Wilmington Riverfront Transportation Infrastructure Project
Draft Environmental Assessment
Appendix D: Draft Noise Technical Report

March 29, 2024

U.S. Department of Transportation
Federal Highway Administration

Table of Contents

Appendices

List of Tables

List of Figures

List of Acronyms

CFR – Code of Federal Regulations

CNE – Common Noise Environment

dBA – A-weighted decibels

DelDOT – Delaware Department of Transportation

EA – Environmental Assessment

FEMA – Federal Emergency Management Agency

FHWA – Federal Highway Administration

Leq – Equivalent Sound Level

Leq(h) – Hourly value of Leq

L10(h) – The A-weighted noise level that is exceeded 10% of the time

LOS – Level of Service

NAC – Noise Abatement Criteria

NEPA – National Environmental Policy Act

RAISE – Rebuilding American Infrastructure with Sustainability and Equity

RDC – Riverfront Development Corporation

TNM – Traffic Noise Model

I. Introduction

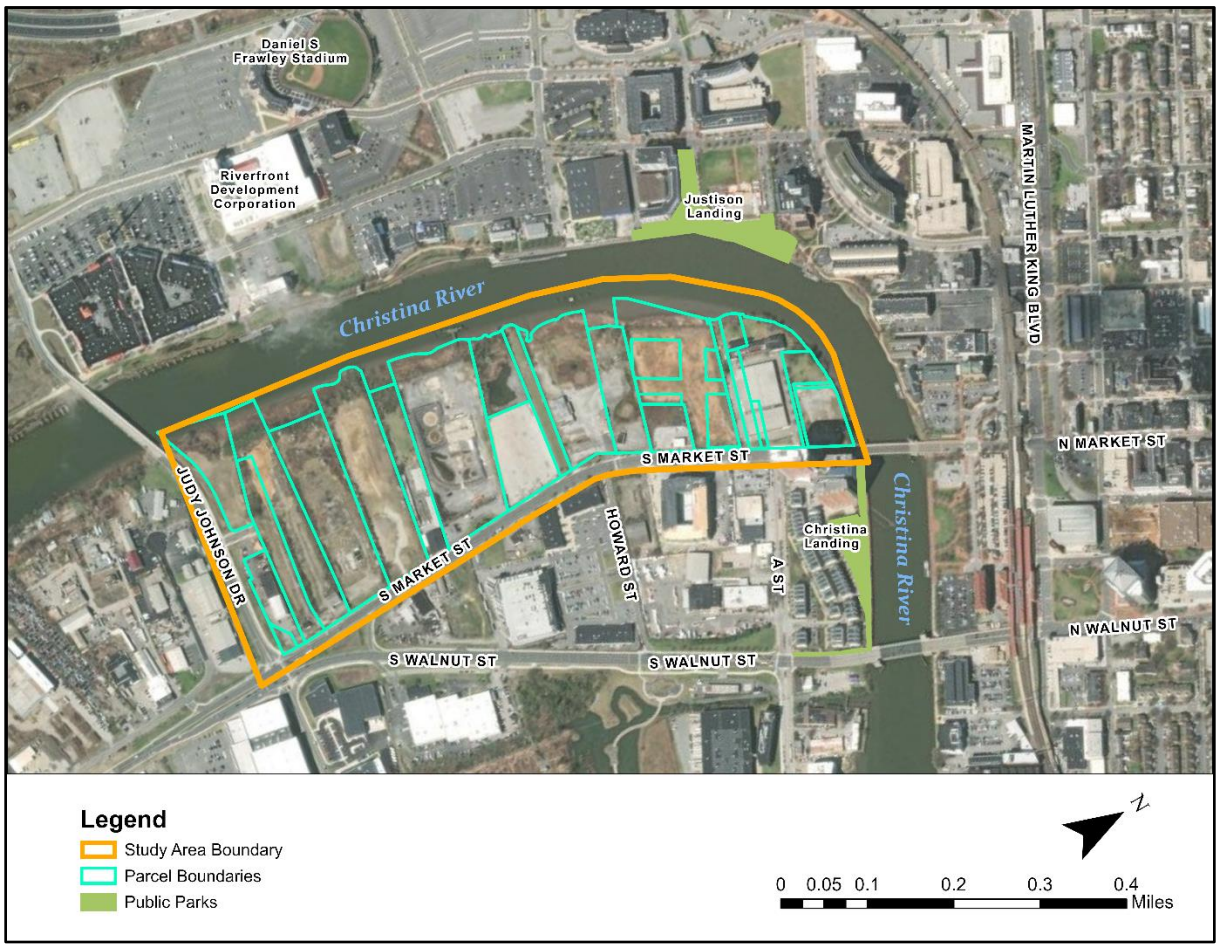
On November 19, 2021, the City of Wilmington, Delaware, was awarded federal funds though a U.S. Department of Transportation FY 2021 Rebuilding American Infrastructure with Sustainability and Equity (RAISE) grant. The Federal Highway Administration (FHWA), as the lead Federal Agency; the City of Wilmington, as project sponsor and joint lead agency; and in partnership with the Riverfront Development Corporation (RDC), are preparing an Environmental Assessment (EA) for the Wilmington Riverfront Transportation Infrastructure Project (formerly known as the South Market Street Redevelopment Project) in accordance with the requirements of the National Environmental Policy Act of 1969 (NEPA), the Council on Environmental Quality (CEQ) regulations implementing NEPA, FHWA regulations implementing NEPA, and applicable Federal, state, and local laws and regulations.

The Noise Technical Report was developed to support the Draft EA for the Wilmington Riverfront Transportation Infrastructure Project (Project). The following technical report presents the existing conditions and an assessment of potential effects of the Build Alternatives. The report begins with a description of the Project study area followed by a summary of the Purpose and Need, and a description of the alternatives evaluated.

A. Study Area

The Project is located along the East Christina riverbank in Wilmington, New Castle County, Delaware. The Project's study area is bound by the Christina River on the north and west and by South Market Street on the east and by Judy Johnson Drive (formerly New Sweden Street) in the south (**Figure 1**).

Figure 1: Wilmington Riverfront Transportation Infrastructure Project Study Area Map



The existing conditions of the Project study area include former industrial buildings and accessory structures, surface parking, former junkyards, miscellaneous uses, and brownfields. This area has been shaped by its history of shipping and manufacturing and was an active industrial area until its decline after World War II. The *City of Wilmington's 2028 Comprehensive Plan*[1]defines the land use in the Project study area as waterfront mixed use and the entire Project study area is within the 100-year floodplain caused by coastal storm surge from the Delaware Bay. The parcels located within the Project study area have limited access for vehicles, pedestrians, and bicycles.

The Christina riverbank on the western and northern boundary of the Project study area is marshy and largely inaccessible. Significant differences of elevation between the high and low tide conditions have created a mud flat condition along the northern and western edges of the Project study area. South Market Street, the eastern project border, is a one-way, four-lane arterial road that extends 0.57 mile along the study area.

[1] https://www.wilmingtonde.gov/government/city-departments/planning-and-development/wilmington-2028

The purpose of the Project is to provide transportation infrastructure to further the connectivity of the riverfront area and provide multi-modal resources. The needs of the project are the following:

- An expanded road network branching from South Market Street west into the Project study area;
- Pedestrian and cyclist accommodation on new roadways and a new set of pedestrian and bicycle pathways that connect to the existing network of pathways surrounding the site along the Christina riverbank; and
- Rehabilitate and create effective stormwater management.

The proposed improvements would replicate the city grid characteristics of the North Market Street corridor, north of the Christina River and southward to the intersection of South Market Street and Judy Johnson Drive.

B. Alternatives Considered

The alternatives considered in the EA include a No Build and a Build Alternative and are briefly described below.

1. No Build Alternative

The No Build Alternative assumes the roadway infrastructure; Riverwalk; pedestrian, bicycle and mobility improvements; flood prevention measures; and drainage work would not occur. The No Build Alternative does not meet the purpose and need for this Project, as it would not provide transportation infrastructure to further the connectivity of the area; provide multi-modal resources, including pedestrian and cyclist accommodations; nor rehabilitate or create effective stormwater management. However, the No Build Alternative does provide a baseline condition with which to compare to the Build Alternative. Therefore, the No Build Alternative is retained for evaluation purposes.

2. Build Alternative

The Build Alternative proposes to construct transportation infrastructure improvements for the South Market Street Riverfront East area of the City. The Build Alternative proposes an expanded road network branching from South Market Street, towards the Christina River and replicating the downtown Wilmington grid system in the Project study area (**Figure 2**). Infrastructure improvements are proposed to create continuity of intersection type / spacing and provide key points of access into the Project study area.

The proposed street grid is a balance of defining buildable parcels as well as appropriate infrastructure access for vehicles (local, commuter, public transportation), pedestrians, and bicyclists and will include on street parking. The proposed grid considers major circulation movements, creating three east-west and evenly spaced signalized movements across South Market Street, and connecting the major north-south Market Street and Walnut Street corridors to Orange Street within the limits of the Project study area (from north to south: at A Street, Howard Street, and Jones Street).

Pedestrian routes were also considered while laying out the proposed grid. The Build Alternative proposes to include pedestrian and cyclist accommodations on new roadways and a new set of pedestrian and bicycle pathways that connect to the existing network of pathways surrounding the Project study area (shown in orange in **Figure 2**). The proposed location of the east-west movements at A Street and Howard Street provides direct pedestrian access to and from the South Market Street Bridge, the Walnut Street corridor, the Wilmington Wetland Park, and the Southbridge neighborhood located east of the proposed

Project study area. At the south end of the Project study area, proposed pedestrian and bicycle connections from the proposed street grid connect directly to existing pedestrian and bicycle connections that currently cross the river to the western Riverfront via Judy Johnson Drive and the Senator Margaret Rose Henry Bridge.

Adjacent to the eastern riverbank, a Riverwalk similar to the existing Riverwalk on the western riverbank is proposed to be built as part of the Build Alternative to provide access to this currently inaccessible riverfront. The Riverwalk would be a minimum width of 18 feet and include a dedicated eight-foot bike lane alongside a pedestrian walkway. Under the Build Alternative, connections between the east and west Riverwalks are proposed via the existing Senator Margaret Henry Rose Bridge to the south and the South Market Street bridge to the north.

Under the Build Alternative, the proposed in-water work would include repairing the existing bulkhead which is in current disrepair. The Build Alternative proposes to construct a new bulkhead in front of the existing bulkhead. The new bulkhead would be a higher elevation to allow the new Riverwalk to be constructed at a minimum of 18 inches above the 100-year flood elevation. The tidal influence of the river exposes mud flats in front of the existing bulkhead during the tide cycles. The new bulkhead would be constructed from the landside of the existing bulkhead.

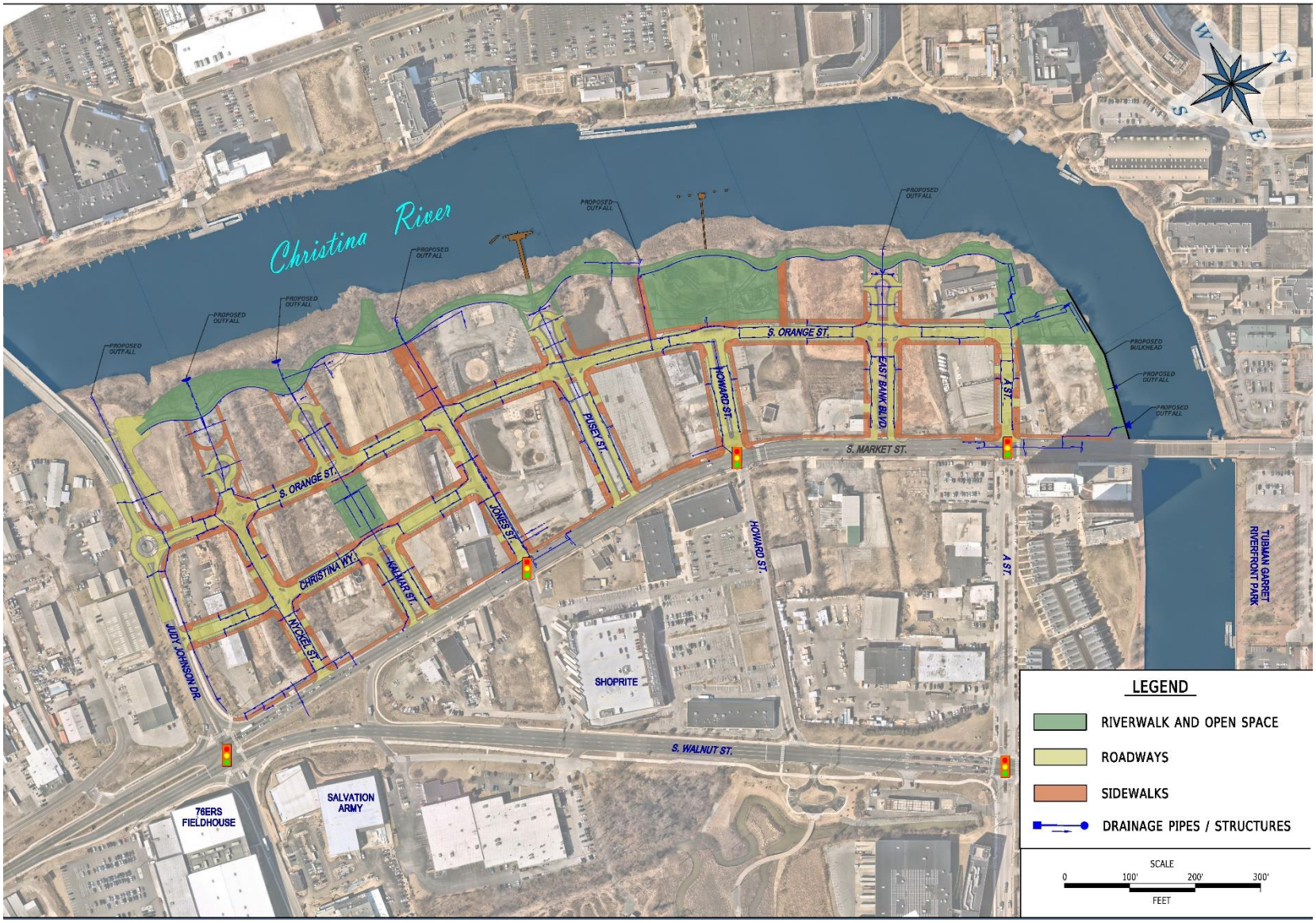
The transportation infrastructure improvements under the Build Alternative also incorporate strategic resiliency solutions to environmental challenges currently faced by the site. The Project Study Area is expected to be entirely inundated in the case of a 100-year flood event under its current condition. The Build Alternative proposes to elevate the transportation elements in compliance with the Federal Emergency Management Agency (FEMA) Floodplain Regulations to protect the site from inundation and flood-related damage. While the existing South Market Street roadway would remain at its existing elevation below the 100-year flood event, all other proposed roads would be constructed at elevations above the 100-year flood event except where they would connect to existing streets at lower elevations. Additionally, proposed sidewalks and the Riverwalk would also be at elevations above the 100-year flood event. These Project elements are aligned with the City of Wilmington's strategies to harden infrastructure vulnerable to sea level rise and extreme weather events.

In addition to raising the elevation of the site, it is anticipated that the Project study area would need a two-foot clean cap over contaminated soils, prior to the infrastructure improvements, to prevent contaminated soil erosion and human contact. The soils and groundwater are contaminated; these contaminants have also been found in sediment and surface water along the bank of the Christina River. Multiple Brownfield Redevelopment Agreements and remedial action plans for the Project study area are under development between the City, the RDC, the U.S. Environmental Protection Agency (EPA), and the Delaware Department of Natural Resources and Environmental Control (DNREC), and existing remediation agreements will be followed accordingly.

Currently, the Project study area has 23.3 acres of impervious area. As part of the Build Alternative, existing impervious surface would be removed accordingly. The proposed transportation improvements would reduce impervious area to 18.6 acres (a decrease by 4.7 acres). The Build Alternative proposes to add drainage outfalls to support the proposed transportation infrastructure. The outfalls would be strategically located throughout the Project study area to address ongoing drainage issues and provide adequate conveyance for the proposed transportation infrastructure. All proposed outfalls would be designed to discharge above Mean Low Water elevation of the Christina River at higher elevations than

existing outfalls. In addition to the higher outfall elevation, there would be tide control valves installed at each outfall to eliminate the backup of the tidal water during the tidal fluctuations. The proposed storm drain and trench drain systems would be designed to provide efficient collection of surface runoff and adequate conveyance of stormwater throughout the Project study area. The separation of storm drain networks and proposed construction of new outfalls would provide an overall improvement to the current drainage conditions to the tidally influenced Christina River throughout the Project study area.

Figure 2: Build Alternative Site Plan



II. Noise Analysis

NEPA provided broad authority and responsibility to Federal agencies for evaluating and mitigating adverse environmental effects, including highway traffic. As such, any project that receives Federal funding or requires a federal action, requires environmental studies, including noise assessment. The Project will receive Federal funding. Therefore, this technical report details the evaluation of potential noise impacts that would result from the proposed improvements to South Market Street and the street network grid system west toward the east bank of the Christina River, in the Project area.

Federal requirements for completing a highway noise analysis are established in Title 23 of the Code of Federal Regulations (CFR) 772, *Procedures for Abatement of Highway Traffic Noise and Construction Noise*. Highway traffic noise studies, noise abatement procedures, coordination requirements and design noise levels in CFR 772 constitute the noise standards mandated by 23 U.S.C. 109(i). The City of Wilmington does not have a transportation noise policy that is in conformance with 23 CFR 772; therefore, the March 2021 Delaware Department of Transportation's (DelDOT) Noise Policy, which has been approved by FHWA, was utilized for this noise analysis.

Under the current version of 23 CFR 772.5, projects are categorized as Type I, Type II, or Type III projects. The construction of a highway/roadway on a new location triggers a Type I noise analysis. An overview of noise/activity relationships is provided herein. This report summarizes the 2022 Existing noise conditions as well as predicted noise levels for 2040 design year Build condition. Impacts to noise sensitive receptors are identified and potential abatement for impacts is examined.

A. Criteria for Determining Noise Impacts

To describe noise environments and to assess impact on noise sensitive areas, a frequency weighing measure that simulates human subjective response to noise is typically used. A weighted measure of noise sources which reflect the human ear's reduced sensitivity to low frequencies have been found to positively correlate with human perceptions of the annoying aspects of noise, particularly from traffic noise sources. A weighted noise levels, described in decibels A (dBA), are the values cited by FHWA in its Noise Abatement Criteria. Typical levels are shown below.

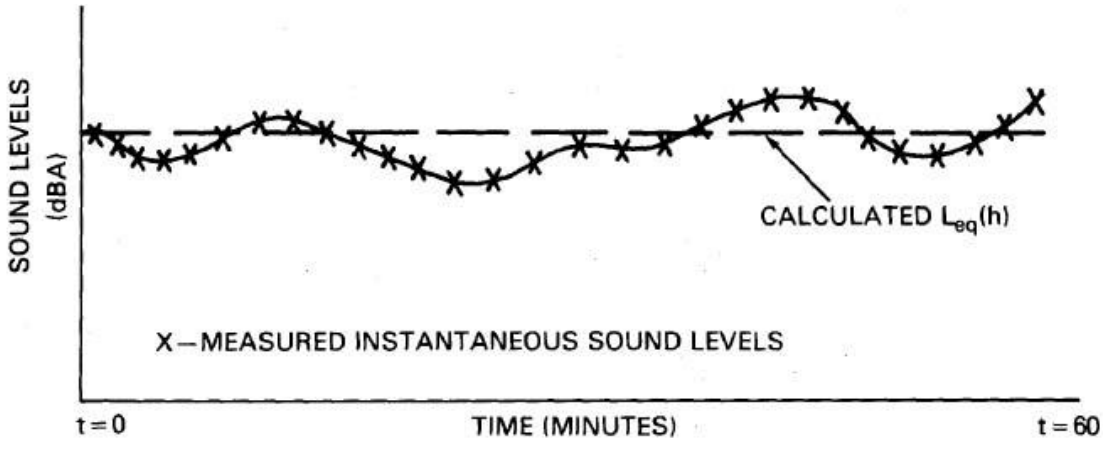
Common Outdoor and Indoor Noise Levels

Common Outdoor Noise Example	Noise Level (dBA)	Common Indoor Noise Example
	110	Rock Band
Jet Flyover at 1,000 feet	100	Inside Subway Train
Gas Lawn Mower at 3 feet		
Diesel Truck at 50 feet	90	Food Blender at 3 feet
Noisy Urban Daytime	80	Garbage Disposal at 3 feet, Shouting at 3 feet
Gas Lawn Mower at 100 feet	70	Vacuum Cleaner at 10 feet
Commercial Area		Normal Speech at 3 feet
	60	
		Large Business Office
Quiet Urban Daytime	50	Dishwasher, Next Room
Quiet Urban Nighttime	40	Small Theater, Large Conference Room (background)
Quiet Suburban Nighttime		Library
	30	
Quiet Rural Nighttime		Bedroom at Night, Concert Hall (background)
	20	
		Broadcast and Recording Studio
	10	Threshold of Hearing
	0	

Adapted from Guide on Evaluation and Attenuation of Traffic Noise. AASHTO. 1974

Most environmental noise fluctuates from moment to moment. To correlate noise environments with community annoyance, a single-number noise descriptor called the equivalent sound level (L_{eq}), which characterizes the fluctuating sound, is commonly used. The L_{eq} is the value or level of a steady, non-fluctuating sound that represents the same amount of acoustical energy over the same period of time. For traffic noise assessment, L_{eq} is typically evaluated over a one-hour period, $L_{eq}(h)$, an example of which is illustrated below.

Sound Level Versus Time



Source: http://www.fhwa.dot.gov/environment/noise/construction_noise/special_report/hcn02.cfm

DelDOT's Noise Policy was approved by the FHWA on July 16, 2011 and was most recently updated on March 1, 2021. DelDOT policy states that a traffic noise analysis must be completed for each category of land use shown in the current 23 CFR Part 772 Noise Abatement Criteria, included herein as **Table 1**. Category F is an exception, for there are no impact criteria and no required noise analysis for this land use. Category D would be initiated only for certain cases after completion of analysis for outdoor activity areas or determination that exterior abatement is not feasible or reasonable. No Category D areas are present within the Project study area. For Category G, abatement is not required under 23 CFR 772; however, highway traffic predicted noise levels must be documented and provided to local officials under the revised policy.

The design noise levels indicated in **Table 1** were used to determine highway traffic noise impacts and the need for considering abatement measures. For the Project study area, noise-sensitive land use potentially affected by the proposed improvements are in activity Categories B and C, for which the 67 dBA (exterior) Noise Abatement Criteria (NAC) noise level is applicable for residential and recreational areas with outdoor activities. When the predicted design-year Build Alternative noise levels in the Project study area approach or exceed the NAC, noise impact occurs and requires the consideration of abatement to reduce traffic noise.

Table 1: Noise Abatement Criteria

Activity Category	Activity Criteria		Evaluation Location	Activity Description
	Leq(h)	L10(h)		
A	57	60	Exterior	Lands on which serenity and quiet are of extraordinary significance and serve an important public need and where the preservation of those qualities is essential if the area is to continue to serve its intended purpose.
B	67	70	Exterior	Residential.
C	67	70	Exterior	Active sport areas, amphitheaters, auditoriums, campgrounds, cemeteries, day care centers, hospitals, libraries, medical facilities, parks, picnic areas, places of worship, playgrounds, public meeting rooms, public or nonprofit institutional structures, radio studios, recording studios, recreation areas, Section 4(f) sites, schools, television studios, trails, and trail crossings.
D	52	55	Interior	Auditoriums, day care centers, hospitals, libraries, medical facilities, places of worship, public meeting rooms, public or nonprofit institutional structures, radio studios, recording studios, schools, and television studios.
E	72	75	Exterior	Hotels, motels, offices, restaurants/bars, and other developed lands, properties or activities not included in A-D or F.
F	-	-	-	Agriculture, airports, bus yards, emergency services, industrial, logging, maintenance facilities, manufacturing, mining, rail yards, retail facilities, shipyards, utilities (water resources, water treatment, electrical), and warehousing.
G	-	-	-	Undeveloped lands that are not permitted.

1. The Leq(h) and L10(h) Activity Criteria values are for impact determination only and are not design standards for noise abatement measures.
2. While most DOTs rely on the Leq(h) metric for traffic noise assessment, FHWA also allows the use of L10(h) metric. DelDOT uses only the Leq(h) metric for traffic noise studies.

Source: 23 CFR Part 772 Noise Abatement Criteria

Criteria adopted by DelDOT for the determination of an impacted receptor under the State Noise Abatement Policy are summarized as follows:

- Loudest hour Leq A-weighted noise levels.
- Design year noise levels approach or exceed the NAC levels.
- Design year noise levels substantially exceed existing noise levels (12 dBA or more).

Under section 772.11 of 23 CFR, highway agencies are to establish an “approach” level to be used when determining a traffic noise impact. DelDOT policy sets the approach level to be 1 dBA less than the NAC level. For Categories B and C land uses, this level would be 66 dBA.

B. Analysis Procedures and Methodology

This analysis was conducted in accordance with recommended standard procedures, including those outlined in the FHWA's Noise Measurement Handbook (Report No. FHWA-HEP-18-065, June 2018)[2] and the current DelDOT noise policy. The analysis began with the determination of existing noise levels along the Project study area in order to assess the traffic noise contributions on the adjacent noise sensitive areas. Future proposed design year 2040 noise calculations and predictions were performed using FHWA-approved methods. The noise predictions were performed with the FHWA Traffic Noise Model (TNM) version 2.5 (FHWA-PD-96-009)[3]. The model incorporates vehicle noise emission levels updated for modern vehicle classification, traffic speed and traffic volume, sound propagation factors from atmospheric absorption, divergence, intervening ground, intervening barriers, and intervening rows of buildings and areas of heavy vegetation.

C. Existing Noise Levels

To determine the existing noise characteristics within the Project study area, ambient noise measurements must first be recorded. Short-term ambient noise measurements of 30-minutes duration were acquired on June 1, 2022, at two locations as detailed in **Table 2** and shown in **Appendix B**. The two locations were areas of frequent human use and were conducted during period of free-flowing traffic, dry roadways, and low to moderate wind speeds (less than 12 miles per hour (mph) to avoid extraneous wind noise).

Two noise monitors were placed at Christina Landing during sustained but non-peak traffic periods in order to establish an accurate representation of the noise environment at those locations, for the particular time interval. Traffic was simultaneously hand counted and classified by vehicle type in order to correlate measured noise levels with the traffic generating the noise. This data is used to validate the Traffic Noise Model.

Table 2: Noise Levels at Ambient Measurement Locations

CNE	Receptor	Community, Subdivision or Historic Name	Address	Location Notes	Measured Ambient Leq (dBA)
B-01	M-01	The River Tower at Christina Landing	105 Christina Landing Drive	Front Walk	67
B-03	M-02	Single Family Homes at Christina Landing	132 Christina Landing	Front Yard	61

Table 3 shows the validation results for the noise model, comparing measured noise levels with those calculated by TNM using traffic volumes observed during the measurements. A difference of 3 decibels or less between measured and modeled levels is deemed acceptable. Noise levels for all conditions shown are calculated to 0.1 dBA and then rounded to the nearest whole integer. TNM validation and

[2] https://www.fhwa.dot.gov/ENVIRonment/noise/measurement/fhwahep18066.pdf

[3] https://www.fhwa.dot.gov/environment/noise/traffic_noise_model/old_versions/tnm_version_10/users_guide/tnm10usersguide.pdf

prediction runs developed for this Project are digitally archived and have been submitted separately in electronic format and will be kept in the Project's technical file.

Table 3: Model Validation Summary

CNE	Receptor	Measurement Date and Time	Measured Noise Level (dBA)	Modeled Noise Level (dBA)	Difference (dBA)	Validated?
B-01	M-01	2022-06-01_1210-1239	67	65	2	Yes
B-03	M-02	2022-06-01_1210-1239	61	60	1	Yes

Note: The difference in noise levels is first calculated from TNM noise level output accurate to the one-tenth decibel. The predicted noise levels in decimals and the calculated differences in decimals are then rounded to integers for reporting. Any decimal value from .0 to .4 is rounded down to the lower integer, and any decimal from .5 to .9 to the higher integer.

Both receptors validated to within 3 dBA of measured noise levels, with receptors M-01 and M-02 validating with differences of 2 dBA and 1 dBA, respectively.

Since it is not possible to place ambient receptors at every noise sensitive land use, additional noise receptors are incorporated to the noise model after validation, in addition to worst noise hour traffic volumes and speeds which are calculated by analysis of all available traffic data. Worst noise conditions for the loudest hour can then be predicted for all noise sensitive locations.

A Common Noise Environment (CNE) represents a common group of land uses that could be exposed to similar noise sources, noise levels, traffic conditions and topographic features. Generally, CNEs are located between two secondary noise sources, such as interchanges and crossroads to the proposed roadway alignments. A CNE could consist of residences, historic properties, schools, churches, and other facilities with common outdoor use areas. Below are descriptions for each CNE within the Project study area.

CNE B-01: This CNE consists of Category B land uses and represents the River Tower at Christina Landing, a condominium complex situated at the northeast corner of South Market Street and A Street. The tower rises 295 feet with 27 stories with 183 condominium units with an 8-story parking garage connected to the north of the building. Of the 27 stories, 24 are used for residential, with 21 floors having 8 units (four on each side of the building), floors 9 and 24 having six units and floor 25 having 3 units. Ambient measurements were taken at receptor M-01.

CNE B-02: This CNE consists of Category B land uses and represents the Residences at Christina Landing, an apartment building situated on the northeast quadrant of South Market Street and A Street. This apartment is largely visually and acoustically shielded from South Market Street by the high-rise condominiums of the River Tower at Christina Landing.

CNE B-03: This CNE consists of Category B land uses and represents the Christina Landing community of single-family town homes with 2nd and 3rd story balconies, situated on the northeast quadrant of South Market Street and A Street. These homes along Christina Landing Drive are somewhat visually and acoustically shielded from South Market Street by the high-rise apartments of the River Tower at Christina Landing and the Residences at Christina Landing. Ambient measurements were taken at receptor M-02.

CNE B-04: This CNE consists of Category B land uses and represents the Luxor Lifestyle Apartments Wilmington, an apartment complex situated along the eastern side of South Market Street, between A Street and Howard Street. The building is approximately 50 feet tall, with 4 stories and 150 units. There is no sensitive outdoor use associated with this land use area that is within the influence of traffic noise from South Market Steet; therefore, this CNE is not considered for potential noise impact.

CNE C-05: This CNE consists of Category C land use and represents an outdoor pool at Luxor Lifestyle Apartments Wilmington. The pool is located at the south-western corner of the apartment building.

D. Predicted Existing and Future Noise Levels

FHWA requires noise to be analyzed for the "worst noise hour" of the day. As noted previously, ambient measurements may not reflect the worst hour of the day. The worst noise hour traffic condition represents a combination of vehicle volume, classification mix and speed that would produce the worst traffic noise condition to be experienced along the Project corridor. For future conditions within the Project area, the worst noise hour typically occurs when traffic volumes approach peak conditions along South Market Street.

Worst noise hour traffic volumes were predicted for the design year 2040. These volumes can consist of either peak AM or PM traffic flow, whichever produces the highest noise levels for a given community, while not exceeding Level of Service C (LOS C). Volumes in excess of LOS C can result in lower speeds and reduced noise levels. Where necessary, traffic volumes were limited to LOS C to simulate the worst noise condition. To determine the loudest hour noise volumes, the peak hour was chosen based on the higher volume intersection wide, with PM peak being the higher volume along South Market Street and New Sweden Street, and AM peak the higher volume within the internal movements of the Phase 1/2 localized street network.

A comparison of predicted Existing and Build Noise levels is shown in **Table 4.** Predicted noise levels were calculated to 0.1 dBA accuracy and then rounded to the nearest whole integer. See **Table 5** for complete noise level data for individual receptors and **Appendix B** for a detailed Study Area Map with receptor locations.

Table 4: Predicted Design Year Noise Levels

CNE	Location	Range of Predicted Worst-Hour Leq Exterior Noise Levels (dBA)	
		Existing	Build
B-01	The River Towers at Christina Landing	55-64	55-66
B-02	The Residences at Christina Landing	55	55
B-03	Christina Landing – Single Family Homes	55-57	55-61
C-05	Luxor Lifestyle Wilmington – Outdoor Pool	57	63

E. Impact Assessment/Abatement

The results from TNM modeling indicate that 24 receptors, representing 24 existing residential noise sensitive land uses, will be impacted by traffic generated noise. All noise impacts are predicted to occur as a result of predicted noise levels that equal or exceed the 66 dBA impact threshold of NAC Category B. There are no instances of substantial increases of 12 dBA or greater associated with the proposed improvements.

- CNE B-01 (The River Towers at Christina Landing) is predicted to experience 24 impacts. The impacts are associated with receptor R-04, representing the multistory exterior balconies in the south corner of the building.
- CNE B-02 (The Residences at Christina Landing) is predicted to experience no impacts
- CNE B-03 (Christina Landing–Single Family Homes) is predicted to experience no impacts
- CNE C-05 (Luxor Lifestyle Wilmington – Outdoor Pool) is predicted to experience no impacts

The impacts in the entire Project study area fall under NAC Category B, all resulting from noise levels that meet or exceed 66 dBA for the design year. There are no significant increases of 12 dBA or more associated with this Project. B-01 is the only impacted CNE with design year noise levels that meet 66 dBA.

CNE B-01 is composed of the River Towers at Christina Landing. The modeled receptors begin at the second story of the building, as the first level does not have any areas of frequent outdoor use. Balconies at each floor from the second floor upward are considered frequent outdoor use areas. A receptor was placed in the model at each balcony to represent the outdoor use of each apartment. The modeled receptors represented in this report are limited to the first 5 stories of the building because the calculated noise level of each elevated receptor beyond the 5th floor remains nearly the same noise level, with a change of only 0.2 dBA from 58 feet to 295 feet. Through a separate build condition model that isolates the R-04 receptor, it was confirmed that there is negligible loss in sound level to elevated receptors. The attenuation of noise was sustained from the second floor to the 25th floor at 295 feet with a rounded noise level of 66 dBA.

Table 5: Individual Predicted Design Year Noise Level

CNE	Receptor	Multi-Story Level	Existing Leq (dBA)[1]	No-Build Leq (dBA)[1]	Build Leq (dBA)[1]
B-01	R-01A	2	63	65	64
B-01	R-01B	3	63	65	64
B-01	R-01C	4	63	65	64
B-01	R-01D	5	62	65	64
B-01	R-02A	2	63	66	65
B-01	R-02B	3	63	65	65
B-01	R-02C	4	63	65	65
B-01	R-02D	5	63	65	65
B-01	R-03A	2	63	66	65
B-01	R-03B	3	63	66	65
B-01	R-03C	4	63	65	65
B-01	R-03D	5	63	65	65
B-01	R-04A	2	64	66	66
B-01	R-04B	3	63	66	66
B-01	R-04C	4	63	66	66
B-01	R-04D	5	63	66	66
B-01	R-05A	2	55[2]	55[2]	55[2]
B-01	R-05B	3	55[2]	55[2]	55[2]
B-01	R-05C	4	55[2]	55[2]	55[2]
B-01	R-05D	5	55[2]	55[2]	55[2]
B-01	R-06A	2	55[2]	55[2]	55[2]
B-01	R-06B	3	55[2]	55[2]	55[2]
B-01	R-06C	4	55[2]	55[2]	55[2]
B-01	R-06D	5	55[2]	55[2]	55[2]
B-01	R-07A	2	58	60	62
B-01	R-07B	3	58	60	62
B-01	R-07C	4	58	60	62
B-01	R-07D	5	58	60	62
B-02	R-08A	2	55[2]	56	55[2]
B-02	R-08B	3	55[2]	56	55[2]
B-02	R-08C	4	55[2]	56	55[2]
B-02	R-08D	5	55[2]	56	55[2]
B-02	R-09A	2	55[2]	55[2]	55[2]
B-02	R-09B	3	55[2]	55	55[2]
B-02	R-09C	4	55[2]	55	55[2]
B-02	R-09D	5	55[2]	55[2]	55[2]
B-02	R-10A	2	55[2]	55[2]	55[2]
B-02	R-10B	3	55[2]	55[2]	55[2]

B-02	R-10C	4	55[2]	55[2]	55[2]
B-02	R-10D	5	55[2]	55[2]	55[2]
B-02	R-11A	2	55[2]	55[2]	55[2]
B-02	R-11B	3	55[2]	55[2]	55[2]
B-02	R-11C	4	55[2]	55[2]	55[2]
B-02	R-11D	5	55[2]	55[2]	55[2]
B-02	R-12A	2	55[2]	55[2]	55[2]
B-02	R-12B	3	55[2]	55[2]	55[2]
B-02	R-12C	4	55[2]	55[2]	55[2]
B-02	R-12D	5	55[2]	55[2]	55[2]
B-03	R-13B	2	57	58	61
B-03	R-13C	3	57	58	61
B-03	R-14B	2	56	58	61
B-03	R-14C	3	57	58	61
B-03	R-15B	2	56	57	60
B-03	R-15C	3	56	57	60
B-03	R-16B	2	56	57	60
B-03	R-16C	3	56	57	60
B-03	R-17B	2	55	56	59
B-03	R-17C	3	55	56	60
B-03	R-18B	2	55[2]	56	59
B-03	R-18C	3	55[2]	56	59
B-03	R-19B	2	55[2]	56	59
B-03	R-19C	3	55[2]	56	59
B-03	R-20B	2	55[2]	55	58
B-03	R-20C	3	55[2]	55	59
B-03	R-21B	2	55[2]	55[2]	58
B-03	R-21C	3	55[2]	55	58
B-03	R-22B	2	55[2]	55[2]	57
B-03	R-22C	3	55[2]	55[2]	57
B-03	R-23B	2	55[2]	55[2]	56
B-03	R-23C	3	55[2]	55[2]	56
B-03	R-24B	2	55[2]	55[2]	56
B-03	R-24C	3	55[2]	55[2]	56
B-03	R-25B	2	55[2]	55[2]	55
B-03	R-25C	3	55[2]	55[2]	55
B-03	R-26B	2	55[2]	55[2]	55[2]
B-03	R-26C	3	55[2]	55[2]	55[2]
B-03	R-27B	2	55[2]	55[2]	55[2]
B-03	R-27C	3	55[2]	55[2]	55[2]
B-03	R-28B	2	55[2]	55[2]	55[2]
B-03	R-28C	3	55[2]	55[2]	55[2]

B-03	R-29B	2	55[2]	55[2]	55[2]
B-03	R-29C	3	55[2]	55[2]	55[2]
B-03	R-30B	2	55[2]	55[2]	55[2]
B-03	R-30C	3	55[2]	55[2]	55[2]
B-03	R-31B	2	55[2]	55[2]	55[2]
B-03	R-31C	3	55[2]	55[2]	55[2]
B-03	R-32B	2	55[2]	55[2]	55[2]
B-03	R-32C	3	55[2]	55[2]	55[2]
B-03	R-33B	2	55[2]	55[2]	55[2]
B-03	R-33C	3	55[2]	55[2]	55[2]
B-03	R-34B	2	55[2]	55[2]	55[2]
B-03	R-34C	3	55[2]	55[2]	55[2]
B-03	R-35B	2	55[2]	55[2]	55[2]
B-03	R-35C	3	55[2]	55[2]	55[2]
B-03	R-36B	2	55[2]	55[2]	55[2]
B-03	R-36C	3	55[2]	55[2]	55[2]
B-03	R-37B	2	55[2]	55[2]	55[2]
B-03	R-37C	3	55[2]	55[2]	55[2]
B-03	R-38B	2	55[2]	55[2]	55[2]
B-03	R-38C	3	55[2]	55[2]	55[2]
C-05	R-39	N/A	57	58	63

[1] All noise levels are shown as hourly equivalent sound levels (Leq(h)) with units in A-weighted decibels ((dB(A)) The level is rounded to the nearest whole decibel in accordance with DelDOT guidelines.

[2] Background noise level determined by ambient sound level data obtained by the short-term monitoring, determined that the non-traffic environmental noise of the project area remained consistently around 55 dB(A); therefore, the minimum predicted/modeled noise levels are limited to this threshold.

III. Noise Abatement Determination

Whenever traffic noise impacts are identified, abatement is evaluated for feasibility and reasonableness. The analysis takes into account the overall social, economic, and environmental effects of roadway noise. Primary consideration is given to exterior areas where frequent human use occurs. In addition to noise barriers, other noise abatement measures such as traffic management, alteration of roadway horizontal and vertical alignments, or acquisition of real property for buffer zones are considered as well. In evaluating noise barrier placement, consideration will be given to a reasonable variety of noise barrier dimensions, to determine what height and width of barrier provides the greatest overall value, in both economic and social terms.

A. Feasibility

The entire project is analyzed for an appropriate breakdown of individual and separate CNEs. This may result in the feasibility being treated on a total project basis for compact projects, or – in the case of this Project, several separate individual CNEs.

To determine feasibility of highway traffic noise abatement, the following two conditions shall be considered:

- For each CNE, neighborhood, or defined cluster of land uses, noise abatement will be considered effective for an impacted receptor if it can achieve at least a 5-dBA highway traffic noise reduction. DelDOT requires that 75 percent or more of impacted receptor experience a 5 dBA or more reduction in highway traffic noise through noise abatement measures.
- Account for a variety of factors that may limit the ability to achieve substantial noise reduction. These include, but are not limited to, safety conditions, barrier height, access requirements, maintenance requirements, topography, drainage, utilities, and other noise sources.

B. Reasonableness

DelDOT's policy outlines the three factors or "tests" to be evaluated to determine whether noise abatement measures meet the definition of being reasonable. Each of the following three test must be individual met in order for the construction of a noise barrier to be considered a reasonable expenditure:

- The barrier must provide at least 9 dBA noise reduction to at least 25% of impacted receptors.
- Cost of the barrier, including any additional right-of-way and utility costs should not to exceed $30,000 per benefited receptor.
- Noise abatement is acceptable to the majority of people affected.

As per DelDOT's current policy, a unit cost of $53.00 per square foot of noise barrier wall would be used for this Project. Cost figures are based upon data for various state DOT projects in the Mid-Atlantic region and are intended to reasonably reflect the cost of constructing a ground mounted noise wall system at the current time, at this location.

Barrier abatement of the projected noise impacts was determined to be not feasible for CNE B-01. The location of the impacted receptors in relation to the dominant noise source of South Market Street would not allow for the feasible construction of a noise barrier given the very short distance between the building and roadway which would severely limit access requirements for pedestrians.

IV. Impact Assessment/Abatement Conclusions

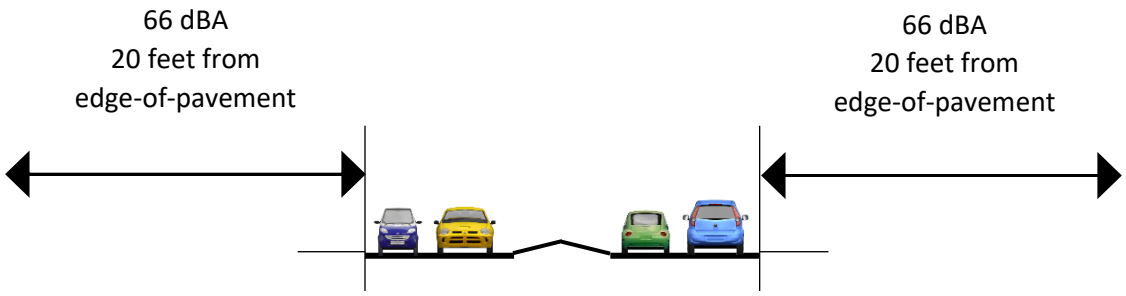
Abatement must be both feasible and reasonable for approval. Abatement was determined to be not physically feasible for CNE B-01; therefore, reasonableness was not assessed.

A. Undeveloped Land

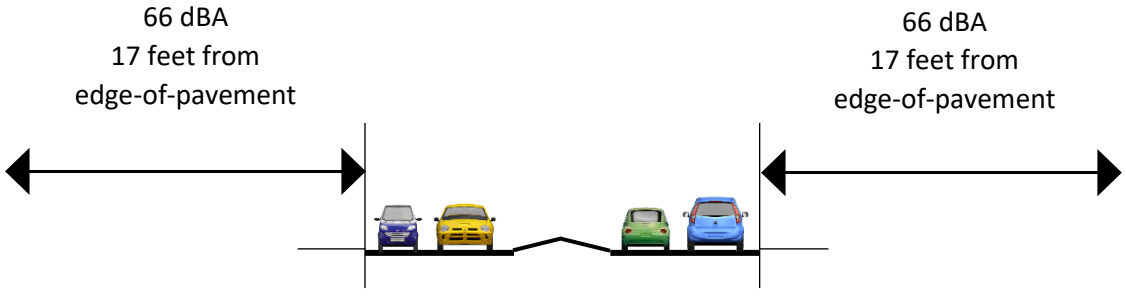
Undeveloped land falls under activity Category G in 23 CFR Part 772 Noise Abatement Criteria. This category applies to all lands that are undeveloped and do not have any development plans which have been issued bona-fide building permits by the effective date of public knowledge of the project. No abatement will be considered for this land use category, but predicted noise levels, conveyed as distances from the edge of roadway for noise levels to reach impact criteria for various land uses, are provided so that local planning officials may consider them when permitting future development.

Distance from the proposed edge-of-roadway to noise levels of 66 dBA for the undeveloped land between the east bank of the Christina River at the location of Area 1 is 20 feet, and for Area 2 it is 17 feet. These distances represent the most conservative / worst case noise environments generated by the proposed improvements at the location of South Market Street and the grid network or roadways east to the Christina River. While it can be difficult to precisely predict the characteristics of future development, Areas 1 and 2 were modeled without trees and existing structures, and with flat grade, representing a potential worst-case condition for traffic noise propagation. See diagrams representing the distance to Activity Category B and C impact thresholds below in **Figure 3**.

Figure 3: Noise Contours for Local Officials



Area 1 - Activity Category B/C



Area 2 - Activity Category B/C

B. Construction Noise

Land uses that are sensitive to vehicular noise would also be sensitive to construction noise. Although highway construction is a short-term phenomenon, temporary noise impacts could occur in the Project study area during construction of a Build Alternative. Areas around the construction zone will experience varied periods and degrees of noise that differ from that of surrounding ambient community noise levels. Construction would have a direct impact on the receptors located close to the construction site and would have an indirect impact on receptors located near roadways where traffic flow characteristics are altered due to re-routing of vehicles from the construction area.

This type of project would probably employ the following types of construction equipment that would likely be sources of construction noise:

- Bulldozers and earth movers.
- Graders.
- Vibratory rollers
- Pavers
- Front-end Loaders.
- Dumps and other diesel trucks.
- Pile-drivers
- Jackhammers
- Compressors.

In most cases, the temporary effect of increased noise levels associated with construction equipment is limited to within 300 feet of the source.

Some measures that may be employed to minimize temporary construction noise include:

- All equipment shall comply with pertinent equipment noise standards of the U.S. Environmental Protection Agency (EPA) and have sound-control devices no less effective than those provided on the original equipment.
- No equipment may have unmuffled exhaust.
- Locate stationary construction equipment as far from nearby noise-sensitive properties as feasible.
- Shut off idling equipment.
- Schedule loud construction operations to avoid periods when noise annoyance is likely.
- Notify nearby residents whenever extremely noisy work will be occurring.
- Install temporary or portable acoustic barriers around stationary construction noise sources.
- Operate electrically powered equipment using line voltage power or solar power.

In addition, all construction operations shall be in compliance with the City's Code of Ordinances, in particular, Chapter 11 – Environment, Article III – Noise Control and Abatement[4]. Section 11-60 (c) (7) provides specific construction noise prohibitions as well as defines construction operation times to be restricted to the following: In business and industrial districts at any time before 7:00 a.m. and after 10:00 p.m., Monday through Friday; before 9:00 a.m. and after 10:00 p.m. on Saturday, Sunday, or the day of a

[4] https://www.wilmingtoncitycouncil.com/city-council/city-code/

legal, national, or state holiday which creates a noise disturbance. In residence districts at any time before 8:00 a.m. and after 7:00 p.m., Monday through Friday; before 9:00 a.m. and after 7:00 p.m. on Saturday; and before 10:00 a.m. and after 5:00 p.m., on Sunday or the day of a legal, national, or state holiday which creates a noise disturbance.

If construction noise impacts are expected to occur, project managers will meet with representatives of the impacted property and discuss specific ways in which construction noise can be minimized.

These measures would be re-examined during final design and provisions added to the contract documents to minimize annoyances from temporary construction noise impacts.

V. References

Delaware Department of Transportation. March 1, 2021. *Highway Transportation Noise Policy*. Policy Implement No. D-03.

Title 23 CFR Part 772. 2010. Procedures for Abatement of Highway Traffic Noise and Construction Noise.

U.S. Department of Transportation, Federal Highway Administration. 2004. *FHWA Traffic Noise Model*. FHWA-PD-96-010

U.S. Department of Transportation, Federal Highway Administration. 2011. *Highway Traffic Noise: Analysis and Abatement Guidance*. FHWA-HEP-10-025

U.S. Department of Transportation, Federal Highway Administration. 2017. *Noise Measurement Handbook*. FHWA-HEP-18-065

U.S. Department of Transportation, Federal Highway Administration. 2017. *Noise Measurement Field Guide*. FHWA-HEP-18-066