HIGHWAY 10 (ELK RIVER) TRAFFIC NOISE ANALYSIS

The purpose of this analysis is to evaluate and document the potential traffic noise impacts from the proposed Highway 10 project in Elk River, Minnesota (State Project 7102-123). This analysis includes modeled traffic noise levels for existing (2008) and future (2030) No-Build and Build conditions. This report is organized into the following sections:

- Introduction (Background Information)
- Analysis Methodology
- Modeling Results
- Noise Mitigation
- Noise Barrier Evaluation
- Conclusions

Introduction

Noise is defined as any unwanted sound. Sound travels in a wave motion and produces a sound pressure level. This sound pressure level is commonly measured in decibels. Decibels (dB) represent the logarithm of the ratio of a sound energy relative to a reference sound energy. For highway traffic noise, an adjustment, or weighting, of the high- and low- pitched sound is made to approximate the way that an average person hears sound. The adjusted sound levels are stated in units of "A-weighted decibels" (dBA). A sound increase of 3 dBA is barely noticeable by the human ear, a 5 dBA increase is noticeable, and a 10 dBA increase is heard as twice as loud. For example, if the sound energy is doubled (i.e., the amount of traffic doubles), there is a 3 dBA increase in noise, which is just barely noticeable to most people. On the other hand, if traffic increases by a factor of ten times, the resulting sound level will increase by about 10 dBA and be heard to be twice as loud.

In Minnesota, traffic noise impacts are evaluated by measuring and/or modeling the traffic noise levels that are exceeded 10 percent and 50 percent of the time during the hours of the day and/or night that have the loudest traffic scenario. These numbers are identified as the L_{10} and L_{50} levels, respectively. The L_{10} value is the noise level that is exceeded for a total of 10 percent, or 6 minutes, of an hour. The L_{50} value is the noise level that is exceeded for a total of 50 percent, or 30 minutes, of an hour. The L_{10} value is compared to the Federal Highway Administration (FHWA) noise abatement criteria (see Table D-1 below).

The following chart provides a rough comparison of the noise levels of some common noise sources.

Sound Pressure Level (dBA)		Noise Source
140	----------	Jet Engine (at 75 feet)
130	----------	Jet Aircraft (at 300 feet)
120	----------	Rock and Roll Concert
110	----------	Pneumatic Chipper
100	----------	Jointer/Planer
90	----------	Chainsaw
80	----------	Heavy Truck Traffic
70	----------	Business Office
60	----------	Conversational Speech
50	----------	Library
40	----------	Bedroom
30	----------	Secluded Woods
20	----------	Whisper

Source: "*A Guide to Noise Control in Minnesota*," Minnesota Pollution Control Agency, http://www.pca.state.mn.us/programs/pubs/noise.pdf and "*Highway Traffic Noise*," FHWA, http://www.fhwa.dot.gov/environment/htnoise.htm.

Along with the volume of traffic and other factors (e.g., topography of the area and vehicle speed) that contribute to the loudness of traffic noise, the distance of a receptor from a sound's source is also an important factor. Sound level decreases as distance from a source increases. A general rule regarding sound level decrease due to increasing distance from a line source (roadway) that is commonly used is: beyond approximately 50 feet from the sound source, each doubling of distance from the line source over hard ground (such as pavement or water) will reduce the sound level by 3 dBA, whereas each doubling of distance over soft ground (such as vegetated, or grassy ground) results in a sound level decrease of 4.5 dBA.

Minnesota state noise standards have been established for daytime and nighttime periods. For residential land uses (identified as Noise Area Classification 1 or NAC-1), the Minnesota State standards for L_{10} are 65 dBA for daytime and 55 dBA for nighttime; the standards for L_{50} are 60 dBA for daytime and 50 dBA for nighttime. The Minnesota Pollution Control Agency (MPCA) defines daytime as 7:00 a.m. to 10:00 p.m. and nighttime from 10:00 p.m. to 7:00 a.m. State noise standards are depicted in Table D-1. Minnesota State noise standards apply to the outdoor atmosphere (i.e., exterior noise levels).

TABLE D-1
MINNESOTA STATE NOISE STANDARDS

MPCA State Noise Standards					
Land Use	**Code**	**Daytime (7 a.m. – 10 p.m.) dBA**		**Nighttime (10 p.m. – 7 a.m.) dBA**	
Residential	**NAC-1**	L_{10} of 65	L_{50} of 60	L_{10} of 55	L_{50} of 50
Commercial	**NAC-2**	L_{10} of 70	L_{50} of 65	L_{10} of 70	L_{50} of 65
Industrial	**NAC-3**	L_{10} of 80	L_{50} of 75	L_{10} of 80	L_{50} of 75

For residential and parkland uses (Federal Land Use Category B), the Federal L_{10} noise abatement criterion is 70 dBA for both daytime and nighttime. Locations where noise levels are "approaching" or exceeding the criterion level must be evaluated for noise abatement reasonableness. Mn/DOT defines a level as "approaching" the criterion level when it is 1 dBA or less below the criterion level (e.g., 69 dBA is defined as "approaching" the Federal noise abatement criterion for residential land uses). Federal Noise Abatement Criteria (NAC) are shown in Table D-2.

TABLE D-2
FEDERAL NOISE ABATEMENT CRITERIA

FHWA Noise Abatement Criteria		
Category	**L_{10} dBA**	**Land Use**
A	**60**	Special areas requiring serenity
B	**70**	Residential and recreational areas
C	**75**	Commercial and industrial areas
D	**NA**	Undeveloped areas
E	**55***	Residential, hospitals, libraries, etc.

* Applies to interior noise levels. All other land uses are exterior levels.

In addition to the identified noise criteria, the FHWA also defines a noise impact as a "substantial increase" in the future noise levels over the existing noise levels. Mn/DOT considers an increase of 5 dBA or greater a substantial noise level increase.

Methodology

Affected Environment

The purpose of this noise analysis is to determine the effect on impacts of the proposed project on traffic-generated noise levels. It is also important to note that the project setting includes other noise sources in the area that may have some affect on ambient noise levels.

The Highway 10 project corridor is located in an urban area in Elk River. Traffic noise is generated by vehicles traveling on Highway 10 as well as intersecting local roadways. Other sources include noise generated by freight trains traveling on the BNSF Railway line, which runs parallel to Highway 10 within the project corridor. Based on available information from BNSF Railway and the Mn/DOT Office of Freight and Commercial Vehicle Operations, more than 40 freight trains per day operate on the BNSF line through Elk River.[1] The St. Paul and Pacific (BNSF) Railroad Corridor also carries the Northstar Commuter Rail between Big Lake and Minneapolis (additional 12 trains per day).

Noise Monitoring

Background noise level monitoring is commonly performed during a noise study to document existing noise levels. Existing noise levels were monitored at two sites in the project area, chosen to represent areas of outdoor human activity (i.e., residential land uses). Monitoring locations were chosen at residential sites adjacent to proposed construction areas within the project corridor. Monitoring site 1 (receptor 11) is located at the intersection of Highway 10 and 4th Street on the south side of Highway 10. Monitoring site 2 (receptor 17) is located at the terminus of the Rush Avenue cul-de-sac on the south side of Highway 10. Noise monitoring receptor locations are illustrated in Figure D1.

Daytime noise levels were monitored on October 16, 2008. Noise levels were monitored at each location twice; once during the morning (8:45 a.m.-10:00 am) and again during the afternoon (2:15 p.m.-3:15 p.m.). The morning and afternoon monitored levels were averaged and reported as one monitored noise level for each monitoring site. A trained noise monitoring technician was present at each session for the entire monitoring session to ensure correct operation of the instrumentation.

Noise monitoring results are presented in Table D-3 along with the results of computer modeling for existing noise conditions.

Noise Modeling

Traffic noise impacts were assessed by modeling noise levels at receptor sites likely to be affected by the construction of the proposed project. Noise levels were modeled at 25 representative receptor sites along the project corridor. Of the 25 noise model receptor locations, 19 receptor locations were residential land uses and 5 receptor locations were commercial, business/office, or industrial land uses. One modeled receptor location represented a church located south of Highway 10, east of Proctor Avenue (receptor 12). The land use at each receptor location is indicated in Tables D-3 and D-4. The locations of model receptor sites are illustrated in the attached Figure D1.

Noise modeling was done using the noise prediction program "MINNOISE", a version of the FHWA "STAMINA" model adapted by Mn/DOT. This model uses traffic volumes, speed, class

[1] Minnesota Department of Transportation Office of Freight and Commercial Vehicle Operations. 2009. The Minnesota Department of Transportation Web Site (online). Minnesota 2009 Freight Railroad Map accessed 01-15-09 at http://www.dot.state.mn.us/ofrw/freightData.html.

of vehicle, and the typical characteristics (e.g., roadway horizontal and vertical alignment) of the roadway being analyzed. Noise model input files were developed based on the following assumptions:

- Traffic data input into the MINNOISE noise model included existing (year 2008) and future (year 2030 No-Build and Build forecast traffic volumes). Year 2030 was identified as the future year for analysis because this is the design year used for the traffic operations analysis and design of the proposed improvements.
- The peak daytime hour (approximately 4:00 p.m. to 5:00 p.m.) was assumed to be the loudest hour of the daytime period. The p.m. peak period represents approximately nine percent of average daily traffic.
- The 6:00 a.m. to 7:00 a.m. period, just prior to the morning rush hour period, was assumed to be the loudest hour of the nighttime period. The 6:00 a.m. to 7:00 a.m. period represents approximately six percent of average daily traffic.
- Existing and No-Build noise model input files assumed that vehicles were traveling through the at-grade intersections in downtown Elk River at constant speeds as a worst-case scenario.
- An acoustically "soft" surface (alpha=0.5) between receptor locations and roadways was assumed in noise model input files.
- Second-row residences were modeled to take into account first-row residences (shielding factor=3) where appropriate.

Traffic noise model input files under future (year 2030) Build conditions were developed based on a posted speed of 65 miles per hour (mph) along Highway 10. Since completion of the traffic noise analysis, the design speed for the Highway 10 mainline through Elk River has been revised to 50 mph. The results described below are based on a 65 mph operating speed as a worst-case scenario. Traffic noise impacts and mitigation will be re-assessed in the future at the time of project implementation, based on project design speed, conditions and land uses in place at that time.

Noise Model Results

Results of the noise modeling analysis are tabulated in Tables D-3 and D-4. While both the L_{10} and L_{50} descriptors are shown in the tables, the discussions of modeling results presented below only reference the L_{10} values, because the L_{10} descriptor is used to define both the State and Federal noise level regulatory thresholds.

As tabulated in Tables D-3 and D-4, existing (2008) daytime noise levels range from 60.1 dBA to 74.8 dBA, whereas existing nighttime noise levels range from 60.0 dBA to 72.8 dBA. In general, existing nighttime noise levels are approximately 0 dBA to 3 dBA lower than existing daytime levels at modeled receptor locations. All modeled residential receptor locations with existing conditions exceed State nighttime standards. Thirteen (13) of the modeled residential receptor locations exceed State daytime standards under existing conditions.

TABLE D-3
HIGHWAY 10 ELK RIVER NOISE MODEL RESULTS: DAYTIME

Receptor*	Monitored		Existing (2008)		No-Build (2030)		Difference Between Existing (2008) and No-Build (2030)		Build (2030)		Difference Between Existing (2008) and Build (2030)	
	L_{10}	L_{50}	L_{10}	L_{50}	L_{10}	L_{50}	L_{10}	L_{50}	L_{10}	L_{50}	L_{10}	L_{50}
1-1 (R) (3)			64.0	59.9	64.6	**60.9**	0.6	1.0	**70.9**	**67.3**	6.9	7.4
2-1 (R) (5)			62.4	58.7	63.1	59.7	0.7	1.0	**69.2**	**66.0**	6.8	7.3
3 (R) (3)			**66.0**	58.9	**67.5**	**60.9**	1.5	2.0	**69.6**	**64.8**	3.6	5.9
4 (R) (1)			**67.0**	58.2	**67.8**	59.4	0.8	1.2	**70.3**	**64.2**	3.3	6.0
5 (C) (2)			62.9	59.4	63.8	60.5	0.9	1.1	**70.9**	**67.5**	8.0	8.1
6 (C) (2)			68.5	62.5	69.7	64.1	1.2	1.6	**70.1**	**66.8**	1.6	4.3
7 (C) (3)			60.1	57.4	60.8	58.2	0.7	0.8	69.9	**66.7**	9.8	9.3
8 (C) (3)			**72.1**	**66.0**	**72.8**	**66.9**	0.7	0.9	**73.6**	**69.7**	1.5	3.7
9 (R) (3)			60.7	56.6	61.7	57.9	1.0	1.3	**66.5**	**64.0**	5.8	7.4
10 (C) (2)			**72.9**	**66.5**	**73.5**	**67.3**	0.6	0.8	**73.4**	**69.9**	0.5	3.4
11 (R) (4)	**67.0**	**61.5**	**67.8**	**63.0**	**68.4**	**63.7**	0.6	0.7	**69.3**	**66.0**	1.5	3.0
12-1 (R/Ch) (4)			63.8	**60.1**	**64.4**	**60.8**	0.6	0.7	**68.0**	**65.2**	4.2	5.1
13-1 (R) (5)			64.0	**60.3**	**64.6**	**61.1**	0.6	0.8	**67.9**	**64.9**	3.9	4.6
14-1 (R) (3)			64.2	59.5	**65.0**	**60.5**	0.8	1.0	**67.4**	**64.2**	3.2	4.7
15 (R) (3)			**66.6**	59.0	**68.6**	**61.8**	2.0	2.8	**66.5**	**60.3**	-0.1	1.3
State Standards[(1)]	**65**	**60**	**65**	**60**	**65**	**60**	-	-	**65**	**60**	-	-
Federal Criteria[(1)]	**70**	-	**70**	-	**70**	-	-	-	**70**	-	-	-
State Standards[(2)]	**70**	**65**	**70**	**65**	**70**	**65**	-	-	**70**	**65**	-	-
Federal Criteria[(2)]	**75**	-	**75**	-	**75**	-	-	-	**75**	-	-	-

Bold refers to L_{10} and L_{50} values above State daytime standards.
Underlined refers to L_{10} values approaching or exceed Federal noise abatement criteria.
(R) – Residential; (C) – Commercial; (Ch) – Church
* Number in" receptor" column is the number of receptors and/or commercial buildings represented by each receptor.
(1) State daytime standards and Federal noise abatement criteria for residential land uses.
(2) State daytime standards for commercial land uses and Federal noise abatement criteria for commercial and industrial land uses.

TABLE D-3 continued
HIGHWAY 10 ELK RIVER NOISE MODEL RESULTS: DAYTIME

Receptor*	Monitored		Existing (2008)		No-Build (2030)		Difference Between Existing (2008) and No-Build (2030)		Build (2030)		Difference Between Existing (2008) and Build (2030)	
	L_{10}	L_{50}	L_{10}	L_{50}	L_{10}	L_{50}	L_{10}	L_{50}	L_{10}	L_{50}	L_{10}	L_{50}
16-1 (R) (8)			**67.3**	**62.7**	**67.9**	**63.4**	0.6	0.7	**69.3**	**65.4**	2.0	2.7
17-1 (R) (5)	**66.8**	**61.0**	**68.8**	**63.5**	**69.3**	**64.2**	0.5	0.7	**67.8**	**64.1**	-1.0	0.6
18-1 (R) (6)			**68.6**	**64.1**	**70.3**	**66.4**	1.7	2.3	**65.8**	**62.4**	-2.8	-1.7
19-1 (R) (5)			**67.3**	**63.2**	**69.2**	**65.9**	1.9	2.7	**67.6**	**64.3**	0.3	1.1
20 (R) (5)			**63.8**	**60.3**	**65.7**	**62.8**	1.9	2.5	**65.3**	**62.4**	1.5	2.1
21-1 (R) (3)			**70.2**	**65.7**	**72.3**	**68.6**	2.1	2.9	**71.5**	**68.0**	1.3	2.3
22 (R) (2)			**67.1**	**63.2**	**69.1**	**66.0**	2.0	2.8	**70.1**	**67.2**	3.0	4.0
23-1 (R) (1)			**72.1**	**67.1**	**74.2**	**70.1**	2.1	3.0	**75.1**	**70.8**	3.0	3.7
24 (R) (2)			**73.4**	**68.0**	**75.5**	**71.1**	2.1	3.1	**77.5**	**73.0**	4.1	5.0
25 (R) (1)			**70.6**	**66.0**	**72.7**	**68.9**	2.1	2.9	**74.3**	**70.5**	3.7	4.5
State Standards[(1)]	**65**	**60**	**65**	**60**	**65**	**60**	**-**	**-**	**65**	**60**	**-**	**-**
Federal Criteria[(1)]	**70**	**-**	**70**	**-**	**70**	**-**	**-**	**-**	**70**	**-**	**-**	**-**
State Standards[(2)]	**70**	**65**	**70**	**65**	**70**	**65**	**-**	**-**	**70**	**65**	**-**	**-**
Federal Criteria[(2)]	**75**	**-**	**75**	**-**	**75**	**-**	**-**	**-**	**75**	**-**	**-**	**-**

Bold refers to L_{10} and L_{50} values above State daytime standards.
Underlined refers to L_{10} values approaching or exceed Federal noise abatement criteria.
(R) – Residential; (C) – Commercial; (Ch) – Church
* Number in" receptor" column is the number of receptors and/or commercial buildings represented by each receptor.
(1) State daytime standards and Federal noise abatement criteria for residential land uses.
(2) State daytime standards for commercial land uses and Federal noise abatement criteria for commercial and industrial land uses.

TABLE D-4
HIGHWAY 10 ELK RIVER NOISE MODEL RESULTS: NIGHTTIME

Receptor*	Existing (2008)		No-Build (2030)		Difference Between Existing (2008) and No-Build (2030)		Build (2030)		Difference Between Existing (2008) and Build (2030)	
	L_{10}	L_{50}	L_{10}	L_{50}	L_{10}	L_{50}	L_{10}	L_{50}	L_{10}	L_{50}
1-1 (R) (3)	**63.3**	**59.0**	**64.6**	**60.8**	1.3	1.8	**70.1**	**66.5**	6.8	7.5
2-1 (R) (5)	**61.6**	**57.8**	**62.9**	**59.4**	1.3	1.6	**68.4**	**65.2**	6.8	7.4
3 (R) (3)	**64.1**	**56.4**	**65.6**	**58.5**	1.5	2.1	**68.0**	**63.1**	3.9	6.7
4 (R) (1)	**63.7**	**54.2**	**66.2**	**57.3**	2.5	3.1	**69.5**	**63.1**	5.8	8.9
5 (C) (2)	62.0	58.0	63.2	59.7	1.2	1.7	**70.1**	**66.6**	8.1	8.6
6 (C) (2)	67.5	61.2	68.6	62.8	1.1	1.6	69.6	66.1	2.1	4.9
7 (C) (3)	59.4	56.5	60.6	58.0	1.2	1.5	69.1	65.9	9.7	9.4
8 (C) (3)	**71.8**	**65.3**	**72.7**	**66.7**	0.9	1.4	**73.6**	**69.3**	1.8	4.0
9 (R) (3)	**60.0**	**55.7**	**61.1**	**57.3**	1.1	1.6	**65.9**	**63.3**	5.9	7.6
10 (C) (2)	**72.8**	**66.1**	**73.5**	**67.3**	0.7	1.2	**73.5**	**69.6**	0.7	3.5
11 (R) (4)	**67.6**	**62.4**	**68.4**	**63.7**	0.8	1.3	**69.6**	**66.1**	2.0	3.7
12-1 (R/Ch) (4)	**63.5**	**59.4**	**64.3**	**60.7**	0.8	1.3	**68.3**	**65.3**	4.8	5.9
13-1 (R) (5)	**63.7**	**59.6**	**64.5**	**60.9**	0.8	1.3	**68.2**	**65.3**	4.5	5.7
14-1 (R) (3)	**63.6**	**58.7**	**64.6**	**60.1**	1.0	1.4	**67.6**	**64.5**	4.0	5.8
15 (R) (3)	**65.8**	**57.9**	**67.9**	**60.7**	2.1	2.8	**65.7**	**59.3**	-0.1	1.4
State Standards[(1)]	**55**	**50**	**55**	**50**	-	-	**55**	**50**	-	-
Federal Criteria[(1)]	**70**	-	**70**	-	-	-	**70**	-	-	-
State Standards[(2)]	**70**	**65**	**70**	**65**	-	-	**70**	**65**	-	-
Federal Criteria[(2)]	**75**	-	**75**	-	-	-	**75**	-	-	-

Bold refers to L_{10} and L_{50} values above State nighttime standards.
(R) – Residential; (C) – Commercial; (Ch) – Church
* Number in" receptor" column is the number of receptors and/or commercial buildings represented by each receptor.
(1) State nighttime standards and Federal noise abatement criteria for residential land uses.
(2) State nighttime standards for commercial land uses and Federal noise abatement criteria for commercial and industrial land uses.

TABLE D-4 continued
HIGHWAY 10 ELK RIVER NOISE MODEL RESULTS: NIGHTTIME

Receptor*	Existing (2008)		No-Build (2030)		Difference Between Existing (2008) and No-Build (2030)		Build (2030)		Difference Between Existing (2008) and Build (2030)	
	L_{10}	L_{50}	L_{10}	L_{50}	L_{10}	L_{50}	L_{10}	L_{50}	L_{10}	L_{50}
16-1 (R) (8)	**67.1**	**62.1**	**67.8**	**63.3**	0.7	1.2	**71.0**	**67.2**	3.9	5.1
17-1 (R) (5)	**68.6**	**63.0**	**69.3**	**64.1**	0.7	1.1	**69.2**	**65.4**	0.6	2.4
18-1 (R) (6)	**67.8**	**62.7**	**68.9**	**64.6**	1.1	1.9	**66.1**	**62.6**	-1.7	-0.1
19-1 (R) (5)	**65.4**	**60.8**	**66.9**	**63.0**	1.5	2.2	**67.6**	**64.4**	2.2	3.6
20 (R) (5)	**62.1**	**58.2**	**63.6**	**60.3**	1.5	2.1	**65.6**	**62.9**	3.5	4.7
21-1 (R) (3)	**69.2**	**64.0**	**70.5**	**66.2**	1.3	2.2	**71.8**	**68.0**	2.6	4.0
22 (R) (2)	**65.9**	**61.3**	**67.1**	**63.4**	1.2	2.1	**67.8**	**64.8**	1.9	3.5
23-1 (R) (1)	**70.0**	**64.4**	**71.6**	**66.7**	1.6	2.3	**69.6**	**66.3**	-0.4	1.9
24 (R) (2)	**71.1**	**65.2**	**72.8**	**67.6**	1.7	2.4	**76.2**	**71.6**	5.1	6.4
25 (R) (1)	**68.6**	**63.3**	**70.1**	**65.6**	1.5	2.3	**73.1**	**69.0**	4.5	5.7
State Standards[(1)]	**55**	**50**	**55**	**50**	-	-	**55**	**50**	-	-
Federal Criteria[(1)]	**70**	-	**70**	-	-	-	**70**	-	-	-
State Standards[(2)]	**70**	**65**	**70**	**65**	-	-	**70**	**65**	-	-
Federal Criteria[(2)]	**75**	-	**75**	-	-	-	**75**	-	-	-

Bold refers to L_{10} and L_{50} values above State nighttime standards.
(R) – Residential; (C) – Commercial; (Ch) – Church
* Number in" receptor" column is the number of receptors and/or commercial buildings represented by each receptor.
(1) State nighttime standards and Federal noise abatement criteria for residential land uses.
(2) State nighttime standards for commercial land uses and Federal noise abatement criteria for commercial and industrial land uses.

Noise levels for the year 2030 No-Build conditions generally increase by approximately 1 dBA to 2 dBA over existing (2008) modeled noise levels for both daytime and nighttime conditions. Future No-Build daytime noise levels are predicted to range from 60.8 dBA to 76.9 dBA, whereas future No-Build nighttime noise levels are predicted to range from 60.6 dBA to 74.1 dBA. All of the modeled residential receptor locations are predicted to exceed State nighttime standards under future No-Build conditions. Fourteen (14) of the modeled residential receptor locations exceed State daytime standards under existing future No-Build conditions (see Tables D-3 and D-4).

In general, construction of the Build Alternative under year 2030 conditions is predicted to increase modeled daytime noise levels by approximately 1 dBA to 7 dBA compared to existing (2008) conditions. Modeled noise levels under future Build conditions are predicted to be greater than 5 dBA at modeled receptor locations north of Highway 10 adjacent to Main Street and Jackson Avenue. The proposed Highway 10 alignment is shifted to the north at Main Street and Jackson Avenue, closer to modeled receptor sites. Future (2030) Build daytime noise levels are predicted to range from 65.3 dBA to 77.5 dBA, whereas future Build nighttime noise levels are predicted to range from 65.6 dBA to 76.2 dBA. All of the modeled receptor locations are predicted to exceed State daytime and nighttime standards under future Build conditions, with the exception of one modeled receptor site (receptor 7) representing commercial land uses north of the BNSF Railway (see Tables D-3 and D-4).

Traffic Noise Abatement Analysis

The future Highway 10 Project through Elk River is considered a Type I project for purposes of noise mitigation analysis. A Type I project is the construction of a new highway on a new alignment or the physical alteration of an existing highway (e.g., change in horizontal or vertical alignment; increase in number of through lanes). 23 CFR 772.13(c) describes noise abatement measures that are to be considered when a noise impact has been identified with a Type I highway project. These noise abatement measures include:

- Traffic management measures (e.g., traffic control devices and signing for prohibition of certain vehicle types, time-use restrictions for certain vehicle types, modified speed limits, and exclusive land designations);
- Alteration of horizontal and vertical alignments;
- Acquisition of property rights (either in fee or lesser interest) for construction of noise barriers;
- Construction of noise barriers (including landscaping for aesthetic purposes) whether within or outside the highway right-of-way;
- Acquisition of real property or interests therein (predominately unimproved property) to serve as a buffer zone to preempt development which would be adversely impacted by traffic noise; and
- Noise insulation of noise sensitive public use or nonprofit institutional structures.

Noise Barrier Evaluation

Noise barrier construction decisions are based on a study of feasibility and reasonableness. Feasibility is determined by physical and/or engineering constraints, i.e., whether a noise barrier could feasibly be constructed on the site. Reasonableness is a more subjective criterion and is based on a number of factors. Economic reasonableness is determined by consideration of Mn/DOT's cost-effectiveness index in concert with Mn/DOT's noise barrier acoustical effectiveness (noise level reduction capability) limits. If noise mitigation is found to be cost-effective, additional reasonableness factors such as aesthetics and the desires of affected property owners are considered. Affected communities are also consulted as to their desire for noise walls.

The feasibility of noise barrier construction is sometimes dependent on design details that are not known until the final design phase of the project. It is assumed that any utilities located within the project corridor can be relocated to accommodate noise barriers. The following analysis assumes that noise walls could be feasibly constructed up to 20 feet high throughout the project corridor.

For a noise barrier to be considered acoustically effective, it must achieve a noise reduction of 5 dBA or more. To be considered cost-effective, the cost per dBA of reduction per residence should be equal to, or less than $3,250 (in 1997 dollars). The following formula can be used to determine the cost-effectiveness of the barrier:

The cost-effectiveness index is equal to the cost of the noise barrier[1] divided by the product of the average noise level reduction based on those residences that had noise level reductions of 5 dBA or more and the number of residences that had noise level reductions of 5 dBA or more.

[1]The cost of a noise wall is calculated using $15 per square foot of wall (in 1997 dollars), except on structures, where the cost is $18 per square foot.

Only receptor areas that experience a five or greater decibel decrease in noise following construction of a noise barrier are considered in this analysis. The result of the above formula is a cost per decibel per receptor represented. This overall approach is outlined in Mn/DOT Noise Policy for Type I and Type II Federal-Aid Projects as per 23 CFR 772.

There are several steps to assessing the cost-effectiveness of noise barriers. First, the cost-effective noise wall height is determined for each segment of the project area. For this study, three heights of potential noise barriers were analyzed: 20, 15 and 10 feet. If a 20-foot noise barrier meets the reasonableness criteria and is feasible, it would be proposed for construction. If the 20-foot barrier does not meet the criteria, a 15-foot barrier is evaluated. Likewise if a 15-foot barrier does not meet the criteria, a 10-foot barrier is studied. If a 10-foot noise barrier meets the reasonableness criteria and is feasible, it would then be proposed for construction.

State noise standards (daytime and nighttime L_{10}) would be exceeded throughout the project area. Noise barriers were evaluated at eight locations within the study area. Additional model

receptor locations were added as needed for purposes of calculating barrier cost-effectiveness. The modeled scenario for the noise wall analysis considered train noise as described in the noise modeling section above. The locations of modeled noise walls are shown in the attached Figure D1. See Tables D-5, D-6, and D-7 for noise mitigation data.

Area 1 (Southeast quadrant of Highway 10/Main Street Interchange)
Receptors 1-1, 1-2, 2-1 and 2-2

Area 1 consists of commercial and residential land uses east Main Street, north of Highway 10 and the BNSF Railway. The proposed project will relocate the BNSF Railway approximately 100 feet closer to these modeled receptors. Modeled noise levels at the residential receptors are predicted to exceed State daytime and nighttime standards with future Build conditions.

An approximately 1,160-foot long noise wall was modeled between Highway 10 and the BNSF Railway east of Main Street (Area 1). The modeled noise wall was located on a proposed retaining wall along the north side of the westbound Highway 10 to Main Street exit ramp. These residences and commercial land uses are located approximately 10 feet (near Main Street) to approximately 30 feet (at the exit ramp from westbound Highway 10) above the proposed Highway 10 elevation.

The approximately 1,160-foot long, 20-foot high modeled barrier provides a reduction that varies from 3.6 dBA to 8.1 dBA. The cost-effectiveness of the 20-foot high wall is $5,789/dBA/receptor. The approximately 1,160-foot long, 15-foot high modeled barrier provides a reduction that varies from 2.6 dBA to 5.4 dBA in modeled noise levels. The cost-effectiveness of the 15-foot wall is $15,694/dBA/receptor. The approximately 1,160-foot long, 10-foot high modeled barrier provides a reduction that ranges from 1.3 dBA to 2.9 dBA

The 20-foot high and 15-foot high modeled barriers do not meet Mn/DOT's minimum $3,250 cost-effectiveness criteria. The 10-foot high modeled barrier does not meet Mn/DOT's minimum 5 dBA reduction threshold to be considered acoustically effective. Therefore, none of the analyzed barriers are proposed.

Area 2 (North of Highway 10 between Main Street and Jackson Avenue)
Receptors 3, 4, 5, 7 and 9

Area 2 consists of primarily commercial land uses along the north side of Highway 10 and the BNSF Railway between Main Street and Jackson Avenue. The proposed project will relocate the BNSF Railway approximately 100 feet closer to these modeled receptors. Residential land uses are located west of Main Street along Gates Avenue (receptor 4) and east of Jackson Avenue along 4th Street (receptor 9). Modeled noise levels at residential receptors are predicted exceed State daytime and nighttime standards with future Build conditions. Modeled noise levels at two commercial receptors (receptor 3 and 5) are predicted to exceed State daytime and nighttime standards with future Build conditions, whereas other commercial receptor locations (receptor 7) are predicted to be in compliance with State standards.

An approximately 1,380-foot noise wall was modeled within proposed highway right of way between Highway 10 and the BNSF Railway from Main Street to the proposed Jackson Avenue

underpass (Area 2). The BNSF Railway and Highway 10 elevation is approximately 5 feet higher than adjacent commercial land uses at this location.

The approximately 1,380-foot long, 20-foot high modeled barrier provides a reduction that varies from 1.4 dBA to 6.4 dBA. The cost-effectiveness of the 20-foot high wall is $13,632/dBA/receptor. The approximately 1,380-foot long, 15-foot high modeled barrier provides a reduction that varies from 1.1 dBA to 4.1 dBA. The approximately 1,380-foot long, 10-foot high modeled barrier provides a reduction that varies from 0.3 dBA to 2.3 dBA.

The 20-foot high modeled barrier does not meet Mn/DOT's minimum $3,250 cost-effectiveness criteria. The 15-foot and 10-foot high modeled barriers does not meet Mn/DOT's minimum 5 dBA reduction threshold to be considered acoustically effective. Therefore, none of the analyzed barriers are proposed.

Area 3 (South of Highway 10 between Main Street and Jackson Avenue)
Receptors 6 and 8

Area 3 consists of commercial land uses along the south side of Highway 10 between Main Street and Jackson Avenue in downtown Elk River. These commercial land uses are predicted to exceed State daytime standards for commercial land uses with future Build conditions.

An approximately 1,290-foot noise wall was modeled within highway right of way between Highway 10 and the proposed frontage road from the Jackson Avenue underpass to Main Street (Area 3). The 1,290-foot long, 20-foot high modeled barrier provided a reduction that varies from 3.0 dBA to 5.5 dBA. The cost-effectiveness of the 20-foot high wall is $22,818/dBA/receptor. The approximately 1,290-foot long, 15-foot high modeled barrier provided a reduction that varies from 2.8 dBA to 5.0 dBA in modeled noise levels. The cost-effectiveness of the 15-foot wall is $18,900/dBA/receptor. The approximately 1,290-foot long, 10-foot high modeled barrier provides a reduction that varies from 2.2 dBA to 3.8 dBA.

The 20-foot high and 15-foot high modeled barriers do not meet Mn/DOT's minimum $3,250 cost-effectiveness criteria. The 10-foot high modeled barrier does not meet Mn/DOT's minimum 5 dBA reduction threshold to be considered acoustically effective. Therefore, none of the analyzed barriers are proposed.

Area 4 (South of Highway 10 between Jackson Avenue and Morton Avenue)
Receptor 10

Area 4 consists of commercial land uses along the south side of Highway 10 between Jackson Avenue and Morton Avenue. These commercial land uses are predicted to exceed State daytime and nighttime standards with future Build conditions.

An approximately 1,060-foot noise wall was modeled between Highway 10 and the proposed frontage road from the Jackson Avenue underpass to the Morton Avenue intersection with the proposed frontage road (Area 4). The approximately 1,060-foot long, 20-foot high modeled barrier provides a reduction of 5.9 dBA. The cost-effectiveness of the 20-foot high wall is

$26,059/dBA/receptor. The approximately 1,060-foot long, 15-foot high modeled barrier provides a reduction of 4.7 dBA. The approximately 1,060-foot long, 10-foot high modeled barrier provides a reduction of 2.5 dBA.

The 20-foot high modeled barrier does not meet Mn/DOT's minimum $3,250 cost-effectiveness criteria. The 10-foot and 15-foot high modeled barriers do not meet Mn/DOT's minimum 5 dBA reduction threshold to be considered acoustically effective. Therefore, none of the analyzed barriers are proposed.

Area 5 (South of Highway 10, East of Proctor Avenue)
Receptors 11, 12-1, 12-2, 13-1, 13-2, 14-1 and 14-2

Area 5 consists of residential land uses south of Highway 10 and east of Proctor Avenue. These receptors represent a total of 30 residences. Modeled noise levels in Area 5 are predicted to exceed State daytime and nighttime standards with future Build conditions.

An approximately 1,270-foot noise wall was modeled between Proctor Avenue and Morton Avenue south of Highway 10 and the proposed one-way eastbound frontage road (Area 5). The approximately 1,270-foot long, 20-foot high barrier provided a reduction that varies from 0.6 dBA to 7.1 dBA. The cost-effectiveness of the 20-foot wall is $4,631/dBA/residence. The approximately 1,270-foot long, 15-foot high barrier provided a reduction that varies from 0.5 dBA to 5.8 dBA. The cost-effectiveness of the 15-foot wall is $5,110/dBA/residence. The approximately 1,270-foot long, 10-foot high modeled barrier provides a reduction that varies from 0.4 dBA to 4.2 dBA.

The 20-foot high and 15-foot high modeled barriers do not meet Mn/DOT's minimum $3,250 cost-effectiveness criteria. The 10-foot high modeled barrier does not meet Mn/DOT's minimum 5 dBA reduction threshold to be considered acoustically effective. Therefore, none of the analyzed barriers are proposed.

Area 6 (Southwest quadrant of Highway 10/Proctor Avenue Interchange)
Receptors 16-1, 16-2, 16-3, 17-1, 17-2, 17-3 and 17-4

Area 6 consists of residential land uses along the south side of Highway 10 between Proctor Avenue and Bridge Street. Modeled receptor locations in Area 6 represent a total of 26 residences. The proposed Highway 10 elevation is approximately 8 to 12 feet lower than the existing highway elevation at this location. The proposed south frontage road is approximately 5 to 10 feet above existing ground elevations at the south frontage road intersections with Proctor Avenue and Bridge Street. Modeled noise levels are predicted to exceed State daytime and nighttime standards with future Build conditions.

Two separate noise walls were modeled for Area 6 between Proctor Avenue and Bridge Street. A 1,400-foot long wall was modeled between Highway 10 and the proposed one-way eastbound frontage road. An alternative 1,450-foot long wall was modeled within the proposed highway right of way south of the one-way eastbound frontage road. The results of the Area 6 evaluation are summarized below.

Wall 6A (Between Highway 10 and One-Way Eastbound Frontage Road)

An approximately 1,400-foot long wall was modeled between Highway 10 and the one-way eastbound frontage road from Proctor Avenue to Bridge Street. The modeled wall was located on top of a proposed retaining wall between eastbound Highway 10 and the eastbound one-way frontage road. This analysis assumed that up to a 20-foot high noise barrier could be constructed on the proposed retaining walls.

The approximately 1,400-foot long, 20-foot high barrier provides a reduction that varies from 0.2 dBA to 5.2 dBA. The cost-effectiveness of the 20-foot wall is $19,688/dBA/residence. The approximately 1,400-foot long, 15-foot high modeled barrier provides a reduction that varies from 0.1 dBA to 4.6 dBA. The approximately 1,400-foot long, 10-foot high modeled barrier provides a reduction that varies from 0 dBA to 3.4 dBA.

The 20-foot high modeled barrier does not meet Mn/DOT's minimum $3,250 cost-effectiveness criteria. The 15-foot and 10-foot high modeled barriers do not meet Mn/DOT's minimum 5 dBA reduction threshold to be considered acoustically effective. Therefore, none of the analyzed barriers are proposed.

Wall 6B (South of the One-Way Eastbound Frontage Road)

An approximately 1,450-foot long wall was modeled south of the proposed one-way eastbound frontage road from Bridge Street to Proctor Avenue. The modeled wall was located on top of proposed retaining walls south of the frontage road at the proposed Bridge Street/south frontage road intersection and the Proctor Avenue/south frontage road intersection. This analysis assumed that up to a 20-foot high noise barrier could be constructed on the proposed retaining walls.

The approximately 1,450-foot long, 20-foot high barrier provided a reduction that varies from 1.1 dBA to 8.0 dBA. The cost-effectiveness of the 20-foot high wall is $3,412/dBA/residence. The approximately 1,450-foot long, 10-foot high barrier provided a reduction that varies from 0.8 dBA to 5.4 dBA. The cost-effectiveness of the 10-foot high wall is $9,931/dBA/residence.

The approximately 1,450-foot long, 15-foot high noise barrier would shield four modeled receptor locations, representing 16 residences, along the south side of Highway 10 between Bridge Street and Proctor Avenue. The approximately 1,450-foot long, 15-foot high barrier provides a reduction that varies from 1.0 dBA to 7.0 dBA. The cost-effectiveness of this 15-foot high wall is $3,182/dBA/receptor (see Table D-6), which meets Mn/DOT's cost-effectiveness criteria and is proposed. Traffic noise impacts and mitigation will be re-evaluated at the time of project implementation based on conditions in place at that time. Final mitigation decisions will be based on the results of this re-assessment, input from affected residents, community input, and final design considerations.

Area 7 (Southwest quadrant of Highway 10/Upland Avenue Interchange)
Receptors 18-1, 18-2, 21-1, 21-2 and 22

Area 7 consists of residential land uses in the northwest quadrant of the Highway 10/Upland Avenue interchange. These receptors represent a total of 11 residential locations. Modeled noise levels at all receptor locations are predicted to exceed State daytime and nighttime standards with future Build conditions.

Two separate noise walls were modeled for Area 7 west of the Upland Avenue overpass. A 1,300-foot long wall was modeled west of the Upland Avenue adjacent to the exit ramp from eastbound Highway 10 to the south frontage road. A 1,690-foot long wall was modeled south of Highway 10 from east of Xenia Avenue to west of Simonet Drive. The results of the Area 7 evaluation are summarized below.

Wall 7A (Southwest quadrant of Highway 10/Upland Avenue interchange)

An approximately 1,300-foot long wall was modeled south of Highway 10 adjacent to the exit ramp from westbound Highway 10 to Upland Avenue. The modeled wall was located on top of a proposed retaining wall south of the exit ramp in the southwest quadrant of the ramp intersection with Upland Avenue. This analysis assumed that up to a 20-foot high noise barrier could be constructed on the proposed retaining wall.

The approximately 1,300-foot long, 20-foot high barrier provides a reduction that varies from 3.3 dBA to 5.5 dBA. The cost-effectiveness of the 20-foot high wall is $11,500/dBA/residence. The approximately 1,300-foot long, 15-foot high modeled barrier provides a reduction that varies from 2.3 dBA to 4.1 dBA. The approximately 1,300-foot long, 10-foot high modeled barrier provides a reduction that varies from 1.2 dBA to 2.1 dBA.

The 20-foot high modeled barrier does not meet Mn/DOT's minimum $3,250 cost-effectiveness criteria. The 10-foot and 15-foot high modeled barriers do not meet Mn/DOT's minimum 5 dBA reduction threshold to be considered acoustically effective. Therefore, none of the analyzed barriers are proposed.

Wall 7B (South of Highway 10 from Simonet Drive to Xenia Avenue)

An approximately 1,690-foot long wall was modeled south of Highway 10 from Simonet Drive to Xenia Avenue. The approximately 1,690-foot long, 20-foot high barrier provides a reduction that varies from 4.7 dBA to 9.0 dBA. The cost-effectiveness of the 20-foot wall is $9,793/dBA/residence. The approximately 1,690-foot long, 15-foot high barrier provides a reduction that varies from 3.8 dBA to 6.7 dBA. The cost-effectiveness of the 15-foot wall is $10,122/dBA/residence. The approximately 1,690-foot long, 10-foot high modeled barrier provides a reduction that varies from 2.1 dBA to 3.8 dBA.

The 20-foot high and 15-foot high modeled barriers do not meet Mn/DOT's minimum $3,250 cost-effectiveness criteria. The 10-foot high modeled barrier does not meet Mn/DOT's minimum 5 dBA reduction threshold to be considered acoustically effective. Therefore, none of the analyzed barriers are proposed.

Area 8 (North of Highway 10 and West of Upland Avenue)
Receptors 19-1, 19-2, 19-3, 19-4, 20, 23-1, 23-2 and 24

Area 8 consists of residential land uses north of Highway 10 and west of Upland Avenue. These receptors represent a total of 19 residences. Modeled noise levels at this location are predicted to exceed State daytime and nighttime standards with future Build conditions.

Two separate noise walls were modeled for Area 8 west of the Upland Avenue overpass. An approximately 1,790-foot long wall was modeled west of the Upland Avenue adjacent to the entrance ramp from the north frontage road to westbound Highway 10. An approximately 650-foot long wall was modeled north of Highway 10 at the western project terminus. The location of these modeled walls was identified to minimize impacts to a public waters wetland adjacent to Highway 10. The results of the Area 8 evaluation are summarized below.

Wall 8A (North of Highway 10 from Xenia Avenue to Upland Avenue)

An approximately 1,790-foot long wall was modeled north of Highway 10 adjacent to the entrance ramp from Upland Avenue to westbound Highway 10. The approximately 1,790-foot long, 20-foot high barrier provides a reduction that varies from 4.0 dBA to 11.6 dBA. The cost-effectiveness of the 20-foot wall is $7,846/dBA/residence. The approximately 1,790-foot long, 15-foot high barrier provides a reduction that varies from 3.2 dBA to 8.5 dBA. The cost-effectiveness of the 15-foot wall is $46,588/dBA/residence. The approximately 1,790-foot long, 10-foot high modeled barrier provides a reduction that varies from 1.2 dBA to 4.6 dBA.

The 20-foot high and 15-foot high modeled barriers do not meet Mn/DOT's minimum $3,250 cost-effectiveness criteria. The 10-foot high modeled barrier does not meet Mn/DOT's minimum 5 dBA reduction threshold to be considered acoustically effective. Therefore, none of the analyzed barriers are proposed.

Wall 8B (North of Highway 10 at Albany St)

An approximately 650-foot long wall was modeled north of Highway 10 at the western project terminus. The approximately 650-foot long, 20-foot high barrier provides a reduction that varies from 2.9 dBA to 13.7 dBA. The cost-effectiveness of the 20-foot wall is $6,734/dBA/residence. The approximately 650-foot long, 15-foot high barrier provides a reduction that varies from 2.5 dBA to 10.9 dBA. The cost-effectiveness of the 15-foot wall is $6,399/dBA/residence. The approximately 650-foot long, 10-foot high barrier provides a reduction that varies from 1.7 dBA to 7.1 dBA. The cost-effectiveness of the 10-foot wall is $6,655/dBA/residence.

The 20-foot high, 15-foot high and 10-foot high modeled barriers do not meet Mn/DOT's minimum $3,250 cost-effectiveness criteria. Therefore, none of the analyzed barriers are proposed.

Area 9 (North of Highway 10 at Proctor Avenue/School Street Intersection)
Receptor 15

Area 9 represents residential land uses north of Highway 10 at the intersection of Proctor Avenue and School Street. The proposed project includes the grade-separation of Proctor Avenue from the BNSF Railway. The alignment of Proctor Avenue is shifted to the east of its existing alignment to minimize right of way impacts to properties to the west of Proctor Avenue and at the Proctor Avenue/School Street intersection.

Proctor Avenue is a county-owned roadway. The segment of Proctor Avenue at School Street at receptor 15 consists of private driveways providing access for adjacent residences. Multiple gaps in a barrier at this location along Proctor Avenue would limit its acoustical effectiveness. The distance between consecutive driveways ranges from approximately 30 feet to 100 feet. As such, there is no feasible mitigation measure that could be implemented along this segment of Proctor Avenue.

Alternative Noise Abatement

Noise abatement measures other than noise barriers were considered for the proposed project. These measures are identified in 23 CRF 772.13c and are listed above.

- Traffic management measures: Measures such as signing for prohibition of certain vehicle types and time-use restriction for certain vehicle types would not be feasible or practicable for this project. To limit the vehicle types and time of use on Highway 10 would not be consistent with the function of Highway 10 as a principal arterial and medium priority interregional corridor (IRC).

  Preliminary engineering layouts for Highway 10 within Elk River were initially developed based on a design speed of 70 mph. The traffic noise analysis described above was based on this design as a worst-case scenario, and assumed a posted speed of 65 mph. To allow greater flexibility in roadway geometric design, the design speed for Highway 10 within Elk River was lowered to 50 mph. This lower design speed allows for greater flexibility in minimizing impacts to the surrounding environment, and is consistent with the urban characteristics of the project corridor within of downtown Elk River. Lowering the design speed from 70 mph to 50 mph could result in some reductions in predicted traffic noise levels under future (2030) Build conditions. In general, a decrease in speed of approximately 20 mph is necessary for a noticeable decrease in noise levels.

- Alteration of horizontal and vertical alignments: Additional changes in the horizontal alignment of Highway 10 are not feasible because of existing development adjacent to the project corridor. The proposed design includes changes to the vertical alignment of Highway 10 west of Proctor Avenue. The Highway 10 vertical alignment is depressed west of Proctor Avenue to accommodate the overpasses at Upland Avenue, Bridge Street, and Proctor Avenue. The extent to which Highway 10 can be depressed in this area is limited by the depth to groundwater. Changes in the vertical alignment through downtown Elk River from Proctor Avenue to Main Street are not practical because this is the central business district

for the City of Elk River. The City of Elk River desires to maintain visibility of the downtown area from Highway 10, similar to existing conditions.

- Acquisition of real property or interests therein (predominately unimproved property) to serve as a buffer zone to preempt development which would be adversely impacted by traffic noise: Exclusive land use designations or acquisition of property to serve as a buffer zone between the roadway and adjacent lands would not be feasible because land has already been developed along the project corridor.

- Noise insulation of noise sensitive public use or nonprofit institutional structures: Acoustical insulation of individual residences is not reasonable. This noise abatement measure would not affect noise levels that exceed Minnesota State Noise Standards because these are intended for exterior uses only. Under Mn/DOT and FHWA guidelines, only public buildings such as schools and hospitals should be considered for acoustical insulation.

Conclusions

In general, construction of the project will result in increases in traffic noise at most modeled receptor locations within the project area. Cost-effectiveness of noise barriers was calculated; one 15-foot high wall located along the south side of Highway 10 between Proctor Avenue and Bridge Street that achieved a 5 dBA reduction was found to be cost-effective and is proposed.

Traffic noise impacts and mitigation will be re-assessed in the future at the time of project implementation, based on regulations, conditions and land uses in place at that time. Decisions on noise mitigation to be included in the project will be based on the results of the future noise impact reassessment. Final mitigation decisions will be subject to community input, input from affected property owners, and final design considerations.

TABLE D-5
NOISE MITIGATION COST EFFECTIVENESS RESULTS (DAYTIME)
20-foot Modeled Walls

Receptors	Daytime L_{10} Noise (dBA)		Reduction (in dBA) with 20 ft noise wall	Number of residences	Number of affected residences	Length of wall (feet)	Wall Area (SF) [1]	Total cost of wall $15/sq ft	Cost/dBA/ receptor
	Pref. Alt. year 2030 (no wall)	Pref. Alt. year 2030 (20 ft wall)							
Area 1, Wall 1A: East of Main Street between Highway 10 and BNSF Railway									
1-1 (R)	**70.9**	62.8	8.1	3	3	1,160	22,500	$337,500	$5,789
1-2 (R)	**65.2**	61.2	4.0	4	0				
2-1 (R)	**69.2**	62.4	6.8	5	5				
2-2 (C)	**65.9**	62.3	3.6	2	0				
Area 2: Main Street to Jackson Avenue north of Highway 10									
3 (C)	69.6	68.2	1.4	3	0	1,380	26,900	$403,500	$13,632
4 (R)	**70.3**	**68.2**	2.1	1	0				
5 (C)	**70.9**	65.7	5.2	2	2				
7 (C)	69.9	63.5	6.4	3	3				
9 (R)	**66.5**	64.0	2.5	3	0				
Area 3: South of Highway 10 between Main Street and Jackson Avenue									
6 (C)	**70.1**	67.1	3.0	2	0	1,290	25,100	$376,500	$22,818
8 (C)	**73.6**	68.1	5.5	3	3				
Area 4: South of Highway 10 between Jackson Avenue and Morton Avenue									
10 (C)	**73.4**	67.5	5.9	2	0	1,060	20,500	$307,500	$26,059
Area 5: South of Highway 10 between Proctor Avenue and Morton Avenue									
11 (R)	**69.3**	64.0	5.3	4	4	1,270	24,700	$370,500	$4,631
12-1 (R)	**68.0**	60.9	7.1	1	1				
12-2 (R)	**66.0**	60.1	5.9	3	3				
13-1 (R)	**67.9**	61.1	6.8	5	5				
13-2 (R)	64.6	62.5	2.1	3	0				
14-1 (R)	**67.4**	**65.9**	1.5	4	0				
14-2 (R)	**66.7**	**66.1**	0.6	3	0				

Bold numbers exceed State daytime noise standards.
N/A = not applicable because all receptors adjacent to the modeled wall did not meet the minimum 5 dBA threshold to be considered acoustically effective.
(R) – Residential; (C) – Commercial; (Ch) – Church
[1] Surface area includes wall taper at each end.

TABLE D-5 continued
NOISE MITIGATION COST EFFECTIVENESS RESULTS (DAYTIME)
20-foot Modeled Walls

Receptors	Daytime L_{10} Noise (dBA)		Reduction (in dBA) with 20 ft noise wall	Number of residences	Number of affected residences	Length of wall (feet)	Wall Area (SF) [1]	Total cost of wall $15/sq ft	Cost/dBA/ receptor
	Pref. Alt. year 2030 (no wall)	Pref. Alt. year 2030 (20 ft wall)							
Area 6, Wall 6A: Between Highway 10 and one-way eastbound frontage road from Proctor Avenue to Bridge Street									
16-1 (R)	**69.3**	**66.5**	2.8	4	0	1,400	27,300	$409,500	$19,688
16-2 (R)	**69.1**	63.9	5.2	4	4				
16-3 (R)	**65.8**	**65.6**	0.2	3	0				
17-1 (R)	**67.8**	63.5	4.3	4	0				
17-2 (R)	**66.3**	64.0	2.3	4	0				
17-3 (R)	63.7	62.1	1.6	3	0				
17-4 (R)	62.1	60.6	1.5	4	0				
Area 6, Wall 6B: South of one-way eastbound frontage road from Proctor Avenue to Bridge Street									
16-1 (R)	**69.3**	61.4	7.9	4	4	1,450	28,300	$424,500	$3,412
16-2 (R)	**69.1**	60.7	8.4	4	4				
16-3 (R)	**65.8**	64.7	1.1	3	0				
17-1 (R)	**67.8**	59.8	8.0	4	4				
17-2 (R)	**66.3**	59.5	6.8	4	4				
17-3 (R)	63.7	60.1	3.6	3	0				
17-4 (R)	62.1	58.6	3.5	4	0				
Area 7, Wall 7A: 1,300-foot long wall from westbound Hwy 10 exit ramp to Bridge Street									
18-1 (R)	**65.8**	60.3	5.5	6	6	1,300	25,300	$379,500	$11,500
18-2 (R)	63.3	60.0	3.3	8	0				
Area 7, Wall 7B: 1,690-foot long wall from west project limits to westbound Hwy 10 exit ramp to frontage road									
21-1 (R)	**71.5**	62.5	9.0	3	3	1,690	33,100	$496,500	$9,793
21-2 (R)	**67.8**	59.9	7.9	3	3				
22 (R)	**70.1**	**65.4**	4.7	2	0				

Bold numbers exceed State daytime noise standards.
N/A = not applicable because all receptors adjacent to the modeled wall did not meet the minimum 5 dBA threshold to be considered acoustically effective.
(R) – Residential; (C) – Commercial; (Ch) – Church
[1] Surface area includes wall taper at each end.

TABLE D-5 continued
NOISE MITIGATION COST EFFECTIVENESS RESULTS (DAYTIME)
20-foot Modeled Walls

Receptors	Daytime L_{10} Noise (dBA)		Reduction (in dBA) with 20 ft noise wall	Number of residences	Number of affected residences	Length of wall (feet)	Wall Area (SF) [(1)]	Total cost of wall $15/sq ft	Cost/dBA/ receptor
	Pref. Alt. year 2030 (no wall)	Pref. Alt. year 2030 (20 ft wall)							
Area 8A: North of Highway 10 along entrance ramp to westbound Highway 10, west of Upland Avenue									
19-1 (R)	**68.4**	61.6	6.8	3	3	1,790	35,100	$526,500	$7,846
19-2 (R)	**66.7**	61.0	5.7	2	2				
19-3 (R)	**72.3**	64.4	7.9	3	3				
19-4 (R)	**74.8**	63.2	11.6	1	1				
19-5 (R)	**74.2**	**70.2**	4.0	1	0				
20 (R)	**65.3**	60.5	4.8	2	0				
Area 8B:North of Highway 10 at western project terminus									
23-1 (R)	**76.1**	**72.3**	3.8	2	0	650	12,300	$184,500	$6,734
23-2 (R)	**66.5**	63.6	2.9	2	0				
24 (R)	**77.5**	63.8	13.7	2	2				
25 (R)	**74.3**	**70.8**	3.5	1	0				

Bold numbers exceed State daytime noise standards.
N/A = not applicable because all receptors adjacent to the modeled wall did not meet the minimum 5 dBA threshold to be considered acoustically effective.
(R) – Residential; (C) – Commercial; (Ch) – Church
(1) Surface area includes wall taper at each end.

TABLE D-6
NOISE MITIGATION COST EFFECTIVENESS RESULTS (DAYTIME)
15-foot Modeled Walls

Receptors	Daytime L_{10} Noise (dBA)		Reduction (in dBA) with 15 ft noise wall	Number of residences	Number of affected residences	Length of wall (feet)	Wall Area (SF) [1]	Total cost of wall $15/sq ft	Cost/dBA/ receptor
	Pref. Alt. year 2030 (no wall)	Pref. Alt. year 2030 (15 ft wall)							
Area 1: East of Main Street north of Highway 10									
1-1 (R)	**70.9**	**65.5**	5.4	3	3	1,160	16,950	$254,250	$15,694
1-2 (R)	**65.2**	61.6	3.6	4	0				
2-1 (R)	**69.2**	64.8	4.4	5	0				
2-2 (C)	**65.9**	63.3	2.6	2	0				
Area 2: Main Street to Jackson Avenue north of Highway 10									
3 (C)	69.6	68.5	1.1	3	0	1,380	20,250	$303,750	N/A
4 (R)	**70.3**	**68.5**	1.8	1	0				
5 (C)	**70.9**	66.8	4.1	2	0				
7 (C)	69.9	66.5	3.4	3	0				
9 (R)	**66.5**	**65.4**	1.1	3	0				
Area 3: South of Highway 10 between Main Street and Jackson Avenue									
6 (C)	**70.1**	67.3	2.8	2	0	1,290	18,900	$283,500	$18,900
8 (C)	**73.6**	68.6	5.0	3	3				
Area 4: South of Highway 10 between Jackson Avenue and Morton Avenue									
10 (C)	**73.4**	**68.7**	4.7	2	0	1,060	15,450	$231,750	N/A
Area 5: South of Highway 10 between Proctor Avenue and Morton Avenue									
11 (R)	**69.3**	64.3	5.0	4	4	1,270	18,600	$279,000	$5,110
12-1 (Ch)	**68.0**	62.4	5.6	1	1				
12-2 (R)	**66.0**	61.1	4.9	3	0				
13-1 (R)	**67.9**	62.1	5.8	5	5				
13-2 (R)	64.6	62.7	1.9	3	0				
14-1 (R)	**67.4**	**66.0**	1.4	4	0				
14-2 (R)	**66.7**	**66.2**	0.5	3	0				

Bold numbers exceed State daytime noise standards.
N/A = not applicable because all receptors adjacent to the modeled wall did not meet the minimum 5 dBA threshold to be considered acoustically effective.
(R) – Residential; (C) – Commercial; (Ch) – Church
[1] Surface area includes wall taper at each end.

TABLE D-6 continued
NOISE MITIGATION COST EFFECTIVENESS RESULTS (DAYTIME)
15-foot Modeled Walls

Receptors	Daytime L_{10} Noise (dBA)		Reduction (in dBA) with 15 ft noise wall	Number of residences	Number of affected residences	Length of wall (feet)	Wall Area (SF) [1]	Total cost of wall $15/sq ft	Cost/dBA/ receptor
	Pref. Alt. year 2030 (no wall)	Pref. Alt. year 2030 (15 ft wall)							
Area 6, Wall 6A: Between Highway 10 and one-way eastbound frontage road from Proctor Avenue to Bridge Street									
16-1 (R)	**69.3**	**66.7**	2.6	4	0	1,400	20,550	$308,250	N/A
16-2 (R)	**69.1**	64.5	4.6	4	0				
16-3 (R)	**65.8**	**65.7**	0.1	3	0				
17-1 (R)	**67.8**	64.0	3.8	4	0				
17-2 (R)	**66.3**	64.3	2.0	4	0				
17-3 (R)	63.7	62.3	1.4	3	0				
17-4 (R)	62.1	60.8	1.3	4	0				
Area 6, Wall 6B: South of one-way eastbound frontage road from Proctor Avenue to Bridge Street									
16-1 (R)	**69.3**	62.3	7.0	4	4	1,450	21,300	$319,500	$3,182
16-2 (R)	**69.1**	62.8	6.3	4	4				
16-3 (R)	**65.8**	64.8	1.0	3	0				
17-1 (R)	**67.8**	61.9	5.9	4	4				
17-2 (R)	**66.3**	60.4	5.9	4	4				
17-3 (R)	63.7	60.6	3.1	3	0				
17-4 (R)	62.1	59.1	3.0	4	0				
Area 7, Wall 7A: 1,300-foot long wall from westbound Hwy 10 exit ramp to Bridge Street									
18-1 (R)	**65.8**	61.7	4.1	6	0	1,300	19,050	$285,750	N/A
18-2 (R)	63.3	61.0	2.3	8	0				
Area 7, Wall 7B: 1,690-foot long wall from west project limits to westbound Hwy 10 exit ramp to frontage road									
21-1 (R)	**71.5**	64.8	6.7	3	3	1,690	24,900	$373,500	$10,122
21-2 (R)	**67.8**	62.2	5.6	3	3				
22 (R)	**70.1**	**66.3**	3.8	2	0				

Bold numbers exceed State daytime noise standards.
N/A = not applicable because all receptors adjacent to the modeled wall did not meet the minimum 5 dBA threshold to be considered acoustically effective.
(R) – Residential; (C) – Commercial; (Ch) – Church
[1] Surface area includes wall taper at each end.

TABLE D-6 continued
NOISE MITIGATION COST EFFECTIVENESS RESULTS (DAYTIME)
15-foot Modeled Walls

Receptors	Daytime L_{10} Noise (dBA)		Reduction (in dBA) with 15 ft noise wall	Number of residences	Number of affected residences	Length of wall (feet)	Wall Area (SF) [(1)]	Total cost of wall $15/sq ft	Cost/dBA/ receptor
	Pref. Alt. year 2030 (no wall)	Pref. Alt. year 2030 (15 ft wall)							
Area 8A: North of Highway 10 along entrance ramp to westbound Highway 10, west of Upland Avenue									
19-1 (R)	**68.4**	63.8	4.6	3	0	1,790	26,400	$396,000	$46,588
19-2 (R)	**66.7**	62.8	3.9	2	0				
19-3 (R)	**72.3**	**67.4**	4.9	3	0				
19-4 (R)	**74.8**	**66.3**	8.5	1	2				
19-5 (R)	**74.2**	**70.5**	3.7	1	0				
20 (R)	**65.3**	62.1	3.2	2	0				
Area 8B:North of Highway 10 at western project terminus									
23-1 (R)	**76.1**	**73.0**	3.1	2	0	650	9,300	$139,500	$6,399
23-2 (R)	**66.5**	64.0	2.5	2	0				
24 (R)	**77.5**	**66.6**	10.9	2	2				
25 (R)	**74.3**	**71.1**	3.2	1	0				

Bold numbers exceed State daytime noise standards.
N/A = not applicable because all receptors adjacent to the modeled wall did not meet the minimum 5 dBA threshold to be considered acoustically effective.
(R) – Residential; (C) – Commercial; (Ch) – Church
(1) Surface area includes wall taper at each end.

TABLE D-7
NOISE MITIGATION COST EFFECTIVENESS RESULTS (DAYTIME)
10-foot Modeled Walls

Receptors	Daytime L_{10} Noise (dBA)		Reduction (in dBA) with 10 ft noise wall	Number of residences	Number of affected residences	Length of wall (feet)	Wall Area (SF) [1]	Total cost of wall $15/sq ft	Cost/dBA/ receptor
	Pref. Alt. year 2030 (no wall)	Pref. Alt. year 2030 (10 ft wall)							
Area 1: East of Main Street north of Highway 10									
1-1 (R)	**70.9**	**68.0**	2.9	3	0	1,160	11,400	$171,000	N/A
1-2 (R)	**65.2**	62.3	2.9	4	0				
2-1 (R)	**69.2**	**67.1**	2.1	5	0				
2-2 (C)	**65.9**	64.6	1.3	2	0				
Area 2: Main Street to Jackson Avenue north of Highway 10									
3 (C)	69.6	69.1	0.5	3	0	1,380	13,600	$204,000	N/A
4 (R)	**70.3**	**68.9**	1.4	1	0				
5 (C)	**70.9**	68.6	2.3	2	0				
7 (C)	69.9	68.6	1.3	3	0				
9 (R)	**66.5**	**66.2**	0.3	3	0				
Area 3: South of Highway 10 between Main Street and Jackson Avenue									
6 (C)	**70.1**	67.9	2.2	2	0	1,290	12,700	$190,500	N/A
8 (C)	**73.6**	69.8	3.8	3	0				
Area 4: South of Highway 10 between Jackson Avenue and Morton Avenue									
10 (C)	**73.4**	**70.9**	2.5	2	0	1,060	10,400	$156,000	N/A
Area 5: South of Highway 10 between Proctor Avenue and Morton Avenue									
11 (R)	**69.3**	**65.1**	4.2	4	0	1,270	12,500	$187,500	N/A
12-1 (Ch)	**68.0**	64.6	3.4	1	0				
12-2 (R)	**66.0**	62.7	3.3	3	0				
13-1 (R)	**67.9**	63.7	4.2	5	0				
13-2 (R)	64.6	63.1	1.5	3	0				
14-1 (R)	**67.4**	**66.3**	1.1	4	0				
14-2 (R)	**66.7**	**66.3**	0.4	4	0				

Bold numbers exceed State daytime noise standards.
N/A = not applicable because all receptors adjacent to the modeled wall did not meet the minimum 5 dBA threshold to be considered acoustically effective.
(R) – Residential; (C) – Commercial; (Ch) – Church
[1] Surface area includes wall taper at each end.

TABLE D-7 continued
NOISE MITIGATION COST EFFECTIVENESS RESULTS (DAYTIME)
10-foot Modeled Walls

Receptors	Daytime L_{10} Noise (dBA)		Reduction (in dBA) with 10 ft noise wall	Number of residences	Number of affected residences	Length of wall (feet)	Wall Area (SF) [1]	Total cost of wall $15/sq ft	Cost/dBA/ receptor
	Pref. Alt. year 2030 (no wall)	Pref. Alt. year 2030 (10 ft wall)							
Area 6, Wall 6A: Between Highway 10 and one-way eastbound frontage road from Proctor Avenue to Bridge Street									
16-1 (R)	**69.3**	**67.2**	2.1	4	0	1,400	13,800	$207,000	N/A
16-2 (R)	**69.1**	**65.7**	3.4	4	0				
16-3 (R)	**65.8**	**65.8**	0	3	0				
17-1 (R)	**67.8**	**65.1**	2.7	4	0				
17-2 (R)	**66.3**	64.8	1.5	4	0				
17-3 (R)	63.7	62.6	1.1	3	0				
17-4 (R)	62.1	61.2	0.9	4	0				
Area 6, Wall 6B: South of one-way eastbound frontage road from Proctor Avenue to Bridge Street									
16-1 (R)	**69.3**	63.9	5.4	4	4	1,450	14,300	$214,500	$9,931
16-2 (R)	**69.1**	**65.7**	3.4	4	0				
16-3 (R)	**65.8**	65.0	0.8	3	0				
17-1 (R)	**67.8**	64.7	3.1	4	0				
17-2 (R)	**66.3**	62.2	4.1	4	0				
17-3 (R)	63.7	61.6	2.1	3	0				
17-4 (R)	62.1	60.0	2.1	4	0				
Area 7, Wall 7A: 1,300-foot long wall from westbound Hwy 10 exit ramp to Bridge Street									
18-1 (R)	**65.8**	63.7	2.1	6	0	1,300	12,800	$192,000	N/A
18-2 (R)	63.3	62.1	1.2	8	0				
Area 7, Wall 7B: 1,690-foot long wall from west project limits to westbound Hwy 10 exit ramp to frontage road									
21-1 (R)	**71.5**	**67.7**	3.8	3	0	1,690	16,700	$250,500	N/A
21-2 (R)	**67.8**	64.9	2.9	3	0				
22 (R)	**70.1**	**68.0**	2.1	2	0				

Bold numbers exceed State daytime noise standards.
N/A = not applicable because all receptors adjacent to the modeled wall did not meet the minimum 5 dBA threshold to be considered acoustically effective.
(R) – Residential; (C) – Commercial; (Ch) – Church
[1] Surface area includes wall taper at each end.

TABLE D-7 continued
NOISE MITIGATION COST EFFECTIVENESS RESULTS (DAYTIME)
10-foot Modeled Walls

Receptors	Daytime L_{10} Noise (dBA)		Reduction (in dBA) with 10 ft noise wall	Number of residences	Number of affected residences	Length of wall (feet)	Wall Area (SF) [(1)]	Total cost of wall $15/sq ft	Cost/dBA/ receptor
	Pref. Alt. year 2030 (no wall)	Pref. Alt. year 2030 (10 ft wall)							
Area 8A: North of Highway 10 along entrance ramp to westbound Highway 10, west of Upland Avenue									
19-1 (R)	**68.4**	**66.3**	2.1	3	0	1,790	17,700	$265,500	N/A
19-2 (R)	**66.7**	64.9	1.8	2	0				
19-3 (R)	**72.3**	**70.1**	2.2	3	0				
19-4 (R)	**74.8**	**70.2**	4.6	1	0				
19-5 (R)	**74.2**	**71.5**	2.7	1	0				
20 (R)	**65.3**	64.1	1.2	2	0				
Area 8B:North of Highway 10 at western project terminus									
23-1 (R)	**76.1**	**74.0**	2.1	2	0	650	6,300	$94,500	$6,655
23-2 (R)	**66.5**	64.8	1.7	2	2				
24 (R)	**77.5**	**70.4**	7.1	2	0				
25 (R)	**74.3**	**71.9**	2.4	1	0				

Bold numbers exceed State daytime noise standards.
N/A = not applicable because all receptors adjacent to the modeled wall did not meet the minimum 5 dBA threshold to be considered acoustically effective.
(R) – Residential; (C) – Commercial; (Ch) – Church
(1) Surface area includes wall taper at each end.

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NOISE RECEPTOR AND MODELED BARRIER LOCATIONS

ENVIRONMENTAL ASSESSMENT
T.H. 10 - SP 7102-123

Figure D1