4

ENVIRONMENTAL ANALYSIS

Sustainable and Resilient Buildings Questionnaire
LEED Compliance
Shadow Study
Pedestrian Level Wind Analysis
Solar Glare Analysis

SUSTAINALBLE AND RESILIENT BUILDINGS QUESTIONNAIRE

This document outlines development review application requirements in relation to the long-term environmental sustainability and climate resilience of buildings within Somerville. Development proposals that require Site Plan Approval by the Somerville Zoning Ordinance must include a completed Sustainable & Resilient Buildings Questionnaire with the required Development Review Application. A Development Review Application is considered incomplete unless a completed questionnaire is submitted with the application.

The purpose of this questionnaire is to ensure that the impacts of future climate conditions are carefully evaluated and to encourage reasonable efforts to reduce or eliminate greenhouse gas emissions and mitigate the impacts related to climate change in the design, construction, and occupancy of buildings. Completion of this questionnaire raises awareness of site specific vulnerability, ensures that future climate conditions are considered throughout the stages of development.

Please review the following documents before completing the questionnaire:

- **Somerville Climate Change Vulnerability Assessment**
- **Carbon Neutrality Pathway Assessment**

RESOURCES:

For information on net-zero and resilient building and site design, please review the following resources:

- **Architecture 2030 Palette (Net-zero design tools)**
- **Building Resilience in Boston**
- **Enhancing Resilience in Boston**
- **A Better City's Resiliency Toolkit**
- **Ready to Respond: Strategies for Multifamily Building Resilience**

For additional information visit www.somervillema.gov/sustainaville

PROCEDURE:

A completed Sustainable & Resilient Buildings Questionnaire must be submitted with a Development Review Application for all development proposals that require Site Plan Approval. New construction or alterations to existing structures of 25,000 square feet or more must also submit an updated questionnaire prior to the issuance of the first Building Permit and prior to the issuance of the first Certificate of Occupancy to identify any design changes made subsequent to Site Plan Approval or additional information determined as the development process unfolds.

BACKGROUND: CARBON NEUTRALITY

Understanding the global imperative to reduce greenhouse gas emissions in order to prevent extreme changes to the climate, Mayor Joseph A. Curtatone set a goal for Somerville to become carbon neutral by the year 2050. In 2017, the Somerville Board of Aldermen passed a resolution re-affirming the city's carbon neutrality goal. Carbon neutrality is defined as the net-zero release of carbon dioxide and other greenhouse gases (GHG) within Somerville's municipal boundary.

To achieve carbon neutrality by 2050, Somerville will need to drastically reduce greenhouse gas emissions from electricity, buildings, transportation, and waste disposal. Development within the city will need to be high performing and progressively improve its energy performance to become carbon neutral. Buildings should be designed to maximize energy efficiency, produce or procure renewable energy, and phase out fossil fuel use.

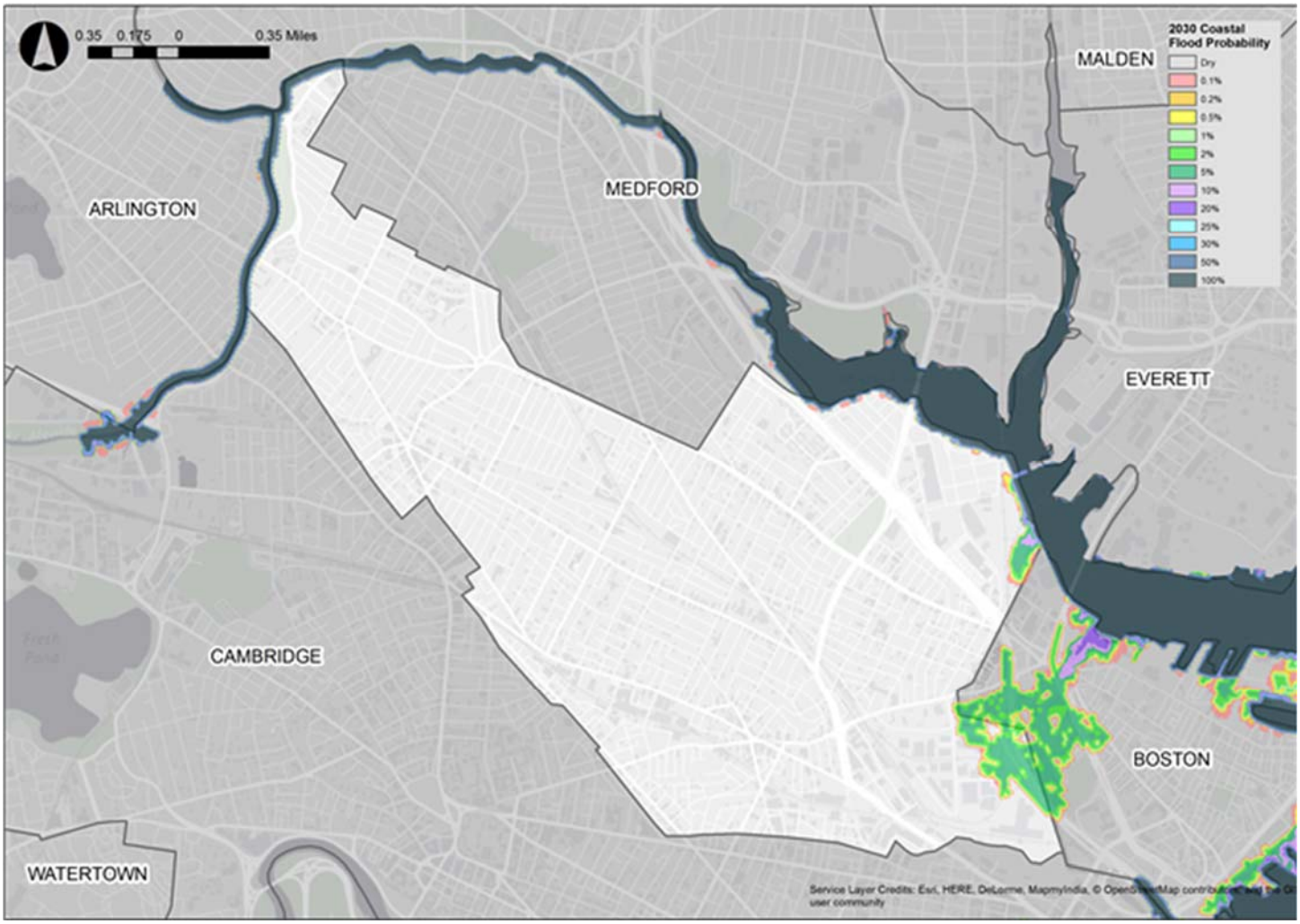
BACKGROUND: CLIMATE CHANGE VULNERABILITY

Despite efforts to minimize greenhouse gas emissions, climate change is already impacting the City of Somerville and changes to the climate will continue to intensify unless global emissions are swiftly and significantly reduced. The City of Somerville's Climate Change Vulnerability Assessment analyses vulnerabilities associated with Somerville's key climate stressors: increased precipitation, sea level rise and storm surge, and higher temperatures. The analysis recommends that new development consider these climate impacts and take appropriate measures to address the projected climatic conditions described in the assessment.

Sea level rise and storm surge are already potential concerns for areas of East Somerville. By 2035-2040, the Amelia Earhart Dam could be regularly flanked by strong storms resulting in flooding for areas of Assembly Square, Ten Hills, and Winter Hill. Additionally, future 100-year (1% annual chance of occurrence) 24-hour storm events are projected to have a more than 30% increase in rainfall. This increased storm water will put additional stress on Somerville's water infrastructure and is likely to worsen precipitation-based flooding across many areas of the city. As the climate continues to change, average seasonal temperatures are expected to increase and the number of days above 90 degrees Fahrenheit (currently about 10 a year) could rise to 40 days by 2030, a third of the summer, and 90 days by 2070, nearly the entire summer.

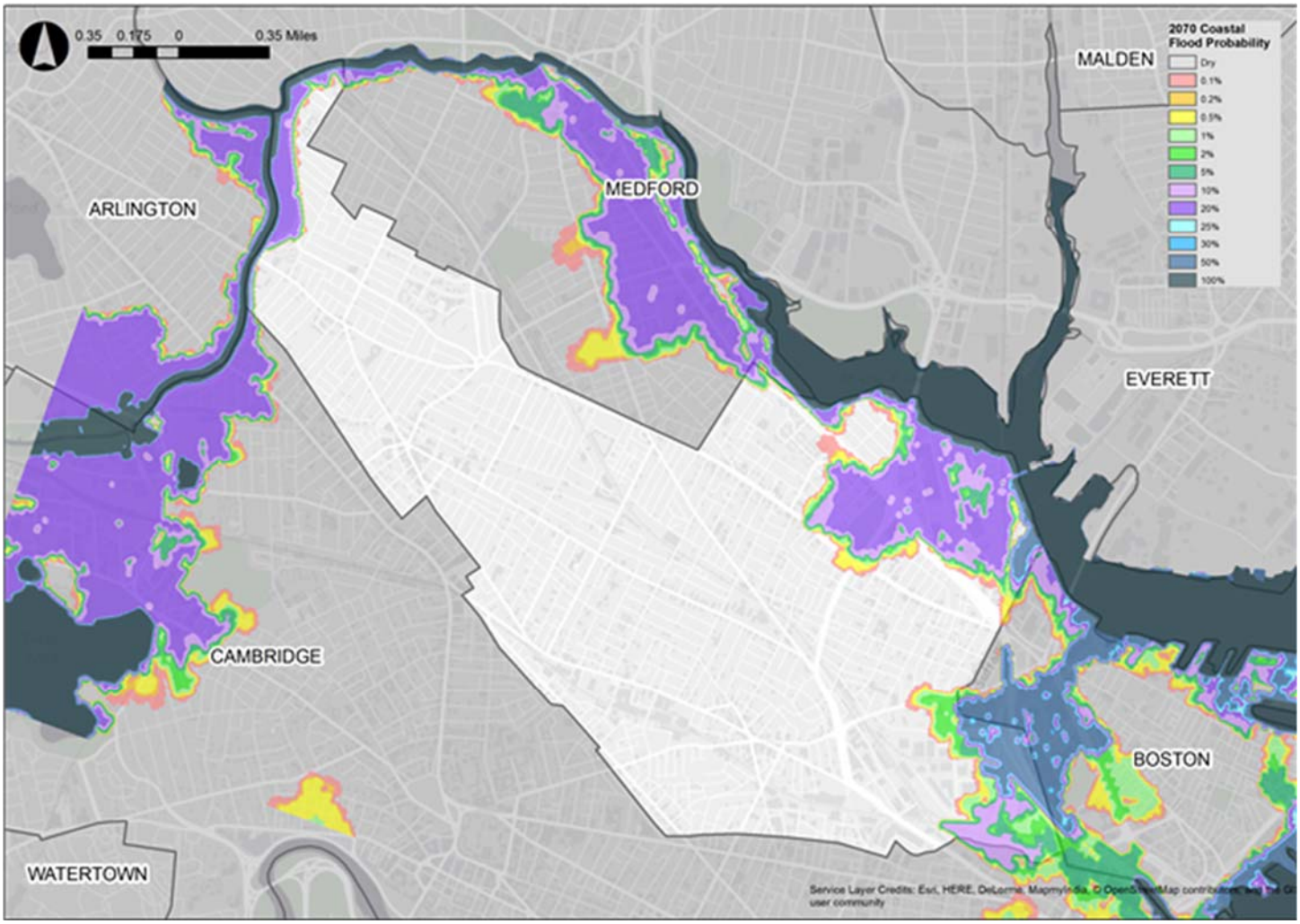
The following maps and figures provide an overview of projected climate exposure. Please review the Climate Change Vulnerability Assessment for more detailed analysis on Somerville's exposure, vulnerability, and risk to climate change.

2030 Coastal Flood Probability



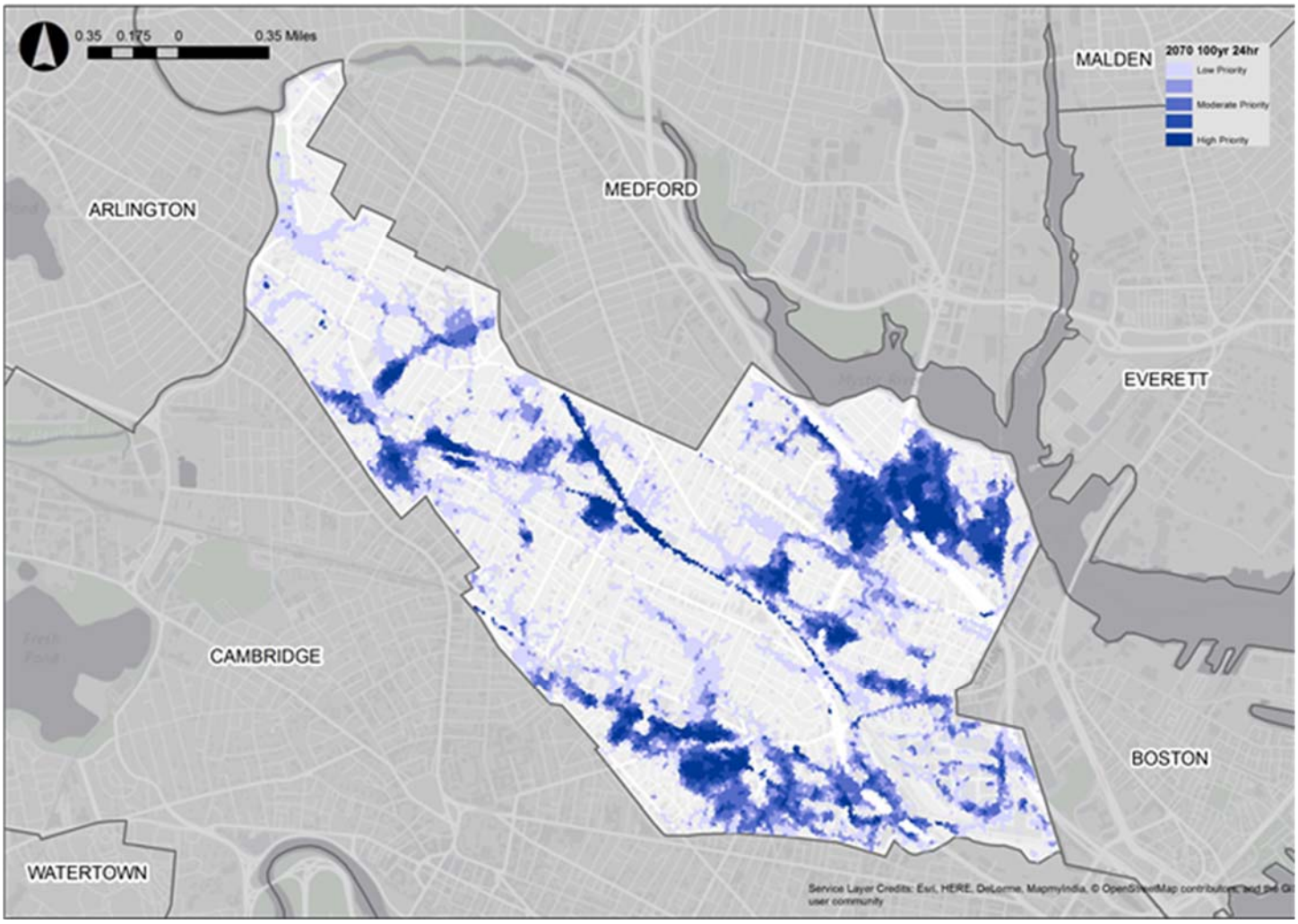
This map shows the annual chance of flooding from coastal storm events and sea level rise in 2030. A 100% chance of flooding means that area is very likely to flood that year, while a 50% chance means that there is an equal chance that it may or may not flood in a given year. A 1% chance of flooding corresponds with a '100-year event'. A 0.1% chance corresponds with a '1000-year event'. (Somerville Climate Change Vulnerability Assessment, 2017)

2070 Coastal Flood Probability



This map shows the annual chance of flooding from coastal storm events and sea level rise in 2070. A 100% chance of flooding means that area is very likely to flood that year, while a 50% chance means that there is an equal chance that it may or may not flood in a given year. A 1% chance of flooding corresponds with a 100-year event. A 0.1% chance corresponds with a 1000-year event. (Somerville Climate Change Vulnerability Assessment, 2017)

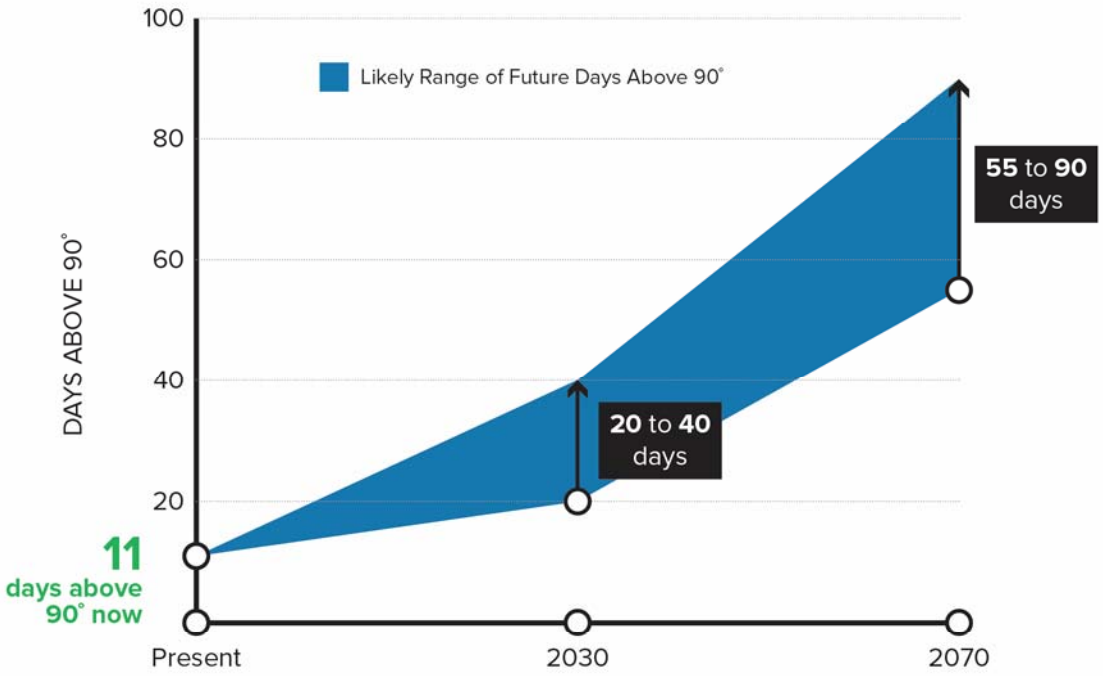
Precipitation Projections



2070 100-year, 24-hour Design Storm Priority Areas of Flood Concern
(Somerville Climate Change Vulnerability Assessment, 2017)

Storm Type	Present-day Rainfall	2030 Rainfall	2070 Rainfall
10-year (10%), 24-hour	4.9 in	5.6 in	6.4 in
100-year (01%), 24-hour	8.9 in	10.2 in	11.7 in

Temperature Projections



(Somerville Climate Change Vulnerability Assessment 2017)

Temperature	1971-2000 (average)	2030 (low)	2030 (high)	2070 (low)	2070 (high)
Annual	50.0º F	53.3º F	53.5º F	55.8º F	58.7º F
Summer	70.6º F	74.5º F	74.8º F	77.4º F	80.6º F
Winter	29.8º F	32.2º F	33.0º F	34.6º F	38.0º F

SUSTAINABLE & RESILIENT BUILDINGS QUESTIONNAIRE

Proposal Information	
Proposal Name	Union Square Redevelopment Project Parcel D2.1
Address	Parcel D2.1
Owner/Developer	Union Square RELP Master Developer LLC (US2)
Business Address	31 Union Square, Somerville, MA 02143
Designated Contact	Greg Karczewski
Telephone Number	617.996.8255
Email Address	Greg@discoverusq.com

Design Team	
Design Architect	SGA
Architect of Record	SGA
Engineer	AHA Consulting Engineers
Landscape Architect	Ground, Inc.
Sustainability/LEED	dbHMS
Permitting	N/A
Construction Management	TBD

State Review	
Is MEPA Approval Required?	Yes

Building & Site Details	
Building Type	Core and shell lab/office building
Gross Floor Area	Approximately 178,890
Principal Uses	Lab and office space
Ground Floor Uses	Retail and BOH
Site Elevation	Average Ground Level
Ground Story Elevation	16.50’ (City of Somerville Datum)
Building Height	8 stories (129'-6")
Below Grade Levels	None
Ground Water Elevation	Approx. 3.5-7.0 below grade (based on monitoring in Oct. 2014)
Parking Spaces	269 in shared parking garage
EV Ready Spaces	None
EV Charging Spaces	10 EV Spots with 5 dual charging stations

Climate Vulnerability Exposure (check all that apply)	✓ Sea Level Rise & Storm Surge ✓ Precipitation Induced Flooding ✓ Heat ☐ Other(s):

Green Building	
LEED Version	LEED for New Construction version 4
LEED Certifiable	LEED certified
LEED Rating	Gold
LEED Point Score	60

Building Systems	
Expected Life of Building	60 years
Critical Site Infrastructure	Pumps - 10 years, all other site infrastructure - 75 years
Expected Life of Key Systems	30 years
Type of Heating System(s)	Condensing boiler serving hot water loop to AHUs and terminal reheats
Type of Cooling System(s)	Water cooled chillers serving chilled water loop to AHUs

Building Energy Use & Continuity

Reducing greenhouse gas emissions is critical to avoiding the worst impacts of climate change. To achieve Somerville's 2050 carbon neutrality goal, new construction must be designed to maximize energy efficiency, produce or procure renewable energy, and phase out fossil fuel use. At the same time, new development should make efforts to improve resiliency to disruptions in utility services, which could become more frequent with more powerful storm events and heat waves.

1. Explain how building energy loads & performance were determined:

An eQuest energy model based on the project design documents was created to estimate the energy performance and peak loads of the designed building.

Annual Electric Load	5,052,101 (kWh)	Peak Electric Load	1,700 (kW)
Annual Heating Load	9,224 (MMbtu/hr)	Peak Heating Load	19.3 (MMbtu)
Annual Cooling Load	71,492 (Tons/hr)	Peak Cooling Load	1575 (tons)

Energy Use Intensity	125 (kBtu/SF)

2. Describe any strategies that will be implemented to support continued building operations during potential utility outages.

Interruptions of power can be mitigated in the short term by the emergency generator.

Back-Up/Emergency Power Systems

Electric Output	750 kW	Number of Power Units	1
System Type	Combustion	Fuel Source	Diesel

Emergency and Critical System Loads (in the event of service disruption)

Electric	525 (kWh)	Heating	7.2 (MMbtu/hr)
		Cooling	200 (Tons/hr)

2. How is the building designed to reduce energy usage? Please describe the key design features of the building including any active (equipment, controls, features, etc.) or passive (orientation, massing, systems, etc.) energy efficiency measures.

The building is designed to reduce energy use by incorporating key features such as: reduced lighting power density in core areas that is controlled by occupancy sensors and daylight controls, low flow plumbing fixtures, demand control ventilation, and condensing boilers.

Energy Use below Mass Code	29.5 %	Energy Use below ASHRAE 90.1 (current edition)	29.5 %

3. Will the building use air or ground source heat pumps or solar thermal systems? Please describe any such system. If no, please explain the building's heating and cooling systems and whether high efficiency electric or renewable powered systems were considered.

The building does not use air or ground source heat pumps or solar thermal systems. Ground source heat pumps are not viable at this time due to their recirculation of air. In lab buildings this is not possible due to airborne chemical and biological contaminants The buildings are designed with condensing boilers serving a hot water loop and high efficiency chillers serving a chilled water loop. The 100% OA roof top units heat and cool the building with an energy recovery coil as well as hot water and chilled water coils. It is unknown if existing geologic conditions are suitable to accommodate vertical boreholes. Given the dense urban nature of the Phase 1 Project area, and the site's history of Industrial uses, extensive underground drilling is not recommended.

4. Describe any existing or planned connections to distributed energy or district energy systems.

The building does not expect to connect to a distributed energy or district energy system. Development of a new district heating and cooling system is not commercially viable for the Project due to the non-contiguous nature of the development and the infeasibility of traversing several major roadways.

5. Is on-site renewable energy generation feasible? Please describe your analysis and findings. If yes, will any renewable energy be produced onsite? If so, please describe (system type and capacity).

The building is currently designed with conduits and structural upgrades to provide a 'solar-ready roof, and the project team plans to study the incorporation of solar as an on-site renewable energy strategy as building design continues. A preliminary solar feasibility study was conducted to determine a 10,000 SF array resulted in 104kW of power. The Applicant supports the Idea of PV rooftop Installations and will continue to examine the benefits of PV as design progresses; however, the technical and economic potential of PV must be evaluated based on the current Incentives, alternatives, and physical constraints.

6. Describe any on-site energy storage systems.

The building design does not include any on-site energy storage systems.

7. Describe any other measures intended to reduce energy use and greenhouse gas emissions.

The building design includes a high-performance building envelope, blue roof, energy recovery, demand-controlled ventilation, reduced lighting power densities, high efficiency HVAC, and high performance exterior lighting. The project targets energy and emissions reductions through multiple strategies, Including Smart Growth planning principles, transportation, energy metering, and commissioning, among others. Please reference the LEED narrative and scorecard for additional Information.

8.Does the electric utility's infrastructure have enough capacity to support the addition of your building's energy load? Please confirm that you have consulted with the local utility.

A letter with the estimated connected electrical load of the building was sent to Eversouce on August 23, 2018. Associated meetings have been held and coordination Is ongoing.

9. Describe measures that will be implemented to reduce building energy demands on utilities and infrastructure, such as a demand response program.

As the building is occupied, the property managers will evaluate the requirements of the tenants to determine if the temperature controls in the building can be adjusted (up or down) to reduce the energy demands from the building at peak external thermal loads.

The City of Somerville recognizes that as technology advances, incorporating design elements to mitigate carbon emissions and increase resilience may become more feasible. Applicants are encouraged to devise strategies that permit building systems to adapt and evolve over time to further reduce GHG emissions and to avoid path dependency that perpetuates reliance on fossil fuels. With this in mind, please answer the following questions:

10. Will the building be a net zero carbon building? A net zero carbon building is a highly energy efficient building that either produces or procures enough carbon-free renewable energy to meet building operations or offsets any remaining carbon emissions. If the building will not be a net zero carbon building, describe how the building's systems will be adapted over time to achieve net zero energy emissions. Changes could include, but are not limited to, additional renewable energy generation, energy storage, additional energy efficiency measures, or other measures that would further reduce greenhouse gas emissions.

The building will not be a net zero carbon building. As described in items 5 and 7 above, the project will provide the conduits and structural capacity to deliver a solar-ready roof. Similarly, beyond provisions to offset consumption through renewables, the building introduces sustainable strategies around parking and alternative transportation, energy commissioning, and others that specifically target tempering reliance on fossil fuels. Green Power and Carbon offsets have been studied as a potential measure that would further combat emissions. Please reference the LEED narrative and scorecard for additional Information.

11. Will the building's roof include any sustainability features? These may include, but are not limited to, high albedo roof materials, solar panels, or vegetation. If no features are included in the design, please describe why and if any features could be added in the future.

The roof will be a blue roof as part of the storm water strategy. Integrated conduits and added structural capacity will deliver a solar ready roof.

12. Has the building been planned and designed to accommodate any additional future resiliency enhancements? Please describe if designs could accommodate future additions of any of the following:

- Solar PV (roof or site is solar ready)
- Solar Thermal
- Connection to district energy system
- Potable water storage
- Wastewater storage
- Back up energy systems & fuel
- Electric Vehicle Charging
- Green roof

The project is solar ready. 10 Electric vehicle charging stations will be provided within the shared parking facility within the adjacent residential building. Additional monetary contributions to offsite Infrastructure will support area-wide resilience planning efforts. Please reference the LEED narrative for additional details on resiliency enhancements.

Climate Change Risk and Vulnerability

13. How did you use climate change projections from Somerville's Climate Change Vulnerability Assessment (CCVA) to inform the building and site design of your project?

The CCVA identified site specific risks of flooding and heat Island Impacts and informed decision making relative to each. All low level uses were considered in light of the potential for flood impacts, and were designed to protect building systems. Flood sensitive systems will not be located in areas that are deemed to be susceptible to flooding without the necessary precautions to protect them for the long term. Further bolstering long-term resiliency, the inclusion of emergency back-up systems, critical to future building occupants and their operations, will be addressed in more detail as specific occupant needs become known. New open spaces across the site were designed with their climate-change combatting potential in mind, incorporating green Infrastructure elements paired with a new tree canopy to address the urban heat Island effect directly. By reducing the around of storm water runoff and Increasing the uptake of water by new plant materials, the amount of runoff discharged from the parcel will be reduced. Working in coordination with the City, the Project will investigate storm water management infrastructure that will allow for detention and infiltration on site to reduce rates and volumes to the maximum extent practicable. For additional information please reference Chapter 6 - 'Climate Change Resilience and Adaptation' of the Applicant's Draft Environmental Impact Report (EEA#15889)

14. Based on the information in the Climate Exposure section of the CCVA, what are the projected climate change impacts that your site might vulnerable to? Please list and describe all relevant impacts from the CCVA.

Sea level rise, storm surge, precipitation and temperature are the key stressors to the area. The existing site is already susceptible to precipitation flooding. The project's approach to stormwater management and ground level design have been designed with future resiliency in mind.

The next two sections ask specific questions about how the project is designed to manage climate-related risks from heat, coastal and inland flooding.

Managing Heat Risks

As temperatures increase, Somerville will become more susceptible to the urban heat island effect which causes hotter temperatures due to paved surfaces and waste heat generated by energy use when compared to less developed areas. Open space, trees coverage, and impervious surfaces can help reduce heat exposure and the intensity of the urban heat island effect.

Increasing average temperatures can have wide-ranging impacts on human life, the built environment, and natural ecosystems. Rising temperatures and more intense heat waves present significant public health concerns and can contribute toward kidney, lung, and heart problems. Vulnerable populations are particularly susceptible to heat-induced illness and mortality. Buildings also demand greater electricity for cooling. Even small changes in average temperatures can significantly impact the natural environment.

15. Describe how the building and its energy systems will be adapted to efficiently manage future higher average temperatures, higher extreme temperatures, additional annual heat waves, and longer lasting heat waves.

The building is designed with space to expand the number and size of the chillers supporting the building.

Temperature Design Conditions

Low Temperature	7 Degrees	High Temperature	91 Degrees
Annual Cooling Days	750 (CDD65) #	Annual Heating Days	5596 (HDD65) #
		Days Above 90º	11 #

16. What design features will be implemented on site to minimize the site's contribution to the urban heat island effect? Please describe any and all design elements. Strategies could include, but are not be limited to, the following:

- High albedo pavement or roof materials
- Passive cooling or increased ventilation capacity
- Green roofs or walls
- Heat resistant trees and plants
- Additional landscaped areas

The Project includes a network of planned open spaces subject to the requirements of the Union Square Zoning – regulations aligned with resilient planning practices that require vegetated areas, permeability, and the large trees that provide shade and cooling to reduce the urban heat island effect. Although, not on the project site over 20 new trees will be planted at the adjacent Civic Space, provided within the green infrastructure that will facilitate their support and growth to maturity. Please refer to the LEED narrative for additional detail around sustainability Initiatives.

17. What additional design and operations strategies will be implemented to protect building occupants during extreme heat events?

Emergency generators will provide backup power for life safety systems. Facade glazing will be tuned to shield heat such that southeastern and southwestern facades will achieve greater solar heat gain coefficients.

Managing Flood Risks

Several areas of Somerville are already prone to flooding from intense precipitation. As part of a wet region, Somerville is projected to experience more than a 30% increase in rainfall during a 100-year 24-hour event. With climate change, precipitation events will become more intense—meaning that a greater volume of rain will fall in a shorter period of time. This can lead to flooding in areas where the drainage system does not have sufficient capacity. It will be further exacerbated by the presence of impervious surfaces, such as roads and parking lots, where the water cannot be absorbed into the ground, but rather is funneled into storm drains, nearby water bodies or other low-lying areas.

In addition to flooding from precipitation, sea level rise and storm surge are already potential concerns for areas of East Somerville and by 2035-2040 the Amelia Earhart Dam could be regularly flanked by storms. More information can be found in the complete Vulnerability Assessment.

18. How has the site and building been designed to manage storm water from rain event?

The project employs a Blue Roof to aid in storm water retention. A joint below-grade Storm Water Retention Tank serving all three D2 Parcels will capture D2.1 storm water mitigating outflow rate to city storm sewer. The building does not have a basement. Lowest level is at grade above base flood elevation.

19. Is the site susceptible to flooding from sea level rise and storm surge or rain events now or during its expected lifetime? Please refer to the Somerville Climate Change Vulnerability Assessment and restate your potential flood risks based on the CCVA.

The existing site is susceptible to precipitation flooding. The project's approach to stormwater management and ground level design have been designed with future resiliency in mind.

If you answered YES to the previous question, please complete the next section.
Otherwise, you have completed the questionnaire. Thank you.

Flooding Design Considerations

Site Elevation - Low	7.4 (ft) NVGD 88	Site Elevation - High	23.8 (ft) NVGD 88
Site Elevation - Avg.	Average Ground Level	Ground Level Elevation	D2.1=10.3 (ft) NVGD 88
Is any portion of the site in a FEMA SFHA? (1% chance floodplain)	No	What FEMA zone(s)	N/A
Base Flood Elevation	N/A	Design Flood Elevation	N/A
2030 Flood Risk	N/A (%)	2070 Flood Risk	N/A (%)

20. What are the ground floor uses of the building? Are there any below ground stories of the building? If so, what uses are located below ground?

The ground floor is used for the lobby, back of house spaces, retail, and circulation space. There are no below ground stories of the building.

21. Are there any flood-sensitive assets, utilities, mechanical equipment, or critical site infrastructure located in areas of the building that are at risk of flooding? What measures will protect building systems during a flood or severe storm? These might include, but may not be limited to, the following:

- Elevation of utilities and mechanical systems
- Water tight utility conduits
- Waste water back flow prevention
- Storm water back flow prevention
- Systems located above the ground floor
- Securing objects at risk of becoming dislodged

Flood vulnerable building assets are located on ground level above base flood elevation. A building services mezzanine level above the ground floor additionally locates assets. Water tight utility conduits, waste water back flow and holding tank, and a storm water retention tank servicing all three D2 Parcels are part of project scope.

22. Will any flood-damage resistant materials be used in design and construction in flood risk areas?

Per FEMA's Flood Damage-Resistant Materials Requirements (Technical Bulletin 2, dated 2008), the proposed finish materials are intended to meet the National Flood Insurance Program's (NFIP) Class Rating 4-5 ("acceptable") standard.

23. What flood control design elements will be used to mitigate a 2070 coastal flood event with a 10% chance to occur in any given year (a '10-year' event)? These might include, but may not be limited to, the following:

- Elevation of the site
- Structural elevation of the building
- Non-structural elevation of the ground floor
- Wet flood-proofing (allowing water to flow through building envelope)
- Dry flood-proofing (preventing water from entering building)

The site is susceptible to precipitation flooding, not coastal flooding. In any event,
The full perimeter of the building will include a flood foundation curb located in elevation one foot above the ground floor level. At building openings (doorways) temporary flood gates could be employed during major storm events.

24. What is the recovery plan for a 2070 coastal flood event with a 1% chance to occur in any given year (a '100-year' event)? Summarize anticipated pre- and post-event policies, strategies,

and actions necessary to facilitate post-flood recovery. These might include, but may not be limited to, the following:

- Flood mitigation design (see #23)
- Recovery management team
- Annual training & exercises
- Hazard evaluation & mitigation
- Damage assessment
- Demolition & debris removal
- Repair permitting
- Business resumption

The property manager will create a flood/storm event plan to manage implementation of resiliency measures, including raising elevators, selectively turning off power, implementing temporary flood barrier system, etc.

The plan will also include methods for maintaining property operation during such events, resident and tenant communication and updates protocols, current remediation company contact information, management and maintenance personnel responsibilities, and property specific protocol and logistics for remediation, repairs, documentation, and approvals and clearances for occupancy.

The plan will be documented, reviewed and updated yearly, and kept in the management office.

25. Will hazardous or toxic material be stored on site? Where will it be stored? How will you protect hazardous or toxic material from flooding?

By code a Laboratory Use building is required to store Chemicals at the ground level. Storage strategies for chemicals will address the top-shelf locating of these hazardous and toxic materials, locating them several feet above base flood elevation.

26. Will the building employ any temporary measures to prevent flooding on site? These could include barricades, flood gates, and other measures. Please describe any temporary measures and include the elevation the measures are designed for.

The building has been designed for compatibility with temporary flood barrier systems to provide continuous protection at the building perimeter during a flood event.

27. Will the site be accessible during a flood inundation? If yes, to what flood elevation?

Access will be maintained, but access points will be somewhat reduced. A temporary ramp system accompanying flood barriers at doorways is being studied. According to the draft US2 - Union Square Hydraulic Modeling Report provided by the City of Somerville, precipitation flooding caused by the 100yr24 storm reaches an elevation of approximately 10.30 (NAVD88 Vertical Datum). The proposed buildings have been set at or above this elevation to maintain accessibility.

28. Will any additional measures be employed to protect the building from storms and flooding?

Emergency power provided for elevators, life safety, and security.

LEED COMPLIANCE

db|HMS

CHICAGO
GRAND RAPIDS
PHILADELPHIA
DELHI
AHMEDABAD

Affidavit

As the Sustainability Consultant overseeing the planning, design, and construction of the Union Square Redevelopment Project Parcel D2.1, I, Claudia Mattison, LEED AP BD+C, certify that I am knowledgeable of the project's green building strategies, designs, plans, and details, and to the best of my knowledge, this project has been planned and designed so as to meet the prerequisites and earn the credits necessary to achieve 60 points (minimum for Gold level of certification is 60 points) using the LEED for Core and Shell v4 Rating System. Assuming that the project follows through on the green strategies described in the LEED Checklist, the project will be able to earn LEED Gold level of certification.

Claudia (Fischmann) Mattison
P.E., LEED AP BD+C, LEED for Homes Green Rater
Group Leader | Sustainability Planning Studio
db|HMS

LEED v4 for Core and Shell

Project Checklist - DSPR Submission

db|HMS

Project:	Somerville D2.1
Address:	Prospect St and Somerville Ave, MA
Date:	02.08.2019
Goal:	Gold

			LEED Project Information Forms	Required Information	Resp. Party	Action Items
REQ'D	d	PI	Project Information	Site area, date of substantial completion, occupancy, mechanical systems, provide uploads of Site Plan with LEED project Boundary, Plans, Elevations/Sections, Photos/Renderings, Mechanical Plans and Schedules	dbHMS	

Y	?	N	d/C		Integrative Project Planning and Design	1	Strategy	Resp. Party	Action Items
REQ'D			d	Prereq	Integrated Project Planning and Design		Use cross-discipline design and decision making, beginning in the programming and pre-design phase.		
1			d	Credit	Integrative Process	1	Use the analyses described below to inform the owner's project requirements (OPR), basis of design (BOD), design documents, and construction documents. STEP 1. BECOME FAMILIAR WITH INTEGRATIVE PROCESS. STEP 2&3. CONDUCT PRELIMINARY ENERGY & WATER RESEARCH AND ANALYSIS STEP 4. CONVENE GOAL-SETTING WORKSHOP STEP 5. EVALUATE POSSIBLE ENERGY STRATEGIES STEP 6. EVALUATE POSSIBLE WATER STRATEGIES STEP 7. DOCUMENT HOW ANALYSIS INFORMED DESIGN AND BUILDING FORM	AHA	- All disciplines involved at SD, kick off shortly to follow. - MEPA energy model to be used. - Water analysis needed from plumbing.

Y	?	N	d/C		Location & Transportation	20	Strategy	Resp. Party	Action Items
2			d	Credit	Sensitive Land Protection	2	OPTION 1. Locate the development footprint on land that has been previously developed. OPTION 2. Locate the development footprint on land that has been previously developed or that does not meet the following criteria for sensitive land: Prime farmland/Floodplains/Habitat/Water bodies/ Wetlands	dbHMS	-Urban Infill , previously developed parking lot
3			d	Credit	High Priority Site	1-3	OPTION 2. Locate the project on a Difficult Development Area. (2 pts Core & Shell) OPTION 3. Locate the project on Brownfield & perform remediation. (3 pts Core & Shell)	Ownership	- DDA -Request Phase II assessment report.
6			d	Credit	Surrounding Density and Diverse Use	1-6	OPTION 1. Locate on a site whose surrounding existing density within a 1/4 mile radius of the project boundary meets the values in Table 1 (pg 78).(Point(s) 2-3) **AND/OR** OPTION 2. building's main entrance is within a 1/2 mile (800-meter) walking distance of the main entrance of 4-7 (1 point) or 8 or more (2 points) existing & publicly available diverse uses (listed in Appendix 1).	dbHMS	-Requires density calculation but should comply for maximum points -Services definite yes.
3		3	d	Credit	Access to Quality Transit	1-6	Locate any functional entry of the project within a 1/4-mile (400-meter) walking distance of existing or planned bus, streetcar, or rideshare stops, or within a 1/2-mile (800-meter) walking distance of existing or planned bus rapid transit stops, light or heavy rail stations, commuter rail stations, or commuter ferry terminals.	dbHMS	- Weekly trips 198, weekend trips 92 - Assumed 110 weekend and 202 weekday stops for Green Line Union Square Station based on Lechmere stops. -- ~400 weekday trips, ~202 weekend trips - just shy of the next threshold. - Can only track 1 way trips at each transit stop
1			d	Credit	Bicycle Facilities	1	**Bicycle Network**: Functional entry or bicycle storage within a 200-yard walking distance or bicycling distance from a bicycle network that connects to at least one of the following: -at least 10 diverse uses (see Appendix 1); -a school or employment center, if the project total floor area is 50% or more residential; or -a bus rapid transit stop, light or heavy rail station, commuter rail station, or ferry terminal. within a 3-mile bicycling distance of the project boundary. **AND** **Bicycle Storage and Shower Rooms:** **Case 1. Commercial or Institutional Projects** short-term> 2.5% of all peak visitors, but > 4/building & long-term > 5% of all regular building occupants, but > 4/building Shower 1/100 regular building occupants + 1/additional 150 thereafter	SGA	- 5 showers required - can be split into 3 per one gender and 2 for other gender per LI #5231. - Approx 50 bicycle spots currently on the plan - 32 long terms spots are required. - No short term spots shown on plan, but the 50 spots could include short term requirement of 4 spots.
1			d	Credit	Reduced Parking Footprint	1	Do not exceed the minimum local code requirements for parking capacity. **Case 1.** Projects that have not earned points under LT Credit Surrounding Density and Diverse Uses or LT Credit Access to Quality Transit must achieve a 20% reduction from the base ratios. **Case 2.** Projects earning 1 or more points under either LT Credit Surrounding Density and Diverse Uses or LT Credit Access to Quality Transit must achieve a 40% reduction from the base ratios. Provide 5% carpool preferred parking spaces EXEMPLARY PERFORMANCE Case 1. Achieve a 60% parking reduction from the base ratios. Case 2. Achieve a 80% parking reduction from the base ratios.	SGA	- 300 spaces total, 175 designated for D2.1 - Approx 80% reduction based on lab, retail, and office spaces. - 5% of 175 spaces = 9 carpool spots required to be shown on plan for D2.1.
1			d	Credit	Green Vehicles	1	5% of all parking spaces must be labled preferred parking for Green Vehicles **OPTION 1. ELECTRIC VEHICLE CHARGING** -Install electrical vehicle supply equipment (EVSE) in 2% of all parking spaces used by the project. -Clearly identify and reserve these spaces for the sole use by plug-in electric vehicles. -EVSE parking spaces must be provided in addition to preferred parking spaces for green vehicles.	SGA	- 5% of 175 spaces = 9 Green Vehicle spots required to be shown on plan. - 2% of 175 spaces = 4 EV stations required to be shown on plan.

Y	?	N	d/C		Sustainable Sites	11	Strategy	Resp. Party	Action Items
REQ'D			c	Prereq	**Construction Activity Pollution Prevention**		Create & implement an erosion & sedimentation control plan for construction activities associated with project (conform to the erosion and sedimentation requirements of the 2012 U.S. EPA CGP or local equivalent (stringent one))	GC	
1			d	Credit	Site Assessment	1	Complete & document site survey or assessment that includes the following info: Topography,Hydrology, Climate, Vegetation, Soils, Human use, Human health effects. Demonstrate the relationships between the site features and topics listed above and how these features influenced the project design.	Ground	- Confirm Civil/Landscape has assessed the requirements.
		2	d	Credit	Site Development, Protect or Restore Habitat	1-2	OPTION 1. On-site restoration, 30% of site with native or adapted vegetation	Ground	- Currently not enough vegetated area shown on drawings
		1	d	Credit	Open Space	1	Provide outdoor space: > 30% of the total site area >25% of that outdoor space must be vegetated (except turf grass)/overhead vegetated canopy. Outdoor space must be physically accessible and be one or more of the following: -a pedestrian-oriented paving or turf area -a recreation-oriented paving or turf area -a garden space with a diversity of vegetation types and species -a garden space dedicated to community gardens or urban food production; -preserved or created habitat (SS Credit Site Development—Protect or Restore Habitat) and also includes elements of human interaction.	Ground	- Currently not enough vegetated area shown on drawings

		3	d	Credit	Rainwater Management	2-3	**OPTION 1.** Path 1: Best replicate natural site hydrology processes, manage on site the runoff from the developed site for the 95th percentile of regional or local rainfall events using LID and green infrastructure.(pts 2) EXEMPLARY PERFORMANCE Manage 100% of rainwater that falls within the project boundary.	Stantec	- Not managing 100% of stormwater.
2			d	Credit	Heat Island Reduction	1-2	$\frac{\text{Area of Nonroof Measures}}{0.5} + \frac{\text{Area of High-Reflectance Roof}}{0.75} + \frac{\text{Area of Vegetated Roof}}{0.75} \geq \text{Total Site Paving Area} + \text{Total Roof Area}$ OR OPTION 2. Place a minimum of 75% of parking spaces under cover.(1) have a three-year aged SRI of at least 32 (2) be a vegetated roof, or (3) be covered by energy generation systems (Point(s) 1) EXEMPLARY PERFORMANCE Achieve both Options 1 and 2. Locate 100% of parking under cover.	Gound	- Site paving must be >28 SRI and Roof materials must be >82 SRI
1			d	Credit	Light Pollution Reduction	1	OPTION 1. Do not exceed luminaire uplight ratings, based on the specific light source installed in the luminaire, as defined in IES TM-15-11, Addendum A. (refer table 1, pg 208) OR OPTION 2. Do not exceed the following percentages of total lumens emitted above horizontal. (refer table 2, pg 208) AND OPTION 1. Do not exceed the following luminaire backlight and glare ratings as defined in IES TM-15-11, Addendum A, based on the mounting location and distance from the lighting boundary. OR OPTION 2. Don't exceed the following vertical illuminances at the lighting boundary(refer Table 4,pg210) AND Do not exceed a luminance of 200 cd/m2 (nits) during night & 2000 cd/m2 (nits) during day.	AHA	- Requires exterior site lighting design to comply with BUG method. - 100% DD set: For LZ3, spec-ed Lithonia OLVTWM has compliant BUG ratings.
1			d	Credit	Tenant Design and Construction Guidelines	1	Publish for tenants an illustrated document with the following content, as applicable: -a description of the sustainable design and construction features incorporated in the core and shell project and the project's sustainablity goals and objectives, including those for tenant spaces -recommendations, including exmaples, for sustaainble strategies, products, materials, and services -information that enables a tenant to coordinate space design and construction with teh building systems when pursuing the LEED v4 for Interior Design and Construction prerequisites and credits	Ownership	- dbHMS to assist with creation of this document.

9	1	1	d/c	Water Efficiency	11	Strategy	Resp. Party	Action Items
Y	?	N						
REQ'D			d	Prereq	Outdoor Water Use Reduction	OPTION 1. No irrigation required OR OPTION 2. Reduce the project's landscape water requirement by at least 30% from the calculated baseline for the site's peak watering month	Ground/ Stantec	- Confirm no irrigation or use of stormwater for irrigation.
REQ'D			d	Prereq	Indoor Water Use Reduction	Reduce aggregate water consumption by 20% from the baseline. No once-through cooling with potable water for any equipment or appliances that reject heat. Equip cooling towers and evap condensers with makeup water meters, conductivity controllers and overflow alarms, efficient drift eliminators that reduce drift to maximum of 0.002% of recirculated water volume for counterflow towers and 0.005% of recirculated water flow for cross-flow towers.	AHA	- Mechanical to inlcude in design.
REQ'D			d	Prereq	Building-Level Water Metering	Install permanent water meters that measure the total potable water use for the building and associated grounds. Meter data must be compiled into monthly and annual summaries; meter readings can be manual or automated. Commit to sharing with USGBC the resulting whole-project water usage data for a five-year period .	AHA	-Whole building meter specified in P-401 - PLUMBING WATER SERVICE ROOM PART PLANS
1	1		d	Credit	Outdoor Water Use Reduction	2	OPTION 1. Show that the landscape does not require a permanent irrigation system beyond a maximum two-year establishment period.(Point(s) 2) OR OPTION 2. Reduce the project's LWR by at least 50% from the calculated baseline for the site's peak watering	Ground/ Stantec	- Potential stormwater for irrigation. Stantec to confirm.
				x	Option 2 : 50% from baseline	1			
				?	Option 2 : 100% from baseline	2			
5		1	d	Credit	Indoor Water Use Reduction	1-6	Further reduce fixture and fitting water use from the calculated baseline in WE Prerequisite Indoor Water Use Reduction. Additional potable water savings can be earned above the prerequisite level using alternative water sources. Include fixtures and fittings necessary to meet the needs of the occupants. Some of these fittings and fixtures may be outside the project boundary. Points are awarded according to Table 1. EXEMPLARY PERFORMANCE Achieve 55% water use reduction.	AHA	- 46% with the following rates: -- 1.0 gpf toilets -- 0.125 gpf urinals -- 0.35 gpm lav faucets -- 1.0 gpm showers
					Water use percentage reduction 25%	1			
					Water use percentage reduction 30%	2			
					Water use percentage reduction 35%	3			
					Water use percentage reduction 40%	4			
				x	Water use percentage reduction 45%	5			
					Water use percentage reduction 50%	6			
2			d	Credit	Cooling Tower Water Use	2	Conduct a one-time potable water analysis, measuring at least the five control parameters listed : Ca (as CaCO3) 1000 ppm, Total alkalinity 1000 ppm, SiO2 100 ppm, Cl- 250 ppm, Conductivity 2000 µS/cm Calculate the number of cooling tower cycles. Limit cooling tower cycles to avoid exceeding maximum values for any of these parameters.	AHA	-Requires water analysis and control measures. Mechanical to confirm.
					Up to maximum of 10 cycles	1			
					Minimum 10 cycles OR Min. no. of cycles to earn 1 point & min. 20% recycled nonpotable water	2			
1			d	Credit	Water Metering	1	Install permanent water meters for two or more of the following: Irrigation, Indoor plumbing fixtures and fittings, Domestic hot water, Boiler with aggregate projected annual water use of 100,000 gallons (378 500 liters) or more, or boiler of more than 500,000 BtuH (150 kW), Reclaimed water, Other process water.	AHA	-Select 2 sub-systems for metering.

12	6	15	d/c	Energy & Atmosphere	33	Strategy	Resp. Party	Action Items
Y	?	N						
REQ'D			c	Prereq	Fundamental Commissioning & Verification	Complete the following commissioning (Cx) process activities for mechanical, electrical, plumbing, and renewable energy systems and assemblies, in accordance with ASHRAE Guideline 0-2005 and ASHRAE Guideline 1.1-2007 for HVAC&R Systems, as they relate to energy, water, indoor environmental quality, and durability. Requirements for exterior enclosures are limited to inclusion in the owner's project requirements (OPR) and basis of design (BOD), as well as the review of the OPR, BOD and project design. NIBS Guideline 3-2012 for Exterior Enclosures provides additional guidance.·· Develop the OPR.·· Develop a BOD.	dbHMS	
REQ'D			d	Prereq	Minimum Energy Performance	**OPTION 1.** Improve 2% in proposed building performance rating compared to baseline(according to ANSI/ASHRAE/IESNA Standard 90.1-2010, Appendix G)performance rating with errata, using a simulation model. Projects must meet the min. percentage savings before taking credit for renewable. **OR** **OPTION 2**. Comply with mandatory & prescriptive provisions of ANSI/ASHRAE/IESNA Standard 90.1-2010, with errata. Comply with HVAC & service water heating requirements, including equipment efficiency, economizers, ventilation, and ducts and dampers, in Chapter 4, Design Strategies and Recommendations by Climate Zone, for the appropriate ASHRAE 50% Advanced Energy Design Guide and climate zone **OPTION 3.** Comply with Section 1: Design Process Strategies, Section 2: Core Performance Requirements, and the following three strategies from Section 3: Enhanced Performance Strategies, as applicable. Where standards conflict, follow the more stringent of the two. To be eligible for Option 3, the project must be less than 100,000 square feet (9 290 square meters).	AHA	- Can only take savings for base building systems; tenant design cannot be incorporated unless there is a signed tenant lease provided.
REQ'D			d	Prereq	Building Level Energy Metering	- New or use existing building-level energy meters/submeters to provide building level data for total building energy consumption (electricity, natural gas, chilled water, steam, fuel oil, propane, biomass, etc.). - Utility-owned meters acceptable. - Commit to sharing data with USGBC for a 5-year period. - Tracked at one-month intervals.	AHA	- Gas and Electric meter on P-101 - PLUMBING LEVEL 1 PLAN & E002A - ELECTRICAL DISTRIBUTION RISER DIAGRAM A

REQ'D			d	Prereq	Fundamental Refrigerant Management			-Do not use CFC-based refrigerants in new HVAC&R systems. -When reusing existing HVAC&R equipment, complete a comprehensive CFC phase-out conversion before project completion. -Existing small HVAC&R units with < 0.5 lbs of refrigerant, are exempt.	AHA	- R123 has been used as seen on M003 - HVAC SCHEDULES
6			c	Credit	Enhanced Commissioning		2-6	**OPTION 1.** Path 1: Enhanced Commissioning (3 points) **OR** Path 2: Achieve Path 1. **AND** Develop monitoring-based procedures and identify points to be measured and evaluated to assess performance of energy- and water-consuming systems.(4 points) **AND/OR** **OPTION 2.** (2 points) Fulfill the requirements in EA Prerequisite Fundamental Commissioning and Verification as they apply to the building's thermal envelope in addition to mechanical and electrical systems and assemblies.	dbHMS	- Enhanced Cx is included in dbHMS services. - Enclosure and Monitoring-based Cx confirmed.
5	4	9	d	Credit	Optimize Energy Performance		1-18	**OPTION 1.**Analyze efficiency measures during design process & account for results in design decision making. Use energy simulation of efficiency opportunities, past energy simulation analyses for similar buildings, or published data (e.g., Advanced Energy Design Guides) from analyses for similar buildings. Analyze efficiency measures, focusing on load reduction& HVAC-related strategies (passive measures are acceptable) appropriate for the facility. Project potential energy savings and holistic project cost implications related to all affected systems.	AHA	- Can only take savings for base building systems, tenant design cannot be incorporated unless there is a signed tenant lease provided - 2 pts in maybe column as buffer.
						Option 1. 13% improvement in energy performance	6			
					x	Option 1. 15% improvement in energy performance	7			
						Option 1. 17% improvement in energy performance	8			
						Option 1. 19% improvement in energy performance	9			
						Option 1. 21% improvement in energy performance	10			
1			d	Credit	Advanced Energy Metering		1	Install advanced energy metering for the following: -Independently metering energy consumptions (electricity, chilled water, etc.) for all systems to tenant spaces -At least one meter per floor The advanced energy metering must have the following characteristics. -Permanently installed, record at intervals of 1hr or less, & transmit data to remote location. -Elec. meters record both consumption & demand. Whole-building electricity meters should record the power factor, if appropriate. -The data collection system must use a local area network, building automation system, wireless network, or comparable communication infrastructure. -The system must be capable of storing all meter data for at least 36 months. -The data must be remotely accessible. -All meters in the system must be capable of reporting hourly, daily, monthly, and annual energy use.	AHA	-Narrative describes metered systems for electricity, hot water, and chilled water.
		2	c	Credit	Demand Response		1-2	Case 1. -Participate in existing DR program & complete Design a system with the capability for real-time, fully-automated DR based on external initiation by a DR Program Provider. Semi-automated DR may be utilized in practice.	AHA	-Difficult to achieve with this building type. Can reach out to utility company to inquire.
		3	d	Credit	Renewable Energy Production		1-3	Use renewable energy systems to offset building energy costs. % renewable energy = (Equivalent cost of usable energy produced by the renewable energy system / Total building annual energy cost) Use the building's annual energy cost, calculated in EA Prerequisite Minimum Energy Performance, if Option 1 was pursued; otherwise use the U.S. Department of Energy's (CBECS) database to estimate energy use and cost.	AHA	-Not currently in documents or narratives.
		1	d	Credit	Enhanced Refrigerant Management		1	OPTION 1. No refrigerants or low-impact refrigerants (1 POINT) OR OPTION 2. Select refrigerants for HVAC&R equipment to minimize or eliminate the emission of compounds that contribute to ozone depletion and climate change. The combination of all new and existing base building and tenant HVAC&R equipment that serve the project must comply. (1 POINT)	AHA	- Dependent on system design and equipment specifications - Would need to be in TLA.
					Green Power & Carbon Offsets		1-2	Engage in a contract for qualified resources that have come online since January 1, 2005, for a minimum of five years, to be delivered at least annually. The contract must specify the provision of at least 50% or 100% of the project's energy from green power, carbon offsets, or renewable energy certificates (RECs).RECs can only be used to mitigate the effects of Scope 2, electricity use.	Ownership	- 1 time purchase based on design energy use. - Current cost is $4,415 for 50% and $8,387 for 100% - Patrick confirmed yes 10.26.18
	2		c	Credit		50% of total energy addressed by green power, RECs and/or offsets	1			
					x	100% of total energy addressed by green power, RECs and/or offsets	2			

4 Y	1 ?	9 N	d/C	Materials and Resources	14	Strategy	Resp. Party	Action Items
REQ'D			d	Prereq	Storage and Collection of Recyclables	Provide dedicated areas accessible to waste haulers & building occupants for the collection & storage of recyclable materials (may be separate locations). Recyclable materials: mixed paper, corrugated cardboard, glass, plastics, and metals. Take appropriate measures for the safe collection, storage, and disposal of two of the following: batteries, mercury containing lamps, and electronic waste.	SGA	
REQ'D			c	Prereq	Construction and Demolition Waste Management Planning	Develop and implement a construction and demolition waste management plan: -Establish waste diversion goals for the project by identifying at least five materials targeted for diversion. Approximate a percentage of the overall project waste that these materials represent. -Specify whether materials will be separated or commingled and describe the diversion strategies planned for the project. Describe where the material will be taken and how the recycling facility will process the material. -Provide a final report detailing all major waste streams generated, including disposal and diversion rates. -Alternative daily cover (ADC) does not qualify	GC	
		6	c	Credit	Building Life-Cycle Impact Reduction	2-6	**OPTION 4.** Conduct LCA of project's structure & enclosure that demonstrates min 10% reduction, compared with baseline building, in at least 3 of the 6 LC impact categories, 1 of which must be GWP. No impact category assessed may increase by more than 5% compared with the baseline building.	n/a	-Requires LCA software and additional services.
1		1	c	Credit	Building Product Disclosure and Optimization - Environmental Product Declarations	1-2	**OPTION 1.** Use min 20 different permanently installed products sourced from at least 5 different manufacturers that meet one of the disclosure criteria below. -Product-specific declaration. -Environmental Product Declarations which conform to ISO 14025, 14040, 14044, and EN 15804 or ISO 21930 and have at least a cradle to gate scope. -USGBC approved program - Products that comply with other USGBC approved environmental product declaration frameworks.(1 Point) **OPTION 2.** - Third party certified products that demonstrate impact reduction below industry average in at least three of the following categories are valued at 100% of their cost for credit achievement calculations.	SGA, GC	- Will require research and coordination between Architect and GC - May be difficult on C&S; requires 20 different products from 5 different manufacturers

	1	1	c	Credit	Building Product Disclosure and Optimization - Sourcing of Raw Materials	1-2	**OPTION 1.** RAW MATERIAL SOURCE AND EXTRACTION REPORTING (1 POINT) Use min. 20 different permanently installed products from at least five different manufacturers that have report from raw material suppliers which include raw material supplier extraction locations, commitment to long-term ecologically responsible land use, commitment to reducing environmental harms from extraction and/or manufacturing processes, & commitment to meeting applicable standards or programs voluntarily that address responsible sourcing criteria. **OPTION 2.** LEADERSHIP EXTRACTION PRACTICES (1 POINT) Use products with min. 1 of extraction criteria below for min. 25%(cost), of permanent products. -Extended producer responsibility. Products are valued 50% of their cost for credit achievement calc. -Bio-based materials. ASTM Test Method D6866 & be legally harvested, valued at 100% of their cost. -Wood products. Certified by Forest Stewardship Council/USGBC-approved, valued at 100% of their cost -Materials reuse. valued at 100% of their cost -Recycled content. valued at 100% of their cost -Other USGBC approved programs meeting leadership extraction criteria. Products sourced within 100 miles(project site) valued at 200% of their base contributing cost. Contributing cost of individual products compliant with multiple responsible extraction criteria is not to exceed 100% total actual cost. No product to contribute > 200% of its total actual cost. Structure and enclosure materials may not constitute more than 30% of the value.	SGA, GC	-Will require research and coordination between Architect and GC. - Aim for 25% recycled content by cost of total material cost of the project.
1		1	c	Credit	Building Product Disclosure and Optimization - Material Ingredients	1-2	**OPTION 1. MATERIAL INGREDIENT REPORTING (1 POINT)** Use min. 20 different permanently installed products from at least 5 different manufacturers that use any of following programs to demonstrate chemical inventory of the product to at least 0.1%(1000 ppm). -The manufacturer has published complete content inventory for product following these guidelines: 1. A publicly available inventory of all ingredients identified by name and CASRN. 2. Materials defined as trade secret/intellectual property may withhold the name and/or CASRN but must disclose role, amount and Green Screen benchmark, as defined in Green Screen v1.2. -The end use product has a published, complete Health Product Declaration with full disclosure of known hazards in compliance with the Health Product Declaration open Standard. -The end use product has been certified at the Cradle to Cradle (v2 Basic level/v3 Bronze level). -Other USGBC approved programs meeting the material ingredient reporting criteria. **AND/OR** **OPTION 2. MATERIAL INGREDIENT OPTIMIZATION (1 POINT)** Use products that document their material ingredient optimization for at least 25%, by cost, of the total value of permanently installed products in the project. **OPTION 3. PRODUCT MANUFACTURER SUPPLY CHAIN OPTIMIZATION (1 POINT)** EXEMPLARY PERFORMANCE Option 1. Purchase at least 40 permanently installed building products that meet the credit criteria.	SGA, GC	-Will require research and coordination between Architect and GC. - May be difficult on C&S, requires 20 different products from 5 different manufacturers.
2			c	Credit	Construction and Demolition Waste Management	1-2	**OPTION 1.** Path 1. Divert at least 50% of the total construction & demolition material; diverted materials must include at least three material streams.(1 Points) OR Path 2. Divert at least 75% of the total construction and demolition material; diverted materials must include at least four material streams.(2 Points) OR **OPTION 2.** Do not generate more than 2.5 pounds of construction waste per square foot (12.2 kilograms of waste per square meter) of the building's floor area.(2 Points) EXEMPLARY PERFORMANCE Achieve both Option 1 (either Path 1 or Path 2) and Option 2.	GC	

6 Y	4 ?	0 N	d/C	Indoor Environmental Quality	10	Strategy	Resp. Party	Action Items
REQ'D			d	Prereq	Minimum Indoor Air Quality Performance	**Ventilation** **Mechanically ventilated spaces** (and mixed-mode with mechanical ventilation activated), determine min. outdoor air intake flow for mechanical ventilation systems using ventilation rate procedure from ASHRAE 62.1-2010/ local equivalent(stringent one). Meet min. requirements of ASHRAE Standard 62.1-2010, Sections 4-7, Ventilation for Acceptable Indoor Air Quality (with errata),/ local equivalent, whichever is more stringent. **Monitoring** **Mechanically ventilated spaces** (& mixed-mode) monitor outdoor air intake flow as follows: -For VAV systems, **provide direct outdoor airflow measurement device capable of measuring the min. outdoor air intake flow.** This device must measure min. outdoor air intake flow with accuracy +/-10% of design minimum outdoor airflow rate, as defined by ventilation requirements above. Alarm must indicate when the outdoor airflow value varies by 15% or more from the outdoor airflow set point. -For constant-volume systems, balance outdoor airflow to design minimum outdoor airflow rate defined by ASHRAE Standard 62.1-2010 (with errata), or higher. Install a current transducer on the supply fan, an airflow switch, or similar monitoring device.	AHA	- Mechanical ventilation systems installed during C&S construction must be capable of meeting projected ventilation levels and monitoring based on the requirements of anticipated future tenants.
REQ'D			d	Prereq	Environmental Tobacco Smoke Control	Prohibit smoking inside the building. Prohibit smoking outside building except in designated smoking areas at least 25 feet from all entries, outdoor air intakes, & operable windows. Also prohibit smoking outside property line spaces used for business purposes. If the requirement to prohibit smoking within 25 feet cannot be implemented because of code, provide documentation of these regulations. Signage must be posted within 10 feet of all building entrances indicating the no-smoking policy.	Ownership, SGA	- No Smoking signage is present in the dwg but the places need to be marked on the plan where they are or will be located (according to the requirements stated in the stratergy column)- G-301 - Signage and Branding
2			d	Credit	Enhanced Indoor Air Quality Strategies	1-2	**OPTION 1. ENHANCED IAQ STRATEGIES (1 POINT).** Comply with following requirements, as applicable. Mechanically ventilated spaces: A. entryway systems; B. interior cross-contamination prevention; and C. filtration. **OPTION 2. ADDITIONAL ENHANCED IAQ STRATEGIES (1 PT).** Comply below requirements, as applicable. Mechanically ventilated spaces (select one): A. exterior contamination prevention; B. increased ventilation; C. carbon dioxide monitoring; or D. additional source control and monitoring.	SGA, AHA	-10' entryway systems at all regularly used entrances. Arch to show on plans. -Exhaust in Janitor/Housekeeping closets. - Final filer is MERV 13 filters ffor all AHU - Provide CO2 monitoring in all densely occupied spaces.

2	1		c	Credit	Low-Emitting Materials	1-3	For product manufacturing & project teams. Covers VOC emissions into indoor air & content in materials, & emissions testing methods. The building interior & exterior organized in 7 categories, each with different thresholds of compliance. The building interior is defined as everything within the waterproofing membrane. The building exterior is everything outside and inclusive of the primary and secondary weatherproofing system. OPTION 1.Achieve threshold compliance with emissions & content stds for categories listed in Table2. OPTION 2. If products in a category do not meet the criteria, project teams may use the budget calculation method(Table 3). EXEMPLARY PERFORMANCE Option 1. Earn all points and reach 100% of products. Option 2. Reach 100% of products.	SGA, GC	-2 for 1pt: Paints/Coatings, Flooring -4 for 2pts: +Insulation, Composite Wood -5 for 3pts: +Adhesive/Sealants
1			c	Credit	Construction Indoor Air Quality Management Plan	1	Develop & implement IAQ management plan for construction & preoccupancy and must address: -During construction, meet/exceed all recommended control measures of SMACNA IAQ Guidelines for Occupied Buildings under Construction, 2nd edition, 2007, ANSI/SMACNA 008-2008, Chapter 3. -Protect absorptive materials stored on-site and installed from moisture damage. -Permanent air-handling equipment must have minimum MERV 8 filtration media during construction, before occupancy, replace all filtration media with the final design filtration media. -Prohibit tobacco use inside building & within 25 ft of the building entrance during construction.	GC	-Common construction practice
	3		c	Credit	Daylight	3	OPTION 1. SIMULATION: SPATIAL DAYLIGHT AUTONOMY AND ANNUAL SUNLIGHT EXPOSURE (2-3 POINTS) Demonstrate spatial daylight autonomy 300/50% (sDA300/50%) of at least 55%(2 Points)/75%(3 Points) is achieved. Use regularly occupied floor area. AND Demonstrate annual sunlight exposure1000,250 (ASE1000,250) < 10% is achieved. Use the regularly occupied floor area that is daylit per the sDA300/50% simulations. The sDA and ASE calculation grids< 2 feet square & laid across the regularly occupied area at work plane height of 30 inches above finished floor (unless otherwise defined). Use an hourly time-step analysis based on typical meteorological year data/equivalent, for the nearest available weather station. Include permanent interior obstructions. Moveable furniture and partitions may be excluded. OR OPTION 2. SIMULATION: ILLUMINANCE CALCULATIONS (1-2 POINTS) Demonstrate illuminance levels b/w 300 lux and 3,000 lux for 9 am & 3 pm, both on clear-sky day at equinox, for the floor area 55%(1 Points)/75%(2 Points). Use regularly occupied floor area. Calculate illuminance intensity for sun & sky for clear-sky conditions as follows: -Use typical meteorological year data, or an equivalent, for the nearest available weather station. -Select 1 day within 15 days of Sep 21 and 1 within 15 days of Mar 21 for the clearest sky condition. -Use the avg of the hourly value for the 2 selected days. Exclude blinds/shades from model. Include permanent interior obstructions. Moveable furniture and partitions may be excluded.	TBD	- Requires simulation to prove compliance. - Glare control may be an issue.
1			c	Credit	Quality Views	1	Achieve direct line of sight to outdoors via vision glazing for 75% of all reg. occupied floor area. View glazing in the contributing area must provide a clear image of the exterior. Additionally, 75% of all regularly occupied floor area must have min. 2 of below: -multiple lines of sight to vision glazing in different directions at least 90 degrees apart; -views that include at least two of the following: (1) flora, fauna/sky; (2) movement; &(3) objects at least 25 feet (7.5 meters) from the exterior of the glazing; -unobstructed views located within the distance of 3 times the head height of vision glazing; and -views with a view factor of 3/greater, as defined in "Windows & Offices; A Study of Office Worker Performance & the Indoor Environment." Include in calculations permanent interior obstructions. Movable furniture & partitions may be excluded. Views into interior atria may be used to meet up to 30% of the required area. EXEMPLARY PERFORMANCE New Construction, Core and Shell, Schools, Retail, Data Centers, Hospitality Meet the requirements for 90% of all regularly occupied area.	dbHMS	- Need the calculation done, but from the drawing it can be seen that all the regularly occupoed spaces have views.

4 Y	2 ?	0 N	d/C		Innovation	6	Strategy	Resp. Party	Action Items
1			c	Credit	Innovation in Design: EP for Parking Reduction	1	80% parking reduction over Baseline.	SGA	
1			c	Credit	Innovation in Design: EP for Heat Island Effect	1	100% of parking under cover AND meeting SRI requirements for site and roof.	SGA	
1			c	Credit	Innovation in Design: Community Outreach and Involvement	1	Meet with the community during predesign and premilinary design. Modify design based on results of meetings. Establish ongoing means for communication between the developer and the community throughout the design and construction phases and, in cases where the developer maintains any control, after construction.	dbHMS, Ownership	
	1		c	Credit	Innovation in Design: Parksmart Bicycle Parking	1	100 bicycle storage spaces, signage, tire inflation station.	SGA	
	1		c	Credit	Innovation in Design: TBD	1			
1			c	Credit	LEED Accredited Professional	1	At least one principal participant of the project team must be a LEED Accredited Professional (AP) BD+C	dbHMS	-dbHMS

2 Y	1 ?	1 N	d/C		Regional Priority	4	Strategy	Resp. Party	Action Items
1			c	Credit	Indoor Water Use (4pts)	1	Renewable Energy (3pts), Optimize Energy (8pts), High Priority Site, Rainwater Management, Indoor Water Use (4pts)	dbHMS	
		1	c	Credit	Rainwater Management	1		dbHMS	
1			c	Credit	High Priority Site	1		dbHMS	
	1		c	Credit	Optimize Energy	1		dbHMS	

60	15	35	Total Points	Possible Points: 110

Certified 40-49 points Silver 50-59 points Gold 60-79 points Platinum 80-110

Sustainable Design Narrative
Union Square Redevelopment Project Parcel D2.1

As part of meeting the Union Square Redevelopment zoning requirements, the Somerville D2.1 project goals include meeting LEED version 4 Gold level of certification requirements. The descriptions below highlight strategies to focus on to achieve the level of sustainability desired for the project. The LEED Checklist is included at the end of the document. This document has been prepared by Claudia Mattison, LEED AP BD+C, LEED for Homes Green Rater.

Integrative Process

Integrative Process (Credit)

During SD and the early part of DD, the project team has used cross-discipline design and decision making to identify and use opportunities to achieve synergies across disciplines and building systems. As part of the commissioning process, an Owner's Project Requirements document has been put together to guide the design and construction team. As part of the MEPA and GHG processes and in early phase energy modeling, preliminary energy models were developed to test potential strategies associated with the following opportunities: Site condition, massing and orientation, basic envelope orientation, lighting levels, thermal comfort ranges, and plug and process load needs. A preliminary water budget analysis was completed for both indoor and outdoor water demand, and process water demand and supply sources were investigated. The results of these analysis were incorporated into the design of the project where practical and economical.

Location and Transportation

Sensitive Land Protection (Credit)

The project is located on a previously developed site.

High Priority Site (Credit)

The project team expects to earn both Option 2 - Priority Designation and Option 3 – Brownfield Remediation. The site has been assessed for pollutants and measures will be taken for remediation, abatement and removal in accordance with regulations. Additionally, the site is a 2019 Difficult Development Area, which qualifies it for Option 2.

Surrounding Density and Diverse Uses (Credit)

The project is a new building on a previously developed site; therefore, it meets the "Previously Developed" requirements. The area round the project will satisfy the surrounding density requirement. The project team will identify building sites and buildable land within required radius of the project site, collect information on density, and perform combined residential and non-residential density calculations. To fulfill the diverse uses requirements, the development is located within ½ mile of a dense residential area and a number of amenities including but not limited to: Bronwyn, Ebi Sushi, the Museum, Reliable Market, Market Basket, Foursquare Church, St. Joseph's Church, Grace Salon, Citizens Bank, Belly Dance Somerville, Union Square Farmers Market, Community Laundry, East Boston Savings Bank, Third Life Studio, Loyal Supply, and the Somerville Fire Department.

Access to quality Transit (Credit)

The project is located within ¼ mile of the CT2, 85, 86, and 87 MBTA bus lines. Additionally, the project will be directly adjacent to the Green Line Extension Union Square stop, which should be complete in 12/2021, within twenty-four months of the project's completion date.

Bicycle Facilities (Credit)

The project will meet the credit requirements by providing short-term bicycle storage for at least 2.5% of all peak visitors, and long-term bicycle storage for at least 30% of all regular building occupants. The current plans show 50 bicycle spaces, which is greater than the 32 long term and 4 short term spots required. The bicycle storage will be provided in Bike Room 105. The bicycle network through Union Square and the diverse destinations (noted above in the Surrounding Density and Diverse Uses credit) will be documented via a map.

Reduced Parking Footprint (Credit)

The 175 parking spaces provided (out of the 290 which serve Parcel D2.2/2.3 and Parcel D2.1), are an 80% reduction from the LEED Baseline for parking spaces for an office/lab building, which meets the 40% reduction requirement and earns an additional point for exemplary performance (80% reduction). Additionally, 15 preferred parking spaces (5%) have been reserved for carpools to meet the requirement for both Parcel D2.2/2.3 and Parcel D2.1.

Green Vehicles (Credit)

The project will designate 5% of all parking spaces used by the project as preferred parking for green vehicles (15 spaces). These spaces will be clearly identified and enforced for sole use by green vehicles. Additionally, 6 electric vehicle charging spaces have been show on the plans to meet the 2% electric vehicle charging stations requirement for both Parcel D2.2/2.3 and Parcel D2.1.

Sustainable Sites

Construction Activity Pollution Prevention (Prerequisite)

An erosion and sedimentation plan will enforce measures to protect adjacent areas from pollution from wind and water-borne soil and sedimentation. The civil design team prepared the erosion and sedimentation plan that meats the local codes and the EPA Construction General Permit of the National Pollution Discharge Elimination System (NPDES) program. The construction team will implement the erosion and sedimentation measures and will follow the requirements of the stormwater pollution prevention plan during the construction.

Site Assessment (Credit)

The project will complete and document a site assessment that includes topography, hydrology, climate, vegetation, soils, human use, human health effects.

Heat Island Reduction (Credit)

The project will meet Option 1 by using a white roof membrane over the entire roof surface and using site paving that has a solar reflectance of at least 0.28 (3-year aged value). The project will meet Option 2 by placing 100% of parking area under the compliant roof. The project will earn an exemplary performance credit for meeting both options.

Light Pollution Reduction

The project will design the exterior lighting to meet the BUG rating requirements for Lighting Zone LZ3.

Tenant Design and Construction Guidelines

The project will provide a Tenant Design and Construction Guidelines to all tenants that includes a description of the sustainable design and construction features incorporated in the core and shell project; the project's sustainability goals and objectives (including those for tenant spaces); recommendations, including examples, for sustainable strategies, products, materials, and services; and information that enables the tenants to coordinate space design and construction with the building systems when pursuing the LEED v4 for Interior Design and Construction prerequisites and credits.

Water Efficiency

Outdoor Water Use Reduction (Prerequisite)

The project will reduce the project's landscape water requirement by at least 30% from the calculated baseline for the site's peak watering month. Reductions will be achieved through plant species selection and irrigation system efficiency (drip irrigation and smart controllers), as calculated by the Environmental Protection Agency (EPA) WaterSense Water Budget Tool. The project is currently planning on using stormwater for irrigation to avoid using any potable water for irrigation purposes.

Indoor Water Use Reduction (Prerequisite)

The project will use low flush 1.0 GPF toilets, 0.125 GPF urinals, 0.35 GPM lavatory faucets, 1.5 GPM kitchen faucets, and 1.0 GPM showerheads, which are are calculated to achieve a reduction in water usage of approximately 46% over the baseline. All fixtures except the kitchen and lavatory faucets will be WaterSense certified, and all appliances will be ENERGY STAR.

Building-Level Water Metering (Prerequisite)

The project will install permanent water meters that measure the total potable water use for the building and associated grounds.

Outdoor Water Use Reduction (Credit)

The project will reduce the project's landscape water requirement by at least 30% from the calculated baseline for the site's peak watering month. Reductions will be achieved through plant species selection and irrigation system efficiency (drip irrigation and smart controllers), as calculated by the Environmental Protection Agency (EPA) WaterSense Water Budget Tool. The project is currently planning on using stormwater for irrigation to avoid using any potable water for irrigation purposes.

Indoor Water Use Reduction (Credit)

The project will use low flush 1.0 GPF toilets, 0.125 GPF urinals, 0.35 GPM lavatory faucets, 1.5 GPM kitchen faucets, and 1.0 GPM showerheads, which are are calculated to achieve a reduction in water usage of approximately 46% over the baseline. All fixtures except the kitchen and lavatory faucets will be WaterSense certified, and all appliances will be ENERGY STAR.

Cooling Tower Water Use (Credit)
The project will conduct a one-time potable water analysis, measuring Ca (as CaCO3), total alkalinity, SiO2, Cl-, and Conductivity. The project will achieve a minimum 10 cycles by increasing the level of treatment in condenser or make-up water and will study the potential for using a minimum 20% recycled nonpotable water through rainwater capture and reuse.

Water Metering (Credit)
The project will install permanent water meters to monitor water use for at least two water subsystems, likely irrigation and cooling tower water use.

Energy and Atmosphere
Fundamental Commissioning (Prerequisite)
Commissioning of mechanical, electrical, and plumbing, in accordance with ASHRAE Guideline 0-2005 and ASHRAE Guideline 1.1–2007 is under contract and will be performed. An Owner's Project Requirements has been developed, and a Basis of Design will be developed as well.

Minimum Energy Performance (Prerequisite)
The energy code utilized for the Project will be the Massachusetts Energy Stretch Code and ASHRAE Standard 90.1-2010 for LEED purposes. The energy model has been developed and shows approximately 15.9% energy cost reductions over the LEED Baseline and 29.5% energy savings over the Stretch Code Baseline.

Building-Level Energy Metering (Prerequisite)
Building-level energy meters and submeters that can be aggregated to provide building-level data representing total building energy consumption (electricity and natural gas) will be installed. Energy consumption will be tracked and shared with the USGBC for a five-year period.

Refrigerant Management (Prerequisite)
No CFC-based refrigerants will be utilized for the Project.

Enhanced Commissioning (Credit)
An independent commissioning authority has been contracted to perform on-board design reviews, verify operator training, and review building operations ten months after occupancy in accordance with ASHRAE Guideline 0–2005 and ASHRAE Guideline 1.1–2007. Additionally, the project will develop a monitoring-based commissioning plan that includes monitoring-based procedures and identifies points to be measured and evaluated to assess performance of energy- and water-consuming systems. An independent envelope commissioning authority will be hired to fulfill the requirements in EA Prerequisite Fundamental Commissioning and Verification as they apply to the building's thermal envelope. The BECxA will complete the commissioning process activities for the building's thermal envelope in accordance with ASHRAE Guideline 0–2005 and the National Institute of Building Sciences (NIBS) Guideline 3–2012, Exterior Enclosure Technical Requirements for the Commissioning Process, as they relate to energy, water, indoor environmental quality, and durability.

Optimize Energy Performance (Credit)
The energy model has been developed and shows approximately 15.9% energy cost reductions over the LEED Baseline.

Advanced Energy Metering (Credit)
The project will install submeters for all end-uses that represent 10% or more of total energy consumption. The BAS system will be used for the automatic data collection.

Green Power (Credit 6)
The project will investigate the cost of purchasing renewable energy credits in the amount of 50% of the electricity and gas used in the building once construction is complete.

Materials and Resources
Storage and Collection of Recyclables (Prerequisite)

There will be a dedicated recycling storage area within the loading dock of the building. This area will store paper, corrugated cardboard, glass, plastics and metals for pick-up by local recycling haulers. This area will also include space for the storage and disposal of two of the following: batteries, mercury-containing lamps, and electronic waste.

Construction and Demolition Waste Management Planning (Prerequisite)
The project team will develop and implement a construction and demolition waste management plan establishing waste diversion goals and identify at least five materials targeted for diversion. The plan will specify materials that will be separated onsite, as well as comingled waste, and note the exclusion of Alternative Daily Cover from recycled materials. A final report detailing all major waste streams generated, including disposal and diversion rates, will be provided.

Building Product Disclosure and Optimization— Environmental Product Declarations (Credit)
The project will specify at least 20 different products sourced from at least 5 manufacturers that either have industry-wide EPD's available. The project is targeting 40 EPD's to earn the exemplary performance point for this credit.

Building Product Disclosure and Optimization—Sourcing of Raw Materials (Credit)
The project will use products that have recycled content and wood that is FSC-certified for at least 25%, by cost, of the total value of permanently installed building products in the project.

Building Product Disclosure and Optimization— Material Ingredients (Credit)
The project will use at least 20 different permanently installed products from at least five different manufacturers that have either a manufacturer inventory, a Health Product Declaration, or Cradle to Cradle certification.

Construction and Demolition Waste Management (Credit)
The project team will develop and implement a construction and demolition waste management plan to maximize diversion and reuse of material and identify at least five materials targeted for diversion. The project will divert at least 75% of the total construction and demolition material, and the diverted materials will include at least four material streams.

Indoor Environmental Quality
Minimum IAQ Performance (Prerequisite)
The ventilation code utilized for the Project will be ASHRAE Standard 62.1-2010, as required by the present Massachusetts Building Code and LEED. The mechanical systems are designed to provide the required ventilation throughout the building. Direct outdoor airflow measurement devices capable of measuring the minimum outdoor air intake flow will be provided for all OA systems.

Environmental Tobacco Smoke Control (Prerequisite)
Smoking is prohibited anywhere in the building and within 25 feet of main entries, operable windows, and air intakes. Signage will be posted at entrances to convey this prohibition.

Enhanced Indoor Air Quality Strategies (Credit)
Permanent entryway systems will be provided at least 10 feet long in the primary direction of travel at all regularly used exterior entrances. Spaces where hazardous gases or chemicals may be present will be exhausted at a minimum of 0.50 cfm per square foot to create negative pressure with respect to adjacent spaces when the doors to the room are closed. For each of these spaces, self-closing doors and deck-to-deck partitions will be provided. All ventilation systems will be provided with MERV 13 filters. Carbon dioxide will be monitored in all densely occupied spaces. CO2 monitors will have an audible or visual indicator or alert the building automation system if the sensed CO2 concentration exceeds the setpoint by more than 10%.

Low-Emitting Materials (Credit)
Flooring, paints and coatings, and insulation will be in compliance with the CDPH Standard Method v1.1-2010 emissions testing, and the project will target adhesives and sealants to be in compliance with the CDPH Standard Method v1.1-2010 emissions testing. Paints, coatings, adhesives, and sealants will be specified to meet the low-VOC content limits as prescribed by the respective applicable standards. All composite wood will be documented to have low formaldehyde emissions that meet the California Air Resources Board ATCM for formaldehyde requirements for ultra-low-emitting formaldehyde (ULEF) resins or no added formaldehyde resins.

Construction IAQ Management Plan (Credit)
An Indoor Air Quality Management plans will be implemented during the construction phase in accordance with the SMACNA Indoor Air Quality for Buildings under Construction Guideline. Absorptive materials will be protected from moisture damage. Permanently installed

air handling units will most likely not be operated, but if they are, MERV 8 filters will be used and the filtration media changed prior to occupancy.

Quality Views (Credit)
At least 75% of all regularly occupied spaces will have a direct line of sight to the outdoors. View glazing in the contributing area will provide a clear image of the exterior, not obstructed by frits, fibers, patterned glazing, or added tints that distort color balance. Additionally, 75% of all regularly occupied floor area will have views with a view factor of 3 or greater and views that include at least two of the following: flora, fauna, or sky; movement; and objects at least 25 feet from the exterior of the glazing. This will be documented using typical floor plan layouts.

Innovation in Design
The team will be pursuing two exemplary performance points for Heat Island Reduction and for Parking Reduction. The team will also be pursuing the Community Outreach and Development innovation credit through community engagement.

Regional Priority
The project expects to earn two regional priority points. One additional regional priority point may potentially be earned.

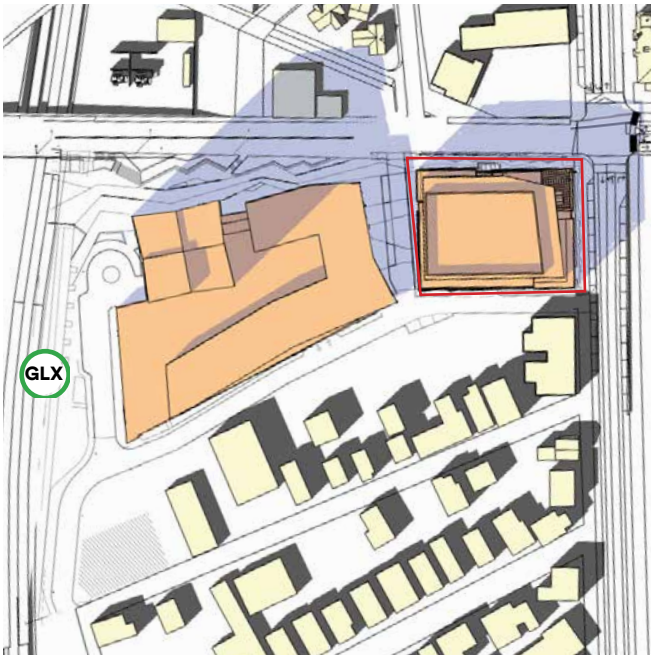
LEED for New Construction v4 Summary: 60 'yes' points and 15 'maybe' points.

SHADOW STUDY

SHADOW STUDY

Existing and Net New Shadows (March, 21)

9AM



12PM

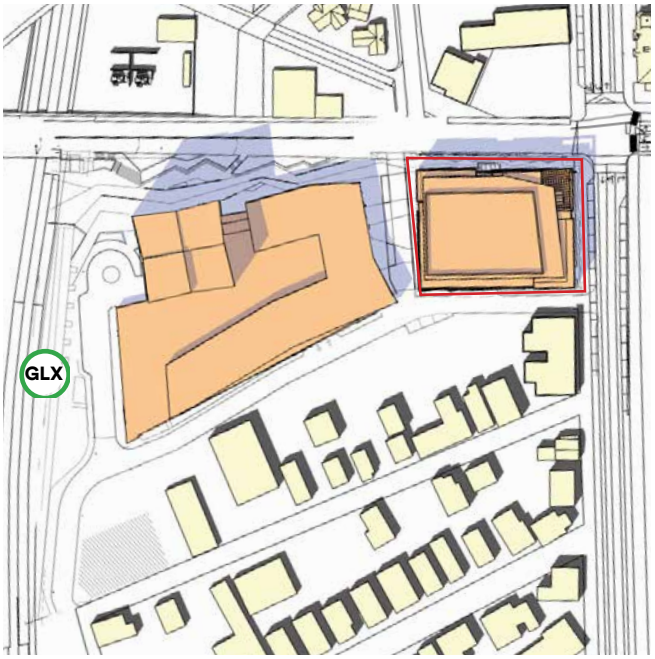
3PM

SCALE 1"=200'-0"

SHADOW STUDY

Existing and Net New Shadows (June, 21)

9AM



12PM

3PM

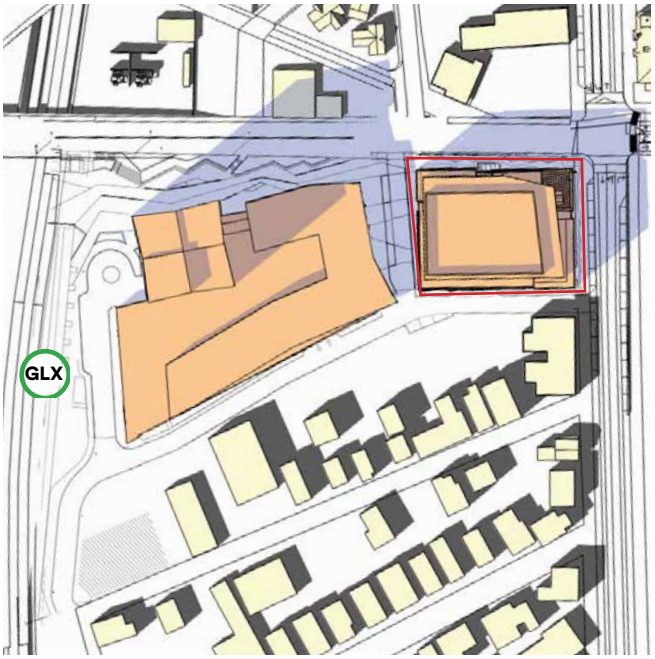
6PM

SCALE 1"=200'-0"

SHADOW STUDY

Existing and Net New Shadows (September, 21)

9AM



12PM

3PM

6PM

SCALE 1"=200'-0"

SHADOW STUDY

Existing and Net New Shadows (December, 21)

9AM

12PM

3PM

SCALE 1"=200'-0"

SHADOW STUDY

Cumulative New Shadows

March, 21

June, 21

September, 21

December, 21

SCALE 1"=200'-0"

PEDESTRIAN LEVEL WIND ANALYSIS

PRELIMINARY RESULTS

UNION SQUARE

SOMERVILLE, MA

PEDESTRIAN WIND STUDY
RWDI #1802485
February 8, 2019

SUBMITTED TO
Patrick D. Borzenski
Vice President of Architecture and Design
pborzenski@magellandevelopment.com

Magellan Development Group LLC
225 N. Columbus Drive, Suite 100
Chicago, Illinois
T: 312-469-8100

SUBMITTED BY
Priya Patel, B.Eng., EIT
Technical Coordinator
Priya.Patel@rwdi.com

Jordan Gilmour, P.Eng.
Project Delivery Manager, Principal
Jordan.Gilmour@rwdi.com

Rowan Williams Davies & Irwin Inc.
600 Southgate Drive,
Guelph, Canada, N1G 4P6
T: 519.823.1311
F: 519.823.1316

SUMMARY

The following document provides the preliminary results for the Pedestrian Wind Study conducted for the proposed Building D2.1 and Building D2.2/2.3 of the Union Square development located in Massachusetts. The project site overlaid with wind statistics recorded at Boston Logan International Airport (**Images 1.1 through 1.5**) as well as photographs of the wind tunnel study model (**Image 2a through 2d**) are shown below. The City of Somerville Wind Suitability Criteria, which deals with both pedestrian safety and comfort as they relate to wind force, is also included in the report in order to assist with the interpretation of the results presented.

The predicted wind comfort and safety conditions pertaining to the four site and surrounding configurations assessed are graphically depicted on a site plan in **Figures 1a through 3d**. These conditions and the associated wind speeds are presented in **Tables 1 and 2**. These results are presented in the attached results package and can be summarized as follows:

- All tested locations are anticipated to meet the effective gust criterion in the No Build configuration. Exceedance of the effective gust criterion, based on the annual climate, is expected at seven locations for the Build configuration. Introducing proposed mitigating elements reduces this count to three, with the addition of future developments eliminating these to result in no exceedances of the effective gust criterion.
- Wind speeds on the site are expected to be low under the No Build configuration.
- In the Build configuration, the proposed building is predicted to increase wind speeds around it. Uncomfortable wind conditions are expected to occur around the south side of the project site, as well as one isolated area at the north corner of Building D2.1. The introduction of mitigating elements reduces these conditions by half, with the addition of future developments further limiting impacts on the D2.1, D2.2/2.3 sites. Most other areas are anticipated to be suitable for walking or better.
- With the addition of the future buildings, in the Full Build configuration, wind speeds are predicted to decrease at several areas located west through north-east of Building D2.1. However, an increase in wind speeds is predicated south of Building D2.3, including a few areas along Webster Avenue.

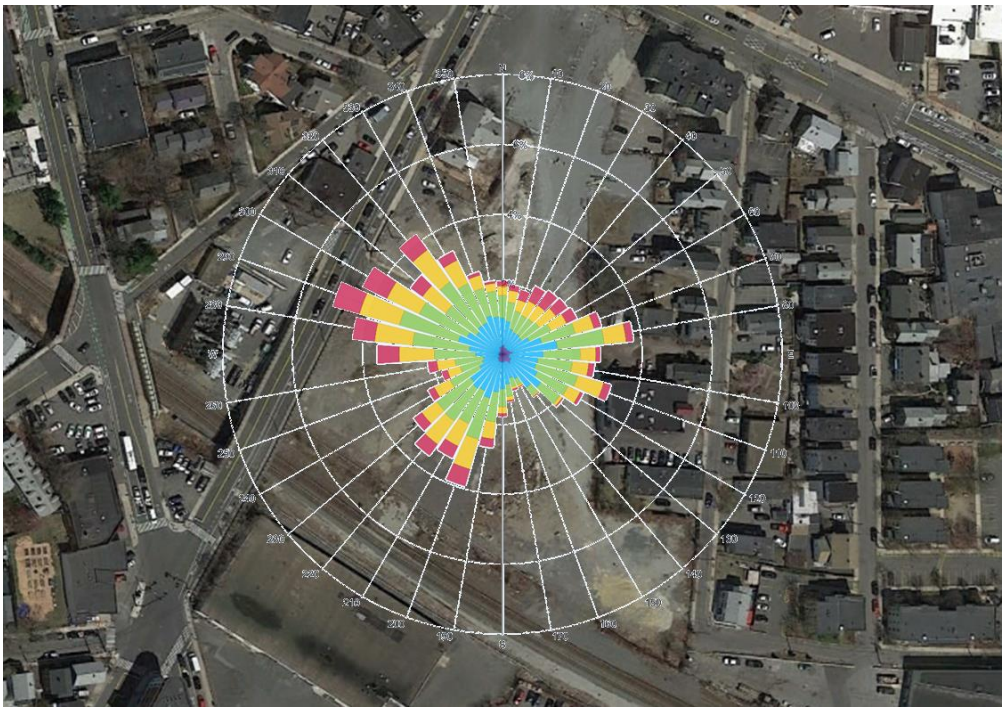
RWDI worked with the design team to review results and develop mitigating strategies coordinating with pedestrian usage at specific locations. Additional commentary regarding background on wind flow patterns, wind comfort levels, and any further recommendations for wind control measures to help moderate wind activity in areas of high wind activity will be presented within the final report. Prior to issuing the report, we suggest that we have a teleconference to go over the results and discuss the types, locations and feasibilities of possible wind control measures.

Meteorological Data

Long-term meteorological data, recorded during the years 1995 through 2017 at Boston's Logan International Airport were used to predict full scale wind conditions. The analysis was performed separately for each of the four seasons and for the entire year. **Images 1.1 through 1.5** present "wind roses" overlaid on the Project site, summarizing the seasonal and annual wind climates in the Somerville area respectively, based on the data from Logan Airport.

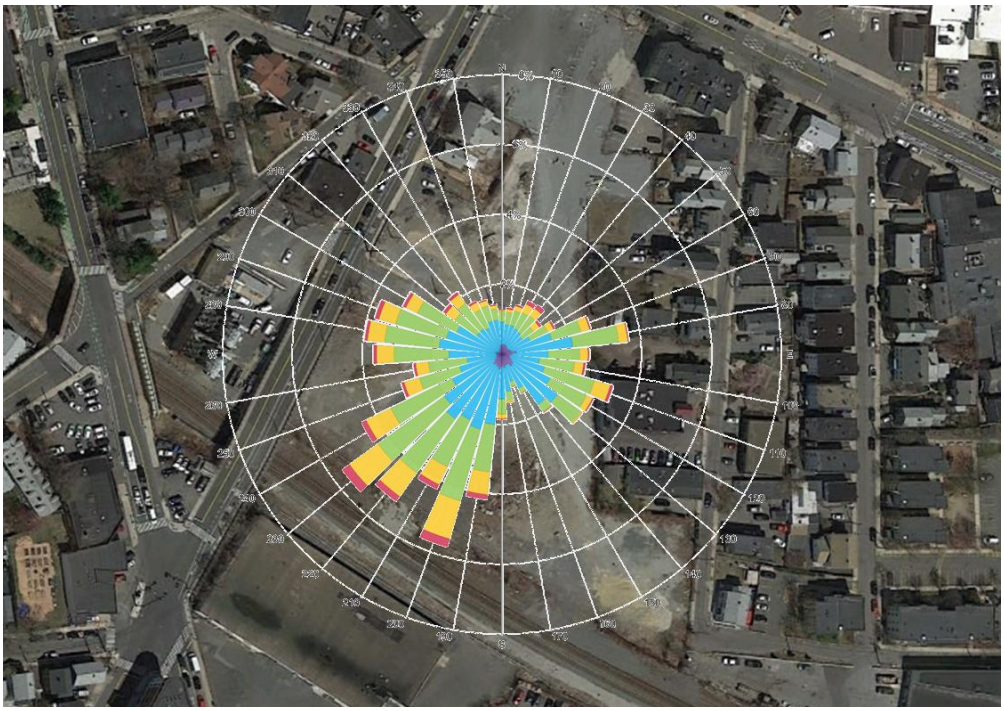
For example, **Image 1.1** summarizes the spring (March, April, and May) wind data which in general, indicate prevailing winds occurring from the northwest to south-southwest and northeast to east-southeast and strong winds (red bands), primarily occurring from the west-northwest, northwest, south-southwest and west directions.

On an annual basis, as shown in **Image 1.5**, the most common wind directions are those between north-northwest and south-southwest. Winds from the east-northeast to the east-southeast are also relatively common. In the case of strong winds, west-northwest, northwest and west are the dominant wind directions.



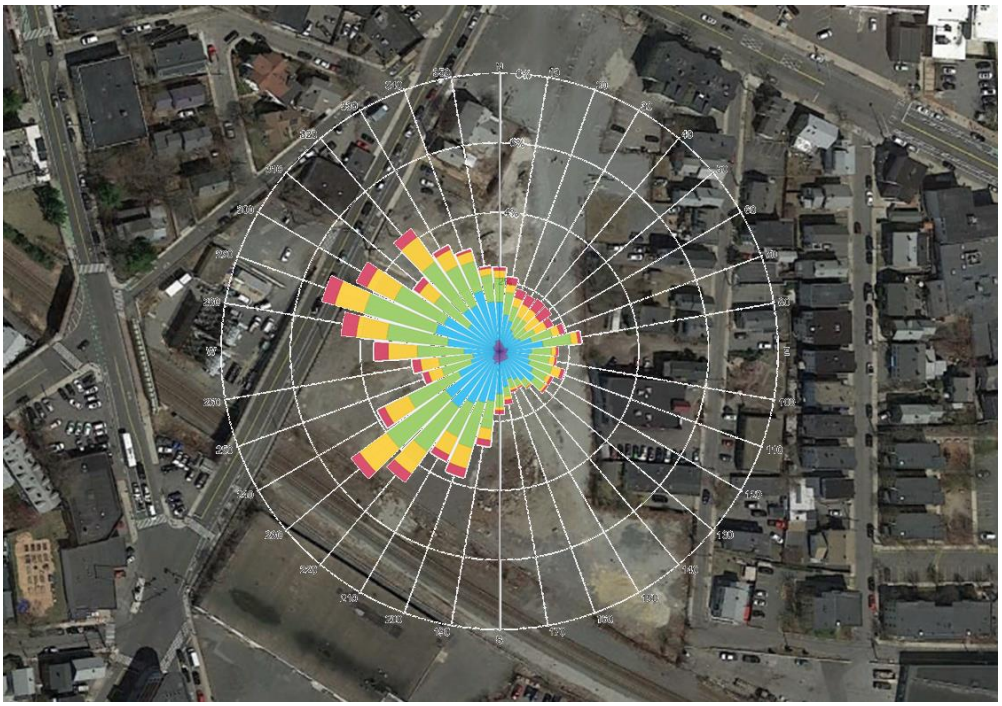
Wind Speed (mph)	Probability (%)
Calm	2.8
1-5	6.8
6-10	28.9
11-15	32.5
16-20	19.1
>20	10.0

Image 1.1: Spring (March-May)



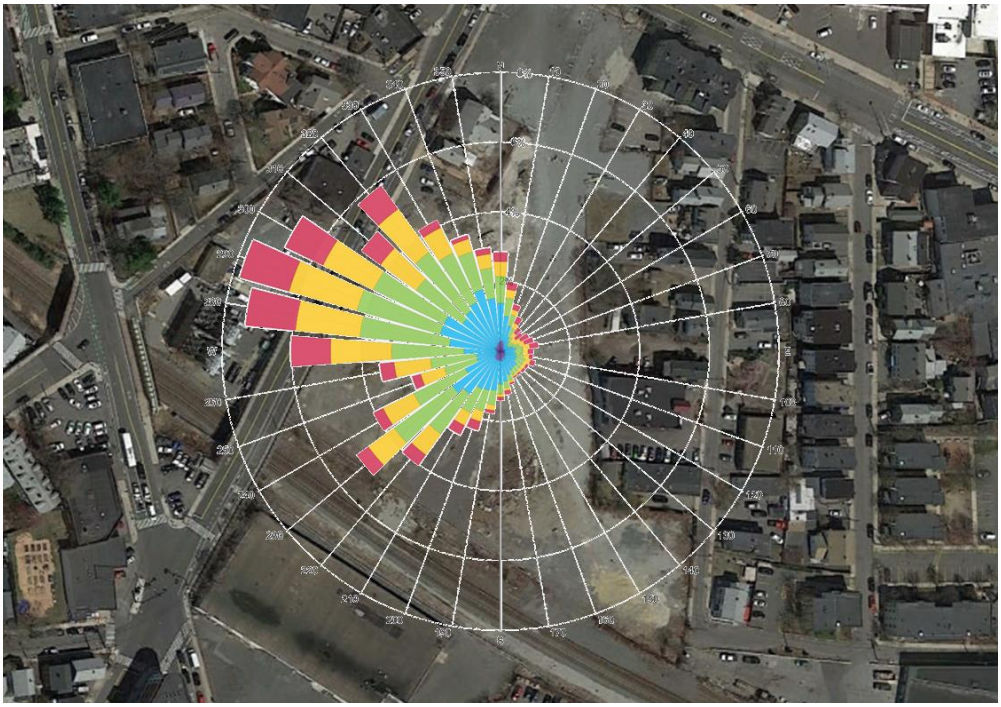
Wind Speed (mph)	Probability (%)
Calm	3.1
1-5	9.5
6-10	38.7
11-15	34.4
16-20	11.8
>20	2.6

Image 1.2: Summer (June-August)



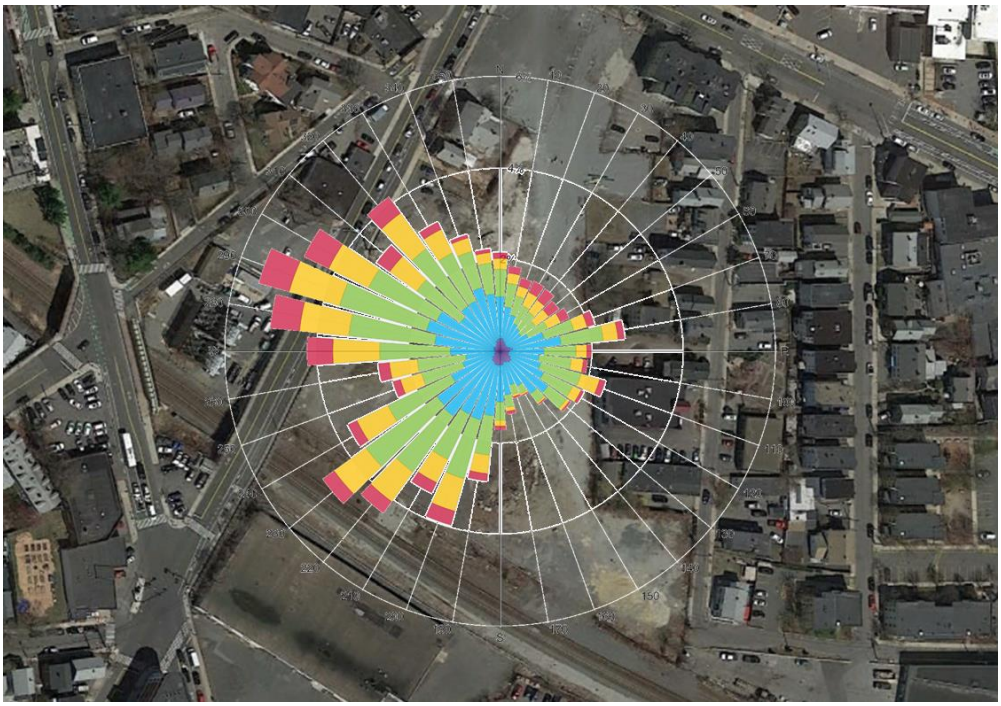
Wind Speed (mph)	Probability (%)
Calm	3.4
1-5	8.7
6-10	34.5
11-15	32.0
16-20	14.6
>20	6.8

Image 1.3: Fall (September- November)



Wind Speed (mph)	Probability (%)
Calm	2.6
1-5	6.5
6-10	27.9
11-15	30.8
16-20	19.7
>20	12.4

Image 1.4: Winter (December-February)



Wind Speed (mph)	Probability (%)
Calm	3.0
1-5	7.9
6-10	32.5
11-15	32.4
16-20	16.3
>20	7.9

Image 1.5: Annual

Image 2a: Wind tunnel study model – No build

Image 2b: Wind tunnel study model – Build

Image 2c: Wind tunnel study model – Build with trees

Image 2d: Wind tunnel study model – Full Build

FIGURES

SOLAR GLARE ANALYSIS

FINAL REPORT

UNION SQUARE DEVELOPMENT BUILDING D2.1

DETAILED SOLAR REFLECTION ANALYSIS

JANUARY 31, 2019
PROJECT #: 1802485

SUBMITTED TO
Patrick D. Borzenski AIA
Vice President of Architecture and Design
Magellan Development Group LLC
T: 312-469-8100
pborzenski@magellandevelopment.com

SUBMITTED BY
Jordan Gilmour, P.Eng.
Senior Project Manager/Principal
jordan.gilmour@rwdi.com

Ryan Danks, B.A.Sc., P.Eng.
Senior Engineer/Associate
ryan.danks@rwdi.com

Sina Hajitaheri, M.A.Sc.
Technical Coordinator
sina.hajitaheri@rwdi.com

RWDI
600 Southgate Drive,
Guelph, Canada, N1G 4P6
T: 519.823.1311
F: 519.823.1316

EXECUTIVE SUMMARY

RWDI was retained to investigate the impact that solar reflections emanating from building D2.1 of the proposed Union Square development will have on the surrounding urban realm.

Thermal Impacts on People

The planar nature of the facades of the proposed building ensure that reflected sunlight will not focus (multiply) in any particular area. Therefore, RWDI does not expect any significant thermal impacts (i.e. risks to human safety or property damage) to occur in the surrounding neighborhood.

Thermal Impacts on Facades

At all studied facade areas, reflections are of low intensity and short duration. Hence, we would not expect these reflections to lead to a significant additional cooling load for a building. Should an individual choose to expose themselves to the reflected energy through a window, they may feel warm, however this would be a temporary experience and one which would easily be remedied by closing window treatments.

Visual Glare Impact on Drivers

As with the addition of any glazed building, drivers travelling in the vicinity of the building are expected to experience an increased level of visual glare impact. Drivers along Somerville Avenue, Prospect Street, and Bennett Court are predicted to experience reflections from the buildings which can cause a high level of impact. However, the potential for high impacts at these locations is possible in less than 0.9% of the daytime.

Visual Glare Impact on Pedestrians and Facades

Typical levels of visual glare are possible for pedestrians and building occupants in the vicinity of the development. Some of these reflections are frequent and relatively long in duration particularly on the residences immediately east of the building and on the rooftops of building D2.2. That said, these types of reflections represent at worst a visual nuisance, as viewers can look away or close blinds. This condition is common in many urban centers and is unlikely to present a safety risk.

Overall Impact of Reflections

The impacts of building D2.1 on its surrounds are typical of any modern building of this size. However, we note that detailed facade material properties were not available. As a result, the results and conclusions presented herein may not be valid if the ultimately selected glazing and metal types are significantly more reflective than the typical values assumed by RWDI. Refer to the Assumptions and Limitations section starting on page 8 for details.

TABLE OF CONTENTS

INTRODUCTION

This report provides the computer modeling results of reflected sunlight from building D2.1 of the proposed Union Square Development in Somerville, MA. The D2.1 building is part of a larger project that will encompass multiple blocks in the Union Square area as shown in Figure 1. It is our understanding that the development will be surrounded by typical urban spaces such as busy roadways, and other buildings.

RWDI was retained to investigate the impact that solar reflections emanating from the proposed building will have on the surrounding urban terrain.

A preliminary set of simulations was conducted to determine peak reflection intensities and the frequency of occurrence of reflections for a broad area around the building. This served to identify areas which may experience high intensity or very frequent reflections. This informed the selection of 15 points which underwent a more detailed analysis.

These receptor points represent drivers, pedestrians, and building facades and the detailed analysis allows us to quantify the frequency, intensity and duration of glare events at those locations as well as the sources of those reflections.

Figure 1: Location of the Proposed Development

Urban Reflections

While a common occurrence, solar reflections from buildings can lead to numerous visual and thermal issues.

Visual glare can:

- Impair the vision of motorists and others who cannot easily look away from the source;
- Cause nuisance to pedestrians or occupants of nearby buildings; and,
- Create undesirable patterns of light throughout the urban fabric.

Heat gain can:

- Affect human thermal comfort;
- Be a safety concern for people and materials, particularly if multiple reflections are focused in the same area; and
- Create increased cooling needs in conditioned spaces affected by the reflections.

The most significant safety concerns with solar reflections occur with concave facades (Figure 2) which act to focus the reflected light in a single area. RWDI does not expect this to be a concern given the form of the building.

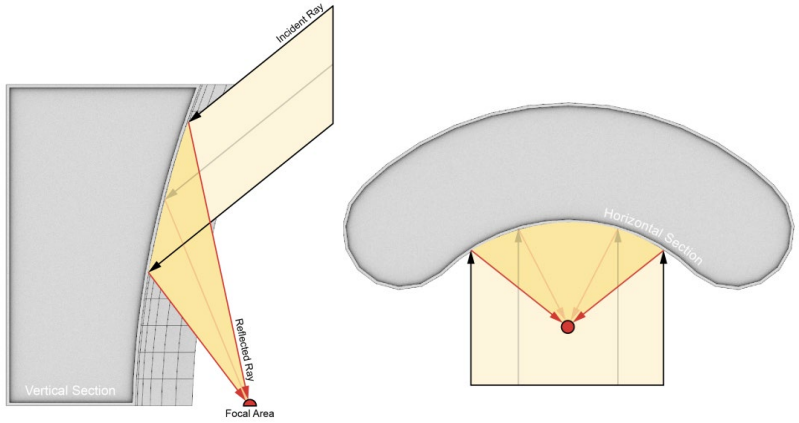


Figure 2: Illustration of Reflection Focusing Due to a Concave Facade

Methodology

RWDI assessed the potential reflection issues using RWDI's in-house proprietary *Eclipse* software, in two phases as per the steps outlined below:

- The Phase 1 "Screening" assessment began with the development of a 3D model of the area of interest (as shown in Figure 3). This was then subdivided into many smaller triangular patches (see Figure 4).
- For each hour in a year, the expected solar position was determined, and "virtual rays" were drawn from the sun to each triangular patch of the 3D model. Each ray that was considered to be "unobstructed" was reflected from the building surface and tracked through the surrounding area. The study domain included the entire pedestrian realm within 1,000 feet of the proposed building.
- The total reflected energy at that hour from all of the patches was computed and its potential for visual and thermal impacts was assessed.
- Finally, a statistical analysis was performed to assess the frequency, and intensity of the glare events occurring throughout the year within the nearby airspace. The criteria used to assess the level of impact can be found in Appendix B of this report.

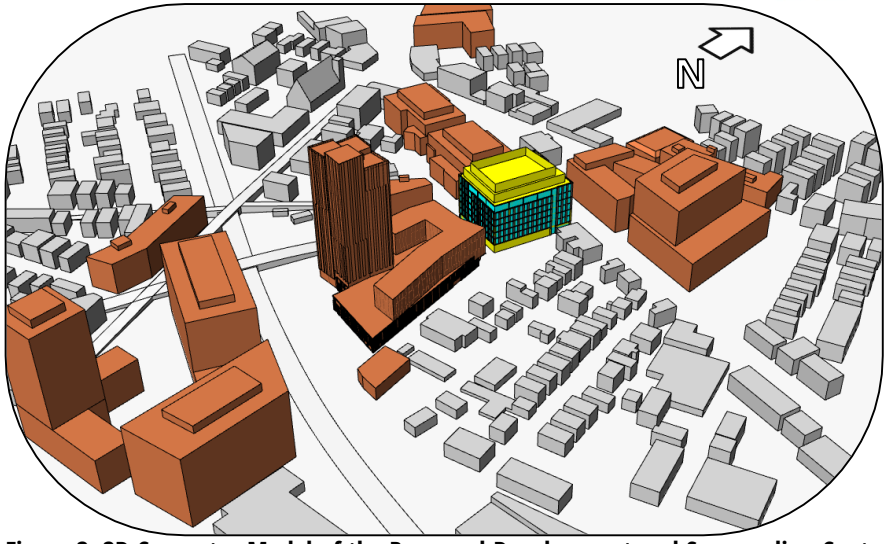


Figure 3: 3D Computer Model of the Proposed Development and Surrounding Context

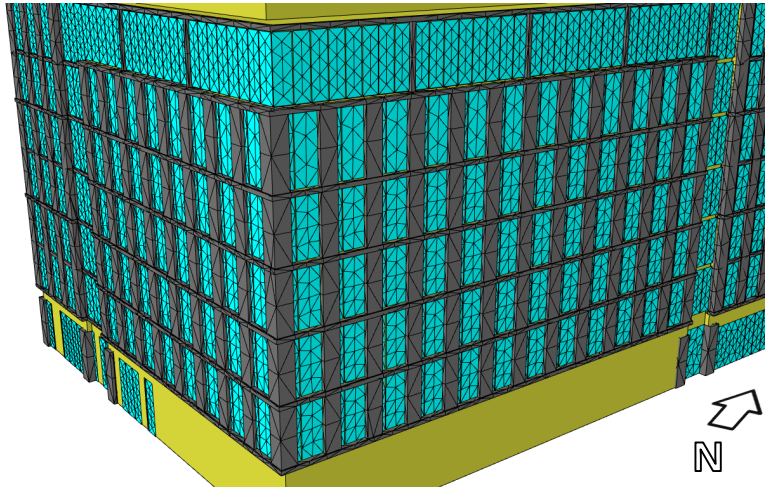


Figure 4: Close-up View of the Model, Showing Surface Subdivisions

Methodology (cont'd)

- Based on the findings of the Screening analysis, representative 'receptor points' were selected to undergo the more detailed, Phase 2 analysis.

- The points were chosen to understand in greater detail how reflections from the building will impact drivers, pedestrians and other buildings. These points are discussed further in the Detailed Analysis section this report.

- The Detailed analysis process is similar to the Screening analysis, except reflections are analyzed at one minute increments for the entire year.

- In addition to the frequency and duration of reflection impacts, the Detailed analysis allows for the prediction of when those impacts will occur, how long they occur for and which building element is the cause.

Assumptions and Limitations

Meteorological Data

This analysis used 'clear sky' solar data computed at the location of Logan International Airport. This approach uses mathematical algorithms to derive solar intensity values for a given location, ignoring local effects such as cloud cover. This provides a 'worst case' scenario showing the full extent of when and where glare could ever occur.

Radiation Model

RWDI's analysis is only applicable to the thermal and visual impacts of solar radiation (i.e. ultraviolet, visible and infrared wavelengths) on people and property in the vicinity of the development. It does not consider the impact of the building related to any other forms of radiation, such as cellular telephone signals, RADAR arrays, etc.

Study Building and Surrounds Models

The analysis was conducted based on the proposed geometry for building D2.1 provided by bKL Architecture to RWDI on September 12, 2018. The remainder of the Union Square development was modelled based on 3D models provided by bKL Architecture on August 22, 2018 and September 11, 2018. The exceptions to this are buildings D2.4, D7.1 and D7.2 which did not have 3D models available at the time of this study. The geometry of these buildings was estimated from site plans, renderings and other documents from bKL. Given the height of these buildings and their distance from the D2.1 building, we do not expect minor changes to the form of these buildings to significantly alter the findings of this report.

The surroundings model was developed based on data made available by the City of Boston and included all buildings which currently exist, are under construction or approved for construction by the BPDA. The ground surface and the surrounding buildings were topographically corrected based on a high-resolution LiDAR survey conducted by the National Oceanic and Atmospheric Administration (NOAA) in 2013-2014. According to NOAA, the horizontal accuracy of this data set is stated as 16.5 inches at a 95% confidence level. Its vertical accuracy is stated as 4.8 inches at a 95% confidence level.

Potential reductions of solar reflections due to the presence of Vegetation or other non-architectural obstructions were not included, nor are reflections from other buildings. Light that has reflected off several surfaces is assumed to have a negligible impact. As such, only a single reflection from the development was included in the analysis.

Assumptions and Limitations (cont'd)

Facade Material Reflectance

Detailed facade material properties are still under consideration by the design team. As such assumptions are required for this analysis.

For glazed surfaces RWDI has assigned reflectivity characteristics which are typical for the 1-inch insulated glazing units (IGUs) used in contemporary construction in the Boston area. The visible reflectance (which relates to glare) of this IGU is 23% and the full spectrum reflectance (which relates to heat gain) is 37%. All glazing on the building has been assigned these properties.

Metallic facade elements typically feature a matte finish with a low specular reflectivity as opposed to a high gloss finish. Thus, we have conservatively taken the metal elements to have a uniform 10% specular reflectance.

Figure 5 shows the location of the reflective materials on the facades of the proposed building. Similarly, the reflectance properties of the glazing unit are summarized in Table 1.

Applicability of Results

The results presented in this report are highly dependent on both the form and materiality of the facade. Should there be any changes to the form or materiality of the design, it is recommended that RWDI be contacted and requested to review their potential effects on solar reflection.

Assumptions and Limitations (cont'd)

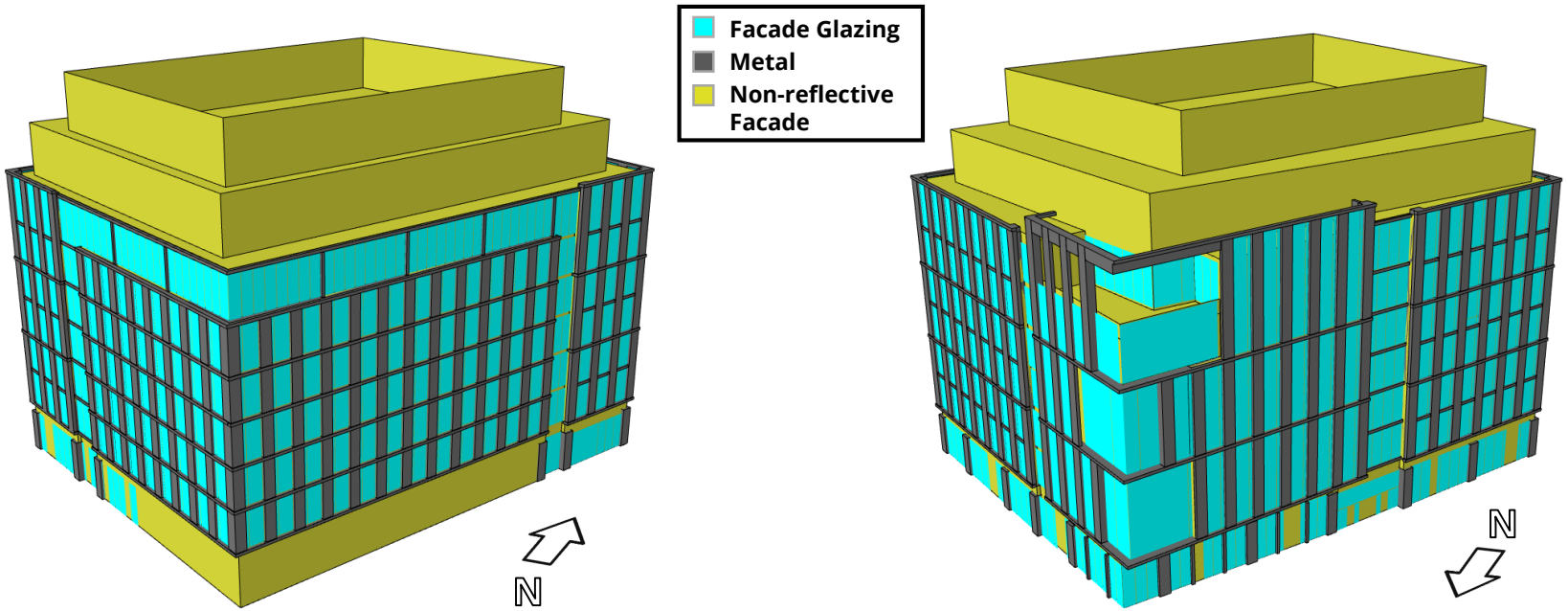


Figure 5: Locations of Reflective Building Elements

Table 1: Nominal Visible and Full Spectrum Reflectance Values of the Reflective Building Elements

Location	Material	Visible Reflectance	Full Spectrum Reflectance
Entire Glazed Facade Area	Representative 1" IGU	23%	37%
All Metal Elements	Generic Architectural Metal	10%	10%

Presentation of Results

This section presents the screening results pertaining to the solar impacts of the building on the surrounding urban area. The following three plots are presented :

Peak Annual Reflected Irradiance
This plot displays the annual peak intensity of all reflections emanating from the development at a typical pedestrian height (5 feet) above local grade.

Two versions of this plot are included:

- **Visible Reflectance (Visual Glare):** This plot (Figure 6a) displays the intensity of reflected visible light only. Depending on the ambient conditions, reflection intensities as low as 50 W/m² could be visible to people outdoors.

- **Full Spectrum Reflectance (Heat Gain):** This plot (Figure 6b) presents the total intensity of a reflection, including both visible light and thermal energy which relates to the risk of excessive heat gain. For full spectrum reflectance, RWDI considers 1,500 W/m² as a short term thermal comfort threshold and reflections above 2,500 W/m² as a human safety threshold (refer to Appendix B).

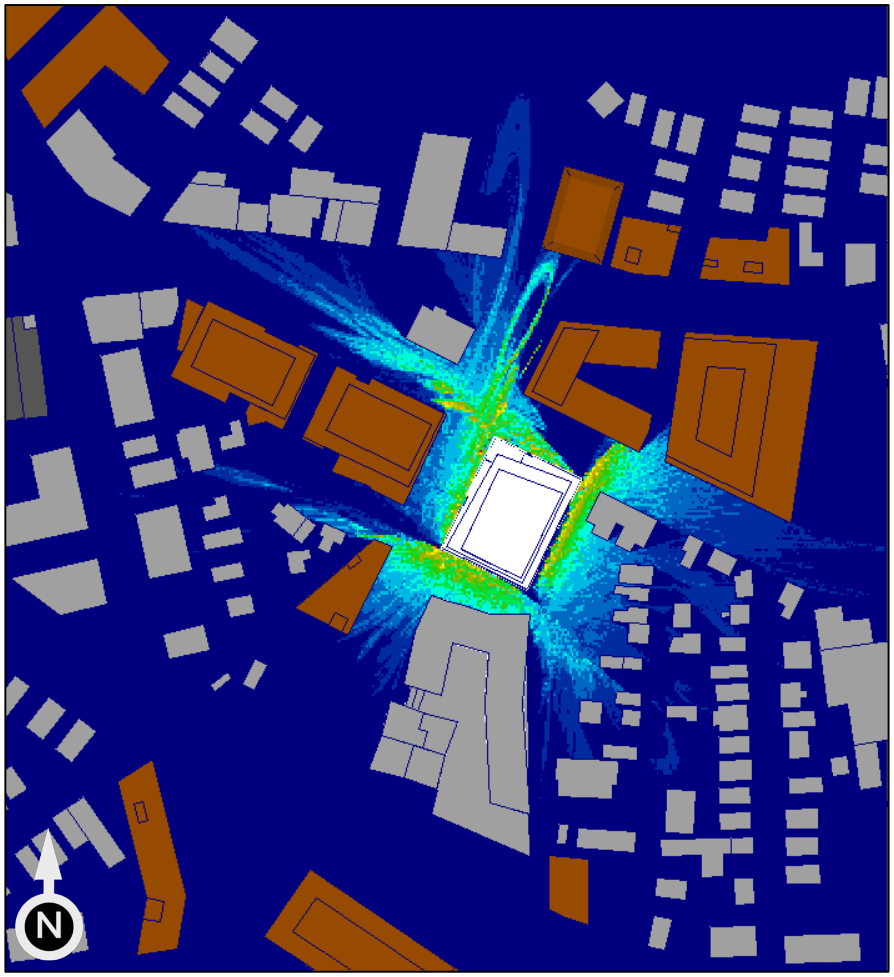
Frequency of Significant Visual Reflections
This plot (Figure 6c) identifies the locations of the most frequent significant reflections emanating from the facades. In this context a 'significant' reflection is one that is at least 50% as intense as one that would cause after imaging on a viewer (refer to Appendix B).

As this criteria is visually based, the visible reflectance of the facades was used.

In order to attain a complete understanding of the impact that reflections may have on drivers, other factors must be considered, including the duration of the reflections and when they occur. The following plots serve to illustrate the general characteristics of reflections from the building and inform the locations of the receptor points used in the detailed phase of work which will analyze these factors in greater depth.

Peak Annual Reflected Irradiance - Visible Reflectance (Visual Glare)

Reflections as low as 50 W/m² may be visible to people, depending on outdoor lighting levels.



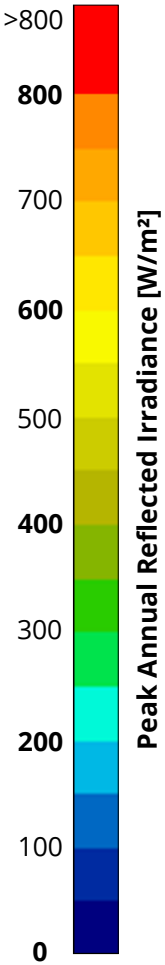
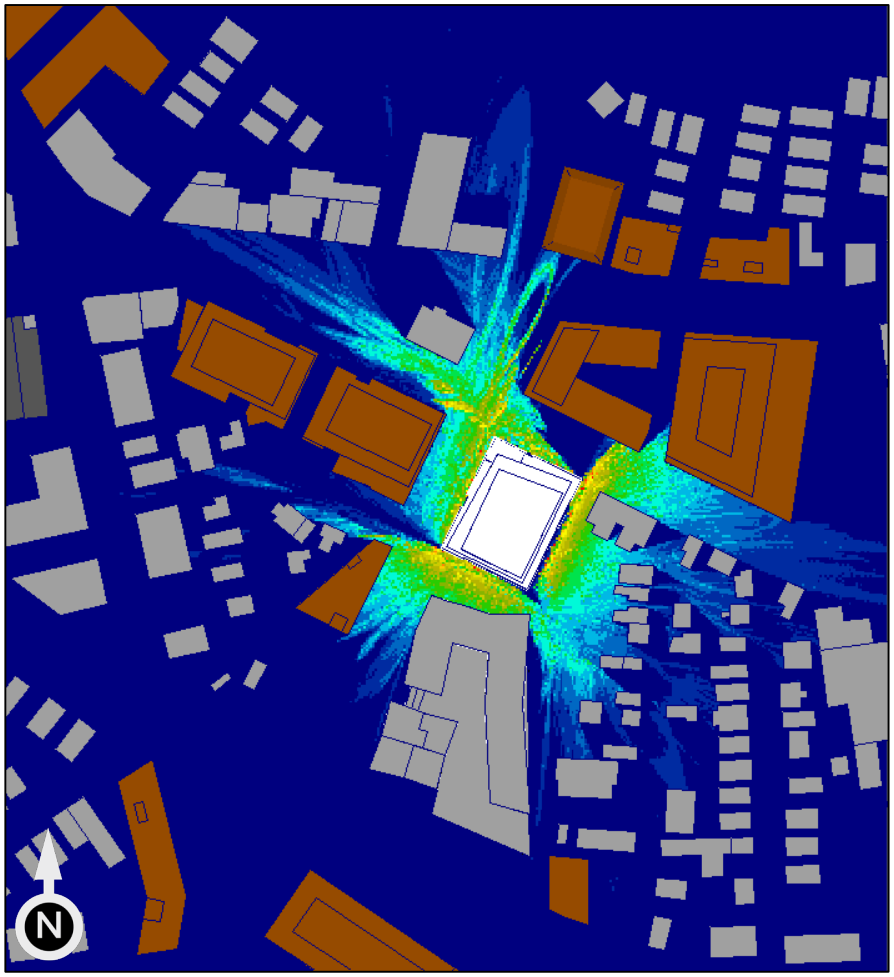


Figure 6a: Maximum Annual Intensity of Visible Reflections at Pedestrian Height

Peak Annual Reflected Irradiance - Full Spectrum Reflectance (Heat Gain)

800 W/m² represents a typical intensity for direct sunlight.



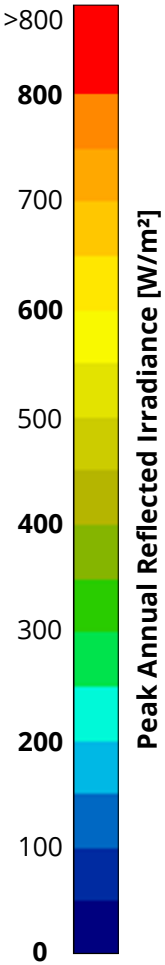
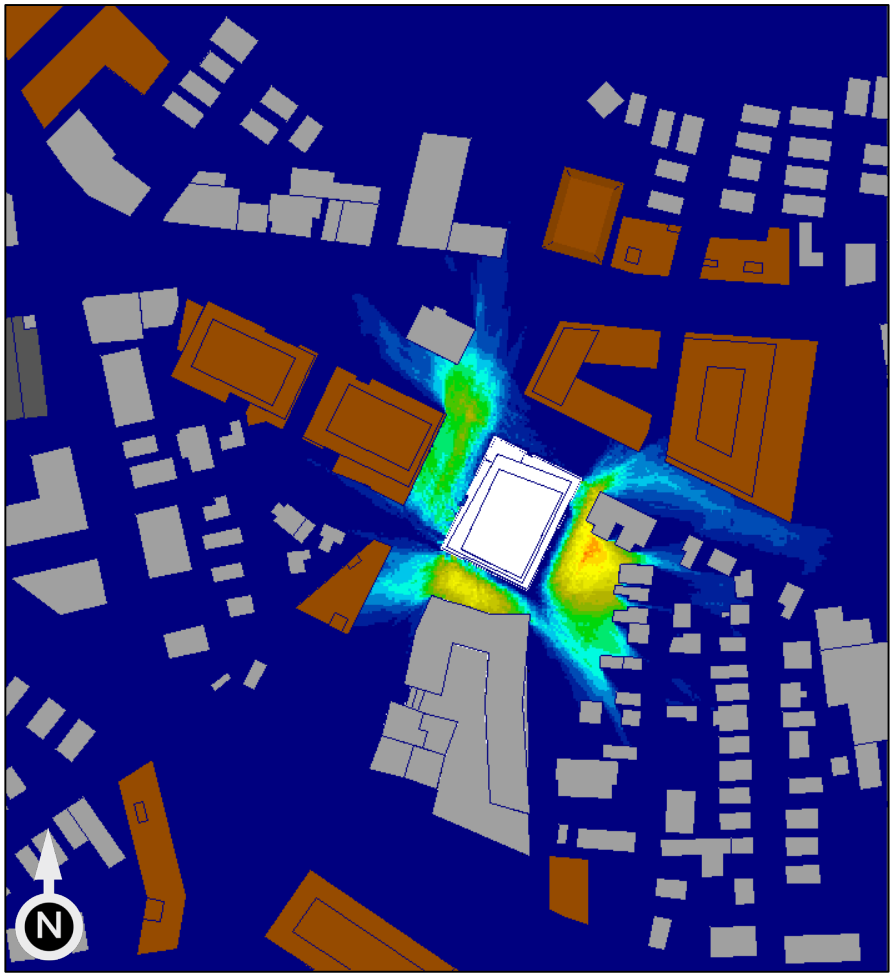


Figure 6b: Maximum Annual Intensity of Full Spectrum Reflections at Pedestrian Height

Frequency of Significant Visible Reflections



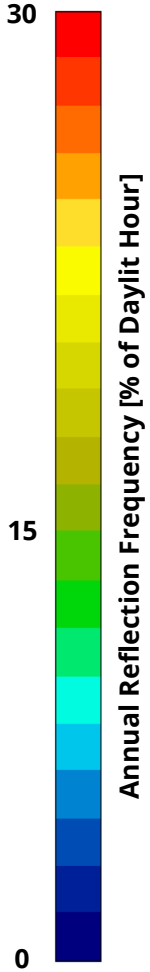


Figure 6c: Frequency (% of Daylit Hours) Where Significant Visible Reflections Can Occur

SCREENING ANALYSIS OBSERVATIONS

1. Like any contemporary building, the reflective surfaces of the proposed Union Square development are naturally causing solar reflections in the surrounding neighborhood.

2. The planar nature of the facades prevents reflections emanating from the building from focusing (concentrating) in any particular area. Thus, RWDI does not anticipate any heat gain issues on people or property.

3. At pedestrian level, reflections are predicted to fall most frequently onto the areas immediately east, south, and west of the development. The remainder of the surrounding areas are expected to be impacted less frequently. The maximum frequency of glare occurrence found at pedestrian level is approximately 27% of daytime hours.

4. Reflections emanating from the north and west facades of the building are the primary sources of impacts along Somerville Avenue and Prospect Street, respectively. These reflections may affect motorists and cyclists travelling towards the building at various times of day and days of the year. Similarly, some reflections may impact drivers at some locations on Bennett Court to the south of building . The potential impact of these reflections will be analyzed in detail in the following sections.

5. The occupants of the buildings located in the vicinity of building D2.1 are expected to experience visible reflections from the building . That being said, the reflections do not pose a risk to safety, and are likely a nuisance at worst, as the occupants can look away or close blinds.

6. Pedestrians in the vicinity of building D2.1 may also experience intermittent reflections. This condition is common in many urban centers and is unlikely to present a significant safety risk.

7. We do not anticipate reflections from this building to have an impact on the trains travelling to the southern region of the development.

8. The recessed nature of the windows is a positive design feature which aids in reducing the frequency and intensity of reflections.

9. Given the density of the surrounding neighborhood, we suggest that the metal panels have a matte finish and the glazing to have a low visible reflectance to minimize potential glare. Selecting facade elements with significantly higher specular reflectivities than what was assumed herein may increase the predicted intensities and frequencies described above.

DETAILED ANALYSIS RESULTS

Based on the findings of the Screening Analysis and the risk levels associated with reflections effecting specific areas, 15 representative points were selected for the Detailed Analysis. These points are described in Table 2 and illustrated in Figure 7.

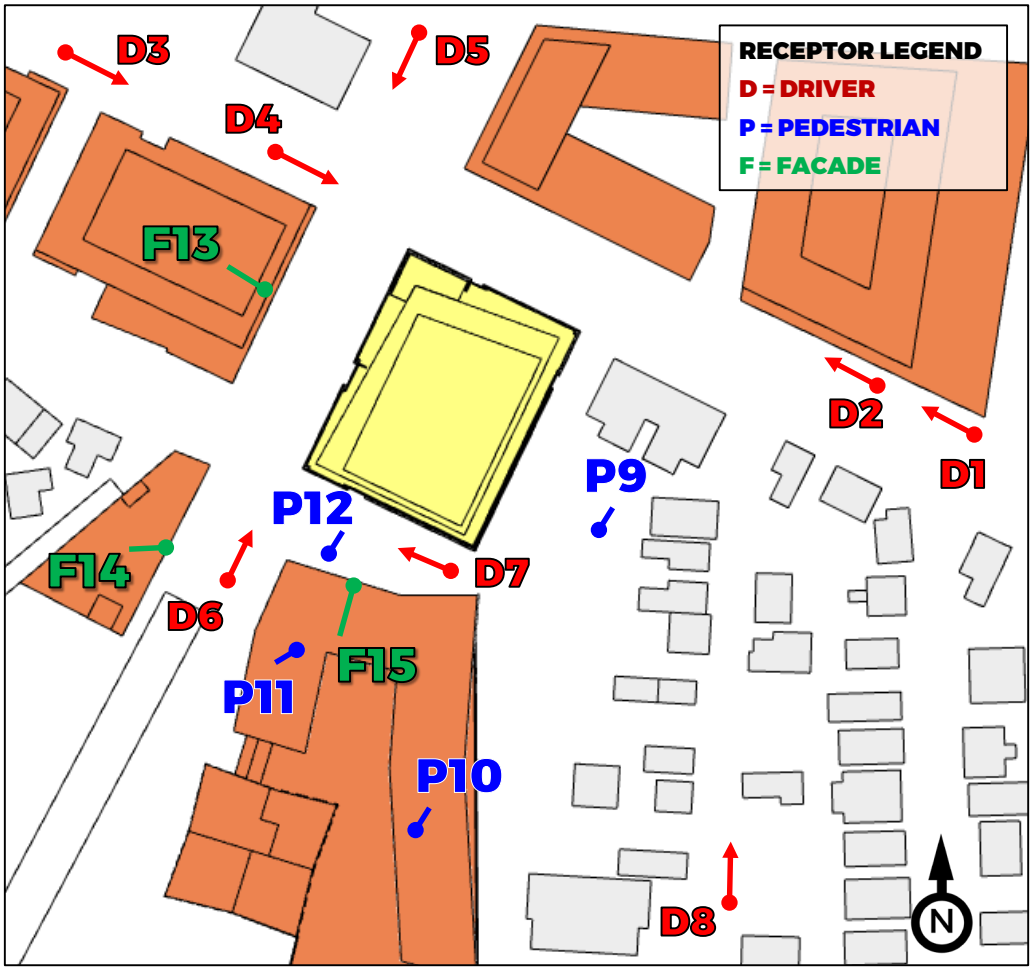


Figure 7: Receptor Locations

Table 2: Receptor Descriptions

Receptor Number	Receptor Description
D1-D2	Drivers traveling northwest on Somerville Ave.
D3-D4	Drivers traveling southeast on Somerville Ave.
D5	Drivers traveling southwest on Prospect St.
D6	Drivers traveling northeast on Prospect St.
D7	Drivers traveling northwest on Bennett Ct.
D8	Drivers traveling north on Allen St.
P9	Pedestrians to the northeast of the development
P10-P11	Pedestrians on the rooftops of future building D2.2
P12	Pedestrians in the neighborhood of the development
F13	Facade of future building D6.1
F14	Facade of future building D4.1
F15	Facade of future building D2.2

DETAILED ANALYSIS RESULTS

Table 3 summarizes the level of visual and thermal impact from the building's reflections at each of the studied locations. For each category (visual impact, thermal impacts on people, thermal impacts on facades/property), the location is classified as experiencing one of three impact levels:

- **Low** impacts indicate that either no reflections reach the receptor, or that reflections which do reach the location are unlikely to lead to visual or thermal concerns.

- **Moderate** impacts indicate the potential for visual nuisance, minor thermal discomfort to people, or heating of materials. Moderate impacts do not indicate a significant safety risk and are common in urban areas. They represent effects such as intermittent visual glare on pedestrians or occupants of adjacent buildings which can be safely self-mitigated.

- **High** impacts indicate the potential for risks to safety, either through impairing the visual acuity of a vehicle operator or through reflection intensities high enough to cause injury or property damage. When the sun is also in a driver's field of view, we would expect that brightness of the sun to dominate over the less intense reflected light, likely reducing the perceived effect of high impact reflections. This situation is noted in Table 3 where applicable, as are notes on high impact reflection frequencies and durations.

The minute-by-minute results for each point are presented as "Annual Reflection Impact Diagrams" which distill an entire years worth of data into a single diagram. The diagrams for each of the receptor points as well as an explanation for how to read the diagrams are provided in Appendix A.

For further detail on RWDI's criteria refer to Appendix B.

The level of mitigation required (discussed further in the Overall Observations & Conclusions section), is determined based on a combination of factors including the predicted level of impact, the frequency and duration of the impacts, and the risk level associated with activities likely to be engaged in at the location.

DETAILED ANALYSIS RESULTS

Table 3: Summary of Overall Predicted Impacts on Receptors

Receptor Number	Receptor Type	Assumed Activity Risk Level	Assumed Ability to Self-Mitigate	Peak Reflected Light Visual Impact	Sun in Field of View During High Impact Reflection (Y/N)	Duration / Number of Days with High Impact Reflection	Peak Reflected Solar Thermal Impact on People	Peak Reflected Solar Thermal Impact on Facade
D1	Driver	High	Low	***Moderate***	N/A	N/A	***Low***	N/A
D2	Driver	High	Low	***Moderate***	N/A	N/A	***Low***	N/A
D3	Driver	High	Low	***Moderate***	N/A	N/A	***Low***	N/A
D4	Driver	High	Low	***High***	***Some Impacts***	Longest Duration: **15 minutes** Average Duration: **4 minutes** No. of days: **62**	***Low***	N/A
D5	Driver	High	Low	***High***	***No*****	Longest Duration: **25 minutes** Average Duration: **9 minutes** No. of days: **62**	***Low***	N/A
D6	Driver	High	Low	***Moderate***	N/A	N/A	***Low***	N/A
D7	Driver	High	Low	***High****	***No*****	Longest Duration: **6 minutes** Average Duration: **3 minutes** No. of days: **91**	***Low***	N/A
D8	Driver	High	Low	***Moderate***	N/A	N/A	***Low***	N/A
P9	Pedestrian	Low	High	***Moderate***	N/A	N/A	***Low***	N/A
P10	Pedestrian	Low	High	***Low***	N/A	N/A	***Low***	N/A
P11-P12	Pedestrian	Low	High	***Moderate***	N/A	N/A	***Low***	N/A
F13-F15	Facade	Low	High	***Moderate***	N/A	N/A	N/A	***Low***

* The majority of high impact reflections are infrequent and short in duration.
** The sun is not within a driver's field-of-view due to obstruction from a building rather than its position.

OVERALL OBSERVATIONS & CONCLUSIONS

Thermal Impacts on People

1. The planar facades of the proposed building ensure that reflected sunlight will not focus (multiply) in any particular area. Therefore, RWDI does not expect any significant thermal impacts (i.e. risks to human safety or property damage) to occur either within the development or in the surrounding neighborhood.

Visual Glare Impact on Drivers

2. As with the addition of any glazed building, drivers travelling in the vicinity of the building are expected to experience an increased level of visual glare impact. Some reflections with high visual impact potential were noted. Some of these impacts may alter a driver's experience. In particular, a driver's experience could be altered when:

   - travelling southeast on Somerville Avenue approaching Prospect Street (receptor D4)
   - travelling south on Prospect Street approaching Somerville Avenue (receptor D5)
   - travelling west on Bennett Court approaching Prospect Street (receptor D7)

   The reflections on receptors D4 and D5 are predicted to occur 62 days per year at most, and last up to 15 and 25 minutes in duration, respectively. The impacts on receptor D4 occur in January, February and September through November during the morning hours. All high impact events at D4 are predicted to finish before 8:00 am EST. The impacts on receptor D5 only occur between 2:00 pm and 3:30 pm EST in January, November, and December. This equates to high impact glare being possible at Somerville Avenue and Prospect Street in 0.22% and 0.83% of the daytime respectively.

   The impacts on receptor D7 are brief and infrequent. They can occur in the afternoons between May and July. The impacts are predicted to last 6 minutes or less. In addition, Bennett Court appears to be a local street, and therefore is expected to experience a lower traffic volume compared to Prospect Street and Somerville Avenue.

3. We would also note that the glare at the above-noted driver receptors occurs at a time when the sun would already be generally in a driver's field of view which means that they would likely already be expecting a bright light source and have taken mitigation measures (i.e. lowering the sun visor, and/or putting on sunglasses).

4. For the remainder of the driver receptors (driver receptors D1-D3, D6, and D8), visual glare impacts are moderate at worst, hence they are not expected to pose a safety concern to drivers. For further details refer to the visual impact diagram for driver receptors D1-D8 illustrated in Appendix A.

OVERALL OBSERVATIONS & CONCLUSIONS

Visual Impacts on Pedestrians and Facades

5. Moderate levels of visual impact are predicted to fall on the pedestrian and facade receptors in the surrounding neighborhood (receptors P9, P11-P12, and F13-F15).

6. Frequent reflections with long durations are expected to impact the residential areas immediately to the east of the building (e.g., receptor P9). The impacts can occur for much of the morning hours throughout the year. We would not consider this a risk to safety but rather a nuisance issue. While this condition is not unprecedented in an urban environment, we would encourage the use low reflectivity materials on the eastern elevation of D2.1 as much as practical to reduce reflection impacts.

7. Pedestrians on the rooftop (receptor P11) of the future building to the south of the development (Building D2.2) may also experience intermittent reflections with moderate impacts in the months of January, November, and December. This condition is common in many urban centers and is unlikely to present a significant safety risk.

Thermal Impacts on Facades

8. The majority of reflected solar energy at the studied areas are of a low intensity (less than 300 W/m^2). We would not expect these reflections to lead to a significant additional cooling load for a building. Should an individual choose to expose themselves to the reflected energy through a window, they may feel warm, however this would be a temporary experience and one which would easily be remedied by closing window treatments.

General

9. The recessed nature of the windows is a positive design feature which aids in reducing the frequency and intensity of reflections.

10. Given the density of the surrounding neighborhood, we suggest that the metal panels have a matte finish and the glazing to have a low visible reflectance to minimize potential glare. Selecting facade elements with significantly higher specular reflectivities from what was assumed herein may increase the predicted levels of impact described above.

MITIGATION SUGGESTIONS

Overall, the reflections emanating from the D2.1 building of the proposed Union Square development onto the surrounding neighborhood are comparable to reflections elsewhere in the city. If however, there are concerns about the predicted reflection impacts, RWDI offers the following suggestions for further consideration (refer to Figures 8 to 10 on the following three pages for mark-ups of these recommendations):

1. **Exterior Surface Modification:** Using architectural metals on the north facade (area colored in red in Figure 8) with a matte finish would help in reducing the frequency and duration of reflections falling onto the drivers travelling southeast along Somerville Avenue (receptor D4).

   Employing this same approach on the metallic surfaces of the west facade (area colored in blue in Figure 9) could reduce the impacts on drivers travelling southwest on Prospect Street (receptor D5). Modifying the exterior surface of the glazed facades at the same location (glazing units inside the blue area) to diffuse light rather than reflect directly (i.e. by "frosting" or roughening the exterior surface) could also help in reducing the impacts on those drivers

   The above approaches would also lead to reductions in visual glare impact on the residences east of the site if it were applied to the eastern facade (Figure 10).

2. **Glazing Change-out:** In general, selecting glazing units with lower visible reflectance properties on the east, south and west facades (see Figure 10) aids in reducing the frequency and duration of visual impacts on adjacent buildings (receptors F13, F15) and pedestrians in the neighborhood (receptors P9, P11, P12) in the mornings and afternoons.

   In particular, we suggest that the glazing units on the east facade (areas colored in white in Figure 10) be selected with as low of a visible reflectance as practical to minimize potential glare in the residential buildings to the east of the D2.1 (e.g., receptor P9).

MITIGATION SUGGESTIONS

Using architectural metals on the north facade (area colored in red) with a matte finish could help in reducing the frequency and duration of reflections falling onto the drivers travelling southeast along Somerville Avenue (D4).

Similar modifications to the metallic surfaces of the west facade (area coloured in blue) could reduce the impacts on drivers near point D5.

Modifying the exterior surface of the western glazed facades (glazing units inside the blue area) to diffuse light rather than reflect directly (i.e. by "frosting" or roughening the exterior surface) could help in reducing the frequency and duration of high-impact reflections on the drivers travelling southwest on Prospect Street (D5).

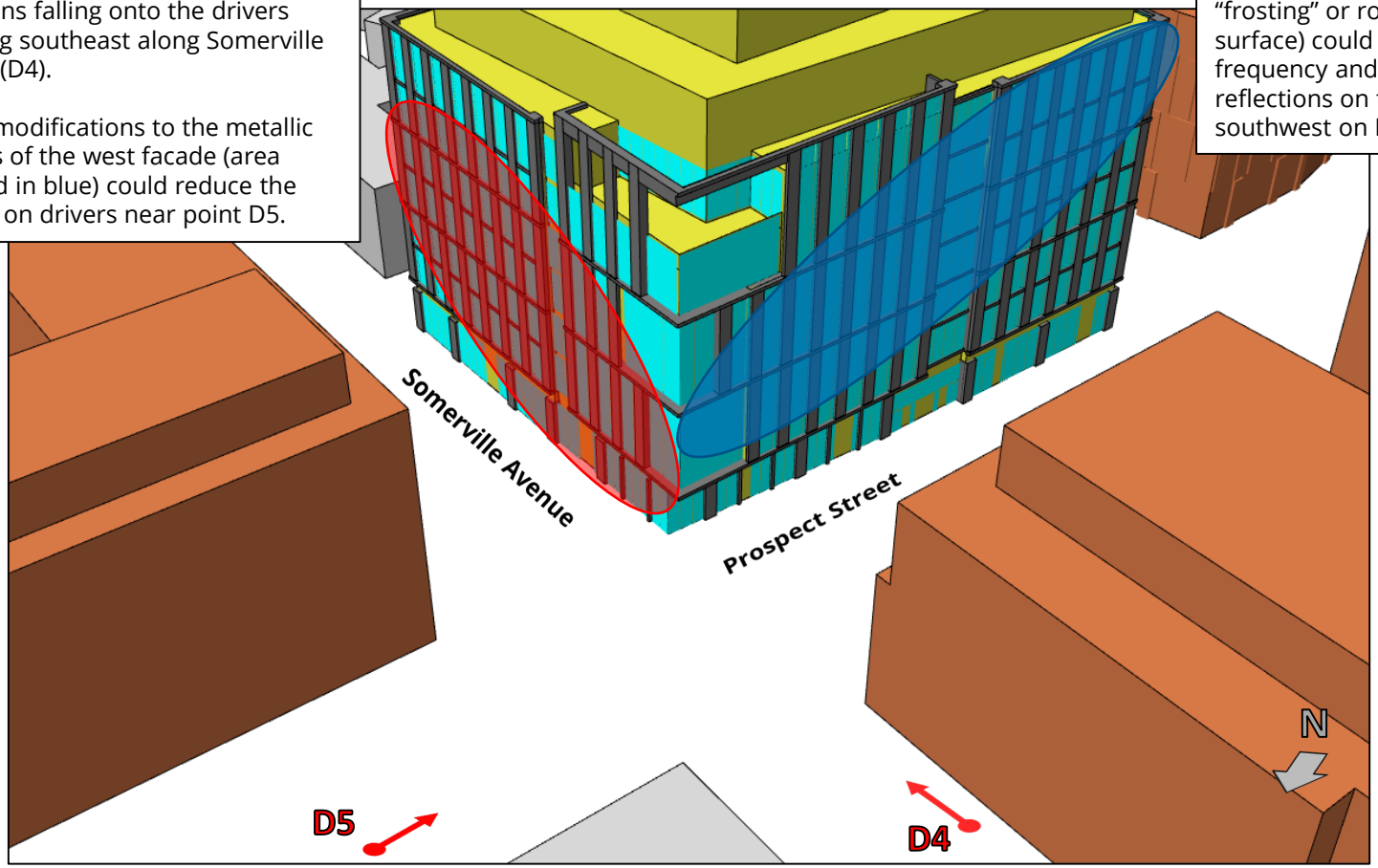


Figure 8: Markup of Facade Locations Where Exterior Surface Modification Would be an Appropriate Approach

MITIGATION SUGGESTIONS

Modifying the exterior surface of the southwest facade (area colored in white) to diffuse light rather than reflect directly (i.e. by applying matte finish on the exterior surface) could help in reducing the frequency and duration of reflections falling onto drivers near point D7.

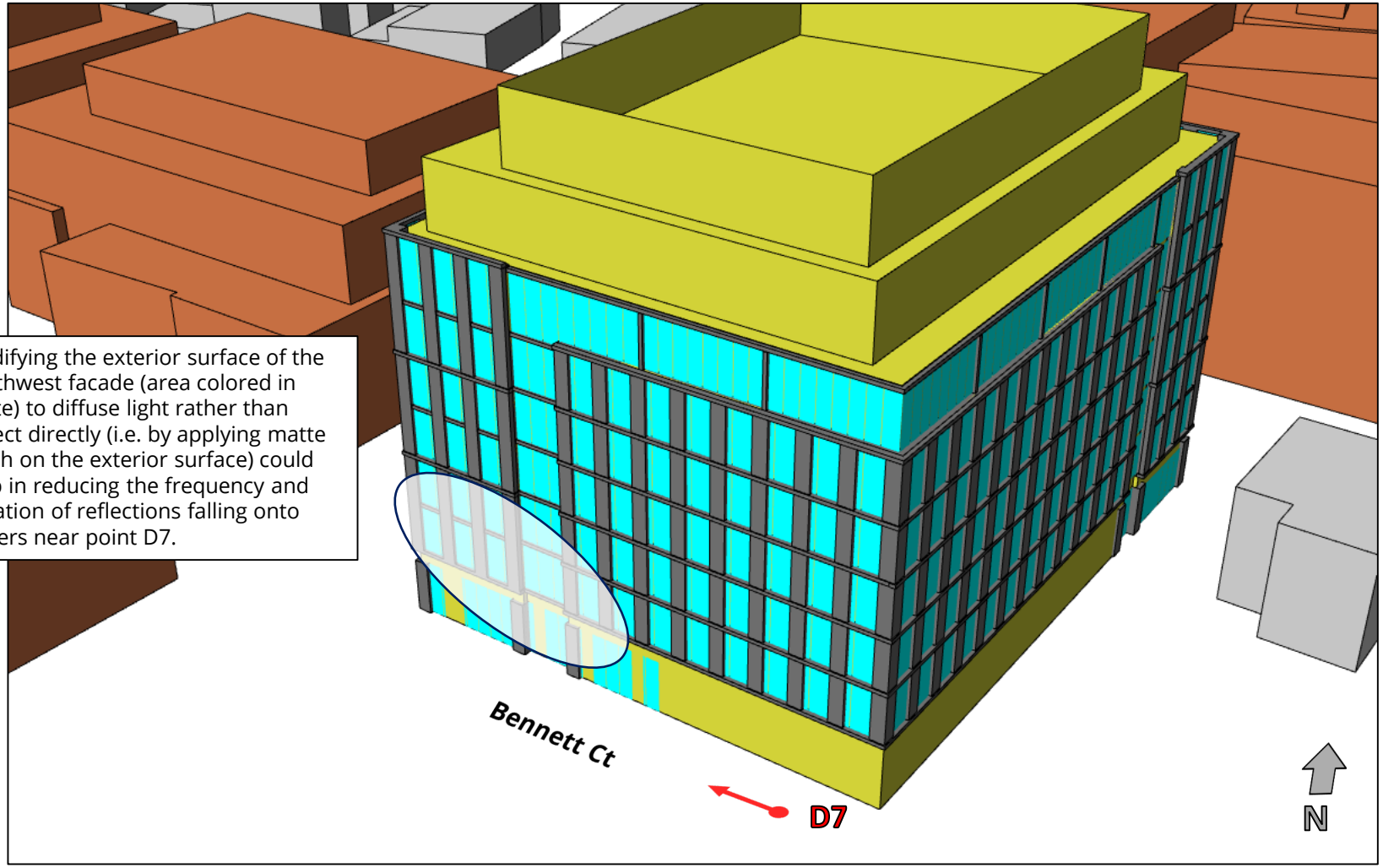


Figure 9: Markup of Facade Locations Where Exterior Surface Modification Would be an Appropriate Approach

MITIGATION SUGGESTIONS

In general, selecting glazing units with lower visible and full spectrum reflectance properties on the east, south and west facades aids in reducing the frequency and duration of visual and thermal impacts on adjacent buildings (receptors F13, F15) and pedestrians in the neighborhood (receptors P9, P11, P12) in the mornings and afternoons.

In particular, given the proximity of the east facade to the residential buildings east of the site, we would suggest that both the glazing and the metal elements have as low of a reflectivity as practical to minimize the impact of any reflections.

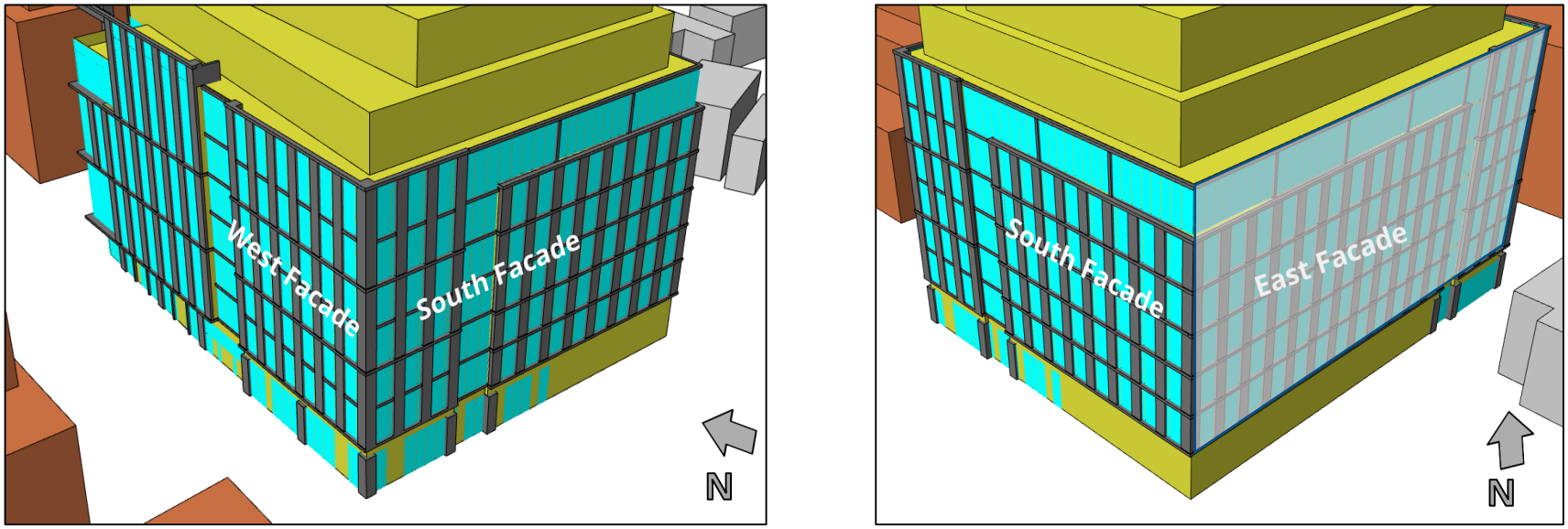


Figure 10: Markup of Facade Locations Where Glazing Change-out Would be an Appropriate Approach