Abstract

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Digital Terrain Analysis of Portland's Hazards and Accessibility to Relief Sites and Services in a Catastrophic Subduction Zone Earthquake.

Digital Terrain Analysis, Portland State University, Fall 2018.

Historical records show that the Pacific Northwest is likely to experience the impact of an 8.7 to 9.3 magnitude earthquake due to its distinct geographic location between the Pacific Ocean Plate and the North American Plate. Since the ocean floor has been inching from the West to the East, a subduction zone has formed which is putting populations in the State of Oregon at risk. According to The Oregon Resilience Plan, the seismic effects of such an event would cause permanent population loss and economic decline. The current infrastructure in the greater Portland area is inadequate due to the vulnerability of buildings not seismically reinforced, neighborhood network connectivity (unsafe roads and bridges), and liquefaction/ soft soil hazard trends. These complex issues demand meaningful analysis in order to improve the city's resiliency by examining accessibility to safe Basic Earthquake Emergency Communication Nodes (BEECN) and resources. By identifying areas that will experience earthquake liquefaction, hazardous landslides, and debris from unreinforced masonry buildings (URM), the volume of obstruction can be statistically determined. For this project, we used geographic information systems to conduct a post earthquake least cost path analysis that incorporates key impedance factors identified above. The post-earthquake scenario results determine neighborhood accessibility to BEECN locations and other relief sites such as schools, hospitals, and community centers. Multi-ring buffers were processed to accommodate communities within .25, .5, and 1 mile of established safe BEECN locations. Additional data analysis for neighborhoods with no BEECN provides potential safe site locations such as parks with facility buildings, schools, and safe ORCA sites. These findings could be suitable for emergency resource planning, especially in underserved neighborhoods.

Keywords:

Cascadia Subduction Zone (CSZ), Earthquake, Risk Mitigation, Public Safety, Basic Earthquake Emergency Communication Node (BEECN), Unreinforced Masonry (URM) Buildings, Portland, Pacific Northwest, DEM, Digital Terrain Analysis, Network Analysis

Citations:

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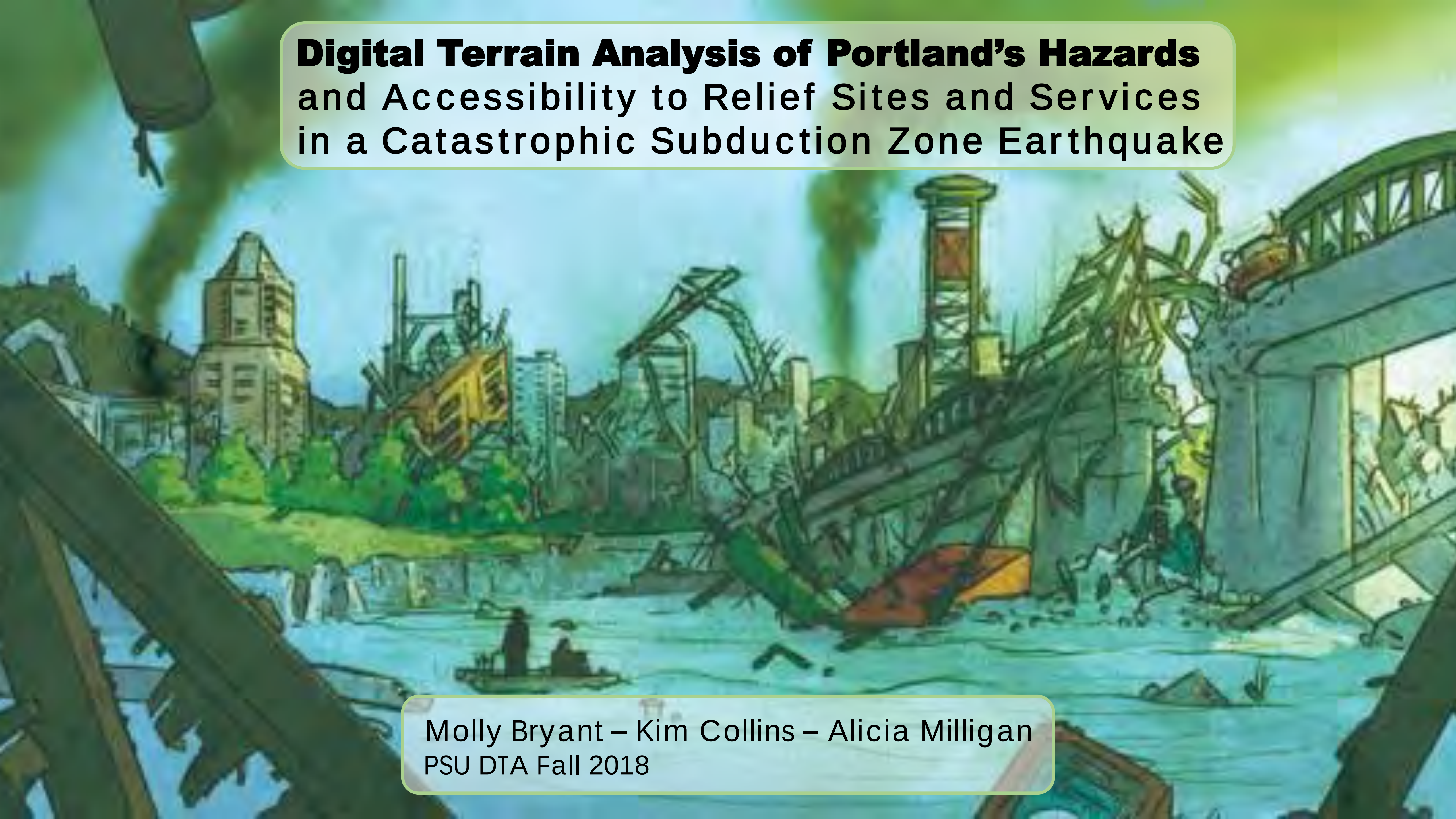
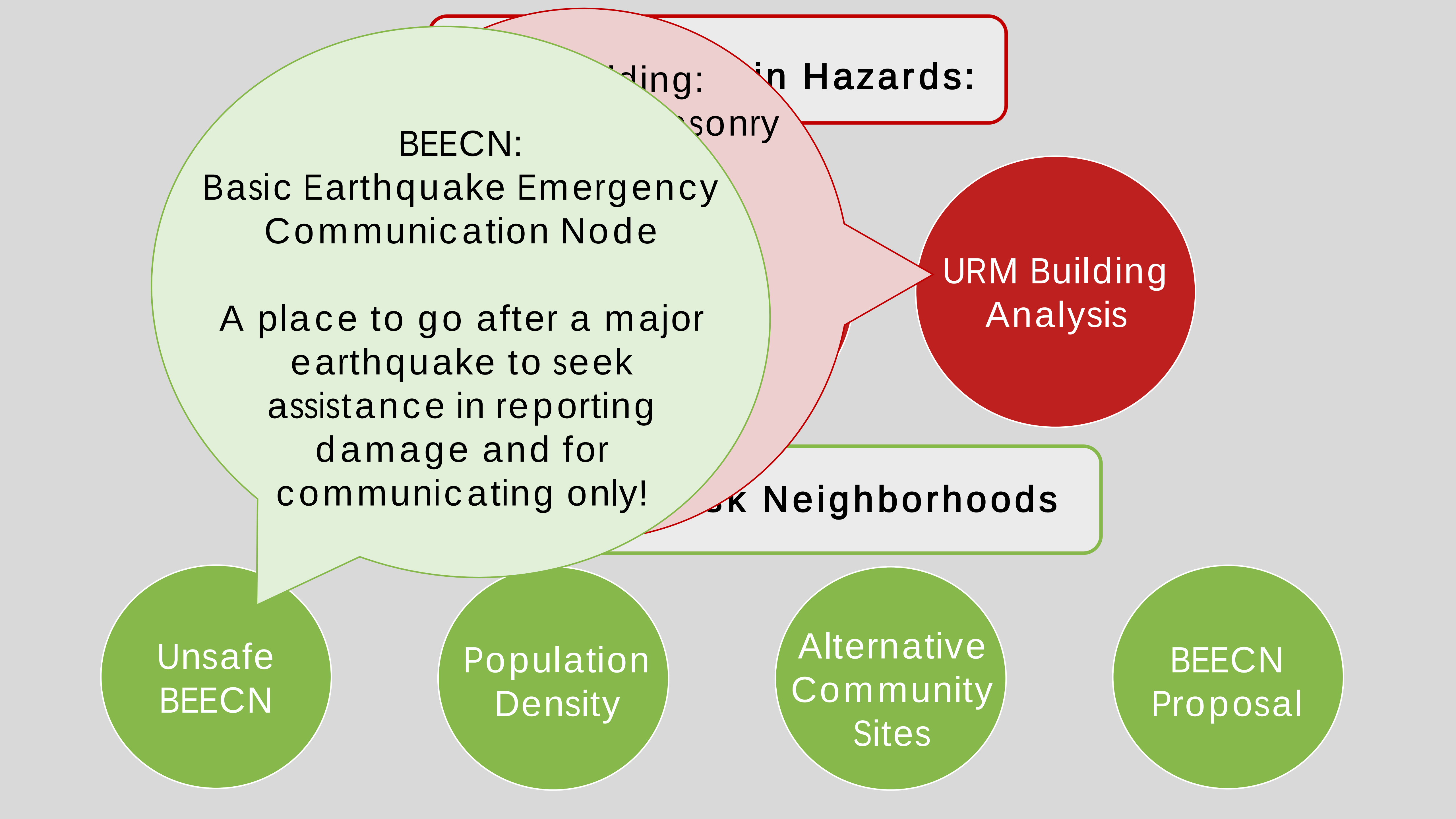
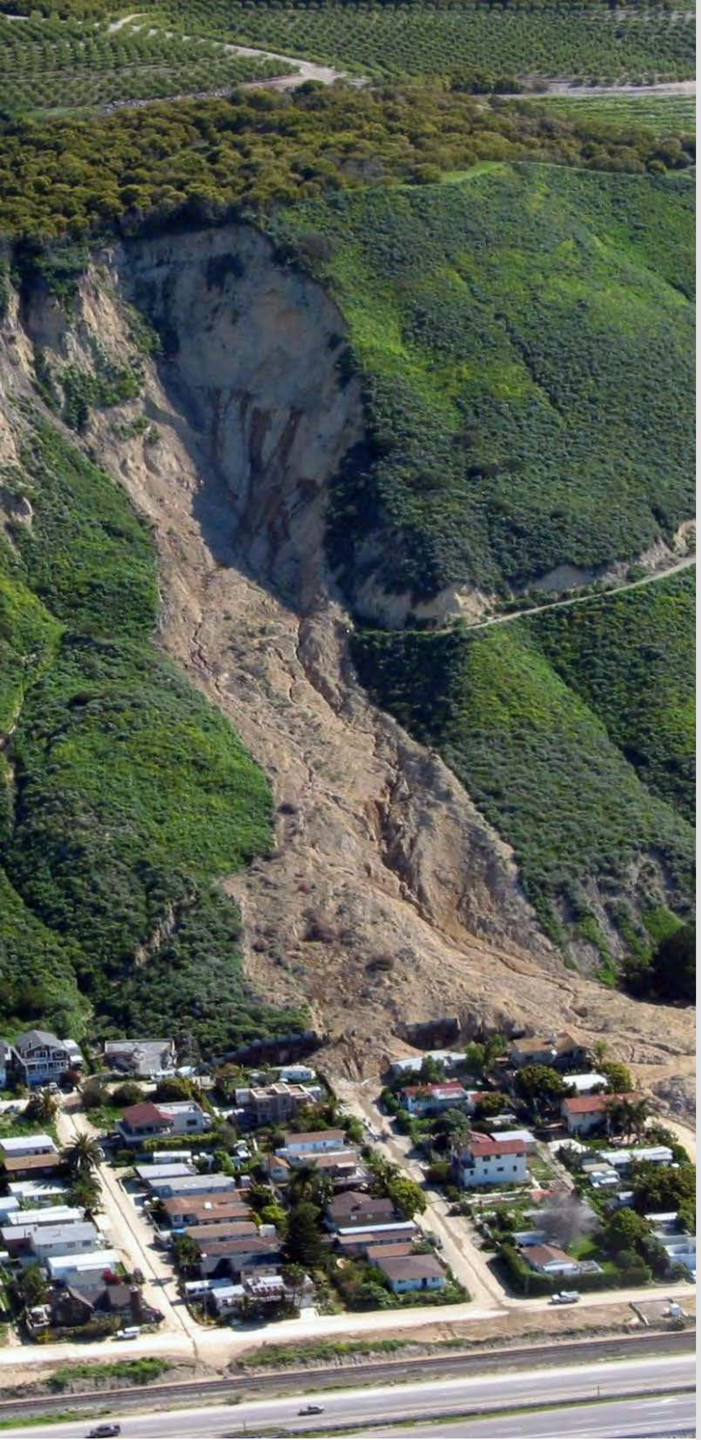
Digital Terrain Analysis of Portland's Hazards
and Accessibility to Relief Sites and Services
in a Catastrophic Subduction Zone Earthquake



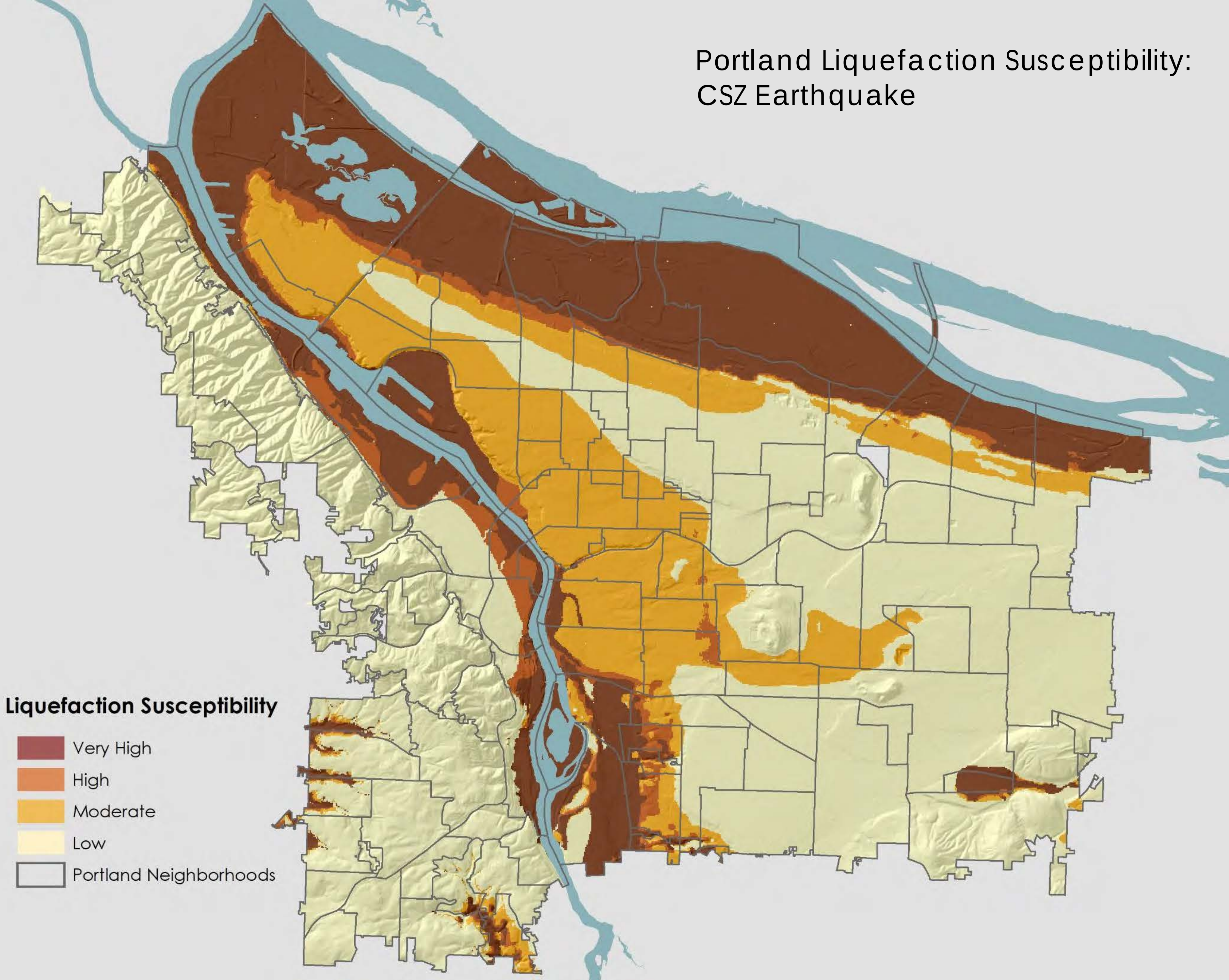
Molly Bryant – Kim Collins – Alicia Milligan
PSU DTA Fall 2018


in Hazards:
BEECN:
Basic Earthquake Emergency Communication Node
A place to go after a major earthquake to seek assistance in reporting damage and for communicating only!
URM Building Analysis
Neighborhoods
Unsafe BEECN
Population Density
Alternative Community Sites
BEECN Proposal

Portland Landslide Susceptibility: CSZ Earthquake



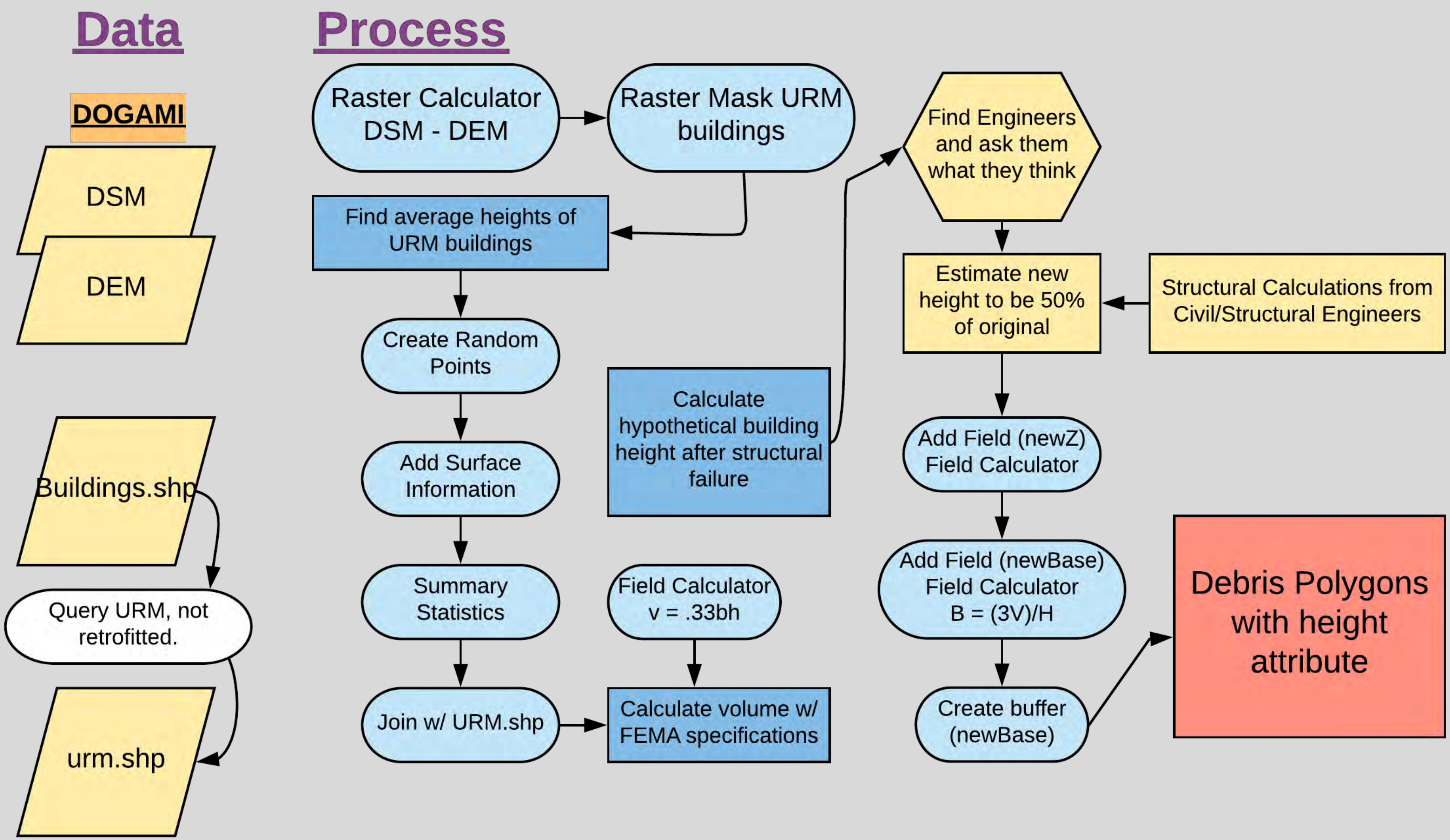
Portland Liquefaction Susceptibility: CSZ Earthquake



URM Building Analysis

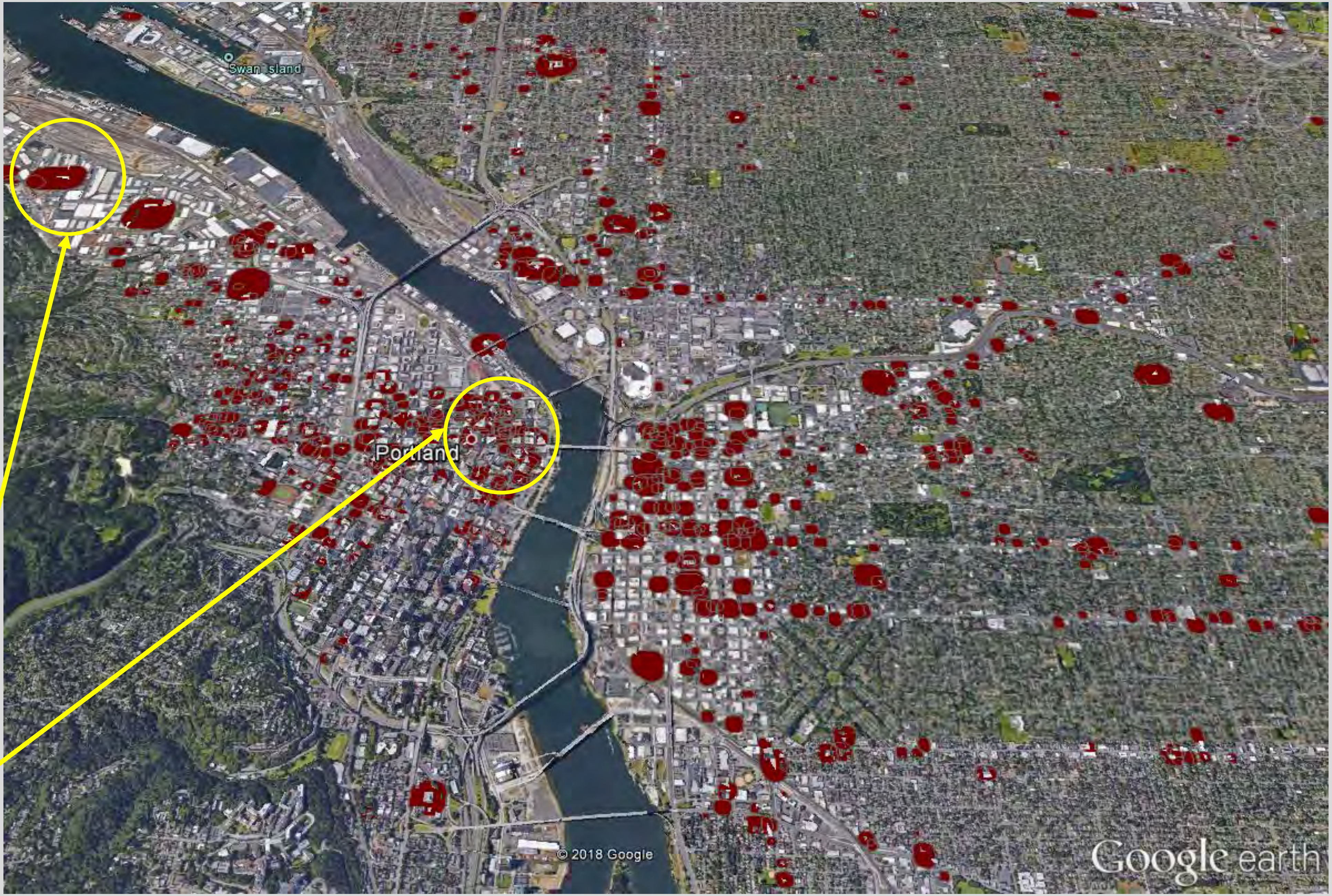
1,792 URM Buildings

URM Building Analysis

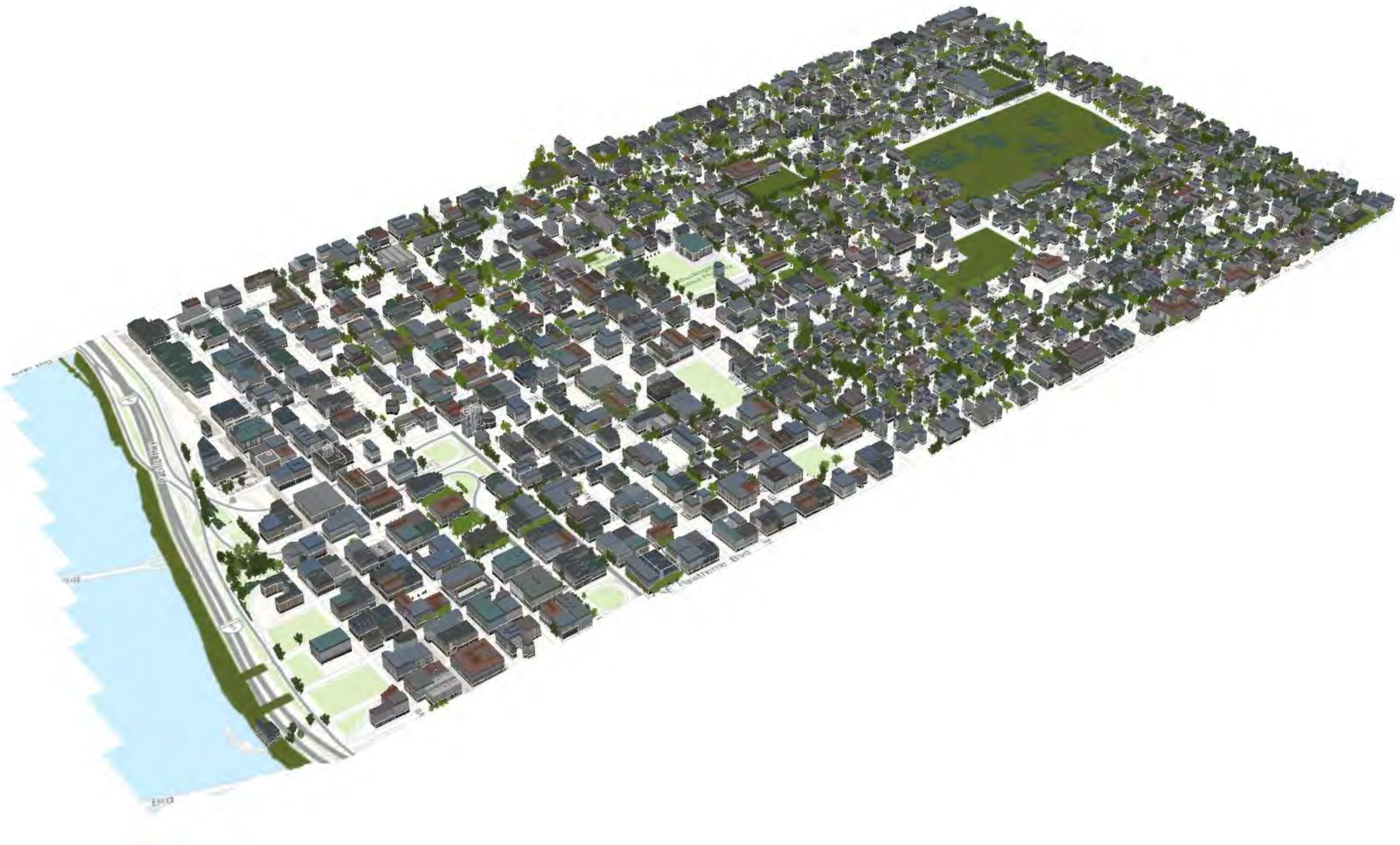


URM Debris Statistics

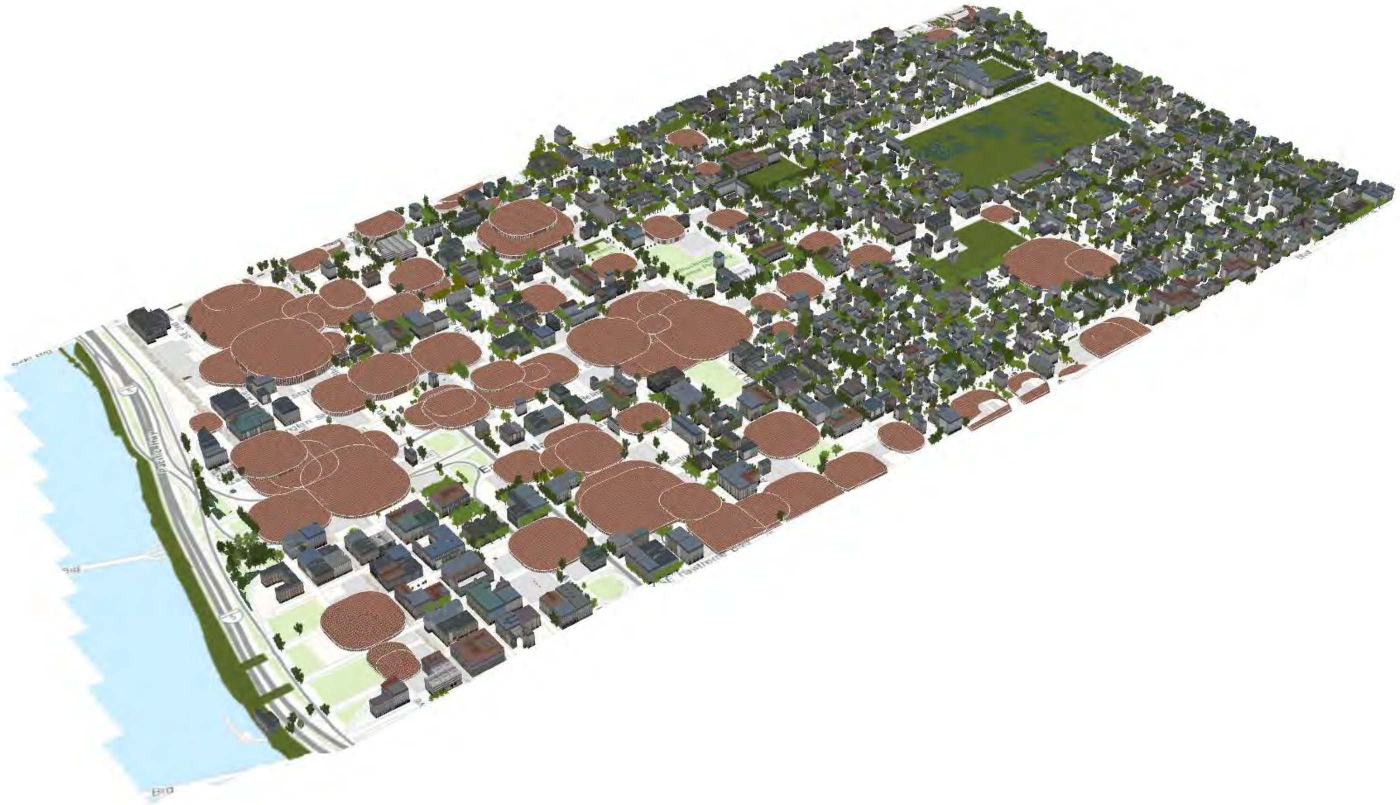
- URM debris volume: 2,838,001 CY
- Area covered with URM debris: 2,568 acres
- Largest URM debris volume from single building at: NW Nela St & NW 29th
- Largest area of debris: Downtown Portland

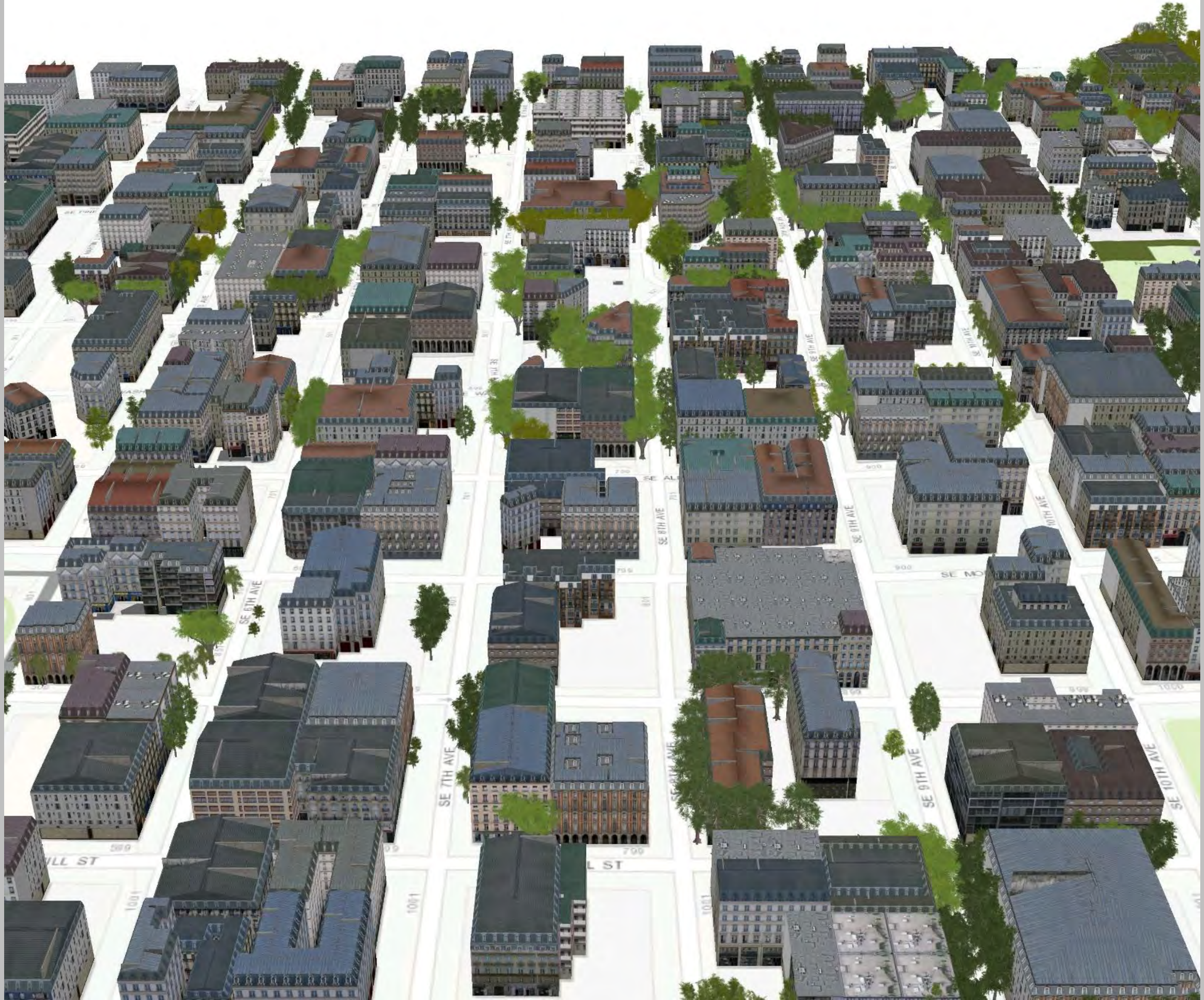


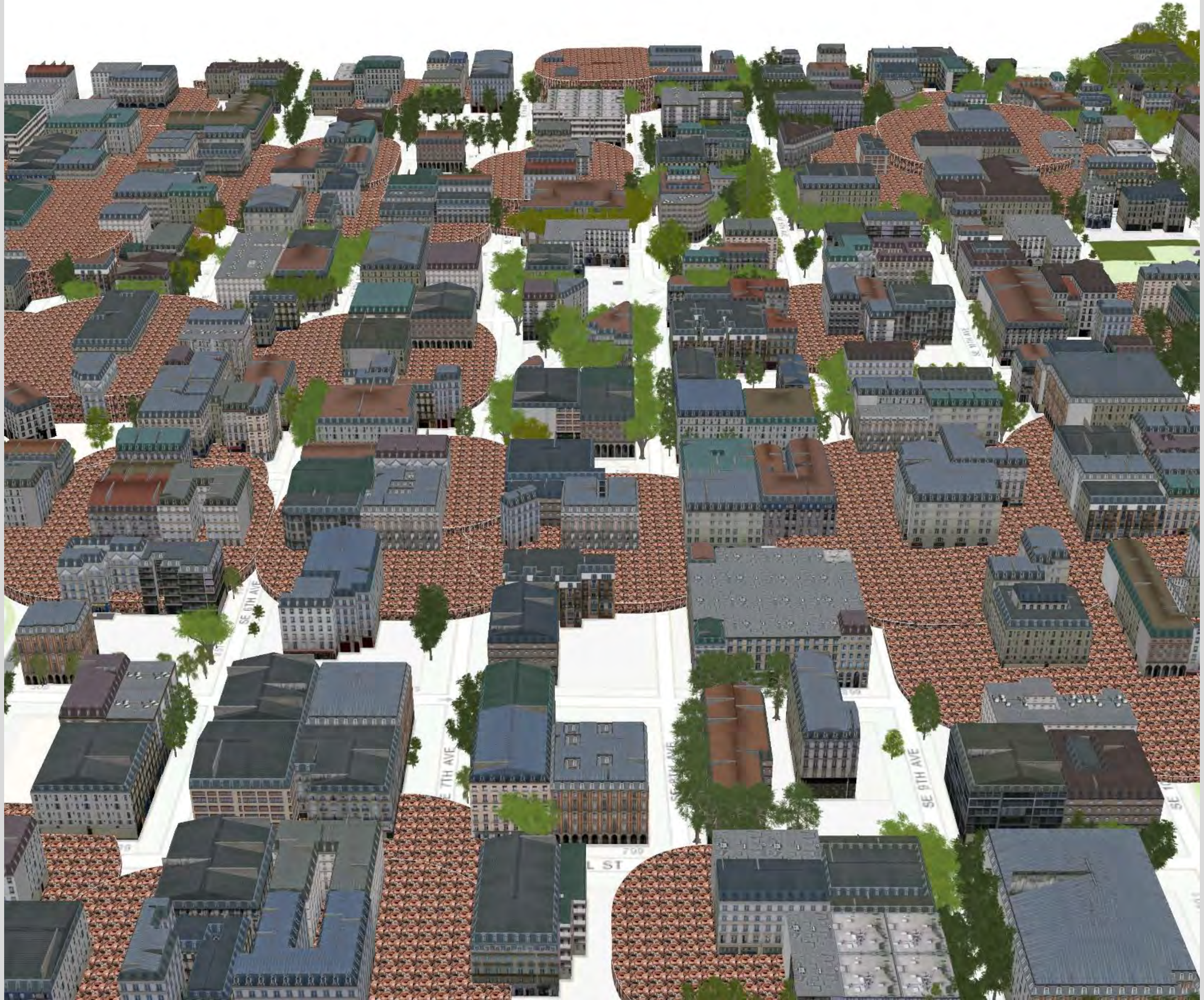
Buckman Neighborhood Pre-URM Collapse

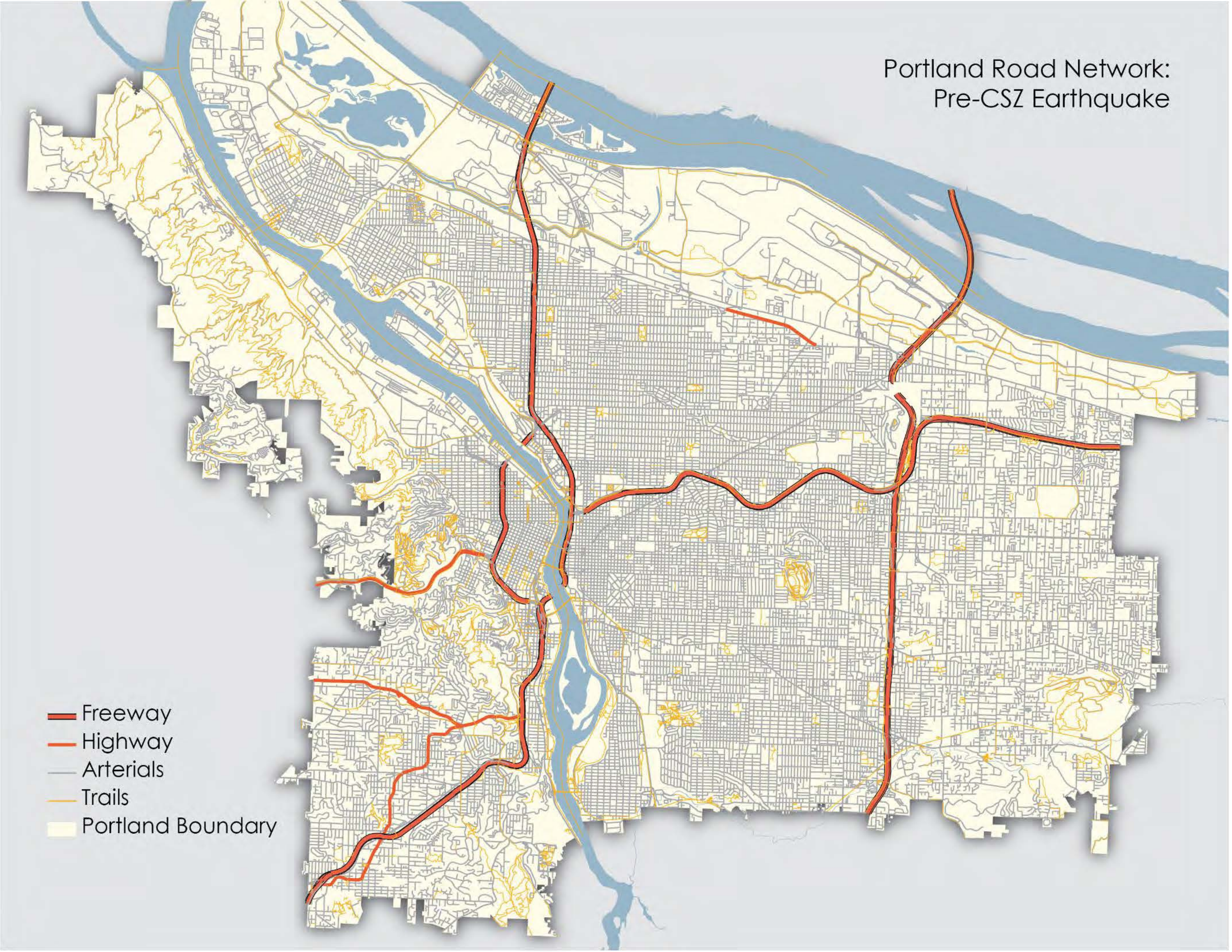


Buckman Neighborhood Post-URM Collapse




SE 6TH AVE
SE 7TH AVE
SE 8TH AVE
SE 9TH AVE
SE 10TH AVE


SE 9TH AVE
700
L ST

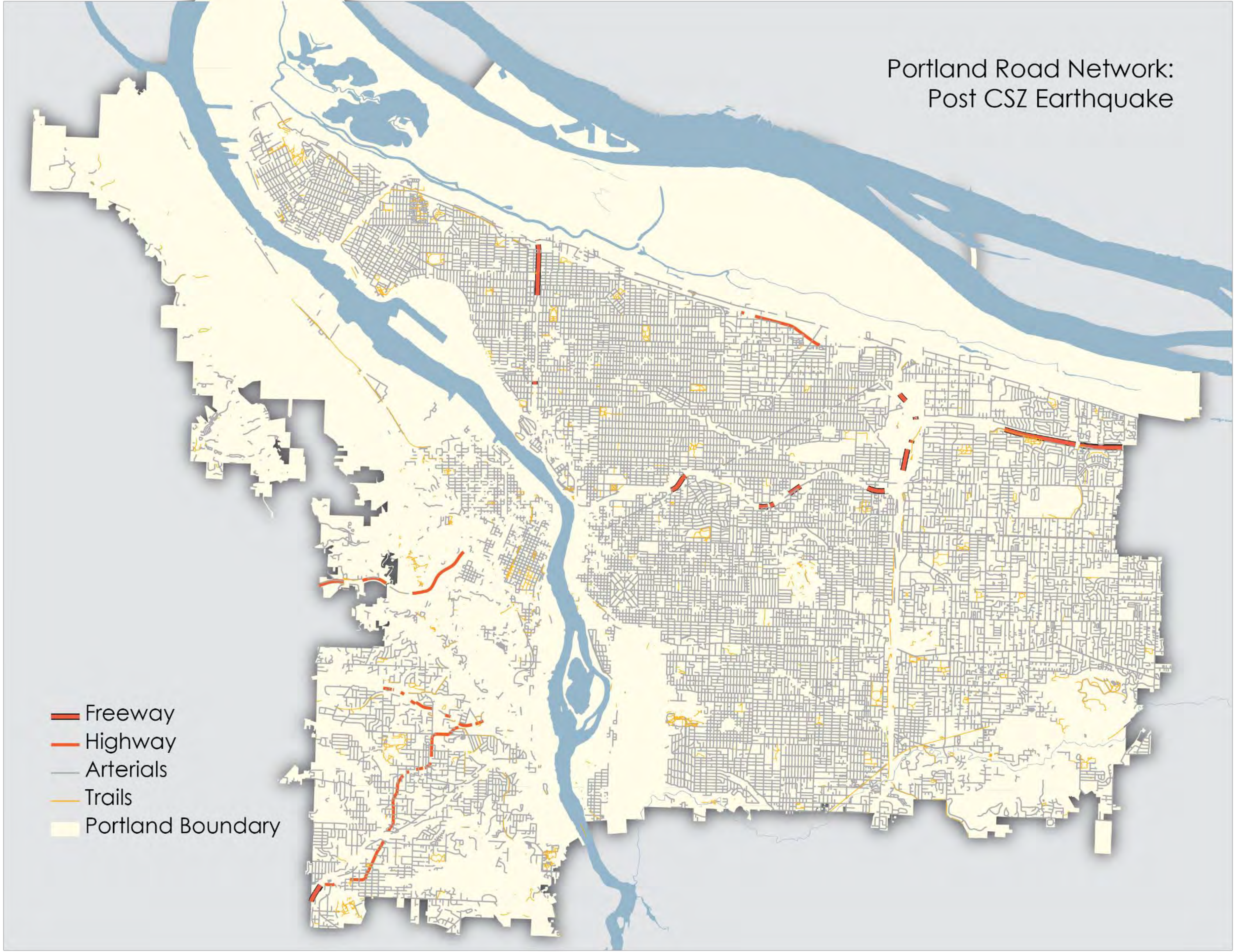


Portland Road Network:
Pre-CSZ Earthquake
Freeway
Highway
Arterials
Trails
Portland Boundary

49%

Road Network Damage

[Burnside Bridge Demo]



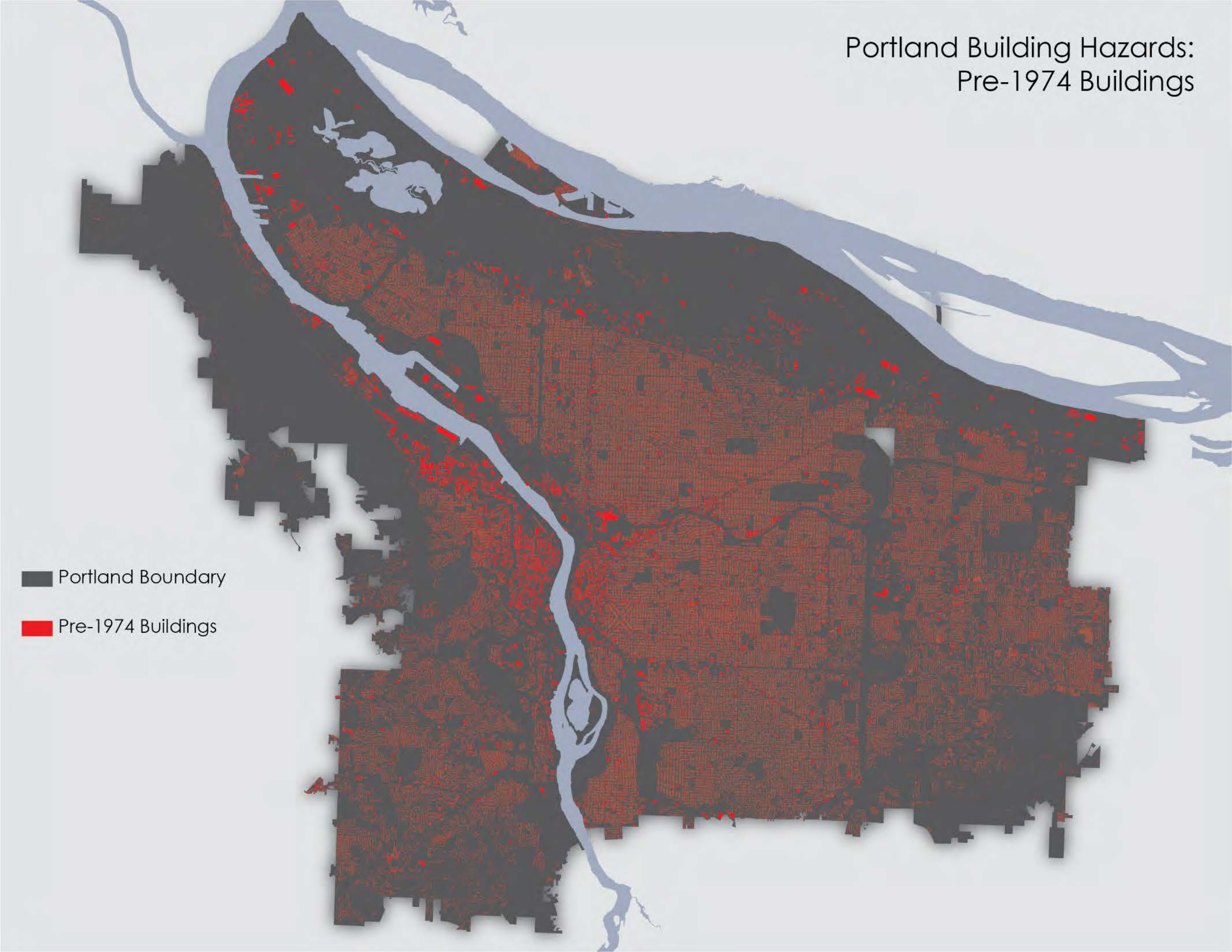
Portland Building Hazards: Current Building Footprints

81%

Possible complete structural failure

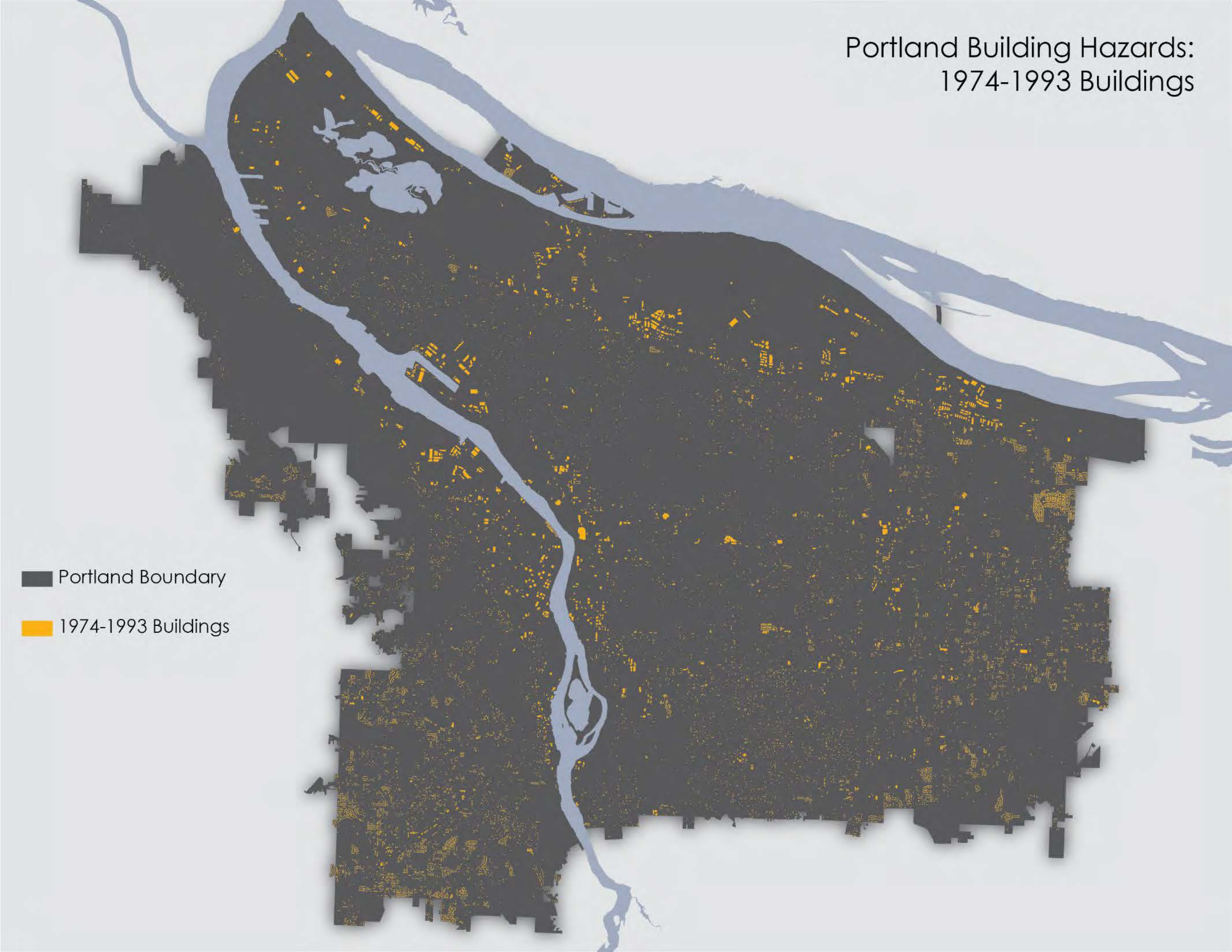
87.8%

SFR-MFR



8%
Significant structural damage

80%
SFR-MFR

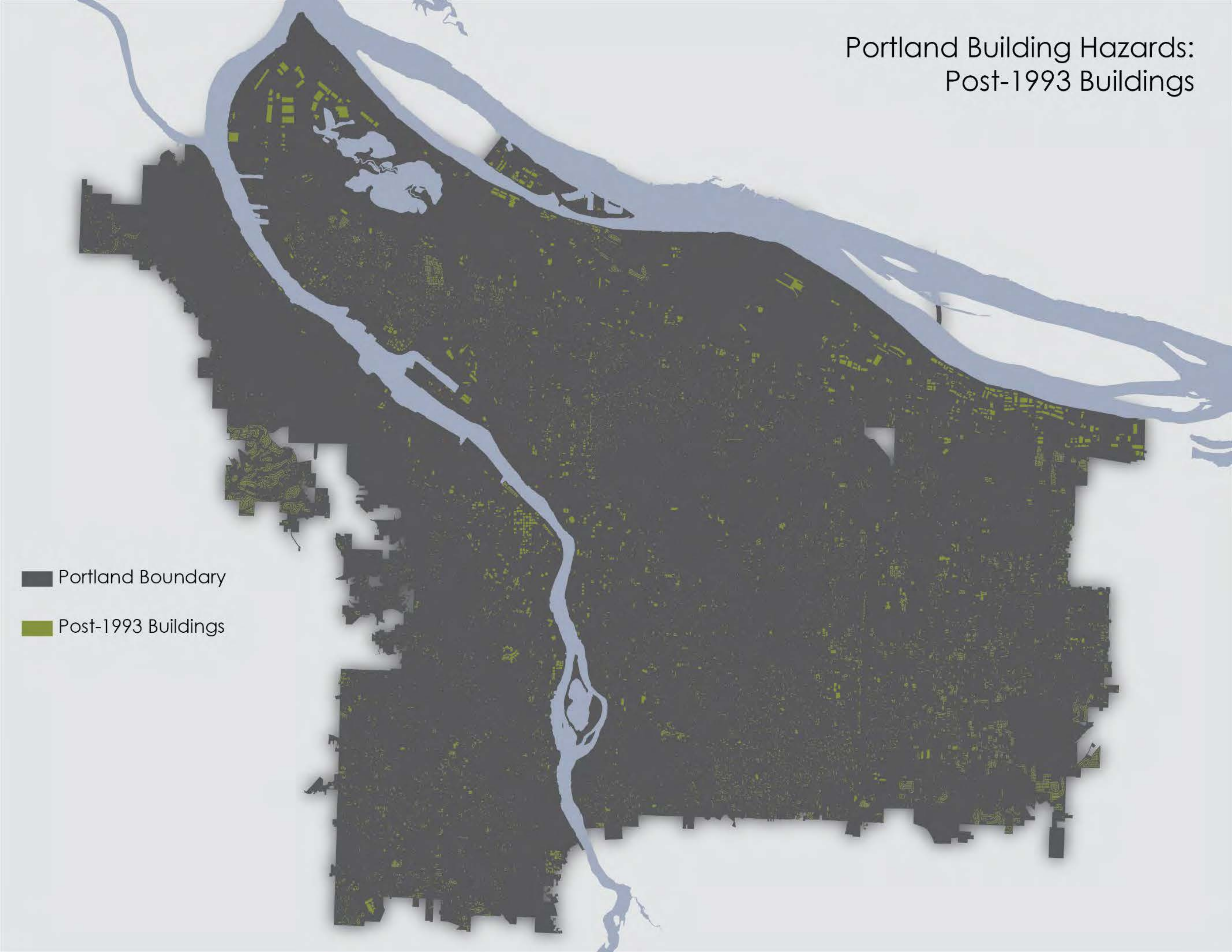


11%

Least structural damage

65%

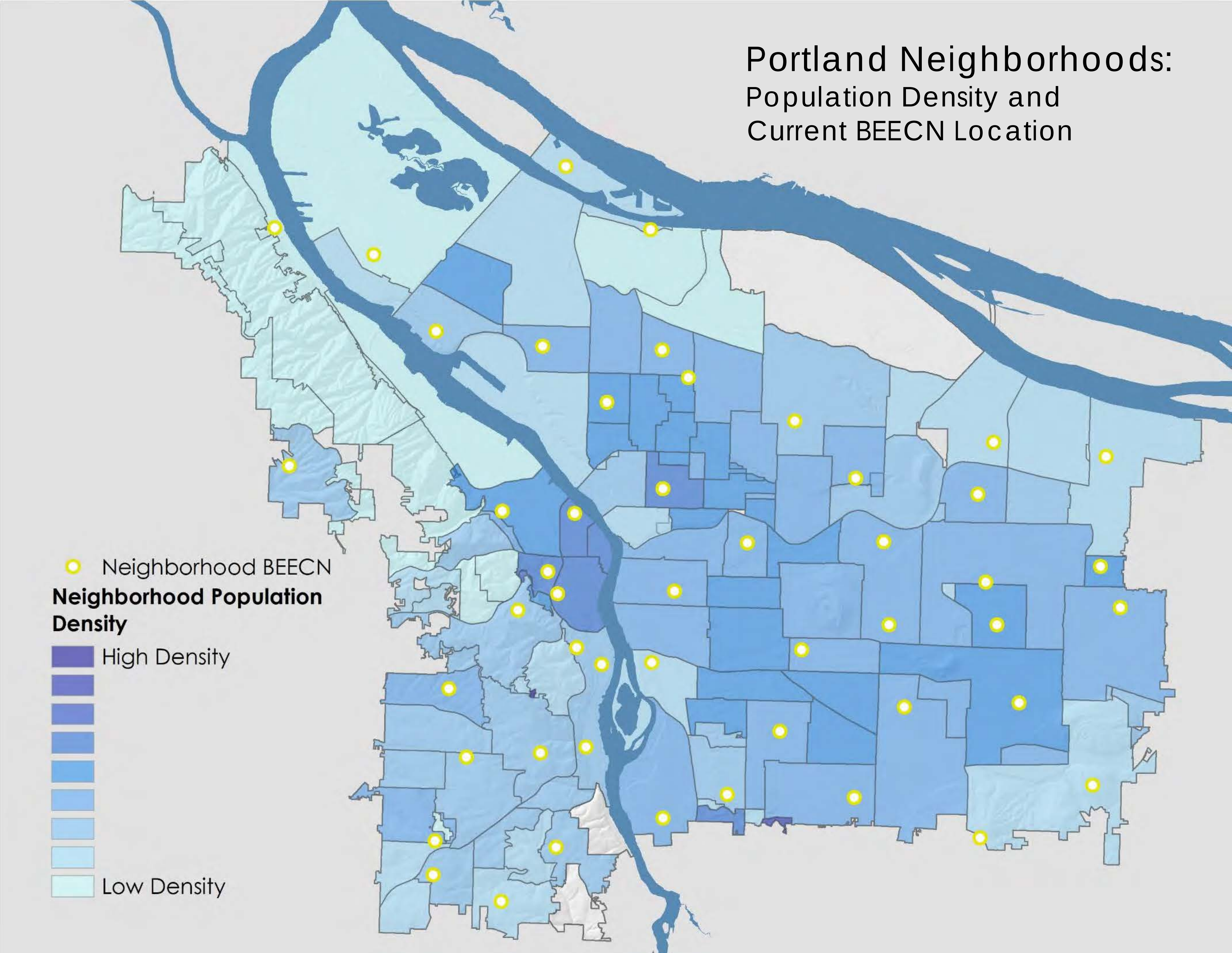
SFR-MFR



Currently

49

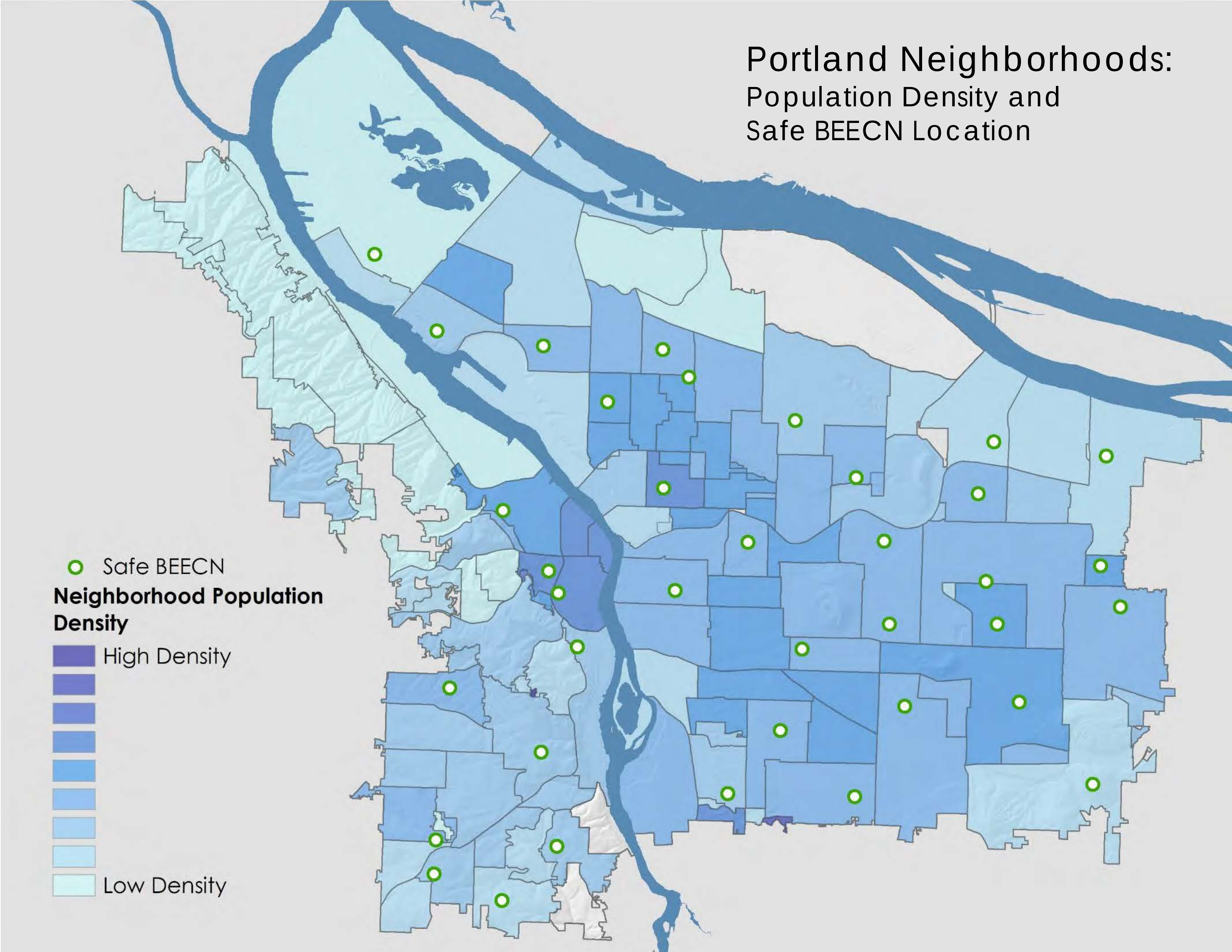
BEECNS



Safe

37

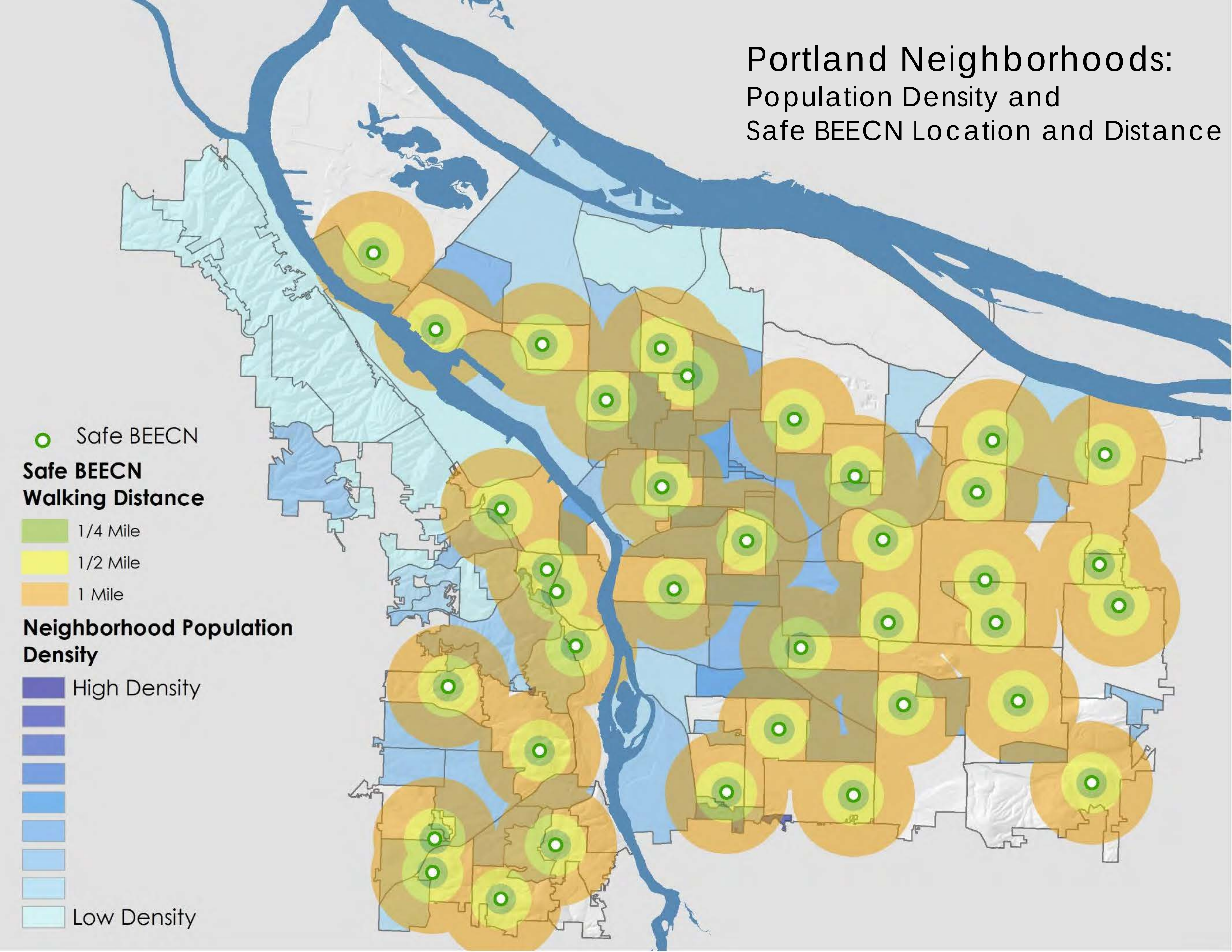
BEECNS



92

Of

123


Portland Neighborhoods:
Population Density and
Safe BEECN Location and Distance
Safe BEECN
Safe BEECN Walking Distance
1/4 Mile
1/2 Mile
1 Mile
Neighborhood Population Density
High Density
Low Density

Grant Park

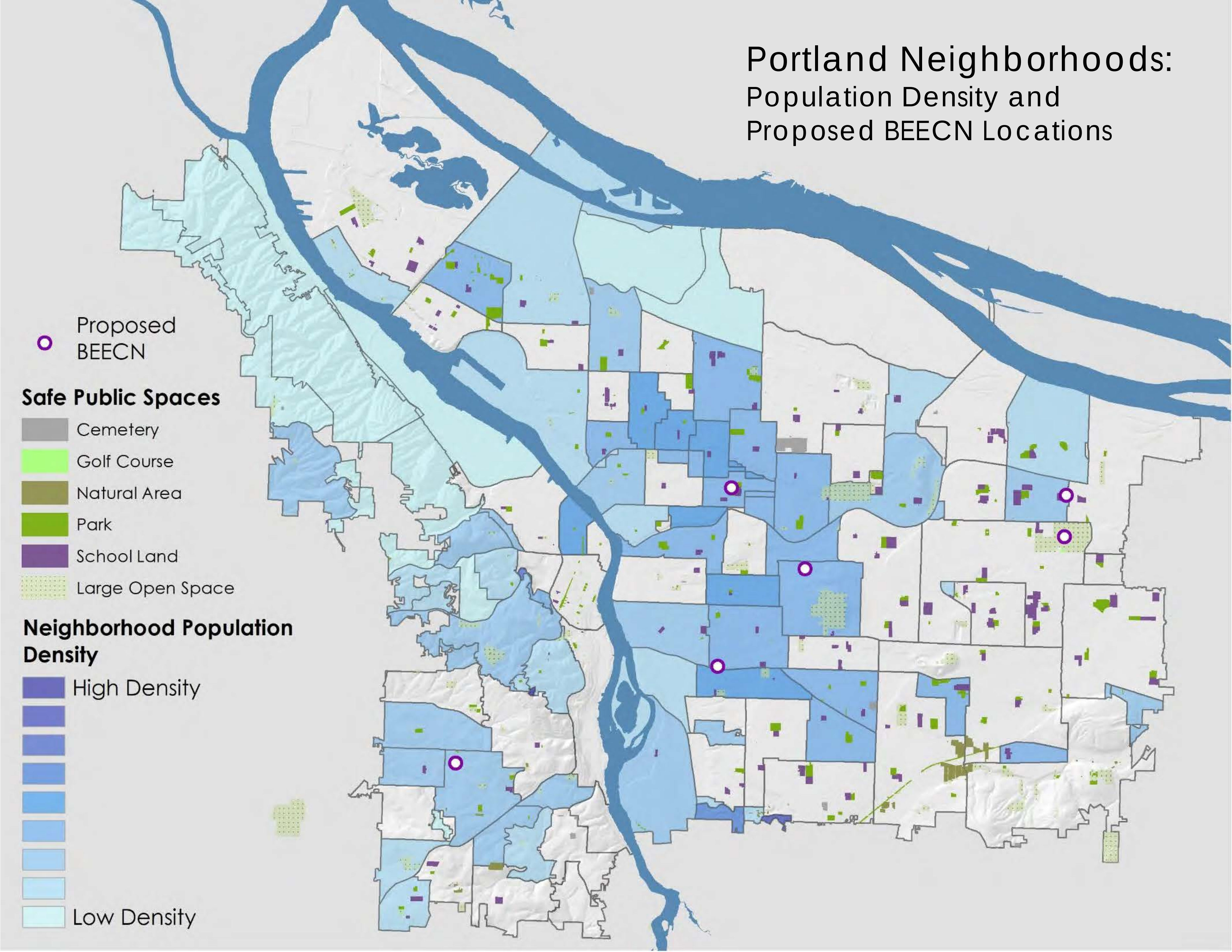
Glendoveer Golf Course

Mt. Tabor Middle School

Thompson Park
– Mt. Hood CC
Head Start

Gabriel Park

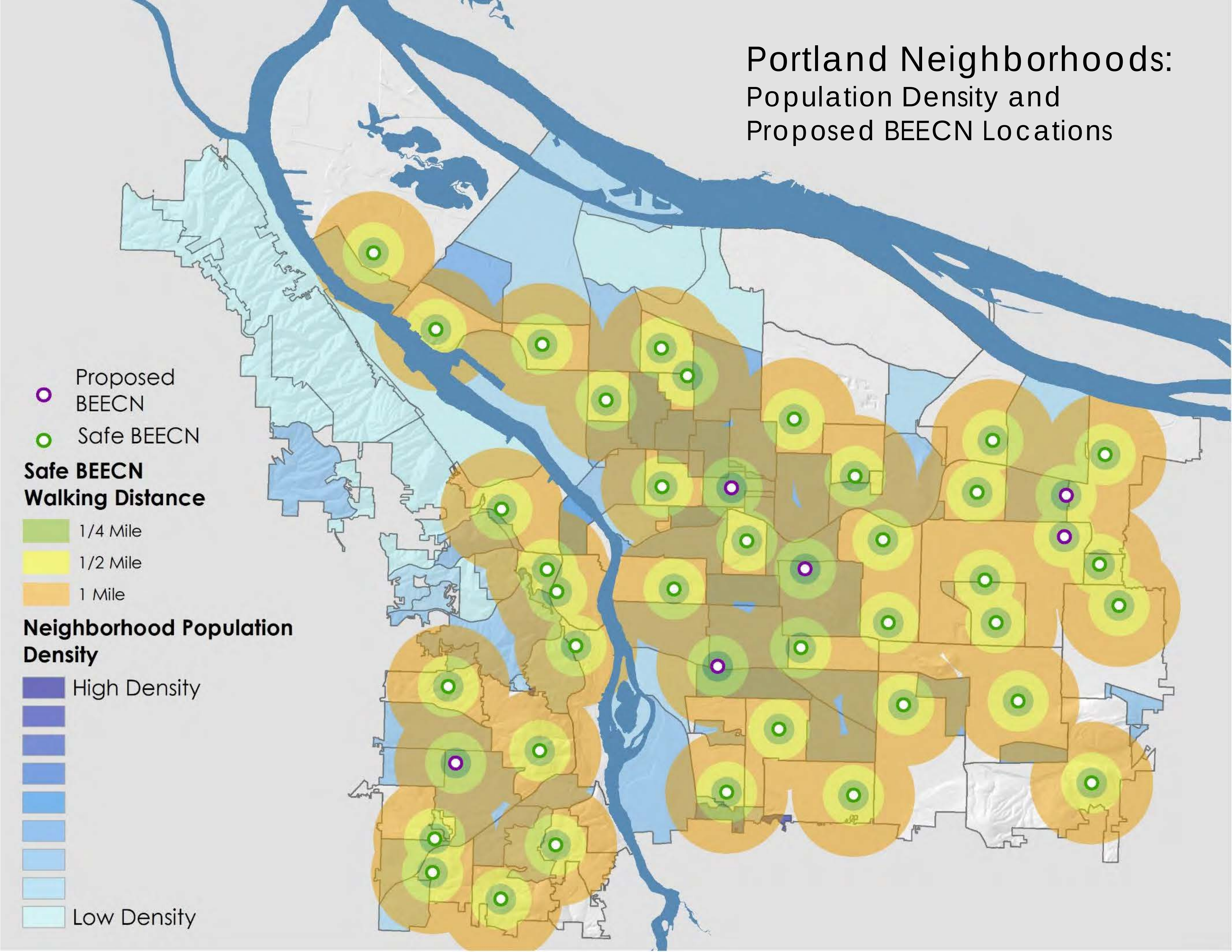
Cleveland High School



Safe

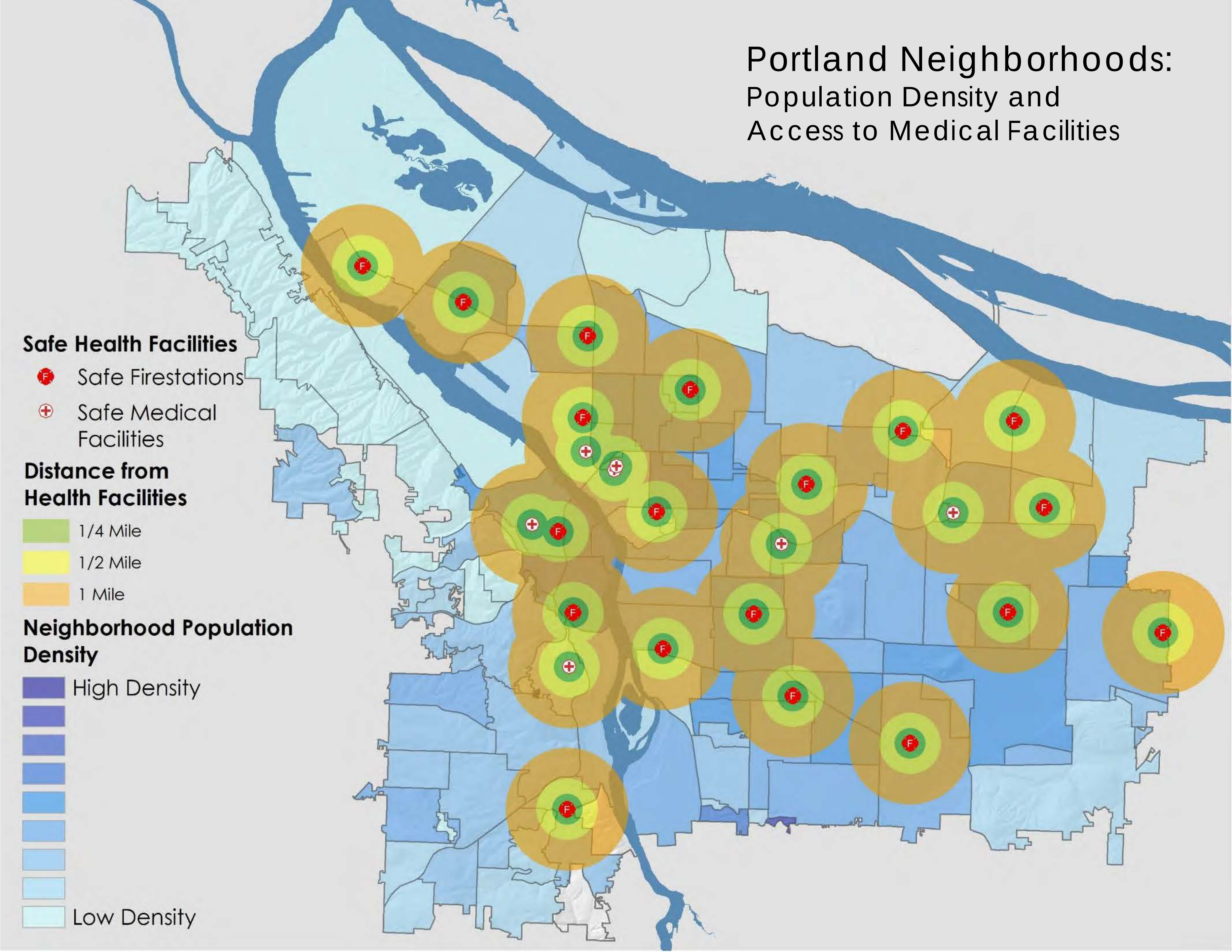
43

BEECNS

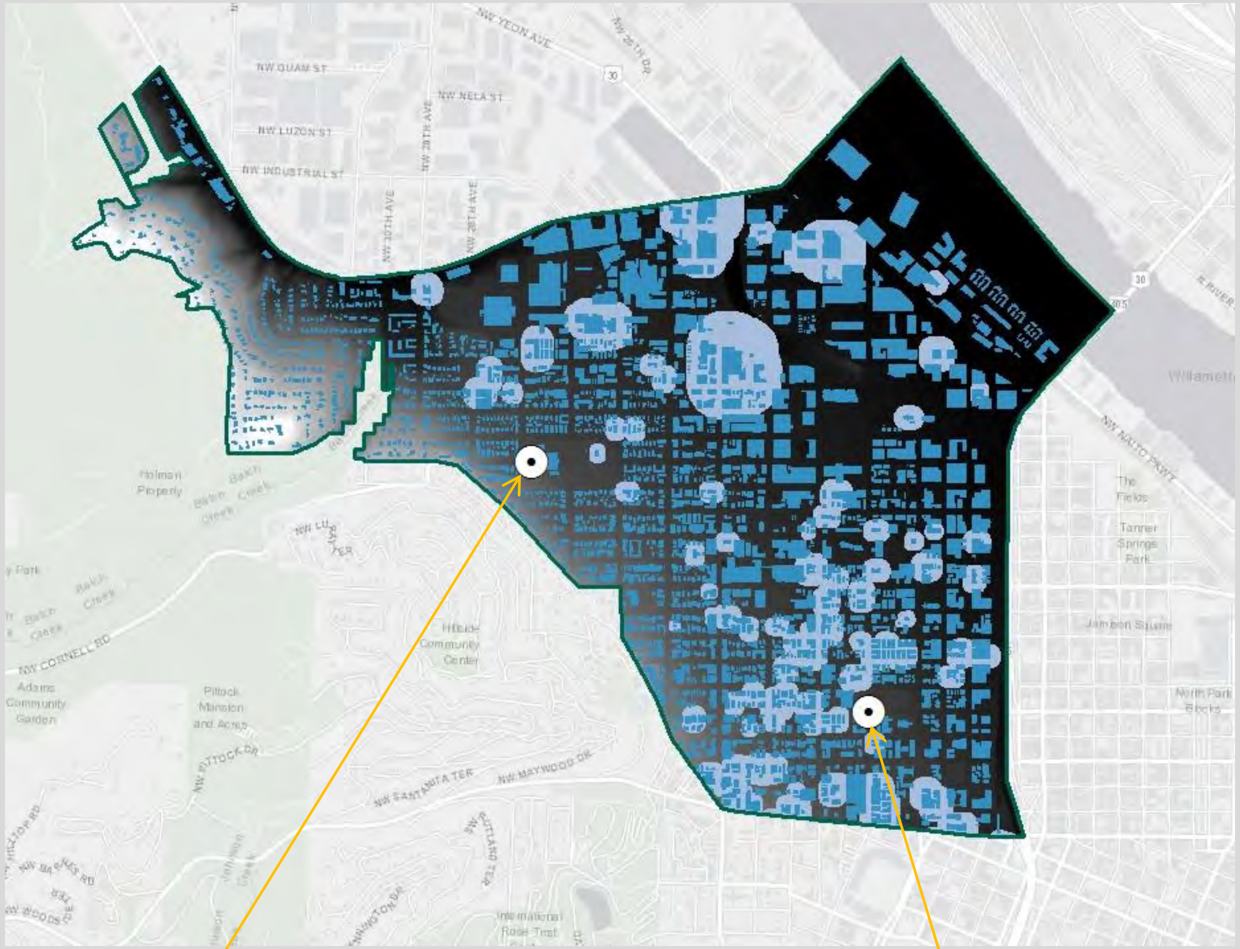


19
Fire Stations

6
Medical Facilities



Case Study: Northwest District

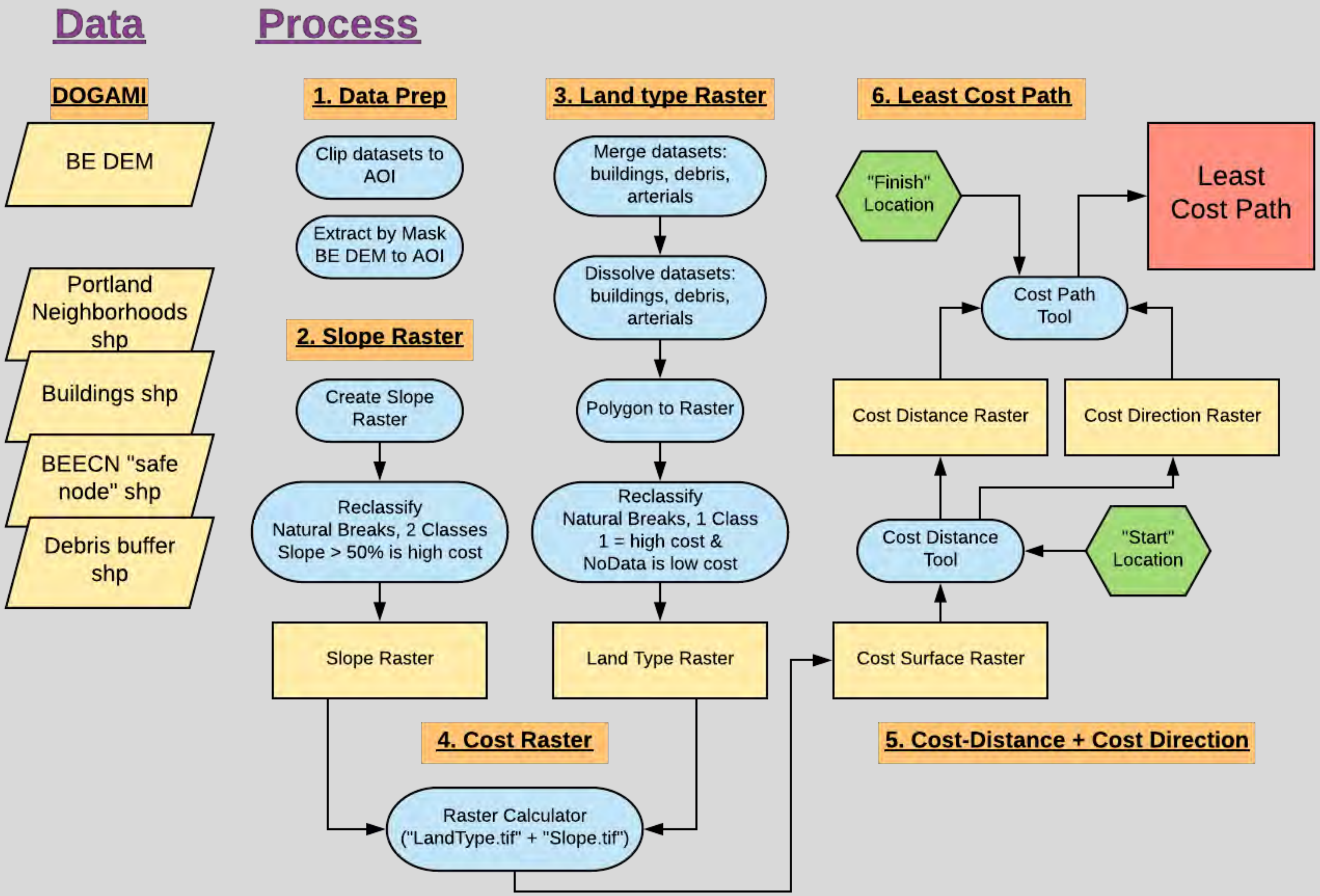


Finish:
Chapman Elementary School

Start:
Metropolitan Learning Center

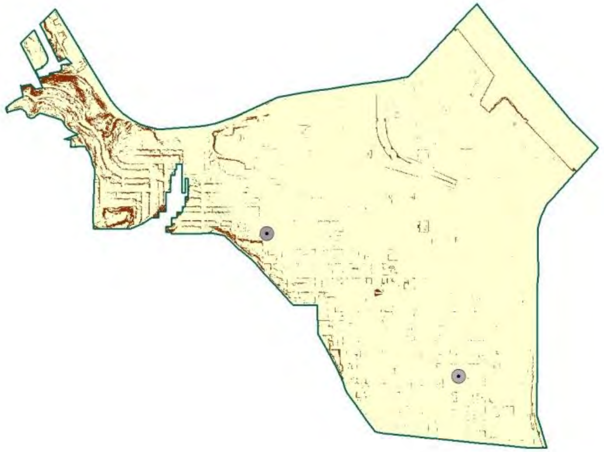
- Least cost path is a cost weighted distance and direction raster surface analysis to determine a cost-effective route between a source and a destination
- Volume displacement of URM buildings and impedances such as slope and building footprints are weighted as high cost resistance in raster equation
- Neighborhood analysis could be suitable to identify emergency evacuation routes and resource planning

Least Cost Path Analysis



Case Study: Northwest District cont.

Raster Calculator
to get
Cost Surface Raster



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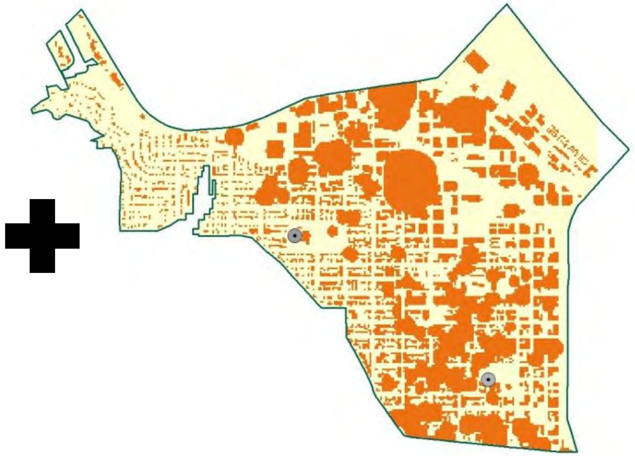

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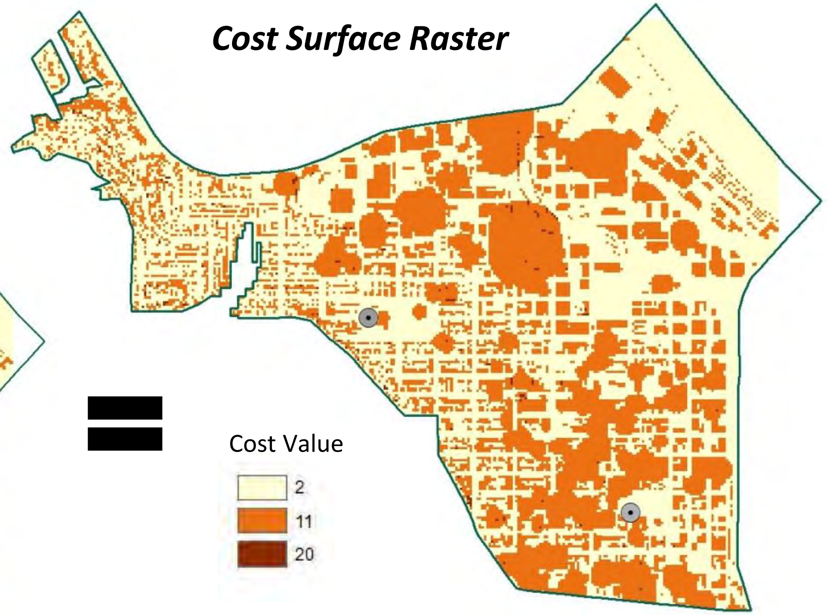
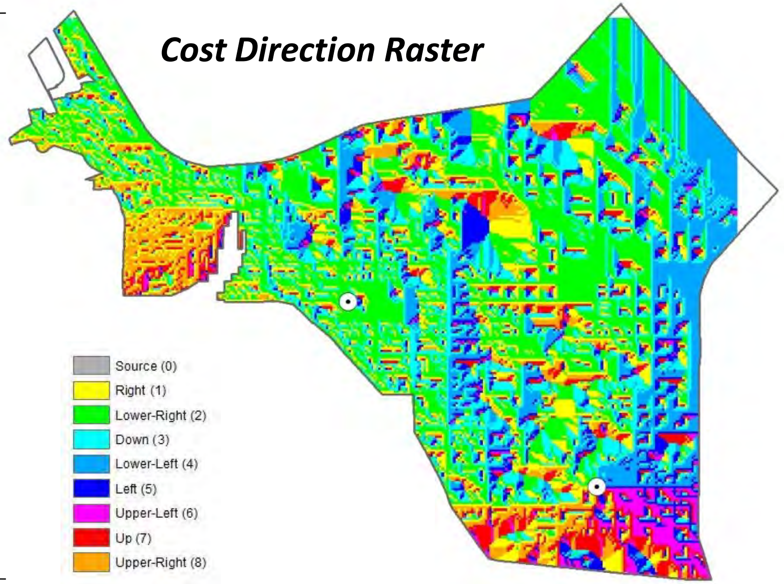
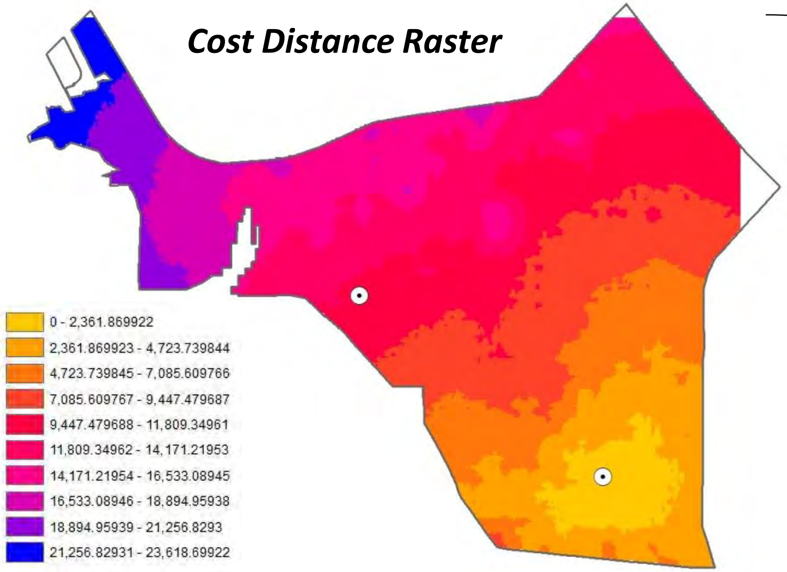


Cost Distance Tool





Least Cost Path Results

Northwest District
1. Start: Metropolitan Learning Center
2. Finish: Chapman Elementary School

Buckman Neighborhood
1. Start: Grand & SE Morrison intersection
2. Finish: Colonel Summers Park

South Portland
1. Start: Terwilliger/ Lair Hill residential neighborhood
2. Finish: Lair Hill Park