NOISE IMPACT ANALYSIS FOR UNIVERSITY STATION

WESTWOOD, MASSACHUSETTS

February 2013

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NOISE IMPACT ANALYSIS FOR
UNIVERSITY STATION
WESTWOOD, MASSACHUSETTS

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1.0 EXECUTIVE SUMMARY

The objective of this study is to determine whether the operation of the proposed University Station project (herein referred to as the Project) in Westwood, Massachusetts will comply with the Massachusetts Department of Environmental Protection (MassDEP) Noise Policy. Although the Project is exempt from the Zoning Bylaw noise limits, the acoustic modeling results for the roof-top mechanical equipment and loading dock areas were also compared to those Zoning Bylaw limits, for informational purposes only.

University Station will have approximately 2.1 million gross square feet (sf) of development consisting of retail, office, residential and hotel space. The Project will be located on approximately 130 acres of primarily vacant, partially cleared land located in the former University Avenue Industrial Park adjacent to the I-93/I-95 interchange and within walking distance of the MBTA Route 128 Station on the Providence/Stoughton Commuter Rail Line in Westwood.

The first step was to measure sound levels at locations near the Project site to document the existing acoustic environment prior to construction of the proposed project. The second step was to use the Cadna-A acoustic model, based on International Standard ISO 9613, to calculate the sound levels from mechanical equipment on the buildings in the Project and to use the Federal Highway Administration (FHWA) Traffic Noise Model (TNM), Version 2.5 to calculate sound from for Project vehicle trips and truck deliveries to the site. The calculated sounds levels at the nearby noise-sensitive receptors were then compared with limits in the MassDEP Noise Policy for the Project, and with FHWA noise guidelines for Project generated vehicle trips. Although not regulated under the MassDEP Noise Policy, sound from backup alarms on trucks backing into loading dock areas were calculated and compared to existing baseline sound conditions.

Baseline sound level monitoring was conducted at three locations representative of the nearby residential areas. These measurements were completed during a late night period to capture the quieter existing sound levels in the residential areas and establish the background level used in the MassDEP Noise Policy. Sound monitoring was done at three Noise Sensitive Areas (NSAs): 1) a residence at 190 Partridge Drive, which is located north of the Project site; 2) a residence at 10

Endicott Street, which is located northeast of the Project site, and 3) a residence at the intersection Whitewood Road and Juniper Ridge Road, which is located east of the Project site. The dominant existing sources of sound were high speed motor vehicles on Interstate 95 (I-95), local area businesses, periodic aircraft over flights, and natural sounds.

The principal stationary sound sources from the Project will be rooftop heating, ventilating and air conditioning (HVAC) units used for climate control in buildings and loading docks. The Cadna-A acoustic modeling assumed simultaneous operation of all HVAC equipment at maximum load and simultaneous truck deliveries at five loading docks to ensure a conservative analysis. Future maximum sound levels were calculated at the three NSAs and the maximum sound levels from the Project range from 45.4 dBA at NSA 2 to 46.2 dBA at NSA 1. The maximum sound levels from the Project will increase the lowest nighttime background sound levels by only 1.2 dBA to 2.6 dBA, well below the 10-dBA incremental limit imposed by the MassDEP Noise Policy. Therefore, the Project will fully comply with the MassDEP Noise Policy. For informational purposes, these maximum sound levels also are less than the Town of Westwood Zoning Bylaw noise limits. Maximum sound levels from the Project in residential and commercial areas will be less than 50 dBA and 60 dBA during the daytime and nighttime, respectively and will be inaudible to slightly audible at all nearby residences.

Project trip generation was compared for University Station and the previous development proposal. The results reveal that University Station peak-hour trip generation will be less on weekdays and approximately the same on Saturdays, than the trip generation of the previous development proposal. The FHWA TNM modeling results reveal that sound from roadway traffic for the 2022 full build condition will fully comply with FHWA Roadway Noise Abatement Criteria for residential areas (1-hour L_{eq} sound level below 67 dBA, and no increase[1] of 10 dBA or more).

Two roadway sound barriers were designed as part of the previous development proposal, and the first of those, a long serpentine 8-foot high wall-and-berm construction between Whitewood Road and University Avenue has been built. The developer is committed to constructing the second barrier in connection with the University Station development, a shorter 12-foot sound wall along

[1] Increase in worst case sound levels over the Existing case as analyzed in the 2007 Tech Environmental report.

Blue Hill Avenue west of Whitewood Road. With both barriers in place, the maximum increase in worst case sound levels (1-hour L_{eq}) at any residence will be only 2.4 dBA, and the maximum increase in worst case sound levels (1-hour L_{eq}) at any property line will be only 2.7 dBA. A 3-dBA change in the sound level is generally defined as being just perceptible to the human ear in an outdoor environment. Thus, at nearby residences under the 2022 full build condition for University Station, the results suggest there will be no perceptible difference in the 1-hour L_{eq} sound levels.

Back-up alarm sounds will occur when delivery trucks are backing into loading docks. For this modeling analysis, it was conservatively assumed that five 18-wheel trucks are simultaneously backing into the loading docks with their backup alarms emitting sound. The predicted hourly sound levels at the nearest residential receptors range from 29.1 dBA to 38.6 dBA, and are below the nighttime average sound levels at all locations. The increase in background sound levels will be less than 1 dBA. However, given the tonal nature of backup alarms, their sound levels need to be at least 10 dBA lower than existing sound conditions to be inaudible. The predicted backup alarm sound levels are more than 10 dBA lower than the background sound levels, except at NSA-1 Partridge Drive (8.4 dBA). The site design includes natural rock and earth barriers at the rear of the loading docks that will significantly reduce backup alarm sounds and noise from other "back door" retail operations. Therefore, backup alarms in the loading dock areas will sometimes be slightly audible at only NSA-1. This is a typical circumstance for residences that abut commercial areas, similar to the Project site.

Construction of the Project will require the use of equipment that may be audible from off-site locations. Project construction will consist of demolition, site clearing, excavation, foundation work, steel erection, and finishing work. Work on these phases will overlap. No pile driving is planned, though some metal sheeting may need to be installed with a non-impact driver. No vibrations from project construction will be perceptible off site. The sound levels resulting from construction activities vary greatly depending on such factors such as the type of equipment, the specific equipment model, the operations being performed, and the overall condition of the equipment. Maximum projected sound levels will be similar to existing maximum daytime sound levels at these same locations from traffic on nearby roadways. Thus, the temporary sound of construction will not create a noise nuisance condition and will be similar in character to existing daytime sound levels in the nearby residential areas. Reasonable efforts will be made to minimize the impact of noise resulting from construction activities.

The following list of noise mitigation measures are planned and will be incorporated into the Project design, and construction management guidelines:

- Low-noise HVAC units will be installed at two office buildings (Office A and B) closest to NSA 1 and for three residential buildings (Residential A1, A2 and B) closest to NSA 3.
- Sealed loading docks will be used for all loading docks in the Project, and rubber gaskets will be provided at all seal connections to further address noise from unloading activities.
- Rubber mats will be used on docking plates.
- The site design includes natural rock and earth barriers at the rear of the loading docks to block sound propagation toward residential areas.
- A 12-foot sound wall will be built along Blue Hill Avenue west of Whitewood Road, to complement the already constructed 8-foot sound wall.
- Construction activities that produce significant noise will be limited to daytime hours.
- The contractor construction specification will require that all construction equipment exhaust mufflers be in good working order, and regular maintenance and lubrication will be required.

2.0 COMMON MEASURES OF COMMUNITY NOISE

The unit of sound pressure is the decibel (dB). The decibel scale is logarithmic to accommodate the wide range of sound intensities to which the human ear is subjected. A property of the decibel scale is that the sound pressure levels of two separate sounds are not directly additive. For example, if a sound of 70 dB is added to another sound of 70 dB, the total is only a 3-decibel increase (or 73 dB), not a doubling to 140 dB. Thus, every 3 dB increase represents a doubling of sound energy. For broadband sounds, a 3 dB change is the minimum change perceptible to the human ear. Table 1 below gives the perceived change in loudness of different changes in sound pressure levels.

TABLE 1

SUBJECTIVE EFFECT OF CHANGES IN SOUND PRESSURE LEVELS

Change in Sound Pressure Level	Perceived Change in Loudness
3 dB	Just perceptible
5 dB	Noticeable
10 dB	Twice (or half) as loud

Non-steady noise exposure in a community is commonly expressed in terms of the A-weighted sound level (dBA); A-weighting approximates the frequency response of the human ear. Levels of many sounds change from moment to moment. Some are sharp impulses lasting one-second or less, while others rise and fall over much longer periods of time. There are various measures of sound pressure designed for different purposes. To establish the background sound level in an area, the L_{90} metric, which is the sound level exceeded 90 percent of the time, is typically used. The L_{90} can also be thought of as the level representing the quietest 10 percent over a given time period. The L_{eq}, or equivalent sound level, is the steady-state sound level over a period of time that has the same acoustic energy as the fluctuating sounds that actually occurred during that same period. It is commonly referred to as the average sound level. The L_{max}, or maximum sound level, represents the one-second peak level experienced during a given time period. These measures are generally reported to the nearest whole decibel as broadband sound pressure level, i.e., broadband meaning includes sounds at all frequencies. Sound level data also typically include an analysis of the sound spectrum into its various frequency components to determine tonal characteristics. The unit of frequency is Hertz (Hz), measuring the cycles per second of the sound pressure waves, and typically the frequency analysis examines eleven octave bands from 16 to 16,000 Hz. The MassDEP Noise Policy states that a source creates a pure tone if acoustic energy is concentrated in a narrow frequency range and one octave band has a sound level 3 dB greater than both adjacent octave bands.

The acoustic environment in a suburban area such as Westwood results from numerous sources. Major contributors are motor vehicle traffic on I-95 and local roadways, as well as from existing businesses located in the area. Typical sound levels associated with various activities and environments are presented in Table 2.

TABLE 2

COMMON SOUND LEVELS

Activity	**dBA**
Threshold of pain	130
Chipping on metal	120
Loud rock band	110
Jack hammer	100
Jet airliner 1 mile away	95
Threshold of hearing damage	90
Freeway traffic - downtown streets	80
Urban residential area	70
Normal conversation	60
Busy suburban area	50
Quiet suburban area	40
Rural area	30
Wilderness area	25
Threshold of audibility	0

3.0 NOISE REGULATIONS

3.1 <u>MassDEP Noise Policy</u>

The Massachusetts Department of Environmental Protection (MassDEP) regulates noise through 310 CMR 7.10, "Air Pollution Control". In these regulations "air contaminant" is defined to include sound and a condition of "air pollution" includes the presence of an air contaminant in such concentration and duration as to "cause a nuisance" or "unreasonably interfere with the comfortable enjoyment of life and property".

Regulation 7.10 prohibits "unnecessary emissions" of noise. The MassDEP Noise Policy (Policy Statement 90-001, February 1, 1990) interprets a violation of this noise regulation to have occurred if the source causes either:

(1) An increase in the broadband sound pressure level of more than 10 dBA above the ambient, or

(2) A "pure tone" condition

The ambient background level is defined as the L_{90} level as measured during equipment operating hours. A "pure tone" condition occurs when any octave band sound pressure level exceeds both of the two adjacent octave band sound pressure levels by 3 dB or more.

The MassDEP does not regulate sound from construction activity and does not regulate sound from motor vehicles accessing the site or the truck backup notification alarms as required by the Occupational Safety and Health Administration (OSHA). Federal law pre-empts state and local governments from regulating the sound of trucks making deliveries to a commercial site under the federal Noise Control Act of 1972 and the Surface Transportation Assistance Act of 1982. Therefore, the provisions described above only apply to the sound of mechanical equipment proposed for the Project and its operation.

3.2 Town of Westwood Zoning Bylaw

The University Avenue Mixed Use District (UAMUD) is an overlay district established to encourage the development of mixed use projects in an area that provides proximate access to major highways and public transportation. Under Section 9.8.10.14 of this Bylaw, the approved project must comply with the MassDEP applicable standards including the MassDEP's Noise Policy (See Section 3.1). Although projects within the UAMUD are exempt from the noise limits in Section 6.6 of the Town of Westwood Zoning Bylaw, we have addressed such local requirements in this study for information purposes only.

The Town of Westwood Zoning Bylaw Section 6.6 establishes standards for sound from a commercial site as received by different zones. The most stringent limit of 50 dB applies at night for sound received in a residential area more than 200 feet from a state numbered highway, which applies to all residential areas abutting the Project site. A nighttime limit of 60 dB applies to commercial/industrial property off the premises of University Station. It is assumed that these standards are A-weighed limits (dBA). If the generated noise has a single dominant frequency above 4,800 Hz, the above stated standards are reduced by 5 dBA.

4.0 EXISTING ACOUSTIC ENVIRONMENT

Existing baseline sound levels were measured at three locations representative of the nearest Noise Sensitive Areas and the Project's property boundaries in 2005. The existing acoustic environment, dominated by highway traffic noise, has not changed significantly since then and the measurements taken are still valid. Furthermore, the 2005 levels are conservative since those measurements were taken before the demolition of the site. The old buildings at the site shielded sounds from I-95, and thus, current baseline sound levels are likely to be higher than those measured in 2005.

The baseline sound measurements were completed during a late night period to characterize the quieter existing sound levels in the residential areas and establish the background level used in the MassDEP Noise Policy. Measurements were made at publicly accessible locations, 5 feet above grade, and away from vertical reflective surfaces. The three baseline sound level measurement locations are presented in Figure 1, details of which are summarized below:

1. **Partridge Drive - Residential.** Measurements were completed adjacent to #190 Partridge Drive which is located north of the Project site.

2. **Endicott Street - Residential.** Measurements were completed adjacent to #10 Endicott Street which is located northeast of the Project site.

3. **Whitewood Road - Residential.** Measurements were completed at the intersection Whitewood Road and Juniper Ridge Road. The measurement location is east of the Project site.

Weather conditions during the nighttime sound survey were acceptable for accurate acoustic measurements during the period from 11:00 p.m. to 2:00 a.m. on December 15 and 16, 2005. Skies were overcast with no precipitation, temperatures ranged from 20^o to 30^oF, and wind speeds were variable from 0 to 4 mph. The dominant sources of sound were high speed motor vehicles on I-95, local area businesses, periodic aircraft over flights, and natural sounds.

All measurements were taken by an acoustic engineer using a CEL model 593 real-time sound level analyzer equipped with a model CEL 250 ½” precision condenser microphone, windscreen, and frequency analyzer. The CEL model 593 analyzer has an operating range of 5 dB to 140 dB, and an overall frequency range of 3.5 to 20,000 Hz. This meter meets or exceeds all requirements set forth in the American National Standards Institute (ANSI) Type 1 Standards for quality and accuracy. Prior to and immediately following the measurement session, the sound analyzer was calibrated (no level adjustment was required) with an ANSI Type 1 calibrator which has an accuracy traceable to the National Institute of Standards and Technology (NIST). All instrumentation was laboratory calibrated within the previous 12-month period. For the measurement session, the microphone was fitted with a 3" windscreen to negate the effect of air movement across microphone diaphragm. All data were downloaded to a computer following the measurement session for the purposes of storage and further analysis.

Summaries of the baseline measurement results are provided in Table 3. At the three measurement locations, average sound levels (L_{eq}) range from 48 to 52 dBA, maximum (L_{max}) sound levels range from 50 to 55 dBA, and the background (L_{90}) levels range from 47 to 51 dBA. These L_{90} levels establish the ambient level for the MassDEP Noise Policy and serve as the basis for Project limits on regulated sources of sound. Under the MassDEP Policy, offsite sound generated by the Project must not exceed 57 to 61 dBA (10 dBA higher than the measured background L_{90} sound levels), as shown in Table 3. Analysis of the measurements reveal no pure tones in the existing sound environment and overall baseline levels that are typical of a suburban area which is situated near a major transportation corridor.

TABLE 3

EXISTING SOUND LEVELS AT THREE LOCATIONS NEAR THE PROPOSED UNIVERSITY STATION PROJECT FROM 11:00 P.M. TO 2:00 A.M. DECEMBER 15 AND 16, 2005

Sound Level Measurement	NSA 1 Partridge Drive	NSA 2 Endicott Street	NSA 3 Whitewood Road
Octave Bands L_{90}(dB)			
16 Hz	54	50	54
31.5 Hz	52	49	52
63 Hz	50	46	50
125 Hz	47	44	49
250 Hz	46	45	47
500 Hz	47	47	50
1,000 Hz	44	44	48
2,000 Hz	27	28	35
4,000 Hz	12	12	16
8,000 Hz	12	12	12
16,000 Hz	13	13	13
Broadband (dBA)			
L_{max}	54	50	55
L_{eq}	48	48	52
L_{90}	47	48	51
Existing Pure Tone Condition?	**No**	**No**	**No**
MassDEP Noise Policy Limit (dBA)*	**57**	**58**	**61**

* Defined as a 10 dBA incremental increase relative to the existing nighttime baseline (L_{90})

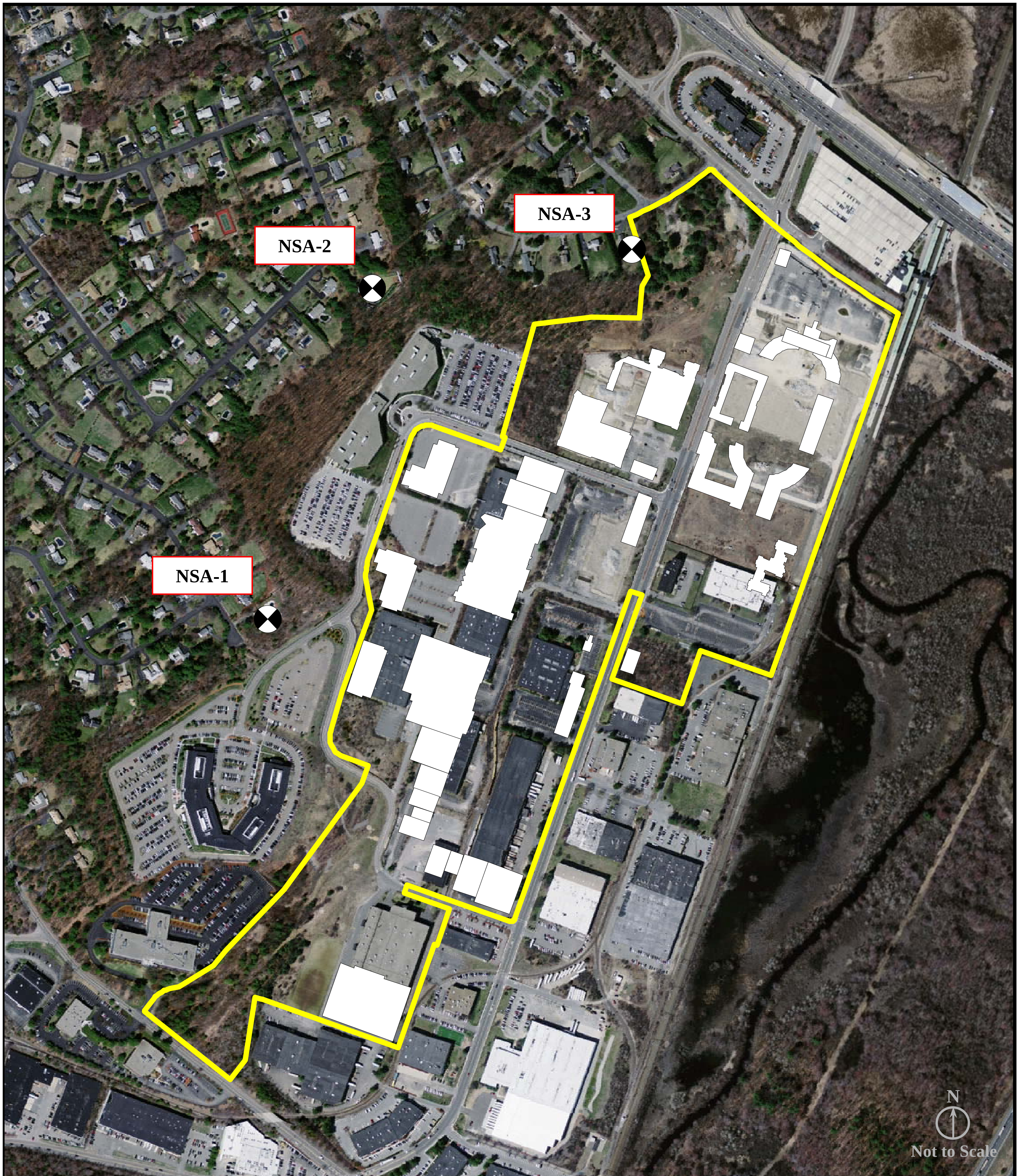

Figure 1.

Project Site and Noise Monitoring Locations
University Station
Westwood, MA

5.0 CALCULATED FUTURE SOUND LEVELS

This section describes the sound impact analysis methodologies and modeling results associated with our review of the roof-top equipment, loading dock operations (including truck backup beepers), and traffic associated with the Project.

5.1 Facility Operations

The primary sources of continuous operational sound are rooftop-mounted heating, ventilating, and air conditioning (HVAC) equipment for building comfort and trucks making deliveries in loading dock areas. The acoustic profiles from all potential sources operating concurrently under full load conditions were integrated into the acoustic modeling analysis to determine the resultant sound levels from the site under a worst-case scenario. Standard-design Trane (or equivalent) 25-ton HVAC units were assumed to be installed on all buildings, except those buildings closest to NSA 1 and NSA 3. Carrier (or equivalent) low-noise HVAC units were assumed to be installed on the two office buildings closest to NSA 1 (Office A and B) and on three residential buildings closest to NSA 3 (Residential A1, A2 and B). According to the manufacturers, the reference sound pressure level of a Trane HVAC unit is 69 dBA at a distance of 25 feet away and for a Carrier low-noise unit it is 56.3 dBA at 25 feet. The size and number of the HVAC units required for each building were estimated based on 1 ton of HVAC capacity per 400 square feet of space. Because the Project is at the concept level of design, the actual mechanical equipment selected for each building may be different than these study estimates. As a design guide, for each of the two office buildings (Office A and B), the total sound power level[2] of rooftop equipment should not exceed 95 dBA, and for each of the three residential buildings (Residential A1, A2 and B), the total sound power level[1] of rooftop equipment should not exceed 100 dBA.

For the purposes of modeling loading dock activities, it was assumed that 18-wheel trucks were simultaneously idling in each of the five loading docks closest to the neighborhood residences and each was backing into a loading dock with backup alarms emitting sound at the same time. One of

[2] The sound power level is not the same as the same pressure level which is what people hear, though both are expressed on a decibel level scale. The sound power level is defined as $10*\log_{10}(W/W_o)$, where W is the sound power of the source in Watts and W_o is the reference power of 10^{-12} Watts.

the trucks was assumed to be a refrigerated truck operating in the proposed Wegman's loading dock. Because the MassDEP Noise Policy does not regulate truck backup notification alarms, they were not included in the noise impact analysis to assess their compliance with MassDEP Noise Policy at nearby noise sensitive areas. A separate analysis to evaluate backup alarm sound impacts at noise sensitive areas is presented in Section 5.4.

Future maximum sound levels at the upper floors of the nearest residences were calculated with the Cadna-A acoustic model assuming simultaneous operation of all rooftop HVAC equipment at maximum load and trucks backing up into all five nearby loading docks. This is a highly unlikely scenario, selected to establish the worst-case condition. Cadna-A is a sophisticated 3-D model for sound propagation and attenuation based on International Standard ISO 9613[3]. Atmospheric absorption is the process by which sound energy is absorbed by the air and was calculated using ANSI S1.26-1995.[4] Absorption of sound assumed standard day conditions and is significant at large distances and at high frequencies. ISO 9613 was used to calculate propagation and attenuation of sound energy by hemispherical divergence with distance, surface reflection, ground, and shielding effects by barriers, buildings, and ground topography. Offsite topography was determined using MassGIS digital elevation data for the study area. Onsite topography and site grading are also included in the model. The site design includes natural rock and earth barriers at the rear of the loading docks that will significantly reduce backup alarm sounds and noise from other "back door" retail operations.

The predicted maximum sound levels are conservative because:

1. The model assumes a ground-based temperature inversion, such as may occur on a clear, calm night when sound propagation is at a maximum. This worst-case condition is infrequent.

2. Rooftop HVAC equipment will be designed with excess capacity to ensure the buildings could operate even with the failure of some fan condenser units. Thus, it is unlikely that all HVAC equipment would ever operate simultaneously, as assumed in the model.

3. It was assumed that delivery trucks in the loading docks are all idling simultaneously.

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[3] International Standard, ISO 9613-2, Acoustics – Attenuation of Sound During Propagation Outdoors, -- Part 2 General Method of Calculation.
[4] American National Standards Institute, ANSI S1.26-1995, American National Standard Method for the Calculation of the Absorption of Sound by the Atmosphere, 1995.

4. Hard ground surface (G=0) was assumed for all buildings and parking lots. A mixed surface representative of winter frozen ground conditions (G=0.5) was assumed for all vegetated surfaces.

Future maximum sound levels were predicted at three noise sensitive areas (NSAs) that represent the upper floors of the nearest residences and residential property lines:

- NSA 1 - Partridge Drive
- NSA 2 - Endicott Street
- NSA3 - Whitewood Road

Future sound levels were calculated at the upper floors of the noise sensitive areas, which could receive the greatest potential effects of the Project. Locations below these upper floors will receive less sound because the lower the elevation of the receptor, the more shielding it will experience from the acoustic screens and building rooflines. Therefore, sound levels at ground level are lower than the predicted maximum levels at the noise sensitive receptors.

As noted above, future maximum sound levels were calculated at the three NSAs based on simultaneous operation of all HVAC equipment at maximum load and simultaneous truck operations at the five loading dock areas. Table 4 presents the compliance demonstration for the MassDEP Noise Policy. The maximum sound levels from the Project will increase the lowest nighttime background sound levels by only 1.2 dBA to 2.6 dBA, well below the 10-dBA incremental limit allowed by the MassDEP Noise Policy. Maximum sound levels from the Project in residential and commercial areas will be less than 50 dBA and 60 dBA during the daytime and nighttime, respectively and will be inaudible to slightly audible at all nearby residences. Therefore, the Project will fully comply with the MassDEP Noise Policy. Actual sound levels from the Project will be substantially less than those presented in Table 4, since it is unlikely that all sound sources would operate simultaneously.

While inapplicable to a UAMAD project, we note for informational purposes that these maximum sound levels also comply with the noise limits established under Section 6.6 of the Town of Westwood Zoning Bylaw.

Figure 2 presents color-coded decibel contours for the maximum sound impacts from the project and their effects on the nearby areas. These contours display the maximum continuous sound levels for the Project. The results in Figure 2 confirm compliance with the MassDEP Noise Policy at all nearby residential property lines and residences.

TABLE 4

MASSDEP NOISE POLICY COMPLIANCE DEMONSTRATION FOR PROJECT SOUND LEVELS AT THE CLOSEST NOISE SENSITIVE AREAS

Noise Sensitive Areas	Lowest Measured Background Sound Level (L_{90}) (dBA)	Predicted Maximum Sound Level from the Project (dBA)	Total Predicted Sound Level (dBA)	Predicted Sound Level Increase (dBA)	Complies with MassDEP Noise Policy?
NSA-1: Partridge Drive	47	46.2	49.6	2.6	Yes
NSA-2: Endicott Street	48	45.4	49.9	1.9	Yes
NSA-3: Whitewood Road	51	46.1	52.2	1.2	Yes

5.2 Roadway Noise

A roadway noise study was performed for University Station. The goal was to compare the existing and future worst-case 1-hour equivalent (L_{eq}) sound levels at nearby residences to the Federal Highway Administration (FHWA) Noise Abatement Criteria in 23 CFR 772 for residential areas. Those criteria define a "traffic noise impact" to occur when roadway L_{eq} sound levels approach or equal 67 A-weighted decibels (dBA) or when an action substantially exceeds the existing worst-case 1-hour L_{eq} level. The Massachusetts Department of Transportation (MassDOT) interprets "substantially exceeds" to mean increase by 10 dBA or more.

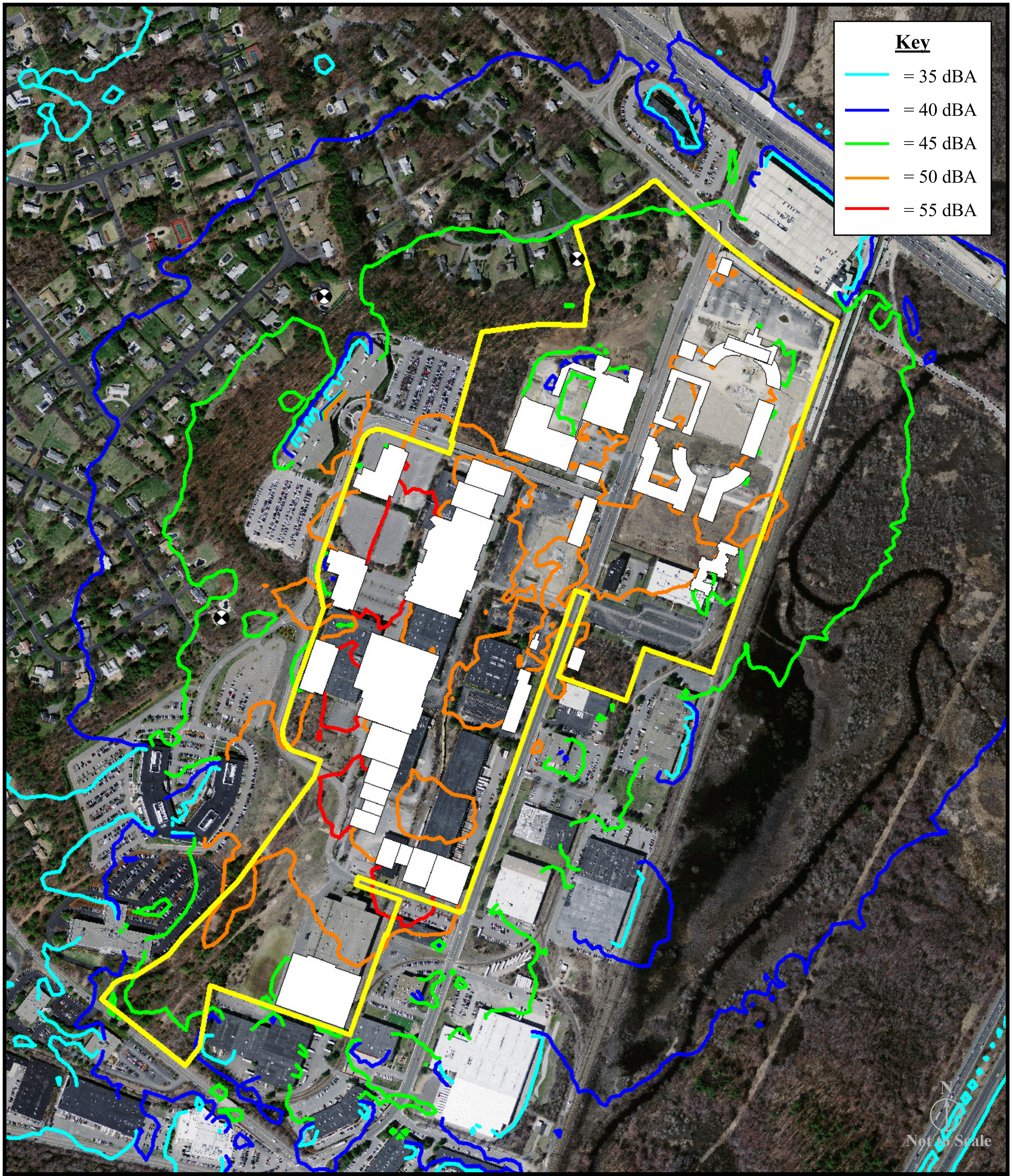

Figure 2.

Maximum Project Sound Levels
University Station
Westwood, MA

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Calculations were done for the weekday morning peak-hour, weekday evening peak-hour, and Saturday peak hour using the results of the roadway noise study done for the previous development proposal at this site.[5] Acoustic model receivers (see Figure 3) included all homes on Whitewood Road, Juniper Ridge Road and Blue Hill Drive within 500 feet of the Project, and, in addition, the closest homes to the Project along Peartree Drive and Partridge Drive. A total of 33 residential properties were examined. Anticipated sound levels were determined both at the property line and at the upper story windows of the houses.

Project trip generation was compared for University Station and the previous development proposal. The results reveal that University Station peak-hour trip generation will be less on weekdays and approximately the same on Saturdays, than the trip generation of the previous development proposal. The FHWA TNM modeling results from the 2007 Tech Environmental report[1] for the 33 residential receivers shown in Figure 3 were adjusted to the new trip generation rates. The results, summarized in Tables 5 and 6, reveal that sound from roadway traffic for the 2022 full build condition will fully comply with FHWA Roadway Noise Abatement Criteria for residential areas (1-hour L_{eq} sound level below 67 dBA, and no increase[6] of 10 dBA or more).

Two roadway sound barriers were designed as part of the previous development proposal, and the first of those, a long serpentine 8-foot high wall-and-berm construction between Whitewood Road and University Avenue has been built. University Station is committed to getting the second barrier constructed, a shorter 12-foot sound wall along Blue Hill Avenue west of Whitewood Road. With both barriers in place, the results in Tables 5 and 6 reveal the maximum increase in worst case sound levels (1-hour L_{eq}) at any residence will be only 2.4 dBA, and the maximum increase in worst case sound levels (1-hour L_{eq}) at any property line will be only 2.7 dBA. A 3-dBA change in the sound level is generally defined as being just perceptible to the human ear in an outdoor environment. Thus, at nearby residences under the 2022 full build condition for University Station, the results suggest there will be no perceptible difference in the 1-hour L_{eq} sound levels.

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[5] Tech Environmental, Inc., "Roadway Noise Study for the Westwood Station Project," revised September 2007.
[6] Increase in worst case sound levels over the Existing case as analyzed in the 2007 Tech Environmental report.

Figure 3.

Residential Receivers
for the TNM Analysis

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5.3 Acoustic Modeling of Truck Backup Alarm

The sound from truck safety alarms (backup alarms) is exempt from state and local regulation (see Section 3.0). For the purposes of this modeling analysis, it was assumed that five 18-wheel trucks would simultaneously be backing into the loading docks with their backup alarms emitting sound. A usage factor was applied to the backup alarm sound power level of 114 dBA (114 dB in the 1,000 Hz band)[7] to represent the intermittent nature of backup alarm operations in any one hour period. The usage factor was based on five-minutes of operation in any given one hour period. This is conservative assumption given that the average time for a truck to backup into a loading dock is typically less than one minute.

The predicted hourly sound levels at the nearest residential receptors range from 29.1 to 38.6 dBA, as shown in Table 7, and are below the nighttime average sound levels at all locations. The increase in background sound levels will be less than 1 dBA. However, given the tonal nature of backup alarms, their sound levels need to be at least 10 dBA lower than existing sound conditions to be inaudible. The predicted backup alarm sound levels are more than 10 dBA lower than the background sound levels, except at NSA-1 Partridge Drive (8.4 dBA). The site design includes natural rock and earth barriers at the rear of the loading docks that will significantly reduce backup alarm sounds and noise from other "back door" retail operations. Therefore, backup alarms in the loading dock areas will sometimes be slightly audible at only the NSA-1 location. This is a typical circumstance for residences that abut commercial areas, similar to the project site.

7 Backup alarm sound power level is based on typical unit with a sound pressure level of 85 dBA at 50 feet away.

TABLE 5

WORST CASE 1-HOUR L_{eq} ROADWAY SOUND LEVELS AT NEARBY RESIDENCES (dBA)

Nearby Residences[1]	Existing	Project Full Build 2022	Increase Over Existing
126 Partridge Drive	44.2	44.5	0.3
20 Peartree Drive	48.8	49.9	1.1
171 Whitewood Road	52.8	55.2	2.4
95 Juniper Ridge Road	57.8	59.3	1.5
385 Blue Hill Drive	60.9	61.8	0.9

[1] The one residence with the largest predicted sound level increase on each street is listed here. All other residences on the street have a lower predicted sound level increase.

TABLE 6

WORST CASE 1-HOUR L_{eq} ROADWAY SOUND LEVELS AT NEARBY RESIDENTIAL PROPERTY LINES (dBA)

Nearby Residential Properties[1]	Existing	Project Full Build 2022	Increase Over Existing
126 Partridge Drive	40.2	39.9	-0.3
20 Peartree Drive	48.9	49.8	0.9
197 Whitewood Road	52.0	54.7	2.7
95 Juniper Ridge Road	56.5	59.3	1.2
385 Blue Hill Drive	59.5	60.2	0.7

[1] The one residence with the largest predicted sound level increase on each street is listed here. All other properties on the street have a lower predicted sound level increase.

TABLE 7

COMPARISON OF PREDICTED TRUCK BACKUP ALARM SOUND LEVELS TO EXISTING AVERAGE SOUND LEVELS AT NEARBY RESIDENTIAL AREAS

Receptor Location	Measured Existing Daytime Average Sound Levels (L_{90}) (dBA)	Predicted Future Sound Level from Backup Alarm (dBA)	Predicted Average Sound Level Difference (dBA)
NSA-1: Partridge Drive	47	38.6	0.6
NSA-2: Endicott Street	48	29.1	0.1
NSA-3: Whitewood Road	51	29.7	0.0

6.0 CONSTRUCTION NOISE AND VIBRATION

Construction of the Project will require the use of equipment that may be audible from off-site locations. Project construction will consist of demolition, site clearing, rock ledge blasting and rock processing, excavation, foundation work, steel erection, and finishing work. Work on these phases will overlap. No pile driving is planned, though some metal sheeting may need to be installed with a non-impact driver. No vibrations from project construction will be perceptible off site. The sound levels resulting from construction activities vary greatly depending on such factors such as the type of equipment, the specific equipment model, the operations being performed, and the overall condition of the equipment.

The U.S. Environmental Protection Agency[8] has published data on the average sound levels for typical construction phases. Following the EPA method, sound levels were projected from the acoustic center of the building footprint to the closest residential uses. This calculation conservatively assumes all equipment operating concurrently onsite for the specified construction phase. The results of these calculations are presented in Table 8 and show estimated construction sound levels at the nearest residential properties will be between 60 and 76 dBA. These levels are similar to existing maximum daytime sound levels at these same locations from traffic on nearby roadways. Thus, the temporary sound of construction will not create a noise nuisance condition and will be similar in character to existing daytime sound levels in the nearby residential areas.

Reasonable efforts will be made to minimize the impact of noise resulting from construction activities. The following list of noise mitigation measures are planned and would be incorporated into construction management guidelines for the project:

- Construction activities that produce significant noise will be limited to daytime hours.
- The contractor construction specification will require that all construction equipment exhaust mufflers be in good working order, and regular maintenance and lubrication will be required.

[8] U.S. EPA, Noise From Construction Equipment and Operations, Building Equipment, and Home Appliances, December, 1971.

TABLE 8

MAXIMUM CONSTRUCTION SOUND LEVELS AT THE CLOSEST RESIDENTIAL LOCATIONS

Construction Phase	**50 Feet from Source (L_{eq})**	**At Closest Residential Locations, (L_{eq})**
Demolition and Site Clearing	84	66
Ledge Blasting and Rock Processing	94	76
Excavation Foundations	89	71
Vibratory Sheeting	88	70
Foundations	78	60
Erection	85	67
Finishing	89	71

APPENDIX A

NOISE MONITORING SUMMARIES

Westwood Station
Baseline Sound Level Measurements
NSA 1 - Partridge Drive

CEL SoundTrack - dB2 3.0 © CEL Instruments Ltd 1998

- Run summary -

Instrument	CEL-593.C1T Version 7.21 Type 1
Instrument ID (DPB)	112240
Run mode	Octave band Environmental
Run start	12/15/2005 23:23:30
Run end	12/15/2005 23:54:39
Run duration	000 00:31:09.74
Last calibration	12/15/2005 23:11:39
Measurement range	5 - 80 dB
Microphone response	Free Field
Polarizing voltage	Off
Time weighting	F
Frequency weighting	L, A
Exchange rate (Q)	3
Period time	30 min
Periods too short for LNs	No
Profiles recorded	No
Profile sample interval	1 s
Number of records	1
Events enabled	No
Overload occurred	No
Low battery occurred	No
Pause was used	No

- Period results -

Record number	1 : 1
Record start	12/16/2005 23:23:30.0
Period time	30 min
Periods too short for LNs	No
Overload occurred	No
Overload %time	0.00
Low battery occurred	No
Pause was used	No
Paused all the time	No

Band (Hz)	Fw	Leq (dB)	SPLMAX F (dB)	LN10.0% F (dB)	LN50.0% F (dB)	LN90.0% F (dB)
Broadband	L	62.1	71.2	64.0	61.0	60.0
Broadband	A	48.4	54.2	50.0	48.0	47.0
16	L	58.3	70.7	61.0	57.0	54.0
32	L	54.7	62.1	57.0	54.0	52.0
63	L	51.8	56.2	53.0	52.0	50.0
125	L	48.7	53.8	50.0	48.0	47.0
250	L	47.5	51.4	49.0	47.0	46.0
500	L	48.2	53.7	50.0	48.0	47.0
1k	L	44.9	51.5	46.0	45.0	44.0
2k	L	28.1	38.7	29.0	28.0	27.0
4k	L	14.5	36.3	13.0	12.0	12.0
8k	L	13.3	31.9	13.0	12.0	12.0
16k	L	13.1	23.4	13.0	13.0	13.0

Westwood Station
Baseline Sound Level Measurements
NSA 2 - Endicott Street

CEL SoundTrack - dB2 3.0

- Run summary -

Instrument	CEL-593.C1T Version 7.21 Type 1
Instrument ID (DPB)	112240
Run mode	Octave band Environmental
Run start	12/16/2005 00:12:17
Run end	12/16/2005 00:42:28
Run duration	000 00:30:11.56
Last calibration	12/15/2005 23:11:39
Measurement range	5 - 80 dB
Microphone response	Free Field
Polarizing voltage	Off
Time weighting	F
Frequency weighting	L, A
Exchange rate (Q)	3
Period time	30 min
Periods too short for LNs	No
Profiles recorded	No
Profile sample interval	1 s
Number of records	1
Events enabled	No
Overload occurred	No
Low battery occurred	No
Pause was used	No

- Period results -

Record number	1 : 1
Record start	12/16/2005 00:12:17.0
Period time	30 min
Periods too short for LNs	No
Overload occurred	No
Overload %time	0.00
Low battery occurred	No
Pause was used	No
Paused all the time	No

Band (Hz)	Fw	Leq (dB)	SPLMAX F (dB)	LN10.0% F (dB)	LN50.0% F (dB)	LN90.0% F (dB)
Broadband	L	59.4	69.8	61.0	58.0	57.0
Broadband	A	48.4	50.4	49.0	48.0	48.0
16	L	55.6	68.8	58.0	53.0	50.0
32	L	51.5	56.2	53.0	51.0	49.0
63	L	48.3	52.6	50.0	48.0	46.0
125	L	46.7	51.7	49.0	46.0	44.0
250	L	47.1	55.6	49.0	47.0	45.0
500	L	48.0	50.4	49.0	48.0	47.0
1k	L	45.2	47.3	46.0	45.0	44.0
2k	L	28.2	29.8	29.0	28.0	28.0
4k	L	13.1	21.4	14.0	12.0	12.0
8k	L	12.4	15.9	13.0	12.0	12.0
16k	L	12.9	13.2	13.0	13.0	13.0

Westwood Station
Baseline Sound Level Measurements
NSA 3 - Whitewood Road

CEL SoundTrack - dB2 3.0 © CEL Instruments Ltd 1998

- Run summary -

Instrument	CEL-593.C1T Version 7.21 Type 1
Instrument ID (DPB)	112240
Run mode	Octave band Environmental
Run start	12/16/2005 01:00:16
Run end	12/16/2005 01:33:14
Run duration	000 00:32:58.38
Last calibration	12/15/2005 23:11:39
Measurement range	5 - 80 dB
Microphone response	Free Field
Polarizing voltage	Off
Time weighting	F
Frequency weighting	L, A
Exchange rate (Q)	3
Period time	30 min
Periods too short for LNs	No
Profiles recorded	No
Profile sample interval	1 s
Number of records	1
Events enabled	No
Overload occurred	No
Low battery occurred	No
Pause was used	No

- Period results -

Record number	1 : 1
Record start	12/16/2005 01:06:16.0
Period time	1 min
Periods too short for LNs	No
Overload occurred	No
Overload %time	0.00
Low battery occurred	No
Pause was used	No
Paused all the time	No

Band (Hz)	Fw	Leq (dB)	SPLMAX F (dB)	LN10.0% F (dB)	LN50.0% F (dB)	LN90.0% F (dB)
Broadband	L	65.1	77.2	67.0	62.0	61.0
Broadband	A	52.2	55.3	53.0	52.0	51.0
16	L	62.7	76.1	65.0	58.0	54.0
32	L	55.9	63.1	59.0	55.0	52.0
63	L	52.3	56.6	54.0	52.0	50.0
125	L	51.7	56.7	54.0	51.0	49.0
250	L	49.0	52.3	50.0	49.0	47.0
500	L	51.4	54.1	53.0	51.0	50.0
1k	L	49.3	53.2	50.0	49.0	48.0
2k	L	36.9	42.6	39.0	37.0	35.0
4k	L	21.0	40.2	23.0	19.0	16.0
8k	L	14.1	34.9	13.0	12.0	12.0
16k	L	12.9	24.0	13.0	13.0	13.0

APPENDIX B

CADNA-A MODELING RESULTS

Cadna Results

Results With Backup Alarms

Name	Sound Level (dBA)	Height (m)	Coordinates X (m)	Y (m)	Z (m)
NSA-1	46.9	4	228173.77	883992.5	52.35
NSA-2	45.5	4	228327.17	884475.8	47.52
NSA-3	46.2	4	228706.61	884531.9	28.2

Results Without Backup Alarms

Name	Sound Level (dBA)	Height (m)	Coordinates X (m)	Y (m)	Z (m)
NSA-1	46.2	4	228173.77	883992.5	52.35
NSA-2	45.4	4	228327.17	884475.8	47.52
NSA-3	46.1	4	228706.61	884531.9	28.2

Cadna Sources

Name	Building	Value	Unit	Sound Power	Correction	Height	Coordinates		
				(dBA)	dB(A)	(m)	X (m)	Y (m)	Z (m)
HVAC-1	Retail A	HVAC	Trane 25 Ton	99.4	5.4	1	228511.04	883599.74	27.1
HVAC-2	Retail B	HVAC	Trane 25 Ton	97.3	3.3	1	228469.48	883617.55	27.27
HVAC-3	Retail C	HVAC	Trane 25 Ton	92.1	-1.9	1	228446.23	883635.85	27.71
HVAC-4	Retail D	HVAC	Trane 25 Ton	95	1	1	228422.18	883638.43	27.9
HVAC-5	Retail E	HVAC	Trane 25 Ton	94.8	0.8	1	228387.12	883688.32	29.54
HVAC-6	Retail F	HVAC	Trane 25 Ton	91.4	-2.6	1	228399.73	883707.31	29.57
HVAC-7	Retail G	HVAC	Trane 25 Ton	94.2	0.2	1	228402.09	883727.93	31.78
HVAC-8	Retail H	HVAC	Trane 25 Ton	96.3	2.3	1	228412.1	883756.79	32.03
HVAC-9	Retail I	HVAC	Trane 25 Ton	99.6	5.6	1	228418.19	883800.57	38.03
HVAC-10	Retail J	HVAC	Trane 25 Ton	105.4	11.4	1	228430.56	883893.24	39.14
HVAC-11	Retail K	HVAC	Trane 25 Ton	105.5	11.5	1	228514.91	884076.23	30.22
HVAC-12	Retail L	HVAC	Trane 25 Ton	98.1	4.1	1	228551.27	884170.23	34.52
HVAC-13	Retail M	HVAC	Trane 25 Ton	98.1	4.1	1	228571.56	884204.12	34.05
HVAC-14	Retail N	HVAC	Trane 25 Ton	93.8	-0.2	1	228723.68	884209.83	28.04
HVAC-15	Retail O	HVAC	Trane 25 Ton	96.7	2.7	1	228714.04	884136.83	27.84
HVAC-16	Retail P	HVAC	Trane 25 Ton	88.3	-5.7	1	228642.62	883952.82	27.09
HVAC-17	Retail Q	HVAC	Trane 25 Ton	97.6	3.6	1	228617.09	883860.94	27.32
HVAC-18	Retail R	HVAC	Trane 25 Ton	106.1	12.1	1	228318.43	883432.43	27.07
HVAC-19	Retail T	HVAC	Trane 25 Ton	94	0	1	228918.41	884390.81	25.95
HVAC-20	Retail U	HVAC	Trane 25 Ton	94	0	1	228998.55	884362.61	26.34
HVAC-21-A	Office A	HVAC_20T_LN	Carrier Low Noise 20-T	81.3	0	1	228296.72	883891.43	45.82
HVAC-21-B	Office A	HVAC_20T_LN	Carrier Low Noise 20-T	81.3	0	1	228306.94	883920.41	45.82
HVAC-21-C	Office A	HVAC_20T_LN	Carrier Low Noise 20-T	81.3	0	1	228317.38	883950.84	45.82
HVAC-21-D	Office A	HVAC_20T_LN	Carrier Low Noise 20-T	81.3	0	1	228308.73	883887.69	45.82
HVAC-21-E	Office A	HVAC_20T_LN	Carrier Low Noise 20-T	81.3	0	1	228314.69	883905.69	45.82
HVAC-21-F	Office A	HVAC_20T_LN	Carrier Low Noise 20-T	81.3	0	1	228322.25	883928.36	45.82
HVAC-21-G	Office A	HVAC_20T_LN	Carrier Low Noise 20-T	81.3	0	1	228329.61	883946.46	45.82
HVAC-21-H	Office A	HVAC_20T_LN	Carrier Low Noise 20-T	81.3	0	1	228320.76	883883.81	45.82
HVAC-21-I	Office A	HVAC_20T_LN	Carrier Low Noise 20-T	81.3	0	1	228331	883911.66	45.82
HVAC-21-J	Office A	HVAC_20T_LN	Carrier Low Noise 20-T	81.3	0	1	228341.05	883942.48	45.82
HVAC-22-A	Office B	HVAC_20T_LN	Carrier Low Noise 20-T	81.3	0	1	228346.81	884030.07	42.59
HVAC-22-B	Office B	HVAC_20T_LN	Carrier Low Noise 20-T	81.3	0	1	228353.72	884014.21	42.59
HVAC-22-C	Office B	HVAC_20T_LN	Carrier Low Noise 20-T	81.3	0	1	228369.81	884021.65	42.59
HVAC-22-D	Office B	HVAC_20T_LN	Carrier Low Noise 20-T	81.3	0	1	228360.62	884036.88	42.59
HVAC-22-E	Office B	HVAC_20T_LN	Carrier Low Noise 20-T	81.3	0	1	228354.46	884050.97	42.59
HVAC-22-F	Office B	HVAC_20T_LN	Carrier Low Noise 20-T	81.3	0	1	228376.86	884042.9	42.59
HVAC-22-G	Office B	HVAC_20T_LN	Carrier Low Noise 20-T	81.3	0	1	228368.69	884058.78	42.59
HVAC-22-H	Office B	HVAC_20T_LN	Carrier Low Noise 20-T	81.3	0	1	228384.61	884064.76	42.59

Cadna Sources

Name	Building	Value	Unit	Sound Power	Correction	Height	Coordinates		
				(dBA)	dB(A)	(m)	X (m)	Y (m)	Z (m)
HVAC-22-I	Office B	HVAC_20T_LN	Carrier Low Noise 20-T	81.3	0	1	228375.85	884079.22	42.59
HVAC-22-J	Office B	HVAC_20T_LN	Carrier Low Noise 20-T	81.3	0	1	228358.98	884074.13	42.59
HVAC-22-K	Office B	HVAC_20T_LN	Carrier Low Noise 20-T	81.3	0	1	228342.75	884068.54	42.59
HVAC-22-L	Office B	HVAC_20T_LN	Carrier Low Noise 20-T	81.3	0	1	228349.48	884088.28	42.59
HVAC-23	Office C	HVAC	Trane 25 Ton	104.9	10.9	1	228416.39	884202.11	41.94
HVAC-24	Office W	HVAC	Trane 25 Ton	101.8	7.8	1	228976.29	884278.01	27.43
HVAC-25	Office X	HVAC	Trane 25 Ton	102.8	8.8	1	228920.39	884190.94	27.21
HVAC-26	Restaurant A	HVAC	Trane 25 Ton	93	-1	1	228705.13	883930.61	22.21
HVAC-27	Restaurant B	HVAC	Trane 25 Ton	92.1	-1.9	1	228872.4	884395.75	22.02
HVAC-28	Restaurant C	HVAC	Trane 25 Ton	90.8	-3.2	1	228927.8	884519.88	20.59
HVAC-30	Hotel 1	HVAC	Trane 25 Ton	105.1	11.1	1	228960.46	884396.74	38.56
HVAC-31	Assisted Living 1	HVAC	Trane 25 Ton	98	4	1	228912.84	884069.97	30.26
HVAC-32-A	Residential A1	HVAC_20T_LN	Carrier Low Noise 20-T	81.3	0	1	228677.28	884333.33	35.27
HVAC-32-B	Residential A1	HVAC_20T_LN	Carrier Low Noise 20-T	81.3	0	1	228681.65	884346.12	35.27
HVAC-32-C	Residential A1	HVAC_20T_LN	Carrier Low Noise 20-T	81.3	0	1	228686.57	884358.57	35.27
HVAC-32-D	Residential A1	HVAC_20T_LN	Carrier Low Noise 20-T	81.3	0	1	228703.62	884369.94	35.27
HVAC-32-E	Residential A1	HVAC_20T_LN	Carrier Low Noise 20-T	81.3	0	1	228719.59	884364.32	35.27
HVAC-32-F	Residential A1	HVAC_20T_LN	Carrier Low Noise 20-T	81.3	0	1	228756.72	884321.7	35.27
HVAC-32-G	Residential A1	HVAC_20T_LN	Carrier Low Noise 20-T	81.3	0	1	228745.53	884376.86	35.27
HVAC-32-H	Residential A1	HVAC_20T_LN	Carrier Low Noise 20-T	81.3	0	1	228795.9	884357.92	35.27
HVAC-32-I	Residential A1	HVAC_20T_LN	Carrier Low Noise 20-T	81.3	0	1	228720.52	884295.9	35.27
HVAC-32-J	Residential A1	HVAC_20T_LN	Carrier Low Noise 20-T	81.3	0	1	228744.51	884287.53	35.27
HVAC-32-K	Residential A1	HVAC_20T_LN	Carrier Low Noise 20-T	81.3	0	1	228769.14	884278.85	35.27
HVAC-32-L	Residential A1	HVAC_20T_LN	Carrier Low Noise 20-T	81.3	0	1	228761.4	884295.11	35.27
HVAC-32-M	Residential A1	HVAC_20T_LN	Carrier Low Noise 20-T	81.3	0	1	228752.41	884309.48	35.27
HVAC-32-N	Residential A1	HVAC_20T_LN	Carrier Low Noise 20-T	81.3	0	1	228735.51	884303.95	35.27
HVAC-32-O	Residential A1	HVAC_20T_LN	Carrier Low Noise 20-T	81.3	0	1	228769.14	884317.05	35.27
HVAC-32-P	Residential A1	HVAC_20T_LN	Carrier Low Noise 20-T	81.3	0	1	228738.91	884342.08	35.27
HVAC-32-Q	Residential A1	HVAC_20T_LN	Carrier Low Noise 20-T	81.3	0	1	228748.93	884298.74	35.27
HVAC-32-R	Residential A1	HVAC_20T_LN	Carrier Low Noise 20-T	81.3	0	1	228737.38	884357.89	35.27
HVAC-32-S	Residential A1	HVAC_20T_LN	Carrier Low Noise 20-T	81.3	0	1	228771.98	884345.15	35.27
HVAC-32-T	Residential A1	HVAC_20T_LN	Carrier Low Noise 20-T	81.3	0	1	228790.61	884339.94	35.27
HVAC-32-U	Residential A1	HVAC_20T_LN	Carrier Low Noise 20-T	81.3	0	1	228755.48	884351.07	35.27
HVAC-32-V	Residential A1	HVAC_20T_LN	Carrier Low Noise 20-T	81.3	0	1	228785.79	884324.95	35.27
HVAC-32-W	Residential A1	HVAC_20T_LN	Carrier Low Noise 20-T	81.3	0	1	228760.69	884333.39	35.27
HVAC-32-X	Residential A1	HVAC_20T_LN	Carrier Low Noise 20-T	81.3	0	1	228742.93	884327	35.27
HVAC-32-Y	Residential A1	HVAC_20T_LN	Carrier Low Noise 20-T	81.3	0	1	228728.25	884317.21	35.27
HVAC-32-Z	Residential A1	HVAC_20T_LN	Carrier Low Noise 20-T	81.3	0	1	228777.03	884301.27	35.27

Cadna Sources

Name	Building	Value	Unit	Sound Power	Correction	Height	Coordinates		
				(dBA)	dB(A)	(m)	X (m)	Y (m)	Z (m)
HVAC-33-A	Residential A2	HVAC_20T_LN	Carrier Low Noise 20-T	81.3	0	1	228629.97	884313.38	35.07
HVAC-33-B	Residential A2	HVAC_20T_LN	Carrier Low Noise 20-T	81.3	0	1	228643.44	884309.39	35.07
HVAC-33-C	Residential A2	HVAC_20T_LN	Carrier Low Noise 20-T	81.3	0	1	228660.54	884303.82	35.07
HVAC-33-D	Residential A2	HVAC_20T_LN	Carrier Low Noise 20-T	81.3	0	1	228624.94	884299.65	35.07
HVAC-33-E	Residential A2	HVAC_20T_LN	Carrier Low Noise 20-T	81.3	0	1	228640.26	884295.07	35.07
HVAC-33-F	Residential A2	HVAC_20T_LN	Carrier Low Noise 20-T	81.3	0	1	228656.76	884288.51	35.07
HVAC-33-G	Residential A2	HVAC_20T_LN	Carrier Low Noise 20-T	81.3	0	1	228619.37	884285.52	35.07
HVAC-33-H	Residential A2	HVAC_20T_LN	Carrier Low Noise 20-T	81.3	0	1	228636.68	884280.15	35.07
HVAC-33-I	Residential A2	HVAC_20T_LN	Carrier Low Noise 20-T	81.3	0	1	228652.59	884275.58	35.07
HVAC-33-J	Residential A2	HVAC_20T_LN	Carrier Low Noise 20-T	81.3	0	1	228614	884271.6	35.07
HVAC-33-K	Residential A2	HVAC_20T_LN	Carrier Low Noise 20-T	81.3	0	1	228632.7	884265.63	35.07
HVAC-33-L	Residential A2	HVAC_20T_LN	Carrier Low Noise 20-T	81.3	0	1	228643.85	884245.32	35.07
HVAC-33-M	Residential A2	HVAC_20T_LN	Carrier Low Noise 20-T	81.3	0	1	228608.03	884256.28	35.07
HVAC-33-N	Residential A2	HVAC_20T_LN	Carrier Low Noise 20-T	81.3	0	1	228627.53	884250.12	35.07
HVAC-33-O	Residential A2	HVAC_20T_LN	Carrier Low Noise 20-T	81.3	0	1	228690.34	884234.9	35.07
HVAC-33-P	Residential A2	HVAC_20T_LN	Carrier Low Noise 20-T	81.3	0	1	228668.1	884269.81	35.07
HVAC-33-Q	Residential A2	HVAC_20T_LN	Carrier Low Noise 20-T	81.3	0	1	228687.56	884250.51	35.07
HVAC-33-R	Residential A2	HVAC_20T_LN	Carrier Low Noise 20-T	81.3	0	1	228699.48	884258.77	35.07
HVAC-33-S	Residential A2	HVAC_20T_LN	Carrier Low Noise 20-T	81.3	0	1	228649.64	884260.12	35.07
HVAC-33-T	Residential A2	HVAC_20T_LN	Carrier Low Noise 20-T	81.3	0	1	228669.34	884256.95	35.07
HVAC-33-U	Residential A2	HVAC_20T_LN	Carrier Low Noise 20-T	81.3	0	1	228683.91	884263.32	35.07
HVAC-33-V	Residential A2	HVAC_20T_LN	Carrier Low Noise 20-T	81.3	0	1	228679.84	884225.62	35.07
HVAC-33-W	Residential A2	HVAC_20T_LN	Carrier Low Noise 20-T	81.3	0	1	228674.7	884240.75	35.07
HVAC-33-X	Residential A2	HVAC_20T_LN	Carrier Low Noise 20-T	81.3	0	1	228659.99	884233.26	35.07
HVAC-33-Y	Residential A2	HVAC_20T_LN	Carrier Low Noise 20-T	81.3	0	1	228658.99	884247.41	35.07
HVAC-34-A	Residential B	HVAC_20T_LN	Carrier Low Noise 20-T	81.3	0	1	228850.54	884281.38	31.96
HVAC-34-B	Residential B	HVAC_20T_LN	Carrier Low Noise 20-T	81.3	0	1	228842.26	884284.15	31.96
HVAC-34-C	Residential B	HVAC_20T_LN	Carrier Low Noise 20-T	81.3	0	1	228833.81	884287.07	31.96
HVAC-34-D	Residential B	HVAC_20T_LN	Carrier Low Noise 20-T	81.3	0	1	228825.92	884289.83	31.96
HVAC-34-E	Residential B	HVAC_20T_LN	Carrier Low Noise 20-T	81.3	0	1	228831.53	884296.06	31.96
HVAC-34-F	Residential B	HVAC_20T_LN	Carrier Low Noise 20-T	81.3	0	1	228835.24	884306.41	31.96
HVAC-34-G	Residential B	HVAC_20T_LN	Carrier Low Noise 20-T	81.3	0	1	228838.87	884316.75	31.96
HVAC-34-H	Residential B	HVAC_20T_LN	Carrier Low Noise 20-T	81.3	0	1	228842.66	884326.85	31.96
HVAC-34-I	Residential B	HVAC_20T_LN	Carrier Low Noise 20-T	81.3	0	1	228845.65	884336.01	31.96
HVAC-34-J	Residential B	HVAC_20T_LN	Carrier Low Noise 20-T	81.3	0	1	228849.13	884345.79	31.96
HVAC-34-K	Residential B	HVAC_20T_LN	Carrier Low Noise 20-T	81.3	0	1	228851.81	884354.48	31.96
HVAC-34-L	Residential B	HVAC_20T_LN	Carrier Low Noise 20-T	81.3	0	1	228854.5	884361.9	31.96
HVAC-34-M	Residential B	HVAC_20T_LN	Carrier Low Noise 20-T	81.3	0	1	228863.2	884356.6	31.96

Cadna Sources

Name	Building	Value	Unit	Sound Power	Correction	Height	Coordinates		
				(dBA)	dB(A)	(m)	X (m)	Y (m)	Z (m)
HVAC-34-N	Residential B	HVAC_20T_LN	Carrier Low Noise 20-T	81.3	0	1	228872.95	884353.11	31.96
HVAC-34-O	Residential B	HVAC_20T_LN	Carrier Low Noise 20-T	81.3	0	1	228882.47	884349.59	31.96
HVAC-34-P	Residential B	HVAC_20T_LN	Carrier Low Noise 20-T	81.3	0	1	228890.31	884346.67	31.96
HVAC-34-Q	Residential B	HVAC_20T_LN	Carrier Low Noise 20-T	81.3	0	1	228899.88	884345.64	31.96
HVAC-34-R	Residential B	HVAC_20T_LN	Carrier Low Noise 20-T	81.3	0	1	228897.75	884338.53	31.96
HVAC-34-S	Residential B	HVAC_20T_LN	Carrier Low Noise 20-T	81.3	0	1	228894.67	884329.85	31.96
HVAC-34-T	Residential B	HVAC_20T_LN	Carrier Low Noise 20-T	81.3	0	1	228891.91	884321.52	31.96
HVAC-34-U	Residential B	HVAC_20T_LN	Carrier Low Noise 20-T	81.3	0	1	228889.23	884314.06	31.96
HVAC-34-V	Residential B	HVAC_20T_LN	Carrier Low Noise 20-T	81.3	0	1	228886.23	884306.01	31.96
HVAC-34-W	Residential B	HVAC_20T_LN	Carrier Low Noise 20-T	81.3	0	1	228883.7	884297.96	31.96
HVAC-34-X	Residential B	HVAC_20T_LN	Carrier Low Noise 20-T	81.3	0	1	228880.54	884289.43	31.96
HVAC-34-Y	Residential B	HVAC_20T_LN	Carrier Low Noise 20-T	81.3	0	1	228877.23	884278.86	31.96
HVAC-34-Z	Residential B	HVAC_20T_LN	Carrier Low Noise 20-T	81.3	0	1	228871.86	884273.33	31.96
HVAC-35	Residential C	HVAC	Trane 25 Ton	104.6	10.6	1	228832.29	884180.31	31.97
Trash Compactor		Compactor		90.4	0	1.52	228456.4	884044.17	20.72
Idling Truck #1		Idling_Truck		95.5	0	2	228445.35	883584.91	18.98
Backup Alarm #1		Backup_Alarm		104.2	0	1	228445.55	883584.84	17.98
Backup Alarm #2		Backup_Alarm		104.2	0	1	228372.88	883717.36	20.07
Backup Alarm #3		Backup_Alarm		104.2	0	1	228356.61	883873.4	20.2
Idling Truck #2		Idling_Truck		95.5	0	2	228372.48	883717.49	21.08
Idling Truck #3		Idling_Truck		95.5	0	2	228356.98	883873.33	21.2
Idling Truck #4		Idling_Truck		95.5	0	2	228455.84	884068.09	21.2
Idling Truck #5		Idling_Truck		95.5	0	2	228471.86	884125.77	21.2
Truck Reefer Unit		Reefer		96.8	0	2	228455.62	884068.07	21.2