at residential structures (or places in which quiet is a basis for use)[28]. This guidance recommends that noises at residences be limited to 55 dBA L_{dn}, where L_{dn} is the average sound level of a 24-hour period with the inclusion of a 10-dB penalty during the nighttime hours of 10PM to 7AM. So, the 55 dBA L_{dn} limit could be met with 55 dBA daytime noise and 45 dBA nighttime noise, or a 24-hour noise (L_{eq}) of 48.6 dBA. In addition to the EPA guidance, the United Nations WHO published "Guidelines for Community Noise" (1999) which suggested daytime and nighttime protective noise levels, which are to be applied outside the bedroom window.[29] During the day (7AM to 11PM), the equivalent continuous sound level threshold to protect against serious annoyance is 55 dBA L_{eq}, and 50 dBA L_{eq} to protect against moderate annoyance. During the night (11PM to 7AM), the averaged equivalent continuous sound level threshold is 45 dBA L_{eq}. So, the EPA and the WHO recommend similar daytime noise limits (~55 to 48.6 dBA and 55 to 50 dBA, respectively), and similar nighttime limits as well (~45 to 48.6 dBA and 45 dBA, respectively). Without local noise regulations or recommendations, these recommended noise limits from EPA and WHO provide well-established criteria for acceptable noise in rural residential areas.

At this stage of project development, the final site plan package can be used to conduct a preliminary screening level noise impact assessment. Available sound power data from representative equipment is used in this assessment, so the installed equipment could have somewhat different noise generation, but the difference is expected to be insignificant. The loudest piece of equipment is the inverter, which is planned to be a 2 to 4 MW central model, and this assessment used sound data from one of the most common central inverters on the market today, with a capacity of 3.6 MW. Generally, the difference in sound from different transformers of a similar capacity is minimal, so like the inverter, the representative sound data for the substation transformer is expected to be very similar to the equipment installed at Morven Solar. The third and final component that makes some noise is the motor in the tracker system, which is often located in the center of some rows of solar panels. There is a wide variety of tracker system systems with varying numbers, sizes, and styles of motors. Due to the uncertainty about the tracker that will be installed, a very conservative sound power level is used for the tracker motors in this assessment. The ISU transformers located with each inverter also makes some noise but is significantly quieter than the inverter, so it has negligible impact on the sound level heard some distance from the inverter/transformer pair, so for simplicity the ISU transformers are not included in this screening level noise impact assessment.

The following analysis starts with the sound power level of the equipment, which is measured in decibels but is different than sound pressure level, which is also measured in decibels and is used to describe how loud a sound is to humans. The sound power level of the equipment is a measure of the total acoustic energy emitted from a source of noise. The sound power level value and the distance between the equipment and the person is all that is needed to calculate the loudness of the sound in the person's ears, which is the sound pressure level. The sound power levels of representative equipment are as follows[30]: 3.6MW inverter: 101 dBA, substation transformer: 88 dBA, and tracker motors: 90 dBA. The distance used in this sound assessment is an estimation of the closest distance between the equipment and a residence, which will provide an estimation of the worst-case noise at the homes closest to the project. The 500-ft residential equipment setback distance is used as a conservative distance for the inverters and the tracker motors, although most are likely to be significantly further from the closest residence. The substation transformer is located in the substation, which is much further from the closest residence, at least 1,500 feet. The sound pressure level (in dBA) can be calculated from the sound power level (in dBA) and the distance from the source as follows:

- Sound pressure level = sound power level – 20 x log (distance in feet)
    - Inverters: 101 dBA – 20 x log (500 feet) = 47.0 dBA
    - Substation transformer: 88 dBA – 20 x log (1,500 feet) = 24.5 dBA
    - Tracker motors: 90 dBA – 20 x log (500 feet) = 36.0 dBA

All three of these worst-case sound estimates meet the EPA and WHO recommended guidelines for daytime noise in a residential setting, which is the only time the inverters and tracker motors are expected to make any noise. It is important to

[28] US Environmental Protection Agency (EPA), "Information on Levels of Environmental Loise Requisite to Protect Public Health and Welfare With An Adequate Margin of Safety", 1974, https://nepis.epa.gov/Exe/ZyPDF.cgi/2000L3LN.PDF?Dockey=2000L3LN.PDF
[29] World Health Organization (WHO), "Guidelines for Community Noise", 1999, https://apps.who.int/iris/handle/10665/66217
[30] Inverter and substation transformer sound data provided in *Speedway Solar Sound Study Report*, Revision 1 dated 10/29/2020. Produced by Burns McDonnell for Duke Energy project in Cabarrus County, NC. Tracker motor data and inverter data provided in Kaliski, et. al. Noise-Con 2020 Conference paper titled "An Overview of Sound From Commercial Photovoltaic Facilities", https://rsginc.com/wp-content/uploads/2021/04/Kaliski-et-al-2020-An-overview-of-sound-from-commercial-photovolteic-facilities.pdf