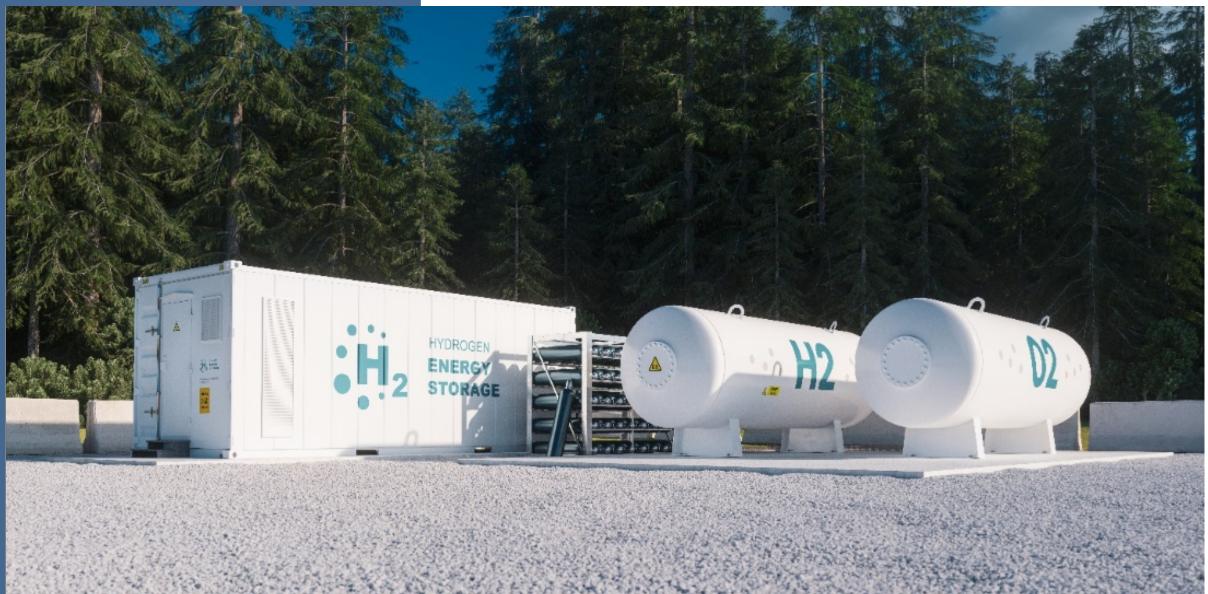

Appendix J: Noise and Vibration Technical Appendix

For Programmatic Environmental Impact Statement on Green Hydrogen Energy Facilities in Washington State

By

HDR

For the

Shorelands and Environmental Assistance Program

Washington State Department of Ecology

Olympia, Washington

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DEPARTMENT OF ECOLOGY
State of Washington

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Acronyms and Abbreviations List

BESS	battery energy storage system
dB	decibel(s)
dBA	A-weighted decibels
EDNA	Environmental Designation for Noise Abatement
FHWA	Federal Highway Administration
FTA	Federal Transit Administration
Hz	hertz
in/sec	inches per second
L_{dn}	average A-weighted noise level during a 24-hour day
PEIS	Programmatic Environmental Impact Statement
PPV	peak particle velocity
RCNM	Roadway Construction Noise Model
RMS	root mean square
SMR	steam-methane reforming
VdB	vibration decibels
WAC	Washington Administrative Code

Summary

This technical appendix describes noise and vibration impacts on people and the vibration impacts on structures in the study area. It also describes the regulatory context and potential impacts and actions that could avoid or reduce impacts.

Potential impacts of noise and vibration on terrestrial and aquatic species and habitats are described in the *Biological Resources Technical Appendix*.

Noise and vibration impacts described in this technical appendix are summarized as follows:

- Through compliance with laws and permits and with implementation of measures to avoid and reduce impacts, most construction, operation, and decommissioning activities would likely result in **less than significant impacts** related to noise and vibration.
- **Potentially significant adverse impacts** related to vibration would occur if:
    - Vibration from specific construction activities occurs at distances closer than 350 feet from residential land uses, or in close proximity to conventional or historic structures.
    - If some types of blasting during construction are conducted within 2,000 feet of historic structures
- Through compliance with laws and permits, and with implementation of actions to avoid and mitigate significant impacts, green hydrogen facilities would have **no significant and unavoidable adverse impacts** on noise or vibration from construction, operation, or decommissioning.

1 Introduction

This technical appendix describes noise and vibration within the study area and assesses probable impacts associated with types of green hydrogen facilities, and a No Action Alternative, which are described in Chapter 2 of the State Environmental Policy Act Programmatic Environmental Impact Statement (PEIS).

This section provides an overview of the aspects of noise and vibration and lists relevant regulations that contribute to the evaluation of potential impacts.

1.1 Resource description

1.1.1 Fundamentals of noise

Noise is generally defined as unwanted sound. Sound, traveling in the form of waves from a source, exerts a sound pressure level that is measured in decibels (dB), which is the standard unit of sound amplitude measurement. The dB scale is a logarithmic scale that describes the physical intensity of the pressure vibrations that make up any sound, with 0 dB corresponding roughly to the threshold of human hearing and 120 to 140 dB corresponding to the threshold of pain.

Sound pressure fluctuations can be measured in units of hertz (Hz), which correspond to the frequency of a particular sound. Typically, sound does not consist of a single frequency, but rather a broad band of frequencies varying in levels of magnitude spanning 20 to 20,000 Hz.

The typical human ear is not equally sensitive to all frequencies of the audible sound spectrum. As a consequence, when assessing potential noise impacts, sound is measured using an electronic filter that de-emphasizes the frequencies below 1,000 Hz and above 5,000 Hz in a manner corresponding to the human ear's decreased sensitivity to extremely low and extremely high frequencies. This method of frequency weighting is referred to as A-weighting and is expressed in units of A-weighted decibels (dBA). Some representative noise sources and their corresponding A-weighted noise levels are shown on Figure 1. All noise levels presented in this technical appendix are A-weighted unless otherwise stated.

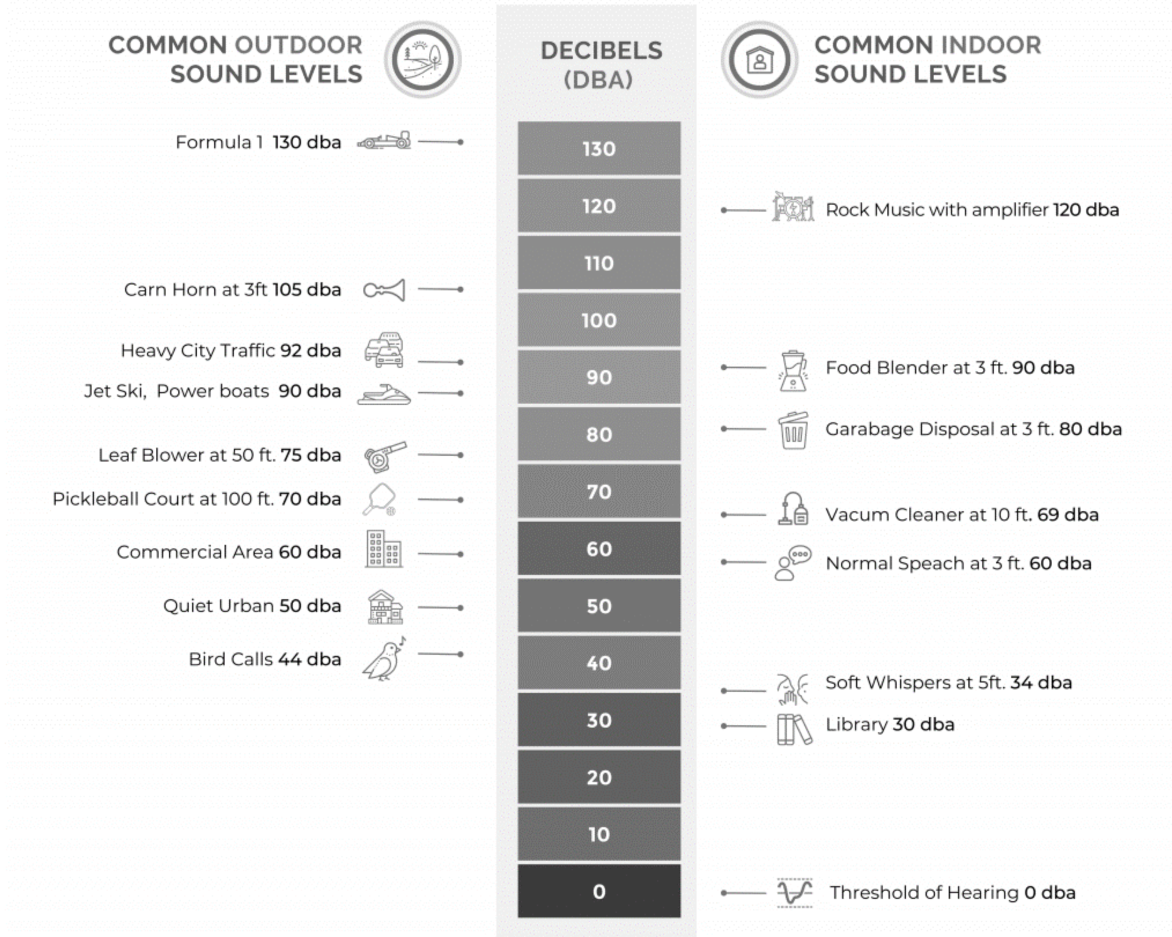

Figure 1. Common range of noise levels

Data Source: Federal Aviation Administration 2022

A 10 dBA change in noise levels is perceived by most people to be approximately a twofold change in loudness (e.g., an increase from 50 to 60 dBA causes the perceived loudness to double) (FHWA 2017). Generally, 3 dBA is the minimum change in outdoor sound levels that can be perceived by a person with normal hearing. Typically, noise levels higher than 85 dBA require hearing protection. General reference noise levels are listed below:

- Normal conversation ranges between 55 and 65 dBA when the speakers are 3 to 6 feet apart.
- Quiet urban nighttime noise dBAs range in the low 40s.
- Noise levels during the day in a noisy urban area are frequently as high as 80 dBA.
- Noise levels above 110 dBA become intolerable and can result in hearing loss.

When distance is the only factor considered, sound levels from isolated point sources of noise typically decrease by about 6 dBA for every doubling of distance from the noise source. When the noise source is a continuous line (e.g., vehicle traffic on a highway), noise levels decrease by about 3 dBA for every doubling of distance away from the source. Noise levels at receptor locations can also be affected by factors other than the distance from the noise source, such as topographic features and physical barriers. Atmospheric conditions (e.g., wind speed and direction, humidity levels, and temperatures) can affect the degree to which sound is attenuated over distance. The degree of impact also depends on the individual sensitivity of people listening and on ambient sound levels. For example, where background noise levels are high, introducing a new noise source tends to have less impact than in an environment where background noise levels are low.

Some land uses are considered more sensitive to noise than others due to the amount of noise exposure and the types of activities typically involved. Residences, motels and hotels, schools, libraries, churches, hospitals, nursing homes, and auditoriums generally are more sensitive to noise than are commercial and industrial land uses. Section 3.2 provides more detail on noise-sensitive receptors. Impacts to terrestrial and aquatic species from noise are discussed in the *Biological Resources Technical Appendix*. Impacts to human health and safety from noise are discussed in the *Environmental Health and Safety Technical Appendix*. Recreational uses are also sensitive to noises, and impacts to recreationists from noise are discussed in the *Recreation Technical Appendix*.

1.1.2 Fundamentals of vibration

A generally accepted source document for assessment of vibration impacts is the Federal Transit Administration's (FTA's) *Transit Noise and Vibration Impact Assessment* (FTA 2018). It is unusual for vibration from sources such as trucks to be perceptible, even in locations close to major roads. Some common sources of human-induced groundborne vibration are trains; loaded haul-trucks on rough roads; and construction activities such as blasting, pile-driving, and operation of heavy earth-moving equipment. Vibrations from naturally occurring phenomena such as earthquakes are addressed in the *Earth Resources Technical Appendix*.

Several different methods are used to quantify vibration. The peak particle velocity (PPV) is defined as the maximum instantaneous peak of the vibration signal. The PPV is most frequently used to describe vibration impacts on buildings. The root mean square (RMS) amplitude is most frequently used to describe the effect of vibration on the human body. The RMS amplitude is defined as the average of the squared amplitude of the signal. Decibel notation (vibration decibels, VdB) is commonly used to measure RMS. Typically, groundborne vibration generated by man-made activities attenuates rapidly with distance from the source of the vibration.

The effects of groundborne vibration include movement of building floors, rattling of windows, shaking of items on shelves or hanging on walls, and rumbling sounds. In extreme cases, vibration can damage buildings. Building damage is not a factor for most projects, with the occasional exception of blasting and pile-driving during construction. The FTA measure of the threshold of architectural damage for historic structures[1] is 0.12 inch/second (in/sec) PPV (FTA 2018).

[1] FTA applies this criterion for buildings that are extremely susceptible to vibration damage.

In residential areas, the background vibration velocity level is usually around 50 VdB (approximately 0.0013 in/sec PPV) or lower. This level is well below the vibration velocity level threshold of perception for humans, which is approximately 65 VdB. A vibration velocity level of 75 VdB is considered the approximate dividing line between barely perceptible and distinctly perceptible levels for many people (FTA 2018). Annoyance from vibration often occurs when the vibration levels exceed the threshold of perception by only a small margin. A vibration level that causes annoyance would be well below the damage threshold for modern buildings.

Sensitive receptors for vibration include historic structures that may be damaged by vibration, residential uses during nighttime hours, and vibration-sensitive equipment such as magnetic resonance imaging machines. Section 3.2 provides more detail on vibration-sensitive receptors.

1.2 Regulatory context

Table 1 provides a list of potentially applicable federal, state, and local laws, plans, and policies that will contribute to the evaluation of potential noise and vibration impacts.

Table 1. Applicable laws, plans, and policies

Regulation, statute, guideline	Description
Federal	
Noise Control Act of 1972 (42 United States Code 4910)	Protects the health and welfare of U.S. citizens from the growing risk of noise pollution, primarily from transportation vehicles, machinery, and other commerce products. Increases coordination between federal researchers and noise control activities, establishes noise emissions standards, and presents noise emissions and reduction information to the public.
Federal Transit Administration Construction Noise Impact Criteria for General Assessment; *Transit Noise and Vibration Impact Assessment Manual* (FTA 2018)	This document provides procedures and guidance for analyzing the level of noise and vibration, assessing the resulting impacts, and determining possible mitigation for most federally funded transit projects.
State	
Washington State Noise Control Act of 1974 (Chapter 70.107 Revised Code of Washington)	This act establishes maximum environmental noise levels. The regulations (Chapter 173-60 Washington Administrative Code) apply to a variety of land uses, activities, and facilities including general construction activities and maintenance facilities. Exemptions include electrical substations, mobile noise sources, vehicles traveling in public right-of-way, and safety warning devices such as bells. Many cities and counties in Washington have adopted the state provisions.
Local	
County and city municipal codes	Many counties and cities in Washington defer to the Washington Administrative Code regulations. Some counties and cities may have additional standards for noise and vibrations.

2 Methodology

2.1 Study area

The study area for noise and vibration includes the PEIS geographic scope of study for green hydrogen facilities (Figure 2) and surrounding areas with potential to be affected by noise and vibration.

The study area for the evaluation of noise and vibration associated with the construction and operation of green hydrogen facilities would be determined by the presence (or absence) of noise and vibration during project-specific reviews. Parameters could include ambient noise levels, sensitive receptors (residences, motels and hotels, schools, libraries, churches, hospitals, nursing homes, and auditoriums) and vibration-sensitive receptors including structures (older masonry structures), people (residential uses during nighttime hours), and vibration-sensitive equipment (recording studios or magnetic resonance imaging).

Figure 2, which shows the PEIS geographic scope of study, does not include federal lands, national parks, wilderness areas, wildlife refuges, state parks, or Tribal reservation lands, but information related to these areas is provided as context for the affected environment.

2.2 Technical approach

The approach for assessing construction-related noise impacts utilizes the General Assessment methodology of the FTA's *Noise and Vibration Impact Assessment Manual* (FTA 2018). Based on an equipment list commonly used for construction of green hydrogen facilities, a tabular range of construction noise was generated with respect to distance from the outermost equipment for a typical construction site. The Federal Highway Administration's (FHWA's) Roadway Construction Noise Model was used to calculate noise levels at relevant distances for comparison to FTA's published construction noise criteria (FHWA 2006).

Similarly, the approach for construction-related vibration impact assessment used a tabular estimate of vibration generation with distance from specific construction equipment known to generate vibration. Reference vibration levels published by FTA were used to develop impact distances to modern structures of standard construction as well as to historic structures.

For operational impacts from green hydrogen facilities, reference noise levels from sources associated with these facilities were researched from existing project-level analysis (proxy projects) that included three-dimensional noise modeling of noise generation. Using the existing analysis from proxy projects that fall within the scale of the PEIS facility types, a conservative estimate of noise generation with distance was developed for distances at which potential impacts of operational noise may occur from the extent of a green hydrogen facility footprint.

The PEIS analyzes a timeframe of up to 25 years of potential facility construction and up to 50 years of potential facility operations (totaling up to 75 years into the future).

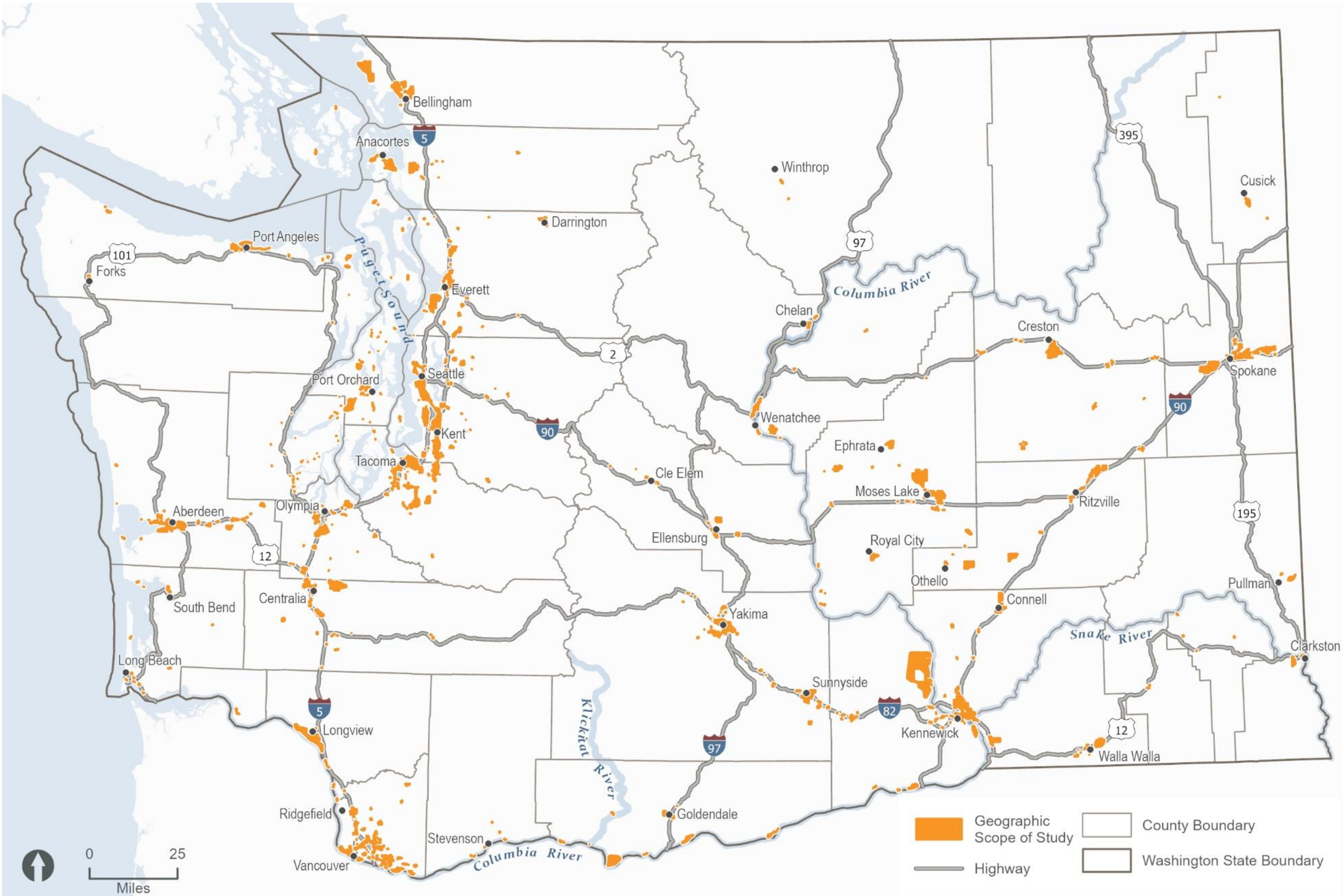

Figure 2. Green Hydrogen Energy Facilities PEIS geographic scope of study

2.3 Impact assessment approach

The impact analysis for noise and vibration for a green hydrogen facility considered the following:

- Site characterization activities of a green hydrogen facility would result in noise and vibration associated with site assessment, including geotechnical investigation and geotechnical drilling rigs.
- Construction and decommissioning would result in noise and vibration associated with construction-related activities including operation of off-road equipment, and operation of haul trucks to bring in equipment and materials and remove soil or demolition debris. Blasting, if required, would also generate noise and vibration impacts.
- Construction for distribution lines to connect facilities to utilities could include noise and vibration from off-road equipment for power poles and line stringing, cut and cover trenching, and potentially sheet pile installation for jack-and-bore pits, where necessary.
- Operational noise sources may include intermittent and/or continuous noise from green hydrogen facility operations, including compressors, water pumps, and air blowers. Intermittent noise from maintenance activities would also occur during operating hours, including testing of emergency equipment such as engine-driven fire pumps and emergency diesel generators.
- Additional operations' noise sources may include battery storage liquid cooling units, battery storage inverters, and potential corona noise from overhead connector and distribution lines during wet weather conditions.
- Noise-generating activities common for green hydrogen facilities during operation and maintenance also include those from site inspection; maintenance and repair at the facilities (e.g., periodic replacement proton-exchange membrane electrolyzers, and alkaline electrolyzers), vehicles for employee commuting, support activities, and deliveries within and around the green hydrogen facility; and noise from control/administrative buildings. Vibration-generating activities include those associated with operating rotational machinery including compressors, fans, and generators.

Site characterization, construction, and decommissioning-related noise impacts were evaluated for potential exposure of noise-sensitive land uses in excess of the FTA criteria, or potential to exceed the maximum permissible environmental noise levels specific to land use as codified in Chapter 173-60 Washington Administrative Code[2] (WAC).

Chapter 173-60 WAC exempts sounds originating from blasting and from temporary construction sites as a result of construction activity between the hours of 7:00 a.m. and 10:00 p.m.

This PEIS assumes green hydrogen facilities would be sited in areas zoned for industrial or industrial-supporting uses with Environmental Designation for Noise Abatement [EDNA] Class C

[2] https://app.leg.wa.gov/wac/default.aspx?cite=173-60

noise levels per WAC 173-60-040.[3] Adjacent land uses could be Class C industrial properties, Class B receiving properties (e.g., commercial properties, automobile services, office buildings), or Class A receiving properties (e.g., residential, recreational and entertainment, community service).

For the purposes of this assessment, a **potentially significant impact** would occur if a facility resulted in the following:

- Construction and decommissioning activities that generate construction noise that would conflict with local ordinances or would result in exposure of noise-sensitive land uses in excess of the FTA daytime criterion of 90 dBA or a nighttime criterion of 80 dBA for a substantial (greater than a 2-week) period.
- Operational noise generation that would exceed the maximum permissible environmental noise levels specific to land use as codified in Chapter 173-60 WAC. For industrial uses, an EDNA of 70 dBA would apply during nighttime hours for other Class C receiving properties, 65 dBA for Class B receiving properties (e.g., commercial properties, automobile services, office buildings), and 60 dBA for Class A receiving properties (e.g., residential, recreational and entertainment, community service). During nighttime hours, the noise limitation for receiving Class A properties is reduced by 10 dBA to 50 dBA.
- Construction, operation, and decommissioning activities that generate vibration that exposes nearby land uses and structures to PPV levels that would meet or exceed FTA criteria of 0.5 in/sec for modern structures or 0.12 in/sec for historic structures.

The study area includes some lands that are zoned for industrial or industrial-supporting uses but are currently undeveloped in rural areas. This analysis assumes that the city and county jurisdictions considered the potential for noise from industrial facilities when approving zoning designations. All facilities would require a site-specific noise analysis to assess noise impacts on adjacent lands and conformance with WAC requirements and local ordinances.

[3] https://app.leg.wa.gov/wac/default.aspx?cite=173-60-040

3 Technical Analysis and Results

3.1 Overview

This section describes the potential significant adverse noise and vibration impacts that might occur for a green hydrogen facility analyzed in the PEIS. The extent of the impact area would depend on the size and design of the specific facility and the relative quiet (low ambient noise levels) of a given location. This section also evaluates actions that could avoid, minimize, or reduce the identified impacts, and potential unavoidable significant adverse impacts.

3.2 Affected environment

3.2.1 Ambient noise levels

The affected environment represents the conditions at the time this study was prepared. Given the geographic extent of the green hydrogen facility study area, the affected environment, in terms of existing ambient noise levels, would vary based on the specific facility siting conditions. Noise levels vary continuously with location and time. In general, noise levels are high around major transportation corridors (highways and railways), airports, industrial facilities, and construction activities.

Lands shown in Figure 2 are zoned for industrial or industrial-supporting uses. Industrial land uses typically include noise-generating activities and industrial areas typically have higher ambient sound levels than non-industrial areas (e.g., residential or rural areas). The existing acoustic environment in these industrial lands could include existing power plant operations, refinery operations, distribution warehouse activities, port and shipping activities, off-road equipment, freight corridors, highways and freeways, local roadways, and aircraft flyovers, as well as natural sounds. Levels around 75 dBA are common in busy urban areas and industrial lands, and levels up to 85 dBA can occur near major freeways and airports. Noise-generating activities in industrial lands can be continuous throughout the day and night, or sporadically elevated in localized areas due to specific operational activities, roadway noise, or other periods of increased human activity.

Lands in the study area may include rural and agricultural use lands, Tribal lands, and a range of non-industrial, low-intensity land uses. Ambient noise levels for these land use types would vary based on the types and densities of activities occurring in these areas, as well as natural sounds. To characterize noise levels associated with general community activities on non-industrial lands, countywide background Ldn (i.e., average A-weighted noise level during a 24-hour day) levels may be estimated based on population density. More densely populated counties such as King County and Pierce County have generalized background Ldn values of between 45 and 55 dBA, while more remote, sparsely populated counties such as Columbia County have background Ldn values of less than 35 dBA (BLM 2024).

Sound propagating through the air is affected by air temperature, humidity, wind and temperature gradients, vicinity and type of ground surface, obstacles, and terrain features. Natural terrain features such as hills and constructed features such as buildings and walls, can significantly alter noise levels. Industrial lands commonly possess a range of man-made features that can serve to reduce the propagation of noise such as buildings, walls, and landscape barriers.

It is uncommon for trees and vegetation to result in a noticeable reduction in noise. A vegetative strip must be very dense and wide for there to be any meaningful shielding effect. However, a heavily vegetated ground surface may increase ground absorption, which can increase attenuation over distance.

3.2.2 Noise-sensitive receptors

Some land uses are considered more sensitive to noise than others due to the amount of noise exposure (in terms of both exposure duration and insulation from noise) and the types of activities typically involved. Residences, motels and hotels, schools, libraries, churches, hospitals, nursing homes, and auditoriums generally are more sensitive to noise than are commercial and industrial land uses. While green hydrogen facilities are anticipated to be located on land that is zoned for industrial or industrial-supporting uses, adjacent land uses could contain noise-sensitive receptors. Recreational uses are also sensitive to noises; refer to the *Recreation Technical Appendix* for an analysis of noise impacts on recreationists.

Environmental justice populations and overburdened community areas may be at increased risk to adverse impacts from noise. Urban noise pollution is generally found to be greater in minority and low-income neighborhoods. Refer to the *Environmental Justice Technical Appendix* for analysis of noise impacts on environmental justice populations and overburdened community areas.

Sensitive wildlife and habitats, including the habitat of rare, threatened, or endangered species, can also be impacted by noise. For noise impacts on wildlife including airborne noise effects on terrestrial wildlife and waterborne noise effects on fish and marine mammals, refer to the *Biological Resources Technical Appendix*.

3.2.3 Vibration-sensitive land uses and structures

Sensitive receptors for vibration include structures (especially older masonry structures), people (particularly residential uses during nighttime hours), and vibration-sensitive equipment (such as recording studios or magnetic resonance imaging). There are separate criteria for evaluating the potential for structural damage depending on whether the structure is of conventional (modern) construction versus older historic structures that are more sensitive to vibration. Sensitive receptors for vibration could occur within the geographic scope of study area or on adjacent lands.

3.3 Potentially required permits and approvals

There would be no specific permit requirements related to noise or vibration unless blasting or nighttime work is planned.

If blasting is needed for construction, then a blasting permit would be required:

- **Blasting Permits (local fire department or building authority):** Required for blasting activities. Blasting with explosives requires a Washington State explosives license to abate potential hazards, including noise and vibration.

Additionally, local jurisdictions may require a permit or variance to conduct nighttime construction work. Compliance with local noise ordinances is also required and would be reviewed as part of the use permit process:

- **Land Use Permits (e.g., Comprehensive Plan Amendments, Conditional Use Permit/Special Use Permit, or Zoning Amendments) (local agency):** Required if changes to a comprehensive plan or zoning designation and/or if a conditional use permit, special use permit, or variance is required for the project.

3.4 Green hydrogen production facility

This section describes potential impacts of green hydrogen production facilities. For the purposes of the PEIS, the estimated footprint of a green hydrogen production facility ranges from 1 acre to 10 acres, depending on the production method, type of storage facilities, and layout of external pipes and tanks, a parking area, and security fencing. The estimated height of structures is up to 100 feet.

A green hydrogen production facility would typically include a connection to the electricity grid to power all, or a portion of, the facility's equipment needs and buildings. Facilities typically connect to the main transmission line through distribution lines that can be up to 100 feet high and between 1 and 8 miles in length, which would be determined by the project developer based on the distance between a selected site and existing electricity grid infrastructure. This technical appendix includes evaluation of impacts associated with distribution line connections to main transmission lines.

Off-site access roads may be needed to connect a facility to the existing state routes. Most of study area is less than 10 miles from a state route (63% within 1 mile and 99% within 10 miles). If needed, the project developer would determine the length of off-site access road needed, based on the distance between a selected site, existing road infrastructure, and coordination with state and local departments of transportation.

3.4.1 Impacts from construction and decommissioning

3.4.1.1 Noise

Sources of noise would include a variety of standard site characterization, construction, and decommissioning activities. Sources of temporary noise include:

- Geotechnical investigation and drilling rigs
- Off-road equipment used for site preparation and construction
- On-road truck trips to bring materials to work sites including sand, gravel, and cement
- Blasting
- Pile driving for facility building construction
- Noise generated by steam blows for steam boilers in the gasification process

Noise levels would vary with the level of activity, number and type of equipment, and the location and type of activity. Noise levels would be highest during early construction when most of the noisy and heavy equipment would be used for land clearing, grading, and road construction.

Off-road equipment noise for site preparation and construction

An example inventory of equipment that is expected to construct a green hydrogen production facility is provided in Table 2. The table summarizes the types of equipment that may be used and identifies associated noise levels at a reference distance of 50 feet, 100 feet, and 200 feet from each piece of equipment. The composite noise levels in Table 2 include the background sound level from all sources when operating at the same time.

Table 2. Maximum and equivalent noise levels from construction equipment associated with green hydrogen production facility construction

Equipment	Acoustical usage factor (%) [a]	Lmax at 50 feet (dBA) [b]	Leq at 50 feet (dBA)	Leq at 100 feet (dBA)	Leq at 200 feet (dBA)
Crane	16	85	77	71	65
Generator	50	82	79	73	67
Front end loader	40	80	76	70	64
Backhoe	40	80	76	70	64
Grader	40	85	81	75	69
Dozer	40	85	81	75	69
Ventilation fan	100	85	85	79	73
Pumps	50	77	74	68	62
Truck	40	84	80	74	68
Welder	40	73	69	63	57
Compressor	40	80	76	70	64
Impact pile driver	20	95	88	82	76
Vibratory pile driver	20	95	88	82	76

Equipment	Acoustical usage factor (%) [a]	Lmax at 50 feet (dBA) [b]	Leq at 50 feet (dBA)	Leq at 100 feet (dBA)	Leq at 200 feet (dBA)
Concrete mixer truck	40	85	81	75	69
Dump truck	40	85	81	75	69
Blasting	1	94	74	68	65
Composite	NA	NA	87	81	82

Source: FHWA 2006.

Notes:

Leq = equivalent continuous sound level, the steady sound level, which over the measurement period has the same total energy as the fluctuating noise.; Lmax = maximum sound level, the highest sound level measured during a single noise event.

a. The usage factor is the percentage of time during operation that a piece of construction equipment is operating at full power.
b. These are maximum field-measured values at 50 feet as reported from multiple samples. Where sufficient data are unavailable, the reference noise level is a manufacturer-specified level.

As shown in Table 2, FTA's daytime criterion of 90 dBA would be exceeded only if blasting or pile driving activity was operating less than 50 feet from a noise-sensitive receptor. For a green hydrogen production facility located in an industrial environment, this proximity to noise-sensitive receptors is unlikely. The extent of a construction noise impact would, however, depend on the existing ambient noise level and the nature of adjacent land uses at any given receptor.

Pile driving

Green hydrogen production facilities may include pile driving for facility foundations and may include either impact or vibratory pile-driving. Pile-driving activities would not occur during the full time of construction and would be limited to a span of days required in which to install the piles for foundations. As shown in Table 2, noise generated by pile driving is similar in magnitude to that of other construction activities, based on the reference noise levels for the Roadway Construction Noise Model (RCNM; FHWA 2006) and the low usage factor. The combined noise levels in Table 2 include both methods of pile driving. Vibration impacts from blasting are addressed in Section 3.4.1.2.

An impact pile-driving hammer is a large piston-like device that is usually attached to a crane. The power source for impact hammers may be mechanical (drop hammer), air steam, diesel, or hydraulic. Most impact pile driver hammers have a vertical support that holds the pile in place, and a heavy weight, or ram, moves up and down, striking an anvil that transmits the blow of the ram to the pile. In hydraulic hammers, the ram is lifted by fluid, and gravity alone acts on the down stroke.

Vibratory pile-driver hammers may also be used. A vibratory pile-driving hammer has a set of jaws that clamp onto the top of the pile. The pile is held steady while the hammer vibrates the pile to the desired depth. Because vibratory hammers are not impact tools, noise levels are typically not as high as with impact pile drivers. However, piles installed with a vibratory hammer must often be proofed, which involves striking the pile with an impact hammer to determine its load-bearing capacity, possibly with multiple impacts.

Blasting noise
Blasting is not expected to be needed for construction of most facilities but may occur depending on subsurface conditions. Noise from blasting activities was estimated using reference noise levels from RCNM and assuming one blast per hour; the associated noise levels are presented in Table 2. Blasting mats are usually used to control noise. Blasting would typically be a part of site preparation and, therefore, not occur simultaneously with pile driving or other construction building activities. As shown in Table 2, noise generated by blasting is similar in magnitude to that of other construction activities, based on the reference noise levels for RCNM and the low usage factor. The combined noise levels in Table 2 include construction blasting. Vibration impacts from blasting are addressed in Section 3.4.1.2.

Noise from on-road trucks
Noise from trucks bringing materials from off-site locations to a facility construction site and exporting excavated materials from the facility site would potentially increase noise levels along roadways used to access a given green hydrogen facility. Generally, these truck trips would be distributed throughout the day, and, except in cases where substantial volumes of material would be hauled, the increase in noise levels would not be sufficient to result in a noticeable increase in traffic noise.

Noise generated by steam blows
Specific to the bio-gasification production process, steam blowdown for steam boilers would occur during the latter part of facility construction. Steam blowdown is a procedure using pressurized steam to clear certain equipment of debris and residue from manufacturing. Steam blowdown activities typically consist of a series of blows over a brief period of days before the commencement of operation and can produce sound at a level of approximately 102 dBA at a distance of 50 feet from the source (DOE 2007, 2010). This noise would likely attenuate to levels approaching human annoyance beyond the limits of construction, depending on the attenuating factors of the site (DOE 2007, 2010). Persons indoors would experience reduced levels of noise as compared to persons outdoors. Silencers could be installed on piping vents during steam blows to reduce noise levels.

Construction noise impact summary
Heavy equipment use would vary during construction of facilities. Typically, noise levels would be highest during early construction when most of the noisy and heavy equipment would be used for land clearing, grading, and road construction.

Most local jurisdictions and the noise standards in Chapter 173-60 WAC exempt sounds originating from temporary construction sites as a result of construction activity between the hours of 7:00 a.m. and 10:00 p.m. Outside of these times, construction activities would be required to meet noise limits.

Potential construction noise impacts would depend on the activities, surrounding land uses, distance to the nearest sensitive receptors, and noise-attenuating factors such as topography, barriers, and atmosphere. Although green hydrogen facilities would be located in areas zoned for industrial or industrial supporting uses, some adjacent non-industrial land uses could include noise-sensitive receptors.

Through compliance with laws and permits and with implementation of measures to avoid and reduce impacts, most construction and decommissioning activities would likely result in **less than significant impacts** related to noise.

For the purposes of this analysis, it is assumed that facility decommissioning would result in noise levels similar to construction. Decommissioning activities would last for a short period, and their potential impacts would be minor and temporary in nature. Therefore, noise impacts from decommissioning activities would be similar to or less than those described for construction.

3.4.1.2 Vibration

Construction may involve the use of equipment such as impact pile drivers and vibratory rollers, which could generate substantial vibration.

Vibration impacts and human annoyance

Vibration impact criteria related to human disturbance published by FTA are established in terms of the VdB metric. Vibration levels from various construction activities were estimated in Table 3 using reference vibration levels published by FTA (2018) and attenuating that vibration at a range of distances encompassing impact criteria. The **bold text** in Table 3 indicates the distances at which vibration levels would exceed the applicable FTA criterion. As seen from the table, vibration from pile driving would exceed the applicable FTA criterion at distances closer than 350 feet, while vibration from vibratory rollers would exceed FTA criterion at distances closer than 50 feet. All other construction equipment could be 25 feet or closer without exceeding FTA criteria. Therefore, vibration from specific construction activities occurring at distances closer than 350 feet from residential land uses could be a potential impact with respect to human annoyance.

Table 3. Predicted vibration levels (VdB) from construction activities at a distance

Equipment or Activity	Predicted VdB at 25 feet (reference)	Predicted VdB at 50 feet	Predicted VdB at 100 feet	Predicted VdB at 200 feet	Predicted VdB at 350 feet	FTA criteria for residential uses (human response)
Jack hammer	79	70	61	52	45	80
Loaded trucks	**86**	77	68	59	52	80
Large bulldozer	**87**	78	69	60	53	80
Caisson drilling	**87**	78	69	60	53	80
Vibratory roller	**94**	**85**	76	66	60	80
Impact pile driver	**104**	**65**	**86**	**77**	70	72 [a]

Source: FTA 2018.
Notes:
Bold numbers indicate exceedance of the applicable FTA criterion.
a. FTA defines a frequent event as more than 70 events per day.

Vibration impacts and structural damage

Construction-related vibration also has the potential to result in architectural damage to nearby structures. For historic structures, including buildings that are structurally weakened, a continuous vibration limit of 0.12 in/sec PPV is the standard applied to minimize the potential for structural or cosmetic damage (e.g., minor cracking in plastered walls). A continuous vibration limit of 0.50 in/sec PPV is applied to minimize the potential for cosmetic damage at buildings of modern construction.

Table 4 presents the analysis of vibration from typical construction activities with distances to structures. In Table 4, **bold numbers** indicate the distances at which vibration levels would exceed the criterion for conventional structures. The numbers followed by asterisks (*) indicate the distances at which the criterion would be exceeded for historic structures or structurally weakened buildings. As shown in Table 4, cosmetic damage could result from pile driving closer than 30 feet to a conventionally constructed building, or closer than 80 feet to a historic building. Therefore, vibration from specific construction activities occurring close to conventional or historic structures could result in building damage. Control measures and monitoring programs in place and as required by permits would reduce vibration impacts.

Table 4. Vibration levels (PPV) for construction activity

Equipment	Estimated PPV (inches per second) at 25 feet	Estimated PPV (inches per second) at 30 feet	Estimated PPV (inches per second) at 40 feet	Estimated PPV (inches per second) at 80 feet
Jackhammer	0.035	0.027	0.01710	0.00610
Loaded trucks	0.076	0.058	0.038	0.013
Caisson drilling	0.089*	0.068	0.044	0.016
Large bulldozer	0.089*	0.068	0.044	0.016
Vibratory roller	0.20*	0.160*	0.104	0.037
Impact pile driver	**0.65**	0.494*	0.321*	0.113*

Source: FTA 2018.

Note: **Bold numbers** indicate distances where vibration levels would exceed the criterion for conventional structures. Numbers with asterisks (*) indicate the distances at which the criterion for historic structure or buildings that are documented to be structurally weakened would be exceeded.

Vibration generated by blasting

Blasting is not expected to be needed for construction of most facilities but may occur as part of site preparation activities, depending on subsurface conditions. When blasting occurs at greater distances from sensitive structures, the primary concern is the potential for cosmetic damage. Cosmetic damage can occur as a result of groundborne vibration or acoustic overpressures. Vibration levels that may be generated by blasting events were calculated using methods established by the former U.S. Bureau of Mines (USDI 2000) and are presented in Table 5. Calculated ground vibration levels are summarized in Table 5 for a variety of charge weights and distances. Receptors located farther from blasting activities would experience lower vibration levels.

Table 5. Ground vibration levels generated by blasting

Distance (feet)	Blasting level (in/sec PPV) for various explosive charge weights per delay[a]: 175 lbs	Blasting level (in/sec PPV) for various explosive charge weights per delay[a]: 350 lbs	Blasting level (in/sec PPV) for various explosive charge weights per delay[a]: 700 lbs
2,000	0.098	0.170	0.296
3,000	0.051	0.089	0.155
4,000	0.032	0.056	0.098

Note:
lbs = pounds
a. The maximum quantity of explosive charge detonated on one interval (delay) within a blast.

Construction vibration impact summary
Potential construction vibration impacts would depend on the equipment, methods, and distance to sensitive receptors or structures. Through compliance with laws and permits and with implementation of measures to avoid and reduce impacts, most construction and decommissioning activities would likely result in **less than significant impacts** related to vibration.

Vibration from specific construction activities occurring at distances closer than 350 feet from residential land uses, or in close proximity to conventional or historic structures, would be a **potentially significant adverse impact** with respect to human annoyance or building damage. If some types of blasting during construction are conducted within 2,000 feet of historic structures, it would result in a **potentially significant adverse impact**.

For the purposes of this analysis, it is assumed that facility decommissioning would result in vibration similar to construction, with the exception of pile-driving activities and blasting, which would not occur. Decommissioning activities would last for a short period, and their potential impacts would be minor and temporary in nature. Therefore, vibration impacts from decommissioning activities would be similar to or less than those described for construction.

3.4.2 Impacts from operation

3.4.2.1 Noise

The primary anticipated noise sources for green hydrogen production are various compressors, water pumps, and air blowers. Engine-driven fire pumps and emergency diesel generators may also operate on a maintenance and emergency basis. Specific types and quantities of equipment are expected to vary depending on the size and type of green hydrogen production facility; however, compressors are generally anticipated to produce the greatest source of noise during operation. In general, noise-producing sources at the facilities from equipment would operate 24 hours per day and would therefore generate noise during the more sensitive nighttime hours.

Vehicular noise on and around the site associated with automobiles, medium trucks, and heavy trucks that travel off and onto the site could be an additional source of noise, depending on the size and type of the facility and proximity and traffic volumes of nearby existing roadways. Larger facilities could create more vehicle traffic and greater vehicular noise during operation than smaller ones.

For green hydrogen production facilities, project-level noise assessments for proxy projects were used to estimate the noise generation potential and the results of the analysis are presented below for the production facility types.

Electrolysis and pyrolysis

The proxy project analysis used for the green hydrogen production facility was for a proposed green hydrogen electrolysis facility (Green Hydrogen Energy Site and Battery Energy Storage System [BESS] facility at Eaglesham, Glasgow, Scotland). While the proxy study considered only electrolysis-type hydrogen production, the noise levels for pyrolysis production types are expected to be of similar. Additionally, the proxy project includes a BESS and would subsequently include greater generation of noise than the same green hydrogen production facility that does not include a BESS. Operations noise impacts for green hydrogen production facilities with a co-located BESS are described in Section 3.5.2.

Noise modeling contours for the proxy project show that the compressors, hydrogen electrolyzer stackhouses, and cooling towers are the predominant noise sources (Scottish Power Renewables 2023). Noise-producing electrical components such as inverters and transformers were included in the noise modeling. The 40 dBA Leq noise contour extended approximately 750 feet at the noisiest location and the 50 dBA Leq contour extended to approximately 360 feet at the noisiest location (Scottish Power Renewables 2023). These noise levels are below the thresholds for EDNA Class C noise levels in industrial and industrial-receiving areas and thresholds for receiving sensitive land uses (EDNAs Class A and Class B). Because the proxy project included a BESS, production noise for facilities without a BESS would be somewhat reduced.

Table 6 describes the modeled sound levels for individual equipment types from the proxy study associated with the green hydrogen production facility.

Table 6. Sound levels from green hydrogen facility proxy study

Equipment	Quantity	Sound power level per unit (dBA) [a]	SPL (sound pressure level) per unit at 50 feet (dBA) [b]	Total SPL at 50 feet (dBA re: 20 µPa)
Hydrogen electrolyzer stackhouse	10	88	56	66
Compressor housing	5	83	51	58
Cooling tower	2	92	60	63
Total	--	--	--	68

Note:
µPa = micropascals.
a. re: 10–12 watts.
b. re: 20 µPa.

Steam-methane reformatting and bio-gasification
Steam-methane reforming (SMR) and bio-gasification noise impacts would be greater than electrolysis and pyrolysis due to the greater volume of pump and process equipment such as water pumps and compressors and are expected to be similar to the operation noise from gas- or coal-fired power plants. A proxy project was used for comparable noise levels for bio-gasification and SMR production types which conducted a noise study and contour modeling for a proposed coal-fired power plant (Coal-fired Highwood Generating Station, Great Falls, Montana). Noise-producing electrical components such as transformers were included in the noise modeling. L_{dn} noise levels for the proxy project were found to be 55 dBA at a distance of 0.6 mile of the plant. The typical L_{eq} noise levels of the plant were modeled to be less than 50 dBA (Montana Department of Environmental Quality 2007). These noise levels are below the thresholds for EDNA Class C noise levels in industrial and industrial-receiving areas and thresholds for receiving sensitive land uses (EDNAs Class A and Class B).

3.4.2.2 Operational vibration

Sources of operational vibration from green hydrogen production facilities are expected primarily from rotational equipment such as fans, generators, cooling towers, pumps, and compressors. The level of vibrations transmitted through the ground basically depend on the type, size, and position of the rotating and reciprocating machines, and the foundation design and soil characteristics. All machinery would be required to comply with international standards such as ISO 20816 in terms of vibrations discharged to the baseplates of the foundations, relevant testing, and measurement (International Organization for Standardization 2022). Based on the type of anticipated equipment and design standards, these types of facilities are not expected to generate high vibration levels during operation beyond the footprint of the facility.

3.4.2.3 Operational impact summary

Green hydrogen production facilities are anticipated to be sited in areas zoned for industrial uses that, through land use planning, have considered industrial sources of noise relative to noise-sensitive receptors. While siting and design considerations would need to consider site-specific noise attenuation for each project as appropriate, proxy studies from similar types of projects suggest that noise produced during facility operation are below the thresholds for EDNA Class C noise levels in industrial and industrial-receiving areas and thresholds for receiving sensitive land uses (EDNAs Class A and Class B).Through compliance with laws and permits and with implementation of measures to avoid and reduce impacts, operations activities would likely result in **less than significant impacts** related to noise and vibration.

3.4.3 Measures to avoid, reduce, and mitigate impacts

The PEIS identifies a variety of measures to avoid, reduce, and mitigate impacts. These measures are grouped into five categories:

- **General measures:** The general measures apply to all projects using the PEIS.
- **Recommended measures for siting and design:** These measures are recommended for siting and design in the pre-application phase of a project.

- **Required measures:** These measures must be implemented, as applicable, to use the PEIS. These include permits and approvals, plans, and other required measures.
- **Recommended measures for construction, operation, and decommissioning:** These measures are recommended for the construction, operation, and decommissioning phases of a project.
- **Mitigation measures for potential significant impacts:** These measures are provided only in sections for which potential significant impacts have been identified.

Noise and vibration impact distances identified in this programmatic analysis are based on proxy projects and unspecified existing conditions and locations of sensitive receptors. Each facility would need to conduct facility- and site-specific modeling to determine the applicable distances necessary to avoid a significant noise or vibration impact.

3.4.3.1 General Measures

- **Laws, regulations, and permits:** Obtain required approvals and permits and ensure that a project adheres to relevant federal, state, and local laws and regulations.

  Rationale: Laws, regulations, and permits provide standards and requirements for the protection of resources and the PEIS impact analysis and significance findings assume that developers would comply with all relevant laws and regulations and obtain required approvals.

- **Coordination with agencies, Tribes, and communities:** Coordinate with agencies, Tribes, and communities prior to submitting an application and throughout the life of the project to discuss project siting and design, construction, operations, and decommissioning impacts; and measures to avoid, reduce, and mitigate impacts. Developers should also seek feedback from agencies, Tribes, and communities when developing and implementing the resource protection plans and mitigation plans identified in the PEIS.

  ***Rationale*:** Early coordination provides the opportunity to discuss potential project impacts and measures to avoid, reduce, and mitigate impacts. Continued coordination provides opportunities for adaptive management throughout the life of the project.

- **Land use:** Consider the following when siting and designing a project:
  - Existing land uses
  - Land ownership/land leases (e.g., grazing, farmland, forestry)
  - Local comprehensive plans and zoning
  - Designated flood zones, shorelines, natural resource lands, conservation lands, priority habitats, and other critical areas and lands prioritized for resource protection
  - Military testing, training, and operation areas
  - State-designated harbors
  - Air quality nonattainment areas

***Rationale*:** Considering these factors early in the siting and design process avoids and minimizes the potential for land use conflicts. Project-specific analysis is needed to determine land use consistency.

- **Choose a project site and a project layout to avoid and minimize disturbance:** Select the project location and design the facility to avoid potential impacts to resources. Examples include:
    - Minimizing the need for extensive grading and excavation and reducing soil disturbance, potential erosion, compaction, and waterlogging by considering soil characteristics.
    - Minimizing facility footprint and land disturbances, including limiting clearing and alterations to natural topography and landforms and maintaining existing vegetation.
    - Minimizing the number of structures required and co-locate to share pads, fences, access roads, lighting, etc.

  ***Rationale*:** Project sites and layouts may differ substantially in their potential for environmental impacts. Thoughtful selection of a project site and careful design of a facility layout can avoid and reduce environmental impacts.

- **Use existing infrastructure and disturbed lands, and co-locate facilities:** During siting and design, avoid and minimize impacts by:
    - Using existing infrastructure and disturbed lands, including roads, parking areas, staging areas, aggregate resources, and electrical and utility infrastructure.
    - Co-locating facilities within existing rights-of-way or easements.
    - Considering limitations of existing infrastructure, such as water and energy resources.

  ***Rationale*:** Using existing infrastructure and disturbed lands, and co-locating facilities reduces impacts to resources that would otherwise result from new ground disturbance and placement of facilities in previously undisturbed areas.

- **Conduct studies and surveys early:** Conduct studies and surveys early in the process and at the appropriate time of year to gather data to inform siting and design. Examples include:
    - Geotechnical study
    - Habitat and vegetation study
    - Cultural resource survey
    - Wetland delineation

  ***Rationale*:** Conducting studies and surveys early in the process and at the appropriate time of year provides data to inform siting and design choices that avoid and reduce impacts. This can reduce the overall timeline as well by providing information to agencies as part of a complete application for environmental reviews and permits.

- **Restoration and decommissioning:** Implement a Site Restoration Plan for interim reclamation following temporary construction and operations disturbance. Implement a Decommissioning Plan for site reclamation at the end of a project. Coordinate with state and local authorities, such as the Washington Department of Fish and Wildlife, county extension services, weed boards, or land management agencies on soil and revegetation measures, including approved seed mixes. Such plans address:
  - Documentation of pre-construction conditions and as-built construction drawings
  - Measures to salvage topsoil and revegetate disturbed areas with native and pollinator-supporting plants
  - Management of hazardous and solid wastes
  - Timelines for restoration and decommissioning actions
  - Monitoring of restoration actions
  - Adaptive management measures

  Rationale**:** Restoration and decommissioning actions return disturbed areas to pre-construction conditions, promote soil health and revegetation of native plants, remove project infrastructure from the landscape, and ensure that project components are disposed of or recycled in compliance with all applicable laws and regulations.

- **Cumulative impact assessment:** Assess cumulative impacts on resources based on reasonably foreseeable past, present, and future projects. Identify actions to avoid, reduce, and mitigate cumulative impacts. Consider local studies and plans, such as comprehensive plans.

  Rationale**:** Cumulative impacts can result from incremental, but collectively significant, actions that occur over time. The purpose of the cumulative impacts analysis is to make sure that decision-makers consider the full range of consequences under anticipated future conditions.

3.4.3.2 Recommended measures for siting and design

- Site noise sources to reduce impacts and take advantage of existing topography and distances.
- Model project-level noise and vibration for construction and operations activities and equipment to determine project-specific setback distances for noise and vibration-sensitive land uses and receptors. Model noise and vibration using estimates that address variations in equipment type selected in final project design.
- Use noise and vibration modeling results during siting and design and establish setback distances for construction and operations. Provision of a setback distance from noise-or vibration-sensitive receptors would reduce the need for additional mitigation measures. Examples of activities and equipment to consider when establishing setback distances include:
  - Sources of construction vibration
  - Construction vehicle routes
  - Immobile construction equipment (e.g., compressors and generators)

    - Permanent sound-generating facilities, including transformers, inverters, and substations
    - Blasting
- Incorporate low-noise systems (e.g., for pumps, generators, compressors, and fans) and select equipment with low noise emissions and/or without prominent discrete tones, as indicated by the manufacturer.
- Install silencers on piping vents during steam blows to reduce noise levels.

3.4.3.3 Required measures

This section lists permits and approvals, plans, and other required measures for use of the PEIS, as applicable. See Section 3.3 for more detailed information on potentially required permits and approvals.

- Comply with Washington state EDNA thresholds levels per WAC 173-60-040
- Blasting Permits (local fire department or building authority)
- Land Use Permits (e.g., Comprehensive Plan Amendments, Conditional Use Permit/Special Use Permit, or Zoning Amendments) (local agency)
- Implement a worker hearing protection program for work areas with noise in excess of 85 dBA per OSHA standard 1910.95(c)(1).

3.4.3.4 Recommended measures for construction, operation, and decommissioning

- Implement noise reduction measures during construction, including:
    - Notify potentially affected residents in advance of noisy activities, such as blasting or pile driving, before and during the construction period.
    - Post warning signs at high-noise areas
    - Schedule construction activity during normal working hours on weekdays.
    - Limit possible evening shift work to low-noise activities, such as welding, wire pulling, and similar activities.
    - Maintain tools and equipment in good operating order according to manufacturer specifications.
    - Ensure all heavy trucks and internal combustion engines are properly maintained and equipped with noise-control (e.g., muffler) devices, in accordance with manufacturer specifications.
    - Limit noise-producing signals, such as horns, whistles, or alarms, to safety warning purposes only. Prohibit nighttime (10 p.m. to 7 a.m.) blasting.
- Use acoustical enclosures or barriers to reduce operational noise impacts.

3.4.3.5 Mitigation measures for potential significant impacts

- If project-specific construction vibration modeling indicates potential significant impacts to existing structures, implement a Construction Vibration Management Plan to reduce the potential for building damage. Measures and controls should be identified based on project-specific design and may include, but are not limited to, the following:
    - Installing cast-in-place concrete piles to minimize vibration.

- Vibrating piles into place and installing shrouds around the pile-driving hammer.
- Using nonvibratory, excavator-mounted compaction wheels and small, smooth drum rollers for final compaction of asphalt base and asphalt concrete. If needed to meet compaction requirements, use smaller vibratory rollers to minimize vibration levels during repaving activities where needed to meet vibration standards.
- Using active or passive vibration isolation systems for equipment that may produce high levels of vibration.
- Implementing a vibration, crack, and line and grade monitoring program for identified historic buildings in coordination with a geotechnical engineer and qualified architectural historian.
- During blasting, calculating and maintaining the weight of explosives necessary to ensure that vibrations from blasting do not exceed a performance standard of 0.5 PPV inches/second for conventional construction and 0.12 PPV inches/second for historic structures.

***Rationale*:** A Construction Vibration Management Plan can reduce the potential for building damage to occur during construction.

3.5 Green hydrogen production facility with co-located battery energy storage system (BESS)

This section describes potential impacts of green hydrogen production facilities with up to two co-located BESS containers. The BESSs would be used to balance loads or to provide up to 15% of power in case of an outage or power quality deviation. One BESS would provide 2.85 megawatts of electricity for 4 hours (a capacity of 11.4 megawatt hours or 11,400 kilowatt hours). Each container would be approximately 60 by 12 feet wide and 10 feet tall.

3.5.1 Impacts from construction and decommissioning

Site characterization, construction, and decommissioning of a green hydrogen facility with co-located BESSs would include the same equipment and activities generating construction noise and vibration as those analyzed for green hydrogen facilities, but with the addition of up to two co-located BESSs. Construction equipment and methods for green hydrogen facilities with a BESS would be the same as those for green hydrogen facilities alone. Therefore, construction and decommissioning noise and vibration impacts for green hydrogen production facilities with a co-located BESSs would be similar to those identified in Section 3.4.1.1.

3.5.2 Impacts from operation

Operation of a green hydrogen facility with co-located BESS would add one or two BESSs to the same equipment analyzed for green hydrogen facilities. Noise from BESS would be generated by battery storage liquid cooling units as well as inverters specific to the BESS. The BESS would not be expected to generate operational vibration.

In general, BESSs would likely operate 24 hours per day, and hence would generate noise during the more noise-sensitive nighttime hours. The proxy project described in Section 3.4.2 included BESS; as described in that section, noise modeling for the facility was found to produce noise levels below the thresholds for EDNA Class C noise levels in industrial and industrial-receiving areas and the thresholds for receiving sensitive land uses (EDNAs Class A and Class B). Impacts related to noise and vibration would be similar to those for production facilities without BESSs and would be **less than significant**.

3.5.3 Measures to avoid, reduce, and mitigate impacts

Available means of reducing noise and vibration-related impacts for green hydrogen facilities with co-located BESSs are the same as those identified for green hydrogen facilities without co-located BESSs (Section 3.4.3). Additionally, noise generated by BESSs may need to be controlled to maintain operational noise exposure to within the noise standards of WAC 173-60-040.

3.6 Green hydrogen storage facility (gas or liquid form)

This section describes potential impacts of green hydrogen storage facilities. A green hydrogen storage facility could store hydrogen in gas or liquid form. Gaseous hydrogen would be stored in stationary, aboveground, cylindrical storage systems, each of which employs different construction materials to achieve maximum working pressure ratings. Liquid hydrogen would be stored in double-walled, vacuum-insulated cryogenic storage tanks. The footprint of storage facilities would depend on the amount of hydrogen needed to store but would be less than 1 acre. This includes the storage tanks, separation space between tanks (if more than one), on-site access roads, and ancillary equipment.

A green hydrogen storage facility may be co-located with a green hydrogen production facility, or it may be located at a standalone facility, transport terminal, or end-use location such as an industrial facility or fueling facility.

3.6.1 Impacts from construction and decommissioning

Site characterization, construction, and decommissioning of a green hydrogen storage facility would include the same types of equipment and activities generating construction noise and vibration as those analyzed for green hydrogen facilities, with the exception that blasting or pile driving for structural foundations may not be necessary depending on the type and size of storage. Noise and vibration from multiple sources, including off-road equipment, pile driving, vendor and haul truck trips, could all increase noise levels at receptors in the vicinity of the construction area footprint. Therefore, construction noise and vibration impacts of a green hydrogen storage facility would be similar to or less than those identified in Section 3.4.1.1.

3.6.2 Impacts from operation

For a green hydrogen storage facility, impacts from operation would vary depending on the sizes, operating conditions, types, and quantity of storage tanks, but noise sources are expected to be limited and of a diminished volume compared to production facilities, as storage facilities would have a smaller footprint and require a lesser volume of noise-producing equipment such as compressors, electrolyzers, and cooling equipment. Primary noise sources would be produced from compressors and cooling equipment, which would produce similar levels of noise as similar equipment listed under green hydrogen production facilities and the proxy projects described in Section 3.4.2, but in a lesser volume, as the quantity of noise-producing equipment would be less than that used for production. Vibration from operations equipment is not expected. Noise and vibration impacts from operation of storage facilities would be **less than significant**.

3.6.3 Actions to avoid and reduce impacts

Available means of reducing noise and vibration-related impacts for green hydrogen storage facilities are the same as those identified in Section 3.4.3.

3.7 No Action Alternative

Under the No Action Alternative, agencies would continue to conduct environmental review and permitting for green hydrogen facilities under existing laws on a project-by-project basis. The potential impacts would be similar to the impacts for the types of facilities described above for construction, operations, and decommissioning, depending on facility size and design, and would range from **less than significant to potentially significant adverse impacts**.

3.8 Unavoidable significant adverse impacts

Through compliance with laws and permits, and with the implementation of measures to avoid, reduce, and mitigate impacts, green hydrogen facilities would have **no significant and unavoidable adverse impacts** on noise or vibration from construction, operation, or decommissioning.

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