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DuPont West
Noise Study

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Table of Contents

Introduction

This report addresses the issue of noise impacts related to the proposed DuPont West Warehouse/Distribution Center project, which is a proposed light-industrial business park planned for the property located on the north side of the Sequalitchew Creek Trail next to DuPont City Hall, in DuPont, WA. A site plan for the project is presented in Figure 1 on page 2 of this report. The site is bordered on the north by undeveloped woods for future residential development), on the east by an existing apartment complex, and on the south and west by the Sequalitchew Creek Trail. The project site and the property north of the site is zoned MRP (manufacturing and research). The property to the west (existing apartments) is zoned R12, and the property to the south and west is zoned OS (open space, sensitive area). From an environmental noise perspective, the primary areas with a potential noise impact are the Sequalitchew Creek Trail and the apartment complex to the east.

Noise Standards

Noise is always present in the environment. Noise is generated by both natural phenomena (e.g. wind, water flowing in a stream or river) and by man-made machinery (e.g. motor vehicles, aircraft, ventilation fans). Noise can have both positive and negative impacts on the environment. The steady sound of a distant waterfall or a quiet fan can provide a soothing background noise to promote sleep and/or "mask" other annoying sounds that may be in the environment. Sounds that are too loud, too abrupt, or simply unwanted (e.g. music from someone else's property) may disrupt sleep, impede speech communication, or simply create annoyance.

The level (which is proportional to loudness as perceived by humans) of environmental noise is typically measured in terms of A-weighted decibels, abbreviate dBA. Most outdoor environments have noise levels that fall into the 30 to 100 dBA range. Occasionally you will find noise levels outside this range, but it is a very rare occurrence. A noise level of 0 dBA is the approximate threshold of human hearing. Noise at or below this level exists only inside specially designed acoustical test chambers. At the other extreme: the approximate threshold of pain for most humans is 120 dBA. The noise of gunfire at close range can exceed this level for a brief period of time. A level above 120 dBA is also typical of a military jet engine during take-off, if the listener is within 100 feet of the aircraft. Table 1 presents a summary of typical sound levels associated with various sources of noise.

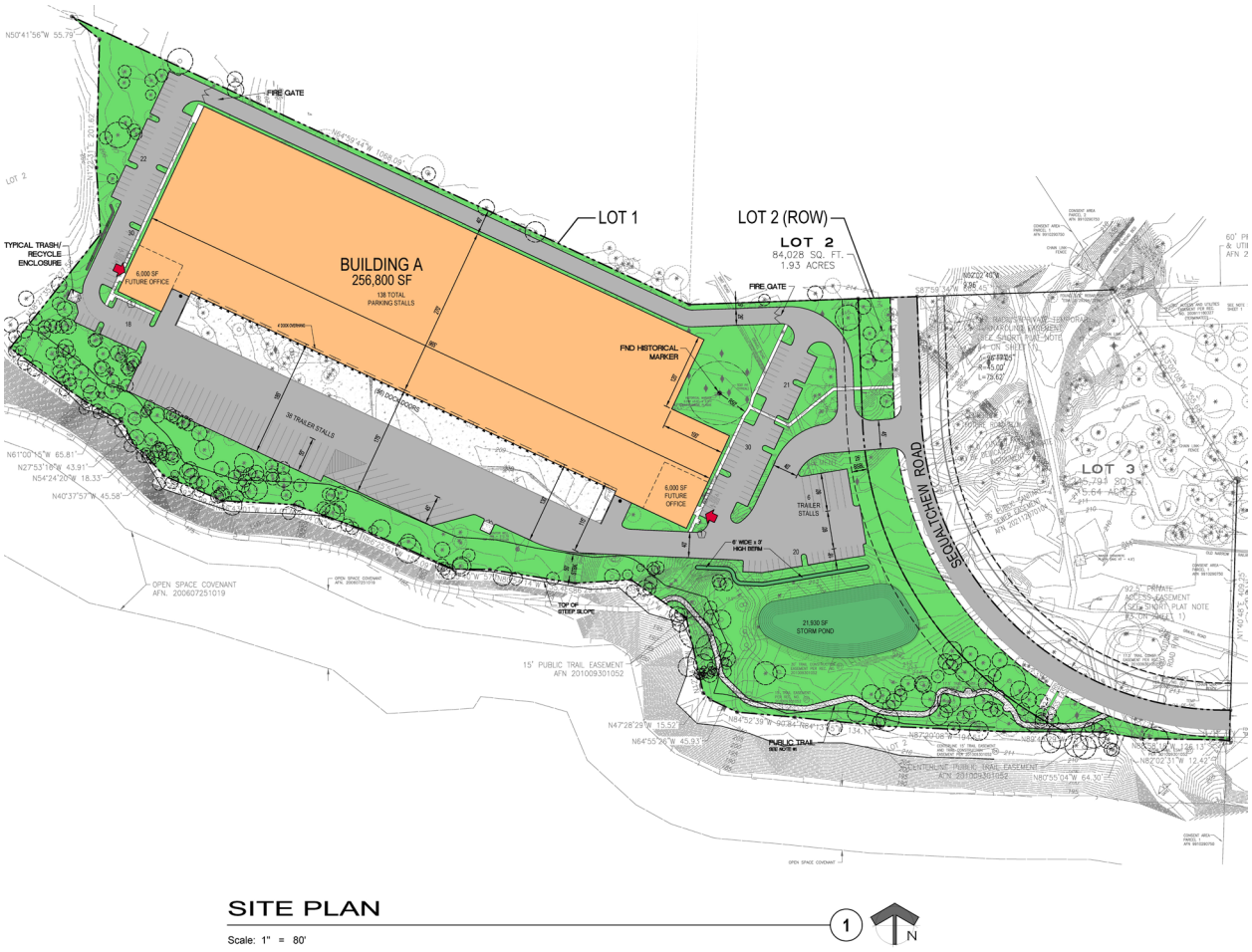


Figure 1. Project site plan.

Table 1. Typical Sound Levels

Noise Source	Distance (feet)	Noise Level (dBA)
Military Jet @ Takeoff	100	100 to 120
Chain Saw	5	90 to 100
Heavy Truck @ 50 mph	50	80 to 90
Automobile @ 50 mph	50	65 to 75
Normal Speech	5	55 to 65
Indoor Air-Conditioner	5	45 to 55
Refrigerator	5	35 to 45
Ticking Clock	5	25 to 35

It is also important to understand the importance of a change in noise level, particularly when evaluating noise impacts. In general, it takes an increase of 10 dBA to create a perceived doubling of the loudness of a noise. This relationship applies to all types of noise (except for very low frequency noise). Therefore, increasing the level of noise from 40 dBA to 50 dBA would be perceived as a doubling of the loudness, as would an increase from 78 dBA to 88 dBA. Conversely, reducing a given noise level from 94 dBA to 84 dBA would be perceived as a 50% reduction in the loudness. A 5 dBA increase or decrease is generally perceived as clearly noticeable and significant. A change in level of only 1 dBA is generally too small to be detected, except under very special (laboratory-like) conditions. In general, it takes a 3 dBA change to be noticed by the casual listener, unless the "character" or "quality" of the sound is changed significantly.

In general, the noise level at any location is almost never constant. The noise level will typically fluctuate with time and location. However, when averaged over a significant time period (e.g. several minutes or an hour), most outdoor environments will exhibit a reasonably steady noise level. The most significant outdoor noise level statistic is the average noise level, abbreviated L_{eq} (which stands for equivalent sound level). The L_{eq} is defined as the steady (constant) sound level that has the same total acoustic energy as the actual time-varying sound level. The L_{eq} can be measured over any time interval, but usually an interval somewhere in the range of 1 second to 1 hour is used. Other important noise level statistics include the L_{max} (which is the maximum sound level during an interval of time), the L_{min} (which is the minimum sound level during an interval of time), and the L_{90}. The L_{90} is a statistic defined as the sound level that is exceeded 90% of the time interval (i.e. the noise level is below the L_{90} value only 10% of the time interval). It is usually controlled by noise sources very far from the measurement location. The L_{90} is often called the "background noise level" as opposed to the ambient noise level (which includes all noise sources, both near and far).

There is one other important noise level statistic that must be mentioned: the day-night sound level, abbreviated L_{dn} or DNL. The L_{dn} is a 24-hour average noise level (with a built-in penalty of 10 dB for nighttime noise) that is most often used in reference to land use compatibility. In terms of DNL or L_{dn}, nighttime is defined as 10 PM to 7 AM. By convention, the day-night sound level is expressed in units of dB (not dBA like L_{eq} or L_{max}) even though the measured values are A-weighted decibels. Most federal government noise guidelines are defined in terms of the L_{dn} statistic. For example, in 1972 the U.S. Environmental Protection Agency identified an L_{dn} of 55 dB as the maximum recommended outdoor ambient noise level for residential areas to protect the health and safety of the general public with an adequate margin of safety[1]. The EPA standard is only a guideline – it is not regulatory. In fact, the same report admitted that over 50% of the U.S. population, living in urban areas, does not meet this sound level.

[1] Protective Noise Levels, U.S. Environmental Protection Agency Report No. 550/9-79-100, 1978.

The U.S. Department of Housing and Urban Development (HUD) has identified an L_{dn} of 65 dB as the maximum allowable exterior noise level recommended for residential development. If a building site exceeds an L_{dn} of 65 dB, then special noise mitigating measures should be included in the design to further control noise. According to HUD, residential development should be seriously discouraged at sites where the existing L_{dn} is above 75 dB, regardless of the special noise control measures that are implemented.

The Federal Highway Administration (FHWA) has slightly different noise standards that relate specifically to highway noise. The FHWA has identified an average (L_{eq}) noise level of 67 dBA, measured over a one-hour period (typically during peak traffic flow), as the threshold of acceptance. For example, the FHWA will not fund highway noise barriers to reduce traffic noise in residential neighborhoods unless the peak hour L_{eq} is above 67 dBA. There are also other factors related to the construction of noise barriers (including number of residents impacted, construction feasibility, availability of funds, etc.), but the first requirement is a peak hour L_{eq} greater than 67 dBA.

City of DuPont Noise Ordinance

Chapter 9.09 of the DuPont Municipal Code contains the maximum allowable noise levels which will regulate this project. The DuPont noise level limits are the same as those in the Washington State Noise Ordinance (WAC 173-60). The maximum allowable noise level depends upon the zoning of the source and receive properties. The proposed development is on property zoned MRP, which is considered a commercial zone (Class B EDNA from the noise ordinance), and the receiving properties range from Class B to the north to Class A to the east, south, and west. With these current zonings, the maximum allowable continuous sound level on the Class B property to the north is 60 dBA. The maximum allowable continuous sound level on the Class A properties to the east, south, and west is 57 dBA during the day and 47 dBA during the nighttime (10 PM to 7 AM). The noise ordinance also allows the noise level to exceed these limits, but only for limited durations. If the cumulative duration of the noise does not exceed 15 minutes per hour the allowable noise level is 5 dBA higher than the continuous (steady) limit. If the cumulative duration of the noise does not exceed 5 minutes per hour the maximum allowable noise level is 10 dBA higher than the steady-level limit, and if the cumulative duration of the noise does not exceed 1.5 minutes per hour the maximum allowable noise level is 15 dBA higher than the steady level limit. Table 2 summarizes the maximum allowable noise levels from the proposed project at the residential properties on the south side of Center Drive. It is important to remember than noise from all traffic on public roa ds as well as aircraft noise is exempt from the noise ordinance. It is also important to note that the absolute maximum allowable noise level (even for time periods less than 1 second) is 75 dBA on Class B receiving property and 72 dBA during the day and 62 dBA at night on Class A receiving property.

Table. 2. Maximum allowable project noise levels at receiving properties

Receive Property	Steady Noise	< 15 minutes/hr	< 5 minutes/hr	< 1.5 minutes/hr
Class B	60	65	70	75
Class A (day)	57	62	67	72
Class A (night)	47	52	57	62

Note that many noise sources are exempt from the noise level limits specified in the noise ordinance, including but not limited to:

- Motor vehicles operating on public streets and highways,
- Aircraft in flight,
- Surface carriers engaged in interstate commerce by railroad, and
- Emergency equipment, including warning devices (e.g., backup beepers).

This means that motor vehicles on public streets are exempt from the noise ordinance limits, but once these vehicles enter onto private property, they must comply with the noise limits listed above. Also, note that warning devices, which includes back-up beepers are also exempt from the noise ordinance limits.

Existing Noise Levels

Environmental noise in the vicinity of this project is impacted primarily from traffic on Center Drive, aircraft flyovers from JBLM, and people walking the Sequalitchew Creek Trail. Other sounds noted in the area are birds, the sound of wind blowing through the trees, and the sound of water flowing in Sequalitchew Creek. Noise from emergency vehicles entering and leaving the fire and police stations near City Hall are also likely to be heard, although not noted during my time on site.

Measurements of existing ambient noise were collected at 3 different locations in the vicinity of the proposed project from 3 PM on Sunday, April 8, 2019 through 3 PM on Tuesday, April 30, 2019. Figure 2 presents an aerial view showing the location of each noise measurement. Position 1 was located 5 feet above grade at the northwest corner of the property line adjacent to the existing apartment complex. Position 2 was located 5 feet above existing grade near the proposed new trail approximately 350 feet southwest of the proposed warehouse building. Position 3 was located 5 feet above grade on the south side of the existing paved Sequalitchew Creek Trail approximately 665 feet past the posted 0.25 mile marker.

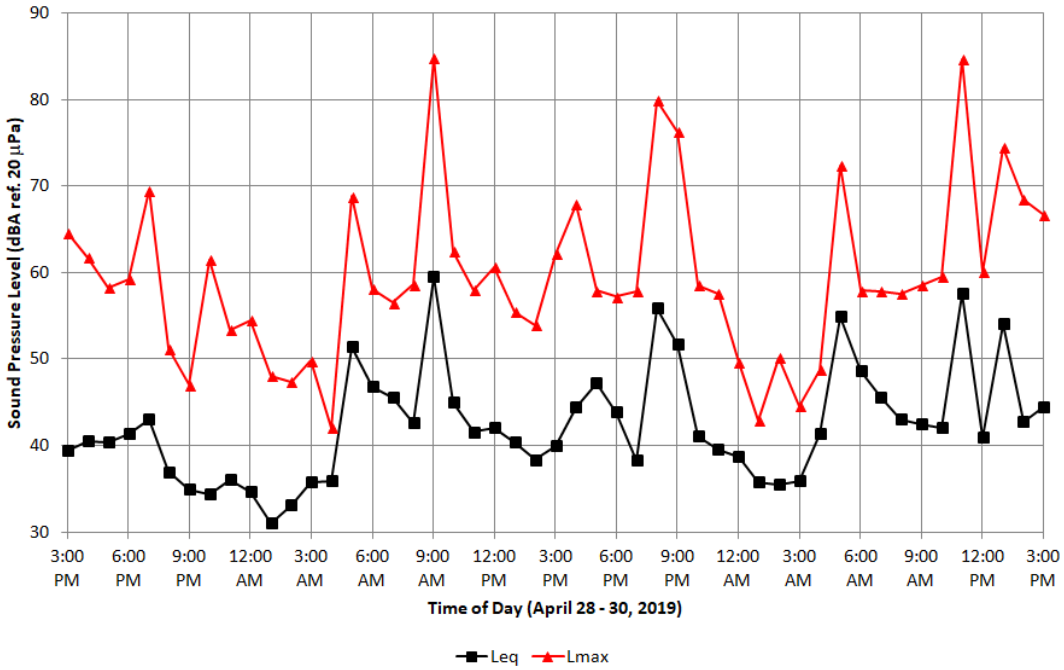
Three different instruments were used to collect the data. The instrument at Position 1 was a Bruel & Kjaer model 2238 data logging sound level meter. The instrument used at Position 2 was a Bruel & Kjaer model 2250 sound level meter running the BZ-7224 logging software. The instrument used at Positions 3 was a Larson Davis model 700 data logging sound level meter.

Figure 2. Aerial view of project site showing noise monitoring locations.

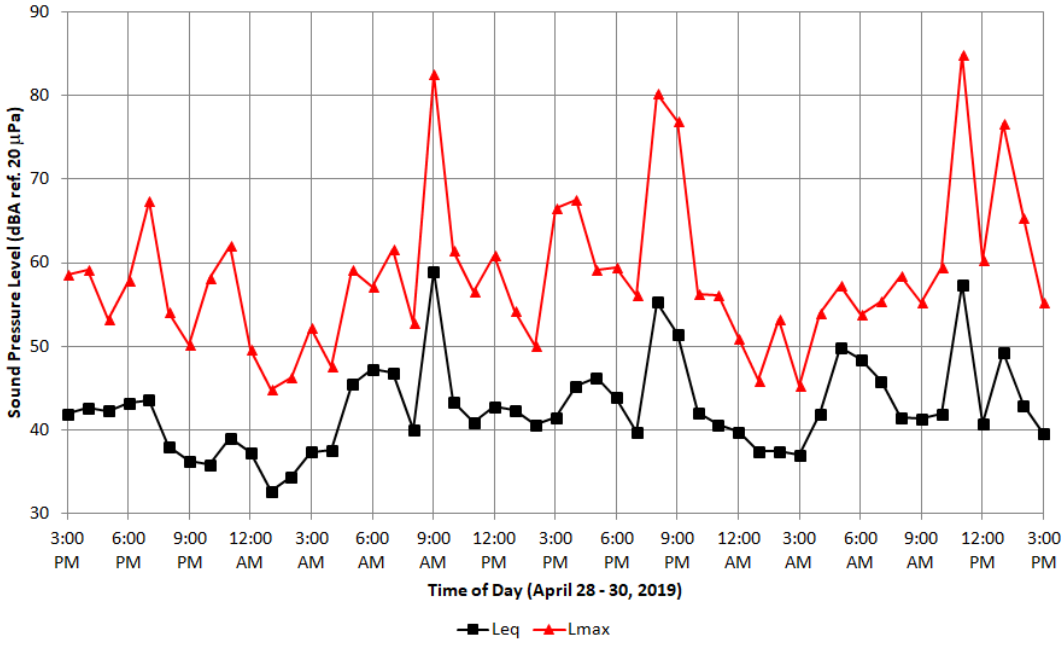
All three instruments were calibrated with the same Bruel & Kjaer model 4230 portable calibrator, and the internal clocks in each instrument were synchronized prior to starting the measurements so the sound level results could be correlated in time. All three microphones were covered with a foam windscreen for all measurements. Weather conditions during the measurements were excellent with no precipitation, warm temperatures, and little wind.

Figure 3 presents the measured hourly average and maximum ambient noise levels at Position 1 during the 2-day measurement period. The hourly average (L_{eq}) noise level was usually between 30 dBA and 50 dBA, with the exception of a few hours when military aircraft flew over the site, causing the maximum noise levels (L_{max}) to exceed 70 dBA. Note that the hourly average (L_{eq}) noise levels were below 40 dBA and the hourly maximum (L_{max}) noise levels were below 60 dBA during the nighttime hours of 11 PM and 4 AM. The overall day-night sound level (L_{dn}) for the two day measurement period was 52.8 dB. Figures 4 and 5 present the same test results from Position 2 and 3, respectively. Note that all 3 locations show high L_{max} sound levels on Monday during the 9 AM and 8 PM hours, and Tuesday morning during the 11 AM and 1 PM hours. This noise is caused by military aircraft flying over or near the site. Position 3 experienced high sound levels (above 70 dBA L_{max}) during the 3 PM, 4 PM, and 5 PM hours on Sunday, and the 1 PM, 2 PM, and 5 PM hours on Monday. This noise was generated by people using the trail.

DuPont Industrial Partners Warehouse
Figure 3. Hourly ambient noise statistics at Apartment Complex (Position 1)
(Ldn = 52.8 dB)



DuPont Industrial Partners Warehouse
Figure 4. Hourly ambient noise statistics new trail (Position 2)
(Ldn = 47.6 dB)



DuPont Industrial Partners Warehouse
Figure 5. Ambient noise on Sequalitchew Creek Trail (Position 3)
(Ldn = 53.3 dB)

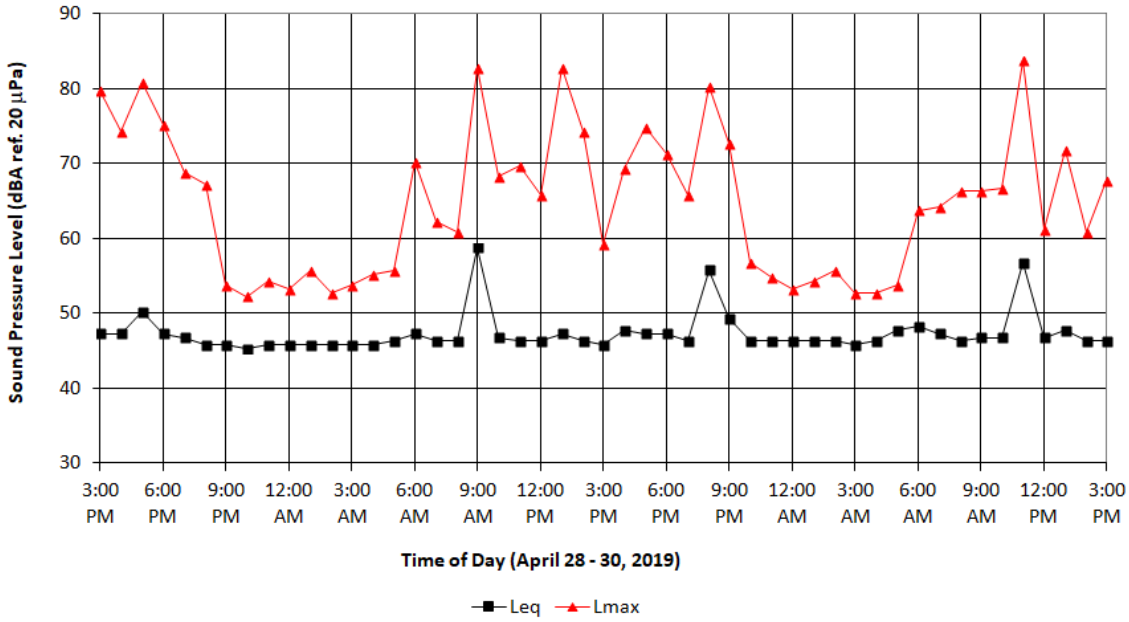


Table 3 presents a summary of the measured ambient noise level statistics at the 3 ambient noise measurement locations. Note that all 3 locations exhibit day-night average sound levels (L_{dn}) below the EPA recommended guideline of 55 dB. The daytime average sound level (L_{eq}) is remarkably uniform between the 3 measurement locations, with a range of only 1 dBA and an average level of 49.4 dBA. During the nighttime hours (10 PM to 7 AM) there is a little more variation between the 3 locations, with a range of 3.4 dBA and an average value of 45 dBA. The daytime hourly average maximum level (L_{max}) is much higher at Position 3 than Positions 1 and 2, because people walking the trail come within 10 feet of the microphone as they pass by. Groups of teens were noticed as being quite noisy as they walk along on the trail.

Table 3. Measured ambient noise level statistics.

Noise Level Statistic	Pos. 1	Pos. 2	Pos. 3
Average Day-Night Level, L_{dn} (dB)	52.8	47.6	53.3
Average Daytime L_{eq} (dBA)	49.4	48.9	49.9
Average Nighttime L_{eq} (dBA)	45.5	43.0	46.4
Average Daytime L_{max} (dBA)	62.9	61.8	70.0
Average Nighttime L_{max} (dBA)	53.7	52.8	55.7

There are several potential new sources of environmental noise that will be associated with the proposed project. The most notable are the delivery trucks and automobiles that will frequent the site. As mentioned above, noise generated by motor vehicles entering and leaving the site are exempt from the noise ordinance sound level limits while they are operating on public streets and highways. However, once on private property all noise sources (except for back-up beepers and emergency vehicles) must comply with the noise level limits specified in the noise ordinance.

In addition to vehicles entering and leaving the site, there will also be mechanical and electrical equipment serving the building. At the present time there are no specific plans for this equipment, but noise from this equipment is easily controlled by selecting quiet units and locating them far enough from the property lines so as not to be a concern. In most cases, warehouse buildings are not air-conditioned, so the mechanical units are often only small ventilation fans that would not be audible beyond the perimeter of each building. If certain areas are upgraded to include typical office space with air-conditioning, it is not difficult to design these systems so that they will comply with the noise ordinance (taking into consideration the other noise sources associated with the project) and not become an annoyance to the neighbors.

Predicted Site-Generated Noise Levels

The expected noise levels that will be generated by the proposed project have been computed using the computer model CadnaA (ver. 2022). Noise levels were calculated at 20 selected off-site locations. These locations include ambient noise measurement Positions 1, 2, and 3, plus calculated receiver Positions T1 through T16 (shown in Figure 6), which represent locations along the new Sequalitchew Creek Trail, and at the north property line near the center of the warehouse building (Position 4).

Table 4 summarizes the expected hourly truck and automobile volume as a function of the hour of the day. The average daily traffic (ADT) volumes were obtained from Table 3 of the traffic study[2], titled Project Trip Generation. These values represent an average for all days of the week. It turns out that some days of the week are busier than others, and according to the Texas Transportation Institute[3], Wednesdays and Thursdays are the busiest days of the week, each with 118% of the average daily traffic volumes. Sunday is the lightest day of the week, averaging only about 72% of the weekly average. In order to assess the worst-case condition, all noise calculations in this report are based on Wednesday or Thursday traffic volumes, which are 18% higher than the average daily values presented in Table 3 of the traffic study. The worst case total daily truck and automobile volumes are 180 and 366, respectively.

[2] DuPont Industrial Traffic Impact Analysis, Heath & Associates, Inc., October 2022
[3] Trip Generation, 9th Edition, Institute of Transportation Engineers

Project noise levels were calculated for the worst-case hour 6 AM, which has the highest truck traffic volume of any hour of the day. Noise levels during any other hour of the day would be lower, because of lower traffic volumes. In addition to trucks and automobiles moving on the site, the noise analysis also assumes eight trucks idling (15 minutes per hour) at the loading dock, two trucks idling (15 minutes per hour) at the new 21-trailer parking stall area, plus four HVAC rooftop units that could be exhaust fans or self-contained air conditioning units operating continuously on the roof of the building. Each rooftop unit has an assumed A-weighted sound power level of 90 dB (ref. 1 picowatt). The overall A-weighted sound power level of each of the moving delivery trucks is 100 dB (ref. 1 picowatt), and the assumed overall A-weighted sound power level of each automobile is 80 dB (ref. 1 picowatt). The noise level contours in Figure 6 represent the hourly average (L_{eq}) project noise level, ranging from 40 dBA to 60 dBA.

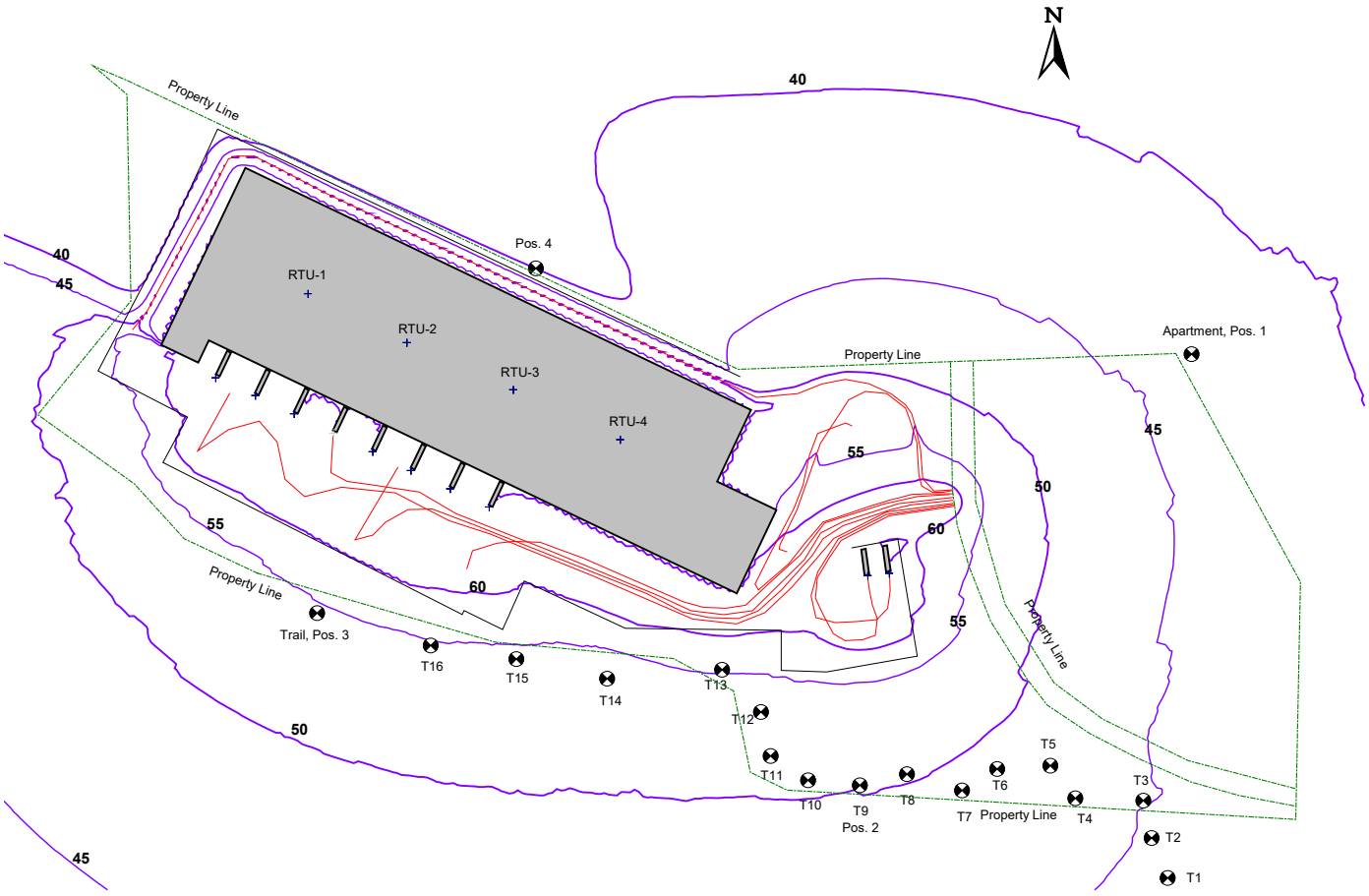


Figure 6. Noise level contours (dBA) and receiver locations for the 6 AM hour. Noise contours are evaluated at an elevation that is 5 feet above the pavement elevation at the loading docks.

Table 4. Projected average daily traffic volume entering and leaving site by hour.

Start Time	Inbound	Outbound	Trucks In	Trucks Out	Autos In	Autos Out
12:00 AM	1.0%	1.0%	0.90	0.90	1.83	1.83
1:00 AM	1.0%	2.0%	0.90	1.80	1.83	3.66
2:00 AM	1.0%	3.0%	0.90	2.70	1.83	5.49
3:00 AM	1.0%	6.0%	0.90	5.40	1.83	10.98
4:00 AM	3.0%	2.0%	2.70	1.80	5.49	3.66
5:00 AM	5.0%	1.0%	4.50	0.90	9.15	1.83
6:00 AM	20.0%	2.0%	18.00	1.80	36.60	3.66
7:00 AM	4.0%	3.0%	3.60	2.70	7.32	5.49
8:00 AM	3.0%	3.0%	2.70	2.70	5.49	5.49
9:00 AM	3.0%	3.0%	2.70	2.70	5.49	5.49
10:00 AM	4.0%	4.0%	3.60	3.60	7.32	7.32
11:00 AM	4.0%	4.0%	3.60	3.60	7.32	7.32
12:00 PM	4.0%	5.0%	3.60	4.50	7.32	9.15
1:00 PM	5.0%	5.0%	4.50	4.50	9.15	9.15
2:00 PM	5.0%	5.0%	4.50	4.50	9.15	9.15
3:00 PM	6.0%	7.5%	5.40	6.75	10.98	13.73
4:00 PM	6.0%	8.0%	5.40	7.20	10.98	14.64
5:00 PM	10.0%	11.5%	9.00	10.35	18.30	21.05
6:00 PM	3.0%	7.5%	2.70	6.75	5.49	13.73
7:00 PM	2.5%	7.5%	2.25	6.75	4.58	13.73
8:00 PM	2.5%	4.0%	2.25	3.60	4.58	7.32
9:00 PM	2.5%	2.5%	2.25	2.25	4.58	4.58
10:00 PM	2.0%	1.5%	1.80	1.35	3.66	2.75
11:00 PM	1.5%	1.0%	1.35	0.90	2.75	1.83
Total ADT	100.0%	100.0%	90	90	183	183

It is important to note that the busiest hours of the day are the 6 AM and 5 PM hours, with those two hours accounting for nearly half (43.5%) of the total daily traffic. From a noise perspective, the 6 AM hour is the most troublesome because that hour is included in the nighttime hours for noise ordinance compliance and calculating noise impact using the day-night sound level (L_{dn}). In this study it is assumed that all trucks are traveling at 10 mph and all cars are traveling at 20 mph while on site.

Noise Ordinance Compliance

As mentioned previously, the DuPont Municipal Code specifies that the maximum allowable noise level generated by activities on the proposed project site must not exceed 57 dBA during the day and 47 dBA at night at nearby Class A properties. On Class B properties (the property

north of the site) the limit is 60 dBA (day or night). Noise levels are allowed to exceed these levels for short periods of time as specified in Table 2 of this report.

Table 5 presents the predicted project generated average and maximum noise levels at each of the 20 receiver locations. Note that the Trail Receivers P2 and T3 through T13 (these rows are shaded in Table 5) are on the source property and therefore not subject to the noise ordinance limits. The predicted hourly average (L_{eq}) and hourly maximum (L_{max}) noise levels from the CadnaA model are all within the limits specified by the noise ordinance (both day and night) for all receivers located off-site, except for the portion of the Sequalitchew Creek Trail near T14 where the average (L_{eq}) noise is expected to exceed the 47 dB nighttime limit by 2.7 dBA. This, however, is not a violation of the noise ordinance because the sound level is allowed to exceed the specified limit by no more than 5 dBA for up to 15 minutes per hour. The predicted total duration over 47 dBA at T14 is only 10.33 minutes. The Table 5 values shown in black **bold** exceed the limits, but these locations are on-site, and are not subject to the noise ordinance.

Table 5. Predicted project noise ordinance compliance statistics (6 AM nighttime hour).

Receiver Location	Night L_{eq} (6 AM)	Night L_{max} (6 AM)	Time Over Ordinance Level	Time Over Ordinance Level + 5 dBA	Time Over Ordinance Level + 10 dBA
P1	43.6	47.4	0.48 min	0 sec	0 sec
P2	49.5	53.4	9.52 min	2.9 sec	0 sec
P3	41.6	50.4	0.32 min	0 sec	0 sec
P4	40.0	49.3	0.81 min	0 sec	0 sec
T1	43.7	44.2	0.0 min	0 sec	0 sec
T2	44.4	45.2	0.0 min	0 sec	0 sec
T3	44.9	46.3	0.0 min	0 sec	0 sec
T4	46.4	47.2	0.06 min	0 sec	0 sec
T5	47.5	48.4	2.33 min	0 sec	0 sec
T6	48.3	48.4	3.05 min	0 sec	0 sec
T7	48.2	49.5	4.69 min	0 sec	0 sec
T8	49.2	51.7	9.77 min	0 sec	0 sec
T9	49.5	53.4	9.52 min	2.9 sec	0 sec
T10	50.3	53.0	11.31 min	4.4 sec	0 sec
T11	50.6	53.3	12.08 min	14.2 sec	0 sec
T12	51.5	54.9	12.47 min	**5.66 min**	0 sec
T13	53.5	61.7	11.13 min	**6.62 min**	**3.6 min**
T14	49.7	54.8	10.33 min	2.51 min	0 sec
T15	46.1	49.1	7.35 min	0 sec	0 sec
T16	43.6	49.1	0.19 min	0 sec	0 sec
Max Time Above	**47**	**62**	**15 min.**	**5 min.**	**1.5 min.**

Noise Impact Analysis

Noise generated by this or any new project will radiate additional noise to the surrounding environment. A noise impact analysis compares the anticipated project noise with the existing ambient noise. This analysis is independent from the noise ordinance compliance analysis, and unlike the noise ordinance, all noise sources (including vehicles traveling on public roads and emergency vehicles) must be included. The most important sound level statistics for a noise impact analysis are the average daytime and nighttime L_{eq}, the L_{max}, and the L_{dn}.

In this project the maximum project noise level in any hour is caused by trucks entering and leaving the facility. Trucks and automobiles moving on the Sequalitchew Drive are assumed to be moving at 25 mph. While on site, the trucks are assumed to be moving at 10 mph and automobiles at 20 mph. As in the noise ordinance compliance analysis, the rooftop HVAC units are assumed to be operating continuously, 24 hours per day. Table 6 presents the results of the noise impact analysis for the 3 receiver locations where ambient noise measurements were taken, plus one additional location at the north property line (P4). Because P1 is closest to P4, this analysis assumes that the ambient statistics for P1 (the apartments) are the same as P4.

Table 6. Predicted project noise impact analysis at 4 receiver locations (dBA)

	P1	P2	P3	P4
Project Day L_{eq}	40.8	47.4	40.7	36.8
Ambient Day L_{eq}	49.4	48.9	49.9	49.4
Future Day L_{eq}	50.0	51.2	50.4	49.6
Day L_{eq} Increase	0.6	2.3	0.5	0.2
Project Night L_{eq}	38.8	45.4	38.7	34.8
Ambient Night L_{eq}	45.5	43.0	46.4	45.5
Future Night L_{eq}	46.3	47.4	47.1	45.9
Night L_{eq} Increase	0.8	4.4	0.7	0.4
Project Day L_{max}	44.6	54.8	52.5	50.7
Ambient Day L_{max}	62.9	61.8	70.0	62.9
Future Day L_{max}	62.9	61.8	70.0	62.9
Day L_{max} Increase	0.0	0.0	0.0	0.0
Project Night L_{max}	44.6	54.8	52.5	50.7
Ambient Night L_{max}	53.7	52.8	55.7	53.7
Future Night L_{max}	53.7	54.8	55.7	53.7
Night L_{max} Increase	0.0	2.0	0.0	0.0
Project L_{dn}	38.9	45.5	38.8	34.9
Ambient L_{dn}	52.8	47.6	53.3	52.8
Future L_{dn}	53.0	49.7	53.5	52.9
L_{dn} Increase	0.2	2.1	0.2	0.1

When assessing noise impacts the obvious question that always arises is how much of a noise level increase is acceptable. The U.S. Federal Transit Authority[4] has established a criterion based on the average day-night noise level (L_{dn}) that has been widely accepted for many years in assessing the impacts of transit projects on residential receiving properties. As illustrated in Figure 7, the allowable increase in the L_{dn} is primarily dependent upon the pre-existing L_{dn} at the receiver location. As evidenced from Table 6 the predicted project Ldn is below 40 for receiving locations P1, P3, and P4, so they are well below the no impact criterion. The projected Ldn for P2 is 45.5 with an existing Ldn of 47.6 which puts it clearly in the no impact area of the graph.

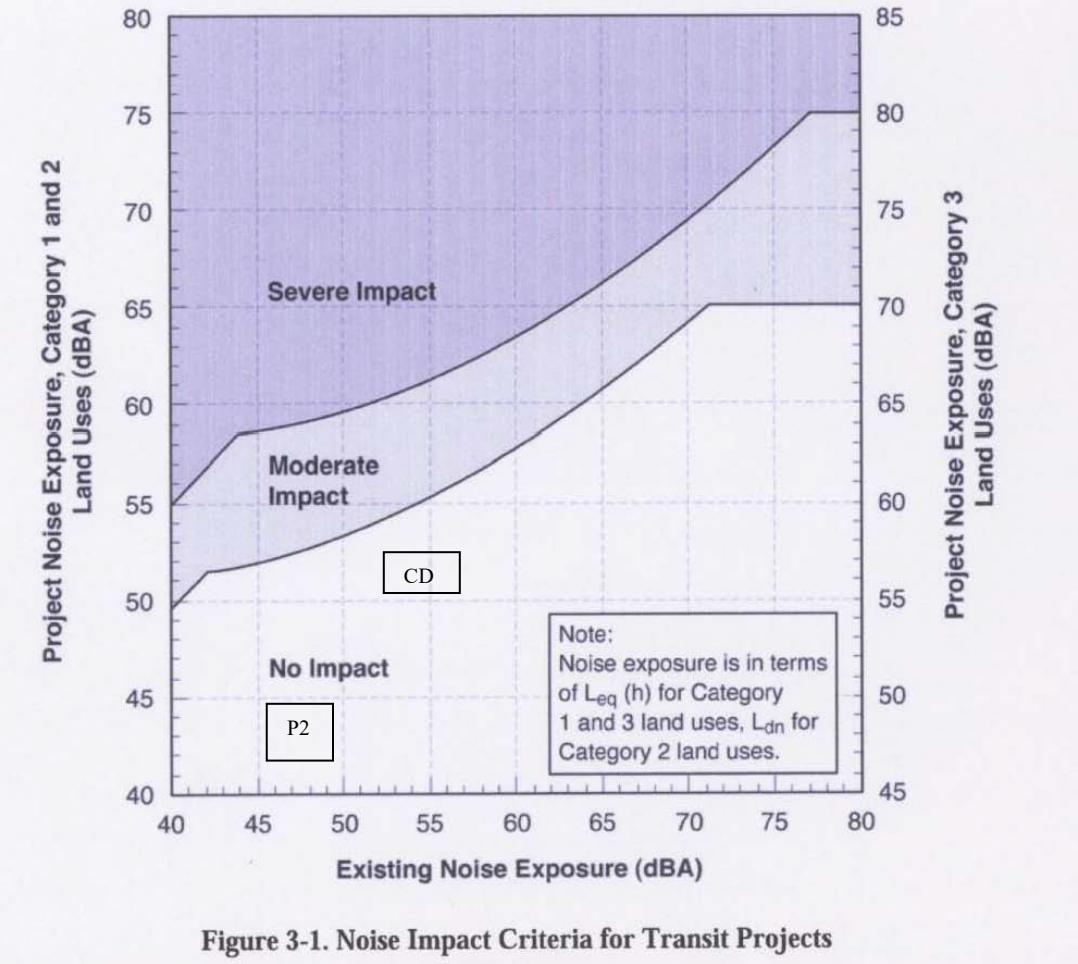


Figure 7. FTA Noise Impact Criteria showing the expected noise impacts.

[4] Federal Transit Authority in the Transit Noise and Vibration Impact Assessment (FTA-VA-90-1003-06, May 2006.

The other noise impact that should be addressed is the impact of the additional truck traffic on the residential properties adjacent to Center Drive between the DuPont Steilacoom Road and the project access road, Sequalitchew Drive. While ambient noise measurements along Center Drive were not taken for this project, ambient noise measurements were taken in 2017 along Center Drive, approximately ½ mile from the DuPont Steilacoom Road for another warehouse project. The results of those measurements revealed that the ambient L_{dn} at the existing 90 ft. setback from the nearest lane was 54.7 dB. The calculated L_{dn} from the traffic associated with this project is 51.2 dB at this same location assuming a vehicle speed of 35 mph. The predicted future L_{dn} (ambient + project) is 56.3 dB, which is an increase of 1.6 dB in the L_{dn}. This is shown as the mark CD in Figure 7, which is clearly identified as no noise impact.

Impulsive Noise Sources

In addition to the noise generated by trucks, automobiles, and rooftop HVAC equipment, the project will also occasionally generate impulsive sounds that may be heard off-site. These sounds include the abrupt release of air pressure associated with the air brakes on tractor trailers, and the sound of backup beepers found on most trucks. These sounds typically last less than 1 second, but can be loud enough to be heard off-site. In the case of the standard backup beeper, the pulsing tone is typically at a single frequency above 1,000 Hz at a level of approximately 100 dB (ref. 1 picowatt). Although each pulse of sound is brief, it is repetitive – often lasting for several seconds. The pulsing tonal feature of this sound is such that it can be audible at distant locations even if the maximum level of the beeper is below the ambient noise level. When the air pressure in the air brake system is abruptly released after the truck comes to a stop, it typically generates an impulsive, broad-band sound level of approximately 120 dB (ref. 1 picowatt), which is about 20 dBA louder than a conventional backup beeper. Because this sound is broadband, it generally cannot be heard at sound levels below the ambient noise level.

Table 7 presents the predicted maximum sound levels of a standard backup beeper and a standard air brake release from trucks accessing the loading docks on the south side of the warehouse building. Note that noise levels are very low at P1 and P4 because these receive locations are shielded by the warehouse building from the impulsive noise sources. Noise levels at receiving locations south of the warehouse building are much higher due to the close proximity and the reflection of sound off the south face of the warehouse building. Note that the predicted maximum sound levels from these impulsive sources are all less than the existing 6 AM L_{max} measured at Position 3 on the trail (see Figure 5 on page 8 of this report).

Table 7. Predicted maximum sound levels of impulsive noise sources (dBA)

Impulsive Source	P1	P2	P3	P4	T10	T13	T15
Backup Beeper at Loading Dock, L_{max}	13.0	39.0	34.9	15.7	39.2	38.6	38.7
Air Brake Release at Loading Dock, L_{max}	30.8	63.1	55.4	42.1	63.8	63.4	61.2
6 AM Hour Ambient, L_{max}	58.1	57.2	70.3	N/A	N/A	N/A	N/A

Construction Noise

There will be some additional noise generated by this project during the construction phase. Noise will be generated by earth moving equipment to grade the site, and dig the foundations for each building. Noise will also be generated by construction equipment including concrete trucks, portable generators, delivery vehicles, and power tools. During the framing process there will be noise generated by construction workers using power tools, hammers, and portable radios. Noise from these construction activities is very similar to that found during the construction or remodel of any single-family residence in a residential development.

Construction noise levels at the nearest receiver locations could be as high as 70 dBA (L_{eq}) and 85 dBA (L_{max}) during construction hours when activity is close to the property lines. This is a worse case scenario. Noise levels will be at least 10 dBA lower than these levels during most of the construction period when activity is farther from the apartments and the trail. Noise from construction work is exempt from the noise ordinance during the daytime hours. Construction work is likely to be limited to daytime hours only (7:00 am to 6:00 pm), so there should be no violations of the noise ordinance during construction.

Summary & Noise Mitigation

This study has shown that the noise impacts of this project will be negligible on all surrounding properties when evaluated against FTA noise criteria. The study has also shown that the operational noise of the proposed project will meet the requirements of the DuPont Noise Ordinance during all hours of the day on all adjacent properties.

Even though the project is expected to be in compliance with the DuPont noise ordinance and no significant noise impacts are expected, the following additional noise mitigation measures are recommended to further reduce project noise levels off-site:

1. **Air Brake Release Silencers**. Small, inexpensive pneumatic silencers are available (e.g., Allied Witan Company) for reducing the noise level created by the pressure release of air brake systems. These devices typically weigh less than 2 pounds and can reduce impulsive sound levels from air brakes as much as 20 dBA.

2. **Broadband Backup Alarms**. Broadband backup alarms are now becoming more commonplace in replacing conventional backup beepers. These warning devices generate approximately the same sound level as the conventional pulsing tonal beepers, but because they are not tonal, they cannot be heard at distances where the sound level of the warning device is less than the ambient noise level. If trucks accessing this facility were equipped with broadband backup alarms (e.g., BBK-TEK) it would be very unlikely that users of the trail or tenants in the apartment complex would complain about noise from these warning devices.