US Route 395 – North Spokane Corridor
MP 159 to MP 162

Noise Technical Report

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EXECUTIVE SUMMARY

The North Spokane Corridor (NSC) projects address the need for a major improvement to allow motorists and freight to move through metropolitan Spokane along the corridor from I-90 to US 395 at Wandermere. The projects will provide a four- to eight-lane, fully controlled access highway. The length of the NSC is approximately 10.4 miles. This project will help reduce congestion and other related operational problems on city streets by providing a transportation facility that will accommodate high volume traffic movements between I-90 and areas north.

The Washington State Department of Transportation has been constructing the northern section of the NSC from Francis/Freya to Wandermere since 2001. This 5.5 mile segment will be complete in 2012.

In 2009, the NSC design from the Spokane River to the Francis/Freya interchange changed. There are several reasons why this change took place. First, the Burlington Northern Santa Fe (BNSF) railroad bridge over the NSC near Illinois Avenue is impractical to build. Retaining walls in the depressed section of the original design are unacceptable to BNSF. The depressed section is also exceedingly expensive, which nearly doubles the cost of the project. Lastly, current construction funding comes in packages that are too small to complete the entire depressed section, and will provide little local benefit until completed. These reasons are discussed in greater detail in the "Reevaluation Summary" document.

The redesign has several components designed to alleviate these concerns. The first component is to maintain the BNSF railroad on west side of the NSC. This will eliminate a need for a bridge crossing over the NSC. The profile for the NSC has been raised from the Spokane River to Wellesley Avenue. This will eliminate a large portion of excavation, and the expensive and unworkable retaining walls. The Wellesley Avenue Interchange has decreased its footprint size by using a roundabout and raising the NSC to pass over instead of under Wellesley Avenue. The NSC will be at grade at Francis Avenue instead of on fill. Francis Avenue will need to cross the NSC on a bridge. Finally, a southbound NSC access ramp from Francis Avenue has been removed keeping the NSC inside the original project footprint. By utilizing these changes, the project will now become more constructible in light of expected funding increments and staging requirements.

This discipline report focuses on the Upriver Drive to Wilding Avenue section of the corridor and supplements previous noise studies. This update had been prepared because the vertical and horizontal alignment of the NSC through this area has changed since the May 20, 2010 Noise Discipline Report. Changes in vertical and horizontal alignment can also be found on local streets that are adjacent to the corridor, specifically Greene St. and the frontage road between the corridor and Ralph St. will be affected by these changes in alignment. Four intersections located

throughout the study area were also evaluated for abatement because the intersections either added lanes or changed the configuration of the intersection. These intersections are at Francis and Market, Wellesley and Market, Wellesley and Freya, and Euclid and Market.

Noise levels were modeled at 43 sites throughout the study area. These receivers represent a variety of residential, commercial, and industrial sites. None of the modeled locations are above the noise abatement criteria level (NAC) in either the existing conditions or the no build scenario. Model results show 18 receiver locations over the NAC in the build scenario. Twenty-six of the receivers show a substantial increase in noise (greater than 10 dBA).

The area east of the roadway, between Upriver Drive and Wellesley was evaluated for noise abatement. A noise wall from Upriver Drive to north of Wildhorse Park was found to be both reasonable and feasible. The minimum wall runs 8 feet tall with the exception of a 6' section from Grace Avenue to Courtland Avenue. A wall in this area is recommended; final wall design will be determined through engineering and public outreach processes.

The area west of the proposed roadway from Upriver Drive to the railroad tracks was evaluated for noise abatement. The minimum wall to meet both feasibility and reasonableness criteria is 8 to 12 feet. A wall in this area is recommended; final wall design will be determined through engineering and public outreach processes.

The area west of the proposed roadway from Grace Ave to Courtland Ave was also evaluated for noise abatement. The minimum wall meets the feasibility requirements, but fails to meet reasonableness criteria, therefore, a wall is not recommended in this area.

The Francis and Market, Wellesley and Freya, and Euclid and Market intersections had no impacted receivers and, therefore, no abatement was evaluated. The Wellesley and Market intersection had one receiver with the noise level exceeding the NAC. Abatement is not recommended here because a wall will not meet reasonableness requirements.

CHARACTERISTICS OF NOISE

Characteristics of Noise

Sound is created when objects vibrate, resulting in a minute variation in surrounding atmospheric pressure called sound pressure. The human response to sound depends on the magnitude of a sound as a function of its frequency and time pattern (EPA, 1974). Magnitude measures the physical sound energy in the air. The range of magnitude from the faintest to the loudest sound the ear can hear is so large that sound pressure is expressed on a logarithmic scale in units called decibels (dB). Loudness, compared to physical sound measurement, refers to how people subjectively judge a sound and varies from person to person. Magnitudes of typical noise levels are presented in Exhibit 1.

Humans respond to a sound's frequency or pitch. The human ear is very effective at perceiving sounds with a frequency between approximately 1,000 and 5,000 Hz, with the efficiency decreasing outside this range. Environmental noise is composed of many frequencies, each occurring simultaneously at its own sound pressure level. Frequency weighting, which is applied electronically by a sound level meter, combines the sound frequencies into one sound level that simulates how an average person hears sounds. The commonly used frequency weighting for environmental noise is A-weighting (dBA), which is most similar to how humans perceive sounds of low to moderate magnitude.

Because of the logarithmic decibel scale, a doubling of the number of noise sources, such as the number of cars operating on a roadway, increases noise levels by 3 dBA. A tenfold increase in the number of noise sources will add 10 dBA. As a result, a noise source emitting a noise level of 60 dBA combined with another noise source of 60 dBA yields a combined noise level of 63 dBA, not 120 dBA. The human ear can barely perceive a 3 dBA increase, while a 5 or 6 dBA increase is readily noticeable and sounds as if the noise is about one and one-half times as loud. A 10 dBA increase appears to be a doubling in noise level to most listeners.

Noise levels from traffic sources depend on volume, speed, and the type of vehicle. Generally, an increase in volume, speed, or vehicle size increases traffic noise levels. Vehicular noise is a combination of noises from the engine, exhaust, and tires. Other conditions affecting traffic noise include defective mufflers, steep grades, terrain, vegetation, distance from the roadway, and shielding by barriers and buildings.

Noise levels decrease with distance from the noise source. For a line source such as a roadway, noise levels decrease 3 dBA over hard ground (concrete, pavement) or 4.5 dBA over soft ground (grass) for every doubling of distance between the source and the receptor. For a point source such as construction sources, noise levels will decrease between 6 and 7.5 dBA for every doubling of distance from the source.

CHARACTERISTICS OF NOISE

The propagation of noise can be greatly affected by terrain and the elevation of the receiver relative to the noise source. Level ground is the simplest scenario. Noise travels in a straight line-of-sight path between the source and receiver. If the noise source is depressed or the receiver is elevated, noise generally travels directly to the receiver. Noise levels may be reduced because the terrain crests between the source and receiver, resulting in a partial noise barrier near the receiver. If the noise source is elevated or the receiver is depressed, noise often is reduced at the receiver. The edge of the roadway can act as a partial noise barrier, blocking some sound transmission between the source and receiver. Even a short barrier, such as a solid concrete jersey-type safety barrier, can be effective at further reducing noise levels. Breaking the line of sight between the receiver and the highest noise source reduces the noise level approximately 5 dBA.

EXHIBIT 1 Typical Noise Levels

Transportation Sources	Noise Level (dBA)	Other Sources	Description
	130	Gunshot (5 ft)	**Painfully Loud**
	125		
Jet Takeoff (200 ft)	120		
Car Horn (3 ft)	115		**Maximum Vocal Effort**
	110		
	105		
	100	Shout (1.5 ft)	
	95		**Very Annoying**
Heavy Truck (50 ft)	90	Jackhammer (50 ft)	
Train on a Structure (50 ft)	85	Home Shop Tools (3 ft) Backhoe (50 ft)	
	80	Bulldozer(50 ft)	**Annoying**
Train (50 feet)	75	Vacuum Cleaner (3 ft) Blender (3 ft)	
City Bus at Stop (50 ft) Freeway Traffic (50 ft)	70	Lawn Mower (50 ft)	
Train in Station (50 ft)	65	Large Office Washing Machine (3 ft)	**Intrusive**
	60	TV (10 ft)	
	55	Talking (10 ft)	
Light Traffic (50 ft)	50		**Quiet**
Light Traffic (100 ft)	45	Refrigerator (3 ft)	
	40	Bedroom Library	
	35		
	30	Soft Whisper (15 ft)	**Very Quiet**

Noise Level Descriptors

A widely used descriptor for environmental noise is the equivalent sound level (Leq). The Leq can be considered a measure of the average noise level during a specified period of time. It is a measure of total noise, or a summation of all sounds during a time period. It places more emphasis on occasional high noise levels that accompany general background noise levels. Leq is defined as the constant level that, over a given period of time, transmits to the receiver the same amount of acoustical energy as the actual time-varying sound. For example, two sounds, one of which contains twice as much energy, but lasts only half as long, have the same Leq noise levels. Leq measured over a one-hour period is the hourly Leq [Leq(h)], which is used for highway noise impact and abatement analyses.

Either the total noise energy or the highest instantaneous noise level that occurs during the event can describe short-term noise levels, such as those from a single truck pass-by. The sound exposure level (SEL) is a measure of total sound energy from an event, and is useful in determining what the Leq would be over a period in time when several noise events occur. The maximum sound level (Lmax) is the greatest short-duration sound level that occurs during a single event. Lmax is related to impacts on speech interference and sleep disruption. In comparison, Lmin is the minimum sound level during a period of time.

People will generally find a moderately high, constant sound level more tolerable than a quiet background level interrupted by frequent high-level noise intrusions. An individual's response to sound depends greatly upon the range that the sound varies in a given environment. For example, steady traffic noise from a highway is normally less bothersome than occasional aircraft flyovers in a relatively quiet area. In light of this subjective response, it is often useful to look at a statistical distribution of sound levels over a given time period in addition to the average sound level. Such distributions identify the sound level exceeded and the percentage of time exceeded; therefore, it allows for a more thorough description of the range of sound levels during the given measurement period. These distributions are identified with an Ln where n is the percentage of time that the levels are exceeded. For example, the L10 level is the noise level that is exceeded 10 percent of the time.

Effects of Noise

Environmental noise at high intensities directly affects human health by causing hearing loss. Prolonged exposure to very high levels of environmental noise can cause hearing loss. The EPA has established a protective level 70 dBA Leq(24), below which hearing is conserved for exposure over a 40-year period (U.S. EPA, 1974). Although scientific evidence currently is not conclusive, noise is suspected of causing or aggravating some diseases. Environmental noise indirectly affects human welfare by interfering with sleep, thought, and conversation. The FHWA

noise abatement criteria are based on speech interference, which is a well documented impact that is relatively reproducible in human response studies. Noise also can affect wildlife.

Noise Regulations and Impact Criteria

Applicable noise regulations and guidelines provide a basis for evaluating potential noise impacts. For federally funded highway projects, traffic noise impacts occur when predicted Leq(h) noise levels approach or exceed noise abatement criteria (NAC) established by the FHWA, or substantially exceed existing noise levels (U.S. Department of Transportation, 1982, Noise Abatement Council). Although "substantially exceed" is not defined, WSDOT considers an increase of 10 dBA or more to be a substantial increase.

The FHWA noise abatement criteria specify exterior Leq(h) noise levels for various land activity categories (Exhibit 2). For receptors where serenity and quiet are of extraordinary significance, the noise criterion is 57 dBA. For residences, parks, schools, churches, and similar areas, the noise criterion is 67 dBA. For developed lands, the noise criterion is 72 dBA. WSDOT considers a noise impact to occur if predicted Leq(h) noise levels approach within 1 dBA of the noise abatement criteria in Exhibit 2. Thus, if a noise level were 66 dBA or higher, it would approach or exceed the FHWA noise abatement criterion of 67 dBA for residences. Increases in noise levels of more than 10 dBA over existing noise levels are considered substantial increases and also qualify for noise abatement.

EXHIBIT 2 FHWA Noise Abatement Criteria

Activity Category	L_{eq} (h) (dBA)	Description of Activity Category
A	57 (exterior)	Lands on which serenity and quiet are of extraordinary significance and serve an important public need and where the preservation of those qualities is essential if the area is to continue to serve its intended purpose.
B	67 (exterior)	Picnic areas, recreation areas, playgrounds, active sports areas, parks, residences, motels, hotels, schools, churches, libraries, and hospitals.
C	72 (exterior)	Developed lands, properties, or activities not included in Categories A or B above.
D	—	Undeveloped lands.
E	52 (interior)	Residences, motels, hotels, public meeting rooms, schools, churches, libraries, hospitals, and auditoriums.

Source: U.S. Department of Transportation, 1982.

Washington State Department of Ecology limits noise levels at property lines of neighboring properties (WAC Chapter 173-60). Traffic noise is exempt from the property line noise limits,

but the limits apply to construction noise during certain hours. The maximum permissible noise levels depend on the land uses of both the noise source and receiving property (Exhibit 3). The Environmental Designation for Noise Abatement (EDNA) is defined by the land use of a property. In general, residential uses are class A, commercial are class B, and industrial are class C. The nighttime (10:00 PM to 7:00 AM) allowable noise levels at Class A receiving properties (residential) are reduced by 10 dBA.

EXHIBIT 3 Maximum Permissible Environmental Noise Levels

	EDNA of Receiving Property		
EDNA of Noise Source	Class A	Class B	Class C
CLASS A	55 dBA	57 dBA	60 dBA
CLASS B	57	60	65
CLASS C	60	65	70

Source: WAC 173-60-040

Short-term exceedences above the permissible sound level are allowed. During any one-hour period the maximum level may be exceeded by 5 dBA for a total of 15 minutes, by 10 dBA for a total of 5 minutes, or by 15 dBA for a total of 1.5 minutes (WAC 173-60-040).

Construction noise is exempt from property line standards during daytime hours. During nighttime hours (10 p.m. and 7 a.m.), construction noise must meet Department of Ecology property line regulations. Noise levels in Exhibit 3 apply to construction equipment only at rural and residential receiving properties between 10 p.m. and 7 a.m.

METHODOLOGY

Operational Noise

Ambient noise levels were measured to describe the existing noise environment, identify major noise sources in the project area, and validate the noise model. Once validated, the model was used to estimate future noise levels.

FHWA's Traffic Noise Model (TNM) Version 2.5 computer model (FHWA, 2004) was used to predict Leq(h) traffic noise levels. TNM calculates precise estimates of noise levels at discrete points by considering interactions between different noise sources and the effects of topographical features on the noise level. The model estimates the acoustic intensity at a receiver location calculated from a series of straight-line roadway segments. Noise emissions from free-flowing traffic depend on the number of automobiles, medium trucks, and heavy trucks per hour; vehicular speed; and reference noise emission levels of individual vehicles. TNM also considers effects of intervening barriers, topography, vegetation, and atmospheric absorption. Noise from sources other than traffic is not included; therefore, when non-traffic noise, such as aircraft, is considerable in an area, TNM will under predict the actual noise level.

To create the model, a Microstation DGN file was imported as a DXF file into the TNM package, and major roadways, topographical features, and sensitive receptors were digitized into the model. Elevations were added from topographic contour data and design plans. Aerial photographs were also used to verify site conditions.

Model Validation

Noise model validation ensures that the noise model created in TNM accurately represents the noise environment on site. To be considered valid, a model must calculate current noise levels within ±2.0 dBA of the measured values. For this analysis noise levels were measured at 4 sites near the project area and used to validate the model. Exhibit 4 shows the results of model validation. Receiver locations indicated with “V” in Exhibits 5 and 6 with were used to validate the model. Traffic counts taken during noise measurements are shown in Exhibit 9.

Receiver V5 was used only for validating the model and was not modeled in the Existing, Build, or No Build scenarios.

Four of the validation sites met the requirement of having the measured and modeled noise levels within 2.0 dBA. The measurement in the field north of Wildhorse Park did not come within 2.0 dBA of the modeled value. However, there was noticeable non-traffic noise during the noise measurement from train horns, planes, and helicopters. This would result in the measured level being higher than the modeled noise level. TNM only models traffic noise, therefore, it can underestimate the actual noise level if there are other, non-traffic noise sources. Indeed, this is

the case here. Therefore, despite the model not predicting the noise levels within 2.0 dBA at all of the measured locations, the model was determined to be valid.

EXHIBIT 4 Noise Model Validation

Location	Date	Start Time	Measured L_{eq}	Modeled L_{eq}	Difference
V1 – Field	11/25/2008	3:45 pm	51.6	44.3	-7.3
V2 – Wildhorse Park	11/25/2008	3:10 pm	50.2	49.9	-0.3
V3 – Fairview & Thor	11/25/2008	2:47 pm	48.4	50.1	1.7
V4 – Fairview & Ralph	11/25/2008	2:23 pm	59.4	58.2	-1.2
V5 – Jackson	3/22/2010	–	65.1	63.3	-1.8

Future Noise Levels

Existing and future noise levels, both build and no build, were modeled at 43 locations based on p.m. peak traffic volumes. All receiver locations identified in Exhibits 5 and 6 were modeled for all three scenarios. Traffic data used is shown in Exhibits 10 through 14.

Build scenario noise levels were compared to the NAC, existing, and no build noise levels. Areas with noise levels above the NAC were evaluated for mitigation.

Rail Noise

Because the rail line is being moved as part of the project, rail noise was evaluated using the Federal Transit Administration's Noise Impact Assessment Spreadsheet. Typically, four trains use the track each day and travel at 25 miles per hour through the study area. To make room for the new roadway, the rail tracks will be moved to the west:

- Grace to Euclid: 0-55'
- Euclid to Empire: 55-270'
- Empire to Wellesley: 270-55'
- Wellesley to Central: 55-0'
- Central to Lyons: 0-110'
- Lyons to Wilding: 110-0'

Construction Noise

Construction noise was qualitatively assessed compared to Department of Ecology property line regulations.

EXHIBIT 5 Receiver Locations – East Rich Avenue to East Wilding Avenue

EXHIBIT 6 Receiver Locations – Up River Drive to East Rich Avenue

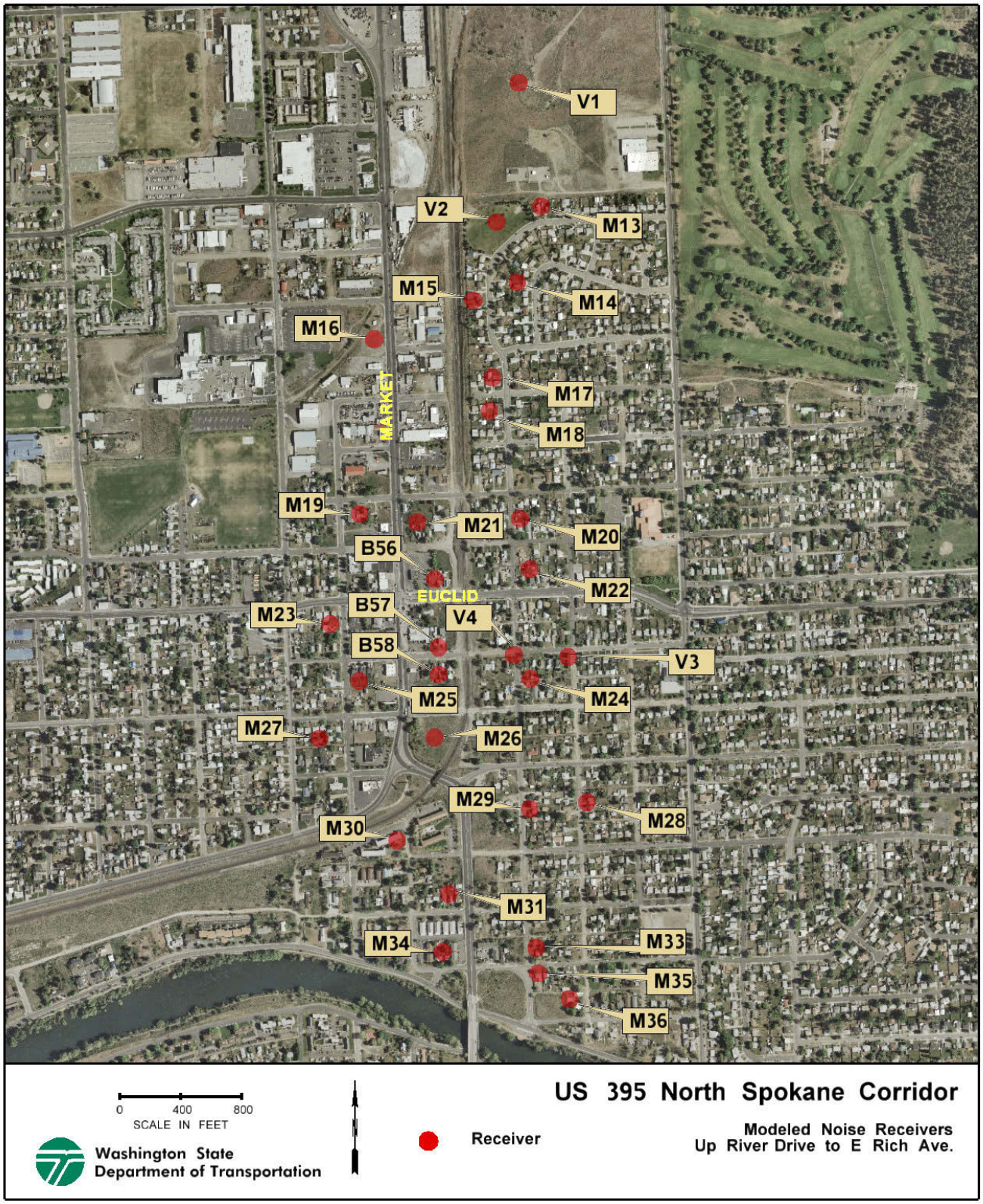


EXHIBIT 7 Modeled Intersections

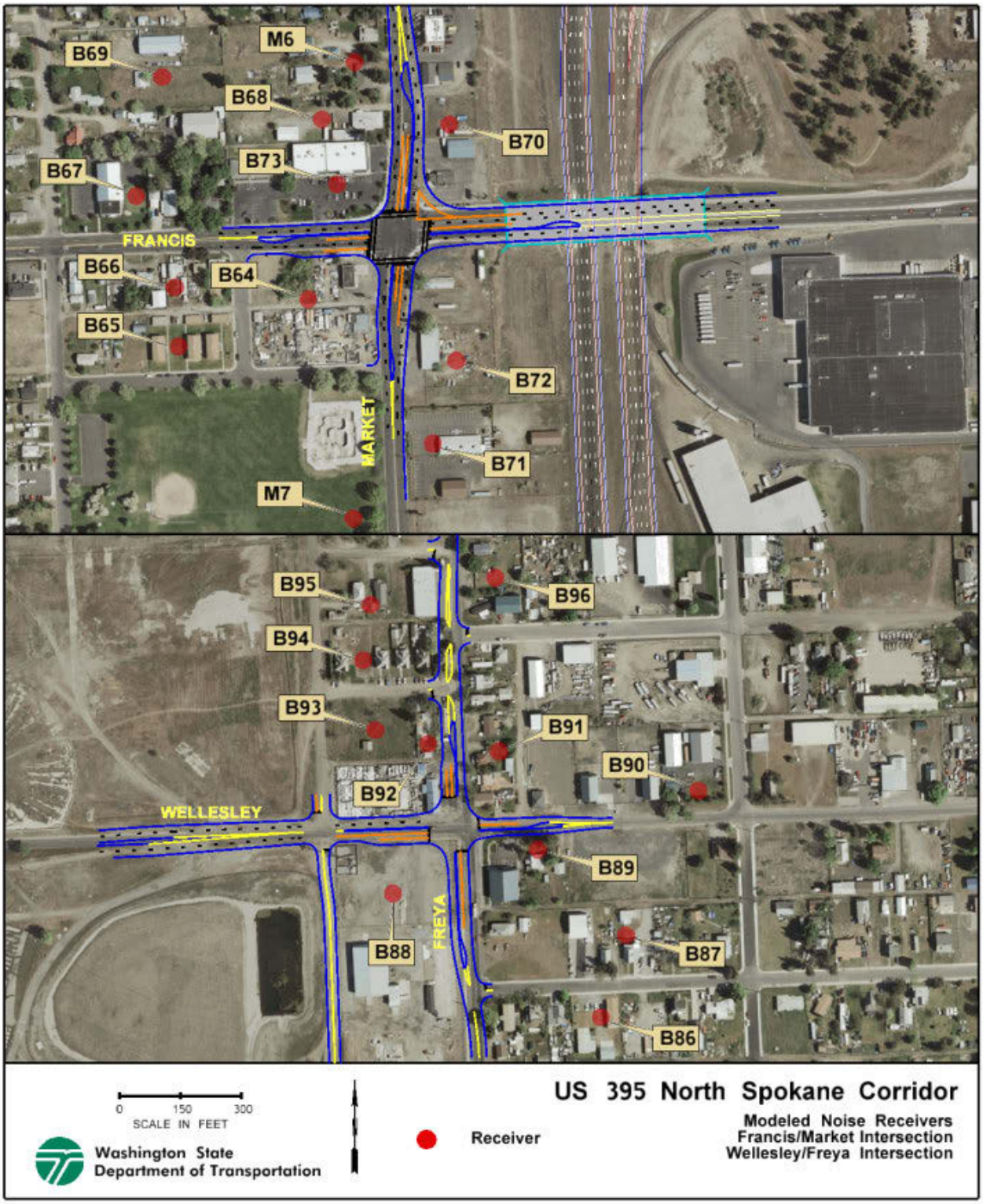


EXHIBIT 8 Modeled Intersections

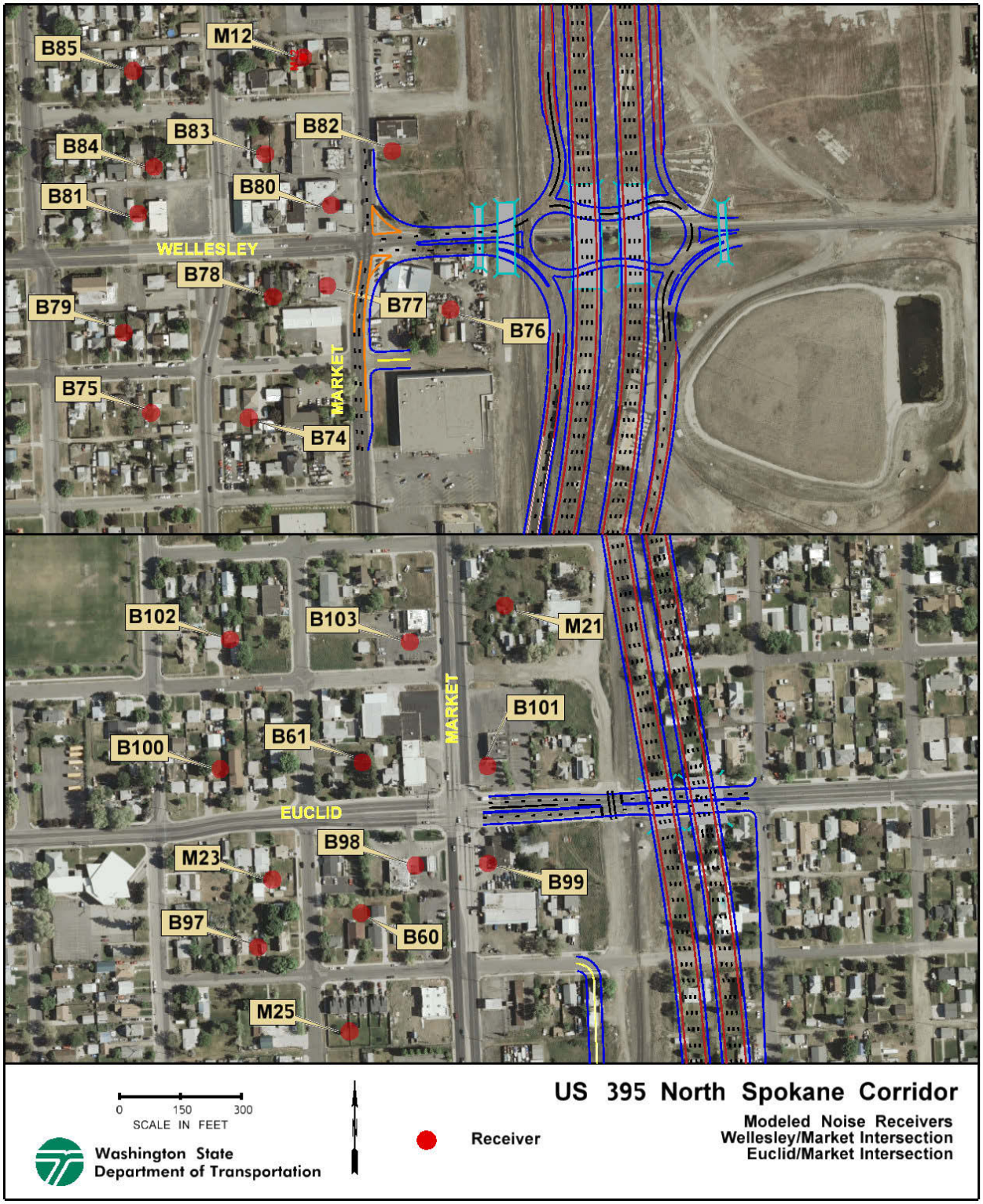


EXHIBIT 9 Counted Hourly Traffic Volumes

Location	Speed (mph)	Cars	Medium Trucks	Heavy Trucks
V1 – Field	25	632	28	0
V2 – Wildhorse Park (Market)	25	2424	25	68
V3 – Fairview & Thor	25	20	4	0
V4 – Fairview & Ralph	25	104	4	0
V5 – Jackson (Market NB)	35	824	32	20
V5 – Jackson (Market SB)	35	800	48	40

EXHIBIT 10 Modeled Hourly Traffic Volumes – Existing

Street and Location (both directions)	Total	Cars (92.4%)	MT (5.1%)	HT (2.5%)	Speed	Count Date
Eculid @ Cook (4:00 pm)	1,077	995	55	27	30	6/16/2009
Euclid @ Ralph (4:00 pm)	919	849	47	23	30	6/11/2009
Francis @ Myrtle (5:00 pm)	1,041	962	53	26	25	7/1/2009
Frederick @ Myrtle (5:00 pm)	683	631	35	17	25	6/11/2009
Freya @ Cleveland (5:00 pm)	342	316	17	9	25	5/4/2009
Freya @ Dalke (3:00 pm)	469	433	24	12	25	5/4/2009
Freya @ Euclid (3:00 pm)	583	539	30	15	25	5/4/2009
Freya @ Longfellow (3:00 pm)	601	555	31	15	25	5/4/2009
Freya @ Welleslsy (4:00 pm)	430	397	22	11	25	5/4/2009
Garland @ Regal (4:00 pm)	717	663	37	18	25	6/17/2009
Haven @ Lacrosse (7:00 am)	1,227	1,134	63	31	25	4/22/2009
Haven @ Rowan (7:00 am)	941	869	48	24	25	4/22/2009
Haven @ Wabash (7:00 am)	1,018	941	52	25	25	4/22/2009
Haven North Wellesley Average	980	905	50	24	25	–
Market @ Bismark (4:00 pm)	1,602	1,480	82	40	30	4/16/2009
Market @ Broad (4:00 pm)	974	900	50	24	30	4/22/2009
Market @ Cleveland (4:00 pm)	2,612	2,413	133	65	30	5/6/2009
Market @ Courtland (5:00 pm)	2,889	2,669	147	72	30	5/20/2009
Market @ Lacrosse (4:00 pm)	1,501	1,387	77	38	30	4/30/2009
Market @ Nebraska (3:00 pm)	884	817	45	22	30	4/22/2009
Wellesley @ Haven (4:00 pm)	773	714	39	19	25	6/17/2009
Wellesley @ Market (4:00 pm)	538	497	27	13	25	7/16/2009
Wellesley @ Myrtle (4:00 pm)	234	216	12	6	25	7/16/2009
Green	2,614	2,416	133	65	35	estimated
Jackson	151	139	8	4	25	estimated
Illinois	701	647	36	18	35	estimated

NOTE: Traffic numbers provided by the City of Spokane, except where noted as estimated.

EXHIBIT 11 Modeled Hourly Traffic Volumes – 2030 No Build

Street and Location (both directions)	Total	Cars (92.4%)	MT (5.1%)	HT (2.5%)	Speed
Francis – West of Market	1,861	1,720	95	47	25
Francis – East of Market	2,537	2,344	129	63	25
Francis – West of Freya	2,187	2,021	112	55	25
Francis – East of Freya	2,700	2,495	138	68	25
Wellesley – West of Haven	1,464	1,353	75	37	25
Wellesley – Haven to Market	1,251	1,156	64	31	25
Wellesley – East of Market	1,671	1,544	85	42	25
Wellesley – West of Frey	1,401	1,295	71	35	25
Freya – North of Francis	2,153	1,989	110	54	25
Freya – North of Wellesley	1,098	1,015	56	27	25
Freya – Average	1,561	1,443	80	39	25
Market – Haven north to Wellesley	1,763	1,629	90	44	30
Market – Wellesley north to Haven	1,078	996	55	27	30
Freya – Average	1,561	1,443	80	39	25
Market – Average – Haven to Euclid	2,185	2,018	111	55	25
Euclid – Average	859	793	44	21	30
Haven – North of Wellesley – Average	904	835	46	23	25
Haven – South of Wellesley - Average	1,314	1,214	67	33	25
Green	2,184	2,018	111	55	35
Illinois	1,035	953	56	27	35
Jackson	238	219	13	6	25

EXHIBIT 12 Modeled Hourly Traffic Volumes – 2030 Build – Northbound

Build - Northbound	Total	Cars	Trucks	MT	HT	Speed
Mainline				60%	40%	
S of Wellesley	6,137	5,769	368	220	148	60
Inside Wellesley	4,709	4,439	270	162	108	60
Wellesley to F/F	5,033	4,748	285	171	114	60
N of F/F	4,126	3,911	215	129	86	60
Ramps				79%	21%	
NB off to Wellesley	1,428	1,330	98	77	21	40
NB on from Wellesley	324	310	14	11	3	40
NB off to Francis/Freya	907	837	70	55	15	40
NB on from Francis/Freya	218	201	17	13	4	40

NOTE: Total traffic volumes and truck volumes provided by project office. Medium Truck/Heavy Truck splits taken from 1997 FEIS.

EXHIBIT 13 Modeled Hourly Traffic Volumes – 2030 Build – Southbound

Build - Southbound	Total	Cars	Trucks	MT	HT	Speed
Mainline				60%	40%	
S of Wellesly	5,965	5,594	371	222	149	60
Inside Wellesly	4,405	4,142	263	157	106	60
Wellesly to F/F	4,670	4,394	276	165	111	60
N of F/F	3,818	3,606	212	127	85	60
Ramps				60%	40%	
SB on from Wellesley	1,560	1,452	108	85	23	40
SB off to Wellesley	264	253	11	9	2	40
SB on from Francis/Freya	852	788	63	50	13	40
SB off to Francis/Freya	356	325	31	24	7	40

NOTE: Total traffic volumes and truck volumes provided by project office. Medium Truck/Heavy Truck splits taken from 1997 FEIS.

EXHIBIT 14 Modeled Hourly Traffic Volumes – 2030 Build – Local Streets

Street and Location (both directions)	Total	Cars (92.4%)	MT (5.1%)	HT (2.5%)	Speed
Francis – West of Market	2,329	2,033	119	58	25
Francis – East of Market	3,043	2,657	155	76	25
Francis – West of Freya	2,710	2,366	138	68	25
Francis – East of Freya	2,449	2,138	125	61	25
Wellesley – West of Haven	1,612	1,407	82	40	25
Wellesley – Haven to Market	1,776	1,550	91	44	25
Wellesley – Market to Ramp	2,196	1,917	112	55	25
Wellesley – Ramp to Ramp	1,538	1,343	78	38	25
Wellesley – Ramp to Freya	1,322	1,154	67	33	25
Freya – North of Francis	715	624	36	18	25
Freya – Francis to Dalke	784	684	40	20	25
Freya – Dalke to Wellesley	505	441	26	13	25
Freya – South of Wellesley - Average	812	709	41	20	25
Market – North of Francis	1,189	1,038	61	30	30
Market – Haven to Francis	737	643	38	18	30
Market – Haven to Haven	583	509	30	15	30
Market – Haven to Euclid - Average	1,640	1,432	84	41	30
Euclid – Average	1,086	948	55	27	30
Haven – North of Wellesley - Average	730	637	37	18	25
Haven – South of Wellesley - Average	804	702	41	20	25
Green	2,433	2,330	36	67	35
Jackson	238	219	13	6	25
Illinois	1,036	953	56	27	35

AFFECTED ENVRIONMENT

Description of Study Area

The study area includes all lands within 500 feet of the fog line within the project area.

This analysis considers the area from Upriver Drive to E. Wilding Avenue. From Upriver Drive to E. Francis Avenue, the roadway will be between N. Market Street and N Ralph Street. North of Francis, the new roadway will veer slightly to the east before heading north again.

To the east of the proposed roadway, from the Upriver Drive to E. Empire Avenue the land use is residential. North of Empire, the land use becomes light industrial and then heavy industrial up to E. Francis Avenue. North of E. Francis Avenue, the project leaves the city of Spokane.

Immediately to the west of the roadway, the area is zoned for commercial use. A block or two farther to the west, the land use becomes residential.

Noise levels were also modeled at four intersections (Exhibits 7 and 8):

- **The Francis and Market** intersection was modeled because turn lanes are being added to improve mobility. On Market, a second left turn lane is being added in both directions. Francis is adding a right turn lane in both directions as well.
- **The Wellesley and Market** intersection was modeled because right turn lanes will be added on Market and Westbound Wellesley.
- **The Wellesley and Freya** intersection was modeled because turn lanes are being added to the intersection:
    - Southbound Freya is adding a left turn lane and a right turn pocket.
    - Northbound Freya is adding a left turn lane.
    - Eastbound Wellesley is adding a left turn lane and a right turn pocket.
    - Westbound Wellesley is adding a left turn lane.
- **At the Euclid and Market** intersection Euclid is undergoing street improvements bringing the road up to current standards. Since there will not be any added lanes and traffic is not moving closer to sensitive receivers, the noise environment will not be affected. These improvements are taking place from Market St. to Ralph St.

Existing Noise Levels

Existing noise levels (Exhibits 15-19) were modeled using traffic counts taken in 2006 provided by the City of Spokane peak traffic volumes. All of the receivers are currently below the NAC.

EXHIBIT 15 Modeled Existing Noise Results

Location	Land Use Category	NAC	Existing Noise Level
V1 - Field	D	No NAC	49
V2 - Park	B	66	48
V3 - Fairview/Thor	B	66	52
V4 - Fairview/Ralph	B	66	57
M1	B	66	40
M2	B	66	41
M3	C	72	45
M4	B	66	46
M5	B	66	58
M6	B	66	60
M7	B	66	62
M8	C	72	46
M9	B	66	65
M10	B	66	64
M11	D	No NAC	45
M12	B	66	59
M13	B	66	49
M14	B	66	47
M15	B	66	51
M16	C	72	65
M17	B	66	51
M18	B	66	50
M19	B	66	57
M20	B	66	48
M21	B	66	62
M22	B	66	54
M23	B	66	58
M25	B	66	55
M26	B	66	60
M27	B	66	51

Location	Land Use Category	NAC	Existing Noise Level
M28	B	66	49
M29	B	66	41
M30 (first floor)	B	66	52
M30-2 (second floor)	B	66	54
M30-3 (third floor)	B	66	56
M31	B	66	63
M33	B	66	43
M34	B	66	58
M35	B	66	48
M36	B	66	45
B56	B	66	60
B57	B	66	57
B58	B	66	57

Note: Receivers have been moved since previous reports; do not compare noise results by receiver name.

EXHIBIT 16 Modeled Francis/Market Intersection Noise Results

Location	Land Use Category	NAC	Existing Noise Level
M6	B	66	60
M7	B	66	62
B64	B	66	59
B65	B	66	53
B66	B	66	59
B67	B	66	58
B68	B	66	56
B69	B	66	50
B70	C	72	59
B71	C	72	63
B72	C	72	59
B73	C	72	60

Note: Receivers have been moved since previous reports; do not compare noise results by receiver name.

EXHIBIT 17 Modeled Wellesley/Market Intersection Noise Results

Location	Land Use Category	NAC	Existing Noise Level
M12	B	66	59
B74	B	66	60
B75	B	66	59
B76	B	66	56
B77	C	72	63
B78	B	66	61
B79	B	66	56
B80	C	72	63
B81	B	66	59
B82	C	72	63
B83	B	66	59
B84	B	66	58
B85	B	66	56

Note: Receivers have been moved since previous reports; do not compare noise results by receiver name.

EXHIBIT 18 Modeled Wellesley/Freya Intersection Noise Results

Location	Land Use Category	NAC	Existing Noise Level
B86	B	66	50
B87	B	66	49
B88	B	66	54
B89	B	66	57
B90	B	66	55
B91	B	66	56
B92	B	66	58
B93	B	66	52
B94	B	66	52
B95	B	66	51
B96	B	66	55

Note: Receivers have been moved since previous reports; do not compare noise results by receiver name.

EXHIBIT 19 Modeled Euclid/Market Intersection Noise Results

Location	Land Use Category	NAC	Existing Noise Level
M23	B	66	58
M25	B	66	55
B60	B	66	58
B61	B	66	61
B97	B	66	54
B98	C	72	65
B99	C	72	67
B100	B	66	57
B101	C	72	67
B102	B	66	51
B103	C	72	65

Note: Receivers have been moved since previous reports; do not compare noise results by receiver name.

CONSTRUCTION

Construction Noise

Construction activities would generate noise during the construction period. Construction usually would be carried out in several reasonably discrete steps, each of which has its own mix of equipment and, consequently, its own noise characteristics. Roadway demolition and construction would involve clearing, cut-and-fill activities, removing old roadways, importing fill, and paving.

The most constant noise source at construction sites would be internal combustion engines. Engine-powered equipment includes earth-moving equipment, material-handling equipment, and stationary equipment. Mobile equipment operates in a cyclic fashion, while stationary equipment, such as generators and compressors, operates at sound levels fairly constant over time. Because trucks would be present during most phases and would not be confined to the project site, noise from trucks could affect more receptors. Other noise sources would include impact equipment, which could be pneumatically powered, hydraulic, or electric.

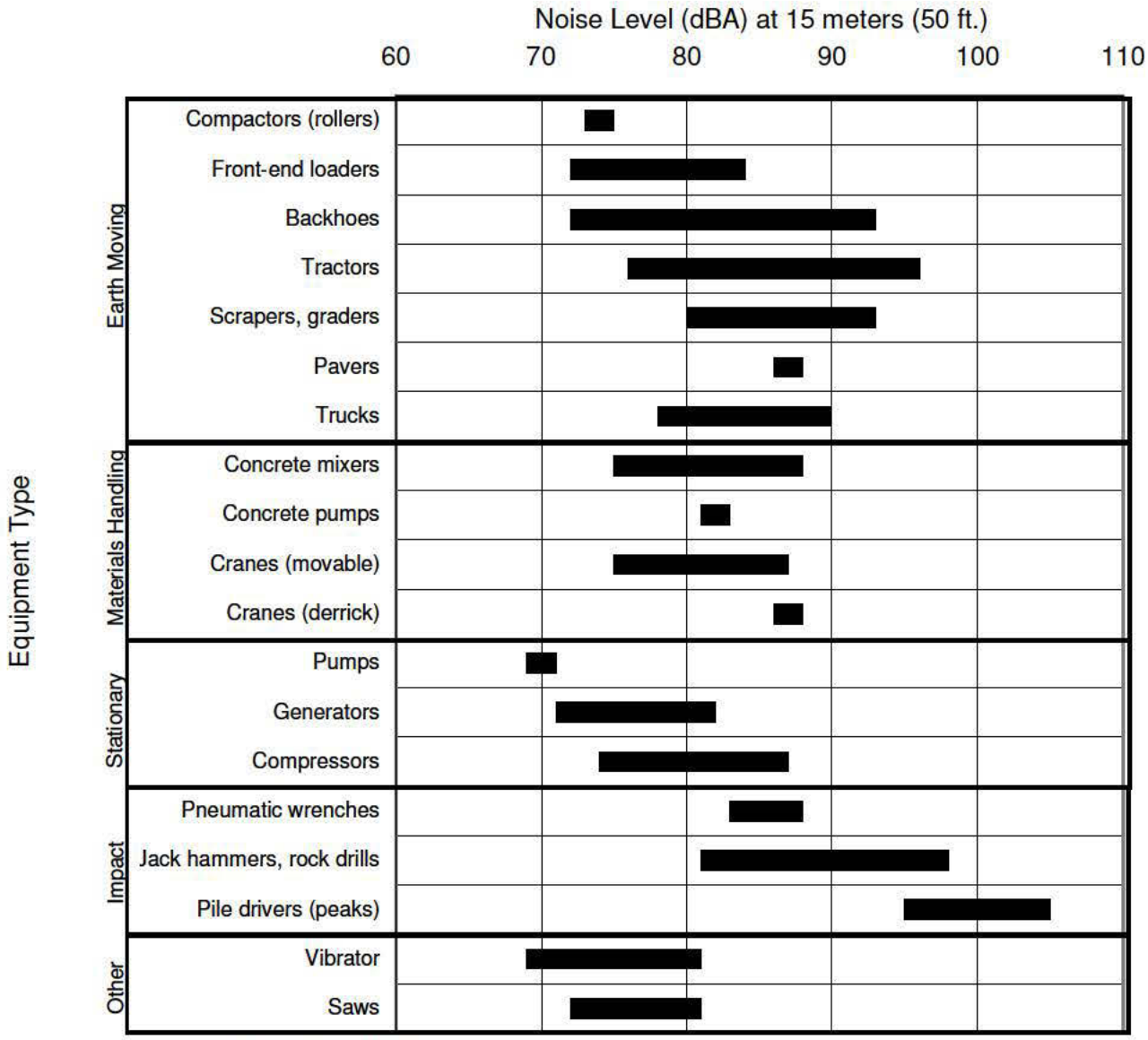
Noise levels during the construction period would depend on the type, amount, and location of construction activities. The type of construction methods would establish the maximum noise levels of construction equipment used. The amount of construction activity would quantify how often construction noise would occur throughout the day. The location of construction equipment relative to adjacent properties would determine any effects of distance in reducing construction noise levels. Maximum noise levels of construction equipment would be similar to typical maximum construction equipment noise levels presented in Exhibit 20.

As shown in Exhibit 20, maximum noise levels from construction equipment would range from 69 to 106 dBA at 50 feet (15 meters). Construction noise at residences farther away would decrease at a rate of 6 dBA per doubling of distance from the source. Because various pieces of equipment would be turned off, idling, or operating at less than full power at any time, and because construction machinery is typically used to complete short-term tasks at any given location, average L_{eq} noise levels during the day would be less than maximum noise levels presented in Exhibit 20.

Construction noise is exempt from local property line regulations during daytime hours. If nighttime construction will be required for this project, WSDOT will apply for variances or exemptions from local noise ordinances for the duration of the project. These noise variances or exemptions are granted with conditions for implementation of mitigation measures.

In addition to area residents, construction workers also would be subject to construction noise while working on the site. Construction noise levels could be reduced by the construction practices identified in the Mitigation Section.

EXHIBIT 20 Construction Equipment Noise Ranges



Source: EPA, 1971 and WSDOT, 1991.

IMPACTS

Operational Noise

Noise levels were modeled at 43 sites throughout the study area (Exhibits 5 and 6). These receivers represent a variety of residential, commercial, and industrial sites. Exhibit 21 shows the model results for the existing, 2030 no build, and 2030 build conditions.

None of the modeled locations are above the noise abatement criteria level in either the existing conditions or the no build scenarios. Model results show 18 receiver locations are over the NAC in the build scenario. Twenty-six of the receivers show a substantial increase in noise (an increase greater than 10 dBA) in the build scenario.

EXHIBIT 21 Modeled Future Noise Results

Location	Land Use Category	NAC	Existing (2006) Leq (dBA)	No Build (2030) Leq (dBA)	Build (2030) L_{eq} (dBA)	Increase over existing
V1 - Field	D	No NAC	49	47	61	**12**
V2 - Park	B	66	48	48	63	**15**
V3 - Fairview/Thor	B	66	52	52	65	**13**
V4 - Fairview/Ralph	B	66	57	58	**68**	**11**
M1	B	66	40	44	63	**23**
M2	B	66	41	44	61	**21**
M3	C	72	45	51	54	9
M4	B	66	46	48	63	**18**
M5	B	66	58	65	**66**	8
M6	B	66	60	62	63	4
M7	B	66	62	62	63	1
M8	C	72	46	48	64	**18**
M9	B	66	65	65	64	-1
M10	B	66	64	63	64	0
M11	D	No NAC	45	46	70	**24**
M12	B	66	59	59	63	4
M13	B	66	49	49	58	9
M14	B	66	47	47	58	**12**
M15	B	66	51	50	**73**	**22**
M16	C	72	65	64	67	3
M17	B	66	51	49	65	**14**

Location	Land Use Category	NAC	Existing (2006) Leq (dBA)	No Build (2030) Leq (dBA)	Build (2030) L_{eq} (dBA)	Increase over existing
M18	B	66	50	49	**70**	**21**
M19	B	66	57	56	63	6
M20	B	66	48	50	**66**	**18**
M21	B	66	62	61	**66**	5
M22	B	66	54	55	**67**	**13**
M23	B	66	58	57	60	2
M25	B	66	55	55	61	5
M26	B	66	60	60	**70**	**10**
M27	B	66	51	51	58	7
M28	B	66	49	50	61	**12**
M29	B	66	41	51	**68**	**27**
M30	B	66	52	51	64	**12**
M30 (second floor)	B	66	54	54	65	**11**
M30 (third floor)	B	66	56	55	**66**	**10**
M31	B	66	63	62	**67**	4
M33	B	66	43	54	**69**	**26**
M34	B	66	58	57	**66**	8
M35	B	66	48	55	**68**	**20**
M36	B	66	45	49	**67**	**22**
B56	B	66	60	60	**67**	7
B57	B	66	57	57	**67**	**10**
B58	B	66	57	56	**67**	**10**

Note: **Bold** indicates noise levels above the NAC. Numbers may not add due to rounding. Receivers have been moved since previous reports; do not compare noise results by receiver name.

EXHIBIT 22 Modeled Francis/Market Intersection Noise Results

Location	Land Use Category	NAC	Existing (2006) Leq (dBA)	Build (2030) L_{eq} (dBA)	Increase over existing
M6	B	66	60	63	3
M7	B	66	62	63	1
B64	B	66	59	64	6
B65	B	66	53	59	6
B66	B	66	59	62	3
B67	B	66	58	62	4
B68	B	66	56	60	4
B69	B	66	50	56	6
B70	C	72	59	66	7
B71	C	72	63	66	3
B72	C	72	59	67	9
B73	C	72	60	66	6

Note: **Bold** indicates noise levels above the NAC. Numbers may not add due to rounding. Receivers have been moved since previous reports; do not compare noise results by receiver name.

EXHIBIT 23 Modeled Wellesley/Market Intersection Noise Results

Location	Land Use Category	NAC	Existing (2006) Leq (dBA)	Build (2030) L_{eq} (dBA)	Increase over existing
M12	B	66	59	62	3
B74	B	66	60	62	2
B75	B	66	59	60	1
B76	B	66	56	**70**	**14**
B77	C	72	63	68	4
B78	B	66	61	65	4
B79	B	66	56	60	4
B80	C	72	63	68	5
B81	B	66	59	63	4
B82	C	72	63	68	5
B83	B	66	59	61	1
B84	B	66	58	60	2
B85	B	66	56	56	1

Note: **Bold** indicates noise levels above the NAC. Numbers may not add due to rounding. Receivers have been moved since previous reports; do not compare noise results by receiver name.

EXHIBIT 24 Modeled Wellesley/Freya Intersection Noise Results

Location	Land Use Category	NAC	Existing (2006) Leq (dBA)	Build (2030) L_{eq} (dBA)	Increase over existing
B86	B	66	50	54	4
B87	B	66	49	54	5
B88	B	66	54	62	8
B89	B	66	57	65	7
B90	B	66	55	60	5
B91	B	66	56	60	4
B92	B	66	58	63	5
B93	B	66	52	60	8
B94	B	66	52	58	6
B95	B	66	51	58	7
B96	B	66	55	57	2

Note: **Bold** indicates noise levels above the NAC. Numbers may not add due to rounding. Receivers have been moved since previous reports; do not compare noise results by receiver name.

EXHIBIT 25 Modeled Euclid/Market Intersection Noise Results

Location	Land Use Category	NAC	Existing (2006) Leq (dBA)	Build (2030) L_{eq} (dBA)	Increase over existing
M23	B	66	58	60	2
M25	B	66	55	59	4
B60	B	66	58	61	3
B61	B	66	61	63	3
B97	B	66	54	60	6
B98	C	72	65	67	2
B99	C	72	67	69	2
B100	B	66	57	62	5
B101	C	72	67	69	3
B102	B	66	51	58	7
B103	C	72	65	66	1

Note: **Bold** indicates noise levels above the NAC. Numbers may not add due to rounding. Receivers have been moved since previous reports; do not compare noise results by receiver name.

Rail Noise

In an area with a background noise level of 50 dBA with 4 trains per day, each traveling at 25 miles per hour, a receiver would need to be within 45 feet of the rail line for there to be a moderate impact and within 17 feet for a severe impact. No sensitive receivers are expected to be within 45 feet of the rail line, therefore no rail noise impacts are expected from this project.

MITIGATION

Operational Mitigation

Noise abatement is considered when noise levels in the Build scenario are above the NAC, or when noise levels increase by 10 dBA over existing conditions (substantial increase). If such a situation exists, abatement is considered only where frequent human use occurs and where a lower noise level would have benefits (FHWA 1982). Noise levels can be reduced by the following types of abatement:

- Traffic management measures, such as restrictions on the types of vehicles and the time of day they may use a certain roadway
- Change in vertical or horizontal alignment of the roadway
- Acquisition of property
- Insulation of buildings to dampen noise
- Construction of noise barriers, such as noise attenuation berms or walls

Traffic Management Measures

Limiting traffic flow is not considered a viable alternative for the proposed project.

Change in Vertical or Horizontal Alignment of the Roadway

Realigning the roadway to mitigate noise impacts is not a feasible option for the proposed project.

Property Acquisition for Noise Buffers

Noise-sensitive receivers adjacent to the proposed projects include single and multi-family residences. Acquiring this property for noise buffers is not a reasonable option for the proposed project.

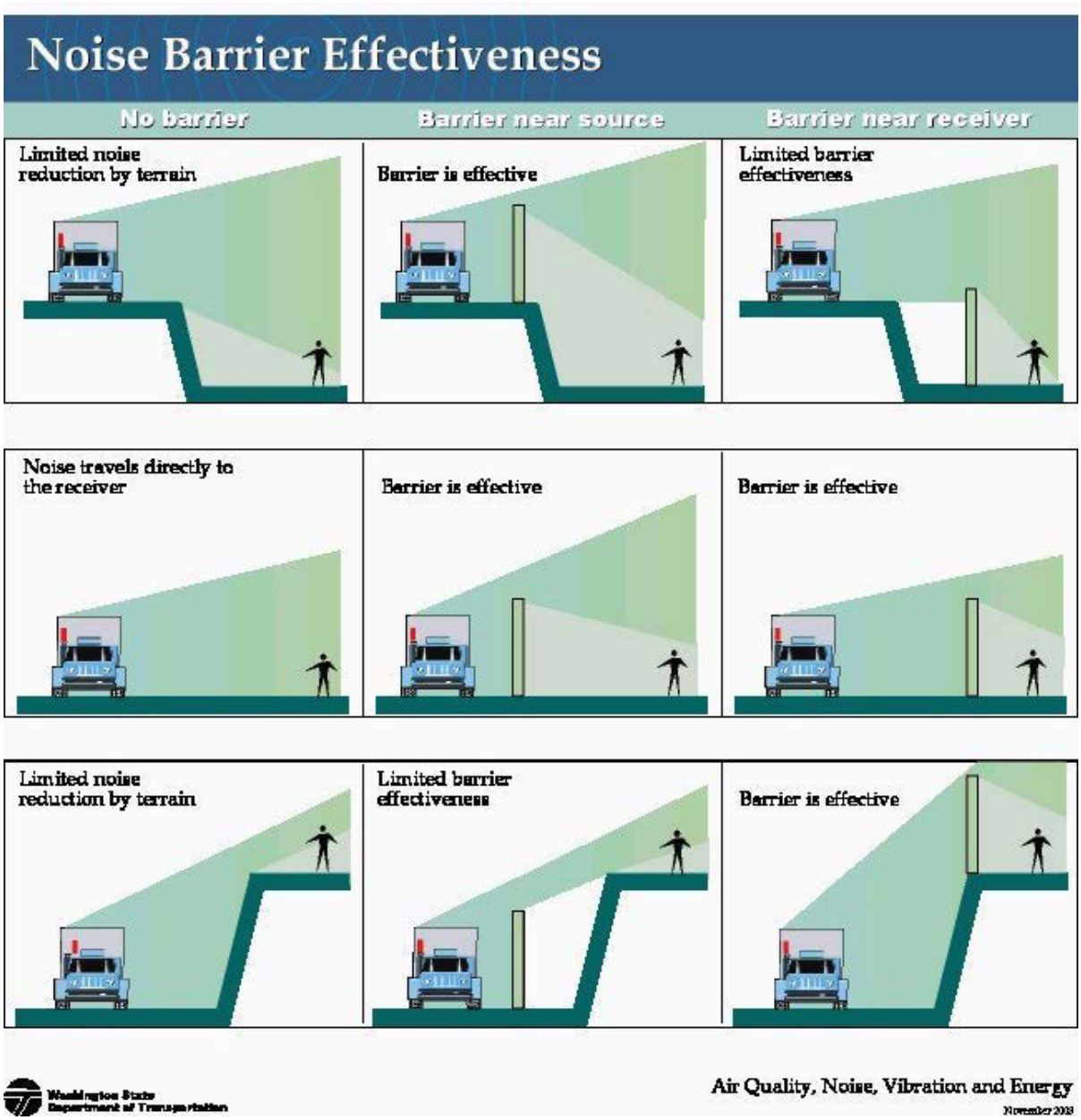
Insulation of Buildings

Insulation of buildings is allowed for non-profit institutional buildings. This remedy does not apply to commercial and residential structures. Further, it would not address noise impacts occurring at outdoor activity areas, which require consideration under state and federal regulations. Finally, there are no qualifying buildings impacted by this project.

Noise Barriers

Noise barriers include noise walls, berms, and buildings that are not noise sensitive. The effectiveness of a noise barrier is determined by its height and length, and the project's topography. To be effective, the barrier must block the "line of sight" between the highest point of a noise source (e.g., a truck's exhaust stack) and the highest part of a receiver. The barrier must be long enough to prevent sounds from passing around the ends, have no openings such as driveway connections, and be dense enough so that noise would not be transmitted through it (FHWA 1973). Exhibit 26 illustrates noise barrier effectiveness in different topographical situations.

EXHIBIT 26 Noise Barrier Effectiveness



Barrier Analysis

When traffic noise levels are predicted to exceed the NAC, WSDOT evaluates many factors to determine whether barriers are feasible and reasonable. Engineering feasibility includes whether barriers could be built in a location to achieve a noise reduction of at least 7 dBA at one first-row receiver and 5 dBA at over 60 percent of first-row receivers. First-row receivers are those receivers closest to the noise source. Second-row receivers are those receivers behind the first-row that are shielded by the first-row. Safety factors must also be included in a feasibility analysis, including maintenance of clear recovery zone, redirection of errant vehicles, adequate sight distance, and fire and emergency vehicle access.

Determination of reasonableness involves weighing the cost of the noise mitigation per benefited receiver. Other considerations, such as aesthetics, are also taken into account.

When a proposed noise barrier is predicted to reduce noise levels by 3 dBA or more at a residence, then the residence is considered a benefited receiver. Each benefited receiver is allowed a mitigation allowance based on the noise-level predictions for the design year, build alternative. Exhibit 27 summarizes the mitigation allowance per benefited receiver. If the cost of a noise barrier is less than the combined allowance for all receivers benefited by the wall, then the barrier is considered reasonable based on cost.

EXHIBIT 27 Mitigation Allowance for Traffic Noise Impacts

Design Year Traffic Noise L_{eq} (dBA)	Allowed Wall Square Footage per Impacted Household	Allowed Cost per Impacted Household[a]
66	700	$37,380
67	768	$41,110
68	836	$44,640
69	904	$48,270
70	972	$51,900
71 or 10 dBA increase	1,040	$55,530
72 or 11 dBA increase	1,108	$59,160
73 or 12 dBA increase	1,176	$62,790
74 or 13 dBA increase	1,244	$66,420
75 or 14 dBA increase	1,312	$70,060
76 or 15 dBA increase	1,380	$73,690

[a]Based on a construction cost of $53.40 per square foot.

Aesthetics may be considered in making a reasonableness determination; this consideration may include the noise barrier's effects on nearby residences. For example, if the presence of a barrier will interfere with residences' scenic vista, the residents may decide that they would rather not have the barrier built.

Noise Walls

Future noise levels were modeled at several locations along the project corridor to determine if they approach or exceed the NAC. In areas where the criteria were exceeded, noise walls were evaluated. These areas are listed in Exhibit 28.

EXHIBIT 28 Noise Wall Summary

Noise Wall	Eastside	Westside (South)	Westside (North)
Location	End of bridge to north end of Wildhorse Park	End of bridge to Grace Avenue	Grace Avenue to Courtland Ave
Reasonable	Yes	Yes	No
Feasible	Yes	Yes	Yes
Minimum wall – square foot	36,030	10,433	54,018
Minimum wall – length	5,100	1,096	2,408
Minimum wall – cost (million)	$1.9	$0.56	$2.9
Allowable funds (million)	$11.3	$3.9	$2.2
Impacted receivers	172	49	8
Benefitting receivers	162	89	58
Non-benefitting receivers	17	14	0

Note: Benefitting receivers includes receivers benefitting from the wall that do not meet the criteria to be impacted receivers. Therefore, the number of benefitting receivers plus non-benefitting receivers may be greater than the number of impacted receivers.

Eastside Wall (Feasible, Reasonable)

TNM modeling shows that residences in the area east of the proposed roadway between the river and Wildhorse Park would experience noise levels up to 73 dBA in the build scenario. Because this location exceeds the NAC of 66 dBA, a noise wall was analyzed. Exhibits 30 and 31 show the placement of the modeled walls. The modeled wall begins at the NSC ROW stationing of 95+25. The wall assumes a 3.5 foot barrier on the bridge over the river before tapering up to the

wall height of 8 feet. The model also includes a 3.5 foot barrier on the Euclid Avenue overpass and the wall tapers down at both ends of the overpass at two foot increments.

The minimum wall meets feasibility requirements. This wall would be about 5,100 feet long. Beginning at station 103+80, the wall tapers up to 8 feet tall from the 3.5 foot barrier on the bridge. This wall will run at 8 feet tall, with an exception at station 115+10, where the wall steps down to 6 feet. The wall will run at 6 feet until station 137+10, where it will step up to 8 feet and remain at 8 until the wall terminates at station 154+70. The total square footage would be 36,029. The residences benefitting from the wall qualify for 212,540 square feet, making this wall both reasonable and feasible.

For this area, a wall is recommended. Final wall design will be determined through the engineering and community outreach processes. Exhibit 34 shows the noise reductions expected from the minimum wall.

Westside Wall-South (Feasible, Reasonable)

On the southern west side of the corridor, TNM modeling predicts that residences would experience noise levels of up to 70 dBA under the build conditions. This noise level exceeds the NAC (66 dBA), so the area was also analyzed for a noise wall (Exhibit 32). The modeled wall begins at the ROW station of 94+90. This wall also assumes a 3.5 foot barrier on the bridge over the river before tapering up to a wall height of 8 feet.

The minimum wall meets feasibility requirements. This wall would be approximately 1,100 feet long. Beginning at ROW stationing of 103+70, the wall tapers up to 8 feet tall from 3.5 feet. The wall will be 8 feet tall until station 107+00, where it will step up to 10 feet tall. At station 109+70, the wall will again step up to a wall height of 12 feet. The wall will run at 12 feet tall for an approximate length of 360 feet before tapering to 8 feet tall in two foot increments. The wall will terminate at station 114+70. The total square footage would be 10,433. The residences benefiting from the wall qualify for 73,724 square feet. This wall is both reasonable and feasible and a noise wall in this area is recommended. Final wall design will be determined through the engineering and community outreach processes.

The noise reductions anticipated from this wall are shown in Exhibit 35.

Westside Wall-North (Feasible, Not Reasonable)

TNM modeling also predicts that residences from Grace Ave. to Courtland would experience noise levels up to 67 dBA under the build conditions. This noise exceeds the NAC (66 dBA), so the area was analyzed for a noise wall (Exhibit 33). The modeled minimum wall would begin at ROW stationing 115+70 and end at station 138+90. This wall would be 24 feet tall with the exception of 3.5 foot barrier on the Euclid overpass structure. The total square footage would be 54,139. The residences benefiting from the wall qualify for 41,892 square feet. The minimum wall was found to meet feasibility requirements, but failed to meet the reasonable requirements.

Since this wall did not meet the reasonableness requirements, a wall is not recommended in this area. The noise reductions expected from the minimum wall can be seen in Exhibit 36.

Wellesley and Market Intersection

The Wellesley and Market intersection was modeled because of improvements being made to increase mobility; right turn lanes will be added on Market and Westbound Wellesley (see Exhibit 8). The results show only one receiver above the NAC, B76. The primary source of traffic noise will be the NSC, and not the local arterials, therefore, a wall was evaluated for the NSC instead of the arterials.

Generally, a noise wall needs to extend past the receiver roughly four times the distance from the receiver to the wall to effectively abate roadway noise. Exhibit 29 shows calculations to determine the maximum wall size for the affected receiver. This analysis shows that the receivers only qualify for a wall 1.5 feet tall. Wall analyses done on other portions of this project show that affected receivers on this project (traffic volumes and topography) generally need at least a 6 foot tall wall to meet feasibility requirements. Because the allowance for this receiver is far from providing this minimum wall area, a wall in this area is not reasonable and, therefore, not recommended.

Exhibit 29 Wellesley and Market Wall Analysis

Description	Quantity
Receiver to wall distance (ft.)	225
Four times distance from receiver to wall (ft.)	900
Approximate wall length needed (ft.)	1800
Number of residences above NAC	2
Wall allowance per residence (sq. ft.)	1312
Total wall allowance (sq. ft.)	2624
Maximum height of wall (ft.)	1.5
Minimum wall height in other areas of project to meet feasibility criteria (ft.)	6

EXHIBIT 30 Eastside Noise Wall - North

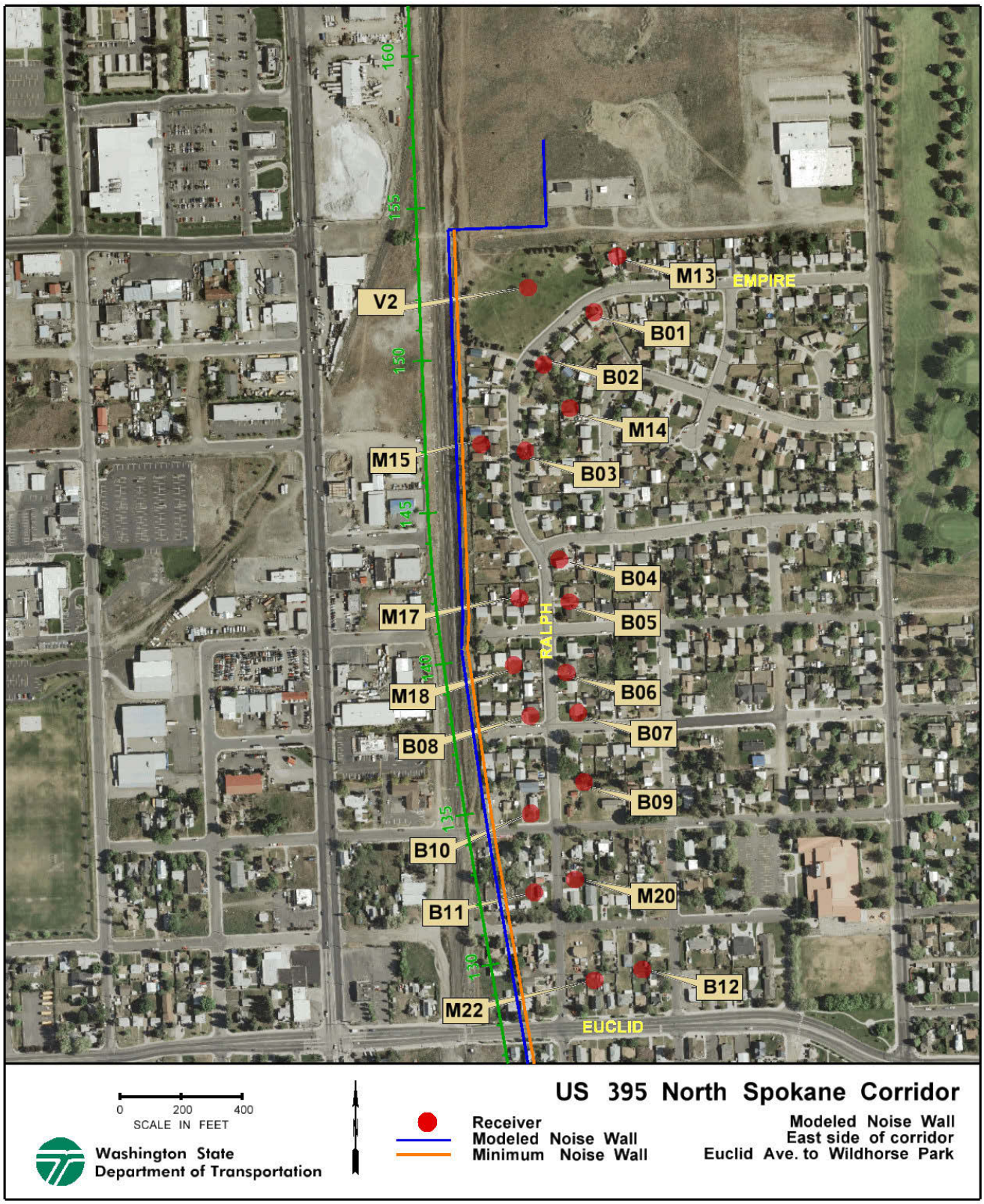


EXHIBIT 31 Eastside Noise Wall – South

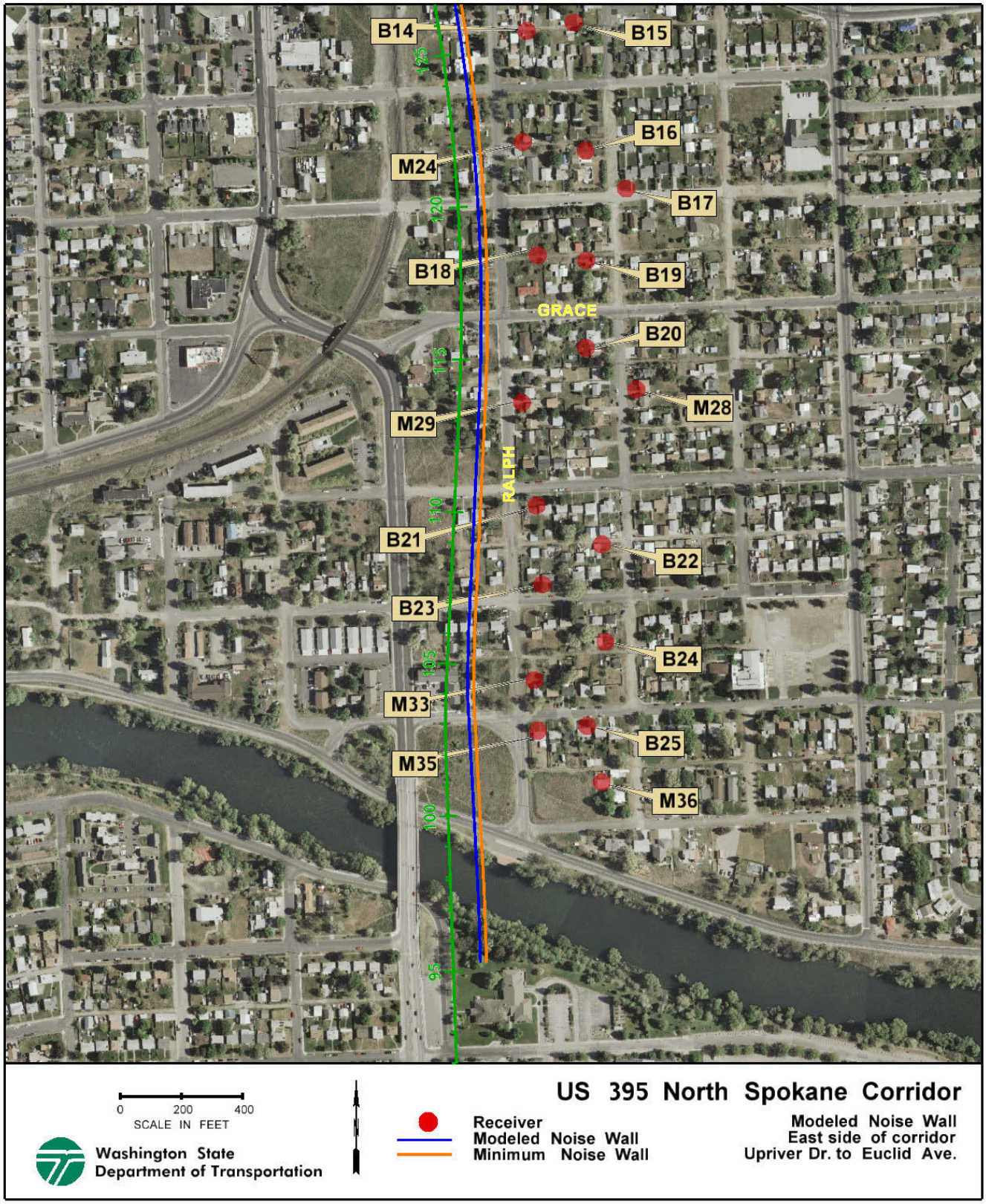


EXHIBIT 32 Westside Noise Wall – South

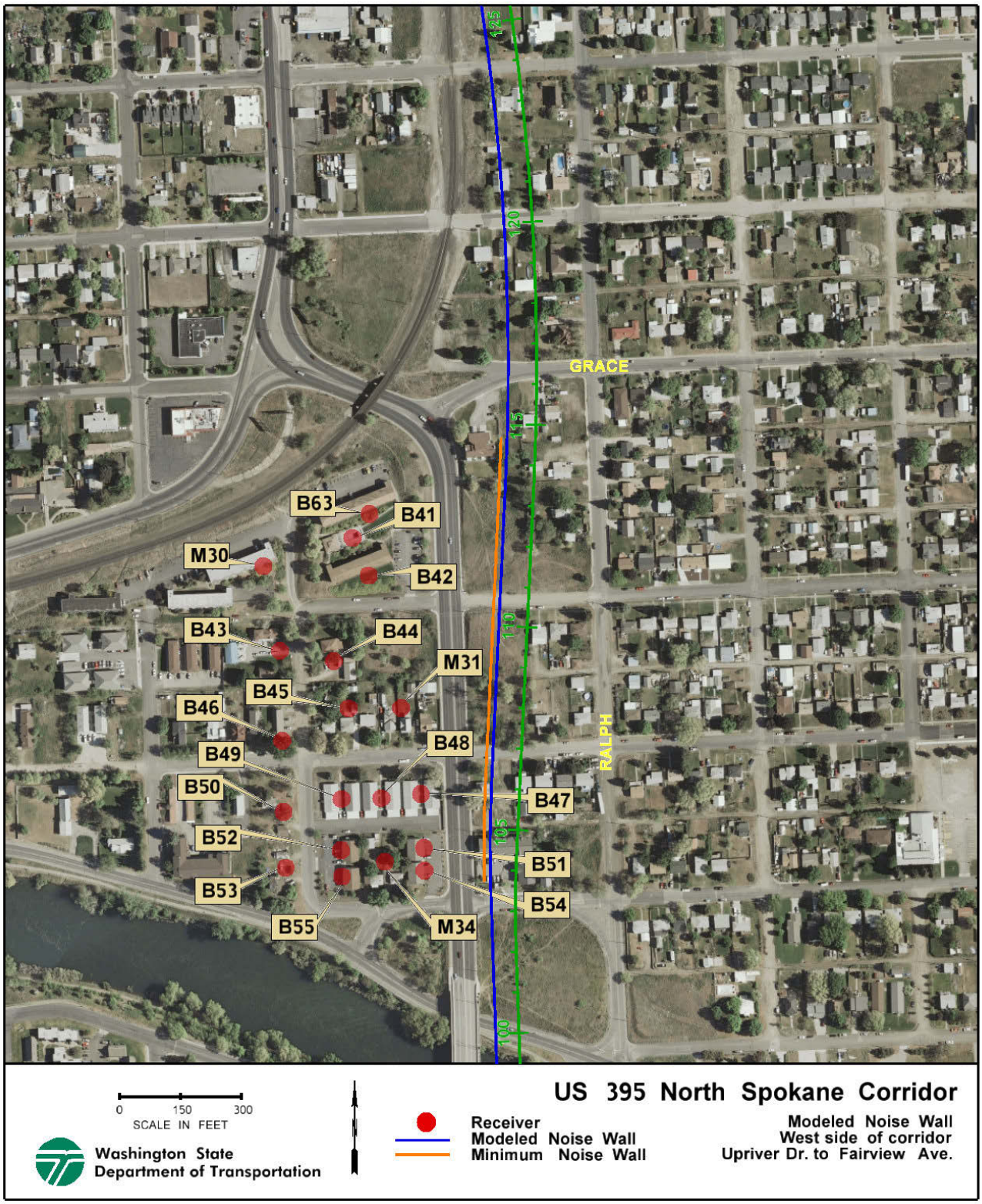


EXHIBIT 33 Westside Noise Wall – North

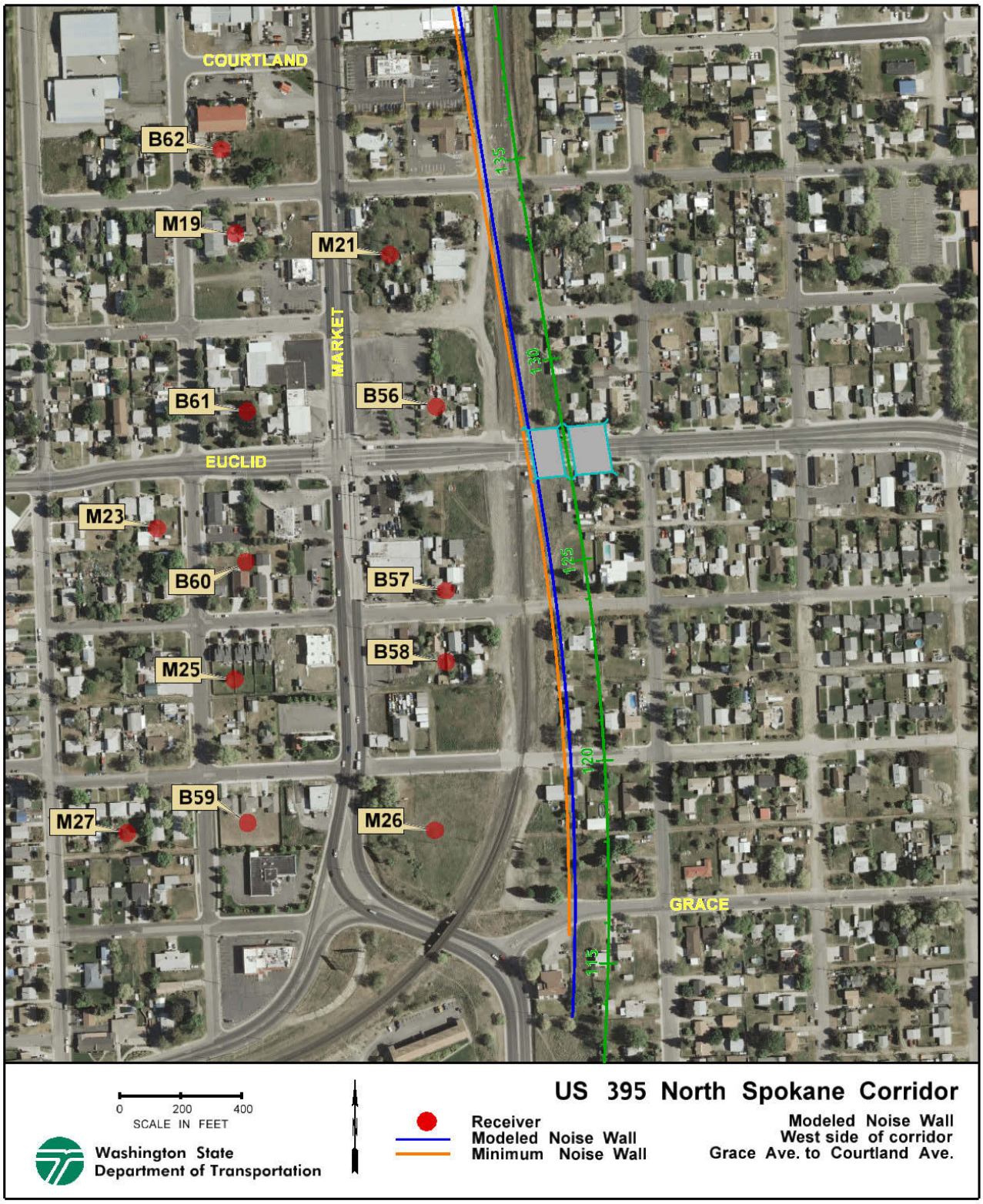


EXHIBIT 34 Eastside Noise Wall – Minimum

Receiver	DU	1st row DU	1st row DU > 5 db	Ex	B	Inc	Wall	Red	Sq Ft allowable	Total Sq ft.
V2 - Park	1		0	50	62	**12**	60	2	1,176	0
M13	1		0	49	57	8	56	1	700	0
M14	9		0	47	58	**12**	56	2	1,108	0
M15	11	11	11	51	**73**	**22**	66	7	1,380	15,180
M17	6	3	0	51	65	**14**	61	4	1,312	7,872
M18	3	1	1	50	**72**	**22**	64	8	1,380	4,140
M20	9		0	48	**66**	**18**	60	5	1,380	12,420
M22	5	2	2	54	**66**	**13**	62	5	1,176	5,880
M24	6	2	2	52	**68**	**16**	63	6	1,380	8,280
M28	6		0	49	60	**12**	57	3	1,108	6,648
M29	10	6	0	41	**67**	**27**	64	4	1,380	13,800
M33	6	2	0	43	**69**	**26**	65	4	1,380	8,280
M35	2	1	0	48	**68**	**21**	65	4	1,380	2,760
M36	2		0	45	**67**	**23**	65	3	1,380	2,760
B01	2		0	53	58	5	57	1	700	0
B02	4		0	53	60	8	59	2	700	0
B03	7		0	53	64	**11**	60	5	1,108	7,756
B04	3		0	53	64	**11**	61	4	1,108	3,324
B05	3		0	52	65	**13**	60	4	1,244	3,732
B06	3		0	50	**66**	**16**	61	5	1,380	4,140
B07	3		0	50	65	**15**	61	4	1,312	3,936
B08	2	1	1	52	**68**	**16**	62	5	1,380	2,760
B09	7		0	48	65	**17**	61	5	1,380	9,660
B10	3	2	2	52	**68**	**16**	62	6	1,380	4,140
B11	2	2	2	51	**67**	**16**	61	6	1,380	2,760
B12	5		0	54	65	**11**	60	5	1,108	5,540
B14	6	2	2	53	**67**	**14**	62	5	1,244	7,464
B15	5		0	54	**66**	**12**	61	5	1,108	5,540
B16	4		0	49	**66**	**17**	60	5	1,380	5,520
B17	4		0	51	64	**13**	60	4	1,176	4,704
B18	4	2	2	47	**68**	**21**	64	5	1,380	5,520
B19	5		0	47	65	**18**	61	4	1,380	6,900
B20	8		0	47	65	**18**	61	4	1,380	11,040
B21	4	1	0	48	**68**	**20**	64	4	1,380	5,520
B22	4		0	49	65	**17**	62	4	1,380	5,520
B23	4	1	0	54	**68**	**14**	65	4	1,312	5,248
B24	6		0	49	**67**	**18**	63	3	1,380	8,280
B25	4		0	50	**68**	**18**	65	3	1,380	5,520
	179	39	24			$/Sq. Ft. qualified for:			$11,349,850	212,544
First row >5 db red		62%				$/Sq. Ft. needed for wall:			$1,923,949	36,029

Notes: Numbers may not add due to rounding; All noise levels given in dBA
DU = dwelling units; Ex = existing sound level; B = Build sound level; Inc = increase of build over existing; Wall = sound level with wall in place; Red = noise reduction with wall; Receivers with a dashed number indicate the floor level of the receiver; Receivers without a dashed number are ground level receivers. Do not compare the receivers by name between the earlier report and this one.

EXHIBIT 35 Westside (South) Noise Wall – Minimum

Receiver	DU	1st row DU	1st row DU > 5 db	Ex	B	Inc	Wall	Red	Sq Ft allowable	Total Sq ft.
M30	6		0	52	64	**12**	60	4	1,108	6,648
M30-2	6		0	54	65	**11**	60	5	1,040	6,240
M30-3	6		0	56	**66**	**10**	61	5	1,040	6,240
M31	3	1	0	65	**66**	1	62	4	700	2,100
M34	2		0	58	65	8	62	3	700	1,400
B41	18	18	18	58	65	7	60	5	700	12,600
B42	3	3	0	60	**67**	7	63	4	700	2,100
B42-2	3	3	3	62	**68**	7	64	5	836	2,508
B42-3	3	3	3	62	**71**	9	64	6	972	2,916
B43	2		0	54	63	8	59	4	700	1,400
B44	2		0	57	65	8	61	4	700	1,400
B45	3		0	56	64	8	60	4	700	2,100
B46	1	1	0	54	63	9	60	3	700	700
B47	6	3	0	67	64	-4	61	2	700	0
B48	6		0	51	60	8	57	3	700	4,200
B49	6		0	50	57	7	54	3	700	4,200
B50	1		0	53	63	**11**	59	4	1,040	1,040
B51	2	2	0	67	**69**	2	67	3	904	1,808
B51-2	2	2	0	67	**71**	3	68	3	972	1,944
B52	2		0	48	51	3	50	1	700	0
B52-2	2		0	49	52	4	51	1	700	0
B53	1		0	52	63	**11**	60	3	1,108	1,108
B54	2	2	0	67	**69**	2	67	2	904	0
B54-2	2	2	0	67	**71**	3	68	3	972	1,944
B55	2		0	48	51	4	51	1	700	0
B55-2	2		0	49	58	9	54	4	700	1,400
B63	3	3	3	58	**67**	9	61	6	700	2,100
B63-2	3	3	3	61	**70**	9	63	7	904	2,712
B63-3	3	3	3	61	**70**	9	64	6	972	2,916
	103	49	33		$/Sq. Ft. qualified for:				$3,936,862	73,724
First row >5 db red		67%			$/Sq. Ft. needed for wall:				$557,122	10,433

Notes: Numbers may not add due to rounding; All noise levels given in dBA
DU = dwelling units; Ex = existing sound level; B = Build sound level; Inc = increase of build over existing; Wall = sound level with wall in place; Red = noise reduction with wall; Receivers with a dashed number indicate the floor level of the receiver; Receivers without a dashed number are ground level receivers. Do not compare the receivers by name between the earlier report and this one.

EXHIBIT 36 Westside (North) Noise Wall – Minimum

Receiver	DU	1st row DU	1st row DU > 5 db	Ex	B	Inc	Wall	Red	Sq Ft allowable	Total Sq ft.
M19	4		0	57	63	6	59	4	700	2,800
M21	2	1	1	62	**67**	5	63	5	768	1,536
M23	11		0	58	61	3	58	3	700	7,700
M25	6		0	55	61	6	57	4	700	4,200
M26	0		0	60	**67**	7	62	5	768	0
M27	11		0	51	58	7	53	5	700	7,700
B56	2	1	0	60	**67**	7	64	4	768	1,536
B57	1	1	1	57	**67**	**10**	61	6	700	700
B58	3	1	1	57	**67**	**10**	61	7	1,040	3,120
B59	5		0	57	62	4	58	4	700	3,500
B60	7		0	58	63	6	60	4	700	4,900
B61	5		0	61	65	4	62	3	700	3,500
B62	1		0	56	62	6	59	4	700	700
	58	4	3		$/Sq. Ft. qualified for:				$2,237,033	41,892
First row >5 db red		75%			$/Sq. Ft. needed for wall:				$2,891,023	54,139

Notes: Numbers may not add due to rounding; All noise levels given in dBA
DU = dwelling units; Ex = existing sound level; B = Build sound level; Inc = increase of build over existing; Wall = sound level with wall in place; Red = noise reduction with wall; Receivers with a dashed number indicate the floor level of the receiver; Receivers without a dashed number are ground level receivers. Do not compare the receivers by name between the earlier report and this one.

Construction Noise Mitigation

Construction noise could be reduced by using enclosures or walls to surround noisy equipment, installing mufflers on engines, substituting quieter equipment or construction methods, minimizing time of operation, and locating equipment farther from sensitive receptors. To reduce construction noise at nearby receptors, the following mitigation measures could be incorporated into construction plans and contractor specifications:

- Limiting construction activities to between 7 a.m. and 10 p.m. would reduce construction noise levels during sensitive nighttime hours;
- Using haul vehicles with rubber bed-liners would reduce noise from loading trucks;
- Equipping trucks with ambient backup alarms would reduce the noise for equipment backing;
- Equipping construction equipment engines with adequate mufflers, intake silencers, and engine enclosures would reduce their noise by 5 to 10 dBA (U.S. EPA, 1971);
- Specifying the quietest equipment available would reduce noise by 5 to 10 dBA;
- Turning off construction equipment during prolonged periods of nonuse would eliminate noise from construction equipment during those periods;
- Requiring contractors to maintain all equipment and train their equipment operators would reduce noise levels and increase efficiency of operation;
- Locating stationary equipment away from receiving properties would decrease noise from that equipment in relation to the increased distance;

Constructing temporary noise barriers or curtains around stationary equipment that must be located close to residences would decrease noise levels at nearby sensitive receptors

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