Noise Test Plan

Astoria Station Project

Otter Tail Power Company

Astoria, South Dakota

September 20, 2022

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Executive Summary

Otter Tail Power (OTP) contracted with HDR Engineering, Inc. (HDR) to prepare a noise test plan, conduct two sets of noise measurements, process noise measurement results, and prepare a report documenting measurement results for far-field noise emissions testing of a Mitsubishi Hitachi Power Systems (MHPS) 501GAC gas turbine at Astoria Station (the Station) located in Astoria, South Dakota. This document describes the process to conduct the two sets of noise measurements, which may occur consecutively if conditions allow.

The objective of the testing is to compare Station-only noise with the noise limits set forth by the South Dakota Public Utilities Commission (SDPUC) in Settlement Stipulation EL17-042. The noise measurements will be conducted by HDR acousticians under the direction of HDR's Acoustic Program Manager Tim Casey.

This test plan documents the planned testing activities, the meteorological and Station operating conditions under which the tests are to be performed, the instrumentation to be used for the tests, and the evaluation of the test results. Any deviations from this test plan shall be mutually agreed upon in writing by all the testing parties.

1.0 Test Overview

1.1 Scope of Work

Otter Tail Power (OTP) contracted with HDR Engineering, Inc. (HDR) to prepare a noise test plan, conduct two sets of noise measurements, process noise measurement results, and prepare a report documenting measurement results for far-field noise emissions testing at Astoria Station (the Station) located in Astoria, South Dakota. This document describes the process to conduct the noise measurements. This document describes the process to conduct the two sets of noise measurements, which may occur consecutively if conditions allow.

The objective of the testing is to compare Station-only noise with the noise limits set forth by the South Dakota Public Utilities Commission (SDPUC) in Settlement Stipulation EL17-042. The noise measurements will be conducted by HDR acousticians under the direction of HDR's Acoustic Program Manager Tim Casey.

1.2 Plant Description

The Otter Tail Astoria Station is a 245-megawatt (MW) simple cycle facility which consists of one MHPS 501GAC gas turbine generator and supporting equipment which is fired solely on natural gas. The gas turbine is equipped with an evaporative cooler to increase power output when ambient conditions allow. The maximum rated capacity of the turbine varies with temperature and other meteorological conditions and can reach a load of approximately 270 to 286 MW under ideal operating conditions.

1.3 Permit Requirements

Condition 29 of the SDPUC Stipulation EL17-042, signed July 12, 2018, lists the Station noise level requirements:

> "The noise levels exclusively associated with the Project shall not exceed the following standards at the nearest occupied, existing residences (determined on the date the permit is issued) not owned by the Applicant:
>
> a. a day-night average (L_{dn}) sound level of 55 dB(A), which includes a nighttime penalty of 10 decibels; and
> b. a maximum (L_{max}) C-weighted sound level of 65 dB(C) applicable at all times."

No test tolerance will be applied to the measured sound levels for comparison with the limits set forth by the South Dakota Public Utilities Commission.

During a previous series of noise measurements, HDR observed that during periods when the Station was not operating the C-weighted L_{max} limit was exceeded thousands of times due to transient noise from extraneous sources such as wind and farm equipment. It would be a significant undertaking to manually investigate each C-weighted L_{max} peak above the limit using audio review to determine the cause of the peak. HDR also observed that above wind speeds of 6 mph, the 1-minute C-weighted L_{eq} was still regularly above the 65 dBC limit when the Station was not operating. For this reason, minutes with average wind speeds above 6 mph were not

considered for evaluation of compliance with the 65 dBC limit. A background noise correction based on wind speed for both dBA and dBC levels was also developed from the data obtained when the Station was not operating. These topics are discussed below in the context of this noise test plan.

2.0 Measurement Plan

HDR will conduct two series of measurements at the Station: the first series of measurements will be to determine the preliminary maximum compliant load, i.e., the maximum steady load achievable at the time of the measurements (245 MW or greater) under which the turbine maintains compliance with the Permit; the second series of measurements will be a formal compliance demonstration to show compliance with the SDPUC limits.

2.1 Measurement Locations

Far-field testing will consist of measurements at two points, as shown in Figure 1:

- ML1, approximately 3,800 feet southwest of the Station power block.
- ML2, approximately 6,000 feet east-southeast of the Station power block.

These measurement locations represent the nearest occupied residences to the Station, in accordance with the settlement conditions.

Due to the distance from the turbine unit, HDR assumes that the maximum compliant load will be lower at ML1 than at ML2, and as such will only conduct the first preliminary series of measurements at ML1. HDR will conduct measurements at both ML1 and ML2 during the second series of measurements to demonstrate compliance with the Permit at both residences.

2.2 Prior to Measurements

HDR will coordinate with OTP to obtain site access to the measurement locations. HDR will provide OTP a right-of-entry form which will be completed and returned to HDR prior to commencing the measurements.

HDR will perform a job hazard analysis to determine safety requirements, including required training and PPE, for the acousticians performing the noise measurements. OTP will communicate to HDR any site-specific safety requirements prior to commencing the measurements.

Exact dates of the noise measurements have not been determined as of the issuance of this test plan; however, the measurements are anticipated to occur in the first two weeks of December 2022. The maximum compliant load determination is expected to occur simultaneously with operational testing of the turbine. Compliance demonstration measurements will occur as soon as practical once the unit is able to run continuously at the determined maximum compliant load following operational testing. Specific measurement dates will be scheduled as soon as practical due to the need for calm weather and low temperatures to support higher combustion turbine output. Additionally, noise measurement accuracy is

particularly sensitive to meteorological conditions. For these reasons, the weather forecast will be considered when finalizing measurement dates.

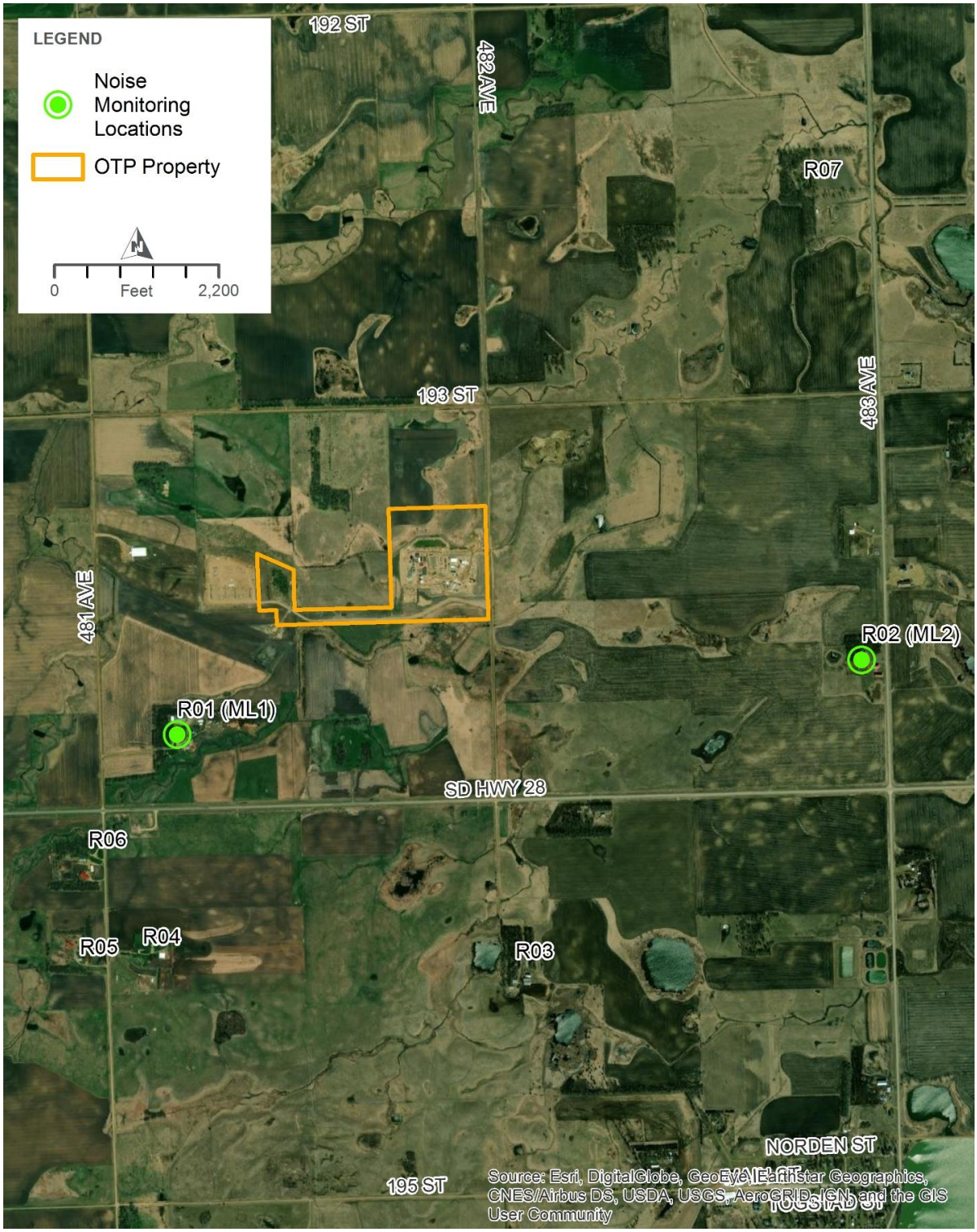

Figure 1. Noise Monitoring Locations

2.3 Measurement Procedure

The following sections explain the two different measurements, and the general procedures HDR will follow.

2.3.1 Preliminary Maximum Compliant Load

HDR will perform the first series of measurements to determine the preliminary maximum compliant load at ML1. During the measurement, HDR will be in contact with Station staff, and will direct staff to increase or decrease the turbine load as necessary while monitoring the A- and C- weighted real-time sound levels. The Station staff will operate the turbine at a given load for at least ten minutes while the sound level meter is measuring, during which HDR acousticians will monitor the A-weighted L_{eq} and C-weighted L_{max}. For the purposes of this measurement, an A-weighted L_{eq} of 48.6 dBA will be used as a proxy for the 55 dBA L_{dn} limit, as a 24-hour continuous noise level of 48.6 dBA results in a 55 dBA day-night noise level due to the 10 dBA penalty between 10 PM and 7 AM. The maximum turbine load measured that did not result in an exceedance of either noise limit will be taken to be the preliminary maximum compliant load.

HDR will use a Larson Davis 831C sound level meter/real-time analyzer, equipped with a Larson Davis PRM2103 preamplifier and PCB Piezotronics 377B02 1/2-inch free-field microphone to record sound levels and continuous audio. The microphone will be fitted with a Larson Davis 079A06 windscreen, and positioned approximately five feet above the ground. HDR will configure the sound level meter to automatically correct the sound level measurements for the windscreen. The sound level meter, mic and preamp will be within one year of laboratory calibration and will be field-calibrated prior to the noise measurements using a Larson Davis CAL200 Calibrator. The calibrator will also have been laboratory-calibrated within one year of the measurement.

To record wind speed and direction, temperature, humidity, and barometric pressure, HDR will deploy a Vaisala WXT536 weather station connected to the sound level meter. The weather station will be positioned on its own tripod located approximately 6 feet away from the microphone to avoid interfering with the sound level measurements.

2.3.2 Compliance Demonstration

HDR will conduct the compliance demonstration measurements at locations ML1 and ML2. The sound level meters will be left unattended at the measurement locations. A minimum of 2 hours of measurement results at each measurement location while the turbine is operated at or near the preliminary maximum compliant load will be sufficient to demonstrate compliance with the SDPUC noise limits. OTP will provide HDR with Station load data during the measurement period. Following the measurement period, HDR staff will download and provide raw data to OTP prior to returning to Minneapolis if possible. Due to the large file sizes created by the recording of continuous audio, downloading the data prior to demobilizing may not be possible. If this is the case, HDR staff will provide OTP with a summary of unprocessed hourly A-weighted L_{eq} and C-weighted L_{max} results immediately following the measurement period and will provide full files of raw measurement data as soon as practical after returning to Minneapolis.

Measurement instrumentation will include two sound level meter and weather station systems as described for the maximum compliant load measurements. To facilitate the unattended measurement, the microphone will be fitted with a Larson Davis EPS2116 environmental shroud that includes a windscreen and bird spike; HDR will configure the sound level meter to automatically correct the sound level measurements for the windscreen. The sound level meters will also be equipped with external D-cell batteries and a USB flash drive to provide sufficient power and storage capacity for the duration of the measurements. The sound level meter and power supply will be stored in a weather-resistant Pelican case. The Pelican case and microphone tripod will be chained to a permanent structure such as a tree or fencepost, if possible, to deter theft and vandalism.

2.3.3 General Procedures

For both noise measurements HDR may substitute the listed equipment with equivalent equipment, if necessary. HDR will document model and serial numbers and calibration histories of actual equipment used for the measurements.

For both series of noise measurements HDR will configure the sound level meter to store at a minimum:

- The hourly L_{eq}, L_{min}, and L_{max} in both A- and C-weighted decibels
- 1-second L_{eq}, L_{min}, and L_{max} in both A- and C-weighted decibels
- 1-second one-third octave band sound levels, unweighted (Z-weighted)
- Continuous uncompressed audio at a sample rate of 48 kHz.

Noise measurements will be conducted under fair weather conditions without any precipitation occurring. The average wind speed during measurement periods should not exceed 6 mph. Previous noise studies at the Station have demonstrated that higher wind speeds cause ambient noise levels in excess of the SDPUC C-weighted L_{max} limit, which makes isolating Station-related noise levels difficult.

During the sound level measurements, the turbine will be operated with all equipment in a normal operating configuration. All access doors and hatches on sound mitigating enclosures will be closed. Testing will be conducted when construction, heavy machinery operation, maintenance and repair activities, road traffic, and any other extraneous activities that produce excess noise are at a minimum.

HDR will maintain a test log during the attended measurements to record any occurrences affecting the test, the time of the occurrences, and the observed effect. These occurrences may include things such as nearby vehicular traffic, wildlife such as birds chirping, and farm machinery activity.

3.0 Post-Processing

HDR will process the compliance demonstration measurement results for comparison to the SDPUC noise limits. HDR will store a copy of the raw measurement results, then make a duplicate copy for post-processing, which includes filtering out periods of wind speeds above 11 mph for the L_{dn} determination and 6 mph for the dBC determination. The 11 mph limit for dBA is

based on ANSI S12.9 part 3 (2013). The 6 mph limit for dBC is based on previous measurements performed by HDR at this site, where wind speeds above 6 mph during background measurements caused exceedances of the L_{max} limit at such a rate that the data was effectively unusable. HDR will also remove periods of precipitation.

HDR will also perform a limited amount of selective audio review, which allows the removal of extraneous noise events that are unrelated to the project. If compliance is not immediately evident after removing non-Station peaks, HDR may identify hours when the Astoria Station is not operating and use those measurement results to subtract background noise from measurements when the Station was operating. In this manner, Station-only noise will be isolated. Then HDR will recalculate hourly L_{eq} in dBA and hourly maximum 10-second L_{eq} (as a proxy for L_{max}) in dBC. Those results will be used to evaluate compliance with the project noise limits.

4.0 Test Responsibilities

This section outlines the responsibilities and preparation activities required for the successful execution of the noise measurements.

OTP will be responsible for the following:

- reviewing and approving the HDR noise testing plan
- distribution of the test plan to Station staff assisting with noise measurements
- communicating changes to testing schedule to HDR
- coordinating site access, completing right-of-entry forms and giving a copy of them to HDR staff.
- communicating site-specific safety requirements to HDR
- ensuring that pre-test checks have been completed and the unit is ready for testing
- operating the unit under the conditions specified by this test plan
- facilitating communication of between Station and HDR staff during maximum load testing
- providing the specific operating conditions of the Station during compliance demonstration monitoring to HDR
- review of monitoring reports

HDR will be responsible for the following:

- providing noise measurement staff and equipment
- configuring equipment for deployment
- conducting noise measurements
- submitting preliminary data to OTP following compliance demonstration measurements
- processing data following measurements and comparing to SDPUC noise limits
- preparing report outlining results

5.0 Reporting

HDR will prepare a brief letter report that describes the measurements, how the data was processed, what data was removed, and results of the compliance determination. The sound levels will meet the permit requirements if the following is true after processing:

- The day-night A-weighted sound level at both ML1 and ML2 is less than 55 dBA
- The maximum 10-second C-weighted equivalent sound level (as a proxy for maximum sound level) at both ML1 and ML2 is less than 65 dBC

Measurement results will be presented in text, tables, and graphs. The report will include a map/figure based on an aerial photograph that shows where measurements occurred and the location of the Station.

Appendix A. Résumés

Timothy G. Casey

Sr. Environmental Scientist

Mr. Casey is HDR's National Acoustics Program Manager and has three decades of experience finding creative solutions to address noise and vibration on projects throughout the United States and Puerto Rico. He has extensive experience performing noise analyses for a wide variety of infrastructure-related projects including simple and combined cycle turbines, passive and active solar, wind farms, and more. Mr. Casey's experience includes working with NEPA, CEQR, a variety of impact assessment methodologies, making presentations at public meetings, before city councils, and expert witness testimony, and expert panel review for projects in locations throughout the United States and Puerto Rico. Following is a brief summary of some of his experience related to power and energy projects.

EDUCATION
Bachelor of Science, Biological/Life Sciences, Saint Xavier University, 1988

Associate of Science, Science, Valley Community College, 1986

Highway Noise Modeling (STAMINA 2.0/OPTIMA) Course, University of Louisville

FHWA Traffic Noise Model (TNM) Modeling Course, Elk Grove Village, IL

REGISTRATIONS
Institute for Noise Control Engineering – Full Member

PROFESSIONAL MEMBERSHIPS
Past President of the Upper Midwest Chapter of the Acoustical Society of America

Past Vice-President of the Upper Midwest Chapter of the Acoustical Society of America

Member of the Institute for Noise Control Engineering

Transportation Research Board's Transportation Noise and Vibration Committee

INDUSTRY TENURE
33 years

HDR TENURE
33 years

RELEVANT EXPERIENCE

Power and Energy-related Project Experience

Astoria Station Combustion Turbine Power Plant, Ottertail Power, *South Dakota*
Mr. Casey led the analysis of noise from a proposed simple cycle combustion turbine power plant. The analysis measured existing noise levels, established A- and C-weighted acoustical design goals, evaluated spectral sound power level data provided by turbine manufacturers, calculated noise from the selected manufacturer, evacuated compliance with the applicable noise limits and acoustical design goals, and developed noise mitigation measures. The noise analysis utilized spreadsheets, Cadna-A, and GIS.

Aberdeen Station Combustion Turbine Power Plant, NorthWestern Energy, *South Dakota*
Mr. Casey led the analysis of noise from a proposed simple cycle combustion turbine power plant. The analysis measured existing noise levels, measured noise levels from existing equipment on-site, established A- and C-weighted acoustical design goals for the proposed combustion turbines, evaluated spectral sound power level data provided by turbine manufacturers, calculated noise from the selected manufacturer, evacuated compliance with the applicable noise limits and acoustical design goals, and developed noise mitigation measures. The noise analysis utilized spreadsheets, Cadna-A, and GIS.

Kings Mountain Combustion Turbine Power Plant, NTE, *North Carolina*
Mr. Casey led the analysis of noise from a proposed combined cycle combustion turbine power plant. The Kings Mountain Energy Center

OFFICE LOCATION
Minneapolis, MN

consists of a single Mitsubishi 501GAC combustion turbine with a Toshiba steam turbine and a Vogt HRSG. The analysis established A- and C-weighted acoustical design goals, evaluated spectral sound power level data provided by turbine manufacturers, calculated noise from the selected manufacturer, evacuated compliance with the applicable noise limits and acoustical design goals, and developed noise mitigation measures. The noise analysis utilized spreadsheets, Cadna-A, and GIS.

Oakridge Cogeneration Plant, Interstate Power and Light, *Iowa*
Mr. Casey oversaw the analysis of noise from a proposed combined cycle combustion turbine power plant. The analysis established A- and C-weighted acoustical design goals, calculated indoor noise levels and radiated that energy through the building envelop using spectral sound power level data provided by manufacturers, evacuated compliance with the applicable noise limits and acoustical design goals, and developed noise mitigation measures. The noise analysis utilized spreadsheets, INSUL, Cadna-A, and GIS.

Great River Energy Noise Study, Great River Energy, *Minnesota*
Mr. Casey researched monitoring and modeling methodologies and wrote a spectral model to evaluate combustion turbine noise for peaking turbine. Revised the analysis and presented the results at a public hearing. Facility is a greenfield site, and will be used for peaking purposes only, no base load generation.

Great River Energy Noise Study, Lakefield Junction Generating Station, *Minnesota*
Lakefield Junction Generating Station utilizes six gas/oil-fired combustion turbines providing 550 MW. Mr. Casey researched monitoring and modeling methodologies and wrote a spectral model to evaluate combustion turbine noise for peaking turbine. HDR measured spectral noise emissions data using octave band analyzers to evaluate compliance with contractual performance guarantees. The monitoring protocol was prepared in accordance with applicable ANSI and ASME standards for monitoring noise from combustion turbines. Low frequency noise emissions were an issue.

Great River Energy Noise Study, Pleasant Valley Junction Generating Station, *Minnesota*
Pleasant Valley Generating Station utilizes two gas/oil-fired combustion turbines providing 434 MW. Mr. Casey researched monitoring and modeling methodologies and wrote a spectral model to evaluate combustion turbine noise for peaking turbine. HDR collected spectral noise emissions data using octave band analyzers to evaluate compliance with contractual performance guarantees. HDR also modeled noise emissions from a proposed third turbine to evaluate low frequency noise emissions at the nearest residence.

Great River Energy Noise Study, Cambridge Generating Station, *Minnesota* Pleasant Valley Generating Station utilizes two gas/oil-fired combustion turbines, one was recently installed. HDR performed noise guarantee performance measurements of the new turbine when it was fired on natural gas and fuel oil.

Northern Alternative Energy/Navitas combustion turbine siting, *Wisconsin, Iowa, and Minnesota*
Project proposes to install two twin-pack combustion turbine installations for peaking use in two different cities in each of the three states. Mr. Casey researched monitoring and modeling methodologies and wrote a spectral model to evaluate combustion turbine noise for peaking turbine. Performed noise modeling and presented results to city council and county zoning board, and at a public meeting. GIS was used in this analysis.

Sarpy County Combustion Turbine, Omaha Public Power District, *Nebraska* Combustion turbine noise monitoring and modeling study for combustion turbine expansion project. Mr. Casey researched combustion turbine noise assessment and prediction methods through ASME articles and developed a site monitoring protocol for measuring existing noise levels. Mr. Casey also developed a spectral model to predict the propagation and attenuation of combustion turbine noise. Modeled proposed setting and reported results. GIS was used in this analysis.

Combustion Turbine Power Plant, Confidential Client, *Nebraska*
Mr. Casey led the analysis of noise from a proposed simple cycle combustion turbine power plant. The analysis established A- and C-weighted acoustical design goals, evaluated spectral sound power level data provided by turbine manufacturers, calculated noise from the selected manufacturer, evacuated compliance with the applicable noise limits and acoustical design goals, and developed noise mitigation measures. The noise analysis utilized spreadsheets, Cadna-A, and GIS.

Reciprocating Engine (RICE) Power Plant, Confidential Client, *Nebraska*
Mr. Casey led the analysis of noise from a proposed RICE power plant proposed to be located in close proximity to residential neighborhoods. The analysis established A- and C-weighted acoustical design goals, evaluated spectral sound power level data provided by turbine manufacturers, calculated noise from the selected manufacturer, evacuated compliance with the applicable noise limits and acoustical design goals, and developed noise mitigation measures. The noise analysis utilized spreadsheets, Cadna-A, and GIS.

Laurel Station Reciprocating Engine (RICE) Power Plant, NorthWestern Energy, *Montana*
Mr. Casey oversaw the analysis of noise from a proposed RICE power plant proposed to be located in close proximity to residential neighborhoods. The analysis established A- and C-weighted acoustical design goals,

evaluated spectral sound power level data provided by turbine manufacturers, calculated noise from the selected manufacturer, evacuated compliance with the applicable noise limits and acoustical design goals, and developed noise mitigation measures. The noise analysis utilized spreadsheets, Cadna-A, and GIS.

Champlain-Hudson Express, *New York*
The Champlain Hudson Power Express project will bring up to 1,000 megawatts (MW) of clean, renewable power approximately 350 miles to the New York City metro area from Quebec, Canada. Mr. Casey managed the analysis of construction noise and vibration, and operational noise. This included burying cable on land and under Lake Champlain and other waterways.

Invenergy LLC, White Oak Wind Energy, *Illinois*
Mr. Casey performed a noise analysis for a wind energy facility proposed by Invenergy Wind, LLC. The analysis modeled 131 GE 1.5sle wind turbines, and predicted noise levels at 183 residences, covering over 1200 acres of rural McLean County near Bloomington, Illinois. The analysis utilized the Cadna-A acoustical analysis software model. HDR performed two 24-hour noise measurements, which were incorporated into the analysis. Mr. Casey testified for over 2.5 hours before the County Board of Zoning Appeals, answering questions from the Board, the attorney hired by residents opposed to the wind farm, and from residents themselves. The Board approved the application to rezone agricultural land for use as a wind farm.

Grand Ridge Wind Farm, *Ottawa, Illinois*
Mr. Casey performed a noise analysis for a wind energy facility proposed by Invenergy Wind, LLC. The analysis modeled 79 GE 1.5sle wind turbines, and predicted noise levels at 120 residences, covering over 20,000 acres of rural LaSalle County near Ottawa, Illinois. The analysis utilized the Cadna-A acoustical analysis software model. HDR performed two 24-hour noise measurements, which were incorporated into the analysis. Mr. Casey testified before the County Board of Zoning Appeals, answering questions from the Board and from residents themselves. The Board approved the application to rezone agricultural land for use as a wind farm.

Buffalo Ridge II Wind Farm, *South Dakota*
Mr. Casey managed the noise analysis performed in support of Iberdrola Renewables, Inc. (IBR) proposed Buffalo Ridge II wind farm. The analysis included modeling noise from the proposed wind turbines using the Cadna-A acoustical analysis software model. The analysis imported GIS shape files for turbine locations, residences in the project area, and terrain. A project-specific wind rose (annual meteorological summary) was also imported into Cadna-A for use in the noise analysis. The Project will have a nameplate capacity of up to 306 megawatts (MW) and a net operating capacity of between approximately 1,045,000 and 1,152,000 MW hours per year (MWh/yr.) and will include up to 121 wind turbines.

IBR proposed to use Gamesa G87 turbines on this project.

Buffalo Ridge III Wind Farm, *South Dakota*
Mr. Casey managed the noise analysis performed in support of Iberdrola Renewables, Inc. (IBR) proposed Buffalo Ridge III wind farm. The analysis included a comparison of modeled noise from three different types of considered for use on the project. The turbine types were Mitsubishi 2.4 MW, Gamesa 2.0 MW, and the GE 1.5 MW. The analysis was performed using the Cadna-A acoustical analysis software model.

Grand Ridge V Wind Farm, *Illinois*
Mr. Casey is managing the noise analysis performed in support of Invenergy Wind LLC's proposed Grand Ridge V wind farm. The analysis will include modeling noise from the proposed wind turbines using the Cadna-A acoustical analysis software model. The analysis will import GIS shape files for turbine locations, residences in the project area, and terrain. A project-specific wind rose (annual meteorological summary) will also be imported into Cadna-A for use in the noise analysis. The Project will have a nameplate capacity of up to 1506 megawatts (MW) using 100 General Electric 1.5 or 1.6 XLE turbines.

Tule Wind Farm, *California*
Mr. Casey managed the noise analysis performed in support of Iberdrola Renewables, Inc. (IBR) proposed Tule wind farm. The analysis included modeling noise from the proposed wind turbines using the Cadna-A acoustical analysis software model. The analysis imported GIS shape files for turbine locations, residences and other noise-sensitive land uses in the project area, and terrain. A project-specific wind rose (annual meteorological summary) was also imported into Cadna-A for use in the noise analysis. Mr. Casey also co-authored a review of the San Diego County's proposed draft wind turbine noise ordinance, which is based on a siting guidance document authored by Kamperman and James. IBR proposes to install 129 General Electric 1.5 xle wind turbines on this project.

Broad Mountain Wind Farm, *Pennsylvania*
Mr. Casey managed the noise analysis performed in support of Wind Capital Group's proposed Broad Mountain wind farm. The analysis included modeling noise from the proposed wind turbines using the Cadna-A acoustical analysis software model. The analysis imported GIS shape files for turbine locations, residences in the project area, and terrain. A project-specific wind rose (annual meteorological summary) was also imported into Cadna-A for use in the noise analysis. The analysis evaluated overall A-weighted noise levels, C-weighted noise levels, and C-A (C minus A) weighted noise levels (to assess the potential for low frequency noise nuisance issues. Wind Capital Group is proposing to construct up to 35 wind turbine generators (WTG), utilizing the 1.5xle model turbine manufactured by General Electric (GE) as part of the Broad Mountain Wind Energy Project (Project). Mr. Casey also provided expert

witness testimony at zoning board hearings throughout a five-month period.

La Sierrita Wind Energy, *New Mexico*
Mr. Casey managed the noise analysis performed in support of Invenergy Wind LLC's proposed La Sierrita wind farm. Invenergy proposes to construct up to 57 wind turbine generators (WTG), utilizing the 1.5xle with wind extend model turbine manufactured by General Electric(GE) as part of the La Sierrita Wind Energy (Project).The analysis included modeling noise from the proposed wind turbines using the Cadna-A acoustical analysis software model. The analysis imported GIS shape files for turbine locations, residences in the project area, and terrain. A project-specific wind rose (annual meteorological summary) was also imported into Cadna-A for use in the noise analysis. The analysis evaluated overall A-weighted noise levels, C-weighted noise levels, and C-A (C minus A) weighted noise levels (to assess the potential for low frequency noise nuisance issues. Mr. Casey also participated in zoning approval meetings, and a review of the proposed wind turbine noise ordinance.

White Pine Pumped Storage, *White Pine County, NV*
Mr. Casey oversaw the noise study performed in support of the proposed licensing, construction, and operation of the White Pine Pumped Storage Project (FERC No. 14851), approximately 8 miles northeast of the City of Ely. The Project is a 1,000 megawatt, closed-loop, pumped storage facility that will require the construction of two new reservoirs joined by underground or surface conduits along with a powerhouse and associated generation, pumping, and transmission equipment. The noise study included measuring ambient noise using Sage Grouse noise study guidelines, due to proximity to sage grouse leks. HDR used Cadna-A software to model noise emissions from the proposed facility.

Geronimo Wind Farm, *Minnesota*
Mr. Casey managed the noise analysis performed in support of the proposed Geronimo wind farm project. The analysis consisted of determining the distance to a noise level of 50 dBA using the Cadna-A acoustical analysis software model. Mr. Casey also participated in an open house public meeting, where he led an hour-long discussion of wind turbine noise and potential health effects due to exposure to wind turbine noise.

National Goodhue Wind Farm, *Minnesota*
Mr. Casey managed the noise analysis performed in support of the proposed National Goodhue wind farm project. The analysis consisted of determining the distance to a noise level of 45 dBA using the Cadna-A acoustical analysis software model. Mr. Casey also participated in an open house public meeting, where he led an hour-long discussion of wind turbine noise and potential health effects due to exposure to wind turbine noise. Mr. Casey has also provided expert witness testimony during hearings related to this project.

Lost Lakes Wind Farm, *Iowa*
Mr. Casey managed the noise analysis performed in support of Horizon Wind Energy's proposed Lost Lakes wind farm. Horizon proposes to construct 61 wind turbines, each utilizing the VestasV82-1.65 MW MK II turbine. The Project consists of wind turbine generators, foundations, access roads, and a new substation to interconnect the wind far with transmission system. The project has a nominal generation capacity of 100 MW. The analysis included modeling noise from the proposed wind turbines using the Cadna-A acoustical analysis software model. The analysis imported GIS shape files for turbine locations, residences and other noise-sensitive land uses in the project area, and terrain. A project-specific wind rose (annual meteorological summary) was also imported into Cadna-A for use in the noise analysis. Mr. Casey also participated in an open house meeting and attended the zoning board public hearing.

Miscellaneous Power Transmission Projects, Great River Energy, *Minnesota*
Used the Bonneville Power Agency CFIX8 model to evaluate corona noise and EMF associated with proposed high voltage power transmission lines.

Pentagon Remote Delivery Facility, Pentagon Renovation Office (PenRen), *Washington DC*
Analysis of noise from emergency diesel electric generators at the Remote Delivery Facility at the United States Pentagon. Mr. Casey researched and wrote a spectral noise model to evaluate noise emissions from seven diesel generators were evaluated with respect to applicable noise limits. GIS was used in this analysis.

Moores Bridges WTP Backup Power Project, City of Virginia Beach Public Utilities, *Virginia*
Screening-level analysis of noise from combustion turbines, natural gas engines, and diesel engines proposed for emergency power supply. Mr. Casey researched and wrote a spectral model to evaluate noise emissions from these three power sources as part of a feasibility study. Task included an octave band analysis of emissions from combustion turbine, and also evaluated mitigation equipment from vendors. Noise emissions from the three equipment categories were evaluated for compliance with local noise limits. GIS was used in this analysis.

Rapid City Basin Electric Noise & Vibration Study, *Rapid City, SD*
Mr. Casey performed spectral noise measurements, and ground-borne vibration measurements near a 200MW Intertie substation. Mr. Casey also performed 24-hour noise measurements at residences nearby. Results of the study were presented in a written report, and also in presentations made to project shareholders, and Rapid City land use planning and legal/finance committees.

Tessera Solar, San Luis Valley 200MW Solar Project, *Saquache County, CO*
Mr. Casey assisted with analysis of noise from a proposed solar project in Colorado that proposed to use Stirling Engine technology to convert solar power into electricity. Mr. Casey led the development of a dynamic noise model that calculated project-related noise levels at the property line throughout the range of the movement of the sun during daytime hours. Mr. Casey also edited the noise model constructed using Cadna-A software. Additionally, Mr. Casey provided expert witness testimony at a hearing in Saquache County, Colorado.

Alliant Energy Creston Solar, *Union County, IA*
Mr. Casey oversaw the noise analysis performed in support of a proposed solar energy project in the town of Creston, Union County, Iowa, on primarily agricultural land. The proposed site consists of two separate areas split by County Road H33. The Project will have a Phase 1 nameplate capacity of 50 MWac consisting of approximately 66 MWdc solar array across the site of approximately 600 acres, as well as on off-site collector substation. The analysis estimated existing noise levels using desktop methods. The analysis also used Cadna-A noise modeling software to calculate the distances at which noise from pad-mounted inverters and related equipment would approach, equal, or be below ambient noise levels. Those distances were used as buffers around the nearest homes, providing siting guidance for where inverter pads could be located. The analysis also evaluated construction noise.

Alliant Energy Weaver Solar, *Lee County, IA*
Mr. Casey oversaw the noise analysis performed in support of a proposed solar energy project in the town of Wever, Lee County, Iowa, on primarily agricultural land. The proposed site consists of ten separate areas split by a variety of rural arterial roadways. The analysis estimated existing noise levels using desktop methods. The analysis also used Cadna-A noise modeling software to calculate the distances at which noise from pad-mounted inverters and related equipment would approach, equal, or be below ambient noise levels. Those distances were used as buffers around the nearest homes, providing siting guidance for where inverter pads could be located. The analysis also evaluated construction noise.

Alliant Crawfish River Solar, *Jefferson County, WI*
Mr. Casey performed an independent third-party review of a noise study performed by Stantec.

Dubuque Solar, *Dubuque, IA*
Mr. Casey oversaw the noise analysis performed in support of a proposed solar energy project. The primary sources of noise on each site include the 2000 KVA transformers and 50-60 kV inverters. The Port site includes one transformer and 19 inverters, and the West site includes two transformers and 64 inverters. HDR evaluated construction noise. HDR used Cadna-A

noise modeling software to evaluate noise from operations; calculated noise contours were overlaid upon digital aerial photos.

Logan County Solar, *Russellville, KY*
Mr. Casey oversaw response to comments from the Kentucky Siting Board on an initial noise study performed in support of the proposed project located in Russellville, KY. The response included use of Cadna-A noise modeling software to refine the understanding of inverter noise and construction noise. Mr. Casey also provided expert witness testimony (remotely) at a hearing in Kentucky.

Great Northern Transmission Line, *Minnesota*
Mr. Casey performed an assessment of noise from transformers in a proposed substation that was associated with a proposed transmission line in Minnesota. The noise emissions were evaluated for compliance with Minnesota Pollution Control Agency noise standards.

EXPERT WITNESS AND PUBLIC HEARING SUPPORT
Mr. Casey has provided expert witness testimony for numerous hearings in front of county boards, city councils, local landowners, and the general public regarding the methodology used to determine noise levels for various development projects. Below is a listing of the specific projects.

Natural Gas Pump Station, *Providence, RI*
Mr. Casey provided testimony regarding the noise study HDR performed for a portable natural gas pump station, in a public hearing in Rhode Island. The study included measurements of ambient noise and equipment noise, three-dimensional noise modeling, and an evaluation of noise mitigation options.

Broad Mountain Wind Farm, *Butler Township, PA*
Mr. Casey managed the analysis of noise from the proposed Broad Mountain Wind Farm. HDR's noise analysis included several iterations of analyses to provide project stakeholders with greater insight on the range of potential noise emissions associated with the proposed project. He also provided over six hours of expert witness testimony at numerous hearings associated with the proposed project.

Logan County Solar, *Russellville, KY*
Mr. Casey oversaw response to comments from the Kentucky Siting Board on an initial noise study performed in support of the proposed project located in Russellville, KY. The response included use of Cadna-A noise modeling software to refine the understanding of inverter noise and construction noise. Mr. Casey also provided expert witness testimony (remotely) at a hearing in Kentucky.

White Oak Wind Farm, *Bloomington, IL*
Mr. Casey performed a noise analysis for a proposed wind farm. The

analysis modeled 131 GE 1.5SLE wind turbines, and predicted noise levels at 183 residences, covering over 1200 acres of rural McLean County near Bloomington, Illinois. HDR performed two 24-hour noise measurements, which were incorporated into the analysis. Mr. Casey testified for over 2.5 hours before the County Board of Zoning Appeals, answering questions from the Board, the attorney hired by residents opposed to the wind farm, and from residents themselves.

California Ridge Wind Farm, *Urbana IL*
Mr. Casey provided expert witness testimony in a zoning board of approvals hearing related to the proposed California Ridge Wind Energy project. Mr. Casey's testimony addressed a variety of noise-related topics associated with the proposed wind energy project.

La Sierrita Wind Energy, *Las Vegas, NV*
Mr. Casey provided expert witness testimony in several public hearings related to the proposed La Sierrita Wind Energy project. Mr. Casey's testimony addressed a variety of noise-related topics associated with the proposed wind energy project.

Goodhue Wind Farm, *Goodhue, MN and St. Paul, MN*
Mr. Casey managed the noise assessment for a proposed wind farm in Goodhue County. Mr. Casey also provided expert witness testimony in a public hearing (in Goodhue, MN) and also at a MN Public Utilities Commission hearing (in St. Paul, MN) related to the proposed Goodhue Wind Energy project. Mr. Casey's testimony addressed a variety of noise-related topics associated with the proposed wind energy project.

Grand Ridge Wind Farm, *Ottawa, IL*
Mr. Casey performed a noise analysis for a proposed wind farm. The analysis modeled 79 GE 1.5SLE wind turbines, and predicted noise levels at 120 residences, covering over 20,000 acres of rural LaSalle County near Ottawa, Illinois. HDR performed two 24-hour noise measurements, which were incorporated into the analysis. Mr. Casey testified before the County Board of Zoning Appeals, answering questions from the Board and from residents themselves. The Board approved the application to rezone agricultural land for use as a wind farm.

Tessera Solar San Luis Valley 200 Megawatt (MW) Solar Project (SLVSP), *Saguache County, CO*
Mr. Casey reviewed the noise analysis performed to assess potential noise emissions from over 5,000 proposed SunCatcher solar power stations. Mr. Casey also provided expert witness testimony at a hearing in Saguache County, Colorado.

Canadian National – Elgin Joliet and Eastern Railway Acquisition, *Chicago, IL*
Mr. Casey managed the noise and vibration analyses associated with the proposed acquisition of the Elgin, Joliet and Eastern Railway (EJE) by the

Canadian National Railway (CN). Serving as an independent third party contractor to the Surface Transportation Board (STB), HDR prepared a draft and final environment impact statement. Mr. Casey testified during a hearing, before the STB, in Washington D.C. regarding the final results of the noise and vibration analyses. The project area included several hundred miles of freight rail line in the Chicago metro area.

Columbia Center Boulevard Grade Separation, *Kennewick, WA*
Mr. Casey performed noise and vibration monitoring and modeling in support of a proposed railroad grade separation project. Over concerns about noise and vibration, owners of a nearby apartment complex challenged the project, and hired the president of Wilson Ihrig Associates (a well-known West Coast acoustics firm with decades of experience in railroad noise and vibration). Mr. Casey defended his analyses in a Board of Approvals hearing, responding to challenges from council for the project opponents and from the president of Wilson Ihrig. HDR's client won the case.

Browning Ferris Industries Solid Waste Landfill, *Salinas, Puerto Rico*
Mr. Casey performed air quality and noise modeling in support of a proposed landfill in southern Puerto Rico. Wealthy local land owners hired a law firm to challenge the project. Through an interpreter Mr. Casey defended the noise and air quality analyses in a public hearing that was conducted in Spanish. The project was not approved for development. Noise and air quality issues were not the dominant concern of project opponents, and did not affect the decision to deny approval for the project.

RiverStone Group Gravel Mine Expansion, *Moline, IL*
Mr. Casey provided expert witness testimony regarding noise analyses performed in support of a proposed expansion of a gravel mining facility. There was no opposing testimony to Mr. Casey's analysis and testimony. Mr. Casey's client prevailed; noise was not considered an issue of primary concern.

RiverStone Group Gravel Mine Expansion, *Cleveland Township, IL*
Mr. Casey provided expert witness testimony regarding noise analyses performed in support of a proposed expansion of a gravel mining facility. Mr. Casey's client prevailed; noise was considered an issue of primary concern.

RiverStone Group Gravel Mine Expansion, *Cordova Township, IL*
Mr. Casey provided expert witness testimony regarding noise analyses performed in support of a proposed expansion of a gravel mining facility.

Sunny Point Interchange Improvements, *Juneau, AK*
Mr. Casey made presentations and answered questions about the traffic noise analysis performed in support of this highway improvement project. The presentations were offered at two public meetings, before and after

the noise analysis was performed.

Pacific Northwest High Speed Rail Corridor, *Vancouver, WA*
Mr. Casey made a presentation and answered questions at a public hearing, about the traffic noise analysis performed in support of this rail corridor improvement project.

I-35 Reconstruction Project, *Duluth, MN*
Mr. Casey made a presentation and answered questions about the traffic noise analysis performed in support of this project, at a public meeting.

I-29 Noise Analysis, South Dakota DOT, *Sioux Falls, SD*
Mr. Casey made presentations during a public meeting at the beginning and end of this project to explain the noise analysis process and subsequent results to residents in the project area. Highway noise is extremely controversial in this project area.

PAPERS/PRESENTATIONS

Transportation Research Board Committee on Transportation Noise and Vibration (ADC40) Summer Meeting, Minneapolis, MN. Mr. Casey hosted the 2017 Summer Meeting of ADC40 in Minneapolis, Minnesota in July 2017.

Noise from Multi-Modal Transportation and Petroleum Development on the North Slope of Alaska. Presented at the annual meeting of the Transportation Research Board's Transportation Noise and Vibration Committee, January 2014, Washington, DC. Mr. Casey led the half-million dollar noise study that collected over 5,000 hours of measurement data stored every second during the arctic winter and summer. The analysis also evaluated noise from construction and operation of several alternatives, in both winter and summer.

Assessing Noise and Vibration on FRA Tier I NEPA Projects
Presented to the summer meeting of the Transportation Research Board's Transportation Noise and Vibration Committee, July 2013, Santa Fe, New Mexico. Mr. Casey made a presentation describing the hybrid noise and vibration analysis methodology HDR created. HDR's methods were recently endorsed by FRA.

Summary of Noise and Vibration Analyses performed for CN-EJE Acquisition, presented to the United States Surface Transportation Board (STB), Washington, DC, November 18, 2009. Mr. Casey presented a summary of the noise and vibration analyses to the STB at a public hearing in Washington D.C. The STB, formerly the ICC, regulates portions of the interstate freight railroad industry including acquisitions and new construction.

Modeling Unique Locomotive Horn Noise Contours for the CN-EJ&E

Environmental Impact Statement, October 2009, Presented at the 2009 Railroad Environmental Conference, Champaign, IL, by Timothy Casey

Impact of Train-induced Ground-borne Vibration on Future Research Activities at Fermi National Accelerator Laboratory (Fermilab), a poster presentation, October 2009, Presented at the 2009 Railroad Environmental Conference, Champaign, IL, by Timothy Casey

Wind Turbine Noise in the United States: The Environmental Speed Limit vs. Worst Case Noise Analyses, June 2009, Presented at the Third International Wind Turbine Noise Conference, Aalborg Denmark, by Timothy Casey

Modeling Noise from Auto Transloading and Intermodal Facilities, January, 2008, Presented at the January meeting of the Upper Midwest Chapter of the Acoustical Society of America, by Timothy Casey.

Modeling Noise from Intermodal and Auto Transloading Facilities, October 23, 2007, Presented at the 2007 Railroad Environmental Conference, Champaign, IL, by Timothy Casey.

Wind Turbine Noise Primer, Canadian Acoustics Journal, June 2006, Beth Regan and Timothy Casey.

Fundamentals of Environmental Acoustics, 2006
Mr. Casey presented a workshop-like session to select staff of the New York City Department of Environmental Conservation, to help them understand the fundamentals of acoustics, environmental noise, noise mitigation, noise perception, etc.

Regulating Environmental Noise in Minnesota, 2005 joint meeting of the Acoustical Society of America and the Institute of Noise Control Engineering, Minneapolis, Minnesota. This presentation discussed MPCA and MDNR jurisdiction to regulate environmental noise, Mn/DOT noise abatement practices, the MOA between Mn/DOT and MPCA, and shortcomings of the MPCA noise rule with regard to its statutory mandates.

Modeling Engine Compression Brake Noise using a STAMINA-based Model, by Timothy G. Casey, 17th Annual Transportation Research Conference, St. Paul, Minnesota, May, 2005.

Modeling Engine Compression Brake Noise using a STAMINA-based Model, 2004 joint meeting between the Transportation Research Board (TRB) and Noise Control Engineering (NoiseCon), Baltimore, MD. This presentation discussed ground-breaking monitoring, statistical data analysis, and modeling performed by HDR on a highway project in Duluth, Minnesota. The leader of the Noise Team in the Federal Highway Administration's (FHWA) Office of Natural and Human Environment called

HDR "pioneers" for being the first consultant to perform this kind of analysis in the US.

2004 Forum on Environmental Acoustics, A two-day forum organized and hosted by Mr. Casey. Day 1 focused on the new FRA regulation on locomotive horn use and quiet zones, and featured speakers from FRA, Mn/DOT, BNSF, CP Rail, Twin Cities & Western Railroad, and others. Day 2 featured updates on the Metropolitan Airports Commission noise monitoring and Part 150 airport noise abatement programs. The remainder of Day 2 featured technical presentations by local environmental acousticians and government staff involved with noise issues. Mr. Casey's presentation addressed FTA noise and vibration assessment methodologies. The 2004 Forum occurred on July 20 and 21 in Minneapolis.

Meeting Noise Regulations from the Inside Out, Fall 2003 issue of HDR Innovations.

2002 Forum on Environmental Acoustics, a day-long forum featuring speakers from Mn/DOT, Minnesota Pollution Control Agency, Metropolitan Airports Commission, and featuring the Honorable Mayor R.T. Rybak (mayor of Minneapolis) as keynote speaker. Mr. Casey organized and hosted the event in Minneapolis on June 26th, 2002.

Multi-modal Acoustics Analyses, by Timothy G. Casey, 12th Annual Transportation Research Conference, St. Paul, Minnesota, May 23, 2001.

GIS and Noise Analyses Go Together Like a Hammer and Nail, by Timothy G. Casey, HDR Engineering E&RM Conference, Tempe Arizona, May 19, 2001.

How the Iron Ore Mining Industry (SIC 1011) Achieved Exemption from State and Federal Toxic Release Inventory Regulations, by Timothy G. Casey, Air & Waste Management Association's 92nd Annual Meeting & Exhibition, June, 1999, St. Louis, Missouri.

Pros and Cons of the "One Plan" Approach to Multiple Emergency Response Planning Requirements, by Tim Casey and Ed Liebsch, Presented at the Air & Waste Management Association's 90th Annual Meeting & Exhibition, June 8-13, 1997, Toronto, Ontario, Canada.

Petition to the Minnesota Emergency Response Commission to Exempt all Facilities Having a Standard Industrial Classification Code 1011 (Iron Ore Mining) from Toxic Pollution Prevention Reporting Requirements under MN Statutes 115D and 299K.08, presented to the Minnesota Emergency Response Commission. February 9, 1995.

Title V of the 1990 Clean Air Act Amendments: Coverage and Minimum Permit Content of 40 CFR Part 70 - The USEPA Operating Permit Program;

and a Brief Comparison of Implementation in Six States by Timothy G. Casey, HDR Engineering, Inc. 1993

Pollution Prevention for Lead by Cynthia A. Boyd and Timothy G. Casey, Presented at 85th Annual Meeting and Exhibition, Air and Waste Management Association, Kansas City, June 21-26, 1992.

Medical Waste Regulatory Developments and Facility Compliance by Mark L. Wollschlager, JD. and Timothy G. Casey, Consulting-Specifying Engineer, Mid-September, 1991.

Ben Copenhaver, INCE

Acoustician

Ben is an experienced acoustician with 8 years of experience carrying out noise studies for the energy industry. In his previous position at Innova Global (formerly ATCO Emissions Management), he conducted noise modeling and measurement for power plants and compressor stations throughout North America. Since joining HDR, he has performed numerous environmental noise studies for wind and other industry, including measurement, modeling, and mitigation design. He is proficient with Cadna/A, FHWA TNM 2.5, and GIS, as well as Larson-Davis and Brüel & Kjær noise monitoring equipment.

He also has a strong educational background in acoustics, with a Master's degree from the acoustics program at the University of Texas at Austin. Coursework included Physical Acoustics, Architectural Acoustics, Vibrations, Nonlinear Acoustics, and Ultrasound. His Master's thesis involved development of a vibroacoustic method for landmine detection, including lumped-element modeling of the soil/mine system, experiment design and data analysis

EDUCATION
M.S.E., Mechanical Engineering – Acoustics, University of Texas at Austin (2014)

B.S., Physics, University of Minnesota – Twin Cities (2011)

PROFESSIONAL MEMBERSHIPS
Member of the Acoustical Society of America

Member of the Institute of Noise Control Engineering

RELEVANT EXPERIENCE

Otter Tail Power, *Astoria, SD*

Supported at various points through project life cycle, including CadnaA modeling during vendor selection and post-construction noise monitoring. Carried out noise monitoring during testing with unattended measurements lasting over one week. Correlated varying operating loads with sound levels, and established contribution of wind noise based on background measurements.
Role: Acoustician

ATCO Power, *Strathcona Cogeneration Plant, AB, Canada*

Created an acoustical model of a proposed 96 MW cogeneration plant. Modeled multiple modes of operation and recommended mitigation to meet project noise targets. Supported HRSG designers with acoustical consideration to meet required noise emissions.

Fluor, Multiple Combined Cycle Power Plant Bids, *PA*

Created acoustical models to determine noise impact of 2-on-1 and 3-on-1 combined cycle power plants in support of Fluor bids. Recommended mitigation including realignment of cooling tower located adjacent to the project boundary in order to reach project noise goals and keep a competitive bid.

AMP, Multiple Peaking Power Plants, *OH*

Created acoustical models for proposed peaking power plants in Ohio. Measured environmental noise in surrounding communities to establish baseline for noise increase. Compared noise impact and mitigation requirements for different engine suppliers to determine most cost-effective solution for minimizing noise impact.

AEP, Welsh Power Plant Environmental Retrofit, Pittsburg, *TX*

Performed operational measurements of Activated Carbon Injection and Pulse Jet Fabric Filter equipment at the coal-burning Welsh Power Plant. Determined on-site areas where 85 dBA was exceeded and performed 24-hour measurements at representative residences. Determined the presence of significant tonal noise at some far-field receptors was due to ID fan noise emanating from stacktop, and determined exact frequency peak for silencer design. Repeated far-field noise measurements after silencer retrofit and confirmed significant reduction of tonal noise.

Panda Sherman, Panda Sherman Power Project, *TX*

Made on-site measurements and created a noise map for a 2-on-1 combined cycle power plant showing all employee-accessible areas that exceeded 85 dBA sound pressure level in order to meet OSHA requirements.

AES, Escondido and El Cajon Battery Energy Storage Facilities, *San Diego County, CA*

Performed noise impact analyses for the world's largest lithium-ion battery energy storage facility – a 30 MW installation in Escondido, CA – as well as a smaller 7.5 MW installation in El Cajon. Made ambient noise measurements around project boundaries to establish existing noise levels. Created noise propagation models to determine the projected noise impact of the facilities' transformers and ventilation equipment. The facilities were projected to meet local requirements, and this was confirmed with operational noise measurements once the facilities were online.

Sempra, Apple Blossom Wind Farm, *Huron County, MI*

Prepared post-construction noise monitoring protocol. Performed continuous post-construction noise monitoring for over a week at 4 locations, including establishing background ambient levels during turbine outages. Processed collected data along with meteorological data and audio recordings in accordance with local regulations. Prepared a detailed written report. Defended findings at county planning board meeting.

Sempra, Black Oak Getty Wind Farm, *Stearns County, MN*

Performed continuous post-construction noise monitoring for 2 weeks at 5 locations. Processed collected data with meteorological data and audio recordings in accordance with local regulations to establish reasons for each hour in which exceedances were observed. Prepared a detailed written report.
Role: Acoustician

Alliant Energy, Bent Tree Wind Farm, *Freeborn County, MN*

Reviewed and re-processed post-construction noise measurement data collected by another consultant to investigate reasons for noise exceedances. Showed that the data was not conclusive due to unrepresentative meteorological conditions and incomplete audio data.

Tenaska, Nobles 2 Wind Farm, *Nobles County, MN*

Prepared post-construction noise monitoring protocol. Performed continuous post-construction noise monitoring for over two weeks, with remote monitoring via wireless modems. Determined remotely whether sufficient data was collected for compliance determination. Processed collected noise data with meteorological data and turbine operation data in accordance with Minnesota Public Utilities Commission guidance. Prepared a detailed written report demonstrating compliance with state regulations.

Robert M. Brenneman PE, INCE BD. CERT.

Senior Acoustician

Robert is a Senior Acoustician with 24 years of industry experience, and has expertise in all aspects of architectural acoustics, environmental acoustics, community noise control, and mechanical noise and vibration control. He has extensive experience measuring and modeling, using a variety of platforms. He is a registered Professional Engineer, and also certified by the Board of the Institute for Noise Control Engineering. Mr. Brenneman leads HDR's Advanced Acoustical Analytics practice.

EDUCATION
Bachelor of Science, Mechanical Engineering, Penn State University Park, 1998
Master of Engineering, Acoustics, Penn State University Park, 2023

REGISTRATIONS
Professional Engineer - Mechanical, Maryland, US, #31210, JAN-2023
Institute of Noise Control Engineers, US, #14001 - Board Certified, JAN-2027

PROFESSIONAL MEMBERSHIPS
Institute of Noise Control Engineering, Member, Board Certified, 2003-Present
Acoustic Society of America, Committee on Noise, Committee on Architectural Acoustics Member, 2007-Present

INDUSTRY TENURE
23 years

HDR TENURE
4 years

RELEVANT EXPERIENCE

OAKRIDGE COGENERATION POWER PLANT, *Cedar Rapids, IA*

Mr. Brenneman performed a comprehensive acoustical analysis combining environmental acoustics, architectural acoustics, and aspects of his mechanical engineering background to evaluate sound emission levels from the proposed new Oakridge Cogeneration Power Plant to surrounding industrial and residential areas. The sound study accounted for major and minor equipment sound sources, noise ordinance or project acoustical requirements, unmitigated and mitigated acoustic scenarios, proposed site conditions and building parameters, room acoustics and building shell noise reduction for interior equipment, environmental sound propagation over intervening terrain with atmospheric effects, and acoustical shielding and reflections from intervening structures.

New York City Dept. of Environmental Protection, *New York, NY*

HDR was retained by DEP to design for the upgrade of Mersereau Avenue and Richmond Avenue pumping stations. Mr. Brenneman performed comprehensive noise control analyses to achieve arduous, multi-faceted ordinance criteria. The studies included the noise emissions from pumps, fans, transformers, generators, and similar equipment located both outdoors and inside buildings, incorporating

ENGIE-OSU Smart Campus, Phase II, *Columbus, OH*
Mr. Brenneman conducted an environmental and architectural acoustical analysis for a proposed combined cycle power plant, determining sound transmission from gas turbines and related equipment at nearby noise-sensitive areas. In addition to the important aspects of sound propagation, the analysis accounted for the noise attenuation effects of enclosures and rooftop parapets, where applicable.

Southern Star Tougaloo Compression Station, *Grant County, OK*
HDR was retained by Southern Star for environmental services related to the FERC Prior Notice Application for the installation of a new compressor station along Southern Star's TL Line natural gas pipeline. Mr. Brenneman performed an acoustical analysis to identify noise levels at nearby residents from the proposed facility. A noise-mitigation scenario was also included.

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Adam Buck

Acoustician

Adam specializes in architectural and environmental acoustics. He has measured and modeled environmental noise for a wide variety of projects, including roadway, transit, rail, power generation, mining, and construction. He has also consulted in the areas of noise control, sound isolation, and room acoustics, with experience in health, workplace, education, fitness, and power generation buildings.

EDUCATION
Master of Architectural Engineering, University of Nebraska, Lincoln, 2013

Bachelor of Science, Architectural Engineering, University of Nebraska, Omaha, 2012

REGISTRATIONS
Engineering Intern, Nebraska, United States

PROFESSIONAL MEMBERSHIPS
Acoustical Society of America, 2014-Present

Institute of Noise Control Engineering, 2014-Present

INDUSTRY TENURE
9 years

HDR TENURE
9 years

OFFICE LOCATION
Minneapolis, MN

PUBLICATIONS

Presentations

Adam T. Buck, "Studying the sound produced by centerline rumble strips", Transportation-Related Noise and Vibration 2014 Summer Meeting, Portsmouth, New Hampshire, 2014

RELEVANT EXPERIENCE

Alamo Solar Engineer of Record, *CA*

Alamo Solar Facility is a 20MW power generating plant on roughly 125 acres of land. HDR's scope of work on the project included multi-disciplined design for the facility, and construction inspection of the testing and commissioning of the solar generating facility. HDR modeled noise emissions from inverters and transformers to evaluate compliance with residential noise limits. Adam modeled project noise using the 3D environmental noise software Cadna-A, and produced noise contour mapping.

Ecosphere BHP Coal Noise, *San Juan County, NM*

HDR conducted noise source measurements at Navajo Mine and modeled noise from the mining activities to refine a previous HDR noise and vibration study. Adam performed the noise source measurements, modeled mining activities using the 3D environmental noise software Cadna-A, and prepared a technical report.

Hampton Roads Transit Virginia Beach Transit Extension Study (VBTES), *Virginia Beach, VA*

HRT conducted the Virginia Beach Transit Extension Study (VBTES) to examine the best transit options available for a former freight rail right of way in Virginia Beach. HDR evaluated the potential for noise and vibration impacts from operations and construction using the impact assessment methods of the Federal Transit Administration (FTA). Adam performed the FTA general noise and vibration impact assessments. As part of these assessments, he performed 24-hour existing condition residential noise measurements.

NTE Energy Kings Mountain Energy Center, *Kings Mountain, NC*

NTE Energy is proposing to construct a new combined cycle combustion

turbine electric generation facility. The proposed facility has a nominal generation capacity of approximately 475 MW and an expected service life of 40 years. HDR performed a noise study for the proposed project. Adam measured existing noise levels for 24 hours at two locations in the area of the proposed site. He modeled the proposed generation facility using the 3D environmental noise software Cadna-A and evaluated the potential for noise impacts at nearby residences.

Prairie Rose Wind, LLC, Prairie Rose Wind Post-Construction Noise, *MN*

Post-construction noise measurements for the Prairie Rose Wind Farm based on the Guidance for Large Wind Energy Conversion System Noise Study Protocol and Report (MN DOC). Also included a task to update the post-construction noise measurement methodology prepared for the Prairie Rose Wind Farm located in Rock County, MN. Adam helped perform the seven-day noise measurements, summarized the measurement data, and prepared a post-construction noise measurement report.

Sempra Black Oak Getty, *MN*

Black Oak Wind LLC constructed the Black Oak Getty Wind Farm, which operates 39 Vestas V110 2.0 MW wind turbines. HDR modeled operational noise emissions from the wind turbines to evaluate compliance with Minnesota Pollution Control Agency (MPCA) noise standards at nearby noise-sensitive receptors. HDR measured preconstruction noise levels throughout the project area over a seven-day period. HDR also measured post-construction noise levels throughout the project area over a 14-day period to evaluate MPCA compliance. Adam updated the Cadna-A environmental noise model for operational noise, performed the preconstruction noise measurements, and summarized the measurement data. Adam also performed the post-construction noise measurements.

Simon Solar 40 MW PV Facility

HDR completed feasibility assessment services for a 40 MW PV facility in a confidential location. HDR provided civil, structural, and substation/interconnection electrical design services for the PV facility construction. HDR also provided support services during construction for environmental and SWPPP requirements. HDR performed source noise measurements of the on-site inverters and transformers, and then modeled mitigation options to reduce noise emissions to nearby residences. Adam evaluated various noise barrier configurations to reduce inverter noise using the 3D environmental noise software Cadna-A.

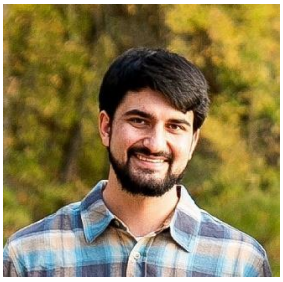
WPL New Resource Planning - Feasibility Study, *Beloit, WI*

The objective of the Generation Alternatives Feasibility study was to support future Wisconsin Power and Light (WPL) New Resource Planning team efforts and eventual Certificate of Authority (COA) submittal to the Public Service Commission (PSC) of Wisconsin related to future generation

additions in WPL's service territory. HDR followed PSC protocols to study noise for a proposed combined cycle facility. HDR measured existing noise levels in the area of two proposed site alternatives, which consisted of 24-hour measurements at eight locations. HDR modeled operational facility noise for both site alternatives and evaluated the potential for noise impacts. Adam performed the existing noise measurements, modeled operational noise using the 3D environmental noise software Cadna-A, drafted a noise study report, and drafted noise text for the Application for Certificate of Public Convenience and Necessity (CPCN).

Xcel Adams Substation Noise, *Adams, MN*

Xcel Energy operates the Adams Substation, which is located east of Adams, Minnesota, along State Highway 56. A nearby resident expressed concerns regarding noise emissions from the substation. HDR visited the substation to evaluate the site and measure noise emissions from four reactors and a transformer. Adam visited the site, performed source noise measurements, and measured noise levels at the nearest residence under different substation operating conditions. He prepared a memo of the findings, which included a discussion of possible mitigation measures.



Patrick Buffington

Noise Specialist

Patrick is a noise specialist with 4 years of experience providing environmental support for energy and other industrial clients. Patrick's experience includes evaluating project applicability to federal, state, and local noise regulations and authoring the noise section of Resource Report 9 as a part of Federal Energy Regulatory Commission (FERC) licensing applications. He has been responsible for participating in and coordinating field efforts for ambient and post-construction noise monitoring, as well as leading noise modeling efforts evaluating the noise impact of proposed project horizontal directional drill (HDD) activities and operational facilities at nearby noise sensitive areas (NSAs).

EDUCATION

Bachelor of Civil Engineering, University of Minnesota – Twin Cities, 2018

Bachelor of Environmental Engineering, University of Minnesota – Twin Cities 2018

REGISTRATIONS

Engineer-in-Training

RELEVANT EXPERIENCE

WBI Energy, North Bakken Expansion Project, *ND*

Provided support for proposed natural gas pipeline in Williams and McKenzie Counties in North Dakota. The project included the installation of a new pipeline, construction of a new compressor station, installation of additional compression equipment at an existing compressor station, and a 2.5-mile directional drill. Measured ambient sound levels at NSAs nearby the compressor stations and HDD entry sites to characterize existing noise environment. Modeled operation of compressor stations and HDD activities to determine impact of project on NSAs and ensure compliance with FERC requirements. Proposed mitigation options necessary to meet FERC nighttime noise limits for HDD work. Lead author of noise portion of Resource Report 9. Also responsible for coordinating field efforts for post-construction noise surveys at compressor stations following project completion and authoring the noise study report.
Role: Noise Specialist

WBI Energy, Wahpeton Expansion Project, *ND*

Provided support for proposed natural gas pipeline in Cass and Richland Counties in North Dakota. The project included the installation of a new pipeline, construction of a new compressor station and several meter stations, and the modification of an existing compressor station to connect to the new line. Reviewed aerial imagery to identify NSAs near proposed project facilities, and applicability of local noise regulations. Evaluated equipment design for meter stations to determine required extent of noise impact analysis. Responsible for writing noise portion of Resource Report 9.
Role: Noise Specialist

Freeport LNG, Post-Startup Noise Survey, *TX*
Provided support for recently constructed natural gas liquefaction facility in Freeport, Texas. Project involved compliance testing for a three-train natural gas liquefaction facility following completion of construction and commissioning. Measured noise levels during facility operation following commissioning of first two trains at the noise source and at NSAs to characterize noise emitted by the facility. Coordinated field efforts for monitoring noise levels following commissioning of third train the following year. Modeled attenuation of facility operational noise to determine impact on NSAs and determine compliance with FERC limits. Prepared noise study report demonstrating compliance for filing to FERC.
Role: Noise Specialist

New Fortress Energy, Post-Startup Noise Survey, *PR*
Provided support for recently constructed liquefied natural gas (LNG) terminal in San Juan, Puerto Rico. Project involved compliance testing for facility operations following completion of construction and commissioning. Measured noise levels at facility noise-generating equipment including vaporizers, compressors, vessel loading, flares, and air compressors, as well as noise levels at selected NSAs deemed to be representative of sensitive neighborhoods surrounding the facility. Modeled noise levels from facility operation using measured facility data to assess potential impact at NSAs and produced report presenting findings.
Role: Noise Specialist

ExxonMobil, Gas-to-Energy Project, *Guyana*
Provided support for proposed natural gas pipeline and processing plant in West Bank Demerara, Guyana. Project involved preparation of Environmental Impact Assessment (EIA) for submittal to the Environmental Protection Agency (EPA). Trained local subcontractors to handle sound level meters to monitor ambient noise levels at NSAs near project footprint. Used equipment information provided by design contractor to model noise impact of normal and maximum facility operation on NSAs.
Role: Noise Specialist

Enbridge, Complaint Response Noise Surveys, *OH, PA*
Provided support for existing meter and regulator stations along natural gas pipeline in Ohio and Pennsylvania. Project involved three facilities that received noise complaints from nearby residents. Trained local staff to handle sound level meters to monitor noise levels at NSAs and near facility valves determined to be source of unwanted noise. Used facility noise level data to model impact of facility operation on NSAs and, in conjunction with NSA measurements, evaluated compliance with noise regulations. Provided noise mitigation recommendations to lower noise impacts at NSAs to reduce likelihood of future complaints.
Role: Noise Specialist

Russellville Solar LLC, Logan County Solar Project, *KY*

Provided support for proposed solar power installation in Kentucky. The project included provided responses to comments from the Kentucky Siting Board regarding project-related noise. Reviewed aerial imagery to identify noise-sensitive receptors, estimated existing noise levels at and around the project site based on proximity to major roads and railroads, and calculated pile-driving noise estimates at nearby receptors. Responsible for drafting responses to Siting Board questions.
Role: Noise Specialist

Alliant Energy, Creston Solar Project, IA

Provided support for proposed solar power installation in Iowa. The project included the installation of a 50 MW solar array near a small town. Reviewed state, county, and local regulations to determine noise limitations for the project, and modeled inverter noise levels at 24 residences surrounding the project. Created a map of allowable inverter locations to comply with project noise criteria.
Role: Noise Specialist

Clearway Energy, Mount Storm (NedPower) Project, *WV*

Provided support for proposed wind turbine installation project in West Virginia. Project involved acquisition of existing wind farm and proposed replacement of existing turbines with new models with higher power output. Modeled noise levels at NSAs within 1 mile of project footprint for existing and proposed layouts and produced noise contour maps in accordance with West Virginia Public Service Commission (PSC) requirements. Produced PowerPoint presentation of model results for client presentation to PSC.
Role: Noise Specialist

The Danone Company, Noise Complaint Response, *OH*

Provided support for operating manufacturing facility in Minster, Ohio. Project involved facility response to nearby residents' complaints of backup alarm noise originating from facility loading dock area. Trained local staff to handle sound level meters to monitor noise levels at NSAs and to assess noise levels at noise source of two backup alarm types, broadband (white noise) and tonal (standard). Modeled noise levels of area surrounding facility for existing conditions and four mitigation options. Provided client with cost estimates and noise contour maps for each mitigation for aid in selection.
Role: Noise Specialist

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