A. INTRODUCTION

According to the *CEQR Technical Manual*, a shadow is defined as the circumstance in which a building or other built structure blocks the sun from the land. An adverse shadow impact is considered to occur when the incremental shadow from a proposed project falls on a sunlight-sensitive resource and substantially reduces or completely eliminates direct sunlight exposure, thereby significantly altering the public's use of the resource or threatening the viability of vegetation or other resources. Sunlight-sensitive resources include publicly accessible open space, historic architectural resources if the features that make the resource significant depend on sunlight, natural resources, and greenstreets. In general, shadows on city streets and sidewalks or on other buildings are not considered significant under CEQR. In addition, shadows occurring within an hour and a half of sunrise or sunset generally are also not considered significant under CEQR.

According to the *CEQR Technical Manual*, a shadows assessment is required only if a project would result in structures (or additions to existing structures) of 50 feet or more, or be located adjacent to, or across the street from, a sunlight-sensitive resource. As described in Chapter 1, "Project Description, the proposed action calls for the rezoning of approximately 6 blocks in the Bushwick neighborhood in Brooklyn. The blocks zoned M3-1 would be rezoned M1-2 and the blocks zoned M1-1 would be rezoned R7A and R6A with a C2-4 commercial overlay mapped along portions of the Bushwick, Flushing and Evergreen Avenue frontages to a depth of 100 feet. The proposed action also includes a zoning text amendment, which modifies Section 23-922 of the NYC Zoning Resolution to make the appropriate R7A districts "inclusionary housing designated areas." This will establish an inclusionary floor area ratio (FAR) bonus, providing opportunity and incentive for the development of affordable housing.

The Proposed Action would rezone an area encompassing approximately 6 blocks. For analysis purposes, as described in Chapter 1, "Project Description," the reasonable worst-case development scenario (RWCDSs) has been identified for the Proposed Action, resulting in a total of 8 projected development sites. The Proposed Action would allow for the development of new uses and higher densities at the projected and potential development sites. In the future with the Proposed Action, it is expected that a total of approximately 1,076 dwelling units, of which 215 are expected to be affordable to low-to moderate-income households, and 81,790 sf (net 74,194 sf) of local retail. There are also 3 potential development sites (sites that are also rezoned but which are less likely to be developed), which will be discussed in detail in this section.

The proposed buildings could potentially cast incremental shadows as they will be 70-80 feet in height and is located within the vicinity of Green Central Knoll Park, Bushwick Playground and Pool, and Garden Playground. Therefore, the Proposed Action requires an assessment of shadows.

In accordance with *2012 CEQR Technical Manual* guidelines, this attachment provides a shadows assessment to determine whether the proposed action would result in new shadows long enough to reach any sunlight-sensitive resources (except within an hour and a half of sunrise or sunset). As discussed below, the proposed action would result in minimal new shadows being cast on the open spaces within the vicinity of the rezoning area, which would not be significant either in terms of frequency or duration.

B. PRINCIPAL CONCLUSIONS

As discussed in detail below, projected and potential development sites resulting from the Proposed Action would cast new shadows at times throughout the year on some of the existing open space in the study area. The open spaces in the study area would not be significantly affected. Although the three open spaces (Green Central Knoll Park, Playground and Pool, and Garden Playground) would be subject to varying amounts of incremental shadows as a result of the Proposed Action, these increments would be not be significant due to their limited extent and/or duration, and other site specific factors, as presented in the detailed assessment below.

C. RESOURCES OF CONCERN

In coordination with the analysis set forth in Chapter 5, "Open Space," publicly accessible open spaces within the 344-foot radius to the north, east, and west of the projected and potential development sites were identified, as shadows created by the proposed development could fall in the direction of these resources. According to the *CEQR Technical Manual*, historic resources that need to be considered in a shadows analysis must have sunlight-dependent features such as stained glass windows, historic landscapes, design elements that are part of a recognized architectural style that depends on contrast between light and dark design features, exterior materials and color that depend on direct sunlight for visual character, or elaborate, highly carved ornamentation. As discussed below, there are no historic resources with sunlight-dependent features in the immediate vicinity of the projected and potential development sites, but three open space resources have been identified within the applicable maximum shadow radius.

Open Space Resources

As illustrated in Figure 6-1, three open space resources falls within the maximum shadow radius for the projected and potential development sites. The Green Central Knoll Park is a 2.6-acre open space that contains a baseball field, play equipment with safety surfacing, benches and plantings. The Bushwick Playground and Pool is a 1.29-acre facility with a large pool, a children's pool, play equipment with safety surfacing, benches, handball courts, spray showers and swings. The Garden Playground (P.S. 120) is a 1.1-acre open space with basketball courts and a spray shower on the upper level, closer to the P.S. 120 building and a lower area filled with benches, play structures and toddler play equipment, it is completely paved. Green Central Knoll Park is located immediately east of the proposed rezoning area while the Bushwick Playground and Pool is located to the north and Garden Playground to the east and south (see Figure 6-1). According to the *CEQR Technical Manual*, uses that rely on sunlight include passive uses such as sitting or sunning, gardening and children's wading pools, among others.

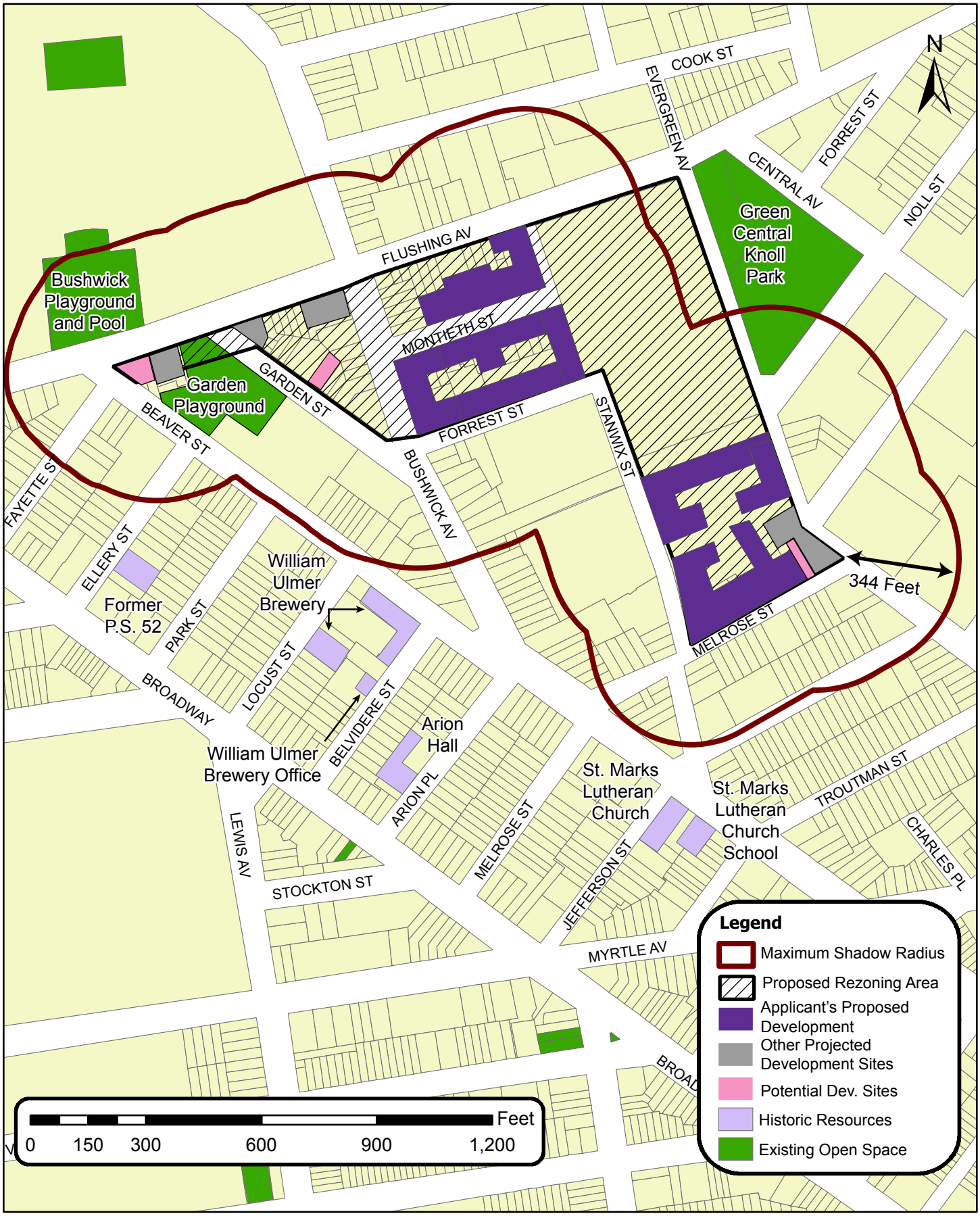
Historic Resources

According to the *CEQR Technical Manual*, historic resources are considered to be sunlight-sensitive if the features that make the resource significant depend on sunlight. There are no historic resources within the 344-foot radius, however, there are several historic resources that are just outside the 344-foot radius including the Former P.S. 52, The William Ulmer Brewery Buildings, Arion Hall and the St. Mark's Lutheran Church and School (see Figure 6-1).

As there are no identified historic resources in the immediate vicinity of the rezoning area, no shadows impacts on any historic resources are expected as a result of the proposed action.

Resources Within Maximum Shadow Radius

Figure 6-1



D. METHODOLOGY

According to the *CEQR Technical Manual*, the longest shadow a structure will cast in New York City, except for periods close to dawn or dusk, is 4.3 times its height. For actions resulting in structures less than 50 feet high, a shadow assessment is generally not necessary unless the site is adjacent to a park, historic resource, or important natural feature (if the features that make the structure significant depend on sunlight).

First, a preliminary screening assessment must be conducted to ascertain whether a project's shadow could reach any sunlight-sensitive resources at any time of year. The preliminary screening assessment consists of three tiers of analysis. The first tier determines a simple radius around the proposed building representing the longest shadow that could be cast. If there are sunlight-sensitive resources within this radius, the analysis proceeds to the second tier, which reduces the area that could be affected by project shadow by accounting for the fact that shadows can never be cast between a certain range of angles south of the project site due to the path of the sun through the sky at the latitude of New York City. If the second tier of analysis does not eliminate the possibility of new shadows on sunlight-sensitive resources, a third tier of screening analysis further refines the area that could be reached by project shadow by looking at specific representative days of the year and determining the maximum extent of shadow over the course of each representative day.

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

E. PRELIMINARY SCREENING

A base map was developed (see Figure 6-1) showing the location of the projected and potential development sites and the surrounding street layout. In coordination with the open space assessment, sunlight-sensitive resources were identified and shown on the map. According to the *CEQR Technical Manual*, the longest shadow a structure will cast in New York City, except for periods close to dawn or dusk, is 4.3 times its height. Following CEQR guidelines, a radius of 4.3 times the maximum height of the projected and potential development sites was drawn (Tier 1 Assessment). Although the Proposed Action would result in both 70- and 80-foot buildings, the maximum shadow radius of 344-feet was utilized for all buildings for conservative analysis purposes. As shown in Figure 6-1, the radius was adjusted to exclude the triangular area south of the rezoning area between –108 degrees from true north and 108 degrees from true north, as in New York City no shadow can be cast from a building within this triangular area (Tier 2 Assessment). Any resource that fell outside the shadow radius was screened out from further consideration, as no shadows cast by projected or potential development sites would reach it.

Given the presence and proximity of the three sunlight-sensitive resource in the vicinity of the rezoning area (refer to Figure 6-1), it was apparent that shadows from the projected and potential development sites would reach this resource on at least one of the representative analysis days. As such, this intermediate step (Tier 3 Assessment) in the assessment was skipped, and a detailed shadows assessment was conducted, as detailed in Section E below.

F. DETAILED SHADOW ANALYSIS

An adverse shadow impact is considered to occur when the incremental shadow from a development falls on a sunlight-sensitive resource and substantially reduces or completely eliminates direct sunlight exposure, thereby significantly altering the public's use of the resource or threatening the viability of vegetation or other resources. The uses and vegetation in an open space establish its sensitivity to shadows. This sensitivity is assessed for both (1) warm-weather- dependent features like wading pools and sand boxes, or vegetation that could be affected by a loss of sunlight during the growing season; and (2) features, such as benches, that could be affected by a loss of winter sunlight. Uses that rely on sunlight include: passive use, such as sitting or sunning; active use, such as playfields or paved courts; and such activities as gardening, or children's wading pools and sprinklers. Where lawns are actively used, the turf requires extensive sunlight. Vegetation requiring direct sunlight includes the tree canopy, flowering plants and plots in community gardens. Generally, four to six hours a day of sunlight, particularly in the growing season (defined as March to October), is often a minimum requirement.

The shadow analysis considers the times when development anticipated as a result of the proposed action would increase shadows falling on identified resources of concern. As the sun travels across the sky during the day, shadows fall in a curve on the ground opposite the sun. When the sun rises, shadows fall to the west. As the sun travels across the southern part of the sky throughout the day, shadows move in a clockwise direction until they stretch east when the sun sets in the west. Midday shadows are always shorter than those at other times of the day because the sun is highest in the sky at that time. Further, because of the tilt of the earth's axis, the angle at which the sun's rays strike the earth varies throughout the year, so that during the summer, the sun is higher in the sky and shadows are shorter than during the winter. Winter shadows, although longest, move the most quickly along their paths (because of the earth's tilt) and do not affect the growing season of outdoor trees and plants.

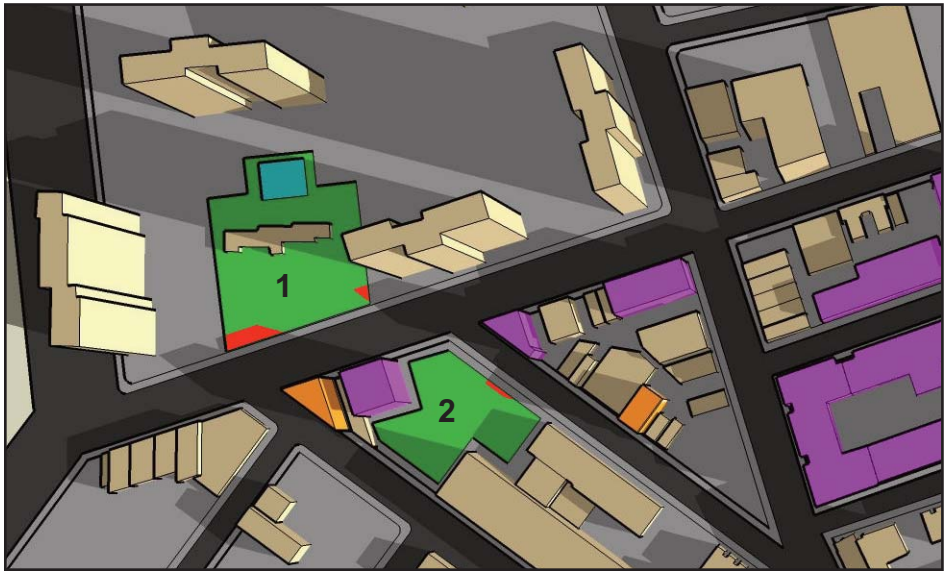
As directed by the *CEQR Technical Manual*, shadow analyses were performed for the one open space resource identified above, for four representative days of the year: March 21/September 21, the equinoxes; May 6, the midpoint between the summer solstice and the equinox (and equivalent to August 6); June 21, the summer solstice and the longest day of the year; and December 21, the winter solstice and shortest day of the year. The *CEQR Technical Manual* defines the temporal limits of a shadow analysis period to fall from an hour and a half after sunrise to an hour and a half before sunset. The results of the shadow analysis on the open space resource of concern are summarized in Table 6-1 and discussed below. All times referenced in this section are Eastern Standard Time (EST); daylight savings time is not considered.

March 21/September 21

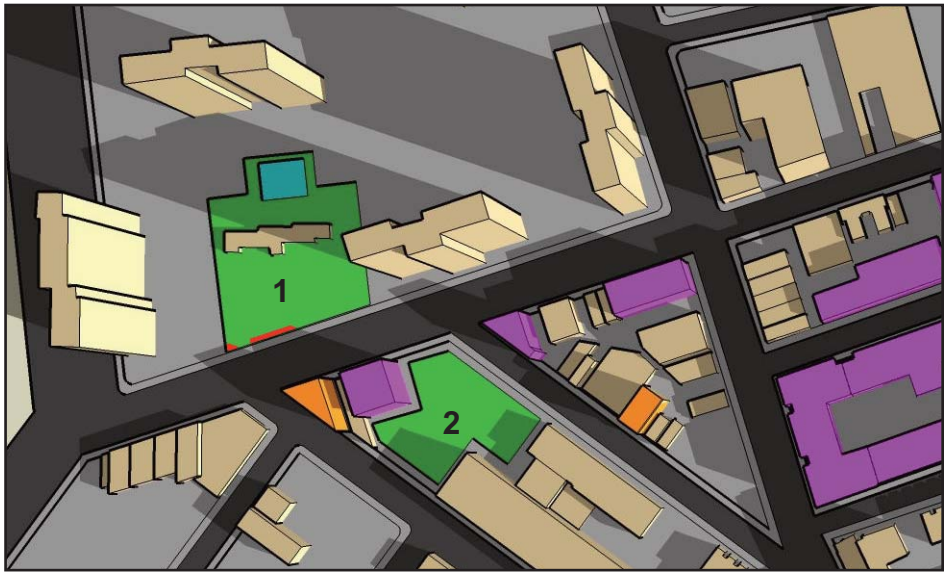
On the equinoxes, incremental shadows from the development resulting from the Proposed Action would reach Bushwick Pool and Playground in the early morning, as shown in Table 6-1. As shown in the table and illustrated in Figure 6-2, incremental shadows would be cast on the southern edge of Bushwick Pool and Playground for a duration of approximately 51 minutes (7:36 AM – 8:27 AM), and would exit this resource entirely by 8:27 AM.

As shown in Table 6-1 and illustrated in Figure 6-2, incremental shadows would be cast on a small portion on the eastern edge of Garden Playground for a duration of 5 minutes in the early morning (7:36 AM-7:41 AM), and would exit this resource entirely by 7:41 AM. Shadows would be cast on the northern portion of this resource in the afternoon starting at 12:01 PM for a duration of 4 hours and 28 minutes (12:01 PM -4:18PM), and would exit this resource entirely by 4:18 PM.

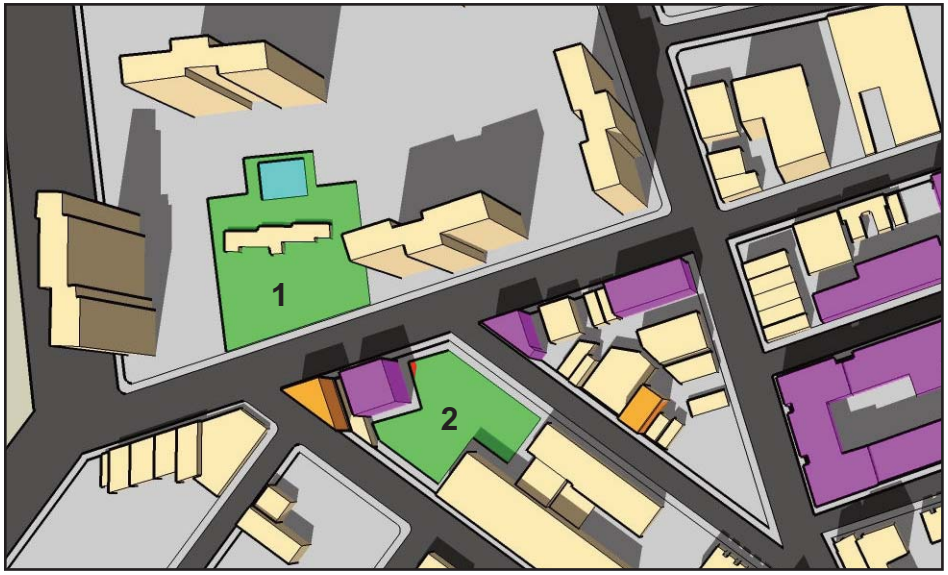
No shadows would be cast on Green Central Knoll Park on this analysis day.



March 21 - 7:36 AM



March 21 - 8:00 AM



March 21 - 12:30 PM



March 21 - 2:00 PM

Projected Development Site

Potential Development Site

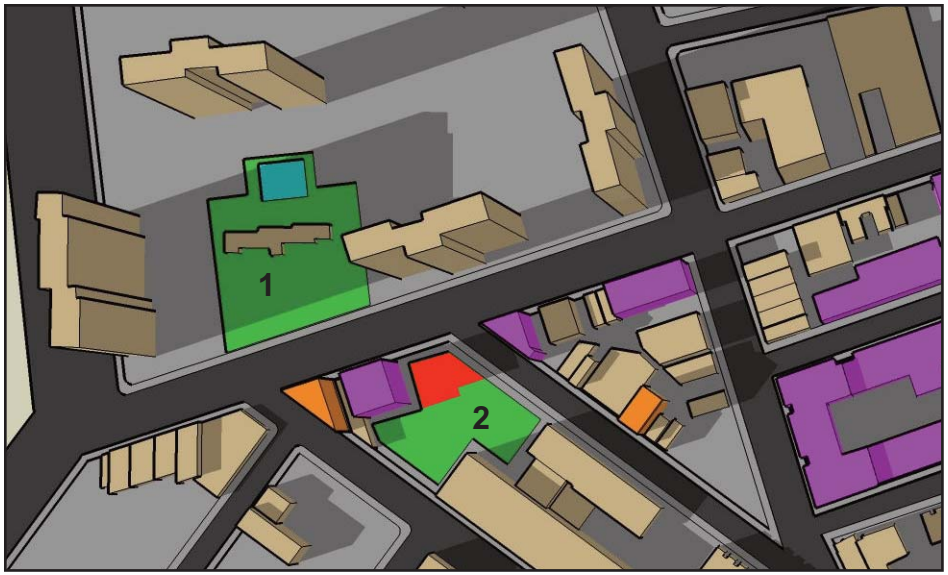
Incremental Shadow

Open Space
(keyed to Table 6-1)

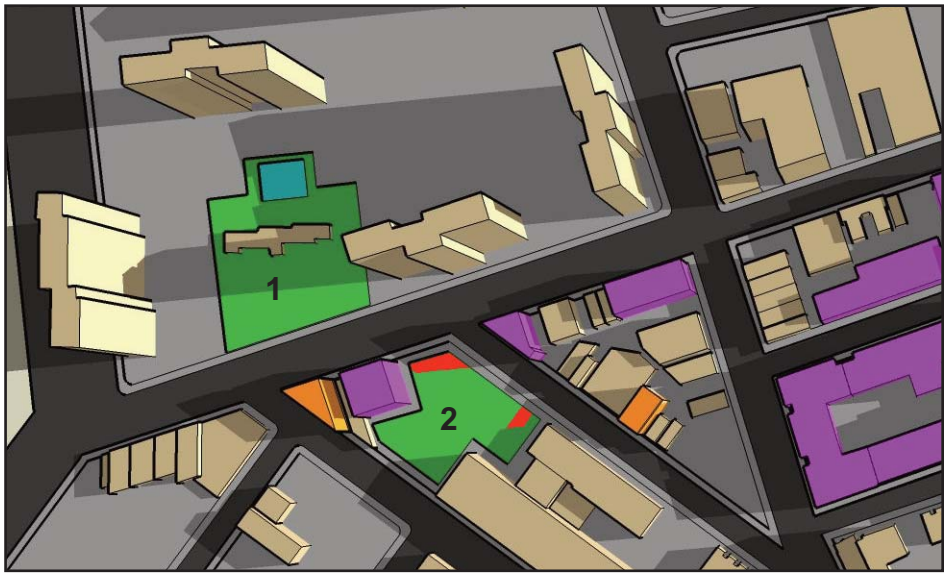
Rheingold Development Rezoning

Figure 6-2

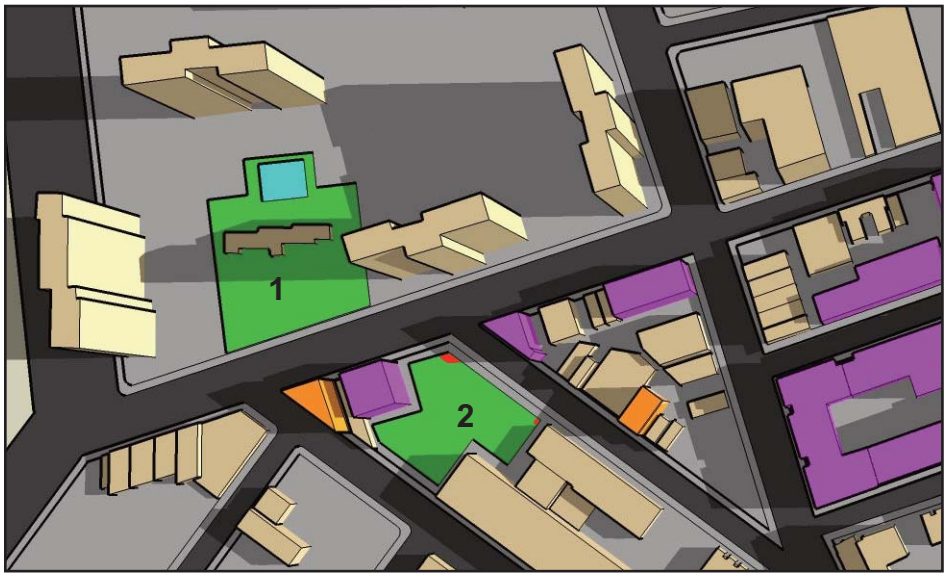
Shadows on Open Space - Bushwick Playground & Pool and Garden Playground



March 21 -4:15 PM



May 6 - 6:45 AM



May 6 - 7:15 AM



May 6 - 12:45 PM

Projected Development Site

Potential Development Site

Incremental Shadow

Open Space
(keyed to Table 6-1)

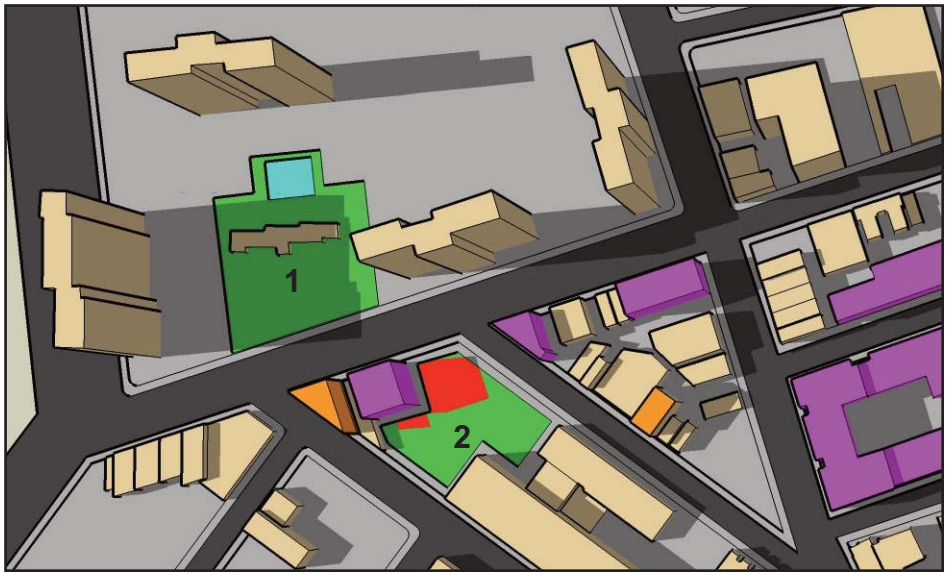
Rheingold Development Rezoning

Figure 6-2

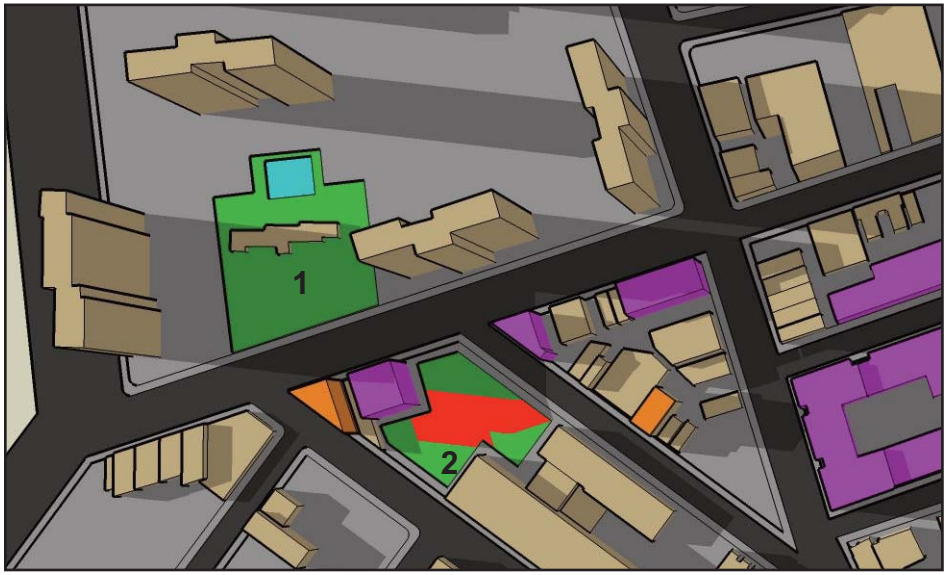
Shadows on Open Space - Bushwick Playground & Pool and Garden Playground



May 6 -2:30 PM



May 6 - 4:00 PM



May 6 - 5:15 PM



June 21 - 6:00 AM

Projected Development Site

Potential Development Site

Incremental Shadow

Open Space
(keyed to Table 6-1)

Rheingold Development Rezoning

Figure 6-2

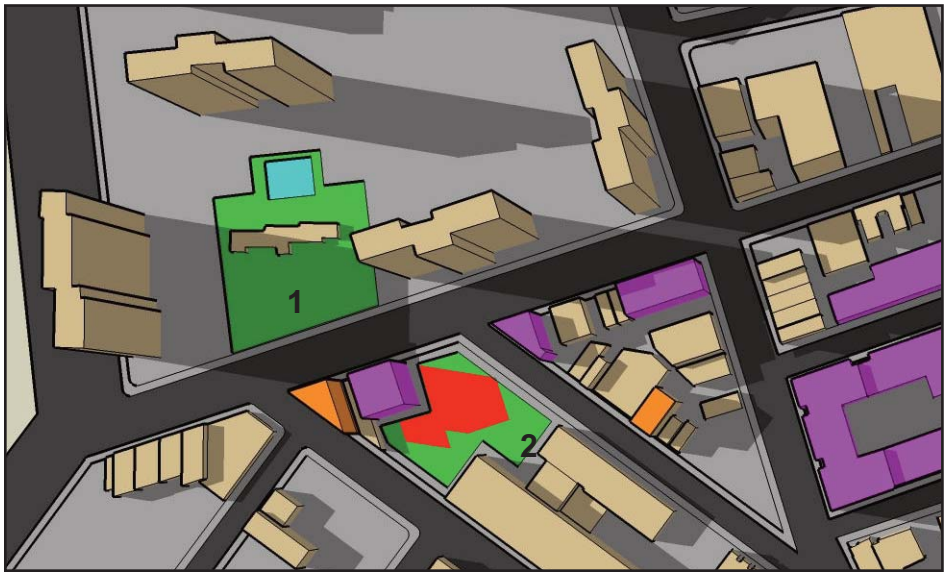
Shadows on Open Space - Bushwick Playground & Pool and Garden Playground



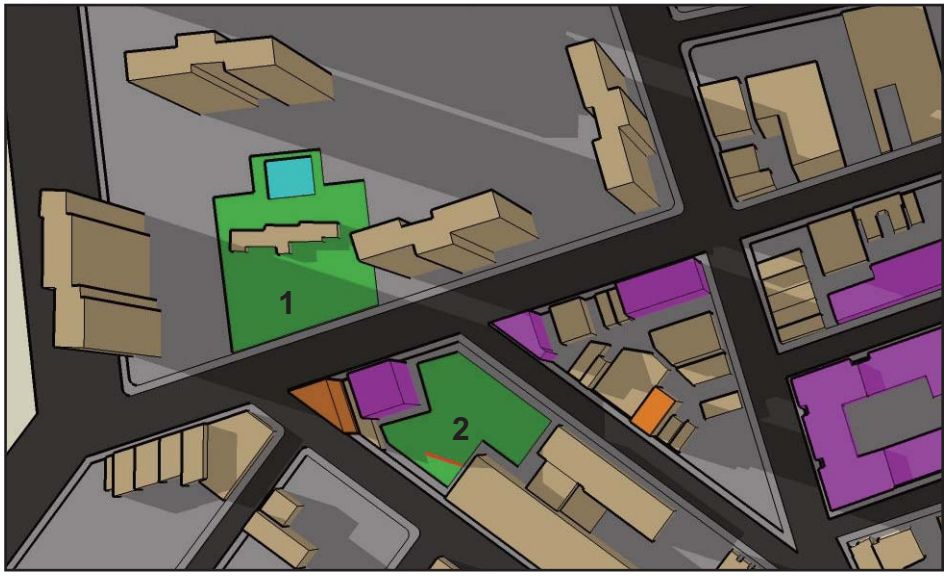
June 21 - 1:00 PM



June 21 -3:00 PM



June 21 - 5:00 PM



June 21 - 6:00 PM

Projected Development Site

Potential Development Site

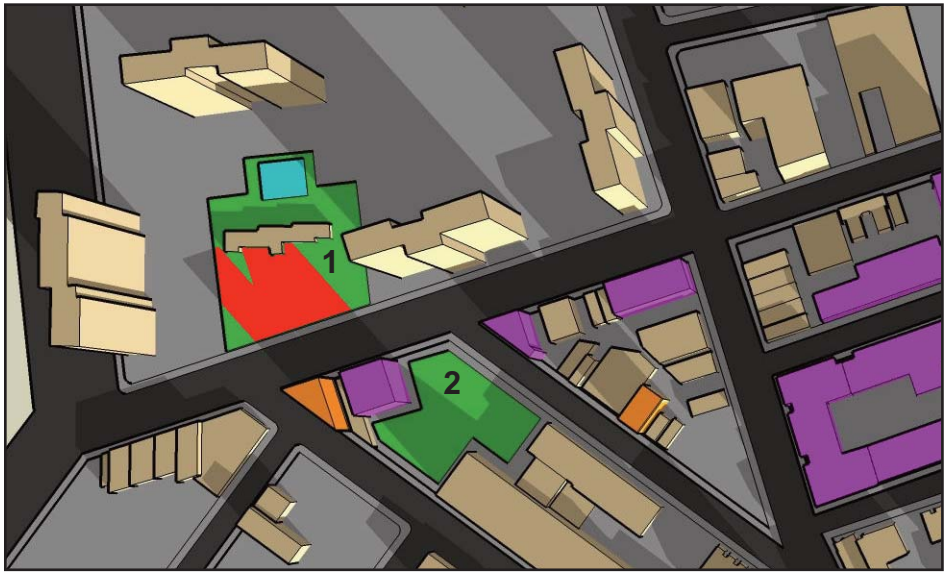
Incremental Shadow

Open Space
(keyed to Table 6-1)

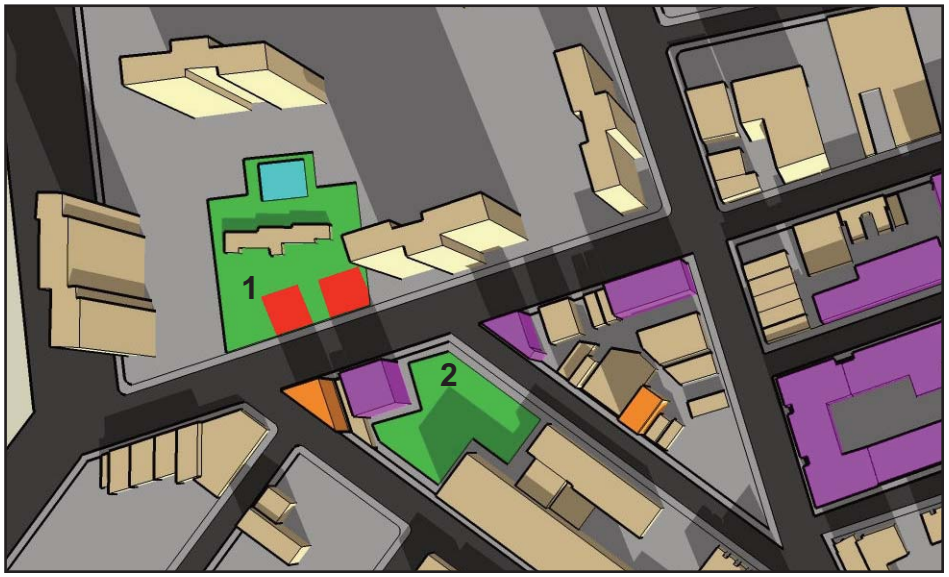
Rheingold Development Rezoning

Figure 6-2

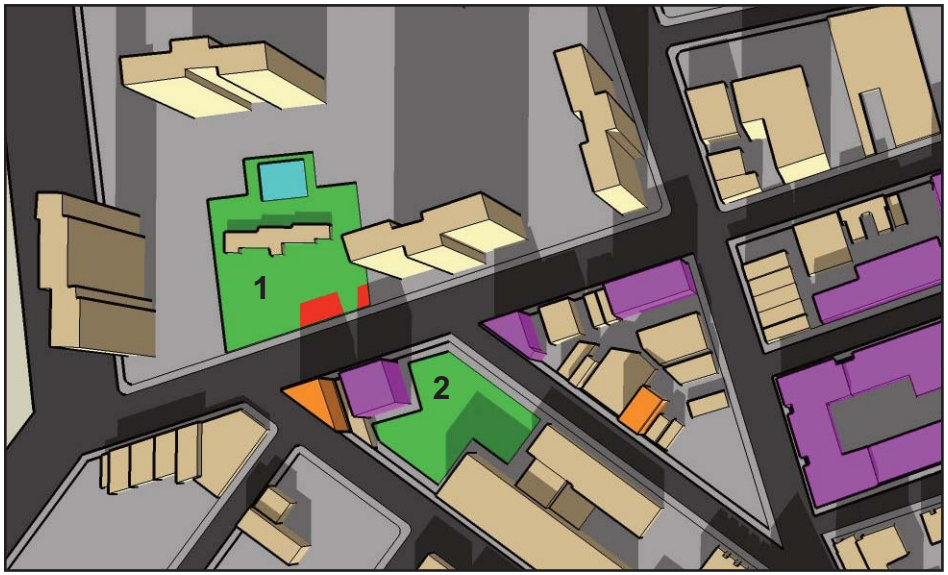
Shadows on Open Space - Bushwick Playground & Pool and Garden Playground



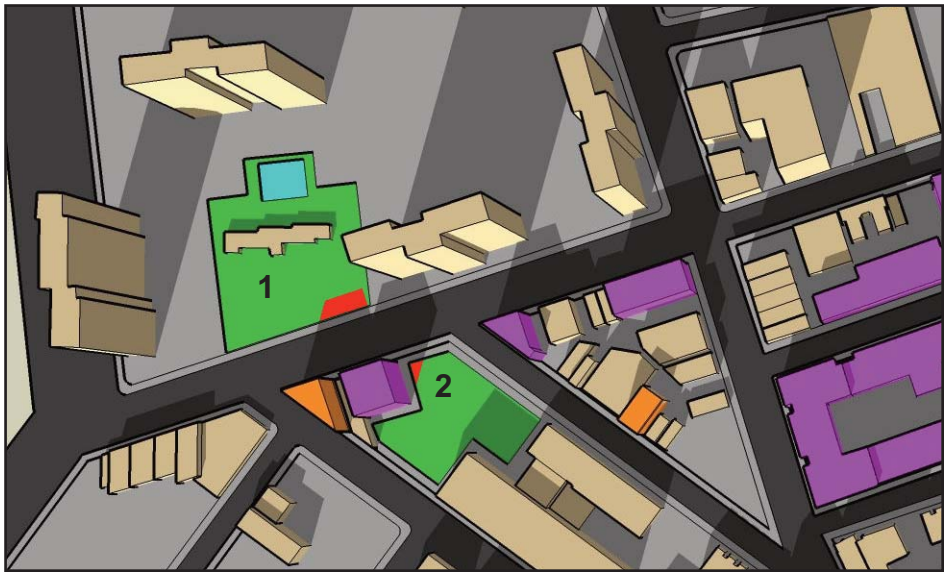
December 21 - 9:00 AM



December 21 - 10:30 AM



December 21 - 12:00 PM



December 21 - 1:00 PM

Projected Development Site

Potential Development Site

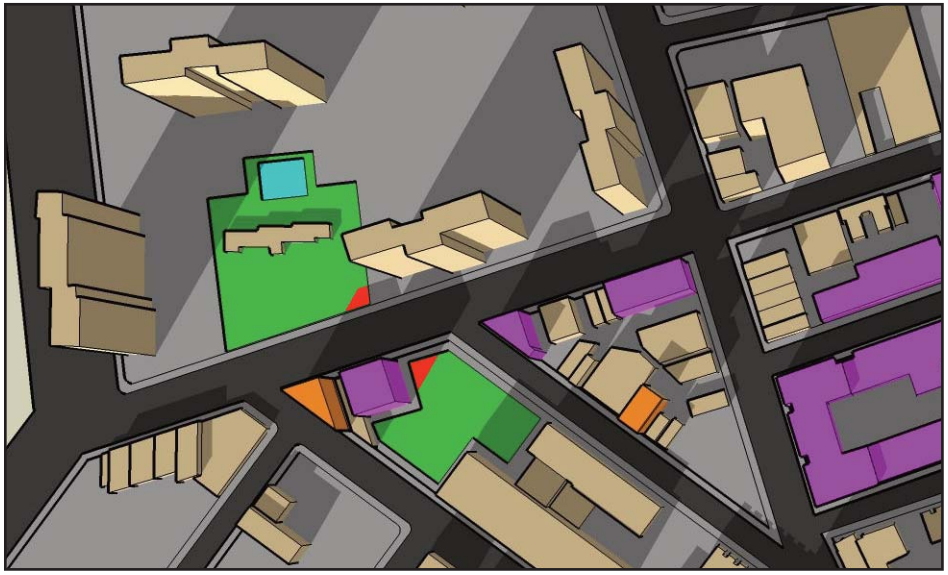
Incremental Shadow

Open Space
(keyed to Table 6-1)

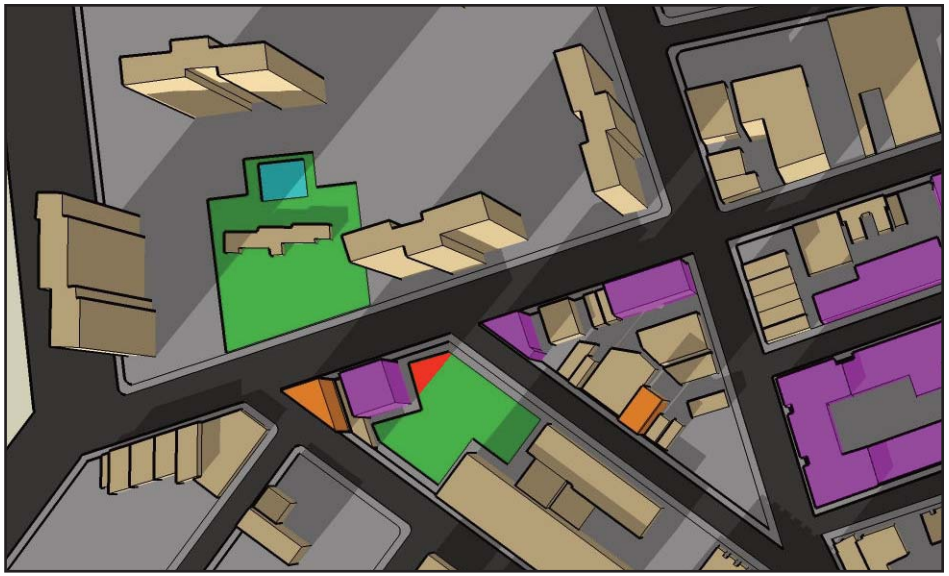
Rheingold Development Rezoning

Figure 6-2

Shadows on Open Space - Bushwick Playground & Pool and Garden Playground



December 21 - 2:00 PM



December 21 - 2:45 PM

Projected Development Site

Potential Development Site

Incremental Shadow

Open Space
(keyed to Table 6-1)

Rheingold Development Rezoning

Figure 6-2

Shadows on Open Space - Bushwick Playground & Pool and Garden Playground

May 6/August 6

On May 6 (and August 6), which is halfway between the solstice and equinox, there would be no incremental shadows cast on the Bushwick Playground and Pool and Green Central Knoll Park by the development resulting from the Proposed Action as shown in Table 6-1.

As shown in Table 6-1 and illustrated in Figure 6-2, incremental shadows would be cast on very small portions of Garden Playground for a duration of 1 hour and 3 minutes in the early morning (6:27 AM-7:30 AM), and would exit this resource entirely by 7:30 AM. Shadows would be cast on the northern portion of this resource in the afternoon starting at 12:14 PM for a duration of 5 hours and 04 minutes (12:14 PM -5:18), and would exit this resource entirely by 5:18 PM.

Table 6-1
Results of Shadow Analysis

Figure ID #	Resource	Action Shadow Increment 3/21	Action Shadow Increment 5/6	Action Shadow Increment 6/21	Action Shadow Increment 12/21
1.	**Green Central Knoll Park**	none	none	none	Enter: 12:30 pm Exit: 2:43 pm Duration: 2hr 23 min.
2.	**Bushwick Pool and Playground**	Enter: 7:36 am Exit: 8:27 am Duration:51min.	none	none	Enter: 8:51 am Exit: 2:42 pm Duration: 5hr 51 min.
3.	**Garden Playground**	Enter:7:36 am Exit: 7:45 am Duration: 05 min Enter: 12:01 pm Exit: 4:29 pm Duration: 4hr 28min	Enter:6:27 am Exit: 7:30 am Duration: 1hr 03 min Enter: 12:14 pm Exit: 5:18 pm Duration: 5hr 04min	Enter:5:57 am Exit: 7:34 am Duration: 1hr 37 min Enter: 12:30 pm Exit: 6:01 pm Duration: 5hr 31 min	Enter: 11:45 am Exit: 2:53 pm Duration: 3hr 08 min.

June 21

On the summer solstice, June 21, the sun is most directly overhead and shadows are shortest for most of the day. On this analysis day, the projected/potential development sites would cast incremental shadows on only Garden Playground (see Table 6-1).

As shown in Table 6-1 and illustrated in Figure 6-2, incremental shadows would be cast on the northern portion of Garden Playground for a duration of 1 hour and 37 minutes in the early morning (5:57 AM-7:34 AM), and would exit this resource entirely by 7:34 AM. Shadows would then enter the resource again at 12:30 PM for a duration of 5 hours and 31 minutes, exiting at 6:01 PM. As shown in Figure 6-2, a small portion of this resources is covered in shadow in the early afternoon. By 5:00 PM, approximately 50 percent of Garden Playground is covered in shadows from the projected development and by 6:01 PM, the incremental shadows would exit this resource entirely.

December 21

On the shortest day of the year (winter solstice) when the sun is low in the sky, shadows are the longest they will be all year, although they travel quickly. As shown in Table 6-1, on this analysis day, the

projected/potential development sites would cast incremental shadows on all three of the open space resources of concern.

As shown in Table 6-1 and Figure 6-2 incremental shadows cast by the projected development sites would cast shadows on the Bushwick Pool & Playground a total duration of 5 hours and 51 minutes. As shown in Figure 6-2, the incremental shadows would cover the majority of this open space resource in the morning and move east throughout the day until exiting completely by 2:42 PM.

As shown in Figure 6-2 and Table 6-1, incremental shadows cast by the projected development sites would enter Garden Playground at 11:45 AM and exit at 2:53 PM for a duration of 3 hours and 8 minutes. As shown in Figure 6-2, the incremental shadows would be cast on a small northwest portion of the playground.

As shown in Table 6-1 and Figure 6-3, new incremental shadows from the projected development sites would be cast on Green Central Knoll Park. As shown in Table 6-1, incremental shadows would be cast in the afternoon from 12:30 PM to 2:43 PM, for a total duration of 2 hours and 23 minutes. As shown in Figure 6-3, the incremental shadow would be cast on a small southern portion of the park.

Assessment

A shadow impact occurs when the incremental shadow from a proposed project falls on a sunlight-sensitive resource or feature and reduces its direct sunlight exposure. Determining whether this impact is significant or not depends on the extent and duration of the incremental shadow and the specific context in which the impact occurs.

For open spaces, the uses and features of the space indicate its sensitivity to shadows. Shadows occurring during the cold-weather months of interest generally do not affect the growing season of outdoor vegetation; however, their effects on other uses and activities should be assessed. Therefore, this sensitivity is assessed for both (1) warm-weather-dependent features like wading pools and sand boxes, or vegetation that could be affected by a loss of sunlight during the growing season; and (2) features, such as benches, that could be affected by a loss of winter sunlight. Uses that rely on sunlight include: passive use, such as sitting or sunning; active use, such as playfields or paved courts; and such activities as gardening, or children's wading pools and sprinklers. Where lawns are actively used, the turf requires extensive sunlight. Vegetation requiring direct sunlight includes the tree canopy, flowering plants and plots in community gardens. Generally, four to six hours a day of sunlight, particularly in the growing season, is often a minimum requirement. Consequently, the assessment of an open space's sensitivity to increased shadow focuses on identifying the existing conditions of its facilities, plantings, and uses, and the sunlight requirements for each.

As indicated in Table 6-1 and discussed below, the projected and potential developments resulting from the Proposed Action would cast incremental shadows on several resources in one or more of the analysis periods.

Green Central Knoll Park

Given its location relative to the projected and potential development sites, the incremental shadows resulting from the Proposed Action would reach a small area at the southern edge of Green Central Knoll Park on the December 21 analysis day. As December falls outside of the growing period between March and October, new incremental shadows cast by the Proposed Action in winter would not create significant adverse impacts on the trees and vegetation that are located in this area of Green Central Knoll Park. Moreover, this area of the park does not contain any benches, playgrounds or other active recreation areas that require winter sunlight. Therefore, new incremental shadows cast by the Proposed Action are not



December 21 - 1:00 PM



December 21 - 2:00 PM



December 21 - 2:45

Projected Development Site

Potential Development Site

Incremental Shadow

Open Space
(keyed to Table 6-1)

Rheingold Development Rezoning

Figure 6-3
Shadows on Open Space - Green Central Knoll Park

expected to create significant adverse impacts on the trees and vegetation that are located in Green Central Knoll Park, nor would they adversely affect the utilization of this area of the park.

Bushwick Pool & Playground

Given its location relative to projected and potential development sites, the incremental shadows resulting from the Proposed Action would reach a portion of the Bushwick Pool & Playground on two analysis days, with durations ranging from 51 minutes (March 21/September 21) to 5 hours and 51 minutes (December 21). As noted above, The Bushwick Playground and Pool is a 1.29-acre facility with a large pool, a children's pool, play equipment with safety surfacing, benches, handball courts, spray showers and swings. The incremental shadows cast on March 21 would be cast in the early morning and be of short duration (51 minutes) and only cover a small portion of the park (see Figure 6-2). The incremental shadows cast in December would not be within the plant growing season. In addition, as shown in Figure 6-2, the incremental shadows that would be cast as a result of the Proposed Action would move quickly, so that no single area of the park would be cast in shadow for extended periods of time. As shown in Figure 6-2, incremental shadows would be cast on the playground early morning, however, only a small portion of this open space resource would be cast in incremental shadows by 12:00 PM. It should also be noted that the pool is not open during either of these analysis days. Therefore, new incremental shadows cast by the Proposed Action would not create significant adverse impacts on the Bushwick Pool & Playground.

Garden Playground

The projected development sites would cast incremental shadows on the Garden Playground open space during the early morning and midday/evening on the March 21/September 21, May 6/August 6, and June 21 analysis periods, and during the midday on the December analysis period. As discussed above, the Garden Playground is a 1.1-acre open space with basketball courts and a spray shower, benches, play structures and toddler play equipment, and it is completely paved (with the exception of several trees). As shown in Figure 6-2, only small portions of this open space resource would be cast in incremental shadows with the exception of May 6/August 6 and June 21 analysis periods where approximately 50 percent of the park would be cast in incremental shadow in the late afternoon/evening.

While the total shadow duration would range from 3 to 5.5 hours, as illustrated in Figure 6-2, no given section of the playground would be cast in shadow for the entire shadow duration. For example, on the June 21 analysis day, the northern portion of the playground would experience incremental shadow at 6:00 AM; by 1:00 PM, incremental shadows would have shifted to a very small area at the western edge of the playground; and by 5:00 PM incremental shadows would be cast on approximately 50 percent of the playground; by 6:00 PM, incremental shadows would again be cast on a small sliver of the southwest portion of the playground, before exiting this section entirely by 6:01 PM. Between this intermittent shadowing, it is expected that all planted areas of the playground would, in the aggregate, be able to receive at least 4 to 6 hours of sunlight during the plant growing season. Similarly, because no given section of the playground would be cast in shadow for the entire shadow duration, the utilization of the benches and recreation areas located throughout playground would also not be adversely affected.

Therefore, new incremental shadows cast by the Proposed Action are not expected to create significant adverse impacts on the trees that are located in Garden Playground, nor would they adversely affect the utilization of this resource.