Appendix B.2.3 Shadows

B.2.3.1 INTRODUCTION

This assessment evaluates the potential for the Proposed Project to cast new shadows on sunlight-sensitive resources and to assess the significance of those shadows. Following the guidelines of the *City Environmental Quality Review (CEQR) Technical Manual (2021)*, sunlight-sensitive resources include publicly accessible parks and open space, features of historic resources that depend on sunlight, and natural resources that depend on sunlight. Therefore, this section is closely linked to the data and assessments presented in Appendix 3C, Open Space, Chapter 6, Historic and Cultural Resources, and Chapter 7, Natural Resources incorporated in **Appendix A, "Draft Environmental Impact Statement,"** and **Chapter 2, "Errata Table of DEIS Revisions."**

Pursuant to CEQR guidance, an assessment of shadows is required if a proposed project would consist of new structures or additions 50 feet or greater in height, or of any height if the project site is located adjacent to, or across the street from, a sunlight-sensitive resource. The Main Terminal, Storage and Staging Facility, and ramps would be approximately 157 feet, 170 feet, and 164 feet in height, respectively.[1] The Proposed Project also includes two private development towers at heights of approximately 926 feet and 1,343 feet. Therefore, a shadow analysis was prepared to determine the potential for the Proposed Project to result in shadow impacts to sunlight-sensitive resources.

The programming of the Proposed Project was modified since initial Public Scoping in 2021. As originally proposed, the Replacement Facility (Main Terminal, Storage and Staging Facility, and the ramps) was accompanied by four private developments consisting of three commercial towers (Towers 1, 2, and 4) and a residential building (Tower 3). Private development has been included in the Proposed Project (as detailed in **Chapter 1, "Introduction"**) to generate revenue to help fund the project, particularly as the scope of the Proposed Project was expanded, further increasing the capacity of the terminal to include inter-city buses currently operating on curbside locations .[2] As the Port Authority of New York & New Jersey (PANYNJ) conducted initial analyses and public engagement, Towers 3 and 4 were removed from the program, and Tower 2 (initially located atop the western side of the Main Terminal fronting on Ninth Avenue) was relocated to the Eighth Avenue side of the Main Terminal.

1 Component heights represent the roof height as measured from the lowest curb level.

2 The Proposed Project creates an improved ramp structure and larger capacity terminal, but at the request of the local community and government stakeholders, also would create additional capacity for intercity buses, many of which operate at curbside locations adjacent to the PABT today. It would also create space for nearly 350 buses to park or stage in the Storage and Staging Facility, replacing off-street parking lots and reduce the amount of bus circulation due to direct connections to the Main Terminal via ramp network. Lastly, the Proposed Project would create nearly 3.5 acres of publicly accessible open space on the Dyer Deck-Overs following construction of the Main Terminal in 2032.

These program modifications were made as the result of significant engagement with the local community, stakeholders and governmental partners. Specifically, the shift of Tower 2 from the Ninth Avenue side of the Main Terminal to the Eighth Avenue side was made at the request of the community which stated a preference for more active uses to be located farther east of Ninth Avenue, which the community considers the edge of the lower-density / less-intensive residential neighborhood west of Ninth Avenue. The relocation reduced the amount of potential project-generated shadows reaching sunlight-sensitive resources, particularly the McGraw-Hill Building, which further justified the modification.

Accordingly, additional shadow analysis was prepared reviewing and comparing a series of scenarios. These include comparisons of the existing Port Authority Bus Terminal (PABT) to the new Main Terminal, results of incremental shadows cast by Tower 2 in its previous and currently proposed locations, and reduced heights of both remaining private development towers. Supplementary shadow analysis, including the shift of Tower 2 and additional options are located in **Section B.2.3.5**.

B.2.3.2 METHODOLOGY

This analysis has been prepared in accordance with the definitions and methodology of the *CEQR Technical Manual*.

B.2.3.2.1 Definitions

The *CEQR Technical Manual* provides the following definitions:

- **Incremental shadow** is the additional, or new, shadow that a building or other built structure resulting from a proposed project would cast on a sunlight-sensitive resource (beyond any shadows cast by other existing or planned buildings that are not part of the Project);
- **Sunlight-sensitive resources of concern** are those resources that depend on sunlight or for which direct sunlight is necessary to maintain the resource's usability or architectural integrity. Such resources generally include:
  - Public open space such as parks, beaches, playgrounds, plazas, schoolyards (if open to the public during non-school hours), greenways, and landscaped medians with seating.
  - Features of architectural resources that depend on direct sunlight for their enjoyment by the public. Only the sunlight-sensitive features need to be considered, as opposed to the entire resource. Such sunlight-sensitive features include design elements that depend on the contrast between light and dark (e.g., recessed balconies, arcades, deep window reveals), elaborate, highly carved ornamentation, stained-glass windows, historic landscapes and scenic landmarks, and features for which the effect of direct sunlight is described as playing a significant role in the structure's importance as a historic resource.
  - Natural resources where the introduction of shadows could alter the resource's condition or microclimate. Such resources could include surface water bodies, wetlands, or designated resources such as coastal fish and wildlife habitats. Planted areas within

unused portions of roadbeds that are part of New York City's Greenstreets Program are also considered sunlight-sensitive resources.[3]

Resources not subject to shadows analyses include:

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

The *CEQR Technical Manual* indicates that a significant adverse shadow impact occurs when the incremental shadow introduced by a proposed project falls on a sunlight-sensitive resource of concern and substantially reduces or completely eliminates direct sunlight exposure (generally to be considered at least 10 minutes in length), thereby significantly altering the public's use and enjoyment of the resource or threatening the viability of vegetation or other natural resources. Each case must be considered on its own merits based on the extent and duration of new shadow and an analysis of the resource's sensitivity to reduced sunlight.

B.2.3.2.2 Methodology

Under the No Action Alternative, the PANYNJ would continue to operate the existing PABT by undertaking necessary maintenance and an extensive set of structural and building repairs and upgrades. The structural repairs would include the critical restoration of structural slabs that would be functionally obsolete unless significant investments are made in the 2027 to 2037 timeframe. Given the extent of the reconstruction, the PANYNJ would need to restore improved areas of the facility to comply with the Americans with Disabilities Act. In the No Action Alternative, the gross square footage and building footprint of the existing terminal would not change. Therefore, there would be no changes to shadows cast.

As described above, for the Proposed Project, the Main Terminal, Storage and Staging Facility, and ramps would be approximately 157 feet, 170 feet, and 164 feet in height, respectively. The Proposed Project also includes two private development towers at heights of approximately 926 feet and 1,343 feet. Following the guidelines of the *CEQR Technical Manual*, a preliminary screening assessment must first be conducted to ascertain whether a project's shadow could reach any sunlight-sensitive resources at any time of the year. The preliminary screening assessment consists of three tiers of analysis. Tier 1 analysis determines a simple radius around the proposed buildings representing the longest shadow that could be cast. According to the *CEQR Technical Manual*, the longest shadow that a structure can cast at the latitude of New York City occurs on December 21st, the winter solstice, at the start of the analysis day at 8:51 a.m., and the shadow length is equal to 4.3 times the height of the structure. If there are sunlight-sensitive

[3] NYC Greenstreets Program converts unused, paved sections of streets, medians or traffic islands into green spaces with plantings, trees or permeable surfaces in order to capture stormwater. (https://portal.311.nyc.gov/article/?kanumber=KA-01554)

resources within this radius, the analysis proceeds to Tier 2, which refines the area that could be affected by project shadows. This refinement accounts for the fact that shadows can never be cast between a certain range of angles south of the project site due to the path of the sun through the sky at the latitude of New York City.

If the Tier 2 analysis does not eliminate the possibility of new shadows reaching sunlight-sensitive resources, a Tier 3 screening analysis further refines the area that could be reached by project shadows by looking at specific representative days in each season and determining the maximum extent of shadow over the course of each representative day.

If a Tier 3 analysis does not eliminate the possibility of new shadows on sunlight-sensitive resources, a detailed shadow analysis is required to determine the extent and duration of the shadow resulting from the project. The detailed analysis provides the data needed to assess potential shadow impacts. The effects of the new shadows on the sunlight-sensitive resources are described, and their degree of significance is compared to existing and projected shadows anticipated from other land development projects in the vicinity. The results of the analysis and assessment are documented with graphics, a table of incremental shadow durations, and narrative text.

B.2.3.3 PRELIMINARY ANALYSIS

B.2.3.3.1 Tier 1 Screening Assessment

A Tier 1 assessment was conducted for the Proposed Project. For the Tier 1 assessment, the longest shadow that the Proposed Project would cast was calculated, and using this length as the radius, a perimeter was drawn around the Project Area. Anything outside this perimeter (representing the longest possible shadow) could never be shaded by the Proposed Project, while anything inside the perimeter would warrant additional assessment.

In addition to the Replacement Facility, the Proposed Project would contain two towers at heights of approximately 926 feet and 1,343 feet. Using Geographic Information System mapping, a perimeter was generated around the Proposed Project by multiplying 4.3 times the maximum approximate height of each component of the Proposed Project, representing the longest shadow that could be cast by the Proposed Project. The longest shadow that the Proposed Project could cast would be approximately 5,775 feet, from Tower 1. The individual longest shadow study area perimeters of each of the components of the Proposed Project were merged into one overall perimeter, collectively representing the longest shadow study area (**Figure B.2.3-1**). As shown in **Figure B.2.3-1**, the Proposed Project would cast a shadow extending over an area that includes 36 potentially sunlight-sensitive resources (31 open space resources, 4 historic resources, and 1 natural resource). Based on the results of the Tier 1 screening, further screening is warranted to determine whether these sunlight-sensitive resources would receive shadows generated by the Proposed Project.

Table B.2.3-1. Resources Identified in the Tier 1 Assessment

Name	Dec. 21	March 21/ Sept. 21	May 6/ August 6	June 21
OPEN SPACE RESOURCES				
McCaffery Playground	Potential	Potential	Potential	Potential
Mathews – Palmer Playground	Potential	Potential	Potential	Potential
Father Duffy Square	Potential	Potential	Potential	Potential
Ramon Aponte Park	Potential	Potential	Potential	Potential
Clinton Community Garden	Potential	Potential	Potential	Potential
Hell's Kitchen Park	Potential	Potential	Potential	Potential
Gutenberg Playground	Potential	Potential	Potential	Potential
DeWitt Clinton Park	Potential	Potential	Potential	Potential
Central Park	Potential	Potential	Potential	Potential
Greenstreet – Broadway above 47th Street	Potential	Potential	Potential	Potential
Hudson River Park Greenway	Potential	Potential	Potential	Potential
Gregory JM Portley Plaza	Potential	Potential	Potential	Potential
Bella Abzug Park/ Hudson Park	Potential	Potential	Potential	Potential
Hudson Yards Public Square and Gardens	Potential	Potential	Potential	Potential
High Line	Potential	Potential	Potential	Potential
Lorraine Hansberry Plaza	Potential	Potential	Potential	Potential
Park Avenue Malls	Potential	Potential	Potential	Potential
Manhattan West Plaza	Potential	Potential	Potential	Potential
East High Line Extension	Potential	Potential	Potential	Potential
Chelsea Recreation Center	Potential	Potential	Potential	Potential
Chelsea Park	Potential	Potential	Potential	Potential
Penn South Playground	Potential	Potential	Potential	Potential
Green Street – Ninth Avenue below West 32nd Street	Potential	Potential	Potential	Potential
Greeley Square Park	Potential	Potential	Potential	Potential
Herald Square	Potential	Potential	Potential	Potential
Green Street – Broadway below West 32nd Street	Potential	Potential	Potential	Potential
Madison Square Park	Potential	Potential	Potential	Potential
Park Avenue Mall	Potential	Potential	Potential	Potential
Bryant Park	Potential	Potential	Potential	Potential
Lincoln Center	Potential	Potential	Potential	Potential
Gertrude Ederle Playground	Potential	Potential	Potential	Potential
NATURAL RESOURCES				
Hudson River	Potential	Potential	Potential	Potential
HISTORIC RESOURCES				
Holy Cross Roman Catholic Church Complex	Potential	Potential	Potential	Potential
McGraw-Hill Building	Potential	Potential	Potential	Potential
St. Raphael Roman Catholic Church and Rectory	Potential	Potential	Potential	Potential
Metro Baptist Church	Potential	Potential	Potential	Potential

Figure B.2.3-1. Tier 1 Screening Assessment

Source: WSP (2023)

B.2.3.3.2 Tier 2 Screening Assessment

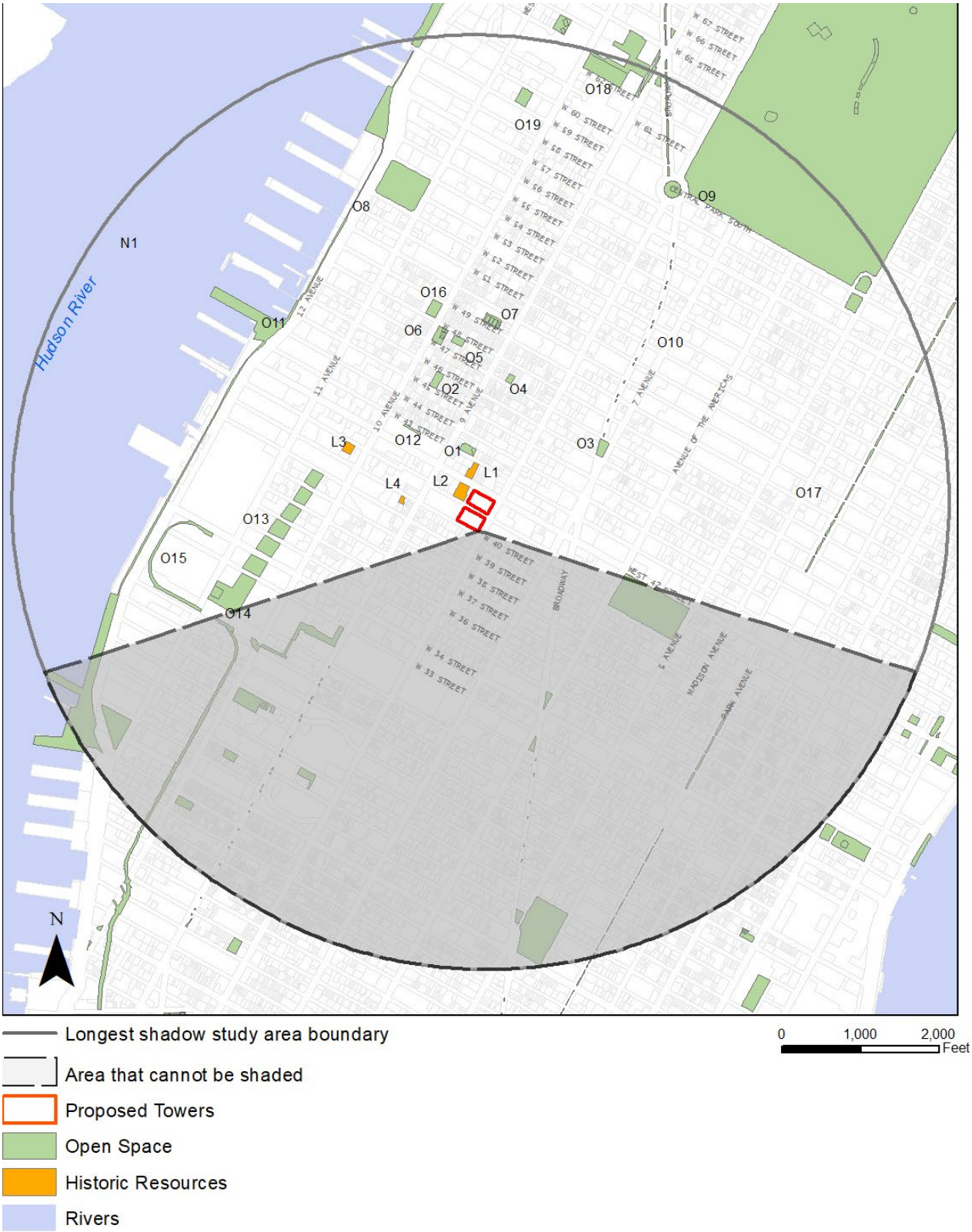
The purpose of the Tier 2 screening assessment is to determine whether the sunlight-sensitive resources shown in **Figure B.2.3-2** fall within the area that can be potentially shaded by shadows resulting from the Proposed Project. Because of the path that the sun travels across the sky in the northern hemisphere, no shadow can be cast in a triangular area south of any given development site. In New York City this area lies between -108 and +108 degrees from true north. As shown in **Figure B.2.3-2**, 24 sunlight-sensitive resources fall within the portion of the shadow study area in which a shadow could occur.

Based on the results of the Tier 2 screening, a Tier 3 screening assessment was warranted to determine whether the shadows resulting from the Proposed Project could reach the sunlight-sensitive resources identified during the representative analysis days.

Table B.2.3-2. Resources Identified in the Tier 2 Assessment

Map Reference	Name	Dec. 21	March 21/ Sept. 21	May 6/ August 6	June 21
OPEN SPACE RESOURCES					
O1	McCaffery Playground	Potential	Potential	Potential	Potential
O2	Mathews – Palmer Playground	Potential	Potential	Potential	Potential
O3	Father Duffy Square	Potential	Potential	Potential	Potential
O4	Ramon Aponte Park	Potential	Potential	Potential	Potential
O5	Clinton Community Garden	Potential	Potential	Potential	Potential
O6	Hell's Kitchen Park	Potential	Potential	Potential	Potential
O7	Gutenberg Playground	Potential	Potential	Potential	Potential
O8	DeWitt Clinton Park	Potential	Potential	Potential	Potential
O9	Central Park	Potential	Potential	Potential	Potential
O10	Greenstreet	Potential	Potential	Potential	Potential
O11	Hudson River Park Greenway	Potential	Potential	Potential	Potential
O12	Gregory JM Portley Plaza	Potential	Potential	Potential	Potential
O13	Bella Abzug Park/ Hudson Park	Potential	Potential	Potential	Potential
O14	Hudson Yards Public Square and Gardens	Potential	Potential	Potential	Potential
O15	High Line	Potential	Potential	Potential	Potential
O16	Lorraine Hansberry Plaza	Potential	Potential	Potential	Potential
O17	Park Avenue Malls	Potential	Potential	Potential	Potential
O18	Lincoln Center	Potential	Potential	Potential	Potential
O19	Gertrude Ederle Playground	Potential	Potential	Potential	Potential
	Manhattan West Plaza	No	No	No	No
	East High Line Extension	No	No	No	No
	Chelsea Recreation Center	No	No	No	No
	Chelsea Park	No	No	No	No
	Penn South Playground	No	No	No	No
	Green Street – Ninth Avenue below West 32nd Street	No	No	No	No
	Greeley Square Park	No	No	No	No
	Herald Square	No	No	No	No
	Green Street – Broadway below West 32nd Street	No	No	No	No
	Madison Square Park	No	No	No	No
	Park Avenue Mall	No	No	No	No
	Bryant Park	No	No	No	No
NATURAL RESOURCES					
N1	Hudson River	Potential	Potential	Potential	Potential
HISTORIC RESOURCES					
L1	Holy Cross Roman Catholic Church Complex	Potential	Potential	Potential	Potential
L2	McGraw-Hill Building	Potential	Potential	Potential	Potential
L3	St. Raphael Roman Catholic Church and Rectory	Potential	Potential	Potential	Potential
L4	Metro Baptist Church	No	Potential	Potential	Potential

Figure B.2.3-2. Tier 2 Screening Assessment



Source: WSP (2023)

B.2.3.3.3 Tier 3 Screening Assessment

According to the *CEQR Technical Manual*, a Tier 3 screening assessment should be performed to determine whether, in the absence of intervening buildings, shadows resulting from a proposed project can reach a sunlight-sensitive resource, thereby warranting a detailed shadow analysis. If the Tier 3 assessment determines that no shadows from a proposed project reach any of the sunlight-sensitive resources on any of the representative analysis days, no further assessment would be warranted for those resources.

The direction and length of shadows change throughout the course of the day and vary seasonally. To determine whether project-generated shadows could fall on a sunlight-sensitive resource, three-dimensional computer modeling software was used to calculate and display the project-generated shadow on representative days of the year. A computer model was developed containing three-dimensional representations of the elements in the base map used in the preceding assessments, the topographic information of the shadow study area, and a three-dimensional representation of the Proposed Project. The Tier 1 and Tier 2 assessments assumed the maximum building height would cover the entire footprint of the development. However, the Tier 3 assessment accounts for the specific massing and setbacks of buildings in the Project Area, including assumptions for rooftop mechanical equipment and bulkheads as required by the *CEQR Technical Manual*.

Representative Days for Analysis

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

Timeframe Window of Analysis

The shadow assessment considers shadows occurring between 1.5 hours after sunrise and 1.5 hours before sunset. At times earlier or later than this timeframe, the sun is near the horizon and the sun's rays reach the earth at very tangential angles, diminishing the amount of solar energy and producing shadows that are very long, move fast, and generally blend with shadows from existing structures. Consequently, shadows occurring outside of the window of analysis timeframe are not considered significant under CEQR and their assessment is not required.

Tier 3 Screening Results

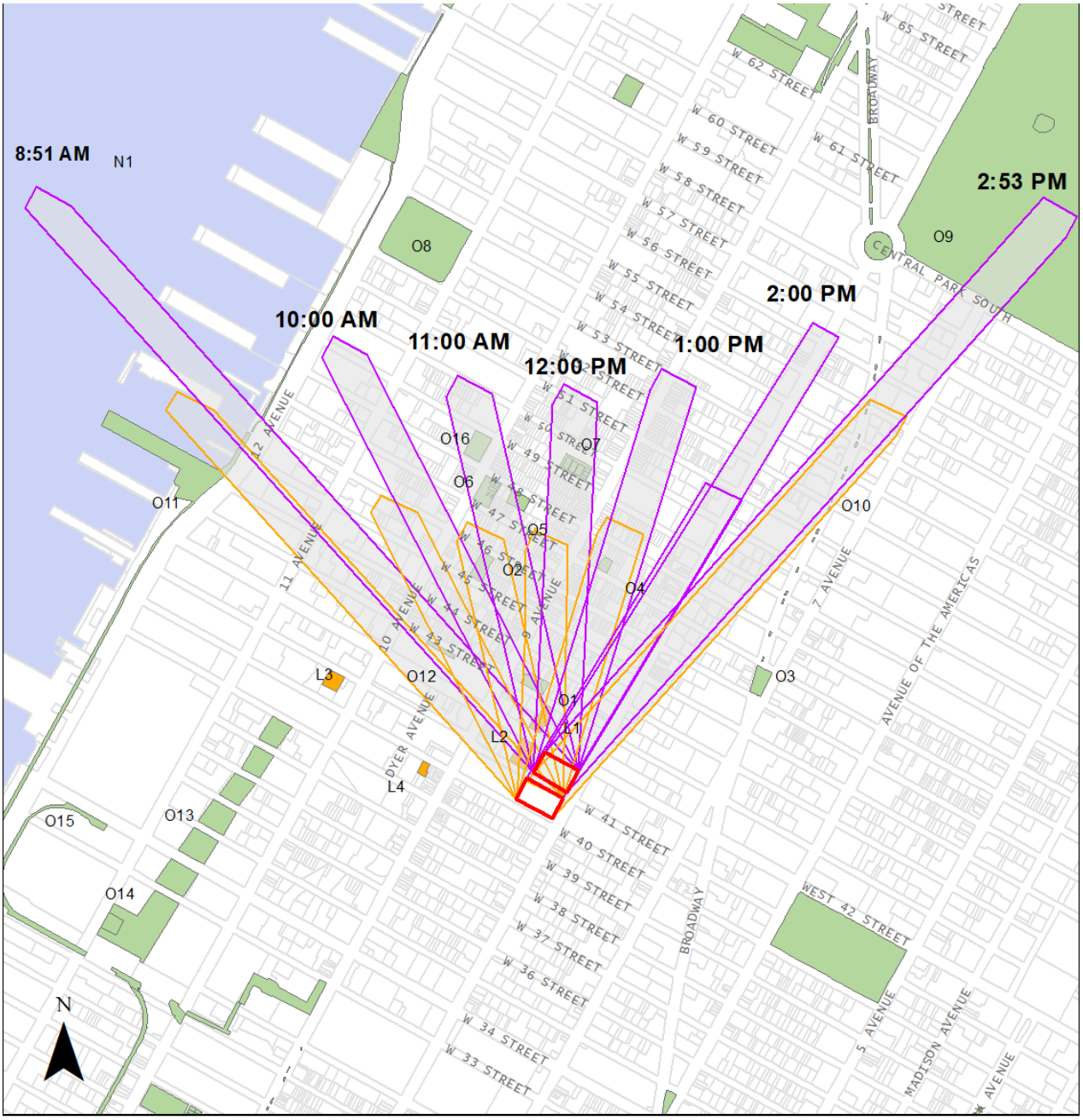
Figure B.2.3-3 through **Figure B.2.3-6** illustrate the range of shadows that would occur, in the absence of intervening buildings, from the Proposed Project on the four representative days for analysis. As they move clockwise and generally west to east over the landscape, the shadows are shown in 60-minute intervals from the start of the analysis day (90 minutes after sunrise) to the end of the analysis day (90 minutes before sunset). **Table B.2.3-3** summarizes which analysis day (or days) each resource could potentially receive project-generated shadow. The Tier 3 assessment concluded that 16 of the 19 open space resources, each of the four historic resources, and the one natural resource could potentially receive shadow on one or more of the representative analysis days, without accounting for intervening buildings and existing shadows. These resources, indicated in **Table B.2.3-3**, required a detailed analysis. The Tier 3 assessment determined project-generated shadow would not have the potential to be cast on DeWitt Clinton Park, Lincoln Center, and Gertrude Ederle Playground; therefore, no further assessment is warranted for these resources.

Table B.2.3-3. Resources Identified in the Tier 3 Assessment

Map Reference	Name	Dec. 21	March 21/ Sept. 21	May 6/ August 6	June 21
OPEN SPACE RESOURCES					
O1	McCaffery Playground	Potential	Potential	Potential	No
O2	Mathews – Palmer Playground	Potential	Potential	No	No
O3	Father Duffy Square	No	Potential	No	No
O4	Ramon Aponte Park	Potential	Potential	No	No
O5	Clinton Community Garden	Potential	No	No	No
O6	Hell's Kitchen Park	Potential	No	No	No
O7	Gutenberg Playground	Potential	No	No	No
O8	DeWitt Clinton Park	No	No	No	No
O9	Central Park	Potential	No	No	No
O10	Greenstreet	Potential	Potential	No	No
O11	Hudson River Park Greenway	Potential	Potential	Potential	Potential
O12	Gregory JM Portley Plaza	Potential	Potential	Potential	No
O13	Bella Abzug Park/ Hudson Park	No	No	Potential	Potential
O14	Hudson Yards Public Square and Gardens	No	No	No	Potential
O15	High Line	No	No	Potential	Potential
O16	Lorraine Hansberry Plaza	Potential	No	No	No
O17	Park Avenue Malls	No	No	Potential	No
O18	Lincoln Center	No	No	No	No
O19	Gertrude Ederle Playground	No	No	No	No
NATURAL RESOURCES					
N1	Hudson River	Potential	Potential	Potential	Potential
HISTORIC RESOURCES					
L1	Holy Cross Roman Catholic Church Complex	Potential	Potential	Potential	Potential
L2	McGraw-Hill Building	Potential	Potential	Potential	Potential
L3	St. Raphael Roman Catholic Church and Rectory	Potential	Potential	Potential	Potential
L4	Metro Baptist Church	No	Potential	Potential	Potential

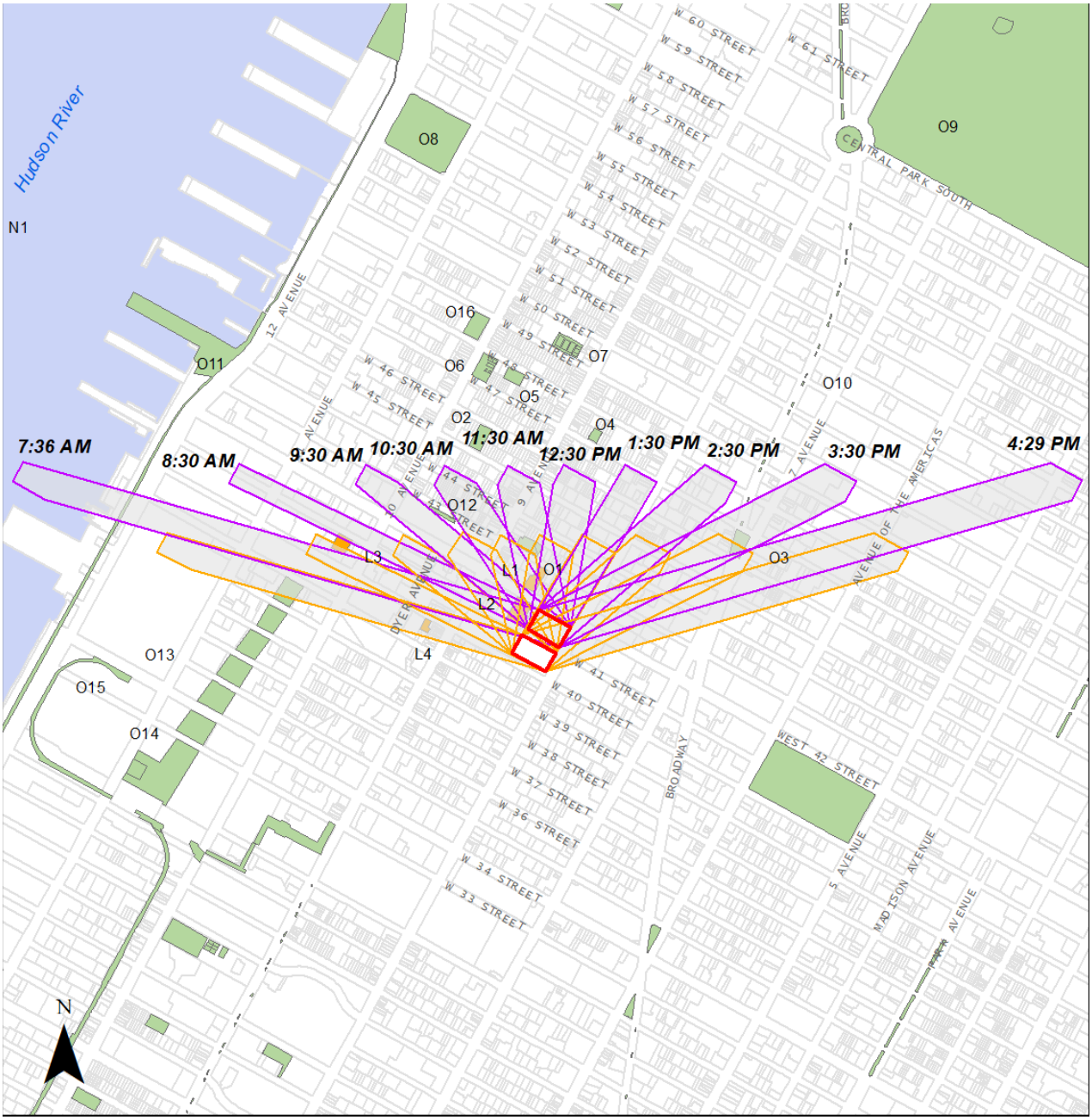
Source: WSP (2023)

Figure B.2.3-3. Tier 3 Screening Assessment – December 21



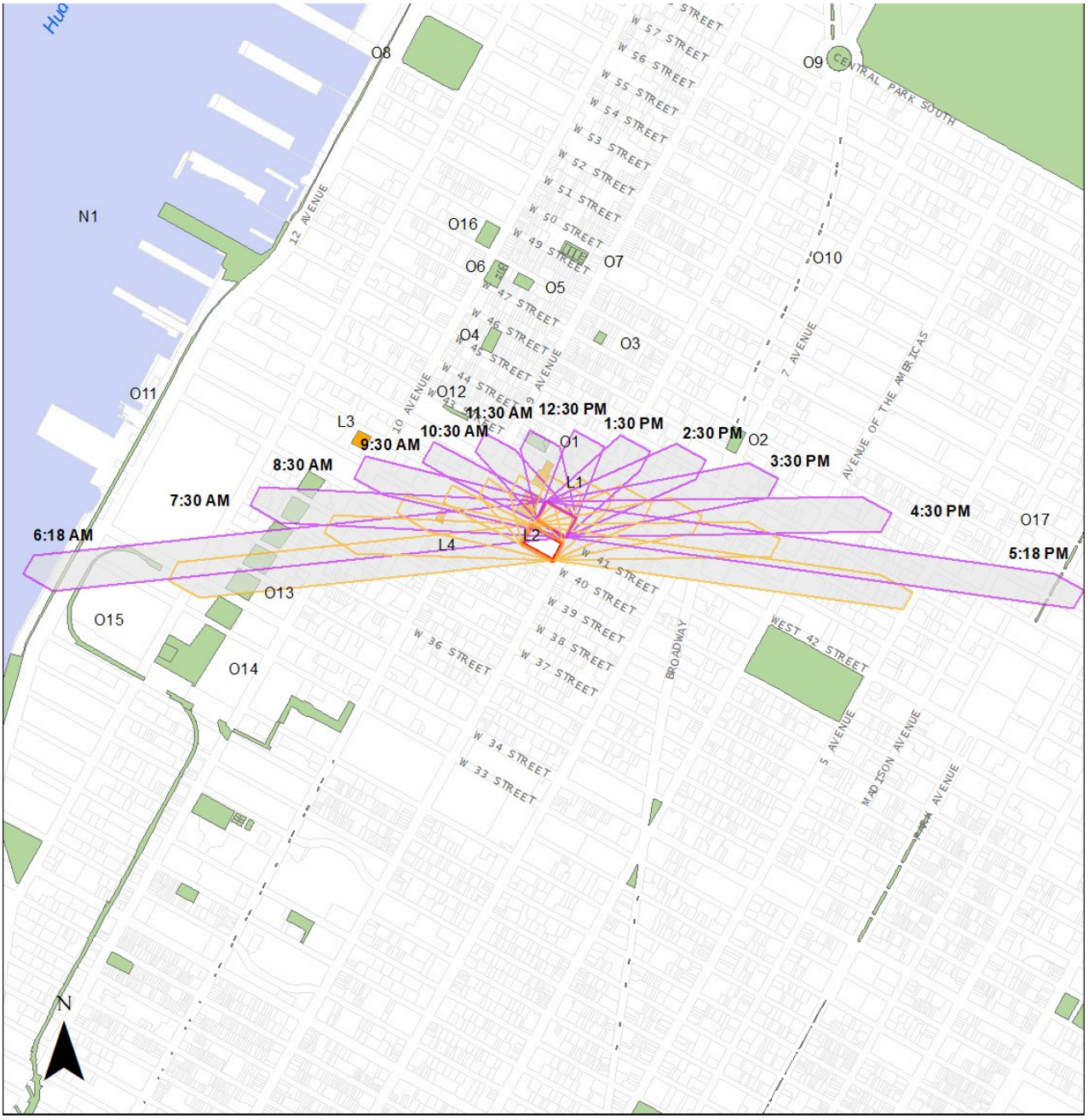
Source: WSP (2023)

Figure B.2.3-4. Tier 3 Screening Assessment – March 21/September 21



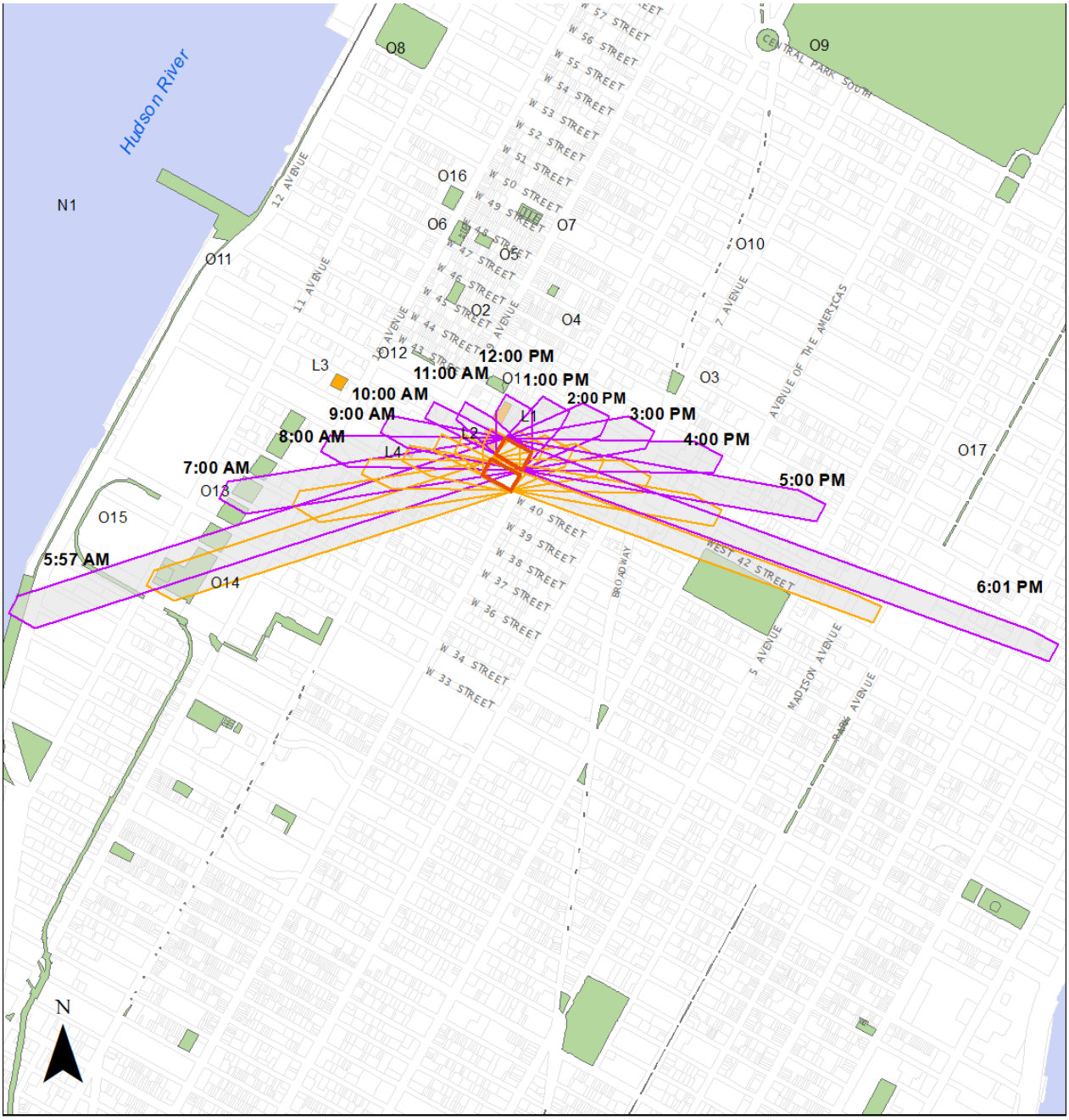
Source: WSP (2023)

Figure B.2.3-5. Tier 3 Screening Assessment – May 6/August 6



Source: WSP (2023)

Figure B.2.3-6. Tier 3 Screening Assessment – June 21



Source: WSP (2023)

B.2.3.4 DETAILED ANALYSIS

A detailed analysis is warranted when the screening analyses do not rule out the possibility that project-generated shadows would reach sunlight-sensitive resources. The detailed analysis establishes a baseline condition, the Future Without the Proposed Project, to account for the shadow cast by existing buildings and other future planned buildings. This baseline is then compared to the Future With the Proposed Project to distinguish the incremental shadows cast by the Proposed Project. The purpose of the detailed analysis is to determine the extent and duration of new incremental shadows that could be cast on sunlight-sensitive resources as a result of the Proposed Project.

As the sun tracks a course through the southern sky, the length and shape of shadows are in constant movement. The computer simulation software utilized for the analysis produces an animation showing the movement of shadows over the course of each analysis period. The detailed analysis determines the time when incremental shadow would enter (or reach) a resource, and the time it would exit. Shadow analyses were performed for each of the representative days and analysis periods indicated in the Tier 3 assessment.

B.2.3.4.1 Determination of Impact Significance

The determination of significance of shadow impacts on a sunlight-sensitive resource is based on (1) the information resulting from the detailed shadow analysis describing the extent and duration of incremental shadows; and (2) an analysis of the resource's sensitivity to reduced sunlight. The goal of the assessment is to determine whether the effects of incremental shadows on a sunlight-sensitive resource are classified as significant under CEQR.

Pursuant to CEQR guidance, a significant shadow impact may occur when an incremental shadow results in one of the following changes for each type of resource.

Vegetation

- A substantial reduction in sunlight available to a sunlight-sensitive feature of the resource to less than the minimum time necessary for its survival (when there was sufficient sunlight without the Proposed Project). In the growing season, four to six hours a day of sunlight is a minimum requirement.
- A reduction in direct sunlight exposure where the sensitive feature of the resource is already subject to substandard sunlight (i.e., less than the minimum time necessary for its survival).

Historic and Cultural Resources

- A substantial reduction in sunlight available for the enjoyment or appreciation of the sunlight-sensitive features of a historic or cultural resource.

Open Space Utilization

- A substantial reduction in the usability of publicly accessible open space as a result of increased shadows, accounting for anticipated new users and the open space's utilization rates throughout the affected time periods.

For Any Sunlight-Sensitive Feature of a Resource

- Complete elimination of direct sunlight on the sunlight-sensitive feature of the resource, when the complete elimination results in substantial effects on the survival, enjoyment, or, in the case of open space or natural resources, the use of the resource.

B.2.3.4.2 Summary of Analysis Results

Of the 16 open space resources that were included in the detailed analysis, six would receive incremental shadows on one or more representative analysis days. In addition, each of the four historic resources analyzed would receive incremental shadow on one or more analysis days. The one natural resource included in the detailed analysis, the Hudson River, would also receive incremental shadows on one or more representative analysis days.

The remaining 10 open space resources did not receive any incremental shadows, generally due to shadows from existing, intervening buildings. In these cases, shadows from the Proposed Project overlapped with existing shadows and did not result in new shadows on the open space resources.

Table B.2.3-4 summarizes the entry and exit times and total duration of incremental shadows on each identified sunlight-sensitive resource. **Figure B.2.3-21** to **Figure B.2.3-29** (at the end of this appendix) document the results of the analysis by providing graphic representations from the computer animation of times when incremental shadows would fall on a sunlight-sensitive resource. The figures illustrate the extent of additional incremental shadow at that moment in time, and also show existing shadow and remaining areas of sunlight.

B.2.3.4.3 Assessment of Shadow Impacts by Resource

The following section describes each affected resource that would receive more than 10 minutes of incremental shadow; its sunlight sensitivity; and the extent, duration, and potential effects of incremental shadow.

Times are given in Eastern Standard Time in all seasons, consistent with guidance in the *CEQR Technical Manual*, but Eastern Daylight Time is in effect for all representative analysis days except for December 21.

Table B.2.3-4. Incremental Shadow Durations

Map No.	Name	Dec. 21	March 21/ Sept. 21	May 6/ August 6	June 21
Timeframe Window		8:51 a.m. – 2:53 p.m.	7:36 a.m. – 4:29 p.m.	6:27 a.m. – 5:18 p.m.	5:57 a.m. – 6:01 p.m.
Timeframe Duration (Hours)[4]		6 hr 2 min	8 hr 53 min	10 hr 51 min	12 hr 4 min
OPEN SPACE RESOURCES					
O1	McCaffrey Playground		10:45 a.m. – 12:39 p.m. Total: 1 hr 54 min	11:12 a.m. – 12:05 p.m. Total: 0 hr 53 min	
O2	Mathews - Palmer Playground	10:24 a.m. – 11:14 a.m. Total: 0 hr 50 min			
O5	Clinton Community Garden	11:12 a.m. – 11:50 a.m. Total: 0 hr 38 min			
O6	Hell's Kitchen Park	10:45 a.m. – 11:27 a.m. Total: 0 hr 42 min			
O11	Hudson River Park Greenway	8:59 a.m. – 10:00 a.m. Total: 1 hr 01 min	7:36 a.m. - 7:51 a.m. Total: 0 hr 15 min		
O13	Bella Abzug Park/ Hudson Park			6:27 a.m. – 8:32 a.m. Total: 1 hr 35 min	6:45 a.m. – 7:43 a.m. Total: 0 hr 58 min
NATURAL RESOURCES					
N01	Hudson River	8:51 a.m. – 9:55 a.m. Total: 1 hr 04 min	7:36 a.m. - 7:48 a.m. Total: 0 hr 12 min		
HISTORIC RESOURCES					
L01	Holy Cross Roman Catholic Church Complex	9:25 a.m. – 10:09 a.m. 10:39 a.m. - 1:25 p.m. Total: 3 hr 30 min	9:51 a.m. - 1:20 p.m. Total: 3 hr 29 min	10:28 a.m. –12:32 p.m. Total: 2 hr 02 min	10:53 a.m. –12:18 p.m. Total: 1 hr 25 min
L02	McGraw-Hill Building	8:51 a.m. – 2:53 p.m. Total: 6 hr 02 min	7:36 a.m. – 4:29 p.m. Total 8 hr 53 min	6:27 a.m. - 5:18 p.m. Total: 10 hr 51 min	5:57 a.m. - 6:01 p.m. Total: 12 hr 04 min
L03	St. Raphael Roman Catholic Church and Rectory	10:25 a.m. – 12:47 p.m. 2:32 p.m. - 2:53 p.m. Total: 2 hrs 43 min	3:23 p.m. – 4:22 p.m. Total: 0 hr 59 min		
L04	Metro Baptist Church	2:29 – 2:53 Total: 0 hr 24 min	7:36 a.m. – 7:48 a.m. 1:52 p.m. – 3:11 p.m. 3:48 p.m. - 4:17 p.m. Total 2 hr 00 min	6:37 a.m. – 9:06 a.m. 1:25 p.m. – 3:23 p.m. - 4:07 p.m. - 4:54 p.m. Total: 5 hr 14 min	7:03 a.m. - 9:14 a.m. 1:23 p.m. – 5:49 p.m. Total: 6 hr 37 min

Source: WSP (2023)

[4] Timeframe duration is the duration of sunlight or daylight time, considered by CEQR shadow analysis, for each season reviewed. Per CEQR guidelines for Tier 3 screening, the shadow assessment considers shadows occurring between 1.5 hours after sunrise and 1.5 hours before sunset.

Open Space Resources

McCaffrey Playground (O1)

McCaffery Playground is a 0.44-acre playground located along West 43rd Street, between Eighth Avenue and Ninth Avenue. Amenities include basketball courts, handball courts, playgrounds, and spray showers.

During the December 21 and June 21 analysis periods, project-generated incremental shadow would not be cast on the park.

During the March 21/September 21 analysis period, project-generated incremental shadow would enter the park at 10:45 a.m. and would move across the park for a duration of approximately 1 hour and 54 minutes, before exiting at 12:39 p.m. (see **Figure B.2.3-25**).

During the May 6/August 6 analysis period, project-generated incremental shadow would enter the park at 11:12 a.m. and would move across the park for a duration of approximately 53 minutes, before exiting at 12:05 p.m. (see **Figure B.2.3-28**).

McCaffery Playground would receive the longest period of project-generated incremental shadow on the March 21/September 21 analysis day, with a duration of approximately 1 hour and 54 minutes. Project-generated incremental shadows would move across the park during the March 21/September 21 analysis period but would reduce in size and would exit in time to allow for additional sunlight exposure. During the March 21/ September 21 analysis day, project-generated incremental shadow would exit the park before utilization is expected to be at its highest, after school hours. In addition, during the June 21 analysis period, when seasonal amenity utilization is expected to be at its highest, there would be no project-generated incremental shadows cast on the park.

Given the limited duration and size of incremental shadow, the time of year when the project-generated incremental shadow would be cast, and the remaining sunlit areas during the affected periods, the Proposed Project would not result in significant adverse impacts to McCaffery Playground.

Mathews - Palmer Playground (O2)

Mathews-Palmer Playground is a 0.47-acre playground located along West 45th Street, between Ninth Avenue and Tenth Avenue. Amenities include basketball courts, handball courts, playgrounds, and spray showers.

During the March 21/September 21, May 6/August 6, and June 21 analysis periods, project-generated incremental shadow would not be cast on the park.

During the December 21 analysis period, project-generated incremental shadow would enter the park at 10:24 a.m. and would move across the park for a duration of approximately 50 minutes, before exiting at 11:14 a.m.

Mathews-Palmer Playground would receive the longest period of project-generated incremental shadow on the December 21 analysis day, with a duration of approximately 50 minutes. Project-generated incremental shadows would move across the park during the December 21 analysis period, reduce in size and would exit before park utilization is expected to be at its highest, after school hours. In addition, during the June 21 analysis period, when amenity utilization is expected to be at its highest, there would be no project-generated incremental shadows cast on the park.

Given the limited duration and size of incremental shadow, the time of year when the project-generated incremental shadow would be cast, and the remaining sunlit areas during the affected periods, the Proposed Project would not result in significant adverse impacts to Mathews-Palmer Playground.

Clinton Community Garden (O5)

Clinton Community Garden is a 0.34-acre community garden located at 434 West 48th Street. Amenities include planting plots, landscaping, walkways, and seating.

During the March 21/September 21, May 6/August 6, and June 21 analysis periods, project-generated incremental shadow would not be cast on the park.

During the December 21 analysis period, project-generated incremental shadow would enter the park at 11:12 a.m. and would move across the park for a duration of approximately 38 minutes, before exiting at 11:50 a.m. (see **Figure B.2.3-22**).

Clinton Community Garden would only receive project-generated incremental shadow on the December 21 analysis day, with a duration of approximately 38 minutes. Project-generated incremental shadows would only be cast in the cold-weather months, when plant growth would be limited, and passive amenity utilization is expected to be at its lowest.

Given the limited duration and size of incremental shadow, the time of year when the project-generated incremental shadow would be cast, and the remaining sunlit areas during the affected periods, the Proposed Project would not result in significant adverse impacts to Clinton Community Garden.

Hell's Kitchen Park (O6)

Hell's Kitchen Park is a 0.58-acre neighborhood park located along Tenth Avenue, between West 47th Street and West 48th Street. Amenities include basketball courts, handball courts, and playgrounds.

During the March 21/September 21, May 6/August 6, and June 21 analysis periods, project-generated incremental shadow would not be cast on the park.

During the December 21 analysis period, project-generated incremental shadow would enter the park at 10:45 a.m. for a duration of approximately 42 minutes, before exiting at 11:27 a.m. (see **Figure B.2.3-22**).

Hell's Kitchen Park would only receive project-generated incremental shadow on the December 21 analysis day, with a duration of approximately 42 minutes. Project-generated incremental shadow would move across the park during the analysis period, reduce in size and would exit before park utilization is expected to be at its highest after school and working hours. In addition, project-generated incremental shadow would only be cast on the December 21 analysis period when seasonal amenity utilization is expected to be at its lowest.

Given the limited duration and size of incremental shadow, the time of year when the project-generated incremental shadow would be cast, and the remaining sunlit areas during the affected periods, the Proposed Project would not result in significant adverse impacts to Hell's Kitchen Park.

Hudson River Park (O11)

Hudson River Park, located along the west side of Manhattan between The Battery and West 59th Street, comprises 13 public piers, a marine estuary, upland open spaces, a water-front esplanade, and a bikeway. Amenities include playgrounds, landscaped lawns, kayaking facilities, and basketball courts.

During the December 21 analysis period, project-generated incremental shadow would enter the park at 8:59 a.m. and would move across the park for a duration of approximately 1 hour and 1 minute, before exiting at 10:00 a.m. (see **Figure B.2.3-21**).

During the March 21/September 21 analysis period, project-generated incremental shadow would enter the park at the start of the analysis window (7:36 a.m.) and would move across the park for a duration of approximately 15 minutes, before exiting at 7:51 a.m. (see **Figure B.2.3-24**).

Hudson River Park would receive the longest period of project-generated incremental shadow on the December 21 analysis day, with a duration of approximately 41 minutes. Project-generated incremental shadows would move across the park during the December 21 and March 21/ September 21 analysis periods but would reduce in size and would exit in time to allow for additional sunlight exposure. Project-generated incremental shadow cast on Hudson River Park would exit before noon, and before park utilization is expected to be at its highest. This would allow for the continued enjoyment of the park and the shadow durations would not reduce sunlight exposure enough to impede plants during the growing season.

Given the limited duration and size of incremental shadow, the time when the project-generated incremental shadow would be cast, and the remaining sunlit areas during the affected periods, the Proposed Project would not result in significant adverse impacts to Hudson River Park.

Bella Abzug Park/ Hudson Park (O13)

Bella Abzug Park/Hudson Park is a 2.15-acre neighborhood park located along Hudson Boulevard East from West 33rd to West 36th Street. Amenities include seating, restrooms, landscaped areas, a playground, a fountain, and pathways for passive recreation. The first

phase of the park was completed in 2015. The second phase of the park, located between West 36th Street and West 39th Street, is expected to be complete by 2025.

During the December 21 and March 21/September 2 analysis periods, project-generated incremental shadow would not be cast on the park.

During the May 6 analysis period, project-generated incremental shadow would enter the park at the start of the analysis window (6:27 a.m.) and would move across the park for a duration of approximately 1 hour 35 minutes, before exiting at 8:32 a.m.

During the June 21 analysis period, project-generated incremental shadow would enter the park at 6:45 a.m. and would move across the park for a duration of approximately 58 minutes, before exiting at 7:43 a.m. (see **Figure B.2.3-29**).

Given the limited duration and size of incremental shadow, the time when the project-generated incremental shadow would be cast, and the remaining sunlit areas during the affected periods, the Proposed Project would not result in significant adverse impacts to Bella Abzug Park/Hudson Park.

Natural Resources

Hudson River (N01)

The Hudson River is a 315-mile river that originates in the Adirondack Mountains of Upstate New York and flows southward through the Hudson Valley to the Upper New York Bay between New York City and New Jersey. The Hudson River contains various ecological communities and natural resources including plankton, invertebrates, fish, and marine mammal species.

During the December 21 analysis period, project-generated incremental shadow would be cast on the river at the start of the analysis window (8:51 a.m.) and would move across the river for a duration of approximately 1 hour and 04 minutes, before exiting at 9:55 a.m. (see **Figure B.2.3-21**). During this period, the largest project-generated incremental shadow would be cast on the Hudson River and would represent approximately less than 1% of the portion of the Hudson River that falls within the shadow study area.

During the March 21/September 21 analysis period, project-generated incremental shadow would be cast on the river at the start of the analysis window (7:36 a.m.) and would move across the river for a duration of approximately 12 minutes, before exiting at 7:48 a.m. (see **Figure B.2.3-24**).

During the May 6/August 6 and June 21 analysis periods, project-generated incremental shadow would not be cast on the river.

The Hudson River would receive the longest period of project-generated incremental shadow on the December 21 analysis day, with a duration of approximately 1 hour and 04 minutes. Shadows would enter the river typically in the early morning when the sun is low on the horizon.

At this time of day, the incident angle of sunlight on the surface is acute and a large percentage of available energy is reflected.

Exposure to shadows can cause a decrease in light intensity, which can affect primary productivity within the shaded waters.[5] Primary productivity within the Hudson River is generated mainly from phytoplankton. However, light requirements for phytoplankton are low, and the reduction in light within the shadow footprint would have a negligible impact on phytoplankton populations. In addition, the current speeds of the river are swift and would quickly carry any light-dependent phytoplankton through the newly shaded areas to areas outside the shadow exposure, limiting their exposure to shaded conditions to a relatively short period of time. Therefore, project-generated incremental shadows would not be expected to have a significant adverse impact on primary productivity in the Hudson River.

Shading can also influence fish behavior and habitat use, with many fish avoiding shaded areas. However, these changes in behavior and habitat use are typically observed with significant shading associated with piers and other overwater structures. Shadows, such as those cast by buildings along a shoreline, result in less reduction in light reaching the water surface than shading due to overwater structures and affect different areas of the habitat over the course of the day, further reducing the potential to affect aquatic biota. Fish patterns demonstrate fish would be expected to avoid areas where shadows temporarily resulted in low light but would have ample areas of the river available for foraging and to maintain anadromous fish migration. Project-generated incremental shadows would not extend to the opposite bank of the Hudson River and would not have a significant effect on fish migration, movement or spawning in the river.

Given the limited duration and size of incremental shadow, the time when the project-generated incremental shadow would be cast, and the remaining sunlit areas during the affected periods, the Proposed Project would not result in significant adverse impacts to the Hudson River.

Historic Resources[6]

Holy Cross Roman Catholic Church Complex (L01)

The Holy Cross Roman Catholic Church Complex (NRHP-Eligible, NYCL-Eligible) at 329-333 West 42nd Street and 334 West 43rd Street consists of a church, rectory, and school. The complex is directly north of the taller McGraw-Hill Building, located on the south side of West 42nd Street.

The brick-and-stone Romanesque Revival-style church at 333 West 42nd Street consists of a central peaked-roof nave separated from corner towers by recessed side-aisle entrances. The central nave entrance is a round-arched opening set within a buttressed stone entrance porch

[5] Primary productivity relates to the rate at which energy (sunlight in this circumstance) is converted to organic substances by photosynthetic producers (e.g., phytoplankton), which obtain energy and nutrients by harnessing sunlight.

[6] For a complete description of historic resources, refer to DEIS Chapter 6, "Historic and Cultural Resources" (**Appendix A).**

with a peaked roof. A large arched stained-glass window fills the center of the nave facade. Smaller stained-glass windows occupy the front entrance doors as well as the semi-circular window above the front entrance. Other decorative features include stone trim, decorative corbels, arched windows, and an ornate bracketed cornice below the nave eave. The rectory at 329 West 42nd Street (directly east of the church) is a four-story brick-and-stone Italianate townhouse with stone window archivolts, bracketed stone windowsills, a cornice of corbeled brackets between the first and second floors, and a bracketed cornice that caps the building. Stained-glass windows occupy the two first-floor windows and the two front doors of the rectory. The six-story school building, fronting on the south side of West 43rd Street, is a brick, Romanesque Revival-style building.

During the December 21 analysis period, project-generated incremental shadow would enter the church complex at 9:25 a.m. and would move across the south facades of the church and rectory before exiting at 10:09 a.m. (when the shadow of the McGraw-Hill Building would be cast on the complex). The incremental shadow would reenter the church complex at 10:39 a.m. and exit at 1:25 p.m. for a total duration of approximately 3 hours 30 minutes.

During the March 21/September 21 analysis period, project-generated incremental shadow would enter the church complex at 9:51 a.m. and would move across the church and rectory before exiting at 1:20 p.m., for a total duration of approximately 3 hours 29 minutes.

During the May 6/August 6 analysis period, project-generated incremental shadow would enter the church complex at 10:28 a.m. and would move across the church and rectory before exiting at 12:32 p.m., for a total duration of approximately 2 hours 2 minutes.

During the June 21 analysis period, project-generated incremental shadow would enter the church complex at 10:53 a.m. and would move across the church and rectory before exiting at 12:18 p.m., for a total duration of approximately 1 hour 25 minutes.

Due to the durations of project-generated shadows in each of the analysis periods enjoyment of the sunlight-sensitive features of the church and rectory within the Holy Cross Roman Catholic Church Complex would be anticipated to be diminished. Due to its location on the south side of West 43rd Street, and the absence of any sunlight-sensitive features visible from public rights-of-way, there would be no impact to the school building within the complex.

McGraw-Hill Building (L02)

Located at 330 West 42nd Street, directly north- and west-adjacent to the existing PABT, the McGraw-Hill Building (NYCL, NRHP-Listed, NHL) is a 35-story, International-style skyscraper with Art Deco decorative details. The McGraw-Hill Building is significant in the history of skyscraper construction and is considered the first expression of the curtain wall in a high-rise building. The building's structure and cladding are noted for allowing large amounts of sunlight to reach the building's interior. Until recently, when larger office towers were constructed on the east side of Eighth Avenue and along West 42nd Street, the McGraw-Hill Building was an isolated example of high-rise construction in the neighborhood.

During the December 21 analysis period, project-generated incremental shadow would enter the McGraw-Hill Building at the beginning of the analysis period (8:51 a.m.) and would be cast on the building until the end of the analysis period (2:53 p.m.) for a total duration of approximately 6 hours 2 minutes.

During the March 21/September 21 analysis period, project-generated incremental shadow would enter the McGraw-Hill Building at the beginning of the analysis period (7:36 a.m.) and would be cast on the building until the end of the analysis period (4:29 p.m.) for a total duration of approximately 8 hours 53 minutes.

During the May 6/August 6 and the June 21 analysis period, project-generated incremental shadow would be cast on the McGraw-Hill Building for approximately 10 hours 51 minutes, and 12 hours 4 minutes, respectively. Project-generated incremental shadows cast during these periods would remain on the building for the entirety of the analysis periods.

Due to the durations of project-generated shadows in each of the analysis periods during times when occupants within the McGraw-Hill Building would be present, enjoyment of the sunlight-sensitive features of the McGraw-Hill Building would be anticipated to be diminished.

St. Raphael Roman Catholic Church and Rectory (L03)

The Saint Raphael Roman Catholic Church and Rectory (NRHP-Eligible, NYCL-Eligible) is located at 502 West 41st Street directly north across West 40th Street from Galvin Plaza. While fronting on the south side of West 41st Street, the church's west facade along Galvin Avenue and south facade, set back behind a school building and the rectory along West 40th Street, are pierced with Gothic-arched windows, and ornamented with corbeled brick. Rose stained-glass windows are located on the transepts. The pentagonal apse, with stained-glass windows, is visible from West 40th Street to the rear of the church. The taller 555 Tenth Avenue residential tower is directly east.

During the December 21 analysis period, project-generated incremental shadow would enter the Saint Raphael Roman Catholic Church and Rectory at 10:25 a.m. and would move across the resource before exiting at 12:47 p.m. The incremental shadow would reenter the historic resource at 2:32 p.m. and would remain until 2:53 p.m. for a total duration of approximately 2 hours 43 minutes.

During the March 21/September 21 analysis period, project-generated incremental shadow would enter the Saint Raphael Roman Catholic Church and Rectory at 3:23 p.m. and would remain until 4:22 p.m. for a total duration of approximately 59 minutes.

During the May 6/August 6 and June 21 analysis periods, project-generated incremental shadow would not be cast on the Saint Raphael Roman Catholic Church and Rectory.

Due to the durations of project-generated shadows in two of the analysis periods enjoyment of the sunlight-sensitive features of the St. Raphael Roman Catholic Church and Rectory would be anticipated to be diminished.

Metro Baptist Church (L04)

Metro Baptist Church is located at 410 West 40th Street and is located within the NRHP-Eligible Paddy's Market Historic District. The four-story brick-and-stone church fronts on the south side of West 40th Street, but its western facade, with seven stained-glass windows, is exposed to extended afternoon sunlight as the area to the west is occupied by PABT ramps. Metro Baptist Church also has a rooftop kitchen garden. The proposed Storage & Staging/Intercity Terminal would be located approximately 40 feet west of Metro Baptist Church and would rise to a height of approximately 165 feet.

During the December 21 analysis period, project-generated incremental shadow would be cast on the historic resource at 2:29 p.m. and would move across the resource until the end of the analysis period (2:53 p.m.), for a duration of approximately 24 minutes.

During the March 21/September 21 analysis period, project-generated incremental shadow would enter the historic resource at the beginning of the analysis period (7:36 a.m.) and would move across the resource before exiting at 7:48 a.m. The incremental shadow would reenter the resource at 1:52 p.m. and would remain until 3:11 p.m. The incremental shadow would reenter the historic resource again at 3:48 p.m. and would remain until 4:17 p.m. for a total duration of approximately 2 hours and 00 minutes.

During the May 6/August 6 analysis period, project-generated incremental shadow would enter the historic resource at 6:37 a.m. and would move across the resource before exiting at 9:06 a.m. The incremental shadow would reenter the historic resource at 1:25 p.m. and would remain until 3:23 p.m. The incremental shadow would reenter the historic resource at 4:07 p.m. and would remain until 4:54 p.m. for a total duration of approximately 5 hours 14 minutes.

During the June 21 analysis period, project-generated incremental shadow would be cast on the historic resource at 7:03 a.m. and would move across the resource before existing at 9:14 a.m. The incremental shadow would reenter the historic resource at 1:23 p.m. and would remain until 5:49 p.m. for a total duration of approximately 6 hours 37 minutes.

Since the Storage and Staging Facility would be located only approximately 40 feet west of the Metro Baptist Church and would rise to a height of approximately 170 feet, afternoon sunlight to the stained-glass windows on the western facade of the church would be diminished.

Due to the durations of project-generated shadows in each of the identified analysis periods, enjoyment of the sunlight-sensitive features of the Metro Baptist Church would be anticipated to be diminished.

B.2.3.5 ADDITIONAL SHADOW ANALYSIS

Additional modeling of shadow durations was performed to provide further details and evaluation of the potential for the Proposed Project to increase shadows cast on the McGraw-Hill Building. This analysis is intended to provide a deeper understanding of potential outcomes which may occur.

B.2.3.5.1 Comparison of Terminal-Generated Shadows

Table B.2.3-5 outlines the different durations (shown in minutes) between the existing PABT and the new Main Terminal without the private development which would be build atop the terminal. The height of the existing PABT terminal is 82 feet above street level to the top of the bus levels and 107 feet and 125 feet to the top of the various mechanical penthouses, while the new Main Terminal is 157 feet above street level.

The existing PABT generates approximately 2,185 minutes of shadow on the McGraw-Hill Building across the four shadow timeframes used for shadow analyses, and the new Main Terminal (without private development) would generate approximately 2,243 minutes of shadow, about a 2.5% increase in shadow durations over the course of a year. Of the four timeframes used for shadow analysis, the new Main Terminal would only generate a longer shadow duration in one timeframe (December 21), all other timeframes have roughly similar shadow durations.

Table B.2.3-5. Shadow Duration Comparison of Existing PABT and New Main Terminal

Name	Dec 21	Duration (min.)	Mar 21 / Sep 21	Duration (min.)	May 6 / Aug 6	Duration (min.)	Jun 21	Duration (min.)
Existing PABT	8:51 a.m.-1:53 p.m.	302	7:36 a.m.-4:29 p.m.	533	6:44 a.m.-5:18 p.m.	634	6:06 a.m.-5:58 p.m.	716
New Terminal (No Private Development)	8:51 a.m.-2:53 p.m.	362	7:36 a.m.-4:29 p.m.	533	6:44 a.m.-5:18 p.m.	634	6:01 a.m.-6:01 p.m.	724
Difference		**60**		**0**		**0**		**8**

While the CEQR methodology for shadow assessments begins counting "shadow duration" the moment any project-generated shadow reaches the sunlight-sensitive receptor, it does not distinguish by the extent of shadow (i.e., if a receptor is fully-shaded, partially shaded or only receives minor shadows). To evaluate the extent of the McGraw-Hill Building's facade that are in shadow today (as generated by the existing PABT) or would be generated by the new Main Terminal, an analysis was applied calculating the percentage of the McGraw-Hill Building's east, south and west facades that are currently or would be shaded by the existing PABT and the new Main Terminal. Results from the December 21 shadow timeframe were used. Results are summarized in **Table B.2.3-6**.

Table B.2.3-6. McGraw-Hill Building Facade Shadow Coverage, Terminal Comparison

Time	Existing PABT			New Main Terminal		
	East	South	West	East	South	West
8:51 a.m.	1%	0%	0%	2%	0%	0%
10 a.m.	8%	18%	0%	9%	30%	0%
11 a.m.	27%	11%	0%	40%	22%	0%
12 p.m.	15%	0%	0%	28%	4%	0%
1 p.m.	2%	0%	0%	10%	3%	0%
2 p.m.	0%	0%	0%	4%	0%	0%
2:53 p.m.	0%	0%	0%	0%	0%	7%

Shadows generated by the new Main Terminal would be cast on the McGraw-Hill Building for approximately one hour longer than shadows from the existing PABT. During the same period, the new Main Terminal would cast shadows covering as much as 13% more area of the east facade, and 12% more area of the south facade. The increased height of the new Main Terminal would result in shadow also reaching the west facade of the McGraw-Hill Building (something the existing PABT does not do) and covering approximately 7% of the area for the final period of the analysis.

Shadow assessment results showing the percentage of the McGraw-Hill Building's east, south and west facades that would receive project-generated shadow (from the Main Terminal and private development) are shown in **Table B.2.3-7** below.

Table B.2.3-7. McGraw-Hill Building Facade Shadow Coverage, Existing PABT compared to new Main Terminal with Private Development

Time	Existing PABT			New Main Terminal with Private Development		
	East	South	West	East	South	West
8:51 a.m.	1%	0%	0%	20%	0%	0%
10 a.m.	8%	18%	0%	1%	14%	0%
11 a.m.	27%	11%	0%	65%	83%	0%
12 p.m.	15%	0%	0%	61%	53%	0%
1 p.m.	2%	0%	0%	58%	3%	0%
2 p.m.	0%	0%	0%	4%	0%	0%
2:53 p.m.	0%	0%	0%	0%	0%	7%

The areas where the shadowing occurs on the McGraw-Hill Building are shown on **Figure B.2.3-30** through **Figure B.2.3-36** at the end of this appendix. However, shadows generated by both the existing PABT and the new Main Terminal are, or would be, limited to the lower levels of the McGraw-Hill Building, generally below the first setback. Based on this information, the project-generated shadows cast by the new Main Terminal on the McGraw-Hill Building would be generally comparable to the shadows cast by the existing PABT.

The Proposed Project assumes that following construction of the Replacement Facility, there would be a period of several years before the private development towers are built (both commercial towers are assumed complete and occupied by 2040). Accordingly, the condition of a new Main Terminal without commercial development atop would exist for several years at a minimum. Ultimately, the schedule, size and design of the private development will be informed by market conditions.

B.2.3.5.2 Additional Assessment of Private Development Shadows

Previous design plans for the Proposed Project had Tower 2 located atop the Main Terminal, but located on the western side, fronting Ninth Avenue (**Figure B.2.3-7** and **Figure B.2.3-8**). The shift of Tower 2 to the Eighth Avenue frontage was made in response to community preference to locate higher intensity uses farther east on the Project Area. As shown in **Table B.2.3-8**, the westerly location of Tower 2 created a condition where the Proposed Project would cast more shadows throughout the day onto the McGraw-Hill Building; morning sunlight (coming from the east) would first be shaded by Tower 1, and as the day progress and the sun moves toward the west, Tower 2 would have then cast shadows in the afternoon. The relocation of Tower 2 to the east (Eighth Avenue frontage) reduces the amount of potential shadow on the McGraw-Hill Building by nearly 692 minutes (across the four analysis periods), or approximately 11.5 hours per year, when compared to the previous design (when Tower 2 was proposed to front on Ninth Avenue). Furthermore, moving Tower 2 to Eighth Avenue removed almost the entirety of the Project-generated afternoon shadows.

Table B.2.3-9 reviews the project-generated shadow durations from each commercial tower in their proposed locations (atop Main Terminal, fronting Eighth Avenue) cast onto the McGraw-Hill Building. In the Proposed Project, Tower 1 (with a height of 1,343 feet) would generate approximately 972 minutes of shadow while Tower 2 (with a height of 926 feet), would generate approximately 702 minutes of shadow, across the four analysis periods. The mass and height of Towers 1 and 2 were developed to reflect a maximum possible size for the purpose of a conservative analysis; while additional development could occur under as-of-right condition (if they were not part of the Proposed Project), the size and design of the private development associated with the Proposed Project would ultimately be determined by future market conditions. **Table B.2.3-9** also presents several hypothetical development outcomes. These scenarios are presented in response to comments from the Section 106 Consulting Parties related to the relationship between the potential height of the private development associated with the Proposed Project, and the potential shadows that would be cast as a result of that development. With the heights of the private development reduced by approximately 50%

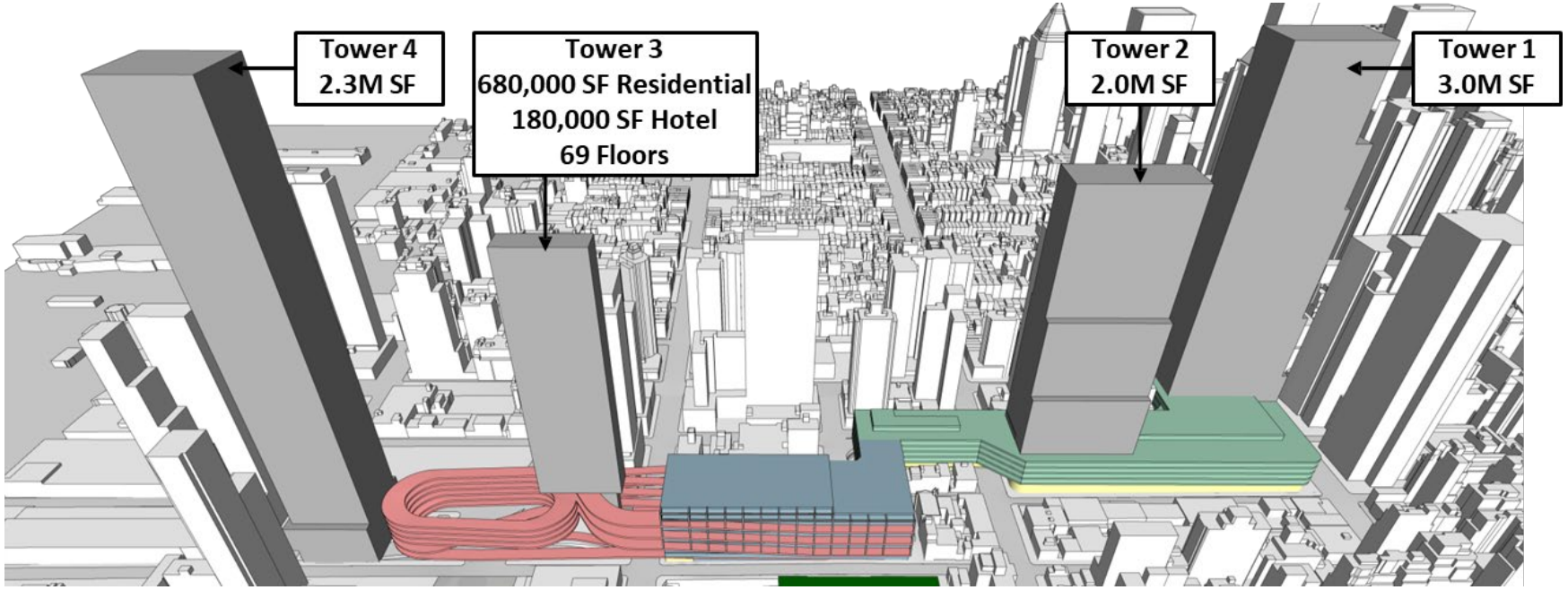
there would be a reduction of approximately 36 minutes of shadow cast on the McGraw-Hill Building across the four analysis periods when compared to the Proposed Project. A third comparison analyzed, reducing both towers to a height of 400 feet, would result in a reduction of approximately 51 minutes of shadows cast across the four analysis periods when compared to the Proposed Project.

Table B.2.3-8. McGraw-Hill Building Shadow Duration Comparison for Tower 2 – Current vs. Previous Location

Name	Dec 21	Duration (min.)	Mar 21 / Sep 21	Duration (min.)	May 6 / Aug 6	Duration (min.)	Jun 21	Duration (min.)
Tower 2 (on Eighth Avenue)	9:17 a.m.-1:25 p.m.	248	9:51 a.m.-1:02 p.m.	191	10:00 a.m.-12:30 p.m.	150	10:34 a.m.-12:22 p.m.	113
Tower 2 (on Ninth Avenue)	10:21 a.m.-2:53 p.m.	272	10:36 a.m.-4:29 p.m.	353	10:54 a.m.-5:18 p.m.	384	11:18 a.m.-5:43 p.m.	385
Difference		**24**		**162**		**234**		**272**

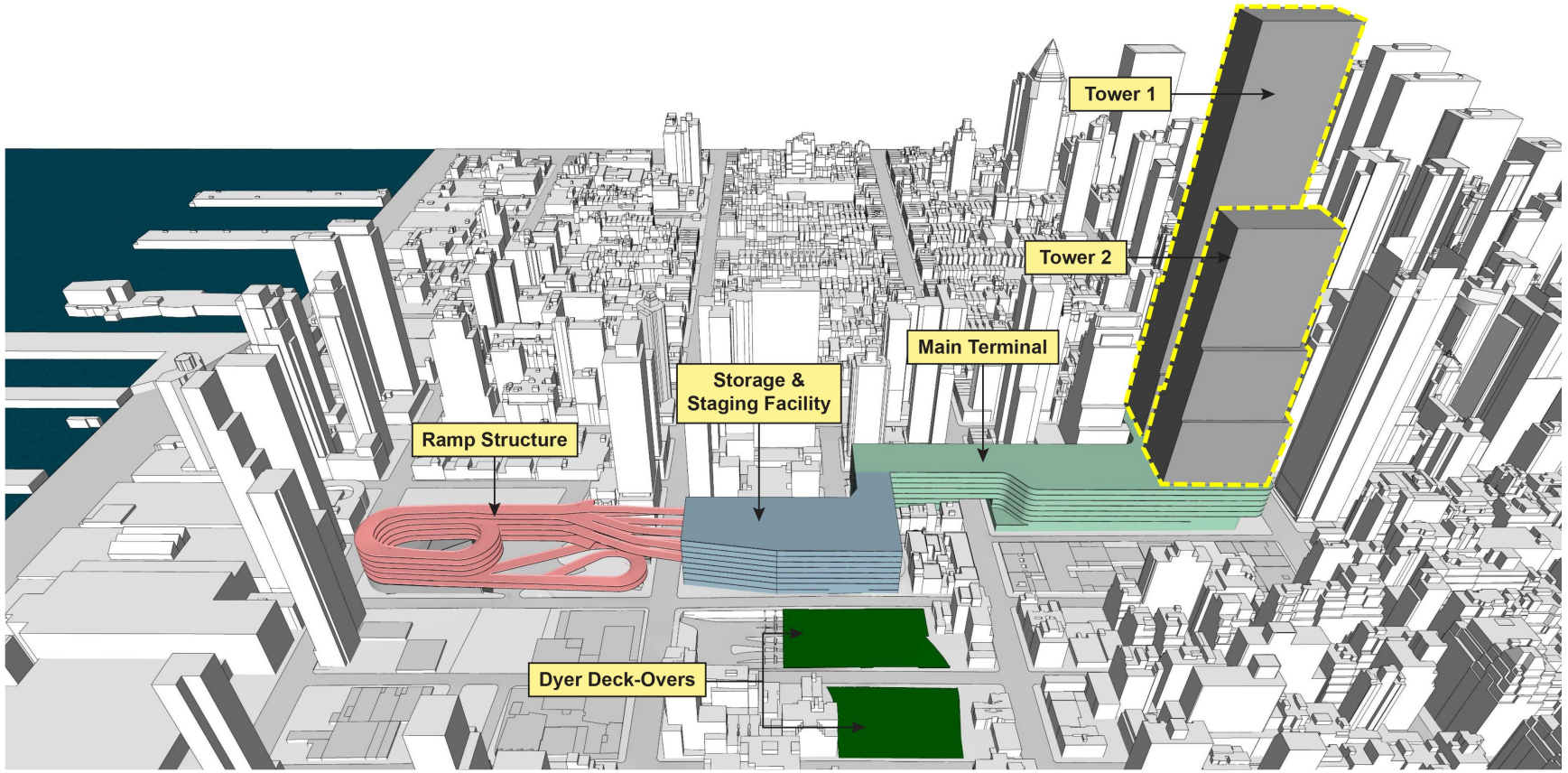
Notes: A previous version of the Proposed Project had Tower 2 located on Ninth Avenue; the current Proposed Project has relocated Tower 2 to the east, to front on Eighth Avenue.

Figure B.2.3-7. Original Proposed Project Concept



Source: PANYNJ (2023)

Figure B.2.3-8. Current Proposed Project Concept



Source: PANYNJ (2024)

Table B.2.3-9. McGraw-Hill Building Shadow Outcomes with Height Alternatives

Name	Dec 21	Duration (min.)	Mar 21 / Sep 21	Duration (min.)	May 6 / Aug 6	Duration (min.)	Jun 21	Duration (min.)
Tower 1 (1,343 feet)	8:51 a.m.- 9:10 a.m.	19	7:36 a.m.-12:23 p.m.	247	6:27 a.m.-12:03 p.m.	336	5:57 a.m.-12:07 p.m.	370
Tower 2 (926 feet)	9:17 a.m.-1:25 p.m.	248	9:51 a.m.-1:02 p.m.	191	10:00 a.m.-12:30 p.m.	150	10:34 a.m.-12:22 p.m.	113
OPTIONS / ALTERNATIVES								
Reduce Height by ~50%								
Tower 1 (630 feet)	8:51 a.m.- 9:10 a.m.	19	7:36 a.m.-12:32 p.m.	256	6:27 a.m.-12:12pm	345	5:57 a.m.-12:12pm	375
Tower 2 (420 feet)	9:17 a.m.-1:19 p.m.	242	9:51 a.m.-12:58 p.m.	187	10:00 a.m.-12:15 p.m.	135	10:34 a.m.-12:01 p.m.	87
Reduce Height to 400 feet								
Tower 1 (400 feet)	8:51 a.m.- 9:10 a.m.	19	7:36 a.m.-12:32 p.m.	256	6:27 a.m.-12:12pm	345	5:57 a.m.-12:02 p.m.	365
Tower 2 (400 feet)	9:17 a.m.-1:19 p.m.	242	9:51 a.m.-12:56 p.m.	185	10:00 a.m.-12:14 p.m.	134	10:34 a.m.-11:59 a.m.	85

B.2.3.6 FAÇADE SHADING ANALYSIS

Based on the results of the analyses prepared in response to comments provided by SHPO, NPS and other Consulting Parties during Section 106 consultations, further analysis of project-generated shadows was prepared in relation to the Section 4(f) Evaluation.

The additional shadow analyses performed in relation to the Section 4(f) Evaluation were prepared to evaluate and illustrate where and when potential project-generated incremental shadow would occur, and to determine how the existing shadows (generated by surrounding buildings) affect the McGraw-Hill Building throughout the analysis periods. This analysis does not present the duration of the shadows during the relevant periods (durations are provided in the prior analyses), but is focused on the extent to which the McGraw-Hill Building is shaded.

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

Due to the path that the sun travels across the sky in the northern hemisphere, the December 21 analysis period represents the condition where the longest shadows would be cast, at approximately 4.3 times the height of a given structure.

The shadow assessment considers shadows occurring between 1.5 hours after sunrise and 1.5 hours before sunset. At times earlier or later than this timeframe, the sun is near the horizon and the sun's rays reach the earth at very tangential (low) angles, diminishing the amount of solar energy and producing shadows that are very long, move fast, and generally blend with shadows from existing structures.

The additional shadow analyses prepared in relation to the Section 4(f) Evaluation evaluates shadows cast on all facades of the McGraw-Hill Building and provides the potential project-generated incremental shadows cast by the new Main Terminal, in addition to the entire Proposed Project. The existing shadow coverage calculations were derived using the three-dimensional building massing model of New York City, published by the New York City Office of Technology and Innovation (March 2023).

Results from the December 21, March 21/September 21, May 6/August 6, and June 21 shadow analysis periods were used to evaluate the extent of the McGraw-Hill Building's facade that are in shadow today (as generated by existing buildings), and shadows that would be generated by the new Main Terminal, and the Proposed Project. An analysis was developed calculating the percentage of the McGraw-Hill Building's north, east, south and west facades that are currently or would be shaded under the existing conditions and in the future with the Proposed Project. Results are summarized in **Table B.2.3-10** through **Table B.2.3-13.**

The December 21 analysis period represents the condition in which the McGraw-Hill Building would experience the greatest amount of existing shadow coverage and the greatest amount of total shadow coverage following completion of the Proposed Project. The March 21/ September 21 analysis period represents the condition in which the McGraw-Hill Building would experience the greatest amount of incremental shadow coverage attributable to the Proposed Project. Accordingly, graphic depictions for the December 21 and March 21/ September 21 analysis periods are provided in **Figure B.2.3-9** through **Figure B.2.3-20**.

Table B.2.3-10. McGraw-Hill Building Facade Shadow Coverage (December 21 Analysis Period)

Time	Existing PABT				New Main Terminal Only				Proposed Project				Total (Existing + Proposed Project			
	North	East	South	West	North	East	South	West	North	East	South	West	North	East	South	West
8:51 a.m.	100%	70%	100%	100%	0%	1%	0%	0%	0%	20%	0%	0%	100%	90%	100%	100%
10 a.m.	100%	89%	18%	100%	0%	1%	12%	0%	0%	1%	82%	0%	100%	90%	100%	100%
11 a.m.	100%	5%	17%	100%	0%	13%	11%	0%	0%	95%	83%	0%	100%	100%	100%	100%
12 p.m.	100%	7%	20%	100%	0%	13%	4%	0%	0%	93%	53%	0%	100%	100%	73%	100%
1 p.m.	100%	8%	23%	100%	0%	8%	3%	0%	0%	92%	3%	0%	100%	100%	26%	100%
2 p.m.	100%	96%	34%	100%	0%	4%	0%	0%	0%	4%	0%	0%	100%	100%	34%	100%
2:53 p.m.	100%	100%	44%	33%	0%	0%	0%	7%	0%	0%	0%	7%	100%	100%	44%	40%
Façade Average	**100%**	**54%**	**37%**	**90%**	**0%**	**6%**	**4%**	**1%**	**0%**	**44%**	**31%**	**1%**	**100%**	**97%**	**68%**	**91%**

Note: Totals may not sum due to rounding.

Table B.2.3-11. McGraw-Hill Building Facade Shadow Coverage (March 21/September 21 Analysis Period)

Time	Existing PABT				New Main Terminal Only				Proposed Project				Total (Existing + Proposed Project			
	North	East	South	West	North	East	South	West	North	East	South	West	North	East	South	West
7:36 a.m.	6%	3%	100%	100%	0%	9%	0%	0%	21%	86%	0%	0%	28%	89%	100%	100%
8:30 a.m.	38%	47%	100%	100%	0%	4%	0%	0%	61%	44%	0%	0%	99%	90%	100%	100%
9:30 a.m.	100%	21%	38%	100%	0%	4%	0%	0%	0%	75%	58%	0%	100%	96%	96%	100%
10:30 a.m.	100%	46%	12%	100%	0%	0%	15%	0%	0%	53%	87%	0%	100%	98%	99%	100%
11:30 a.m.	100%	4%	2%	100%	0%	0%	16%	0%	0%	92%	98%	0%	100%	96%	100%	100%
12:30 p.m.	100%	4%	1%	100%	0%	0%	16%	0%	0%	91%	27%	0%	100%	95%	28%	100%
1:30 p.m.	100%	100%	3%	100%	0%	0%	16%	0%	0%	0%	16%	0%	100%	100%	19%	100%
2:30 p.m.	100%	100%	6%	1%	0%	0%	9%	4%	0%	0%	9%	4%	100%	100%	15%	5%
3:30 p.m.	100%	100%	8%	4%	0%	0%	9%	5%	0%	0%	9%	5%	100%	100%	18%	9%
4:29 p.m.	100%	100%	11%	6%	0%	0%	9%	6%	0%	0%	9%	6%	100%	100%	21%	12%
Façade Average	**84%**	**52%**	**28%**	**71%**	**0%**	**2%**	**9%**	**2%**	**8%**	**44%**	**31%**	**2%**	**93%**	**96%**	**60%**	**73%**

Note: Totals may not sum due to rounding.

Table B.2.3-12. McGraw-Hill Building Facade Shadow Coverage (May 6/August 6 Analysis Period)

Time	Existing PABT				New Main Terminal Only				Proposed Project				Total (Existing + Proposed Project)			
	North	East	South	West	North	East	South	West	North	East	South	West	North	East	South	West
6:27 a.m.	83%	75%	100%	100%	0%	0%	0%	0%	0%	16%	0%	0%	83%	92%	100%	100%
7:30 a.m.	43%	24%	100%	100%	0%	3%	0%	0%	4%	69%	0%	0%	47%	94%	100%	100%
8:30 a.m.	0%	2%	100%	100%	0%	12%	0%	0%	17%	91%	0%	0%	17%	93%	100%	100%
9:30 a.m.	100%	0%	100%	100%	0%	13%	0%	0%	0%	96%	0%	0%	100%	96%	100%	100%
10:30 a.m.	100%	0%	0%	100%	0%	17%	17%	0%	0%	100%	85%	0%	100%	100%	85%	100%
11:30 a.m.	100%	0%	0%	100%	0%	17%	17%	0%	0%	100%	88%	0%	100%	100%	88%	100%
12:30 p.m.	100%	100%	0%	100%	0%	0%	7%	0%	0%	0%	7%	0%	100%	100%	7%	100%
1:30 p.m.	100%	100%	0%	0%	0%	0%	10%	0%	0%	0%	10%	0%	100%	100%	10%	0%
2:30 p.m.	100%	100%	0%	0%	0%	0%	14%	0%	0%	0%	14%	0%	100%	100%	15%	0%
3:30 p.m.	100%	100%	0%	10%	0%	0%	16%	0%	0%	0%	16%	0%	100%	100%	17%	10%
4:30 p.m.	100%	100%	2%	23%	0%	0%	17%	2%	0%	0%	17%	2%	100%	100%	19%	25%
5:18 p.m.	100%	100%	5%	37%	0%	0%	16%	3%	0%	0%	16%	3%	100%	100%	20%	40%
Façade Average	**86%**	**58%**	**34%**	**64%**	**0%**	**5%**	**9%**	**0%**	**2%**	**39%**	**21%**	**0%**	**87%**	**98%**	**55%**	**65%**

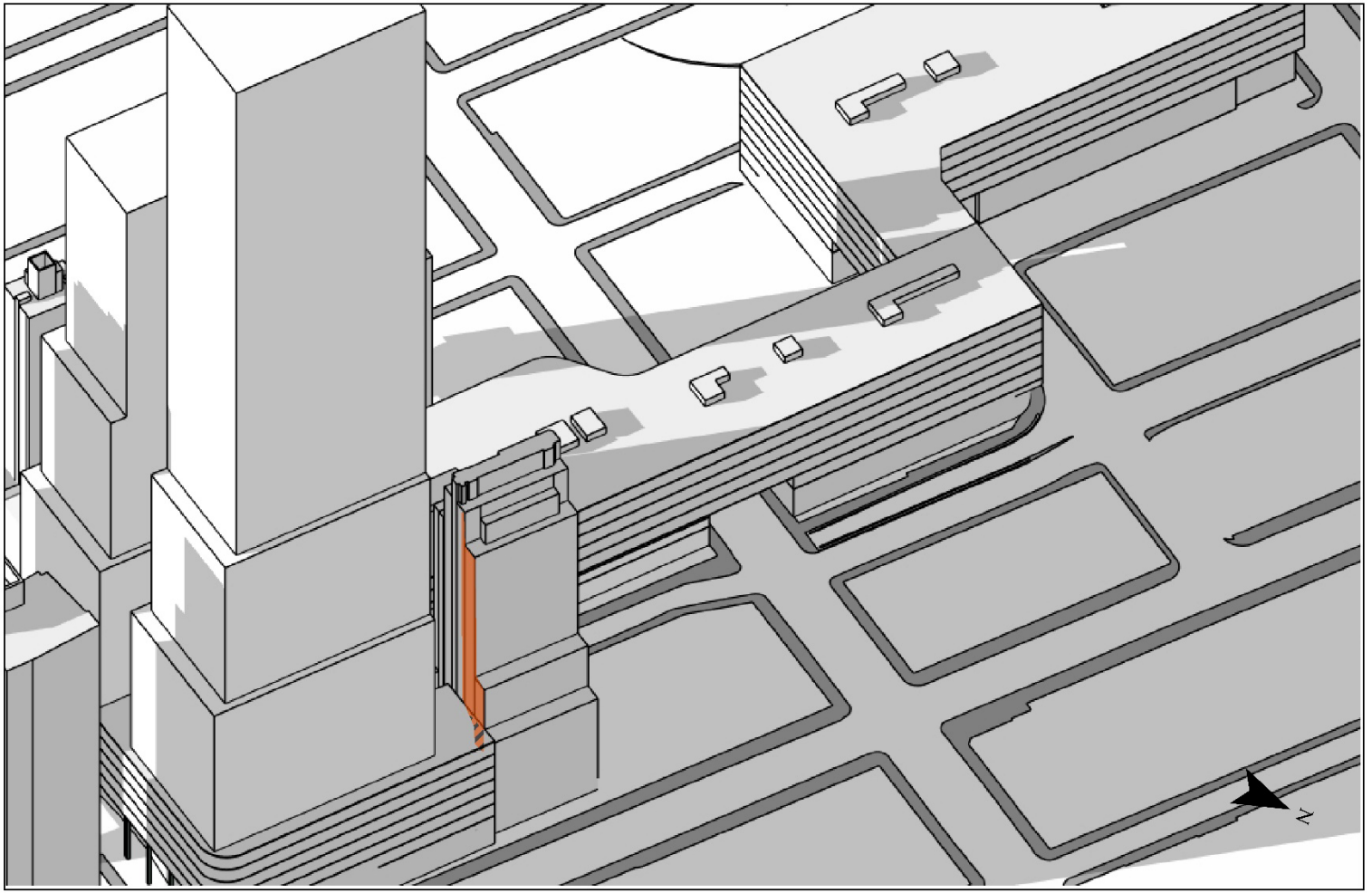
Note: Totals may not sum due to rounding.

Table B.2.3-13. McGraw-Hill Building Facade Shadow Coverage (June 21 Analysis Period)

Time	Existing PABT				New Main Terminal Only				Proposed Project				Total (Existing + Proposed Project)			
	North	East	South	West	North	East	South	West	North	East	South	West	North	East	South	West
5:57 a.m.	42%	33%	100%	100%	0%	0%	0%	0%	0%	26%	0%	0%	42%	59%	100%	100%
7:00 a.m.	7%	17%	100%	100%	0%	2%	2%	0%	0%	43%	0%	0%	7%	59%	100%	100%
8:00 a.m.	8%	0%	100%	100%	0%	9%	9%	0%	3%	78%	0%	0%	10%	78%	100%	100%
9:00 a.m.	0%	0%	100%	100%	0%	11%	11%	0%	10%	90%	0%	0%	10%	90%	100%	100%
10:00 a.m.	30%	0%	100%	100%	0%	17%	17%	0%	70%	100%	0%	0%	100%	100%	100%	100%
11:00 a.m.	100%	0%	0%	100%	0%	18%	18%	0%	0%	100%	62%	0%	100%	100%	62%	100%
12:00 p.m.	100%	0%	0%	100%	0%	16%	16%	0%	0%	63%	32%	0%	100%	63%	32%	100%
1:00 p.m.	100%	100%	0%	0%	0%	0%	7%	0%	0%	0%	7%	0%	100%	100%	7%	0%
2:00 p.m.	100%	100%	0%	0%	0%	0%	10%	0%	0%	0%	10%	0%	100%	100%	10%	0%
3:00 p.m.	100%	100%	1%	0%	0%	0%	15%	0%	0%	0%	15%	0%	100%	100%	15%	0%
4:00 p.m.	100%	100%	1%	22%	0%	0%	15%	0%	0%	0%	15%	0%	100%	100%	16%	22%
5:00 p.m.	100%	100%	1%	45%	0%	0%	14%	0%	0%	0%	14%	0%	100%	100%	15%	45%
6:01 p.m.	100%	100%	18%	87%	0%	0%	5%	0%	0%	0%	5%	0%	100%	100%	23%	87%
Façade Average	**68%**	**50%**	**40%**	**66%**	**0%**	**6%**	**11%**	**0%**	**6%**	**38%**	**12%**	**0%**	**75%**	**88%**	**52%**	**66%**

Note: Totals may not sum due to rounding.

Figure B.2.3-9. Façade Shading Analysis – View Looking South (December 21 at 8:51a.m.)



Incremental Shadow on Sunlight Sensitive Features

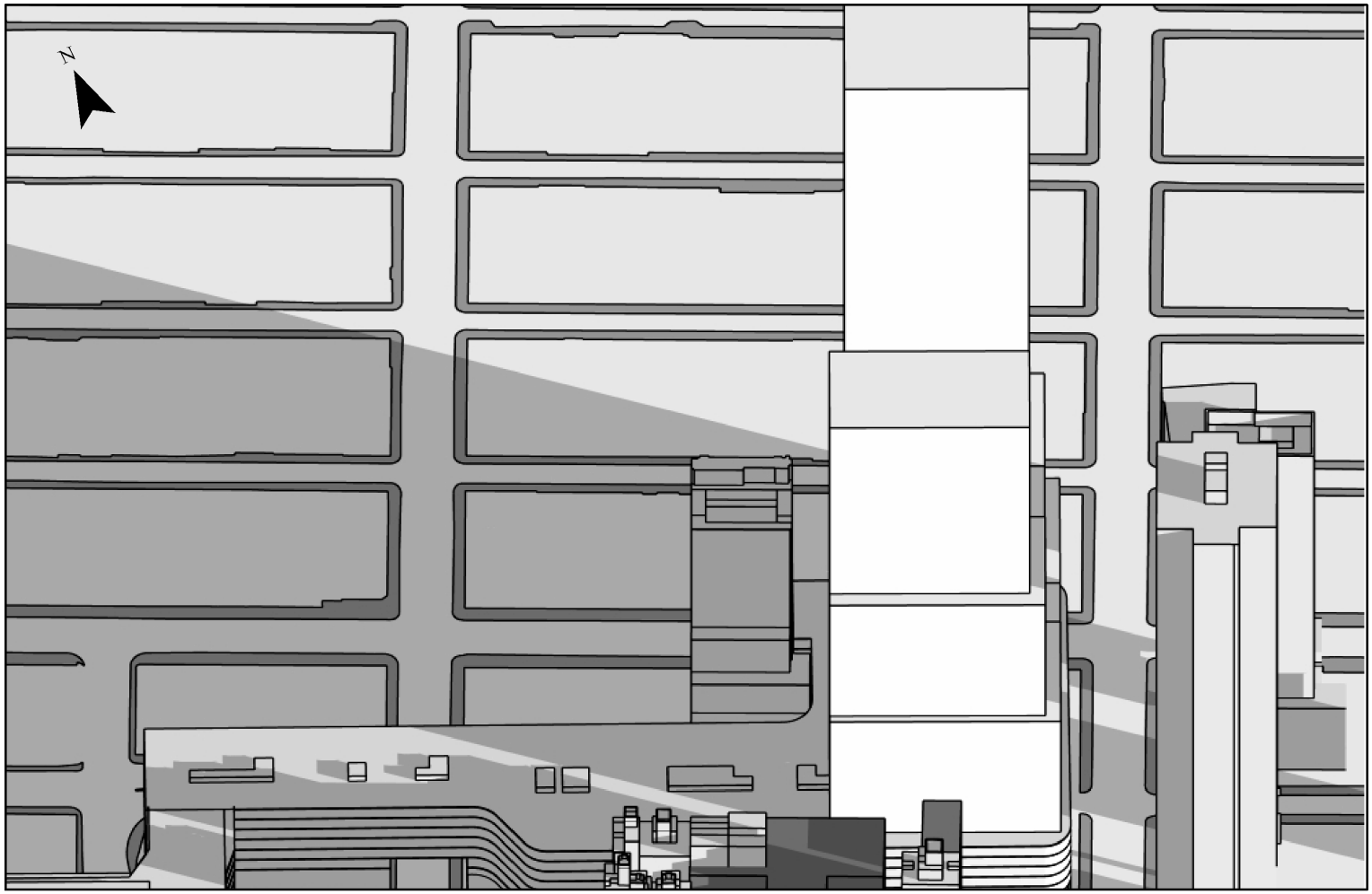
Incremental Shadow on McGraw-Hill Building façade (not visible due to intervening building)

Existing Shadow

Project-Generated Incremental Shadow on McGraw-Hill during December 21 8:51 AM

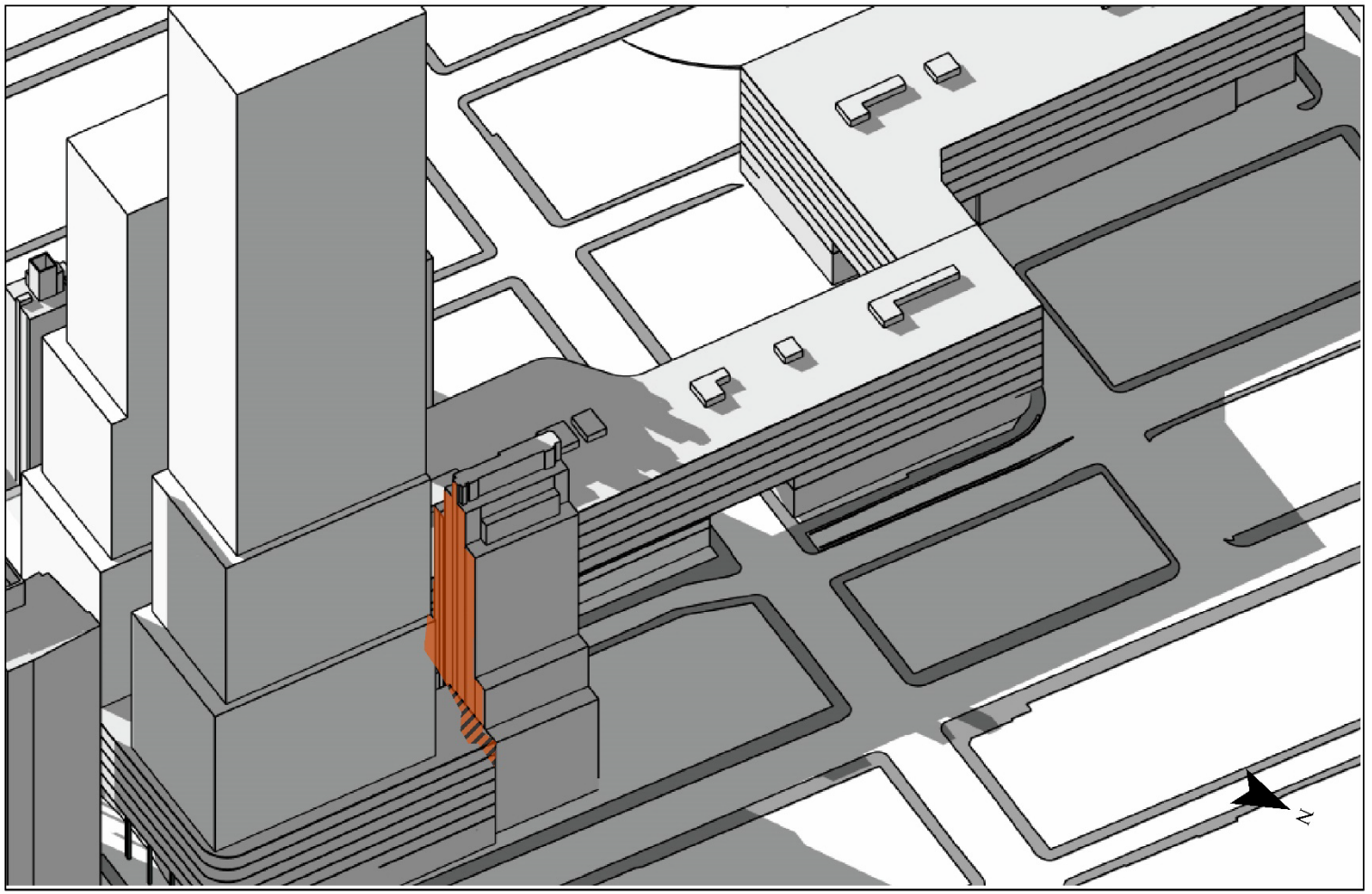
Source: WSP (2024)

Figure B.2.3-10. Façade Shading Analysis – View Looking North (December 21 at 8:51a.m.)



Source: WSP (2024)

Figure B.2.3-11. Façade Shading Analysis – View Looking South (December 21 at 12:00p.m.)



Incremental Shadow on Sunlight Sensitive Features

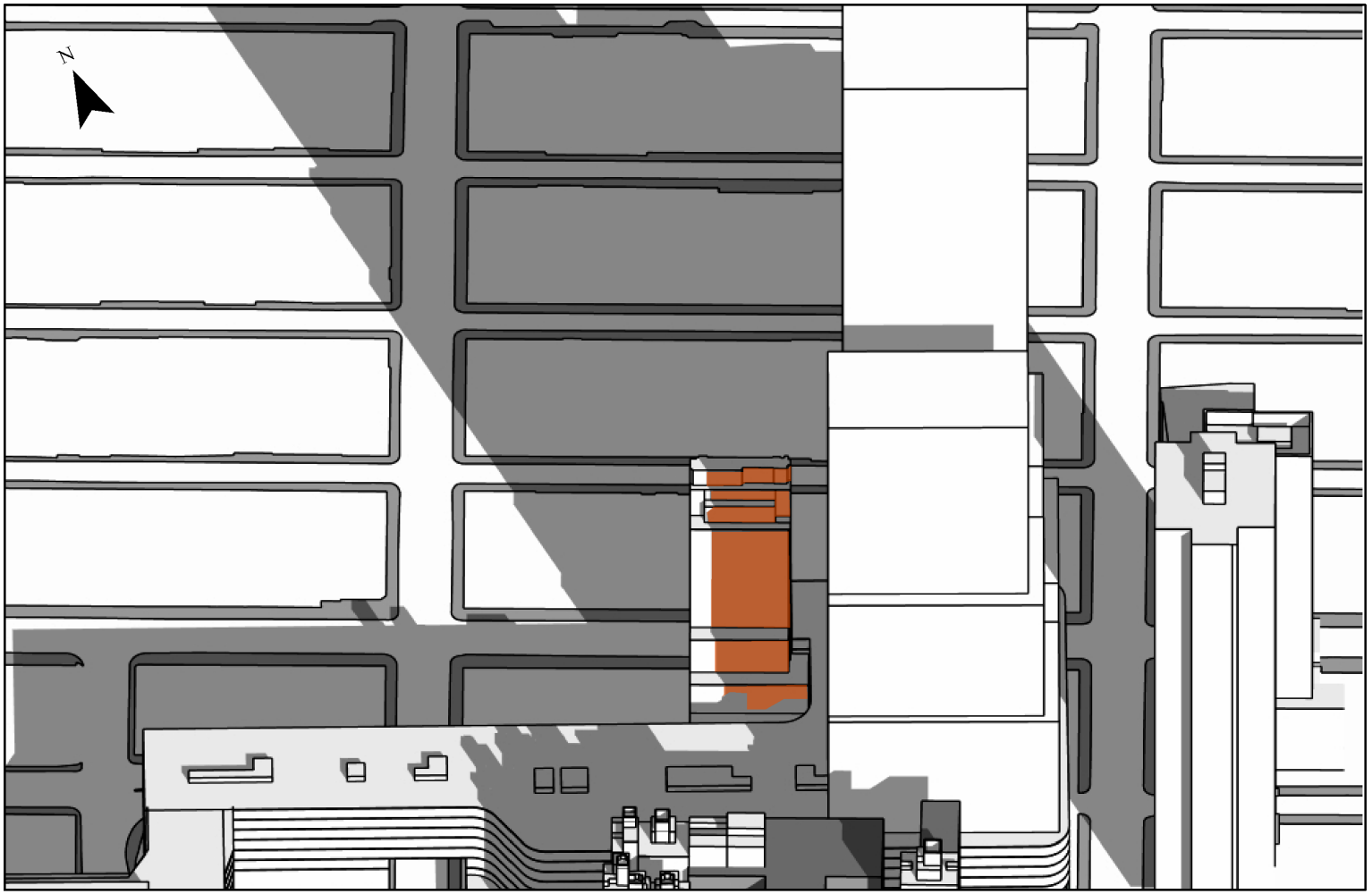
Incremental Shadow on McGraw-Hill Building façade (not visible due to intervening building)

Existing Shadow

Project-Generated Incremental Shadow on McGraw-Hill during December 21 12:00 PM

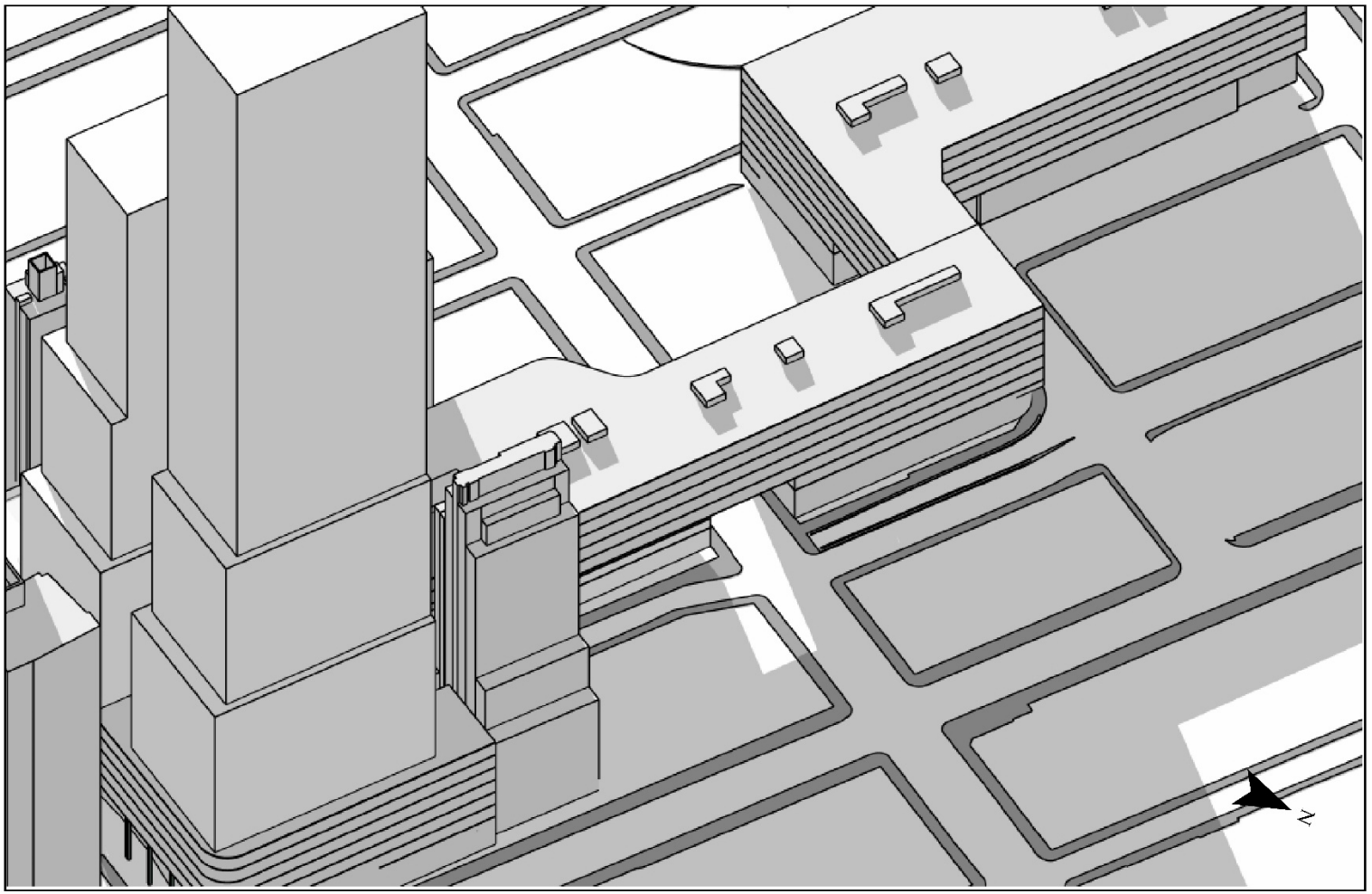
Source: WSP (2024)

Figure B.2.3-12. Façade Shading Analysis – View Looking North (December 21 at 12:00p.m.)



Source: WSP (2024)

Figure B.2.3-13. Façade Shading Analysis – View Looking South (December 21 at 2:53p.m.)



Incremental Shadow on Sunlight Sensitive Features

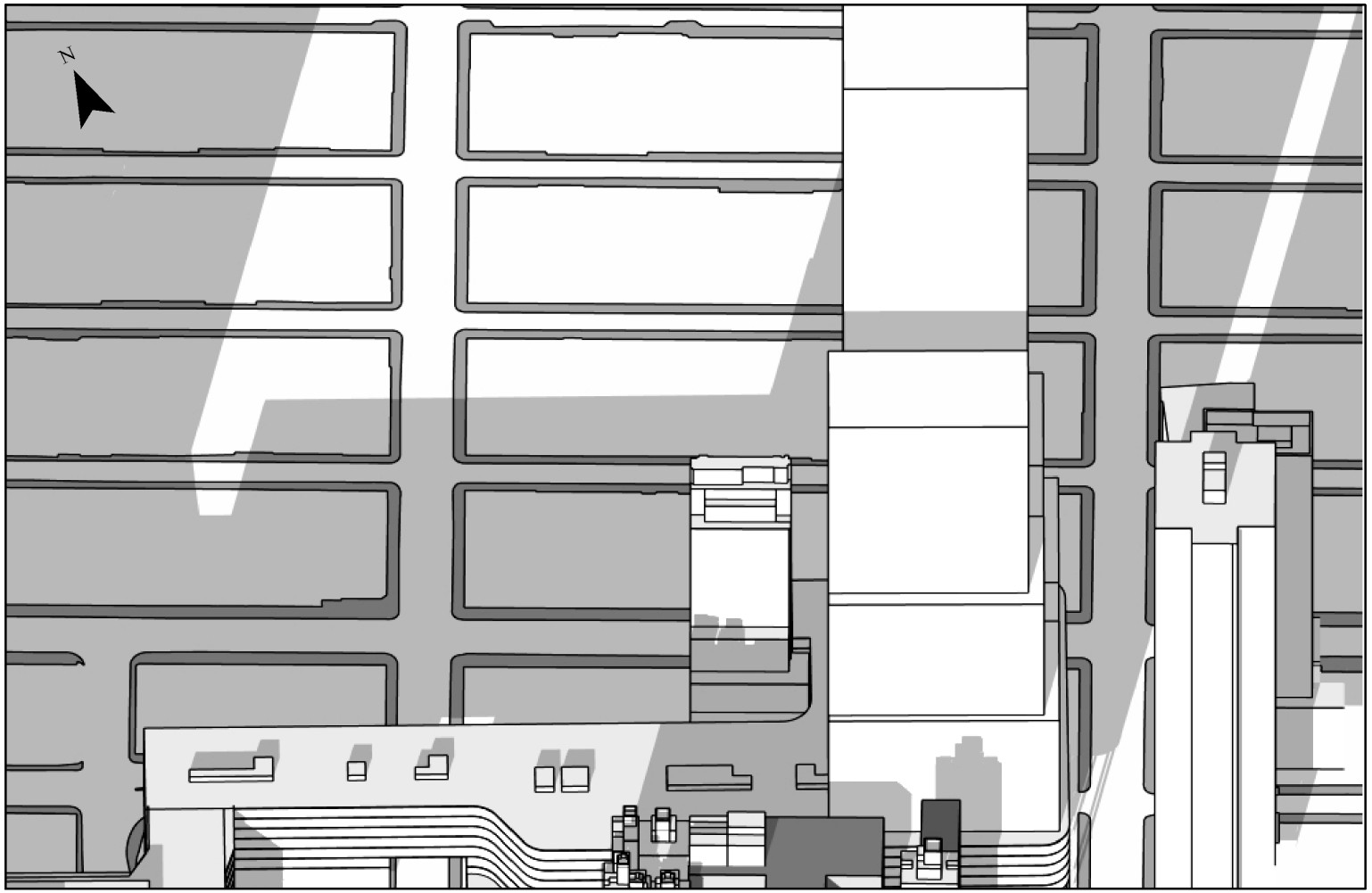
Incremental Shadow on McGraw-Hill Building façade (not visible due to intervening building)

Existing Shadow

Project-Generated Incremental Shadow on McGraw-Hill during December 21 2:53 PM

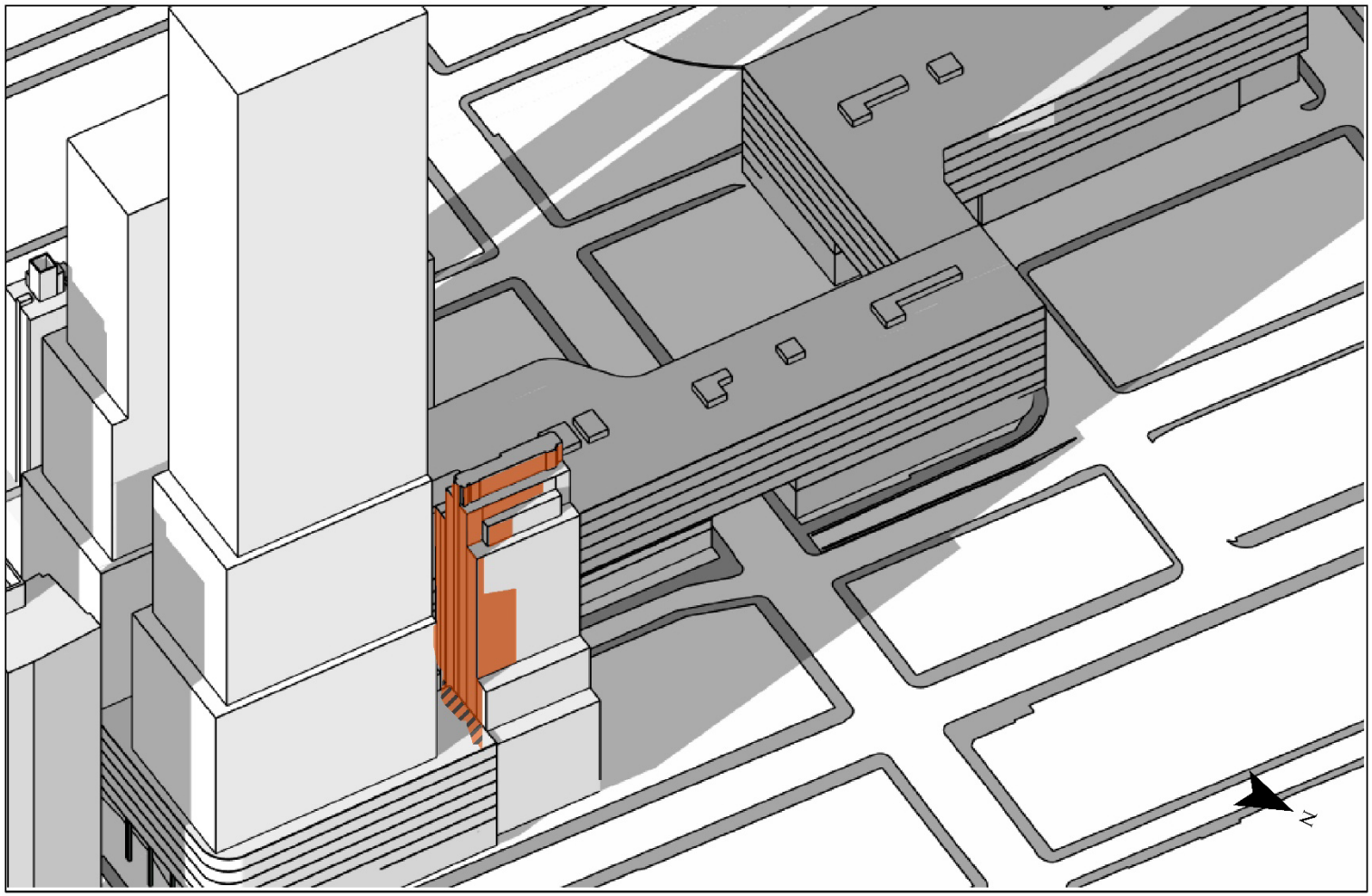
Source: WSP (2024)

Figure B.2.3-14. Façade Shading Analysis – View Looking North (December 21 at 2:53p.m.)



Source: WSP (2024)

Figure B.2.3-15. Façade Shading Analysis – View Looking South (March 21/ September 21 at 7:36a.m.)



Incremental Shadow on Sunlight Sensitive Features

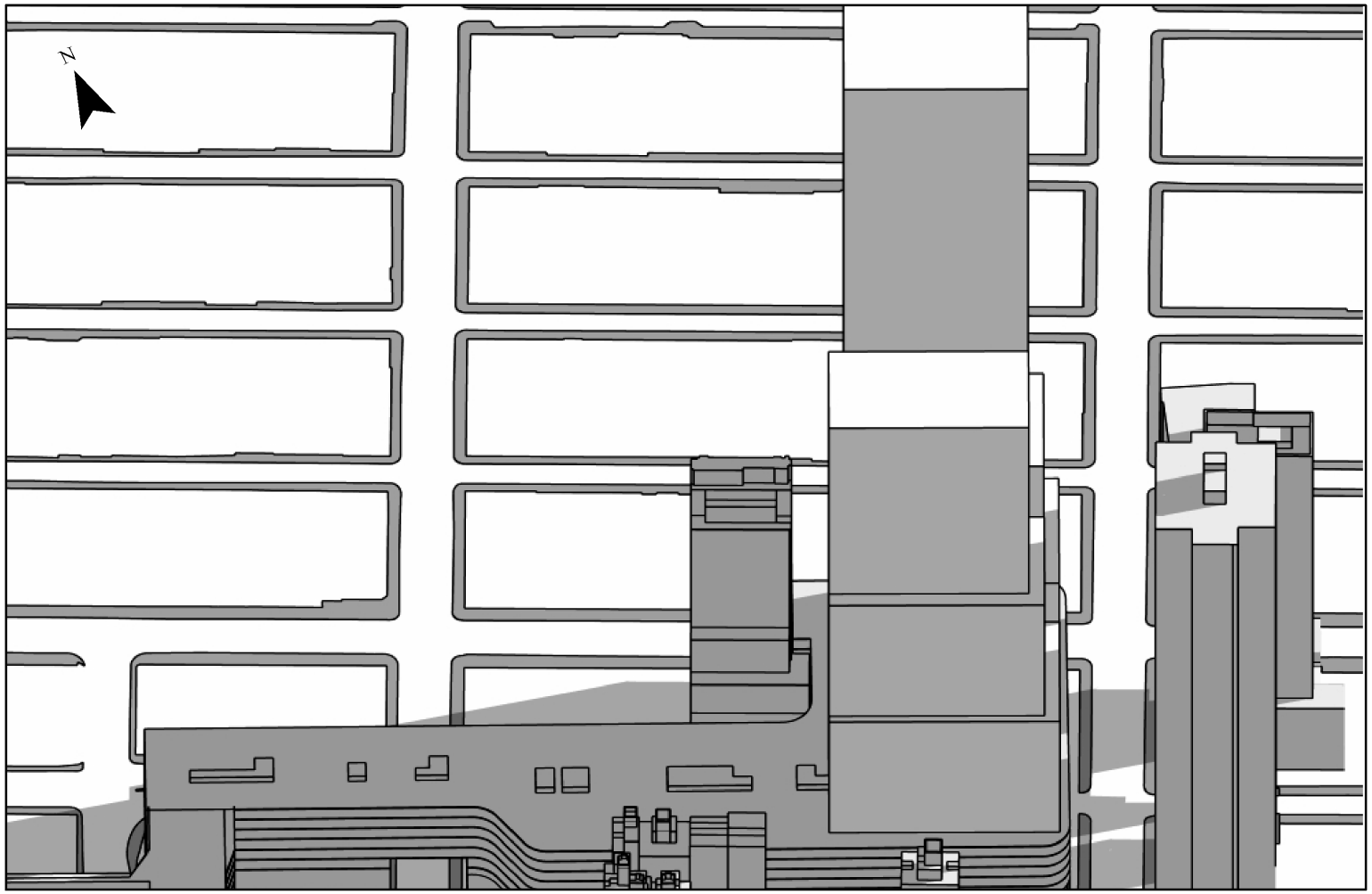
Incremental Shadow on McGraw-Hill Building façade (not visible due to intervening building)

Existing Shadow

Project-Generated Incremental Shadow on McGraw-Hill during March 21 7:36 AM

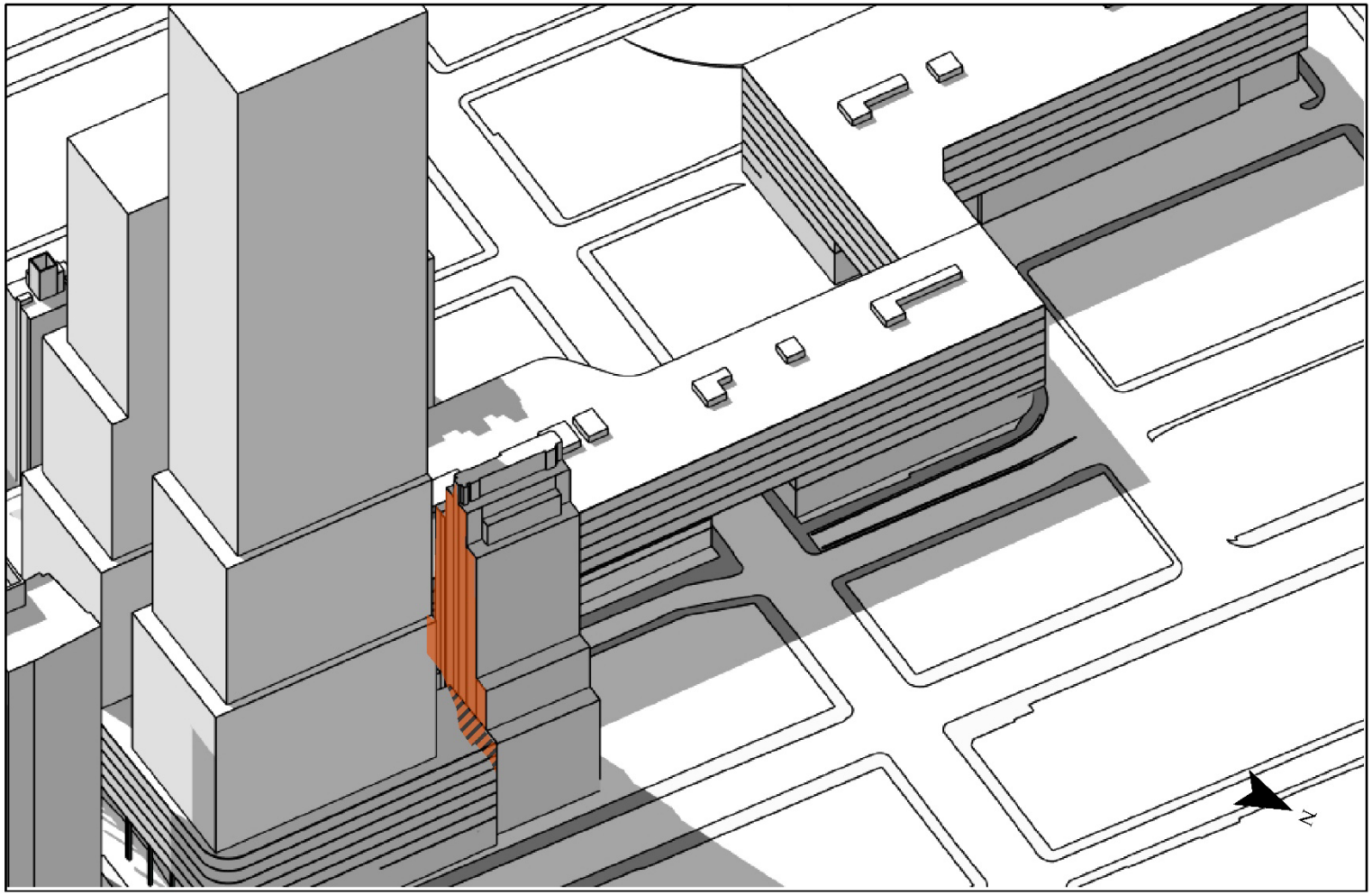
Source: WSP (2024)

Figure B.2.3-16. Façade Shading Analysis – View Looking North (March 21/ September 21 at 7:36a.m.)



Source: WSP (2024)

Figure B.2.3-17. Façade Shading Analysis – View Looking South (March 21/ September 21 at 12:30p.m.)



Incremental Shadow on Sunlight Sensitive Features

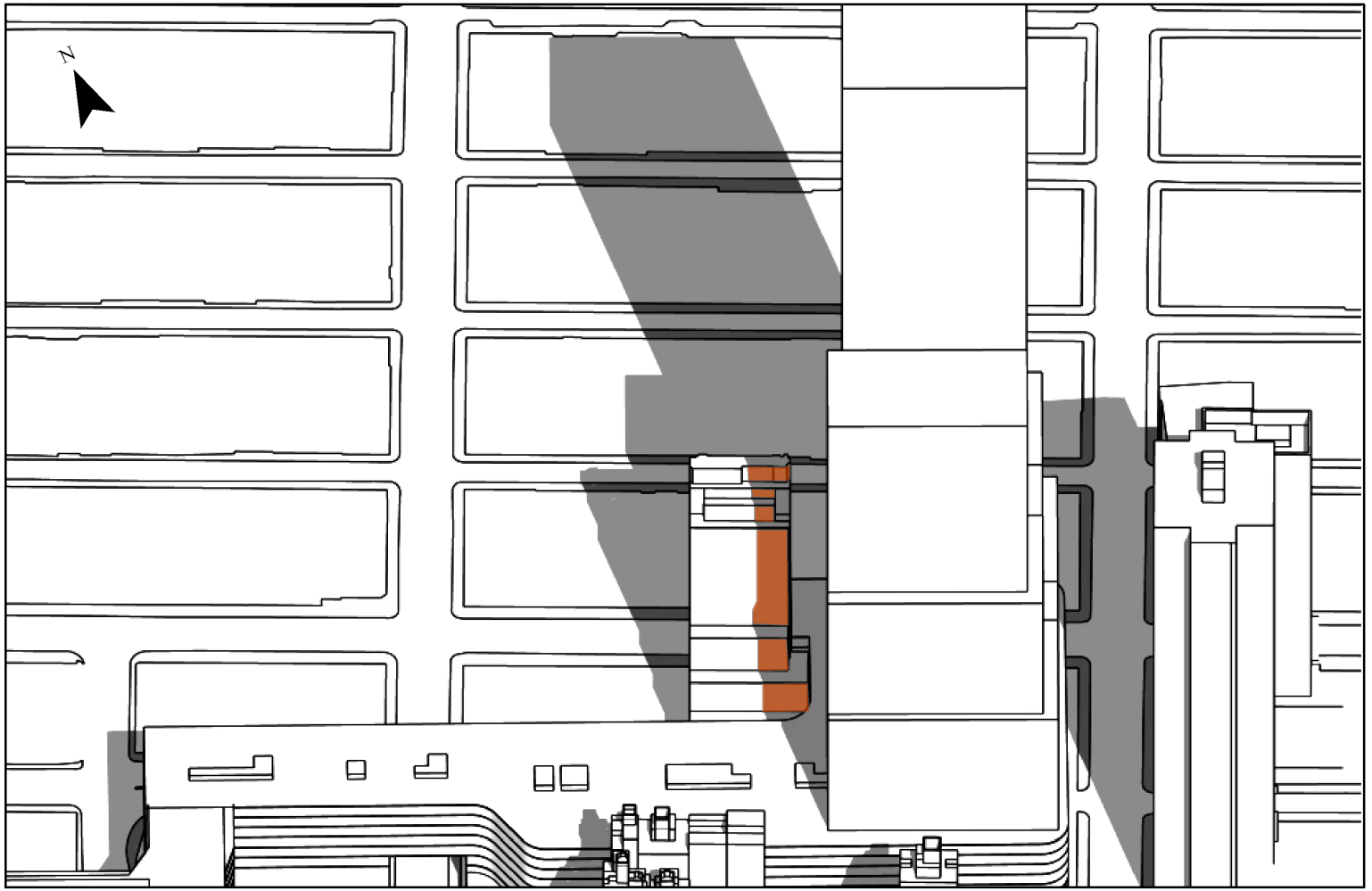
Incremental Shadow on McGraw-Hill Building façade (not visible due to intervening building)

Existing Shadow

Project-Generated Incremental Shadow on McGraw-Hill during March 21 12:30 PM

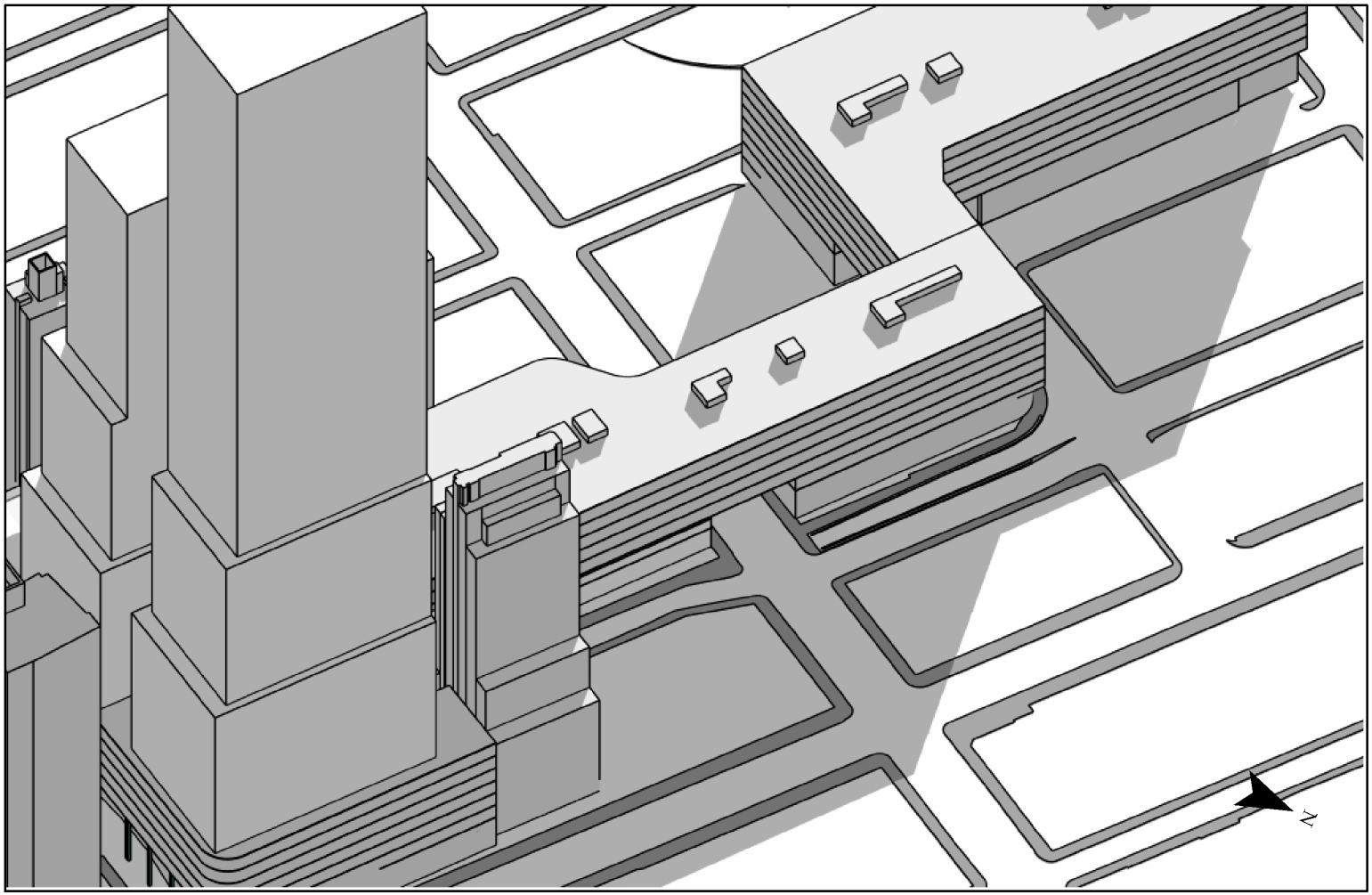
Source: WSP (2024)

Figure B.2.3-18. Façade Shading Analysis – View Looking North (March 21/ September 21 at 12:30p.m.)



Source: WSP (2024)

Figure B.2.3-19. Façade Shading Analysis – View Looking South (March 21/ September 21 at 4:29p.m.)



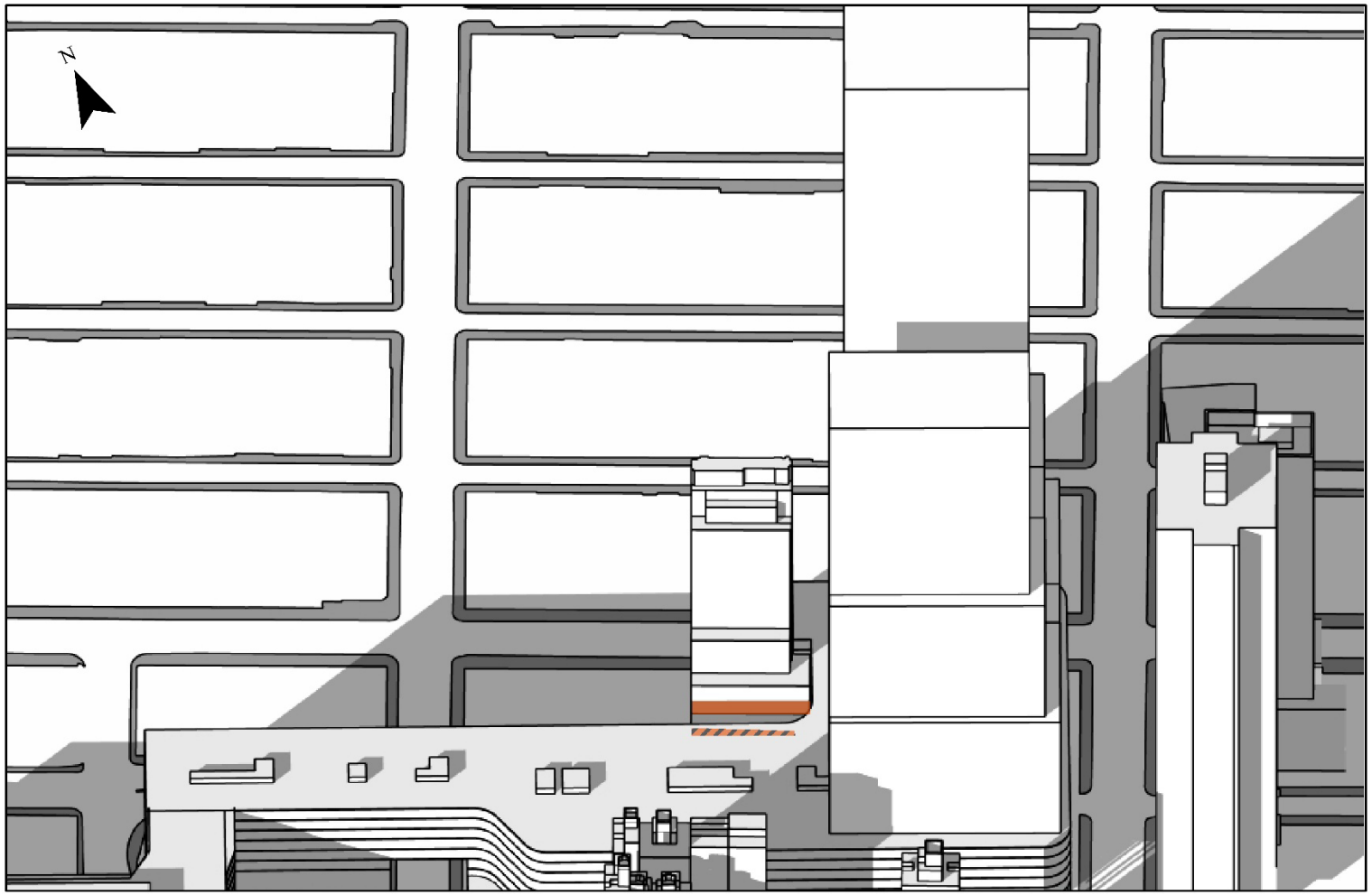
Incremental Shadow on Sunlight Sensitive Features

Existing Shadow

Project-Generated Incremental Shadow on McGraw-Hill during March 21 4:29 PM

Source: WSP (2024)

Figure B.2.3-20. Façade Shading Analysis – View Looking North (March 21/ September 21 at 4:29p.m.)



Source: WSP (2024)

December 21 Analysis Period

During the existing conditions of the December analysis period, the façade of the McGraw-Hill Building is covered by shadows throughout the day. The north and west facades of the McGraw-Hill Building do not receive direct sunlight for much of the analysis period due to the position of the sun during the afternoon hours of the analysis period, resulting in these facades being in shadow for most the daylight hours. The east and south facades experience more shadows in the morning and afternoon analysis hours, with a low percentage of façade areas shaded in the mid-day hours. The aggregated results show that approximately 70% of the McGraw-Hill Building's façade is in shadow or not exposed to direct sunlight in existing conditions.

Introducing the new Main Terminal into the analysis results in an increase of shadow coverage onto the McGraw-Hill Building of approximately three percent, with shadow coverage increasing by 11-13% on the east and south facades (primarily on the lower levels of the building) in the mid-day hours.

Adding the Proposed Project to the evaluation increases the shadow coverage by approximately 19%, with the largest increases of shading occurring from 10 a.m. to 1 p.m. on the east and south facades, but minimal to no increases in shadow coverage occurring in the final hours of the analysis period.

In conclusion, as shown in **Table B.2.3-14** the result of the analysis concluded that in the December analysis period, the McGraw-Hill Building's facades experience an average of approximately 70% shadow coverage in existing conditions and would increase by 19% (to a total of approximately 89%) shadow coverage with the Proposed Project.

March 21/September 21 Analysis Period

During the existing conditions of the March 21/September 21 analysis period, the façade of the McGraw-Hill Building is approximately 59% shaded, on average, throughout the analysis period. Shading from existing buildings is most pronounced on the south and east facades of the McGraw-Hill Building during the morning hours, from 8:30 a.m. to 10:30 a.m. The north façade of the McGraw-Hill Building experiences significant shading throughout much of the analysis period, both as a result of the abundance of existing buildings in the surrounding densely built urban area and as a result of the position of the sun during the analysis period. Similarly, the western façade of the McGraw-Hill Building experiences significant shading during the morning and into the midafternoon as a result of existing buildings and the position of the sun.

Compared to the existing conditions, the new Main Terminal would result in an approximately three percent increase in shaded area on the McGraw-Hill Building, on average, for the March 21/September 21 analysis period. Project-generated incremental shadow attributable to the new Main Terminal would result in a maximum increase of shadow coverage of approximately

16% of the area on the south façade between 11:30 a.m. and 1:30 p.m. These shadows would be limited to the lower levels of the McGraw-Hill Building.

Evaluation of the Proposed Project results in an average increase of shadow area coverage of approximately 21% through the March 21/September 21 analysis period. The largest increase of shading would occur on the south and east facades of the McGraw-Hill Building, with a maximum increase covering approximately 98% of the area on the south façade at 11:30 a.m. Following this peak in the morning hours, project-generated shadow cast on the south and east facades of the McGraw-Hill Building would reduce steadily throughout later hours of the day; by 12:30 p.m. the Proposed Project's incremental shadows covers 27% of the south façade. At 4:29 p.m., shadows cast from the new Main Terminal and private development would result in an increase of approximately 9% of the area on the south façade, and there would be no incremental increase on the east façade.

As shown in **Table B.2.3-15**, the result of the analysis concluded that in the March 21/ September 21 analysis period, the McGraw-Hill Building's facades experience an average of approximately 59% shadow coverage in existing conditions and would increase by approximately 21% (to a total of approximately 80%) shadow coverage with the Proposed Project.

May 6/August 6 Analysis Period

During the existing conditions of the May 6/August 6 analysis period, the façade of the McGraw-Hill Building is approximately 61% shaded, on average, throughout the analysis period. Compared to the existing conditions, the new Main Terminal would result in an approximately four percent increase in shaded area on the McGraw-Hill Building, on average, for the May 6/ August 6 analysis period. Project-generated incremental shadow attributable to the new Main Terminal would result in a maximum increase of shadow coverage of approximately 17% of the area on the east and south façades between 10:30 a.m. and 11:30 a.m., and 17% of the area on the south façade at 4:30 p.m. These shadows would be limited to the lower levels of the McGraw-Hill Building. Evaluation of the Proposed Project results in an average increase of shadow area coverage of approximately 16% through the May 6/ August 6 analysis period. The largest increase of shading would occur on the south and east facades of the McGraw-Hill Building between 8:30 a.m. and 11:30 a.m., with a maximum increase covering approximately 100% of the area on the east façade between 10:30 a.m. and 11:30 a.m. By 5:18 p.m., shadows cast from the Proposed Project would result in an increase of approximately 16% of the area on the south façade, and there would be no incremental increase on the east façade.

As shown in **Table B.2.3-16**, the result of the analysis concluded that in the May 6/ August 6 analysis period, the McGraw-Hill Building's facades experience an average of approximately 61% shadow coverage in existing conditions and would increase by approximately 16% (to a total of approximately 76%) shadow coverage with the Proposed Project.

June 21 Analysis Period

During the existing conditions of the June 21 analysis period, the façade of the McGraw-Hill Building is approximately 56% shaded, on average, throughout the analysis period. Compared to the existing conditions, the new Main Terminal would result in an approximately four percent increase in shaded area on the McGraw-Hill Building, on average, for the June 21 analysis period. Project-generated incremental shadow attributable to the new Main Terminal would result in a maximum increase of shadow coverage of approximately 18% of the area on the east and south façades between at 11:30 a.m. These shadows would be limited to the lower levels of the McGraw-Hill Building. Evaluation of the Proposed Project results in an average increase of shadow area coverage of approximately 14% through the June 21 analysis period. The largest increase of shading would occur on the east facade of the McGraw-Hill Building between 8:00 a.m. and 11:00 a.m., with a maximum increase covering approximately 100% of the area on the east façade between 10:00 a.m. and 11:00 a.m. By 6:01 p.m., shadows cast from the Proposed Project would result in an increase of approximately 5% of the area on the south façade, and there would be no incremental increase on the east façade.

As shown in **Table B.2.3-17**, the result of the analysis concluded that in the June 21 analysis period, the McGraw-Hill Building's facades experience an average of approximately 56% shadow coverage in existing conditions and would increase by approximately 14% (to a total of approximately 70%) shadow coverage with the Proposed Project.

Façade Shading Analysis Summary

The following summarizes the findings for the façade shading analysis for the McGraw-Hill Building's east and south facades, which would experience the greatest shading impacts from existing development and the Proposed Project:

- During the December 21 analysis period an average of 54% and 44% of the east façade would be cast in shadow by the existing conditions and the Proposed Project, respectively. During the December 21 analysis period, an average of 37% and 31% of the south façade would be cast in shadow by the existing conditions and the Proposed Project, respectively.
- During the March 21/September 21 analysis periods, an average of 52% and 44% of the east façade would be cast in shadow by the existing conditions and the Proposed Project, respectively. During the March 21/September 21 analysis periods, an average of 28% and 31% of the south façade would be cast in shadow by the existing conditions and the Proposed Project, respectively.
- During the May 6/August 6 analysis period, an average of 58% and 39% of the east façade would be cast in shadow by the existing conditions and the Proposed Project, respectively. During the May 6/August 6 analysis periods, an average of 34% and 21% of the south façade would be cast in shadow by the existing conditions and the Proposed Project, respectively.
- During the June 21 analysis period, an average of 50% and 38% of the east façade would be cast in shadow by the existing conditions and the Proposed Project, respectively. During the

June 21 analysis period, an average of 40% and 12% of the south façade would be cast in shadow by the existing conditions and the Proposed Project, respectively.

The following is the average shading impact across the entirety of the McGraw-Hill Building's four facades:

- December 21: 70% (existing development), 19% (Proposed Project)
- March 21/September 21: 59% (existing development), 21% (Proposed Project)
- May 6/August 6: 61% (existing development), 16% (Proposed Project)
- June 21: 56% (existing development), 14% (Proposed Project)

Table B.2.3-14. McGraw-Hill Building Average Percent of Total Façade Area Shaded (December 21 Analysis Period)

Time	Existing	New Main Terminal Only	Proposed Project	Total (Existing + Proposed Project)
8:51 a.m.	93%	0%	5%	97%
10 a.m.	77%	3%	21%	97%
11 a.m.	56%	6%	44%	100%
12 p.m.	57%	4%	37%	93%
1 p.m.	58%	3%	24%	81%
2 p.m.	83%	1%	1%	84%
2:53 p.m.	69%	2%	2%	71%
TOTAL	**70%**	**3%**	**19%**	**89%**

Note: Totals may not sum due to rounding.

Table B.2.3-15. McGraw-Hill Building Average Percent of Total Façade Area Shaded (March 21/ September 21 Analysis Period)

Time	Existing	New Main Terminal Only	Proposed Project	Total (Existing + Proposed Project)
7:36 a.m.	52%	2%	27%	79%
8:30 a.m.	71%	1%	26%	97%
9:30 a.m.	65%	1%	33%	98%
10:30 a.m.	65%	4%	35%	99%
11:30 a.m.	52%	4%	48%	99%
12:30 p.m.	51%	4%	30%	81%
1:30 p.m.	76%	4%	4%	80%
2:30 p.m.	52%	3%	3%	55%
3:30 p.m.	53%	4%	4%	57%
4:29 p.m.	54%	4%	4%	58%
TOTAL	**59%**	**3%**	**21%**	**80%**

Note: Totals may not sum due to rounding.

Table B.2.3-16. McGraw-Hill Building Average Percent of Total Façade Area Shaded (May 6/ August 6 Analysis Period)

Time	Existing	New Main Terminal Only	Proposed Project	Total (Existing + Proposed Project)
6:27 a.m.	89%	0%	4%	94%
7:30 a.m.	67%	1%	18%	85%
8:30 a.m.	51%	3%	27%	78%
9:30 a.m.	75%	3%	24%	99%
10:30 a.m.	50%	8%	46%	96%
11:30 a.m.	50%	8%	47%	97%
12:30 p.m.	75%	2%	2%	77%
1:30 p.m.	50%	3%	3%	53%
2:30 p.m.	50%	4%	4%	54%
3:30 p.m.	53%	4%	4%	57%
4:30 p.m.	56%	5%	5%	61%
5:18 p.m.	61%	5%	5%	65%
TOTAL	**61%**	**4%**	**16%**	**76%**

Note: Totals may not sum due to rounding.

Table B.2.3-17. McGraw-Hill Building Average Percent of Total Façade Area Shaded (June 21 Analysis Period)

Time	Existing	New Main Terminal Only	Proposed Project	Total (Existing + Proposed Project)
5:57 a.m.	69%	0%	7%	75%
7:00 a.m.	56%	1%	11%	67%
8:00 a.m.	52%	5%	20%	72%
9:00 a.m.	50%	5%	25%	75%
10:00 a.m.	58%	9%	43%	100%
11:00 a.m.	50%	9%	40%	90%
12:00 p.m.	50%	8%	24%	74%
1:00 p.m.	50%	2%	2%	52%
2:00 p.m.	50%	3%	3%	53%
3:00 p.m.	50%	4%	4%	54%
4:00 p.m.	56%	4%	4%	59%
5:00 p.m.	62%	3%	3%	65%
6:01 p.m.	76%	1%	1%	78%
TOTAL	**56%**	**4%**	**14%**	**70%**

Note: Totals may not sum due to rounding.

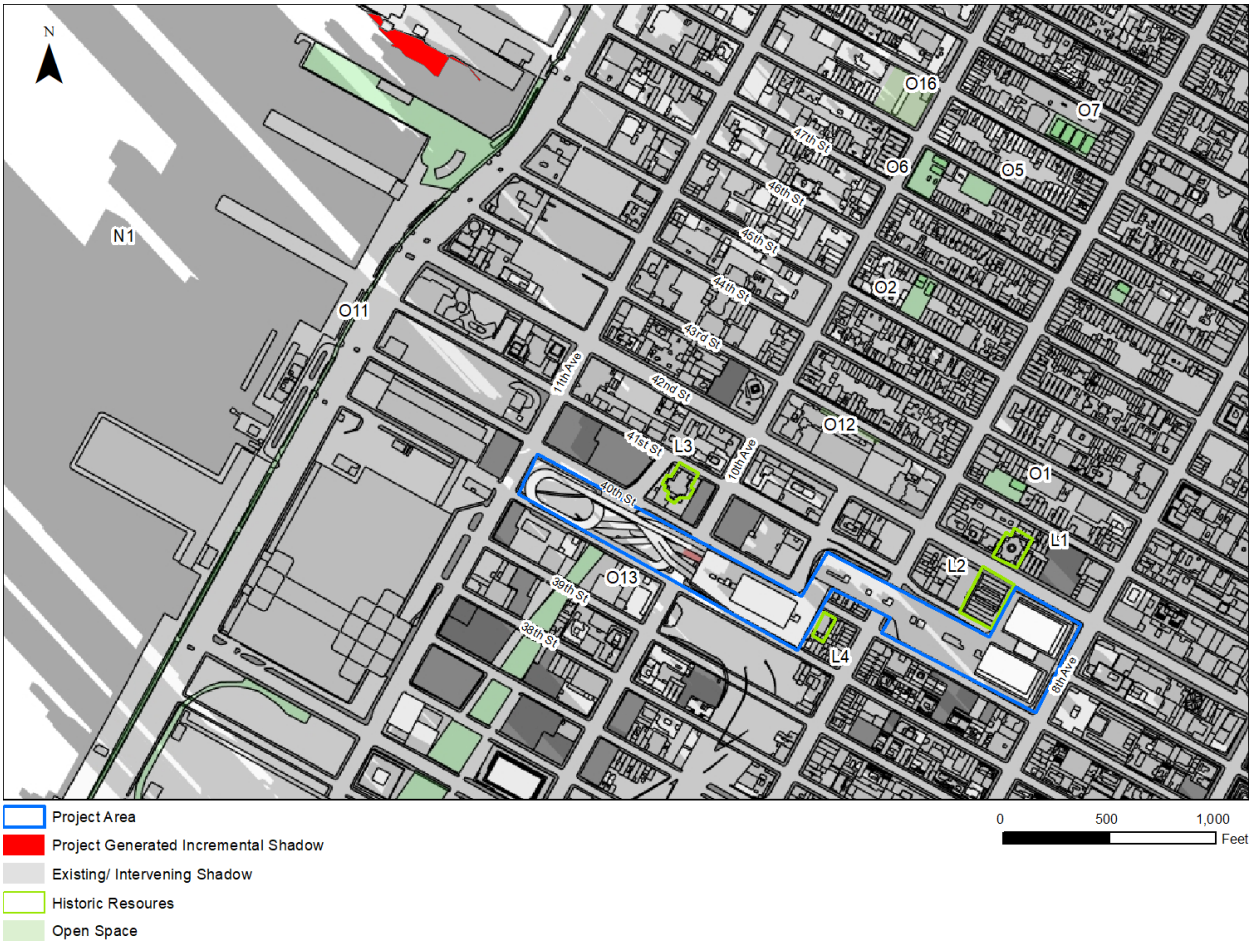
B.2.3.7 CONCLUSIONS

The results of the detailed shadow assessment indicate that the Proposed Project would not result in any significant adverse shadow impacts on the sunlight-sensitive open space and natural resources during any analysis period.

Six open space resources and one natural resource with sunlight-sensitive features would receive incremental shadows on one or more analysis periods, but these shadows would be limited in extent and duration and would not significantly affect the public's use of these open spaces or ecological conditions within the natural resource.

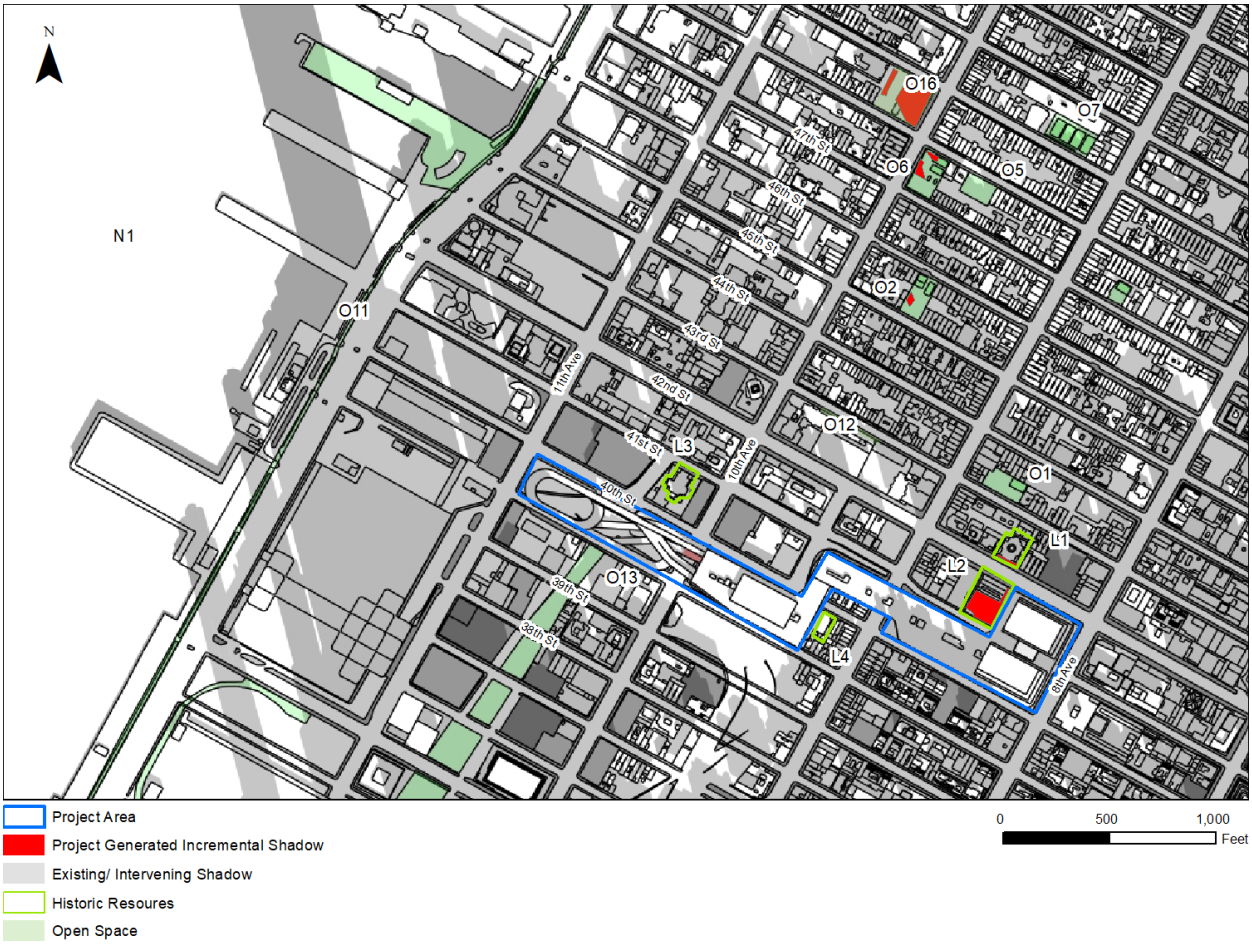
The detailed shadow assessment identified four sunlight-sensitive historic resources: the Holy Cross Roman Catholic Church Complex, the McGraw-Hill Building, the St. Raphael Roman Catholic Church and Rectory, and the Metro Baptist Church. In coordination with the New York State Historic Preservation Office and through the Section 106 Process, PANYNJ would work to address adverse effects to these historic resources as outlined in the Programmatic Agreement (see **Appendix B.2.2, Programmatic Agreement**).

Figure B.2.3-21. Detailed Analysis – December 21 8:51 a.m.



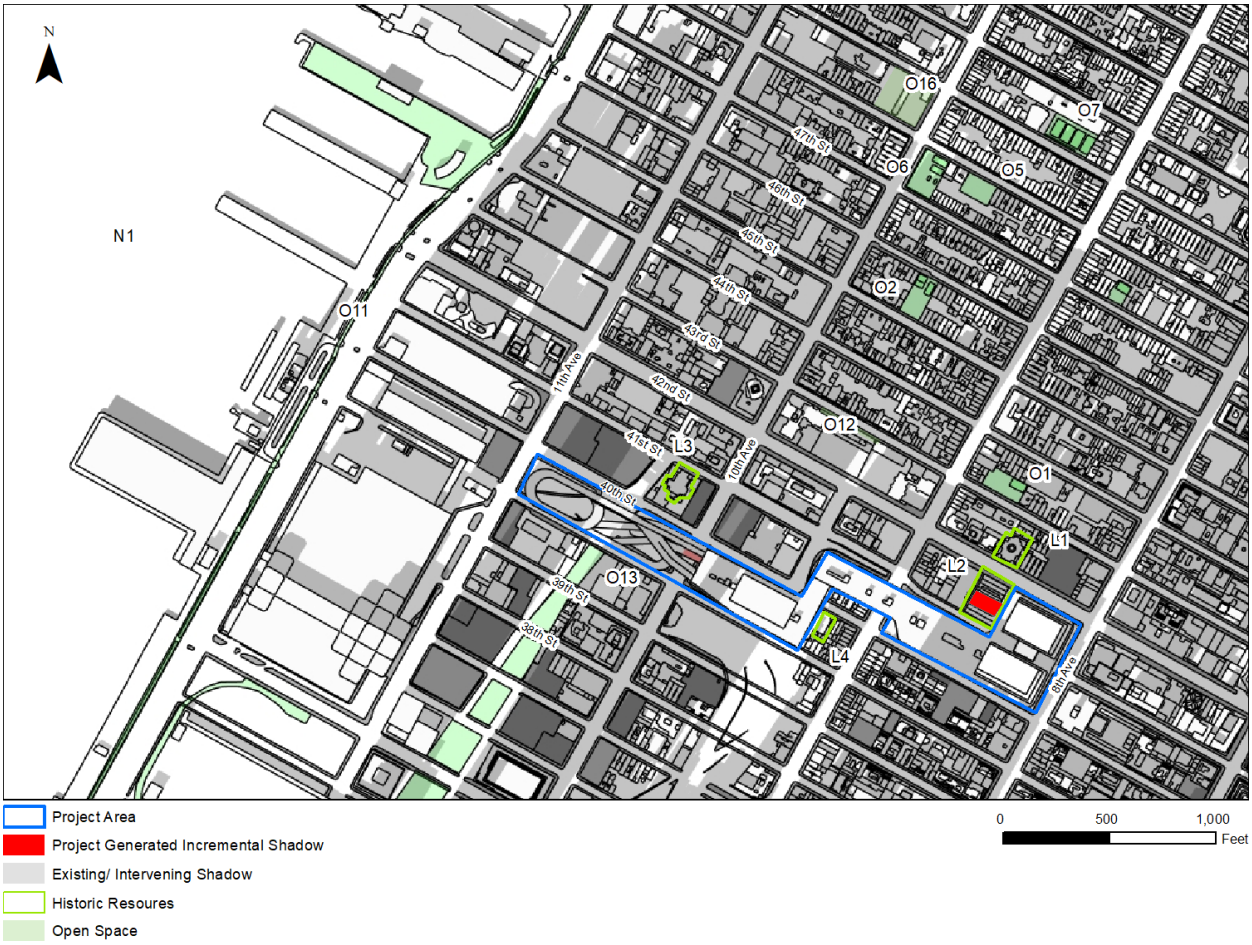
Source: WSP (2024)

Figure B.2.3-22. Detailed Analysis – December 21 11:00 a.m.



Source: WSP (2024)

Figure B.2.3-23. Detailed Analysis – December 21 2:15 p.m.



Source: WSP (2024)

Figure B.2.3-24. Detailed Analysis – March 21/September 21 7:36 a.m.

Source: WSP (2024)

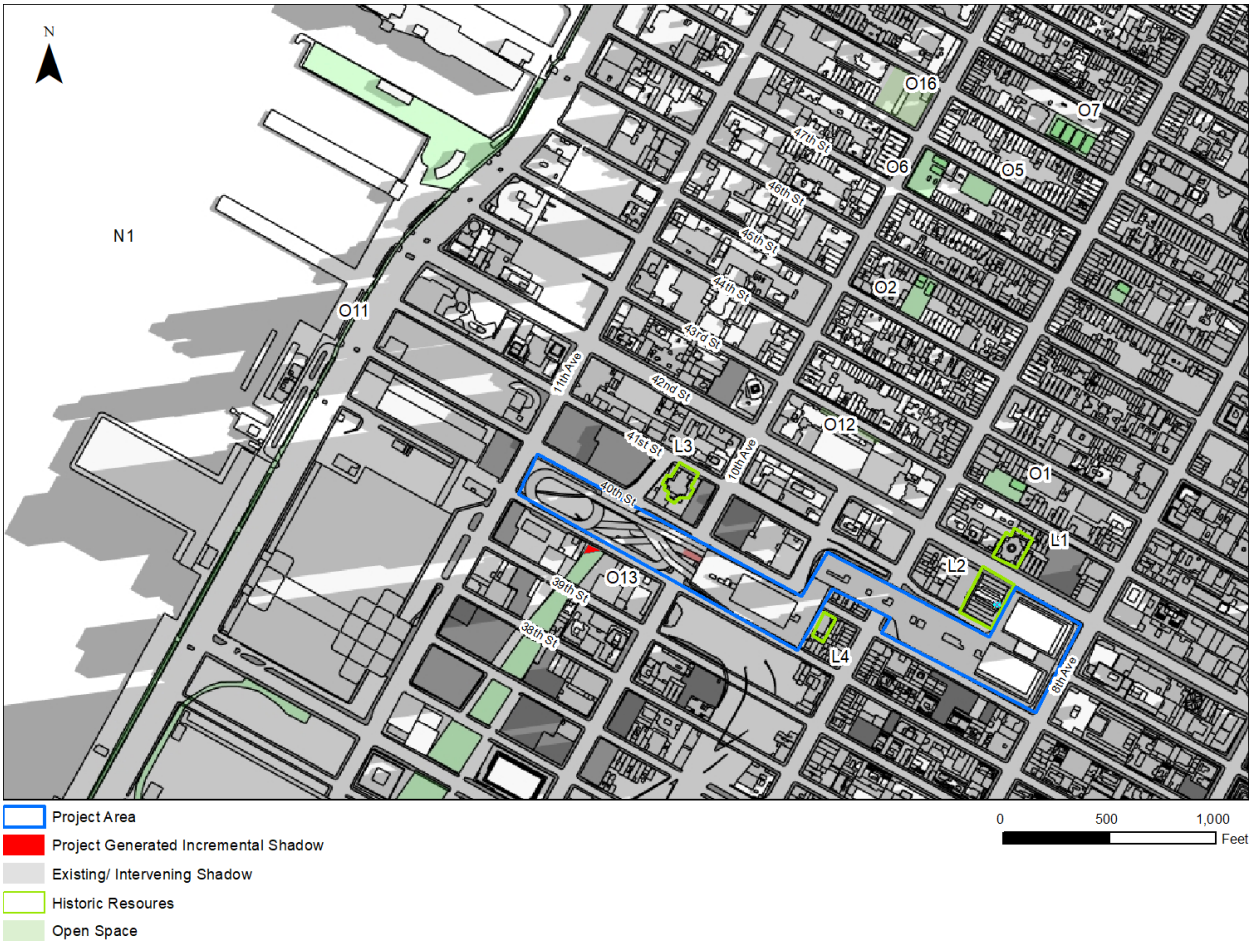
Figure B.2.3-25. Detailed Analysis – March 21/September 21 11:46 a.m.

Source: WSP (2024)

Figure B.2.3-26. Detailed Analysis – March 21/September 21 3:25 p.m.

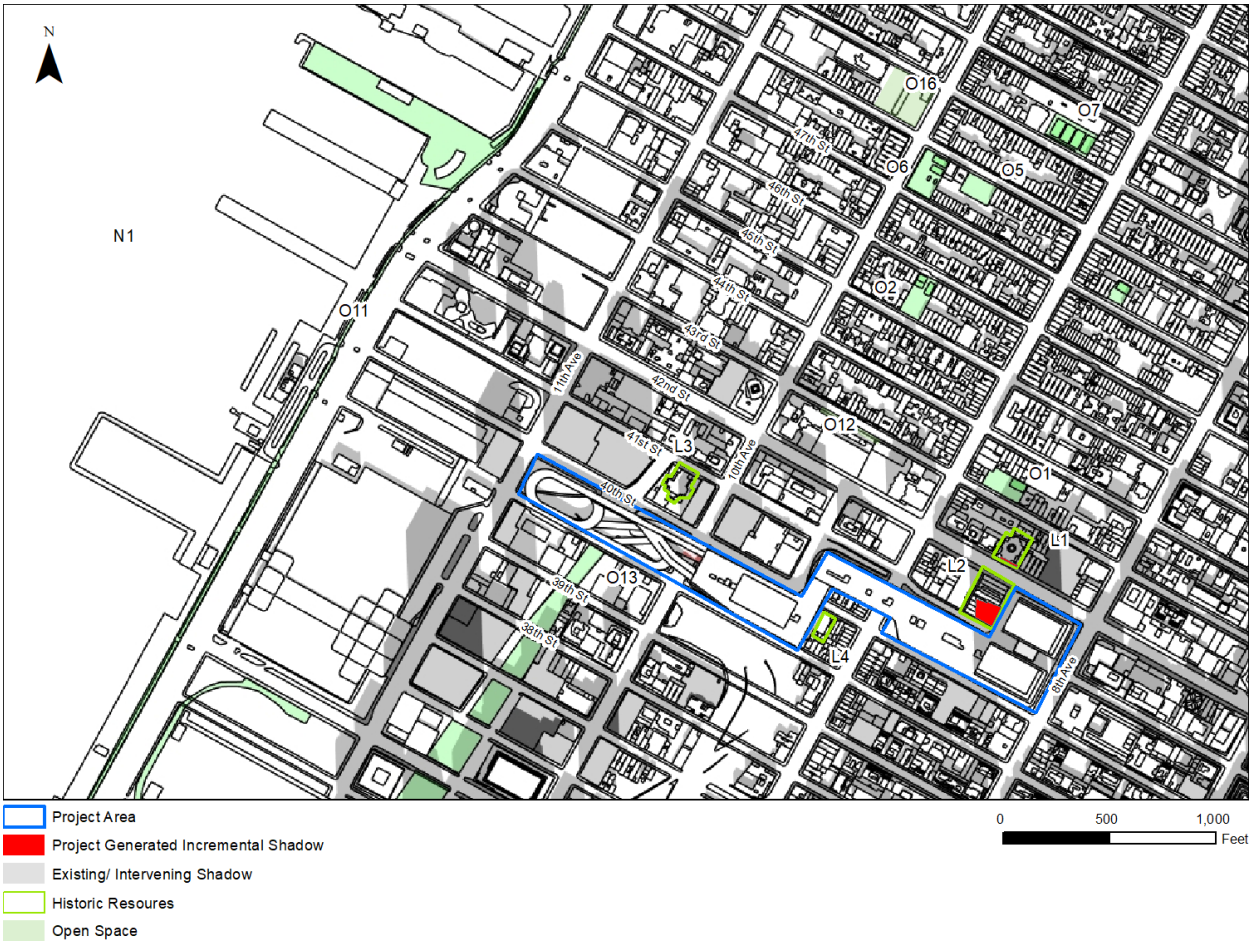
Source: WSP (2024)

Figure B.2.3-27. Detailed Analysis – May 21/August 21 6:27 a.m.



Source: WSP (2024)

Figure B.2.3-28. Detailed Analysis – May 21/August 21 11:50 a.m.



Source: WSP (2024)

Figure B.2.3-29. Detailed Analysis – June 21 5:57 a.m.

Source: WSP (2024)

Note: The private development, which would be atop the Main Terminal in the Proposed Project is not shown; this is to allow a direct comparison of the existing and proposed terminals and their respective shadow generation.

Figure B.2.3-30. Additional Shadow Analysis; Extent of Shadow Coverage on McGraw-Hill Building Facades, Existing PABT Compared to Proposed Main Terminal - December 21

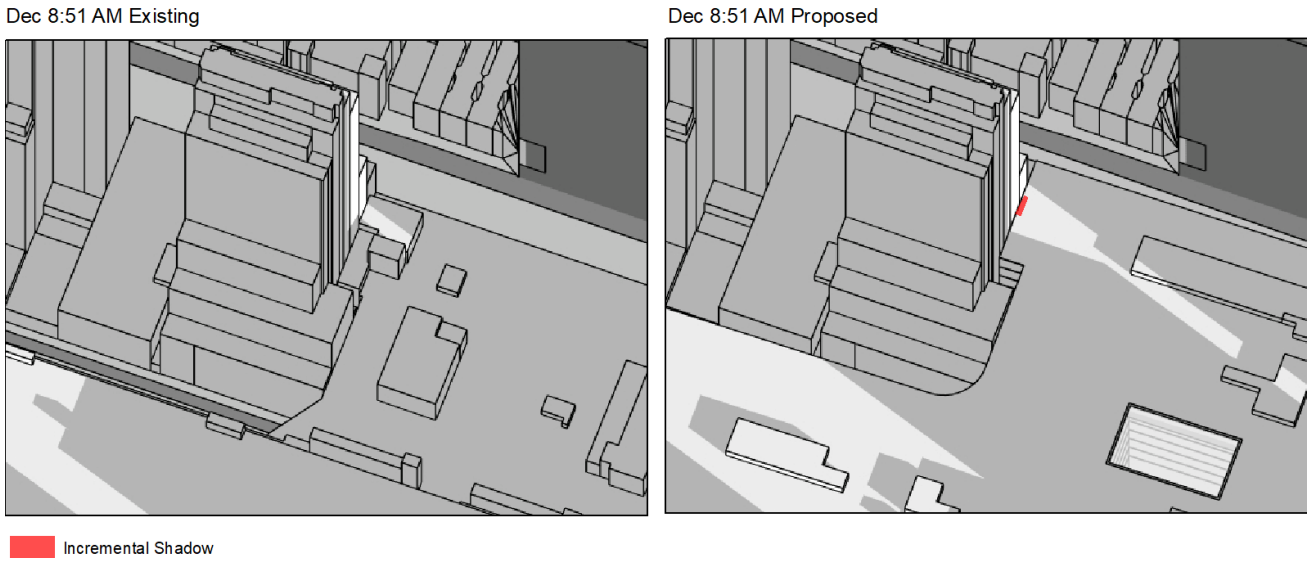
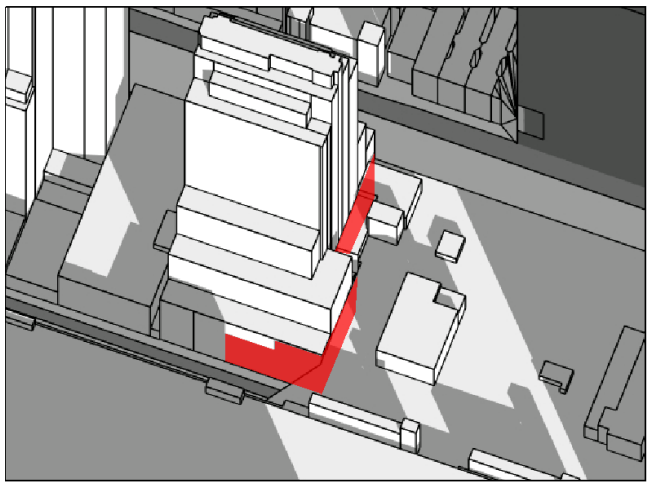


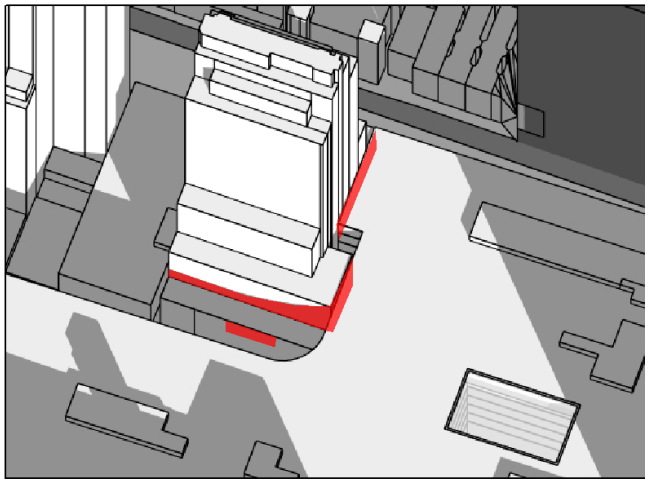
Figure B.2.3-31. Additional Shadow Analysis; Extent of Shadow Coverage on McGraw-Hill Building Facades, Existing PABT Compared to Proposed Main Terminal - December 21

Figure B.2.3-32. Additional Shadow Analysis; Extent of Shadow Coverage on McGraw-Hill Building Facades, Existing PABT Compared to Proposed Main Terminal - December 21

Dec 11:00 AM Existing



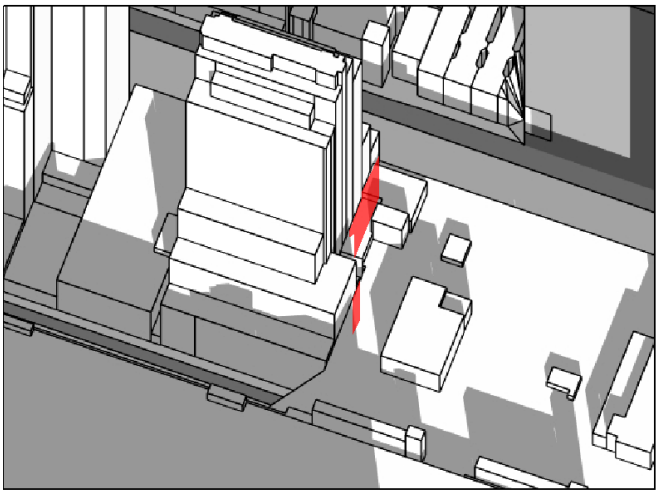
Dec 11:00 AM Proposed



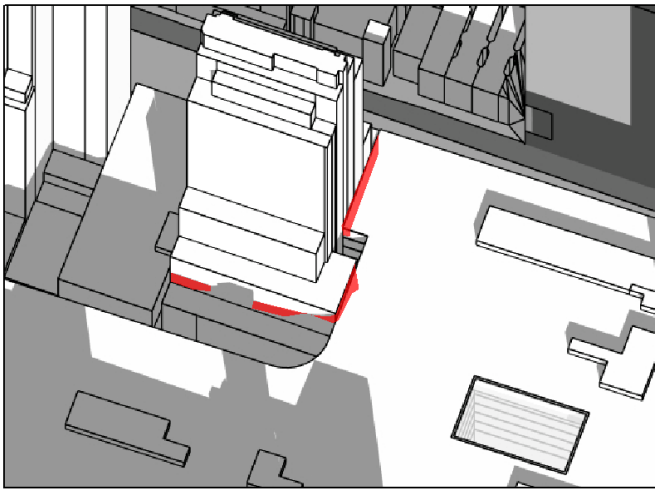
Incremental Shadow

Figure B.2.3-33. Additional Shadow Analysis; Extent of Shadow Coverage on McGraw-Hill Building Facades, Existing PABT Compared to Proposed Main Terminal - December 21

Dec 12:00 PM Existing



Dec 12:00 PM Proposed



Incremental Shadow

Figure B.2.3-34. Additional Shadow Analysis; Extent of Shadow Coverage on McGraw-Hill Building Facades, Existing PABT Compared to Proposed Main Terminal - December 21

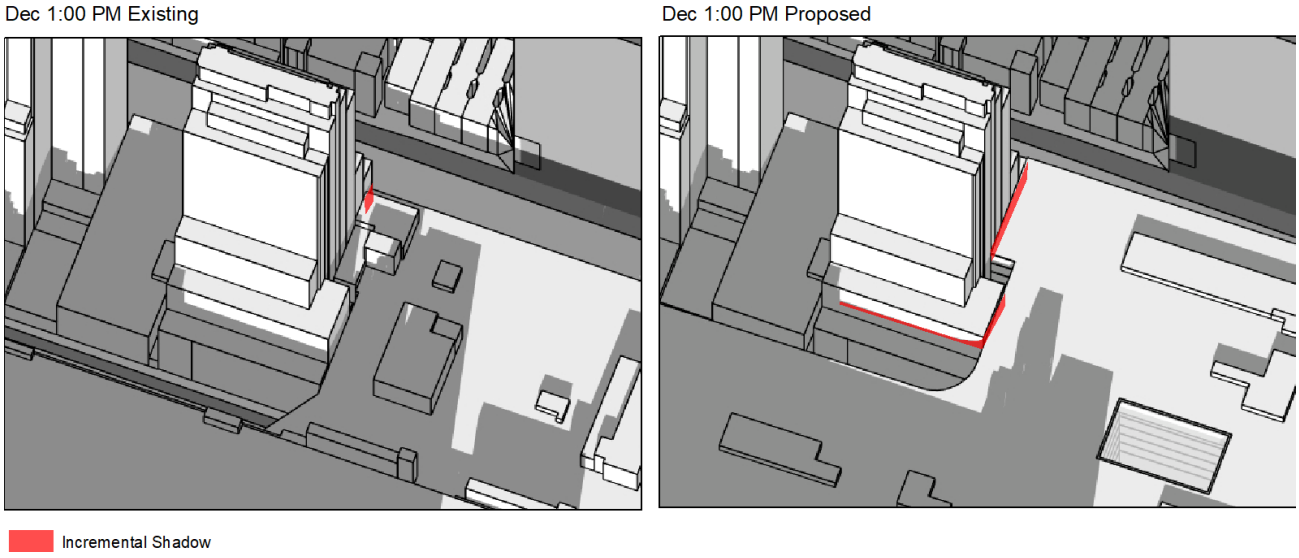


Figure B.2.3-35. Additional Shadow Analysis; Extent of Shadow Coverage on McGraw-Hill Building Facades, Existing PABT Compared to Proposed Main Terminal - December 21

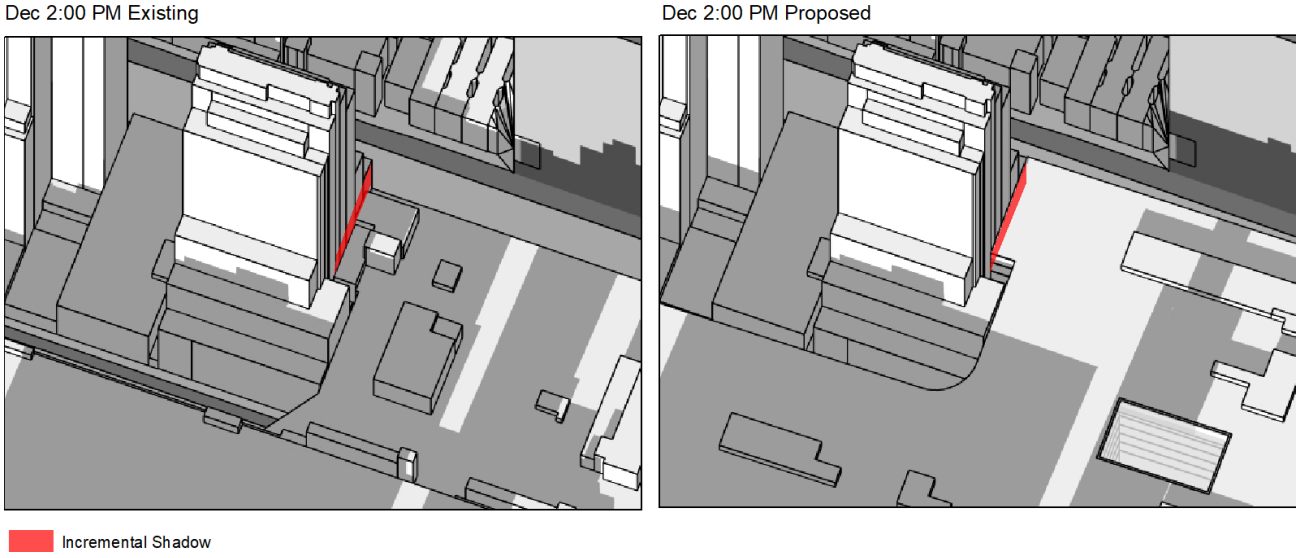


Figure B.2.3-36. Additional Shadow Analysis; Extent of Shadow Coverage on McGraw-Hill Building Facades, Existing PABT Compared to Proposed Main Terminal - December 21