

## 7.1 INTRODUCTION

### 7.1.1 CONTEXT

For three decades, the Twin Towers were among the tallest structures in the world. At 110 stories each, they reached over 1,360 feet and cast long shadows across much of Lower Manhattan. They represented American innovation and were a remarkable technological advancement, standing above all other skyscrapers near Wall Street in New York City's Financial District. They were a prominent feature in the city skyline which could be seen from up to 30 miles away on a clear day. On September 11, 2001, each of the Towers was struck by a hijacked airliner causing structural damage and fires that led to their collapse. Their collapse caused massive death and devastation to Lower Manhattan. In the aftermath, the Twin Towers became an icon of antiterrorist resolve. A rebuilding of the World Trade Center (WTC) Site was called for to honor those who died, to restore the symbol of the Financial District, and to repair the skyline that was now missing the Twin Towers. The Lower Manhattan Development Corporation (LMDC) and The Port Authority of New York and New Jersey (Port Authority), with broad public input, developed the World Trade Center Memorial and Redevelopment Plan (Proposed Action). The Proposed Action would create five towers on the Project Site—one that would be 1,776 feet, taller than the original Towers—and a museum and cultural facilities that would create shadows not unlike the shadows cast by the Twin Towers and the four lower buildings that previously existed on the WTC Site.

The purpose of this analysis is to identify incremental shadows on sun-sensitive resources including open spaces and historic resources with significant features that require sunlight. The incremental shadows will be discussed based on the length of time the increment would occur, how large the increment would be, and the character of the resource (e.g., whether an open space is used for active or passive recreation). Shadow increments are compared to both current and pre-September 11 conditions. Impact criteria used in the analysis are based on the *City Environmental Quality Review (CEQR) Technical Manual*.

The Proposed Action considered in the analysis is the building plan as of late October 2003 developed by LMDC and the Port Authority, based on the Memory Foundations concept created by Studio Daniel Libeskind. The design of Freedom Tower, released on December 19, 2003, does not substantially alter this analysis. The Proposed Action represents the greatest height and bulk that would be contemplated for the Project Site. Tall buildings would descend in a spiral from Freedom Tower in the northwest corner of the WTC Site clockwise to the Southern Site. As compared to pre-September 11 conditions on the WTC Site, the bulk of development would be shifted away from the proposed Memorial area where the Twin Towers stood in the southwest corner along Liberty Street and Route 9A. On the Southern Site, the proposed tower would be in generally the same location as 130 Liberty Street was prior to September 11. Freedom Tower, at the northwest corner of the WTC Site, would be taller than the Twin Towers;

the second tower would be somewhat lower than the Twin Towers; and the three additional towers, descending in a spiral to the Southern Site, would be substantially taller than the other buildings formerly on the WTC Site and the Southern Site. The proposed arrangement of tall buildings, which responds to the goal of creating an appropriate area for the Memorial, would generally be expected to reduce shadows off-site to the west while increasing shadows off-site to the east by comparison to the shadows that the structures on the Project Site cast prior to September 11. It should be noted that the heights of the proposed buildings include structural and architectural detail at the tops of the buildings.

The primary resources of concern on the Project Site, the public open spaces, would also change with the Proposed Action. While none of the space on the site today would warrant analysis because there are no open space amenities, the Proposed Action would create a variety of new publicly accessible open spaces on the Project Site. These include September 11 Place, Wedge of Light Plaza, Heroes Park, Liberty Park North, and Liberty Park South. The Memorial, while not a traditional open space due to its design and contemplated use, is also considered in the shadows analysis.

Since the only potential development on Site 26 as part of the Proposed Action would be below grade, its use would neither generate shadows nor create open space.

### **7.1.2 CONCLUSIONS**

The Proposed Action was analyzed with respect to incremental shadows under two scenarios, the Pre-September 11 Scenario and the Current Conditions Scenario. The Pre-September 11 Scenario provides the comparison of the Proposed Action to the Project Site as it existed prior to the destruction of the WTC. The Current Conditions Scenario provides the comparison to today's conditions in which the major structures above street level are the entrance canopy for the temporary WTC PATH station and 130 Liberty Street. In each scenario, two build years are considered, 2009 and 2015.

All of the above-grade construction for the 2009 build year would occur on the WTC Site. Freedom Tower on the northwest corner, the bases of Towers 2, 3, and 4 along Church Street, and the museum and cultural facilities in the southwest quadrant of the WTC Site would be completed by 2009. By 2015, the tower portions of Tower 2, 3, and 3 along Church Street would be completed as well as Tower 5 on the Southern Site.

#### ***PRE-SEPTEMBER 11 SCENARIO***

The major difference when comparing shadow increments with the Proposed Action to those produced by the Project Site prior to September 11 is the shift in the locations in incremental shadow. While both the Twin Towers and the Proposed Action would produce considerable shadows, the Twin Towers cast larger incremental shadow to the west and the Proposed Action would cast larger shadow increments to the east. This would occur due to shifting the bulk of development to the east in the Proposed Action in order to reserve the southwest quadrant of the WTC Site for a Memorial.

Freedom Tower would cast shadows similar to those of the North Tower that stood prior to September 11, except that the North Tower was opaque, while the cable system at the upper levels of Freedom Tower would allow some light to pass. Tower 2, which at approximately 65 stories is located where the nine-story 5 WTC building stood, would cast incremental shadows on several of the open spaces in the area, including Washington Market Park and a few of the

open spaces northeast of the Project Site. Under the *CEQR Technical Manual*, the December increment would cause a significant adverse impact on Washington Market Park. However, it is noted that a potential development on an intervening site may reduce the Proposed Action's increment on this open space. In the Proposed Action with the bulk of the buildings relocated on the east side of the WTC Site, where there were previously relatively short buildings, open spaces directly across Church Street would receive heavy afternoon to evening shadow. Depending on the analysis day, any buildings over approximately 10 stories would have the potential to cause significant adverse impacts to the open spaces on the east side of Church Street.

The Proposed Action would create incremental shadows on the open spaces to the west of the WTC Site in the early morning hours throughout the year. At this same time, these open spaces would receive sunlight in areas previously cast into shadow by the Twin Towers. From September through March, the Proposed Action would cast mid-morning shadows onto the open spaces northwest of the Project Site in Battery Park City (BPC) and midday shadows to the north falling on open spaces such as Washington Market Park and the playgrounds of PS 234. In the late spring to summer months shadows are shorter and would not reach these open spaces. From March through September, late afternoon to early evening shadows would be cast onto the open spaces such as City Hall Park northeast of the Project Site and the open spaces directly to the east of the Project Site, across Church Street, would receive shadow for most of the afternoon to evening.

On most of the open spaces in the area the incremental shadows created from the Proposed Action would not be large enough or last long enough to create a significant adverse impact to the vegetation or the users of the open spaces. However, the Proposed Action would cast additional shadows onto the already heavily shadowed open spaces directly to the east of the WTC and Southern Sites for one and a half to three and half hours per day in late spring through summer making the open spaces completely covered in shadow. In December the already heavily shadowed Washington Market Park would receive large incremental shadows from Tower 2 and Freedom Tower removing all sun from the park in the midday. Within the criteria under the *CEQR Technical Manual*, as discussed below, this would constitute a significant adverse impact.

The open spaces created by the Proposed Action would receive incremental shadow from the Proposed Action throughout the year. For most of the late spring through summer months, the proposed open spaces on the Project Site would receive full sun in the midday to early evening. Liberty Park North and the Memorial would receive incremental shadows from the base of Towers 3 and 4 during the morning throughout the year. For the spring to fall months, these two open space areas would receive ample sun in the early to mid-afternoon until shadows from existing buildings across Route 9A begin to cast shadow onto the WTC Site. Heroes Park and Wedge of Light Plaza would receive incremental shadows throughout the analysis day all year. The museum and cultural facilities buildings would cast shadows on Heroes Park and Tower 2 and Tower 3 would cast shadow on Wedge of Light Plaza. The southern portion of Heroes Park would receive early morning shadow throughout the year and mid-morning to midday shadows, depending on the season, would fall on the northern portion. Wedge of Light Plaza would receive incremental shadows throughout the day in each analysis period but would receive sun from March through September in the early to mid-morning hours depending on the analysis day. Liberty Park North and the Memorial would receive shadows in the morning from the Proposed Action throughout the year, as compared to shadows on Austin J. Tobin Plaza (Tobin Plaza) from the buildings of the WTC. However, under the Proposed Action, in the spring to fall

## **World Trade Center Memorial and Redevelopment Plan GEIS**

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months, Liberty Park North and the Memorial would receive almost full sun for up to three hours in the middle of the day.

Since the Proposed Action's open spaces would have different layouts than the original open spaces of the WTC they are considered newly created and are not compared to the shadows originally cast on the WTC open spaces. That is, the analysis here of shadows that would be cast on the Proposed Action's open spaces does not take into account shadows that were cast by the original Twin Towers and the lower structures. It should also be noted that prior to September 11, the space where 7 WTC Plaza will be built was occupied by the original 7 WTC building.

### ***CURRENT CONDITIONS SCENARIO***

Shadow increments are generally worse with the Proposed Action compared to the Current Conditions Scenario since the only structures on-site are the temporary WTC PATH station entrance canopy and 130 Liberty Street. Similar to the Pre-September 11 Scenario, the Proposed Action would create incremental shadows on the open spaces to the west of the WTC Site in the early morning hours throughout the year. From September through March, the Proposed Action would cast larger mid-morning shadows onto the open spaces northwest of the Project Site in BPC and midday shadows would be cast north falling on open spaces such as Washington Market Park and the playgrounds of PS 234. In the late spring to summer months, shadows are shorter and would not reach these open spaces. From March through September, late afternoon to early evening shadows would be cast onto the open spaces such as City Hall Park northeast of the Project Site, and the open spaces directly to the east of the Project Site, across Church Street, would receive shadow for most of the afternoon to evening. The incremental shadows would be larger in the Current Conditions Scenario than in the Pre-September 11 Scenario because the shadows from the Proposed Action would be casting all new shadow and would not fall within shadows previously cast by the WTC.

Again, the incremental shadow created from the Proposed Action on most of the open spaces in the area would not be large enough or last long enough to create a significant adverse impact to the vegetation or the users of the open spaces. However, the Proposed Action would cast additional shadows onto the already heavily shadowed open spaces directly to the east of the WTC and Southern Sites for 1½ to 3½ hours per day in late spring through summer making the open spaces completely covered in shadow. In December, the already heavily shadowed Washington Market Park would receive large incremental shadows from Tower 2 and Freedom Tower removing all sun from the park in the midday. The newly created 7 WTC Plaza would receive shadow from Tower 2 and Freedom Tower throughout the year.

The open spaces created by the Proposed Action would receive incremental shadows throughout the year. For most of the late spring through summer months, the proposed open spaces on the Project Site would receive full sun in the midday to early evening. Liberty Park North and the Memorial would receive incremental shadows from the base of Towers 3 and 4 during the morning throughout the year. For the spring to fall months, these two open space areas would receive ample sun in the early to mid-afternoon until shadows from existing buildings across Route 9A begin to cast shadow onto the WTC Site. Heroes Park and Wedge of Light Plaza would receive incremental shadows throughout the analysis day all year. The museum and cultural facilities buildings would cast shadows on Heroes Park and Tower 2 and Tower 3 would cast shadow on Wedge of Light Plaza. The southern portion of Heroes Park would receive early morning shadow throughout the year and mid-morning to midday shadows, depending on the season, would fall on the northern portion. Wedge of Light Plaza would receive incremental

shadows throughout the day in each analysis period but would receive sun from March through September in the early to mid-morning hours depending on the analysis day.

## 7.2 METHODOLOGY

Following the guidelines of the 2001 *CEQR Technical Manual*, this analysis considers shadows on four representative days of the year: March 21, which is the equivalent of September 21 (the equinoxes); May 6, which is the equivalent of August 6th (the midpoints between the summer solstice and the equinox); June 21 (the summer solstice and longest day of the year); and December 21 (the winter solstice and shortest day of the year). In identifying potential effects, CEQR focuses on uses and users of the open space, landscaping and vegetation, and, if there are historic resources, features or details that are both sunlight-dependent and make such resources significant. The CEQR methodology does not consider shadows and incremental increases in shadows within 1½ hours of sunrise or sunset. Therefore, the analysis period is between 1½ hours after sunrise and 1½ hours before sunset.

The *CEQR Technical Manual* identifies the following as situations when a significant shadow impact may occur:

- substantial reduction in sunlight where a sensitive use is already subject to substandard sunlight (i.e., less than the minimum time necessary for survival);
- reduction in sunlight available to a sensitive use from more to less than the minimum time necessary for its survival;
- substantial reduction in sunlight to a sun-sensitive use or feature; and
- substantial reduction in the usability of the open space.

## 7.3 SHADOW SCREENING

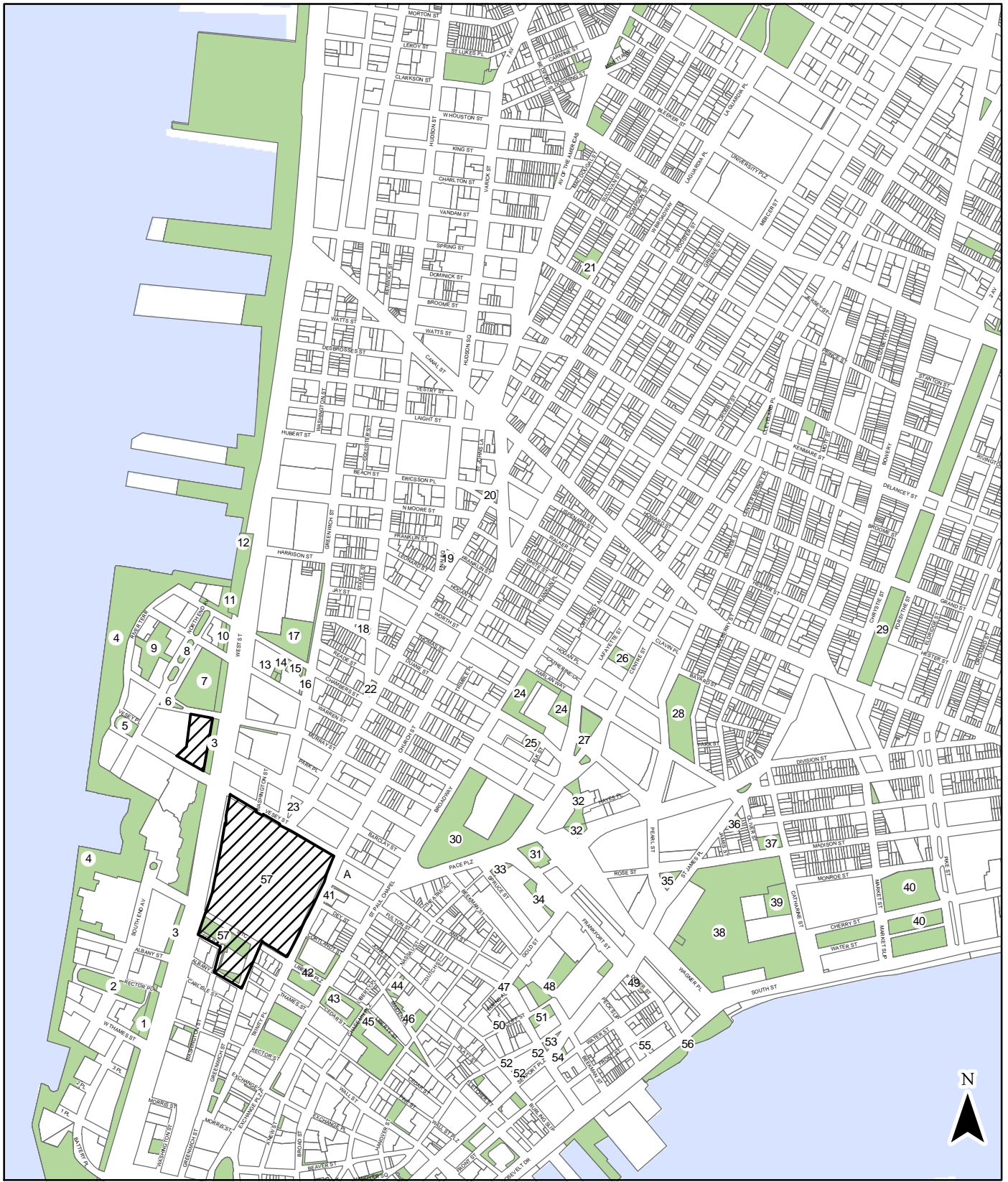
Because of the height of the buildings that would be created with the Proposed Action and the number of open spaces and historic resources near the Project Site, a screening analysis was performed to identify those open spaces or historic resources with significant sunlight dependent features that could be affected by shadows from development with the Proposed Action.



To identify resources of concern, the potential maximum length of the shadows is first considered. Shadow sweeps for the Proposed Action on all four analysis days are delineated on a map showing the open spaces that could potentially be cast into shadow (see Figure 7-1). Historic resources with significant sunlight dependent features that are in the area of the shadow sweeps are also considered. These resources are listed on Table 7-1. Resources that would be out of the shadow range of a proposed building (e.g., any resources directly south of the Project Site) or that would not be affected by project shadows because they are already covered by shadows from existing buildings are eliminated by this analysis.

**World Trade Center Memorial and Redevelopment Plan GEIS**

**Table 7-1  
Shadows Screening: Open Spaces Within Maximum Shadow Sweep**

Map ID	Open Spaces Within Maximum Shadow Sweep Area	Within Shadow Sweep	Fully Shaded by Intervening Buildings
<b>Open Space and Sun-Sensitive Historic Resources Included in Analysis</b>			
	<b>Name</b>		
1	West Thames Playground	YES	NO
3	Bikeway/Walkway	YES	NO
4	Battery Park Esplanade/Nelson A Rockefeller Park/Robert F Wagner Park	YES	NO
5	Irish Hunger Memorial	YES	NO
7	BPC Ball Fields	YES	NO
8	North End Avenue Mall	YES	NO
10	PS/IS 89 Playground	YES	NO
11	Stuyvesant High School Plaza	YES	NO
12	Hudson River Park	YES	NO
13	West & Chambers, WSURA Site 5C	YES	NO
14	PS 234 Open Space – west	YES	NO
15	PS 234 Open Space – east	YES	NO
16	Greening of Greenwich Street	YES	NO
17	Washington Market Park	YES	NO
22	James Bogardus Viewing Garden	YES	NO
23	7 WTC Plaza	YES	NO
30	City Hall Park	YES	NO
31	Brooklyn Bridge Plaza	YES	NO
32	St. Andrew's Plaza/Police Plaza	YES	NO
33	Pace Plaza	YES	NO
41	Millennium Hotel Plaza	YES	NO
42	One Liberty Plaza	YES	NO
57	Project Site Open Spaces	YES	NO
A	The Graveyard at St. Paul's Chapel	YES	NO
<b>Open Space and Sun-Sensitive Historic Resources Screened Out of Analysis</b>			
2	Rector Park	YES	YES
6	Murray Street Triangle	YES	YES
9	Tear Drop Park	YES	YES
18	Duane Triangle	YES	YES
19	Finn Square	YES	YES
20	Tribeca Park	YES	YES
21	Thompson Playground	YES	YES
24	26 Federal Plaza	YES	YES
25	African Burial Grounds	YES	YES
26	Collect Pond Park	YES	YES



-  Project Site
-  1 Open Spaces
-  A Sun-Sensitive Historic Resource

0 250 500 1,000 Feet

# World Trade Center Memorial and Redevelopment Plan

# Open Space and Sun-Sensitive Historic Resources Figure 7 - 1

**Table 7-1 (cont'd)**  
**Shadows Screening: Open Spaces Within Maximum Shadow Sweep (cont'd)**

Map ID	Open Spaces Within Maximum Shadow Sweep Area	Within Shadow Sweep	Fully Shaded by Intervening Buildings
<b>Open Space and Sun-Sensitive Historic Resources Screened Out of Analysis (cont'd)</b>			
	<b>Name</b>		
27	Foley Square	YES	YES
28	Columbus Park	YES	YES
29	Sara D. Roosevelt Park	YES	YES
34	Drumgoole Square	YES	YES
35	James Madison Plaza	YES	YES
36	Israel Cemetery	YES	YES
37	PS 1 Playground	YES	YES
38	NYCHA Open Space	YES	YES
39	Alfred E. Smith Recreation Center	YES	YES
40	Coleman Square Park	YES	YES
43	140 Broadway Plaza	YES	YES
44	Two Federal Reserve Plaza	YES	YES
45	Chase Manhattan Plaza	YES	YES
46	Home Insurance Company Plaza	YES	YES
47	John Delury Plaza	YES	YES
48	Southbridge Tower and Plaza	YES	YES
49	Franklin Square	YES	YES
50	Cliff Street Plaza	YES	YES
51	St. Margaret's House	YES	YES
52	200 Water Street	YES	YES
53	Playground	YES	YES
54	Seaport Park	YES	YES
55	Seating Area	YES	YES
56	Brooklyn Bridge	YES	YES
<b>Note:</b> Map reference numbers correspond to Figure 7-1.			
<b>Source:</b> AKRF, Inc., 2003.			

## 7.4 RESOURCES OF CONCERN FOR SHADOWS ANALYSIS

The features of the identified open spaces and historic resources are described in this section.

### 7.4.1 PUBLIC OPEN SPACES

#### *EXISTING OPEN SPACES*

Nine of the resources are found west of Route 9A. Created by the Route 9A Reconstruction Project, the bikeway/walkway is continuous along the west side of the highway and features landscaping, planters, and a divided path. It also serves as a landscaped buffer separating the open spaces to the west and the roadway to the east.

BPC contains the other eight open spaces in the study area west of the highway. On the south is West Thames Park, located between West Thames and Albany Streets, which includes a



## **World Trade Center Memorial and Redevelopment Plan GEIS**

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playground, lawn, and community garden. The waterfront parks and the Esplanade in BPC together form the largest open space resource in the area. Including Governor Nelson A. Rockefeller Park to the north and Robert F. Wagner, Jr. Park to the south, the Esplanade links a wide variety of open space amenities. Landscaped with trees, flowers, lawns, meandering paths, and plantings, these open spaces also include playgrounds, plazas, eateries, marinas, sculptures, and water features. The extremely well-used Esplanade provides scenic views of the Hudson River, New York Harbor, and New Jersey shore. The Irish Hunger Memorial, located west of North End Avenue at Vesey Street, represents the Irish potato famine and contemporary issues in world hunger. The sloping site includes an abandoned stone cottage, a fallow potato field, and flora typical of Ireland. Visitors may walk through the landscape on a paved path to a viewing area overlooking the Esplanade and the Hudson River.

The BPC ball fields located between Murray and Warren Streets are the largest active open space resource in the area. Although the 2.84-acre space is available by reservation only, the public is welcome to reserve this space for team and league use. Newly constructed and in excellent condition, the ball fields provide valuable active open space amenities and are used for a wide variety of sports and leagues annually. West of the ball fields, the North End Avenue Mall is a series of medians which provide a passive open space resource with landscaping and trees.

The PS/IS 89 playground is adjacent to the bikeway/walkway south of Chambers Street, and provides a jungle gym, an open play area, benches along its east and west sides, and trees are planted along the fence on the east side. North of Chambers Street, there is a wide plaza with benches and landscaping adjacent to Stuyvesant High School. North of Stuyvesant along the waterfront is Hudson River Park, a 5-mile, 550-acre park stretching from BPC to 59th Street. The portion closest to the Project Site contains basketball courts, batting cages, benches and ping-pong tables.

The Tribeca neighborhood also has a variety of open spaces. The major neighborhood open space is Washington Market Park with a lawn, lush trees, garden plots, a variety of play equipment for small children, and a gazebo. The tennis court and basketball court at the corner of Chambers Street and Route 9A are also part of Washington Market Park. On the south side of Chambers Street, PS 234 has two playgrounds. The playground to the west is a paved, fenced-in area with a jungle gym and basketball courts. There is an open play area towards the center and benches along the western edge. The larger playground is at the school's northeast corner. It is a paved, fenced-in area. There are basketball hoops located on the facade of the building, south of the open space. There is also a widened sidewalk with planting beds for the classes along Greenwich Street in front of the school.

The Greening of Greenwich Street Project decreased the width of a portion of Greenwich Street and expanded open space on the west side of the street. Immediately north of Chambers Street, Washington Market Park was expanded. Outside the park the remainder of the expanded sidewalk is home to a Greenmarket on Wednesdays and Saturdays. North of the park there is a very wide sidewalk with benches, flower beds and lighting. Formed by the intersection of West Broadway and Hudson Streets, the James Bogardus Viewing Garden is a triangular area with plantings.

West of Broadway, City Hall Park is the nearest major open space. It has been restored to its original splendor and contains replicas of the original light poles, a fountain, landscaped areas, trees, benches and other amenities. Brooklyn Bridge Plaza is a small area with plantings at the foot of the pedestrian walkway of the Brooklyn Bridge. Police Plaza is a large paved area with

sculptures and benches. Pace Plaza is a small open space with some benches, trees and lighting, and modern sculpture in front of the school on Park Row.

There are a series of open spaces on the east side of Church Street opposite the WTC Site. On the north is the graveyard of St. Paul's Chapel that is to be reopened shortly. Regardless of whether its gate is open, the graveyard is a historic landscape and considered below under historic resources. South of the graveyard, the Millennium Hotel has a paved plaza with plantings and lighting. The steps around One Liberty Plaza serve as an informal passive resource, providing seating. Liberty Plaza is currently home to the former WTC Greenmarket open on Tuesdays and Thursdays. It is also the site of informal chess tournaments. It includes benches, lighting, and planters. East of it there is a paved plaza with plantings, and a sculpture and benches at 140 Broadway.

#### *PROPOSED OPEN SPACES*

The Proposed Action would create five new open space resources with a total of 5.52 acres on the Project Site by 2009. September 11 Place, a 0.55-acre open space shaded by the mass of the museum, would be located in the center of the WTC Site at the southwest corner of Greenwich and Fulton Streets. Heroes Park, a 0.79-acre open space, featuring trees and seating, would be located on both sides of Fulton Street between Greenwich Street and Route 9A.

Wedge of Light Plaza would occupy both sides of Fulton Street between Church Street and Route 9A, linking the center of the site to Church Street and St. Paul's Chapel and providing an open space adjacent to the permanent WTC PATH Terminal entry. With approximately 1.33 acres, it would be designed to accommodate a range of activities.

Liberty Park North would total .55 acres, and Liberty Park South would total 1.34 acres. On the south side of Liberty Street it would stretch from Route 9A to Greenwich Street. North of Liberty Street, a linear section would allow viewing of the Memorial from street level. Along West Street 12,000-square-foot Memorial viewing area is planned.

Since the Memorial might be the only open space that some visitors visit, it could be considered an open space for the purpose of this analysis. Regardless of the specific design of the Memorial, it will provide light and fresh air.

#### *OTHER NEW OPEN SPACE BY 2009*

Additional open spaces are expected to have been created within the study area and be in use by 2009 including a 0.27-acre plaza on Warren Street between Route 9A and Greenwich Street and a triangular plaza in front of 7 WTC. The latter is expected to provide a central open plaza with a fountain, flanked by groves of trees and shrubs. The 30-foot-wide fountain would be surrounded by marble benches. In the winter, this fountain area may be used to display public art.

No other specific plans for new open spaces have been identified at this time.

### **7.4.2 SUN-SENSITIVE HISTORIC RESOURCES**

The graveyard at St. Paul's Chapel is across Church Street from the north end of the WTC Site. The towered front façade of the Church faces west over the 18th century graveyard. There are narrow paths, tall trees and a few benches in the graveyard.

No other historic resources with sun-sensitive features were identified that would be in the shadow path but not already shadowed by intervening structures.

## **7.5 SHADOW EFFECTS**

The sun rises in the east and casts its earliest (and longest) shadows towards the west. Later in the morning, the sun rises higher in the sky, casting shorter shadows towards the northwest. At noon, the sun is at its highest point in the sky and casts the shortest shadows of the day directly north. (During Daylight Savings Time, this occurs at 1 PM rather than at noon.) In the afternoon, the sun continues to move west and begins to descend, casting longer shadows toward the northeast and east.

In its yearly cycle, the height of the sun in the sky and the time and directional location at which it rises and sets varies by season. In the winter, the sun travels in a low arc across the southern sky, rising late in the southeast and setting early in the southwest. Because it is so low in the sky, it casts longer shadows. In the spring and fall, the sun arcs through the sky at a somewhat higher angle, rises earlier in the east, and sets later in the west. In these seasons, shadows are of moderate length. In the summer, the sun arcs through the sky at its highest angle, rising almost directly overhead at noon. For this reason, summer shadows are shortest. However, in the summer, the sun rises earliest and sets latest; it also travels farther, from the northeast to the northwest. Thus, the summer sun casts shadows in more directions than those seen in other seasons and its late sunset and early sunrise creates shadows earlier in the morning and later in the evening than in other seasons.

The shadow diagrams and analysis presented below were developed using building envelope and topographical information obtained from Urban Data Solutions, Inc. Shadows were modeled using the solar rendering capabilities of MicroStation V8 software.

## **7.6 ASSESSMENT OF SHADOW IMPACTS—CURRENT CONDITIONS SCENARIO 2009**

In the Current Conditions Scenario the Project Site is empty of all structures except for the temporary WTC PATH station and the No. 1/9 IRT subway lines. The buildings at 130 and 140 Liberty Street are expected to be redeveloped into 40- and 25-story buildings, respectively. Site 26 is a paved parking lot. From the 2003 baseline condition, all future projects in the area are accounted for that are expected to be developed by the future analysis year of 2009, including developments in BPC and Tribeca and at 7 WTC. The WTC Site Freedom Tower and the bases of the three other towers are assumed to be complete as well as all the open spaces on both the WTC Site and the Southern Site.

Shadows are discussed below first by season and then by resource.

### **7.6.1 SHADOWS BY SEASON**

This section briefly reviews the shadows that would be cast by the Proposed Action on each analysis day. Shadow durations are presented in Table 7-2.

The shadow diagrams in this chapter were created by comparing pre-September 11 conditions to the conditions of the Proposed Action as well as current conditions to the Proposed Action. Pre-September 11 conditions are as they were prior to the terrorist attacks with the six structures on the WTC Site and 130 Liberty Street. Current conditions contain the temporary WTC PATH station. The Proposed Action plans have the Freedom Tower and the base of Towers 2, 3, and 4 in 2009 and the tower portions of Towers 2, 3, 4 and the addition of Tower 5 on the Southern

**Table 7-2  
Project Shadow Durations—Current Conditions—2009**

<b>Open Space / Historic Resource</b>	<b>March 21/ September 21 7:36 AM-4:29 PM EST</b>	<b>May 6/ August 6 7:27 AM-6:18 PM DST</b>	<b>June 21 6:57 AM-7:01 PM DST</b>	<b>December 21 8:51 AM-2:53 PM EST</b>
West Thames Playground	–	–	–	–
Bikeway/Walkway	7:36 AM – 12:15 PM	7:27 AM – 12:45 PM	6:57 AM – 12:45 PM	8:51 AM – 12:30 PM
BPC Waterfront Parks (Battery Park Esplanade / Nelson A Rockefeller Park / Robert F Wagner Park)	7:36 – 8:00 AM, 9:00 – 10:15 AM	9:00 – 10:15 AM	9:00 – 11:00 AM	9:00 – 10:30 AM
Irish Hunger Memorial	9:15 – 9:45 AM	–	–	–
BPC Ballfields	10:45 AM – 12:15 PM	–	–	10:00 AM – 12:15 PM
North End Avenue Mall	–	–	–	9:30 AM
PS/IS 89 Playground	12:00 PM	–	–	10:45 AM – 12:15 PM
Stuyvesant High School Plaza	–	–	–	11:15 AM – 12:15 PM
Hudson River Park	–	–	–	12:00 – 12:30 PM
Warren Street Plaza	12:45 PM	–	–	–
P.S. 234 West Playground	12:45 PM	–	–	–
P.S. 234 East Playground	1:00 – 1:15 PM	–	–	–
Greening of Greenwich Street	1:15 – 1:45 PM	–	–	–
Washington Market Park	1:00 – 1:30 PM	–	–	12:00 – 1:45 PM
James Bogardus Viewing Garden	2:30 PM	–	–	–
7 WTC Plaza	2:45 – 4:29 PM	3:15 – 5:00 PM	3:00 – 5:30 PM	11:45 am – 1:00 PM, 1:30 – 2:53 PM
City Hall Park	–	4:30 – 6:00 PM	5:15 – 7:01 PM	–
Brooklyn Bridge Plaza	–	6:00 – 6:18 PM	–	–
Police Plaza	–	5:45 – 6:00 PM	–	–
Pace Plaza	–	–	–	–
Millennium Hotel Plaza	4:00 – 4:29 PM	5:00 – 6:18 PM	5:45 – 7:01 PM	–
One Liberty Plaza	–	5:15 – 6:00 PM	5:30 – 7:01 PM	–
Liberty Park North	7:36 AM – 12:15 PM	7:27 AM – 1:15 PM	6:57 AM – 1:00 PM	9:30 AM – 11:45 PM
Liberty Park South	–	7:27 AM – 8:15 AM	6:57 AM – 8:30 AM	–
Memorial	7:36 AM – 12:15 PM	7:27 AM – 1:15 PM	6:57 AM – 1:00 PM	9:30 AM – 11:45 AM
Heroes Park	7:36 AM – 4:29 PM	7:27 AM – 6:00 PM	6:57 AM – 5:30 PM	8:51 AM – 2:53 PM
Wedge of Light Plaza	10:15 AM – 4:29 PM	7:27 AM – 9:45 AM, 11:45 AM – 6:18 PM	12:15 PM – 7:01 PM	10:30 AM – 2:53 PM
The Graveyard at St. Paul's Chapel	3:30 – 4:29 PM	4:45 – 6:00 PM	5:00 – 7:01 PM	–
<b>Notes:</b> EST—Eastern Standard Time; DST—Daylight Saving Time September 21 is the equivalent of March 21, but one hour later. August 6 is the equivalent of May 6.				
<b>Source:</b> AKRF, Inc. determined using 3D data from Urban Data Solutions, Inc. with the Solar Study function in MicroStation V8.				

Site in 2015. Both the Pre-September 11 Scenario and the Current Conditions Scenario are compared with the Proposed Action in both the 2009 and 2015 build years. Sample times throughout the day are taken from each analysis period to compare the different scenarios. Figure 7-2 shows the March analysis day at 7:45 AM with the shadows cast by Pre-September 11 Scenario buildings as well as other existing and buildings expected to be developed by 2015. Figure 7-3 shows the same time period with shadows cast by the fully developed Proposed Action as well as existing and other buildings expected to be developed by 2015. The differences between the Pre-September 11 Scenario shadows and those cast by the Proposed Action on open

## **World Trade Center Memorial and Redevelopment Plan GEIS**

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spaces are shown in Figure 7-3 with solid black for additional shadow cast by the Proposed Action and a lined hatching for areas that would receive sun—or less shadow—with the configuration of the Proposed Action that were previously in shadow from the Pre-September 11 Scenario configuration.

### *MARCH/SEPTEMBER 21: ANALYSIS PERIOD—7:36 AM TO 4:29 PM EST (FIGURES 7-4 TO 7-5)*

Open spaces on the proposed Project Site would be cast into shadow throughout the analysis period. Morning shadows would be cast on Liberty Park, the Memorial area, and Heroes Park. Midday to late afternoon shadow would be cast in a northward direction and mainly fall on Heroes Park and Wedge of Light Plaza.

Freedom Tower would cast incremental shadows on the bikeway/walkway, the waterfront parks in BPC, the Irish Hunger Memorial, and the ball fields during the morning to noon hours on the March/September analysis day. It would also cast new shadows on the PS/IS 89 Playground, the plaza on Warren Street, the PS 234 playgrounds, and the James Bogardus Viewing Garden for a very short amount of time near midday. Shadows from the Proposed Action would reach Washington Market Park and the Greening of Greenwich for about thirty minutes each. The plaza at 7 WTC would be cast into shadow for just under 2 hours in the late afternoon. Freedom Tower would cast an incremental shadow on the graveyard at St. Paul's Chapel and the Millennium Hotel Plaza for less than an hour in the mid- to-late afternoon.

The buildings of the Proposed Action would not cast any additional shadows on West Thames Playground, North End Avenue Mall, Stuyvesant High School Plaza, Hudson River Park, City Hall Park, Brooklyn Bridge Plaza, Police Plaza, Pace Plaza, or One Liberty Plaza.

### *MAY/AUGUST 6: ANALYSIS PERIOD—7:27 AM TO 6:18 PM DST (FIGURES 7-6 TO 7-7)*

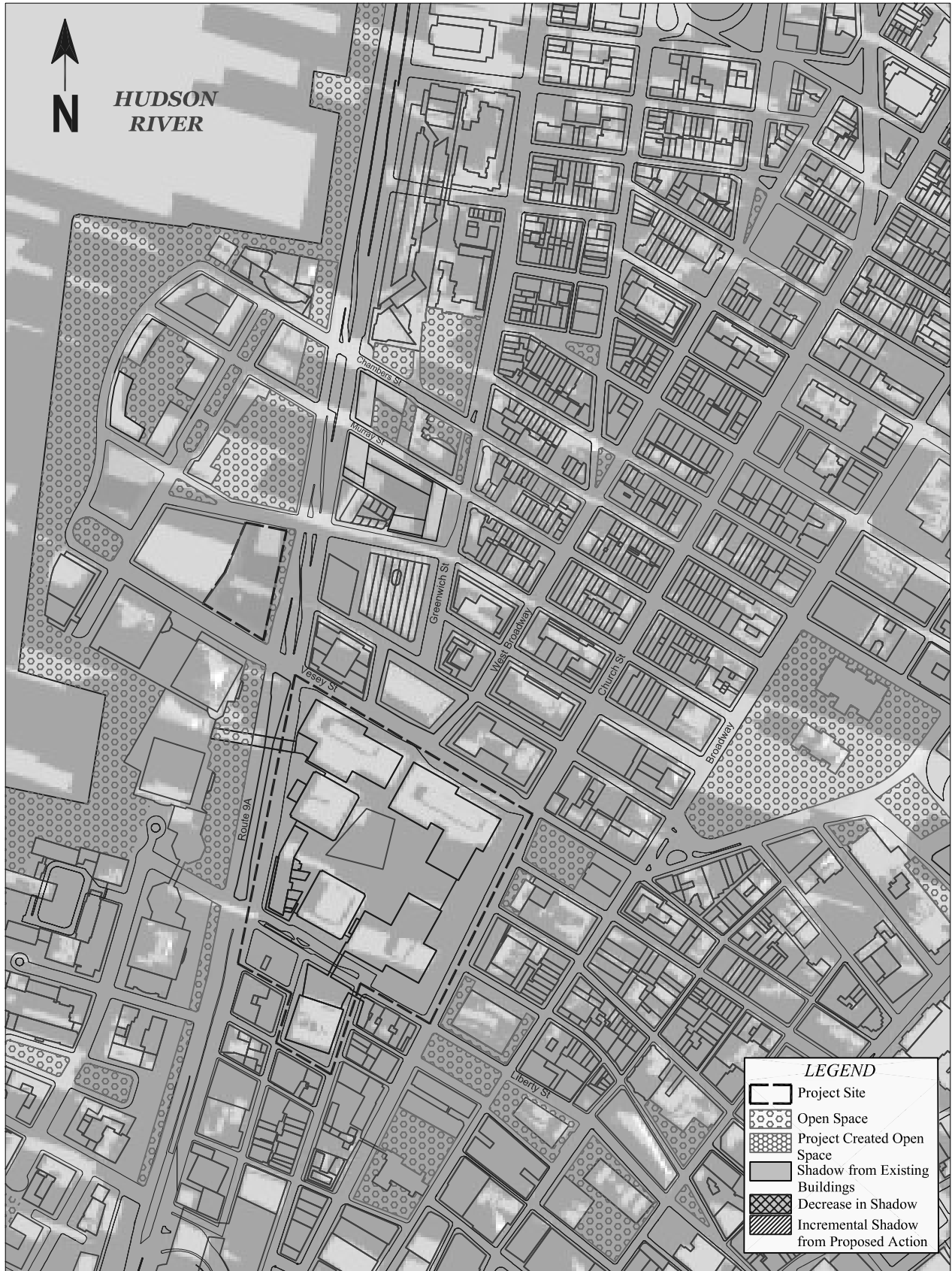
Open spaces on the proposed Project Site would be cast into shadow throughout the analysis period. Early morning shadows would be cast on Liberty Park, the Memorial, Heroes Park, and Wedge of Light Plaza. Mid- to-late-morning shadows would mostly fall on the Memorial and Heroes Park. Midday to early evening shadows would be cast in a northward direction and mainly fall on Heroes Park and Wedge of Light Plaza.

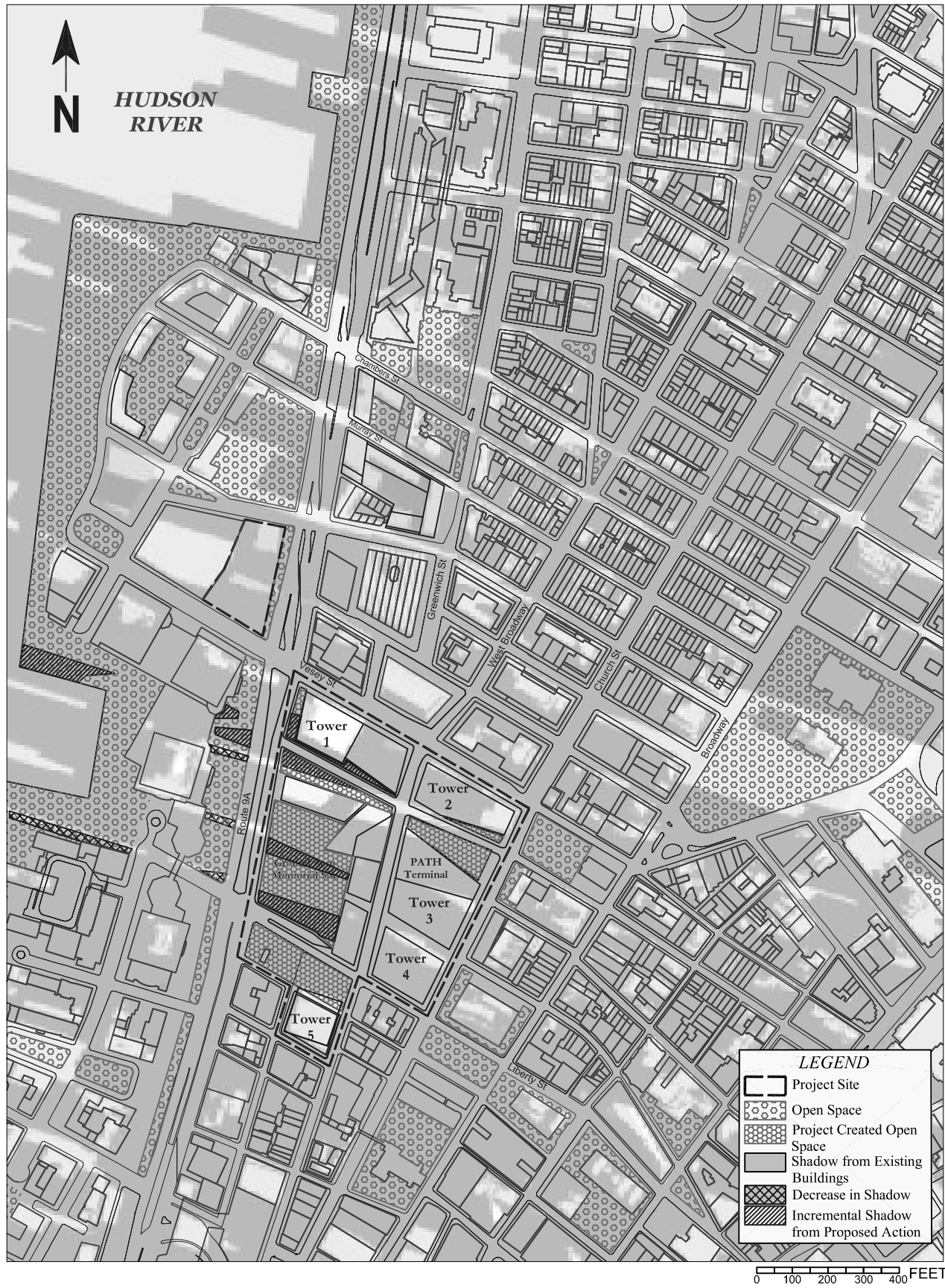
On the May/August 6 analysis day, Freedom Tower would cast incremental shadows on the bikeway/walkway and the BPC waterfront parks during the morning to noon hours. The plaza at 7 WTC, City Hall Park, Brooklyn Bridge Plaza, the Millennium Hotel Plaza, One Liberty Plaza, and the graveyard at St. Paul's Chapel would receive incremental shadows in the late afternoon.

The Proposed Action would not increase the shadows on West Thames Playground, the Irish Hunger Memorial, the BPC ball fields, North End Avenue Mall, PS/IS 89 Playground, Stuyvesant High School Plaza, Hudson River Park, the plaza on Warren Street, the PS 234 playgrounds, the Greening of Greenwich Street, Washington Market Park, James Bogardus Viewing Garden, or Pace Plaza on this analysis day.

### *JUNE 21: ANALYSIS PERIOD—6:57 AM TO 7:01 PM DST (FIGURES 7-8 TO 7-9)*

Open spaces on the proposed Project Site would be cast into shadow throughout the analysis period. Early morning shadows would be cast on Liberty Park, the Memorial, Heroes Park, and Wedge of Light Plaza. Mid- to late-morning shadows would mostly fall on the Memorial and





Proposed Action Conditions 2015 compared to Pre-September 11 Conditions  
 March 21 - 7:45 AM EST  
 Figure 7 - 3









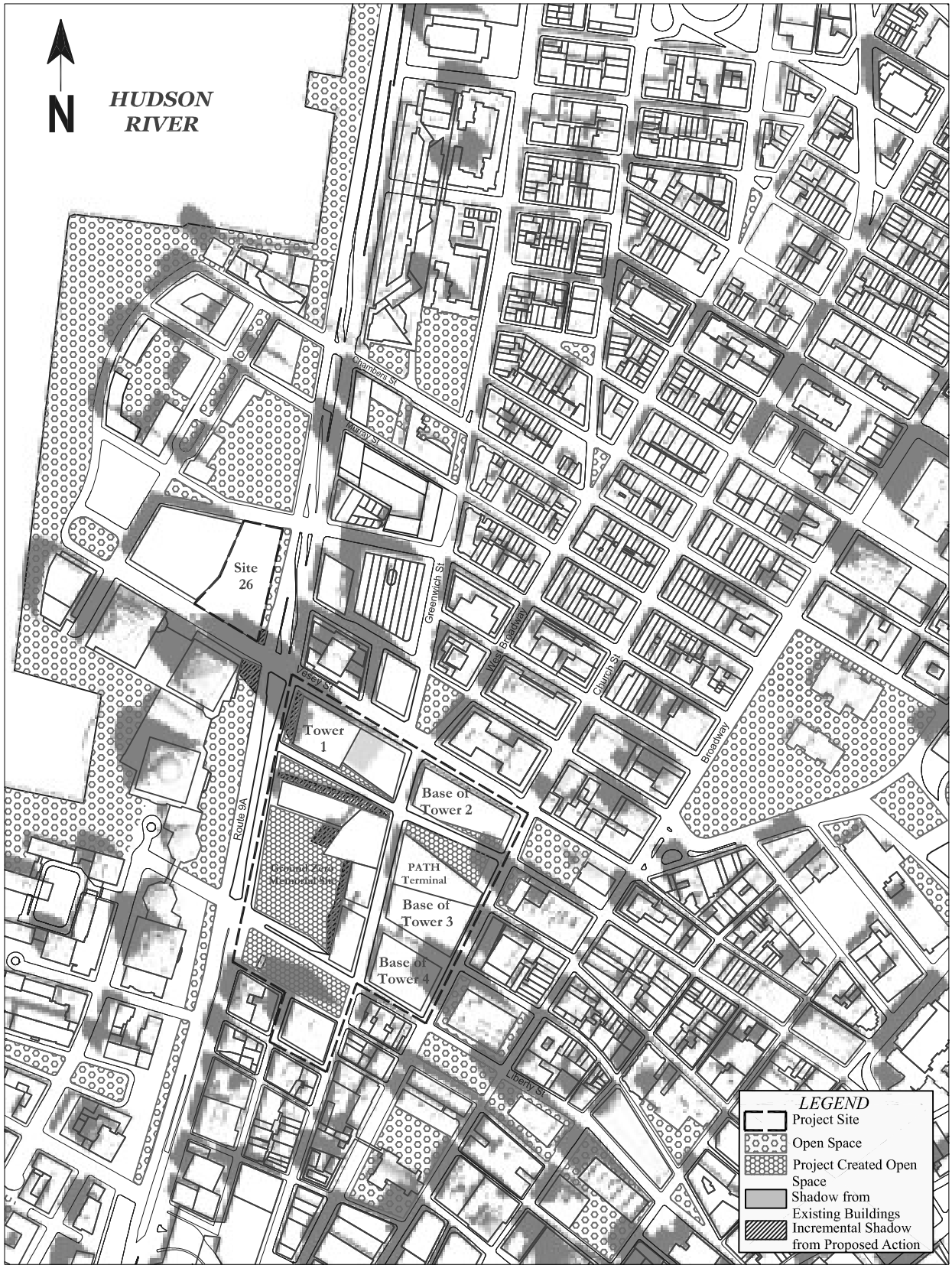




**LEGEND**  
 Project Site  
 Open Space  
 Project Created Open Space  
 Shadow from Existing Buildings  
 Incremental Shadow from Proposed Action

0 100 200 300 400 FEET

Shadow Diagrams  
 Current Conditions 2009  
 June 21 - 10:00 AM DST  
 Figure 7 - 8



Heroes Park. Midday to early evening shadows would be cast in a northward direction and mainly fall on Heroes Park and Wedge of Light Plaza.

On the summer solstice, incremental shadows from the Proposed Action would reach the bikeway/walkway and the BPC waterfront parks during the morning hours. Shadows from the buildings of the Proposed Action would reach 7 WTC Plaza, City Hall Park, the graveyard at St. Paul's Chapel, the plaza at the Millennium Hotel, and One Liberty Plaza in the late afternoon.

No incremental shadows from the Proposed Action would fall on West Thames Playground, the Irish Hunger Memorial, the BPC ball fields, North End Avenue Mall, PS/IS 89 Playground, Stuyvesant High School Plaza, Hudson River Park, the plaza on Warren Street, the PS 234 playgrounds, the Greening of Greenwich Street, Washington Market Park, James Bogardus Viewing Garden, Brooklyn Bridge Plaza, Police Plaza, or Pace Plaza on the June analysis day.

*DECEMBER 21: ANALYSIS PERIOD—8:51 AM TO 2:53 PM EST (FIGURES 7-10 TO 7-11)*

Open spaces on the proposed Project Site would be cast into shadow throughout the analysis period. Morning shadows would be cast on Liberty Park, the Memorial, Heroes Park, and Wedge of Light Plaza. Midday shadows would be cast in a northward direction and mainly fall on Heroes Park and Wedge of Light Plaza.

On the December analysis day, incremental shadows would be cast onto the bikeway/walkway for the entire morning. The BPC waterfront parks, BPC ball fields, the PS/IS 89 Playground, and Stuyvesant High School Plaza would receive incremental shadow for about an hour and a half in the late morning. North End Avenue Mall and Hudson River Park would receive one-half hour or less of incremental shadow due to the Proposed Action. Tower 2 would cast shadow on 7 WTC Plaza for about two hours near noon and again in the middle of the afternoon. Washington Market Park would receive incremental shadows during the middle of the day for slightly less than two hours.

No incremental shadows would be cast onto West Thames Playground, the Irish Hunger Memorial, the plaza on Warren Street, the PS 234 playgrounds, the Greening of Greenwich Street, James Bogardus Viewing Garden, City Hall Park, Brooklyn Bridge Plaza, Police Plaza, Pace Plaza, the Millennium Hotel Plaza, One Liberty Plaza, or the graveyard at St. Paul's Chapel.

Additional figures are located in Appendix C, "Shadows."

## **7.6.2 EFFECT ON SENSITIVE RESOURCES**

Shadow increments due to the Proposed Project of 30 minutes or less would not result in significant adverse impacts to the resources and are not discussed in detail below.

### *PROJECT SITE OPEN SPACES*

Since the proposed open spaces are located throughout the WTC Site and Southern Site, incremental shadow would be cast throughout the day in all analysis periods. The Memorial would receive incremental shadows from the museum and cultural facilities buildings in the morning throughout the year. Heroes Park and Wedge of Light Plaza would receive incremental shadows in the early morning hours of the May/August and June analysis periods as well as midday to afternoon shadows throughout the year.

## **World Trade Center Memorial and Redevelopment Plan GEIS**

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Liberty Park North and the Memorial would receive incremental shadows from the base of Towers 3 and 4 during the morning throughout the year and from Tower 5 during the March/September analysis period. For the spring to autumn months, these two open space areas would receive ample sun in the early to mid-afternoon until shadows from existing buildings across Route 9A begin to cast shadow onto the WTC Site. The Proposed Action would cast shadows onto Liberty Park South in the early morning of the late spring through summer months. Heroes Park would receive incremental shadows throughout the analysis day all year. Heroes Park and Wedge of Light Plaza would receive incremental shadows throughout the analysis day all year. The museum and cultural facilities buildings would cast shadows on Heroes Park and Tower 2 and Tower 3 would cast shadow on Wedge of Light Plaza. The southern portion of Heroes Park would receive early morning shadow throughout the year and mid-morning to midday shadows, depending on the season, would fall on the northern portion. Wedge of Light Plaza would receive incremental shadows throughout the day in each analysis period but would receive sun from March through September in the early to mid-morning hours depending on the analysis day.

### *BIKEWAY/WALKWAY*

Freedom Tower would cast incremental shadows on the bikeway/walkway on all analysis days from the beginning of the analysis period until around 12:30 PM. In March/September, the incremental shadow would fall on the portion of the bikeway/walkway directly west of Freedom Tower at 7:36 AM and move north reaching the area next to the BPC ball fields at 12:15 PM. The May/August incremental shadow would begin on the portion of the bikeway/walkway west of the WTC Site at 7:27 AM and continue north to cast the last shadow on the portion of the bikeway/walkway next to Site 26 at noon. Similar to May, June shadow would begin to fall on the portion of the bikeway/walkway west of the WTC Site at 6:57 AM and continue north to cast the last shadow near Site 26 at 12:45 PM. In December, the incremental shadow would fall mostly on the portion of the bikeway/walkway just south of Vesey Street around 8:51 AM and move north to the portion along Hudson River Park casting the last shadow at 12:30 PM.

### *BPC WATERFRONT PARKS—GOVERNOR NELSON A. ROCKEFELLER PARK, ROBERT F. WAGNER, JR. PARK, AND THE ESPLANADE*

Similar to the bikeway/walkway, the BPC waterfront parks would receive morning shadows from the Proposed Action. In March/September, the incremental shadow would last for about 45 minutes at the beginning of the analysis period and again for an hour and fifteen minutes from 9 AM to 10:15 AM EST.

On the May/August analysis day, incremental shadows would fall on the waterfront parks from 9 AM to 10:15 AM, just over one hour. In June, the shadows would fall on these parks for two hours in morning from 9 AM through 11 AM. December shadows would occur from 9 AM to 10:30 AM. The incremental shadows would fall west of Freedom Tower slightly south of Vesey Street.

### *BPC BALL FIELDS*

The BPC ball fields would receive incremental shadows on the March/September and December analysis days only. The first incremental shadow in March/September would occur at 10:45 AM EST on the southwest corner of the park. The shadow would continue to move north and east creating the largest incremental shadow around 11:30 AM when it would cover just less than



**LEGEND**  
 Project Site  
 Open Space  
 Project Created Open Space  
 Shadow from Existing Buildings  
 Incremental Shadow from Proposed Action

0 100 200 300 400 FEET

Shadow Diagrams  
 Current Conditions 2009  
 December 21 - 10:00 AM EST  
 Figure 7 - 10





**LEGEND**

- Project Site
- Open Space
- Project Created Open Space
- Shadow from Existing Buildings
- Incremental Shadow from Proposed Action

0 100 200 300 400 FEET

Shadow Diagrams  
 Current Conditions 2009  
 December 21 - 12:00 PM EST  
 Figure 7 - 11

half the park. The shadow would continue to move until the last shadow would fall on the park at 12:15 PM. In December, the ball fields would receive slightly more than two hours of shadows. The first shadow would occur at 10 AM and some shadow from Freedom Tower would remain on the ball fields until 12:15 PM. During December, shadows from existing buildings cover much of the park already and the shadows from the proposed Freedom Tower would remove the last sunlight on this open space on the December 21 analysis day. Shadows from the Proposed Action would not reach the ball fields on the May/August or June analysis days.

#### *PS/IS 89 PLAYGROUND*

Incremental shadows from Freedom Tower would only reach this open space on the December analysis day when the PS/IS Playground would receive an hour and a half of incremental shadow. The first incremental shadow would occur at 10:45 AM on the southwest corner. From 11:30 to 11:45 AM, shadow from Freedom Tower would cover the entire playground. By 12:15 PM, the last shadow cast from the Proposed Action would fall on the playground.

#### *STUYVESANT HIGH SCHOOL PLAZA*

Shadow from Freedom Tower would only reach the plaza at Stuyvesant High School during the late morning in December. The first incremental shadow would occur at 11:15 AM on the western area of the plaza and the last incremental shadow would be leaving the park an hour later at 12:15 PM.

#### *WASHINGTON MARKET PARK*

Shadows from Freedom Tower would only reach Washington Market Park for an hour and a half on December 21 and thirty minutes in the March/September analysis period. The first incremental shadow in December would fall at noon on the tennis court and basketball court at the western end of the park. Within an hour, almost the entire park would be in shadow, much of which would come from Freedom Tower. At 1:45 PM the shadow from Freedom Tower would move into an existing shadow from intervening buildings. Incremental shadows from Freedom Tower would fall mostly on the southern edge of the park in March/September.

#### *7 WTC PLAZA*

Shadows from the Proposed Action would fall on the 7 WTC Plaza during the afternoon hours throughout the year. Freedom Tower would cast shadows for less than two hours in March/September and May/August and for up to two and a half hours in June and December.

#### *CITY HALL PARK*

City Hall Park would receive incremental shadows from the Proposed Action during the late afternoon hours of the May/August and June analysis days. On the May/August analysis day, Freedom Tower would cast an incremental shadow on City Hall Park from 4:30 PM to 6 PM. The incremental shadow would occur mostly on the northern edge of the park along Chambers Street. In June, the incremental shadow would last just under two hours, from 5:15 PM to the end of the analysis period at 7:01 PM. The incremental shadow would create slivers of new shadow, mostly falling between shadows from existing buildings.

*THE GRAVEYARD AT ST. PAUL'S CHAPEL*

The graveyard at St. Paul's Chapel would receive incremental shadows during the March/September, May/August and June analysis periods during the mid- to late-afternoon hours. In March/September, the first incremental shadow would occur on the northwest corner at 3:30 PM from the base of Tower 2. The incremental shadow would start out small and move slowly to the east covering slightly more of the graveyard as the afternoon continues. By 4:29 PM, the end of the analysis period, the Proposed Action's incremental shadow would be mostly covered within existing shadows and there would be only a small incremental shadow on the northwest corner. In May/August, beginning at 4:45 PM, the base of Tower 2 would again be casting an incremental shadow on the graveyard. The shadow would again be small as it would begin to fall on the northwest corner. By 6 PM, shadows from existing buildings would cover the portion of the graveyard that was previously receiving incremental shadow from the base of Tower 2. Incremental shadows from the base of Tower 2 would fall on the graveyard from 5 PM to 7:01 PM in the June analysis period. The first incremental shadow would occur on the northwest corner of the plaza and continue farther east, covering the northern two-thirds of the graveyard by the end of the analysis period at 7:01 PM.

*MILLENNIUM HOTEL PLAZA*

The plaza at the Millennium Hotel Plaza would receive incremental shadows from the base of Tower 3 during the March/September, May/August and June analysis days during the mid- to late-afternoon hours. In March/September, the first incremental shadow would occur on the southwest corner at 4 PM EST. The incremental shadow would start out small and move slowly to the east covering slightly more of the plaza as the afternoon continues. By 4:29 PM, the end of the analysis period, the incremental shadow would be covering the southern half of the plaza. In May/August, beginning at 5 PM and lasting until the end of the analysis period at 6:18 PM, the base of Tower 3 would again be casting an incremental shadow on the plaza. The shadow would again be small as it would begin to fall on the southwest corner of the plaza at 5 PM. By 6:15 PM, additional incremental shadow from the museum and cultural facility buildings would begin to fall on the middle to northern portion of the plaza creating a total incremental shadow covering a little more than three-quarters of the plaza. Similar to the May/August shadow increments, June would cast late afternoon shadows as well. The first incremental shadow would occur on the southwest corner of the plaza at 5:45 PM from the base of Tower 3. By 6:30 PM, the museum and cultural facility buildings would again be casting an incremental shadow on the northern portion of the plaza. By the end of the analysis period, 7:01 PM, shadows from existing buildings across Route 9A would be casting shadows onto the plaza and only a small sliver on the southern portion of the plaza would be cast into new shadow from the Proposed Action.

*ONE LIBERTY PLAZA*

One Liberty Plaza would receive incremental shadows in the late afternoon during the May/August and June analysis periods. The first incremental shadow would begin to fall at 5:15 PM in May/August on the northwest corner. By 6 PM, shadows from existing buildings would encompass the plaza and cover the last portion of the incremental shadow from the base of Tower 4. Similarly, in June, the first incremental shadow would occur on the western edge of Liberty Plaza at 5:30 PM. The shadow would continue to move east and cover more of the plaza so that from 6:30 PM to 7:01 PM, the portion along Church Street would be entirely in shadow.

## **7.7 ASSESSMENT OF SHADOW IMPACTS—CURRENT CONDITIONS SCENARIO 2015**

As 2015 is the analysis year when full development is assumed, the discussions below indicate the greatest potential impacts of shadows from the Proposed Action. The new shadows by comparison to the 2009 shadows would fall farther on the WTC Site, the Southern Site, and to the east of Church Street due to the locations of these four towers.

### **7.7.1 SHADOWS BY SEASON**

This section considers the shadows that would be cast by Towers 2, 3, 4 and 5 which are in addition to the shadows cast by Freedom Tower and the bases of Towers 2-4 by analysis day (see Table 7-3).

#### *MARCH/SEPTEMBER 21 ANALYSIS PERIOD—7:36 AM TO 4:29 PM EST (FIGURES 7-12 TO 7-14)*

Incremental shadows would be cast by Tower 5 onto the Memorial for most of the middle portion of the day. Additional incremental shadows would also fall on Liberty Park from Tower 5 for most of the day.

In addition to the shadows cast by Freedom Tower, Towers 3 and 4 would cast incremental shadow to the BPC waterfront parks around North Cove and the bikeway/walkway along Route 9A west of the WTC Site. The addition of the building on Site 26 would reduce some of the incremental shadow originally created on the BPC ball fields from Freedom Tower in 2009. 7 WTC open space would receive additional shadow increment from Tower 2 during the late morning. Additional shadow would be cast onto the graveyard at St. Paul's Chapel, the Millennium Hotel Plaza, City Hall Park, Brooklyn Bridge Plaza, and Police Plaza from Towers 2 and 3.

There would be no additional shadow on the Irish Hunger Memorial, PS/IS 89 Playground, the plaza on Warren Street, the playgrounds at PS 234, Washington Market Park, or the John Bogardus Viewing Garden between 2009 and 2015.

#### *MAY/AUGUST 6 ANALYSIS PERIOD—7:27 AM TO 6:18 PM DST (FIGURES 7-15 TO 7-17)*

Tower 2 would cast early morning incremental shadows on Wedge of Light Plaza and Heroes Park. Tower 4 would cast early morning incremental shadows on Liberty Park South. Additional incremental shadows would be cast from Tower 5 on the Memorial for most of the early part of the day and Liberty Park for most of the analysis period.

In the May/August analysis period, Towers 3 and 4 would cast incremental shadow on the BPC waterfront parks near Liberty Street and the bikeway/walkway along Route 9A west of the Project Site. The plaza at 7 WTC would receive additional late morning shadows. The parks to the west of the Project Site would receive additional shadow in the afternoon to early evening hours. Tower 3 would cast a small incremental shadow on the southern edge of City Hall Park and Tower 2 would cast new shadow on Brooklyn Bridge Plaza. The graveyard at St. Paul's Chapel, the Millennium Hotel plaza, One Liberty Plaza and the graveyard at St. Paul's Chapel would all receive new incremental late afternoon shadow from Towers 3, 4, and 5.

**World Trade Center Memorial and Redevelopment Plan GEIS**

**Table 7-3  
Project Shadow Durations—Current Conditions—2015**






<b>Open Space / Historic Resource</b>	<b>March 21/ September 21 7:36 AM-4:29 PM EST</b>	<b>May 6/ August 6 7:27 AM-6:18 PM DST</b>	<b>June 21 6:57 AM-7:01 PM DST</b>	<b>December 21 8:51 AM-2:53 PM EST</b>
West Thames Playground	–	–	8:15 AM	–
Bikeway/Walkway	7:36 AM – 12:15 PM	7:27 AM – 12:45 PM	6:57 AM – 12:45 PM	8:51 AM – 12:30 PM
BPC Waterfront Parks (Battery Park Esplanade / Nelson A Rockefeller Park / Robert F Wagner Park)	7:36 – 8:30 AM, 9:00 AM – 12:15 PM	7:27 – 10:15 AM	6:57 – 11:00 AM	–
Irish Hunger Memorial	9:15 – 9:45 AM*	–	–	–
BPC Ballfields	11:00 AM – 12:15 PM	–	–	9:15 AM – 12:15 PM
North End Avenue Mall	–	–	–	–
PS/IS 89 Playground	12:00 PM*	–	–	10:45 AM – 12:15 PM*
Stuyvesant High School Plaza	–	–	–	11:15 AM – 12:15 PM*
Hudson River Park	–	–	–	12 – 12:30 PM
Warren Street Plaza	12:45 PM*	–	–	–
P.S. 234 West Playground	12:45 PM*	–	–	–
P.S. 234 East Playground	1:00 – 1:15 PM*	–	–	–
Greening of Greenwich Street	1:15 – 1:45 PM*	–	–	11:45 AM – 12:30 PM
Washington Market Park	1:00 – 1:30 PM*	–	–	11:15 AM – 1:45 PM
James Bogardus Viewing Garden	2:30 PM*	–	–	1:15 – 1:45 PM
7 WTC Plaza	9:30 AM – 1:15 PM, 2:45 – 4:29 PM	11:30 AM – 1:45 PM, 3:15 – 5:00 PM	12:00 – 1:30 PM, 3:00 – 5:30 PM	10:15 – 10:45 AM, 11:45 – 2:53 PM
City Hall Park	3:15 – 4:15 PM	3:45 – 6:00 PM	4:15 – 7:01 PM	–
Brooklyn Bridge Plaza	4:15 PM	5:15 – 6:18 PM	–	–
Police Plaza	4:15 – 4:29 PM	5:45 – 6:00 PM	–	–
Pace Plaza	–	–	6:00 PM	–
Millennium Hotel Plaza	2:00 – 4:29 PM	2:15 – 6:18 PM	2:00 – 7:01 PM	2:30 – 2:53 PM
One Liberty Plaza	–	3:15 – 3:45 PM, 5:00 – 6:00 PM	3:00 – 7:01 PM	–
Liberty Park North	7:36 AM – 12:15 PM	7:27 AM – 1:15 PM	6:57 AM – 1:00 PM	9:30 AM - 11:45 AM
Liberty Park South	–	7:27 AM – 10:30 AM, 11:30 AM – 12:30 PM	6:57 AM – 10:45 AM, 11:45 AM – 12:45 PM	–
Memorial	7:36 AM – 12:15 PM	7:27 AM – 1:15 PM	6:57 AM – 1:00 PM	9:30 AM - 11:45 AM
Heroes Park	7:36 AM – 4:29 PM	7:27 AM – 6:00 PM	6:57 AM – 5:30 PM	8:51 AM – 2:53 PM
Wedge of Light Plaza	10:15 AM – 4:29 PM	7:27 AM – 9:45 AM, 11:45 AM – 6:18 PM	12:15 PM – 7:01 PM	10:30 AM – 2:53 PM
The Graveyard at St. Paul's Chapel	1:45 – 4:29 PM	2:00 – 6:00 PM	3:00 – 7:01 PM	2:30 – 2:53 PM
<b>Notes:</b> EST—Eastern Standard Time DST—Daylight Saving Time September 21 is the equivalent of March 21, but one hour later. August 6 is the equivalent of May 6. * No new incremental shadows between 2009 and 2015.				
<b>Source:</b> AKRF, Inc. determined using 3D data from Urban Data Solutions, Inc. with the Solar Study function in MicroStation V8.				

**JUNE 21 ANALYSIS PERIOD—6:57 AM TO 7:01 PM DST (FIGURES 7-18 TO 7-21)**

Similar to the May/August incremental shadows, Tower 2 would cast early morning incremental shadows on Wedge of Light Plaza and Heroes Park and Tower 4 would cast early morning incremental shadows on the portion of Liberty Park South. Additional incremental shadows



**LEGEND**

-  Project Site
-  Open Space
-  Project Created Open Space
-  Shadow from Existing Buildings
-  Incremental Shadow from Proposed Action

0 100 200 300 400 FEET

Shadow Diagrams  
 Current Conditions 2015  
 March 21 - 7:45 AM EST  
 Figure 7 - 12





**LEGEND**

- Project Site
- Open Space
- Project Created Open Space
- Shadow from Existing Buildings
- Incremental Shadow from Proposed Action

0 100 200 300 400 FEET

Shadow Diagrams  
 Current Conditions 2015  
 March 21 - 3:30 PM EST  
 Figure 7 - 14







**LEGEND**  
 Project Site  
 Open Space  
 Project Created Open Space  
 Shadow from Existing Buildings  
 Incremental Shadow from Proposed Action

0 100 200 300 400 FEET

Shadow Diagrams  
 Current Conditions 2015  
 May 6 - 12:00 PM DST  
 Figure 7 - 16



**LEGEND**

- Project Site
- Open Space
- Project Created Open Space
- Shadow from Existing Buildings
- Incremental Shadow from Proposed Action

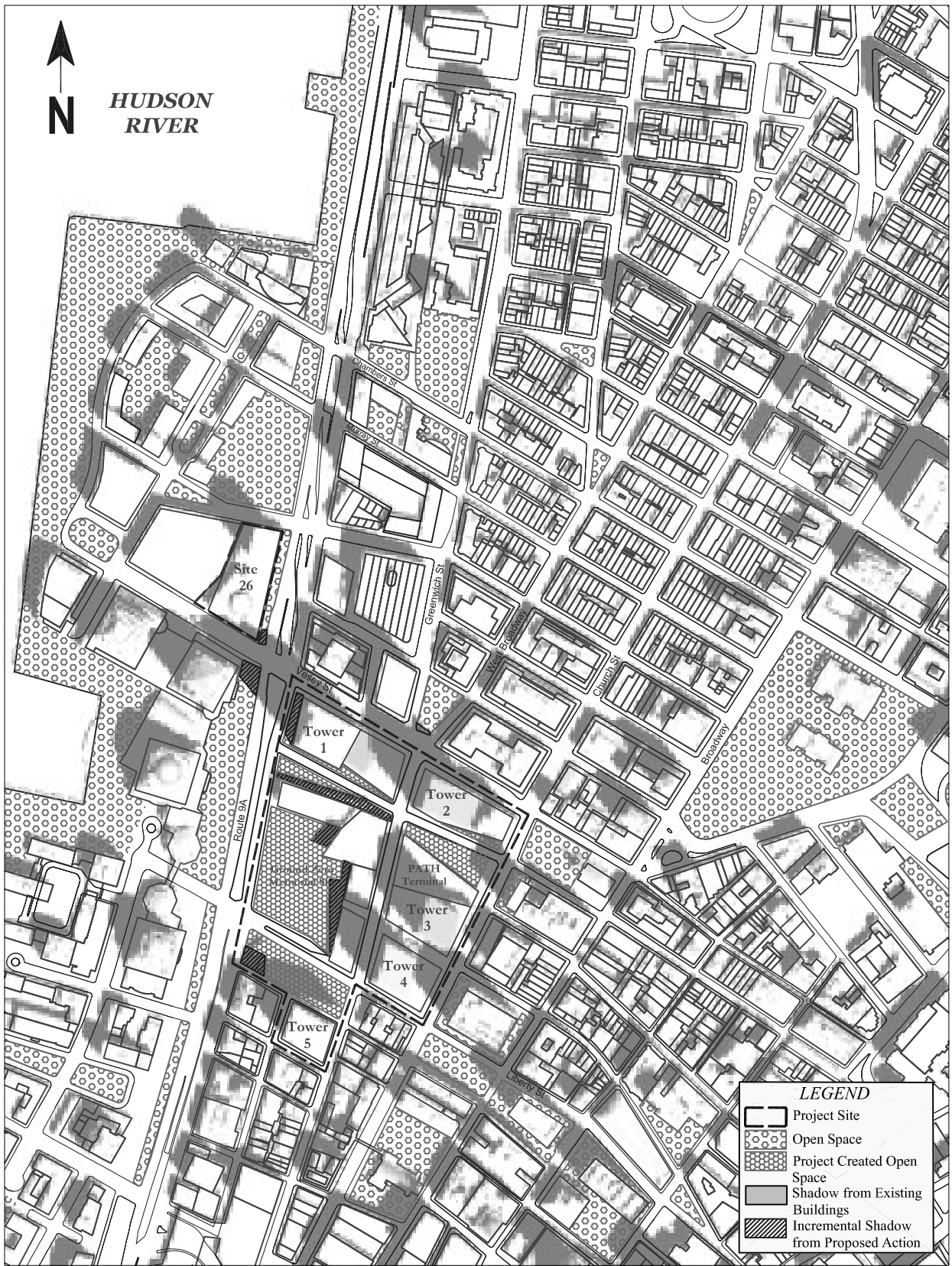
0 100 200 300 400 FEET

Shadow Diagrams  
 Current Conditions 2015  
 May 6 - 5:30 PM DST  
 Figure 7 - 17



0 100 200 300 400 FEET

Shadow Diagrams  
 Current Conditions 2015  
 June 21 - 10:00 AM DST  
 Figure 7 - 18



0 100 200 300 400 FEET

Shadow Diagrams  
 Current Conditions 2015  
 June 21 - 12:00 PM DST  
 Figure 7 - 19



**LEGEND**

	Project Site
	Open Space
	Project Created Open Space
	Shadow from Existing Buildings
	Incremental Shadow from Proposed Action

0 100 200 300 400 FEET

Shadow Diagrams  
 Current Conditions 2015  
 June 21 - 4:00 PM DST  
 Figure 7 - 20



**LEGEND**  
 Project Site  
 Open Space  
 Project Created Open Space  
 Shadow from Existing Buildings  
 Incremental Shadow from Proposed Action

0 100 200 300 400 FEET

Shadow Diagrams  
 Current Conditions 2015  
 June 21 - 6:30 PM DST  
 Figure 7 - 21

would be cast from Tower 5 on the Memorial for most of the early part of the day and Liberty Park for most of the analysis period.

In addition to the shadows created by the Proposed Action in 2009, the tower on the Southern Site would cast a small incremental shadow on West Thames Playground at 8:15 AM. The BPC waterfront parks, specifically near Liberty Street, would receive an additional incremental shadow from Towers 2, 3, and 4 in the early morning. The bikeway/walkway west of the WTC Site would receive additional shadow during the morning. City Hall Park, the graveyard at St. Paul's Chapel, the plaza at the Millennium Hotel, and One Liberty Plaza would all receive additional shadow increments from Towers 2, 3, 4, and 5 in the late afternoon. Pace Plaza would receive an incremental shadow at 6 PM from Tower 2.

*DECEMBER 21 ANALYSIS PERIOD—8:51 AM TO 2:53 PM EST) (FIGURES 7-22 TO 7-24)*

Tower 5 would cast additional shadow on Liberty Park and the Memorial for the entire analysis period.

Towers 2, 3, 4, and 5 in 2015 would cast additional shadow on the bikeway/walkway, the BPC waterfront parks, the BPC ball fields, and Hudson River Park during the morning to noon hours of the December analysis period. The addition of the building slated by the Battery Park City Authority to go on Site 26 would reduce some of the incremental shadow originally created on the BPC ball fields by Freedom Tower in 2009 and eliminate the incremental shadow on the BPC waterfront parks and the North End Avenue Mall. Washington Market Park would receive incremental shadows from the addition of Tower 2 in 2015. Tower 2 would create incremental midday shadows on James Bogardus Viewing Garden and Towers 3 and 4 would add incremental shadows to the graveyard at St. Paul's Chapel and the plaza at the Millennium Hotel in the late afternoon.

Shadow on the PS/IS 89 Playground and the plaza at Stuyvesant High School would be the same as in 2009.

Additional Figures are located in Appendix C, "Shadows."

## **7.7.2 EFFECT ON SENSITIVE RESOURCES**

### *PROJECT SITE OPEN SPACES*

Additional shadow increments would occur throughout the year, with the majority occurring on the Memorial and Liberty Park North in the morning hours of the late spring to summer months when the sun is high in the sky and shadows are generally the shortest. Tower 4 would cast additional small incremental shadows onto Liberty Park South in the morning from May until August. The Memorial and Liberty Park North would receive incremental shadows from Towers 3 and 4 in the morning from May to August.

### *BIKEWAY/WALKWAY*

In addition to the shadows created by Freedom Tower, Towers 3, 4, and 5 would cast additional shadows on the bikeway/walkway. Incremental shadows would occur on the area of the bikeway/walkway directly west of the Project Site. In May/August, incremental shadows would be again added on the bikeway/walkway by Towers 3, 4, and 5. At 7:27 AM incremental shadows would fall on the bikeway/walkway near Albany Street. They would move north to the area directly west of the Project Site remaining on the bikeway/walkway until 12:45 PM. In



## **World Trade Center Memorial and Redevelopment Plan GEIS**

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June, incremental shadows from all four additional towers would reach the bikeway/walkway in the morning adding to the shadow of Freedom Tower. Beginning at 6:57 AM and lasting until 12:45 PM, shadows from the Proposed Action would fall on the bikeway/walkway. Early morning shadows would fall on the portion of the open space near Liberty Street. By mid-morning in June, incremental shadows from Towers 3 and 4 would be off of the open space, and Tower 2 would cast a small incremental shadow west of Freedom Tower. In December, Towers 3, 4, and 5 would create additional shadow on the portion of the bikeway/walkway west of the Project Site.

### *BPC WATERFRONT PARKS*

In March, incremental shadows from Towers 3 and 4 would fall on the portion of the parks near the North Cove. On the May/August analysis day, the incremental shadow on the waterfront parks would be larger than in 2009 the North Cove. The additional incremental shadow would last about an hour in the early morning of the May/August analysis day starting at 7:27 AM. Similar to the May/August analysis period, the June analysis period has increased shadow from the 2015 buildings. The incremental shadows occur in the portion of the open space near the North Cove.

### *BPC BALL FIELDS*

In 2015, with the building slated for Site 26 by the BPCA, shadows from the Proposed Action would be reduced. In 2009, shadows from Freedom Tower would cover about half of the park at 11:30 AM in the March/September analysis period, but in 2015 the incremental shadow would reach only a small portion of the ball fields near Route 9A. The BPC ball fields would receive additional shadow from Tower 4 around 11 AM. The incremental shadow would be a small slice across the central portion of the park.

### *WASHINGTON MARKET PARK*

In December, the addition of Tower 2 would create an incremental shadow on Washington Market Park starting at 11:15 AM and lasting an hour. The shadow would begin on the western area and move quickly to cover the eastern portion of the park by 11:45 AM.

### *THE PLAZA AT 7 WTC*

The plaza at 7 WTC would be in shadow from the towers of the Proposed Action on all analysis days. From the morning to early afternoon, it would be in shadow from Towers 2 and 3 and in the later afternoon it would be in shadow from Freedom Tower.

### *CITY HALL PARK*

Beginning at 3:30 PM during the March/September analysis period, incremental shadows from Tower 3 would fall onto City Hall Park. By 4 PM, the incremental shadow would cover the northwest portion of the park. At 4:29 PM, the end of the analysis period, the only new incremental shadow created on the park since 2009 would be a sliver located near the southeast edge of the park. In the May/August analysis period, Tower 3 would begin to cast a small incremental shadow on the southern edge of City Hall Park at 3:45 PM and would last about an hour. In June, Tower 2 would add small incremental shadows beginning at 4:15 PM and lasting until the end of the analysis period at 7:01 PM. The incremental shadows would fall on the



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**Shadow Diagrams**  
 Current Conditions 2015  
 December 21 - 10:00 AM EST  
 Figure 7 - 22



**LEGEND**

- Project Site
- Open Space
- Project Created Open Space
- Shadow from Existing Buildings
- Incremental Shadow from Proposed Action

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Shadow Diagrams  
 Current Conditions 2015  
 December 21 - 12:00 PM EST  
 Figure 7 - 23



**LEGEND**

- Project Site
- Open Space
- Project Created Open Space
- Shadow from Existing Buildings
- Incremental Shadow from Proposed Action

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Shadow Diagrams  
 Current Conditions 2015  
 December 21 - 1:00 PM EST  
 Figure 7 - 24

southern portion of the park and would only be small slivers that would fall between the shadows of existing buildings.

*BROOKLYN BRIDGE PLAZA*

The shadow of Tower 2 would only reach the plaza on March/September briefly at 4:15 PM. On May/August 6 Tower 2 would cast an incremental shadow on the plaza from 5:15 PM to 6:18 PM.

*GRAVEYARD AT ST. PAUL'S CHAPEL*

At 1:45 PM on the March/September analysis day, incremental shadows from Tower 3 would begin to fall on the graveyard. As the afternoon continues, about half of the park would be cast into shadow by 3:15 PM. By 4:29 PM, existing shadows would cover the portions of the park where Tower 3 would cast a shadow. Tower 3 would cast incremental shadows over those cast in 2009 in May/August beginning at 2 PM on the western edge. From 2:30 to 3 PM, the incremental shadow would remove the last of the sun on the graveyard. By 4 PM, the shadows cast by Tower 3 would begin to fall in shadows cast by existing buildings. In the June analysis period, beginning at 2 PM and lasting until 7:01 PM, Tower 3 would add incremental shadows to the graveyard. Beginning on the western edge and moving east, the shadow increment would cover slightly more than a quarter of the graveyard at 2:45 PM. In less than an hour, the shadows from Tower 3 would fall into shadows already being cast by existing buildings.

*MILLENNIUM HOTEL PLAZA*

In March/September, Tower 3 would cast an incremental shadow on the northwest corner of the plaza at the Millennium Hotel at 2 PM. From 2:45 to 4:29 PM, the entire plaza would be in shadow, some of which would have been first added in 2009 by the base of Tower 3. The plaza would receive additional shadows from Towers 3 and 4 beginning at 2:15 PM in the May/August analysis period. For two hours starting at 2:30 PM, the entire plaza would be in new shadow from the 2015 buildings. At 4:30 PM, shadows would start to move slowly south allowing the northern portion of the plaza to again receive sunlight, but leaving the southern portion in shadow until the end of the analysis period at 6:18 PM. In June, incremental shadow from Tower 3 would begin to fall on the plaza at 2 PM on the western edge. From 2:15 to 3:45 PM, Tower 3 would cast an incremental shadow covering the entire plaza. At 4 PM, the shadow would begin to move slowly south and allow the northern portion of the plaza to receive some sun, similar to the May/August analysis day. On December 21 the plaza would be in shadow from the Proposed Action only briefly from 2:30 to 2:53 PM the end of the analysis period.

*ONE LIBERTY PLAZA*

During the afternoon of the May/August analysis period, incremental shadows from Tower 5 would fall on the western portion of the plaza along Church Street from 3:15 to 3:45 PM. Beginning at 5 PM and lasting one hour, incremental shadow from Tower 4 would fall on the northern portion of the plaza along Church Street. From 3 PM to 7:01 PM on the June analysis day, Towers 4 and 5 would cast incremental shadows on the portions of One Liberty Plaza along Church and Liberty Streets. Tower 5 would cast shadows earlier and mostly cover the portion along Liberty Street. Tower 4 would cast shadows towards the end of the analysis period and cover the portion along Church Street.

## **7.8 ASSESSMENT OF SHADOW IMPACTS—PRE-SEPTEMBER 11 SCENARIO 2009**

The Pre-September 11 Scenario compares conditions with the Proposed Action to conditions as they were expected to have been had the WTC not been destroyed.

The incremental shadows would be smaller when comparing the Proposed Action to the Pre-September 11 Conditions than comparing to the Proposed Action to the Current Conditions Scenario because the buildings previously on the site also cast long shadows on nearby resources.

### **7.8.1 SHADOWS BY SEASON**

This section reviews the shadows that would be cast by the proposed project on each analysis day (see Table 7-4).

#### *MARCH/SEPTEMBER 21: ANALYSIS PERIOD— 7:36 AM TO 4:29 PM EST (FIGURES 7-25 TO 7-26)*

Open spaces on the proposed Project Site would be cast into shadow throughout the analysis period. Morning shadows would be cast on Liberty Park, the Memorial, and Heroes Park. Midday to late afternoon shadow would be cast in a northward direction and mainly fall on Heroes Park and Wedge of Light Plaza.

During the March/September analysis period, Freedom Tower would increase shadows on the Irish Hunger Memorial, PS/IS 89 Playground, the plaza on Warren Street, the PS 234 playgrounds, the Greening of Greenwich Street, Washington Market Park and the Millennium Hotel Plaza for thirty minutes or less.

The BPC waterfront parks would receive incremental shadow from the Proposed Action for about two hours in the morning of the March/September analysis period. The bikeway/walkway would receive early morning shadows lasting until slightly after noon. The BPC ball fields would receive incremental shadow late-morning until 12:15 PM.

No incremental shadows would be cast on the West Thames Playground, North End Avenue Mall, Stuyvesant High School Plaza, Hudson River Park, James Bogardus Viewing Garden, City Hall Park, Brooklyn Bridge Plaza, Police Plaza, Pace Plaza, the graveyard at St. Paul's Chapel or One Liberty Plaza.

#### *MAY/AUGUST 6 ANALYSIS PERIOD—7:27 AM TO 6:18 PM DST (FIGURES 7-27 TO 7-28)*

Open spaces on the proposed Project Site would be cast into shadow throughout the analysis period. Early morning shadows would be cast on Liberty Park, the Memorial, Heroes Park, and Wedge of Light Plaza. Mid- to late-morning shadows would mostly fall on the Memorial and Heroes Park. Midday to early evening shadows would be cast in a northward direction and mainly fall on Heroes Park and Wedge of Light Plaza.

On the May/August 6 analysis day, Brooklyn Bridge Plaza and Police Plaza would receive less than 30 minutes of incremental shadow.



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Shadow Diagrams  
 Pre-September 11 Conditions 2009  
 March 21 - 7:45 AM EST  
 Figure 7 - 25



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Shadow Diagrams  
 Pre-September 11 Conditions 2009  
 March 21 - 11:30 AM EST  
 Figure 7 - 26





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Shadow Diagrams  
 Pre-September 11 Conditions 2009  
 May 6 - 10:00 AM DST  
 Figure 7 - 27



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Shadow Diagrams  
 Pre-September 11 Conditions 2009  
 May 6 - 12:00 PM DST  
 Figure 7 - 28

**Table 7-4  
Project Shadow Durations—Pre-September 11 Conditions—2009**

<b>Open Space / Historic Resource</b>	<b>March 21/ September 21 7:36 AM-4:29 PM EST</b>	<b>May 6/ August 6 7:27 AM-6:18 PM DST</b>	<b>June 21 6:57 AM-7:01 PM DST</b>	<b>December 21 8:51 AM-2:53 PM EST</b>
West Thames Playground	–	–	–	–
Bikeway/Walkway	7:36 AM – 12:15 PM	7:27 AM – 12:45 PM	6:57 AM – 12:45 PM	10:45 AM
BPC Waterfront Parks (Battery Park Esplanade / Nelson A Rockefeller Park / Robert F Wagner Park)	7:36 – 8:00 AM, 9:00 – 10:15 AM	9:00 – 10:15 AM	9:00 – 11:00 AM	9:00 AM
Irish Hunger Memorial	9:15 – 9:45 AM	–	–	–
BPC Ballfields	10:45 AM – 12:15 PM	–	–	10:00 – 11:00 AM
North End Avenue Mall	–	–	–	–
PS/IS 89 Playground	12:00 PM	–	–	11:30 AM
Stuyvesant High School Plaza	–	–	–	–
Hudson River Park	–	–	–	12:00 PM
Warren Street Plaza	12:45 PM	–	–	–
P.S. 234 West Playground	12:45 PM	–	–	–
P.S. 234 East Playground	1:00 – 1:15 PM	–	–	–
Greening of Greenwich Street	1:15 – 1:45 PM	–	–	–
Washington Market Park	1:00 – 1:30 PM	–	–	12:15 PM, 1:00 – 1:30 PM
James Bogardus Viewing Garden	–	–	–	–
City Hall Park	–	4:30 – 6:00 PM	–	–
Brooklyn Bridge Plaza	–	6:00 – 6:15 PM	–	–
Police Plaza	–	5:45 – 6:00 PM	–	–
Pace Plaza	–	–	–	–
Millennium Hotel Plaza	4:00 PM	–	6:15 – 6:45 PM	–
One Liberty Plaza	–	5:15 – 6:00 PM	6:30 – 7:01 PM	–
Liberty Park North	7:36 AM – 12:15 PM	7:27 AM – 1:15 PM	6:57 AM – 1:00 PM	9:30 AM – 11:45 PM
Liberty Park South	–	7:27 AM – 8:15 AM	6:57 AM – 8:30 AM	–
Memorial	7:36 AM – 12:15 PM	7:27 AM – 1:15 PM	6:57 AM – 1:00 PM	9:30 AM – 11:45 AM
Heroes Park	7:36 AM – 4:29 PM	7:27 AM – 6:00 PM	6:57 AM – 5:30 PM	8:51 AM – 2:53 PM
Wedge of Light Plaza	10:15 AM – 4:29 PM	7:27 AM – 9:45 AM, 11:45 AM – 6:18 PM	12:15 PM – 7:01 PM	10:30 AM – 2:53 PM
The Graveyard at St. Paul's Chapel	–	–	–	–
<b>Notes:</b> EST—Eastern Standard Time DST—Daylight Saving Time September 21 is the equivalent of March 21, but one hour later. August 6 is the equivalent of May 6.				
<b>Source:</b> AKRF, Inc. determined using 3D data from Urban Data Solutions, Inc. with the Solar Study function in MicroStation V8.				

## **World Trade Center Memorial and Redevelopment Plan GEIS**

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The BPC waterfront parks would receive incremental shadow for about two hours in the morning and the bikeway/walkway would receive incremental shadow for the entire morning until noon. City Hall Park would receive incremental shadow for about an hour and a half in the late afternoon. One Liberty Plaza would receive additional shadow for about 45 minutes.

No incremental shadows would be cast onto West Thames Playground, the Irish Hunger Memorial, the BPC ball fields, North End Avenue Mall, PS/IS 89 Playground, Stuyvesant High School Plaza, Hudson River Park, the plaza on Warren Street, the PS 234 playgrounds, the Greening of Greenwich Street, Washington Market Park, James Bogardus Viewing Garden, Pace Plaza, the graveyard at St. Paul's Chapel or the Millennium Hotel Plaza during the May/August analysis period.

### *JUNE 21 ANALYSIS PERIOD—6:57 AM TO 7:01 PM DST (FIGURES 7-29 TO 7-30)*

Open spaces on the proposed Project Site would be cast into shadow throughout the analysis period. Early morning shadows would be cast on Liberty Park, the Memorial, Heroes Park, and Wedge of Light Plaza. Mid- to-late morning shadows would mostly fall on the Memorial and Heroes Park. Midday to early evening shadows would be cast in a northward direction and mainly fall on Heroes Park and Wedge of Light Plaza.

On the June analysis day the Millennium Hotel Plaza and One Liberty Plaza would receive thirty minutes of incremental shadow from the Proposed Action which would not result in significant adverse impacts.

The bikeway/walkway would receive an incremental shadow from the start of the analysis period until 12:45 PM and the BPC waterfront parks would receive about two hours of incremental shadow in the morning.

The Proposed Action would not increase shadows on the West Thames Playground, the Irish Hunger Memorial, the BPC ball fields, North End Avenue Mall, PS/IS 89 Playground, Stuyvesant High School Plaza, Hudson River Park, the plaza on Warren Street, the PS 234 playgrounds, the Greening of Greenwich Street, Washington Market Park, James Bogardus Viewing Garden, City Hall Park, Brooklyn Bridge Plaza, Police Plaza, Pace Plaza, or the graveyard at St. Paul's Chapel.

### *DECEMBER 21 ANALYSIS PERIOD—8:51 AM TO 2:53 PM EST (FIGURES 7-31 TO 7-32)*

Open spaces on the proposed Project Site would be cast into shadow throughout the analysis period. Morning shadows would be cast on Liberty Park, the Memorial, Heroes Park, and Wedge of Light Plaza. Midday shadows would be cast in a northward direction and mainly fall on Heroes Park and Wedge of Light Plaza.

The Proposed Action would cast incremental shadow on the bikeway/walkway, the PS/IS 89 playground and Hudson River Park for 30 minutes or less. This would not result in a significant adverse impact.

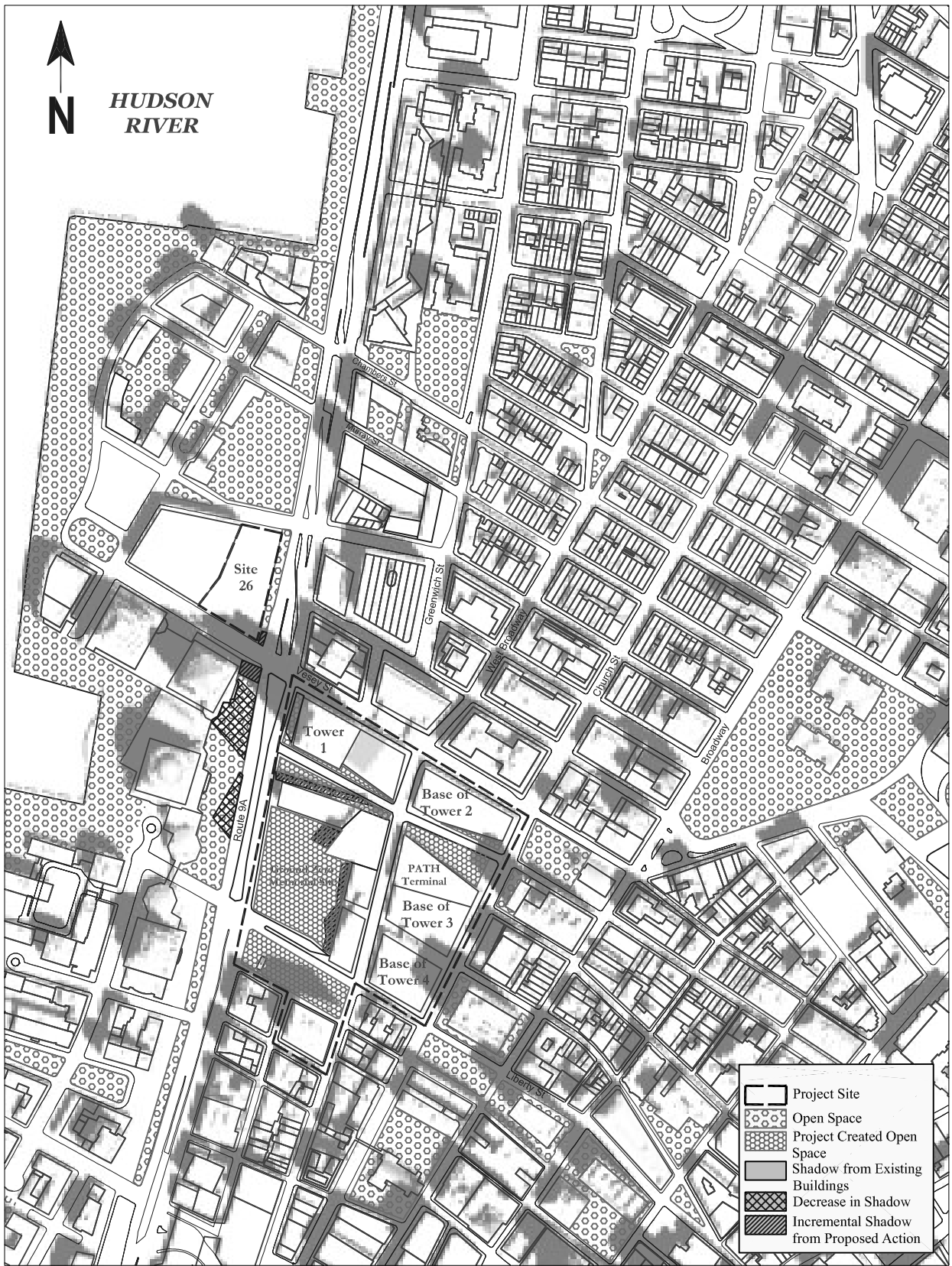
The BPC ball fields would receive incremental shadow for about an hour in the mid-morning during the December analysis period. Washington Market Park would receive about 45 minutes of incremental shadow near midday.

The Proposed Action would not increase shadows on West Thames Playground, the Waterfront Parks, the Irish Hunger Memorial, North End Avenue Mall, the plaza on Warren Street, the plaza at Stuyvesant High School, the PS 234 playgrounds, the Greening of Greenwich Street,



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Shadow Diagrams  
 Pre-September 11 Conditions 2009  
 June 21 - 10:00 AM DST  
 Figure 7 - 29



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Shadow Diagrams  
 Pre-September 11 Conditions 2009  
 June 21 - 12:00 PM DST  
 Figure 7 - 30



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Shadow Diagrams  
 Pre-September 11 Conditions 2009  
 December 21 - 10:00 AM EST  
 Figure 7 - 31



- Project Site
- Open Space
- Project Created Open Space
- Shadow from Existing Buildings
- Decrease in Shadow
- Incremental Shadow from Proposed Action

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Shadow Diagrams  
 Pre-September 11 Conditions 2009  
 December 21 - 12:00 PM EST  
 Figure 7 - 32



James Bogardus Viewing Garden, City Hall Park, Brooklyn Bridge Plaza, Police Plaza, Pace Plaza, the graveyard at St. Paul's Chapel, the plaza at the Millennium Hotel, or One Liberty Plaza.

Additional figures are located in Appendix C, "Shadows."

## **7.8.2 EFFECT ON SENSITIVE RESOURCES**

### *PROJECT SITE OPEN SPACES*

Since the proposed open spaces are located throughout the WTC Site and Southern Site, incremental shadow would be cast throughout the day in all analysis periods. The Memorial would receive incremental shadows from the museum and cultural facilities buildings in the morning throughout the year. Heroes Park and Wedge of Light Plaza would receive incremental shadows in the early morning hours of the May/August and June analysis periods as well as midday to afternoon shadows throughout the year.

Liberty Park North and the Memorial would receive incremental shadows from the base of Towers 3 and 4 during the morning throughout the year and from Tower 5 during the March/September analysis period. For the spring to autumn months, these two open space areas would receive ample sun in the early to mid-afternoon until shadows from existing buildings across Route 9A begin to cast shadow onto the WTC Site. The Proposed Action would cast shadows onto Liberty Park South in the early morning of the late spring through summer months. Heroes Park would receive incremental shadows throughout the analysis day all year. Heroes Park and Wedge of Light Plaza would receive incremental shadows throughout the analysis day all year. The museum and cultural facilities buildings would cast shadows on Heroes Park and Tower 2 and Tower 3 would cast shadow on Wedge of Light Plaza. The southern portion of Heroes Park would receive early morning shadow throughout the year and mid-morning to midday shadows, depending on the season, would fall on the northern portion. Wedge of Light Plaza would receive incremental shadows throughout the day in each analysis period but would receive sun from March through September in the early to mid-morning hours depending on the analysis day.

### *BIKEWAY/WALKWAY*

The bikeway/walkway would receive incremental shadows from the proposed buildings in 2009 for about four and one-half hours during the March analysis period. Freedom Tower would cast incremental shadow on a small portion of the bikeway/walkway directly west of Freedom Tower at 8:15 AM. The incremental shadow would move north through the morning and would be small, mostly occurring on the portion of the bikeway/walkway south of Vesey Street. The last incremental shadow on that portion of the park would occur at 11 AM. The portion of the bikeway/walkway between Vesey and Murray Streets would receive incremental shadow from about 9:45 AM until 11 AM. The first incremental shadow would occur on the portion near Vesey Street. The incremental shadow would move north and east to cast its last incremental shadow on the portion of the bikeway/walkway near Murray Street. The northernmost portion of the bikeway/walkway to receive incremental shadow during the March/September analysis period would be the portion adjacent to the BPC ball fields, which would receive shadow from 11:30 AM until 12:15 PM.

The bikeway/walkway would again receive incremental shadows from the buildings of the Proposed Action during the May/August analysis period. The first incremental shadow would

## **World Trade Center Memorial and Redevelopment Plan GEIS**

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occur at 7:27 AM on the portion of the open space directly west of the Project Site. Through the morning, the incremental shadow would move north and east with the last shadow falling at noon on the portion of the bikeway/walkway between Vesey and Murray Streets.

The incremental shadows cast during the June analysis period are similar to the shadows cast during the May/August analysis period but are slightly shorter. The first incremental shadow occurs at the start of the analysis period, 6:57 AM. This incremental shadow would fall on the bikeway/walkway west of the Project Site. Through the morning, the incremental shadows would move north and east and the last incremental shadow would fall the bikeway/walkway between Vesey and Murray Streets at 12:45 PM.

The December incremental shadow would last less than 15 minutes.

### *BPC WATERFRONT PARKS*

During the March/September analysis period, Freedom Tower would cast shadow on two portions of the BPC waterfront parks. The first incremental shadow would begin at the start of the analysis period at 7:36 AM and last until 8 AM. This incremental shadow would occur to the west of Freedom Tower. From 9 AM until 10:15 AM, the portion of the BPC waterfront parks between Vesey and Warren Streets would receive incremental shadow.

During the May/August analysis period, Freedom Tower would cast the incremental shadow on the portion of the park north of North Cove for two hours from 8:15 AM until 10:15 AM.

During the June analysis period, Freedom Tower would cast shadow on these parks from 8:15AM until 11 AM. The incremental shadow would be on the portion of the park north of North Cove.

While there are incremental shadows during the March, May and June analysis periods, the waterfront parks would receive sun in places where the Pre-September 11 Scenario building configurations would have cast shadow. The additional sunlight would be on the part of the park south and east of North Cove

### *BPC BALL FIELDS*

The March/September incremental shadows from Freedom Tower would fall on the ball fields for an hour and a half in the late morning. The incremental shadow would first reach the fields at 10:45 AM and would fall on the southwest portion of the open space. By 11:15 AM, the southern third of the park would be in shadow. At 11:45 AM, the incremental shadow would be cover the center third of the park. By 12:15 PM, the last incremental shadow would have moved off the eastern edge of the park.

During the December analysis period, the incremental shadow would last from 9:45 until 11 AM. The incremental shadows during this analysis period would be small but would fill in the last portion of the park that is currently in sunlight.

Since the building designs of the Proposed Action vary from those footprints of the Pre-September 11 Scenario building designs, the ball fields would receive sun in 2009 with the Proposed Action where shadow would have occurred in the Pre-September 11 Scenario building configuration.

*WASHINGTON MARKET PARK*

Incremental shadows in December would occur between existing shadows for about 15 minutes at noon and another half hour at 1 PM. At other times the Proposed Action would also allow additional sunlight to fall on the park in areas that are in shadow with the Pre-September 11 Scenario building configuration.

*CITY HALL PARK*

The first incremental shadow would occur at 4:30 PM DST on the northwest corner of the park during the May/August analysis period. As the afternoon continues, the incremental shadows would move further east, creating the last incremental shadow on the northeast portion of the park at 6:00 PM.

*ONE LIBERTY PLAZA*

The Proposed Action would cast an incremental shadow on the plaza at One Liberty Plaza for 45 minutes, from 5:15 until 6 PM, during the May/August analysis period. This incremental shadow would mainly occur on the southern area of the plaza from the base of Tower 3.

**7.9 ASSESSMENT OF SHADOW IMPACTS—PRE-SEPTEMBER 11 SCENARIO 2015**

**7.9.1 SHADOWS BY SEASON**

This section compares the shadows produced by full development of the Proposed Action in 2015 to the shadows that would have been expected had the WTC not been destroyed (see Table 7-5).

*MARCH/SEPTEMBER 21 ANALYSIS PERIOD—7:36 AM TO 4:29 PM EST (FIGURES 7-33 TO 7-35)*

Open spaces on the WTC Site and the Southern Site would receive incremental shadow throughout the day.

In addition to the shadows created by Freedom Tower, shadows from the development completed by 2015 would fall on the bikeway/walkway and the BPC waterfront parks in the morning. The incremental shadow on the BPC ballfields would be reduced because by 2015 it is anticipated that the tower slated for development on that site would have been realized. The plaza of 7 WTC would receive additional shadows from Tower 2 in the morning and midday. Towers 2 and 3 would cast additional incremental shadow on the graveyard at St. Paul's Chapel, the plaza at the Millennium Hotel, City Hall Park, Brooklyn Bridge Plaza, and even Police Plaza during the March/September analysis period.

There would be no additional shadows on the Irish Hunger Memorial, the plaza on Warren Street, the PS 234 playgrounds, Washington Market Park, or James Bogardus Viewing Garden between the 2009 and 2015 development years.

*MAY/AUGUST 6 ANALYSIS PERIOD—7:27 AM TO 6:18 PM DST (FIGURES 7-36 TO 7-38)*

Open spaces on the WTC Site and the Southern Site would receive incremental shadow throughout the day.

**World Trade Center Memorial and Redevelopment Plan GEIS**

**Table 7-5  
Project Shadow Durations—Pre-September 11 Conditions—2015**

<b>Open Space / Historic Resource</b>	<b>March 21/ September 21 7:36 AM-4:29 PM EST</b>	<b>May 6/ August 6 7:27 AM-6:18 PM DST</b>	<b>June 21 6:57 AM-7:01 PM DST</b>	<b>December 21 8:51 AM-2:53 PM EST</b>
West Thames Playground	–	–	8:15 AM	–
Bikeway/Walkway	7:36 AM – 12:15 PM	7:27 AM – 12:45 PM	6:57 AM – 12:45 PM	10:45 – 11:00 AM
BPC Waterfront Parks (Battery Park Esplanade / Nelson A Rockefeller Park / Robert F Wagner Park)	7:36 – 8:30 AM, 9:00 AM – 12:30 PM	8:15 – 10:15 AM	7:15 – 11:00 AM	–
Irish Hunger Memorial	9:15 – 9:45 AM	–	–	–
BPC Ballfields	11:15 AM – 12:15 PM	–	–	10:45 – 11:00 AM
North End Avenue Mall	–	–	–	–
PS/IS 89 Playground	12:00 PM*	–	–	11:00 – 11:30 AM*
Stuyvesant High School Plaza	–	–	–	12:00 PM
Hudson River Park	–	–	–	12:00 PM*
Warren Street Plaza	12:45 PM*	–	–	–
P.S. 234 West Playground	12:45 PM*	–	–	–
P.S. 234 East Playground	1:00 – 1:15 PM*	–	–	–
Greening of Greenwich Street	1:15 – 1:45 PM*	–	–	–
Washington Market Park	1:00 – 1:30 PM	–	–	11:30 AM – 12:30 PM, 1:00 – 1:30 PM
James Bogardus Viewing Garden	2:30 PM*	–	–	1:15 – 1:45 PM
City Hall Park	3:15 – 4:15 PM	4:15 – 6:00 PM	5:30 – 6:30 PM	–
Brooklyn Bridge Plaza	4:15 PM	5:15 – 6:15 PM	–	–
Police Plaza	4:15 PM	5:45 PM – 6:00 PM	–	–
Pace Plaza	–	–	6:00 PM	–
Millennium Hotel Plaza	2:00 - 4:15 PM	2:15 - 4:15 PM	2:00 – 3:45 PM, 6:15 – 6:45 PM	2:00 – 2:53 PM
One Liberty Plaza	–	3:15 – 3:45 PM, 5:00 – 6:00 PM	3:00 – 6:00 PM, 6:30 – 7:01 PM	–
Liberty Park North	7:36 AM – 12:15 PM	7:27 AM – 1:15 PM	6:57 AM – 1:00 PM	9:30 AM - 11:45 AM
Liberty Park South	–	7:27 AM – 10:30 AM, 11:30 AM – 12:30 PM	6:57 AM – 10:45 AM, 11:45 AM – 12:45 PM	–
Memorial	7:36 AM – 12:15 PM	7:27 AM – 1:15 PM	6:57 AM – 1:00 PM	9:30 AM - 11:45 AM
Heroes Park	7:36 AM – 4:29 PM	7:27 AM – 6:00 PM	6:57 AM – 5:30 PM	8:51 AM – 2:53 PM
Wedge of Light Plaza	10:15 AM – 4:29 PM	7:27 AM – 9:45 AM, 11:45 AM – 6:18 PM	12:15 PM – 7:01 PM	10:30 AM – 2:53 PM
The Graveyard at St. Paul's Chapel	–	2:15 – 4:00 PM, 4:30 – 5:45 PM	2:15 – 3:30 PM, 4:00 – 5:00 PM	2:30 – 2:53 PM

**Notes:**

EST—Eastern Standard Time  
DST—Daylight Saving Time  
September 21 is the equivalent of March 21, but one hour later.  
August 6 is the equivalent of May 6.  
\* No new incremental shadows between 2009 and 2015.

**Source:**

AKRF, Inc. determined using 3D data from Urban Data Solutions, Inc. with the Solar Study function in MicroStation V8.



**LEGEND**

- Project Site
- Open Space
- Project Created Open Space
- Shadow from Existing Buildings
- Decrease in Shadow
- Incremental Shadow from Proposed Action

0 100 200 300 400 FEET

Shadow Diagrams  
 Pre-September 11 Conditions 2015  
 March 21 - 7:45 AM EST  
 Figure 7 - 33



**LEGEND**

- Project Site
- Open Space
- Project Created Open Space
- Shadow from Existing Buildings
- Decrease in Shadow
- Incremental Shadow from Proposed Action

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Shadow Diagrams  
 Pre-September 11 Conditions 2015  
 March 21 - 11:30 AM EST  
 Figure 7 - 34



0 100 200 300 400 FEET

Shadow Diagrams  
 Pre-September 11 Conditions 2015  
 March 21 - 3:30 PM EST



0 100 200 300 400 FEET

Shadow Diagrams  
 Pre-September 11 Conditions 2015  
 May 6 - 10:00 AM DST  
 Figure 7 - 36





0 100 200 300 400 FEET

Shadow Diagrams  
 Pre-September 11 Conditions 2015  
 May 6 - 12:00 PM DST  
 Figure 7 - 37



0 100 200 300 400 FEET

Shadow Diagrams  
 Pre-September 11 Conditions 2015  
 May 6 - 5:30 PM DST  
 Figure 7 - 38

Towers 3 and 4 would add to the shadow from Freedom Tower onto the bikeway/walkway and the BPC waterfront parks in the morning. The plaza at 7 WTC would again receive incremental shadows during the morning and midday from Tower 2 as well as Freedom Tower. City Hall Park would receive a small incremental shadow from Tower 3 in the late afternoon. Tower 2 would also cast new shadows on Brooklyn Bridge Plaza. Towers 3, 4, and 5 would add to the shadow on the graveyard at St. Paul's Chapel, the plaza at the Millennium Hotel, and One Liberty Plaza in the afternoon.

*JUNE 21 ANALYSIS PERIOD—6:57 AM TO 7:01 PM DST (FIGURES 7-39 TO 7-42)*

Open spaces on the WTC Site and the Southern Site would receive incremental shadow throughout the day.

In addition to the shadows created by Freedom Tower, Tower 5 would cast a small shadow on West Thames playground at 8:15 AM. The BPC waterfront parks and the bikeway/walkway would receive early morning shadows from Towers 2, 3, and 4 in addition to the shadows from Freedom Tower. Towers 2, 3, 4, and 5 would cast incremental shadow on City Hall Park, the graveyard at St. Paul's Chapel, the plaza at the Millennium Hotel, and One Liberty Plaza. Tower 2 would cast incremental shadows on Pace Plaza at 6 PM.

*DECEMBER 21 ANALYSIS PERIOD—8:51 AM TO 2:53 PM EST (FIGURES 7-43 TO 7-45)*

The shadow cast by Tower 2 would reach Washington Market Park about thirty minutes earlier than the shadow cast by Freedom Tower. Small increments would also be cast on the bikeway/walkway, James Bogardus Viewing Garden, the graveyard at St. Paul's Chapel, and the plaza at the Millennium Hotel. Project generated open spaces would receive incremental shadow throughout the day.

There would be no additional shadow on the plaza at Stuyvesant High School, PS/IS 89 Playground, or Hudson River Park.

Additional figures are located in Appendix C, "Shadows."

## **7.9.2 EFFECT ON SENSITIVE RESOURCES**

### *PROJECT SITE OPEN SPACES*

Additional shadow increments would occur throughout the year, with the majority occurring on the Memorial and Liberty Park North in the morning hours of the late spring to summer months when the sun is high in the sky and shadows are generally the shortest. Tower 4 would cast additional small incremental shadows onto Liberty Park South in the morning from May until August. The Memorial and Liberty Park North would receive incremental shadows from Towers 3 and 4 in the morning from May to August.

### *BIKEWAY/WALKWAY*

In addition to the shadows created by the Proposed Action in 2009 (largely those of Freedom Tower), Towers 2, 3, 4, and 5 would cast shadow on the bikeway/walkway during all four analysis days. During the March/September analysis day, small incremental shadows from Towers 3 and 4 would fall on the open space directly west of the Project Site. In the May/August analysis period, small increments would fall largely on the portions of the bikeway/walkway west of Tower 5 near Albany Street and west of the southwest quadrant. On the June analysis

## **World Trade Center Memorial and Redevelopment Plan GEIS**

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day, the buildings of the Proposed Action would cast additional shadows on the bikeway/walkway west of the Southern Site and the WTC Site.

### *BPC WATERFRONT PARKS*

Towers 3 and 4 would increase shadows in the early morning hours north of North Cove in March/September. In May/August, Towers 2 and 3 would cast incremental shadow on the portion of the waterfront parks west of the Southern Site. The incremental shadow would again fall in North Cove and would last approximately two hours until 10:15 AM. In June, Freedom Tower and Tower 2 would cast shadows near the North Cove for nearly 3 hours in the morning.

### *WASHINGTON MARKET PARK*

On the March/September analysis day, the shadow from Freedom Tower would reach the Park from 1 to 1:30 PM.

In the December analysis day, incremental shadows from Freedom Tower and Tower 2 would fall on Washington Market Park from 11:30 AM to 12:30 PM and from 1 PM to 1:45 PM, respectively. The shadow would begin on the western area and move quickly to cover the eastern portion by 11:45 AM.

### *CITY HALL PARK*

In the March/September analysis period, Tower 3 would cast an additional shadow on City Hall Park. The total duration would be an hour from 3:15 PM to 4:15 PM. The first incremental shadow would occur at 4:30 PM on the northwest corner of the park during the May/August analysis period. As the afternoon continues, the incremental shadows would move farther east, creating the last incremental shadow on the northeast portion of the park at 6:00 PM. In the June analysis period, Tower 2 would cast small shadow increments on the center of the park starting at 5:30 PM and lasting an hour.

### *BROOKLYN BRIDGE PLAZA*

Starting at 5:15 PM and lasting an hour, Tower 2 shadows would reach Brooklyn Bridge Plaza during the May/August analysis period.

### *GRAVEYARD AT ST. PAUL'S CHAPEL*

The incremental shadows in the May/August analysis period would be cast on the western portion of the graveyard along Church Street from 2:15 to 3:45 PM and from 4:30 to 5:15 PM. In June, shadows from the Proposed Action would be cast on the graveyard from 2:15 to 3:30 PM and from 4:30 to 5:45 PM. In December, incremental shadows would be less than 25 minutes at the end of the analysis period.

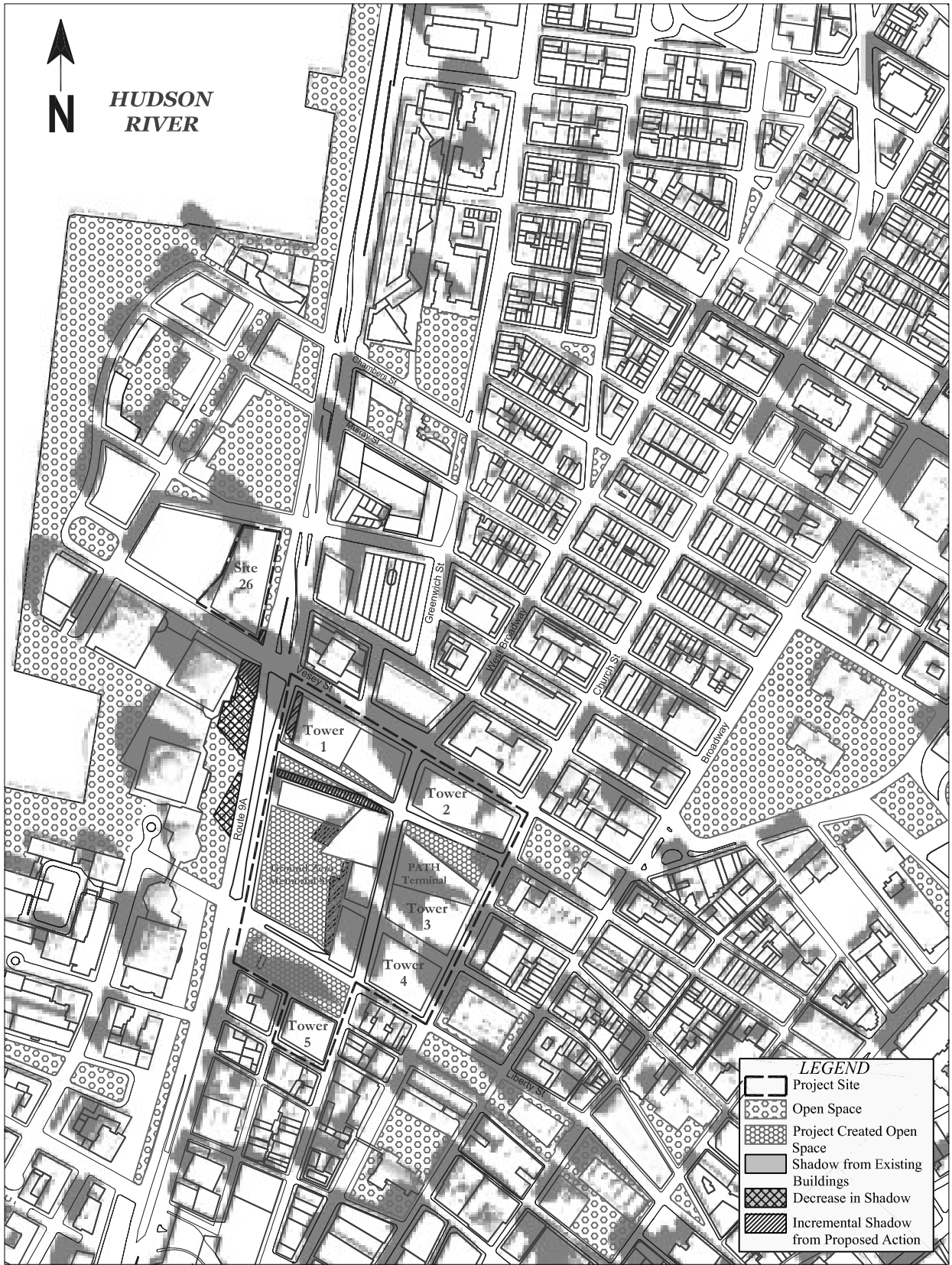
### *MILLENNIUM HOTEL PLAZA*

From 2 PM until 4:15 PM on the March/September analysis day, Towers 3 and 4 would cast an incremental shadow on the plaza at the Millennium Hotel. The incremental shadow would cover the western edge at 2 PM, but would quickly move east and cover the entire plaza from 2:15 until 3:45 PM. Around that time, shadows existing buildings would start to enter the open space. At 2:15 PM, on the May/August analysis period, shadows from Tower 3 would begin to fall on the western portion the plaza at the Millennium Hotel. For about 2½ hours, starting at 2:30 PM,



0 100 200 300 400 FEET

Shadow Diagrams  
 Pre-September 11 Conditions 2015  
 June 21 - 10:00 AM DST  
 Figure 7 - 39



0 100 200 300 400 FEET

Shadow Diagrams  
 Pre-September 11 Conditions 2015  
 June 21 - 12:00 PM DST  
 Figure 7 - 40



Shadow Diagrams  
 Pre-September 11 Conditions 2015  
 June 21 - 4:00 PM DST  
 Figure 7 - 41



0 100 200 300 400 FEET

Shadow Diagrams  
 Pre-September 11 Conditions 2015  
 June 21 - 6:30 PM DST  
 Figure 7 - 42





0 100 200 300 400 FEET

Shadow Diagrams  
 Pre-September 11 Conditions 2015  
 December 21 - 10:00 AM EST  
 Figure 7 - 43



0 100 200 300 400 FEET

Shadow Diagrams  
 Pre-September 11 Conditions 2015  
 December 21 - 12:00 PM EST  
 Figure 7 - 44



**LEGEND**

- Project Site
- Open Space
- Project Created Open Space
- Shadow from Existing Buildings
- Decrease in Shadow
- Incremental Shadow from Proposed Action

0 100 200 300 400 FEET

Shadow Diagrams  
 Pre-September 11 Conditions 2015  
 December 21 - 1:00 PM EST  
 Figure 7 - 45

the entire plaza would be in shadow from Tower 3. On the June analysis day, incremental shadows from Towers 3 and 4 would begin to fall on the plaza at 2 PM. From 2:15 to 3:30 PM, the entire plaza would be cast into shadow. After 3:30 PM, the incremental shadow would decrease in size as the shadows continue to move east and south. There would be another brief duration of shadow from the Proposed Action from 6:15 to 6:45 PM.

*ONE LIBERTY PLAZA*

Incremental shadows from Towers 4 and 5 would fall on One Liberty Plaza for about an hour and a half in the afternoon during the May/August analysis period. The first incremental shadows would occur between 3:15 and 3:45 PM and would fall on western portion along Church Street. For the next hour, existing buildings shadows would cover the open space and no incremental shadow would be added. From 5 to 6 PM, the incremental shadow would again fall on the eastern portion of the plaza as well as portions of the open space along Liberty Street. In June, the incremental shadows from Towers 4 and 5 would begin to fall on the western portion of the plaza along Church Street at 3 PM and increase in size as the afternoon continues. At 6 PM the shadow would be gone, return briefly from 6:30 to 7:01 PM. \*