3.9 NOISE

This section presents an evaluation of potential noise resulting from the construction and operation of the Project. An essential part of this assessment is a comparison of expected noise levels from the Project with acceptable noise levels presented in applicable regulations. The noise criterion for this Project is WAC 173-60. This section, Exhibit 15A, Residences within 'Project Vicinity Map', and Exhibit 15B, 'Results of Noise Impact Model' together provide all the information necessary to demonstrate compliance with this criterion.

3.9.1 Existing Conditions

3.9.1.1 Fundamentals of Acoustics

Airborne sound is a rapid fluctuation of air pressure above and below atmospheric pressure. There are several ways to measure noise, depending on the source of the noise, the receiver, and the reason for the noise measurement. Table 3.9.1-1 summarizes the technical noise terms used in this subsection.

Table 3.9.1-1: Definitions of Acoustical Terms

Term	Definitions
Ambient noise level	The composite of noise from all sources near and far. The normal or existing level of environmental noise at a given location.
Intrusive	Noise that intrudes over and above the existing ambient noise at a given location. The relative intrusiveness of a sound depends upon its amplitude, duration, frequency, time of occurrence, and tonal or informational content, as well as the prevailing ambient noise level.
Decibel (dB)	A unit describing the amplitude of sound, equal to 20 times the base 10 logarithm of the ratio of the reference pressure to the sound pressure, which is 20 micropascals (20 micronewtons per square meter).
Frequency (Hz)	The number of complete pressure fluctuations per second above and below atmospheric pressure.
Decibel A-weighted sound level (dBA)	The sound pressure level in decibels as measured on a sound level meter using the A-weighted filter network. The A-weighted filter de-emphasizes the very low and very high frequency components of the sound in a manner similar to the frequency response of the human ear and correlates well with subjective reactions to noise. All sound levels in this report are A-weighted unless stated otherwise.

Table 3.9.1-1: Definitions of Acoustical Terms	
Term	**Definitions**
Decibel C-weighted sound level (dBC)	The sound pressure level in decibels as measured on a sound level meter using the C-weighted filter network. The C-weighted filter does not de-emphasize the very low and very high frequency components of the sound. It is a flatter weighting in that each frequency has an almost equal weighting. It is therefore more sensitive to low frequencies than the A-weighting.
Equivalent noise level (L_{eq})	The energy average A-weighted noise level during the measurement period.
Percentile noise level (L_n)	The A-weighted noise level exceeded during n % of the measurement period, where n is a number between 0 and 100 (e.g., L_{90})
Community noise equivalent level (CNEL)	The average A-weighted noise level during a 24-hour day, obtained after the addition of 5 decibels to sound levels from 7 p.m. to 10 p.m. and after the addition of 10 decibels to sound levels between 10 p.m. and 7 a.m.
Day-night noise level (Ldn or DNL)	The average A-weighted noise level during a 24-hour day, obtained after the addition of 10 decibels from 10 p.m. to 7 a.m.

Sources: Beranek, 1988; California Department of Health Services, 1977.

In this subsection, some statistical noise levels are stated in terms of decibels on the decibel A-weighted scale (dBA). Noise levels stated in terms of dBA reflect the response of the human ear's audible range by filtering out some of the noise in the low- and high-frequency ranges that the ear does not detect well. The A-weighted scale is used in most noise ordinances and standards. The equivalent sound pressure level (L_{eq}) is defined as the average noise level, on an energy basis, for a stated period of time (such as hourly).

In practice, the level of a sound source is typically measured using a sound level meter that includes an electrical filter corresponding to the A-weighted curve. The sound level meter also performs the calculations required to determine the L_{eq} for the measurement period. The following measurements relate to the noise level distribution during the measurement period. The L_{90} is a measurement that represents the noise level exceeded during 90 percent of the measurement period. Similarly, the L_{10} represents the noise level exceeded for 10 percent of the measurement period.

The effects of noise on people fall into three general categories:

1. Subjective effects of annoyance, nuisance, and dissatisfaction;
2. Interference with such activities as speech, sleep, and learning;
3. Physiological effects such as startling and hearing loss.

In most cases, environmental noise produces effects in the first two categories only. However, workers in industrial plants may experience noise effects in the third category. No completely satisfactory way exists to measure the subjective effects of noise, or to measure the corresponding reactions of annoyance and dissatisfaction. This lack of a common standard is primarily a result of the wide variation in individual thresholds of annoyance and habituation to noise. Thus, an important way of determining a person's subjective reaction to a new noise is by comparing it with the existing or "ambient" environment to which that person has adapted. In general, the more the level or the tonal (frequency) variations of a noise exceed the previously existing ambient noise level or tonal quality, the less acceptable the new noise will be, as judged by the exposed individual (CEC, 2001).

With regard to increases in A-weighted noise level, knowledge of the following relationships is helpful in understanding this subsection (Kryter, 1970):

- Except in carefully controlled laboratory experiments, the human ear cannot perceive a change of 1 decibel (dBA).
- Outside the laboratory, a 3-dBA change is considered a just-perceivable difference.
- A change in level of at least 5 dBA is required before any noticeable change in community response can be expected.
- A 10-dBA change is subjectively heard as approximately a doubling in loudness and would likely cause an adverse response.

The referenced dB increases are for noise of similar nature (e.g., increased traffic noise compared with existing traffic noise). Table 3.9.1-2 shows the relative A-weighted noise levels of common sounds measured in the environment and in industry for various sound levels.

Table 3.9.1-2: Typical Sound Levels Measured in the Environment and Industry

Noise Source at a Given Distance	**A-Weighted Sound Level in Decibels (dBA)**	**Noise Environment**	**Subjective Impression**
	140		
Civil defense siren (100 feet)	130		
Jet takeoff (200 feet)	120		Pain threshold
	110	Rock music concert	
Pile driver (50 feet)	100		Very loud
Ambulance siren (100 feet)	—		
	90	Boiler room	
Freight cars (50 feet)	—	Printing press plant	
Pneumatic drill (50 feet)	80	In kitchen with garbage disposal running	
Freeway (100 feet)	—		
	70		Moderately loud
Vacuum cleaner (10 feet)	60	Data processing center	

Table 3.9.1-2: Typical Sound Levels Measured in the Environment and Industry			
Noise Source at a Given Distance	**A-Weighted Sound Level in Decibels (dBA)**	**Noise Environment**	**Subjective Impression**
Department store	—		
Light traffic (100 feet)	50	Private business office	
Large transformer (200 feet)	—		
	40		Quiet
Soft whisper (5 feet)	30	Quiet bedroom	
	20	Recording studio	
	10		Hearing threshold

Source: Peterson and Gross, 1974.

3.9.1.2 Noise Standards

173-60 WAC provides the applicable noise standards for Washington State, including Kittitas County. Kittitas County has not promulgated independent state-approved noise standards pursuant to WAC 173-60-110. WAC 173-60 establishes maximum permissible environmental noise levels. These levels are based on the environmental designation for noise abatement (EDNA) that is defined as "an area or zone (environment) within which maximum permissible noise levels are established. " There are three EDNA designations (WAC 173-60-030), which roughly correspond to residential, commercial/recreational, and industrial/agricultural uses:

1. Class A: Lands where people reside and sleep (such as residential)
2. Class B: Lands requiring protection against noise interference with speech (such as commercial/recreational); and
3. Class C: Lands where economic activities are of such a nature that higher noise levels are anticipated (such as industrial/agricultural).

As used in this section, "noise-sensitive areas" are equivalent to Class A EDNA areas. Table 3.9.1-3 summarizes the maximum permissible levels applicable to noise received at noise sensitive areas (Class A EDNA) and at industrial/agricultural areas (Class C EDNA) from an industrial facility (Class C EDNA).

Table 3.9.1-3: State of Washington Noise Regulations (173-60-040 WAC)

	Maximum Permissible Noise Levels (dBA) from a Class C EDNA		
	Class A EDNA Receiver		**Class C EDNA Receiver** [1]
Statistical Descriptor	**Daytime (7 a.m. – 10 p.m.)**	**Nighttime (10 p.m. – 7 a.m.)**	**Anytime**
L_{eq}	60	50	70
L_{25}	65	55	75
$L_{16.7}$	70	60	80
$L_{2.5}$	75	65	85

Note: 1. Standard applies at the property line of the receiving property Source: WAC 173-60.

The following are exempted from the limits presented in Table 3.9.1-3 (per 173-60-050 WAC):

- Construction noise (including blasting) between the hours of 7 a.m. and 10 p.m.
- Motor vehicles when regulated by 173-62 WAC (“Motor Vehicle Noise Performance Standards” for vehicles operated on public highways)
- Motor vehicles operated off public highways, except when such noise affects residential receivers
- Noise from electrical substations is exempted from the nighttime limits (173-60-050(2)(a) WAC).

Note that 173-60-50(6) WAC states, “Nothing in these exemptions is intended to preclude the Department from requiring installation of the best available noise abatement technology consistent with economic feasibility.”

173-62 WAC, “Motor Vehicle Noise Performance Standards,” regulates noise generated by vehicles traveling on public roads.

3.9.1.3 Affected Environment

As with most wind projects, this Project is located in a rural area with a low population density. Most of the Project site is located on privately-owned land. Some parcels are owned by WDNR and WDFW, as indicated in Exhibit 1-B, ‘Project Site Layout’. The proposed PSE interconnect substation also lies on privately-owned land. The Applicant has obtained an option to purchase the private land within the Project site boundary from the landowner and has executed a lease with WDNR for wind power on the Project site.

The closest distance between a residence and a wind turbine is nearly two miles, as shown on Exhibit 15b, ‘Noise Impact Model’. Background noise level measurements are not warranted given the large distance between the Project and closest residential receivers. Noise levels at that distance are anticipated to be inaudible or at most similar in level to a soft whisper. For those reasons, Project noise estimates and impact analysis have been based on manufacturers' noise emission data and internationally recognized noise modeling standards.

3.9.2 Impacts of the Proposed Action

3.9.2.1 Construction

Noise generated by construction of the Project is expected to vary, depending on the construction phase (see Section 2.2.6, 'Project Construction Schedule and Workforce'). Table 3.9.2-1 lists the typical noise levels associated with common construction equipment at various distances.

All noise generating construction activities will be conducted between the hours of 7 a.m. and 10 p.m. and are therefore exempt from the limits presented in Table 3.9.1-3 (per 173-60-050 WAC). Blasting is anticipated for the foundations and potentially some road areas. Blasting will be conducted only between the hours of 7 a.m. and 10 p.m. and is anticipated to occur over a period of eight weeks. Blasting activities are specifically exempted from the noise regulations (per WAC 173-60-050 (1)(c)).

Table 3.9.2-1: Noise Levels from Common Construction Equipment at Various Distances (dBA)

Construction Equipment	Typical Sound Pressure Level at 50 feet	Expected Sound Pressure Level at		
		1,000 feet	2,500 feet	5,000 feet
Bulldozer (250 to 700 horsepower)	88	62	54	48
Front-end loader (6 to 15 cubic yards)	88	62	54	48
Truck (200 to 400 horsepower)	86	60	52	46
Grader (13- to 16-foot blade)	85	59	51	45
Shovel (2 to 5 cubic yards)	84	58	50	44
Portable generators (50 to 200 kilowatts)	84	58	50	44
Mobile crane (11 to 20 tons)	83	57	49	43
Concrete pumps (30 to 150 cubic yards)	81	55	47	41
Tractor (3/4 to 2 cubic yards)	80	54	46	40

Note: Estimated levels include attenuation due to distance only (geometric spreading). Atmospheric effects (molecular absorption and excess attenuation) for standard day conditions (59°F, 70% relative humidity) would reduce levels by an additional 3, 7 and 11 dBA at 1000, 2500 and 5000 feet respectively.
Source: Barnes et al., 1977.

3.9.2.2 Operation

Overall, wind turbines are typically quiet, especially when compared to their combustion-based alternatives. The noise generated by wind turbines is likely to be most noticeable when wind speeds are low (8-12 mph) at receptors. Wind turbine noise tends to be masked by other background sources (i.e., the sound generated by the wind) at higher wind speeds.

The procedures for determining sound power levels from wind turbines are defined in International Electrotechnical Commission (IEC) 61400 Wind Turbine Generator Systems Part 11: Acoustic Noise Measurement Techniques (Reference Number: IEC 61400-11:1998(E)). The measurement technique outlines procedures to determine corrections for background noise, apparent sound power level, and wind speed dependence.

Although the exact turbine model to be used for the Project has not been determined yet, conservative values for the type of equipment being considered for this Project have been used for the noise analysis. The turbines are expected to be warranted by the manufacturer not to exceed a maximum sound power level 110 dBA with a wind speed of 18 mph (8 meters per second) at 33-feet (10 meters) in accordance with the protocol established in IEC 61400. This is approximately equivalent to a sound pressure level of 78 dBA at 50 feet from the turbine. Measurements conducted by others at existing wind power projects substantiate that the guaranteed sound power levels are realized under field conditions. More typical guaranteed sound power levels for modern wind turbines are 6 dBA lower (104 dBA) than those used in the model. Measurement data suggests that actual noise levels are several dBA lower than guaranteed values.

Audible noise from the high voltage transmission feeder line(s) will comply with the level specified in 173-60-040 WAC (see Table 3.9.1-3).

Substation transformers and high voltage switching equipment shall be specified or designed to comply with the level specified in 173-60-040 WAC (see Table 3.9.1-3) namely the 70 dBA limit at all Class C EDNA (industrial/agricultural) property lines and 60 dBA at all residences (Class A EDNA).

3.9.2.3 Comparison of Impacts of Proposed Scenarios

Construction noise levels and durations will be the same, regardless of the type of turbine used for the Project. All of the noise analysis and study work was performed for turbine source noise level of 110dBA, which is higher than the guaranteed noise level of all turbine scenarios under consideration and evaluation for the Project. State of Washington Noise Regulations will be observed in all cases.

3.9.2.4 Modeling Results and Regulatory Compliance

The Applicant is committed to designing and operating the Project in a manner that complies with all applicable noise standards.

A three-dimensional noise model was developed using CADNA/A, a sophisticated program developed by DataKustik, GmbH, Munich, Germany. The algorithms in CADNA/A are based on the International Standard ISO –9613-2 "Attenuation of Sound During Propagation Outdoors". Octave band sound power levels (determined in accordance with IEC 61400) for the wind turbines and topographic information from the USGS were input into the model.

The wind turbine noise emissions are required by 173-60 WAC not to exceed 70 dBA at all Class C EDNA (industrial/agricultural) property boundaries. The Project will comply with this requirement at all adjacent property boundaries.

Residential daytime levels are required by 173-60 WAC not to exceed 60 dBA while nighttime levels are not to exceed 50 dBA. As shown in Exhibit 15-B, 'Noise Impact Zones', the Project will comply with the more restrictive nighttime limit of 50 dBA at all existing residential structures.

The Applicant and Applicant's consulting team are unaware of any wind turbine Project where ground borne vibration from an operating wind turbine has adversely impacted a residential or other use. The closest residence is over two miles away and no operational vibration impacts are anticipated.

3.9.2.5 Decommissioning

Decommissioning activities would result in less noise than those for construction, as little or no blasting would be necessary and heavy equipment would be used for a shorter period. Noise generating decommissioning activities would be conducted between 7 a.m. and 10 p.m.

3.9.3 Impacts of the No Action Alternative

Under the No Action Alternative, the Project would not be constructed or operated, and the environmental impacts described in this EIS would not occur. The No Action Alternative assumes that future development would comply with existing zoning requirements for the Project area, which is zoned Commercial Agriculture and Forest and Range. According to Kittitas County's zoning code, the Commercial Agriculture zone is dominated by farming, ranching, and rural lifestyles, and permitted uses include residential, green houses and agricultural practices. Permitted uses in the Forest and Range zone include logging, mining, quarrying, and agricultural practices, as well as residential uses (Kittitas County 1991). However, if the proposed Project is not constructed, it is likely that the region's need for power would be addressed by user-end energy efficiency and conservation measures, by existing power generation sources, or by the development of new renewable and non-renewable generation sources. Baseload demand would likely be filled through expansion of existing, or development of new, thermal generation such as gas-fired combustion turbine technology. Such development could occur at conducive locations throughout the state of Washington.

A baseload natural gas-fired combustion turbine would have to generate 67 average MW of energy to replace an equivalent amount of power generated by the Project (204 MW at 33% net capacity). (An average MW or “aMW” is the average amount of energy supplied over a specified period of time, in contrast to “MW,” which indicates the maximum or peak output [capacity] that can be supplied for a short period.) See Section 2.3, ‘Alternatives’.

3.9.4 Mitigation Measures

There would be no significant construction or operation noise impacts; therefore, no mitigation would be planned.

3.9.5- Significant Unavoidable Adverse Impacts

There are no significant unavoidable construction or operation impacts with regard to noise.