Addendum to Noise Discipline Report

North Spokane Corridor Project

1 STUDIES AND COORDINATION

This addendum report was prepared in coordination with the Washington State Department of Transportation (WSDOT) engineering and planning staff. The objective of the updated noise analysis described in this report was to assess future noise levels near the freeway interchange between the proposed North Spokane Corridor (NSC) project and existing U.S. Highway 2 (US 2). A noise discipline report was prepared previously for the overall NSC project (Jones & Stokes 2000). Recent revisions to the designed vertical alignment at the interchange could result in changes in the noise impacts at local residences. Therefore, WSDOT authorized this addendum report to update the noise impact assessment and the recommendations for noise mitigation at the NSC/US 2 interchange.

Traffic data and road alignments used for traffic noise modeling were provided by the WSDOT Eastern Region Office. Aerial photographs and locations of existing homes were also provided by WSDOT.

1.1 Project Description

The proposed NSC project is located in the northeast quadrant of the City of Spokane, Washington. The NSC will create an approximate 16.6-kilometer (10.3-mile) link between Interstate 90 on the south, and US 2 and US 395 on the north. The proposed NSC originates at Interstate 90 just east of the Spokane central business district, and progresses north to the Wandermere area, thus forming a continuous connection with US 2 and US 395.

The revised alignment of the freeway interchange between NSC and US 2 is shown in Figure 1. The alignment evaluated in this addendum report specifies the NSC roadways and the interchange ramps crossing above US 2 on an overpass. The alignment specified in the previous noise discipline report specified the NSC roadways passing under US 2 in a depressed corridor.

As shown in Figure 1 there are a variety of land uses located adjacent to the proposed interchange. The residential area with the highest density is north of the interchange along Shady Slope Road. Less dense residential areas are located along Garden Street (south of NSC). The areas east and south of the interchange consist of low-density, semi-rural residences or undeveloped land.

1.2 Background Information on Noise

Sound travels through the air as waves of minute air pressure fluctuations caused by some type of vibration. In general, sound waves travel away from the noise source as an expanding spherical surface. As a result, the energy contained in a sound wave is spread over an increasing area as it travels away from the source. This results in a decrease in loudness at greater distances from the noise source.

Sound level meters measure the actual pressure fluctuations caused by sound waves, with separate measurements made for different sound frequency ranges. The decibel (dB) scale used to describe sound is a logarithmic scale which accounts for the large range of audible sound intensities. Most sounds consist of a broad range of sound frequencies. Several frequency weighting schemes have been used to develop composite decibel scales that approximate the way the human ear responds to noise levels. The weighting of noise levels at different frequencies is due to the psychological perception of noise by humans. The A-weighted decibel scale (dBA) is the most widely used for this purpose. Typical A-weighted noise levels for various types of sound sources are summarized in Table 1.

Varying noise levels are often described in terms of the equivalent constant dB level. Equivalent sound levels (L_{eq}) are used to develop single-value descriptions of average noise exposure over various periods of time. Such average noise exposure ratings often include additional weighting factors for annoyance potential attributable to time of day or other considerations. The L_{eq} data used for these average noise exposure descriptors are generally based on A-weighted sound-level measurements. Statistical descriptions are also used to characterize noise conditions over specified periods of time. For example, L_{10}, L_{25}, L_{50}, and L_{90} are the sound levels that are exceeded 10%, 25%, 50%, and 90% of the time during a monitoring period. L_{10} descriptors are commonly used to characterize peak noise levels, while the L_{90} descriptor is commonly used to characterize background noise levels.

The nature of dB scales is such that individual dB ratings for different noise sources cannot be added directly to give the sound level for the combined noise source. For example, two noise sources producing equal dB ratings at a given location will produce a combined noise level 3 dB greater than either sound alone. When two noise sources differ by 10 dB, the combined noise level will be 0.4 dB greater than the louder source alone. People generally perceive a 10 dB increase in a noise source as a doubling of loudness. For example, a 70 dB sound level will be perceived by an average person as twice as loud as a 60 dB sound. People generally cannot detect differences of 1 to 2 dB between noise sources; however, under ideal listening conditions, differences of 2 or 3 dB can be detected by some people. A 5 dB change would probably be perceived by most people under normal listening conditions.

When distance is the only factor considered, sound levels from isolated point sources of noise typically decrease by about 6 dB for every doubling of distance from the noise source. When the noise source is a continuous line (e.g., vehicle traffic on a highway), sound levels decrease by about 3 dB for every doubling of distance in the absence of atmospheric absorption or ground attenuation. For traffic noise modeling, an attenuation rate of 4.5 dB for every doubling of distance is often used when the roadway is at ground level and the intervening ground is effective in absorbing sound (e.g., ground vegetation, scattered trees, clumps of bushes). When the roadway is elevated (as in the case of the NSC crossing above US 2), 3 dB noise attenuation for every doubling of distance is used because the sound-absorbing effects of the intervening ground are limited.

Table 1. Weighted Sound Levels and Human Response

Sound Source	dBA*	Response Criteria
Carrier deck jet operation	140	Limit amplified speech
Limit of amplified speech	130	Painfully loud
Jet takeoff (200 feet) Auto horn (3 feet)	120	Threshold of feeling and pain
Riveting machine Jet takeoff (2,000 feet)	110	
Shout (0.5 feet) New York subway station	100	Very annoying
Heavy truck (50 feet) Pneumatic drill (50 feet)	90	Hearing damage (8-hour exposure)
Passenger train (100 feet) Helicopter (in flight, 500 feet) Freight train (50 feet)	80	Annoying
Freeway traffic (50 feet)	70	Intrusive
Air conditioning unit (20 feet) Light auto traffic (50 feet)	60	
Normal speech (15 feet)	50	Quiet
Living room Bedroom Library	40	
Soft whisper (15 feet)	30	Very quiet
Broadcasting studio	20	
	10	Just audible
	0	Threshold of hearing

* Typical A-weighted sound levels taken with a sound-level meter and expressed as decibels on the scale. The "A" scale approximates the frequency response of the human ear.

Source: U.S. Council on Environmental Quality 1970.

Noise levels at different distances can also be affected by several factors other than the distance from the noise source. Topographic features and structural barriers that absorb, reflect, or scatter sound waves can increase or decrease noise levels. Atmospheric conditions (wind speed and direction, humidity levels, and temperatures) can also affect the degree to which sound is attenuated over distance.

Echoes off topographical features or buildings can sometimes result in higher sound levels (lower sound attenuation rates) than normally expected. Temperature inversions and attitudinal changes in wind conditions can also refract and focus a sound wave to a location at considerable distance from the noise source. These effects are usually noticeable only for very intense noise sources, such as blasting operations. As a result, the existing noise environment can be highly variable depending on local conditions.

1.3 Federal Highway Administration and WSDOT Noise Standards

The Federal Noise Control Act of 1972 (Public Law 92-574) requires that all federal agencies administer their programs in a manner that promotes an environment free from noises that may jeopardize public health or welfare.

Federal regulations (23 CFR 772) specify criteria for evaluating noise impacts associated with federally-funded highway projects, and for determining whether such impacts are sufficient to justify funding noise abatement actions. The Federal Highway Administration (FHWA) noise abatement criteria (NAC) are summarized in Table 2.

Table 2. Federal Highway Administration Noise Abatement Criteria

Activity Category	Leq Noise Levels (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.		

1.4 Definition of a Traffic Noise Impact

A noise impact occurs when a predicted traffic noise level approaches or exceeds the noise abatement criteria listed in Table 2, or when the predicted traffic noise level substantially exceeds the existing noise level. As defined by WSDOT, a noise level within 1 dBA of the NAC is considered to approach the NAC, while a noise level greater than or equal to the NAC is considered to exceed the NAC. According to FHWA guidelines, a 10-dBA increase over