CITY OF CAMBRIDGE

Climate Resilience Zoning Task Force

February 2022

Executive Summary

Over the course of approximately 19 meetings, the members of the Climate Resilience Zoning Task Force ("Task Force") discussed how to revise Cambridge's development standards to strengthen the climate resilience of the City's built environment. The Task Force brought together stakeholders from across the Cambridge community to reach consensus on an effective approach to regulating urban development in a way that mitigates the identified impacts and risks of on-going climate change. Specifically, the Task Force was charged with discussing climate change vulnerabilities identified in the Cambridge Climate Vulnerability Assessment (CCVA), reviewing recommendations from the ongoing Climate Change Preparedness and Resilience (CCPR) planning effort and other related initiatives, and recommending development standards to incorporate into Cambridge's Zoning Ordinance.

The Task Force's robust learning and deliberation process was guided by a set of principles and objectives that identified shared values across the diverse perspectives among the group. Task Force members recognized that some of the most effective strategies to promote climate adaptation and mitigation would not be implemented through zoning. Zoning is but one of many tools in the City's climate resilience toolkit.

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Credits

Executive Office

- Louis A. DePasquale, City Manager

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- Sumbul Siddiqui, Mayor
- Alanna M. Mallon, Vice Mayor
- Burhan Azeem
- Dennis J. Carlone
- Marc C. McGovern
- Patricia M. Nolan
- E. Denise Simmons
- Paul F. Toner
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City Staff to the Task Force

- Jeff Roberts, Director of Zoning and Development, Community Development Department
- Sarah Scott, Associate Zoning Planner, Community Development Department
- Shabnam Bista, Zoning and Development Intern, Community Development Department
- Tracey Joyce, Administrative Assistant, Community Development Department
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- Elizabeth Cooper, Consensus Building Institute
- Ona Ferguson, Consensus Building Institute
- Angel Suero, Consensus Building Institute
- Mariana Rivera-Torres, Consensus Building Institute
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- Indrani Ghosh, Weston and Sampson

credits continued on next page >

Task Force Members

Residents

- Doug Brown (Co-Chair) – West Cambridge resident
- Ted Cohen – North Cambridge resident and Planning Board Member
- Conrad Crawford – East Cambridge resident and Cambridge Redevelopment Authority Board Member
- Mike Nakagawa – North Cambridge resident

Union/Trades Representative

- Louis Bacci, Jr. – Laborers Local 151, East Cambridge resident, and Planning Board Member

Institutional/Non-Profit Representatives

- Brian Goldberg – Assistant Director, MIT Office of Sustainability
- Tom Lucey – Director of Government & Community Relations, Harvard University
- Margaret Moran – Director of Planning & Development, Cambridge Housing Authority
- Craig Nicholson – Director of Real Estate Acquisitions, Just-a-Start Corporation

Business Representatives/Property Owners

- Jason Alves – Executive Director, East Cambridge Business Association
- Nancy Donohue – Director of Government & Community Relations, Cambridge Chamber of Commerce
- Joe Maguire – Senior Vice President, Alexandria Real Estate Equities, Inc. [left in Spring 2020] / Rick Malmstrom - Executive Director of Sustainability Operations, Alexandria Real Estate Equities, Inc. [joined in Fall 2020]
- Mike Owu – Managing Director, Real Estate, MIT Investment Management Company (MITIMCo)
- Tom Sullivan – President of the Development Division, Divco West [left in Spring 2020] / Mark Johnson – Director of Development, Divco West [joined in Fall 2020]

Subject Matter Experts

- Tom Chase – Energy & Resilience Consultant, New Ecology
- Lauren Miller – Climate Consultant, CDM Smith
- Jim Newman – Resilience Consultant, Linnaean Solutions

City Staff

- John Bolduc – Environmental Planner, Community Development Department
- Iram Farooq (Co-Chair) – Assistant City Manager for Community Development
- Kathy Watkins – City Engineer/ Assistant Commissioner, Department of Public Works

Introduction

- Role of the Task Force
- Process & Work Plan

Role of the Task Force

The Climate Resilience Zoning Task Force (CRZTF) was created to bring together diverse stakeholders to identify development standards that would increase the capacity of development in Cambridge to withstand and adapt to impacts from climate change. The Climate Change Vulnerability Assessment (CCVA) and ongoing Climate Change Preparedness and Resilience (CCPR) planning has been underway since 2012, and the Envision Cambridge comprehensive planning process (2019) began combining the City's multidisciplinary work on climate change with a vision for the future growth and development of Cambridge. The Douglas Brown, et al. Zoning Petition (2017) also demonstrated citizens' interest in this important issue. The City Council issued a Policy Order requesting the formation of an advisory committee to work through resiliency elements raised during the Envision process and through the Brown petition.

The City Manager appointed 20 members to the Task Force to ensure that a diversity of perspectives would be included in the discussions. The Task Force included residents from neighborhoods throughout the city, a union/trades representative, representatives from academic institutions, affordable housing builders, small business representatives, property owners, subject matter experts, and City staff. By bringing together stakeholders from across the Cambridge community, the vision was that the Task Force would reach consensus around an effective approach to regulating urban development in a way that would mitigate the identified impacts and risks of on-going climate change.

Task Force members were supported by staff in the Community Development Department (specializing in Zoning and Development and Environmental Planning) and Department of Public Works, and by consultants who were also involved in the CCVA, CCPR, and Urban Forest Master Plan.

The purpose of the Task Force was to discuss the specific climate change vulnerabilities identified in the CCVA, review recommendations from the ongoing CCPR planning effort and other related initiatives including the Urban Forest Master Plan, and recommend development standards to incorporate into Cambridge's Zoning Ordinance. The Task Force focused on two specific impacts of climate change: flooding from sea level rise, storm surge, and precipitation, and rising temperatures exacerbated by the urban heat island effect.

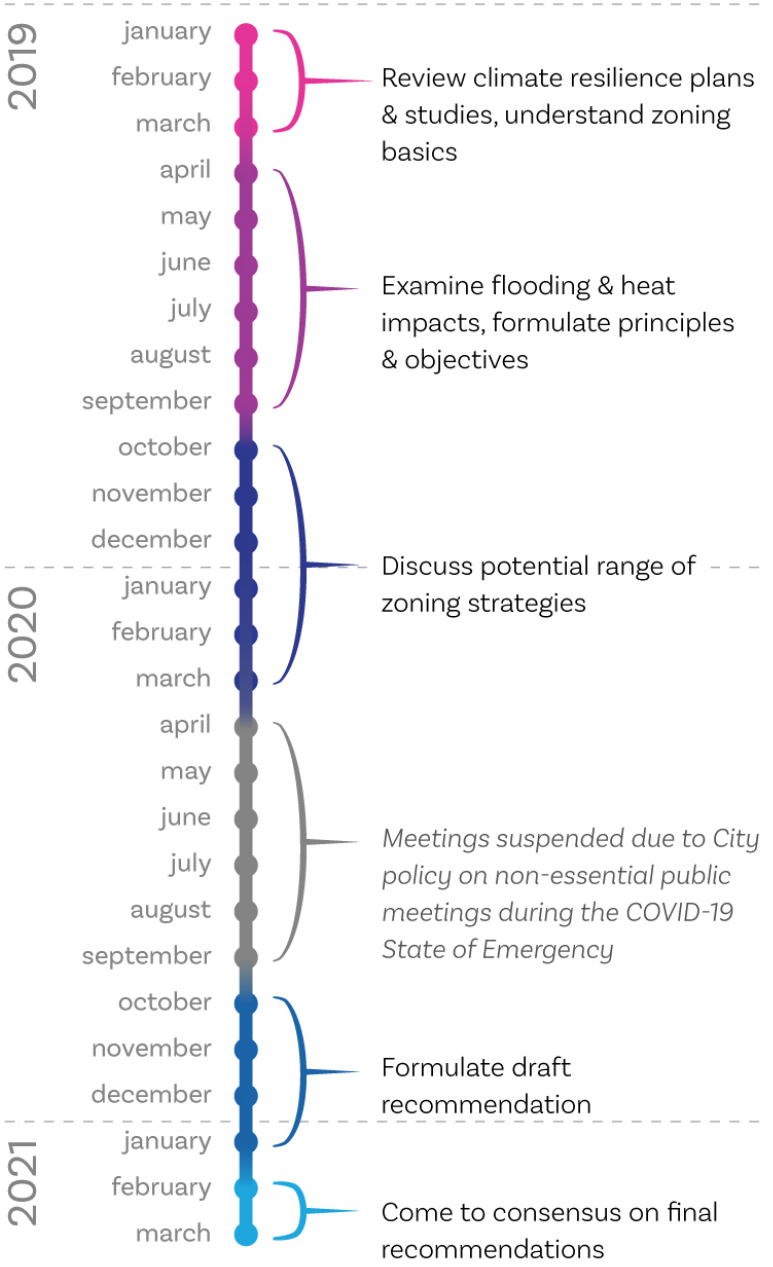
The goal of the Task Force was to recommend zoning amendments that could be translated into a formal zoning petition by City staff and be presented to the City Council for consideration and adoption. The Task Force considered all types of development and all parts of the city. The final zoning recommendations are citywide in scope and would create standards for all new development, large and small, and specific types of additions and alterations to existing buildings and uses. The Task Force also considered both prescriptive- and performance-based approaches to creating new zoning standards, ultimately gravitating toward performance-based standards. The Task Force also provided recommendations for actions that the City could pursue separately in the future.

Introduction

Process & Work Plan

The Task Force met 19 times between January 2019 and March 2021. All meetings were open to the public and a website with information about the Task Force was actively maintained to ensure transparency. The City Council, through its Health and Environment Committee, had an active and ongoing role in shaping the work of the Task Force. Throughout the course of its discussions, the Task Force held two joint meetings with the Committee to provide updates on its progress and solicit feedback.

Note that meetings were suspended between March and October 2020, due to City policy on non-essential public meetings during the COVID-19 State of Emergency.



Background Information & Resources

After establishing its work plan and ground rules, the Task Force spent the first phase of its process reviewing and discussing information relevant to its work. These included City-led climate change initiatives, other planning studies, and community-based initiatives.

Members also learned about what can and can't be effectively regulated through zoning and the types of zoning strategies used in Cambridge. This phase included a tour of the Alewife area to see in-person examples of older and more recent development and to identify and discuss resilience issues in the context of buildings and sites.

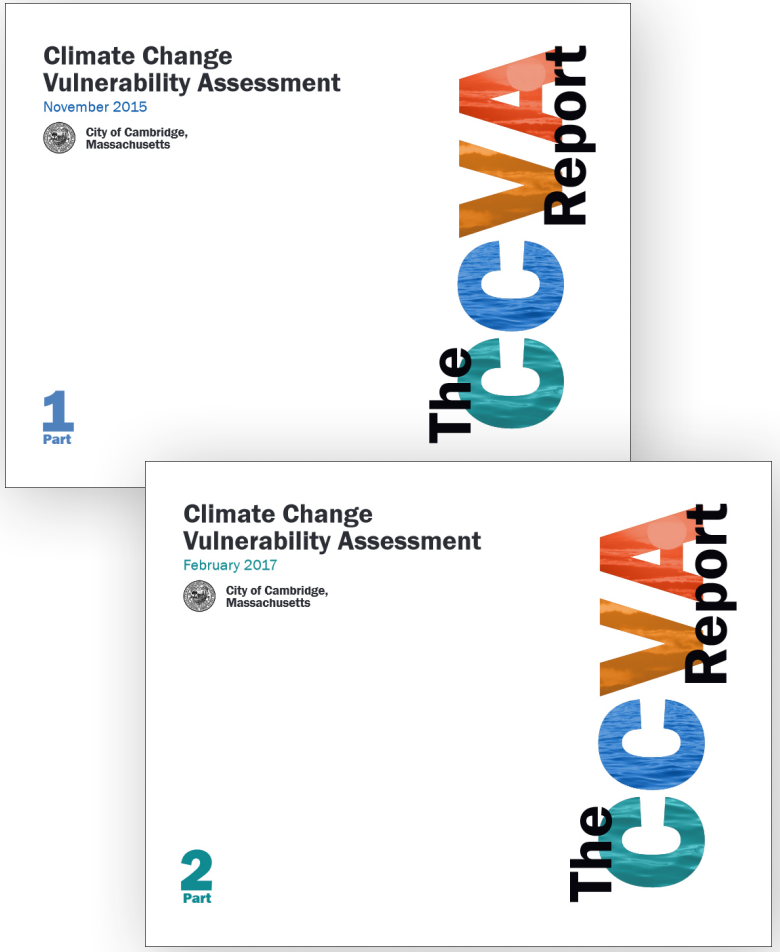
Background Information and Resources

City's Climate Planning Initiatives

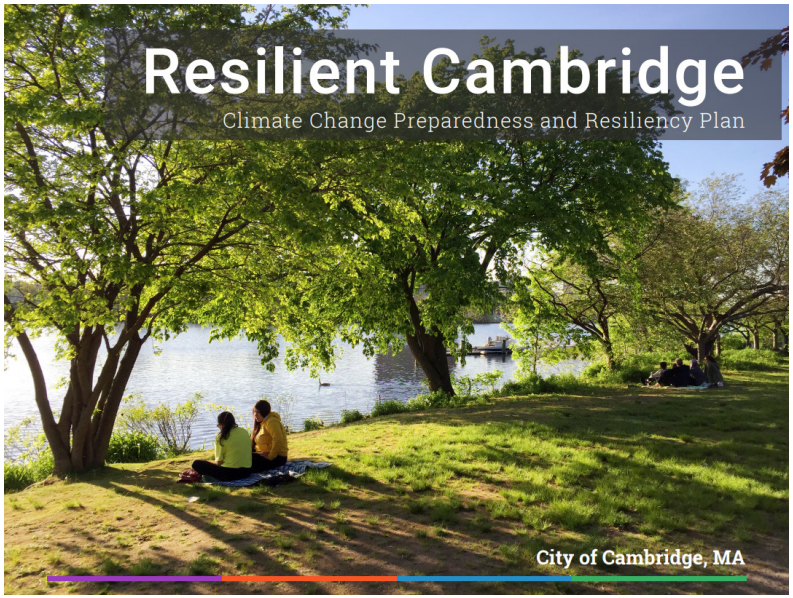
Since it joined ICLEI – Local Governments for Sustainability in 1999, Cambridge has taken an active role in both preparing for climate change and reducing its causes. The following recent planning efforts were the most relevant to the Task Force's work:

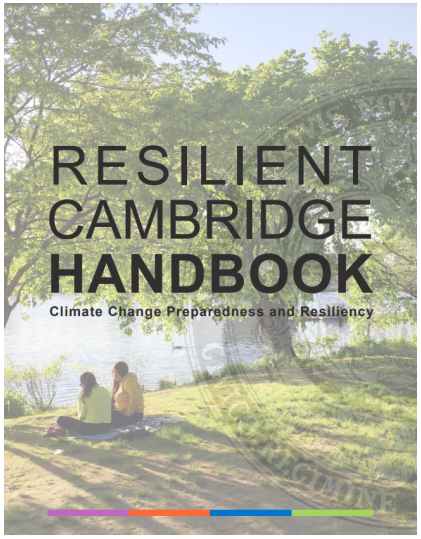
- **Climate Change Vulnerability Assessment (CCVA):** Completed in 2017, this technical study explored Cambridge's physical and social vulnerabilities to increasing temperatures, more intense storms, and storm surge flooding associated with sea level rise. Part 1 of the CCVA Report focused on risks posed by ever-increasing temperatures and precipitation while Part 2 focused on risks from rising sea levels and coastal storm surges.

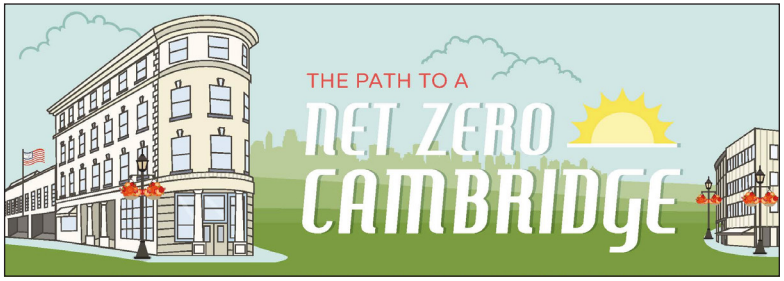
  The CCVA serves as the technical foundation for the City's other climate-related work, and its findings will be updated over time as climate change models evolve.

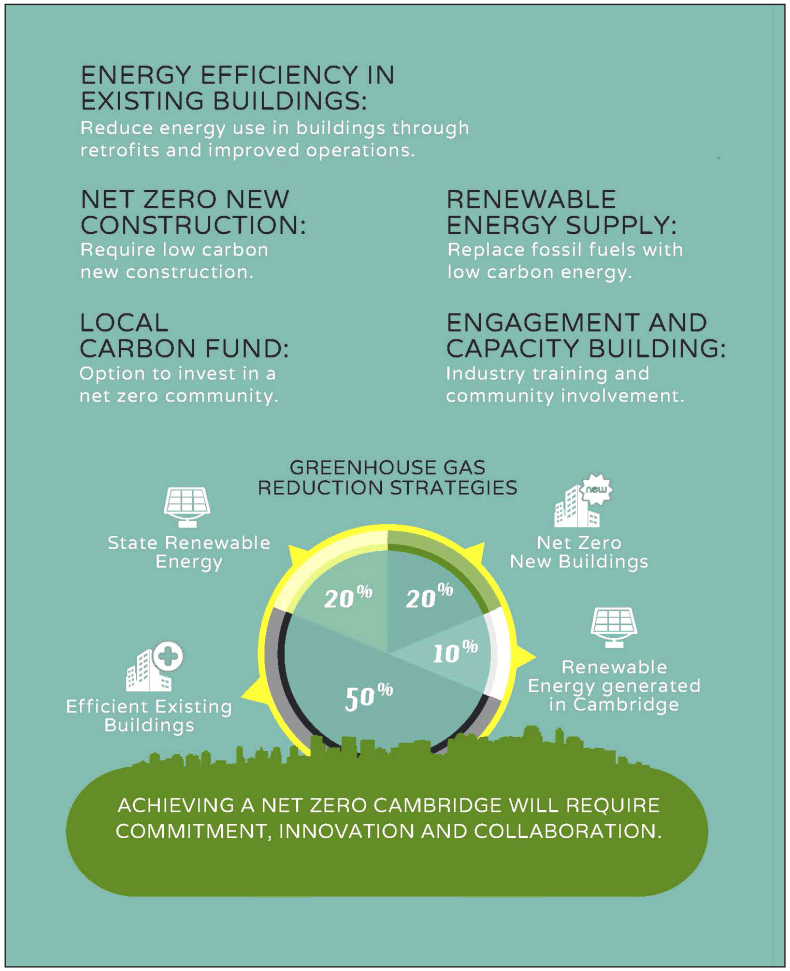


- **Resilient Cambridge Plan (*formerly Climate Change Preparedness and Resilience Plan [CCPR]*):** This ongoing initiative is a roadmap for the City government, its residents, businesses, institutions, and key stakeholders to implement strategies in response to climate change threats. The City completed two area-specific CCPR plans, one with a focus on the Alewife area and the other on The Port neighborhood. These area-specific studies informed the citywide Resilient Cambridge Plan, which was released in June 2021. The plan consists of the main document, a handbook of strategies, and six technical memos to support the plan in addition to a summary report titled Resilient City Resilient People. The Task Force shared the same team of consultants and City staff with the Resilient Cambridge Plan, which ensured that both initiatives worked in tandem.









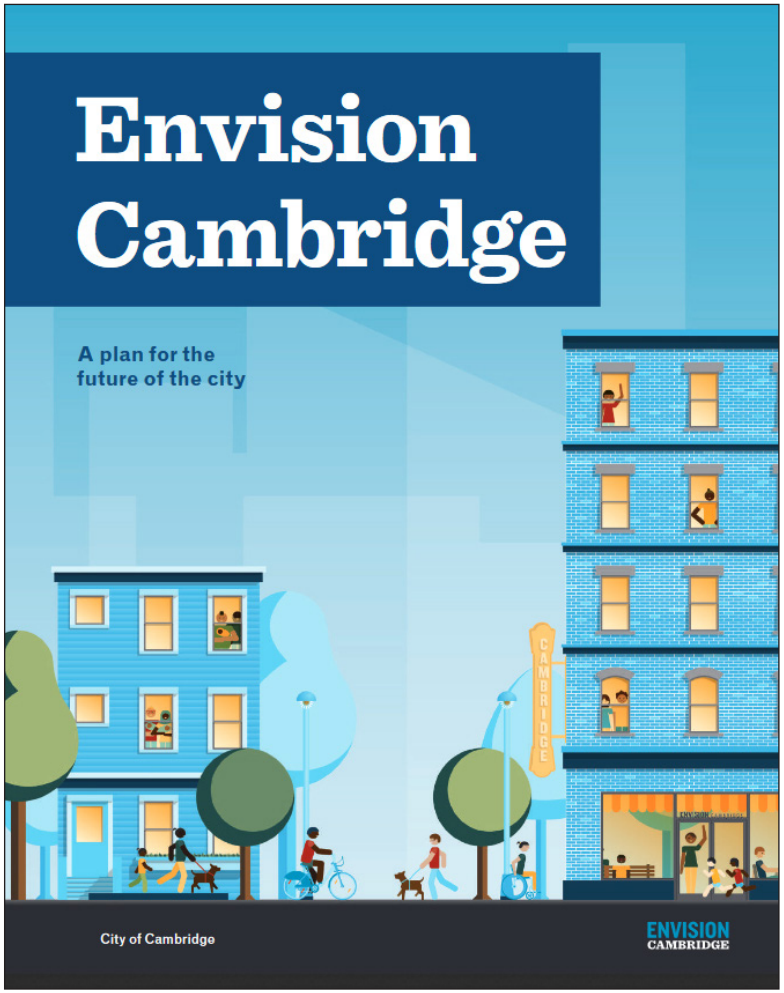
- **Net Zero Action Plan:** Completed in 2015, this plan sets a road map for neutralizing greenhouse gas emissions from Cambridge. While the CCVA and CCPR focus on how to prepare the city for impacts from climate change, the Net Zero Action Plan focuses on reducing the city's contribution to the climate crisis. Some recommendations from this initiative have already been adopted into the Zoning Ordinance. The City is currently conducting a comprehensive 5-Year Review of the Plan in order to evaluate the program's impact to date, consider options to adjust the Net Zero Action Plan framework, and adopt an updated framework that reflects current climate science, policy, technology, and equity considerations.

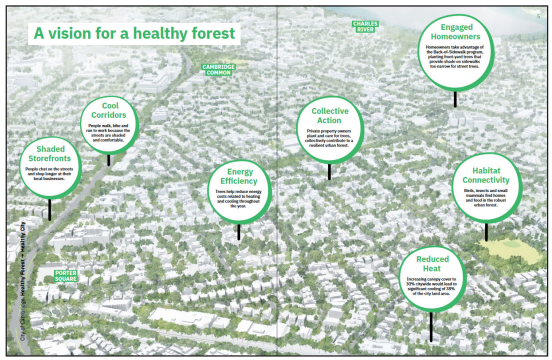
Other City-Led Planning Initiatives

In addition to its climate-specific planning efforts, other recent studies have addressed the need to understand and respond to a changing climate:

- **Envision Cambridge:** Completed in 2019, the City's most recent citywide, long-range comprehensive planning study sets broad goals and recommendations on the topics of climate and the environment, community wellbeing, the economy, mobility, housing, and urban form.

  In addition to the citywide plan, the Envision planning process also produced the Alewife District Plan in 2019, which focused on an area that is especially vulnerable to flooding and heat and suggested some ways to incorporate climate resilience into urban design.





- **Urban Forest Master Plan:** From 2018 to 2020, the Department of Public Works led a task force that focused on creating a strategic plan to evaluate, maintain and expand the urban forest canopy in Cambridge. The work is particularly relevant to the Task Force because trees contribute to climate resilience by reducing the urban heat island effect and mitigating stormwater runoff. The Cambridge Urban Forest Master Plan Technical Report was released in November 2019 and the City of Cambridge Urban Forest Report: Healthy Forest, Healthy City was published in September 2020. The lead consultant for the Urban Forest Master Plan also advised the Climate Resilience Zoning Task Force and one representative serves on the task forces for both initiatives. The Healthy Forest, Healthy City initiative has been formally launched.

- **Ten Year Sewer and Drain Infrastructure Plan:** The City has developed a strategic plan to manage the infrastructure improvements of the sewer and storm water mains, manholes, catch basins, pumping stations and Combined Sewer Overflow (CSO) outfalls that carry waste and storm water to treatment plants and discharge locations. This 10-year plan, published in 2019, serves as a guidance document to prioritize construction and rehabilitation of these complex systems. The goals of the Plan include addressing high-risk infrastructure conditions, managing stormwater quality and quantity, reducing flooding, and protecting neighborhoods. These various planning initiatives work together to maximize co-benefits to Cantabrigians.

Background Information and Resources

Douglas Brown, et al., Zoning Petition

In 2017, a group of residents (including Task Force members Doug Brown and Mike Nakagawa) proposed a zoning amendment informed in part by the CCVA work. The amendment would have expanded the current Flood Plain Overlay District to include areas projected to be vulnerable to future flooding. All development or site work in that district would be subject to new requirements outlined in the petition, in addition to the existing requirements. The petition also proposed a "Green Factor" scoring system for all development subject to the Project Review Special Permit requirements.

There was broad agreement on the goals of this petition, which sought to use development standards in the Zoning Ordinance to build a more resilient Cambridge. While there were concerns raised about how to ensure effective implementation of some of the proposed standards, the performance-based approach of the proposed Green Factor was positively received by City staff, the Planning Board, and the City Council, with suggestions for further study and testing.

This petition catalyzed support for the creation of a multi-stakeholder task force to study potential zoning standards that would complement the City's suite of climate resilience initiatives. As a result, the City Manager created the Climate Resilience Zoning Task Force.

Task Force Study and Findings

The following section summarizes information that was presented to and discussed by the Task Force, along with some of the key points that emerged from the Task Force's discussion.

Overall Climate Impacts and Climate Planning

The CCVA used global climate model simulations to generate temperature, humidity, precipitation, and sea level rise projections specifically for the city. The scenarios were developed between 2013-2017 using the best available science with the understanding that assumptions, methodologies, and resultant projections will need to be revised over time in light of new data or technologies, or changes in the environment itself. The CCVA projections are not intended to be a precise prediction of future conditions but are more of a "climate stress test" to understand how people and the built environment would be impacted by these changes.

The CCVA developed projections for two planning horizons, 2030 and 2070, and two categories of impacts, heat and flooding. City staff recommended that the Task Force focus on 2070 projections since buildings constructed today are expected to have at least a 50-year lifespan.

Drawing on the findings of the CCVA, the Resilient Cambridge Plan focuses on both reducing risks and preparing for unavoidable risks. It takes a multipronged but coordinated approach that focuses on performance. As a result, the Resilient Cambridge Plan project team identified four key categories of resilience strategies: closer neighborhoods, better buildings, stronger infrastructure, and a greener city.

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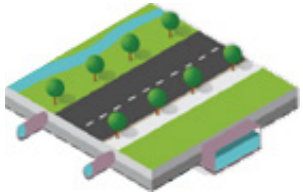
A. **Closer Neighborhoods:** Strategies to strengthen community, social, and economic resilience.

C. **Better Buildings:** Strategies to protect buildings against projected climate change impacts.



B. **Stronger Infrastructure:** Strategies to ensure continued service or a speedy recovery from community-wide infrastructure systems.

D. **Greener City:** An enhanced living environment integrating air quality, waterways, green infrastructure, and the urban forest as a system resilient to climate impacts.

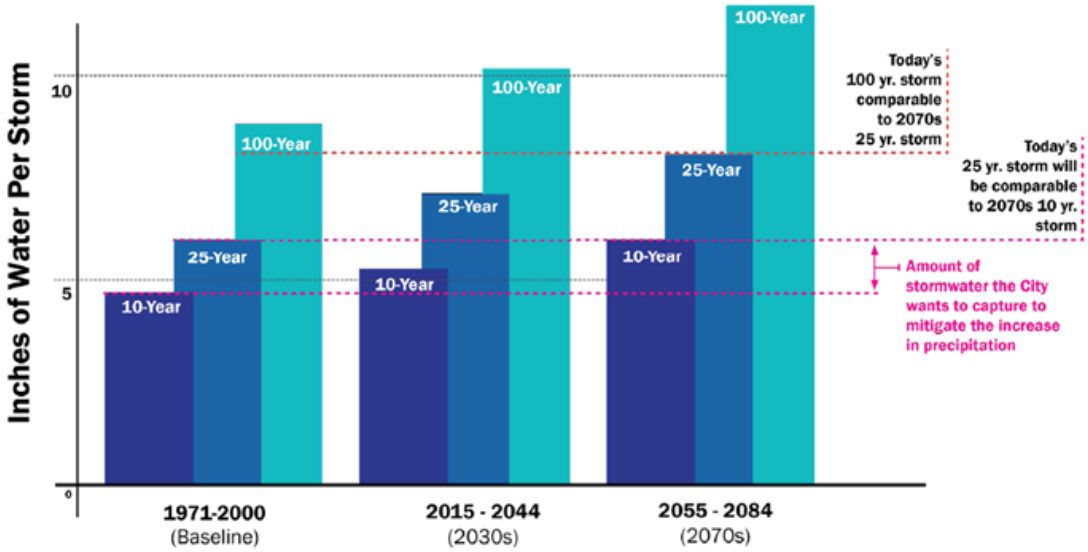
The Task Force focused exclusively on zoning mechanisms to complement other actions recommended in the Resilient Cambridge Plan. **Task Force members recognized that zoning could help the City achieve its goals but cannot resolve every issue identified in the Resilient Cambridge Plan.**

Flooding | *Climate Projections, Risks, and Outcomes*

The Task Force reviewed key impacts associated with the two main kinds of flooding that Cambridge faces: precipitation-driven flooding and flooding from a combination of sea level rise and storm surge (SLR/SS). Overall, the CCVA found that, due to climate change, Cambridge will face increasing rates of precipitation and a greater frequency of larger storms.

Precipitation

Currently, flooding in Cambridge is driven by precipitation, which causes streets to fill with water when drainage infrastructure is unable to immediately discharge floodwaters. According to CCVA projections, precipitation-driven flooding in Cambridge will become more frequent, cover broader areas of the city (including areas where it has not frequently occurred in the past), and have a greater depth. However, this type of flooding is mostly short-term in nature, and generally does not last for more than a day.



Projected Increases in Precipitation Volume and Frequency

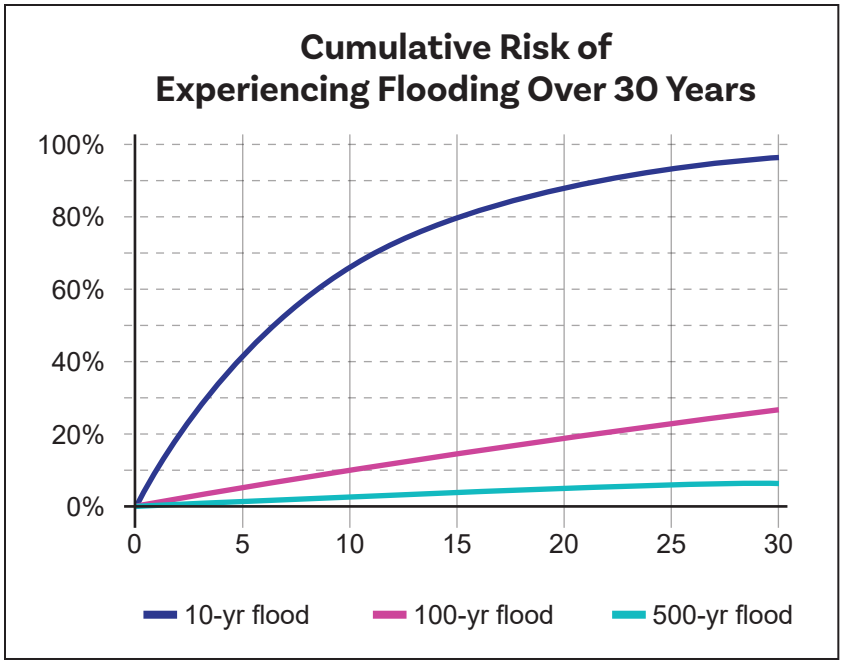
Not only will the rates of precipitation increase, but the frequency of storms will as well. (Source: Resilient Cambridge Plan, July 2021)

Sea Level Rise/Storm Surge

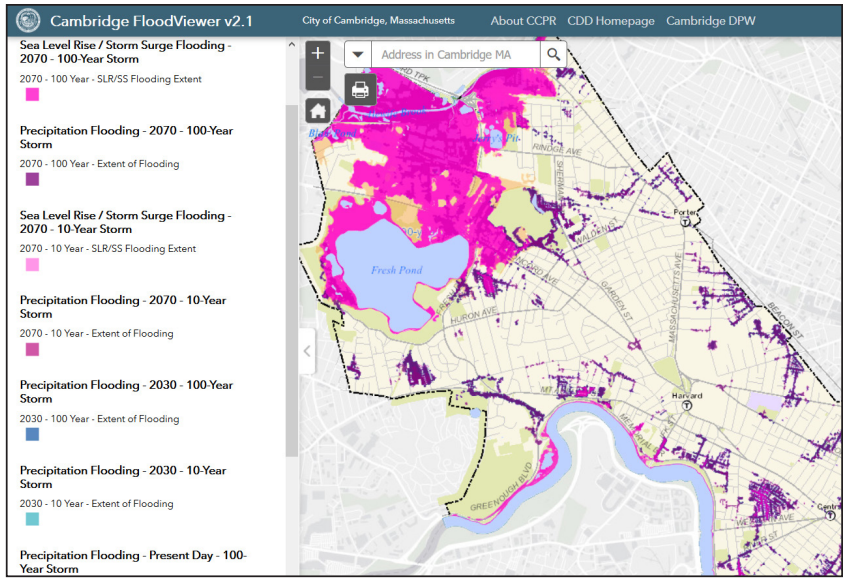
Flooding caused by rising ocean levels, both long-term sea level rise and water surges during storm events, does not currently impact Cambridge because it is protected by the Amelia Earhart Dam and the Charles River Dam. CCVA projections show that this regional infrastructure will likely protect Cambridge through 2030; however, projected 2070 SLR/SS levels have the potential to overtop the Amelia Earhart Dam if it is not adapted to meet future conditions, which would result in storm surges affecting the Alewife-Fresh Pond area. This type of saltwater flooding could last for more than a day and could impact buildings differently than freshwater flooding from precipitation.

Projected Flood Elevations

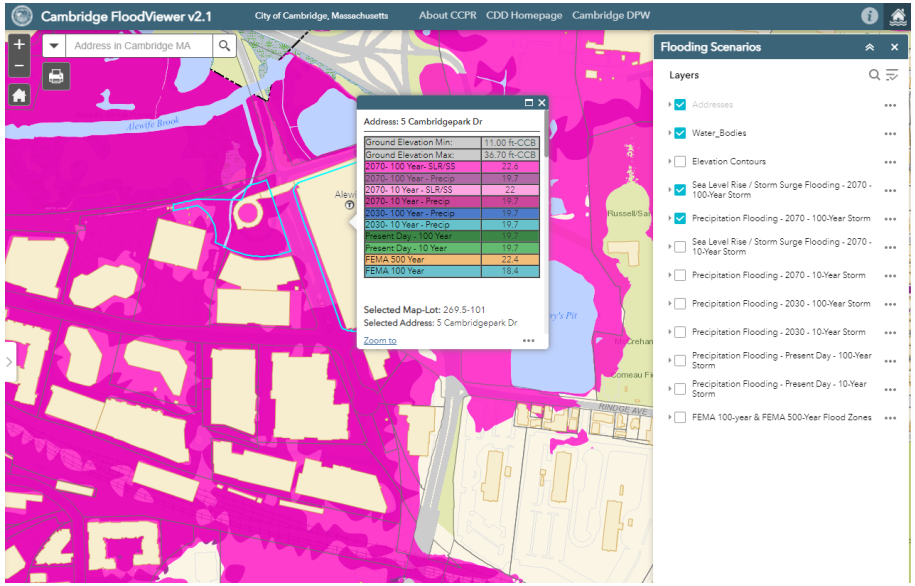
The CCVA determined the elevation of projected flooding for locations throughout the city based on three sets of variables: the nature of flooding (precipitation driven or SLR/SS), the probability of flooding (10% probability of occurring within a year, sometimes called a "10-year flood," or 1% probability of occurring within a year, sometimes called a "100-year flood"), and the timeframe of the projection (2030 or 2070). While these probabilities appear low, the risk over time is significant. For instance, a 10% annual probability event has a 96% probability of occurring within a 30-year period, and a 1% annual probability event has a 26% probability of occurring within a 30-year period, meaning that there is approximately a one in four chance. This type of saltwater flooding could last for more than a day and could impact buildings differently than freshwater flooding from precipitation.



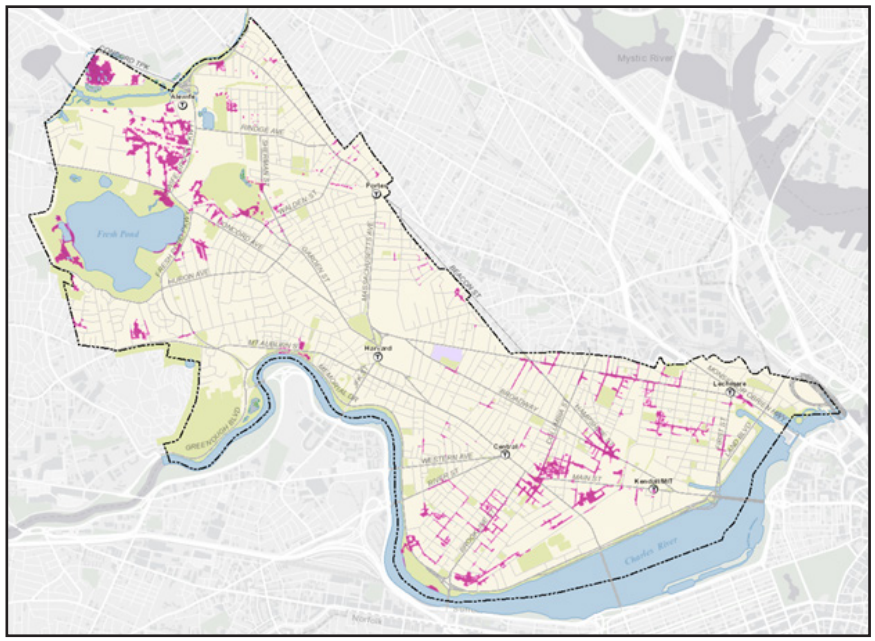
To communicate the CCVA flooding projections in a useful way, the City created an online, interactive tool called the **FloodViewer** where users can select land parcels on a map and view all projected flooding elevations.



The Cambridge FloodViewer 2.1 identifies the flood elevations for 10-year and 100-year storms for every parcel in Cambridge. The elevations include flooding from both precipitation and sea level rise/storm surge.

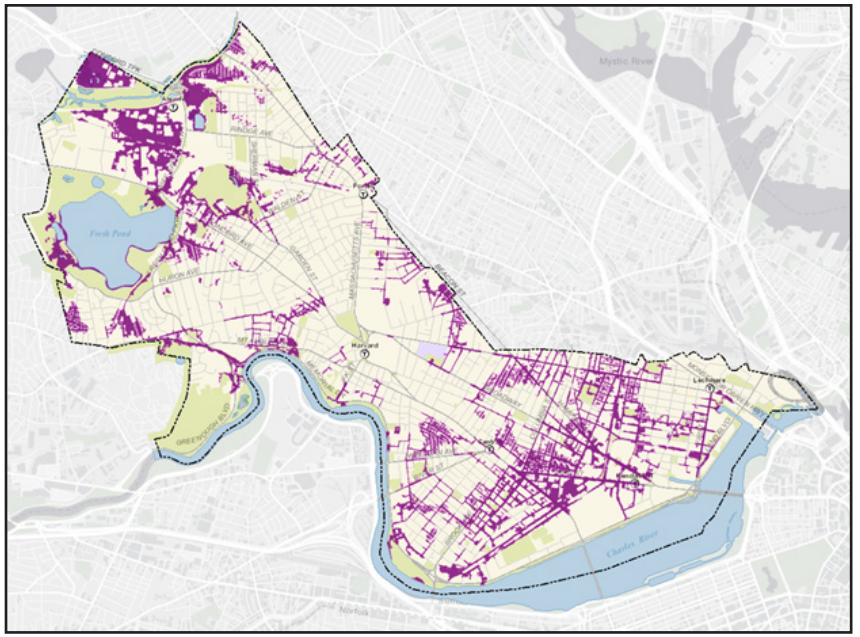


Selecting individual parcels shows detailed information about projected flood elevations.



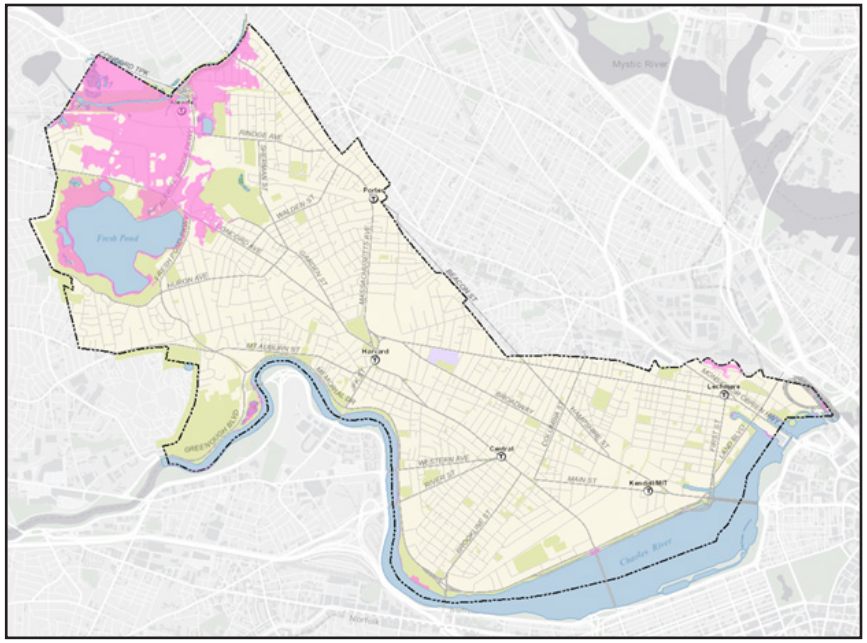
2070 10% Precipitation-Driven Flooding

By 2070, 17% of properties in Cambridge have a 10% chance of experiencing precipitation-driven flooding in any given year. (Source: Cambridge Department of Public Works)

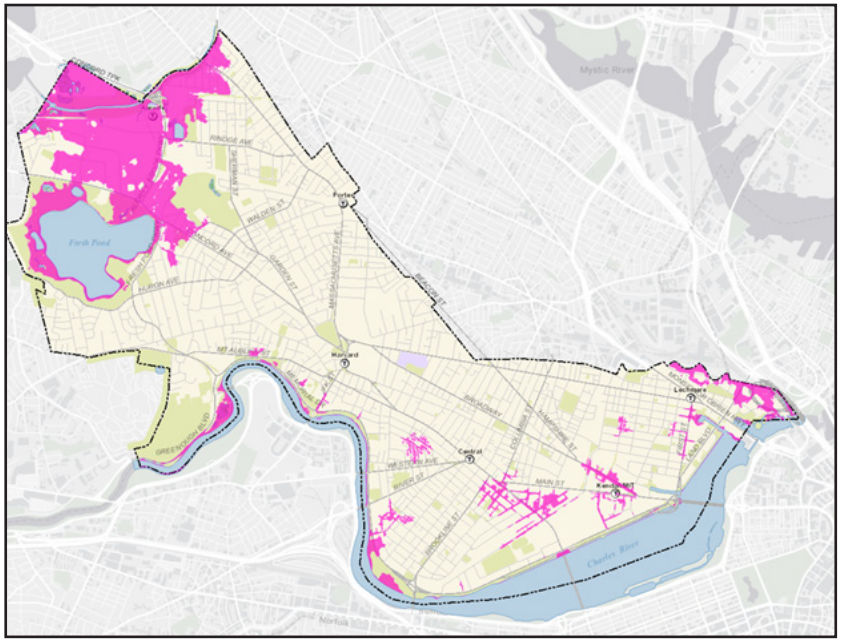


2070 1% Precipitation-Driven Flooding

By 2070, 47% of properties in Cambridge have a 1% chance of experiencing precipitation-driven flooding in any given year. (Source: Cambridge Department of Public Works)



2070 10% Sea Level Rise and Storm Surge-Driven Flooding
By 2070, 4% of properties in Cambridge have a 10% chance of experiencing flooding driven by sea level rise and storm surge in any given year. (Source: Cambridge Department of Public Works)



2070 1% Sea Level Rise and Storm Surge-Driven Flooding
By 2070, 7% of properties in Cambridge have a 1% chance of experiencing flooding driven by sea level rise and storm surge in any given year. (Source: Cambridge Department of Public Works)

Flooding | *Flooding Impacts*

Based on the findings of the CCVA, increased flooding will impact buildings and sites (such as houses, office buildings, and parks); infrastructure (such as roads, electricity, and water and stormwater systems); and critical services facilities (such as hospitals, fire stations, and community centers). The Task Force focused most of its discussion on how zoning standards can mitigate these risks, including the following:

- **Structural damage** to buildings, property, transit systems, and utilities requiring remediation or replacement.

- **Disruption to the habitability of the housing stock**, since flooding can result in public health and safety concerns due to mold, contamination, and other consequences. These impacts can be more severe in basement-level living spaces, which can be more difficult to keep dry after a flooding event. The risks can also be more severe for lower-income households with fewer housing options and less ability to repair or replace damaged property.

- **Economic disruption** due to business closures and property needing to be replaced. These disruptions could disproportionately impact small businesses without the financial resources to withstand sudden losses.

- **Social disruption** caused by damage to community resources such as public schools, daycare and youth centers, pharmacies, food pantries, social service centers, and municipal resources that are relied upon by vulnerable populations. These disruptions would significantly impact personal health and safety.

Flooding | *Adaptation Strategies*

While Cambridge cannot reduce its flood risk through City-led actions alone, changing how the City regulates development will improve citywide resilience. The Resilient Cambridge Plan promotes a set of adaptation strategies along these lines, including the following:

- **Design new buildings using 2070 flood projections**, given that buildings are likely to last for 50+ years.
- **Design usable spaces** in a building that are **below the 10% probability flood elevation to prevent flooding** (i.e. "dry floodproof").
- **Design auxiliary uses** in a building that are **below the 10% probability flood elevation to experience flooding but recover from any impacts** (i.e. "wet floodproof").
- **Design usable spaces** in a building that are **below the 1% probability flood elevation to experience flooding but recover from any impacts** (i.e. "wet floodproof").
- **Elevate critical utilities**, such as electrical boxes and shut-offs, **above the 1% probability flood elevation** where possible **or protect them if below that elevation.**

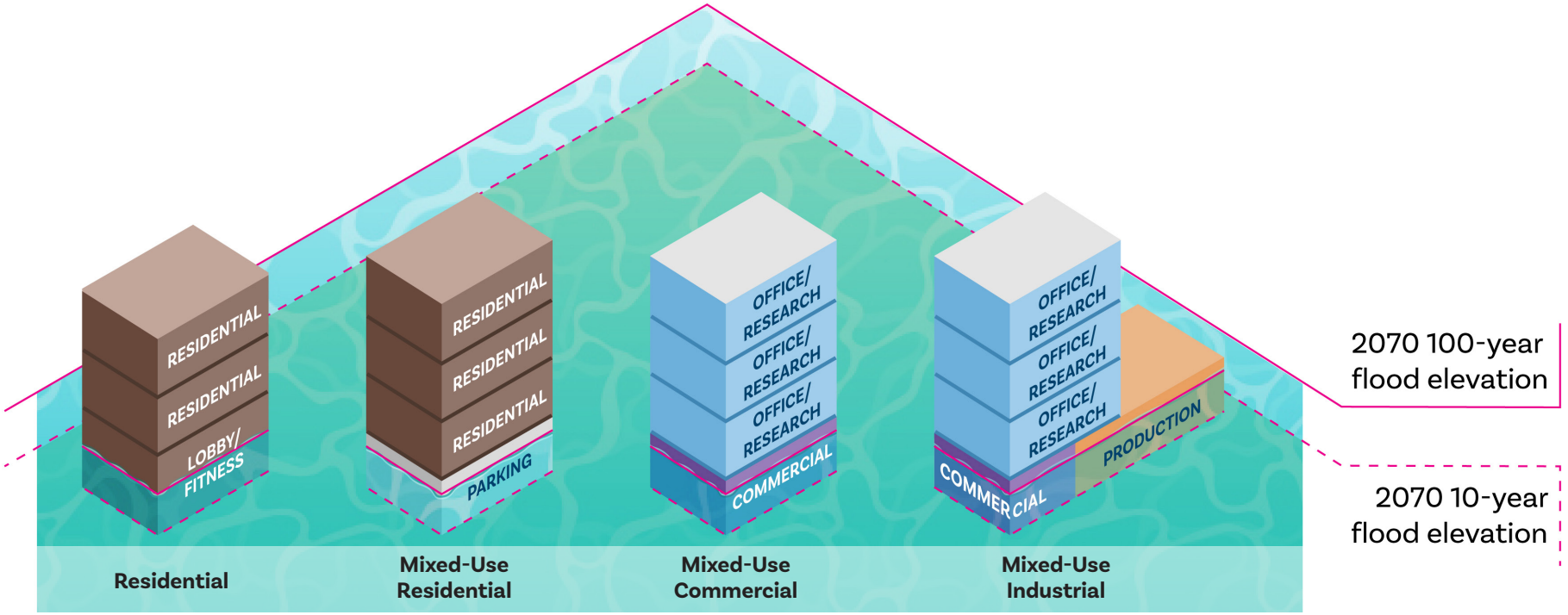
City staff have already begun to incorporate CCVA projections and some of the above-mentioned Resilient Cambridge Plan strategies into its review of development proposals. For example, applicants for special permits from the Planning Board are asked to study and mitigate future flood risks based on CCVA projections identified in the FloodViewer. Outside of zoning, the Department of Public Works (DPW), which is responsible for applying stormwater management standards and other regulations that control impacts of development on public infrastructure and resources, now relies on 2070 projections to inform its review. While this guidance has improved the resiliency of new development to flood risks, these standards are not codified in the Zoning Ordinance.

Flooding | *Key Points in Task Force Discussions*

Over the course of several months, the Task Force discussed the benefits, costs, and challenges of different development strategies as framed by the City's current climate planning efforts. Some key considerations that helped focus which strategies to prioritize relative to flooding included:

- **Basements and low-level first floors** are the most vulnerable parts of buildings to flooding; flooding in these living spaces can lead to damaged utilities, mold, poor indoor air quality, and contaminated water.
- **Certain types of habitable uses** should not be allowed below a certain flood elevation.
- **It is easier to regulate new construction** than it is to regulate renovations to existing buildings.
- Regulations could pose a financial burden that would make renovations cost-prohibitive for some residents; as a result, **property owners need some flexibility** to be able to make their own choices about how to weigh the costs and benefits of different adaptation options.
- Development standards can have an impact on stormwater management, but **zoning regulates land use and development**, not larger infrastructure systems, **which limits the nature of the interventions.**
- Since flood projections are subject to change and the impacts from precipitation and SLR/SS flooding varies throughout Cambridge, **it is important to match the zoning requirements to the level of risk** and give property owners some flexibility to choose how to protect against or recover from flooding.
- **Incremental solutions**, such as solar-ready roofs, **and strategies that provide co-benefits**, including a pathway to net zero renewable energy, **improve future resiliency** while acknowledging current standards.
- **Standards adopted into the Zoning Ordinance will need to balance other City priorities** such as urban design guidelines, housing affordability, and the city's historic character.

Residential		Non-Residential		
Residental	Mixed-Use Residential	Mixed-Use Commercial	Mixed-Use Industrial	
• Housing must be elevated or floodproofed • Garage levels can be floodproofed or floodable • Elevate or protect utilities and major equipment	• Housing must be elevated • Commercial or retail uses can be floodproofed • Elevate or protect utilities and major equipment	• Office uses can be floodproofed • Commercial or retail uses can be floodproofed • Elevate or protect utilities and major equipment	• Office uses can be floodproofed • Commercial, industrial, or retail uses can be floodproofed • Elevate or protect utilities, major equipment, and chemical storage	**Envision Prototypes**



Heat | *Climate Projections, Risks, and Outcomes*

The Task Force also reviewed key impacts associated with heat and humidity. According to CCVA projections, the average ambient air temperature will be warmer, but will also fluctuate between greater extremes of heat and cold. Heat waves will be more frequent and longer in duration, which means that building energy use will shift from predominantly heating to predominantly cooling by mid-century. Each year, Cambridge currently experiences less than two weeks' worth of days over 90°F, known as high heat days. The CCVA found that by 2070, there may be over two months' worth of high heat days.

Projected Change in High Heat Days

By the 2030s, the average summer heat index in the City could be around 95°F and by the 2070s, the average summer heat index could be as high as 110°F. (Source: CCVA 2015 as referenced in the Resilient Cambridge Plan)

Above 90° F Low Scenario

Above 90° F High Scenario

Above 100° F Low Scenario

High 100° F High Scenario

S	M	T	W	T	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31	1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30

1971 - 2000
(Baseline)

S	M	T	W	T	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31	1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30

2015 - 2044
(2030)

S	M	T	W	T	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	1	2	3	4	5
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13	14	15	16	17	18	19
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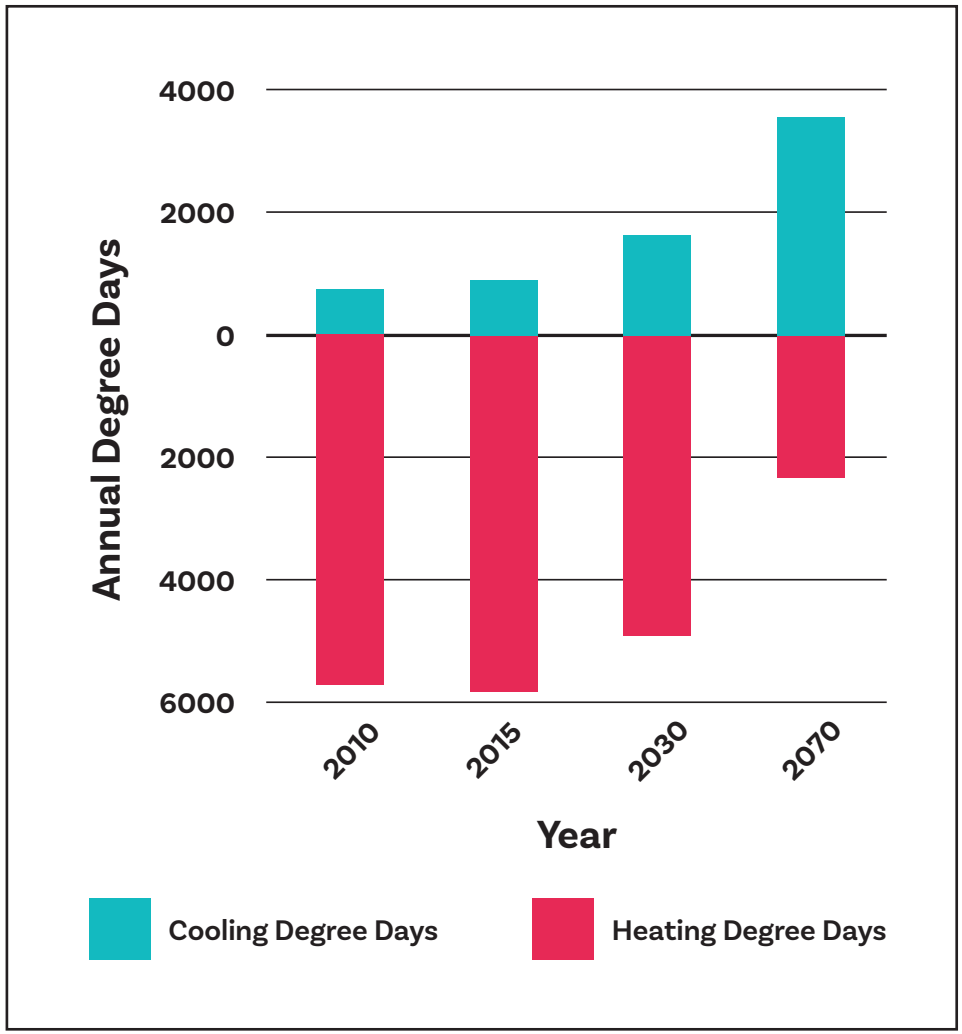
2055 - 2084
(2070)



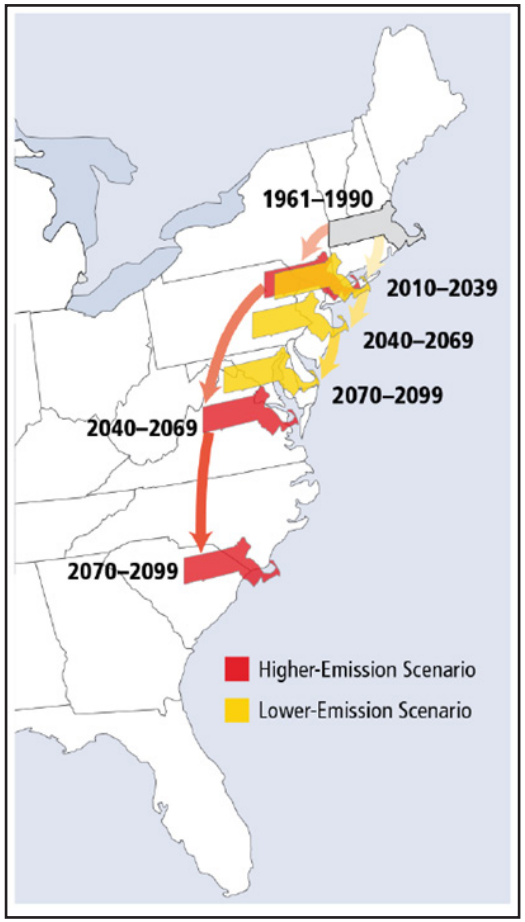
Projected Change in High Heat Days

Cooling degree days have increased by 1.5 times since 2000 compared to 1970-2000. By 2070, there will be more cooling degree days than heating.

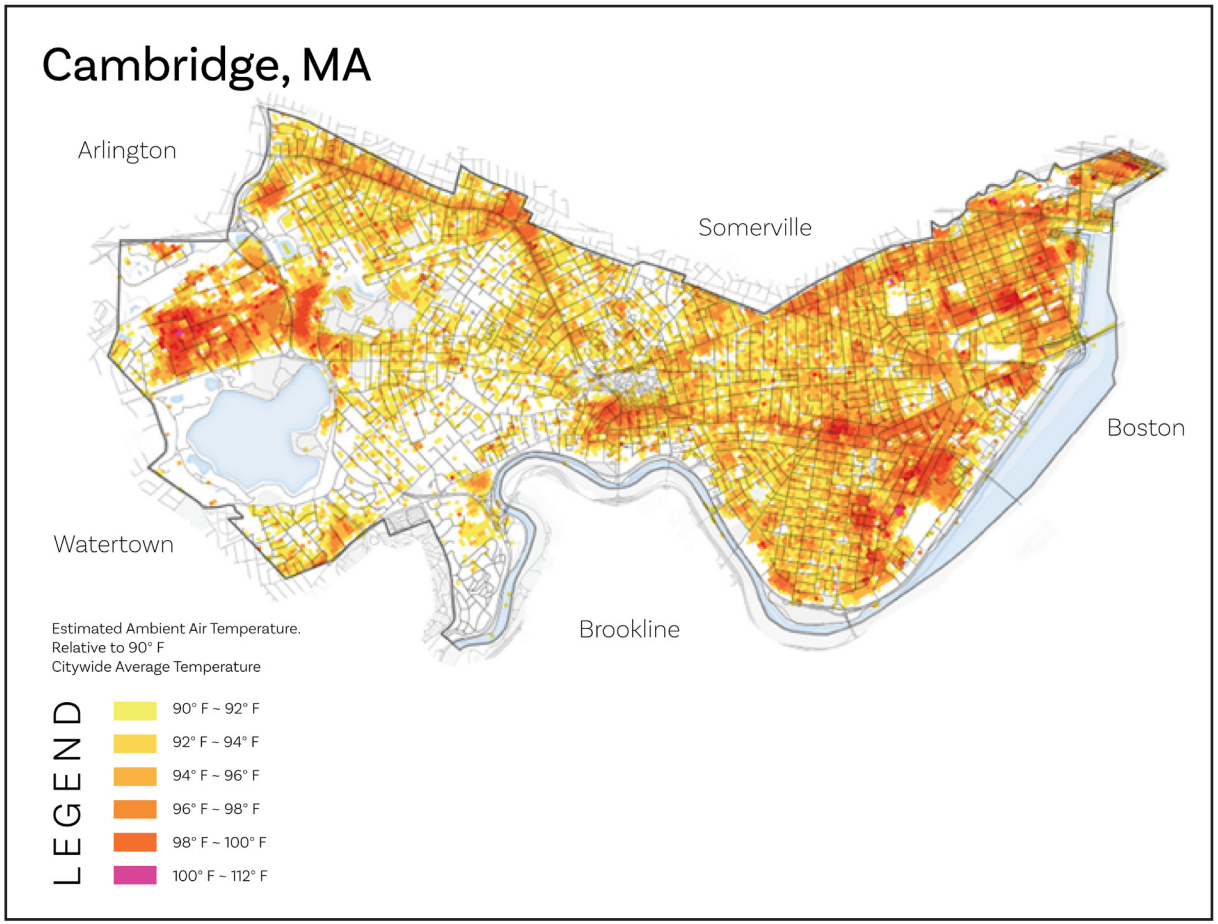
(Source: The Port Preparedness Plan, Appendix 2: Energy Resilience for The Port Technical Memo)

In addition, the heat index, which is a function of temperature and relative humidity, is projected to increase significantly. This will make hot temperatures feel even hotter and could exacerbate the likelihood of heat exhaustion and heat stroke. Heat waves and poor indoor air quality will become increasingly challenging public health concerns and high heat days will place stress on infrastructure, such as roads and utilities.

While heat is an issue citywide, its impacts vary throughout the city due to the urban heat island effect, which magnifies ambient air temperature, making the air hotter than it would be otherwise. Areas in Cambridge with minimal tree canopy and large amounts of impervious surfaces, such as pavement and dark roofs, tend to capture and retain heat. This is especially prevalent in the Alewife Quadrangle and East Cambridge, but heat islands exist throughout the city. Climate projections show that the urban heat island effect will expand in area and become more intense over time.



Massachusetts Climate Migration
Projected climate "migrations" for Massachusetts illustrate that average temperatures could be compared to South Carolina by 2070. (Source: Resilient Cambridge Handbook, June 2021)

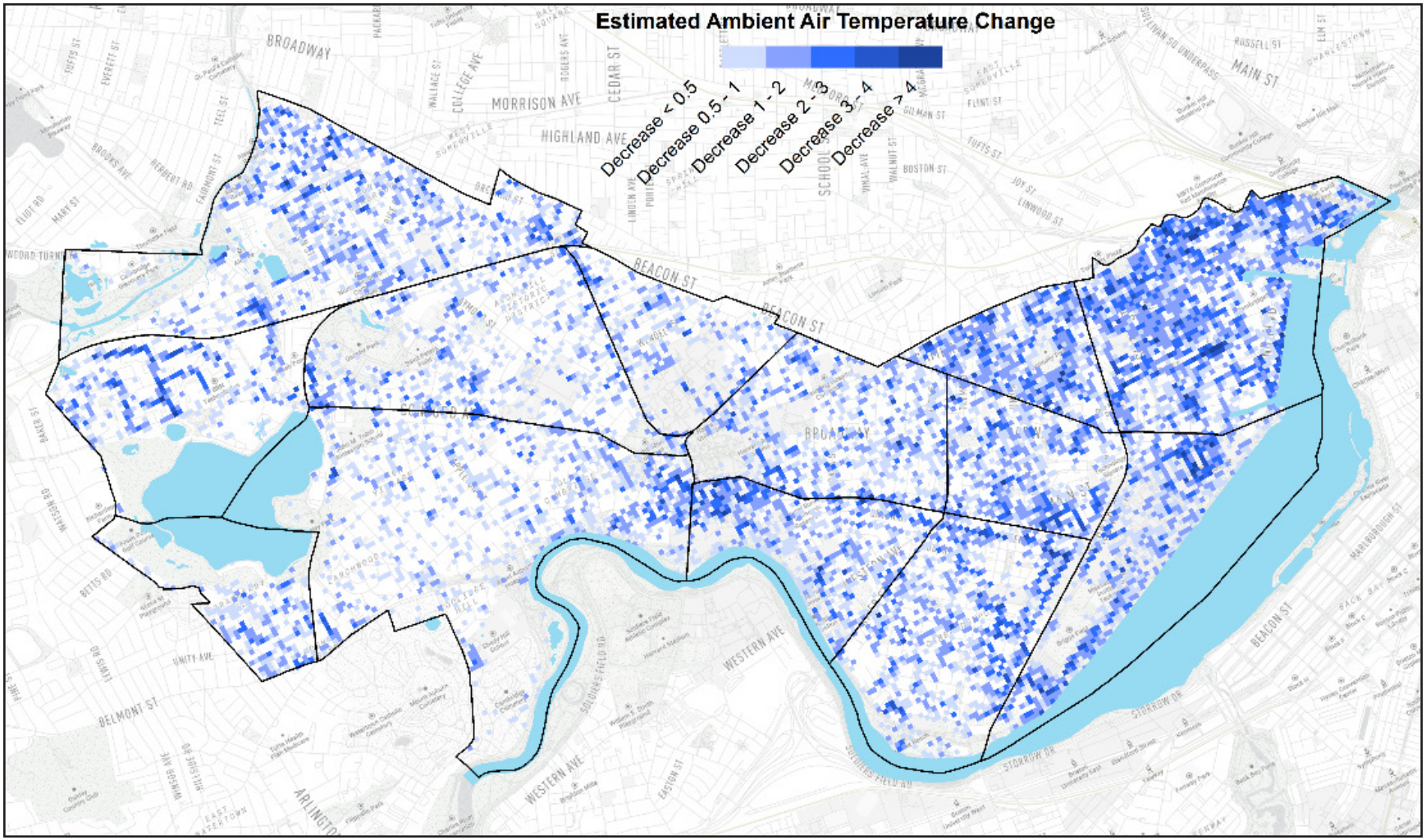


Variations in Ambient Air Temperature
This model shows that the actual ambient air temperature varies greatly when the citywide average temperature is 90°F. (Source: Resilient Cambridge Plan, June 2021)

Heat | *Adaptation Strategies*

Through the CCPR planning process, the City has identified three significant strategies to mitigate the impacts of rising temperatures by reducing heat island effects: increasing vegetation while decreasing impervious surfaces, promoting shade by expanding the urban forest canopy and using non-vegetative shade structures, and using high solar reflective index (SRI) building envelopes and roofs.

- **Vegetation and impervious surfaces:** Converting impervious surfaces to vegetation using green infrastructure techniques also reduces ambient air temperature since reducing impervious area decreases air temperature and green infrastructure effectively reduces impervious area. Testing the maximum extent practicable of this conversion in the same area near Alewife and North Cambridge demonstrates that there could be an average temperature decrease of 1.7°F with a temperature reduction in the range of 0.1-6°F;
- **Shade:** The CCPR plans found that a 1% increase in the tree canopy relates to 0.12°F of cooling. It also found that increasing canopy cover to 30% citywide would lead to significant cooling of 38% of the city land area and that tree canopy provides the most significant cooling effects above 60% coverage. The UFMP acknowledges that while trees are more effective than shade structures, shade structures can provide shade immediately while new tree plantings require many years to achieve significant shade. As a result, shade structures act as a complementary heat reduction strategy to trees;
- **High-SRI building envelopes and roofs:** One study done in the area near Alewife and North Cambridge shows that if 50% of roofs were painted white to have a high SRI, the average ambient air temperature could decrease by 2.4°F with a maximum temperature reduction of 4.5°F.



Cooling Impact of Increased Tree Canopy

Increasing canopy cover on both public and private properties to 30% citywide would lead to significant cooling of 38% of the land area in Cambridge. (Source: Cambridge Urban Forest Master Plan)

Heat | *Key Points in Task Force Discussion*

The Task Force discussed how Cambridge's urban form influences temperatures and how it could be modified to promote cooling. Some key considerations that helped focus which strategies to prioritize for heat adaptation included:

- All areas of the city will experience an increase in the ambient air temperature, so cooling strategies should provide **citywide benefits in addition to targeting priority areas**;
- A **performance-based requirement for heat resilience** that gives a property owner a menu of options from which to choose allows for the most flexibility and choice because it acknowledges that conditions vary across sites;
- Vegetation is not always a feasible way to provide shade, so **structures such as overhangs and canopies should be considered as a complement**;
- **The City should promote tree maintenance and encourage contiguous canopy coverage**, especially for public corridors and areas of high public use;
- Standards adopted into the Zoning Ordinance should **strive to meet the goal of the UFMP** to increase tree canopy coverage citywide, though they will need to balance other City priorities such as urban design guidelines, housing needs and affordability, and the city's historic character.

Task Force Study and Findings

Other Aspects of Resilience

The Task Force focused primarily on urban development strategies to mitigate flooding and heat, as they are the source of the most significant impacts from climate change that Cambridge will face, and they can be addressed directly through development standards in zoning. However, the Task Force also discussed other planning strategies that could be addressed more indirectly in zoning.

Emergency Planning

Emergency planning involves better preparing residents for emergency scenarios by providing resources that educate them and connect them with their community in the instance of an emergency event. It is distinct from emergency response, which provides immediate services to those impacted by disaster or trauma to limit the negative impacts they experience. **The goal of emergency planning is to improve human comfort and safety during an emergency with stand-alone or passive life support systems.**

Task Force members agreed that **new construction or substantial investments in renovations should incorporate emergency planning to help residents** — particularly vulnerable residents — **shelter in place.** For instance, these projects could include a resilient community room that is elevated above potential flooding and has a backup energy supply, food and water, and a communication system. They could also have emergency egress and programming that enhances social resilience. Task Force members also discussed how emergency planning requires thinking about sharing resources and shelter among buildings.

While emergency planning falls outside the scope of development standards that can be mandated through zoning, it could be included as a topic to be discussed when development proposals are required to undergo a holistic design review process, such as a Planning Board special permit or an advisory development consultation.

Passive Resilience

The concept of "passive design" encourages buildings to be designed to maximize interior comfort while requiring minimal energy use. This is effective as a climate change mitigation strategy because it reduces greenhouse gas emissions, but also promotes climate resilience because it increases a building's ability to withstand heat and to keep occupants safe in the event of power outages or extreme weather events.

Passive design strategies involve careful attention to building envelope assemblies, building systems, and materials, which are regulated by the building code and therefore generally outside the scope of zoning.

However, there are ways that such approaches can be encouraged. **As with emergency preparedness measures, passive design strategies could be a consideration for developments that undergo a holistic design review process.** For example, the "Passive House" rating system is incorporated into the city's Green Building Requirements as an alternative to the LEED rating system.

Zoning Approaches

Zoning is a form of land use regulation that controls the type and intensity of land use, including the size and scale of buildings, as well as site and building characteristics such as setbacks and open space. Along with other regulations such as building codes, stormwater regulations, and historic preservation reviews, zoning is a key aspect of how Cambridge shapes its built environment.

Far from being a rigid, one-size-fits-all tool, zoning offers municipalities different approaches to land use regulation. **How zoning is crafted depends on the outcomes that Cambridge wants to achieve**, including the types of projects that it wants to encourage or discourage.

Zoning mainly controls new development and alterations to existing development. Existing uses and buildings may be maintained even if the zoning is changed but, depending on the type of modification or expansion, may have to conform with new zoning standards if they are modified or expanded, with a presumption that development will transition from being less-conforming to more-conforming over time.

While zoning may influence the choices that a property owner makes, **it only regulates and does not dictate change.** As mentioned above, there are many other regulations and factors that influence development.

In addition, **zoning is more effective when it sets specific, quantifiable standards that are easy to measure and do not change.** Zoning is less effective at regulating more qualitative standards and criteria that involve changes over time.

How Zoning Works

Cambridge is divided into base zoning districts that regulate basic aspects of development, such as use, building height, floor area, number of housing units, open space, setbacks, and parking. Each district has a set of uniform rules that correspond to its unique development characteristics. Some districts are more permissive – allowing a wider range of uses, or larger buildings – while others are more restrictive. Any new development standards would need to interact with existing standards in a logical way.

Not Controlled By Zoning	Other Non-Zoning Regulations
• Land ownership & tenancy • Business operations • Construction methods & materials • Licensing • Taxation	• Building code • Sanitary code • Stormwater regulations • Wetlands permitting • Business licensing • Historic preservation

In addition to base zoning, there are citywide development standards that apply to all (or most) base zoning districts as well as area-specific overlay districts that overlap with all or parts of base zoning districts. Citywide rules serve particular policy objectives, and include Green Building Requirements (Section 22.20), Inclusionary Housing and Incentive Zoning (Section 11.203), and Project Review (Article 19.000). Area-specific overlay districts modify the base zoning in locations that are subject to particular planning concerns, and include Planned Unit Development (PUD) districts, mixed-use overlay districts (e.g., Central Square and Harvard Square), and the Flood Plain Overlay District.

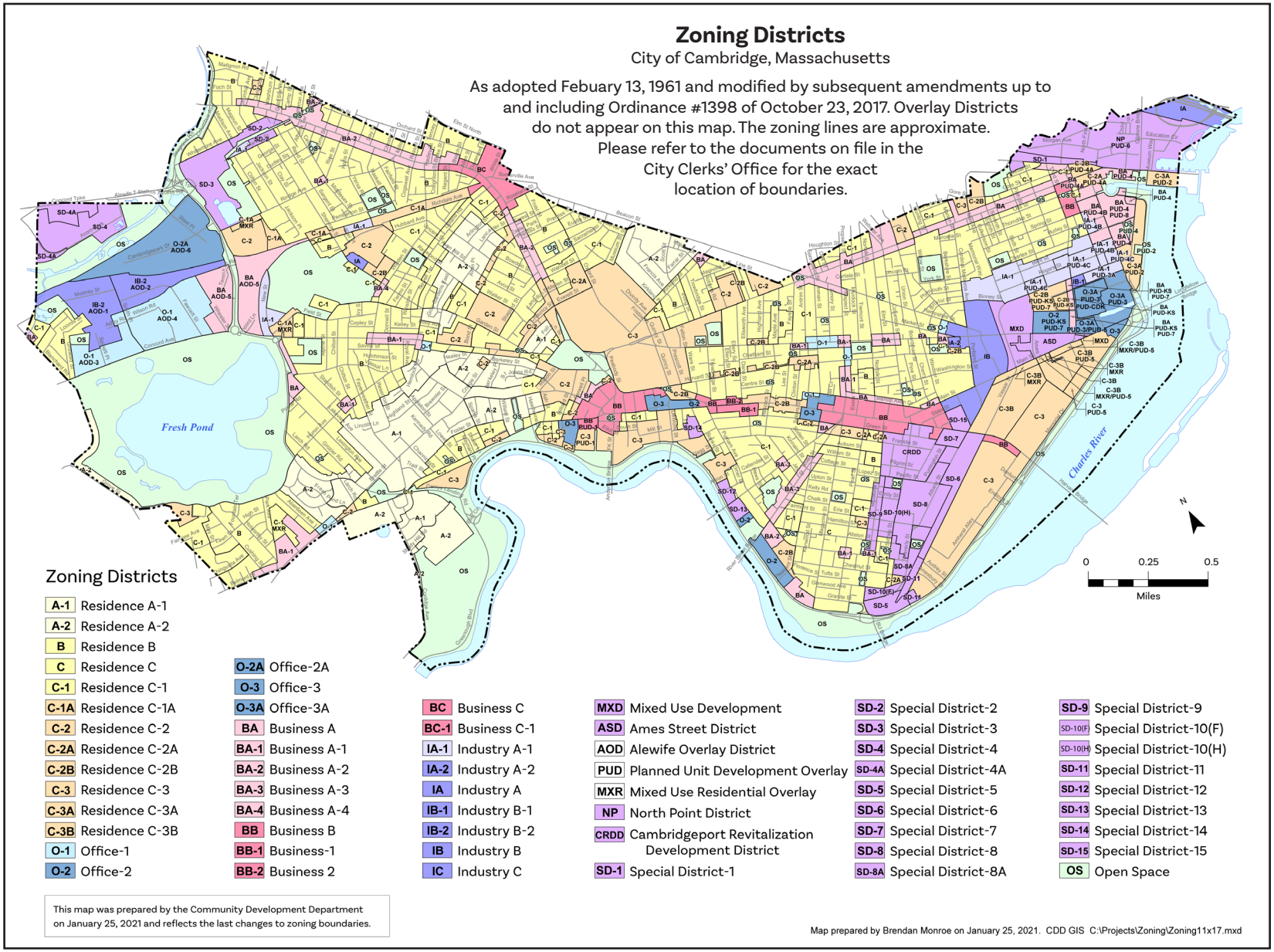
Each approach to applying development standards has benefits and drawbacks (*see Table 1 on next page*).

Table 1. Each approach to zoning has its benefits and drawbacks.

Approach	Benefits	Drawbacks
Base Zoning Districts	• Tailored to the land use character of the district (height, scale, density) • Uniformity across a district	• Standards are not consistent throughout the city • Current district boundaries might not be ideal for a particular standard
Citywide Rules	• Consistent application of a citywide standard • Uniformity across multiple zoning districts	• Can create widespread non-conformity issues • Must be compatible with underlying district regulations
Area-Specific Overlays	• Same as citywide overlay, but more customizable/targeted	• Confusing to interpret/apply in combination with base zoning • Must be compatible with underlying district regulations • Fragmentation creates tension with uniformity

Table 2. There are advantages and disadvantages to the different types of development standards.

Development Standard	Benefits	Drawbacks
Prescriptive	• Easily understandable • Straightforward to apply/enforce	• No allowance for flexibility • Some issues can't be expressed as simple standards
Performance	• More direct in addressing some issues/impacts • Opportunity to meet standards in different ways	• Requires more professional expertise • Potential for ambiguity • Unforeseen consequences
Discretionary	• Case-by-case review allows for input, improvement, mitigation • Relies on good judgment	• Discretionary decisions can be challenged • Relies on good judgment
Incentives	• Easily understandable • Encourages "better than the minimum" approach	• Challenge to agree on balance between incentive and benefit • Doesn't guarantee a particular outcome



Cambridge Zoning Map: *The Zoning Map complements the Zoning Ordinance by showing the locations of base zoning districts along with special districts and Planned Unit Developments (PUDs).*

Guiding Principles & Objectives

After reviewing and discussing the aforementioned background information, but before developing zoning recommendations, the Task Force discussed and reached consensus around a set of principles and factors to guide its discussions.

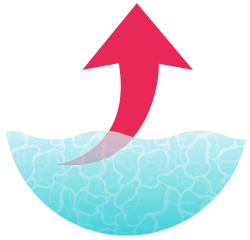
With this framework in mind, it then identified more specific land use and development objectives that the final recommendations would aim to achieve. While not all of these objectives are best accomplished through zoning, they can guide the development of climate-resilient zoning standards, as well as the City's other climate resilience strategies.

Principles & Factors to Guide Zoning Strategies

PRINCIPLES	**1. Focus on people, communities, and equity**	**2. Account for differentiation and choice**	**3. Balance strategies to address new construction & existing development**	**4. Use performance-based standards as well as prescriptive standards**
FACTORS	• Consider **human needs** in relation to the physical environment; • For residential development, focus on **health, safety, and livability** of people's homes; • For commercial development, focus on **economic impacts** that broadly affect people's lives; • Acknowledge the **differing capacities for risk**, or willingness to accept risk, of people across the income spectrum; • Foster **greater social connectiveness** and **mutual support**.	• **Differentiation**: Apply different strategies to different land use scenarios (e.g., new buildings can be elevated while elevating existing buildings or systems is more difficult; open space and tree plantings will have different effects in areas with different prevailing patterns of development); • **Choice**: Provide options to allow for economic choices (e.g., cost of floodproofing to withstand damage vs. cost of replacement; installation of structural sun-shading devices vs. green infrastructure).	• **Target policies** to new construction or existing development **depending on how much of the population will be affected**; • **Evaluate what changes to existing buildings can reasonably be expected** if they are incentivized and what changes are less likely to be feasible; • **Assess implications of** the recent trend toward **more intensive use of basement space** in existing buildings.	• **Adopt standards that allow for a range** of possible solutions; • Set performance standards for larger development that undergoes a **higher level of review**; • **Set prescriptive standards where they can be applied universally** across a broad range of land use and development scenarios; • Use **tested and established frameworks** where possible (e.g., LEED resilience credits as a starting point); • **Incorporate programmatic approaches** (e.g., emergency preparedness plans) where practical.

5. Allow flexibility in changing circumstances	6. Support actions with co-benefits	7. Seek effectiveness	8. Make decisions based on best available data and science
• **Incrementalism**: Promote present actions that can lead to future improvements, mindful of the balance of risks and costs; • **Ratcheting**: Modify standards to become more or less strenuous as climate projections and associated risks change over time; • **Learning**: Periodically review what strategies have worked, if desired outcomes are being achieved, and if changes are needed to achieve outcomes or adjust to new data; • **Patience**: Recognize that the built environment changes slowly so evaluating the effectiveness of zoning interventions requires time to see impacts and benefits unfold.	• Implement strategies that **mitigate both flooding and heat**; • **Prioritize strategies that have other benefits** such as reduced energy demand (e.g., passive livability), improved water quality (e.g. increased pervious surface), air quality, open space, habitat, or recreation when possible; • **Balance strategies** that improve flooding and heat resilience with other city priorities.	• Choose strategies that are the **best suited** to address the issue or impact; • **Use zoning to complement non-zoning tools** and other actions the City is undertaking (e.g. CCPR); • **Affect enough sustainable development to have a meaningful impact** on residents and the built environment; • **Aim for benefits** at the individual property, abutter, neighborhood, and city scale **that will exceed costs** over the life of a structure.	• **Build a base of knowledge** for future decision-making by continuing to collect and evaluate information about climate change and its impacts; • **Plan for climate science to evolve** and our understanding of impacts to become clearer with time; • **Use forward-looking data**, acknowledging uncertainties while anticipating that future climate conditions will be warmer and wetter.

Land Use and Development Objectives
to Mitigate Flooding and Heat Impacts



1. Elevate and Floodproof

Protect flood-sensitive uses such as residential units and critical building systems by elevating above future design flood elevations or dry floodproofing where below future design flood elevations

2. Design to Recover

Design buildings to withstand or recover from projected flooding (e.g. wet floodproofing, temporary barriers, water-resistant or replaceable materials)

3. Green Infrastructure

Use green infrastructure (e.g., swales, wetlands, green roofs) in addition to gray infrastructure (e.g. storage tanks) to manage stormwater on-site

4. Preserve Vegetation

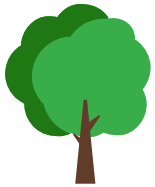
Preserve existing vegetation (e.g. trees, ground cover, planted roofs)

5. Create Vegetation

Create new vegetated areas (e.g. trees, ground cover, planted roofs) and design so that plantings can thrive over time

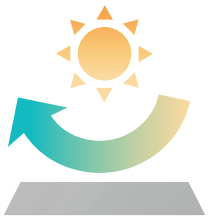
6. Limit Paved Areas

Limit amount of paved area, increase permeable area



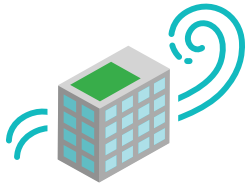
7. Provide Shading

Provide shade with trees or structural shading where trees are infeasible, especially over paved areas



8. Use Reflective Surfaces

Use solar-reflective surface materials for roofs, buildings, and paved surfaces to the extent possible



9. Promote Passive Resilience

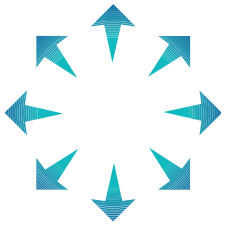
Incorporate "passive resilience" features including high performance building envelope, shading, natural ventilation, and limit air leakage

10. Shelter in Emergencies

Provide spaces for sheltering and services during extreme events

11. Create Emergency Plan

Create emergency plans with protocols to implement during an extreme weather event, where practical



12. Implement Area-Wide Strategies

Achieve the above results across larger areas (e.g., protective berms, elevated infrastructure, larger-scale green infrastructure, pooled open space, neighborhood preparedness plans)

13. Produce Co-Benefits

Promote objectives with other environmental benefits, such as reducing energy demand, greenhouse gas emissions, and auto trip generation; and increasing renewable energy production

Recommendations

- ***Category 1*** | Flood Resilience
- ***Category 2*** | Heat Resilience
- ***Category 3*** | Adjust Current Zoning Standards
- ***Category 4*** | Planning Board Review
- ***Category 5*** | Future Study

Recommendations

The final phase of the Task Force's process involved working to develop recommended changes to the Cambridge Zoning Ordinance that are informed by the Principles and Factors described above and would achieve the Land Use and Development Objectives described above. The recommendations are grouped in the following categories:

- **Category 1: Flood Resilience** – Codification of standards based on 2070 projected flooding elevations that are consistent and/or achievable with current City practices and goals.
- **Category 2: Heat Resilience** – Creation of the performance-based Cool Factor and establishment of new standards based on City plans.
- **Category 3: Adjust Current Zoning Standards** – Removing obstacles in current base zoning standards that prevent or discourage resilience measures that are recommended in the City's Climate Change Preparedness and Resilience planning.
- **Category 4: Planning Board Review** – Addition of new standards that are applicable to major new development regulated by Article 19.000 (including Green Building Requirements in Section 22.20), generally developments of 25,000+ square feet.
- **Category 5: Future Study** – Other initiatives that could directly or indirectly advance resilience planning, and efforts to undertake as new zoning is implemented.

The consensus of the Task Force was to set new flood resilience and heat resilience standards in the case of larger-scale development (25,000 square feet or more) and newly-constructed buildings of all sizes, but not to impose requirements that could be overly burdensome to owners of smaller sites making alterations or additions to existing buildings. Task Force members recognized the importance of promoting climate resilience citywide through zoning; however, they believed that the City needs to further study how requirements could be tailored to existing buildings on smaller parcels to ensure that they do not place undue burdens on small property owners.

Category 1: Flood Resilience

Overview

To address the impacts of flooding in Cambridge, the Task Force identified development standards based on the Long-Term Flood Elevations (LTFE) identified in the Cambridge FloodViewer. By using future projections rather than flood risk maps prepared by the Federal Emergency Management Agency (FEMA), the City will be able to protect buildings and sites that experience riverine flooding, localized flooding, and flooding due to sea level rise and storm surge (SLR/SS). The Task Force decided to use the LTFE projections because most buildings built today are designed to last for 50 years, which is in alignment with the timeframe of the projections. The Task Force recommends that these standards be updated at regular intervals as the science evolves and projections change, as long as there is advance notice before they become effective.

Standards and Application

The Task Force recommends requiring flood protection for all new construction occurring on sites below the projected flood elevations as identified in the Cambridge FloodViewer. Flood protection is defined differently for different uses and is based around the build/protect/recover standards identified in the Resilient Cambridge Plan. Alterations to non-conforming buildings (as regulated by Article 8.000 of the Zoning Ordinance) would not be subject to the requirements if expressly exempted.

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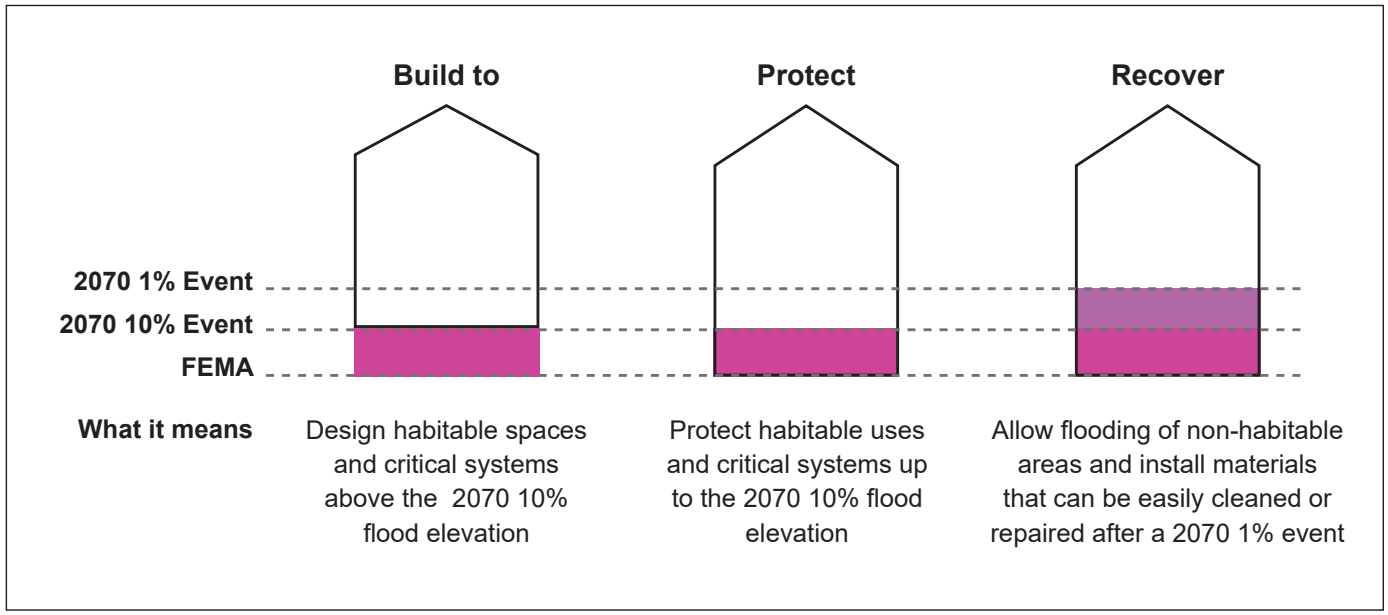
For portions of buildings that are below the **1%-probability LTFE,** the following standards would apply:

- Protect vulnerable residential living space and critical building systems with barriers to prevent flooding (i.e., dry floodproofing), if they cannot be elevated above the 1%-probability LTFE;
- Design other occupiable spaces to recover from flooding without irreparable damage (i.e., wet floodproofing).

For portions of buildings that are below the **10%-probability LTFE**, the following standards would apply:

- Protect all occupiable spaces intended for regular active use with barriers to prevent flooding (i.e., dry floodproofing), if they cannot be elevated above the 10%-probability LTFE;
- Design all other parts of the building to recover without irreparable damage (i.e., wet floodproofing).



Design Standards for Flood Resilience

The Resilient Cambridge Plan recommends a three-tiered approach to designing buildings to be flood resilient.

(Source: Resilient Cambridge: Better Buildings Technical Report, June 2021)

The Task Force is recommending these standards because they will codify existing City-recommended practices and because they give property owners greater flexibility while still protecting buildings and people. Task Force members also noted that the details of the recommended standards and application will need to be refined as City staff translate them into final zoning language, particularly when identifying the precise uses within a building that are subject to "protect" or "recover" standards.

Task Force Comments

The Task Force was supportive of these standards because they are targeted to areas that are projected to experience flooding and because they offer a certain amount of flexibility and choice. Task Force members noted that the FloodViewer should be updated at regular, pre-determined intervals to ensure predictability. Some Task Force members also suggested that the City establish a mechanism for property owners to contest the FloodViewer's assessment of flood risk for their parcel based on ground elevation data. Other Task Force members suggested that historic structures may need special considerations and that it would be useful to allow modifications through a Planning Board special permit process. Some Task Force members asked that language be included that encourages developers of large projects to protect to the 1%-LTFE where possible, since the higher standard increases a building's flood resilience.

The Task Force discussed how the Affordable Housing Overlay (AHO) could be affected by proposed new standards. Some Task Force members expressed that they do not want to interfere with the goals of the AHO. AHO Projects are currently subject to the City's sustainable development standards (including Green Building Requirements), though many other zoning requirements are waived. Since the AHO purposefully allows development to proceed as-of-right, if an AHO Project requires a variance or special permit due to additional requirements, then it could undermine its intent. Task Force members recognized that this issue would be an important consideration for the City Council when adopting any new zoning.

Category 2: Heat Resilience

Overview

A key component of the Task Force's recommendations is the use of the performance-based Cool Factor to measure the heat resilience of a development proposal. The Cool Factor is a variation on other performance-based "green area ratios," such as Seattle's Green Factor and Somerville's Green Score, as well as the Green Factor that was proposed by the Brown, et al., zoning petition. The Task Force favored this approach as an innovative and meaningful way to create development standards to address urban heat island mitigation directly. The proposed standards were developed collaboratively by the lead consultants working on the Resilient Cambridge Plan and the Urban Forest Master Plan, drawing from the research and findings of both studies.

The Cool Factor calculates a weighted score based on site features including mature tree preservation, new tree planting, ground-level vegetation coverage, green roofs, shade structures, and the use of high-solar-reflectivity paving materials. Aside from one prerequisite – the use of high-solar-reflectivity roof coverings – property owners are given the flexibility to choose which Cool Factor strategies are most appropriate for their project, as long as they meet the minimum weighted score requirement or "Cool Score" applicable to that site. The Task Force is recommending this strategy because traditional zoning does not adequately encourage overall cooling performance of buildings and sites. In addition, members acknowledged that this approach would work in tandem with Cambridge's other regulations, including existing zoning requirements for open space and permeable area as well as DPW's stormwater management regulations that combine green and grey infrastructure.

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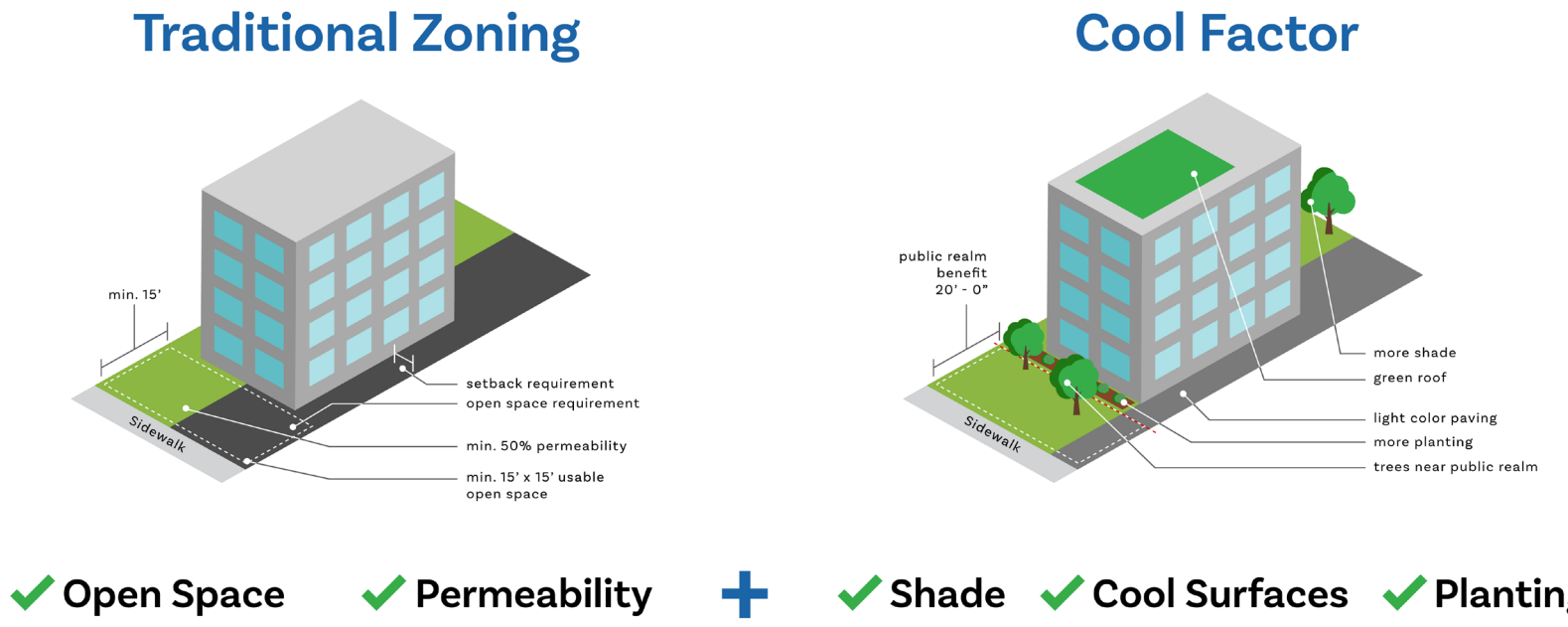
In developing the Cool Factor, the City's staff and consultants looked at other cities' performance-based "green area ratio" standards, including Somerville and Seattle, as well as the Green Factor proposed by the Brown, et al. zoning petition. The below table compares which strategies are included in these precedents as well as the proposed Cool Factor. Some differences are based on Cambridge-specific research into what interventions have the most significant effects on cooling. The Cool Factor does not give points to water features or pervious paving because they do not have a substantial cooling benefit. However, it does give points to high-SRI paving and shade structures because research shows that they lower the ambient air temperature, though they are weighted lower than "green" interventions.

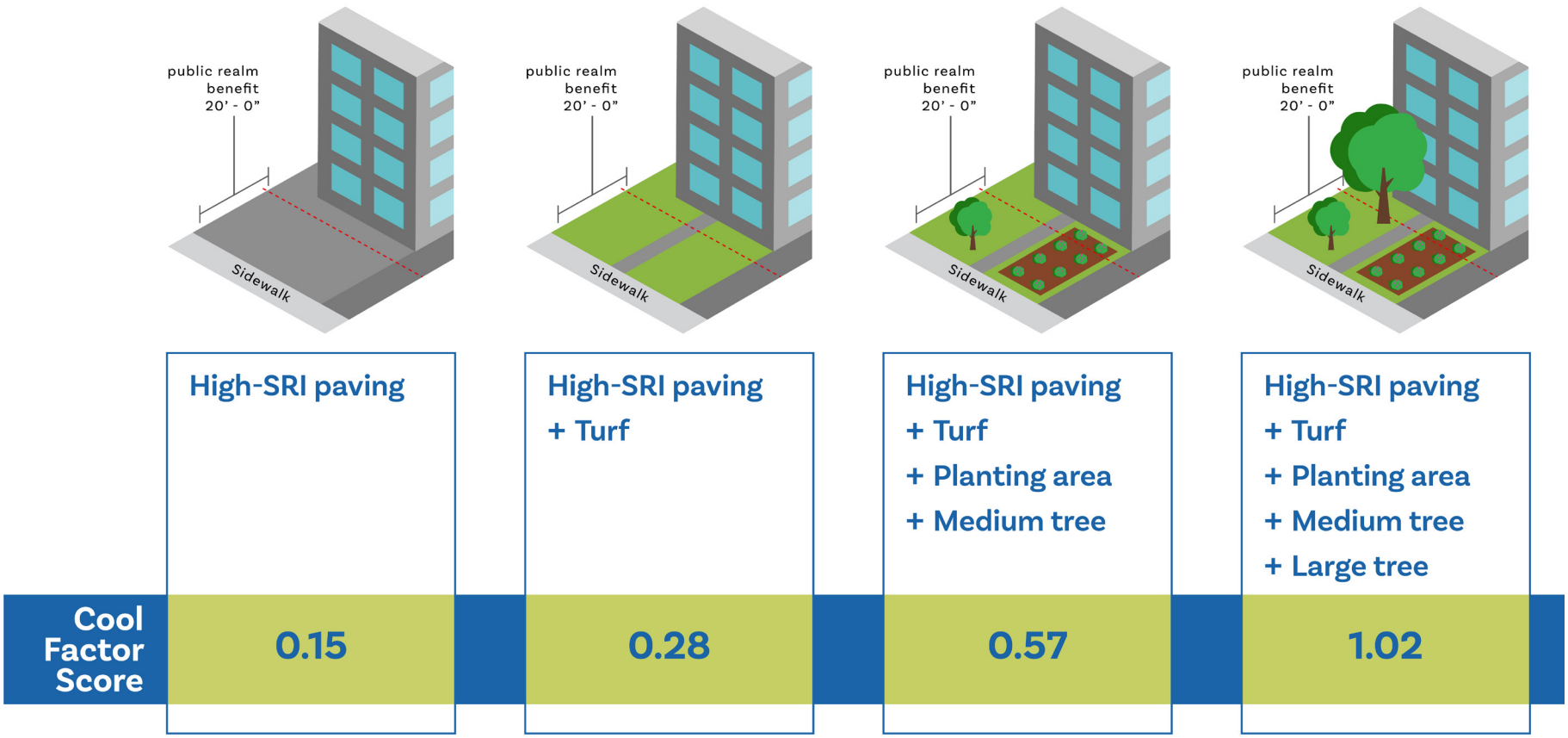
STRATEGIES	Somerville Green Score	Seattle Green Factor	Brown, et al. Green Factor	Proposed Cool Factor
Landscaped area	✔	✔	✔	✔
Vegetation	✔	✔	✔	✔
New trees	✔	✔	✔	✔
Preserved trees	✔	✔	✔	✔
Green roofs	✔	✔	✔	✔
Rain gardens & bioswales	✔	✘	✔	✔
Bioretention facilities	✘	✔	✔	✔
Water features	✘	✔	✘	✘
Vegetated walls	✔	✔	✔	✔
Turfgrass & mulch	✔	✔	✔	✔
Pervious paving	✔	✔	✔	✘
Structural soil systems	✔	✔	✔	✔
High-SRI paving	✘	✘	✘	✔
High-SRI shade structure	✘	✘	✘	✔

Cool Factor Comparison: *The strategies included in the proposed Cool Factor are largely similar to those in other approaches, with an emphasis on scientifically-proven cooling interventions.*

Many cities with a green area ratio-type requirement also use it to address other issues, such as landscape aesthetics, stormwater management, and greenhouse gas reduction. Because Cambridge already regulates these through other requirements, the Task Force recommended a Cool Factor approach that focuses on elements that are not already required. One reason is that because the system relies on earning credits, it did not seem worthwhile to grant credit for non-cooling interventions that are already required. However, interventions that have co-benefits would be encouraged. For example, vegetation strategies could count toward the proposed Cool Factor as well as existing Green Building Requirements and stormwater management regulations, among others.



Cool Factor Complements Traditional Zoning: *The structure of the Cool Factor complements traditional zoning by emphasizing the use of cooling strategies to meet existing zoning requirements.*



Layering of Cool Factor Strategies Allows Flexibility

The Cool Factor allows property owners to choose a combination of strategies that provide them with flexibility to meet cooling targets.

Standards and Applications

The Task Force recommends adopting the Cool Factor as the City's primary standard for measuring the heat resilience of development projects. The Cool Factor would be applied in the following ways:

- **For new construction of 25,000+ square feet**, the Cool Factor would apply with a minimum "Cool Target" equal to the open space requirement in the zoning district, or a minimum of 20%.
- **For alterations to buildings of 25,000+ square feet or to their sites**, the Cool Factor (with the minimum targets above) would need to be met. If the site does not currently meet the applicable target, then it cannot be further reduced (i.e., if the proposed alterations would further reduce the Cool Factor below the applicable target, then additional features must be included on the site to compensate for that reduction).
- **For development that is less than 25,000 square feet**, the Cool Factor (with the minimum targets above) would apply only when a new building is being built on a site, but not when alterations are proposed.
- **Modifications to the above standards may be approved by special permit.**

Task Force Comments

There was interest among some Task Force members to apply the Cool Factor to alterations and renovations that are under 25,000 square feet; however, the Task Force decided that more analysis was needed to understand the impacts of doing so. Similarly, Task Force members were not comfortable recommending changing the existing open space requirements in the Zoning Ordinance due to the possibility for unintended consequences. Overall, Task Force members supported having all properties in Cambridge contribute to cooling but thought that the City needed to conduct additional research to identify an appropriate citywide standard that acknowledges different zoning scales and contexts. Task Force members also noted that the details of the recommended standards and application will need to be refined as City staff translate them into final zoning language.

Task Force members suggested establishing a process to revisit the Cool Factor scoring a few years after its adoption, once the City and property owners have had experience implementing the

standard. Some Task Force members preferred setting a minimum cooling multiplier of 25% but were able to agree to a 20% minimum; they suggested that it might be appropriate to increase the cooling multiplier in the future. Some Task Force members advocated for a separate Green Factor score that would account for resiliency measures outside of cooling and would complement the Cool Factor. Task Force members noted that the City needed to work out the specifics for how property owners of non-conforming buildings could compensate for a reduction in their existing Cool Factor score. They also mentioned the need for flexibility for historic structures. Some Task Force members suggested setting minimum and maximum requirements for the percentage by which any given strategy contributes to the overall Cool Factor score.

Category 3: Adjust Current Zoning Standards

Overview

New zoning requirements should work in tandem with development standards that are already in place. Therefore, in addition to creating additional requirements that development must meet, it is important to ensure that other zoning requirements do not constrain or discourage the outcomes that are desired.

There are certain standards in the current Zoning Ordinance that could be revised or removed because they create impediments to achieving the Task Force's Principles and Objectives. Removing these requirements would provide incentives for property owners to change buildings and sites to be more resilient without imposing new regulatory burdens.

Standards and Application

The Task Force recommends the following changes to the Zoning Ordinance:

- **Exempt outdoor shade canopies** from GFA, height, setback, and open space limitations. This would apply to new construction or alterations where shade canopies are proposed.

- **Exempt exterior flood-resilience measures** (e.g., stairs, ramps) from GFA, setback, and open space limitations. This would apply to new construction or alterations where site flood protection measures are proposed.

- **Exempt usable green roof areas and rooftop access headhouses** from GFA and height limitations as-of-right. This would apply to new construction or alterations where green roofs are proposed.

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(Standards and Applications, continued)

- **Allow a compensating increase in height limit** (up to 4') **if the ground story is elevated up to the 2070 1%-LTFE**. This would apply to new construction or alterations where site flood protection measures are proposed.

- **Exempt basement area from GFA limitations as-of-right, if protected from flooding below 2070 1%-LTFE**. This would apply to new construction or alterations where site flood protection measures are proposed and would modify an existing standard.

Task Force members also noted that the details of the recommended standards and application will need to be refined as City staff translate them into final zoning language.

Task Force Comments

The Task Force was very supportive of these five recommendations. One Task Force member expressed concern with exempting shade structures from height and setback requirements, but ultimately all Task Force members agreed to these recommendations.

Similarly, some Task Force members expressed concern with completely exempting rooftop access headhouses from GFA and height requirements because of the possibility that the exemption could be exploited; they suggested placing a limit on these exemptions.

Other Task Force members noted that a compensation of 4' in height may be inadequate to offset elevating the ground floor of buildings to the 2070 1%-LTFE; they suggested that allowing a slightly larger height standard would ensure that raising a building does not diminish a site's full development potential.

Category 4: Planning Board Review

Overview

Section 19.20 of the Zoning Ordinance establishes a process by which the Planning Board reviews major development for consistency with the urban design objectives of the City and to mitigate adverse impacts on city traffic. Typically, the special permit only applies to buildings equal to or greater than 50,000 gross square feet, though in some districts review is required for projects equal to or greater than 20,000 gross square feet. Applicants are required to submit a variety of studies, plans, and narratives, and the Planning Board makes specific findings based on criteria in the Zoning Ordinance.

These special permits only apply to a limited number of developments, but most new development in Cambridge falls into this large project category. The holistic review process, with public input and approval based on a set of established criteria, provides an opportunity to conduct a site-specific review of how a development is planned and designed for resilience.

Standards and Application

The Task Force recommends adding two standards to Article 19.000 that would apply to projects applying for a special permit from the Planning Board:

- **Require applicants for a Project Review Special Permit to submit a Resilience Narrative** with their application that includes projections for flood risk and heat risk as well as a description of adaptation strategies, including flood protection, heat island mitigation, passive resilience measures, and operational preparedness.
- **Add a Resilience Objective to the Citywide Urban Design Objectives in Section 19.30** that notes that development should be planned to respond to anticipated effects of climate change, with indicators related to flood protection, heat island mitigation, passive resilience measures, and emergency planning.

The goal of the Resilience Narrative recommendation is that it would require applicants

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to consider resilience measures early in the development of their projects. It also ties into the Task Force's recommendations for flood resilience and heat resilience. Similarly, the Resilience Objective gives City staff and Planning Board members guidance for evaluating applications for a special permit.

Task Force Comments

The Task Force supported these recommendations because they prioritize resilience and create consistency in how it is reviewed by the Planning Board. Some Task Force members noted that the indicators will need to be specific and fact-based in order to improve the resilience of projects. They suggested including drawing sheets in the submission package and requiring applicants to identify a full range of resiliency measures for all of the key aspects identified in both the Resilience Narrative and the Resilience Objective.

Some Task Force members suggested that templates and a menu of strategies could be made available to applicants to promote best practices and encourage consistency. Some Task Force members also suggested that applicants reference how their projects conform with specific City plans and goals outlined in policies such as the UFMP and the Resilient Cambridge Plan.

Category 5: Future Study

The Task Force acknowledged that climate science is dynamic, so **members suggested that these amendments to the zoning ordinance be evaluated for their performance at a future date**. In particular, they recommended studying the success of these amendments in meeting the Task Force's Principles and Objectives, with a focus on climate resilience effects as well as impacts on housing costs and production, historic preservation, and small business viability. Task Force members also suggested revisiting climate projections and recommendations from the Resilient Cambridge Plan to determine if additional approaches should be considered, such as expanding the Cool Factor as mentioned above.

As the Task Force discussed possible recommendations to the Zoning Ordinance, members also acknowledged that **there were related issues that needed to be addressed but were outside of the scope of zoning**. For example, Task Force members discussed the importance of preserving Cambridge's built cultural heritage through standards that balance historic preservation with resiliency. Members also noted the role that urban design guidelines could play to guide climate-resilient development in the city.

In addition, the Task Force discussed how **revising the City's parking requirements in Article 6.000 of the Zoning Ordinance would also make Cambridge more resilient to climate change**. By taking such steps as eliminating minimum parking requirements, lowering maximum parking requirements, and reducing parking ratios, the City would decrease the amount of land used for the storage of vehicles. This would likely reduce the amount of impervious surface and create more opportunities for green infrastructure, which would improve the City's ability to withstand the impacts of increased flooding and increased heat. However, the Task Force decided not to include these strategies in its final recommendations because members chose to focus more specifically on buildings and sites.

Implementation and Next Steps

The Charge and Operating Procedures that guided the Climate Resilience Zoning Task Force set an expectation that City staff would translate these recommendations into a zoning petition, with input from the City's Law Department and other departments. As City staff work to implement the Task Force's recommendations, staff will have to evaluate how to incorporate those recommendations within the parameters of what can be legally regulated through zoning. In instances where the final zoning standards look different from the initial recommendations, they will still meet the Principles and Objectives identified by the Task Force.

Since amending the Zoning Ordinance requires the Planning Board and the City Council or the City's Ordinance Committee to hold public hearings, there will be many opportunities for continued public comment and involvement. City staff also intends to provide opportunities for the Task Force to provide input when the zoning language is drafted.

Appendix

- ***Charge and Operating Procedures***
- ***Cool Factor Score Sheet***
- ***Cool Factor Guidance Document***

Charge and Operating Procedures

February 4, 2019

Vision: To bring together stakeholders from across the Cambridge community and reach consensus around an effective approach to regulating urban development in a way that will mitigate the identified impacts and risks of on-going climate change.

Purpose: To discuss climate change vulnerabilities identified in the Cambridge Climate Vulnerability Assessment, review recommendations from the ongoing Climate Change Preparedness and Resilience (CCPR) planning effort and other related initiatives and recommend development standards to incorporate into Cambridge's Zoning Ordinance.

Product: Report to the City Manager detailing a set of recommendations for climate-resilient zoning that can be translated into a formal zoning petition by City staff and presented to the City Council for consideration and adoption. Should the Task Force reach consensus on recommendations that can be reasonably advanced during rather than at the end of the process, without constraining the group's ability to reach consensus on the work product as a whole, they can and will do so.

Note: All meetings are open to the public. Meetings will be posted on the City web page and meeting notes and other materials will be prepared and posted on the web. All formulation and prioritization of recommendations will take place at Task Force meetings, though members may informally and individually engage one another for relationship building, sharing of interests, and idea generation. Group email discussions are discouraged, and any information meant to be shared with the group should be sent to the project manager for moderation.

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Specific Climate Change Impacts to Discuss:

- Anticipated impacts of flooding from sea level rise, storm surge, and precipitation
- Anticipated rise in temperatures exacerbated by the urban heat island effect

Scope of Zoning Recommendations:

- Major new development subject to project review procedures
- Smaller-scale development subject to as-of-right zoning
- Additions/alterations to existing buildings and uses
- Citywide and area-specific (e.g., Alewife, Port, etc.)

Relationship to City Council:

- The Committee has been appointed by the City Manager in response to a City Council Policy Order.
- The Council, through its Health & Environment Committee, intends to have an active and on-going role in following, engaging with, and shaping the work of the Task Force.

Coordinating Team:

- The Task Force will be coordinated by a small team in order to ensure an overall effective work plan driving to goals and end products, design engaging and focused meeting agendas, provide for necessary technical support, and help resolving issues that may arise during deliberations. The Team will include:
    - Co-Chairs (Doug Brown, Iram Farooq)
    - Staff Project Manager (Jeff Roberts)
    - Facilitator (CBI)

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Expectations of Task Force Members:

- Attend all meetings or notify the project manager if they cannot attend a particular meeting
- Prepare for meetings by reading materials, considering issues, reviewing the agenda, and engaging with constituents as needed
- Listen and learn as well as speak and advocate
- Strive throughout the process to listen actively, bridge gaps in understanding, and seek resolution of differences
- Help create an environment that is safe, respectful, and constructive for participants
- Stay on track with the agenda, working on the issues at hand
- Avoid repetition and revisiting resolved issues
- Provide clear and specific recommendations that are connected to well-articulated objectives
- Seek evidence-based recommendations while recognizing decisions will need to be made in the face of uncertainty and incomplete data

Expectations of the City:

- Participate in the Coordinating Team
- Provide for logistics, including meeting space, AV, scheduling, facilitation and communications with the Task Force
- Create a basic website for information, notice of dates and events, and posting of documents
- Provide the necessary in-house and consulting technical assistance to aid the Task Force in their work to help ensure a well-informed, technically credible, operationally-feasible set of final recommendations
- Coordinate effectively among City staff, managers, elected officials, and consultants
- To the extent possible, provide additional information that the Task Force may request throughout the course of the process to advance its discussions
- Prepare draft written products based on Task Force discussion for Task Force review
- Develop a zoning petition based on Task Force recommendations in a timely fashion that can in turn be considered by the Council and its various committees through the formal zoning process

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Expectations of the Co-Chairs and Facilitators:

- Ensure groundrules for participation are met
- Develop meeting agendas, prepare and distribute draft and final meeting summaries, generate draft written products
- Help participants resolve their differences on the issues raised
- The co-chairs and/or facilitator have no decision-making authority and cannot impose any solution, settlement, or agreement among any or all of the parties
- The facilitators are accountable to the Task Force as a whole and will work in a non-partisan and impartial manner

Developing Recommendations to the City Manager by a Consensus Process:

- Once discussions have proceeded in creating options and identifying preferences, the project team will present a draft recommendation or a narrow set of options.
- The participants will then work to refine, adjust and improve the draft recommendation.
- The facilitator will then test for consensus upon group refinement. determine if consensus has been reached, and declare whether the group has or has not reached consensus. Such determinations will be recorded clearly in meeting summaries. Remaining objections will be recorded in the meeting summary.
- Consensus in this context is defined as concurrence of all or almost all of the participating members (see next page for members) that they can at least “accept” or “live with” the group’s recommendation, even if it is not their preferred outcome.

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Developing Recommendations to the City Manager by a Consensus Process, continued:

- Participants may also "abstain" or "stand aside" and not offer their consent to avoid blocking an agreement while also not lending their endorsement. Absence is the equivalent of abstaining.
- Participants should not block or withhold consensus unless they have serious reservations with the approach or solution that is proposed for consensus. If participants disagree with the approach or solution proposed, they should make every effort to offer an alternative for consideration that will be satisfactory to all participants.
- On decisions in which the Task Force does not reach consensus, participants will explore the reasons for disagreement. The participants will identify points upon which they agreed and disagreed, the reasons behind each, a description of the interests that must be satisfied to reach an agreement, and if possible, ways to address the differences in the future.
- In such cases of disagreement, if there are remaining disagreements at the end of the process, the facilitators and co-chairs would try to characterize the nature of that disagreement in the final report.

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Meeting Logistics and Process:

- Meetings will be held roughly once a month unless otherwise decided by the Co-Chairs
- Meetings will be held in the early evening for approximately 2.5 hours
- The Coordinating Team will meet (in person or phone) at least 2 weeks before each task force meeting to prepare for the next meeting
- Each meeting will include a time for brief public comment. The public is also welcome to submit written comments at any time to the City to be distributed to the Task Force
- The City will prepare background materials to distribute to members 1 week before each meeting. The intent is to provide material to Task Force members with sufficient lead time so that the members can review and, if necessary, confer with constituents prior to Task Force meetings.

Background Materials:

- CCPR Alewife Preparedness Plan (November, 2017)
- CCPR Preparedness Handbook (November, 2017)
- Douglas Brown, et al., Zoning Petition Materials (petition text, supporting narratives, CDD report, Planning Board recommendation)
- Other materials as identified over the course of the process

Members

Residents	1. Doug Brown (Co Chair) - West Cambridge 2. Conrad Crawford - East Cambridge/Cambridge Redevelopment Authority 3. Ted Cohen - North Cambridge/Planning Board 4. Mike Nakagawa - North Cambridge
Union/Trades Rep	5. Louis Bacci Jr - Laborers Local 151/East Cambridge/Planning Board
Institutional/Non-Profit Representatives	6. Brian Goldberg - MIT Office of Sustainability 7. Tom Lucey - Harvard University 8. Margaret Moran - Cambridge Housing Authority 9. Deborah Ruhe - Just-a-Start
Business Representatives/ Property Owners	10. Jason Alves - East Cambridge Business Assoc. 11. Nancy Donahue - Cambridge Chamber of Commerce 12. Joe Maguire - Alexandria 13. Tom Sullivan - Divco West 14. Mike Owu - MITIMCo
Subject Matter Experts	15. Tom Chase - Energy & Resilience Consultant, New Ecology 16. Lauren Miller - Climate Consultant, CDM Smith 17. Jim Newman - Resilience Consultant, Linnaean Solutions
City Staff	18. John Bolduc - Environmental Planner 19. Iram Farooq (Co-Chair) - Assistant City Manager for Community Development 20. Kathy Watkins - City Engineer/Assistant Commissioner

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Draft Work Plan (*subject to change*)

Title	Mtg #	Purpose	Outcome
January 23, 2019	1	• Review purpose and scope of TF • Establish ground rules • Introduce members, share perspectives • Distribute materials	• Members have a common base of knowledge and a shared understanding of the task • Agreement to work cooperatively toward a common goal
February 27, 2019	2	• Recap CCPR work to date (w/Q&A) • Review zoning basics, what can and can't be regulated (w/Q&A)	• Shared understanding of past and current resilience studies, what can be accomplished through zoning, and other related City efforts
March 21, 2019	3	• Walking tour to review real-life development scenarios • Review different types of flooding and specific risks • Review different causes and risks of heat island effect • Discuss approaches to mitigating risks that can be implemented through zoning	• Better shared understanding of physical issues • Set of issues to be addressed through zoning and general sense of priority

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Draft Work Plan (*subject to change*)

Title	Mtg #	Purpose	Outcome
April 24, 2019	4	• Focus on flood resilience • Recap priority issues from previous meeting • Present potential zoning approaches • Discuss & refine	• Sense of what approaches have broad agreement • Identify key areas of disagreement
May (TBD)	5	• ***Joint meeting with Health & Environment Committee***	• Update on progress to date, get input/ feedback
June 26, 2019	6	• Focus on heat resilience • Recap priority issues from prior discussions • Present potential zoning approaches • Discuss & refine	• Sense of what approaches have broad agreement • Identify key areas of disagreement
July	7	• Synthesize flood and heat resilience • Present combined framework of preferred zoning approaches based on prior discussions • Discuss & refine	• Set of preferred alternatives (including opportunities for combined approaches) • Prioritization among all alternatives
August (or Sept.)	8	• ***Joint meeting with Health & Environment Committee***	• Update on progress to date, get input/ feedback

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Draft Work Plan (*subject to change*)

Title	Mtg #	Purpose	Outcome
September	9	• Present first draft of full recommendations • Discuss & refine	• Identify overall areas of agreement • Identify issues still to be resolved
October	10	• Present revised draft of full recommendations • Reach final consensus or continue to discuss & refine as needed	• Work toward resolution on remaining outstanding issues (recursive process)
November	11	• ***Joint meeting with Health & Environment Committee***	• Update on progress to date, get input/ feedback
December	12	• Finalize Recommendations	• Establish what goes into final report to City Manager

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Cambridge Cool Factor
Guidance Document

How to use this document

This document guides applicants in completing the Cool Factor Score Sheet. Below, each strategy that contributes to the score is defined, and any requirements for utilizing and counting the strategies are explained.

How to fill out the Score Sheet

First, fill out the fields at the top of the Score Sheet, including the total lot area of the site in square feet and the Cool Target. The Cool Target is either the open space requirement per the Zoning Ordinance or 20%, whichever is higher. Then, for all strategies except those in category A, enter the number of square feet dedicated to the strategy (such as B3: Planting Area or C3: Green Roof). For strategies in category A, simply enter the number of trees; the corresponding square footage of tree canopy is automatically calculated by the Score Sheet. The Score Sheet distinguishes between strategies that are within 20 feet of the public right-of-way and those that are not. Note that a strategy can only be counted once.

Cambridge Cool Factor
Strategy Definitions & Prerequisites

How the Score Sheet is calculated

For all strategies, the area of each strategy is automatically multiplied by a weighting factor, so strategies that provide a greater cooling benefit have a higher relative value. For example, preserving large canopy trees, which provide large areas of shade and significant cooling, has the highest value due to its high multiplication factor. Similarly, strategies that are within 20 feet of the public right-of-way have a higher multiplication factor than strategies that are outside of that area because they provide an additional public benefit.

The Score Sheet automatically calculates the value of all strategies, then divides that sum by the total cooling area goal, which is simply the total lot area multiplied by the open space requirement. If the resulting figure is 1 or above and the building design includes a high-Solar Reflectance Index roof, then the requirements of the Cool Factor have been met. If the score is below 1, revisit the initial site strategies and try to identify any opportunities to increase the use of strategies with higher multipliers and strategies within 20' of the public right of way. Also consider increasing the area of individual strategies.

A TREES

Strategies A1 through A5 are for existing trees while strategies A6 and A7 are for new and transplanted trees. Existing trees are preserved and protected onsite throughout the construction process. Because of their maturity, existing trees often provide more shade than young trees, which is why they have a relatively high multiplier. In order to receive credit, existing trees must be in good health. Existing tree size is defined by the canopy width at the time of score sheet submittal.

New trees may take several years before they form a mature canopy and contribute to the shading of the site; therefore, they have a smaller multiplier than preserved existing trees. Since transplanted trees are not guaranteed to survive, they also have a smaller multiplier.

For all trees, the score sheet approximates the canopy width of understory trees at 150 square feet and the canopy width of canopy trees at 700 square feet.

Definitions

Understory Trees are defined as trees reaching a canopy spread of 8' to 15' at maturity. Examples include Serviceberry (*Amelanchier Canadensis*), Eastern Redbud (*Cercis Canadensis*), and Cornelian-cherry dogwood (*Cornus mas*).

Canopy Trees are defined as trees reaching a spread of 25' to 30' at maturity. Examples include Pin oak (*Quercus palustris*), Kentucky Coffeetree (*Gymnocladus dioicus*), and American Linden (*Tilia Americana*).

Strategies

A1: Understory Tree, currently <10' canopy spread
A2: Understory Tree, currently >10' canopy spread
A3: Canopy Tree, currently <15' canopy spread
A4: Canopy Tree, currently between 15' and 25' canopy spread
A5: Canopy Tree, currently >25' canopy spread
A6: New and Transplanted Understory Trees (at least 400 cubic feet of soil per tree required)
A7: New and Transplanted Canopy Trees (at least 700 cubic feet of soil per tree required)

B PLANTING AREAS

Planting areas may include lawn, perennials and groundcovers, or woody plants, such as shrubs. Planting areas are divided into categories based on the plants' mature height. Taller plants contribute more to temperature reduction, which is why plants taller at maturity receive a higher multiplier. Permanent above-grade planters may be counted for credit; movable planters may not be counted for credit.

Definitions

Herbaceous plants (i.e. plants without persistent woody stems) include Little Blue Stem (*Schizachyrium scoparium*), New England Aster (*Aster novae-angliae*), and Foamflower (*Tiarella cordifolia*).

Woody plants (i.e. plants with hard stems) include Winterberry (*Ilex verticillata*), Summersweet (*Clethra anifolia*), and Oakleaf hydrangea (*Hydrangea quercifolia*).

Strategies

B1: Lawn Area, sod or seeded tall grasses (minimum 8" soil depth is required)
B2: Low Planting Area, herbaceous or woody plants less than 2' tall at maturity (minimum 12" soil depth is required)
B3: Planting Area, herbaceous or woody plants more than 2' tall at maturity (minimum 18" soil depth is required)

C 1-2 GREEN FACADE + LIVING WALL

Green facades and living walls are living vertical systems that contain plant species and/or a planting medium.

Definitions

Green Façades are vertical surfaces covered with vines or climbing species that are planted in the ground and attach themselves to a lattice, cable, mesh, or wall surface. Some species need vertical support structures while others do not.

Living Walls are vertical surfaces comprised of plants that are planted directly in a suspended growing medium. These systems are usually more intensive to construct and maintain because they require special structures to hold the soil volume.

Strategies

C1: Green Façade, requirements include:

- Provide a minimum 15' wide and 10' tall structure for vines that need a support system;
- Plant species based on their recommended spacing to cover at least a 15' wide portion of wall for vines that do not need support;
- Green facades can receive a maximum credit equivalent to the expected extent of coverage within 10 years or the total area of the support structure, whichever is smaller;
- Soil requirements: minimum 6 cubic feet per plant.

C2: Living Wall (an irrigation system is required to receive the credit)

C 3-5 GREEN ROOFS

Definitions

Green Roof is defined as a planted area over a built structure with a "lightweight with a shallow layer of growing substrate of less than 8" deep, requiring minimal maintenance. They generally have lower water requirements and use small, low-growing plant species, particularly succulents." (*Growing Green Guide*)

Intensive Green Roof is defined as a planted area over built structure that is "generally heavier, with a deeper layer of growing substrate, that supports a wider variety of plant types. Intensive green roofs need more irrigation and maintenance than extensive roofs, and are highly engineered landscapes, often built directly on structures with considerable weight load capacity." (*Growing Green Guide*)

Strategies

C3: Green Roof, low soil volume planting such as succulents and grasses (minimum 4" soil depth)

C4: Short Intensive Green Roof, herbaceous and woody plants less than 2' tall at maturity (minimum 18" soil depth)

C5: Tall Intensive Green Roof, herbaceous and woody plants greater than 2' tall at maturity (minimum 24" soil depth, trees counted separately)

D PAVING AND SHADE STRUCTURES

"Solar reflective cool pavements stay cooler in the sun than traditional pavements. Pavement reflectance can be enhanced by using reflective aggregate, a reflective or clear binder, or a reflective surface coating" (*Berkeley Lab, Heat Island Group*). Note that all projects are required to have a high SRI roof, per the definition and strategies below.

Definitions

Solar Reflective Index (SRI): "The SRI is a composite score of solar reflectance and thermal emittance. Solar reflectance, or albedo, is the percentage of solar energy reflected by a surface." (Hui Li Ph.D., P.E., in *Pavement Materials for Heat Island Mitigation*, 2016). Thermal emittance characterizes the surface capability to reemit the previously absorbed heat away from itself (A.L. Pisello, in *Eco-Efficient Materials for Mitigating Building Cooling Needs*, 2015).

Strategies

D1: High SRI Roof, low slope roofs (i.e. ≤ 2:12) must have a minimum SRI of 82 and steep slope roofs (i.e. > 2:12) must have a minimum SRI of 39

D2: High-SRI Paving must have an SRI of 39 or higher (LEED, V4)

D3: High-SRI Shade structures may include fabric or tensile shade structures as well as hard-material structures, the shade structure material must have an SRI of 39 or higher (LEED, V4)

Cambridge Cool Factor
Sample Score Sheet

Total Lot Area (SF) 40,000	**Cool Target** 20%		**Outside 20' of PROW**	**Value Factor**		**Within 20' of PROW**	**Value Factor**	**Contributing Area**
Trees	A1	Understory tree currently <10' canopy spread	1	0.80	+	1	1.60	360
	A2	Understory tree currently >10' canopy spread	1	1.00	+	1	2.00	450
	A3	Canopy tree currently <15' canopy spread	1	0.80	+	1	1.60	1,680
	A4	Canopy tree currently between 15' and 25' canopy spread	1	1.00	+	1	2.00	2,100
	A5	Canopy tree currently >25' canopy spread	1	1.20	+	1	2.40	2,520
	A6	New or transplanted understory tree	1	0.60	+	1	1.20	270
	A7	New or transplanted canopy tree	1	0.70	+	1	1.40	1,470
Planting Areas	B1	Lawn	100	0.30	+	100	0.60	90
	B2	Low Planting	100	0.40	+	100	0.80	120
	B3	Planting	100	0.50	+	100	1.00	150
Green Roofs & Facades	C1	Green Façade	100	0.10	+	100	0.20	30
	C2	Living Wall	100	0.30	+	100	0.60	90
	C3	Green Roof	100	0.30	+	100	0.60	90
	C4	Short Intensive Green Roof	100	0.50	+	100	1.00	150
	C5	Intensive Green Roof	100	0.60	+	100	1.20	180
Paving & Structures	D1	High-SRI Roof	Required	N/A				
	D2	High-SRI Paving	100	0.1				10
	D3	High-SRI Shade Structure	100	0.2	+	100	0.40	60
Project Summary	Portion of lot area utilizing green strategies 24%					**Total Contributing Area:**		9,820
	Portion of score from green strategies 96%					**Total Area Goal:**		8,000
	Portion of score from trees . . . . . 86&							
	Portion of score contributing to public realm cooling 67%					**COOL FACTOR SCORE:**		1.2