4.3. Noise

Regulatory Setting

The statewide Noise Control Code in New Jersey (N.J.A.C. 7:29) regulates sound from certain operational noise sources. Pump stations are proposed as an operational element of this project. Each pump station would include an emergency generator that would provide power to pumps in the event of a loss of primary power (i.e. emergency situations). The statewide Noise Control Code (N.J.A.C. 7:29) establishes maximum permissible sound level limits, which shall be met at or within the property line of a sensitive receiver. In accordance with N.J.A.C. 7:29-1.5(a)14m, each emergency generator would be exempt from compliance with these maximum permissible sound level limits when providing power to pumps in the event of a loss of primary power (i.e., emergency situations).

While exempt from the code under emergency situations, instantaneous sound levels associated with operation of each pump station's emergency generator must be at or below maximum permissible sound level limits at the nearest sensitive site property line including residential, commercial, and community facilities during weekly testing. Since nighttime (10:00PM to 7:00AM) maximum permissible sound level limits are more stringent, it has been assumed that generator testing would be restricted to daytime hours. As per N.J.A.C. 7:29-1.2, during daytime hours (7:00 AM to 10:00 PM), the generator cannot emit sound levels during testing in excess of 65 A-weighted decibels (dBA) and also cannot emit sound levels in excess of the specific octave band sound pressure levels (dB) listed in **Table 4.15** at property lines of the nearest sensitive receiver.

In the absence of any weekday daytime construction-related noise level limits established on a federal level by HUD, FHWA or FTA, or by state, municipal or county noise codes, Noise Abatement Criteria (NAC) listed within Table 1 of 23 CFR 772 for schools, libraries, places of worship and recreational areas were reviewed and accepted as the best available criteria to protect these land use types.

4.3.1 Methodology

Certain critical factors affect noise and the way it is perceived by the human ear. Such factors include the acoustical level (noise), frequency, and the length of the exposure period. Sound or noise levels are measured in units of decibels (dB). Due to the complex manner in which the human ear functions, measurement of different noise sources does not always correspond to relative loudness or annoyances. Therefore, different scales have been developed to furnish guidance in evaluating the importance of different noise sources. The A-weighted scale (unit expressed as dBA) is utilized almost exclusively in noise measurement and prediction assessments since it reflects the frequency range to which the human ear is most sensitive (1,000 to 6,000 Hertz).

Noise is described in a logarithmic scale where doubling the power of a noise source results in a 3 dB increase in the sound pressure level. Studies have shown that a decrease in 10 dB is perceived by the average listener as a reduction of loudness by one-half, while an increase in 10 dB is discerned as a doubling of loudness. Under normal circumstances, a 3 dB change is required for the average person to detect a difference without the use of instruments. A change of 5 dB is considered to be a noticeable change.

The L_{dn} metric is the A-weighted day-night equivalent sound level, defined as a 24-hour continuous noise level average with 10 dB added to all noise levels between the hours of 10:00 PM and 7:00 AM. This 10 dB addition is a penalty that accounts for the extra sensitivity that people have to noise during typical sleeping hours. The L_{dn} metric is commonly used in community noise assessments and was utilized to characterize the existing noise environment within the Study Area. Both HUD and EPA utilize the L_{dn} metric to characterize community noise levels.

The L_{eq} is an equivalent steady-state sound level, which in a specific period of time, contains the same acoustic energy as the time-varying sound level during that same period. Since construction-related noise levels vary with time and intensity, the L_{eq} metric was utilized to address construction-related noise levels. Therefore, A-weighted construction-related noise levels are referred herein as $LA_{eq.}$

Table 4.15 New Jersey Administrative Code 7:29

OCTAVE BAND CENTER FREQUENCY (Hz)	OCTAVE BAND SOUND PRESSURE LEVEL (dB)
31.5	96
63	82
125	74
250	67
500	63
1,000	60
2,000	57
4,000	55
8,000	53

Source: New Jersey Administrative Code 7:29-1.2(a).

The Resist infrastructure of the Project is anticipated to be constructed over a 3.5-year period and the DSD infrastructure will be completed as funding becomes available.

Activities necessary to construct DSD elements will require standard construction equipment and activities such as excavators for ground excavation and backfill, as well as asphalt paving machines, rollers, and plate compactors to restore roadway surfaces. Excavators or truck-mounted cranes will be necessary to lift and lower small tanks into trenches. Larger cranes are necessary to lift and lower precast chamber units into water detention basins. Depending on the size and location of installation, cranes may be necessary for one day to a few weeks. These types of construction activities and equipment are typical and commonplace within this Study Area. However, construction activities

necessary to construct Resist structures, including the 14th Street high-level storm sewer for Alternatives 2 and 3 and the force main outfalls along Weehawken Cove for all alternatives, require heavy equipment. Heavy equipment and activities necessary for this type of construction include impact and vibratory hammers to drive piles. These types of construction activities would result in the highest construction-related noise levels associated with the Project. As such, construction-related noise levels for these heavy construction activities were calculated for each Build Alternative.

Construction noise is exempt under the Noise Ordinance of the Hudson Regional Health Commission (NOHRHC) during weekday daytime hours (i.e., 7:00 AM to 6:00 PM); therefore, noise-sensitive receivers to which daytime construction activities would be disruptive were reviewed including schools, libraries, places of worship, as well as recreational areas. As noted within the Noise and Vibration Technical Environmental Study (2017), noise has the potential to interfere with speech intelligibility and disrupt the intended use of these sites.

Schools, libraries, and places of worship are considered Activity Category C (exterior) and D (interior) land use according to Table 1 in 23 CFR 772. Libraries, places of worship, and some schools within the Study Area lack exterior areas of frequent human use, and based on FHWA guidance, should be evaluated based on interior noise abatement criteria. Additionally, FHWA guidance states that noise levels should be estimated based on open windows, unless there is firm knowledge that the windows are kept closed almost every day of the year. Conservatively, noise sensitive sites including all schools and places of worship were assessed based on a window-wall attenuation value of 10 dB (L_{Aeq}) to account for a window's open condition. The Go Ye Therefore Ministries church does not possess windows; therefore, a conservative window-wall attenuation value of 35 dB (L_{Aeq}) was assumed. In addition, both locations of the Hoboken Montessori School (14th Street and Bloomfield Street) do not possess operable windows, therefore a window-wall attenuation value of 35 dB (L_{Aeq}) was assumed, as per FHWA 23 CFR 772 guidance. Any impacted school with operable windows was further investigated to determine whether alternative means of ventilation was present. In that case, a window-wall attenuation value of 35 dB (L_{Aeq}) was assumed to account for a windows closed condition.

All schools within the Study Area were assessed based on interior noise levels (Category D). Additionally, schools with exterior areas of frequent human use were assessed including the Wallace School, Hoboken Catholic Academy, All Saints Episcopal Day Schools (Washington and Clinton Streets locations), and TG Connors Elementary School. These schools, as well as all recreational areas, were evaluated as FHWA Activity Category C, in accordance with FHWA procedures. FHWA's Noise Abatement Criteria is presented within **Table 4.16**.

According to NJDOT's 2011 Traffic Management Policy and Noise Wall Design Guidelines, noise levels that approach the criteria are defined as occurring 1 dBA L_{eq} less than the NAC. Therefore, all schools, as well as any libraries or places of worship without exterior areas of frequent human use where construction-related interior noise levels of 51 dBA (L_{eq}) or greater were predicted, were determined to be adversely affected. In addition, any schools with exterior areas of frequent human use and recreational areas where construction-related exterior noise

Table 4.16 FHWA Noise Abatement Criteria

ACTIVITY CATEGORY	THRESHOLD OF NOISE INTERFERENCE		EVALUATION LOCATION	DESCRIPTION OF ACTIVITY CATEGORY
	L_{eq}	L_{10}		
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 non-profit 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.

Source: 23 CFR, Part 772, Table 1 Noise Abatement Criteria

Table 4.17 Construction Scenarios

CONSTRUCTION ACTIVITY	POTENTIAL EQUIPMENT TYPE	REASONABLE EQUIPMENT QUANTITY
Impact Pile Driving	Pile Driving Rig	1
Sheet Pile Operation	Vibratory Hammer	1
	Crane	1

Source: Dewberry. 2015-2017

levels of 66 dBA (L_{eq}) or greater were predicted were considered to be adversely affected. The interior and exterior NAC were developed based on several factors, including task interference or disturbance as well as interference with speech communication. According to FHWA, the NAC are intended to establish a compromise between desirable and achievable noise levels.

Although residential land use is typically most sensitive during nighttime hours when the majority of people are home and sleeping, it is noted that there may be a small population of residents who occupy their homes during daytime periods. Identifying this population or number of residences which may experience elevated weekday daytime construction-related noise levels is not feasible at this time. Therefore, construction-related noise levels were predicted along the Resist structure alignment and high-level storm sewer and force main outfalls associated with each alternative to address elevated noise levels along these element alignments for first row residential receivers only. An increase in 10 dBA over existing noise levels was considered a reference point for determining construction-related noise annoyance, which is consistent with the NJDOT's substantial noise increase impact criterion and also represents a perceived doubling of noise levels.

Heavy construction activities related to the Project were identified to be the installation of Resist structures and high-level storm sewer and force main outfalls planned throughout the Study Area. Resist structures were assumed to require impact pile driving and sheet pile driving activities, while the high-level storm sewer and force main outfalls were assumed to only require sheet piles.

Impact pile driving via use of a pile driving rig was assumed. In addition, driving sheet piles through the use of a vibratory hammer suspended from a crane was assessed. Individually, these operations have the potential to generate construction noise impacts. **Table 4.17** presents a summary of construction activities evaluated in the construction noise impact assessment. For purposes of this analysis, it is important to note that only one construction crew was assumed to perform each operation. In addition, it was assumed that sufficient distance would separate any other simultaneous construction activity such that noise levels would not result in cumulative noise effects.

Reference noise levels for construction equipment at a distance of 50 feet are provided in the FHWA's Roadway Construction Noise Model (RCNM) database. The algorithms within RCNM for predicting construction noise levels assume that equipment are point sources of noise, whereby the rate of reduction in noise levels is approximately 6 dBA per doubling of distance. Therefore, to perform a reasonable worst-case construction noise analysis, the FHWA's RCNM was utilized, including reference noise emission levels provided within the model.

For all alternatives, approximate work locations and limits were measured based on the closest distance between source and receiver for each activity analyzed. The ground between source and receiver was assumed to be asphalt, therefore ground effects were ignored. Attenuation due to shielding by intervening buildings was assumed to be 15 dBA for sensitive noise sites without a direct line-of-sight to the construction activities. This shielding factor is consistent with recommendations presented in the RCNM user's manual (Noise and Vibration Technical Environmental Study 2016). For all first row sites or high-rise buildings that may possess a direct line-of-sight to construction activities, attenuation due to shielding was not included (i.e. a shielding factor of 'zero' was utilized).

Construction-related noise levels predicted at all schools, as well as libraries, and places of worship without exterior areas of frequent human use were compared to the interior NAC of 51 dB (L_{Aeq}), while those with, including recreational areas, were compared to the exterior NAC of 66 dB (L_{Aeq}). High construction-related noise levels may prove especially disruptive to schools, libraries and places of worship as well as recreational areas within the Study Area (by interfering with speech communication) during daytime hours (see Sections 4.8.2.7 and 4.8.3.9).

Since construction of the Resist structures and high-level storm sewer and force main outfalls will progress in a linear manner, all predicted noise impacts were assessed further in order to determine the potential duration of impact. The noise analysis performed assumed a construction rate of 240 linear feet (LF) per month associated with Resist structures and high-level storm sewer and force main outfall installation.

4.3.2 Affected Environment

Noise sensitive receivers, which include locations for which exposure to excessive sound levels would be detrimental or interfere with "normal" operations (e.g., residences, schools, libraries, places of worship, and recreational areas) were identified within the Study Area. In order to characterize existing noise levels throughout the Study Area, a background noise monitoring study was performed.

A detailed review of aerial mapping and field surveys was performed to identify locations appropriate for background noise monitoring. Locations were identified based on representativeness of noise-sensitive land use, variability in existing noise sources contributing to the overall noise environment, accessibility, and security of monitoring equipment. All noise monitoring locations were approved by NJDEP. Access permission for installation on private property was coordinated through NJDEP.

Background noise monitoring was performed in 15 locations within the Study Area throughout October and November 2015, as detailed in **Figure 4.47**. Of the 15 locations, 12 locations were long-term monitoring sites (i.e., continuous, unstaffed 24-hour monitoring for approximately one to two weeks), while three locations were short-term sites (i.e., staffed one or two days between 7:00 AM and 3:00 PM), due to access restrictions and equipment security concerns. In Weehawken Township, data was collected by Paul Carpenter Associates, Inc. in April and May 2013 at the Weehawken Waterfront Park and Recreation Center; therefore, supplemental short-term spot measurements were performed at this site to confirm the validity of the historic data. Since supplemental measurement data showed that existing 2015 noise levels were similar to historic 2013 noise levels (i.e., within one dBA), no further monitoring was necessary at Weehawken Waterfront Park and Recreation Center to identify current background noise levels.

A-weighted noise levels, averaged over 10-minute periods (i.e., 10-minute L_{eq}, dBA), were documented utilizing Type 1 noise level meters set to a 3 dB exchange rate and slow response. Each long-term noise level meter was housed within a weather-proof case and equipped with rechargeable batteries. The outdoor microphone kit included a heavy-duty windscreen, which allowed the unit to be left unattended during most weather conditions. Every four to five days, a field technician performed data downloads, equipment field calibration, battery replacement, and verified that the wind screen was properly affixed to the microphone.

Once data collection was complete, raw noise levels were plotted on 24-hour graphs and filtered to remove anomalous data, as well as data documented during meteorological conditions, which exceed equipment tolerances based on manufacturer specifications. Such conditions include winds in excess of 17 mph, relative humidity above 97 percent, and any precipitation. Equipment calibration certificates and photos of each short- and long-term monitoring location and data collected are included in the Noise and Vibration Technical Environmental Study (2017).

Filtered long-term data was averaged over the monitoring period and utilized to develop 24-hour noise level trends. Exterior noise levels above 75 dBA (L_{dn}) are considered "unacceptable" by HUD when considering funding for noise-sensitive housing sites. EPA categorizes outdoor settings into six distinct descriptions using the L_{dn} metric, as detailed in **Table 4.18**. Noise level trend data was utilized to calculate L_{dn} values for all long-term noise monitoring locations. Based on EPA outdoor noise descriptions, existing noise levels documented would characterize portions of the Study Area during weekdays and weekends as "urban," "noisy urban," and "city areas," as generally illustrated in **Figure 4.48**.

4.3.3 Environmental Consequences

Project-specific noise impacts, as a result of the weekday daytime construction-related activities, are presented in **Tables 4.19 through 4.23**. Noise impacts related to any school interior as well as any library, or place of worship without exterior areas of frequent human use were assessed based on an interior noise level of 51 dB (L_{Aeq}), assuming a windows open condition. However, both Hoboken Montessori Schools (14th Street and Bloomfield Street) are located within buildings without operable windows. As such, a window-wall attenuation value of 35 dBA (L_{Aeq}) was assumed based on FHWA 23 CFR 772 guidance. Additionally, noise impacts related to schools with exterior areas of frequent human use and recreational areas were assessed based on an exterior noise level of 66 dB (L_{Aeq}). Typical noise levels at first row residences have been calculated on a representational basis for residences located in the northern and southern portions of the Study Area under each alternative. Actual noise levels at the residences in the northern and southern portion of the Study Area are expected to vary based on distance to pile driving activities and intervening buildings. A noise level increase of 10 dB over existing noise levels (utilizing the closest noise monitoring location to the alternative under review) was considered a reference point for construction-related noise annoyance. All noise sensitive categories were assumed to operate during typical construction hours (7:00 AM to 3:00 PM). A detailed discussion of noise impact calculation formulas is presented in the Noise and Vibration Technical Environmental Study (2016) and all calculation results are presented in Appendix E of that report.

Table 4.18 Outdoor Ldn Noise Descriptions

SOUND SOURCE	L_{DN} (dBA)
City (Downtown Major Metropolis)	75-80
Very Noisy Urban	70
Noisy Urban	65
Urban	60
Suburban	55
Small Towns and Quiet Suburban	45-50

Source: USEPA, Office of Noise Abatement and Control, Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety, March 1974

Alternative 1

Operations

Emergency generators associated with the pump stations are exempt from N.J.A.C. 7:29 compliance during emergency situations; however, instantaneous sound levels must be at or below maximum permissible sound level limits at the nearest sensitive site property line during testing. **Table 4.21** details conservative noise levels predicted at the closest sensitive receiver property lines relative to each pump station (see Attachment 3 Noise and Vibration Technical Environmental Study). Based on the analysis performed, all emergency generators installed within pump stations are predicted to meet N.J.A.C. 7:29 noise level limits during weekly daytime testing.

Construction

Construction of Alternative 1, Options 1 and 2, would

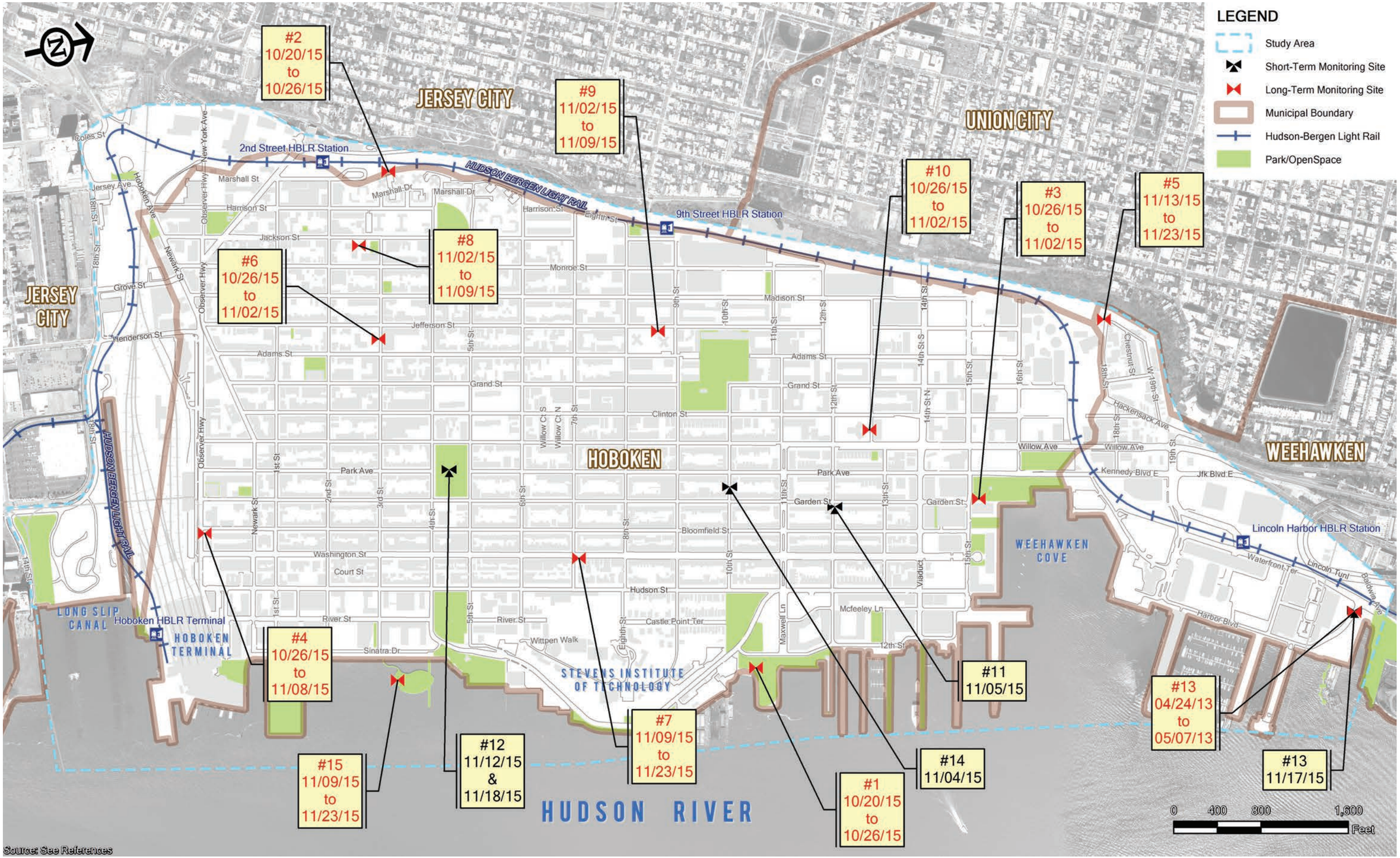
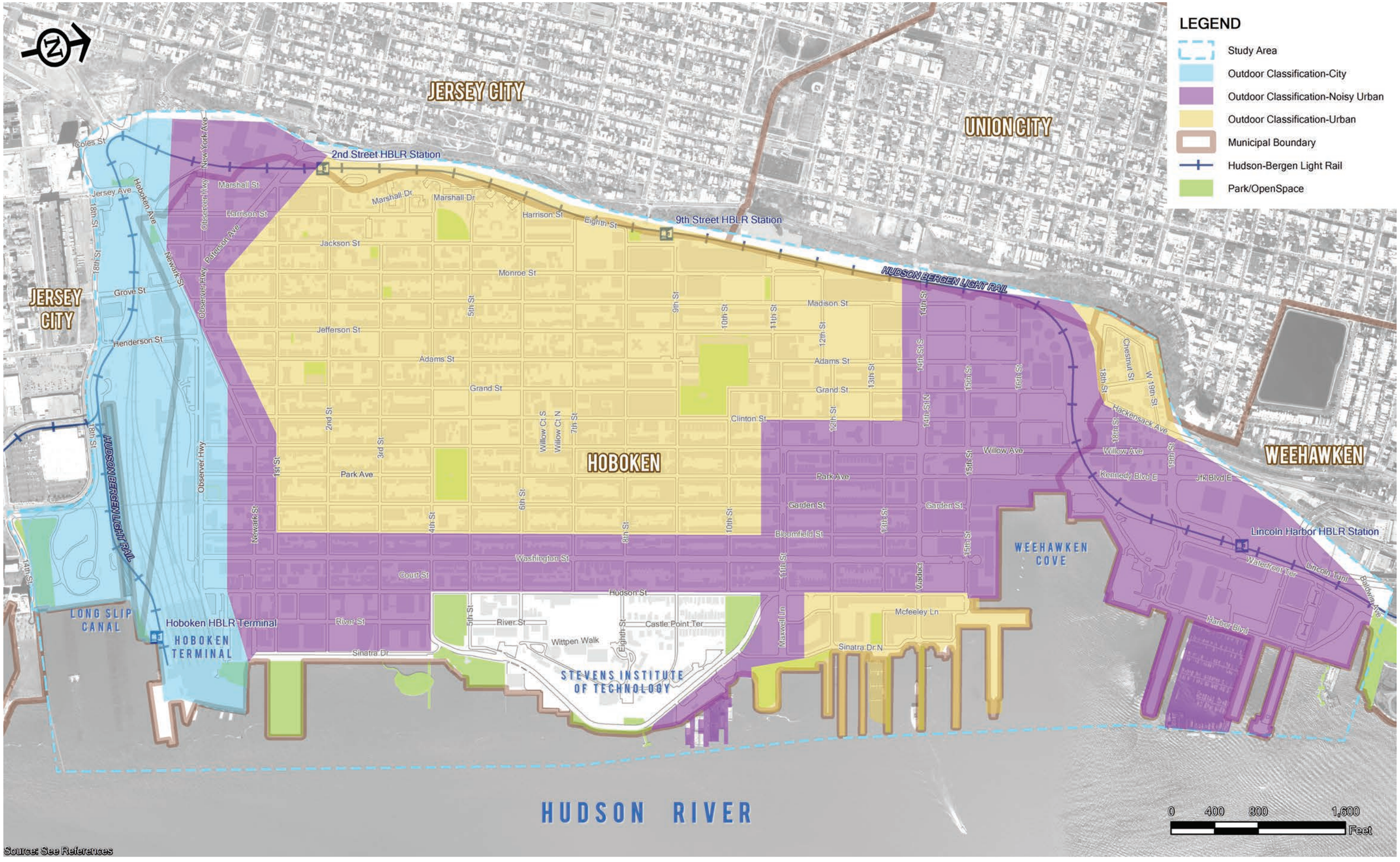


Figure 4.47 Background Noise Monitoring Locations



Source: See References

Figure 4.48 Existing Outdoor Noise Classification

Table 4.19 Weekday and Weekend Ldn Calculations

SITE NUMBER	LOCATION	MUNICIPALITY	WEEKDAY L_{DN} (dBA)	WEEKEND LDN (dBA)
1	Maxwell Place Park	Hoboken	67	61
2	2nd Street Light Rail Station	Hoboken	62	62
3	Harborside Park	Hoboken	68	67
4	55 Bloomfield Street	Hoboken	76	78
5	18th Street	Weehawken	60	59
6	Adams Gardens	Hoboken	61	61
7	All Saints Episcopal Church	Hoboken	70	69
8	Monroe Gardens	Hoboken	60	58
9	Columbus Gardens	Hoboken	60	59
10	Fox Hill Gardens	Hoboken	64	63
11	1145 Garden Street[1]	Hoboken	-	-
12	Church Square Park[1]	Hoboken	-	-
13	Weehawken Waterfront Park and Recreation Center	Hoboken	69	67
14	204 10th Street[1]	Hoboken	-	-
15	Pier C Park	Hoboken	60	60

Note: 1 - [1] Site included daytime measurements only, Ldn not available.

Source: Paul Carpenter Associates, Inc., 2015

involve the greatest length of Resist structures. In addition, heavy construction activities would be necessary to construct the force main outfalls at Weehawken Cove. Adverse noise impacts under Alternative 1 would impact schools, recreational sites, and residences in different locations in the Study Area over the duration of the construction activities.

Individually, impact pile driving and vibratory sheet driving are predicted to result in noise impacts at four schools and 13 recreational areas (see **Table 4.20**) during construction. No noise impact to libraries or places of worship is expected during construction of Alternative 1, Options 1 and 2.

All of the schools predicted to possess noise levels

Table 4.20 Alternative 1, Options 1 and 2 Construction-Related Weekday Daytime Noise Impacts

SENSITIVE SITE CATEGORY (# OF IMPACT)	RECEIVER NAME	IMPACT CRITERIA (DB LAEQ)	PREDICTED CONSTRUCTION NOISE LEVEL RANGE (DB LAEQ)	DURATION OF IMPACT[1] (MONTH)
School (4)	Stevens (McClean Hall)	51	52 - 70	2
	Stevens (Edwin A. Stevens Hall)		52 - 66	1
	Stevens (Babbio Center)		52 - 65	3
	Elysian Charter School of Hoboken		52 - 70	11
Recreational Area (13)	Weehawken Waterfront Park & Recreational Center	66	67 - 75	7
	1600 Park		67 - 92	15
	Harborside Park		67 - 105	13
	Shipyard Park		67 - 95	10
	Maxwell Place Park		67 - 114	10
	Elysian Park		67 - 114	7
	Sinatra Park		67 - 114	7
	Hoboken Little League Field & Stevens Park		67 - 114	4
	Pier C Park		67 - 86	7
	Pier A Park		67 - 99	8
	Gateway Park[2]		67 - 114	11 / 9
	Erie-Lackawanna Park		67 - 82	2
	Castle Point Skate Park		67 - 71	4

Note: 1 – [1] Duration of impact assumes 240 LF of construction per month based on impact pile driving activities.
2 – [2] Alternative 1, Option 1 / Alternative 1, Option 2 estimated duration.

Source: Paul Carpenter Associates, Inc., 2016

that approach or exceed their respective NAC have elevated classroom windows that provide a direct line-of-sight to construction-related activities. Alternative 1, Options 1 and 2, propose Resist structures mainly along the water's edge. Since several parks within the Study Area are located along the waterfront, with a direct line-of-sight to proposed construction activities, this alternative results in multiple recreational areas that approach or exceed their respective NAC.

Assuming construction would progress at 240 LF per month, the duration in months that schools would be predicted to exceed their respective NAC range from one (Edwin A. Stevens Hall) to 11 months (Elysian Charter School of Hoboken). The duration in months that recreational areas would be predicted to exceed the NAC ranges from two (Erie Lackawanna Park) to 15 months (1600 Park). **Table 4.20** presents a listing of sites in each noise sensitive category, associated impact criteria, construction-related noise level range, and durations predicted to possess weekday daytime noise levels that approach or exceed respective noise criteria.

The most representative waterfront noise monitoring location along the proposed northern Resist alignment associated with Alternative 1 is noise monitoring site # 15 (Pier C). Existing daytime (7:00 AM to 10:00 PM) noise levels of 60 dBA (L_{Aeq}) were documented in this location. As previously mentioned, an increase in 10 dB is discerned as a doubling of loudness. Assuming a change in noise levels of 10 dB as a reference point for annoyance, the closest first-row residential receivers with a direct line-of-sight to construction activities may experience noise levels that annoy any population of occupants during weekday daytime construction periods for approximately eight months. Construction-related noise levels of 107 dBA (L_{Aeq}) at the closest first-row residential receivers may result from pile driving along the proposed northern Alternative 1 Resist structure alignment.

The most representative noise monitoring location along the proposed southern Resist structures alignment associated with Alternative 1, Option 1 and Option 2, is noise monitoring site # 4 (55 Bloomfield Street). Existing weekday daytime (7:00 AM to 10:00 PM) noise levels of 76 dBA (L_{Aeq}) were documented in this location. Assuming a change in noise levels of 10 dB as a reference point for annoyance, the closest first-row residential receivers with a direct line-of-sight may experience noise levels that annoy any population of occupants during weekday daytime construction periods for approximately two months. Residential units within the southern region of the Study Area may experience construction-related noise levels of 79 dBA (L_{Aeq}) to 88 dBA (L_{Aeq}) along the proposed southern Alternative 1, Option 1 and Option 2 alignments, respectively.

As previously mentioned, weekday daytime noise levels as a result of construction activities are exempt from NOHRHC. In some locations, first-row homes provide shielding for second-row homes. Since the number of residences who occupy their homes during the day is unknown and building heights surrounding the Resist structure alignments are also unknown, the population of occupants that are predicted to be annoyed by noise levels during weekday daytime Alternative 1, Option 1 and Option 2, construction cannot be quantified at this time.

DSD construction noise impacts would generally be confined to the project vicinity, whether that project might be installation of curbside stormwater collection basins, high level storm sewer collection lines or one of the three large stormwater collection sites. However, due to: (1) the dynamic noise environment in areas where DSD construction will be undertaken, (2) the nature of the construction equipment required for DSD construction, which is typical of construction activities across the Study Area; and (3) limitation of construction activities to weekday, daytime hours, noise impacts associated with DSD construction noise is expected to be short term and minor.

Alternative 2

Operations

The operational noise impacts are the same as described under Alternative 1.

Construction

Individually, impact pile driving and vibratory sheet driving are predicted to result in noise impacts to one school and four recreational areas (see **Table 4.22**) during construction of Alternative 2, Options 1 and 2 Resist features, 14th Street improvements associated with the high-level storm sewer and the force main outfalls along Weehawken Cove. Adverse noise impacts under Alternative 2 would also impact residences in different locations within the Study Area over the duration of the construction activities.

No noise impact to libraries or places of worship is expected during construction of Alternative 2, Options 1 and 2.

The Elysian Charter School of Hoboken possesses elevated classroom windows that provide a direct line-of-sight to construction-related activities. The assessment conservatively was performed to predict interior noise levels with the windows open. Assuming

Table 4.21 Emergency Generator Noise Levels During Daytime Testing at Nearest Sensitive Receiver Property Line

PUMP STATION SITE	OCTAVE BAND FREQUENCY SPL (dB)									CUMULATIVE SPL (DBA)	N.J.A.C. 7:29 EXCEEDANCE
	31.5	63	125	250	500	1k	2k	4k	8k		
NJ TRANSIT	20	38	36	26	31	22	24	15	5	31	NO
BASF	69	61	55	43	46	33	31	25	21	46	NO
Clinton Street	63	55	49	36	39	26	25	18	15	39	NO

Source: Paul Carpenter Associates, Inc., 2016

construction would progress 240 LF per month, it is predicted that noise levels at the Elysian Charter School of Hoboken would exceed the NAC for 17 months.

Since construction associated with the 14th Street high-level storm sewer outfalls is expected to last less than one week, noise impacts to the Shipyard and Maxwell Place Parks are expected to be negligible. The duration in months for recreational areas predicted to exceed the NAC ranges from two (Gateway Park) to 15 months (Harborside Park). **Table 4.22** presents a listing of sites in each noise sensitive category, associated impact criteria, construction-related noise level ranges, and durations predicted to possess weekday daytime noise levels that approach or exceed respective noise criteria.

The most representative noise monitoring location along the proposed northern Resist features associated with Alternative 2 is noise monitoring site # 3 (Harborside Park). Existing daytime (7:00 AM to 10:00 PM) noise levels of 68 dBA (L_{Aeq}) were documented in this location. As previously mentioned, an increase in 10 dB is discerned as a doubling of loudness. Assuming a change in noise levels of 10 dB as a reference point for annoyance, the closest first-row residential receivers with a direct line-of-sight to construction activities may experience noise levels that annoy any population of occupants during weekday daytime construction periods for approximately three months. Construction-related noise levels of 108 dBA (L_{Aeq}) at the closest first-row residential receivers may result from pile driving along the proposed northern Alternative 2 Resist alignment.

The most representative noise monitoring location along the proposed southern Resist features associated with Alternative 2, Option 1 and Option 2, is noise monitoring site # 4 (55 Bloomfield Street). Existing weekday daytime (7:00 AM to 10:00 PM) noise levels of 76 dBA (L_{Aeq}) were documented in this location. Assuming a change in noise levels of 10 dB as a reference point for annoyance, the closest first-row residential receivers with a direct line-of-sight to construction activities may experience noise levels that annoy any population of occupants during weekday daytime construction periods for approximately two months. Residential units within the southern region of the Study Area may experience construction-related noise levels of 79 dBA (L_{Aeq}) to 88 dBA (L_{Aeq}) along the proposed southern Alternative 2, Option 1 and Option 2 alignments, respectively.

As previously mentioned, weekday daytime noise levels as a result of construction activities are exempt from NOHRHC. In some locations, first-row homes provide shielding for second-row homes. Since the number of residences who occupy their homes during the day is unknown and building heights surrounding the Resist alignments are also unknown, the population of occupants that are predicted to be annoyed by noise levels during weekday daytime construction of Alternative 2, Option 1 and Option 2 cannot be quantified at this time.

Table 4.22 Alternative 2, Options 1 and 2 Construction-Related Weekday Daytime Noise Impacts

SENSITIVE SITE CATEGORY (# OF IMPACT)	RECEIVER NAME	IMPACT CRITERIA (L_{AEQ})	PREDICTED CONSTRUCTION NOISE LEVEL RANGE (LAEQ)	DURATION OF IMPACT[1] (MONTH)
School (1)	Elysian Charter School of Hoboken	51	52 - 87	17
Recreational Area (4)	1600 Park	66	67 - 92	14
	Harborside Park		67 - 114	15
	Gateway Park		67 - 114	2
	Erie-Lackawanna Park[2]		67 - 71	5 / 3

Note: 1 – [1] Duration of impact assumes 240 LF of construction per month based on impact pile driving activities.
2 – [2] Alternative 2, Option 1 / Alternative 2, Option 2 estimated duration.

Source: Paul Carpenter Associates, Inc., 2016

DSD construction impacts are the same as described under Alternative 1.

Alternative 3

Operational

The operational noise impacts are the same as described under Alternative 1.

Construction

Individually, impact pile driving and vibratory sheet driving are predicted to result in noise impacts at three schools and four recreational areas (see **Table 4.23**) during construction of Alternative 3, Options 1 and 2 Resist structures and 14th Street improvements associated with the high-level storm sewer and force main outfalls along Weehawken Cove. Adverse noise impacts under Alternative 3 would impact schools, recreational sites, and residences in different locations within the Study Area over the duration of the construction activities.

No noise impact to libraries or places of worship is expected during construction of Alternative 3, Options 1 and 2.

The Elysian Charter School of Hoboken possesses elevated classroom windows that provide a direct line-of-sight to construction-related activities. The assessment for this school conservatively assumes a windows open condition. However, both locations of the Hoboken Montessori School (14th Street and Bloomfield Street) are located within buildings with inoperable windows.

Assuming construction would progress 240 LF per month, it is predicted that noise levels at the Elysian Charter School of Hoboken would exceed the NAC for 18 months. In addition, Hoboken Montessori Schools located on 14th Street and Bloomfield Street are predicted to possess interior noise levels that would exceed the NAC for one month and less than one month, respectively. The duration in months

Table 4.23 Alternative 3, Options 1 and 2 Construction-Related Weekday Daytime Noise Impacts

SENSITIVE SITE CATEGORY (# OF IMPACT)	RECEIVER NAME	IMPACT CRITERIA (L_{AEQ})	PREDICTED CONSTRUCTION NOISE LEVEL RANGE (L_{AEQ})	DURATION OF IMPACT[1] (MONTH)
School (1)	Elysian Charter School of Hoboken	51	52 - 88	18
Recreational Area (4)	Hoboken Montessori - 14th Street		52 - 58	1
	Hoboken Montessori - Bloomfield Street		52 - 53	< 1
	Gateway Park[2]	66	67 - 92	13
	Harborside Park		67 - 114	11
	Gateway Park[2]		67 - 114	2
	Erie-Lackawanna Park[2]		67 - 71	5 / 3

Note: 1 – [1] Duration of impact assumes 240 LF of construction per month based on impact pile driving activities.
2 – [2] Alternative 3, Option 1 / Alternative 3, Option 2 estimated duration.

Source: Paul Carpenter Associates, Inc., 2016

for recreational areas predicted to exceed the NAC ranges from two (Gateway Park) to 13 months (Harborside Park). **Table 4.23** presents a listing of sites in each noise sensitive category, associated impact criteria, construction-related noise level range, and durations predicted to possess weekday daytime noise levels that approach or exceed respective noise criteria.

The most representative noise monitoring location along the proposed northern Resist features associated with Alternative 3 is noise monitoring site # 3 (Harborside Park). Existing daytime (7:00 AM to 10:00 PM) noise levels of 68 dBA (L_{Aeq}) were documented in this location. As previously mentioned, an increase in 10 dB is discerned as a doubling of loudness. Assuming a change in noise levels of 10 dB as a reference point for annoyance, the closest first-row residential receivers may experience construction-related noise levels that annoy any population of occupants during weekday daytime construction periods for approximately three months. Construction-related noise levels of 114 dBA (L_{Aeq}) at the closest first-row residential receivers may result from pile driving along the proposed northern Alternative 3 Resist alignment.

The most representative noise monitoring location along the proposed southern Resist features associated with Alternative 3, Option 1 and Option 2, is noise monitoring site # 4 (55 Bloomfield Street). Existing weekday daytime (7:00 AM to 10:00 PM) noise levels of 76 dBA (L_{Aeq}) were documented in this location. Assuming a change in noise levels of 10 dB as a reference point for annoyance, the closest first-row residential receivers may experience construction-related noise levels that annoy any population of occupants during weekday daytime construction periods for approximately two months. Residential units within the southern region of the Study Area may experience construction-related noise levels of 79 dBA (L_{Aeq}) to 88 dBA (L_{Aeq}) along proposed southern Alternative 3, Option 1 and Option 2 alignments, respectively.

As previously mentioned, weekday daytime noise levels as a result of construction activities are exempt from NOHRHC. In some locations, first-row homes provide shielding for second-row homes. Since the number of residents who occupy their homes during the day and building heights surrounding the Resist structure alignments are unknown, the population of occupants that are predicted to be annoyed by noise levels during weekday daytime Alternative 3, Option 1 and Option 2 construction cannot be quantified at this time.

DSD construction impacts are the same as described under Alternative 1.

No Action Alternative

There would be no construction or operational noise generated under the No Action Alternative.

4.3.4 Mitigation Measures and BMPs under Alternatives 1, 2, and 3

Durations of noise impact for the three academic buildings located on the Stevens Institute of Technology campus (McClean Hall, Edwin A. Stevens Hall, and the Babbio Center) range from one to three months; therefore, construction may be potentially performed within this area during timeframes of lower attendance for Alternative 1, Options 1 and 2 in order to minimize noise impacts. Additionally, these school buildings provide alternative means of ventilation (i.e., air conditioning), allowing for windows to remain closed year round. Based on FHWA guidance, a window-wall attenuation value of 35 dB (L_{Aeq}) can be assumed. In the event that the school agrees to keep windows closed, impact to the three Stevens Institute of Technology academic buildings could be mitigated for Alternative 1, Option 1 and Option 2 during any month.

Duration of noise impacts predicted for the Elysian Charter School of Hoboken range from 11 months for construction of Alternative 1, 17 months for construction of Alternative 2, and 18 months for construction of Alternative 3. The school is located in a building that provides alternative means of ventilation (i.e., air conditioning) allowing for windows to remain closed year round. Based on FHWA guidance, a window-wall attenuation value of 35 dB ($L_{Aeq)}$ can be assumed. In the event the school agrees to close windows while classes are in session, impact to the Elysian Charter School of Hoboken could be mitigated for Alternative 1, Option 1 and Option 2.

With windows closed during months when the Elysian Charter School of Hoboken is in session, noise impact can be reduced to three and four months for Alternative 2 (Option 1 or 2) and Alternative 3 (Option 1 or 2), respectively. Therefore, to minimize noise

impact, work performed within this area potentially could be performed during timeframes of lower attendance for Alternatives 2 and 3. Alternatively, the school may elect to relocate students from classrooms facing construction activities to other rooms within the building, if possible, during periods of adjacent construction activities.

Under final design, a building noise attenuation study is recommended for the Elysian Charter School of Hoboken to confirm an attenuation value of 35 dB (L_{Aeq}). Since the building is newly constructed, the building may potentially provide a higher building attenuation value than assumed. The study is non-invasive and is performed through a comparison analysis of noise levels documented outside with concurrent interior classroom measurements. Documenting building attenuation values higher than 35 dB (L_{Aeq}) would result in lower interior noise levels while documenting building attenuation values lower than 35 dB (L_{Aeq}) would conversely result in higher interior noise levels.

Hoboken Montessori Schools are located ground level on 14th Street and Bloomfield Street. Duration of noise impact predicted for the Hoboken Montessori School located on 14th Street is estimated to be one month during construction of Alternative 3, Option 1 and 2. In addition the duration of noise impact predicted for the Hoboken Montessori School located on Bloomfield Street is less than one month during construction of Alternative 3, Option 1 and 2. The schools are located within buildings that provide ventilation (i.e., air conditioning) and do not possess operable windows. Alternative 3 construction activities adjacent to these schools could occur during periods of lower attendance in order to minimize noise impact. Under final design , a building noise attenuation study for both Hoboken Montessori schools is recommended to ensure the assumed attenuation value.

Mitigation for recreational areas is challenging since many of these sites are located directly adjacent to Resist alignments. Source heights associated with vibratory sheet driving and impact pile driving will be elevated for a majority of the time. Mitigation utilizing path controls such as temporary noise walls would be ineffective since the line-of-sight to these elevated sources would not be broken. Therefore, a public education campaign would be implemented to advise recreational users of daytime noise levels during the construction period.

To minimize noise impact, construction activities should be limited to weekday (Monday – Friday) daytime hours (7:00 AM - 6:00 PM), as permitted by NOHRHC. Due to the high noise levels associated with construction of Resist features, nighttime and weekend construction should be prohibited. Although construction activities are exempt from meeting maximum permissible sound level limits established within NOHRHC during daytime hours, construction noise level limits are recommended for inclusion within contract documents for daytime-sensitive receivers evaluated as part of the construction noise assessment for this project (schools, libraries, places of worship, and recreational areas). Noise level limits should be established at exterior areas of human use or interior use areas, if no exterior areas exist at the sensitive receiver. Such limits are subject to negotiation by NJDEP and will be defined under final design. Requiring compliance monitoring utilizing established noise level limits is recommended throughout the duration of construction.

In addition to limiting construction hours, primary consideration should be given to ‘source’ controls. Quieter equipment models, mufflers, and exhausts are recommended, as well as utilizing the appropriate size equipment necessary for the activity. Further, alternative construction methods should be considered, such as use of vibratory hammers and drilled piles, where feasible. Alternative measures may not be feasible along the entire Resist alignments due to schedule delays and cost constraints. Specific locations where alternative methods are feasible will be reviewed during final design.

Measures to reduce and control noise during construction should be considered for inclusion in contract documents. Recommended noise control measures for both the Resist and DSD components to be considered for inclusion in contract documents may consist of the following:

- establish construction noise criteria;
- require the contractor to develop a Noise Control and Mitigation Plan based on proposed equipment and methods to document expected noise levels and noise control measures that would be implemented;
- require use of drilled piles and specify locations along Resist alignment where this requirement is applicable;
- construct localized three-sided enclosures with roofs around stationary equipment such as compressors and generators;
- require use of broadband alarms in lieu of pure tone alarms;
- maintain equipment with effective mufflers;
- require the use of silencers on combustion engines;
- limit equipment and delivery/haul-away truck idle times in accordance with N.J.A.C. 7:27-14 and N.J.A.C. 7:27-15;
- line all truck beds and dumpsters with noise dampening material;
- route truck traffic down streets with industrial and commercial land use to avoid excessive truck traffic down streets with residential land use; and
- require third-party compliance construction noise monitoring.