STATE OF MINNESOTA
ENVIRONMENTAL ANALYSIS AND COMPLIANCE SECTION
ENVIRONMENTAL MODELING AND TESTING UNIT

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Subject: Effects of a noise barrier, located on the west side of TH 47 (University Ave.), on the noise levels of residences on the east side of TH 47 located between 45th Ave. N. and 52nd Ave. N.

Summary:

Due to the concerns of residents on the east side of TH 47 (University Ave.) between 45th Ave. N. and 52nd Ave. N. about possible increases of their traffic noise levels due to the construction of a noise barrier on the west side of TH 47, the Metro Division requested a test to determine if increases in noise level due to the noise barrier occur, and if so, the magnitude of the increases. Before construction of the barrier, testing was done in the year 2000 and after barrier construction testing was done in the year 2002. The testing was done at four representative residences. The tested residences were located at 4501 Univ. Ave., 4701 Univ. Ave., 4947 Univ. Ave., and 5131 Univ. Ave. There is no evidence that the barrier increased noise levels at 4501 Univ. Ave., 4701 Univ. Ave., or 4947 Univ. Ave. This result doesn't imply that noise levels haven't increased or decreased since the year 2000. The results indicates only that there is no evidence that the noise barrier is responsible in any way for any measurable increases in noise levels at these three residences.

There is evidence that the barrier increased the noise level at the residence at 5131 Univ. Ave. N. by a measurable average amount of 1 dBA. While this increase is measurable it's not detectable as judged by human hearing capabilities. The human ear doesn't detect changes in noise level of less than 3 dBA. Why the one residence has a measurable increase can't be determined without further consideration of the geometrics of the roadway in relation to the location of the residences and possibly further noise level measurements.

Test Methodology at TH 47 in the vicinity of the noise barrier between 45th Ave. and 52nd Ave.

The four sites in this study are all on the east side of TH 47. Noise measurements were taken in 2000 without the barrier on the west side and again in 2002 with the barrier in place on the west side. Both sets of measurements were done during the same daytime hours. The question asked is "is there a difference between the two sets of "before and after" measurements at each site that can be attributed to the introduction of a noise barrier on the west side of TH 47?".

To answer this question measurements were made before and after the introduction of the noise barrier. During each level measurement, traffic was counted and classified. The noise prediction model Stamina 2.0 was run, without the noise barrier being taken into account, for each measurement made. The modeled levels track changes in noise level due to changes in traffic volumes, traffic mix and speeds. A comparison was done on the set of differences between before and after measurements, corrected for traffic with the modeled results, for each tested site. Using the differences in this manner reduces, if not eliminate, variations due to changes in traffic and makes the test more sensitive to any changes due to the introduction of the noise barrier alone. Any measurable change between the corrected sets of "before and after" data can be attributed to the placement of the noise barrier on the west side of the highway. Student's t-test was used, at a two tailed confidence level of 95%, to test for statistically significant differences at the four sites where testing was done.

Using 95% confidence values for t (which equates to a less than 5% probability value for a calculated t) there is good evidence that no measurable, detectable increase due to the noise barrier exists at the representative sites at 4501 Univ. Ave., 4701 Univ. Ave., and 4947 Univ. Ave. There is, however, good evidence that at the site with address 5131 Univ. Ave. there is a measurable increase due to the noise barrier. The increase averages 1 dBA, which isn't a detectable change as judged by human hearing. The ability of the human ear to detect noise level change is limited to noise level changes of 3 dBA or more. (*See,* U.S. Department of Transportation, Federal Highway Administration, *Fundamentals and Abatement of Highway Traffic Noise* (Textbook and Training Course); Document 2, Sec. 3.5.1 (Sept. 1980).)

Data Analysis
And
Statistical Testing

4501 University L10's

Measured before	Measured after	Modeled before	Modeled after
64.5	66	67.1	69
64.5	65	67.8	67.4
64	65	67.7	67.8
64.5	65	67.6	67.9
	65.5		68.4
	65		68.1
Average 64.375	65.25	67.55	68.1
Std. Dev. 0.25	0.418330013	0.310912635	0.55136195
Var. of mean 0.015625	0.029166667	0.024166667	0.050666667

Mean diff.	Corrected mean diff.	Deg's. of freedom		t_{95}	95% upper limit	95% lower limit
0.875	0.325	14	0.014310141	2.144788596	1.066814755	-0.416814755
			0.000959617			
	0.044791667	0.074833333				

4701 University L10's

Measured before	Measured after	Modeled before	Modeled after
66.5	69	69.5	71.3
66.5	67.5	70.1	69.8
67	67	70.1	70.2
67	68	70	70.3
	67.5		70.8
	68.5		70.5
Average 66.75	67.91666667	69.925	70.48333333
Std. Dev. 0.288675135	0.735980072	0.287228132	0.519294393
Var. of mean 0.020833333	0.090277778	0.020625	0.044944444

Mean diff.	Corrected mean diff.	Deg's. of freedom		t_{95}	95% upper limit	95% lower limit
1.166666667	0.608333333	13	0.031216019	2.16036824	1.516409259	-0.299742592
			0.002320489			
	0.111111111	0.065569444				

4947 University L10's

Measured before	Measured after	Modeled before	Modeled after
64	65.5	70	71.7
66	65.5	70.5	70.2
65.5	66.5	70.5	70.6
65	65	70.4	70.7
	66.5		71.2
	67		70.9
Average 65.125	66	70.35	70.88333333
Std. Dev. 0.853912564	0.774596669	0.238047614	0.519294393
Var. of mean 0.182291667	0.1	0.014166667	0.044944444

Mean diff.	Corrected mean diff.	Deg's. of freedom		t_{95}	95% upper limit	95% lower limit
0.875	0.341666667	8	0.116555857	2.306005626	1.689058429	-1.005725095
			0.013547649			
	0.282291667	0.059111111				

5131 University Ave. L10's

Measured before	Measured after	Modeled before	Modeled after
66	68	66.9	68.7
66.5	68	67.5	67.2
66.5	67.5	67.5	67.5
66.5	67.5	67.4	67.6
	68		68.2
	69		67.9
Average 66.375	68	67.325	67.85
Std. Dev. 0.25	0.547722558	0.287228132	0.539444158
Var. of mean 0.015625	0.05	0.020625	0.0485

Mean diff.	Corrected mean diff.	Deg's. of freedom		t_{95}	95% upper limit	95% lower limit
1.625	1.1	15	0.018157563	2.131450856	1.882419581	0.317580419
			0.001193627			
	0.065625	0.069125				

BEFORE	4501 Univ. Ave.							
L10	64.5		64.5		64		64.5	
L50	57.5		58		58		58	
L90	51		52		52		52	
Leq	60.8		61.2		60.4		61.1	
TIME	15		15		15		15	
TH 47	S.B.	N.B.	SB.	N.B.	S.B.	N.B.	S.B.	N.B.
AUTOS	113	96	123	71	92	97	94	74
M. TRKS	8	7	9	7	9	9	7	8
H. TRKS	5	6	9	10	8	9	14	7
BUSES								
M. CYCS				1	1		2	
TIME	15	15	15	15	15	15	15	15
FR. ROAD								
AUTOS	20		16		12		16	
M. TRKS	1		3		2			
H. TRKS								
BUSES								
M. CYCS								
TIME	15		15		15		15	

AFTER	4501 Univ. Ave.											
L10	66		65		65		65		65.5		65	
L50	59.5		58		59		59.5		59.5		58.5	
L90	52		50		52.5		54		54		52.5	
Leq	62		61.4		61.5		61.7		62.1		61.6	
TIME	10		10									
TH 47	S.B.	N.B.	S.B.	N.B.	S.B.	N.B.	S.B.	N.B.	S.B.	N.B.	S.B.	N.B.
AUTOS	103	106	87	79	100	87	80	95	99	88	92	86
M. TRKS	4	3	5	1	3	3	3	4	4	1		3
H. TRKS	8	10	9	2	6	3	6	5	6	9	5	8
BUSES												
M. CYCS	2		1			1				1	1	
TIME	10	10	10	10	10	10	10	10	10	10	10	10
FR. ROAD												
AUTOS	11		11		7		11		13		11	
M. TRKS			1								1	
H. TRKS												
BUSES												
M. CYCS												
TIME	10		10		10		10		10		10	

BEFORE — 4701 Univ. Ave

L10	66.5		66.5		67		67	
L50	59.5		59		58.5		59	
L90	52.5		51.5		52.5		52	
Leq	63		63.5		63.4		63.2	
TIME	15		15		15		15	
TH 47	S.B.	N.B.	SB.	N.B.	S.B.	N.B.	S.B.	N.B.
AUTOS	113	96	123	71	92	97	94	74
M. TRKS	8	7	9	7	9	9	7	8
H. TRKS	5	6	9	10	8	9	14	7
BUSES								
M. CYCS				1	1		2	
TIME	15	15	15	15	15	15	15	15
FR. ROAD								
AUTOS	20		16		11		12	
M. TRKS	1		3		2			
H. TRKS								
BUSES								
M. CYCS								
TIME	15		15		15		15	

AFTER — 4701 Univ. Ave

L10	69		67.5		67		68		67.5		68.5	
L50	62		61		61.5		62		62		62.5	
L90	56		52.5		54.5		57		57		56	
Leq	64.8		64.5		63.3		64.4		64.2		65.5	
TIME	10		10		10		10		10		10	
TH 47	S.B.	N.B.	S.B.	N.B.	S.B.	N.B.	S.B.	N.B.	S.B.	N.B.	S.B.	N.B.
AUTOS	103	106	87	79	100	87	80	95	99	88	92	86
M. TRKS	4	3	5	1	3	3	3	4	4	1		3
H. TRKS	8	10	9	2	6	3	6	5	6	9	5	8
BUSES												
M. CYCS	2		1			1				1	1	
TIME	10	10	10	10	10	10	10	10	10	10	10	10
FR. ROAD												
AUTOS	13		18		1		11		11		14	
M. TRKS			1				1				2	
H. TRKS												
BUSES												
M. CYCS												
TIME	10		10		10		10		10		10	

BEFORE — 4947 Univ. Ave

	S.B.	N.B.	SB.	N.B.	S.B.	N.B.	S.B.	N.B.
L10	64		66		65.5		65	
L50	57.5		59		60		58	
L90	52		53.5		55.5		52.5	
Leq	60.9		64.1		62.9		61.2	
TIME	15		15		15		15	
TH 47	S.B.	N.B.	SB.	N.B.	S.B.	N.B.	S.B.	N.B.
AUTOS	113	96	123	71	92	97	94	74
M. TRKS	8	7	9	7	9	9	7	8
H. TRKS	5	6	9	10	8	9	14	7
BUSES								
M. CYCS				1	1		2	
TIME	15	15	15	15	15	15	15	15
FR. ROAD								
AUTOS	7		14		3		14	
M. TRKS	1		2		2		1	
H. TRKS					1			
BUSES								
M. CYCS								
TIME	15		15		15		15	

AFTER — 4947 Univ. Ave

	S.B.	N.B.	S.B.	N.B.	S.B.	N.B.	S.B.	N.B.	S.B.	N.B.	S.B.	N.B.
L10	65.5		65.5		66.5		65		66.5		67	
L50	59.5		58.5		59		58.5		60		60	
L90	54		50		51		53		55		54	
Leq	62.3		61.7		65.9		61.7		62.9		63.1	
TIME	10		10		10		10		10		10	
TH 47	S.B.	N.B.	S.B.	N.B.	S.B.	N.B.	S.B.	N.B.	S.B.	N.B.	S.B.	N.B.
AUTOS	103	106	87	79	100	87	80	95	99	88	92	86
M. TRKS	4	3	5	1	3	3	3	4	4	1		3
H. TRKS	8	10	9	2	6	3	6	5	6	9	5	8
BUSES												
M. CYCS	2		1			1				1	1	
TIME	10	10	10	10	10	10	10	10	10	10	10	10
FR. ROAD												
AUTOS	5		10		4		8		11		3	
M. TRKS			3		2		2		3		2	
H. TRKS												
BUSES												
M. CYCS												
TIME	10		10		10		10		10		10	

BEFORE	5131 Univ. Ave.							
L10	66		66.5		66.5		66.5	
L50	59.5		60		60.5		60.5	
L90	55		55		55.5		55	
Leq	62.4		63.3		63.1		63.5	
TIME	15		15		15		15	
TH 47	S.B.	N.B.	SB.	N.B.	S.B.	N.B.	S.B.	N.B.
AUTOS	113	96	123	71	92	97	94	74
M. TRKS	8	7	9	7	9	9	7	8
H. TRKS	5	6	9	10	8	9	14	7
BUSES								
M. CYCS				1	1		2	
TIME	15	15	15	15	15	15	15	15
FR. ROAD								
AUTOS	20		16		15		12	
M. TRKS	1		3				2	
H. TRKS					1			
BUSES					1			
M. CYCS								
TIME	15		15		15		15	

AFTER	5131 Univ. Ave.											
L10	68		68		67.5		67.5		68		69	
L50	61.5		61		60.5		61		61.5		62	
L90	53		54.5		53.5		55		55.5		56	
Leq	65.4		64.4		64		64.5		64.4		65.4	
TIME	10		10		10		10		10		10	
TH 47	S.B.	N.B.	S.B.	N.B.	S.B.	N.B.	S.B.	N.B.	S.B.	N.B.	S.B.	N.B.
AUTOS	103	106	87	79	100	87	80	95	99	88	92	86
M. TRKS	4	3	5	1	3	3	3	4	4	1		3
H. TRKS	8	10	9	2	6	3	6	5	6	9	5	8
BUSES												
M. CYCS	2		1			1				1	1	
TIME	10	10	10	10	10	10	10	10	10	10	10	10
FR. ROAD												
AUTOS	8		7		8		9		12		11	
M. TRKS	4		6		3		7		5		3	
H. TRKS	1		1				2		1		1	
BUSES												
M. CYCS												
TIME	10		10		10		10		10		10	