Memorandum

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Subject: Technical Noise Memorandum

No noise sensitive sites were identified in previous environmental investigations for the South Spokane Street Viaduct Project. Recently, a Secure Community Transition Facility was built just north of the project area at 132 South Spokane Street, between 1st and 2nd Avenues South. This Technical Noise Memorandum includes: results of a field noise measurement at the Secure Community Transition Facility, the results of field investigations to identify additional noise-sensitive sites within 1,000 feet from project improvements, and a qualitative description of the noise readings and potential impacts and mitigation measures.

Introduction

The South Spokane Street Viaduct Project would provide improvements to the existing viaduct and roadway in the south downtown Seattle area. South Spokane Street provides a primary connection to the West Seattle Bridge and serves as an important east-west connection between West Seattle and the Beacon Hill neighborhoods. With the Project, the viaduct would be widened to five lanes with shoulders and a new on- and off-ramp would be constructed at 1st Avenue South. A westbound loop ramp would be provided to 4th Avenue South. At ground level, South Spokane Street would be repaved and existing sidewalks would be improved. The Project represents the final phase of improvements to the roadway and is intended to facilitate movement of freight and goods and improve mobility along South Spokane Street.

Background 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 Table 1.

Table 1: Typical Noise Levels

Transportation Sources	Noise Level (dBA)	Other Sources	Description
	130		Painfully loud
Jet takeoff (200 feet)	120		
Car horn (3 feet)			Maximum vocal
	110		Effort
	100	Shout (.5 feet)	
			Very annoying
Heavy truck (50 feet)	90	Jack hammer (50 feet)	Loss of hearing with
		Home shop tools (3 feet)	prolonged exposure
Train on a structure (50 feet)	85	Backhoe (50 feet)	
City bus (50 feet)	80	Bulldozer (50 feet)	Annoying
		Vacuum cleaner (3 feet)	
Train (50 feet)	75	Blender (3 feet)	
City bus at stop (50 feet)			
Freeway traffic (50 feet)	70	Lawn mower (50 feet)	
		Large office	
Train in station (50 feet)	65	Washing machine (3 feet)	Intrusive
	60	TV (10 feet)	
Light traffic (50 feet)		Talking (10 feet)	
Light traffic (100 feet)	50		Quiet
		Refrigerator (3 feet)	
	40	Library	
	30	Soft whisper (15 feet)	Very quiet

Sources: FTA, 1995; EPA, 1971; EPA, 1974

Environmental noise is composed of many frequencies, each occurring simultaneously at its own sound pressure level. 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). The commonly used frequency weighting for environmental noise is A-weighting (dBA), which simulates how an average person hears sound.

A common noise descriptor for environmental noise is the equivalent sound level (L_{eq}). L_{eq} is a measure of total noise, a summation of all sounds during a period of time. L_{eq} measured over a one-hour period is the hourly L_{eq} (L_{eq}(h)).

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 L_{eq}(h) noise levels approach or exceed the FHWA's established noise abatement criteria (NAC) 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 L_{eq}(h) noise levels for various land activity categories (Table 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 L_{eq}(h) noise levels approach within 1 dBA of the noise abatement criteria in Table 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.

Table 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.

The City of Seattle limits noise levels at property lines of neighboring properties (SMC 25.08.410). Automobiles operating on public roads are exempt from City of Seattle regulations. The maximum permissible sound level depends on the land uses of both the source noise and receiving property (Table 3). The maximum permissible sound levels apply to construction activities only if they occur between 10 p.m. and 7 a.m. on weekdays and 10 p.m. and 9 a.m. on weekends. Performance of construction activities during nighttime hours that would exceed these levels requires a noise variance from the City of Seattle.

Table 3: City of Seattle Maximum Permissible Sound Levels (dBA)

District of Noise Source	District of Receiving Property			
	Residential[a]		Commercial	Industrial
	Day	Night		
Residential	55	45	57	60
Commercial	57	47	60	65
Industrial	60	50	65	70

[a] The maximum permissible sound level is reduced by 10 dBA for residential receiving properties between 10 p.m. and 7 a.m.

Source: Seattle Municipal Code 25.08.410.

Construction activities carried out between 7 a.m. and 10 p.m. on weekdays and between 9 a.m. and 10 p.m. on weekends are allowed to exceed the property line standards per the following limits (SMC 25.08.425):

- Earthmoving or other large construction equipment may exceed the applicable property line limit by 25 dBA;
- Portable powered equipment may exceed the limit by 20 dBA; and
- Impact equipment, such as jackhammers, may not exceed an Leq(h) of 90 dBA.

Short-term exceedances above the permissible sound level are allowed for any noise source. 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 during any one-hour period. These allowed exceptions are referred to in terms of the percentage of time a certain level is exceeded. For example, an L25 is the noise level that is exceeded 15 minutes during an hour. Therefore, the permissible L25 would be 5 dBA greater than the values in Table 3, provided that the noise level is below the permissible level in Table 2-4 for the rest of the hour and never exceeds the permissible level by more than 5 dBA. An hourly Leq of approximately 2 dBA higher than the values in Table 3 is a sound level equivalent to the permissible levels, including the allowed short-term excursions. Using this example, an Leq(h) of 59 dBA corresponds approximately to a noise level of 57 dBA for 45 minutes and 62 dBA for 15 minutes, which is the maximum permissible noise level created by a source in a commercial zone and received by a property in a residential zone.

Methodology

The area surrounding the South Spokane Street Viaduct Project was reviewed for noise-sensitive sites such as residences, hotels, churches, schools, and outdoor uses areas on September 15th and 16th, 2005. Much of the area surrounding the project is commercial and industrial land. The newly constructed, Secure Community Transition Facility was the only identified noise-sensitive site in a 1,000 foot radius from the project area.

Ambient noise levels were measured at one location near the project area, to characterize weekday noise levels (USDOT, 1996). A 15-minute measurement was taken with an LD-820 noise meter to estimate the $L_{eq}(h)$ peak-hour noise levels at the outdoor use area to qualitatively analyze future noise levels and present potential mitigation measures.

Potential impacts and mitigation measures resulting from the project were qualitatively assessed due to the limited number of sensitive noise receptors within the project study area. No noise modeling was performed.

Affected Environment

The Proposed Project would be constructed in the Greater Duwamish Manufacturing and Industrial neighborhood south of Seattle's main downtown core. The immediate project vicinity along South Spokane Street and adjacent blocks is an industrial and commercial area with city streets and railroad tracks serving freight movement to and from the area.

The Secure Community Transition Facility located at 132 South Spokane Street, between 1st and 2nd Avenues South was the only noise-sensitive site within a 1,000 foot radius of the South Spokane Street Project. This facility is capable of housing up to twelve residents at a time. Results of the 15-minute noise measurement taken at this location are presented in Table 4.

Table 4: Field Noise Measurement Results

Measurement Number	Receptor Location	Date	Time	Measured Leq Sound Level (dBA)
1	Secure Community Transition Facility located at 132 South Spokane Street	Sept. 15, 2005	2:20 p.m.	**66**

Bold *Leq dBA levels indicate noise levels approach or exceed FHWA Noise Abatement Criteria.*

Noise levels at the outdoor use area at the Secure Community Transition Facility are measured to be at the WSDOT noise abatement criteria of 66 dBA for residence, parks, schools, churches, and similar facilities. The outdoor use area at this facility is located approximately 50 feet from South Spokane Street and receives noise from South Spokane Street Viaduct, South Spokane Street, aircrafts overhead, nearby railroad tracks, and the surrounding industrial area with machinery operating in the immediate vicinity. Because of the facility's proximity to the noise sources mentioned above, elevated levels are expected.

Impacts

Impacts associated with the South Spokane Street Viaduct Project were qualitatively assessed because of the limited number of noise-sensitive sites located near the project area.

Operational Impacts

With and without the project, future traffic noise levels at the Secure Community Transition Facility are anticipated to increase 1 to 3 dBA. The increase at this site will result from increased traffic on South Spokane Street Viaduct, South Spokane Street, and other nearby surface streets. Noise levels at this facility are anticipated to increase from its existing noise level of 66 dBA to between 67 dBA and 69 dBA in the year 2030, with or without the South Spokane Street Viaduct Project.

Construction Impacts

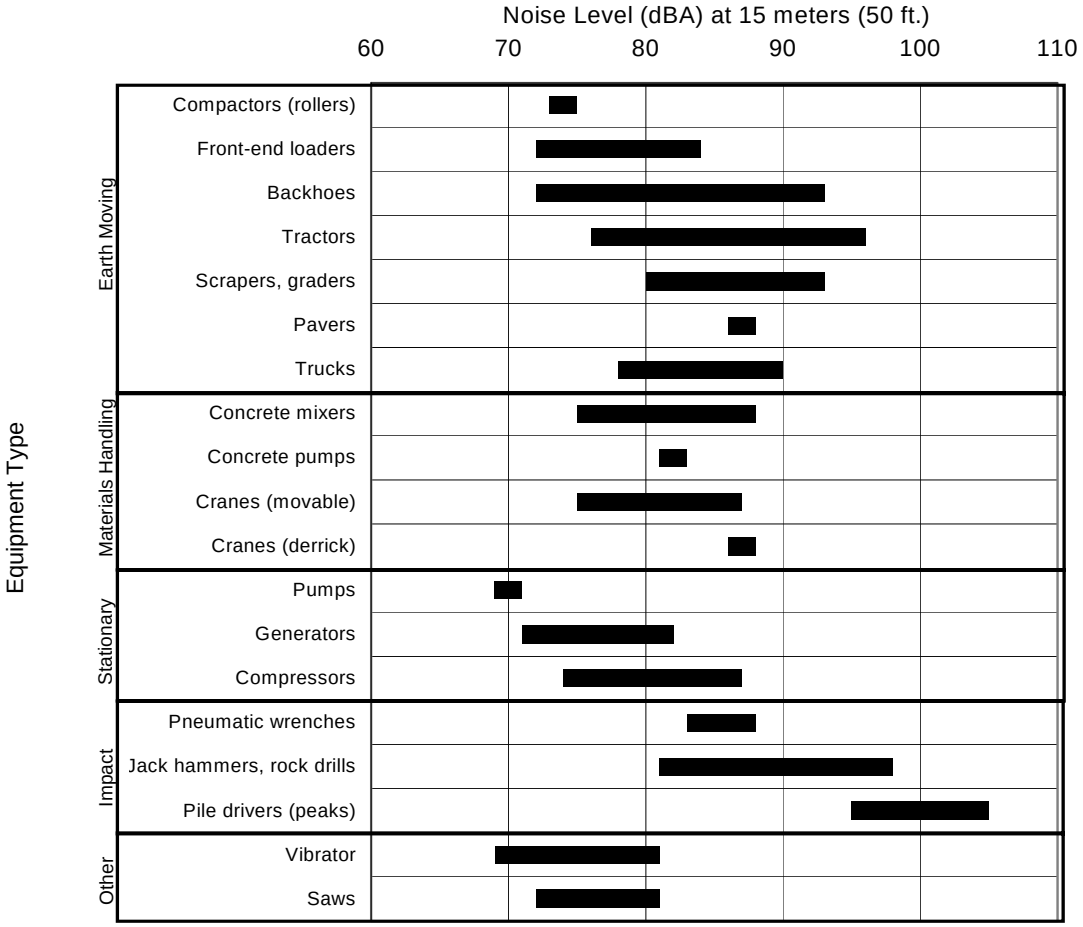
Construction activities will generate noise during the construction period. Construction usually will be carried out in several reasonably discrete steps, each of which has its own mix of equipment and, consequently, its own noise characteristics. Roadway construction will involve clearing, cut-and-fill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

The most prevalent noise source at construction sites will be the use of the internal combustion engine. 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 will be present during most phases and will not be confined to the project site, noise from trucks could affect more receptors. Other noise sources may include impact equipment and tools such as pile drivers. Impact tools could be pneumatically powered, hydraulic, or electric. Construction noise will be intermittent and occurring seasonally. Construction noise levels will depend on the type, amount, and location of construction activities. The type of construction methods will establish the maximum noise levels of construction equipment used. The amount of construction activity will quantify how often construction noise will occur throughout the day. The location of construction equipment relative to adjacent properties will determine any effects of distance in reducing construction noise levels. Maximum noise levels of construction equipment will be similar to typical maximum construction equipment noise levels presented in Figure 1.

As shown in Figure 1, maximum noise levels from construction equipment will range from 69 to 106 dBA at 50 feet (15 meters). Construction noise farther away will decrease at a rate of 6 dBA per doubling of distance from the source. The number of occurrences of the Lmax noise peaks will increase during construction, particularly during pile-driving activities. Because various equipment will 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 Leq noise levels during the day will be less

than maximum noise levels presented in Figure 1. Construction noise levels could be reduced by the construction practices identified in the Mitigation Section.

Figure 1: Construction Noise Levels



Source: EPA, 1971 and WSDOT, 1991.

Mitigation Measures

Noise can be controlled at three locations: (1) at the source, such as with mufflers and quieter engines; (2) along the noise path, with barriers; and (3) at the receptor, with insulation. Noise abatement is necessary only where frequent human use occurs and where a lower noise level will have benefits (U.S. DOT, 1982).

Operational Noise Mitigation Options

A variety of mitigation measures can be effective at reducing traffic noise impacts. The following mitigation measures must be considered when a project will result in a noise impact. Abatement measures include:

- Traffic management,
- Alteration of horizontal and vertical alignments,
- Acquisition of real property to serve as a buffer zone,
- Acquisition of property rights for barrier construction purposes, and
- Insulation of public use, non-profit institutional structures.
- Construction of noise barriers,

These mitigation measures were evaluated for their potential to reduce noise impacts from the South Spokane Street Viaduct Project. The results of the evaluation are summarized below.

Traffic Management Measures

Management measures could include restricting travel times, restrictions on truck traffic, modified speed limits, and exclusive land designations. Restriction of truck traffic is not feasible as there is no alternative route to Spokane Street Viaduct. Noise impacts could be reduced by land use controls throughout the project area to limit the proximity of future construction to major facilities. This can be achieved through building setback requirements.

Acquisition of Property to Serve as a Buffer Zone

Undeveloped parcels adjacent to the South Spokane Street Viaduct study area could be acquired to provide noise buffers. While this could limit the effects of traffic noise on future development, it would not mitigate impacts to the currently existing facility that would experience elevated noise levels under this project. The costs of land acquisition for this purpose would also be prohibitively expensive.

Alteration of Roadway Horizontal and/or Vertical Alignment

In the area where noise impacts are predicted to occur, the vertical and horizontal alignments of South Spokane Street Viaduct are constrained by the existing structure and

surrounding roadways. Additional changes to the South Spokane Street Viaduct vertical or horizontal alignments would not be feasible noise mitigation measures.

Insulation of Public Use, Nonprofit Institutional Buildings

The facility that would be impacted is not public use or a nonprofit institution, and therefore would not be eligible for acoustic insulation.

Noise Barriers

Noise barriers include noise walls, berms, and buildings that are not sensitive to noise. The effectiveness of a noise barrier is determined by its height and length and by the topography of the project site. To be effective, the barrier must block the "line of sight" between the highest point of a noise source, such as a truck's exhaust stack, and the highest part of a receiver. It 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 will not be transmitted through it. Intervening rows of buildings that are not noise sensitive also could be used as barriers.

Determination of engineering feasibility includes whether barriers could be built in a location to achieve a noise reduction of at least 7 dBA at the closest receptors. Determination of reasonability includes the number of sensitive receptors benefited by at least 3 dBA, the cost-effectiveness of the barriers, and concerns such as aesthetics, safety, and the desires of nearby residents.

Noise barriers were not evaluated to mitigate noise levels at the Secure Community Transition Facility because this is the only noise-sensitive use near the project area and the facility receives noise from multiple noise sources other than South Spokane Street Viaduct including: surface streets, nearby railroad lines, aircrafts, and noise from a large number of heavy trucks and machinery located in the immediate vicinity. Designing a noise barrier that would reduce noise levels at the outdoor area of this facility would be extremely difficult and prohibitively expensive due the multiple noise sources located in the surrounding area.

Construction Noise Mitigation Options

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 times 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. will reduce construction noise levels during sensitive nighttime hours;
- Equipping construction equipment engines with adequate mufflers, intake silencers, and engine enclosures will reduce their noise by 5 to 10 dBA (U.S. EPA, 1971);
- Specifying the quietest equipment available will reduce noise by 5 to 10 dBA;

- Turning off construction equipment during prolonged periods of nonuse will eliminate noise from construction equipment during those periods;

- Requiring contractors to maintain all equipment and to train their equipment operators will reduce noise levels and increase efficiency of operation;

- Locating stationary equipment away from receiving properties will decrease noise from that equipment as the distance increases;

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

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