	BLUE MESA NO.	15	8:11	8		30	57.9													
	BLUE MESA SO.	30		7		30														
SITE 7	ARBOLES WEST	100	9:26	26	3	30	63.5	9:09	71	1	30	66.1	11:40	204	5	3	30	66.1		
	ARBOLES EAST	50		49	1	40			49	1	40	61.2	11:50	182	7	3	30	65.1		
	ARBOLES WEST	100	9:45	45	2	30	66.3	8:26	45	2	30	62.0	12:20	91	2	0	25	53.7		
SITE 8	ERBES SOUTH	60	8:56	32	3	25	52.5	8:36	53	1	25	55.0	12:30	113	2	1	25	54.7		
	ERBES NORTH	100		19		35			41		35									
	ERBES SOUTH	60	9:06	34		25	54.0		29		25									
	ERBES NORTH	100		24		35			23		35									

Note : At least two 10-minute samples were acquired at each site during each noise survey. Additional measurements were made at Triunfo (5) and Blue Mesa (6).