3.7 NOISE

This section describes the environmental noise analysis conducted to evaluate the potential noise impacts of the proposed Plymouth Generating Facility (PGF). The following subsections discuss the applicable noise limits, methods of analysis, and results of the noise study.

3.7.1 AFFECTED ENVIRONMENT

The human ear responds to a very wide range of noise intensities. The decibel scale used to describe noise is a logarithmic rating system that accounts for the large differences in audible sound intensities. This scale accounts for the human perception that loudness doubles with an increase of 10 decibels (dB). Therefore, a 70-dB noise level will sound twice as loud as a 60-dB sound level. People generally cannot detect differences of 1 dB. Although differences of 2 or 3 dB can be detected under ideal laboratory situations, they are difficult to discern in an active outdoor noise environment. A 5-dB change would likely be perceived under normal listening conditions.

Several descriptors are used in this section to describe various noise levels. An indication of average noise levels is provided by a noise descriptor known as the equivalent sound level (L_{eq}). The L_{eq} is the level of a constant noise that has the same sound energy as the actual fluctuating sound. The L_{90} is a noise level that is exceeded 90 percent of the time and is often considered a background noise level. Continuous noise sources such as power plants have the potential to affect the background noise environment in their vicinity.

When addressing the effects of noise on people, it is necessary to consider the frequency response of the human ear, or those frequencies that people hear best. Sound measuring instruments are therefore often designed to "weight" sounds based on the way people hear. The frequency-weighting most often used to evaluate environmental noise is A-weighting because it best reflects how humans perceive sound. Measurements from instruments using this system are reported in "A-weighted decibels," or dBA. An alternative frequency weighting system, C-weighting, does not reduce the level of low frequency noise as much as the A-weighting system and is better at describing very loud, low frequency sounds. Although low frequency sound is less audible to humans, C-weighting is often used to assess potential annoyance from structural rattling due to low frequency noise. Measurements from instruments using this system are reported in "C-weighted decibels" or dBC. Unless specified otherwise, noise levels are reported in A-weighted decibels.

Typical noise levels of familiar noise sources and activities are presented in Table 3.7-1.

Table 3.7-1
Common Noise Levels and Subjective Human Responses

<table>
<tr><th>Thresholds/
Noise Sources</th><th>Noise Level
(dBA)</th><th>Subjective
Evaluations</th><th>Possible Effects
on Humans</th></tr>
<tr><td>Human threshold of pain
Carrier jet takeoff (50 feet)</td><td>140</td><td rowspan="4">Deafening</td><td rowspan="7">Continuous exposure to levels above 70 can cause hearing loss in majority of population</td></tr>
<tr><td>Siren (100 feet)
Loud rock band</td><td>130</td></tr>
<tr><td>Jet takeoff (200 feet)
Auto horn (3 feet)</td><td>120</td></tr>
<tr><td>Chain saw
Noisy snowmobile</td><td>110</td></tr>
<tr><td>Lawn mower (3 feet)
Noisy motorcycle (50 feet)</td><td>100</td><td rowspan="2">Very Loud</td></tr>
<tr><td>Heavy truck (50 feet)</td><td>90</td></tr>
<tr><td>Pneumatic drill (50 feet)
Busy urban street, daytime</td><td>80</td><td rowspan="2">Loud</td></tr>
<tr><td>Normal automobile at 50 mph
Vacuum cleaner (3 feet)</td><td>70</td><td rowspan="2">Speech Interference</td></tr>
<tr><td>Large air conditioning unit (20 feet)
Conversation (3 feet)</td><td>60</td><td rowspan="2">Moderate</td></tr>
<tr><td>Quiet residential area
Light auto traffic (100 feet)</td><td>50</td><td rowspan="2">Sleep
Interference</td></tr>
<tr><td>Library
Quiet home</td><td>40</td><td rowspan="2">Faint</td></tr>
<tr><td>Soft whisper</td><td>30</td><td rowspan="4"></td></tr>
<tr><td>Slight rustling of leaves</td><td>20</td><td rowspan="3">Very Faint</td></tr>
<tr><td>Inside a broadcasting studio</td><td>10</td></tr>
<tr><td>Threshold of human hearing</td><td>0</td></tr>
</table>

Note: Both the subjective evaluations and the physiological responses are continuous without true threshold boundaries. Consequently, there are overlaps among categories of response that depend on the sensitivity of the noise receivers.
Source: U.S. EPA 1974; additional information from MFG, Inc.

3.7.1.1 Regulatory Overview

3.7.1.1.1 Benton County and Washington State Noise Limits

The PGF plant site is located in an unincorporated area of Benton County. Benton County does not have a rule specifically controlling levels of environmental noise; therefore, the state noise rule governs. The state noise limits are established in the Washington Administrative Code (WAC 173-60) and are based on the Environmental Designation for Noise Abatement (EDNA) of the noise source and the receiving properties. EDNAs are designated by class where Class A generally corresponds to residential areas, Class B EDNAs to retail and commercial areas, and Class C EDNAs to industrial and agricultural areas. The class of a property is determined by its predominate land use. For example, agricultural properties which may contain a residential structure are classed as agricultural (Class C) not residential (Class A). The noise limits that a new source can impose for each land use classification are presented in Table 3.7-2.

Table 3.7-2
Washington Maximum Permissible Sound Levels (dBA)

EDNA of Noise Source	EDNA of Receiving Property		
	Class A[a] (Residential)	Class B (Commercial)	Class C (Agricultural, Industrial)
Class A	55/45	57	60
Class B	57/47	60	65
Class C	60/50	65	70

[a]Sound limits shall be reduced by 10 dBA between the hours of 10 p.m. and 7 a.m. at Class A EDNAs
Source: WAC Chapter 173-60. Standard applies at property line of receiving property.

The noise limits presented in Table 3.7-2 can be exceeded for certain periods of time: 5 dBA for no more than 15 minutes in any hour, 10 dBA for no more than 5 minutes of any hour, or 15 dBA for no more than 1.5 minutes of any hour. Sometimes these exceptions are described in terms of the percentage of time a certain level is exceeded. For example, L_{25} represents a sound level that is exceeded 25 percent of the time, or 15 minutes in an hour. Similarly, $L_{8.33}$ and $L_{2.5}$ are the sound levels that are exceeded 8.33 and 2.5 percent of the time, or 5 and 1.5 minutes in an hour, respectively. At no time can the allowable sound level be exceeded by more than 15 dBA.

Because the noise generated by the proposed plant would not vary significantly (i.e., there would rarely be short-term peaks), the allowances for short-term increases in the noise level limits would rarely apply. Thus, the proposed plant (a Class C source) may not generate a sound level exceeding 70 dBA at nearby Class C EDNAs (i.e., industrial and agricultural properties) during daytime and nighttime hours. At the nearest Class A EDNAs, noise generated by the plant would be limited to 60 dBA during daytime hours (7 a.m. to 10 p.m.) and 50 dBA during nighttime hours. Because the proposed plant would operate 24-hours per day, it must be designed to meet the 50 dBA nighttime limit at these Class A EDNAs. Traffic on public roads, aircraft, and railroad traffic are exempt from the applicable environmental noise limits. Construction activities are also exempt from the noise regulations during daytime hours.

3.7.1.1.2 U.S. Environmental Protection Agency

While the United States Environmental Protection Agency (U.S. EPA) has no regulations governing environmental noise, the U.S. EPA has conducted extensive studies to identify the effects of certain sound levels on public health and welfare. A U.S. EPA document (U.S. EPA 1974) identifies sound levels "requisite to protect the public health and welfare with an adequate margin of safety." The U.S. EPA specifies a day-night sound level (L_{dn}) of 55 dBA for outdoor areas, where quiet is a basis for use. The L_{dn} is similar to the 24-hour L_{eq} except that a 10-decibel penalty is added to sound levels between 10 p.m. and 7 a.m. to account for sleep interference. Partly because the cost or feasibility of achieving these noise levels was not taken into consideration, these levels have the effect of guidelines, not regulations or standards.

3.7.1.1.3 Umatilla National Wildlife Refuge Noise Limits

No federal, state, or county noise limits exist that are set specifically to protect wildlife in the Umatilla National Wildlife Refuge located to the southwest of the PGF plant site. For the purposes of this analysis, noise levels set by the state to protect humans during the most sensitive nighttime hours are assumed to protect wildlife populations as well. For more information on potential impacts to wildlife, including a discussion of noise effects, see Section 3.5, Biological Resources.

3.7.1.1.4 Low Frequency Noise

Although not specifically addressed in State of Washington noise regulations, low frequency sound may disturb residents near power plants. Low frequency disturbances are more common with simple cycle facilities, sometimes called peaker plants. Although combined cycle plants such as the PGF tend to emit less low frequency sound than simple cycle facilities, low frequency noise impacts are assessed. A noise level limit of 70 dBC has been recommended in California to protect against rattling of windows or objects on shelves.

3.7.1.2 Plant Site and Infrastructure

The plant site and infrastructure corridors are located on land currently used for agricultural or industrial purposes (also Class C EDNA). The nearest neighbors to the plant site are the Plymouth Farm property surrounding the plant site and the Williams Northwest Gas Pipeline Company (Williams Co.) compressor station to the south, both of which are considered industrial/agricultural properties (Class C EDNAs). Residential uses that are nearest the plant site and infrastructure corridors are sparsely situated residences to the northwest, southwest, and southeast of the plant site. Two of these residences are currently located on Plymouth Farm property and would be considered Class C receiving properties. The first is northwest of the plant site on a hillside overlooking the site, and the second is southwest of the plant site adjacent to Christy Road. Most of the other residences are also located on agricultural property and would be considered Class C receiving properties. Several residences located south of Christy Road are not on agricultural property and would be considered Class A receiving properties.

3.7.1.2.1 Existing Sound Levels

The plant site and infrastructure corridors are located in a rural area consisting primarily of agricultural and industrial uses. Primary sources of noise in the area include the Burlington Northern Santa Fe (BNSF) railway, traffic on local roads, the Williams Co. compressor station south of the plant site, and the AgriNorthwest grain facility east of the plant site.

To characterize the existing noise environment near the plant site, 24-hour sound level measurements (SLM) were taken at four locations in February and March 2002. Type I Larson Davis sound level meters were used for the measurements. The sound level meters were calibrated prior to the measurements, and the microphones were placed on tripods approximately 5 feet above the ground. Weather conditions during the measurements included strong winds at two of the measurement locations for a portion of the measurement period.

The sound level meters were placed at residential locations nearest the proposed plant site and infrastructure corridors or at locations representative of nearby residences. A description of the measurement locations and a summary of the measured levels are provided in Table 3.7-3; details of the measured levels are provided in Appendix E. The measurement locations are shown in Figure 3.7-1.

Table 3.7-3
Existing Sound Level Measurement Results (dBA)

SLM Location	Time	L_{eq}	L_{max}	L_2[a]	L_8[b]	L_{25}[c]	L_{90}[d]	L_{dn}
SLM1	Day	42-58	55-85	45-64	44-56	39-51	34-40	58
	Night	40-57	57-82	46-70	44-53	41-46	33-39	
SLM2	Day	42-53	58-74	47-64	45-58	41-50	35-42	58
	Night	39-55	61-76	44-69	41-62	39-51	34-39	
SLM3	Day	44-59	62-85	53-67	48-62	41-58	33-48	58
	Night	44-56	66-84	53-64	47-59	40-54	34-43	
SLM4	Day	48-66	67-90	58-76	54-69	47-64	34-55	65
	Night	51-63	75-88	61-72	53-67	53-67	31-48	

Notes:
SLM1 - Located at the nearest residence to the proposed plant site. This residence is located on Plymouth Farm property on a hillside overlooking the plant site. Notable sound sources during setup and retrieval of the meter consisted of dogs, trains, and residential activity. Noise from the Williams Co. compressor station was audible during the equipment deployment, but did not dominate the environment.

SLM2 - Located south of Christy Road across the street from a residence southeast of the proposed plant site. This measurement represents the existing noise environment at the nearest residences to the southeast of the plant site and at the residence on Plymouth Farm property south of the plant site. Notable sound sources during setup and retrieval of the meter included sparse traffic on Christy Road, trains, and sound from the AgriNorthwest grain facility.

SLM3 - Located at the Marcum residence southeast of the plant site, at 56611 East Christy Road. This location is representative of three houses southeast of the plant site located between Christy Road and the Columbia River. The sound environment was dominated by high winds between 10 a.m. on March 20 and 1 a.m. on March 21. Other notable sound sources during setup of the meter included construction activities nearby. During retrieval of the equipment, when the wind noise had subsided, noise from the AgriNorthwest grain facility was audible.

SLM4 – Located at the Dufault residence on the Emmanuel Orchard property southwest of the plant site. This location is representative of two residences on the orchard property. The noise environment was dominated by high winds between 10 a.m. on March 20 and 1 a.m. on March 21. Other sources included dogs, residential activities, and passing trains.

L_{max} = maximum sound level.
L_{eq} = level of a constant noise that has the same sound energy as the actual fluctuating sound.
L_{dn} = day-night sound level.

[a] The L_2 sound level shown above is roughly equivalent to the $L_{2.5}$ noise descriptor (i.e., the sound level exceeded 2.5 percent of the time, or 1.5 minutes of an hour).
[b] The L_8 sound level shown above is roughly equivalent to the $L_{8.33}$ noise descriptor (i.e., the sound level exceeded 8.33 percent of the time, or 5 minutes of an hour).
[c] The L_{25} is a sound level that is exceeded 25 percent of the time.
[d] The L_{90} is a sound level that is exceeded 90 percent of the time and is often considered a background sound level.

While the state's limits on new noise sources (Table 3.7-2) do not apply to existing noise measurements, they do provide a reference for evaluating existing noise conditions. For example, existing noise levels at SLM1 and SLM2 are less than the state's noise limit of 70 dBA for industrial sources affecting agricultural receivers during all hours of the measurement. Trains passing through on the BNSF rail line likely caused some of the maximum noise levels.

Existing noise levels at SLM3 are less than the state's daytime noise limits except for the maximum levels. The nighttime $L_{2.5}$ limits were exceeded during several hours and the L_{max} limit was exceeded during all nighttime hours. High winds, train horns, and dogs likely caused some of the exceeding sound levels.

Existing noise levels at SLM4 are less than the state's noise limit of 70, 75, and 80 dBA for L_{25}, $L_{8.33}$, and $L_{2.5}$, respectively, during all hours of the measurement. The L_{max} limit of 85 dBA was exceeded during several hours, most likely due to the winds that blew during most of the measurement period. Between 1 a.m. and 3 a.m., the winds appear to have quieted, resulting in much lower background sound levels. During these quieter hours, the maximum sound levels were likely due to train horns or dogs.

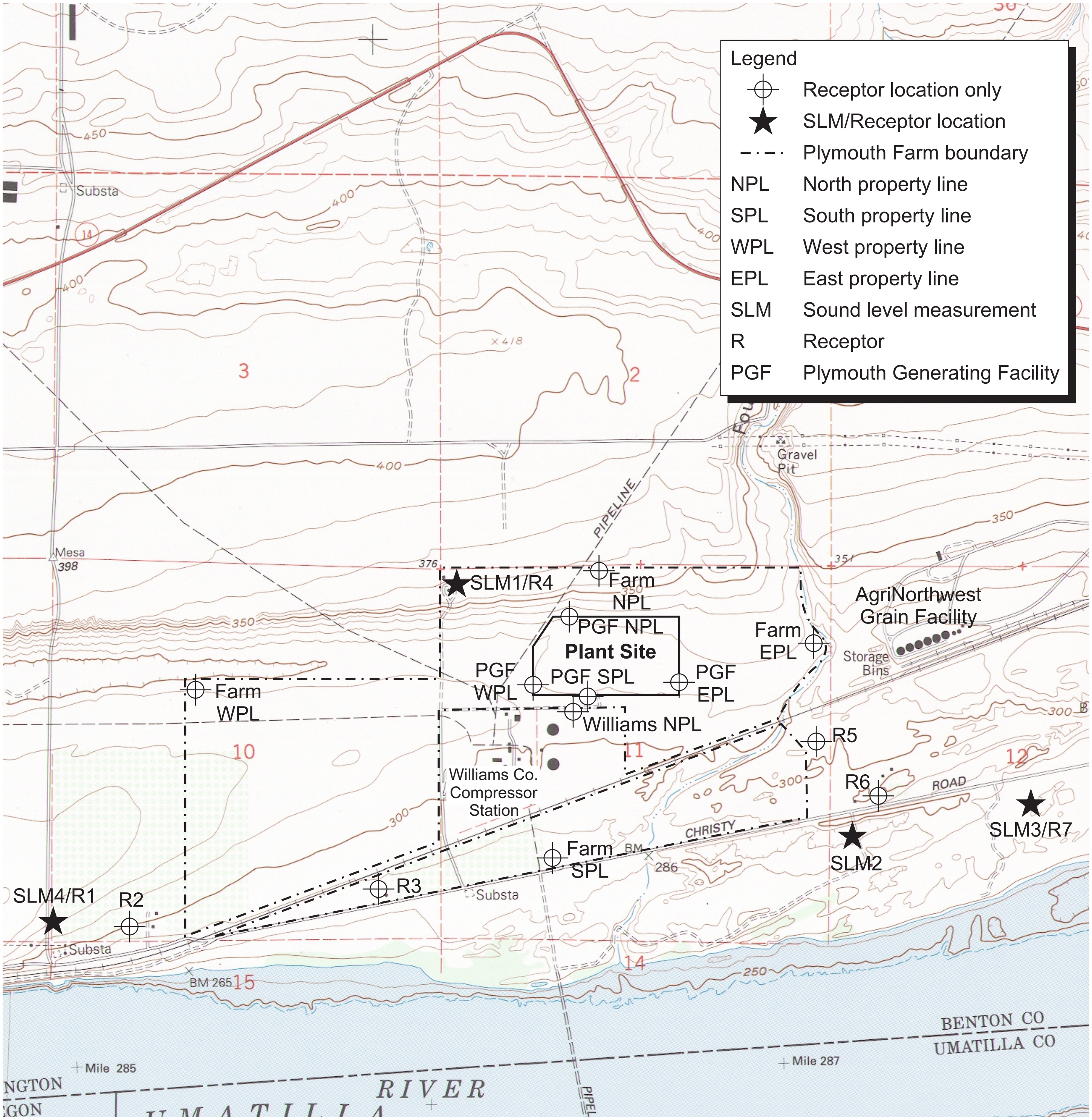
It should be noted that both SLMs 3 and 4 were deployed during high winds, which greatly elevated the measured noise levels during hours with wind. The noise levels measured at location SLM3 were lower than those measured at SLM4 during the high wind event because the location of SLM3 was more protected from northerly winds.

The residential locations analyzed in this study were not heavily influenced by the several small, localized, continuous noise sources in the project vicinity and, therefore, experience similar background noise environments. The primary differences in the noise environment at each location result from short-term events from sources like trains and traffic, which generate varying maximum sound levels at each location. Therefore, under calm conditions, the long-term noise (represented by the L_{eq}, L_{25}, or L_{90}) is likely to be similar at all of the residential locations in the project vicinity.

3.7.2 ENVIRONMENTAL CONSEQUENCES

3.7.2.1 Methodology

Operational noise levels were predicted at several receptor locations in the site area using a noise model described in Section 3.7.2.3.1 (under Environmental Noise Model). The potential for noise impacts depends on many factors, including the existing sound environment, the expectation of a listener regarding the noise, the attitude of a listener toward the noise source, the character of the sound, the control of the receiver over the noise source, whether the receiver perceives a loss of property value or other detriment due to the noise source, or whether the receiver might benefit from the project. Because all these factors affect the potential for impacts from any given noise source, universally applicable noise impact levels cannot be defined. However, the following general categories of "low," "medium," or "high" noise impacts have been defined for this analysis. Predicted project-related noise levels were then evaluated using these categories to determine environmental impacts.



Source: USGS 7.5 minute topographic map Irrigon, WA/OR, dated 1993.

0 0.5 1.0

Approximate Scale in Miles

Figure 3.7-1

SLM and Receptor Locations

URS

Plymouth Energy Project
Plymouth, Washington

Figure 3.7-1 (Continued)

The following criteria were used to assess predicted noise impacts to residential receivers in Class A EDNAs (Residential) from operation of the PGF. Impacts that are rated high are also considered to be significant. Because the PGF is planned to operate 24 hours per day, the impact criteria were defined based on noise received during nighttime hours.

- Low – Predicted PGF-related continuous A-weighted noise levels of 45 dBA or less.
- Medium – Predicted PGF-related continuous A-weighted noise levels greater than 45 dBA and up to 50 dBA.
- High (Significant) – Predicted PGF-related continuous A-weighted noise levels greater than 50 dBA or predicted C-weighted PGF-related noise levels of 70 dBC or greater, or an increase in the existing noise level (L_{25}) of 10 dBA or greater.

The following criteria were used to determine noise impacts to residential structures found in Class C EDNAs (agricultural). Impacts that are rated as high are also considered to be significant. Because the facility is planned to operate 24 hours per day, the impact criteria were defined based on noise received during nighttime hours.

- Low – Predicted PGF-related continuous A-weighted noise levels less than 50 dBA.
- Medium – Predicted PGF-related continuous A-weighted noise levels from 50 to 59 dBA.
- High (Significant) – Predicted PGF-related continuous A-weighted noise levels 60 dBA or higher, predicted C-weighted noise levels 70 dBC or higher, or increases in the existing noise level (L_{25}) of 10 dBA (peak hour L_{eq}) or higher.

The following criteria were used to determine noise impacts to agricultural/industrial receivers (Class C EDNA). Impacts that are rated as high are also considered to be significant.

- Low/Medium – Predicted PGF-related continuous A-weighted noise levels less than or equal to 70 dBA.
- High (Significant) – Predicted PGF-related continuous noise levels greater than 70 dBA.

Impact criteria were not defined for commercial receivers (Class B EDNA) since no commercial receivers (based on land use) are in the immediate noise impact area of the project.

In defining the impact criteria for residential structures located in Class C EDNAs, high noise impacts were defined at a noise level lower than allowed by the WAC limits for several reasons. Although WAC sets a 24-hour noise limit for residences located on agricultural properties of 70 dBA, almost all of the existing studies/literature indicate that this level is too high to protect residences from speech interference and sleep disturbance. Therefore, a lower level was deemed appropriate for determining when high impacts might occur.

The first level considered was the U.S. EPA-recommended level (L_{dn}) of 55 dBA, specified as a guideline level to protect residents from noise impacts with an adequate margin. This was determined to be too low. Using this level would have essentially limited noise from the plant to 49 dBA. (An L_{dn} adds 10 dBA to nighttime levels between 10 p.m. and 7 a.m. to account for sleep sensitivity.) This recommended U.S. EPA guideline was never adopted for regulatory use because the cost and feasibility of achieving this level was not considered. Also, numerous residents in the project vicinity are currently exposed to sound levels exceeding this recommended limit and are unlikely to consider themselves greatly impacted by noise.

The second level considered was 66 dBA, specified by the Washington State Department of Transportation (WSDOT) as a peak hourly L_{eq} at which traffic noise impacts could be expected. However, this level was set with the expectation that off-peak traffic noise would be much lower than peak-hour traffic noise, and that nighttime levels would generally be much quieter. Therefore, a continuous sound level of 66 dBA was deemed inappropriate for protection of residents.

The third level considered came from the Department of Housing and Urban Development (HUD) standards set for new projects. HUD projects in locations with existing L_{dns} of 65 dBA or lower are considered “acceptable.” HUD projects in locations with existing levels higher than 65 dBA are considered “normally unacceptable.” An L_{dn} of 65 dBA corresponds to a continuous 24-hour noise level of 59 dBA; therefore, levels 59 dBA and lower would be considered “acceptable” and levels 60 dBA and higher would not be considered acceptable. Consequently, a continuous level of 60 dBA was selected as the noise limit at which high noise impacts may be expected.

3.7.2.2 No Action Alternative

Under the No Action Alternative, the PGF would not be constructed. Existing sound levels from the site include agricultural activities, which would continue in the future with or without the Proposed Action. No known noise impacts currently occur from these agricultural activities, and none would be anticipated to occur in the future.

3.7.2.3 Proposed Action

3.7.2.3.1 Plant Site

Construction

During construction at the plant site, noise from construction activities would add to the noise environment in the immediate area. Such activities would generate noise levels as indicated in Table 3.7-4. Construction activities are expected to occur during normal daytime working hours. It should be noted that no specific federal, state, or local standards regulate noise from daytime construction activities. In fact, construction noise is exempt from the state noise limits (see Table 3.7-2) between 7 a.m. and 10 p.m.

Table 3.7-4
Typical Construction Equipment Noise

Activity	Type of Equipment	Range of Noise Levels (dBA)		
		At 200 Feet	At 1,400 Feet	At 1,900 Feet
Material Handling	Concrete mixers	62-75	45-58	42-55
	Concrete pumps	69-71	52-54	49-51
	Cranes	64-76	47-59	44-56
Stationary Equipment	Pumps	57-59	40-42	37-39
	Generators	59-70	42-53	39-50
	Compressors	64-75	47-58	44-55
Pile Driving	Drop hammer	69-76	52-59	49-56
	Vibratory hammer	54-83	37-66	34-63
	Auger boring	65-71	48-54	45-51
Land Clearing	Bulldozer	65-84	48-67	45-64
	Dump trucks	70-82	53-65	50-62
Grading	Scraper	68-81	51-64	48-61
	Bulldozer	65-84	48-67	45-64

Based on the typical attenuation of sound over distance (6 dBA per doubling of distance), construction noise levels at the nearest residence to the site (on Plymouth Farm property approximately 0.25 mile northwest of the plant site) would mostly fall within the state daytime noise limits for residential receivers (i.e., 60 dBA). The next nearest residence to the plant construction activity is approximately 0.36 mile southeast of the plant site. Again, construction noise levels would mostly fall within the state daytime noise limits for residential receivers (i.e., 60 dBA). Sound levels at the more distant residential locations would be even lower than the levels shown in Table 3.7-4. Regardless, construction noise is exempt from the state noise limits during daytime hours. Also, the large distances between the plant site and the nearest residential receivers, coupled with the restriction of construction activities to daytime hours, would serve to minimize potential noise impacts from construction activities. Impacts would likely be low or moderate.

Operation

Noise Sources

During operation, the PGF would generate noise from a number of sources, some of which are relatively quiet compared with others. The quieter sources would not be audible when the louder equipment is operating. Therefore, the noise analysis focuses on the loudest noise sources: the gas turbine, inlet air filter, heat recovery steam generator (HRSG), steam turbine, air-cooled condenser, cooling tower, and transformers. Table 3.7-5 summarizes the A-weighted sound pressure levels associated with the noise sources examined in this analysis. Following are brief narrative descriptions of these sources.

Table 3.7-5
Summary of Significant Noise Sources During PGF Operation

Source	Height (ft)	Approximate Sound Pressure Level at 100 ft (dBA)
Inlet Filter House	42	66
Gas Turbine	20 (building = 50)	75
HRSG – Exhaust Duct	23	67
HRSG - T1&T2	50	67
HRSG - B1&B2	70	65
Stack Wall	75	62
Stack Exit	150	79
Rotor Air Cooler	26	64
Steam Turbine	20 (building = 50)	75
Cooling Tower	44	70
Auxiliary Cooling Tower	42	64
Air Cooled Condenser	48	66
Gas & Steam Turbine Transformers	16	72

Note:
Sound levels shown do not include the noise reduction from placing noise sources inside a building. The effect on noise building transmission was accounted for in the noise model.

- **Gas Turbine and Gas Turbine Building** – The PGF would include installation of a 501F gas turbine-generator. The gas turbine-generator would be enclosed in a building to reduce noise emissions. Noise attenuation from the building walls and roof was evaluated assuming they were the approximate density of 22-gauge steel lined with absorbent material (typical building insulation) on the interior surfaces. This analysis assumed that no major noise leaks would occur through any air inlets or exhaust louvers. This may require the installation of silencers on any airflow openings.

  Siemens/Westinghouse guarantees a sound level of 85 dBA at 3 feet from the gas turbine surfaces. This sound level was converted to a sound power level based on the estimated dimensions of the gas turbine. Westinghouse provided a sound frequency spectrum for the gas turbine.

- **Steam Turbine** – The steam turbine generator would be enclosed in the same building as the gas turbine to reduce noise emissions. Siemens/Westinghouse provided the steam turbine sound frequency spectrum for the steam turbine.

- **Inlet Filter House** – The inlet filter house would be located on the south side of the turbine building and serve as the air inlet for the gas turbine. The inlet opening would face east, resulting in reduced inlet sound levels to the north, south, and west. Westinghouse identified sound frequency spectrum information for a quieted filter house that consists of 14-foot-long inlet silencer baffles instead of the standard 10-foot long baffles.

- **Heat Recovery Steam Generator** – An HRSG is a boiler that is used to transfer the heat from combustion turbine exhaust to water. The heated water becomes steam, which is used to drive the steam turbine generator. The sound power levels used in the modeling for different sections of the HRSG assumed an increased thickness for the walls of the HRSG, transition, and exhaust ducts. The thickness' of the walls are 7/8-inch (Sections T1 and T2), 7/8-inch (Section B1), and 5/8-inch (Section B2).

- **HRSG Stack** – Exhaust gases from the combustion turbine would pass through the HRSG and out a 150-foot-high exhaust stack. Both the stack walls and the stack top (the exit point) would be potential noise sources and were addressed in the noise evaluation.

- **Rotor Air Cooler** – Located on the west side of the turbine building and north of the gas turbine exhaust duct, the rotor air cooler would cool the gas turbine rotor. The gas turbine building and HRSG would act as noise barriers from this source to the receptors to the south and southeast.

- **Air-Cooled Condenser** – An 8-cell air-cooled condenser would provide cooling virtually all the time, but would need to be increasingly assisted by a mechanical draft cooling tower as temperatures increase. GEA Power Cooling Systems, Inc. provided an effective sound power level for the condenser.

- **Cooling Tower** – A 3-cell mechanical (wet) draft cooling tower would be constructed north of the air-cooled condenser. Noise would be generated by large fans that would circulate air through the tower and by dripping water. GEA Power Cooling Systems, Inc. provided a far field sound level for this piece of equipment. Three decibels were subtracted from this far field sound level to estimate the benefits of redirecting water flow, a suggested mitigation measure. This reduced sound pressure level was then converted to an estimated sound power level for use in the noise model.

- **Auxiliary Cooling Tower** – A 2-cell mechanical (wet) draft cooling tower would be constructed north of the air-cooled condenser and east of the primary cooling tower. Similar to the primary cooling tower, noise would be generated by large fans that circulate air through the tower and by dripping water. However, the auxiliary cooling tower would be substantially smaller than the primary cooling tower. The auxiliary cooling tower would provide bearing cooling water on cold days when the primary cooling tower is not in operation.

- **Steam Turbine and Gas Turbine Generator Transformers** – A National Electrical Manufacturers Association (NEMA) rated sound level was provided by Black & Veatch, Inc., the electrical engineer for the proposed project. Each of these transformers would emit a maximum sound level of 88 dBA. Based on a transformer 34 feet long, 20 feet wide, and 16 feet high, a sound power level of 125 dB was calculated. The frequency spectrum was determined from an acoustical reference book (Crocker 1998).

Although there could be other equipment on the plant site capable of producing noise, including various pumps and fans, noise produced by the sources identified above would likely dominate the total sound emitted from the plant site. Therefore, only the sources discussed above are included in this analysis.

Table 3.7-6 identifies unweighted sound power levels for different sound frequency ranges associated with each source. It is important to note the distinction between sound power levels (which are analogous to heat) and sound pressure levels (which are analogous to temperature). The A-weighted sound pressure levels identified in Table 3.7-5 are representative of what a person would hear if the individual source were by itself on an open field. The unweighted sound power levels presented in Table 3.7-6 represent the sound energy of the individual sound sources in each frequency range, which are then used to calculate the distant sound pressure levels.

Table 3.7-6
Effective Sound Power Levels of Significant Sources

Source	**Frequency (HZ)**									**Total**	
	31.5	63	125	250	500	1000	2000	4000	8000	dBA	dBC
Inlet Filter House	122	117	115	100	94	100	87	84	90	104	122
Gas Turbine	115	126	124	106	108	108	111	108	103	116	128
HRSG- Exhaust Duct	125	119	117	98	93	84	81	73	66	102	124
HRSG - T1&T2	125	119	117	98	93	84	81	73	66	102	124
HRSG - B1&B2	123	117	115	95	89	78	72	61	52	100	122
Stack Wall	104	104	107	91	78	69	59	34	10	92	109
Stack Exit	128	128	131	115	108	97	83	80	79	116	133
Rotor Air Cooler	112	122	116	107	100	92	88	86	82	105	123
Steam Turbine	114	117	117	109	108	109	109	109	105	116	121
Cooling Tower	N/A	116	115	112	106	106	101	98	91	111	119
Auxiliary Cooling Tower	N/A	110	009	106	100	100	95	92	85	105	113
Air Cooled Condenser	N/A	111	109	104	101	99	91	87	82	103	114
Steam Turbine Transformer	107	113	115	110	110	104	99	94	87	110	118
Gas Turbine Transformer	107	113	115	110	110	104	99	94	87	110	118

Note:
HZ = hertz

Environmental Noise Model

Noise that would be generated by onsite noise sources during PGF operation was evaluated using the Environmental Noise Model (ENM) (RTA 1989). ENM is a computer program designed to evaluate noise propagation in the environment. The model calculates sound levels after considering the noise reductions or enhancements caused by distance, topography, ground surfaces, and atmospheric stability and absorption.

After individual sound sources were identified and quantified, 3-dimensional maps of the plant site and vicinity were created to enable the ENM model to evaluate effects of distance and topography on noise attenuation. Sound power levels of project noise sources were assigned to the appropriate locations on the plant site. ENM was then used to construct topographic cross sections and to evaluate noise impacts in the vicinity of the site.

As sound energy spreads while it radiates from a source, its apparent loudness (perceived noise) decreases. For a single source, the sound level decreases at a rate of 6 dBA per doubling of the distance. At a distance, the PGF would behave as a point source of noise. Sound loss due to divergence of sound energy is the same for all frequencies and is independent of any weighting scale used. In the absence of hills or berms, distance is the primary mechanism for decreasing the noise from a site.

Some of the energy in a sound wave is absorbed by the atmosphere. The amount of absorption depends on the frequency of the sound, the temperature, and relative humidity of the atmosphere. This absorption is small and ignored for short distances, but the effect becomes significant as the distance between the source and receiver increases. Because of the more effective absorption at higher frequencies, atmospheric absorption would also tend to lower the pitch of noise generated at the plant site.

The surfaces over which sound waves travel affect the amount of sound at a distant receptor in a complex manner. Hard surfaces such as asphalt can reflect energy and increase the noise level at distant receptors. A soft surface will absorb sound energy, thus reducing the noise level at a distant receptor. In addition, the surface can produce a reflected wave that interferes with the direct sound wave and actually reduces or increases the sound level expected due to distance. These interactions are commonly referred to as “ground effects.” In addition to surface qualities, the magnitude of the ground effect depends on the height of the source and receiver and the frequency of the sound. In the site area, most of the ground is “soft” and therefore tends to absorb rather than reflect sound.

If a wall or hillside obstructs the line-of-sight between a noise source and receiver, the sound waves must bend (or refract) around the obstruction in order to reach the receiver. Because much of the site area is relatively flat, there is little natural topography that would serve as a noise barrier. However, structures on the plant site would reduce noise from some onsite sources because they would block the line-of-sight from those sources to offsite locations.

Sound propagation through the atmosphere is also affected by wind and by temperature change with height. With a temperature inversion, temperatures at the ground surface are lower than the temperatures aloft and the atmosphere is said to be stable. This causes sound waves radiating upward to bend back toward the ground, which reduces distance attenuation. Sound traveling downwind also bends downward.

Predicted A-Weighted Sound Levels

Sound levels were calculated at residential receivers, the wildlife refuge, and property line locations nearest to the plant site and are shown on Table 3.7-7. Values were calculated for favorable, adverse and worst-case meteorological conditions, as they relate to sound propagation, and compared to state limits. The favorable condition consisted of calm conditions and a neutral atmosphere (loss of 0.55°F or more per 100 feet); the adverse condition consisted of calm conditions and a stable atmosphere (increase of 1.65°F or more per 100 feet); the worst-case condition consisted of 6.7 mph winds blowing from the source to the receiver and a neutral atmosphere. Higher wind speeds were not considered because they tend to increase background noise levels, thereby masking noise from the plant.

The impact analysis calculated sound levels (Table 3.7-7) were compared to the impact criteria and the results are shown in Table 3.7-8 and Table 3.7-9. The impacts from just considering the noise created by operation of the PGF are shown in Table 3.7-8.

The evaluation of impacts with respect to the increase in overall noise levels is shown in Table 3.7-9. In this evaluation, the predicted noise levels from operation of the PGF under adverse meteorological conditions (see Table 3.7-7) were used rather than worst case. The "adverse" meteorological condition used to predict the increase is more consistent with the conditions found during the noise measurement. In Table 3.7-9, the lowest existing noise levels measured in the project vicinity were added to the predicted noise from the PGF and a range of combined or overall noise level calculated. The existing noise level was then subtracted to determine the increase in overall noise that would occur due to operation of the PGF. Impact levels were then assigned based on the range of increase in noise calculated.

Receptors R1 and R2 are located on the Emmanuel orchard west of the plant site. Receptors R3 and R4 represent residences on Plymouth Farm. Receptors R5, R6, and R7 represent the nearest residential locations to the southeast of the plant site. The receptor locations are shown on Figure 3.7-1.

Residential receptor locations R1, R2, R3, R5, and R6 are located on agricultural property (a Class C EDNA) with an applicable 24-hour noise limit of 70 dBA. However, Table 3.7-7 indicates predicted sound levels at all of these residential locations are at or below the state's 50-dBA nighttime noise limit for Class A receivers (i.e., residential properties), under even adverse meteorological conditions (i.e., wind). Also, the predicted sound levels during calm meteorological conditions are below or at the low end of the range of existing measured levels and would not result in a greater than 10 dBA increase in noise due to the PGF. Therefore, noise impacts to these receptor locations from the project would be low (see Table 3.7-8 and 3.7-9).

Receptor location R4, representing a leased residence on Plymouth Farm northwest of the plant site, is also located on agricultural property (a Class C EDNA) with an applicable 24-hour noise limit of 70 dBA. Predicted sound levels under calm conditions or with winds from the north or northwest are less than 50 dBA. However, the highest predicted sound levels occur with winds from the southeast or south and are as high as 57 dBA, representing a moderate noise impact, see Table 3.7-8. Also, the predicted sound level increase over existing levels during adverse (stable) meteorological conditions is 10 dBA and would be considered a high (significant) noise impact (see Table 3.7-9).

Also, it should be noted that residential receiver R7 would be considered a Class A receiving property with an applicable daytime limit of 60 dBA and nighttime limit of 50 dBA. However, Table 3.7-7 shows that the highest predicted generating facility sound level at R7 would be 45 dBA. This would comply with the nighttime limit of 50 dBA, and would also constitute a low noise impact (Table 3.7-8). Also, the predicted levels under calm conditions would be well below the existing range of sound levels in the project vicinity, constituting a low noise impact (Table 3.7-9).

The Umatilla National Wildlife Refuge is located southwest of the plant site, and farther from the site than R1. Therefore, the sound levels from the PGF would be similar to or lower than the levels predicted at R1. These predicted levels range from 30 dBA under calm conditions and a neutral atmosphere to 41 dBA with a wind blowing from the northwest. These levels fall far below the levels considered protective of human use and are presumed to also be protective of wildlife at the refuge.

Sound levels were also calculated at property line locations to determine if the PGF would meet the applicable 70-dBA noise limit at adjacent industrial and agricultural properties. Predicted sound levels at all property line locations (Table 3.7-7) would meet the state noise limit for Class C sources affecting Class C noise receiving properties. The highest predicted sound level of 68 dBA was at the southern boundary of the PGF site. This predicted sound level would fall below the 70-dBA limit applicable during both daytime and nighttime hours.

Table 3.7-7
Calculated A-Weighted Sound Levels (dBA)/Meteorological Conditions

Receptor	Favorable	Adverse	Worst-Case[a]	State Limit (dBA)
Residential and other Sensitive Locations:				
R1	30	32	23 (SW) – 41(NE)	70
R2	29	32	26 (SW) – 43 (NE)	70
R3	39	41	29 (SW) – 48 (NE)	70
R4	45	49	39 (NW) – 57 (SE)	70
R5	39	43	33 (SE) – 50 (NW)	70
R6	37	40	31 (SE) – 48 (NW)	70
R7	34	37	28 (SE) – 45 (NW)	60/50
Umatilla National Wildlife Refuge	30	32	23 (SW) – 41 (NE)	60/50
Property Line Locations:				
Plymouth Energy WPL	59	60	63	70
Plymouth Energy NPL	57	58	63	70
Plymouth Energy EPL	50	53	57	70
Plymouth Energy SPL	66	66	68	70
Plymouth Farm WPL	36	38	46	70
Plymouth Farm NPL	49	51	59	70
Plymouth Farm EPL	41	43	48	70
Plymouth Farm SPL	44	46	55	70
Williams Co. compressor station NPL	60	61	63	70

[a] The sound levels shown represent the highest and lowest predicted levels, according to the wind directions indicated. Predicted sound levels with wind blowing in other directions would fall within the range of levels displayed.
Notes:
EPL = east property line
NPL = north property line
SPL = south property line
WPL = west property line
See Figure 3.7-1 for receptor locations.

Table 3.7-8
Impact Assessment - PGF Noise Levels

Receptor Location	Worst-Case Predicted PGF dBA	Worst-Case Predicted PGF dBC	Impact due to PFG dBA	Impact due to PFG dBC
Residential and other Sensitive Locations:				
R1	41	56	Low	Low
R2	43	59	Low	Low
R3	48	66	Low	Low
R4	57	67	Medium	Low
R5	50	67	Low	Low
R6	48	64	Low	Low
R7	45	63	Low	Low
Umatilla National Wildlife Refuge	41	NA	Low	NA
Property Line Locations:				
Plymouth Energy WPL	63	NA	Low	NA
Plymouth Energy NPL	63	NA	Low	NA
Plymouth Energy EPL	57	NA	Low	NA
Plymouth Energy SPL	68	NA	Low	NA
Plymouth Farm WPL	46	NA	Low	NA
Plymouth Farm NPL	59	NA	Low	NA
Plymouth Farm EPL	48	NA	Low	NA
Plymouth Farm SPL	55	NA	Low	NA
Williams Co. compressor station NPL	63	NA	Low	NA

Table 3.7-9
Impact Assessment - PGF - Noise Levels

Estimated Increase over Existing[a]					Impact due to Increase over dBA
Receptor Location	Existing Levels (L25)[b]	PGF with Adverse Met	Overall Level (Existing + PGF)	Increase	
R1	39-51	32	40-51	0-1	Low
R2	39-51	32	40-51	0-1	Low
R3	39-51	41	43-51	0-2	Low
R4	39-51	49	49-53	2-10	High
R5	39-51	43	44-52	1-5	Low
R6	39-51	40	43-51	0-4	Low
R7	39-51	37	41-51	0-2	Low

[a] In order to estimate potential noise impacts at residential receivers due to an increase in the existing sound level of 10 dBA or greater, predicted sound levels of the PGF were added to the measured existing levels in the project vicinity. Because the lowest existing measured levels used for this analysis generally represent calm conditions, the increase was calculated by using the predicted noise levels during calm but adverse (stable) conditions instead of the worst-case (windy) conditions.

The existing sound levels displaced are the lowest range of sound levels measured at residential locations in the project vicinity. As discussed in Section 3.7.1.2.1 regarding the existing sound levels, the background sound environment is similar at each of the receptor locations. Therefore, the lowest measured levels of all of the locations were used to provide the most conservative comparison of future noise levels to the existing levels.

Predicted C-Weighted Sound Levels

Similar to A-weighted sound levels, C-weighted sound levels were calculated for different meteorological conditions at nearby residential receivers to gauge the potential of low frequency noise to rattle windows or objects on shelves. These values are shown in Table 3.7-10.

Sound levels of 70 dBC or lower should protect against this kind of noise-related phenomenon. As presented in Table 3.7-8, predicted C-weighted sound levels at all nearby residential receivers would be lower than 70 dBC, resulting in a low potential of impacts from low frequency noise at nearby residences.

Table 3.7-10
Calculated C-Weighted Sound Levels (dBA)/Meteorological Conditions

Receptor	Favorable	Adverse	Worst-Case[a]	Impact Limit (dBC)
Residential Receiving Properties				
R1	49	51	43 (SW) – 56 (NE)	70
R2	52	54	45 (SW) – 59 (NE)	70
R3	60	62	52 (SW) – 66 (NE)	70
R4	59	62	52 (NW) – 67 (SE)	70
R5	61	63	54 (E) – 67 (NW)	70
R6	58	59	51 (SE) – 64 (NW)	70
R7	56	58	49 (SE) – 63 (NW)	70

[a] The sound levels shown represent the highest and lowest predicted levels, according to the wind directions indicated. Predicted sound levels with wind blowing in other directions would fall within the range of levels displayed.
See Figure 3.7-1 for receptor locations.

3.7.2.3.2 Transmission Interconnection

Construction

Construction of the proposed transmission interconnection would occur in a corridor extending north of the plant site over uninhabited property to the BPA transmission lines. The corridor is greater than 0.25 mile from the nearest residence, which would greatly reduce noise impacts from construction activities and equipment (see Table 3.7-4.) The large distances between the transmission line corridor and the nearest residential receivers, coupled with the restriction of construction activities to daytime hours, would serve to minimize any potential noise impacts from such activities. Therefore, no significant noise impact is anticipated.

Operation

Operation of the proposed transmission interconnection would occur in a corridor extending north of the plant site over uninhabited property to the BPA transmission lines. The corridor would be greater than 0.25 mile from the nearest residence. This large distance, coupled with the minimal noise produced by operation of the transmission lines, would likely render the transmission line noise inaudible at the nearest residential receivers; therefore, no noise impact is anticipated from this source.

3.7.2.3.3 Access Road

Construction

The proposed access road would include the Plymouth Industrial Road, which currently accesses the AgriNorthwest grain facility. From the AgriNorthwest grain facility, the access road would continue to the northeast corner of the plant site, traversing agricultural and undeveloped properties. The nearest offsite residence to the access road corridor is more than 0.36 mile away. For common construction equipment noise levels at 0.36 mile, refer to Table 3.7-4. The large distances between the access road corridor and the nearest offsite residential receivers, coupled with the restriction of construction activities to daytime hours, would serve to minimize potential noise impacts from such activities; therefore, a low to moderate and less than significant noise impact is anticipated.

Operation

During PGF operation, the proposed access road would be used by small volumes of passenger vehicles and occasional trucks at a distance greater than 0.36 mile from the nearest residence. This large distance, coupled with the light traffic volumes, would greatly reduce the potential for noise impacts from this source; therefore, low to moderate and less than significant impacts are anticipated.

3.7.2.4 Alternative 230-kV Transmission Interconnection

Impacts of the alternate 230-kilovolt (kV) transmission interconnection would be the same as those for the proposed transmission interconnection because the existing 230-kV line is in the same physical location as the proposed 500-kV line.

3.7.2.5 Alternate Benton PUD/BPA Transmission Interconnection

The proposed alternate Benton Public Utility District (PUD)/BPA transmission interconnection would follow the same route as the existing power line on the south side of Christy Road. The nearest residence to this transmission corridor is shown as receptor location R4 in Figure 3.7-1 and is over 40 feet from the transmission line right-of-way (ROW).

3.7.2.5.1 Construction

Construction of the alternate transmission interconnection would occur near the existing power line adjacent to Christy Road. Construction of the interconnection would involve improving the existing line by installing new towers and restringing the line, with minimal construction activities over a limited amount of time. The limited nature of the construction activities, coupled with the restriction of construction activities to daytime hours, would minimize any potential noise impacts from such activities. A low to moderate and therefore less than significant noise impact is anticipated from construction of the alternate Benton PUD/BPA transmission interconnection.

3.7.2.5.2 Operation

Operation of the alternate transmission interconnection could result in audible noise from the transmission lines at the nearest residences. The worst-case condition for noise from the operation of a transmission line occurs during rainfall. Rain and foul weather also increase the background sound levels, which would tend to mask transmission line noise. Calculated audible sound levels from an overhead 230-kV line are 9 dBA under fair conditions (i.e., no rain) and 34 dBA during foul weather, when standing 33 feet from the ROW edge on the side nearest the transmission line.

At the residence nearest to the transmission line, approximately 40 feet from the ROW edge, the predicted levels of audible noise from the transmission line are 8 dBA and 33 dBA during fair and foul weather, respectively. This residence is in a Class C EDNA (i.e., agricultural property) with a noise limit of 70 dBA, day and night. The predicted transmission line levels are far below this 70 dBA limit, and are also far below the more stringent nighttime noise limit of 50 dBA for Class A (i.e., residential) receivers. The predicted transmission line noise levels are also quieter than the lowest measured background sound levels in the study area. Therefore, low to moderate and less than significant noise impacts are anticipated from this alternative.

3.7.2.6 Access Alternative

3.7.2.6.1 Alternate Construction Access Road

The alternate construction access road would follow Christy Road from SR 14 and then veer from Christy Road onto private agricultural property just prior to Christy Road's intersection with the BNSF railroad tracks. The access road would then follow the perimeter of the Plymouth Farm property, adjacent to the Emmanuel Orchards property. This alternate construction access road would most affect persons living on or working nearest the western perimeter of the Emmanuel Orchards property. Although noise from construction vehicles would likely be audible and may be disruptive for brief periods to workers and residents on the orchard property, use of the alternate construction access road would be intermittent and temporary and would only occur during daytime hours. This would reduce potential noise impacts to these nearest receivers, therefore, a low to moderate and less than significant noise impact is anticipated from this source.

3.7.2.6.2 Alternate Operation Access Road

The alternate operation access road would include Christy Road and the existing access road currently used by employees of the Williams Co. compressor station. Only small volumes of passenger vehicles and occasional trucks would use this operational access road; therefore, a low to moderate noise impact is anticipated from this source.

3.7.3 SUMMARY OF IMPACTS

The analysis of noise impacts from the PGF was based on specific design features of the proposed project. These features significantly influence the analysis results, as shown in Table 3.7-7 and Table 3.7-10. These features, which are described in detail in Section 3.7.2.3.1, include the following:

- The gas turbine, steam turbine, and generators would be enclosed in a sound-insulated building.
- A "quieted" inlet air filter unit would be specified and installed.
- Thicker steel walls than standard would be specified and installed for the HRSG.
- A noise wall would be constructed on the south side of the exhaust duct from the gas turbine generator to the HRSG, or as an option, the gas and steam turbine building would be extended to include the exhaust duct before it reaches the HRSG transition ducting.
- Cooling tower water noise would be reduced by deflecting the water flow.
- Noise walls would be constructed on the south and east sides of the steam and gas turbine generator transformers or, as an option, quieted transformers would be installed. The use of quieted transformers would result in lower sound levels from these sources than has been assumed in the analysis.

All but one of the receivers studied would experience low impacts from the construction or operation of the PGF and its appurtenant facilities. High or significant impacts from the operation of the facility were identified at one residential receiver located on Plymouth Farm due to an anticipated increase of 10 dBA over the existing noise level during stable (adverse) meteorological conditions. However, the overall effect of this project-related noise increase may not be significant because the predicted noise levels from the PGF would remain below 60 dBA, and would otherwise be identified as a moderate impact.

3.7.4 MITIGATION

One residential receiver located on Plymouth Farm to the northwest of the PGF plant site was identified as having the potential for high or significant adverse noise impacts. This impact will be mitigated to a level of less than significant by implementation of one of the following mitigation measures: Plymouth Energy would obtain a noise easement from Plymouth Farm to allow an increased noise level at R4, or Plymouth Energy would enter into a contract with Plymouth Farm to relocate the residential structure at R4 or change its use to non-residential.

3.7.5 REFERENCES

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