Appendix E:
Noise and Vibration Discipline Report

Point Defiance Bypass Project

Noise and Vibration Discipline Report

Washington State Department of Transportation

September 2012

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Summary

The Federal Railroad Administration (FRA) is the federal Project lead and the Washington State Department of Transportation (WSDOT) is the lead state agency for the Project.

The Project is located in Pierce County along an approximately 21-mile existing corridor. The three owners of the Project are Sound Transit, Tacoma Rail, and the Burlington Northern Santa FE (BNSF) Railroad.

The Project would improve railroad track and support facilities, and relocate the Tacoma Amtrak Station. Following are the five major Project components:

- Construct a new track adjacent to the existing main line between South Tacoma and Lakewood.
- Reconstruct and rehabilitate the existing main line track.
- Improve the connection to the main line near Nisqually.
- Construct improvements at existing at-grade crossings to improve safety features and allow high-speed rail operations.
- Relocate the Tacoma Amtrak Station to the Tacoma Dome Station at Freighthouse Square.

No new at-grade highway or rail crossings are planned within the Project area, nor would any at-grade crossings be closed as part of the Project.

Noise Assessment Methodology

Predicted noise levels for the Project area were modeled with the current (2011 version) Federal Transit Administration (FTA) noise spreadsheet model. Predicted future noise levels in the Project area were based on existing measured sound levels and future daily rail operations detailed in Chapter 1 of the *Noise and Vibration Discipline Report*. The spreadsheet was developed by FTA and uses the methods and formulas described in "Chapter 6: Detailed Noise Analysis" of the FTA guidance manual, *Transit Noise and Vibration Impact Assessment* (FTA 2006).

To provide a baseline for the analysis of potential noise effects caused by the rail operations, long-term (24-hour) measurements were conducted at

19 sites, which include residences and other buildings where people normally sleep. These measurement locations were supplemented with four short-term (15-minute) noise measurements to determine existing noise levels at typical recreational, institutional, and commercial land uses with primarily daytime and evening activity.

Noise exposure (future noise that would be generated by the Project) was forecast using the FTA 2011 spreadsheet-based noise model.

The predicted noise levels were compared to the site-specific criteria to determine if there would be No Effect, a Moderate Effect, or a Severe Effect at each site.

Rail Vibration Assessment Methodology

Vibration effects from rail operations are generated through the wheel/rail interface. The smoothness of these motions/actions is influenced by wheel and rail roughness, rail vehicle suspension, train speed, track construction (including types of fixation and ballast), the location of switches and crossovers, and the geologic strata (layers of rock and soil) underlying the track. Vibration from a passing train could move through the geologic strata, resulting in building vibration transferred through the building foundation. Because vibration levels are rarely sufficient to cause building damage, the principal concern is annoyance to building occupants.

FRA relies upon the FTA noise and vibration impact assessment procedures for assessing improvements to conventional passenger rail lines and stationary rail facilities and horn noise assessment.[1]

Vibration levels caused by the Project were predicted using the vibration assessment information and procedures contained in the FTA's guidance manual, *Transit Noise and Vibration Impact Assessment* (2006).

All estimates of ground-borne vibration were projected to the foundation of each building, and did not include estimates of building coupling loss. Building coupling loss is the amount of vibration energy lost between the ground vibration and the vibration of the building; generally, the heavier the building foundation, the greater the coupling loss. Predicted ground-borne vibration levels were compared to the FTA impact criteria to determine potential effects.

[1] *Guidance on Assessing Noise and Vibration Impacts (FRA 2011)*

Construction Noise and Vibration Assessment Methodology

Because the means and methods of construction will not be known until a contractor is selected for the Project, analysis of construction noise and vibration was based on typical activities and equipment used for demolition, excavation, and erection work phases. The evaluated activities are representative of activities that would occur during Project construction.

Noise and Vibration Criteria

Per FRA's Guidance on Assessing Noise and Vibration Impacts (2011), FRA relies upon the FTA noise and vibration impact assessment procedures for assessing improvements to conventional passenger rail lines and stationary rail facilities, and horn noise assessment.

Noise and vibration impact assessment procedures are described in detail in Chapter 2 of the *Noise and Vibration Discipline Report*.

Airborne Noise Criteria

The criteria in the FTA guidance manual, *Transit Noise and Vibration Impact Assessment* (2006), are founded on well-documented research on community reactions to environmental noise, and based on project-related changes in noise exposure using a sliding scale. The degree to which a project may increase the existing level of environmental noise is reduced with increasing levels of existing noise. The Noise Impact Criteria group noise-sensitive land uses into the following three categories:

- **Category 1**: Sites where quiet is an essential element of their purpose.
- **Category 2**: Residences and buildings where people normally sleep. This includes single- and multi-family residences, hospitals, and hotels where nighttime sensitivity is assumed to be of utmost importance.
- **Category 3**: Institutional land uses with primarily daytime and evening use. This category includes schools, libraries, churches, office buildings, and other noise-sensitive commercial land uses.

The Average Day/Night Sound Level (L_{dn}) in units of A-weighted decibels (dBA) is used to describe noise exposure for residential receivers/areas (Category 2). The maximum one-hour Equivalent Sound Level (L_{eq}), also in units of dBA, is used to describe noise exposure for other noise-sensitive land uses such as school buildings (Categories 1 and 3). L_{dn} and L_{eq} are described in detail in Chapter 3 of the *Noise and Vibration*

Discipline Report. The criteria, as described in FTA's *Transit Noise and Vibration Impact Assessment* (2006) include two levels of impact:

- **Severe Effect:** Severe noise effects are considered "significant" as this term is used in NEPA and its implementing regulations. Severe noise effects represent the most compelling need for mitigation measures. However, before mitigation measures are considered, the project sponsor should first evaluate alternative locations/alignments to determine whether it is feasible to avoid Severe Effects altogether while still satisfying project goals. If it is not practical to avoid Severe Effects by changing the location or design of the project, mitigation measures must be considered. Severe Effects have the greatest adverse effect on the community; thus, there is a presumption that mitigation would be incorporated in the project unless there are truly extenuating circumstances that prevent it.
- **Moderate Effect:** Moderate noise effects are associated with a change in the cumulative noise level that is noticeable to most people, but may not be sufficient to cause strong, adverse reactions from the community. Project noise levels in the Moderate Effect range would also require consideration and adoption of noise abatement measures when they are considered feasible and reasonable. While effects in this range are not of the same magnitude as Severe Effects, there can be circumstances regarding the factors outlined below that make a compelling argument for mitigation. These other factors can include the predicted increase over existing noise levels, the type and number of noise-sensitive land uses affected, existing outdoor/indoor sound insulation, community views, special protection provided by law, and the cost-effectiveness of mitigating noise to more acceptable levels.

Ground-Borne Noise and Vibration Criteria

The FTA has developed impact criteria for acceptable levels of ground-borne vibration and ground-borne noise. Ground-borne vibration from rail vehicles is characterized in terms of the root-mean-square (RMS) vibration velocity amplitude. The threshold of vibration perception for most humans is around 65-70 vibration decibels (VdB). Levels in the 70-75 VdB range are often noticeable but acceptable, and levels greater than 80 VdB are often considered unacceptable.

Ground-borne noise does not generate effects for at-grade rail operations (such as the Project), because the level of airborne noise from passing trains transmitted through the windows or walls of a building would exceed any ground-borne noise potentially transmitted into the building.

Noise and Vibration Effects

Noise and vibration effects are described in detail in Chapter 5 of the *Noise and Vibration Discipline Report*. Moderate noise effects are predicted at two sites for the Project: Site 6M and Site 16N. Each site represents approximately six residences. The noise levels at these sites would be caused by warning devices at at-grade crossings located near the noise-sensitive land uses.

Operational- and construction-related vibration effects are predicted at two sites: Site 3 and Site 11. Site 3 represents approximately five residences, and Site 11 represents approximately 11 residences located 25-50 feet from the nearest track. Vibration levels at these locations are a result of the small distance between the tracks and the vibration-sensitive land uses.

Noise Minimization Measures

No Build Alternative

Under the No Build Alternative, the Project would not be built and would not cause any additional noise effects. Therefore, no mitigation or minimization measures are required or proposed.

Build Alternative

No severe noise effects are predicted for the Build Alternative. Moderate noise effects are predicted at Sites 6M and 16N. These effects would be caused by warning devices at the nearby at-grade crossings. These crossings will use wayside horns to limit the sounding of train horns and reduce the area exposed to train warning sounds; however, noise effects would still occur near the intersections. The use of wayside horns has been included in the Project's design to minimize noise exposure from the Project. Because the affect would be caused by required warning devices, elimination of the noise source would not be acceptable because it would create a safety hazard. While it is not required, mitigation for moderate effects, where possible, should be considered. Noise barrier placement is not feasible in these areas, because openings in the barriers would be needed for roadway crossings and noise barriers in these areas could create sight-distance hazards.

Structural sound insulation in dwellings is provided only if predicted noise effects are severe. The predicted noise effects identified for the Project are less than severe. Therefore, noise insulation is not recommended as a mitigation measure.

Therefore, no noise mitigation or minimization measures are recommended for grade-crossing noise effects caused by the Build Alternative.

Vibration Minimization Measures

No Build Alternative

Under the No Build Alternative, the Project would not be built and would not cause any vibration effects. Therefore, no minimization measures are required or proposed.

Build Alternative

Vibration effects at Sites 3 and 11 would be caused by train pass-by. Use of track treatments to reduce the vibration transmitted to the ground, such as resiliently supported ties, or ballast mats in this area could reduce the vibration levels below the 80 VdB criteria.

A detailed vibration analysis of the two areas with predicted vibration effects will be conducted during final design. This study will address the vibration from the existing rail line and characterize the soil propagation in the area, which may reduce the number of vibration effects. The detailed study will also address any rail vibration treatments that have already been incorporated by Sound Transit in areas of shared track.

Construction Minimization Measures

Noise and vibration control measures during construction may be required to minimize noise and vibration levels on existing sensitive land uses. All construction activities will have to comply with local noise and vibration regulations. Nighttime work could require a variance for local noise regulations.

The contractor will be required to comply with any noise regulations permits acquired for the Project. Construction hours could be set, and construction activity noise level emission criteria could be determined and compliance required during construction.

Chapter 1 –Project Description

Introduction

Under the High-Speed Intercity Passenger Rail (HSIPR) Program and pursuant to a programmatic Tier I Environmental Assessment (EA) the Federal Railroad Administration (FRA) has approved an application from the Washington State Department of Transportation (WSDOT) to improve the Pacific Northwest Rail Corridor (PNWRC), a federally designated high-speed rail corridor. One project included in the PNWRC application is the Point Defiance Bypass Project (the Project), which would respond to deficiencies in the existing rail operations around Point Defiance. This Discipline Report has been prepared in support of the project-specific EA for the Point Defiance Bypass project.

The Project is located in Pierce County along an existing approximately 20-mile rail corridor between Tacoma and Nisqually.2 The Project would provide for the re-routing of Amtrak passenger trains from the BNSF rail line that runs along the southern Puget Sound shoreline (Puget Sound route) to the Point Defiance Bypass route, an existing rail corridor that runs along the west side of I-5. The Project would consist of railroad track and support facility improvements, and relocation of the Tacoma Amtrak Station to Freighthouse Square in Tacoma.

Purpose and Need

As described above, the Point Defiance Bypass route is part of the larger PNWRC. Within Washington State, the vision for the PNWRC is to "…improve intercity passenger rail service by reducing travel times and achieving greater schedule reliability in order to accommodate growing intercity travel demand…"[3].

The purpose of the Project is to provide more frequent and reliable high-speed intercity passenger rail service along the PNWRC between Tacoma and Nisqually. In conformity with the decisions under the Tier 1 Programmatic EA, the PNWRC Improvement Program has reduced the

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[2] *The three owners of the project corridor are Sound Transit, Tacoma Rail, and BNSF.*
[3] WSDOT 2009

overall environmental effects of providing improved passenger rail service with the use of an existing transportation corridor and associated infrastructure, rather than creating a new corridor.

The Project is needed to address the deficiencies in the existing rail alignment around Point Defiance. The existing alignment (Puget Sound route), shared by freight and passenger rail traffic, is near capacity and is therefore unable to accommodate additional high-speed intercity passenger rail service without substantial improvements. In addition, the existing alignment has physical and operational constraints that adversely affect both passenger train scheduling and reliability.

Improving intercity passenger rail service in the project area and meeting the Project needs would be accomplished by:

- Enhanced Frequency: Increasing Amtrak Cascades round-trips from four to six by 2017 to meet projected service demands.
- Improved Reliability: Reducing scheduling conflicts with freight trains that often result in delays, and by minimizing or avoiding operational delays (e.g., drawbridge openings) and weather-related delays (e.g., mudslides), and improving on-time performance from 68 percent to 88 percent.
- Enhanced Efficiency: Enhancing the efficient movement of people by decreasing trip times by 10 minutes, and reducing the amount of time passenger trains spend yielding to freight movements.
- Improved Safety: Constructing at-grade crossings with upgraded safety features, including wayside horns, median barriers, advance warning signals, and traffic signal improvements.

What alternatives are being considered for the Point Defiance Bypass Project?

FRA and WSDOT conducted an evaluation of three build alternatives: the Point Defiance Bypass Alternative, the Shoreline Alternative, and the Greenfield Alternative. Two of the alternatives (the Shoreline Alternative, and the Greenfield Alternative) were eliminated from further study. Although both alternatives could meet the Project's purpose and need, they were determined to be impracticable and unfeasible due to technical constraints, high construction costs, and significant environmental effects. Grade separations were also evaluated for further consideration. FRA and WSDOT's preliminary analysis revealed that current and projected future traffic volumes do not warrant the construction of new grade-separated crossings.

What's happening in the bypass corridor today?

The rail line between TR Junction and East "D" Street in Tacoma hosts both freight and commuter trains, including freight operators Tacoma Rail and BNSF, and Sound Transit's *Sounder* commuter rail service. Freight train traffic between TR Junction and East "D" Street averages under two trains per day, while Sound Transit currently operates 18 trains per day between Freighthouse Square and Seattle each weekday, and also offers occasional special event trains, usually on weekends, to serve sporting and other events in Seattle. *Sounder* service to Lakewood begins in late 2012.

What would happen if the Project were not built?

If the Project were not built (the No Build Alternative), Amtrak's Cascades and Coast Starlight passenger train service would continue to use the existing Puget Sound route. The No Build Alternative includes only the minor maintenance and repair activities necessary to keep the existing Puget Sound route operational. With the No Build Alternative, it would be expected that as freight traffic increases, congestion would adversely affect Amtrak service reliability, and the travel time for Amtrak trains between Seattle and Portland would increase.

Along the Point Defiance Bypass route, the Tacoma Rail and BNSF freight services would continue. The at-grade crossings at Clover Creek Drive Southwest, North Thorne Lane Southwest, Berkeley Street Southwest, 41st Division Drive, and Barksdale Avenue Southwest would not be upgraded.

Sound Transit's *Sounder* commuter passenger trains will become operational in late 2012 between the Tacoma Dome Station at Freighthouse Square in Tacoma and Sound Transit's Lakewood Station (on the Point Defiance Bypass route) with as many as 18 *Sounder* trains per day.

What are the proposed improvements and related activities of the Point Defiance Bypass Project?

The Project consists of railroad track and support facility improvements, and the relocation of Amtrak's Tacoma Station. **Error! Reference source not found.** shows the components of the Build Alternative. The following details specific components of the Build Alternative.

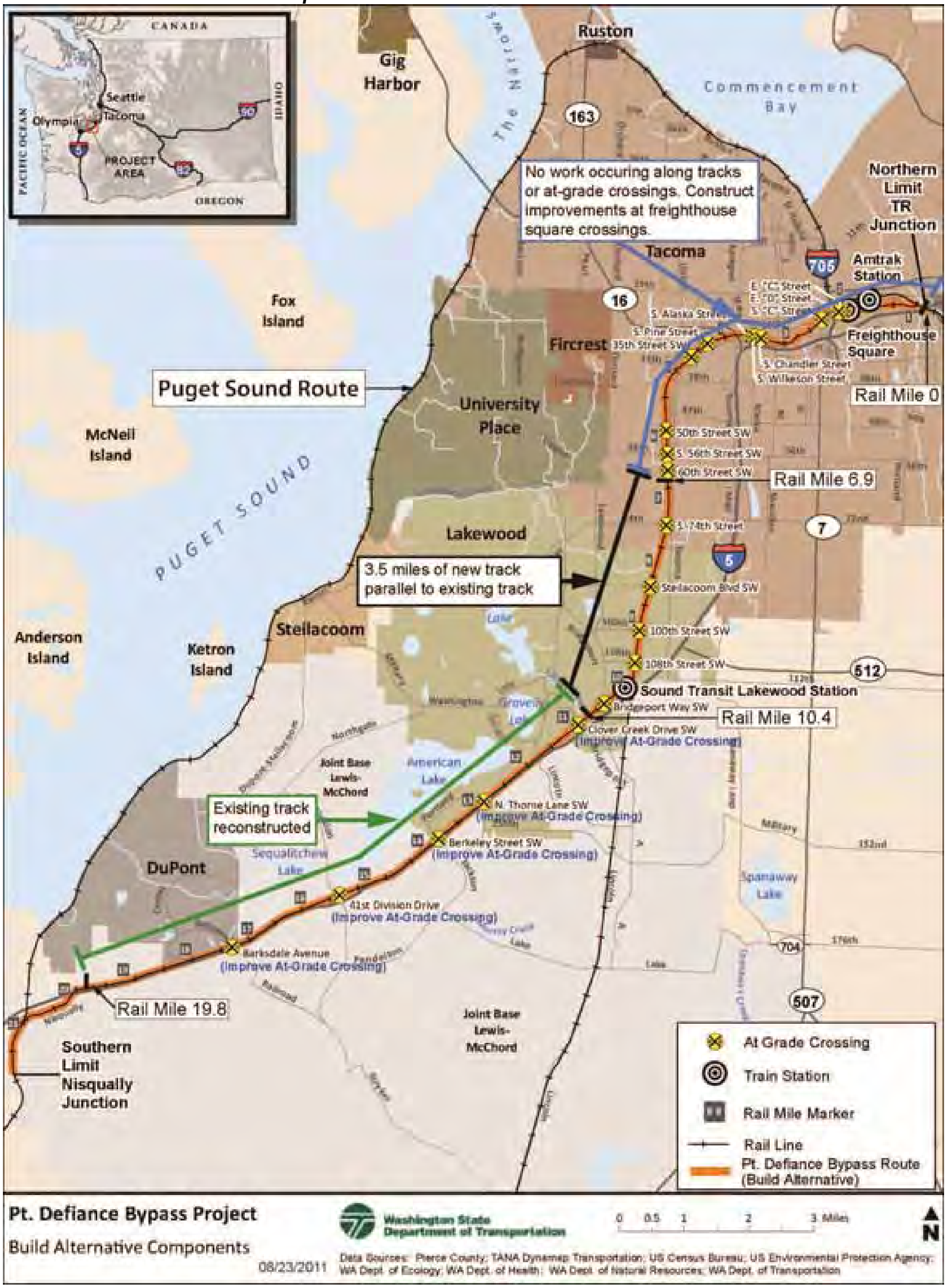
- **Construct New Track Adjacent to the Existing Main Line –** A new 3.5-mile track adjacent to the existing main line would be constructed from South 66th Street (Rail MP 6.9) in Tacoma to between Bridgeport Way SW (Rail MP 10.4) and Clover Creek Drive SW (Rail MP 10.9) in Lakewood.

- **Reconstruct and Rehabilitate the Existing Main Line –** Starting just southwest of Bridgeport Way Southwest (Rail MP 10.4) in Lakewood, the existing track would be reconstructed to a location southeast of the I-5/Mounts Road Southwest interchange (Rail MP 19.8) at Nisqually Junction.
- **Improvements at at-Grade Crossings –** Several grade crossings would be improved with wayside horns, gates, traffic signals and signage, sidewalks, median separators, and warning devices. These crossings include Clover Creek Drive Southwest, North Thorne Lane Southwest, Berkeley Street Southwest, 41st Division Drive and Barksdale Avenue.
- **Tacoma Amtrak Station Relocation –** The existing Tacoma Amtrak Station would be relocated from its Puyallup Avenue location to the Tacoma Dome Station at Freighthouse Square, at 430 E. 25th Street in Tacoma.

What are the proposed operational changes that would result from the Point Defiance Bypass Project?

Amtrak's existing Cascades and Coast Starlight passenger train service would be rerouted from the Puget Sound route along the Puget Sound shoreline to the Point Defiance Bypass route. The Project would also provide for additional Amtrak Cascades service by increasing the number of round trips provided from 4 to 6, or a total of 12 Cascades service train trips. All Amtrak Cascades and Amtrak Coast Starlight service would occur between 7:00 a.m. and 10:00 p.m. No Amtrak nighttime service would be operated on the Point Defiance Bypass route. Amtrak Coast Starlight would also travel on the Point Defiance Bypass route for a total of two Coast Starlight service train trips. The speed of these passenger trains would be up to 79 mph.

Exhibit 1. Build Alternative Components



Chapter 2 – Methodology

Per FRA's Guidance on Assessing Noise and Vibration Impacts (FRA 2011), FRA relies upon the FTA noise and vibration impact assessment procedures for assessing improvements to conventional passenger rail lines and stationary rail facilities and horn noise assessment.

The study area for the noise and vibration analysis is the project corridor. Noise and vibration effects were evaluated at noise- and vibration-senisitive receptors within 1,000 feet of the track centerline.

Noise Assessment Methodology

Predicted noise levels in the area surrounding the Project were modeled with the current (2011 version) FTA noise spreadsheet model. Predicted future noise levels in the study area were based on existing measured sound levels and future daily rail operations oulined in Chapter 1. The spreadsheet was developed by FTA and uses the methods and formulas in "Chapter 6: Detailed Noise Analysis" of the FTA guidance manual, *Transit Noise and Vibration Impact Assessment* (2006).

The operations assumptions (speed, headways, and schedule) used in the noise analysis were the same as those used in estimating ridership, fare revenue, and other effects of the Project.

Noise effects from rail operations are generated from the interaction of wheels on track and motive power. The interaction of steel wheels on rails generates four different types of noise, depending on track work. These include:

1. Noise generated by passing trains operating on tangent track sections;
2. Noise generated from wheel squeal on tightly curved track;
3. Noise generated on special trackwork sections, such as at crossovers or turnouts; and
4. Noise generated at grade crossing, including warning bells, locomotive horns, or wayside horns.

This noise impact analysis considered each of these different sources.

Potentially noise-sensitive land uses and vibration-sensitive buildings were identified, as well as appropriate locations for noise and vibration monitoring by reviewing maps and aerial photographs, and conducting a site visit. Noise levels were measured at locations along the proposed alternative alignments and near the proposed rail station locations to establish the most sensitive existing environment. All noise measurements were made in accordance with American National Standards Institute (ANSI) procedures for community noise measurements. Larson Davis Model 720 or Model 820 sound level meters were used for all noise measurements.

To provide a baseline for the analysis of potential noise effects of the rail operations, long-term (24-hour) measurements were conducted at 19 sites that include residences and other buildings where people normally sleep. These measurement locations were supplemented with four short-term (15-minute) noise measurements, as needed to determine existing noise levels at typical recreational, institutional, and commercial land uses with primarily daytime and evening activity.

Noise exposure (future project-generated noise) was forecast using the FTA noise model. The FTA model includes default reference noise levels for 23 different noise sources that could be part of a rail project. The default noise reference levels for train types are based on measurements taken from different vehicles types. They are conservative because the reference levels represent the worst-case noise from the vehicle types. The noise model spreadsheet takes into account the speed of the train, the number of engines and number of cars per train set, and the number of trains per hour during daytime and nighttime hours. Other inputs included the type of track, track on aerial structures, if a barrier is present, and if there are buildings between the rail and the receiver. This report uses the default reference noise levels provided by FTA (for Amtrak trains comprised of one locomotive and eight rail cars in each train) and validates the calculation using reference sound levels from similar Amtrak passenger trains that are expected to use the tracks.

To validate the noise level predictions, pass-by noise measurements were taken in areas outside the Project area. These pass-by measurements provide additional data about the specific Amtrak passenger trains that would travel on the improved tracks. These areas have already improved tracks and joints that are similar to the Project improvements. Straight-line noise measurements were taken west of the track that parallel to East Valley Highway, between Lake Tapps Parkway and Lakeland Hill Way approximately 50 feet from the railroad tracks. These measurements were compared to the modeled noise levels from the FTA noise model. The result of the pass-by noise measurements correspond to an average sound exposure level (SEL) of 93 dBA for the observed trains; the FTA noise model uses a reference SEL of 93 dBA 50 feet from the railroad tracks for a passenger trains comprised of one locomotive and eight rail cars traveling at 50 miles per hour. Because the measured SEL is similar to the FTA noise model reference SEL, the pass-by noise measurement validates the use of the FTA noise model and reference noise levels.

Pass-by noise measurements were also taken to characterize potential wheel squeal. Wheel squeal is caused when the wheels slip or stick to the rails as trains negotiate tight radius curves. Pass-by noise measurements were taken on the curve track west of East Valley Highway north of Puyallup Street. No wheel squeal was measured or observed during the measurement. The FTA Transit Noise and Vibration Impact Assessment (2006) states that a standard steel wheel on steel rail system will tend to initiate curve squeal at curves with radii less than 100 times the truck wheelbase. The Amtrak Cascades trains are typically operated in a push-pull configuration with an EMD F59HI engine at one end, a 12 or 13 car Talgo-built trainset, and an unpowered EMF F40PH locomotive called a Non-Powered Control Unit (NPCU) on the other end. The leading locomotive engine and the NPCU both have truck wheelbase lengths of nine feet. The Talgo passenger cars are equipped with one set of single axle wheels per car and therefore would not act in the same way as a conventional double axle truck, such as the ones on the locomotive engines. Therefore, according to the FTA guidance, wheel squeal at curves would only be likely to occur on curves with a radius of 900 feet or less (nine feet multiplied by 100).
Data from the WSDOT Rail Offices indicates that there are two curves on the project alignment with curve radii less than 900 feet:

- Curve C-19A-1 at Station # a 534+85.80 with a curve radius of 685.42 feet
- Curve C-20-1 at Station # a 547+15.71 with a curve radius of 828.88 feet

Both these curves are located next to one another near the southern end of the project alignment where the track crosses Interstate 5, south of the City of DuPont. There are no noise-sensitive land uses in the vicinity of these two curves and so wheel squeal was not considered further in the noise impact analysis.

The FTA noise model also provides for the analysis of locomotive horns and waysides horns, at grade crossings, and special track work as separate airborne noise sources. These sources were modeled at the receivers where the Project could affect noise levels.

The predicted noise levels are compared to the site-specific criteria to determine if there is No Effect, a Moderate Effect, or a Severe Effect at each site.

Rail Vibration Assessment Methodology

Vibration effects from rail operations are generated through the wheel/rail interface. The smoothness of these motions/actions are influenced by wheel and rail roughness, rail vehicle suspension, train speed, track construction (including types of fixation and ballast), the location of switches and crossovers, and the geologic strata (layers of rock and soil) underlying the track. Vibration from a passing train has the potential to move through the geologic strata, resulting in building vibration transferred through the building foundation. The principal concern is annoyance to building occupants.

FRA relies upon the FTA noise and vibration impact assessment procedures for assessing improvements to conventional passenger rail lines and stationary rail facilities and horn noise assessment (FRA 2011).

Vibration effects expected from the Project were determined using the general vibration assessment information and procedures contained in the FTA's guidance manual, *Transit Noise and Vibration Impact Assessment* (2006). FTA vibration reference levels for rail vehicles were used to represent the train's force density level function. Transfer mobility functions used to determine the ground attenuation were based on vibration reference data. The combination of force density and transfer mobility functions provide an estimate of ground vibration as it relates to distance from the fixed guideway.

The vibration reference levels are based on FTA reference levels, which use base curves that are representative of the upper range of well-maintained North America systems. The vibration model uses the method and formulas in Chapter 10 of the FTA *Transit Noise and Vibration Impact Assessment* to determine if there are possible vibration effects. The model also takes into account the speed of the train and distance from the nearest track to the building of interest, and then calculates the predicted vibration levels by adjusting the speed and distance of the reference base curves. A number of adjustment factors can be added, including type of track joint, type of wheels on car, type of track bed, if special track work is in place, and if vibration control track treatments are in use.

All estimates of ground-borne vibration were projected to the foundation of each building, and do not include estimates of building coupling loss. Building coupling loss is the amount of vibration energy loss between the ground vibration and the vibration of the building—generally the heavier the building foundation, the greater the coupling loss. Predicted ground-borne vibration levels were compared to the criteria to determine potential effects.

Vibration measurements were taken at locations that could have potential effects based on distance from the tracks or special trackwork. Measurements were completed using Instantel Minimate Plus vibration monitors.

Construction Noise and Vibration Assessment Methodology

Because the means and methods of construction would not be known until a contractor is selected for the Project, analysis of construction noise and vibration was based on typical activities and equipment used for demolition, excavation, and erection work phases. Both daytime and nighttime construction activities were analyzed, since it is possible that construction work would occur 24 hours a day.

The Washington Administrative Code (WAC) has provisions for regulating noise on the state level, and imposes limits on the allowable environmental noise levels from a variety of sources in any 1-hour period (WAC 173-60, Maximum Environmental Noise Levels) that would be applicable to construction noise associated with the Project. The maximum allowable levels depend on the classification of the property receiving the noise and the noise source. The classification system is called the Environmental Designation for Noise Abatement (EDNA) and is generally based on a property's use. However, WAC 173-60-050 exempts sounds originating from temporary construction sites as a result of construction activity except insofar as such provisions relate to the reception of noise within Class A EDNAs (which include residential properties, multiple family living accommodations, recreational and entertainment facilities [e.g., camps, parks, camping facilities, and resorts], and community service facilities [e.g., orphanages, homes for the aged, hospitals, health and correctional facilities]) between the hours of 10:00 p.m. and 7:00 a.m.

The City of Tacoma municipal code Title 8.122, Noise Enforcement, regulates noise from construction activities within the City of Tacoma limits, and prohibits construction and demolition activity, excluding emergency work, from being performed between the hours of 9:00 p.m. and 7:00 a.m. on weekdays or between the hours of 9:00 p.m. and 9:00 a.m. on weekends and federal holidays, except than by variance. However, the code states that after hours work on weekdays and weekends shall be allowed, provided that no sound created by the work exceeds the limits in 8.122.080(a).

The City of Lakewood municipal code Title 8.36, Noise Control, regulates noise from construction activities within the City of Lakewood limits, and prohibits sounds originating from construction sites, including but not limited to sounds from construction equipment, power tools and hammering between the hours of 10:00 p.m. and 7:00 a.m. on weekdays and 10:00 p.m. and 9:00 a.m. on weekends.

The City of DuPont municipal code Title 9.09, Sound and Vibration, regulates noise and vibration from construction activities within the City of DuPont. City of DuPont municipal code Title 9.09.050, Exemptions, exempts sounds originating from temporary construction sites as a result of construction activity except insofar as such provisions relate to the reception of noise within WAC Class A EDNAs (as described above) between the hours of 10:00 p.m. and 7:00 a.m.

The City of DuPont municipal code Title 9.09.050, Prohibited vibrations, prohibits the operation or permitting the operation of any device that creates vibration which is above the vibration perception threshold of an individual at or beyond the property boundary of the source if on private property or at 50 feet from the source if on a public space or public right-of-way. For the purposes of this regulation, “vibration perception threshold” means the minimum ground- or structure-borne vibration motion necessary to cause a person to be aware of the vibration by such direct means as, but not limited to, sensation by touch or visual observation of moving objects.

Pierce County Code, Title 8.76, Noise Pollution Control, regulates noise from construction activities within the limits of Pierce County. Pierce County Code Title 8.76.070, Exemptions, exempts sounds originating from temporary construction sites as a result of construction activity except insofar as such provisions relate to the reception of noise within WAC Class A EDNAs (as described above) between the hours of 10:00 p.m. and 7:00 a.m.

Chapter 3 – Noise and Vibration Criteria and Fundamentals

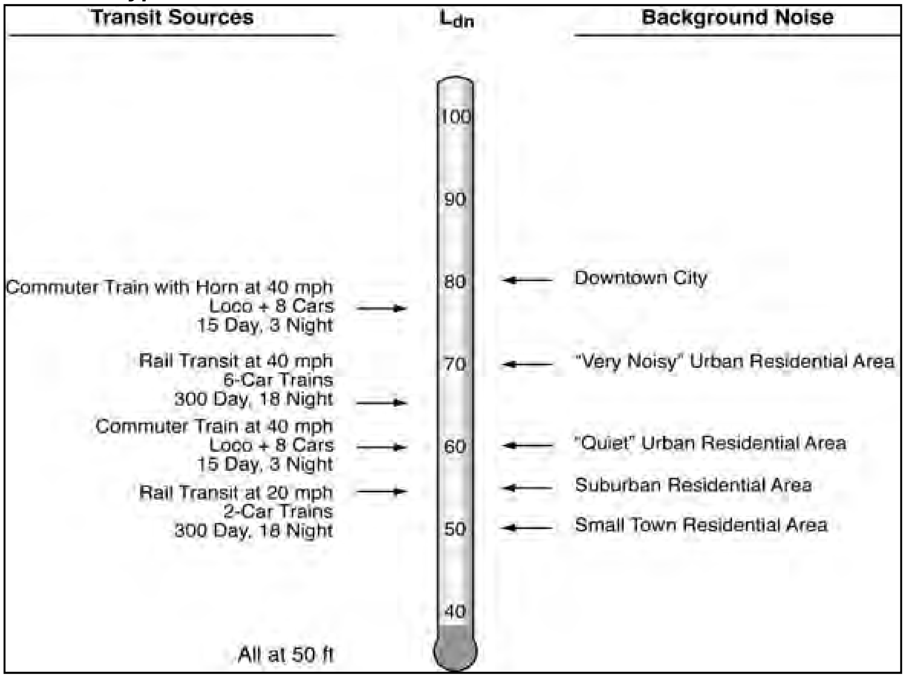
Understanding Noise

The basic unit of measurement for noise is the decibel (dB), which is a logarithmic measure of sound energy that tracks closely with human perception of loudness. To better account for human hearing sensitivity to different frequencies contained in sound (or "unwanted sound" called noise), noise is quantified in units of decibels on an "A-weighted" scale, abbreviated as dBA. The "A" scale incorporates frequency weightings that approximates the average human ear's sensitivity to sounds comprised of many different frequencies. The terms "sound" and "noise" are used interchangeably in this report.

The most commonly used noise metric (also called a "noise descriptor") is the Equivalent Noise Level (L_{eq}), which is the energy sum of all the sound that occurs during a measurement period. Another descriptor known as Average Day-Night Noise Level (L_{dn}) is often used to evaluate environmental noise in areas with noise-sensitive uses that include sleeping quarters such as residential areas. The L_{dn} is a 24-hour L_{eq} with a 10-dB penalty added to noise occurring from 10 PM to 7 AM. The effect of this penalty is that, in the calculation of L_{dn}, any sound (or noise event) during nighttime hours is equivalent to 10 identical events occurring during daytime hours. This strongly weights L_{dn} toward nighttime noise, to reflect that most people are more easily annoyed by noise during nighttime hours when background sounds may be lower and most people are sleeping.

A rural area with no major roads nearby would have a typical L_{dn} of around 40 dBA; a noisy urban residential area close to a major arterial highway would average around 70 dBA L_{dn}. Most residential areas in the study corridor fall within the range of 60-75 dBA L_{dn}. Exhibit 2 provides typical L_{dn} values experienced in a range of residential and urban areas.

Exhibit 2. Typical L_{dn} Values



Source: Transit Noise and Vibration Impact Assessment *(FTA 2006)*

Understanding Ground-Borne Vibration

Ground-borne vibration differs from airborne noise in that it consists of energy transmitted through the earth rather than the air. Ground-borne vibration is not a widespread environmental problem, and is generally limited to localized areas very near roadways, rail systems, construction sites, and some industrial operations. Automobile, bus, and truck traffic rarely create perceptible ground-borne vibration, except where bumps, potholes, or other discontinuities in the roadway surface exist.

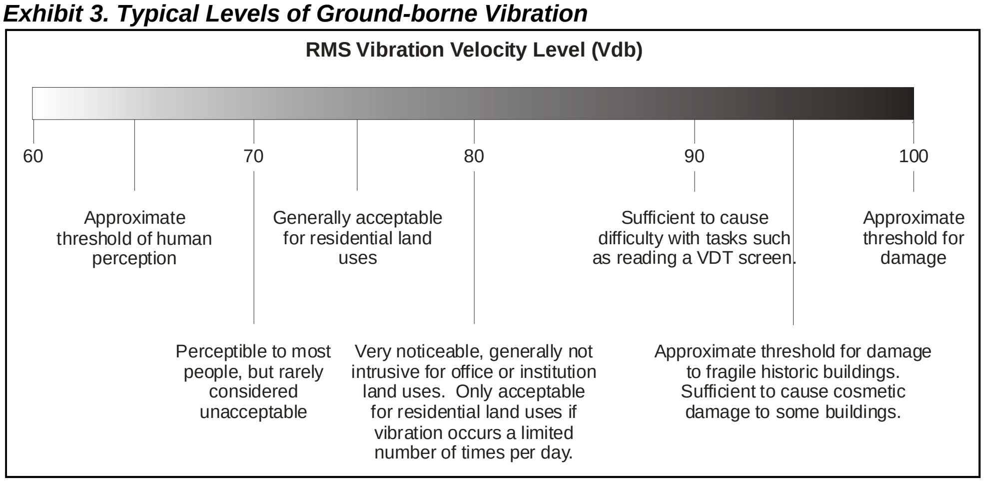
When traffic causes phenomena such as rattling windows, the cause is more likely to be acoustic (airborne) excitation rather than ground-borne vibration. The unusual situations where traffic or other existing sources cause intrusive vibration can be an indication of geologic conditions that could also result in higher-than-normal levels of train vibration.

Vibration is an oscillatory (back-and-forth) motion that can be described in terms of the displacement, velocity, or acceleration of the oscillations. Vibration velocity has been standardized as the metric for evaluating environmental vibration effects on humans. Therefore, vibration in this context usually is expressed in units of inches per second (ips). However, because of the very large velocity range over which typical environmental vibration energy can occur (below .001 to above 1.0 ips), a more convenient decibel scale has been adopted that allows for compression of this large range into a more practical scale. The velocity of vibration is expressed in units of decibels relative to one micro-inch per second, and the abbreviation VdB is used for vibration decibels to avoid confusion with sound decibels. The vibration level in most urban areas ranges typically from about 40-100 VdB.

Train vibration is almost always characterized in terms of the RMS amplitude of the velocity. RMS is a widely used but sometimes confusing method of characterizing vibration and other oscillating phenomena. It represents the average energy over a short time interval; typically, a one-second interval is used to evaluate human response to vibration. RMS vibration velocity is considered to be the best available measure of potential human annoyance from ground-borne vibration because it is highly correlated with the human body’s response to vibration.

Existing background building vibration usually ranges from 40-50 VdB, which is well below the range of human perception. Although the perceptibility threshold is about 65-70 VdB, human response to vibration is usually not substantial unless the RMS vibration velocity level exceeds 70 VdB (see Exhibit 3). This is a typical level of vibration experienced 50 feet from railroad tracks. Buses and trucks rarely create vibration that exceeds 70 VdB, unless there are large bumps or potholes in the road.

Exhibit 3. Typical Levels of Ground-borne Vibration



Source: Transit Noise and Vibration Impact Assessment *(FTA 2006)*

Impact Criteria and Applicable Regulations

State and Local Regulations

There are no applicable state or local noise or vibration impact criteria for operation of the Project.

This project does not contain any Type I elements as described in the WSDOT *2011 Traffic Noise Policy and Procedures.*

The Washington State Administrative Code (WAC) does have provisions for regulating noise on the state level, and imposes limits on the allowable environmental noise levels from a variety of sources in any 1-hour period (WAC 173-60, Maximum Environmental Noise Levels) that would be applicable to construction noise associated with the Project. The maximum allowable levels depend on the classification of the property receiving the noise and the noise source. The classification system is called the Environmental Designation for Noise Abatement (EDNA) and is generally based on a property's use. However, WAC 173-60-050 exempts sounds originating from temporary construction sites as a result of construction activity except insofar as such provisions relate to the reception of noise within Class A EDNAs (which include residential properties, multiple family living accommodations, recreational and entertainment facilities [e.g., camps, parks, camping facilities, and resorts], and community service facilities [e.g., orphanages, homes for the aged, hospitals, health and correctional facilities]) between the hours of 10:00 p.m. and 7:00 a.m.

The City of Tacoma municipal code Title 8.122, *Noise Enforcement*, regulates noise from construction activities within the City of Tacoma limits, and prohibits construction and demolition activity, excluding emergency work, from being performed between the hours of 9:00 p.m. and 7:00 a.m. on weekdays or between the hours of 9:00 p.m. and 9:00 a.m. on weekends and federal holidays, except than by variance. However, the code states that after hours work on weekdays and weekends shall be allowed, provided that no sound created by the work exceeds the limits in 8.122.080(a).

The City of Lakewood municipal code Title 8.36, *Noise Control*, regulates noise from construction activities within the City of Lakewood limits, and prohibits sounds originating from construction sites, including but not limited to sounds from construction equipment, power tools and hammering between the hours of 10:00 p.m. and 7:00 a.m. on weekdays and 10:00 p.m. and 9:00 a.m. on weekends.

The City of DuPont municipal code Title 9.09, *Sound and Vibration*, regulates noise and vibration from construction activities within the City of DuPont. City of DuPont municipal code Title 9.09.050, *Exemptions*, exempts sounds originating from temporary construction sites as a result of construction activity except insofar as such provisions relate to the reception of noise within WAC Class A EDNAs (as described above) between the hours of 10:00 p.m. and 7:00 a.m.

The City of DuPont municipal code Title 9.09.050, *Prohibited vibrations*, prohibits the operation or permitting the operation of any device that creates vibration which is above the vibration perception threshold of an individual at or beyond the property boundary of the source if on private property or at 50 feet from the source if on a public space or public right-of-way. For the purposes of this regulation, “vibration perception threshold” means the minimum ground- or structure-borne vibration motion necessary to cause a person to be aware of the vibration by such direct means as, but not limited to, sensation by touch or visual observation of moving objects.

Pierce County Code, Title 8.76, *Noise Pollution Control*, regulates noise from construction activities within the limits of Pierce County. Pierce County Code Title 8.76.070, *Exemptions*, exempts sounds originating from temporary construction sites as a result of construction activity except insofar as such provisions relate to the reception of noise within WAC Class A EDNAs (as described above) between the hours of 10:00 p.m. and 7:00 a.m.

Federal Noise Impact Criteria

FRA relies upon the FTA noise and vibration impact assessment procedures for assessing improvements to conventional passenger rail lines and stationary rail facilities and horn noise assessment (FRA 2011).

FTA has developed standards and criteria for assessing noise impacts related to transit projects. The standards outlined in *Transit Noise and Vibration Impact Assessment* (2006) are based on community reaction to noise.

These standards evaluate changes in existing noise conditions using a sliding scale. The higher the level of existing noise, the less room there is for a project to contribute additional noise.

Some land use activities are more sensitive to noise than others; for example, parks, churches, and residences are more noise-sensitive than industrial and commercial areas. The Noise Impact Criteria group sensitive land uses into the following three categories:

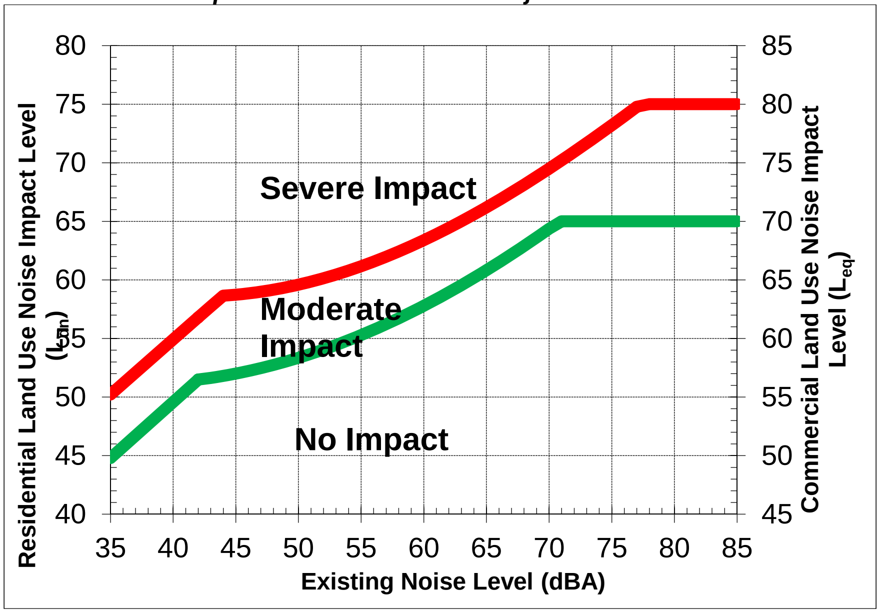
- **Category 1:** Tracts of land where quiet is an essential element in their intended purpose. This category includes lands set aside for serenity and quiet, and such land uses as outdoor amphitheaters and concert pavilions, as well as national historic landmarks with significant outdoor use. Also included are recording studios and concert halls.
- **Category 2:** Residences and buildings where people normally sleep. This includes residences, hospitals, and hotels, where nighttime sensitivity is assumed to be of utmost importance.

- **Category 3:** Institutional land uses with primarily daytime and evening use. This category includes schools, libraries, theaters, and churches where it is important to avoid interference with such activates such as speech, meditation and concentration on reading material. Place for meditation or study associated with cemeteries, monuments, museums, campgrounds and recreational facilities can also be considered to be in this category. Certain historical sites and parks are also included.

L_{dn} is used to characterize noise exposure for residential areas (Category 2); maximum one-hour L_{eq} (during the period that the facility is in use) is used for other noise-sensitive land uses such as school buildings (Categories 1 and 3).

Exhibit 4 shows the levels of impact included in the noise impact criteria.

Exhibit 4. Noise Impact Criteria for Transit Projects



Source: Transit Noise and Vibration Impact Assessment *(FTA 2006)*

The level of impact also affects potential mitigation and minimization requirements for a project. FRA and WSDOT follow this policy for determining impacts on transit and inter-city rail projects for which it is the local lead agency.

- **Severe Impact:** Severe noise impacts are considered "significant" as this term is used in NEPA and its implementing regulations. Severe noise impacts represent the most compelling need for mitigation measures. However before mitigation measures are considered, the project sponsor should first evaluate alternative locations/alignments to determine whether it is feasible to avoid

Severe Impacts altogether. If it is not practical to avoid Severe Impacts by changing the location or design of the project, mitigation measures must be considered. Impacts in this range have the greatest adverse impact on the community; thus, there is a presumption that mitigation would be incorporated in the project unless there are truly extenuating circumstances which prevent it.

- **Moderate Impact**: Moderate impacts are associated with changes in the cumulative noise level that are noticeable to most people, but may not be sufficient to cause strong, adverse reactions from the community (FTA 2006). Project noise levels in the Moderate Impact range would also require consideration and adoption of mitigation measures when it is considered reasonable. While impacts in this range are not of the same magnitude as Severe Impacts, there can be circumstances regarding the factors outlined below which make a compelling argument for mitigation. These other factors can include the predicted increase over existing noise levels, the type and number of noise-sensitive land uses affected, existing outdoor/indoor sound insulation, community views, special protection provided by law and the cost-effectiveness of mitigating noise to more acceptable levels.

Exhibit 5 summarizes the noise impact criteria for commuter and intercity rail operations.

The first column of Exhibit 5 shows the existing noise exposure, and the remaining columns show the level of impact (Moderate Impact or Severe Impact) for future noise exposure. There would be No Impact if noise levels are below the Moderate Impact noise levels. The future noise exposure is the combination of the existing noise exposure and the additional noise exposure caused by the rail project. As the existing noise exposure increases, the amount of the allowable increase in the overall noise exposure caused by the project decreases.

For example, Exhibit 6 and Exhibit 7 show the impact levels for future noise exposure. Exhibit 6 shows the impact level if the existing noise exposure is 53 dBA. As shown, for residential land use (Category 1 or 2), a Moderate Impact would occur at 55 dBA and a Severe Impact would occur at 60 dBA. For commercial land use (Category 3), a Moderate Impact would occur at 60 dBA and a Severe Impact would occur at 65 dBA.

Exhibit 5. Noise Impact Criteria

Existing Noise Exposure L_{eq} or L_{dn}[1]	Project Noise Exposure Impact Thresholds: L_{dn} or L_{eq}[1] (all noise levels in dBA)			
	Category 1 or 2 Sites		*Category 3 Sites*	
	Moderate Effect	*Severe Effect*	*Moderate Effect*	*Severe Effect*
<43	Amb.+10	Amb.+15	Amb.+15	Amb.+20
43-44	52	58	57	63
45	52	58	57	63
46-47	53	59	58	64
48	53	59	58	64
49-50	54	59	59	64
51	54	60	59	65
52-53	55	60	60	65
54	55	61	50	66
55	56	61	61	66
56	56	62	61	67
57-58	57	62	62	67
59-60	58	63	63	68
61-62	59	64	64	69
63	60	65	65	70
64	61	65	66	70
65	61	66	66	71
66	62	67	67	72
67	63	67	68	72
68	63	68	68	73
69	64	69	70	74
70	65	69	70	74
71	66	70	71	75
72-73	66	71	71	76
74	66	72	71	77
75	66	73	71	78
76-77	66	74	71	79
>77	66	75	71	80

Source: Transit Noise and Vibration Impact Assessment *(FTA 2006)*

[1] *L_{dn} is used for land uses where nighttime sensitivity is a factor; Daytime L_{eq} is used for land uses involving only daytime activities.*

Category Definitions:

Category 1: Buildings or parks where quiet is an essential element of their purpose.

Category 2: Residences and buildings where people normally sleep. This includes residences, hospitals, and hotels where nighttime sensitivity is assumed to be of utmost importance.

Category 3: Institutional land uses with primarily daytime and evening use. This category includes schools, libraries, and churches.

Exhibit 6. Example Effect Levels with an Existing Noise Exposure Level of 53 dBA

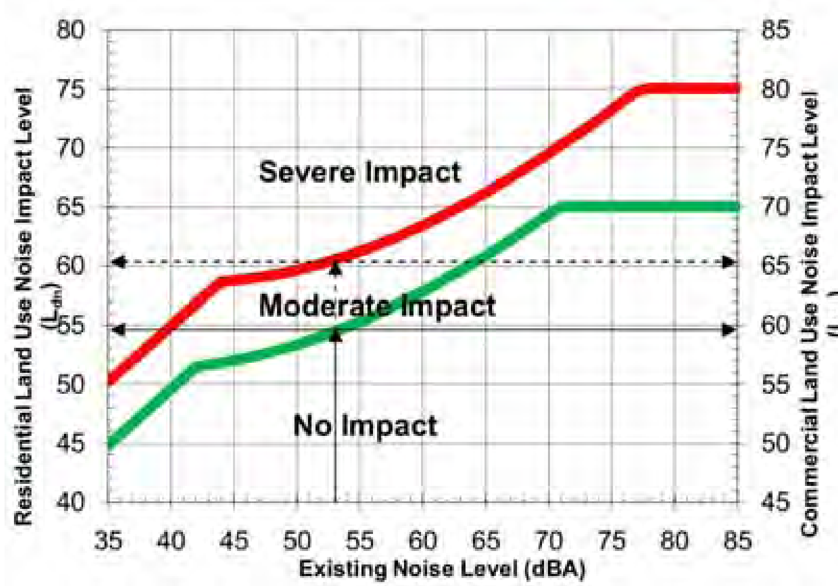
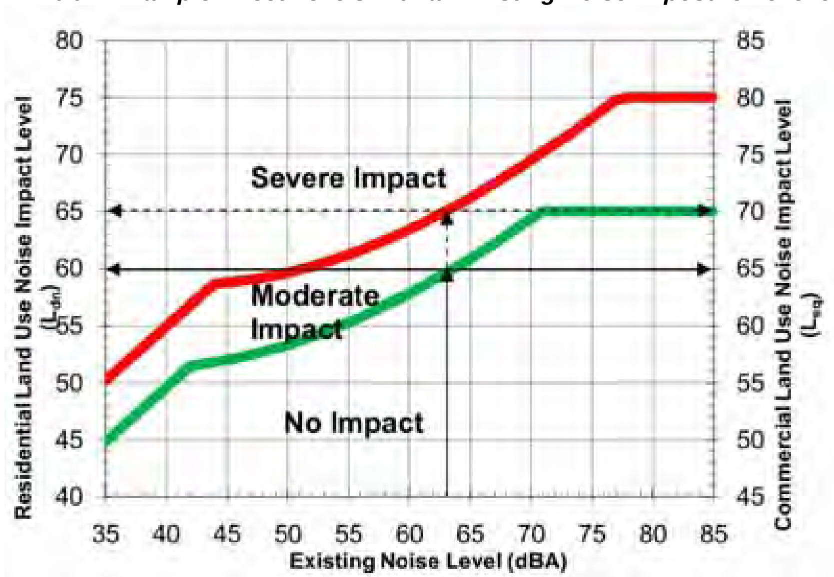


Exhibit 7 shows the effect level if the existing noise exposure is 63 dBA. As shown, for residential land use (Category 1 or 2), a Moderate Effect would occur at 60 dBA and a Severe Effect would occur at 65 dBA. For commercial land use (Category 3), a Moderate Effect would occur at 65 dBA and a Severe Effect would occur at 70 dBA.

Exhibit 7. Example Effect Levels with an Existing Noise Exposure Level of 63 dBA



Federal Vibration Impact Criteria

FRA relies upon the FTA noise and vibration impact assessment procedures for assessing improvements to conventional passenger rail lines and stationary rail facilities (FRA 2011).

FTA has developed impact criteria for acceptable levels of ground-borne noise and vibration (FTA 2006). Ground-borne vibration from rail vehicles is characterized in terms of the RMS vibration velocity amplitude, which is a good indicator for the potential for human disturbance. A one-second RMS time constant is assumed. This is in contrast to vibration from blasting and other construction procedures that could cause building damage. When assessing the potential for building damage, ground-borne vibration is usually expressed in terms of the peak particle velocity.

The threshold of vibration perception for most humans is around 65-70 VdB; levels from 70-75 VdB are often noticeable but acceptable; and levels greater than 80 VdB are usually considered unacceptable.

For human annoyance, there is a relationship between the number of events and the degree of annoyance caused by the vibration. It is intuitive to expect that more frequent or longer duration vibration events would be more annoying to building occupants. To account for the fact that most commuter rail systems having fewer daily operations than the typical urban transit line, the criteria in *Transit Noise and Vibration Assessment* (FTA 2006) include an 8-VdB higher threshold if there are fewer than 30 events of the same source type per day, regardless of the number of cars per train. Thus, for rail systems with fewer than 30 trains per day, the limit for an acceptable level of residential ground-borne vibration is 80 VdB.

Ground-borne vibration from any type of train operation would rarely be high enough to cause any sort of building damage, even minor cosmetic damage. The only real concern is that the vibration would be intrusive to building occupants or interfere with vibration-sensitive equipment.

The vibration of floors and walls may cause a rumble noise within a building. This rumble is the noise radiated from the motion of the room surfaces. In essence, the room surfaces act like a giant loudspeaker. This is called ground-borne noise. Ground-borne noise could result in an affect for underground rail operations. For an urban rail system with 10-20 rail movements per hour throughout the day, the acceptable levels of residential ground-borne noise is 35-38 dBA, with levels above 48 dBA often considered unacceptable. It is not considered for at-grade or above-ground rail operations because the level of airborne noise from the passing train that is transmitted through the windows or walls of a building would exceed the ground- borne noise level occurring inside the building. Existing and proposed rail operations are not underground operations, thus it would not be discussed further.

Exhibit 8 summarizes the impact criteria for ground-borne vibration. These criteria are based on previous standards, criteria, and design goals, including the ANSI S3.29 (Acoustical Society of America, 1983) and the noise and vibration guidelines of the American Public Transit Association (APTA 1981). Some buildings such as concert halls, television and recording studios, and theaters can be very sensitive to vibration but do not fit into any of the three categories. Because of the sensitivity of these buildings, they usually warrant special attention during the environmental review of a transit project.

Exhibit 8. Ground-borne Vibration Impact Criteria

Land Use Category	Ground-Borne Vibration Impact Levels (VdB re: 1 micro-inch/sec)		
	Frequent Events[1]	*Occasional Events*[2]	*Infrequent Events*[3]
Category 1: Buildings where low existing vibration is essential for interior operations	65 VdB[4]	65 VdB[4]	65 VdB[4]
Category 2: Residences and buildings where people normally sleep	72 VdB	75 VdB	80 VdB
Category 3: Institutional land uses with primarily daytime use	75 VdB	78 VdB	83 VdB

Source: Transit Noise and Vibration Impact Assessment *(FTA 2006)*

Notes:

[1] "Frequent Events" is defined as more than 70 vibration events of the same source per day. Most rapid transit projects fall into this category.

[2] "Occasional Events" is defined as between 30 and 70 vibration events of the same sources per day. Most commuter trunk lines have this many operations.

[3] "Infrequent Events" is defined as fewer than 30 vibration events of the same kind per day. This category includes most commuter rail branch lines.

[4] This criterion is based on levels that are acceptable for most moderately sensitive equipment, such as optical microscopes. Vibration-sensitive manufacturing or research uses would require detailed evaluation to define acceptable vibration levels. Ensuring lower vibration levels in a building often requires special design of the HVAC system and stiffened floors.

Amtrak would use the new track adjacent to the existing main line from South 66th Street (Rail MP 6.9) in Tacoma to between Bridgeport Way Southwest (Rail MP 10.4) and Clover Creek Drive Southwest (Rail MP 10.9) in Lakewood. *Sounder* and through freight trains would predominantly use the existing main track. Therefore the Project would have infrequent events as there would be less than 30 vibration events from the same source per day in the Project area. The vibration criteria would be 80 VdB throughout the Project area. Chapter 1 details the existing and future daily rail operations.

Between the northern project terminus at the TR junction in Tacoma and the Lakewood Station in Lakewood, existing vibration from Sound Transit *Sounder* service was also factored into the vibration impact analysis. This segment of the corridor would experience more than twelve train passby events per day as a result of *Sounder* service, but the addition of the Amtrak Cascades and Amtrak Starlight service would not result in a significant increase in the number of vibrations events (defined by the

FTA as a doubling in the number of daily vibration events). Therefore, additional vibration impacts would occur where the project-generated vibration results in a 3 VdB or more increase over existing vibration in this segment of the alignment.

Exhibit 9 provides criteria for acceptable levels of ground-borne vibration for various types of special buildings.

Exhibit 9. Ground-borne Vibration Impact Criteria for Special Buildings

Type of Building or Room	Ground-borne Vibration Impact Levels (VdB re: 1 micro-inch/sec)	
	Frequent Events[1]	*Infrequent Events*[2]
Concert Halls	65 VdB	65 VdB
Television Studios	65 VdB	65 VdB
Recording Studios	65 VdB	65 VdB
Auditoriums	72 VdB	80 VdB
Theaters	72 VdB	80 VdB

Source: Transit Noise and Vibration Impact Assessment, *(FTA 2006)*

Notes:

[1] *"Frequent Events" is defined as more than 70 vibration events per day*

[2] *"Infrequent Events" is defined as fewer than 30 vibration events per day. This category includes most commuter rail systems.*

Chapter 4 – Affected Environment

Understanding the existing baseline noise levels along the Project's study corridor is necessary to predicting the future noise effects of the Project. This was accomplished by performing measurements at representative locations along the project corridor. The vibration impact criteria were used to identify locations where potential effects could occur based on existing land use. Locations that exceed the vibration impact criteria were surveyed for existing vibration levels. This chapter provides details on the noise and vibration survey used to establish baseline conditions.

Current track operations are two freight trains a day: one northbound during daytime hours and one southbound during nighttime hours between TR Junction to East "D" Street and between South "M" Street and the BNSF connection. There are no current freight operations between East "D" Street and South "M" Street. The speed of the trains is limited to 10 mph because of the condition of the jointed tracks. The jointed tracks also increase the noise levels of the existing trains.

Noise Monitoring

Noise measurements were performed at 23 noise-sensitive locations along the study corridor for the Project (Exhibit 10). These locations were evaluated and deemed to be representative of noise-sensitive land uses along the corridor. There were 19 long-term (24-hour) and 4 short-term (15-minute) noise measurements conducted at the locations shown on Exhibit 12. Long-term measurements were conducted at sites that include noise-sensitive nighttime use, such as residences where people sleep. Short-term measurements were conducted at sites where typical use is during daytime hours such as parks or schools. The following sections provide descriptions of noise-sensitive land uses from north to south along the project corridor.

Exhibit 10. Noise Monitoring Locations

Site #	Location	Land Use Activity Category[1]	Start Date	Start Time	Duration	Measured Noise Levels[2] (dBA)*
1	1211 East 26th Street	2	August 16, 2011	11:03 AM	24 Hours	67
2	10312 Rainier Avenue Southwest	2	July 19, 2011	12:42 PM	24 Hours	58
3	11215 Kline Street Southwest	2	July 19, 2011	1:25 PM	24 Hours	66
4	8702 Durango Street Southwest	2	August 4, 2011	11:26 AM	24 Hours	55
5	10106 Lakeview Avenue Southwest	2	August 16, 2011	3:26 PM	24 Hours	63
6	4210 Halcyon Rd Southwest	2	August 4, 2011	12:17 PM	24 Hours	63
7	Adjacent to 12827 Glennwood Avenue Southwest	2	August 4, 2011	2:26 PM	24 Hours	67
8	12624 Glennwood Avenue Southwest	2	August 4, 2011	2:40 PM	24 Hours	61
9	6402 127th Street Southwest	2	August 4, 2011	3:01 PM	24 Hours	69
10	Adjacent to 6820 South Puget Sound Avenue	2	August 16, 2011	11:55 AM	24 Hours	54
11	14505 Union Avenue Southwest	2	August 15, 2011	10:56 AM	24 Hours	75
12	8207 Lake Street Southwest	2	August 15, 2011	3:36 PM	24 Hours	66
13	14515 Washington Avenue Southwest	2	August 15, 2011	11:22 AM	24 Hours	60
14	125 Country Club Circle Southwest	2	August 15, 2011	11:50 AM	24 Hours	61
15	100 Wilmington Drive	2	August 15, 2011	12:16 PM	24 Hours	72
16	11920 Seminole Rd Southwest	3	August 16, 2011	1:04 PM	24 Hours	65
17	146th Street Southwest and Murray Rd Southwest	2	August 16, 2011	3:52 PM	24 Hours	67
18	1400 Wilmington Drive	2	August 16, 2011	4:58 PM	24 Hours	66
19	Brandywine Avenue and Santa Cruz Street	2	August 16, 2011	5:19 PM	24 Hours	68
MW1	4100 Steilacoom Blvd	3	August 17, 2011	2:50 PM	15 Minutes	49
SG1	10202 Earley Avenue Southwest	3	August 17, 2011	3:45 PM	15 Minutes	49
CM1	Arsenal/Museum at Camp Murray	3	August 15, 2011	1:36 PM	15 Minutes	69
CM2	O'Brien Hall at Camp Murray	3	August 15, 2011	2:01 PM	15 Minutes	69

Notes:

[1]*Land Use Category used as described in Exhibit 5. Noise Impact Criteria*

[2]*15-minute noise levels are expressed as L_{eq} and 24 hour noise levels are expressed as L_{dn}. The L_{dn} is a 24-hour L_{eq} with a 10-dB penalty added to noise occurring from 10 PM to 7 AM to reflect that most people are more easily annoyed by noise during nighttime hours when background sounds may be lower and most people are sleeping. L_{dn} is used for land uses where nighttime sensitivity is a factor; daytime L_{eq} is used for land uses involving only daytime activities.*

Vibration Monitoring

Vibration levels were monitored for 24-hour periods at two sites located closest to the Project alignment (Exhibit 11 and Exhibit 12). The first measurement was conducted at the Arsenal/Museum building at Camp Murray. The second measurement was conducted at a residence located just west of the Project alignment along Kline Street Southwest.

Exhibit 11. Vibration Monitoring Locations

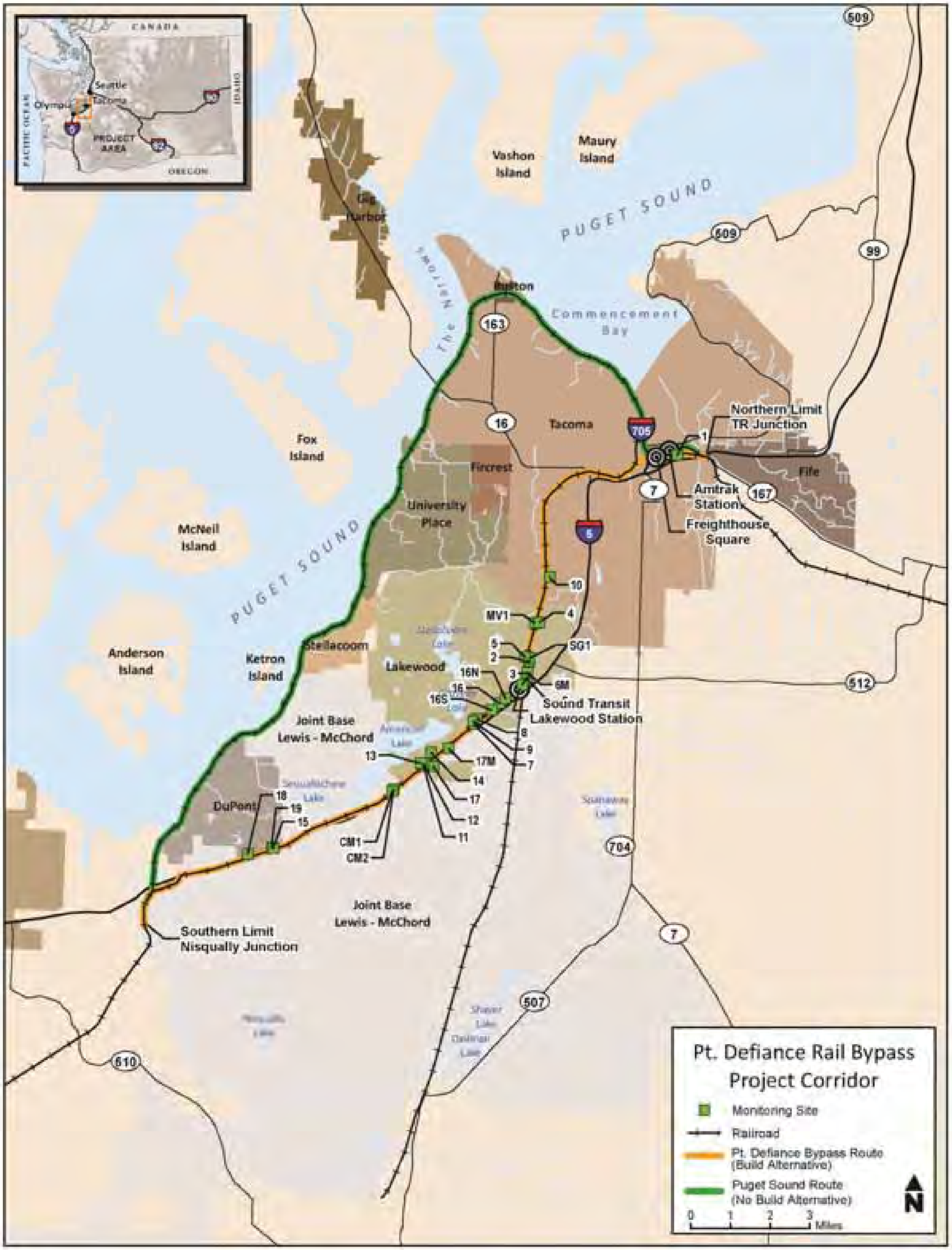
Site #	Address	Land Use Category[1]	Start Date	Start Time	Duration	Existing VdB
3	11215 Kline Street Southwest	2	September 26, 2011	12:18 PM	24 Hours	67
CM2	Arsenal/Museum at Camp Murray	3	October 5, 2011	9:43 AM	24 Hours	65

Note:
[1]*Land Use Category as described in Exhibit 8*

Northern Terminus at TR Junction to South Tacoma Way

Land uses between the northern Project terminus and South Tacoma Way are predominantly commercial and light industrial properties located on East 25th, East 26th, and East 27th Streets. Noise-sensitive land uses include residences near East “L” Street and hotels located along East Portland Street and East “E” Street. Residences are also located at higher elevations on South Delin Street and South 27th Street. Saint Paul Church and Fire Station #2 are located on South Tacoma Avenue above the alignment, and the Tacoma Rescue Mission is located at near the same elevation as the alignment on South Tacoma Way. Long-term measurement Site 1 describes the existing noise environment in this area. Maximum-hour L_{eq}s of 59-63 dBA and an L_{dn} value of 67 dBA were measured. Existing freight train traffic on a line located between East 25th Street and East 26th Street and multiple lines located further north contribute to noise in the area. Local street traffic and nearby traffic on I-5 and I-705 add to area noise levels.

Exhibit 12. Monitoring Locations



South 56th Street to South 74th Street

Land uses on South Tacoma Way, South Adams Street, South Hood Street, and South Washington Street are predominantly commercial. Noise-sensitive land uses include athletic fields and Mt. Tacoma High School to the west and single-family residences to the east. Long-term measurement Site 10 describes the existing noise environment in this area. Maximum-hour L_{eq}s of 44-57 dBA and an L_{dn} value of 54 dBA were measured. Local traffic on Tacoma Way South and existing freight train traffic contribute to area noise levels.

South 74th Street to Steilacoom Boulevard Southwest

Land uses on South Tacoma Way and Durango Way Southwest are predominantly commercial and light industrial. Noise-sensitive land uses include Mountainview Memorial Park located west of the alignment and limited single-family residences at 87th Street Southwest and Durango Street Southwest to the east of the alignment. Long-term measurement Site 4 and short-term measurement Site MV1 describe the existing noise environment in this area. Maximum-hour L_{eq}s of 43-58 dBA and an L_{dn} value of 55 dBA were measured. Local traffic on Tacoma Way South and Durango Street Southwest and existing freight train traffic contribute to noise levels in the area.

100th Street Southwest to 108th Street Southwest

Noise-sensitive land uses in this area are predominantly single-family residences and Southgate Elementary School located to the east of the alignment along Rainier Avenue Southwest. Residences are also located to the west on Lakeview Avenue Southwest, beyond commercial businesses located adjacent to the Project alignment. Long-term measurement Sites 2 and 5 and short-term measurement Site SG1 describe the existing noise environment in this area. Maximum-hour L_{eq}s of 45-59 dBA and L_{dn} values of 58 and 60 dBA were measured. Local traffic on Lakeview Avenue Southwest and existing freight train traffic contribute to noise levels in the area. This area receives periodic noise from JBLM.

108th Street Southwest to Bridgeport Way Southwest

Land uses in this area include single-family residences along Lakeview Avenue Southwest, Kline Street Southwest, and Kendrick Street Southwest, as well as a daycare and St. Clare Hospital. Multi-family residences and hotels are located on Halycon Road Southwest. Long-term measurement Sites 3 and 6 describe the existing noise environment in this area. Maximum-hour L_{eq}s of 49-70 dBA and L_{dn} values of 63 and 66 dBA were measured. Traffic on I-5, local traffic on Lakeview Avenue Southwest and existing freight train traffic contribute to noise levels in the area. This area receives periodic aircraft noise from JBLM. Site 6M was add to this area to predicted noise effects to the residences located between Sites 3 and 6, which are not near the grade crossing.

Bridgeport Way Southwest to Gravelly Lake Drive Southwest

Land use in this area is predominantly single-family residences located along side streets throughout the area. Tyee Park Elementary School is located at 120th Street Southwest and Cochise Lane Southwest. Outdoor play areas at the school are within 100 feet of the Project's study corridor. Long-term measurement Sites 7, 8, 9, and 16, and short-term measurement Site 16M describe the existing noise environment in this area. Maximum-hour L_{eq}s of 48-67 dBA and L_{dn} values of 61-69 dBA were measured. Traffic on I-5, local traffic on side streets and Pacific Highway Southwest, and existing freight train traffic contribute to area noise levels. This area receives periodic aircraft noise from JBLM.

North Thorne Lane Southwest to Berkeley Street Southwest

Land use in this area north and west of the Project is predominantly single-family residences and commercial businesses located east and west of Union Avenue Southwest. Long-term measurement Sites 11, 12, 13, and 14 describe the existing noise environment in this area. Maximum-hour L_{eq}s of 46-71 dBA and L_{dn} values of 60-74 dBA were measured. Traffic on I-5, local traffic on side streets and Union Avenue Southwest, and existing freight train traffic contribute to area noise levels. This area receives periodic aircraft noise from JBLM.

Joint Base Lewis McChord

Land uses in JBLM include areas of residences, open recreational spaces, and schools all located southeast of the Project alignment across I-5. Long-term measurement Site 17 and short-term measurement Sites CM1 and CM2 describe the existing noise environment in this area. Site access was provided at Camp Murray for short-term measurement sites CM1 and CM2. Maximum-hour L_{eqs} of 56-63 dBA and an L_{dn} value of 67 dBA were measured. Traffic on I-5, local traffic on side streets, and existing freight train traffic contribute to area noise levels. This area receives periodic aircraft noise from military activities at JBLM.

Vibration monitoring was conducted at the Camp Murray Arsenal/ Museum building to describe the existing vibration levels at this structure located nearest the Project alignment. The Arsenal/Museum building includes an alarm system that detects vibration near sensitive equipment storage. Vibration levels recorded at the Arsenal/Museum building were below ground-borne vibration impact criteria.

DuPont-Steilacoom Road to Center Drive

Land use in this area is predominantly commercial and residential. An apartment complex is located at Barksdale Avenue and Wilmington Drive with single-family residences located further from the alignment. A hotel is located at Wilmington Drive and Palisade Boulevard with single-family residences and construction of a new hotel along Station Loop road and multi-family residences further from the alignment along McNeil Street. Long-term measurement Sites 15, 18, and 19 describe the existing noise environment in this area. Maximum-hour L_{eq}s of 55-68 dBA and L_{dn} values of 66-71 dBA were measured. Traffic on I-5, local traffic on side streets and Wilmington Drive, and existing freight train traffic contribute to area noise levels. This area receives periodic aircraft noise from JBLM.

Chapter 5 – Potential Project Effects

Noise Effects

No Build Alternative

There would be no change in train noise resulting from the No Build Alternative, since there would be no improved track and no increased speed for freight trains; therefore, there would be no effects under the No Build Alternative. Train service would continue to use the existing Point Defiance tracks, and train noise would continue along those tracks. For a list of projects included in the No Build Alternative, please see Chapter 1 question, "What would happen if the Project is not built?"

Build Alternative

Under the Build Alternative, 14 new daytime-only passenger trains would run between South Tacoma and Nisqually at a maximum speed of 79 mph.

Exhibit 13 provides general information about daily freight and passenger[4] rail operations within the Project area under the No Build and Build alternatives. Exhibit 13 was used to calculate noise exposure levels in the Project study area. Passenger train speeds were modeled at 25 mph at Site 1, and 35 mph for Sites 1M, Tacoma Rescue Mission, St. Paul's Church, and Fire House #2. For all other sites, the passenger train speeds were 79 mph, based on Exhibit 14.

[4] *The most current information available from Sound Transit at the time this report was prepared.*

Exhibit 13. Existing and Future Daily Rail Operations along the Point Defiance Bypass Route

	No Build Alternative	Build Alternative
Daily Trains	***Number of Daily Trains***	***Number of Daily Trains***
Freight	**2**	**2**
Sound Transit *Sounder*	**26**	**26**
Cascades	**0**	**12**
Starlight	**0**	**2**
Total number of daily trains	**28**	**42**

Exhibit 14. Existing and Future Maximum Train Speeds[5] Along the Point Defiance Bypass Route

	TR Junction to East "D" Street (Tacoma)		East "D" Street to South "M" Street (Tacoma)[6]		South "M" Street to Lakewood Station		Lakewood Station to BNSF Connection	
Daily Trains	***Current***	***Future***	***Current***	***Future***	***Current***	***Future***	***Current***	***Future***
Freight	**10**	**10**	**--**	**--**	**20**	**60**	**10**	**60**
Sound Transit *Sounder*	**30**	**30**	**30**	**30**	**30**	**30**	**--**	**--**
Amtrak Cascades	**--**	**30**	**--**	**30**	**--**	**79**	**--**	**79**
Amtrak Coast Starlight	**--**	**30**	**--**	**30**	**--**	**79**	**--**	**79**

Train service would continue to use the existing Point Defiance tracks, and train noise would continue along those tracks; however, the noise would be reduced with removal of the Amtrak passenger rail service from those tracks.

The Build Alternative noise levels also account for improvements made to the track and grade crossing discussed in Chapter 1 and shown in Exhibit 1; these include installing wayside horns at Clover Creek Drive Southwest, North Thorne Lane Southwest, Berkeley Street Southwest and Barksdale Avenue. **Error! Reference source not found.** shows the expected Project noise levels and noise effect from the Amtrak passenger train operations.

[5] *In miles per hour (mph).*
[6] *There will be no freight trains between E. "C" Street and S. Chandler Street.*

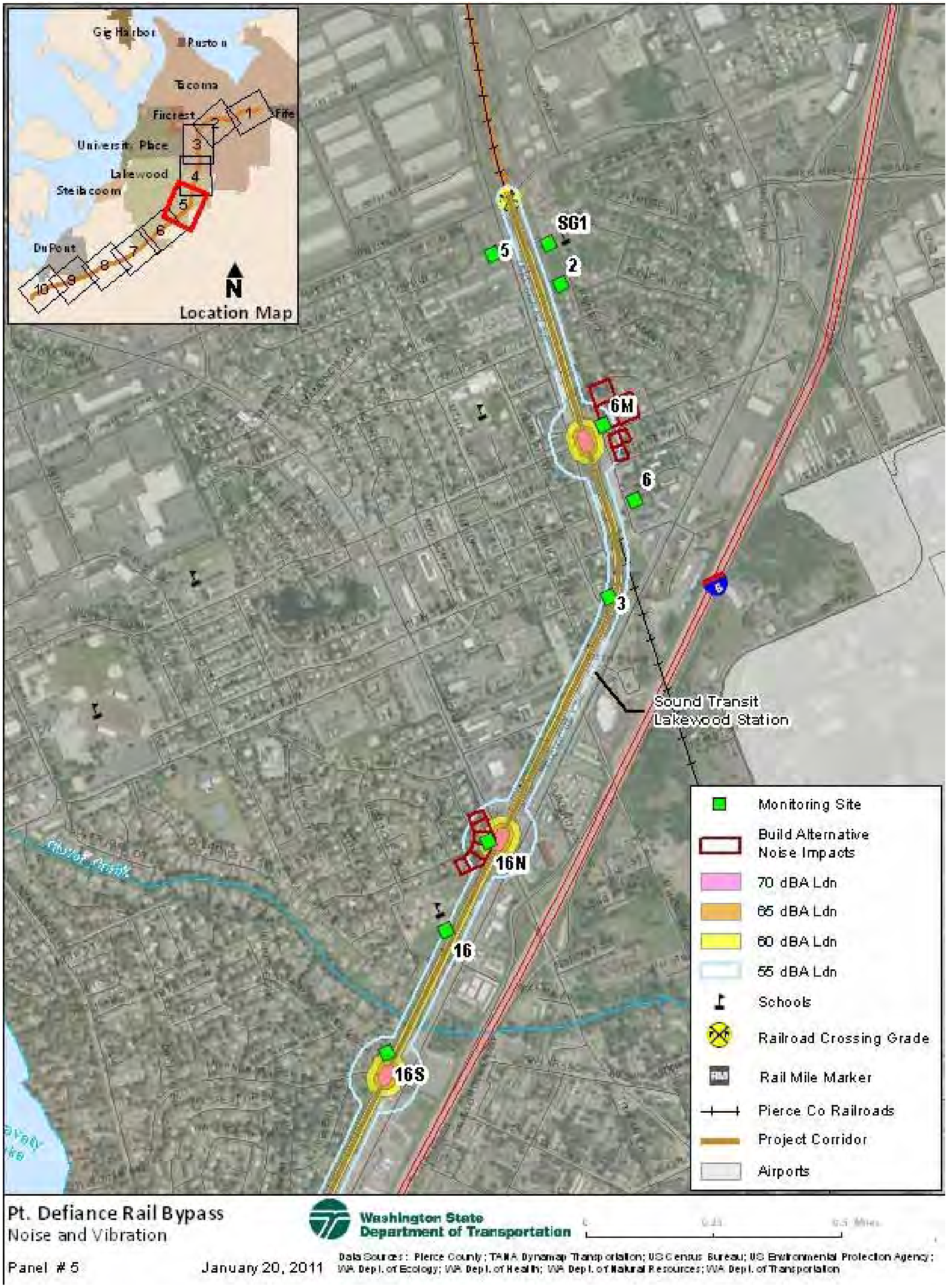
Exhibit 15. Noise Levels from Amtrak Train Operations

Site #	Existing Ldn	FTA Thresholds for Moderate/ Severe Effect	Project Noise Exposure (Ldn)	Project Noise Effect
South Tacoma to Lakewood				
1	67	63/67	51	None
1M	65	61/66	50	None
Tacoma Rescue Mission	67	63/67	53	None
Church	67	63/67	43	None
Fire Station	67	63/67	44	None
2	58	57/62	51	None
3	66	62/67	61	None
4	55	56/61	53	None
5	63	60/65	57	None
6	63	60/65	59	None
6M	65	62/67	62	Moderate
10	54	55/61	39	None
Lakewood to Nisqually				
7	67	63/67	55	None
8	61	69/64	42	None
9	69	64/69	38	None
11	75	66/73	58	None
12	66	62/67	40	None
13	60	58/63	45	None
14	61	59/64	55	None
15	72	66/71	55	None
16N	70	65/69	67	Moderate
16	65	61/66	57	None
16S	67	63/67	60	None
17M	67	63/67	47	None
17	67	63/67	41	None
18	66	62/67	46	None
19	68	62/67	58	None

**The Total Build L_{dn} is calculated by adding the Noise Exposure (L_{dn}) generated by the Project to the No Build Total L_{dn}.*

Moderate noise effects are predicted at two sites for the Project: Site 6M and Site 16N, representing six residences for each site (Exhibit 16). See Attachment A of this report for the spreadsheet calculations for each site.

Exhibit 16. Build Alternative Noise Effects



The Project noise exposure would be generated by several different sources: passing trains, special trackwork, and warning equipment, either wayside or on-train. Exhibit 17 lists the contribution of train and warning device sources to the total Project sound exposure for each location.

Exhibit 17. Contribution of Project Noise Sources to Total Project Noise Exposure

Site #	Pass-by Noise Exposure (L_{dn})	Warning Device Noise Exposure (L_{dn})	Total Project Noise Exposure (L_{dn})
1	52	0	52
1M	51	0	51
Tacoma Rescue Mission	52	0	52
Church	42	0	42
Fire Station	44	0	44
2	50	0	50
3	60	0	60
4	41	52	52
5	48	56	56
6	53	58	59
6M	53	61	62
10	38	0	38
7	54	0	54
8	41	0	41
9	38	0	38
11	57	45	58
12	40	0	40
13	45	0	45
14	55	0	55
15	54	48	55
16N	56	67	67
16	57	0	57
16S	52	59	60
17M	47	0	47
17	41	0	41
18	46	0	46
19	47	58	58

Sites 2, 5, 6, 6M, 16N, 16, and 16S are located near crossover tracks. The Project design has committed to using spring frogs in these areas. The spring frogs would cover the gap between the rails, so the noise associated with the crossover tracks would be reduced.

Wheel squeal is another potential noise source. Wheel squeal is caused when the wheels slip or stick to the rails as vehicles negotiate tight radius curves. The curve between 108th Street Southwest and Bridgeport Way Southwest is the only location in the Project area where there is a potential for wheel squeal.

Pass-by noise measurements were taken adjacent to the curved track west of East Valley Highway north of Puyallup Street, which is similar to the curve that would be located between 108th Street Southwest and Bridgeport Way Southwest. The measured noise levels corresponded to a reference SEL of 93.4 dBA. No wheel squeal was measured or observed during the measurement. The measurement results validated the use of the FTA reference SEL noise levels of 93 dBA to model noise levels between 108th Street Southwest and Bridgeport Way Southwest and indicate that wheel squeal would not be likely in this location.

Horn Noise

Contour lines were created to show the areas potentially affected by warning-system noise from a wayside horn and of a train horn. Exhibit 18 shows the 55, 60, 65, and 70 dBA L_{dn} noise levels for each type of horn at the Bridgeport Way Southwest intersection. Reductions in noise levels from buildings or terrain are not reflected in the exhibit. Exhibit 18 is a graphical representation of the typical condition, but not of sufficient detail to predict noise effects from the Project.

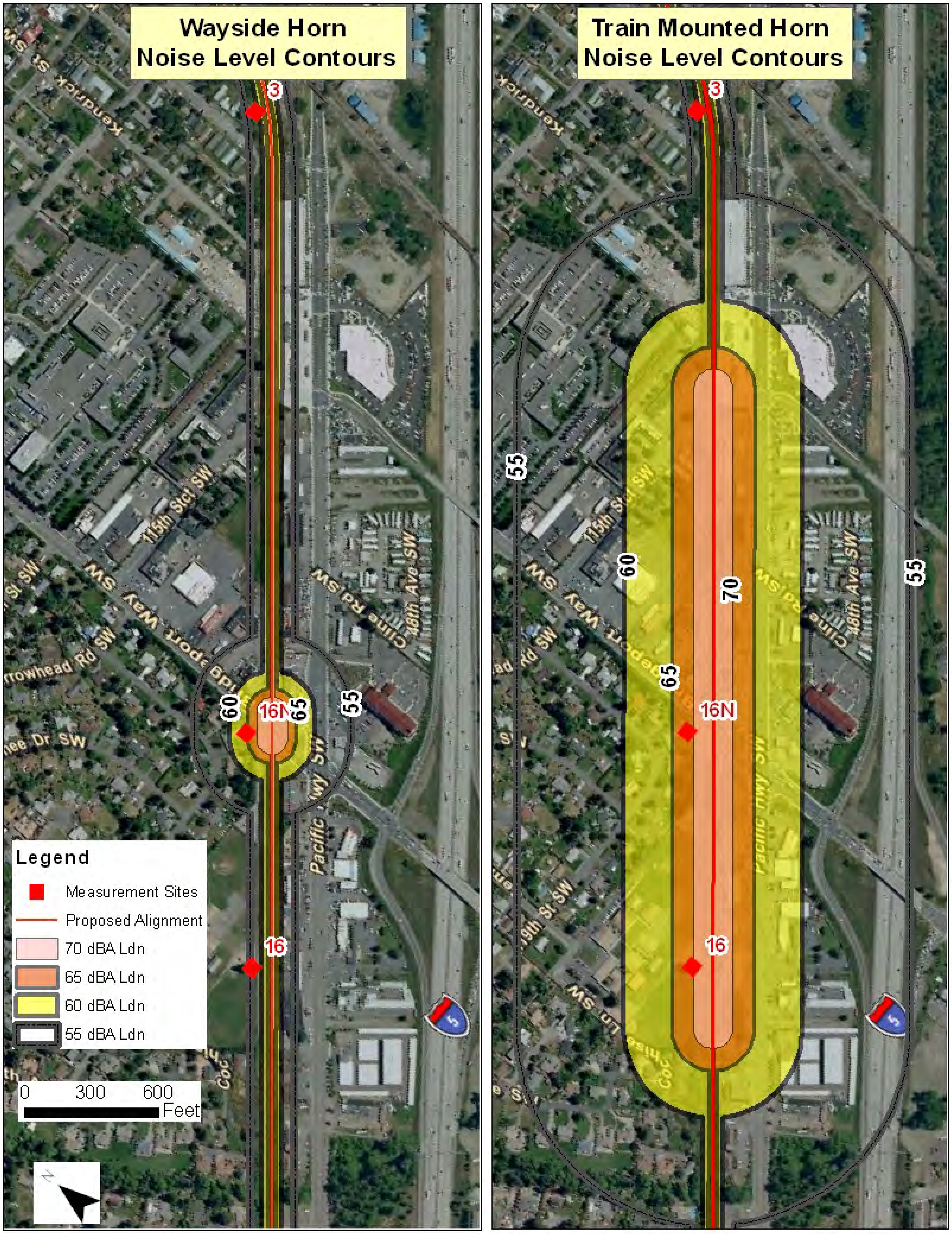
Wayside horns would be located at the intersection, and the noise effect area would be limited to the vicinity of the intersection. The noise levels of the wayside horn cannot be reduced below the 92 dBA L_{max} level at 100 feet as set by the FRA rule, since the wayside horns are safety features. Noise modeling indicates the following:

- 80 dBA L_{dn} noise levels would be experienced at up to 28 feet from the intersection for less than a distance of 300 feet along the tracks.
- 70 dBA L_{dn} noise levels would be experienced at up to 70 feet from the intersection over a distance of 300 feet along the tracks.
- 60 dBA L_{dn} noise levels would be experienced at up to 190 feet from the intersection over a distance of 500 feet along the tracks.

Train horns would generate noise along the tracks for several thousand feet as the trains approach the intersection. Noise modeling indicates the following:

- 80 dBA L_{dn} noise levels would be experienced at up to 20 feet from the tracks over a distance of between 2,500 and 3,000 feet along the tracks.
- 70 dBA L_{dn} noise levels are experienced at up to 90 feet from the tracks over a distance of 3,000 feet along the tracks.
- 60 dBA L_{dn} noise levels are experienced at up to 400 feet from the tracks over a distance of 3,700 feet along the tracks.

Exhibit 18. Wayside Horns and Train Mounted L_{dn} Noise Contours



Vibration Effects

No Build Alternative

There would be no change in vibration levels resulting from the No Build Alternative, as there would be no track changes resulting from the Project and no increased speed for freight trains. Therefore, there would be no vibration effects under the No Build Alternative. For a list of projects included in the No Build Alternative, please see Chapter 1 question, “What would happen if the Project is not built?”

Build Alternative

Vibration levels are based on a single train passing by and are not cumulative; thus, the predicted vibration levels address the Project only. Buildings along the alignment were surveyed to identify any vibration-sensitive buildings. The only vibration-sensitive land uses along the project corridor (Exhibit 8) were Category 2 (residential) buildings.

Vibration effects above the FTA vibration impact criteria of 80 VdB are predicted at Sites 3 and 11 from the train pass-bys. Site 3 represents approximately five residences, and Site 11 represents approximately 11 residences located 25-50 feet from the nearest track. Additional impacts resulting from a 3 VdB or more increase over the existing vibration levels in the corridor shared with Sound Transit *Sounder* service (Lakewood Station to TR Junction) were predicted at Sites 2, 4, 5 and 10. Exhibit 19 shows the predicted vibration levels and predicted areas with vibration effects.

There are two areas where crossover tracks have been proposed near vibration-sensitive receivers: between 100th Street Southwest and 108th Street Southwest and between Bridgeport Way Southwest and Clover Creek Drive Southwest. The effect of the wheel across the gap in the rail can increase the vibration level by up to 10 VdB at crossover tracks, depending the distance to the crossover to the receptor. The Project design has committed to using spring frogs in these areas. The spring frogs would cover the gap between the rails, so vibration effects in areas with crossover tracks would be reduced.

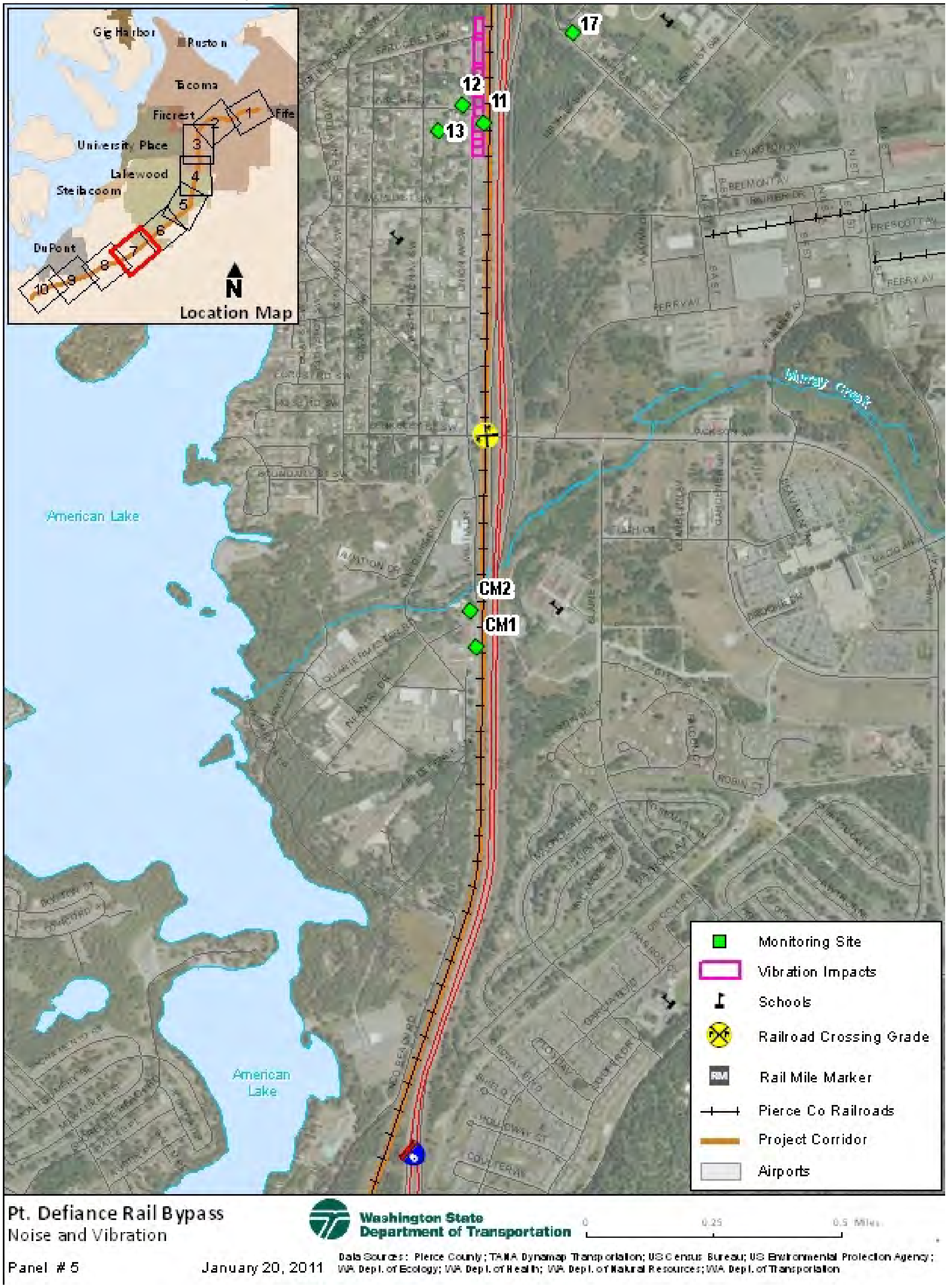
Vibration levels were measured at Sites 3 and 11 (Exhibit 20 and Exhibit 21). Vibration levels were between 75-80 VdB within 25-50 feet of the track when existing freight trains use the track. Because the Project would add 14 new events in the area, over the existing two freight trains, Sites 3 and 11 would have vibration effects. See Attachment B of this report for the spreadsheet calculations for each site.

Exhibit 19. Build Alternative Vibration Levels from Amtrak Passenger Train Operations

Site #	Ground-Borne Vibration Effect Criteria (VdB)	Project Vibration Level (VdB)	Increase over Existing in Shared *Sounder* Corridor (VdB)	Project Vibration Effect
South Tacoma to Lakewood				
1	80	65	-8	None
1M	80	66	-4	None
Tacoma Rescue Mission	80	70	-4	None
Church	80	59	-2	None
Fire Station	80	59	-3	None
2	80	72	4	Effect
3	80	85	2	Effect
4	80	66	5	Effect
5	80	70	6	Effect
6	80	75	2	None
6M	80	75	2	None
10	80	66	5	Effect
Lakewood to Nisqually				
7	80	78	-	None
8	80	66	-	None
9	80	66	-	None
11	80	82	-	Effect
12	80	70	-	None
13	80	66	-	None
14	80	66	-	None
15	80	77	-	None
16N	80	79	-	None
16	80	78	-	None
16S	80	75	-	None
17M	80	66	-	None
17	80	66	-	None
18	80	70	-	None
19	80	70	-	None

Exhibit 20. Vibration Effect, Site 3

Exhibit 21. Vibration Effect, Site 11



Construction Effects

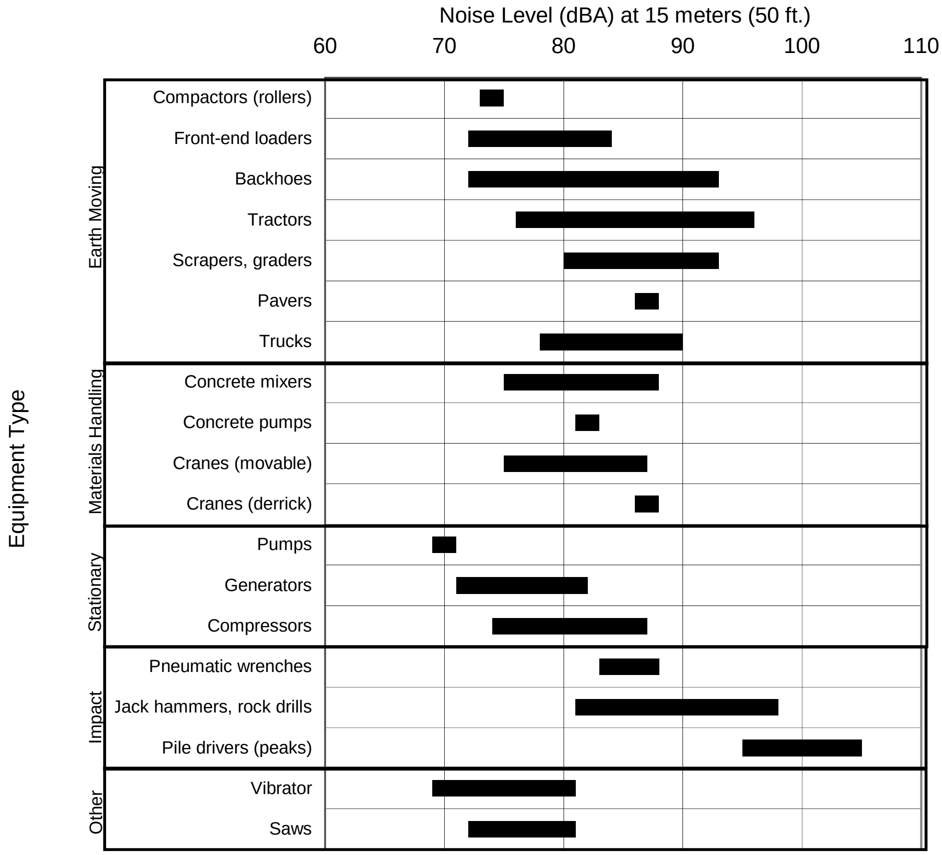
Noise

Noise during the construction period could be bothersome to nearby residences. Construction workers would also be subject to construction noise while working on the site. Construction would take approximately two years to complete. Construction would be carried out in several discrete steps along one or more construction areas (i.e. construction would not take place along the entire alignment at one time), each with its own mix of equipment and, consequently, its own noise characteristics. Railroad and roadway construction would involve clearing, removing old track and roadways, cut-and-fill activities, placing ballast, and installing new track or retrofitting existing track and paving. For the Project, the highest construction noise levels would likely be associated with any pile driving typically associated with wall and bridge structure construction. Construction noise is temporary and would vary widely both spatially and time-wise over the course of the Project's construction.

The most prevalent noise source at Project construction sites would be internal combustion engines. Earth-moving equipment, material-handling equipment, and stationary equipment are all engine-powered. Mobile equipment operates in a cyclical fashion, but stationary equipment (e.g., generators and compressors) operates at sound levels that are 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 and tools such as pile drivers, if pile foundations are needed. Impact tools could be pneumatically powered, hydraulic, or electric.

Construction noise would be intermittent, occurring seasonally during construction at various locations in the Project area. Construction noise levels 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. The maximum noise levels of construction equipment under the Build Alternative would be similar to the typical maximum construction equipment noise levels presented in Exhibit 22.

Exhibit 22. Construction Noise Levels



Source: EPA, 1971 and WSDOT, 1991.

As shown in Exhibit 22, maximum noise levels (L_{max}) from construction equipment would range from 69-106 dBA at 50 feet. Construction noise at residences farther away would decrease at a rate of 6-8 dBA per doubling of distance from the source. The number of occurrences of the L_{max} noise peaks would increase during construction, particularly during pile-driving activities. Because various pieces of equipment would be turned off, idling, or operating at less than full power at any given time and because construction machinery is typically used to complete short-term tasks at any given location, average L_{eq} daytime noise levels would be less than the maximum noise levels presented in Exhibit 22.

Construction noise is exempt from local property line regulations during daytime hours. Construction noise levels could be reduced by the construction practices identified in Chapter 6.

Vibration

Common vibration-producing equipment used during above-ground construction activities includes jackhammers, pavement breakers, bulldozers, backhoes, and ballast tampers. Pavement breaking and soil compaction would probably produce the highest levels of vibration. Exhibit 23 shows types of construction equipment measured under a variety of construction activities, and includes an average of source levels reported in terms of velocity levels. Although the exhibit lists one velocity level for each piece of equipment, considerable variation exists in reported ground-vibration levels from construction activities. The data provide a reasonable estimate for a wide range of soil conditions.

Exhibit 23. Vibration Source Levels for Construction Equipment

Equipment		Peak Particle Velocity at 25 feet (in/sec)	Approximate Lv at 25 feet (VdB)
Clam shovel drop (slurry wall)		0.202	94
Hydromill (slurry wall)	In soil	0.008	66
	In rock	0.017	75
Vibratory Roller		0.210	94
Large bulldozer		0.089	87
Caisson drilling		0.089	87
Loaded trucks		0.076	86
Jackhammer		0.035	79
Small bulldozer		0.003	58

Source: Transit Noise and Vibration Impact Assessment, FTA, FTA 2006
Lv = RMS velocity in decibels (VdB) re 1 micro-inch/sec.
RMS = The square root of the mean-square value of an oscillation waveform.

Maximum vibration at adjacent properties during construction of the Project may result from the use of equipment such as vibratory rollers to compact ballast during construction, reconstruction, or rehabilitation of track. Vibration levels from vibratory rollers were estimated to be the most substantial source of vibration during normal construction activities and were therefore used to estimate vibration levels at the vibration-sensitive land uses listed in Exhibit 19.

Exhibit 19 presents the results of the construction vibration analysis performed.

Exhibit 24. Build Alternative Vibration Levels from Construction

Site #	Ground-Borne Vibration Impact Criteria (VdB)	Estimated Construction Vibration Level (VdB)	Project Vibration Effect
South Tacoma to Lakewood			
1	**80**	**73**	**None**
1M	**80**	**70**	**None**
Tacoma Rescue Mission	**80**	**75**	**None**
Church	**80**	**55**	**None**
Fire Station	**80**	**58**	**None**
2	**80**	**69**	**None**
3	**80**	**88**	**Effect**
4	**80**	**58**	**None**
5	**80**	**63**	**None**
6	**80**	**73**	**None**
6M	**80**	**73**	**None**
10	**80**	**57**	**None**
Lakewood to Nisqually			
7	**80**	**77**	**None**
8	**80**	**59**	**None**
9	**80**	**56**	**None**
11	**80**	**82**	**Effect**
12	**80**	**67**	**None**
13	**80**	**57**	**None**
14	**80**	**50**	**None**
15	**80**	**76**	**None**
16N	**80**	**79**	**None**
16	**80**	**77**	**None**
16S	**80**	**73**	**None**
17M	**80**	**62**	**None**
17	**80**	**50**	**None**
18	**80**	**62**	**None**
19	**80**	**62**	**None**

Based on the limit for an acceptable level of residential ground-borne vibration of 80 VdB, construction-related vibration effects are predicted at Sites 3 and 11. Site 3 represents approximately five residences, and Site 11 represents approximately 11 residences located 25-50 feet from the nearest track.

Construction effects would be transient in nature and short-lived in duration at these sites. In addition, construction activities that may cause perceptible vibration would be likely to occur during daytime hours, and would not be likely to disrupt sleep at these properties.

Indirect Effects

The Project is located within an existing rail corridor and urbanized area. The only potential indirect effect tied to the Project is that it may indirectly influence limited redevelopment near the relocated Amtrak Station at Freighthouse Square (see Land Use Discipline Report[7]). Such redevelopment is not anticipated to change noise levels and would comply with state noise regulations (WAC 173-60). Thus, no indirect noise effects are anticipated. There are no vibration-sensitive land uses near Freighthouse Square, thus no indirect vibration effects are anticipated.

Cumulative Effects

In characterizing the effects of the Project on noise, project scientists considered ongoing (existing) noise sources and reasonably foreseeable future actions (detailed in the Land Use Discipline Report[8]) that would contribute to the noise environment. At sensitive locations north of Lakewood Station, moderate increases in noise would likely result from a combination of future Sound Transit operations and project-related Amtrak operations. FRA and WSDOT found that the Project's contribution to noise in the area would not lead to a significant cumulative effect.

Vibration effects from the Project were also considered in combination with other reasonably foreseeable actions, which for this rail corridor, includes the extension of the Sound Transit Sounder service in 2012, plus the continuing Tacoma Rail service and occasional BNSF freight deliveries. FRA and WSDOT found that the Project's vibration minimization measures are adequate to ensure no contribution to an adverse cumulative effect.

[7] *WSDOT 2012*
[8] *WSDOT 2012*

Chapter 6 – Recommended Minimization Measures

Noise Minimization Measures

No Build Alternative

Under the No Build Alternative, the Project would not be built and would not cause any additional noise effects. Therefore, no mitigation or minimization measures are required or proposed.

Build Alternative

No severe noise effects are predicted for the Build Alternative. Moderate noise effects are predicted at Sites 6M and 16N (**Error! Reference source not found.**). These effects would be caused by warning devices at the nearby at-grade crossing. These crossings will use wayside horns to limit the sounding of train horns and reduce the area exposed to train warning sounds; however, noise effects would still occur near the intersections. This measure to minimize noise exposure has already been included in the Project's design. Because the effect would be caused by required warning devices, elimination of the noise source would create a safety hazard. While it is not required, mitigation for Moderate Effects, where possible, should be considered. Noise barrier placement is not feasible in these areas because openings in the walls would be needed for roadway crossings. Noise barriers in these areas could also create sight-distance hazards.

Structural sound insulation in dwellings is provided only if predicted noise effects are severe. The predicted noise effects identified for the project are not at the severe level. Noise insulation is not recommended as a mitigation measure.

Therefore, no noise mitigation or minimization measures are recommended for grade-crossing noise effects caused by the Build Alternative.

Vibration Minimization Measures

No Build Alternative

Under the No Build Alternative, the Project would not be built and would not cause any vibration effects. Therefore, no minimization measures are required or proposed.

Build Alternative

Vibration effects at Sites 2, 3, 4, 5, 10 and 11 would be caused by train pass-by. Use of track treatments to reduce the vibration transmitted to the ground, such as resiliently supported ties, or ballast mats in this area could reduce the vibration levels below the 80-VdB criteria.

A detailed vibration analysis of these areas with predicted vibration effects will be conducted during final design of the Project. This study would address the vibration from the existing rail line and characterize the soil propagation in the area, which may reduce the number of vibration effects. The detailed study will also address any rail vibration treatments that have already been incorporated by Sound Transit in areas of shared track.

Construction Minimization Measures

Noise

Noise control measures during construction will be required to minimize noise levels on existing noise-sensitive land uses. All construction activities will have to comply with local noise regulations. Nighttime work could require a variance for local noise regulations.

The noise control measures listed in this section are examples of those that will be incorporated into the Project's construction phase. The contractor will be required to comply with any noise regulations permits acquired for the Project. Construction hours could be set, and construction activity noise level emission criteria could be determined and compliance required during construction.

Design Considerations

During the early stages of construction plan development, natural and artificial barriers (e.g., ground elevation changes and existing buildings) could be considered for use as shielding against construction noise. Strategic placement of stationary equipment, such as compressors and generators, could reduce effects at sensitive receivers.

Alternate Construction Methods

Certain phases of rail construction work, such as pile driving, may produce noise levels in excess of acceptable limits, even when feasible noise reduction methods are used. Using alternate methods of construction may reduce these effects. For pile driving, vibratory or hydraulic insertion could be used, depending on a variety of factors (i.e., vibratory pile driving is not always quieter). Drilling holes for cast-in-place piles is an alternative construction method that would produce significantly lower levels of noise.

Source Control

The contractor will comply with standard specifications and all local sound control and noise level rules, regulations, and ordinances that apply to any work performed pursuant to the contract. Each internal combustion engine used for any purpose on the Project or related to the Project will be equipped with a muffler of a type recommended by the manufacturer. No internal combustion engine will be operated without a muffler.

Time and Activity Constraints

Noisier activities involving large machinery will be limited to daytime hours as practical, when most people normally affected are either not present or engaged in less noise-sensitive activities. Nighttime construction will require a variance. Compliance with local noise ordinances would mitigate effects associated with construction noise. To comply with these ordinances, all construction activities adjacent to residential uses will be limited to daytime hours (7:00 AM to 6:00 PM) Monday through Saturday.

Community Relations

Community meetings will be held to explain the construction work, time involved, and control measures to be taken to reduce the effect of construction noise.

Vibration

Vibration control measures during construction could be required to minimize vibration levels on adjacent land uses. The vibration control measures listed in this section are examples of those that will be incorporated into the Project’s construction phase. The contractor will be required to comply with any applicable vibration regulations (such as the City of DuPont municipal code Title 9.09, *Sound and Vibration*).

As with construction noise, in many cases the information available during the preliminary engineering phase is not sufficient to define specific construction vibration minimization measures. In such cases, it is appropriate to describe and commit to a minimization plan that will be developed and implemented during the final design and construction phases of the project. The objective of the plan should be to minimize construction vibration damage using all reasonable and feasible means available. The plan should provide a procedure for establishing threshold and limiting vibration values for potentially affected structures based on an assessment of each structure's ability to withstand the loads and displacements due to construction vibrations. The plan should also include the development of a vibration monitoring plan.

Similar to the approach for construction noise, minimization of construction vibration requires consideration of equipment location and processes, as follows:

Design Considerations

Route heavily-loaded trucks away from residential streets, if possible. Select streets with fewest homes if no alternatives are available.
Operate earth-moving equipment on the construction lot as far away from vibration-sensitive sites as possible.

Sequence of Operations

Phase demolition, earth-moving and ground-impacting operations so as not to occur in the same time period. Unlike noise, the total vibration level produced could be significantly less when each vibration source operates separately.

Avoid nighttime activities. People are more aware of vibration in their homes during the nighttime hours.

Alternative Construction Methods

Select demolition methods not involving impact devices, where possible. For example, sawing bridge decks into sections that can be loaded onto trucks results in lower vibration levels than impact demolition by pavement breakers, and milling generates lower vibration levels than excavation using clam shell or chisel drops.

Avoid vibratory rollers and packers near sensitive areas, where possible.

References

American Public Transit Association, 1981. *Guidelines for design of rail transit facilities.*

Acoustical Society of America, 1983. *American national standard: guide to the evaluation of human exposure to vibration in buildings.* ANSI S3.29-1983

HMMH, 1995. *Description of FTA General Noise Assessment Spreadsheet.* Technical Memorandum from Harris Miller & Hanson to Federal Transit Administration. Burlington, MA.

EPA (U.S. Environmental Protection Agency), 1971. *Noise from Construction Equipment and Operations, Building Equipment, and Home Appliances.* Washington, D.C.

EPA, 1974. *Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety*. Report Number 550/9-74-004.

EPA, Office of Noise Abatement and Control. March 1974. *Information on levels of environmental noise requisite to protect public health and welfare with an adequate margin of safety*. Report Number 550/9-74-004.

FHWA (U.S. Department of Transportation, Federal Highway Administration), 1973. *Fundamentals and Abatement of Highway Traffic Noise*. Washington D.C.

FHWA, 1996. *Measurement of Highway-Related Noise.* Washington D.C.FRA (U.S. Department of Transportation, Federal Railway Administration), 2011. *Guidance on Assessing Noise and Vibration Impacts.* Available at: http://www.fra.dot.gov/Pages/253.shtml. Accessed September 2011.

FRA (U.S. Department of Transportation, Federal Railway Administration), 2011. *Guidance on Assessing Noise and Vibration Impacts.* Available at: http://www.fra.dot.gov/Pages/253.shtml. Accessed September 2011.

FRA, 1999. *Technical Supplement to the Draft Environmental Impact Statement of the Proposed Rule for the Use of Locomotive Horns at Highway-Rail Grade Crossings.* Washington D.C.

FTA (U.S. Department of Transportation, Federal Transit Administration), *May 2006. Transit noise and vibration impact assessment, final report.* FTA-VA-90-1003-06.United States Code. 1969. *National environmental policy act of 1969 (NEPA).* 42 USC 4321-4345. Washington, D.C.

WSDOT. 2009. *Pacific Northwest Rail Corridor Tier 1 Environmental Assessment*. Available at: http://wadot.wa.gov/Freight/publications/PNWRCReports.htm

WSDOT. 2012. *Point Defiance Bypass Project Land Use Discipline Report*.

Attachment A – Noise Modeling Results

Attachment B – Vibration Modeling Results

SITE #	# Bldgs	Noise Sensitive Category (1,2,3)	Speed (mph)	Distance from Nearest Track to Receptor (ft)	Vibration Criteria (Vdb)	Vibration Level (adjusted to speed) (Vdb)	Ground Borne Noise Criteria (GBN) (dBA)	Ground Borne Noise (GBN) (dBA)
1		2	25	130	80	65	43	30
1M		2	35	152	80	66	43	31
TRM		2	35	105	80	70	43	35
St Paul's		2	35	500	80	59	43	24
Fire House		2	35	382	80	59	43	24
2		2	79	174	80	72	43	37
3		2	79	40	80	**85**	43	**50**
4		2	79	400	80	66	43	31
5		2	79	267	80	70	43	35
6		2	79	130	80	75	43	40
6M		2	79	130	80	75	43	40
7		2	79	94	80	78	43	43
8		2	79	360	80	66	43	31
9		2	79	477	80	66	43	31
10		2	79	440	80	66	43	31
11		2	79	64	**80**	**82**	43	**47**
12		2	79	198	80	70	43	35
13		2	79	430	80	66	43	31
14		2	79	750	80	66	43	31
15		2	79	103	80	77	43	42
16		2	79	90	80	78	43	43
16MN		2	79	80	80	79	43	44
16MS		2	79	130	80	75	43	40
17M		2	79	300	80	66	43	31
17		2	79	760	80	66	43	31
18		2	79	290	80	70	43	35
19		2	79	290	80	70	43	35
CM2		2	79	75	80	80	43	45

Pt Defiance Bypass - Construction Vibration Estimate

Vibration Receptors	**Receptor Distance from Nearest Track (ft)**	**Max Construction Vibration - Vibratory Roller (Lv at 25 ft)** [1]	**Max Construction Vibration at Receptor Distance (Lv)** [2 3]
1	130	94	73
1M	152	94	70
TRM	105	94	75
St Paul's	500	94	55
Firehouse	382	94	58
2	174	94	69
3	**40**	**94**	**88**
4	400	94	58
5	267	94	63
6	130	94	73
6M	130	94	73
7	94	94	77
8	360	94	59
9	477	94	56
10	440	94	57
11	**64**	**94**	**82**
12	198	94	67
13	430	94	57
14	750	94	50
15	103	94	76
16	90	94	77
16MN	80	94	79
16MS	130	94	73
17M	300	94	62
17	760	94	50
18	290	94	62
19	290	94	62
CM2[4]	75	94	80

[1] Source: Table 12-2 of the FTA *Transit Noise and Vibration Impact Assesment* guidance (May, 2006).

[2] Source: Annoynace Assessment equation under Section 12.2.1 of the FTA *Transit Noise and Vibration Impact Assesment* guidance (May, 2006).

[3] Highlighted cells show levels equal to or above the Infrequent Event impact criteria for residential properties in Table 8-1 of the FTA *Transit Noise and Vibration Impact Assesment* guidance (May, 2006).

[4] Note that CM2 is a category 3 land use and so would be below the impact threshold for vibration at an estimated level of 80 VdB.

Project:	Point Definace Bypass Project

Receiver Parameters	
Receiver:	Site 1
Land Use Category:	2. Residential
Existing Noise (Measured or Generic Value):	67 dBA

Noise Source Parameters	
Number of Noise Sources:	2

Noise Source Parameters		Source 1
	Source Type:	Fixed Guideway
	Specific Source:	Diesel Electric Locomotive
Daytime hrs	Avg. Number of Locos/train	1
	Speed (mph)	35
	Avg. Number of Events/hr	1.16
Nighttime hrs	Avg. Number of Locos/train	
	Speed (mph)	
	Avg. Number of Events/hr	
Distance	Distance from Source to Receiver (ft)	130
	Number of Intervening Rows of Buildings	0
Adjustments		

Noise Source Parameters		Source 2
	Source Type:	Fixed Guideway
	Specific Source:	Rail Car
Daytime hrs	Avg. Number of Rail Cars/train	8
	Speed (mph)	35
	Avg. Number of Events/hr	1.16
Nighttime hrs	Avg. Number of Rail Cars/train	
	Speed (mph)	
	Avg. Number of Events/hr	
Distance	Distance from Source to Receiver (ft)	130
	Number of Intervening Rows of Buildings	
Adjustments	Noise Barrier?	No
	Jointed Track?	No
	Embedded Track?	No
	Aerial Structure?	No

Project Results Summary

Existing Ldn:	67 dBA
Total Project Ldn:	51 dBA
Total Noise Exposure:	67 dBA
Increase:	0 dB
Impact?:	None

Distance to Impact Contours

Dist to Mod. Impact Contour (Sources 1+2):	25 ft
Dist to Sev. Impact Contour (Sources 1+2):	11 ft

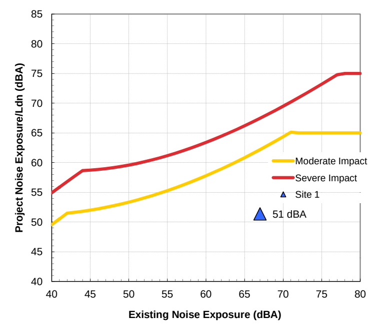
Source 1 Results

Leq(day):	52.4 dBA
Leq(night):	0.0 dBA
Ldn:	50.3 dBA

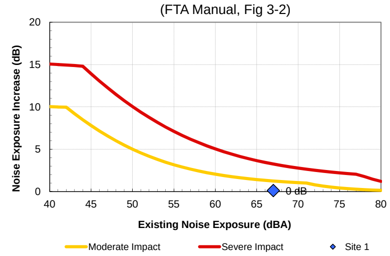
Source 2 Results

Leq(day):	46.8 dBA
Leq(night):	0.0 dBA
Ldn:	44.7 dBA
Incremental Ldn (Src 1-2):	51.4 dBA

Noise Impact Criteria
(FTA Manual, Fig 3-1)



Increase in Cumulative Noise Levels Allowed
(FTA Manual, Fig 3-2)



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Project:	Point Definace Bypass Project

Receiver Parameters	
Receiver:	Site 1
Land Use Category:	2. Residential
Existing Noise (Measured or Generic Value):	65 dBA

Noise Source Parameters	
Number of Noise Sources:	2

Noise Source Parameters		Source 1
	Source Type:	Fixed Guideway
	Specific Source:	Diesel Electric Locomotive
Daytime hrs	Avg. Number of Locos/train	1
	Speed (mph)	35
	Avg. Number of Events/hr	1.16
Nighttime hrs	Avg. Number of Locos/train	
	Speed (mph)	
	Avg. Number of Events/hr	
Distance	Distance from Source to Receiver (ft)	152
	Number of Intervening Rows of Buildings	0
Adjustments		

Noise Source Parameters		Source 2
	Source Type:	Fixed Guideway
	Specific Source:	Rail Car
Daytime hrs	Avg. Number of Rail Cars/train	8
	Speed (mph)	35
	Avg. Number of Events/hr	1.16
Nighttime hrs	Avg. Number of Rail Cars/train	
	Speed (mph)	
	Avg. Number of Events/hr	
Distance	Distance from Source to Receiver (ft)	152
	Number of Intervening Rows of Buildings	
Adjustments	Noise Barrier?	No
	Jointed Track?	No
	Embedded Track?	No
	Aerial Structure?	No

Project Results Summary

Existing Ldn:	65 dBA
Total Project Ldn:	50 dBA
Total Noise Exposure:	65 dBA
Increase:	0 dB
Impact?:	None

Distance to Impact Contours

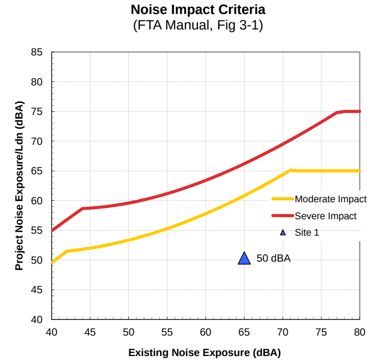
Dist to Mod. Impact Contour (Sources 1+2):	31 ft
Dist to Sev. Impact Contour (Sources 1+2):	13 ft

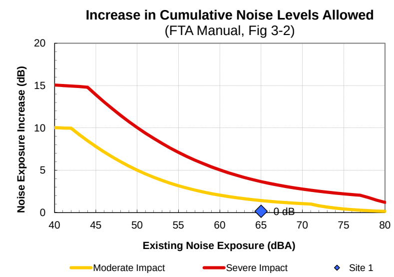
Source 1 Results

Leq(day):	51.4 dBA
Leq(night):	0.0 dBA
Ldn:	49.3 dBA

Source 2 Results

Leq(day):	45.7 dBA
Leq(night):	0.0 dBA
Ldn:	43.7 dBA
Incremental Ldn (Src 1-2):	50.4 dBA





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Project:	Point Definace Bypass Project

Receiver Parameters	
Receiver:	Site TRM
Land Use Category:	2. Residential
Existing Noise (Measured or Generic Value):	67 dBA

Noise Source Parameters	
Number of Noise Sources:	2

Noise Source Parameters		Source 1
	Source Type:	Fixed Guideway
	Specific Source:	Diesel Electric Locomotive
Daytime hrs	Avg. Number of Locos/train	1
	Speed (mph)	35
	Avg. Number of Events/hr	1.16
Nighttime hrs	Avg. Number of Locos/train	
	Speed (mph)	
	Avg. Number of Events/hr	
Distance	Distance from Source to Receiver (ft)	105
	Number of Intervening Rows of Buildings	0
Adjustments		

Noise Source Parameters		Source 2
	Source Type:	Fixed Guideway
	Specific Source:	Rail Car
Daytime hrs	Avg. Number of Rail Cars/train	8
	Speed (mph)	35
	Avg. Number of Events/hr	1.16
Nighttime hrs	Avg. Number of Rail Cars/train	
	Speed (mph)	
	Avg. Number of Events/hr	
Distance	Distance from Source to Receiver (ft)	105
	Number of Intervening Rows of Buildings	
Adjustments	Noise Barrier?	No
	Jointed Track?	No
	Embedded Track?	No
	Aerial Structure?	No

Project Results Summary

Existing Ldn:	67 dBA
Total Project Ldn:	53 dBA
Total Noise Exposure:	67 dBA
Increase:	0 dB
Impact?:	None

Distance to Impact Contours

Dist to Mod. Impact Contour (Sources 1+2):	25 ft
Dist to Sev. Impact Contour (Sources 1+2):	11 ft

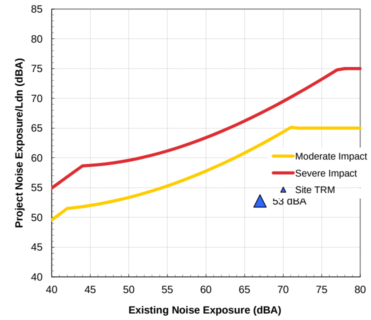
Source 1 Results

Leq(day):	53.8 dBA
Leq(night):	0.0 dBA
Ldn:	51.7 dBA

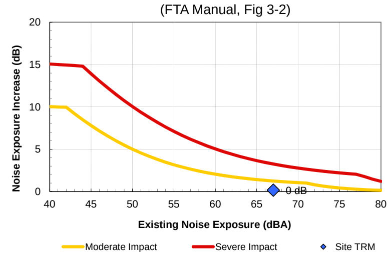
Source 2 Results

Leq(day):	48.1 dBA
Leq(night):	0.0 dBA
Ldn:	46.1 dBA
Incremental Ldn (Src 1-2):	52.8 dBA

Noise Impact Criteria
(FTA Manual, Fig 3-1)



Increase in Cumulative Noise Levels Allowed
(FTA Manual, Fig 3-2)



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Project:	Point Definace Bypass Project

Receiver Parameters	
Receiver:	Site St Pauls
Land Use Category:	2. Residential
Existing Noise (Measured or Generic Value):	67 dBA

Noise Source Parameters	
Number of Noise Sources:	2

Noise Source Parameters		Source 1
	Source Type:	Fixed Guideway
	Specific Source:	Diesel Electric Locomotive
Daytime hrs	Avg. Number of Locos/train	1
	Speed (mph)	35
	Avg. Number of Events/hr	1.16
Nighttime hrs	Avg. Number of Locos/train	
	Speed (mph)	
	Avg. Number of Events/hr	
Distance	Distance from Source to Receiver (ft)	500
	Number of Intervening Rows of Buildings	0
Adjustments		

Noise Source Parameters		Source 2
	Source Type:	Fixed Guideway
	Specific Source:	Rail Car
Daytime hrs	Avg. Number of Rail Cars/train	8
	Speed (mph)	35
	Avg. Number of Events/hr	1.16
Nighttime hrs	Avg. Number of Rail Cars/train	
	Speed (mph)	
	Avg. Number of Events/hr	
Distance	Distance from Source to Receiver (ft)	500
	Number of Intervening Rows of Buildings	
Adjustments	Noise Barrier?	No
	Jointed Track?	No
	Embedded Track?	No
	Aerial Structure?	No

Project Results Summary

Existing Ldn:	67 dBA
Total Project Ldn:	43 dBA
Total Noise Exposure:	67 dBA
Increase:	0 dB
Impact?:	None

Distance to Impact Contours

Dist to Mod. Impact Contour (Sources 1+2):	25 ft
Dist to Sev. Impact Contour (Sources 1+2):	11 ft

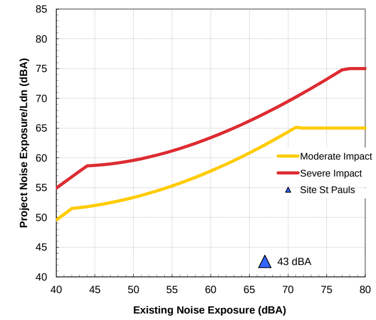
Source 1 Results

Leq(day):	43.6 dBA
Leq(night):	0.0 dBA
Ldn:	41.6 dBA

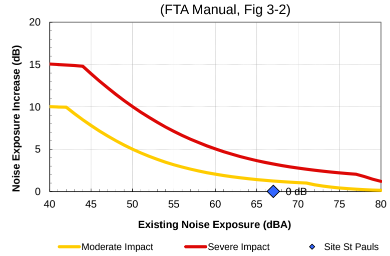
Source 2 Results

Leq(day):	38.0 dBA
Leq(night):	0.0 dBA
Ldn:	35.9 dBA
Incremental Ldn (Src 1-2):	42.6 dBA

Noise Impact Criteria
(FTA Manual, Fig 3-1)



Increase in Cumulative Noise Levels Allowed
(FTA Manual, Fig 3-2)



Project:	Point Definace Bypass Project

Receiver Parameters	
Receiver:	Site Fire House
Land Use Category:	2. Residential
Existing Noise (Measured or Generic Value):	67 dBA

Noise Source Parameters	
Number of Noise Sources:	2

Noise Source Parameters		Source 1
	Source Type:	Fixed Guideway
	Specific Source:	Diesel Electric Locomotive
Daytime hrs	Avg. Number of Locos/train	1
	Speed (mph)	35
	Avg. Number of Events/hr	1.16
Nighttime hrs	Avg. Number of Locos/train	
	Speed (mph)	
	Avg. Number of Events/hr	
Distance	Distance from Source to Receiver (ft)	382
	Number of Intervening Rows of Buildings	0
Adjustments		

Noise Source Parameters		Source 2
	Source Type:	Fixed Guideway
	Specific Source:	Rail Car
Daytime hrs	Avg. Number of Rail Cars/train	8
	Speed (mph)	35
	Avg. Number of Events/hr	1.16
Nighttime hrs	Avg. Number of Rail Cars/train	
	Speed (mph)	
	Avg. Number of Events/hr	
Distance	Distance from Source to Receiver (ft)	382
	Number of Intervening Rows of Buildings	
Adjustments	Noise Barrier?	No
	Jointed Track?	No
	Embedded Track?	No
	Aerial Structure?	No

Project Results Summary

Existing Ldn:	67 dBA
Total Project Ldn:	44 dBA
Total Noise Exposure:	67 dBA
Increase:	0 dB
Impact?:	None

Distance to Impact Contours

Dist to Mod. Impact Contour (Sources 1+2):	25 ft
Dist to Sev. Impact Contour (Sources 1+2):	11 ft

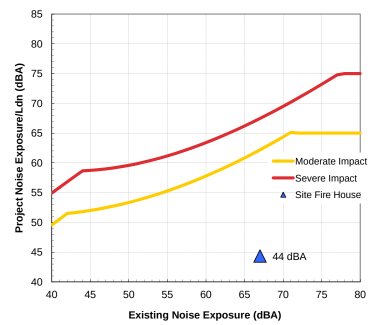
Source 1 Results

Leq(day):	45.3 dBA
Leq(night):	0.0 dBA
Ldn:	43.3 dBA

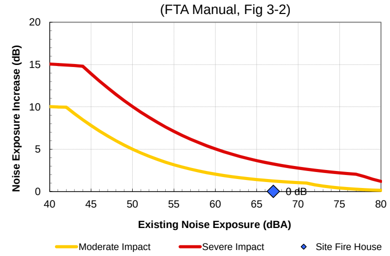
Source 2 Results

Leq(day):	39.7 dBA
Leq(night):	0.0 dBA
Ldn:	37.7 dBA
Incremental Ldn (Src 1-2):	44.4 dBA

Noise Impact Criteria
(FTA Manual, Fig 3-1)



Increase in Cumulative Noise Levels Allowed
(FTA Manual, Fig 3-2)



Project:	Point Defiance Bypass Project

Receiver Parameters	
Receiver:	Site 2
Land Use Category:	2. Residential
Existing Noise (Measured or Generic Value):	59 dBA

Noise Source Parameters	
Number of Noise Sources:	2

Noise Source Parameters		Source 1
	Source Type:	Fixed Guideway
	Specific Source:	Diesel Electric Locomotive
Daytime hrs	Avg. Number of Locos/train	1
	Speed (mph)	79
	Avg. Number of Events/hr	1.16
Nighttime hrs	Avg. Number of Locos/train	
	Speed (mph)	
	Avg. Number of Events/hr	
Distance	Distance from Source to Receiver (ft)	174
	Number of Intervening Rows of Buildings	0
Adjustments		

Noise Source Parameters		Source 2
	Source Type:	Fixed Guideway
	Specific Source:	Rail Car
Daytime hrs	Avg. Number of Rail Cars/train	8
	Speed (mph)	79
	Avg. Number of Events/hr	1.16
Nighttime hrs	Avg. Number of Rail Cars/train	
	Speed (mph)	
	Avg. Number of Events/hr	
Distance	Distance from Source to Receiver (ft)	174
	Number of Intervening Rows of Buildings	
Adjustments	Noise Barrier?	No
	Jointed Track?	No
	Embedded Track?	No
	Aerial Structure?	No

Project Results Summary

Existing Ldn:	59 dBA
Total Project Ldn:	51 dBA
Total Noise Exposure:	60 dBA
Increase:	1 dB
Impact?:	None

Distance to Impact Contours

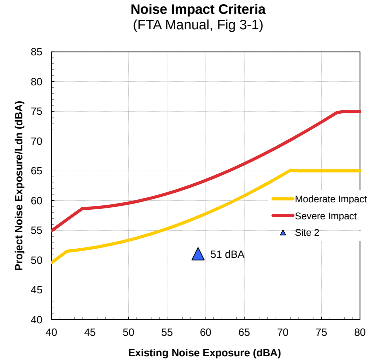
Dist to Mod. Impact Contour (Sources 1+2):	68 ft
Dist to Sev. Impact Contour (Sources 1+2):	28 ft

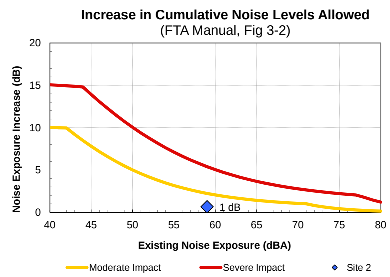
Source 1 Results

Leq(day):	46.9 dBA
Leq(night):	0.0 dBA
Ldn:	44.9 dBA

Source 2 Results

Leq(day):	51.9 dBA
Leq(night):	0.0 dBA
Ldn:	49.9 dBA
Incremental Ldn (Src 1-2):	51.1 dBA





Project:	Point Defiance Bypass Project

Receiver Parameters	
Receiver:	Site 3
Land Use Category:	2. Residential
Existing Noise (Measured or Generic Value):	68 dBA

Noise Source Parameters	
Number of Noise Sources:	2

Noise Source Parameters		Source 1
	Source Type:	Fixed Guideway
	Specific Source:	Diesel Electric Locomotive
Daytime hrs	Avg. Number of Locos/train	1
	Speed (mph)	79
	Avg. Number of Events/hr	1.16
Nighttime hrs	Avg. Number of Locos/train	
	Speed (mph)	
	Avg. Number of Events/hr	
Distance	Distance from Source to Receiver (ft)	40
	Number of Intervening Rows of Buildings	0
Adjustments		

Noise Source Parameters		Source 2
	Source Type:	Fixed Guideway
	Specific Source:	Rail Car
Daytime hrs	Avg. Number of Rail Cars/train	8
	Speed (mph)	79
	Avg. Number of Events/hr	1.16
Nighttime hrs	Avg. Number of Rail Cars/train	
	Speed (mph)	
	Avg. Number of Events/hr	
Distance	Distance from Source to Receiver (ft)	40
	Number of Intervening Rows of Buildings	
Adjustments	Noise Barrier?	No
	Jointed Track?	No
	Embedded Track?	No
	Aerial Structure?	No

Project Results Summary

Existing Ldn:	68 dBA
Total Project Ldn:	61 dBA
Total Noise Exposure:	69 dBA
Increase:	1 dB
Impact?:	None

Distance to Impact Contours

Dist to Mod. Impact Contour (Sources 1+2):	28 ft
Dist to Sev. Impact Contour (Sources 1+2):	13 ft

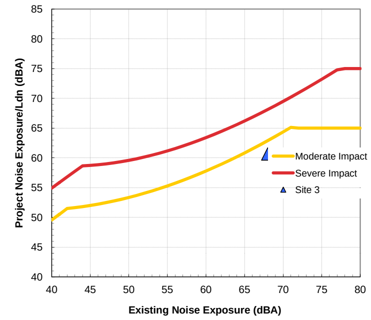
Source 1 Results

Leq(day):	56.5 dBA
Leq(night):	0.0 dBA
Ldn:	54.5 dBA

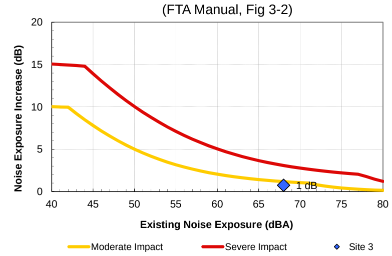
Source 2 Results

Leq(day):	61.5 dBA
Leq(night):	0.0 dBA
Ldn:	59.5 dBA
Incremental Ldn (Src 1-2):	60.7 dBA

Noise Impact Criteria
(FTA Manual, Fig 3-1)



Increase in Cumulative Noise Levels Allowed
(FTA Manual, Fig 3-2)



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Project:	Point Defiance Bypass Project

Receiver Parameters	
Receiver:	Site 4
Land Use Category:	2. Residential
Existing Noise (Measured or Generic Value):	56 dBA

Noise Source Parameters	
Number of Noise Sources:	4

Noise Source Parameters		Source 1
	Source Type:	Fixed Guideway
	Specific Source:	Diesel Electric Locomotive
Daytime hrs	Avg. Number of Locos/train	1
	Speed (mph)	79
	Avg. Number of Events/hr	1.16
Nighttime hrs	Avg. Number of Locos/train	
	Speed (mph)	
	Avg. Number of Events/hr	
Distance	Distance from Source to Receiver (ft)	400
	Number of Intervening Rows of Buildings	1
Adjustments		

Noise Source Parameters		Source 2
	Source Type:	Fixed Guideway
	Specific Source:	Rail Car
Daytime hrs	Avg. Number of Rail Cars/train	8
	Speed (mph)	79
	Avg. Number of Events/hr	1.16
Nighttime hrs	Avg. Number of Rail Cars/train	
	Speed (mph)	
	Avg. Number of Events/hr	
Distance	Distance from Source to Receiver (ft)	400
	Number of Intervening Rows of Buildings	1
Adjustments	Noise Barrier?	No
	Jointed Track?	No
	Embedded Track?	No
	Aerial Structure?	No

Noise Source Parameters		Source 3
	Source Type:	Fixed Guideway
	Specific Source:	Locomotive Warning Horn
Daytime hrs		
	Speed	79
	Avg. Number of Events/hr	1.16
Nighttime hrs		
	Speed	
	Avg. Number of Events/hr	
Distance	Distance from Source to Receiver (ft)	600
	Number of Intervening Rows of Buildings	1
Adjustments		

Noise Source Parameters		Source 4
	Source Type:	Stationary Source
	Specific Source:	Crossing Signals
Daytime hrs	Signal Duration/hr (seconds)	5
Nighttime hrs	Signal Duration/hr (seconds)	0
Distance	Distance from Source to Receiver (ft)	600
	Number of Intervening Rows of Buildings	
Adjustments	Noise Barrier?	No

Project Results Summary

Existing Ldn:	56 dBA
Total Project Ldn:	53 dBA
Total Noise Exposure:	58 dBA
Increase:	2 dB
Impact?:	None

Distance to Impact Contours

Dist to Mod. Impact Contour:	---
Dist to Sev. Impact Contour:	---

Source 1 Results

Leq(day):	37.0 dBA
Leq(night):	0.0 dBA
Ldn:	35.0 dBA

Source 2 Results

Leq(day):	42.0 dBA
Leq(night):	0.0 dBA
Ldn:	40.0 dBA
Incremental Ldn (Src 1-2):	41.2 dBA

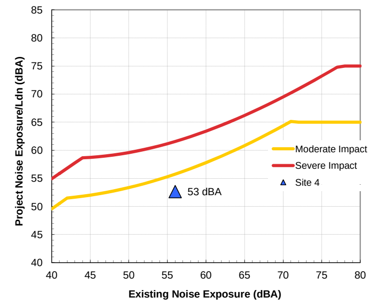
Source 3 Results

Leq(day):	54.4 dBA
Leq(night):	0.0 dBA
Ldn:	52.3 dBA
Incremental Ldn (Src 1-3):	52.6 dBA

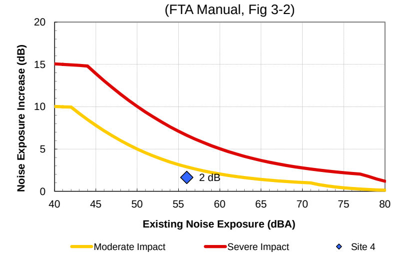
Source 4 Results

Leq(day):	17.8 dBA
Leq(night):	0.0 dBA
Ldn:	16.2 dBA
Incremental Ldn (Src 1-4):	52.6 dBA

Noise Impact Criteria
(FTA Manual, Fig 3-1)



Increase in Cumulative Noise Levels Allowed
(FTA Manual, Fig 3-2)



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Project:	Point Defiance Bypass Project

Receiver Parameters	
Receiver:	Site 5
Land Use Category:	2. Residential
Existing Noise (Measured or Generic Value):	63 dBA

Noise Source Parameters	
Number of Noise Sources:	4

Noise Source Parameters		Source 1
	Source Type:	Fixed Guideway
	Specific Source:	Diesel Electric Locomotive
Daytime hrs	Avg. Number of Locos/train	1
	Speed (mph)	79
	Avg. Number of Events/hr	1.16
Nighttime hrs	Avg. Number of Locos/train	
	Speed (mph)	
	Avg. Number of Events/hr	
Distance	Distance from Source to Receiver (ft)	267
	Number of Intervening Rows of Buildings	0
Adjustments		

Noise Source Parameters		Source 2
	Source Type:	Fixed Guideway
	Specific Source:	Rail Car
Daytime hrs	Avg. Number of Rail Cars/train	8
	Speed (mph)	79
	Avg. Number of Events/hr	1.16
Nighttime hrs	Avg. Number of Rail Cars/train	
	Speed (mph)	
	Avg. Number of Events/hr	
Distance	Distance from Source to Receiver (ft)	267
	Number of Intervening Rows of Buildings	
Adjustments	Noise Barrier?	No
	Jointed Track?	No
	Embedded Track?	No
	Aerial Structure?	No

Noise Source Parameters		Source 3
	Source Type:	Fixed Guideway
	Specific Source:	Locomotive Warning Horn
Daytime hrs	Speed	79
	Avg. Number of Events/hr	0.5
Nighttime hrs	Speed	
	Avg. Number of Events/hr	
Distance	Distance from Source to Receiver (ft)	400
	Number of Intervening Rows of Buildings	
Adjustments		

Noise Source Parameters		Source 4
	Source Type:	Stationary Source
	Specific Source:	Crossing Signals
Daytime hrs	Signal Duration/hr (seconds)	5
Nighttime hrs	Signal Duration/hr (seconds)	0
Distance	Distance from Source to Receiver (ft)	400
	Number of Intervening Rows of Buildings	
Adjustments	Noise Barrier?	No

Project Results Summary

Existing Ldn:	63 dBA
Total Project Ldn:	57 dBA
Total Noise Exposure:	64 dBA
Increase:	1 dB
Impact?:	None

Distance to Impact Contours

Dist to Mod. Impact Contour:	---
Dist to Sev. Impact Contour:	---

Source 1 Results

Leq(day):	44.1 dBA
Leq(night):	0.0 dBA
Ldn:	42.1 dBA

Source 2 Results

Leq(day):	49.1 dBA
Leq(night):	0.0 dBA
Ldn:	47.1 dBA
Incremental Ldn (Src 1-2):	48.3 dBA

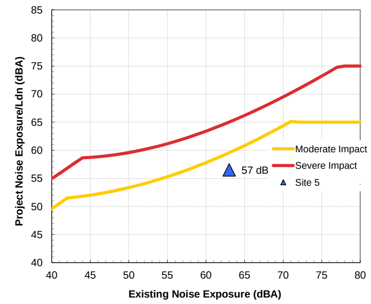
Source 3 Results

Leq(day):	57.8 dBA
Leq(night):	0.0 dBA
Ldn:	55.8 dBA
Incremental Ldn (Src 1-3):	56.5 dBA

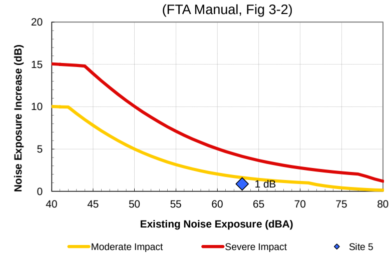
Source 4 Results

Leq(day):	22.2 dBA
Leq(night):	0.0 dBA
Ldn:	20.4 dBA
Incremental Ldn (Src 1-4):	56.5 dBA

Noise Impact Criteria
(FTA Manual, Fig 3-1)



Increase in Cumulative Noise Levels Allowed
(FTA Manual, Fig 3-2)



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Project:	Point Defiance Bypass Project

Receiver Parameters

Receiver:	Site 6
Land Use Category:	2. Residential
Existing Noise (Measured or Generic Value):	63 dBA

Noise Source Parameters

Number of Noise Sources:	4

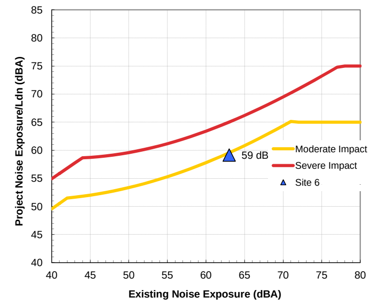
Project Results Summary

Existing Ldn:	63 dBA
Total Project Ldn:	59 dBA
Total Noise Exposure:	65 dBA
Increase:	2 dB
Impact?:	None

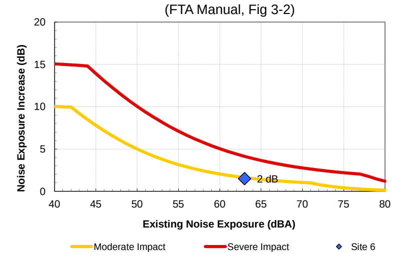
Distance to Impact Contours

Dist to Mod. Impact Contour:	---
Dist to Sev. Impact Contour:	---

Noise Impact Criteria
(FTA Manual, Fig 3-1)



Increase in Cumulative Noise Levels Allowed
(FTA Manual, Fig 3-2)



Noise Source Parameters — Source 1

	Source Type:	Fixed Guideway
	Specific Source:	Diesel Electric Locomotive
Daytime hrs	Avg. Number of Locos/train	1
	Speed (mph)	79
	Avg. Number of Events/hr	1.16
Nighttime hrs	Avg. Number of Locos/train	
	Speed (mph)	
	Avg. Number of Events/hr	
Distance	Distance from Source to Receiver (ft)	130
	Number of Intervening Rows of Buildings	0
Adjustments		

Source 1 Results

Leq(day):	48.8 dBA
Leq(night):	0.0 dBA
Ldn:	46.8 dBA

Noise Source Parameters — Source 2

	Source Type:	Fixed Guideway
	Specific Source:	Rail Car
Daytime hrs	Avg. Number of Rail Cars/train	8
	Speed (mph)	79
	Avg. Number of Events/hr	1.16
Nighttime hrs	Avg. Number of Rail Cars/train	
	Speed (mph)	
	Avg. Number of Events/hr	
Distance	Distance from Source to Receiver (ft)	130
	Number of Intervening Rows of Buildings	
Adjustments	Noise Barrier?	No
	Jointed Track?	No
	Embedded Track?	No
	Aerial Structure?	No

Source 2 Results

Leq(day):	53.8 dBA
Leq(night):	0.0 dBA
Ldn:	51.8 dBA
Incremental Ldn (Src 1-2):	53.0 dBA

Noise Source Parameters — Source 3

	Source Type:	Stationary Source
	Specific Source:	Locomotive Warning Horn
Daytime hrs	Avg. Number of Trains/hr	6
Nighttime hrs	Avg. Number of Trains/hr	6
Distance	Distance from Source to Receiver (ft)	200
	Number of Intervening Rows of Buildings	
Adjustments	Noise Barrier?	No

Source 3 Results

Leq(day):	60.0 dBA
Leq(night):	0.0 dBA
Ldn:	58.0 dBA
Incremental Ldn (Src 1-3):	59.2 dBA

Noise Source Parameters — Source 4

	Source Type:	Stationary Source
	Specific Source:	Crossing Signals
Daytime hrs	Signal Duration/hr (seconds)	5
Nighttime hrs	Signal Duration/hr (seconds)	0
Distance	Distance from Source to Receiver (ft)	200
	Number of Intervening Rows of Buildings	
Adjustments	Noise Barrier?	No

Source 4 Results

Leq(day):	29.8 dBA
Leq(night):	0.0 dBA
Ldn:	27.8 dBA
Incremental Ldn (Src 1-4):	59.2 dBA

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Project:	Point Defiance Bypass Project

Receiver Parameters	
Receiver:	Site 6M
Land Use Category:	2. Residential
Existing Noise (Measured or Generic Value):	65 dBA

Noise Source Parameters	
Number of Noise Sources:	4

Noise Source Parameters		Source 1
	Source Type:	Fixed Guideway
	Specific Source:	Diesel Electric Locomotive
Daytime hrs	**Avg. Number of Locos/train**	1
	Speed (mph)	79
	Avg. Number of Events/hr	1.16
Nighttime hrs	**Avg. Number of Locos/train**	
	Speed (mph)	
	Avg. Number of Events/hr	
Distance	**Distance from Source to Receiver (ft)**	130
	Number of Intervening Rows of Buildings	0
Adjustments		

Noise Source Parameters		Source 2
	Source Type:	Fixed Guideway
	Specific Source:	Rail Car
Daytime hrs	**Avg. Number of Rail Cars/train**	8
	Speed (mph)	79
	Avg. Number of Events/hr	1.16
Nighttime hrs	**Avg. Number of Rail Cars/train**	
	Speed (mph)	
	Avg. Number of Events/hr	
Distance	**Distance from Source to Receiver (ft)**	140
	Number of Intervening Rows of Buildings	
Adjustments	**Noise Barrier?**	No
	Jointed Track?	No
	Embedded Track?	No
	Aerial Structure?	No

Noise Source Parameters		Source 3
	Source Type:	Stationary Source
	Specific Source:	Locomotive Warning Horn
Daytime hrs	**Avg. Number of Trains/hr**	6
Nighttime hrs	**Avg. Number of Trains/hr**	6
Distance	**Distance from Source to Receiver (ft)**	140
	Number of Intervening Rows of Buildings	
Adjustments	**Noise Barrier?**	No

Noise Source Parameters		Source 4
	Source Type:	Stationary Source
	Specific Source:	Crossing Signals
Daytime hrs	**Signal Duration/hr (seconds)**	5
Nighttime hrs	**Signal Duration/hr (seconds)**	0
Distance	**Distance from Source to Receiver (ft)**	130
	Number of Intervening Rows of Buildings	
Adjustments	**Noise Barrier?**	No

Project Results Summary

Existing Ldn:	65 dBA
Total Project Ldn:	62 dBA
Total Noise Exposure:	67 dBA
Increase:	2 dB
Impact?:	Moderate

Distance to Impact Contours

Dist to Mod. Impact Contour:	---
Dist to Sev. Impact Contour:	---

Source 1 Results

Leq(day):	48.8 dBA
Leq(night):	0.0 dBA
Ldn:	46.8 dBA

Source 2 Results

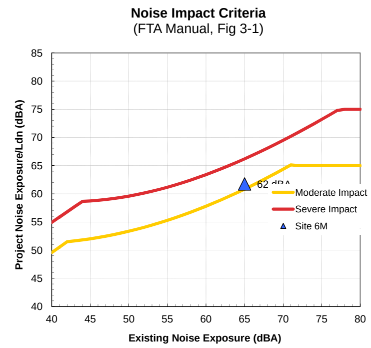
Leq(day):	53.3 dBA
Leq(night):	0.0 dBA
Ldn:	51.3 dBA
Incremental Ldn (Src 1-2):	52.6 dBA

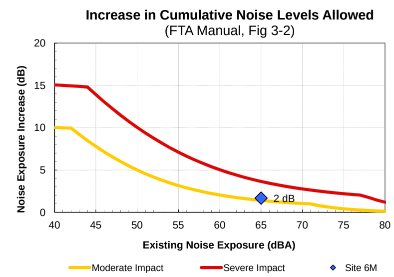
Source 3 Results

Leq(day):	63.2 dBA
Leq(night):	0.0 dBA
Ldn:	61.2 dBA
Incremental Ldn (Src 1-3):	61.7 dBA

Source 4 Results

Leq(day):	34.5 dBA
Leq(night):	0.0 dBA
Ldn:	32.4 dBA
Incremental Ldn (Src 1-4):	61.8 dBA





Project:	Point Defiance Bypass Project

Receiver Parameters	
Receiver:	Site 7
Land Use Category:	2. Residential
Existing Noise (Measured or Generic Value):	67 dBA

Noise Source Parameters	
Number of Noise Sources:	2

Noise Source Parameters		Source 1
	Source Type:	Fixed Guideway
	Specific Source:	Diesel Electric Locomotive
Daytime hrs	Avg. Number of Locos/train	1
	Speed (mph)	79
	Avg. Number of Events/hr	1.16
Nighttime hrs	Avg. Number of Locos/train	
	Speed (mph)	
	Avg. Number of Events/hr	
Distance	Distance from Source to Receiver (ft)	94
	Number of Intervening Rows of Buildings	0
Adjustments		

Noise Source Parameters		Source 2
	Source Type:	Fixed Guideway
	Specific Source:	Rail Car
Daytime hrs	Avg. Number of Rail Cars/train	8
	Speed (mph)	79
	Avg. Number of Events/hr	1.16
Nighttime hrs	Avg. Number of Rail Cars/train	
	Speed (mph)	
	Avg. Number of Events/hr	
Distance	Distance from Source to Receiver (ft)	94
	Number of Intervening Rows of Buildings	
Adjustments	Noise Barrier?	No
	Jointed Track?	No
	Embedded Track?	No
	Aerial Structure?	No

Project Results Summary

Existing Ldn:	67 dBA
Total Project Ldn:	55 dBA
Total Noise Exposure:	67 dBA
Increase:	0 dB
Impact?:	None

Distance to Impact Contours

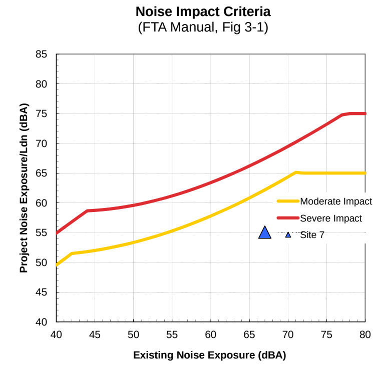
Dist to Mod. Impact Contour (Sources 1+2):	32 ft
Dist to Sev. Impact Contour (Sources 1+2):	14 ft

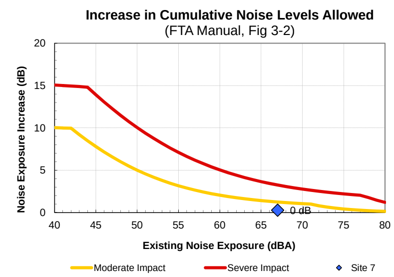
Source 1 Results

Leq(day):	50.9 dBA
Leq(night):	0.0 dBA
Ldn:	48.9 dBA

Source 2 Results

Leq(day):	55.9 dBA
Leq(night):	0.0 dBA
Ldn:	53.9 dBA
Incremental Ldn (Src 1-2):	55.1 dBA





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Project:	Point Defiance Bypass Project

Receiver Parameters	
Receiver:	Site 8
Land Use Category:	2. Residential
Existing Noise (Measured or Generic Value):	61 dBA

Noise Source Parameters	
Number of Noise Sources:	2

Noise Source Parameters		Source 1
	Source Type:	Fixed Guideway
	Specific Source:	Diesel Electric Locomotive
Daytime hrs	Avg. Number of Locos/train	1
	Speed (mph)	79
	Avg. Number of Events/hr	1.16
Nighttime hrs	Avg. Number of Locos/train	
	Speed (mph)	
	Avg. Number of Events/hr	
Distance	Distance from Source to Receiver (ft)	370
	Number of Intervening Rows of Buildings	1
Adjustments		

Noise Source Parameters		Source 2
	Source Type:	Fixed Guideway
	Specific Source:	Rail Car
Daytime hrs	Avg. Number of Rail Cars/train	8
	Speed (mph)	79
	Avg. Number of Events/hr	1.16
Nighttime hrs	Avg. Number of Rail Cars/train	
	Speed (mph)	
	Avg. Number of Events/hr	
Distance	Distance from Source to Receiver (ft)	370
	Number of Intervening Rows of Buildings	1
Adjustments	Noise Barrier?	No
	Jointed Track?	No
	Embedded Track?	No
	Aerial Structure?	No

Project Results Summary

Existing Ldn:	61 dBA
Total Project Ldn:	42 dBA
Total Noise Exposure:	61 dBA
Increase:	0 dB
Impact?:	None

Distance to Impact Contours

Dist to Mod. Impact Contour (Sources 1+2):	57 ft
Dist to Sev. Impact Contour (Sources 1+2):	24 ft

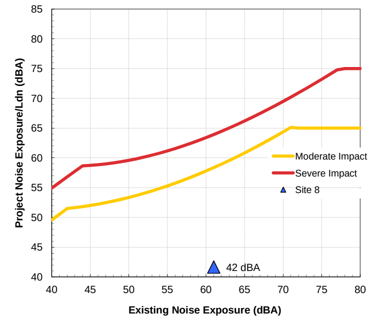
Source 1 Results

Leq(day):	37.5 dBA
Leq(night):	0.0 dBA
Ldn:	35.5 dBA

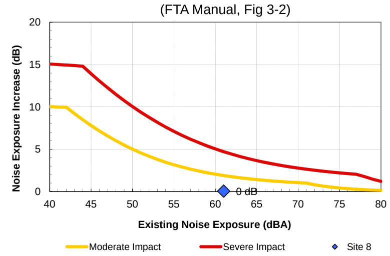
Source 2 Results

Leq(day):	42.5 dBA
Leq(night):	0.0 dBA
Ldn:	40.5 dBA
Incremental Ldn (Src 1-2):	41.7 dBA

Noise Impact Criteria
(FTA Manual, Fig 3-1)



Increase in Cumulative Noise Levels Allowed
(FTA Manual, Fig 3-2)



Project:	Point Defiance Bypass Project

Receiver Parameters	
Receiver:	Site 9
Land Use Category:	2. Residential
Existing Noise (Measured or Generic Value):	69 dBA

Noise Source Parameters	
Number of Noise Sources:	2

Noise Source Parameters		Source 1
	Source Type:	Fixed Guideway
	Specific Source:	Diesel Electric Locomotive
Daytime hrs	Avg. Number of Locos/train	1
	Speed (mph)	79
	Avg. Number of Events/hr	1.16
Nighttime hrs	Avg. Number of Locos/train	
	Speed (mph)	
	Avg. Number of Events/hr	
Distance	Distance from Source to Receiver (ft)	480
	Number of Intervening Rows of Buildings	2
Adjustments		

Noise Source Parameters		Source 2
	Source Type:	Fixed Guideway
	Specific Source:	Rail Car
Daytime hrs	Avg. Number of Rail Cars/train	8
	Speed (mph)	79
	Avg. Number of Events/hr	1.16
Nighttime hrs	Avg. Number of Rail Cars/train	
	Speed (mph)	
	Avg. Number of Events/hr	
Distance	Distance from Source to Receiver (ft)	480
	Number of Intervening Rows of Buildings	2
Adjustments	Noise Barrier?	No
	Jointed Track?	No
	Embedded Track?	No
	Aerial Structure?	No

Project Results Summary

Existing Ldn:	69 dBA
Total Project Ldn:	38 dBA
Total Noise Exposure:	69 dBA
Increase:	0 dB
Impact?:	None

Distance to Impact Contours

Dist to Mod. Impact Contour (Sources 1+2):	25 ft
Dist to Sev. Impact Contour (Sources 1+2):	11 ft

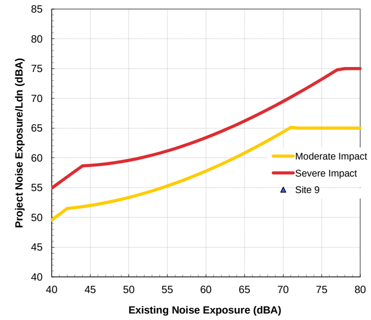
Source 1 Results

Leq(day):	34.3 dBA
Leq(night):	0.0 dBA
Ldn:	32.3 dBA

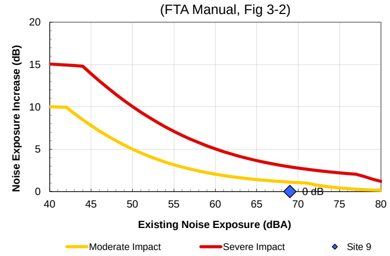
Source 2 Results

Leq(day):	39.3 dBA
Leq(night):	0.0 dBA
Ldn:	37.3 dBA
Incremental Ldn (Src 1-2):	38.5 dBA

Noise Impact Criteria
(FTA Manual, Fig 3-1)



Increase in Cumulative Noise Levels Allowed
(FTA Manual, Fig 3-2)



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Project:	Point Defiance Bypass Project

Receiver Parameters	
Receiver:	Site 10
Land Use Category:	2. Residential
Existing Noise (Measured or Generic Value):	54 dBA

Noise Source Parameters	
Number of Noise Sources:	2

Noise Source Parameters		Source 1
	Source Type:	Fixed Guideway
	Specific Source:	Diesel Electric Locomotive
Daytime hrs	Avg. Number of Locos/train	1
	Speed (mph)	79
	Avg. Number of Events/hr	1.16
Nighttime hrs	Avg. Number of Locos/train	
	Speed (mph)	
	Avg. Number of Events/hr	
Distance	Distance from Source to Receiver (ft)	440
	Number of Intervening Rows of Buildings	2
Adjustments		

Noise Source Parameters		Source 2
	Source Type:	Fixed Guideway
	Specific Source:	Rail Car
Daytime hrs	Avg. Number of Rail Cars/train	8
	Speed (mph)	79
	Avg. Number of Events/hr	1.16
Nighttime hrs	Avg. Number of Rail Cars/train	
	Speed (mph)	
	Avg. Number of Events/hr	
Distance	Distance from Source to Receiver (ft)	440
	Number of Intervening Rows of Buildings	2
Adjustments	Noise Barrier?	No
	Jointed Track?	No
	Embedded Track?	No
	Aerial Structure?	No

Project Results Summary

Existing Ldn:	54 dBA
Total Project Ldn:	39 dBA
Total Noise Exposure:	54 dBA
Increase:	0 dB
Impact?:	None

Distance to Impact Contours

Dist to Mod. Impact Contour (Sources 1+2):	97 ft
Dist to Sev. Impact Contour (Sources 1+2):	39 ft

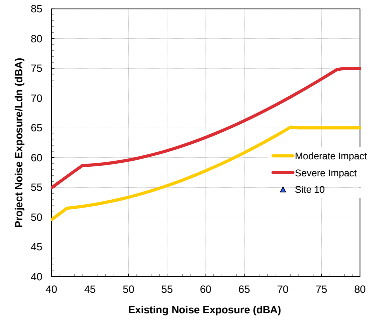
Source 1 Results

Leq(day):	34.9 dBA
Leq(night):	0.0 dBA
Ldn:	32.9 dBA

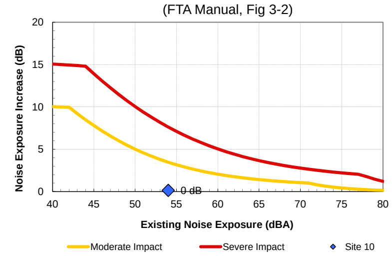
Source 2 Results

Leq(day):	39.9 dBA
Leq(night):	0.0 dBA
Ldn:	37.8 dBA
Incremental Ldn (Src 1-2):	39.0 dBA

Noise Impact Criteria
(FTA Manual, Fig 3-1)



Increase in Cumulative Noise Levels Allowed
(FTA Manual, Fig 3-2)



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Project:	Point Defiance Bypass Project

Receiver Parameters	
Receiver:	Site 11
Land Use Category:	2. Residential
Existing Noise (Measured or Generic Value):	75 dBA

Noise Source Parameters	
Number of Noise Sources:	4

Noise Source Parameters		Source 1
	Source Type:	Fixed Guideway
	Specific Source:	Diesel Electric Locomotive
Daytime hrs	Avg. Number of Locos/train	1
	Speed (mph)	79
	Avg. Number of Events/hr	1.16
Nighttime hrs	Avg. Number of Locos/train	
	Speed (mph)	
	Avg. Number of Events/hr	
Distance	Distance from Source to Receiver (ft)	64
	Number of Intervening Rows of Buildings	
Adjustments		

Source 1 Results

Leq(day):	53.4 dBA
Leq(night):	0.0 dBA
Ldn:	51.4 dBA

Noise Source Parameters		Source 2
	Source Type:	Fixed Guideway
	Specific Source:	Rail Car
Daytime hrs	Avg. Number of Rail Cars/train	8
	Speed (mph)	79
	Avg. Number of Events/hr	1.16
Nighttime hrs	Avg. Number of Rail Cars/train	
	Speed (mph)	
	Avg. Number of Events/hr	
Distance	Distance from Source to Receiver (ft)	64
	Number of Intervening Rows of Buildings	
Adjustments	Noise Barrier?	No
	Jointed Track?	No
	Embedded Track?	No
	Aerial Structure?	No

Source 2 Results

Leq(day):	58.4 dBA
Leq(night):	0.0 dBA
Ldn:	56.4 dBA
Incremental Ldn (Src 1-2):	57.6 dBA

Noise Source Parameters		Source 3
	Source Type:	Stationary Source
	Specific Source:	Locomotive Warning Horn
Daytime hrs	Avg. Number of Trains/hr	6
Nighttime hrs	Avg. Number of Trains/hr	6
Distance	Distance from Source to Receiver (ft)	679
	Number of Intervening Rows of Buildings	
Adjustments	Noise Barrier?	No

Source 3 Results

Leq(day):	46.7 dBA
Leq(night):	0.0 dBA
Ldn:	44.7 dBA
Incremental Ldn (Src 1-3):	57.8 dBA

Noise Source Parameters		Source 4
	Source Type:	Stationary Source
	Specific Source:	Crossing Signals
Daytime hrs	Signal Duration/hr (seconds)	140
Nighttime hrs	Signal Duration/hr (seconds)	0
Distance	Distance from Source to Receiver (ft)	679
	Number of Intervening Rows of Buildings	
Adjustments	Noise Barrier?	No

Source 4 Results

Leq(day):	31.0 dBA
Leq(night):	0.0 dBA
Ldn:	29.0 dBA
Incremental Ldn (Src 1-4):	57.8 dBA

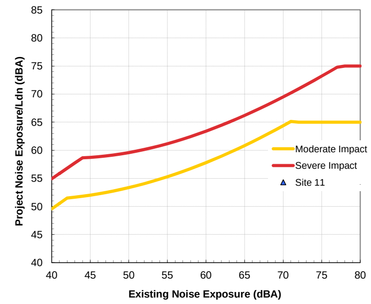
Project Results Summary

Existing Ldn:	75 dBA
Total Project Ldn:	58 dBA
Total Noise Exposure:	75 dBA
Increase:	0 dB
Impact?:	None

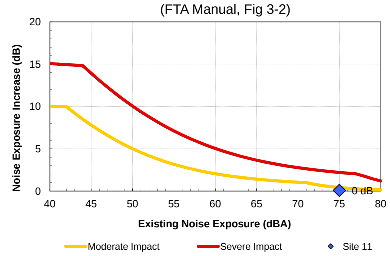
Distance to Impact Contours

Dist to Mod. Impact Contour:	---
Dist to Sev. Impact Contour:	---

Noise Impact Criteria
(FTA Manual, Fig 3-1)



Increase in Cumulative Noise Levels Allowed
(FTA Manual, Fig 3-2)



Project:	Point Defiance Bypass Project

Receiver Parameters	
Receiver:	Site 12
Land Use Category:	2. Residential
Existing Noise (Measured or Generic Value):	66 dBA

Noise Source Parameters	
Number of Noise Sources:	2

Noise Source Parameters		Source 1
	Source Type:	Fixed Guideway
	Specific Source:	Diesel Electric Locomotive
Daytime hrs	Avg. Number of Locos/train	1
	Speed (mph)	79
	Avg. Number of Events/hr	1.16
Nighttime hrs	Avg. Number of Locos/train	
	Speed (mph)	
	Avg. Number of Events/hr	
Distance	Distance from Source to Receiver (ft)	435
	Number of Intervening Rows of Buildings	1
Adjustments		

Noise Source Parameters		Source 2
	Source Type:	Fixed Guideway
	Specific Source:	Rail Car
Daytime hrs	Avg. Number of Rail Cars/train	8
	Speed (mph)	79
	Avg. Number of Events/hr	1.16
Nighttime hrs	Avg. Number of Rail Cars/train	
	Speed (mph)	
	Avg. Number of Events/hr	
Distance	Distance from Source to Receiver (ft)	435
	Number of Intervening Rows of Buildings	1
Adjustments	Noise Barrier?	No
	Jointed Track?	No
	Embedded Track?	No
	Aerial Structure?	No

Project Results Summary

Existing Ldn:	66 dBA
Total Project Ldn:	41 dBA
Total Noise Exposure:	66 dBA
Increase:	0 dB
Impact?:	None

Distance to Impact Contours

Dist to Mod. Impact Contour (Sources 1+2):	35 ft
Dist to Sev. Impact Contour (Sources 1+2):	16 ft

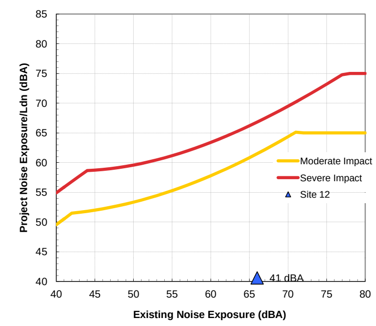
Source 1 Results

Leq(day):	36.5 dBA
Leq(night):	0.0 dBA
Ldn:	34.4 dBA

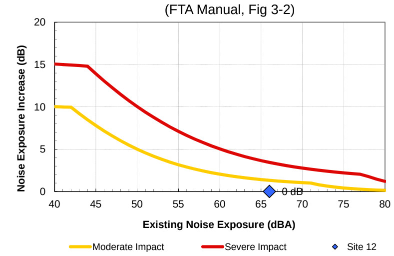
Source 2 Results

Leq(day):	41.5 dBA
Leq(night):	0.0 dBA
Ldn:	39.4 dBA
Incremental Ldn (Src 1-2):	40.6 dBA

Noise Impact Criteria
(FTA Manual, Fig 3-1)



Increase in Cumulative Noise Levels Allowed
(FTA Manual, Fig 3-2)



Project:	Point Defiance Bypass Project

Receiver Parameters

Receiver:	Site 13
Land Use Category:	2. Residential
Existing Noise (Measured or Generic Value):	60 dBA

Noise Source Parameters

Number of Noise Sources:	2

Noise Source Parameters		Source 1
	Source Type:	Fixed Guideway
	Specific Source:	Diesel Electric Locomotive
Daytime hrs	Avg. Number of Locos/train	1
	Speed (mph)	79
	Avg. Number of Events/hr	1.16
Nighttime hrs	Avg. Number of Locos/train	
	Speed (mph)	
	Avg. Number of Events/hr	
Distance	Distance from Source to Receiver (ft)	430
	Number of Intervening Rows of Buildings	0
Adjustments		

Noise Source Parameters		Source 2
	Source Type:	Fixed Guideway
	Specific Source:	Rail Car
Daytime hrs	Avg. Number of Rail Cars/train	8
	Speed (mph)	79
	Avg. Number of Events/hr	1.16
Nighttime hrs	Avg. Number of Rail Cars/train	
	Speed (mph)	
	Avg. Number of Events/hr	
Distance	Distance from Source to Receiver (ft)	430
	Number of Intervening Rows of Buildings	
Adjustments	Noise Barrier?	No
	Jointed Track?	No
	Embedded Track?	No
	Aerial Structure?	No

Project Results Summary

Existing Ldn:	60 dBA
Total Project Ldn:	45 dBA
Total Noise Exposure:	60 dBA
Increase:	0 dB
Impact?:	None

Distance to Impact Contours

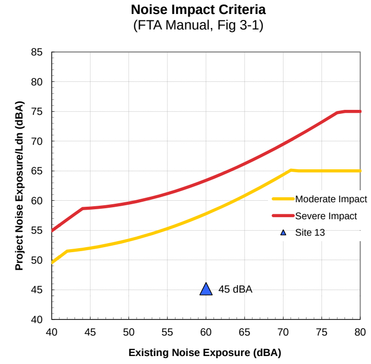
Dist to Mod. Impact Contour (Sources 1+2):	62 ft
Dist to Sev. Impact Contour (Sources 1+2):	26 ft

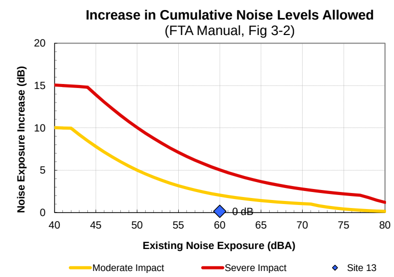
Source 1 Results

Leq(day):	41.0 dBA
Leq(night):	0.0 dBA
Ldn:	39.0 dBA

Source 2 Results

Leq(day):	46.0 dBA
Leq(night):	0.0 dBA
Ldn:	44.0 dBA
Incremental Ldn (Src 1-2):	45.2 dBA





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Project: Point Defiance Bypass Project

Receiver Parameters	
Receiver:	Site 14
Land Use Category:	2. Residential
Existing Noise (Measured or Generic Value):	61 dBA

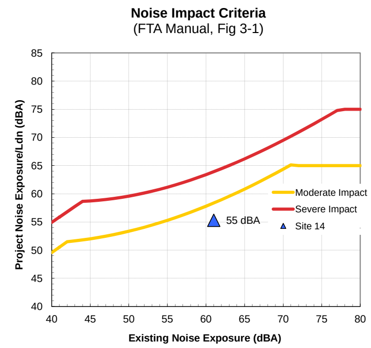
Noise Source Parameters	
Number of Noise Sources:	4

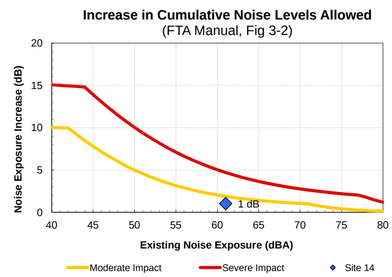
Project Results Summary

Existing Ldn:	61 dBA
Total Project Ldn:	55 dBA
Total Noise Exposure:	62 dBA
Increase:	1 dB
Impact?:	None

Distance to Impact Contours

Dist to Mod. Impact Contour:	---
Dist to Sev. Impact Contour:	---





Noise Source Parameters		Source 1
	Source Type:	Fixed Guideway
	Specific Source:	Diesel Electric Locomotive
Daytime hrs	Avg. Number of Locos/train	1
	Speed (mph)	79
	Avg. Number of Events/hr	1.16
Nighttime hrs	Avg. Number of Locos/train	
	Speed (mph)	
	Avg. Number of Events/hr	
Distance	Distance from Source to Receiver (ft)	750
	Number of Intervening Rows of Buildings	0
Adjustments		

Source 1 Results

Leq(day):	37.4 dBA
Leq(night):	0.0 dBA
Ldn:	35.4 dBA

Noise Source Parameters		Source 2
	Source Type:	Fixed Guideway
	Specific Source:	Rail Car
Daytime hrs	Avg. Number of Rail Cars/train	8
	Speed (mph)	79
	Avg. Number of Events/hr	1.16
Nighttime hrs	Avg. Number of Rail Cars/train	
	Speed (mph)	
	Avg. Number of Events/hr	
Distance	Distance from Source to Receiver (ft)	750
	Number of Intervening Rows of Buildings	
Adjustments	Noise Barrier?	No
	Jointed Track?	No
	Embedded Track?	No
	Aerial Structure?	No

Source 2 Results

Leq(day):	42.4 dBA
Leq(night):	0.0 dBA
Ldn:	40.4 dBA
Incremental Ldn (Src 1-2):	41.6 dBA

Noise Source Parameters		Source 3
	Source Type:	Fixed Guideway
	Specific Source:	Locomotive Warning Horn
Daytime hrs		
	Speed	79
	Avg. Number of Events/hr	1.16
Nighttime hrs		
	Speed	
	Avg. Number of Events/hr	
Distance	Distance from Source to Receiver (ft)	780
	Number of Intervening Rows of Buildings	
Adjustments		

Source 3 Results

Leq(day):	57.1 dBA
Leq(night):	0.0 dBA
Ldn:	55.1 dBA
Incremental Ldn (Src 1-3):	55.3 dBA

Noise Source Parameters		Source 4
	Source Type:	Stationary Source
	Specific Source:	Crossing Signals
Daytime hrs	Signal Duration/hr (seconds)	140
Nighttime hrs	Signal Duration/hr (seconds)	0
Distance	Distance from Source to Receiver (ft)	780
	Number of Intervening Rows of Buildings	
Adjustments	Noise Barrier?	No

Source 4 Results

Leq(day):	29.5 dBA
Leq(night):	0.0 dBA
Ldn:	27.5 dBA
Incremental Ldn (Src 1-4):	55.3 dBA

Project:	Point Defiance Bypass Project

Receiver Parameters		
	Receiver:	Site 15
	Land Use Category:	2. Residential
	Existing Noise (Measured or Generic Value):	72 dBA

Noise Source Parameters		
	Number of Noise Sources:	4

Noise Source Parameters		Source 1
	Source Type:	Fixed Guideway
	Specific Source:	Diesel Electric Locomotive
Daytime hrs	Avg. Number of Locos/train	1
	Speed (mph)	79
	Avg. Number of Events/hr	1.16
Nighttime hrs	Avg. Number of Locos/train	
	Speed (mph)	
	Avg. Number of Events/hr	
Distance	Distance from Source to Receiver (ft)	103
	Number of Intervening Rows of Buildings	0
Adjustments		

Noise Source Parameters		Source 2
	Source Type:	Fixed Guideway
	Specific Source:	Rail Car
Daytime hrs	Avg. Number of Rail Cars/train	8
	Speed (mph)	79
	Avg. Number of Events/hr	1.16
Nighttime hrs	Avg. Number of Rail Cars/train	
	Speed (mph)	
	Avg. Number of Events/hr	
Distance	Distance from Source to Receiver (ft)	103
	Number of Intervening Rows of Buildings	
Adjustments	Noise Barrier?	No
	Jointed Track?	No
	Embedded Track?	No
	Aerial Structure?	No

Noise Source Parameters		Source 3
	Source Type:	Stationary Source
	Specific Source:	Locomotive Warning Horn
Daytime hrs	Avg. Number of Trains/hr	6
Nighttime hrs	Avg. Number of Trains/hr	6
Distance	Distance from Source to Receiver (ft)	515
	Number of Intervening Rows of Buildings	
Adjustments	Noise Barrier?	No

Noise Source Parameters		Source 4
	Source Type:	Stationary Source
	Specific Source:	Crossing Signals
Daytime hrs	Signal Duration/hr (seconds)	140
Nighttime hrs	Signal Duration/hr (seconds)	0
Distance	Distance from Source to Receiver (ft)	515
	Number of Intervening Rows of Buildings	
Adjustments	Noise Barrier?	No

Project Results Summary

Existing Ldn:	72 dBA
Total Project Ldn:	55 dBA
Total Noise Exposure:	72 dBA
Increase:	0 dB
Impact?:	None

Distance to Impact Contours

Dist to Mod. Impact Contour:	---
Dist to Sev. Impact Contour:	---

Source 1 Results

Leq(day):	50.4 dBA
Leq(night):	0.0 dBA
Ldn:	48.3 dBA

Source 2 Results

Leq(day):	55.3 dBA
Leq(night):	0.0 dBA
Ldn:	53.3 dBA
Incremental Ldn (Src 1-2):	54.5 dBA

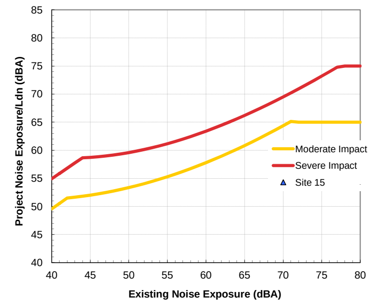
Source 3 Results

Leq(day):	49.7 dBA
Leq(night):	0.0 dBA
Ldn:	47.7 dBA
Incremental Ldn (Src 1-3):	55.3 dBA

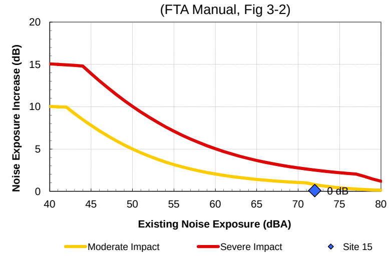
Source 4 Results

Leq(day):	34.0 dBA
Leq(night):	0.0 dBA
Ldn:	31.9 dBA
Incremental Ldn (Src 1-4):	55.3 dBA

Noise Impact Criteria
(FTA Manual, Fig 3-1)



Increase in Cumulative Noise Levels Allowed
(FTA Manual, Fig 3-2)



Project:	Point Defiance Bypass Project

Receiver Parameters	
Receiver:	Site 16
Land Use Category:	2. Residential
Existing Noise (Measured or Generic Value):	65 dBA

Noise Source Parameters	
Number of Noise Sources:	2

Noise Source Parameters		Source 1
	Source Type:	Fixed Guideway
	Specific Source:	Diesel Electric Locomotive
Daytime hrs	Avg. Number of Locos/train	1
	Speed (mph)	79
	Avg. Number of Events/hr	1.16
Nighttime hrs	Avg. Number of Locos/train	
	Speed (mph)	
	Avg. Number of Events/hr	
Distance	Distance from Source to Receiver (ft)	65
	Number of Intervening Rows of Buildings	0
Adjustments		

Noise Source Parameters		Source 2
	Source Type:	Fixed Guideway
	Specific Source:	Rail Car
Daytime hrs	Avg. Number of Rail Cars/train	8
	Speed (mph)	79
	Avg. Number of Events/hr	1.16
Nighttime hrs	Avg. Number of Rail Cars/train	
	Speed (mph)	
	Avg. Number of Events/hr	
Distance	Distance from Source to Receiver (ft)	65
	Number of Intervening Rows of Buildings	
Adjustments	Noise Barrier?	No
	Jointed Track?	No
	Embedded Track?	No
	Aerial Structure?	No

Project Results Summary

Existing Ldn:	65 dBA
Total Project Ldn:	57 dBA
Total Noise Exposure:	66 dBA
Increase:	1 dB
Impact?:	None

Distance to Impact Contours

Dist to Mod. Impact Contour (Sources 1+2):	39 ft
Dist to Sev. Impact Contour (Sources 1+2):	17 ft

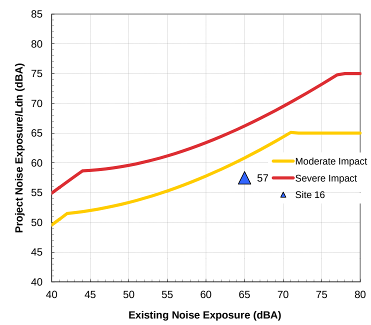
Source 1 Results

Leq(day):	53.3 dBA
Leq(night):	0.0 dBA
Ldn:	51.3 dBA

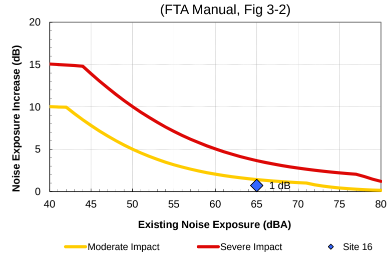
Source 2 Results

Leq(day):	58.3 dBA
Leq(night):	0.0 dBA
Ldn:	56.3 dBA
Incremental Ldn (Src 1-2):	57.5 dBA

Noise Impact Criteria
(FTA Manual, Fig 3-1)



Increase in Cumulative Noise Levels Allowed
(FTA Manual, Fig 3-2)



Project:	Point Defiance Bypass Project

Receiver Parameters	
Receiver:	16 N
Land Use Category:	2. Residential
Existing Noise (Measured or Generic Value):	70 dBA

Noise Source Parameters	
Number of Noise Sources:	4

Noise Source Parameters		Source 1
	Source Type:	Fixed Guideway
	Specific Source:	Diesel Electric Locomotive
Daytime hrs	Avg. Number of Locos/train	1
	Speed (mph)	79
	Avg. Number of Events/hr	1.16
Nighttime hrs	Avg. Number of Locos/train	
	Speed (mph)	
	Avg. Number of Events/hr	
Distance	Distance from Source to Receiver (ft)	80
	Number of Intervening Rows of Buildings	0
Adjustments		

Noise Source Parameters		Source 2
	Source Type:	Fixed Guideway
	Specific Source:	Rail Car
Daytime hrs	Avg. Number of Rail Cars/train	8
	Speed (mph)	79
	Avg. Number of Events/hr	1.16
Nighttime hrs	Avg. Number of Rail Cars/train	
	Speed (mph)	
	Avg. Number of Events/hr	
Distance	Distance from Source to Receiver (ft)	80
	Number of Intervening Rows of Buildings	
Adjustments	Noise Barrier?	No
	Jointed Track?	No
	Embedded Track?	No
	Aerial Structure?	No

Noise Source Parameters		Source 3
	Source Type:	Stationary Source
	Specific Source:	Locomotive Warning Horn
Daytime hrs	Avg. Number of Trains/hr	6
Nighttime hrs	Avg. Number of Trains/hr	6
Distance	Distance from Source to Receiver (ft)	90
	Number of Intervening Rows of Buildings	
Adjustments	Noise Barrier?	No

Noise Source Parameters		Source 4
	Source Type:	Stationary Source
	Specific Source:	Crossing Signals
Daytime hrs	Signal Duration/hr (seconds)	140
Nighttime hrs	Signal Duration/hr (seconds)	0
Distance	Distance from Source to Receiver (ft)	90
	Number of Intervening Rows of Buildings	
Adjustments	Noise Barrier?	No

Project Results Summary

Existing Ldn:	70 dBA
Total Project Ldn:	67 dBA
Total Noise Exposure:	72 dBA
Increase:	2 dB
Impact?:	Moderate

Distance to Impact Contours

Dist to Mod. Impact Contour:	---
Dist to Sev. Impact Contour:	---

Source 1 Results

Leq(day):	52.0 dBA
Leq(night):	0.0 dBA
Ldn:	50.0 dBA

Source 2 Results

Leq(day):	57.0 dBA
Leq(night):	0.0 dBA
Ldn:	54.9 dBA
Incremental Ldn (Src 1-2):	56.1 dBA

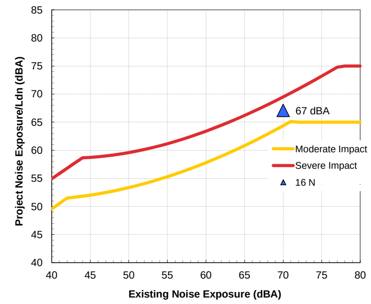
Source 3 Results

Leq(day):	68.7 dBA
Leq(night):	0.0 dBA
Ldn:	66.6 dBA
Incremental Ldn (Src 1-3):	67.0 dBA

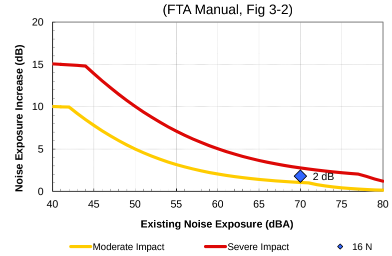
Source 4 Results

Leq(day):	52.9 dBA
Leq(night):	0.0 dBA
Ldn:	50.9 dBA
Incremental Ldn (Src 1-4):	67.1 dBA

Noise Impact Criteria
(FTA Manual, Fig 3-1)



Increase in Cumulative Noise Levels Allowed
(FTA Manual, Fig 3-2)



Federal Transit Administration
Noise Impact Assessment Spreadsheet
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Project:	Point Defiance Bypass Project

Receiver Parameters	
Receiver:	16 S
Land Use Category:	2. Residential
Existing Noise (Measured or Generic Value):	67 dBA

Noise Source Parameters	
Number of Noise Sources:	4

Noise Source Parameters		Source 1
	Source Type:	Fixed Guideway
	Specific Source:	Diesel Electric Locomotive
Daytime hrs	Avg. Number of Locos/train	1
	Speed (mph)	79
	Avg. Number of Events/hr	1.16
Nighttime hrs	Avg. Number of Locos/train	
	Speed (mph)	
	Avg. Number of Events/hr	
Distance	Distance from Source to Receiver (ft)	140
	Number of Intervening Rows of Buildings	0
Adjustments		

Noise Source Parameters		Source 2
	Source Type:	Fixed Guideway
	Specific Source:	Rail Car
Daytime hrs	Avg. Number of Rail Cars/train	8
	Speed (mph)	79
	Avg. Number of Events/hr	1.16
Nighttime hrs	Avg. Number of Rail Cars/train	
	Speed (mph)	
	Avg. Number of Events/hr	
Distance	Distance from Source to Receiver (ft)	140
	Number of Intervening Rows of Buildings	
Adjustments	Noise Barrier?	No
	Jointed Track?	No
	Embedded Track?	No
	Aerial Structure?	No

Noise Source Parameters		Source 3
	Source Type:	Stationary Source
	Specific Source:	Locomotive Warning Horn
Daytime hrs	Avg. Number of Trains/hr	6
Nighttime hrs	Avg. Number of Trains/hr	6
Distance	Distance from Source to Receiver (ft)	184
	Number of Intervening Rows of Buildings	
Adjustments	Noise Barrier?	No

Noise Source Parameters		Source 4
	Source Type:	Stationary Source
	Specific Source:	Crossing Signals
Daytime hrs	Signal Duration/hr (seconds)	140
Nighttime hrs	Signal Duration/hr (seconds)	0
Distance	Distance from Source to Receiver (ft)	184
	Number of Intervening Rows of Buildings	
Adjustments	Noise Barrier?	No

Project Results Summary

Existing Ldn:	67 dBA
Total Project Ldn:	60 dBA
Total Noise Exposure:	68 dBA
Increase:	1 dB
Impact?:	None

Distance to Impact Contours

Dist to Mod. Impact Contour:	---
Dist to Sev. Impact Contour:	---

Source 1 Results

Leq(day):	48.4 dBA
Leq(night):	0.0 dBA
Ldn:	46.3 dBA

Source 2 Results

Leq(day):	53.3 dBA
Leq(night):	0.0 dBA
Ldn:	51.3 dBA
Incremental Ldn (Src 1-2):	52.5 dBA

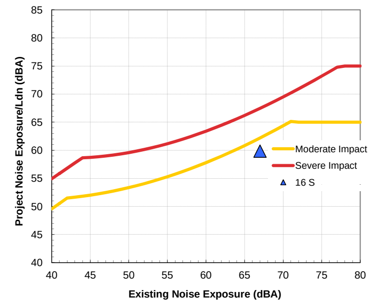
Source 3 Results

Leq(day):	60.9 dBA
Leq(night):	0.0 dBA
Ldn:	58.9 dBA
Incremental Ldn (Src 1-3):	59.8 dBA

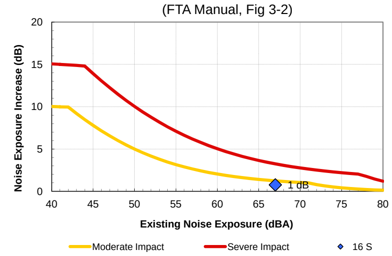
Source 4 Results

Leq(day):	45.2 dBA
Leq(night):	0.0 dBA
Ldn:	43.1 dBA
Incremental Ldn (Src 1-4):	59.9 dBA

Noise Impact Criteria
(FTA Manual, Fig 3-1)



Increase in Cumulative Noise Levels Allowed
(FTA Manual, Fig 3-2)



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Project:	Point Defiance Bypass Project

Receiver Parameters

Receiver:	Site 17M
Land Use Category:	2. Residential
Existing Noise (Measured or Generic Value):	67 dBA

Noise Source Parameters

Number of Noise Sources:	2

Noise Source Parameters		Source 1
	Source Type:	Fixed Guideway
	Specific Source:	Diesel Electric Locomotive
Daytime hrs	Avg. Number of Locos/train	1
	Speed (mph)	79
	Avg. Number of Events/hr	1.16
Nighttime hrs	Avg. Number of Locos/train	
	Speed (mph)	
	Avg. Number of Events/hr	
Distance	Distance from Source to Receiver (ft)	305
	Number of Intervening Rows of Buildings	0
Adjustments		

Noise Source Parameters		Source 2
	Source Type:	Fixed Guideway
	Specific Source:	Rail Car
Daytime hrs	Avg. Number of Rail Cars/train	8
	Speed (mph)	79
	Avg. Number of Events/hr	1.16
Nighttime hrs	Avg. Number of Rail Cars/train	
	Speed (mph)	
	Avg. Number of Events/hr	
Distance	Distance from Source to Receiver (ft)	305
	Number of Intervening Rows of Buildings	
Adjustments	Noise Barrier?	No
	Jointed Track?	No
	Embedded Track?	No
	Aerial Structure?	No

Project Results Summary

Existing Ldn:	67 dBA
Total Project Ldn:	47 dBA
Total Noise Exposure:	67 dBA
Increase:	0 dB
Impact?:	None

Distance to Impact Contours

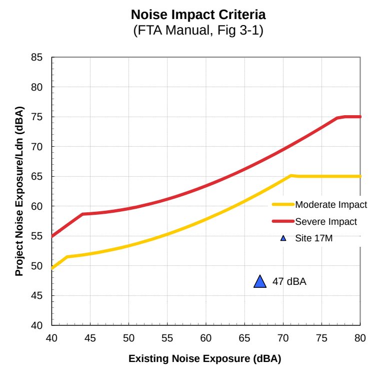
Dist to Mod. Impact Contour (Sources 1+2):	32 ft
Dist to Sev. Impact Contour (Sources 1+2):	14 ft

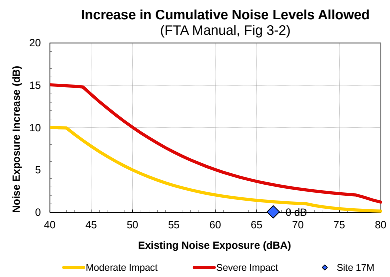
Source 1 Results

Leq(day):	43.3 dBA
Leq(night):	0.0 dBA
Ldn:	41.2 dBA

Source 2 Results

Leq(day):	48.3 dBA
Leq(night):	0.0 dBA
Ldn:	46.2 dBA
Incremental Ldn (Src 1-2):	47.4 dBA





Project:	Point Defiance Bypass Project

Receiver Parameters	
Receiver:	Site 17
Land Use Category:	2. Residential
Existing Noise (Measured or Generic Value):	67 dBA

Noise Source Parameters	
Number of Noise Sources:	2

Noise Source Parameters		Source 1
	Source Type:	Fixed Guideway
	Specific Source:	Diesel Electric Locomotive
Daytime hrs	Avg. Number of Locos/train	1
	Speed (mph)	79
	Avg. Number of Events/hr	1.16
Nighttime hrs	Avg. Number of Locos/train	
	Speed (mph)	
	Avg. Number of Events/hr	
Distance	Distance from Source to Receiver (ft)	760
	Number of Intervening Rows of Buildings	0
Adjustments		

Noise Source Parameters		Source 2
	Source Type:	Fixed Guideway
	Specific Source:	Rail Car
Daytime hrs	Avg. Number of Rail Cars/train	8
	Speed (mph)	79
	Avg. Number of Events/hr	1.16
Nighttime hrs	Avg. Number of Rail Cars/train	
	Speed (mph)	
	Avg. Number of Events/hr	
Distance	Distance from Source to Receiver (ft)	760
	Number of Intervening Rows of Buildings	
Adjustments	Noise Barrier?	No
	Jointed Track?	No
	Embedded Track?	No
	Aerial Structure?	No

Project Results Summary

Existing Ldn:	67 dBA
Total Project Ldn:	41 dBA
Total Noise Exposure:	67 dBA
Increase:	0 dB
Impact?:	None

Distance to Impact Contours

Dist to Mod. Impact Contour (Sources 1+2):	32 ft
Dist to Sev. Impact Contour (Sources 1+2):	14 ft

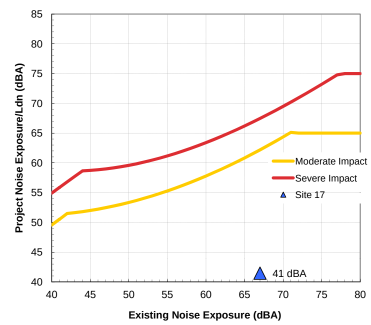
Source 1 Results

Leq(day):	37.3 dBA
Leq(night):	0.0 dBA
Ldn:	35.3 dBA

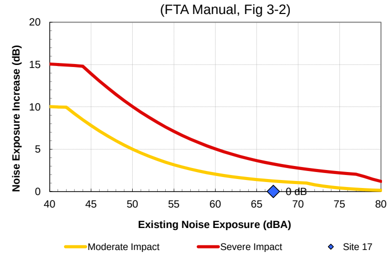
Source 2 Results

Leq(day):	42.3 dBA
Leq(night):	0.0 dBA
Ldn:	40.3 dBA
Incremental Ldn (Src 1-2):	41.5 dBA

Noise Impact Criteria
(FTA Manual, Fig 3-1)



Increase in Cumulative Noise Levels Allowed
(FTA Manual, Fig 3-2)



Project:	Point Defiance Bypass Project

Receiver Parameters	
Receiver:	Site 18
Land Use Category:	2. Residential
Existing Noise (Measured or Generic Value):	66 dBA

Noise Source Parameters	
Number of Noise Sources:	2

Noise Source Parameters		Source 1
	Source Type:	Fixed Guideway
	Specific Source:	Diesel Electric Locomotive
Daytime hrs	Avg. Number of Locos/train	1
	Speed (mph)	79
	Avg. Number of Events/hr	1.16
Nighttime hrs	Avg. Number of Locos/train	
	Speed (mph)	
	Avg. Number of Events/hr	
Distance	Distance from Source to Receiver (ft)	290
	Number of Intervening Rows of Buildings	0
Adjustments		

Noise Source Parameters		Source 2
	Source Type:	Fixed Guideway
	Specific Source:	Rail Car
Daytime hrs	Avg. Number of Rail Cars/train	20
	Speed (mph)	40
	Avg. Number of Events/hr	1.16
Nighttime hrs	Avg. Number of Rail Cars/train	
	Speed (mph)	
	Avg. Number of Events/hr	
Distance	Distance from Source to Receiver (ft)	290
	Number of Intervening Rows of Buildings	
Adjustments	Noise Barrier?	No
	Jointed Track?	No
	Embedded Track?	No
	Aerial Structure?	No

Project Results Summary

Existing Ldn:	66 dBA
Total Project Ldn:	46 dBA
Total Noise Exposure:	66 dBA
Increase:	0 dB
Impact?:	None

Distance to Impact Contours

Dist to Mod. Impact Contour (Sources 1+2):	28 ft
Dist to Sev. Impact Contour (Sources 1+2):	13 ft

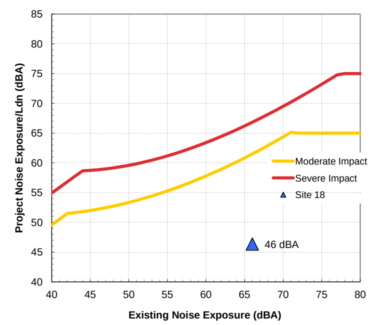
Source 1 Results

Leq(day):	43.6 dBA
Leq(night):	0.0 dBA
Ldn:	41.6 dBA

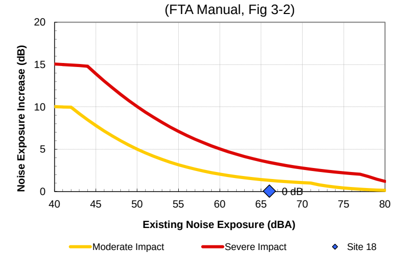
Source 2 Results

Leq(day):	46.7 dBA
Leq(night):	0.0 dBA
Ldn:	44.6 dBA
Incremental Ldn (Src 1-2):	46.4 dBA

Noise Impact Criteria
(FTA Manual, Fig 3-1)



Increase in Cumulative Noise Levels Allowed
(FTA Manual, Fig 3-2)



Federal Transit Administration
Noise Impact Assessment Spreadsheet
Copyright 2007 HMMH Inc.
version: 7/3/2007

Project:	Point Defiance Bypass Project

Receiver Parameters	
Receiver:	Site 19
Land Use Category:	2. Residential
Existing Noise (Measured or Generic Value):	68 dBA

Noise Source Parameters	
Number of Noise Sources:	4

Noise Source Parameters		Source 1
	Source Type:	Fixed Guideway
	Specific Source:	Diesel Electric Locomotive
Daytime hrs	Avg. Number of Locos/train	1
	Speed (mph)	79
	Avg. Number of Events/hr	1.16
Nighttime hrs	Avg. Number of Locos/train	
	Speed (mph)	
	Avg. Number of Events/hr	
Distance	Distance from Source to Receiver (ft)	290
	Number of Intervening Rows of Buildings	0
Adjustments		

Noise Source Parameters		Source 2
	Source Type:	Fixed Guideway
	Specific Source:	Rail Car
Daytime hrs	Avg. Number of Rail Cars/train	8
	Speed (mph)	79
	Avg. Number of Events/hr	1.16
Nighttime hrs	Avg. Number of Rail Cars/train	
	Speed (mph)	
	Avg. Number of Events/hr	
Distance	Distance from Source to Receiver (ft)	290
	Number of Intervening Rows of Buildings	
Adjustments	Noise Barrier?	No
	Jointed Track?	No
	Embedded Track?	No
	Aerial Structure?	No

Noise Source Parameters		Source 3
	Source Type:	Fixed Guideway
	Specific Source:	Locomotive Warning Horn
Daytime hrs		
	Speed	79
	Avg. Number of Events/hr	1.16
Nighttime hrs		
	Speed	
	Avg. Number of Events/hr	
Distance	Distance from Source to Receiver (ft)	550
	Number of Intervening Rows of Buildings	
Adjustments		

Noise Source Parameters		Source 4
	Source Type:	Stationary Source
	Specific Source:	Crossing Signals
Daytime hrs	Signal Duration/hr (seconds)	5
Nighttime hrs	Signal Duration/hr (seconds)	
Distance	Distance from Source to Receiver (ft)	550
	Number of Intervening Rows of Buildings	
Adjustments	Noise Barrier?	No

Project Results Summary

Existing Ldn:	68 dBA
Total Project Ldn:	58 dBA
Total Noise Exposure:	68 dBA
Increase:	0 dB
Impact?:	None

Distance to Impact Contours

Dist to Mod. Impact Contour:	---
Dist to Sev. Impact Contour:	---

Source 1 Results

Leq(day):	43.6 dBA
Leq(night):	0.0 dBA
Ldn:	41.6 dBA

Source 2 Results

Leq(day):	48.6 dBA
Leq(night):	0.0 dBA
Ldn:	46.6 dBA
Incremental Ldn (Src 1-2):	47.8 dBA

Source 3 Results

Leq(day):	59.4 dBA
Leq(night):	0.0 dBA
Ldn:	57.4 dBA
Incremental Ldn (Src 1-3):	57.8 dBA

Source 4 Results

Leq(day):	18.8 dBA
Leq(night):	0.0 dBA
Ldn:	17.1 dBA
Incremental Ldn (Src 1-4):	57.8 dBA