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The Bicycle Network Analysis Workshop, Part I:

All About the BNA

Facilitators

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Project Planner, Toole Design

Workshop Purpose

Learn how to use bicycle network analysis data to build and advocate for better places to bike.

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Training Objectives

- Understand the fundamentals of bicycle network connectivity measures
- Know how to find and interpret BNA data
- Develop skills to use BNA data in applied contexts

Training Methods

- Manual data analysis (pen + paper)
- Excel- and GIS-based data analysis
- GIS mapping and visualization
- Group discussion and brainstorming

Bicycle Connectivity Measures

WHY?

- Consistent framework
- Grow bicycling faster

Bicycle Connectivity Measures

HOW?

- Evolved over past three decades
- Various methods and data
- Range of difficulty
- Basis in empirical research (mostly)

Bicycle Connectivity Measures

The Basics

- Stress measures
- Connectivity measures

BNA
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BICYCLE NETWORK ANALYSIS

- Automated
- National data coverage
- Open-source
- Consistent, comparative ratings
- Lowering the barrier to network analysis

SECTION 1:
Bicycle Network Analysis Data Sources

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BNA

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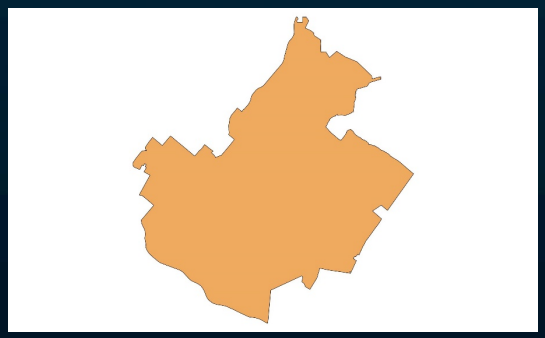
BICYCLE NETWORK ANALYSIS



United States™ Census Bureau

U.S. Census

2010 Population and Housing Counts

- ✓ Population
- ✓ Geographic units

Longitudinal Employer-Household Dynamics

- ✓ Jobs distribution

Explore census data inputs

1. Load OregonNW shapefile into GIS software.
2. Zoom in and explore the census block units – size, shape, distribution. What do you notice?

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3. Open the attribute table. Identify the BLOCKID10 and POP10 columns. Color the map using the POP10 column.

Explore census data inputs

1. Load OregonNW shapefile into GIS software.
2. Zoom in and explore the census block units – size, shape, distribution. What do you notice?
3. Open the attribute table. Identify the BLOCKID10 and POP10 columns. Color the map using the POP10 column.
4. Open the attribute table. Identify the S000 column. Color the map using the S000 column.

OpenStreetMap

- ✓ Bike infrastructure
- ✓ Road characteristics
- ✓ Intersection characteristics
- ✓ Destinations

Explore OpenStreetMap

1. Navigate to openstreetmap.org.
2. Zoom into a city you know containing on- and off-street bicycle infrastructure.

INFRASTRUCTURE DATA

3. Click on an off-street bike path. Click on “Cycle Path” in left-hand panel. Read panel details.

Explore OpenStreetMap

1. Navigate to openstreetmap.org.
2. Zoom into a city you know containing on- and off-street bicycle infrastructure.

INFRASTRUCTURE DATA

3. Click on an off-street bike path. Click on “Cycle Path” in left-hand panel. Read panel details.
4. Find an on-street bike lane. Click on road containing bike lane. Read panel details.

Explore OpenStreetMap

1. Navigate to openstreetmap.org.
2. Zoom into a city you know containing on- and off-street bicycle infrastructure.

INFRASTRUCTURE DATA

3. Click on an off-street bike path. Click on “Cycle Path” in left-hand panel. Read panel details.
4. Find an on-street bike lane. Click on road containing bike lane. Read panel details.
5. Click on an intersection with traffic lights. Click on “Traffic Signals” in panel. Read panel details.

Explore OpenStreetMap

6. If city is in BNA, compare bicycle infrastructure in BNA to the infrastructure you identified in OpenStreetMap.

Explore OpenStreetMap

6. If city is in BNA, compare bicycle infrastructure in BNA to the infrastructure you identified in OpenStreetMap.

DESTINATION DATA

7. Return to openstreetmap.org. Find a K-12 school. Click on it. Check tags.
8. Find a park. Check tags.
9. Find a hospital. Check tags.

Explore OpenStreetMap

6. If city is in BNA, compare bicycle infrastructure in BNA to the infrastructure you identified in OpenStreetMap.

DESTINATION DATA

7. Return to openstreetmap.org. Find a K-12 school. Click on it. Check tags.
8. Find a park. Check tags.
9. Find a hospital. Check tags.
10. Return to BNA website. Explore destination maps for the city.

OpenStreeetMap

What's mapped well?

What's missing?

OpenStreeetMap

What's mapped well?

- Parks, K-12 schools

What's missing?

OpenStreeetMap

What's mapped well?

- Parks, K-12 schools

What's missing?

- Depends on city, but frequently pharmacies, doctors, dentists, and retail are less well mapped

Questions about BNA data sources?

SECTION 2:
Designing a Network Measure
Part I – Stress Ratings

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What factors influence whether a road is good or bad for bicyclists?

WHAT THE BNA INCLUDES

- ✓ Bike facility type
- ✓ # of traffic lanes
- ✓ Speed limit
- ✓ Parking
- ✓ Facility width
- ✓ Intersection treatment

WHAT THE BNA DOESN'T INCLUDE

- Traffic volume
- Actual speed
- Traffic calming features
- Elevation change
- Road shoulders
- Lane markings
- Weather
- Road surface conditions

WHAT THE BNA ASSUMES

- Speed, lanes, parking, facility width details assumed if not provided in OpenStreetMap data; Default values assigned based on street class

WHAT THE BNA ASSUMES

- Speed, lanes, parking, facility width details assumed if not provided in OpenStreetMap data; Default values assigned based on street class
- Residential speed limit defaults assigned based on state and city law (e.g. Portland, OR = 20 mph)

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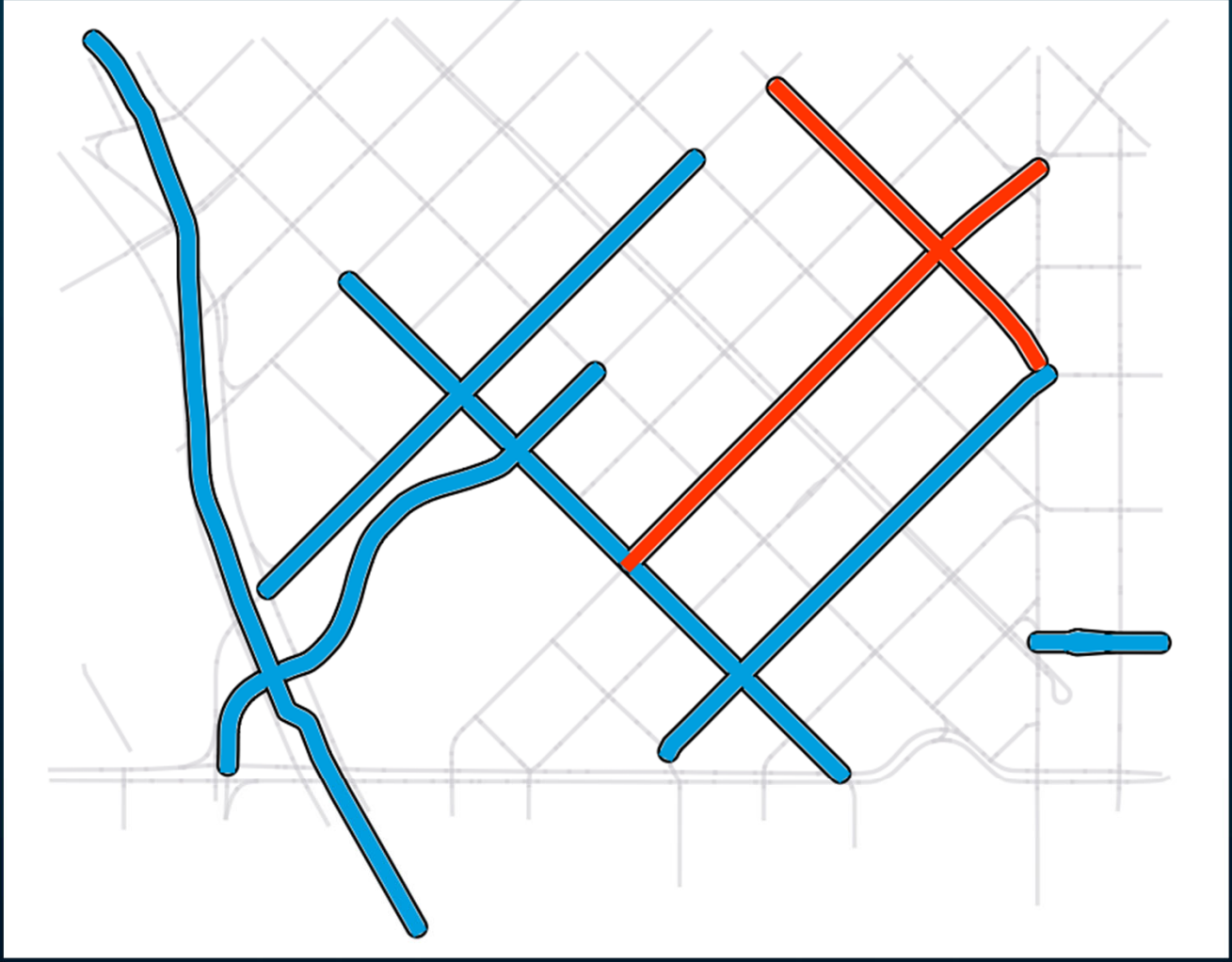
Rate the marked roads in the network based on the BNA rubric. Color accordingly.



Explore the Network Map

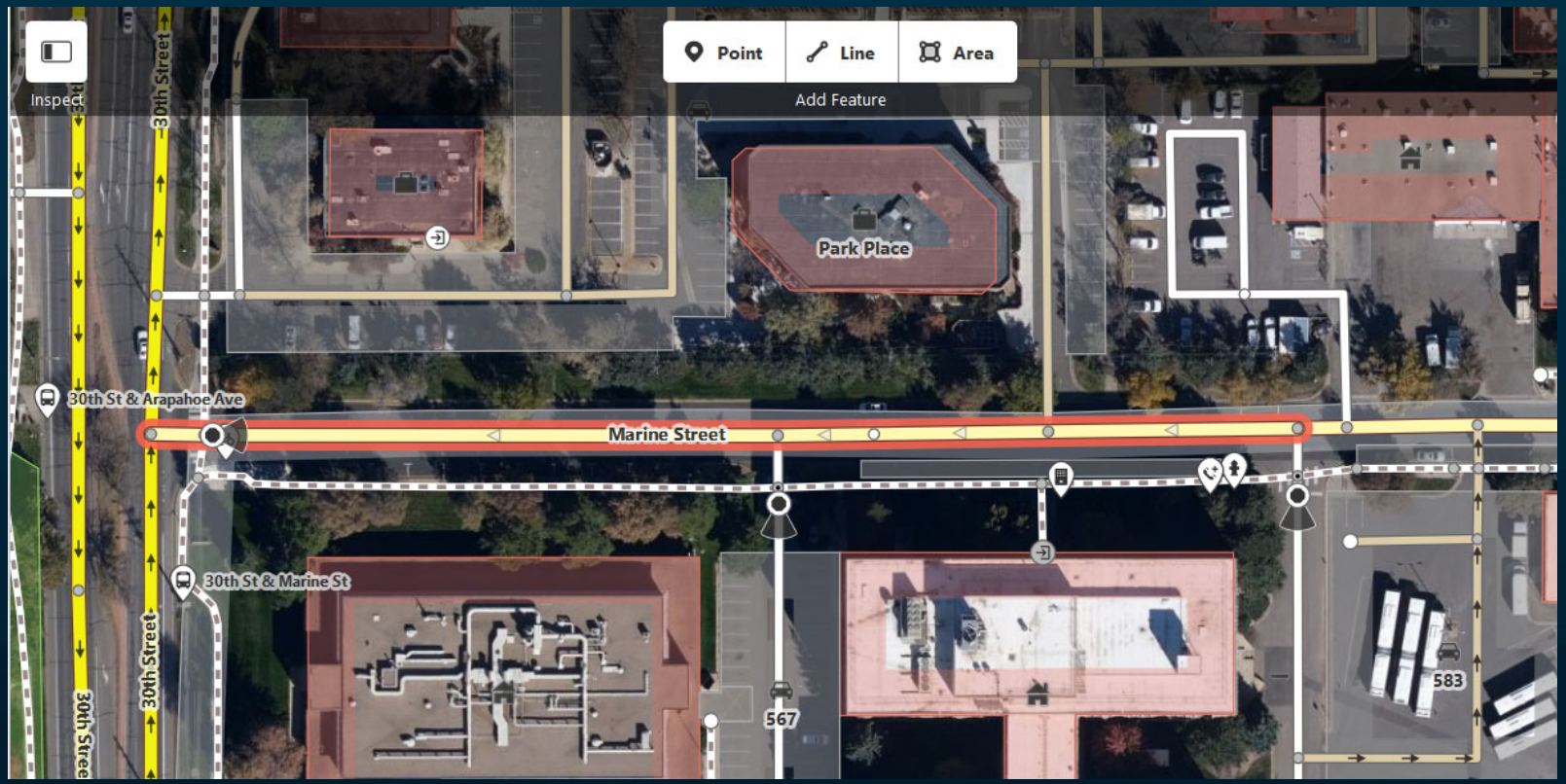
1. Navigate to a city of your choice at bna.peopleforbikes.org.
2. Download the Neighborhood Ways shapefile for that city and open it in GIS software.
3. Download the Data Dictionary Excel file and open it; select the Neighborhood Ways tab.

Explore the Network Map

Attribute	Description
ROAD_ID	Unique identifier
NAME	Road name
INTERSECTI	Intersection identifier for the "from" node
INTERSE_01	Intersection identifier for the "to" node
OSM_ID	OpenStreetMap ID
TDG_ID	Unique identifier
FUNCTIONAL	OSM Functional Class
PATH_ID	Identifier for parent path/trail (where applicable)
SPEED_LIMI	Speed limit
ONE_WAY_CA	One way for car traffic
ONE_WAY	One way for bike traffic
WIDTH_FT	Roadway width
FT_BIKE_IN	Bike infrastructure in the "from-to" (forward) direction
FT_BIKE_01	Width of bike infrastructure in the "from-to" (forward) direction
TF_BIKE_IN	Bike infrastructure in the "to-from" (backward) direction
TF_BIKE_01	Width of bike infrastructure in the "to-from" (backward) direction
FT_LANES	Number of travel lanes in the "from-to" (forward) direction
TF_LANES	Number of travel lanes in the "to-from" (backward) direction
FT_CROSS_L	Number of lanes to be crossed at the "to" intersection
TF_CROSS_L	Number of lanes to be crossed at the "from" intersection
TWLTL_CROS	Flag for whether a TWLTL (center turn lane) is present on the cross street
FT_PARK	Flag for whether on-street parking is allowed on the "from-to" (forward) side of the street
TF_PARK	Flag for whether on-street parking is allowed on the "to-from" (backward) side of the street
FT_SEG_STR	Stress for the street segment in the "from-to" (forward) direction
FT_INT_STR	Stress for the intersection crossing at the "to" intersection
TF_SEG_STR	Stress for the street segment in the "to-from" (backward) direction
TF_INT_STR	Stress for the intersection crossing at the "from" intersection

FT = FROM-TO
TF = TO-FROM

Explore the Network Map



FROM_TO is the forward direction based on how the line segment is drawn in OSM. **TO-FROM** is the reverse.

Explore the Network Map

VISUALIZE INFRASTRUCTURE

4. Identify on-street infrastructure: Color segments based on the column FT_BIKE_IN.
5. Identify off-street paths: Color segments where the column Functional = ‘path’ and FT_BIKE_IN is null.
6. Remove crosswalks from off-street paths: Add condition XWALK is null.

Explore the Network Map

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TF_INT_STR	Stress for the intersection crossing at the "from" intersection

Explore the Network Map

VISUALIZE NETWORK STRESS

1. Identify high- and low-stress streets: Color segments based on the column FT_SEG_STR.
7. For comparison, view map with low-stress streets only.

TIP: To visualize stress in both directions, duplicate the map and color segments by TF_SEG_STR, then offset the lines so that both street directions are visible.

CHALLENGE:
Identify High Stress Infrastructure

Visualize High-Stress Infrastructure

1. Color segments based on the constraints FT_BIKE_IN in ‘buffered_lane’ or ‘lane’ AND FT_SEG_STR > 1.

Visualize High-Stress Infrastructure

1. Color segments based on the constraints FT_BIKE_IN in ‘buffered_lane’ or ‘lane’ AND FT_SEG_STR > 1.

TIP: Paths and cycle tracks are always low stress because they fully separate bicycles from cars.

TIP: Sharrows do not have any impact on the stress rating of a street.

Visualize High-Stress Infrastructure

2. Visualize all infrastructure again. Remove high-stress infrastructure from infrastructure map: Add rule-based constraint FT_SEG_STR = 1.

Visualize High-Stress Infrastructure

2. Visualize all infrastructure again. Remove high-stress infrastructure from infrastructure map: Add rule-based constraint FT_SEG_STR = 1.
3. Identify high-stress intersections:
   Set FT_INT_STR = 3 OR TF_INT_STR = 3. Compare to network stress map.

Questions about measuring network stress?

Now you've seen how the BNA measures network stress. Next, we'll explore how the BNA uses the stress network to measure connectivity.

SECTION 3:
Designing a Network Measure Part II – Connectivity

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What are important destinations for bicyclists in your community?

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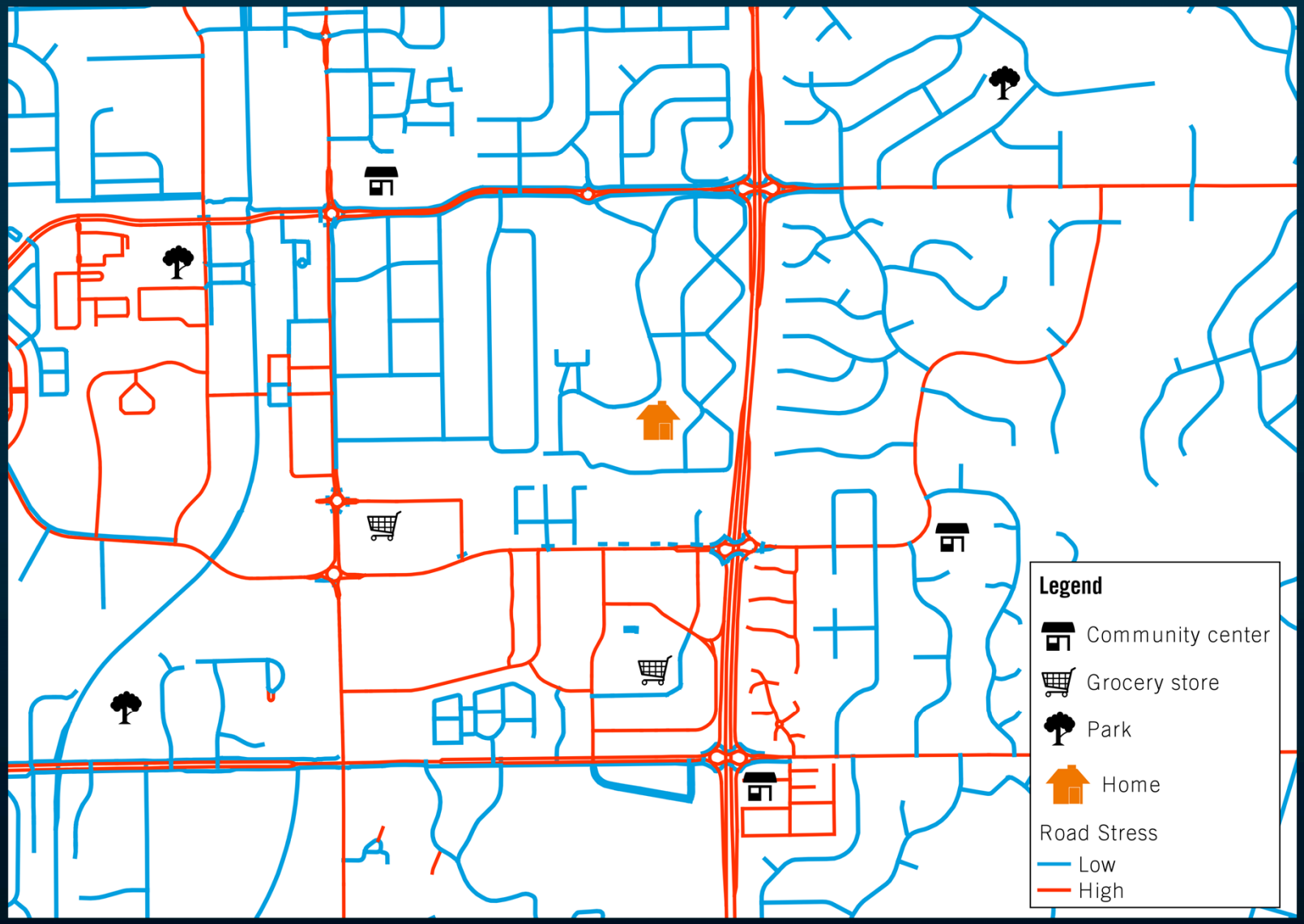
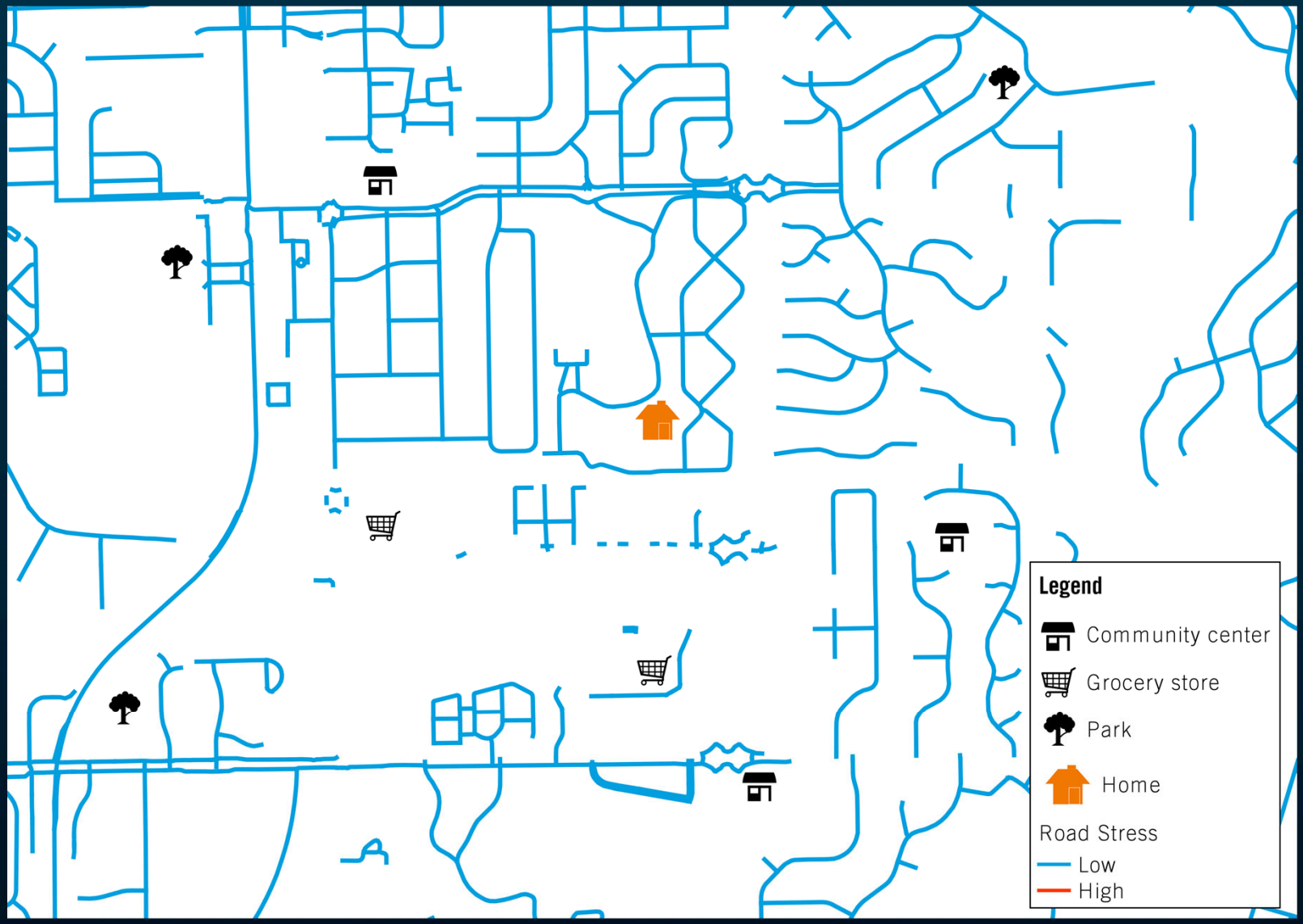
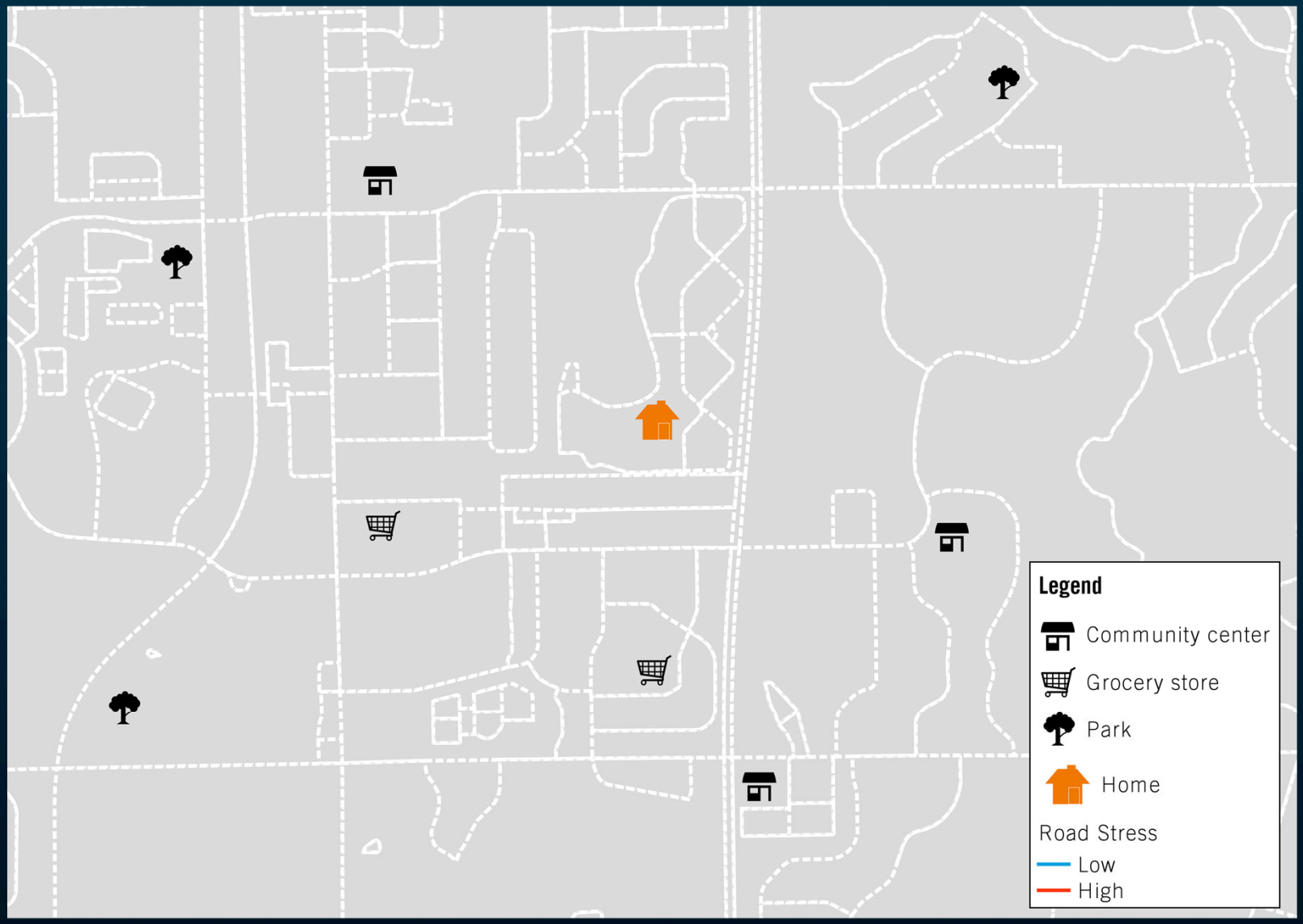



Legend
Community center
Grocery store
Park
Home
Road Stress
Low
High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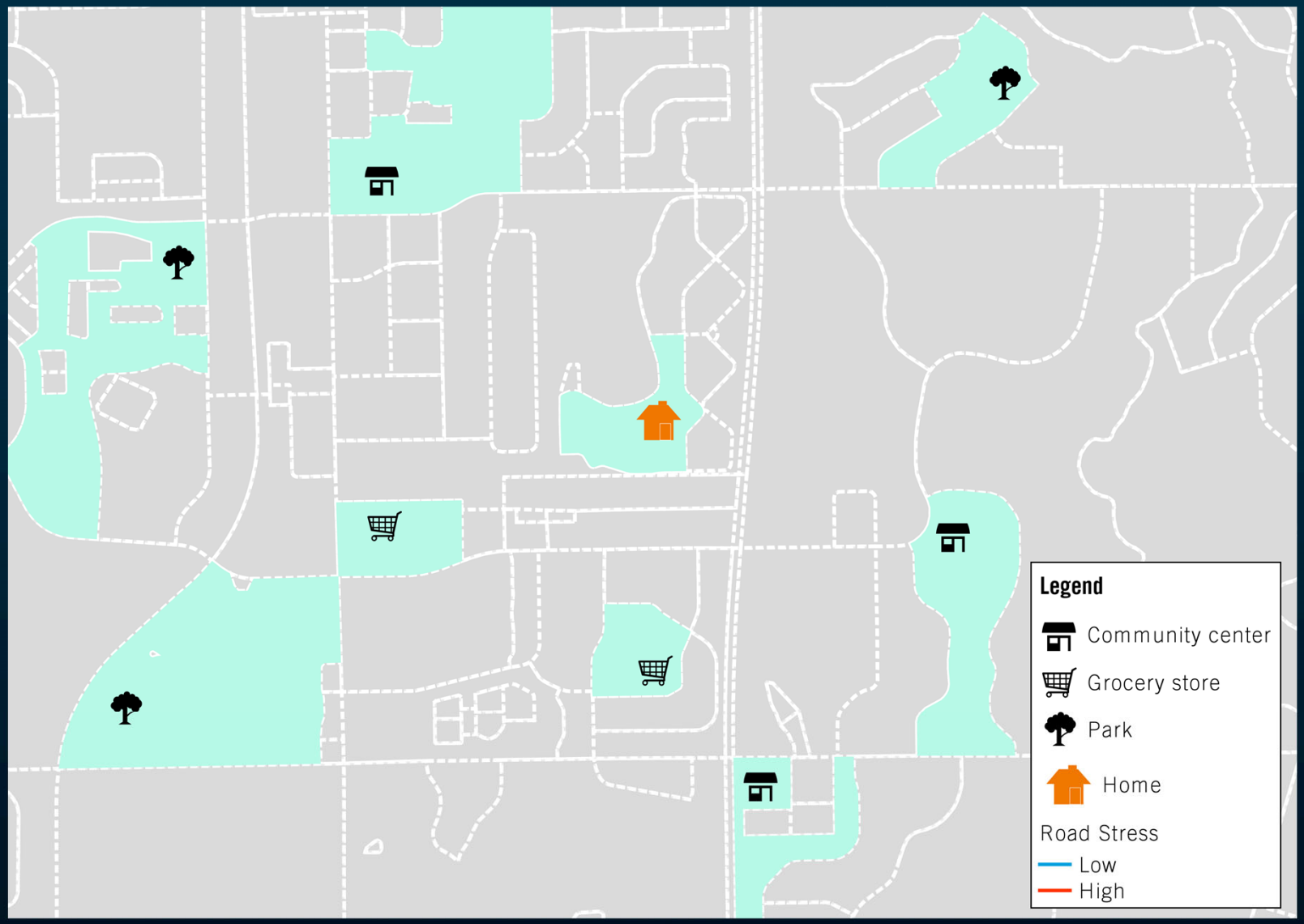
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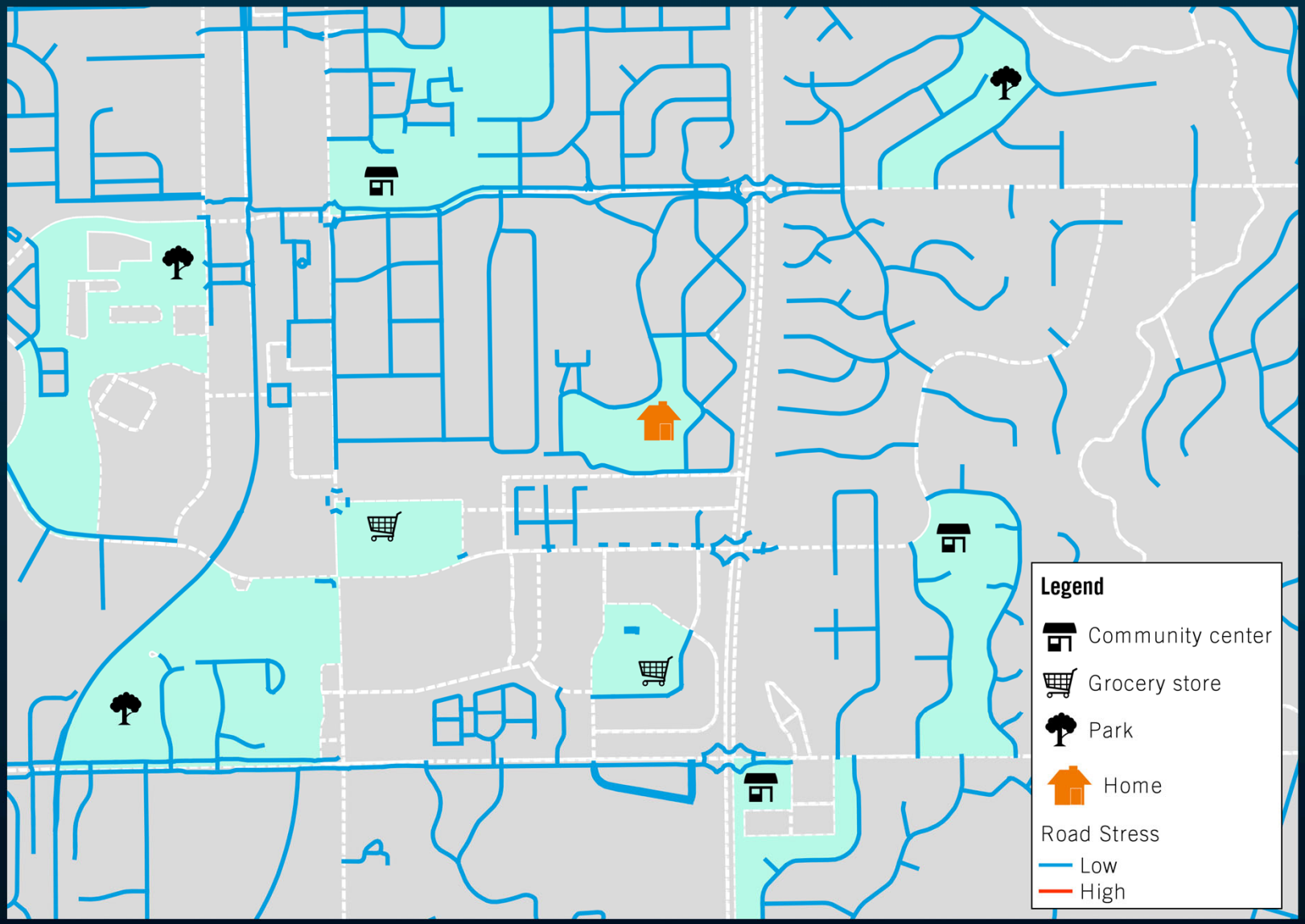

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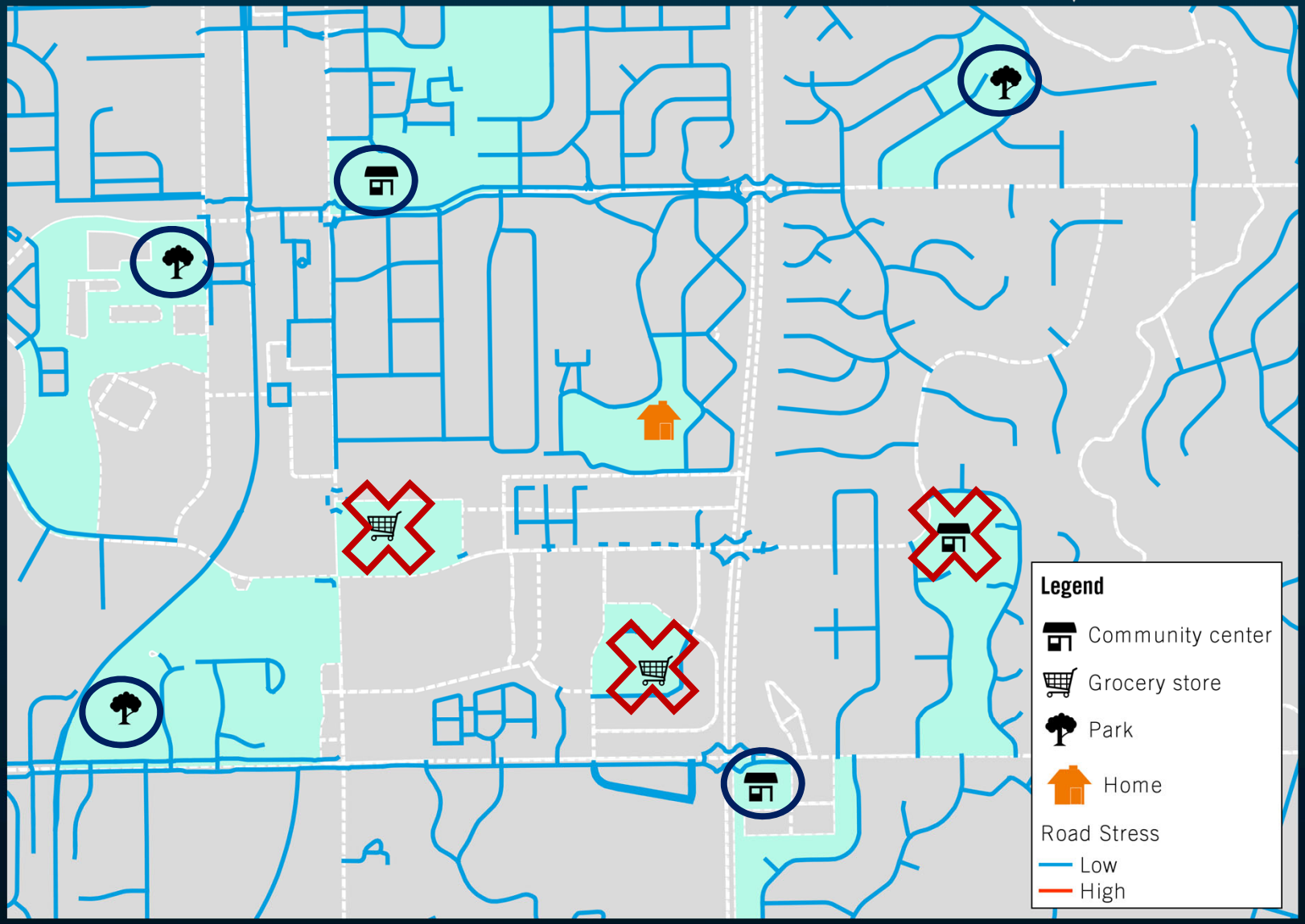

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DESTINATION ACCESS

- Parks
- Grocery stores
- Community centers

DESTINATION ACCESS

- Parks (3/3)
- Grocery stores
- Community centers

DESTINATION ACCESS

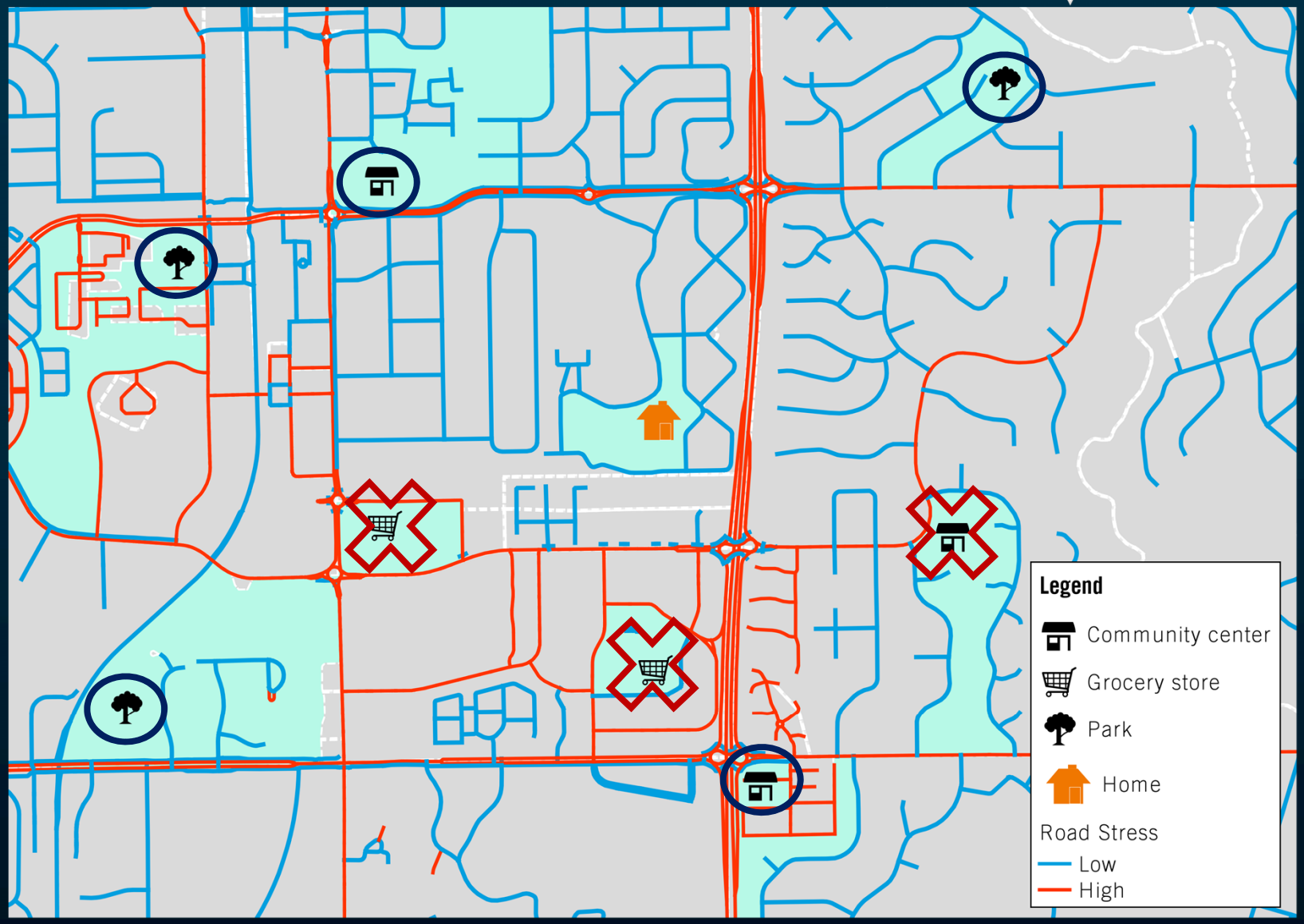
- Parks (3/3)
- Grocery stores (0/2)
- Community centers

DESTINATION ACCESS

- Parks (3/3)
- Grocery stores (0/2)
- Community centers (2/3)

New condition:

Bicycle trip length cannot exceed car trip length by > 25%



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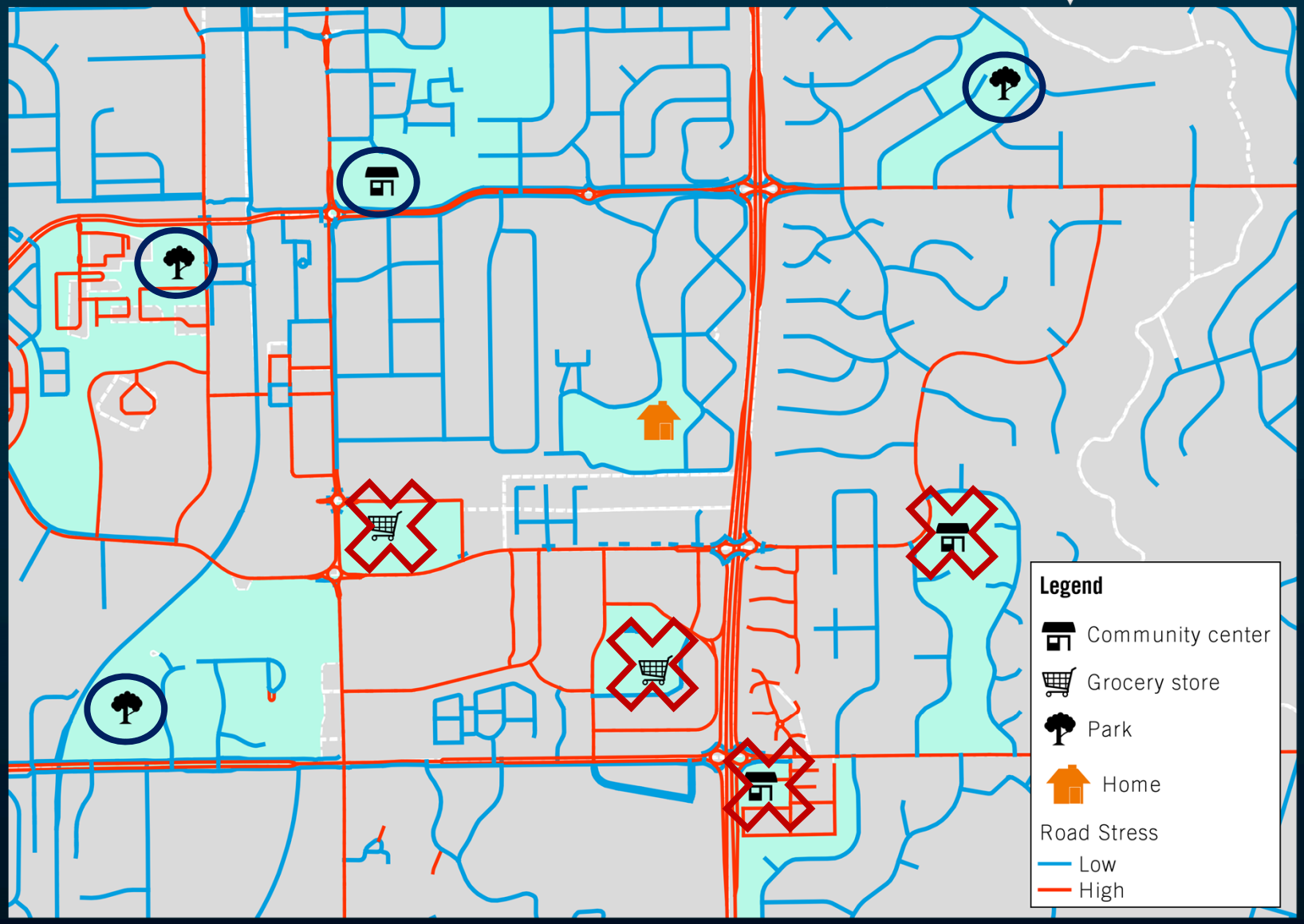
WORKSHOPS 2019



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DESTINATION ACCESS

- Parks (3/3)
- Grocery stores (0/2)
- Community centers (1/3)

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Fill in the missing BNA scores for this census block using the scoring rubric.

Category	Weight	Score	Subcategory	Weight	# Locations w/ Low Stress Access	# Locations w/ High Stress Access	Score
People	15%	49	-	N/A	8,929	33,414	49
Opportunity	20%	66	K-12	35%	6	12	80
			Tech/Vocational School	10%	-	-	-
			Higher Education	20%	-	-	-
			Employment	35%	8,735	30,841	51
Recreation	15%		Parks	40%			
			Trails	35%	2	3	60
			Community Centers	25%			
Core Services	20%		Doctor	20%	2	6	60
			Dentist	10%	4	16	72
			Hospital	20%	0	2	0
			Pharmacy	10%	2	7	60
			Supermarket	25%			
			Social Services	15%	1	8	80
Retail	15%	81	-	N/A	14	32	81
Transit	15%	100	-	N/A	1	1	100
OVERALL SCORE	100%	66					

Category	Weight	Score	Subcategory	Weight	# Locations w/ Low Stress Access	# Locations w/ High Stress Access	Score
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			Employment	35%	8,735	30,841	51
Recreation	15%	71	Parks	40%	3	3	100
			Trails	35%	2	3	60
			Community Centers	25%	1	3	40
Core Services	20%	37	Doctor	20%	2	6	60
			Dentist	10%	4	16	72
			Hospital	20%	0	2	0
			Pharmacy	10%	2	7	60
			Supermarket	25%	0	2	0
			Social Services	15%	1	8	80
Retail	15%	81	-	N/A	14	32	81
Transit	15%	100	-	N/A	1	1	100
OVERALL SCORE	100%	66					

Explore the Census Block Access Map

1. Download the Census Blocks shapefile for any city on the BNA website.
2. Open the neighborhood_census_blocks tab in the Data Dictionary Excel file.
3. Map overall block scores using the OVERALL_SC column.
4. Map block scores for a different destination category, e.g. Parks.

TIP: If there are no destinations for a specific category type, the score will be null and not count towards the overall block BNA score.

Attribute	Description
STATEFP10	State FIPS code
COUNTYFP10	County FIPS code
TRACTCE10	Census tract identifier
BLOCKCE	Census block identifier
BLOCKID10	Full US Census Block identifier
PARTFLG	Partial block
HOUSING10	Number of households in the census block
POP10	Population of the census block
ROAD_IDS	List of road_id values for roads that are associated with this block
POP_LOW_ST	Population in other census blocks that can be accessed via low stress connections from this block
POP_HIGH_S	Population in other census blocks that can be accessed via all connections from this block
POP_SCORE	BNA People Score
EMP_LOW_ST	Jobs in other census blocks that can be accessed via low stress connections from this block
EMP_HIGH_S	Jobs in other census blocks that can be accessed via all connections from this block
EMP_SCORE	BNA Employment Score
RETAIL_LOW	Retail centers in other census blocks that can be accessed via low stress connections from this block
RETAIL_HIG	Retail centers in other census blocks that can be accessed via all connections from this block
RETAIL_SCO	BNA Retail Score
SUPERMARKE	Supermarkets and groceries in other census blocks that can be accessed via low stress connections from this block
SUPERMA_01	Supermarkets and groceries in other census blocks that can be accessed via all connections from this block
SUPERMA_02	BNA Grocery Score
TRAILS_LOW	Trails that can be accessed via low stress connections from this block
TRAILS_HIG	Trails that can be accessed via all connections from this block
TRAILS_SCO	BNA Trails Score
COMMUNITY_	Community centers in other census blocks that can be accessed via low stress connections from this block
COMMUNI_01	Community centers in other census blocks that can be accessed via all connections from this block
COMMUNI_02	BNA Community Centers Score
TRANSIT_LO	Transit hubs in other census blocks that can be accessed via low stress connections from this block
TRANSIT_HI	Transit hubs in other census blocks that can be accessed via all connections from this block
TRANSIT_SC	BNA Transit Score
OVERALL_SC	Overall BNA Score

Explore the Census Block Access Map

5. Select blocks with zero population (POP10 = 0). Visually assess the distribution of these blocks.

Explore the Census Block Access Map

5. Select blocks with zero population (POP10 = 0). Visually assess the distribution of these blocks.
6. Identify the block with the highest population: This block has the highest weighted contribution to the city's overall BNA score.

Questions about measuring connectivity?

CHALLENGE

Mapping the Bikeshed

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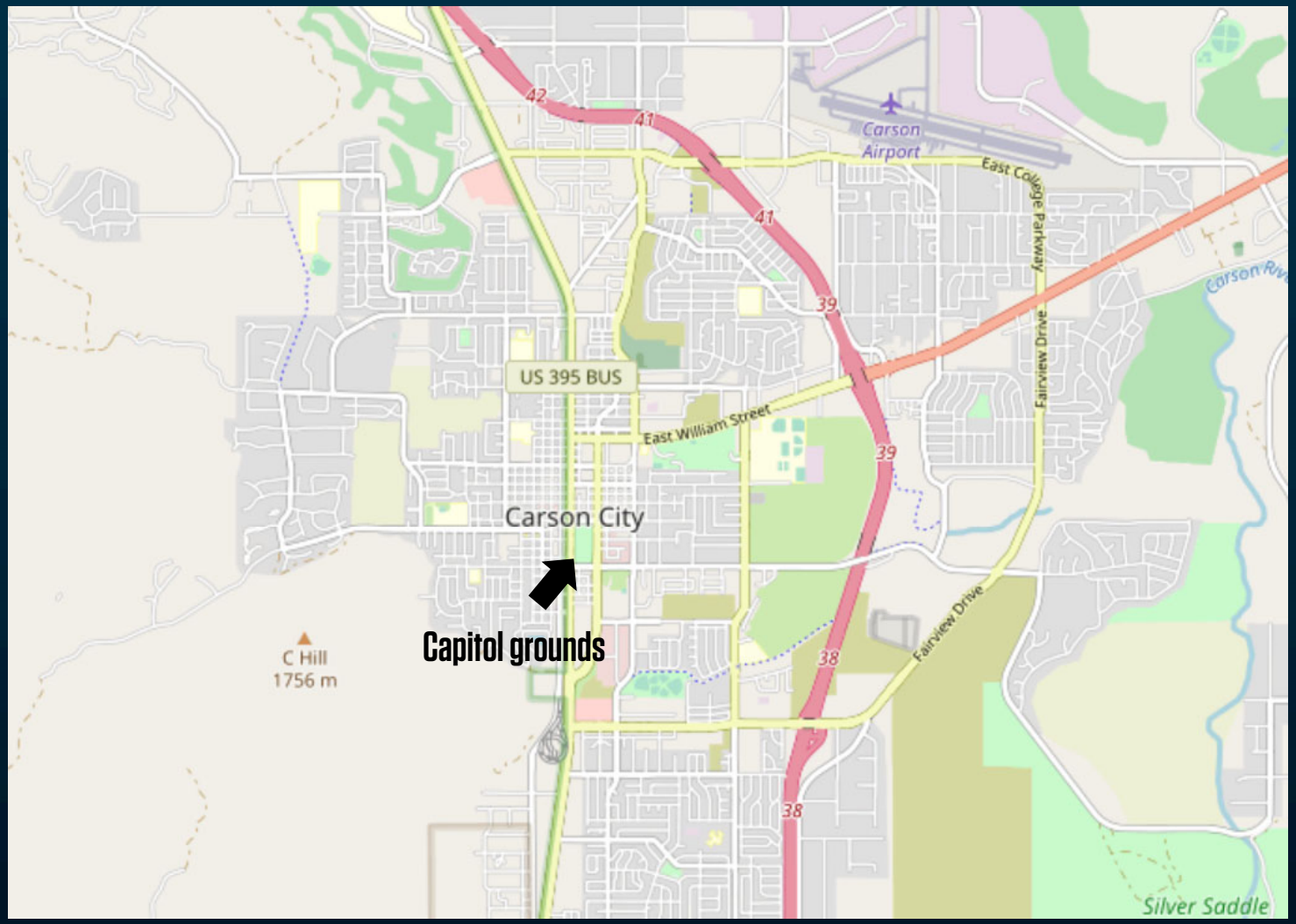
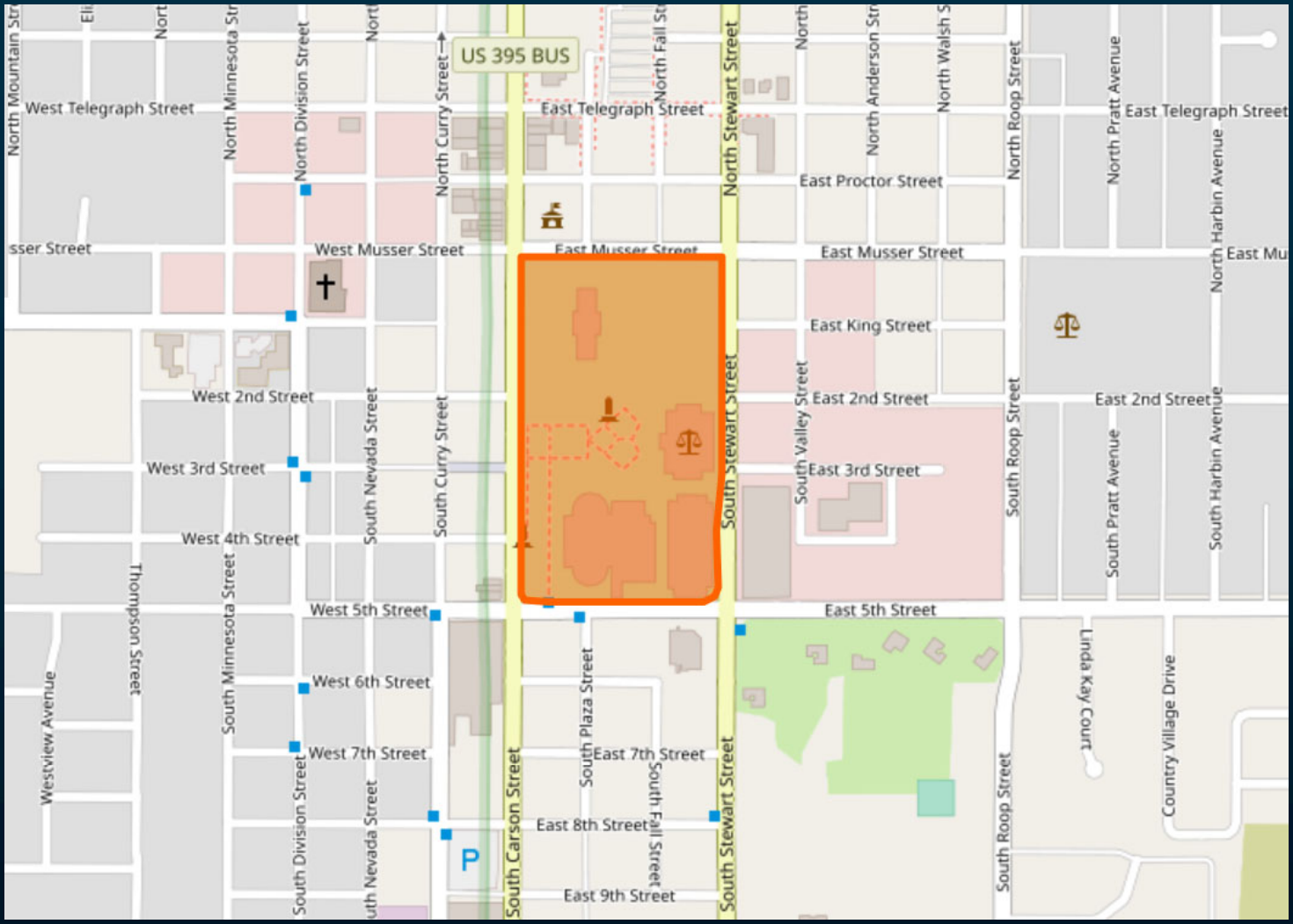

Carson Airport
East College Parkway
Fairview Drive
US 395 BUS
East William Street
Carson City
Capitol grounds
C Hill
1756 m
Silver Saddle
42
41
39
38


US 395 BUS
North Mountain Str
West Telegraph Street
North Minnesota Str
North Division Street
North Curry Street
East Telegraph Street
North Fall St
North Stewart Street
North Anderson Str
North Walsh S
North Roop Street
North Pratt Avenue
East Telegraph Street
North Harbin Avenue
East Proctor Street
sser Street
West Musser Street
East Musser Street
East Mu
East King Street
West 2nd Street
South Nevada Street
South Curry Street
South Stewart Street
South Valley Street
East 2nd Street
East 2nd Street
South Roop Street
South Pratt Avenue
South Harbin Avenue
West 3rd Street
East 3rd Street
West 4th Street
Thompson Street
South Minnesota Street
West 5th Street
East 5th Street
Westview Avenue
West 6th Street
Linda Kay Court
Country Village Drive
West 7th Street
South Plaza Street
East 7th Street
South Division Street
South Nevada Street
South Carson Street
South Fall Street
South Stewart Street
East 8th Street
P
East 9th Street
South Roop Street

Mapping the Bikeshed

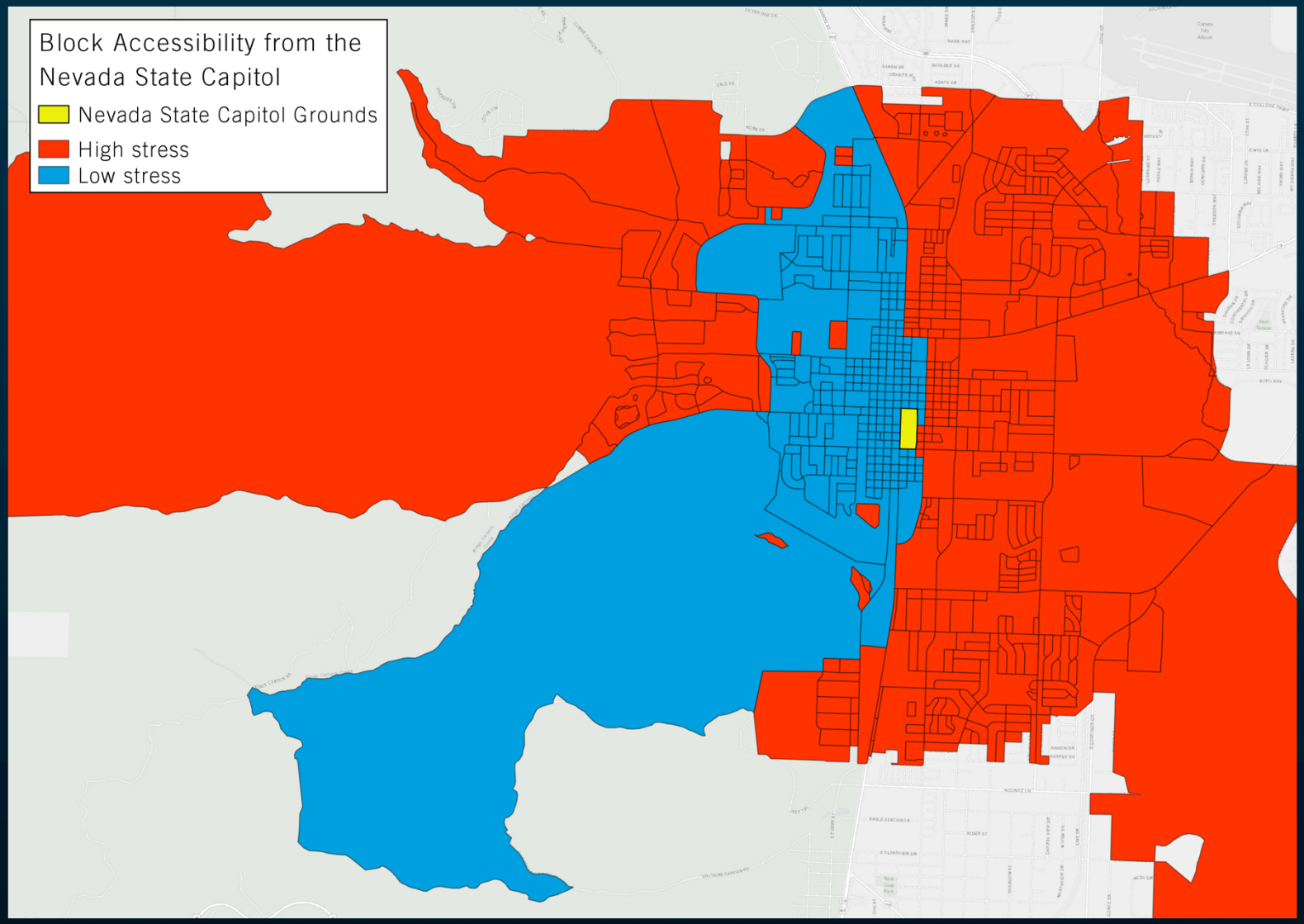
1. Download the Connected Census Blocks csv and the Census Blocks shapefile from the BNA website for Carson City, NV.
2. Open the Connected Census Blocks file in Excel or a similar program.

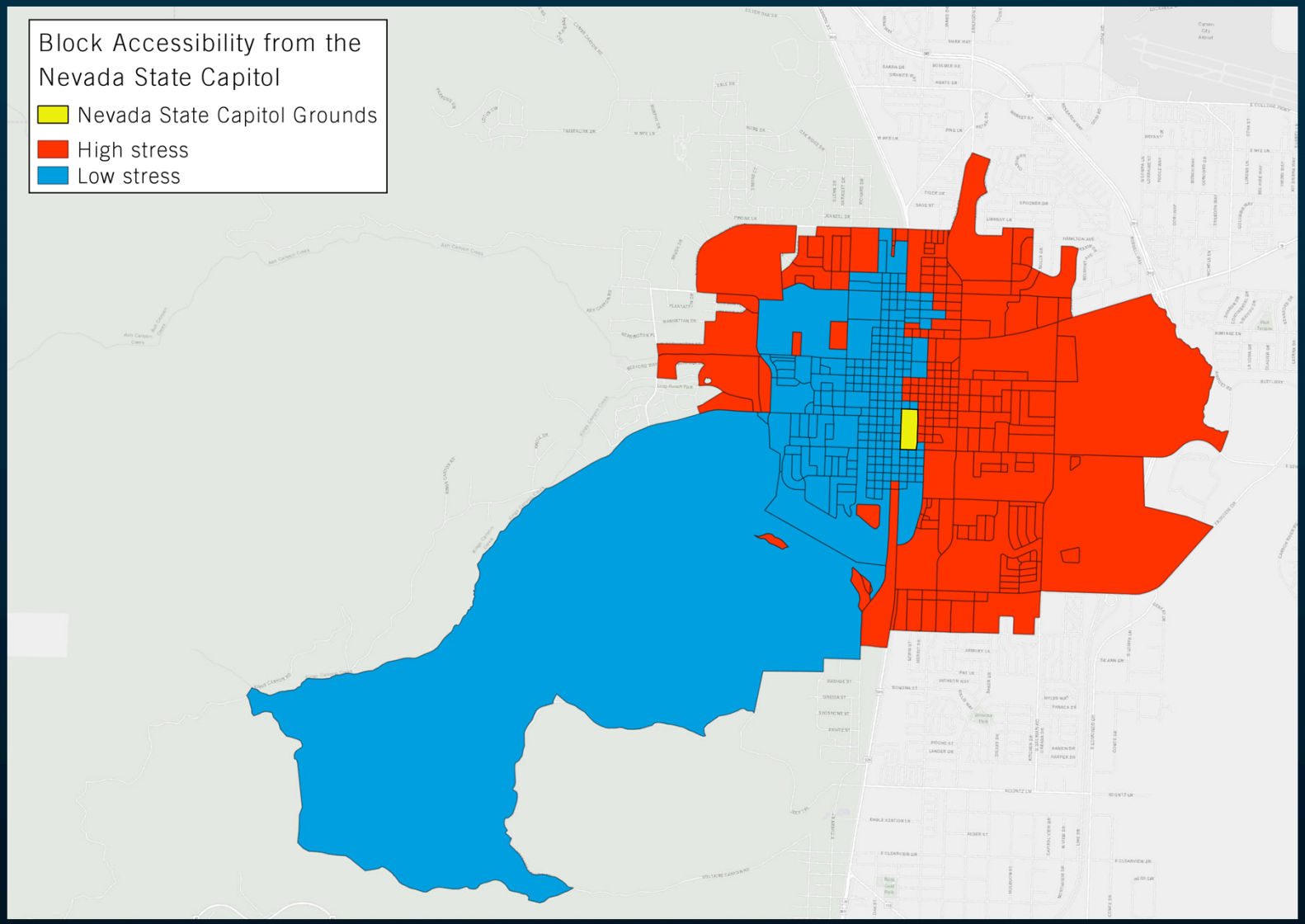
Mapping the Bikeshed

1. Download the Connected Census Blocks csv and the Census Blocks shapefile from the BNA website for Carson City, NV.
2. Open the Connected Census Blocks file in Excel or a similar program.
3. Filter the source_blockid10 column by the census block number for the capitol: 325100001001128.
4. Save the filtered values (Data -> Filter -> Copy filtered values -> Paste in new workbook -> Save workbook as csv).

Mapping the Bikeshed

5. Load the filtered csv and the Census Blocks shapefile into GIS software.
6. Join the files using target_blockid10 in the csv and BLOCKID10 in the shapefile.
7. Color the map by the low_stress column in the joined file (t or f values).


Block Accessibility from the Nevada State Capitol
Nevada State Capitol Grounds
High stress
Low stress


Block Accessibility from the Nevada State Capitol
Nevada State Capitol Grounds
High stress
Low stress

Questions about mapping the bikeshed?

BONUS CHALLENGE:
Measuring Network Equity

Measuring Network Equity

1. Load the Washington State census block groups shapefile wash_data.shp from the USB drive.
2. Select one of the following Washington cities to focus on: Federal Way, Kent, Olympia, Redmond, Richland, Seattle, Spokane, Tacoma, Vancouver.
3. Open the attribute table and create a new layer containing only that city's data using the city identifier column. E.g. city = 'tacoma'

TIP: The wash_data shapefile provides BNA block scores aggregated into census block groups to align with available U.S. census demographic data.

Measuring Network Equity

4. Choose a demographic variable of interest from the attribute table. The exercise will measure how well the network serves that demographic group.

Variable	Label
% of population under 18 years	under_18
% of population over 75 years	over_75
% of population non-white	nonwhite
% of population receiving social security	soc_secur
% of population receiving public assistance	pub_assist
% of population unemployed	unemploy

Measuring Network Equity

5. Create a benchmark for that demographic variable to select priority block groups, e.g. > 25% of the population is under 18 years old.

TIP: Calculate basic statistics for that column to gauge a good benchmark.

6. Create a new map with that subset of block groups.

Measuring Network Equity

5. Create a benchmark for that demographic variable to select priority block groups, e.g. > 25% of the population is under 18 years old.

TIP: Calculate basic statistics for that column to gauge a good benchmark.

6. Create a new map with that subset of block groups.
7. Calculate the BNA block group average score for block groups that meet the demographic criteria.
8. Calculate the BNA block group average score for the whole city.

Does the network serve that population better or worse than the city population?

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Thanks for attending Part I!

Add your city to the BNA! Submit a **City Snapshot** – https://peopleforbikes.org/city-snapshot-notification/

Stay in touch –

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WORKSHOPS 2019

The Bicycle Network Analysis Workshop, Part II:

Running the Analysis

Workshop Part II Purpose

Learn how to run the bicycle network analysis to generate customized, current results.

Workshop Part II Purpose

Learn how to run the bicycle network analysis to generate customized, current results.

Training Objectives

- Prepare your computer to run the BNA
- Understand the components of the source code
- Know how to run the BNA from the source code

Training Methods

- Python- and PostgreSQL-based spatial data analysis

STEP 1:
Setup

Required software

- Python 2 (Windows users)
  - ✓ Provided with macOS and Linux
- PostgreSQL 9.6 (or 10 or 11)
  - ✓ Add extensions pgRouting & PostGIS
- pgAdmin

Required Python packages

- psycopg2 – PostgreSQL adapter for Python
- tqdm
- PyYAML
- GeoPandas – Spatial data analysis
- Munch
- Overpass – OpenStreetMap data API
- OSMnx – Street networks from OpenStreetMap
- [Optional] Osmium – OpenStreetMap data processing

STEP 2:
Prepare the PostgreSQL database

Prepare the PostgreSQL database

1. CREATE Extension PostGIS;
2. CREATE Extension pgRouting;

Prepare the PostgreSQL database

1. CREATE Extension PostGIS
2. CREATE Extension pgRouting
3. Create Received table
4. Create Generated table

STEP 3:
Run the analysis

Files on your USB drive:

- pyBNA
- Boundary shapefile
- OpenStreetMap xml file
- Census jobs csv files (main and aux)
- Census blocks and population shapefile

STEP 4:
Generate results

Generating shapefiles from PostgreSQL

- Shp2pgsql (comes with the PostgreSQL)
- Powershell command prompt (install separately)

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