Chapter 7: Shadows

A. INTRODUCTION

This chapter considers the potential for the proposed actions to result in significant adverse shadows impact on any nearby publicly accessible sunlight-sensitive resources or other resources of concern. According to the 2014 *City Environmental Quality Review (CEQR) Technical Manual*, resources of concern include public open space, sunlight-dependent features of historic architectural resources, and natural resources that depend on sunlight.

As described in Chapter 1, "Project Description," the applicants, the New York City Department of City Planning (DCP) and SJC 33 Owner 2015 LLC, are proposing a series of discretionary actions (the proposed actions) that would facilitate the redevelopment of St. John's Terminal Building at 550 Washington Street (Block 596, Lot 1) (the development site) with a mix of residential and commercial uses, and public open space (the proposed project) in Manhattan Community District 2. The tallest building of the proposed project would be located on the North Site and be 430 feet to the roof and 480 feet to the top of the bulkhead. The tallest building south of West Houston Street would be 320 feet to the roof and 370 feet to the top of the bulkhead. In the future without the proposed actions, the as-of-right (No Action) development would include a tower on the North Site that would be 630 feet to the roof and 666 feet to the top of the bulkhead. South of West Houston, the tallest No Action building would be approximately 100 feet tall. All building heights analyzed in this chapter account for rooftop mechanical structures and bulkhead.

PRINCIPAL CONCLUSIONS

This analysis compared shadows that would be cast by the proposed project with those that would be cast by the as-of-right (No Action) development that would be developed absent the proposed actions. The proposed project would create new shadows on Hudson River Park and its facilities on Pier 40 and on the Hudson River. The detailed shadow analysis showed that the incremental shadows would not substantially alter the usability of the open space resources or their ability to sustain vegetation and would not significantly alter the condition of the affected natural resource. The detailed analysis concludes that the proposed project would not result in significant adverse shadows impacts since the new shadows would be limited in extent, duration and effects as demonstrated in detail below.

B. DEFINITIONS AND METHODOLOGY

This analysis has been prepared in accordance with CEQR procedures and follows the guidelines of the *CEQR Technical Manual*.

DEFINITIONS

Incremental shadow is the additional, or new, shadow that a structure resulting from a proposed project would cast on a sunlight-sensitive resource.

Sunlight-sensitive resources are those resources that depend on sunlight or for which direct sunlight is necessary to maintain the resource's usability or architectural integrity. Such resources generally include:

- *Public open space* such as parks, beaches, playgrounds, plazas, schoolyards (if open to the public during non-school hours), greenways, and landscaped medians with seating. Planted areas within unused portions of roadbeds that are part of the Greenstreets program are also considered sunlight-sensitive resources.
- *Features of architectural resources that depend on sunlight for their enjoyment by the public*. Only the sunlight-sensitive features need be considered, as opposed to the entire resource. Such sunlight-sensitive features might include: design elements that depend on the contrast between light and dark (e.g., recessed balconies, arcades, deep window reveals); elaborate, highly carved ornamentation; stained glass windows; historic landscapes and scenic landmarks; and features for which the effect of direct sunlight is described as playing a significant role in the structure's importance as a historic landmark.
- *Natural resources* where the introduction of shadows could alter the resource's condition or microclimate. Such resources could include surface water bodies, wetlands, or designated resources such as coastal fish and wildlife habitats.

Non-sunlight-sensitive resources include, for the purposes of CEQR:

- *City streets and sidewalks* (except Greenstreets);
- *Private open space* (e.g., front and back yards, stoops, vacant lots, and any private, non-publicly-accessible open space);
- *Project-generated open space* typically is not considered to experience a significant adverse shadow impact from a project, according to CEQR, because without the project the open space would not exist.

A significant adverse shadow impact occurs when the incremental shadow added by a proposed project falls on a sunlight-sensitive resource and substantially reduces or completely eliminates direct sunlight, thereby significantly altering the public's use of the resource or threatening the viability of vegetation or other resources. Each case must be considered on its own merits based on the extent and duration of new shadow and an analysis of the resource's sensitivity to reduced sunlight.

METHODOLOGY

As described in Chapter 2, "Analytical Framework," this Environmental Impact Statement (EIS) considers two scenarios: the proposed project and the proposed project with big box retail. Either of these scenarios could contain hotel or office use on the South Site. This shadows analysis considers the maximum building envelope that would be allowed, which could accommodate either the proposed project or the proposed project with big box retail, with hotel use on the South Site.

Following the guidelines of the *CEQR Technical Manual*, a preliminary screening assessment is first conducted to ascertain whether a project's shadow could reach any sunlight-sensitive

resources at any time of year. The preliminary screening assessment consists of three tiers of analysis. The first tier determines a simple radius around the development site representing the longest shadow that could be cast. If there are sunlight-sensitive resources within this radius, the analysis proceeds to the second tier, which reduces the area that could be affected by project shadow by accounting for the fact that shadows can never be cast between a certain range of angles south of the project site due to the path of the sun through the sky at the latitude of New York City.

If the second tier of analysis does not eliminate the possibility of new shadows on sunlight-sensitive resources, a third tier of screening analysis further refines the area that could be reached by project shadow by looking at specific representative days in each season and determining the maximum extent of shadow over the course of each representative day.

If the third tier of analysis does not eliminate the possibility of new shadows on sunlight-sensitive resources, a detailed shadow analysis is required to determine the extent and duration of the incremental shadow resulting from the project. The detailed analysis provides the data needed to assess the shadow impacts. The effects of the new shadows on the sunlight-sensitive resources are described, and their degree of significance is considered. The results of the analysis and assessment are documented with graphics, a table of incremental shadow durations, and narrative text.

Following the guidance of the *CEQR Technical Manual*, this chapter also qualitatively considers the effect of shadows on the new publicly accessible open space that would be created as part of the proposed project.

C. PRELIMINARY SCREENING ASSESSMENT

A base map was developed using Geographic Information Systems (GIS)[1] showing the location of the proposed project and the surrounding street layout (see **Figure 7-1**). In coordination with the land use and historic and cultural resources assessments presented in other chapters of this Environmental Impact Statement (EIS), potential sunlight-sensitive resources were identified and shown on the map.

TIER 1 SCREENING ASSESSMENT

For the Tier 1 assessment, the longest shadow that the proposed project could cast is calculated, and, using this length as the radius, a perimeter is drawn around the project site. Anything outside this perimeter representing the longest possible shadow could never be affected by project generated shadow, while anything inside the perimeter needs additional assessment.

According to the *CEQR Technical Manual*, the longest shadow that a structure can cast at the latitude of New York City occurs on December 21, the winter solstice, at the start of the analysis day at 8:51 AM, and is equal to 4.3 times the height of the structure.

At a maximum height of 480 feet above curb level, the proposed development could cast a shadow up to 2,064 feet in length (480 x 4.3). Using this length as the radius, a perimeter was drawn around the development site. **Figure 7-1** illustrates the extent of the perimeter or longest

[1] Software: Esri ArcGIS 10.3; Data: New York City Department of Information Technology and Telecommunications (DoITT) and other City agencies, and AKRF site visits.

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Development Site

Tier 1: Longest shadow study area boundary

Tier 2: Area south of site that could never be shaded by proposed building

Publicly Accessible Open Space

Historic Resources with Sunlight-Sensitive Features

Tier 1 and Tier 2 Assessments
Figure 7-1

shadow study area and identifies the sun-sensitive resources included within it. The open spaces within this perimeter include:

- Hudson River Park—Hudson River Park is an approximately 550-acre publicly accessible open space stretching along Manhattan's west side from Battery Park to West 59th Street. The park features near the development site include the Route 9A Bikeway, the Leroy Street Dog Run, a river-adjacent esplanade, and tennis courts. Additional information on Hudson River Park is presented below.
- Pier 40—The Pier 40 open space includes a 15-acre sports facility with various athletic fields.
- The Gardens at St. Luke in the Fields—This privately owned open space is open daily to the public and includes passive amenities such as seating and planted areas.
- James J. Walker Park—This 1.67-acre open space includes benches, trees, a soccer field, a playground, a bocce court, a baseball field, and handball courts.
- Father Demo Square—This 0.25-acre open space includes a fountain, landscaping, and benches.
- Downing Street Playground—This 0.22-acre open space includes a playground, spray shower, and a comfort station.
- Little Red Square—This 0.04-acre open space includes benches and trees.
- William Passannante Ballfield—This 0.61-acre open space includes athletic fields and courts.
- Playground of the Americas—This 0.08-acre open space includes a playground, trees, a bench, and landscaping.
- Charlton Plaza—This 0.04-acre open space with benches, game tables, landscaping, and mural art work.
- Father Fagan Park—This 0.05-acre open space includes benches and trees.
- various Greenstreets—These are planted areas within the roadway right-of-way.
- Canal Park—This 0.67-acre open space includes benches, trees, and landscaping.
- Trump Plaza—This 0.16-acre open space includes benches, landscaping, trees, tables, and chairs.
- Thompson Street Playground—This 0.64-acre open space includes basketball courts, handball courts, an outdoor pool, spray showers, playgrounds, and a comfort station.
- Soho Square—This 0.58-acre open space includes the General Jose Artigas Monument, benches, and trees.

The one natural resource within this perimeter is the Hudson River, an important natural resource flowing along the western border of Manhattan and the Bronx. The river habitat supports both small and large living organisms, and the vitality of phytoplankton, microalgae, and numerous fish and invertebrate species could be affected by the duration of direct sunlight falling on the river's surface. Historic resources with sunlight-sensitive features include: St. Veronica's Church (Christopher Street between Washington and Greenwich Streets) and Our Lady of Pompeii Church (corner of Carmine Street and Bleecker Street).

Because there are sunlight-sensitive resources within the longest shadow study area, the next tier of screening is required.

TIER 2 SCREENING ASSESSMENT

Because of the path that the sun travels across the sky in the northern hemisphere, no shadow can be cast in a triangular area south of any given project site. In New York City, this area lies between -108 and +108 degrees from true north. **Figure 7-1** illustrates this triangular area south of the project site. The complementing area to the north within the longest shadow study area represents the remaining area that could potentially experience new project generated shadow. As illustrated in **Figure 7-1,** sunlight-sensitive open spaces, historic, and natural resources are all located within the area that could potentially experience new project-generated shadows. Four resources identified in the Tier 1 Assessment (Canal Park, Trump Plaza, Thompson Street Playground, and Soho Square) are removed from consideration based on the Tier 2 Screening. The remaining open spaces that could be affected are:

- Hudson River Park—Hudson River Park is an approximately 550-acre publicly accessible open space stretching along Manhattan's west side from Battery Park to West 59th Street. The park features near the development site include the Route 9A Bikeway, the Leroy Street Dog Run, a river-adjacent esplanade, and tennis courts. Additional information on Hudson River Park is presented below.
- Pier 40—The Pier 40 open space includes a 15-acre sports facility with various athletic fields.
- The Gardens at St. Luke in the Fields—This privately owned open space is open daily to the public and includes passive amenities such as seating and planted areas.
- James J. Walker Park—This 1.67-acre open space includes benches, trees, a soccer field, a playground, a bocce court, a baseball field, and handball courts.
- Father Demo Square—This 0.25-acre open space includes a fountain, landscaping, and benches.
- Downing Street Playground—This 0.22-acre open space includes a playground, spray shower, and a comfort station.
- Little Red Square—This 0.04-acre open space includes benches and trees.
- William Passannante Ballfield—This 0.61-acre open space includes athletic fields and courts.
- Playground of the Americas—This 0.08-acre open space includes a playground, trees, a bench, and landscaping.
- Charlton Plaza—This 0.04-acre open space with benches, game tables, landscaping, and mural art work.
- Father Fagan Park—This 0.05-acre open space includes benches and trees.
- Various Greenstreets—These are planted areas within the roadway right-of-way.

In addition, the Hudson River, an important natural resource flowing along the western border of Manhattan and the Bronx, and two historic resources with sunlight-sensitive features (St. Veronica's Church and Our Lady of Pompeii Church) would remain in the Tier 2 assessment.

Therefore, a Tier 3 assessment is required to model project-generated shadows on specific representative days of the year.

TIER 3 SCREENING ASSESSMENT

The direction and length of shadows vary throughout the course of the day and also differ depending on the season. Shadows move constantly but more quickly at the start and the end of the day than they do in the middle of the day. In order to determine whether project-generated shadow could fall on a sunlight-sensitive resource, three-dimensional computer mapping software is used in the Tier 3 assessment to calculate and display the incremental shadows from the proposed project on individual representative days of the year. A computer model was developed containing three-dimensional representations of the elements in the base map used in the preceding assessments, the topographic information of the study area, and the massing of the proposed project.

REPRESENTATIVE DAYS FOR ANALYSIS

Following the guidance of the *CEQR Technical Manual*, shadows on the summer solstice (June 21), winter solstice (December 21) and spring and fall equinoxes (March 21 and September 21, which are approximately the same in terms of shadow patterns) are modeled, to represent the range of shadows over the course of the year. An additional representative day during the growing season is also modeled, the day halfway between the summer solstice and the equinoxes, i.e., May 6 or August 6, which have approximately the same shadow patterns.

TIMEFRAME WINDOW OF ANALYSIS

The shadow assessment considers shadows occurring between one and a half hours after sunrise and one and a half hours before sunset. Within the 90 minutes after sunrise and the 90 minutes before sunset, the sun is low on the horizon, and its rays reach the vicinity of the project site at low angles, producing shadows that are very long, move fast, and generally blend with shadows from existing structures until the sun reaches the horizon and sets. Consequently, shadows occurring in these two 90-minute periods are not considered significant under CEQR, and their assessment is not required.

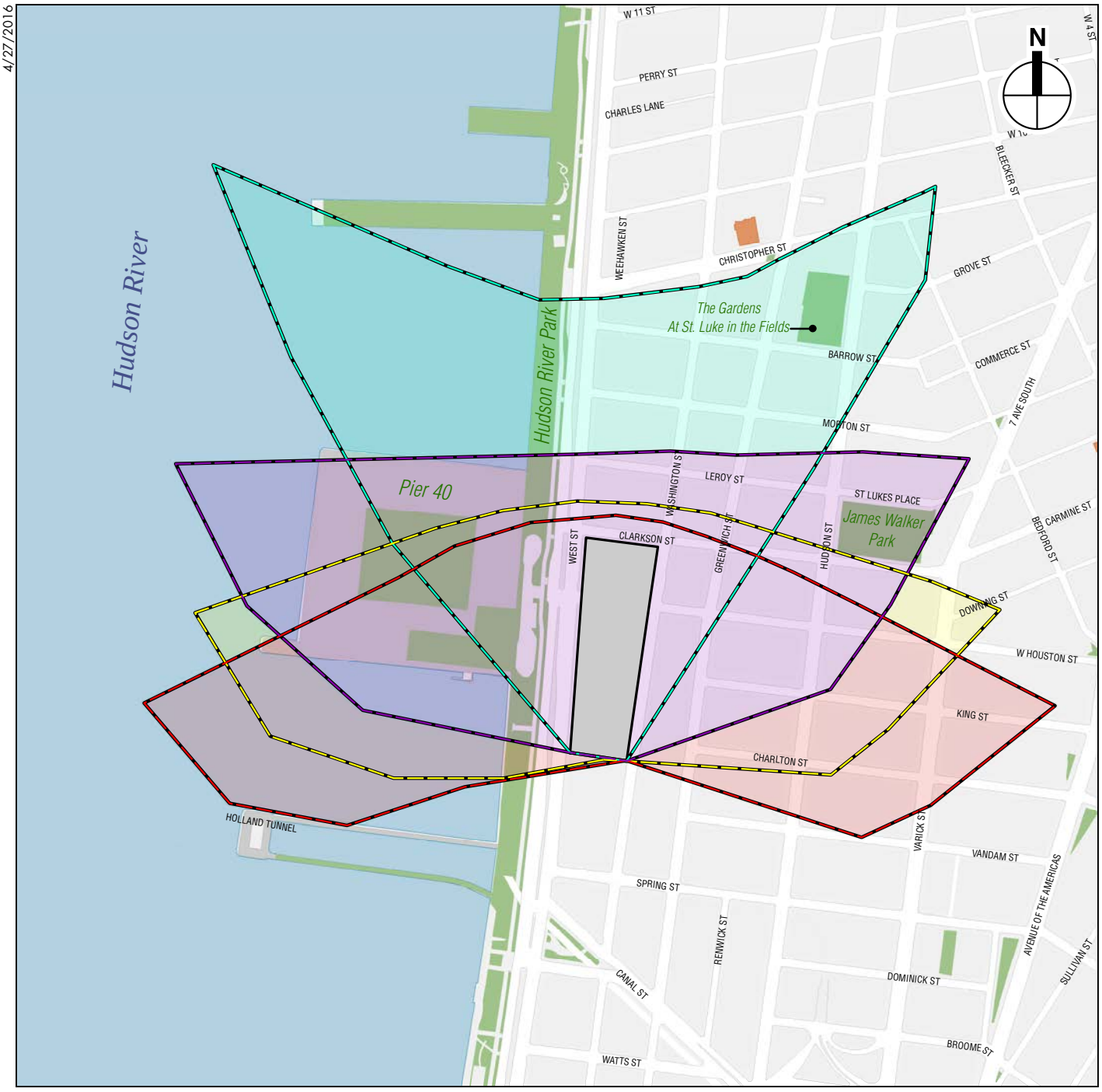
TIER 3 SCREENING ASSESSMENT RESULTS

Figure 7-2 illustrates the range of shadows that would occur, in the absence of intervening buildings, from the project site on the four representative days for analysis. The extent of shadow is shown between the start of the analysis day (one and a half hours after sunrise) to the end of the analysis day (one and a half hours before sunset).

The Tier 3 assessment found that project-generated shadows could potentially reach five of the sunlight-sensitive resources identified in the Tier 2 assessment:

- The Hudson River—This is an important natural resource flowing along the western border of Manhattan and the Bronx.
- Hudson River Park—Hudson River Park is an approximately 550-acre publicly accessible open space stretching along Manhattan's west side from Battery Park to West 59th Street. The park features near the development site include the Route 9A Bikeway, the Leroy Street Dog Run, a river-adjacent esplanade, and tennis courts. Additional information on Hudson River Park is presented below.
- Pier 40—The Pier 40 open space includes a 15-acre sports facility with various athletic fields.
- The Gardens at St. Luke in the Fields—This privately owned open space is open daily to the public and includes passive amenities such as seating and planted areas.

4/27/2016



Development Site

Publicly Accessible Open Space

Historic Resources with Sunlight-Sensitive Features

June 21 Shadow Extent

March 21/September 21 Shadow Extent

May 6/August 6 Shadow Extent

December 21 Shadow Extent

- James J. Walker Park—This 1.67-acre open space includes benches, trees, a soccer field, a playground, a bocce court, a baseball field, and handball courts.

A detailed analysis was performed, as described below, to provide additional information on the potential extent and duration of incremental shadow on these five sunlight-sensitive features.

D. DETAILED ANALYSIS

The purpose of the detailed analysis is to determine the extent and duration of *incremental* shadows that fall on sunlight-sensitive resources as a result of the project and to assess their potential effects. To complete the assessment, a baseline or future No Action condition is established by appending three-dimensional representations of the existing buildings and planned future developments within the vicinity of the project site to the three-dimensional model used in the Tier 3 assessment. The future condition with the proposed project (With Action) and its shadows can then be compared to the baseline condition to determine the incremental shadows that would result with the proposed project.

The No Action development includes a 666-foot-tall (with bulkhead) No Action building on the North Site. **Figure 7-3** illustrates the computer models used in the detailed analysis of the future with the as-of-right building and with the development resulting from the proposed actions. Although the No Action building on the North Site would be taller than the proposed building on this portion of the development site, the No Action development south of West Houston Street would be shorter than the proposed project.

ANALYSIS RESULTS

The analysis found that three of the five resources identified in the Tier 3 analysis would receive new shadow in the With Action condition (see **Figures 7-4 through 7-11)**. Due to intervening buildings between the development site and James J. Walker Park and The Gardens at St. Luke in the Fields, the resources would not be affected by new shadow from the proposed project (see **Figure 7-12**). The remaining three resources (the Hudson River, Hudson River Park, and Pier 40) would receive new shadow in the With Action condition.

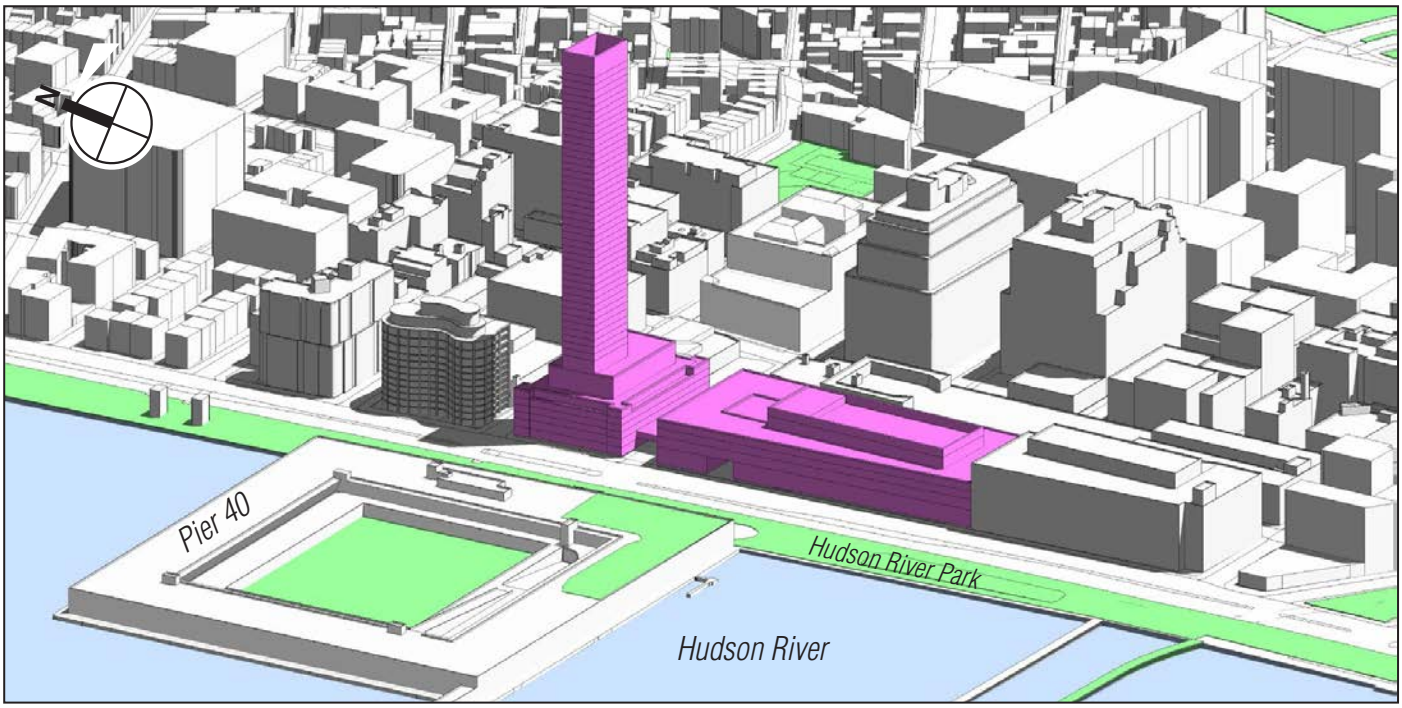
Table 7-1 describes the duration of new (incremental) shadows on the three resources identified in the detailed analysis that would experience new shadow. The table shows the entry and exit times and total duration of incremental shadow on the affected resources.

Table 7-1
Incremental Shadow Durations

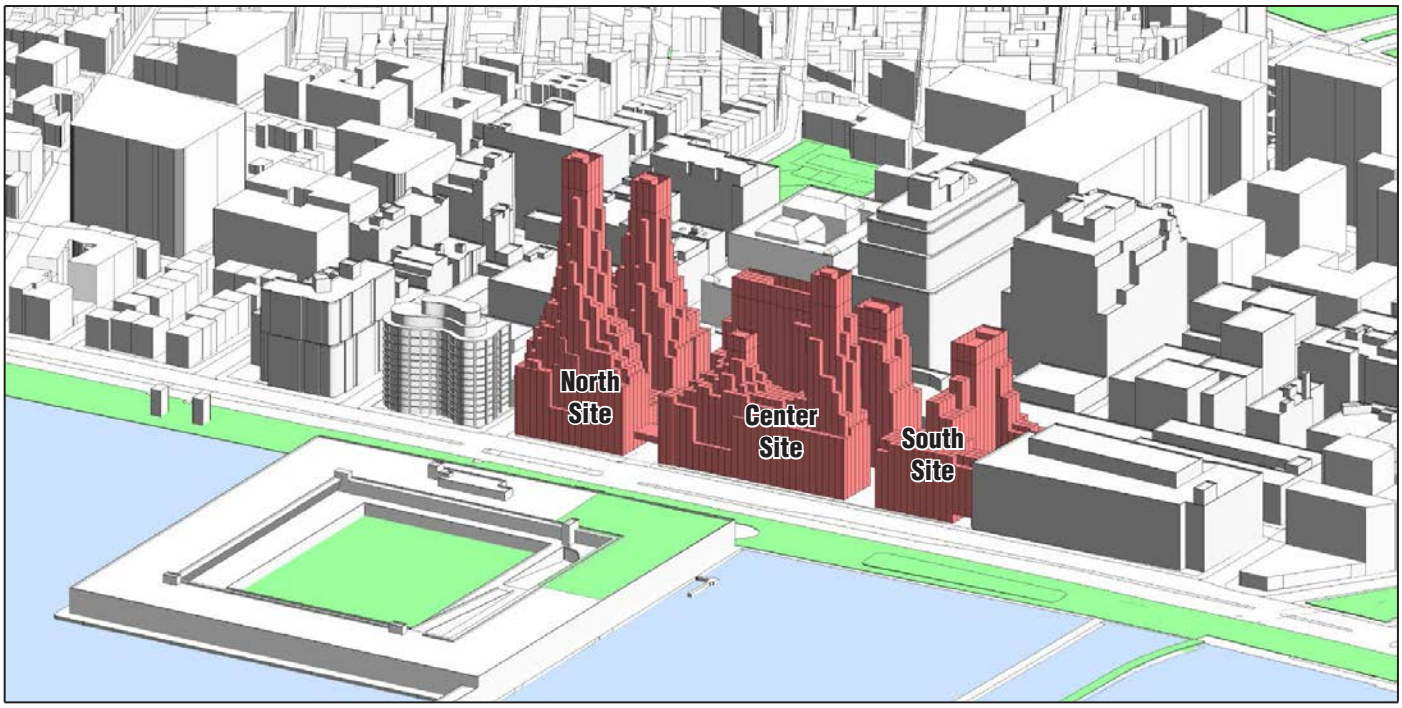
Analysis Day and Timeframe Window	March 21 / Sept. 21 7:36 AM - 4:29 PM	May 6 / August 6 6:27 AM - 5:18 PM	June 21 5:57 AM - 6:01 PM	December 21 8:51 AM - 2:53 PM
Incremental Shadow				
Hudson River	7:36 AM - 9:05 AM Total: 1 hr 29 min	6:27 AM - 8:20 AM Total: 1 hr 53 min	5:57 AM - 9:00 AM Total: 3 hr 3 min	8:51 AM - 10:30 AM Total: 1 hr 39 min
Hudson River Park	7:36 AM - 11:05 AM Total: 3 hr 29 min	6:27 AM - 10:35 AM Total: 4 hr 8 min	5:57 AM - 10:30 AM Total: 4 hr 33 min	8:51 AM - 11:26 AM Total: 2 hr 35 min
Pier 40	7:36 AM - 10:00 AM Total: 2 hr 24 min	6:27 AM - 9:30 AM Total: 3 hr 3 min	5:57 AM - 7:30 AM 8:15 AM - 9:00 AM Total: 2 hr 12 min	8:51 AM - 9:45 AM Total: 54 min

Notes:
Table indicates entry and exit times and total duration of incremental shadow for each sunlight-sensitive resource.
Daylight saving time is not used—times are Eastern Standard Time, per *CEQR Technical Manual* guidelines. However, as Eastern Daylight Time is in effect for the March/September, May/August and June analysis periods, add one hour to the given times to determine the actual clock time.

5.5.16



As-of-Right Development



Proposed Development

Detailed Analysis Model
Figure 7-3

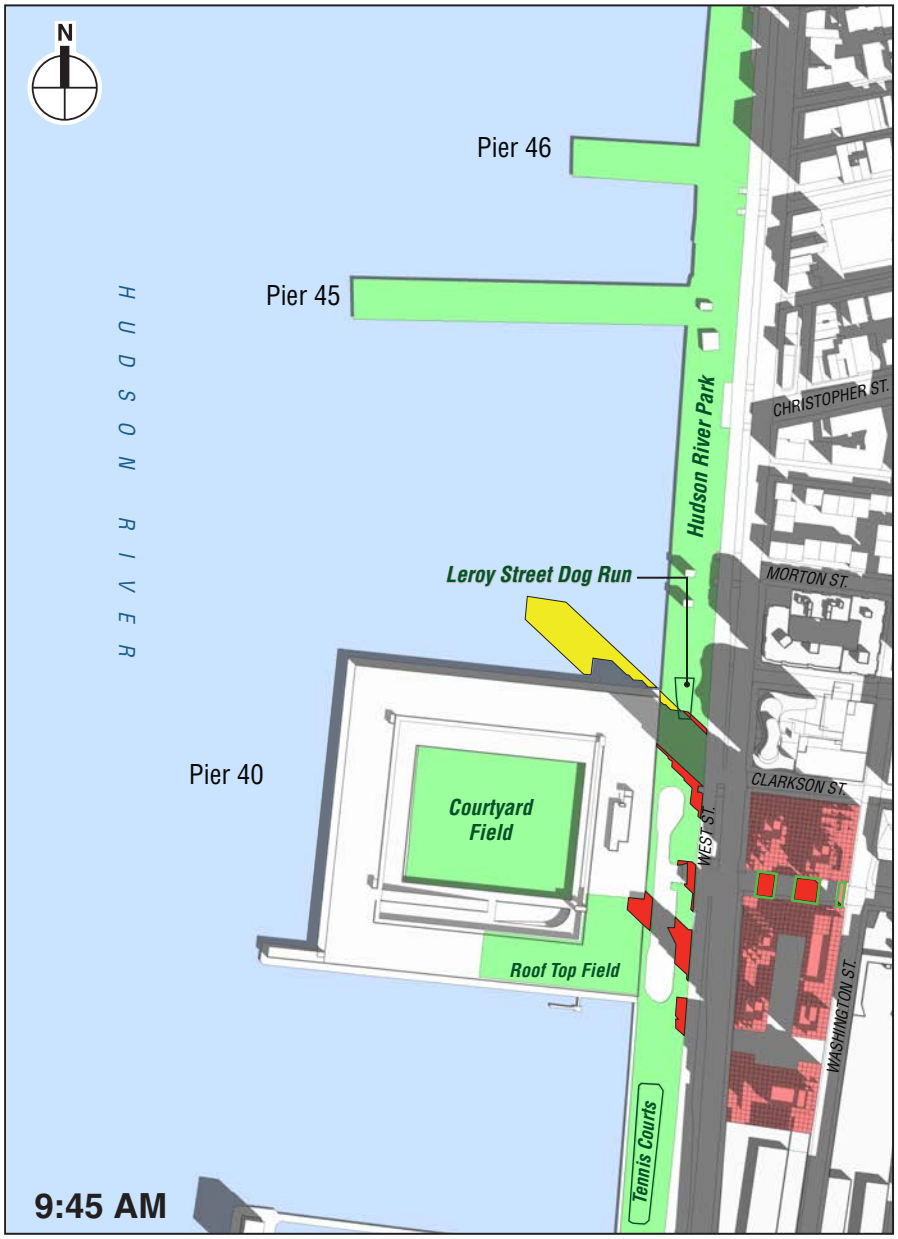
5.5.16

Proposed Development
Publicly Accessible Open Space
Project-Generated Publicly Accessible Open Space
Shadow on Sunlight-Sensitive Resource Originating Only from With Action Development
Shadow on Sunlight-Sensitive Resource Originating Only from No Action Development
Other Shadow (see text on page 7-8 for description)

550 WASHINGTON STREET

March/September 21
Detailed Shadow Analysis
Figure 7-4

5.5.16



Proposed Development
Publicly Accessible Open Space
Project-Generated Publicly Accessible Open Space
Shadow on Sunlight-Sensitive Resource Originating Only from With Action Development
Shadow on Sunlight-Sensitive Resource Originating Only from No Action Development
Other Shadow (see text on page 7-8 for description)

550 WASHINGTON STREET

March/September 21
Detailed Shadow Analysis
Figure 7-5

5.5.16

Proposed Development

Publicly Accessible Open Space

Project-Generated Publicly Accessible Open Space

Shadow on Sunlight-Sensitive Resource Originating Only from With Action Development

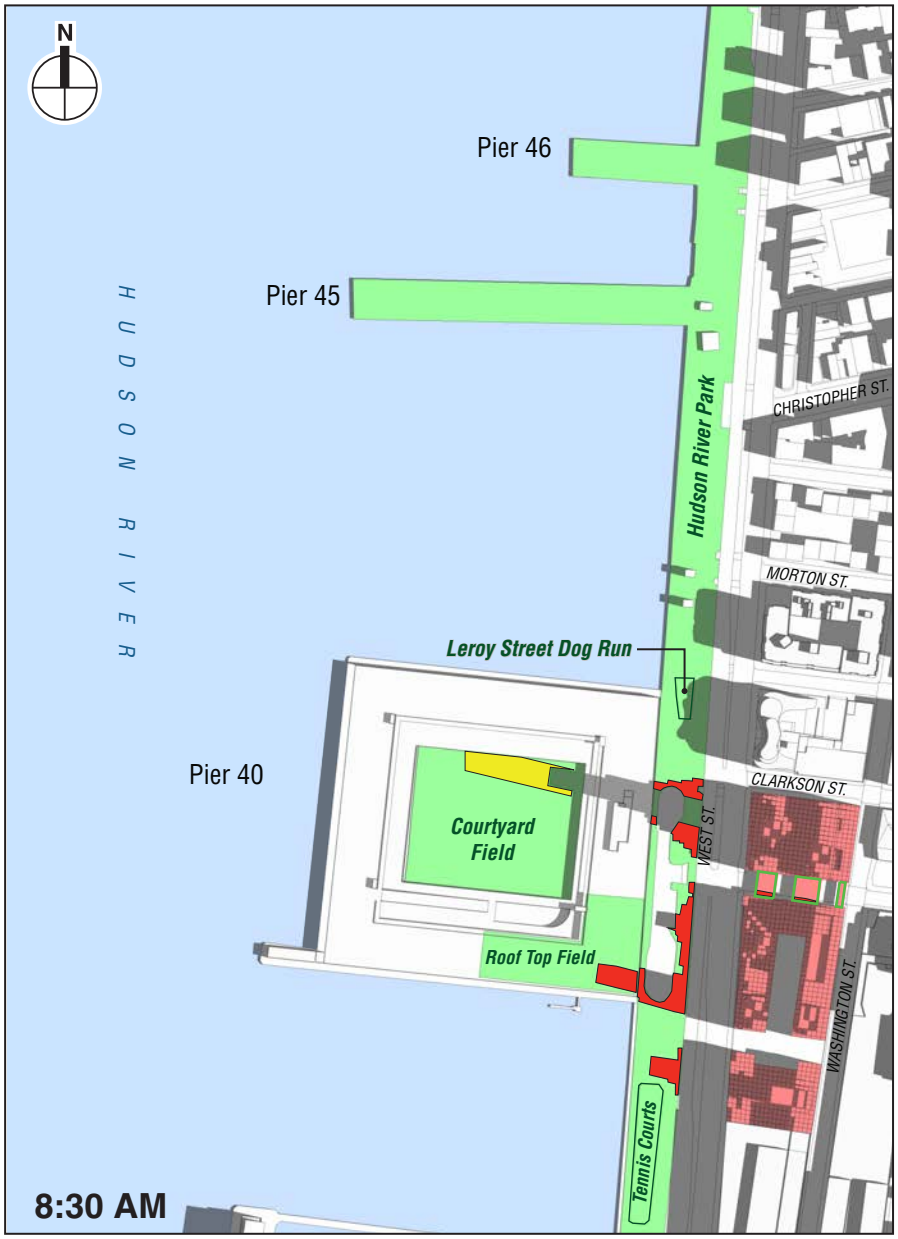
Shadow on Sunlight-Sensitive Resource Originating Only from No Action Development

Other Shadow (see text on page 7-8 for description)

550 WASHINGTON STREET

May/August 6
Detailed Shadow Analysis
Figure 7-6

5.5.16

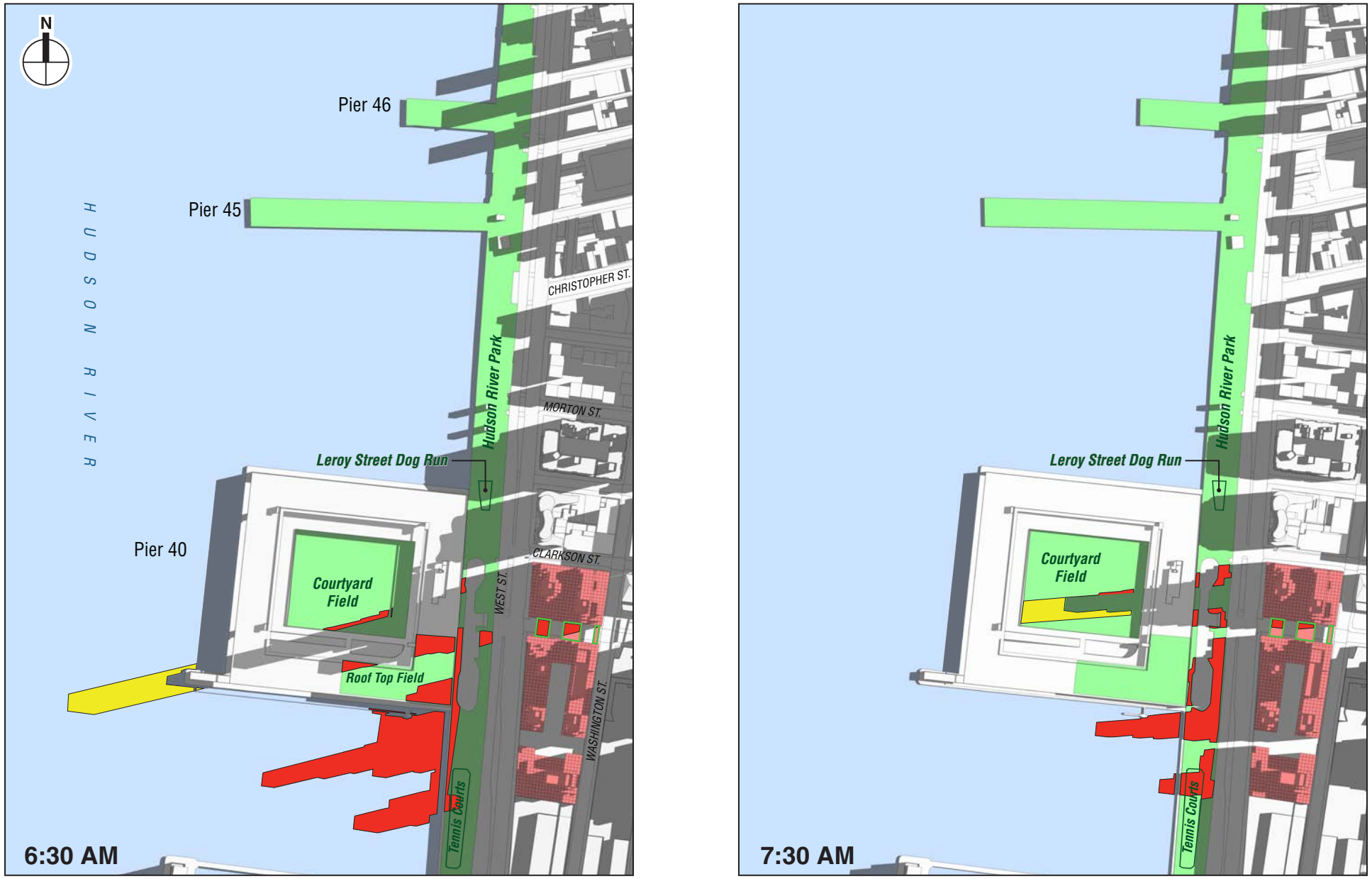


Proposed Development
Publicly Accessible Open Space
Project-Generated Publicly Accessible Open Space
Shadow on Sunlight-Sensitive Resource Originating Only from With Action Development
Shadow on Sunlight-Sensitive Resource Originating Only from No Action Development
Other Shadow (see text on page 7-8 for description)

550 WASHINGTON STREET

May/August 6
Detailed Shadow Analysis
Figure 7-7

5.5.16



Proposed Development

Publicly Accessible Open Space

Project-Generated Publicly Accessible Open Space

Shadow on Sunlight-Sensitive Resource Originating Only from With Action Development

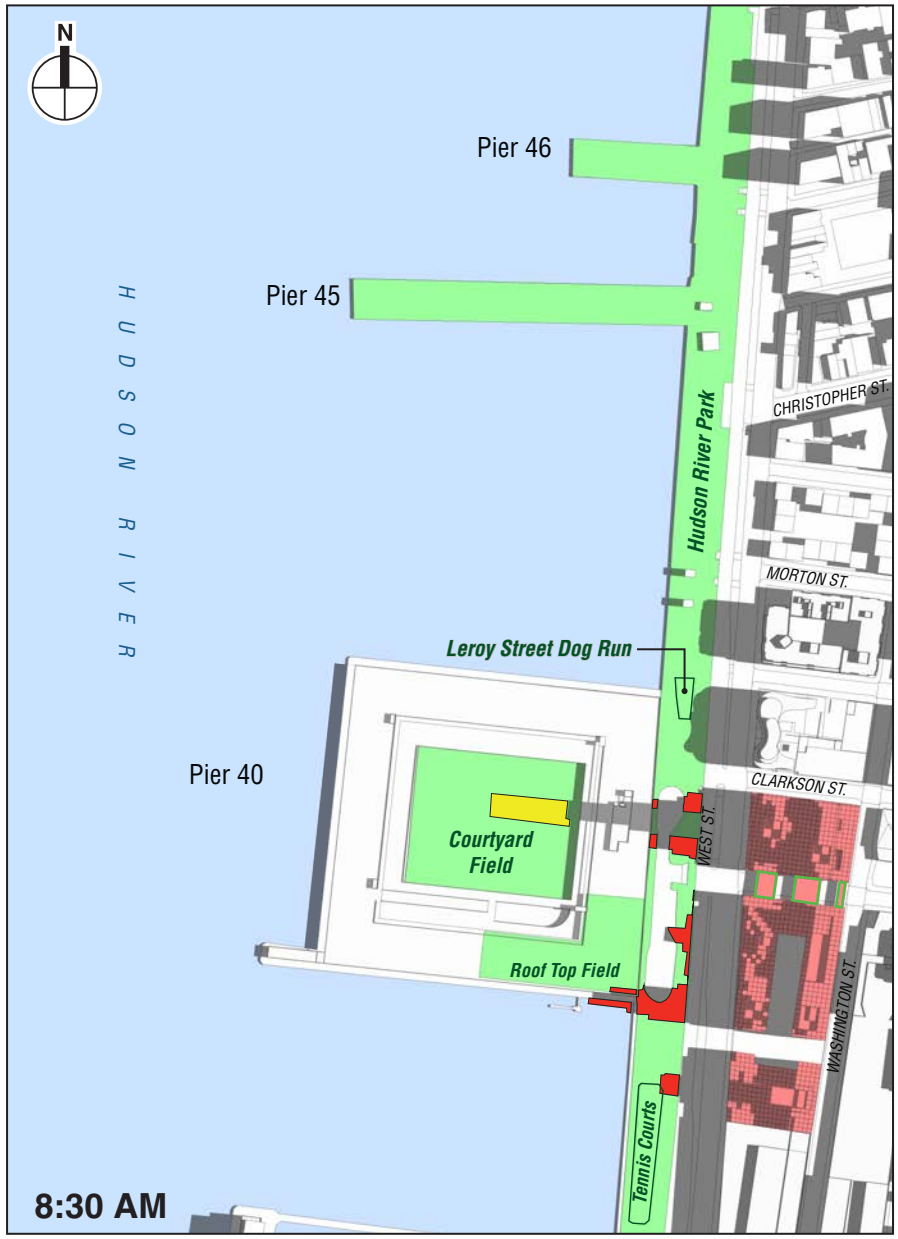
Shadow on Sunlight-Sensitive Resource Originating Only from No Action Development

Other Shadow (see text on page 7-8 for description)

550 WASHINGTON STREET

June 21
Detailed Shadow Analysis
Figure 7-8

5.5.16

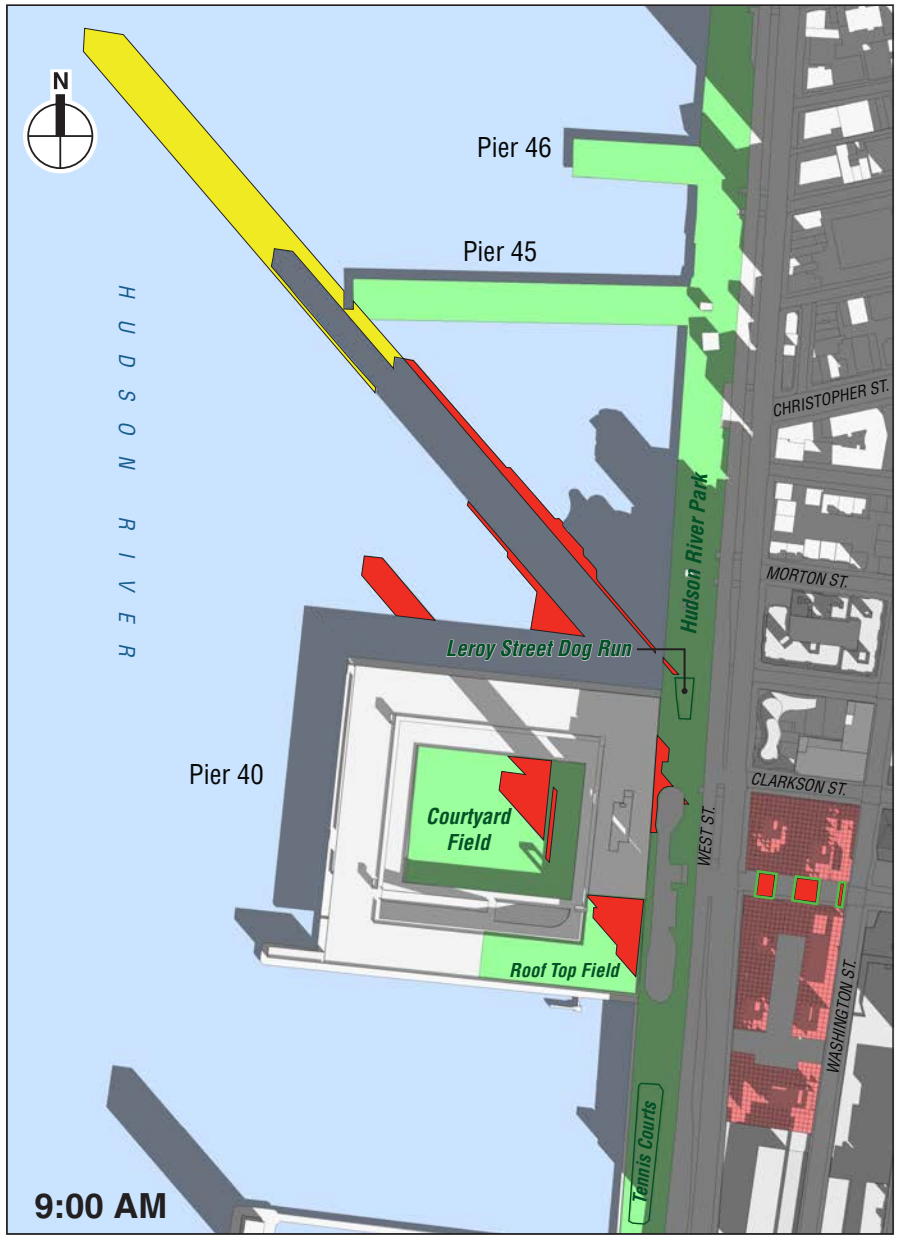


Proposed Development
Publicly Accessible Open Space
Project-Generated Publicly Accessible Open Space
Shadow on Sunlight-Sensitive Resource Originating Only from With Action Development
Shadow on Sunlight-Sensitive Resource Originating Only from No Action Development
Other Shadow (see text on page 7-8 for description)

550 WASHINGTON STREET

June 21
Detailed Shadow Analysis
Figure 7-9

5.5.16



Proposed Development

Publicly Accessible Open Space

Project-Generated Publicly Accessible Open Space

Shadow on Sunlight-Sensitive Resource Originating Only from With Action Development

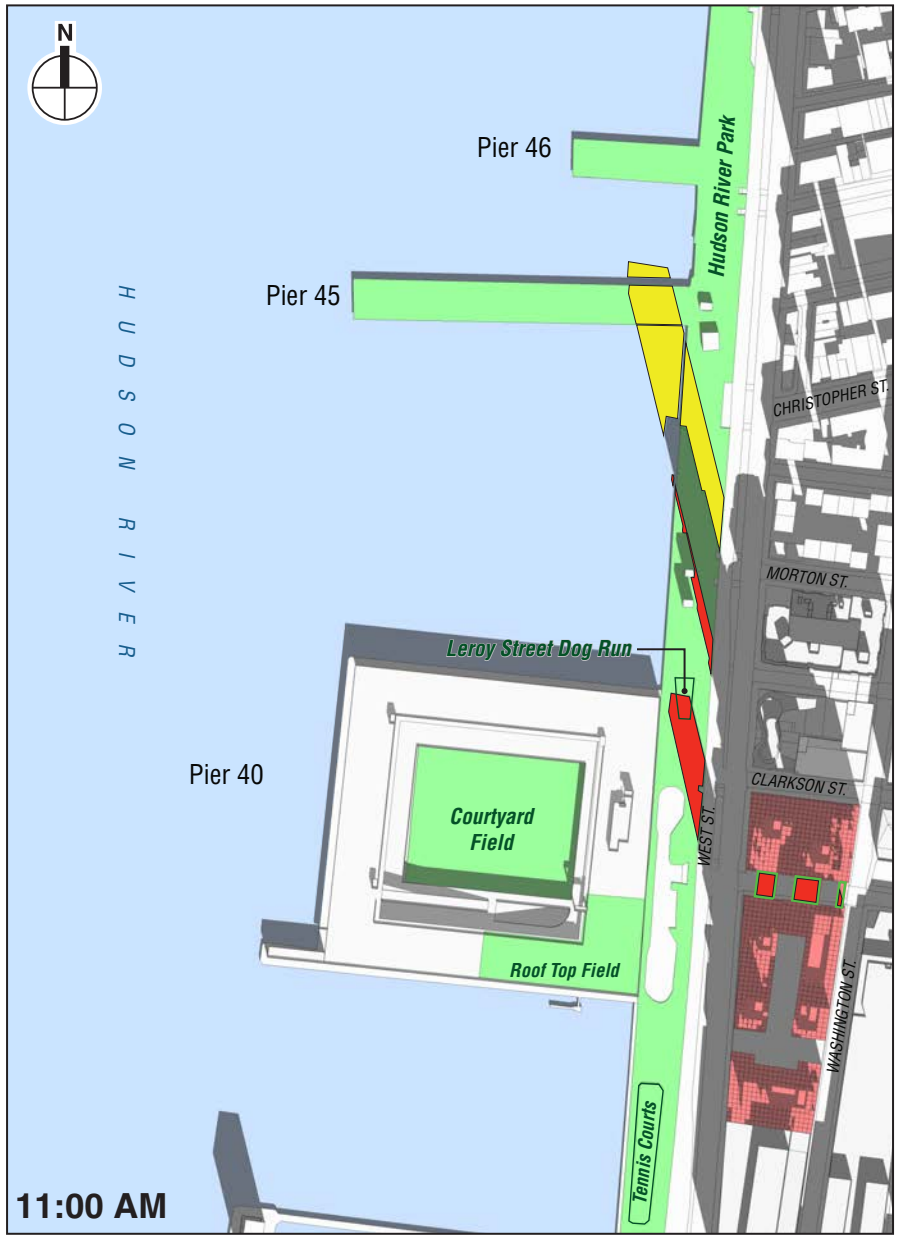
Shadow on Sunlight-Sensitive Resource Originating Only from No Action Development

Other Shadow (see text on page 7-8 for description)

550 WASHINGTON STREET

December 21
Detailed Shadow Analysis
Figure 7-10

5.5.16



Proposed Development

Publicly Accessible Open Space

Project-Generated Publicly Accessible Open Space

Shadow on Sunlight-Sensitive Resource Originating Only from With Action Development

Shadow on Sunlight-Sensitive Resource Originating Only from No Action Development

Other Shadow (see text on page 7-8 for description)

550 WASHINGTON STREET

December 21
Detailed Shadow Analysis
Figure 7-11

4.27.16

Publicly Accessible Open Space

Shadow Originating from Proposed Project

Proposed Building

Note: There would be no incremental shadow on any sunlight-sensitive resource at the illustrated analysis days and times.

Detailed Shadow Analysis
Figure 7-12

Table 7-2 shows the total duration of shadows originating from the development site on the three identified resources in the With Action and No Action conditions. Because the proposed project and No Action development are massed differently and the affected resources are large in size, a sunlight-sensitive resource can experience incremental shadow from the proposed project at the same time that it would experience shadow in the No Action condition. For example, on the March 21/September 21 analysis day, in the No Action condition the Hudson River would experience three hours and twenty-four minutes of shadow originating from the development site; in the With Action condition, the Hudson River would experience twenty-five minutes less shadow originating from the development site, or two hours and fifty-nine minutes. However, because shadow would be cast on different areas of the Hudson River in the two scenarios, the total incremental shadow with the proposed project would be one hour and twenty-nine minutes (see **Table 7-1** and **Figures 7-4 and 7-5**). For all sunlight-sensitive resources, incremental shadow durations described in **Table 7-1** would not be equal to the difference in total shadow durations between the With Action and No Action conditions described in **Table 7-2.**

Table 7-2
No Action and With Action Shadow Durations

Analysis Day and Timeframe Window	March 21 / Sept. 21 7:36 AM - 4:29 PM	May 6 / August 6 6:27 AM - 5:18 PM	June 21 5:57 AM - 6:01 PM	December 21 8:51 AM - 2:53 PM
No Action Shadow Duration				
Hudson River	7:36 AM - 11:00 AM Total: 3 hr 24 min	6:27 AM - 7:40 AM Total: 1 hr 13 min	5:57 AM - 7:20 AM Total: 1 hr 23 min	8:51 AM - 11:20 AM Total: 2 hr 29 min
Hudson River Park	7:36 AM - 11:30 AM Total: 3 hr 54 min	6:27 AM –11:05 AM Total: 4 hr 38 min	5:57 AM - 11:05 AM Total: 5 hr 8 min	8:51 AM - 11:45 AM Total: 2 hr 45 min
Pier 40	7:36 AM - 8:15 AM Total: 49 min	6:27 AM - 9:15 AM Total: 2 hr 48 min	5:57 AM - 9:20 AM Total: 3 hr 23 min	—
With Action Shadow Duration				
Hudson River	7:36 AM - 10:35 AM Total: 2 hr 59 min	6:27 AM - 8:20 AM Total: 1 hr 53 min	5:57 AM - 9:00 AM Total: 3 hr 3 min	8:51 AM - 11:05 AM Total: 2 hr 14 min
Hudson River Park	7:36 AM - 11:15 AM Total: 3 hr 39 min	6:27 AM - 10:45 AM Total: 4 hr 18 min	5:57 AM - 10:45 AM Total: 4 hr 48 min	8:51 AM - 11:35 AM Total: 2 hr 44 min
Pier 40	7:36 AM - 10:00 AM Total: 2 hr 24 min	6:27 AM - 9:30 AM Total: 3 hr 3 min	5:57 AM –9:00 AM Total: 3 hr 3 min	8:51 AM - 9:45 AM Total: 54 min

Notes:
Table indicates entry and exit times and total duration of incremental shadow for each sunlight-sensitive resource. Daylight saving time is not used—times are Eastern Standard Time, per *CEQR Technical Manual* guidelines. However, as Eastern Daylight Time is in effect for the March/September, May/August and June analysis periods, add one hour to the given times to determine the actual clock time.

The results of the detailed analysis are illustrated in **Figures 7-4 through 7-11**. Within the figures, incremental shadow is illustrated in red, and areas of shadow originating from the development site in the No Action condition that would not occur in the With Action condition are illustrated in yellow. Other shadows, including those cast on non-sunlight-sensitive areas, those cast by existing buildings and background projects, and those that occur in both the No Action and With Action conditions on sunlight-sensitive resources, are illustrated in gray. Below is a description of each affected resource and the duration and extent of incremental shadows affecting it.

AFFECTED RESOURCES

HUDSON RIVER

The Hudson River is an important natural resource flowing along the western border of Manhattan and the Bronx. The river habitat supports both small and large living organisms, and the vitality of phytoplankton, microalgae, and numerous fish and invertebrate species could be affected by the duration of direct sunlight falling on the river's surface.

Incremental Shadow

The proposed project would cast new shadows on a narrow portion of the Hudson River along the shore of Manhattan, generally within the pier headline, from approximately West 10th Street on the north to Spring Street on the south. In the beginning of all analysis days, incremental shadow would stretch as much as several hundred feet into the river then shrink in extent as the day continued, moving closer to the shoreline. In addition, incremental shadows cast by the proposed project would move over the course of the morning and would be off the river by 10:30 AM, such that no portion of the river is within the shadow for the entire duration that it is cast. New shadow on the river would last just over three hours on the June 21 analysis day, followed by nine hours of sunlight for the duration of the analysis period. New shadow would fall on the river for less than two hours on all other analysis days. Incremental shadow would have moved off the river by 10:30 AM, at the latest, and the river would remain in sunlight for the rest of the analysis period. Due to the resource's position along the bank of the Hudson River, almost all areas of the river affected by incremental shadow would continue to receive direct sunlight throughout the afternoon of the analysis days. A small, approximately 5,000-square-foot (0.1-acre) section of the Hudson River located adjacent to the northern façade of Pier 40 receives less than two hours of direct sunlight without the proposed project. With the proposed project, the same patch would receive 30 to 45 minutes less of direct sunlight (see **Figure 7-10**). However, with an average river current of 1.4 knots (2.3 feet per second) in the Hudson River, phytoplankton, whose movements are largely governed by prevailing tides and currents, would quickly move through the areas of new shadow and into areas with sufficient sunlight for photosynthesis. Phytoplankton is able to perform photosynthesis with limited direct sunlight. The minimal light requirement for estuarine primary producers, such as phytoplankton, is for one percent of the surface irradiance to reach the lower depth limit for that species[2]. The low light requirement of primary producers, combined with the relatively short residence time within the area of new shadow by primary producers, would limit potential impacts to phytoplankton from shading in the relatively well flushed lower Hudson River.

No Action Shadow Comparison

The With Action condition would cast shadows for less time over the Hudson River on March 21/September 21 and December 21 analysis days than the No Action condition would. (see

[2] Nightingale, B, and C. Simenstad. 2001b. Overwater Structures: Marine Issues. Prepared by Washington State Transportation Center (TRAC), University of Washington; and Washington State Department of Transportation. Research Project T1803, Task 35, Overwater Whitepaper. Prepared for Washington State Transportation Commission, Department of Transportation and in cooperation with the U.S. Department of Transportation, Federal Highway Administration.

Table 7-3). On the remaining two analysis days, the With Action development would result in shadows occurring for more time over the Hudson River than the No Action condition would.

Table 7-3
No Action and With Action Shadow Durations on the Hudson River

Analysis Day and Timeframe Window	March 21 / Sept. 21 7:36 AM - 4:29 PM	May 6 / August 6 6:27 AM - 5:18 PM	June 21 5:57 AM - 6:01 PM	December 21 8:51 AM - 2:53 PM
No Action Shadow Duration				
Hudson River	7:36 AM - 11:00 AM Total: 3 hr 24 min	6:27 AM - 7:40 AM Total: 1 hr 13 min	5:57 AM - 7:20 AM Total: 1 hr 23 min	8:51 AM - 11:20 AM Total: 2 hr 29 min
With Action Shadow Duration				
Hudson River	7:36 AM - 10:35 AM Total: 2 hr 59 min	6:27 AM - 8:20 AM Total: 1 hr 53 min	5:57 AM - 9:00 AM Total: 3 hr 3 min	8:51 AM - 11:05 AM Total: 2 hr 14 min

Notes:
Table indicates entry and exit times and total duration of incremental shadow for each sunlight-sensitive resource. Daylight saving time is not used—times are Eastern Standard Time, per *CEQR Technical Manual* guidelines. However, as Eastern Daylight Time is in effect for the March/September, May/August and June analysis periods, add one hour to the given times to determine the actual clock time.

Although the total durations of shadow on the Hudson River in the With Action condition would be longer on two analysis days, on all analysis days the With Action development would not cast shadow on as many areas of the river as the No Action development otherwise would. The areas of the Hudson River that would receive sunlight in the With Action condition but would be shaded in the No Action condition are highlighted in yellow in **Figures 7-4 to 7-6, 7-8, 7-10, and 7-11**. The largest areas of direct sunlight allowed by the With Action condition occur in the early morning of the all analysis days. For example, **Figure 7-10** illustrates in yellow that at 9:00 AM on the December 21 analysis day a portion of the Hudson River over 1,000 feet in length and approximately two acres in extent would be in sunlight in the With Action condition but not in the No Action condition.

HUDSON RIVER PARK

Hudson River Park is an approximately 550-acre publicly accessible open space stretching along Manhattan's west side from Battery Park to West 59th Street. The portion of the park that would be affected by incremental and reduced shadow from the proposed project is located approximately between Leroy Street to the north and the equivalent of Charlton Street to the south. The park features located within the affected portion are illustrated in **Figure 7-13** and include the Route 9A Bikeway, the Leroy Street Dog Run, a river-adjacent esplanade, and tennis courts. As shown on **Figure 7-13**, an access road serving Pier 40 is located in the center of the portion of Hudson River Park affected by new shadow. The access road is not considered a sunlight-sensitive resource. Pier 40, also a part of Hudson River Park, is described below.

Incremental Shadow

Portions of Hudson River Park would be affected by new shadow from the proposed project on all four analysis days. While the extent of new shadow from the proposed project would be relatively small, the duration of new shadow would last from two to four-and-a-half hours depending on the analysis day. Specific amenities within the open space would receive varying amounts of new shadow. The tennis courts to the south of the project site would only receive new shadow on the June 21 analysis day from 6:15 AM through 8:30 AM (see **Figures 7-8 and 7-9**); the area of new shadow would be limited to a small portion of the courts during this time, and the courts would be mostly in sun after 7:15 AM. This limited extent and duration of new

Hudson River Park Detail

Figure 7-13

shadow would occur only in one season, early in the morning, and would not significantly impact utilization of the courts. The Leroy Street Dog Run would receive incremental shadow from 9:35 AM to 10:35 AM on December 21 and from 9:35 AM to 9:55 AM on March 21/September 21. One hour of new shadow in winter, when usage is lightest, and 20 minutes in the early spring and fall are limited durations that would not substantially alter the use of this feature. The Route 9A Bikeway, Esplanade, and landscaped areas between them would receive longer durations of new shadow from the proposed project due to their linear shape and relative location parallel to the project site. On all analysis days, these features would receive over two hours of new shadow and as much as four and a half hours of new shadow on June 21. Incremental shadows would generally peak in breadth a few hours after the start of the analysis days and shrink in extent as the path of shadow moved off the resource. Hudson River Park extends north and south of the area affected by project-generated shadows, and adjacent and nearby areas of the park would continue to receive direct sunlight. These adjacent sunlit areas of bike path, esplanade, seating, and landscaping would continue to be available for use throughout the period when incremental shadow would fall, in all seasons.

No Action Shadow Comparison

When compared to the shadows originating from the No Action development, the proposed project would decrease the total duration of shadow on Hudson River Park on all four analysis days by, at most, twenty minutes (see **Table 7-4**).

Table 7-4
No Action and With Action Shadow Durations on Hudson River Park

Analysis Day and Timeframe Window	March 21 / Sept. 21 7:36 AM - 4:29 PM	May 6 / August 6 6:27 AM - 5:18 PM	June 21 5:57 AM - 6:01 PM	December 21 8:51 AM - 2:53 PM
No Action Shadow Duration				
Hudson River Park	7:36 AM - 11:30 AM Total: 3 hr 54 min	6:27 AM –11:05 AM Total: 4 hr 38 min	5:57 AM - 11:05 AM Total: 5 hr 8 min	8:51 AM - 11:45 AM Total: 2 hr 45 min
With Action Shadow Duration				
Hudson River Park	7:36 AM - 11:15 AM Total: 3 hr 39 min	6:27 AM - 10:45 AM Total: 4 hr 18 min	5:57 AM - 10:45 AM Total: 4 hr 48 min	8:51 AM - 11:35 AM Total: 2 hr 44 min

Notes:
Table indicates entry and exit times and total duration of incremental shadow for each sunlight-sensitive resource.
Daylight saving time is not used—times are Eastern Standard Time, per *CEQR Technical Manual* guidelines. However, as Eastern Daylight Time is in effect for the March/September, May/August and June analysis periods, add one hour to the given times to determine the actual clock time.

Additionally, the With Action development would not cast shadows in many areas of the park that the No Action development otherwise would, and the duration of the shadow would be slightly less. The areas of Hudson River Park that would receive sunlight in the With Action condition but would be shaded in the No Action condition are highlighted in yellow in **Figures 7-5 through 7-7, and 7-9 through 7-11**. For example, as shown in yellow in **Figure 7-11**, at 11:00 AM on the December 21 analysis day the With Action development would allow direct sunlight to reach a portion of Hudson River Park north of Barrow Street that includes Pier 45. In total, on the December 21 analysis day, the With Action condition allows portions of Hudson River Park that would be shaded in the No Action condition to receive direct sunlight for nearly three hours (**Figures 7-10 and 7-11).** In addition, the With Action condition would cast a smaller extent of shadow on the Leroy Street Dog Run than the No Action condition from 9:45 AM to 10:45 AM on the March 21/September 21 analysis day.

PIER 40

The Pier 40 open space includes a 15-acre sports facility positioned on top of the Hudson River and abutting the rest of Hudson River Park. The resource's various athletic fields are available for public use through a permitting process or on a first-come, first-served basis to the public when not reserved. The pier's athletic fields affected by new shadow from the proposed project are located in the central courtyard of the facility on the ground floor, as well as on the southeast portion of the roof.

Incremental Shadow

Both outdoor athletic fields on Pier 40 would be affected by new shadow from the proposed project on the morning of all four analysis days. New shadow durations would last from under an hour on the December 21 analysis to over three hours on the May 6/August 6 analysis day. However, on all analysis days, incremental shadow would not fall on the Pier 40 athletic fields after 10:00 AM, and the majority of the fields would remain in sunlight for the rest of the day. The athletic fields are large, and despite the long durations of new shadows in the spring, summer, and fall seasons, large areas of the fields would remain in direct sun throughout the two to three hour duration in all seasons. On all analysis days shadow extents would be largest earlier in the day and then shrink throughout out the morning as shadows moved to the east and off the pier. Over half of the rooftop athletic field would be covered in new shadow for approximately 10 to 15 minutes at the start of the spring, summer, and fall analysis days, but would shrink quickly after that initial period. Smaller proportions of the central courtyard field would be affected by new shadow. On all analysis days, the affected portions of the fields would continue to receive hours of direct sunlight throughout the afternoon. Therefore, incremental shadow would not significantly affect utilization.

No Action Shadow Comparison

When compared to the No Action development, the proposed project would increase the total duration of shadow on the Pier 40 open spaces on three of the four analysis days and decrease the total duration of shadow on the remaining analysis day (see **Table 7-5**).

Table 7-5
No Action and With Action Shadow Durations on Pier 40

Analysis Day and Timeframe Window	March 21 / Sept. 21 7:36 AM - 4:29 PM	May 6 / August 6 6:27 AM - 5:18 PM	June 21 5:57 AM - 6:01 PM	December 21 8:51 AM - 2:53 PM
No Action Shadow Duration				
Pier 40	7:36 AM - 8:15 AM Total: 49 min	6:27 AM - 9:15 AM Total: 2 hr 48 min	5:57 AM - 9:20 AM Total: 3 hr 23 min	—
With Action Shadow Duration				
Pier 40	7:36 AM - 10:00 AM Total: 2 hr 24 min	6:27 AM - 9:30 AM Total: 3 hr 3 min	5:57 AM - 9:00 AM Total: 3 hr 3 min	8:51 AM - 9:45 AM Total: 54 min

Notes:
Table indicates entry and exit times and total duration of incremental shadow for each sunlight-sensitive resource. Daylight saving time is not used—times are Eastern Standard Time, per *CEQR Technical Manual* guidelines. However, as Eastern Daylight Time is in effect for the March/September, May/August and June analysis periods, add one hour to the given times to determine the actual clock time.

As illustrated in yellow in **Figures 7-6 through 7-9**, on the May 6/August 6 and June 21 analysis, the With Action development would allow direct sunlight to reach portions of the courtyard field that would be cast in shadow in the No Action condition. For example, **Figure 7-9** highlights in yellow a fifth of an acre portion of the courtyard field that, at 8:30 AM on the

June 21 analysis day, would only receive direct sunlight in the With Action condition and not in the No Action condition. In total, on the May 6/August 6 and June 21 analysis days, the With Action condition allows over two hours of sunlight to reach portions of Pier 40's courtyard field that would otherwise be shaded in the No Action condition.(see **Figures 7-6 and 7-9**).

PROJECT-GENERATED OPEN SPACE

As part of the proposed project, a new publicly accessible open space would be created above West Houston Street between the North and Center Sites. This open space would include passive amenities such as landscaping, benches, and movable tables and chairs, which are expected to be distributed throughout the open space (see Figure 1-9 in Chapter 1, "Project Description"). Portions of the open space would fall within the building footprint and would be covered and are, therefore, not considered in the analysis of shadows.

Shadows on the project-generated open space would vary in extent and duration depending on the time of year. During the May 5/August 5 and June 21 analysis days, less than half of the open space would be cast in shadow for the majority of the analysis period. The open space would receive the most direct sunlight on the June 21 analysis day when a majority of its area would receive direct sunlight for all but an hour of the analysis day (see **Figures 7-8 and 7-9**).

The open space would receive less direct sunlight on the March 21/September 21 analysis when more than half of the open space would be cast in shadow for approximately eight hours of the analysis day and in complete shadow for the remainder of the analysis day. On the December 21 analysis day, the project-generated open space would receive the least amount of direct sunlight. On this day, the open space would be completely cast in shade for approximately five hours and receive partial sunlight in the remainder of the analysis day (see **Figures 7-10 and 7-11**).

The design and plantings for the project-generated open space take into account these conditions, including the selection of shade-tolerant species and the provision of movable tables and chairs. Users of the project-generated open space that wish to be in direct sunlight could find sunlit portions of the open space at all hours of the May 5/August 5 and June 21 analysis days and for eight hours of the March 21/September 21 analysis day. In the colder months, such as December, it can be expected that utilization rates would be lower. As noted in the *CEQR Technical Manual*, shadows on project-generated open space are not considered significant under CEQR.

CONCLUSION

HUDSON RIVER

The new shadow falling on the Hudson River would not be a significant adverse impact to the biota of the natural resource. The proposed project would cast new shadows on a narrow portion of the Hudson River along the shore of Manhattan, generally within the pier headline, from approximately West 10th Street on the north to Spring Street on the south. In the beginning of all analysis days, incremental shadow would stretch as much as several hundred feet into the river then shrink in extent as the day continued, moving closer to the shoreline. In addition, incremental shadows cast by the proposed project would move over the course of the morning and would be off the river by 10:30 AM, such that no portion of the river is within the shadow for the entire duration that it is cast. New shadow on the river would last just over three hours on the June 21 analysis day, followed by nine hours of sunlight for the duration of the analysis period. New shadow would fall on the river for less than two hours on all other analysis days.

Incremental shadow would have moved off the river by 10:30 AM, at the latest, and the river would remain in sunlight for the rest of the analysis period. Due to the resource's position along the bank of the Hudson River, almost all areas of the river affected by incremental shadow would continue to receive direct sunlight throughout the afternoon of the analysis days. A small, approximately 5,000-square-foot (0.1-acre) section of the Hudson River located adjacent to the northern façade of Pier 40 receives less than two hours of direct sunlight without the proposed project. With the proposed project, the same patch would receive 30 to 45 minutes less of direct sunlight. However, with an average river current of 1.4 knots (2.3 feet per second) in the Hudson River, phytoplankton, whose movements are largely governed by prevailing tides and currents, would quickly move through the areas of new shadow and into areas with sufficient sunlight for photosynthesis. Phytoplankton is able to perform photosynthesis with limited direct sunlight. The minimal light requirement for estuarine primary producers, such as phytoplankton, is for one percent of the surface irradiance to reach the lower depth limit for that species. The low light requirement of primary producers, combined with the relatively short residence time within the area of new shadow by primary producers, would limit potential impacts to phytoplankton from shading in the relatively well flushed lower Hudson River. Overall, the proposed actions would not contribute to a loss of habitat or function that would diminish the Hudson River's ability to serve as a major natural resource that provides wildlife habitat and functions as a recreational and scenic resource. Therefore, based on the guidance of the *CEQR Technical Manual*, the proposed actions would not result in a significant adverse natural resources impact to this resource.

HUDSON RIVER PARK

New shadows generated from the proposed actions would not result in significant adverse impact to the usability of Hudson River Park or its ability to support vegetation.

As described in the detailed analysis above, Hudson River Park would receive incremental shadow in the With Action condition on all four analysis days. And although the durations of new shadow would last over four hours on the May 6/August 6 and June 21 analysis days, the areas affected by incremental shadow would be dispersed throughout the park. No single area of the park would receive more than approximately two-and-a-half hours of new shadow on any analysis day.

At all times on analysis days when new shadow originating from the proposed project would fall on Hudson River Park, portions of the resource would remain in sunlight. Also, as shown in **Figures 7-4 through 7-11**, users wishing to sit in direct sunlight would be able to access the remaining sunny areas of the open space directly to the north and would not experience a significant reduction in enjoyment of the resource. Excluding the Leroy Street Dog Run, the portions of the park affected by incremental shadow only contain two sets of benches (see **Figure 7-13**). On the March 21/September 21 and May 6/August 6 analysis days, the benches would not receive more than an hour of new shade, and on the June 21 analysis day approximately an hour and a half in the early morning. The users of the esplanade and Route 9A Bikeway would presumably be in motion and would only be affected by incremental shadows for short periods of time. Furthermore, the largest extents of new shadow would occur early in the morning of the analysis days, when park utilization would be presumably lower than in the afternoon. Hudson River Park would not receive any new shadow after 11:26 AM on any analysis day. Due to its position along the bank of the Hudson River, affected areas would be in the sun for most of the remaining hours of the analysis days. Within the growing season, affected park vegetation and landscaping would continue to receive, at a minimum, four and a

half hours of direct sunlight—a sufficient duration to support plant life, as stated in the *CEQR Technical Manual*. Therefore, the proposed actions would not result in a significant adverse shadow impact to this resource.

PIER 40

New shadow from the proposed project would affect the courtyard and rooftop athletic fields of Pier 40 in the early morning of all analysis days. However, on all analysis days, the addition of new shadow from the proposed project would never cast more than half of either athletic field in shade and the usability of the fields would not be significantly impacted by the proposed project. On the March 21/September 21 analysis day, the athletic fields would be cast completely in sun from 10:00 AM to the end of the analysis day. On the May 5/August 5 analysis day, over three-quarters of both athletic fields would continue to receive direct sunlight from approximately 7:00 AM to the end of the analysis day at 5:18 PM. The same would be true on the June 21 analysis day from approximately 6:30 AM to the end of the analysis day at 6:01 PM. And with the proposed project, on the December 21 analysis day over three-quarters of both athletic fields would continue to receive direct sunlight from approximately 9:15 AM to the 2:00 PM.

In addition, the turf of each field is synthetic and would not be affected by a reduction in direct sunlight. Therefore, the proposed actions would not result in a significant adverse shadow impact to this resource.

In summary, when compared to the No Action condition, the proposed project would result in a new development that would cast incremental shadow on three sunlight-sensitive resources: the Hudson River, Hudson River Park, and Pier 40. All resources would receive new shadow in the morning of all four days in the detailed analysis. Although the duration of new shadow would be a number of hours in some cases, none of the resources would experience a significant adverse shadows impact. Compared to the No Action condition, the incremental shadow falling on the resources would not significantly alter the condition or microclimate of the Hudson River, reduce the usability of Hudson River Park and Pier 40, nor would it threaten the vitality of living organisms within the river and the park. Furthermore, the proposed actions would, at times, allow sunlight to reach portions of the affected resources that would otherwise be cast in shadow in the No Action condition. ✶