Appendix G
Noise Assessment

Dudek 2023

Environmental Noise and Vibration Assessment
NCSD BIOMASS ENERGY SYSTEM PROJECT

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Prepared for:

NORTHSTAR COMMUNITY SERVICES DISTRICT
900 Northstar Drive
Truckee, CA 96161
Contact: Eric Martin, District Engineer

Prepared by:

DUDEK
853 Lincoln Way, Suite 105
Auburn, CA 95603
Contact: Michael Carr, INCE

Michael Carr, INCE
Senior Acoustician

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Acronyms and Abbreviations

Acronym/Abbreviation	Definition
ANSI	American National Standards Institute
Caltrans	California Department of Transportation
CEQA	California Environmental Quality Act
CNEL	Community Noise Equivalent Level
dB	decibel
dBA	A-weighted decibel
ERO	environmental review officer
FHWA	Federal Highway Administration
FTA	Federal Transit Administration
HVAC	heating, ventilation, and air conditioning
In./sec.	inches per second
L_{dn}	day-night sound level
L_{eq}	equivalent sound level
NSLU	Noise-sensitive land use
PPV	peak particle velocity

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1 Introduction

This report reviews applicable noise standards and criteria, evaluates the existing noise environment, describes modeling assumptions and methodologies used to predict noise impacts and effects associated with the proposed NCSD Biomass Energy System Project (project). The report assesses the potential for project-generated noise levels to result in noise impacts on nearby noise-sensitive receptors. Appendix A provides a discussion of acoustical fundamentals and terminology used in this report. Appendix B presents the ambient noise modeling and C thru D provide noise modeling inputs and resulting noise level exposure for construction and traffic noise.

1.1 Project Description

The Northstar Community Services District (NCSD) proposes to build a biomass energy system to meet heating loads that are currently served by natural gas-fired boilers in approximately 14 buildings in the Northstar California ski resort community. The new energy system will consist of two wood chip-fired hot water boilers located on NCSD property at 908 Northstar Drive. A thermal energy distribution pipeline would be installed below-grade along Northstar Drive, from the biomass facility to 4001 Northstar Drive, 8001 Northstar Drive, The Village at Northstar and the Northstar Property Owners Association (NPOA) Recreation Center. Heating loads include a range of residential and commercial space heating, domestic hot water, and swimming pools and spas.

To power the proposed biomass energy system, NCSD would draw organic fuel composed of woody biomass generated from the existing NCSD defensible space and forest fuels management programs and obtained from Tahoe Truckee Sierra Disposal (TTSD). The proposed biomass energy system would employ two biomass boilers with a total capacity of approximately 6.8 MMBtu/hr. and a 3,500-gallon thermal storage tank. The system would be expected to generate 50,735 MMBtu annually by processing 3,500 BDT of material. Existing natural gas boilers within the connected facilities would remain in service to provide backup service, meet peak demand, and serve residual heating loads during periods when the biomass system is operating below maximum capacity.

The project location is shown on Figure 1 and the site plan is shown in Figure 2.

1.2 Noise Analysis Study Area

As shown in Figure 1, Project Location, the project is located within the Northstar California community, which is located approximately six miles southeast of the City of Truckee off of California State Route 267 (SR 267). The project site extends from the NCSD property, located at 908 Northstar Drive, north of the Northstar Drive and Silver Strike intersection, and continues south along Northstar Drive to The Village at Northstar, and the NPOA Recreation Center.

The 908 Northstar Drive portion of the proposed project is bounded by Northstar Drive to the south/ southeast, forest lands to the north, south and east, with medium-density and low-density residential located beyond the forest lands and across Northstar Drive. The project would not change the land uses within the project site, with the exception of replacing the existing building at 908 Northstar Drive, which is currently used as a preschool/day care center.

2 Existing Noise Environment

The proposed project is located in the eastern portion of Placer County, approximately six miles south of the City of Truckee California and approximately five and one-half miles north of Kings Beach, California (a census designated place on the north shore of Lake Tahoe, in Placer County, California), just west of SR 267. The primary project site for the biomass facility (908 Northstar Drive) is zoned as Forestry, with the northern-most portion of the site Office/Professional. The pipeline portion of the project traverses areas zoned Single-Family and Multi-Family Residential; as well as, Resort and Forestry.

The dominant noise source affecting the overall area is transportation noise, primarily generated from vehicular traffic on the local roadway network, SR 267 and aircraft overflights, primarily associated with the Truckee Tahoe Airport. The existing ambient noise environment in the project area was quantified through a noise measurement survey of the existing area and through the application of accepted noise prediction methodologies, based on industry-standard references. Separate discussions of identified major noise sources and their respective effects are provided in the following sections.

2.1 Existing Sensitive Land Uses

Sensitive land uses generally include those uses where exposure to noise would result in adverse effects, as well as uses where quiet is an essential element of the intended purpose. Land uses that are used for relaxation, rest, meditation, learning, and rehabilitative care are of primary concern because of the potential for increased and prolonged exposure of individuals to both interior and exterior noise levels. These noise-sensitive receptor types typically include residential units, transient lodging, houses of worship, schools, libraries, hospitals, childcare and similar facilities.

Existing land uses within the immediate project vicinity consist of single-family and multi-family residential, and transient residential uses (GP designation Tourist/Resort Commercial). Sensitive land uses in the vicinity of the biomass portion proposed project (908 Northstar Drive) are the existing multi-family residences located north, south and west of the biomass facility project site; with the nearest residential receptor being approximately 200 feet south of the proposed biomass building.

2.2 Existing Ambient Noise Survey

An ambient noise survey was performed by Dudek on April 27 and 28, 2022, to document the existing noise environment in the project area. Noise measurements were performed in accordance with American National Standards Institute (ANSI) and American Standards for Testing and Measurement guidelines. Long-term noise monitoring was performed at one (1) location to document 24-hour noise levels and the diurnal noise patterns near the proposed project site and nearby noise-sensitive receptors. Short-term noise monitoring was conducted at two (2) locations to provide additional insight into the existing ambient noise environment in the proposed project vicinity. During the ambient noise monitoring, traffic noise measurements with concurrent vehicle classification counts performed. Ambient monitoring locations are shown on Figure 1. Additional information on the ambient noise level monitoring locations are summarized in Table 1, with additional monitoring data and conditions provided in Appendix B.

Noise measurements were performed using Larson Davis Model 831 precision integrating sound level meters (SLMs). Field calibrations were performed on the SLMs with an acoustic calibrator before and after the measurements. The equipment used meets all pertinent specifications of ANSI for Type 1 sound level meters (ANSI S1.4-1983 [R2006]). Meteorological conditions during the monitoring period were stable with average temperatures of approximately 57°F; winds between 0 and 8 mph, with gusts up to 25 mph, and an average humidity of 29% during the short-term measurement period. The sky was clear with periods of temporary clouds and no precipitation occurring during the monitoring period.

The primary noise sources affecting the noise monitoring locations was vehicular traffic on the regional roadway network and aircraft overflights. Additional noise sources experienced during the noise-monitoring program included noise from the natural environment.

Table 1. Summary of Ambient Noise Measurements

Site	Location[1]	Time/Date[2]	Ldn	Average Noise Levels, dBA					
				Daytime			Nighttime		
				L_{eq}	L_{max}	L_{90}	L_{eq}	L_{max}	L_{90}
Long-Term Monitoring – April 27, 2022 (24-Hour Duration)									
LT-1	North of 3010 Silver Strike	12:00 a.m.	54.6	54.0	68.0	44.6	46.0	59.4	38.6
Short-Term Monitoring – April 28, 2022 (15-Minute Duration)									
ST-1	East of 5006 Gold Bend	11:40 a.m.	47.8	48.6	61.7	41.0	–	–	–
ST-2	West of 3097 Silver Strike	12:05 p.m.	55.3	54.6	66.1	44.4	–	–	–

Source: Dudek performed for this analysis.
Notes: dBA = A-weighted decibels; L_{dn} = Day Night noise level; L_{eq} = energy-equivalent average noise level; Lmax = maximum noise level; L90 = sound level exceeded 90 percent of the period.
1 – Locations of noise monitoring sites are shown on Figure 1.
2 – Long-term measurement was 24-hours in duration, Short-term noise measurements were 15-minutes in duration.

2.3 Existing Traffic Noise

Observations and cataloged noise level data collected during the ambient noise survey indicate that the noise level exposure at receptors in the area surrounding the project site is primarily attributable to vehicular traffic. The magnitude of the noise level exposure at each receptor location would be dependent on the relative distance from nearby roadways to noise measurement locations, the volume of vehicles on the roadway, and shielding provided by nearby structures.

To determine existing traffic noise levels, the average daily traffic volumes for the Northstar Drive, adjacent to the project site were used as inputs to the Federal Highway Administration (FHWA) traffic noise modeling prediction methodologies. The FHWA traffic noise modeling algorithms incorporate sound emissions and sound propagation algorithms based on well-established theory and accepted international standards. The acoustical algorithms contained within the FHWA traffic noise model have been validated with respect to carefully conducted noise measurement programs and show excellent agreement in most cases for sites with and without noise barriers. The noise modeling accounted for factors such as vehicle volume, speed, vehicle type, roadway configuration, distance to the receiver, and propagation over different types of ground (acoustically soft and hard ground).

In order to ensure that modeled existing traffic noise levels correlate with measured traffic noise levels, observations and concurrent traffic counts collected during short-term noise monitoring, the measured noise levels and the annual average daily traffic volumes were used to calibrate the traffic model. Modeled average traffic noise levels, based on the traffic counts and mix of vehicle type were found to be reasonably consistent with the traffic calibration measurement conducted at the project site. The difference between measured and predicted noise levels 0.7 dB, which is within the tolerances of the traffic noise prediction model and the calibration methodology provided by the California Department of Transportation (Caltrans) (Caltrans 2013), as such calibration offsets were not applied to the model.

Modeled traffic noise levels are summarized in Table 2, based on the traffic volumes contained within the Northstar Mountain Master Plan (LSC Transportation Consultants, Inc. 2013) and vehicle classification percentages observed during the monitoring survey. The traffic data includes volumes for the “existing” 2012, and the “long-term (2032) cumulative” winter and summer intersection volumes. The traffic noise levels were modeled at reference setback distances representing the property line of noise-sensitive receptors adjacent to Soledad Canyon Rd. and the receptors nearest to Commuter Way.

Table 2. Summary of Modeled Existing Traffic Noise Levels

Site	Roadway	AADT	Distance from Roadway CL to Receptor	Modeled Day/Night Noise Level, dBA Ldn
Existing (2012)				
P-1	Northstar Drive - Winter	14,450	67.5 feet	65.8
P-1	Northstar Drive - Summer	4,510	67.5 feet	60.8
Cumulative (2032)				
P-1	Northstar Drive - Winter	16,440	67.5 feet	66.4
P-1	Northstar Drive - Summer	6,720	67.5 feet	62.5

Source: Based on traffic noise analysis performed by Dudek 2023, and traffic volumes from the Northstar Mountain Master Plan Transportation Impact Analysis, LSC Transportation Consultants, Inc. 2013.
Notes: AADT = Annual Average Daily Traffic volumes; CL = Centerline; dBA = A-weighted decibels; L_{dn} = Day Night noise level.
Locations of receivers are shown on Figure 1.

As shown in Table 2, existing (2012) traffic noise levels at the receivers representing the residential setback distances near the project site, adjacent to Northstar Drive were modeled to be exposed to existing traffic noise levels of approximately 61 dBA Ldn during summer months. During winter months, traffic volumes along Northstar Drive have been shown to increase from the summer AADT of 4,510 vehicle trips to an AADT of 14,450 vehicle trips; resulting in modeled existing traffic noise levels of approximately 66 dBA Ldn during winter months.

As the “existing” traffic volumes presented in the Northstar Mountain Master Plan are for the 2012 year and the “cumulative” traffic volumes presented are for the 2032 year, actual existing traffic volumes for the current year, 2023, would likely be between the traffic volumes presented for the existing 2012 and cumulative 2032 scenarios. However, for the purposes of determining a project impact, using the lower 2012 traffic volumes would be a more conservative approach, which will be utilized in this analysis.

2.4 Existing Aircraft Operations

The project site is approximately 2.4 miles southwest of the Truckee Tahoe Airport (KTRK), runway 29. The proposed project location is not located within any currently adopted 60, 65 or 70 dBA community noise equivalent level (CNEL)\L_{dn} airport noise contours (Truckee Tahoe Airport Land Use Commission 2016). As such, while the proposed project area may experience aircraft overflights, noise associated with existing and future aircraft operations in the area is not a substantial contributor to the ambient noise environment.

2.5 Existing Vibration

There are no major sources of groundborne vibration in the project area. Transportation-related vibration from roadways in the vicinity of the project site is the primary source of groundborne vibration. Heavy truck traffic can generate groundborne vibration, which varies considerably depending on vehicle type, weight, and pavement conditions. However, groundborne vibration levels generated from vehicular traffic are not typically perceptible outside of the roadway right-of-way (Caltrans 2013).

3 Regulatory Criteria

Placer County has developed and adopted goals and policies with the intent of controlling and diminish environmental noise and to protect its inhabitants from exposure to excessive noise levels. Local noise standards applicable to the proposed Project are contained in Placer County General Plan in the Placer County Code of Ordinances and in the Newcastle-Ophir General Plan (Community Plan).

3.1 Placer County General Plan Noise Element

Applicable noise standards in Placer County General Plan are contained within Chapter IV, Element E of the General Plan (Noise Element). The Noise Element contains specific goals, policies and standards for use in planning and land compatibility determinations within Placer County. The Noise Element establishes exterior noise level standards and maximum allowable noise exposure levels from transportation and non-transportation (stationary) noise sources at noise-sensitive land uses. The following standards and policies of the Noise Element are relevant to the proposed Project.

Goal 9.A To protect County residents from the harmful and annoying effects of exposure to excessive noise.

Policy 9.A.2 Noise created by new proposed non-transportation noise sources shall be mitigated so as not to exceed the noise level standards of Table 9-1 as measured immediately within the property line of lands designated for noise-sensitive uses: provided, however, the noise created by occasional events occurring within a stadium on land zoned for university purposes may temporarily exceed these standards as provided in an approved Specific Plan.

Policy 9.A.5 Where proposed non-residential land uses are likely to produce noise levels exceeding the performance standards of Table 9-1 at existing or planned noise-sensitive uses, the County shall require submission of an acoustical analysis as part of the environmental review process so that noise mitigation may be included in the project design. The requirements for the content of an acoustical analysis are listed in Table 9-2.

Policy 9.A.12 Where noise mitigation measures are required to achieve the standards of Tables 9-1 and 9-3, the emphasis of such measures shall be placed upon site planning and project design. The use of noise barriers shall be considered as a means of achieving the noise standards only after all other practical design-related noise mitigation measure have been integrated into the project.

Goal 9.B. To ensure that areas designated for industrial uses pursuant to Goal 1.E. and Policy 1.E.1. are protected from encroachment by noise-sensitive land uses.

Policy 9.B.2 The County shall apply noise standards in a manner consistent with encouraging the retention, expansion, and development of new businesses pursuant to Goal 1.N. and Policy 1.N.2.

Table 3. Allowable Ldn Noise Levels Within Specified Zone Districts[1]
Applicable to New Projects Affected by or Including Non-Transportation Noise Sources (Table 9-1 of the General Plan)

Zone District of Receptor	Property Line of Receiving Use	Interior Spaces[2]
Residential Adjacent to Industrial[3]	60	45
Other Residential[4]	50	45
Office/Professional	70	45
Transient Lodging	65	45
Neighborhood Commercial	70	45
General Commercial	70	45
Heavy Commercial	75	45
Limited Industrial	75	45
Highway Service	75	45
Shopping Center	70	45
Industrial	--	45
Industrial Park	75	45
Industrial Reserve	--	--
Airport	--	45
Unclassified	--	--
Farm	(see footnote 6)	--
Agriculture Exclusive	(see footnote 6)	--
Forestry	--	--
Timberland Preserve	--	--
Recreation & Forestry	70	--
Open Space	--	--
Mineral Reserve	--	--

Notes:

- Except where noted otherwise, noise exposures will be those which occur at the property line of the receiving use.
- Where existing transportation noise levels exceed the standards of this table, the allowable Ldn shall be raised to the same level as that of the ambient level.

- If the noise source generated by, or affecting, the uses shown above consists primarily of speech or music, of if the noise source is impulsive in nature, the noise standards shown above shall be decreased by 5 dB.
- Where a use permit has established noise level standards for an existing use, those standards shall supersede the levels specified in Table 9-1 and Table 9-3. Similarly, where an existing use which is not subject to a use permit causes noise in excess of the allowable levels in Tables 9-1 and 9-3, said excess noise shall be considered the allowable level. If a new development is proposed which will be affected by noise from such an existing use, it will ordinarily be assumed that the noise levels already existing or those levels allowed by the existing use permit, whichever are greater, are those levels actually produced by the existing use.
- Existing industry located in industrial zones will be given the benefit of the doubt in being allowed to emit increased noise consistent with the state of the art5 at the time of expansion. In no case will expansion of an existing industrial operation because to decrease allowable noise emission limits. Increased emissions above those normally allowable should be limited to a one-time 5 dB increase at the discretion of the decision making body.
- The noise level standards applicable to land uses containing incidental residential uses, such as caretaker dwellings at industrial facilities and homes on agriculturally zoned land, shall be the standards applicable to the zone district, not those applicable to residential uses.
- Where no noise level standards have been provided for a specific zone district, it is assumed that the interior and/or exterior spaces of these uses are effectively insensitive to noise.

1 Overriding policy on interpretation of allowable noise levels: Industrial-zoned properties are confined to unique areas of the County, and are irreplaceable. Industries which provide primary wage-earner jobs in the County, if forced to relocate, will likely be forced to leave the County. For this reason, industries operating upon industrial zoned properties must be afforded reasonable opportunity to exercise the rights/privileges conferred upon them be their zoning. Whenever the allowable noise levels herein fall subject to interpretation relative to industrial activities, the benefit of the doubt shall be afforded to the industrial use.

Where an industrial use is subject to infrequent and unplanned upset or breakdown of operations resulting in increased noise emissions, where such upsets and breakdowns are reasonable considering the type of industry, and where the industrial use exercises due diligence in preventing as well as correcting such upsets and breakdowns, noise generated during such upsets and breakdowns shall not be included in calculations to determine conformance with allowable noise levels.

2 Interior spaces are defined as any locations where some degree of noise-sensitivity exists. Examples include all habitable rooms of residences, and areas where communication and speech intelligibility are essential, such as classrooms and offices.

3 Noise from industrial operations may be difficult to mitigate in a cost-effective manner. In recognition of this fact, the exterior noise standards for residential zone districts immediately adjacent to industrial, limited industrial, industrial park, and industrial reserve zone districts have been increased by 10 dB as compared to residential districts adjacent to other land uses.

4 For purposes of the Noise Element, residential zone districts are defined to include the following zoning classifications: AR, R-1, R-2, R-3, FR, RP, TR-1, TR-2, TR-3, and TR-4.

5 Where a residential zone district is located within an -SP combining district, the exterior noise level standards are applied at the outer boundary of the -SP district. If an existing industrial operation within an -SP district is expanded or modified, the noise level standards at the outer boundary of the -SP district may be increased as described above in these standards.

6 Where a new residential use is proposed in an -SP zone, an Administrative Review Permit is required, which may require mitigation measures at the residence for noise levels existing and/or allowed by use permit as described under "NOTES," above, in these standards.

7 State of the art should include the use of modern equipment with lower noise emissions, site design, and plant orientation to mitigate offsite noise impacts, and similar methodology.

8 Normally, agricultural uses are noise insensitive and will be treated in this way. However, conflicts with agricultural noise emissions can occur where single-family residences exist within agricultural zone districts. Therefore, where effects of agricultural noise upon residences located in these agricultural zones is a concern, an Ldn of 70 dBA will be considered acceptable outdoor exposure at a residence.

Source: Placer County, General Plan Noise Element, Table 9-1

3.2 Placer County Code

The Placer County Noise Ordinance is codified in Article 9.36 of the Placer County Code. For noise-sensitive receptors the Placer County code, noise ordinance establishes sound level limits which are presented below.

9.36.030 Exemptions.

A. Sound or noise emanating from the following sources and activities are exempt from the provisions of this title:

7. Construction (e.g., construction, alteration, or repair activities) between the hours of six a.m. and eight p.m. Monday through Friday, and between the hours of eight a.m. and eight p. m. Saturday and Sunday Provided, however, that all construction equipment shall be fitted with factory installed muffling devices and that all construction equipment shall be maintained in good working order.

9.36.060 Sound limits for sensitive receptors.

B. It is unlawful for any person at any location to create any sound, or to allow the creation of any sound, on property owned, leased, occupied or otherwise controlled by such person that:

1. Causes the exterior sound level when measured at the property line of any affected sensitive receptor to exceed the ambient sound level by five dBA; or
2. Exceeds the sound level standards as set forth in Table 1 (Table 4 of this report), whichever is the greater.

Table 4. Sound Level Standards (On-Site).
(Table 1 of Placer County Code, Article 9.36)

Sound Level Descriptor	Daytime (7 AM to 10 PM)	Nighttime (10 PM to 7 AM)
Hourly Leq, dB	55	45
Maximum Level, (Lmax) dB	70	65

Source: Placer County Code, Article 9.36, 2004

C. Each of the sound level standards specified in Table 1 (Table 4 of this report) shall be reduced by five dB for simple tone noises, consisting of speech and music. However, in no case shall the sound level standard be lower than the ambient sound level plus five dB.

D. If the intruding sound source is continuous and cannot reasonably be discontinued or stopped for a time period whereby the ambient sound level can be measured, the sound level measured while the source is in operation shall be compared directly to the sound level standards of Table 1 (Table 4 of this report). (Ord. 5280-B, 2004)

9.36.080 Exceptions.

B. If the applicant can show to the county that a diligent investigation of available sound suppression techniques for construction-related noise indicates that immediate compliance with the requirements of this article would be impractical or unreasonable, due to the temporary nature or short duration of the exception, a permit to allow exception from the provisions contained in all or a portion of this article may be issued. Factors that the approving authority must consider for construction related exceptions shall include but not be limited to the following:

1. Conformance with the intent of this article;
2. Uses of property and existence of sensitive receptors within the area affected by sound;
3. Factors related to initiating and completing all remedial work;
4. The time of the day or night the exception will occur;
5. The duration of the exception; and
6. The general public interest, welfare and safety.

4 Methodology

Potential noise impacts associated with the Project were calculated and analyzed based on Project information presented in the Project Description, information contained in the Project site plan provided by the applicant, and data obtained during on-site noise monitoring. Observations made during the site survey, along with land-use information and aerial photography, was used to determine potential locations of noise-sensitive receptors in the

Short-term, construction-related noise effects were assessed with respect to nearby noise-sensitive receptors and their relative exposure, based on application of FHWA Roadway Construction Noise Model (RCNM) and Federal Transit Administration (FTA) reference noise level data and usage-factors.

Traffic noise levels for the roadway network in the Project vicinity were modeled based on traffic volume data obtained from the Northstar Mountain Master Plan Traffic Impact Assessment (LSC 2013). Traffic noise levels were calculated using the FHWA traffic noise prediction algorithms. Traffic noise levels were modeled for the existing (2012) and future cumulative (2032) traffic scenarios for winter and summer traffic volumes. Traffic associated with the NCSD Biomass project was evaluated on a more qualitative level, through comparison of the biomass trip generation rates to the Northstar MMP traffic volumes.

Potential effects associated with long-term (operation-related) noise sources were assessed based on project documentation, site reconnaissance data and reference noise level for the various noise sources. The ISO 9613 sound propagation model for stationary noise sources was implemented for this project. This international standard propagation model is used in the U.S. and abroad for stationary noise sources, due to its accurate and reliable propagation equations; which, account for variations in terrain and ground type.

Groundborne vibration impacts were qualitatively assessed based on existing reference documentation (e.g., vibration levels produced by specific construction equipment operations), through the application of Caltrans methodology outlined within the Transportation- and Construction- Induced Vibration Guidance Manual, and the relative distance to potentially sensitive receptors from a given vibration source.

5 Project Analysis

5.1 Construction Noise

Development of the proposed project would generate noise levels associated with the operation of heavy construction equipment and construction-related activities in the project area. It is anticipated that the Project would be constructed in five phases associated with the Biomass facility (908 Northstar Drive) and three phases associated with pipeline construction, tentatively beginning in July 2023 and concluding in January 2024. The Project construction at the 908 Northstar Drive site would involve demolition of any elements remaining from the previous use and site preparation, grading, building construction, paving and boiler plant equipment installation. The thermal energy distribution portion of the project would involve trenching and installation of distribution pipeline, pipeline connection to existing buildings via the heat exchangers, and backfilling and paving of the trench. The construction activities associated with this project are anticipated to occur between 6:00 a.m. and 8:00 p.m., Monday through Friday, with limited work potentially occurring on Saturday during daytime hours of 8:00 a.m. to

8:00 p.m., in compliance with the Placer County Code of Ordinance. Nighttime construction activities are not anticipated.

Construction noise levels in the project area would fluctuate depending on the particular type, number, and duration of usage for the various pieces of equipment, as well as the relative exposure and distance between the source and receptors during the different stages of construction. The typical maximum noise levels for various pieces of construction equipment at a distance of 50 feet are presented in Table 5. Note that the equipment noise levels presented in Table 5 are maximum noise levels. Usually, construction equipment operates in alternating cycles of full power and low or no power, producing average noise levels over time that are less than the maximum noise level. This is accounted for through the use of an “acoustical usage factor”, expressing the percentage of time a piece of equipment is typically operational. The sound level produced by the construction activity also depends on where the equipment actually operates onsite and the intensity of construction activities.

Table 5. Typical Construction Equipment Maximum Noise Levels

Equipment Type	Typical Equipment (Lmax, dBA at 50 Feet)
All Other Equipment > 5 HP	85
Backhoe	78
Compressor (air)	78
Concrete Saw	90
Crane	81
Dozer	82
Excavator	81
Flat Bed Truck	74
Front End Loader	79
Generator	72
Grader	85
Man Lift	75
Paver	77
Roller	80
Scraper	84
Welder / Torch	73

Source: DOT 2006. FTA 2018.
Note: L_{max} = maximum sound level; dBA = A-weighted decibels.

Biomass Facility (908 Northstar Drive)

Aggregate noise emission from proposed project construction activities, broken down by sequential phase, was predicted at two distances to the nearest existing noise-sensitive receptor: 1) from the nearest position of the construction site boundary and 2) from the geographic center of the construction site, which serves as the time-averaged location or geographic acoustical centroid of active construction equipment for the phase under study. The intent of the former distance is to help evaluate anticipated construction noise from a limited quantity of equipment or vehicle activity expected to be at the boundary for some period of time, which would be most appropriate for phases such as site preparation and grading. At the site boundary distance, the analysis assumes that up to only one piece of equipment, for each listed type per phase, will be involved in the construction activity for a limited portion of the 8-hour period. In other words, at such proximity along the boundary of the site, the operating equipment cannot “stack” or crowd the vicinity and still be able to operate. The distance from the boundary of the project's construction operations to the nearest nose-sensitive receptor (3097 Silver Strike) would be approximately 145-feet, for the biomass facility portion of the project.

The distance to the acoustical centroid is used in a manner similar to the general assessment technique as described in the FTA guidance for construction noise assessment (FTA 2018), where the location of individual equipment for a given construction phase is uncertain and where construction equipment is anticipated to operate over some extent of the construction site, near and far. For the acoustical centroid case, which intends to be a geographic average position for all equipment during the indicated phase, this analysis assumes that the equipment may be operating up to all 8 hours per day. The distance from the acoustics centroid of the project's construction operations and the nearest nose-sensitive receptor (3097 Silver Strike) would be approximately 250-feet, for the biomass facility portion of the project. Table 6 summarizes these distances to the apparent closest noise-sensitive receptor for each of the seven sequential construction phases.

Table 6. Predicted Construction Noise Levels per Activity Phase for Biomass Facility

Construction Phase (and Equipment Types Involved)	8-Hr. Leq, dBA (24-Hr. Ldn dBA) at Nearest Noise Sensitive Receptor from	
	Construction Boundary	Acoustical Centroid
Biomass Facility (908 Northstar Drive)	145-feet	250-feet
Demolition and Site Preparation (concrete saw, excavator, loader)	69.1 (64.4)	63.5 (58.8)
Grading (excavator, grader, dozer, backhoe)	69.1 (64.3)	63.5 (58.7)
Building construction (crane, excavator, forklift, backhoe, welder)	68.9 (64.1)	63.2 (58.5)
Paving (paver, roller, concrete mixer truck)	66.9 (62.1)	61.2 (56.4)
Boiler plant equipment installation (crane, forklift, welder, air compressor)	65.6 (60.8)	60.0 (55.2)

Notes: L_{eq} = equivalent noise level; dBA = A-weighted decibels.

As presented in Table 6, the predicted construction noise levels associated with equipment operating along the boundary of the project site are predicted to be as high as 69.1 dBA L_{eq} over an 8-hour period at the nearest existing residences, which would occur during the site preparation and grading phases. Modeled average construction noise levels propagated from the acoustical centroid of the construction activities are calculated to reach approximately 63.5 dBA L_{eq} over an 8-hour period at the nearest existing residences, also occurring during the site preparation and grading phases of project construction at the biomass facility site. Construction equipment noise levels for other construction activity phases are modeled to range from approximately 60 to 63 dBA L_{eq} at the nearest existing noise-sensitive receptors when propagated from the acoustical centroid of the project site.

The Placer County Municipal Code on-site daytime standard for non-transportation noise sources during daytime hours is 55 dBA L_{eq} and a maximum level standard of 70 dBA L_{max} or exceed the ambient sound level by 5 dBA. The modeled construction noise levels associated with the biomass facility would exceed the Placer County on-site non-transportation daytime hourly L_{eq} noise standard at the nearest noise-sensitive receptor. Based on the calibrated existing (2012) traffic noise model, existing ambient traffic noise levels at the nearest noise-sensitive receptor would be 60.8 dBA L_{dn} during the summer months; proposed project construction L_{dn} noise levels are modeled to range from approximately 55 to 59 dBA L_{dn} at the noise-sensitive receptor nearest the biomass facility site. As such, the proposed biomass facility construction noise levels are calculated to be less than five dBA over the ambient noise levels during the off-peak summer season (60.8 + 5 = 65.8 dBA); during the winter season, the proposed construction operations, with increased traffic volumes, the actions would have a further reduced impact on the ambient noise levels. As such, noise generated from construction of biomass facility portion of the proposed project would comply with the ambient plus five dB threshold of the Placer County Code. Additionally, the proposed project construction operations would occur within the daytime hours of Monday through Friday, 6:00 a.m. and 8:00 p.m. and 8:00 a.m. and 8:00 p.m. on Saturday and Sundays, using well-maintained equipment, in compliance with the construction exemption requirements laid out in Placer County Code section 9.36.030. Therefore, construction of the proposed biomass facility at 908 Northstar Drive would be a less than significant impact.

Thermal Energy Distribution Pipeline

As previously mentioned, the thermal energy distribution pipeline portion of the project would include digging a trench approximately 30-inch-wide and a minimum of 48-inches deep along Northstar Drive between the biomass boiler plant and The Village at Northstar, installing either two or four 8-inch diameter pre-insulated steel pipes within the trench, and backfilling the trench. The trench would generally be located below the existing pavement, and in some cases adjacent to the existing pavement. Once the underground pipeline reaches The Village, the pipeline will transition to an exposed mechanical pipeline within the existing parking garage, which will be suspended from the garage ceiling or attached to the garage wall, and transition back to underground pipeline at the southeast parking garage ramp. The pipeline would interface with the existing facilities (a.k.a. connected facilities) heating systems through the installation of an at-grade heat exchanger and meter which would heat the return water piping of the existing boiler systems at the connected facilities.

The nearest noise sensitive residential receptor adjacent to the thermal energy distribution pipeline within the Northstar Drive right-of-way, which could utilize larger pieces of heavy equipment, would be the residence located at 7249 Larkspur Court. Table 7 provides the predicted construction noise levels associated with the potential heavy construction equipment that could be utilized for the installation of the thermal energy distribution pipeline. The residence at 7249 Larkspur Court would be approximately 45-feet from the boundary of construction activities and approximately 70-feet from the acoustical centroid of pipeline construction activities, at the nearest location on the pipeline alignment.

Table 7. Predicted Construction Noise Levels per Activity Phase for the Thermal Energy Distribution Pipeline

Construction Phase (and Equipment Types Involved)	8-Hr Leq, dBA (24-Hr Ldn, dBA) at Nearest Noise Sensitive Receptor from	
	Construction Boundary	Acoustical Centroid
	45-feet	70-feet
Trenching and Pipeline Installation (tractor/backhoe, air compressor, welder)	66.4 (61.7)	62.2 (57.4)
Backfill and Paving (paver, roller, tractor/backhoe)	67.2 (62.5)	63.0 (58.2)

Notes: L_{eq} = equivalent noise level; dBA = A-weighted decibels.

As presented in Table 7, the predicted construction noise levels associated with equipment operating along the boundary of the thermal energy distribution pipeline construction are predicted to be as high as 67.2 dBA L_{eq} over an 8-hour period at the nearest existing residence, which would occur during the backfill and paving phase of the pipeline construction. Modeled average construction noise levels propagated from the acoustical centroid of the construction activities are calculated to reach approximately 63 dBA L_{eq} over an 8-hour period at the nearest existing residences, which would also occur during the backfill and phase of project construction.

These construction noise level predictions are based partially on an assumption that the construction equipment would be operating on a fixed site. However, the thermal energy distribution pipeline construction portion of the project would be a linear construction operation that progresses at a reasonably steady rate along the pipeline alignment during the continuous construction process. As a result, nearby noise sensitive receptors would not be exposed to the predicted noise levels continuously over the course of a day; rather, the residences would be exposed to limited or singular portions of the linear construction operations (trench excavation, trench preparation, pipeline placement and fitting, backfilling, paving, etc.) for considerably shorter periods of time, with limited equipment complements and commiserate reductions in construction noise level exposure.

As with the construction of the biomass processing facility, the thermal energy distribution pipeline construction would have the potential to exceed the Placer County daytime non-transportation noise level standards of 55 dBA Leq and 70 dBA Lmax, if the full complement of equipment associated with the pipeline construction were to remain operational in the immediate vicinity of the nearest noise-sensitive receptors. The pipeline construction would not result in noise levels greater than five dB over the ambient noise level threshold established within the Placer County Code section 9.36.060, based on ambient noise levels associated with the existing (2012) traffic volumes. Moreover, the pipeline construction noise levels would be reduced based on short-term operation of the smaller complement of equipment, used for the portion of the pipeline construction process that is underway at a particular time, which would progress along the linear pipeline construction alignment. Additionally, the proposed project construction operations would occur within the daytime hours of Monday through Friday, 6:00 a.m. and 8:00 p.m. and 8:00 a.m. and 8:00 p.m. on Saturday and Sundays, using well-maintained equipment, in compliance with the construction exemption requirements laid out in Placer County Code section 9.36.030. Therefore, construction of the proposed biomass facility at 908 Northstar Drive would be a less than significant impact.

5.2 Construction Vibration

Construction activities on the proposed project sites (biomass facility and thermal energy distribution pipeline) may result in varying degrees of temporary groundborne vibration, depending on the specific construction equipment used and operations involved. For the potential for continuous/frequent intermittent vibration to result in damage to structures, Caltrans indicates a threshold of 0.5 in/sec PPV for “new residential construction” (Caltrans 2020), such as the types of structures in the proposed project vicinity. Representative groundborne vibration levels for various types of construction equipment that may be associated with the proposed project are summarized below in Table 8 at a reference distance of 25 feet (FTA 2018).

Groundborne vibration attenuates rapidly, even over short distances, with vibration levels varying depending on soil conditions, construction methods, and the equipment used. The attenuation of groundborne vibration as it propagates from source to receptor through intervening soils and rock strata can be estimated with expressions found in FTA and Caltrans guidance. Based on the 25-foot reference levels, construction vibration levels were calculated using standard Caltrans and FTA equations at a distance of 45 feet to the west, to represent the closest existing structure, which would be the residence located at 7249 Larkspur Court.

Table 8. Representative Vibration Levels for Construction Equipment

Equipment	PPV (in/sec)	
	25 feet (Reference Level)	45 feet[1,2]
Hydraulic Breaker/Hoe Ram	0.089	0.037
Caisson Drilling	0.089	0.037
Heavy-duty Trucks (Loaded)	0.076	0.031
Jackhammer	0.035	0.014
Small Bulldozer	0.003	0.001

Source: FTA 2018.
Notes: PPV = peak particle velocity; in/sec = inches per second.
1 Vibration levels can be approximated at other locations and distances using the above reference levels and the following equation: PPVequip = PPVref $(25/D)^{1.5}$ (in/sec); where "PPV ref" is the given reference value in the above table (25-feet), "D" is the distance for the equipment to the new receiver in feet.
2 Representative of the exposure of the closest existing structure (to the south).

As shown in Table 8, project-generated groundborne noise and vibration levels at nearby sensitive receptors are not predicted to exceed the Caltrans recommended damage criteria of 0.5 in/sec PPV for the potential to damage new construction (Caltrans 2020). As such, predicted project-generated construction vibration levels would be a less than significant impact.

5.3 Long-Term Operational Noise Sources

Building Mechanical/HVAC

Building mechanical equipment associated with the long-term occupation of conditioned spaces generally can include HVAC equipment, backup generators, and various fans, pumps, and compressors that can be significant noise sources. HVAC equipment serving commercial spaces is often mounted on rooftops, partially enclosed at grade adjacent to buildings, or located within enclosed mechanical equipment rooms, with residential HVAC outdoor equipment located at-grade. Noise levels generated by the HVAC and other mechanical equipment vary significantly depending on unit size, efficiency, location, type of rotating or reciprocating components, and orientation of openings.

HVAC equipment for the proposed project is assumed to be located at-grade, adjacent to the biomass facility conditioned spaces. Information provided by the project proponent indicates that HVAC equipment for the conditioned portions of the biomass facility is anticipated to include a Mitsubishi "mini-split" style system, consisting of one outdoor condenser unit and two indoor fan-coil units (1 ea. PUZ-HA24NHA1 and 2 ea. PEAD-A12AA7). The outdoor unit would be located adjacent to the proposed biomass facility structure, typically near the indoor conditioned spaces. Based on manufacturer reference information provided by the project proponent, the outdoor unit has a sound power rating[1] (L_w dB) of up to 95 dB.

Assuming typical stationary non-transportation noise source attenuation of 6 dB per doubling of distance, the outdoor unit of the HVAC system associated the proposed biomass facility would generate a noise exposure of 46 dB L_{eq}, if the outdoor unit was to remain active 100% of the time during peak operations. However, HVAC systems typically operate under more restricted cycle times, reducing generated noise levels commensurate to the

1 sound power (L_w) is the acoustic energy capable of being produced by an object and directly radiated out into the environment (energy radiated regardless of location), which is different from the sound pressure produced by a sound source at a distance (SPL, or L_p often presented as L).

operational time. Additionally, accounting for additional noise level reductions provided by terrain, vegetation, atmospheric attenuation, excess ground absorption and partial shielding provided by intervening objects, the HVAC noise level would be reduced to below the Placer County Code non-transportation standard of 45 dBA L_{eq} during nighttime periods (10:00 p.m. to 7:00 a.m. Therefore, the HVAC noise levels modeled for the proposed project are anticipated to comply with the Placer County non-transportation noise level thresholds and would be considered a less-than-significant impact.

On-Site Haul-Truck Operations

The proposed project incorporates transportation of loose and chipped material to the biomass facility for processing and transportation of processed material/ash for off-site disposal. These material transportation operations are anticipated to be performed by haul-trucks/dump trucks (aka, heavy trucks in FHWA nomenclature). NCSD currently anticipates approximately 3,800 bone-dry-tons (BDT), approximately 30,000 cubic yards (yds^3), of material per year. This would result in approximately 275 to 330 haul truck trips per year, or approximately one haul-truck per day, with a maximum of two haul-trucks per day during peak operations which would typically occur during the winter months.

On-site noise associated with the activities of the haul-trucks would typically include vehicles entering and exiting the site, temporary idling (limited to 5-minutes in one location per California regulations), setting and releasing of air brakes, doors opening and closing, and back-up alarms/parking activities at the docks and parking areas. Based on the FTA Transit Noise and Vibration Impact Assessment Manual, the reference source noise levels at a distance of 50-feet from the operational centerline would range from 80 to 83 dBA SEL (Sound Exposure Level)[2] during a pass-by event.

Assuming that one haul truck operation would result in one in-bound and one out-bound trip within a one-hour period the energy equivalent average for tow haul truck vehicle trips are calculated to result in a noise levels between approximately 47 and 50 dBA L_{eq} at 3010 Silver Strike (a distance of 275-feet from the dock of the proposed biomass facility. Additionally, the noise exposure at 3010 Silver Strike from the haul trucks at the dock would be shielded by the biomass facility building and the adjacent Northstar Fire Department building, which would result in an additional noise level reduction of 5 dB or more simply by breaking line of site. The on-site haul truck noise at the dock area would generate a noise exposure levels between approximately 45 and 48 dBA L_{eq} at the nearest noise-sensitive receptors to the northwest, the eastern façade of 5006 Gold Bend. Additionally, the modeled on-site truck noise levels would be below the ambient noise levels. Therefore, project noise levels generated by heavy truck activity during a peak hour are predicted to comply with the Placer County Code non-transportation noise level thresholds and the relative increase threshold of +5 dB over the ambient. As such, noise levels generated by on-site heavy truck activity would be considered a less-than-significant impact.

Off-site Project Generated Traffic Noise

As discussed, the proposed project would result in the creation of additional vehicle trips, from heavy truck/haul-truck traffic on local roadways in the vicinity of the project. The proposed biomass facility would potentially result in two haul trucks accessing the site for delivery of biomass material and collection of processed materials/ash, for a total of four additional heavy truck trips potentially occurring during peak operations.

[2] SEL – Sound Exposure Level is the acoustic energy produced by a source or operation, summed into one-second.

Potential off-site noise impacts resulting from the increase in vehicular traffic on the local roadway network, associated with long-term operations of the proposed project, were conservatively evaluated against Existing (2012) no Project and plus Project scenarios during the summer season, as the existing (2012) summer season has the lowest traffic volumes and have the greatest potential to result in an increase in traffic noise levels. Traffic volumes and the distribution of those volumes were obtained from the Northstar Mountain Master Plan (LSC Transportation Consultants, Inc. 2013). Average vehicle speeds on local area roadways were assumed to be consistent with posted speed limits and remain as such with or without implementation of the proposed project. Refer to Appendix C for modeling inputs and results.

According to Caltrans, a +3 dB change in sound is the beginning at which humans generally notice a barely perceptible change in sound, a +5 dB change is generally readily perceptible, and a +10 dB increase is perceived by most people as a doubling of the existing noise level (Caltrans 2013a). Due to the existing and proposed setting of the project, a readily perceptible change in traffic noise levels (+3 dBA change) would be an appropriate threshold to determine significant increases in traffic noise for receptors.

Existing (2012) traffic volumes, as presented in Table 2, would result in modeled existing traffic noise levels in the project vicinity ranging from approximately 61 to 66 dBA Ldn at the sensitive receptors adjacent to Northstar Drive. Development of the proposed project under the Existing (2012) scenario and addition of the four heavy truck/haul-truck vehicle trips would result in a change of 0.1 dB Ldn at the residences adjacent to Northstar Drive (3010 Silver Strike). The off-site traffic associated with the proposed project is not predicted to result in a relative increase in the ambient noise environment of +3dB or more. Therefore, traffic noise levels associated with the proposed project would be a less-than-significant impact.

Biomass Processing Equipment

Construction and implementation of the proposed project would incorporate the installation of a dual boiler biomass thermal energy system, with a total capacity of approximately 6.8 MMBtu/hr., as mentioned in the project description. The biomass boiler system would consist of a number of electric motors, conveyors, augers, fans and pumps that would contribute to the overall sound levels produced by the overall system. With the exception of the previously discussed ducted mini-split HVAC outdoor unit, these sound sources would be located within the biomass facility building. The biomass system sound sources were analyzed through the development of a three-dimensional computerized noise simulation model (SoundPlan), implementing the ISO 9613 sound propagation algorithms. The computer model was based on United States Geographic Service (USGS) digital topographic/elevation data, parcel information, building footprints and roadway data available through the Placer County Open (Geographic Information Service) GIS Data service (Placer County 2023), the building plans and additional information provided by NCSD.

The sound sources contributing to the overall sound levels generated by the proposed biomass system were located within the biomass building model based on the equipment layout included in the plan set. Reference sound pressure levels (SPLs, noise levels) and operational characteristics were provided by NCSD and the equipment manufacturers for the louder/more prominent noise sources; where reference levels were not available, levels were calculated based on empirical data for similar equipment/components. A list of the biomass system components their sound pressure levels (at a reference distance of 5-feet) and the operational characteristics are included in Table 9.

Table 9. Biomass System Component Reference Information

Component	Quantity	Horsepower	Operational Hours per Day	Noise Level, dBA @ 5-feet
Primary Air Fan	2	10	24	76
Secondary Air Fan	2	5	24	69
Tertiary Air Fan	2	3	24	68
Flue Gas Recirculation Fan	2	3	24	68
Induced Draft Fan	2	30	24	92
Oscillation motor	2	3	12	47
Travel Auger	1	5.5	12	59
Fuel Conveyor #1	1	7.5	12	66
Vibrating Conveyor	1	7.5	12	66
Fuel Conveyor #2	1	5	12	63
Metering Auger	2	1.5	24	49
Stoker Auger	2	1.5	24	49
Combustor ash Auger	2	1.5	8	49
Incline ash Auger	2	1	8	46
Main Ash Conveyor	1	7.5	6	61
Electrostatic Precipitator	2	–	24	65
Multiclone Airlock	2	0.5	6	48
Air Compressor	1	7.5	2	83
WCOG Circulation Pump	4	3	24	76

Source: Data compiled by Dudek from NCSD 2023, Messersmith 2023 and BBN 1982.
Notes: dBA = decibel A-weighted; in/sec = inches per second.
3 Electrostatic Precipitator (ESP) noise level provided at a distance of 3.5-feet.

As the biomass system component noise sources were located within the biomass building, the building envelope was modeled to include the transmission loss of the wall and roof assemblies (e.g., the noise level reduction provided by the exterior building envelope). The biomass building model conservatively included openings in the exterior building envelope at the appropriate locations for the roll-up doors of the fuel and ash storage areas and at the vent locations. Additionally, the computer model included exterior noise sources for the exhaust stacks. Environmental noise exposure levels were modeled at prediction receivers representative of noise-sensitive receptors near the biomass facility, and are presented in Table 10.

Table 10. Modeled Biomass Energy Facility Noise Levels

Receiver			Modeled Noise Level, dBA	
No.	Address	Floor	Ldn	Leq
P-01	3010 Silver Strike	1st	46.1	39.7
		2nd	48.6	42.2
P-02	3005 Silver Strike	1st	43.3	36.9
		2nd	43.2	36.8
P-03	5006 Gold Bend	1st	40.2	33.8
		2nd	40.6	34.2
P-04	5018 Gold Bend	1st	39.3	32.9
		2nd	40.0	33.6
P-05	538 Wolf Tree	1st	22.7	16.2
		2nd	26.3	19.9

Source: Calculated by Dudek 2023
Notes: L_{dn} = Day-Night noise level; L_{eq} = equivalent noise level; dBA = A-weighted decibels.

As shown in Table 10, noise exposure levels resulting from the long-term operations of the biomass system are modeled to range from a day-night level of approximately 23 to 49 dBA Ldn and hourly average levels of approximately 16 to 42 dBA Leq at the nearby noise-sensitive residential land uses surrounding the proposed facility. The greatest noise exposure levels are predicted to occur at the second floor of the nearest noise-sensitive receptor, across Northstar Drive at 3010 Silver Strike, with modeled noise levels of 48.6 dBA Ldn and 42.2 dBA Leq. Therefore, modeled noise level exposure at the nearby noise-sensitive receptors surrounding the biomass facility are predicted to comply with the Placer County non-transportation noise level thresholds presented in the General Plan and County Code (50 dBA Ldn, 55 dBA Leq daytime, and 45 dBA Leq nighttime).

Additionally, as mentioned the modeling assumed no noise level reductions would be provided by penetrations in the building envelope, such as the vents in the façade facing the townhomes to the south (3010 Silver Strike); as such, in-situ (real-life) noise exposure levels could be reduced based on the noise level reductions provided by the vents/louvers.

As presented in Table 2, existing (2012) ambient noise levels generated from traffic on Northstar Drive would range from approximately 61 dBA Ldn during the off-peak summer season, to approximately 66 dBA Ldn during the winter season. With a noise exposure level of 48.6 dBA Ldn from operation of the biomass facility, the proposed project would not result in an increase in ambient noise levels.

5.4 Long-term Operational Groundborne Vibration

The proposed project does not incorporate any project elements that would generate substantial groundborne noise and vibration levels at nearby sensitive receptors during its long-term operation. Therefore, this impact would be less than significant.

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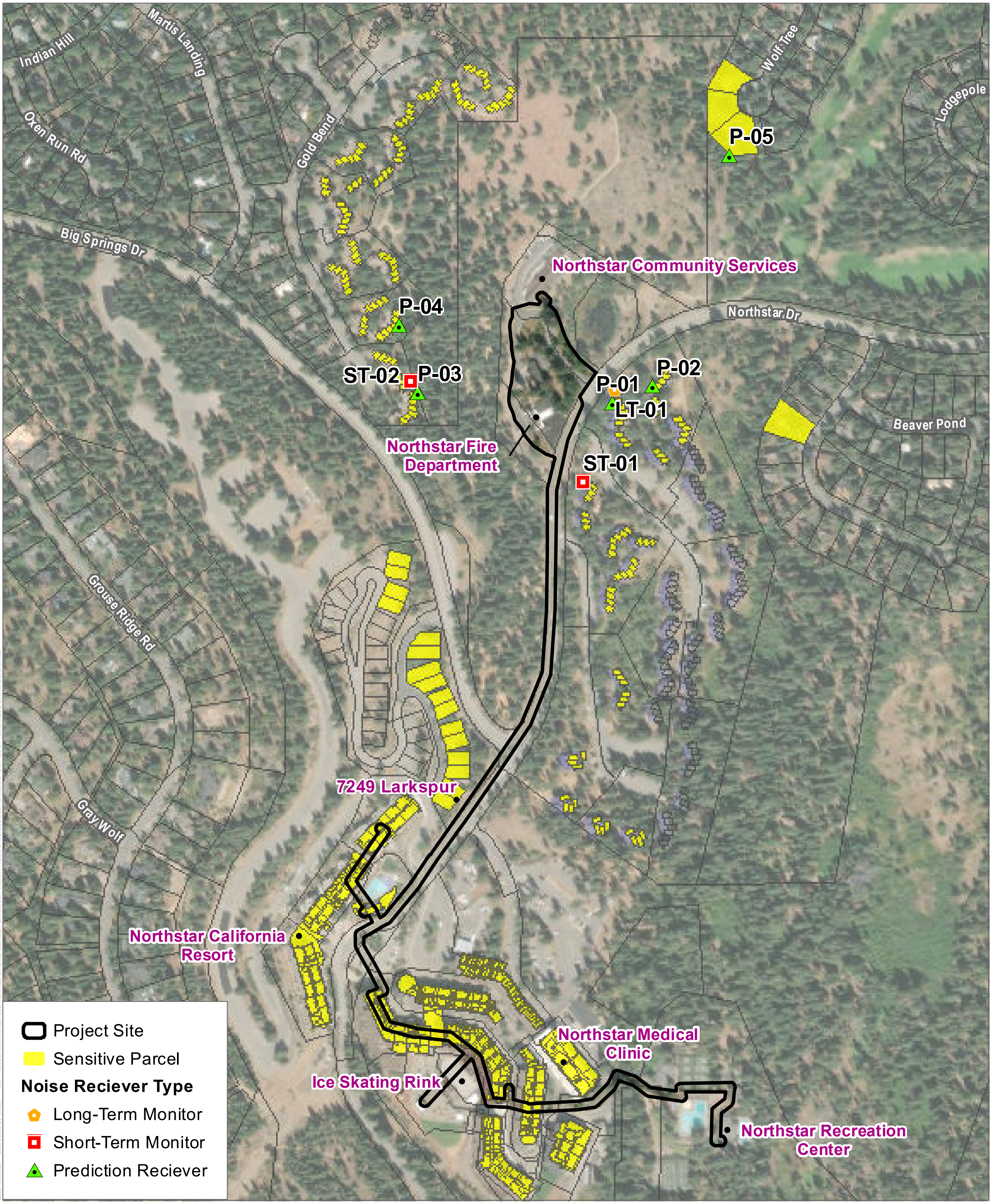

SOURCE: ESRI Imagery 2022, Open Street Map 2019

DUDEK

0 215 430 Feet

FIGURE 1

Project Boundary and Noise Monitoring and Prediction Locations

Northstar Community Services District Biomass Energy System

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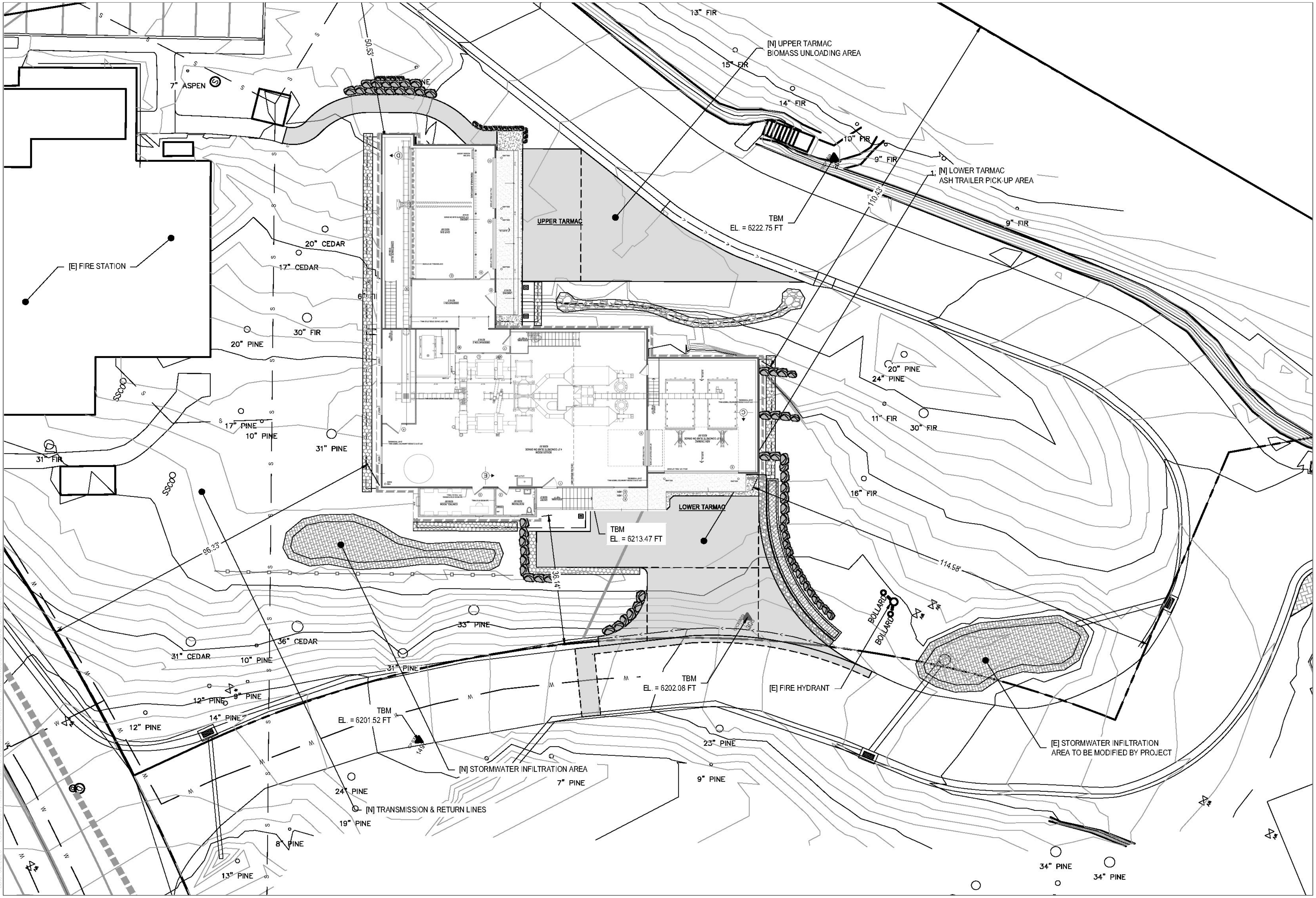

SOURCE: PR Design & Engineering Inc. 2022

DUDEK

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FIGURE 2

Proposed Siteplan and Biomass Equipment Plan

Northstar Community Services District Biomass Energy System

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Appendix A
Acoustic Terminology and Fundamentals

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Acoustic Fundamentals

Acoustics is the scientific study that evaluates perception, propagation, absorption, and reflection of sound waves. Sound is a mechanical form of radiant energy, transmitted by a pressure wave through a solid, liquid, or gaseous medium. Sound that is loud, disagreeable, unexpected, or unwanted is generally defined as noise; consequently, the perception of sound is subjective in nature, and can vary substantially from person to person. Common sources of environmental noise and relative noise levels are shown in Figure A-1.

A sound wave is initiated in a medium by a vibrating object (e.g., vocal chords, the string of a guitar, the diaphragm of a radio speaker). The wave consists of minute variations in pressure, oscillating above and below the ambient atmospheric pressure. The number of pressure variation cycles occurring per second is referred to as the frequency of the sound wave and is expressed in hertz (Hz), which is equivalent to one complete cycle per second.

Directly measuring sound pressure fluctuations would require the use of a very large and cumbersome range of numbers. To avoid this and have a more useable numbering system, the decibel (dB) scale was introduced. Sound level expressed in decibels (dB) is the logarithmic ratio of two like pressure quantities, with one pressure quantity being a reference sound pressure and the second pressure being that of the sound source of concern. For sound pressure in air, the standard reference quantity is generally considered to be 20 micropascals, which directly corresponds to the threshold of human hearing. The use of the decibel is a convenient way to handle the million-fold range of sound pressures to which the human ear is sensitive. A decibel is logarithmic; it does not follow normal algebraic methods and cannot be directly added. For example, a 65 dB source of sound, such as a truck, when joined by another 65 dB source results in a sound amplitude of 68 dB, not 130 dB (i.e., doubling the source strength increases the sound pressure by 3 dB). A sound level increase of 10 dB corresponds to 10 times the acoustical energy, and an increase of 20 dB equates to a 100-fold increase in acoustical energy.

The loudness of sound perceived by the human ear depends primarily on the overall sound pressure level and frequency content of the sound source. The human ear is not equally sensitive to loudness at all frequencies in the audible spectrum. To better relate overall sound levels and loudness to human perception, frequency-dependent weighting networks were developed. The standard weighting networks are identified as A through E. There is a strong correlation between the way humans perceive sound and A-weighted sound levels (dBA). For this reason, the dBA can be used to predict community response to noise from the environment, including noise from transportation and stationary sources. Sound levels expressed as dB in this section are A-weighted sound levels, unless noted otherwise.

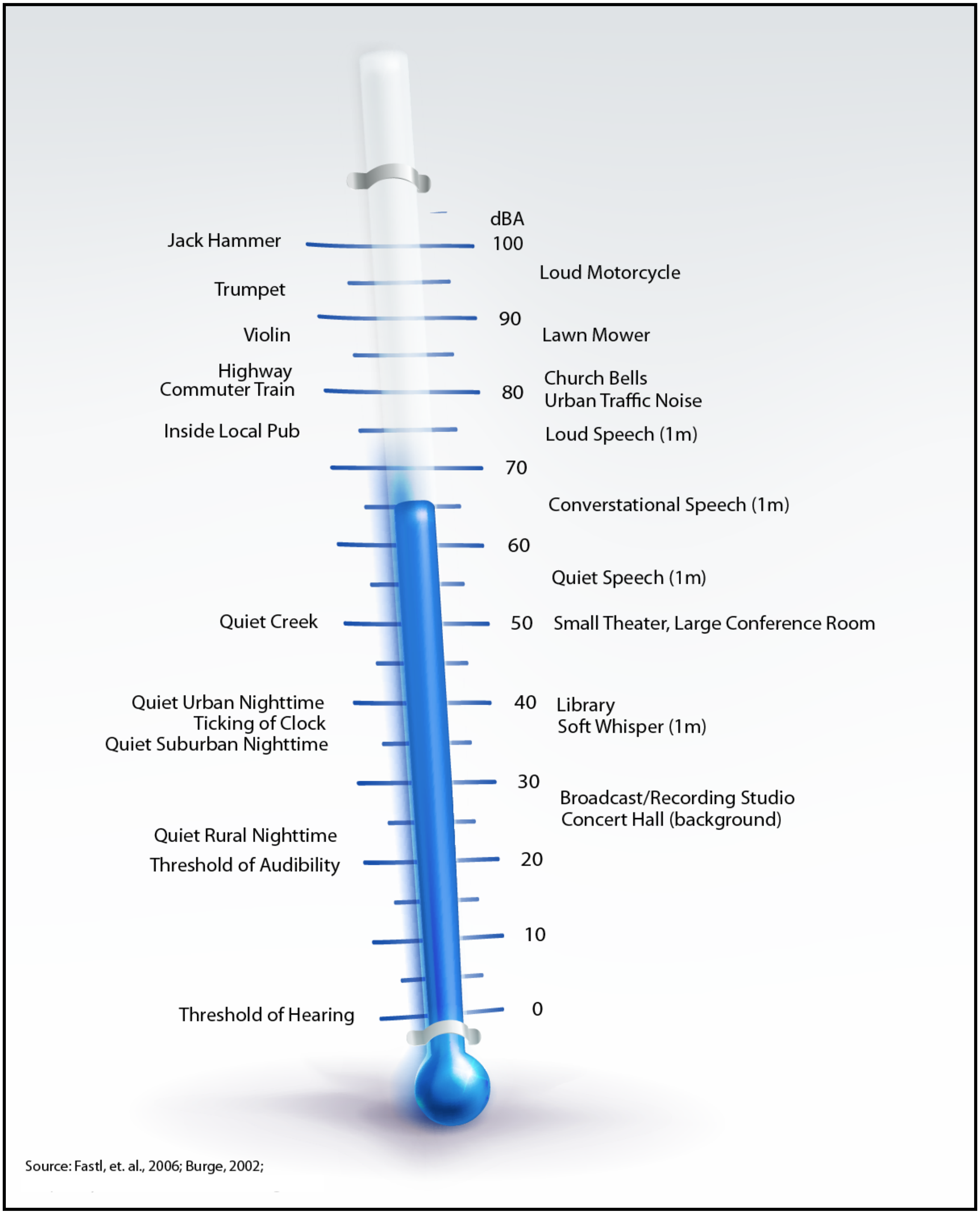

Figure A-1 -Common Noise Sources and Levels.

Noise can be generated by a number of sources, including mobile sources (transportation noise) such as automobiles, trucks, and airplanes and stationary sources (non-transportation noise) such as construction sites, machinery, and commercial and industrial operations. As acoustic energy spreads through the atmosphere from the source to the receiver, noise levels attenuate (decrease) depending on ground absorption characteristics, atmospheric conditions, and the presence of physical barriers (e.g., walls, building façades, berms). Noise generated from mobile sources generally attenuate at a rate of 3dBA (typical for hard surfaces, such as asphalt) to 4.5 dBA (typical for soft surfaces, such as grasslands) per doubling of distance, depending on the intervening ground type. Stationary noise sources spread with more spherical dispersion patterns that attenuate at a rate of 6 to 7.5 dBA per doubling of distance for hard and soft sites, respectively.

Atmospheric conditions such as wind speed, turbulence, temperature gradients, and humidity may additionally alter the propagation of noise and affect levels at a receiver. Furthermore, the presence of a large object (e.g., barrier, topographic features, and intervening building façades) between the source and the receptor can provide significant attenuation of noise levels at the receiver. The amount of noise level reduction or "shielding" provided by a barrier primarily depends on the size of the barrier, the location of the barrier in relation to the source and receivers, and the frequency spectra of the noise. Natural barriers such as berms, hills, or dense woods as well as man-made features such as buildings, berms and walls may be effective barriers for the reduction of source noise levels.

Noise Level Descriptors

The intensity of environmental noise levels can fluctuate greatly over time and as such, several different descriptors of time-averaged noise levels may be used to provide the most effective means of expressing the noise levels. The selection of a proper noise descriptor for a specific source depends on the spatial and temporal distribution, duration, and fluctuation of both the noise source and the environment near the receptor(s). Noise descriptors most often used to describe environmental noise are defined below.

Lmin (Minimum Noise Level): The minimum noise level during a specific period of time, while accounting for the appropriate weighting curve and response setting (i.e., A-weighted, slow).

Lmax (Maximum Noise Level): The maximum instantaneous noise level during a specific period of time, while accounting for the appropriate weighting curve and response setting (i.e., A-weighted, slow).

SEL (Sound Exposure Level): The cumulative exposure to sound energy over a stated period of time.

Ln (Statistical Descriptor): The noise level exceeded "n"% of a specific period of time. For example, L50 is the median noise level, or level exceeded 50% of the time (typically equated to the noise level exceeded 30-minutes out of the hour).

Leq (Equivalent Noise Level): The energy-average noise level or exposure, from all noise events that occur in a specified period; such as one-minute, one-hour, 24-hours, etc. Leq can be used to report results of short-term noise measurements, usually ranging between 15 minutes and 1 hour, to supplement longer term measurements.

Ldn (Day-Night Average Noise Level): The 24-hour Leq with a 10-dBA "penalty" for noise events that occur during the noise-sensitive hours between 10 p.m. and 7 a.m. In other words, 10 dBA is "added" to noise events that occur in the nighttime hours, and this generates a higher reported noise level when determining compliance with noise standards. The Ldn attempts to account for the fact that noise during this specific period of time is a potential source of disturbance with respect to normal sleeping hours.

CNEL (Community Noise Equivalent Level): The CNEL is similar to the Ldn described above, but with an additional 5-dBA "penalty" added to noise events that occur during the noise-sensitive hours between 7 p.m. and 10 p.m., which are typically reserved for relaxation, conversation, reading, and television. When the same 24-hour noise data are used, it is typical for the reported CNEL to be approximately 0.5 dBA higher than the Ldn.

Community noise is commonly described in terms of the ambient noise level which is defined as the all-encompassing noise level associated with a given noise environment. A common statistical tool to measure the ambient noise level is the average, or equivalent sound level (Leq)which corresponds to the steady-state A-weighted sound level containing the same total energy as the time-varying signal over a given time period (usually one hour). The Leq is the foundation of the composite noise descriptors such as Ldn and CNEL, as defined above, and shows very good correlation with community response to noise. Use of these descriptors along with the maximum noise level occurring during a given time period provides a great deal of information about the ambient noise environment in an area.

Effect of Noise on Humans

Excessive and chronic exposure to elevated noise levels can result in auditory and non-auditory effects on humans. Auditory effects of noise on people are those related to temporary or permanent hearing loss caused by loud noises. Non-auditory effects of exposure to elevated noise levels are those related to behavioral and physiological effects. The non-auditory behavioral effects of noise on humans are associated primarily with the subjective effects of annoyance, nuisance and dissatisfaction, which lead to interference with activities such as communications, sleep and learning. The non-auditory physiological health effects of noise on humans have been the subject of considerable research attempting to discover correlations between exposure to elevated noise levels and health problems, such as hypertension and cardiovascular disease. The mass of research infers that noise-related health issues are predominantly the result of behavioral stressors and not a direct noise-induced response. The extent to which noise contributes to non-auditory health effects remains a subject of considerable research, with no definitive conclusions.

The degree to which noise results in annoyance and interference is highly subjective and may be influenced by several non-acoustic factors. The number and effect of these non-acoustic environmental and physical factors vary depending on individual characteristics of the noise environment such as sensitivity, level of activity, location, time of day, and length of exposure. One key aspect in the prediction of human response to new noise environments is the individual level of adaptation to an existing noise environment. The greater the change in the noise levels that are attributed to a new noise source, relative to the environment an individual has become accustomed to, the less tolerable the new noise source will be to an individual.

With respect to how humans perceive and react to changes in noise levels, a 1 dBA increase is generally imperceptible outside of a laboratory environment, a 3 dBA increase is barely perceptible, a 6 dBA increase is clearly noticeable, and a 10-dBA increase is subjectively perceived as approximately twice as loud (Egan 1988). These subjective reactions to changes in noise levels was developed on the basis of test subjects' reactions to changes in the levels of steady-state, pure tones or broad-band noise and to changes in levels of a given noise source. Perception and reaction to changes in noise levels in this manner is thought to be most applicable in the range of 50 to 70 dBA, as this is the usual range of voice and interior noise levels.

Vibration Fundamentals

Vibration is similar to noise in that it is a pressure wave traveling through an elastic medium involving a periodic oscillation relative to a reference point. Vibration is most commonly described in respect to the excitation of a structure or surface, such as in buildings or the ground. Human and structural response to different vibration levels is influenced by a number of factors, including ground type, distance between source and receptor, duration, and the number of perceived vibration events. Sources of vibration include natural phenomena (e.g., earthquakes, volcanic eruptions, sea waves, landslides) and those introduced by human activity (e.g., explosions, machinery, traffic, trains, construction equipment). Vibration sources may be continuous, (e.g., operating factory machinery) or transient in nature (e.g., explosions, impacts). Vibration levels can be depicted in terms of amplitude and frequency; relative to displacement, velocity, or acceleration.

Vibration amplitudes are commonly expressed in peak particle velocity (PPV) or root-mean-square (RMS) vibration velocity. PPV is defined as the maximum instantaneous positive or negative peak of a vibration signal, or the quantity of displacement measured from peak to trough of the vibration wave. Root-mean-square is defined as the positive and negative statistical measure of the magnitude of a varying quantity. The RMS of a signal is the average of the squared amplitude of the signal, typically calculated over a period of one second. PPV is typically used in the monitoring of transient and impact vibration and has been found to correlate well to the stresses experienced by buildings (Federal Transit Administration [FTA] 2006, California Department of Transportation [Caltrans] 2004). PPV and RMS vibration velocity are nominally described in terms of inches per second (in/sec). However, as with airborne sound, vibration velocity can also be expressed using decibel notation as vibration decibels (VdB). The logarithmic nature of the decibel serves to compress the broad range of numbers required to describe vibration and allow for the presentation of vibration levels in familiar terms.

Although PPV is appropriate for evaluating the potential for building damage, it is not always suitable for evaluating human response. Human response to vibration has been found to correlate well to average vibration amplitude; therefore, vibration impacts on humans are evaluated in terms of RMS vibration velocity.

Typical outdoor sources of perceptible groundborne vibration include construction equipment, steel-wheeled trains, and traffic on rough roads. Although the effects of vibration may be imperceptible at low levels, effects may result in detectable vibrations and slight damage to nearby structures at moderate and high levels, respectively. At the elevated levels of vibration, damage to structures is primarily architectural (e.g., loosening and cracking of plaster or stucco coatings) and rarely results in damage to structural components. The range of vibration relevant to this analysis occurs from approximately 60 VdB, which is the typical background vibration-velocity level; to 100 VdB, which is the general threshold where minor damage can occur in fragile buildings (FTA 2006).

Appendix B

Long-Term Monitoring Data

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Appendix B-1
Long-Term 24 Hour Continuous Noise Monitoring

Project: NSCD Biomass Plant
Date: April 27, 2022 to April 27, 2022
Site: LT-01

Hour	Leq	Lmax	L50	L90
0:00	46.3	63.3	45.9	37.9
1:00	43.0	48.1	41.4	37.8
2:00	40.9	46.5	37.6	37.4
3:00	43.7	68.0	37.5	37.4
4:00	38.6	44.2	37.7	37.5
5:00	43.4	65.1	38.4	37.9
6:00	49.5	68.3	40.1	38.5
7:00	54.4	68.5	52.8	39.4
8:00	55.0	69.0	54.2	48.9
9:00	54.6	69.3	54.0	48.0
10:00	53.8	67.6	53.1	46.7
11:00	53.9	66.2	53.2	48.6
12:00	54.1	72.5	52.7	44.1
13:00	53.7	67.5	52.9	46.8
14:00	53.8	68.9	53.3	48.5
15:00	54.9	68.9	53.8	49.8
16:00	54.7	68.1	53.9	49.7
17:00	52.6	67.8	51.3	38.2
18:00	50.1	65.4	49.0	36.8
19:00	49.1	63.9	47.2	36.2
20:00	50.0	70.2	48.3	40.0
21:00	49.7	65.6	49.1	47.3
22:00	49.3	66.4	48.2	46.9
23:00	47.6	64.8	46.2	36.4

Lowermost Level

	Leq	Lmax	L50	L90
Daytime (7 a.m. - 7 p.m.)	49.1	63.9	47.2	36.2
Nighttime (10 p.m. - 7 a.m.)	38.6	44.2	37.5	36.4

Average Level

	Leq	Lmax	L50	L90
Daytime (7 a.m. - 7 p.m.)	53.4	68.0	51.9	44.6
Nighttime (10 p.m. - 7 a.m.)	46.0	59.4	41.4	38.6

Uppermost-Level

	Leq	Lmax	L50	L90
Daytime (7 a.m. - 7 p.m.)	55.0	72.5	54.2	49.8
Nighttime (10 p.m. - 7 a.m.)	49.5	68.3	48.2	46.9

Energy Distribution

Daytime	90%
Nighttime	10%

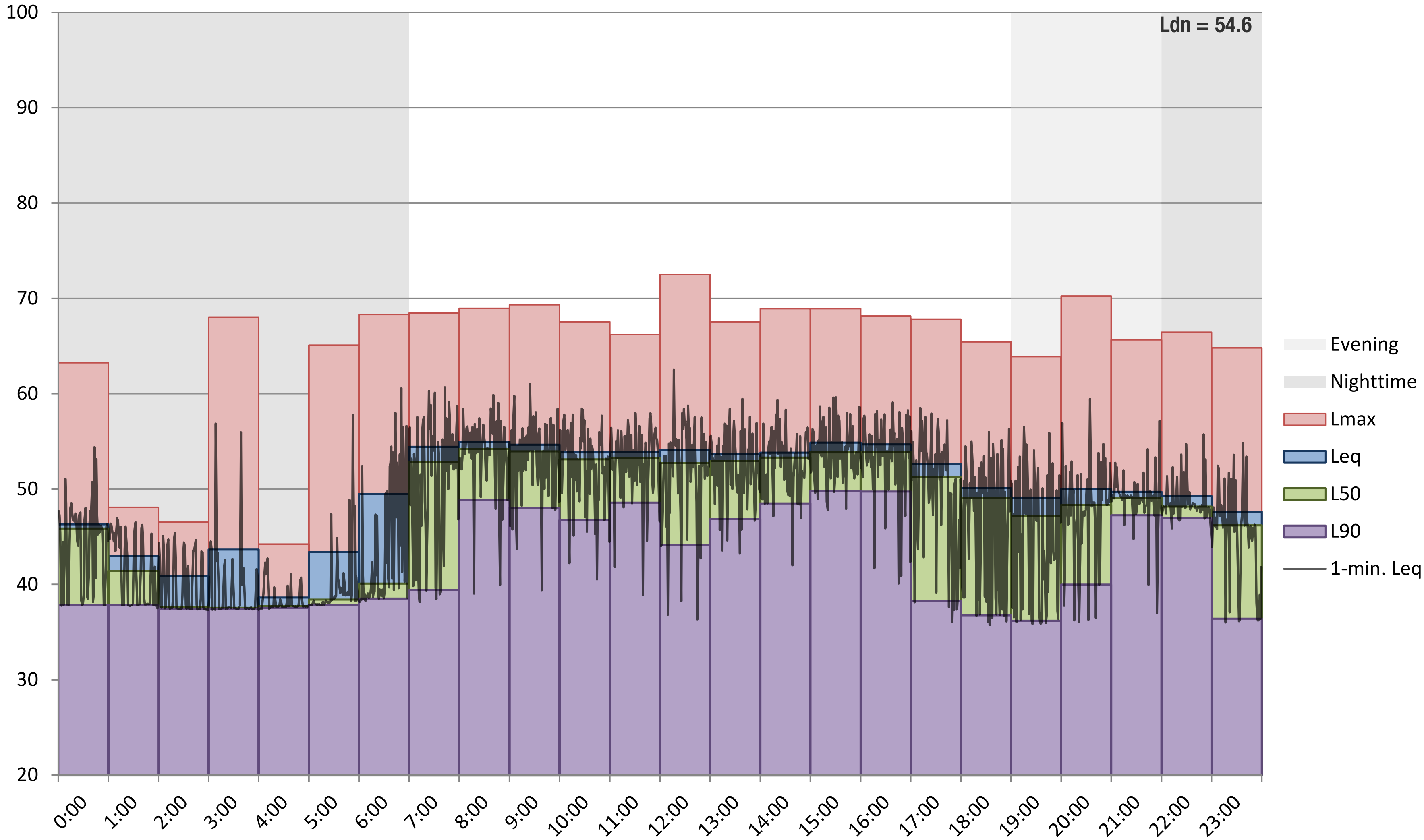
Calculated Ldn, dBA

54.6

Appendix B-1

NSCD Biomass Plant - LT-01

April 27, 2022 to April 27, 2022



Appendix C

Construction Noise Analysis

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Biomass Facility (908 Northstar Drive) - Construction Boundary

receptor: **3097 Silver Strike**

Construction Activity	Equipment	Total Equipment Qty	AUF % (from FHWA RCNM)	Reference Lmax @ 50 ft. from FHWA RCNM	Source to NSR Distance (ft.)	Distance-Adjusted Lmax	Predicted 8-hour Leq
Demolition and Site Preparation	excavator	1	40	81	145	68.4	49
	grader	1	40	85	145	72.4	53
	backhoe	1	40	78	145	65.4	46
	Tractor	1	40	84	145	71.4	52
							57.1
Grading	dozer	1	40	82	145	69.4	50
	front end loader	1	40	79	145	66.4	47
	grader	1	40	85	145	72.4	53
	excavator	1	40	81	145	68.4	49
	backhoe	1	40	78	145	65.4	46
							57.1
Building Construction	crane	1	16	81	145	68.4	45
	Gradall	1	40	83	145	70.4	51
	excavator	1	40	81	145	68.4	49
	front end loader	1	40	79	145	66.4	47
	Tractor	1	40	84	145	71.4	52
							56.8
Paving	Concrete Mixer Truck	1	40	79	145	66.4	47
	roller	1	20	80	145	67.4	45
	paver	1	50	77	145	64.4	46
	Tractor	1	40	84	145	71.4	52
							54.8
Boiler Plant Equipment Installation	crane	1	16	81	145	68.4	45
	Gradall	1	40	83	145	70.4	51
	Welder / Torch	1	40	73	145	60.4	41
	Compressor (air)	1	40	78	145	65.4	46
							53.6

Notes

Biomass Facility (908 Northstar Drive) - Acoustical Center

receptor: **3097 Silver Strike**

Construction Activity	Equipment	Total Equipment Qty	AUF % (from FHWA RCNM)	Reference Lmax @ 50 ft. from FHWA RCNM	Source to NSR Distance (ft.)	Distance-Adjusted Lmax	Predicted 8-hour Leq
Demolition and Site Preparation	excavator	1	40	81	250	62.7	44
	grader	1	40	85	250	66.7	48
	backhoe	1	40	78	250	59.7	41
	Tractor	1	40	84	250	65.7	47
							51.5
Grading	dozer	1	40	82	250	63.7	45
	front end loader	1	40	79	250	60.7	42
	grader	1	40	85	250	66.7	48
	excavator	1	40	81	250	62.7	44
	backhoe	1	40	78	250	59.7	41
							51.4
Building Construction	crane	1	16	81	250	62.7	40
	Gradall	1	40	83	250	64.7	46
	excavator	1	40	81	250	62.7	44
	front end loader	1	40	79	250	60.7	42
	Tractor	1	40	84	250	65.7	47
							51.2
Paving	Concrete Mixer Truck	1	40	79	250	60.7	42
	roller	1	20	80	250	61.7	40
	paver	1	50	77	250	58.7	41
	Tractor	1	40	84	250	65.7	47
							49.2
Boiler Plant Equipment Installation	crane	1	16	81	250	62.7	40
	Gradall	1	40	83	250	64.7	46
	Welder / Torch	1	40	73	250	54.7	36
	Compressor (air)	1	40	78	250	59.7	41
							47.9

Notes

Pipeline Installation - Construction Boundary

receptor: **7429 Larkspur Court**

Construction Activity	Equipment	Total Equipment Qty	AUF % (from FHWA RCNM)	Reference Lmax @ 50 ft. from FHWA RCNM	Source to NSR Distance (ft.)	Distance-Adjusted Lmax	Predicted 8-hour Leq
Trenching and Pipeline Installation	excavator	1	40	81	50	80.9	62
	dozer	1	40	82	50	81.9	63
	Tractor	1	40	84	50	83.9	65
							68.1
Backfill and Paving	backhoe	1	40	78	50	77.9	59
	roller	1	20	80	50	79.9	58
	paver	1	50	77	50	76.9	59
							63.3

Notes

Pipeline Installation - Acoustical Center

receptor: **7429 Larkspur Court**

Construction Activity	Equipment	Total Equipment Qty	AUF % (from FHWA RCNM)	Reference Lmax @ 50 ft. from FHWA RCNM	Source to NSR Distance (ft.)	Distance-Adjusted Lmax	Predicted 8-hour Leq
Trenching and Pipeline Installation	excavator	1	40	81	70	77.6	59
	dozer	1	40	82	70	78.6	60
	Tractor	1	40	84	70	80.6	62
							64.8
Backfill and Paving	backhoe	1	40	78	70	74.6	56
	roller	1	20	80	70	76.6	55
	paver	1	50	77	70	73.6	56
							60.0

Notes

Appendix D
Traffic Noise Modeling

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Appendix D

Traffic Noise Modeling Calculations - Summary

Project: 13924 - Northstar Biomass

Number	Name	From (Segment Description and Location)	To	Existing	Cumulative	Δ Existing – Cumulative
Summary of Net Changes						
1	Northstar Drive - Winter	East of Big Springs Drive		64.2	65.6	1.4

*All modeling assumes average pavement, level roadways (less than 1.5% grade), constant traffic flow and does not account for shielding of any type or finite roadway adjustments. All levels are reported as A-weighted noise levels.

Appendix D

Traffic Noise Model Calculations

Project: 13924 - Northstar Biomass

Noise Level Descriptor: Ldn
Site Conditions: Soft
Traffic Input: ADT
Traffic K-Factor: 10

	Segment Description and Location			Input										Output				
						Distance to Directional Centerline, (feet)[4]		Traffic Distribution Characteristics						Ldn,	Distance to Contour, (feet)[3]			
Number	Name	From	To	ADT	Speed (mph)	Near	Far	% Auto	% Med	% Hvy	% Day	% Eve	% Night	(dBA)[5,6,7]	70 dBA	65 dBA	60 dBA	55 dBA
Existing Conditions																		
1	Northstar Drive - Winter	East of Big Springs Drive		14,450	35	67.5	67.5	95.6%	4.4%	0.0%	85.0%		15.0%	64.2	28	60	130	279
2	Northstar Drive - Summer	East of Big Springs Drive		4,510	35	67.5	67.5	95.6%	4.4%	0.0%	85.0%		15.0%	59.2	13	28	60	128
3																		
4	Northstar Drive - Summer	East of Big Springs Drive	Add'l 4 Heavy Trucks	4,514	35	67.5	67.5	95.5%	4.4%	0.1%	85.0%		15.0%	59.3	13	28	60	130

*All modeling assumes average pavement, level roadways (less than 1.5% grade), constant traffic flow and does not account for shielding of any type or finite roadway adjustments. All levels are reported as A-weighted noise levels.

Appendix D
Traffic Noise Model Calculations

Project: 13924 - Northstar Biomass

Noise Level Descriptor: Ldn
Site Conditions: Soft
Traffic Input: ADT
Traffic K-Factor: 10

Number	Name	From	To	ADT	Speed (mph)	Distance to Directional Centerline, (feet)[4] Near	Far	% Auto	% Med	% Hvy	% Day	% Eve	% Night	Ldn, (dBA)[5,6,7]	Distance to Contour, (feet)[3] 70 dBA	65 dBA	60 dBA	55 dBA
Cumulative Conditions																		
1	Northstar Drive - Winter	East of Big Springs Drive		16,440	35	67.5	67.5	91.1%	8.9%	0.0%	85.0%		15.0%	65.6	35	74	160	345
2	Northstar Drive - Summer	East of Big Springs Drive		6,720	35	67.5	67.5	91.1%	8.9%	0.0%	85.0%		15.0%	61.8	19	41	88	190

Columns ADT through % Night are Input; Ldn and Distance to Contour are Output.

*All modeling assumes average pavement, level roadways (less than 1.5% grade), constant traffic flow and does not account for shielding of any type or finite roadway adjustments. All levels are reported as A-weighted noise levels.

Appendix D

Traffic Noise Modeling Calculations - References

Citation	Reference
1	Caltrans Technical Noise Supplement. 2009 (November). Table (5-11), Pg 5-60.
2	Caltrans Technical Noise Supplement. 2009 (November). Equation (5-26), Pg 5-60.
3	Caltrans Technical Noise Supplement. 2009 (November). Equation (2-16), Pg 2-32.
4	Caltrans Technical Noise Supplement. 2009 (November). Equation (5-11), Pg 5-47, 48.
5	Caltrans Technical Noise Supplement. 2009 (November). Equation (2-26), Pg 2-55, 56.
6	Caltrans Technical Noise Supplement. 2009 (November). Equation (2-27), Pg 2-57.
7	Caltrans Technical Noise Supplement. 2009 (November). Pg 2-53.
8	Caltrans Technical Noise Supplement. 2009 (November). Equation (5-7), Pg 5-45.
9	Caltrans Technical Noise Supplement. 2009 (November). Equation (5-8), Pg 5-45.
10	Caltrans Technical Noise Supplement. 2009 (November). Equation (5-9), Pg 5-45.
11	Caltrans Technical Noise Supplement. 2009 (November). Equation (5-13), Pg 5-49.
12	Caltrans Technical Noise Supplement. 2009 (November). Equation (5-14), Pg 5-49.
13	Federal Highway Administration Traffic Noise Model Technical Manual. Report No. FHWA-PD-96-010. 1998 (January). Equation (16), Pg 67
14	Federal Highway Administration Traffic Noise Model Technical Manual. Report No. FHWA-PD-96-010. 1998 (January). Equation (20), Pg 69
15	Federal Highway Administration Traffic Noise Model Technical Manual. Report No. FHWA-PD-96-010. 1998 (January). Equation (18), Pg 69