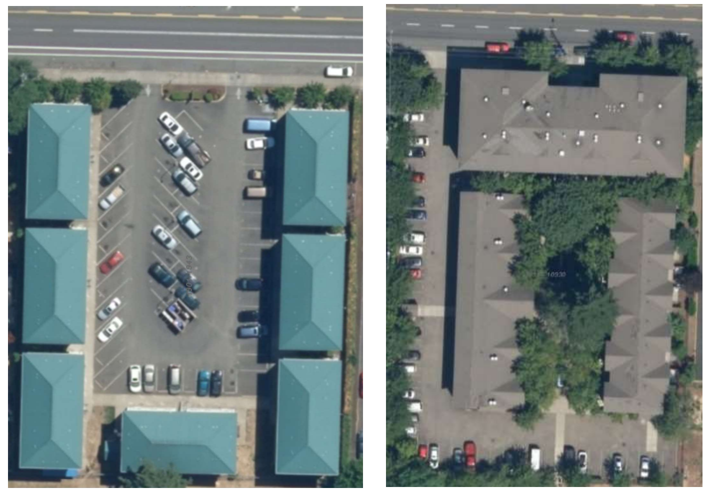
APPENDIX C

Climate Change and Urban Heat

The Better Housing by Design code concepts are intended to help implement not only Comprehensive Plan policies on urban development, but also Climate Action Plan objectives for reducing carbon emissions and preparing for climate change. The code concepts help implement Climate Action Plan objectives that call for creating vibrant neighborhoods with housing close to services, with safe and convenient street connections. The Climate Action Plan also calls for decreasing urban heat islands.



How development is designed, such as amounts of landscaping or surface parking, make a difference in localized temperatures and heat impacts on residents.

This appendix summarizes research and modelling related to urban heat island effects, with a focus on how different development approaches can result in different urban heat outcomes. This research, undertaken by the Sustainable Urban Places Research Lab at Portland State University, has helped inform the Green Site Design code concepts.

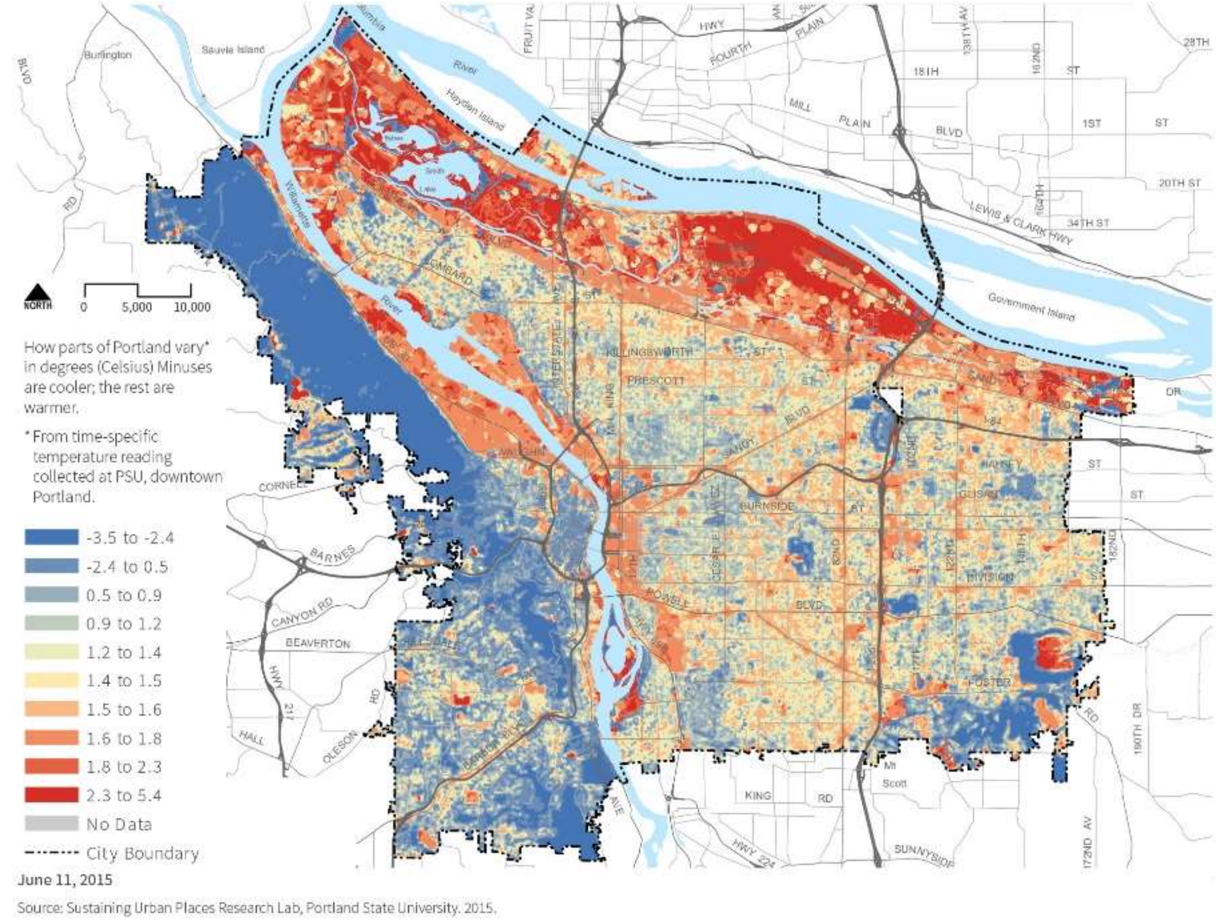
Addressing the primary cause of climate change – carbon emissions – remains a crucial component of the City's climate work. Preparing for the impacts of a changing climate, especially for those most vulnerable to the impacts, is also required. The potential impacts from climate change will be substantial and serious, and preparing for them requires significant changes in Portland's policies, investments and programs. Many of these changes are identified in Portland's adopted Climate Action Plan (www.portlandoregon.gov/bps/climate).

Portland's future is expected to include warmer winters with more intense rain events and hotter, drier summers with an increased frequency of high-heat days. Hotter, drier summers may result in several significant impacts for the Portland area, including poor air quality and increased heat-related illnesses and deaths for Portlanders.

Portland's increased temperatures in the summer will be magnified by the urban heat island effect, which results from the higher concentrations of buildings and paved surfaces in the urban environment. These features can also that retain much of the daytime heat and inhibit overnight cooling. In addition to heat from these impervious surfaces, waste heat – like that radiating off a vehicle's engine or from a building's air-conditioning system – also contributes to the urban heat island.

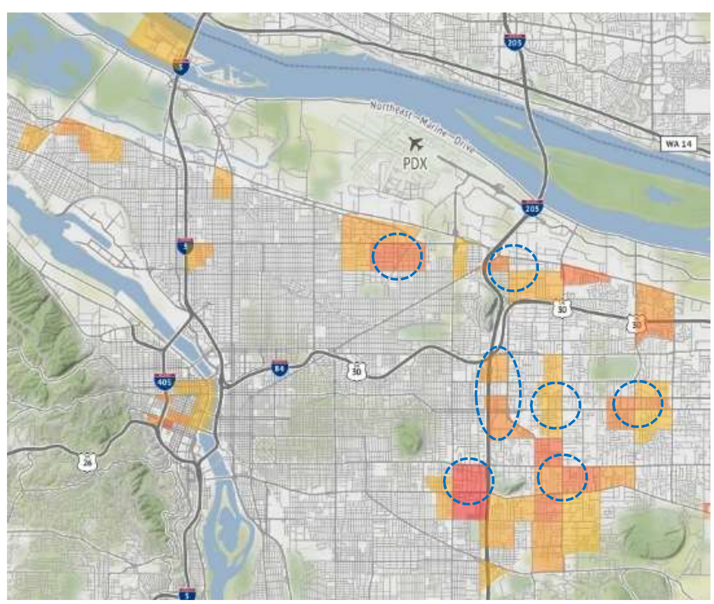
Many of the areas most impacted by Portland's urban heat island effect (see Figure 1, next page) include parts of the Central City, major roads, and locations in and around industrial areas. Temperatures in Portland tend to be the coolest in Forest Park and neighborhoods with high concentrations of trees and less development. Higher temperatures are recorded along freeways and busy roads, and in industrial areas.

FIGURE 1: Certain parts of Portland are measurably hotter relative to other areas. *Source: Sustaining Urban Places Research Lab, Portland State University, 2015.*



Low-income populations and communities of color may be more susceptible to climate impacts, particularly heat and associated poor air quality. Many of Portland's urban heat island areas occur where these populations and those most vulnerable to heat live, including older adults living alone and people with health conditions that can be exacerbated by heat and reduce air quality such as asthma. Urban heat island areas with susceptible populations include urban centers in Eastern Portland with concentrations of multi-dwelling zoning, such as the Jade District and Rosewood centers.

FIGURE 2: Portland's urban heat islands overlap with parts of the city with higher percentages of people who are likely more vulnerable to increased temperatures (shaded areas show overlaps, with Eastern Portland centers circled). *Source: Image from www.climatecope.org, developed by the Sustaining Urban Places Research Lab, Portland State University.*



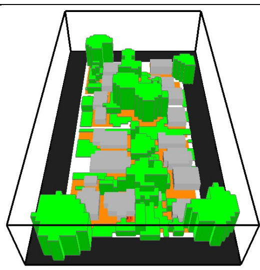
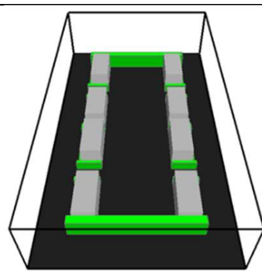
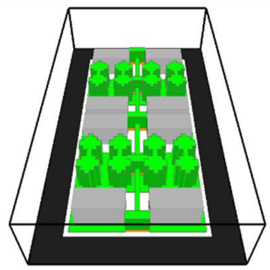
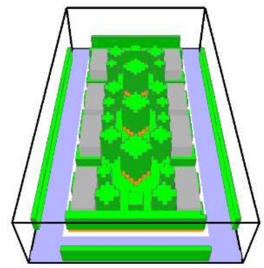
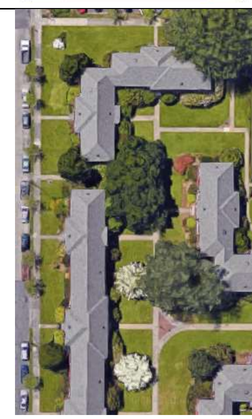
Initial findings from research underway by Dr. Vivek Shandas and Dr. Yasuyo Makido at Portland State University indicate that a key means of dealing with these impacts, and cooling the city more generally, is to increase vegetation and decrease the coverage of paved surfaces.

The researchers are using an advanced modelling technique to study specific locations in Portland and evaluate how different development patterns, including varying amounts of paving and vegetation, impact localized temperatures. Drs. Shandas and Makido's research has found several factors contribute toward cooling the area, as well as delaying the rise in temperatures during the day.

Their initial results indicate that decreasing paved surfaces, increasing vegetation on the property and increasing the reflectivity (albedo) of the building roofs (e.g., lighter colored roof shingles), roads and parking (e.g., lighter colored concrete rather than black asphalt) contribute to cooling the localized area (see Figure 3). These results suggest that the features and materials of development can yield very different urban heat outcomes, with one multifamily prototype (Prototype C in Figure 3, next page) reducing temperatures compared to the base case of predominantly single-family housing.

Different materials and features have different urban heat outcomes. Asphalt and dark roofs (upper left) result in higher temperatures, while concrete (such as pavers, upper right), eco roofs and light-colored roofs (lower right), and especially trees and landscaping (lower left) reduce urban heat effects.

Figure 3: The draft findings for three development prototypes indicate that increased pavement and decreased vegetation result in measurable increases in localized temperatures that contribute to urban heat islands. Initial findings suggest that increases in density can be achieved in ways that maintain and/or reduce local temperatures, when design approaches incorporate landscaping and reflective materials. *Source: Sustaining Urban Places Research Lab, Portland State University*

Base case	Prototype A	Prototype B	Prototype C
Existing conditions of a typical neighborhood block, with parking (white) and roads (black), vegetation (green), soil (brown) and buildings (gray).	Multifamily buildings (gray) with large amounts of asphalt paving and surface parking (black), and small amounts of vegetation (green).	Multifamily buildings (gray) with smaller amounts of surface parking (white) and increased vegetation (green).	Multifamily buildings (gray) with surface parking eliminated and vegetation maximized (green). Also, increased reflectivity (albedo) of roadway paving by use of concrete (blue gray).
			
			
Temperature: represents base case for comparisons.	Temperature: Increased 5.57 degrees Fahrenheit above the base case.	Temperature: Increased 1.26 degrees Fahrenheit above the base case.	Temperature: Decreased 3.15 degrees Fahrenheit below the base case.