Boston Public Transit Inequities and Self-Driving Car Implementation Study

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Background

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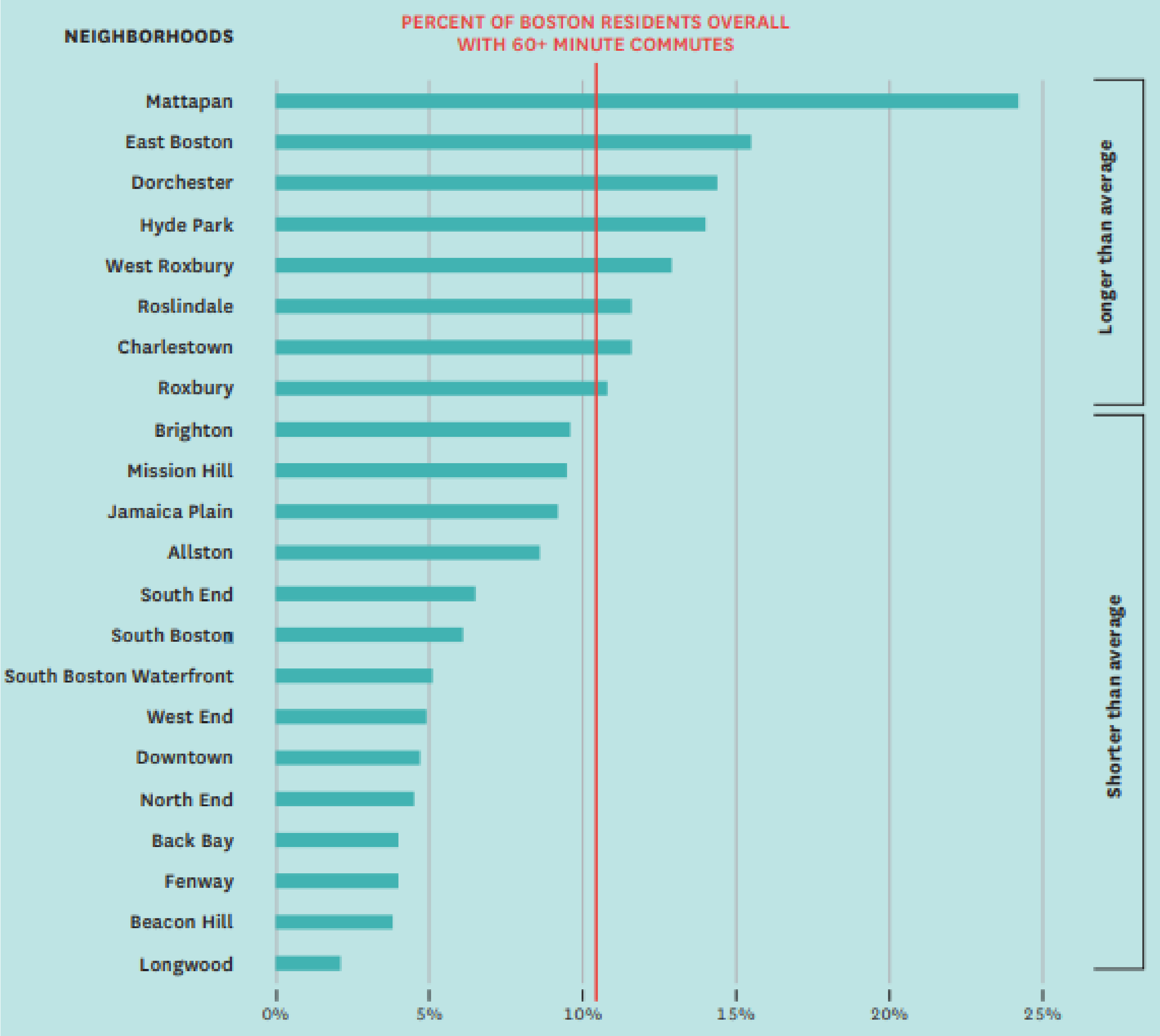
The city of Boston is difficult for traveling and commuting. Although there are multiple modes of public transportation available, some communities experience more transportation inequities than others.

Longest commute times

City	Average commute	By car	By public transit
New York City	43	40	53
Washington DC	41	41	50
Boston	40	40	49
San Francisco	37	36	48
Chicago	37	35	50



Background

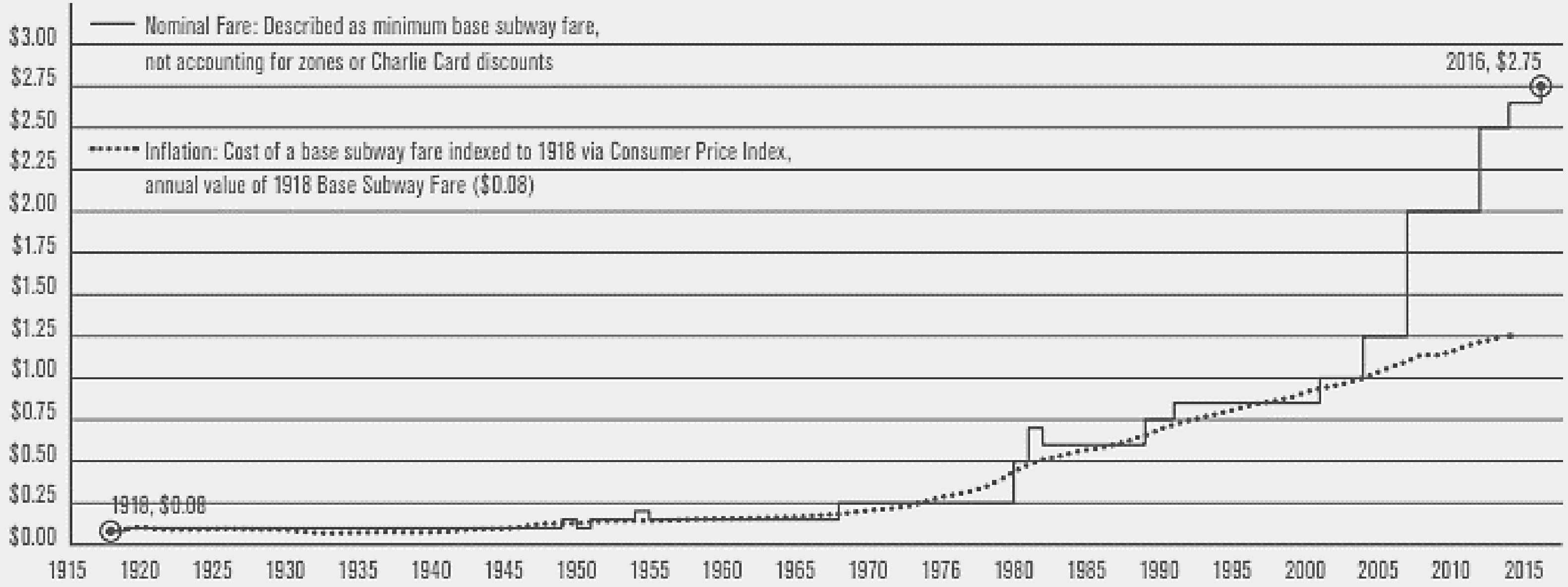
The following table shows the Boston neighborhoods that depend the most on public transportation.

Means of Commuting	% Bus or Trolley Bus	% Streetcar, Trolley Car, Subway, or elevated	% Railroad	% Total
United States	2.4	2.0	0.6	5.0
Massachusetts	3.3	5.1	1.8	10.2
Boston	13.5	18.5	1.1	33.1
Allston	18.8	18.4	1.0	38.2
Back Bay	2.9	20.7	1.1	24.7
Beacon Hill	2.2	16.7	1.4	20.3
Brighton	14.5	18.2	0.5	33.2
Charlestown	12.3	12.8	0.1	25.2
Dorchester	19.6	16.5	0.3	36.4
Downtown	2.6	16.0	1.5	20.1
East Boston	4.7	48.3	0.7	53.7
Fenway	11	14.8	0.4	26.2
Hyde Park	12.1	9.8	2.7	24.6
Jamaica Plain	9.9	31.2	0.7	41.8
Longwood	6.5	7.9	0.0	14.4
Mattapan	20	13.1	0.3	33.4
Mission Hill	10.4	27.4	0.8	38.6
North End	0.9	21.7	1.4	24.0
Roslindale	9.4	14.8	5.2	29.4
Roxbury	31.2	10.3	0.4	41.9
South Boston	22.6	13.7	0.3	36.6
S. Boston Waterfront	6.9	11.0	0.4	18.3
South End	8.5	15.2	2.2	25.9
West End	3	18.7	0.3	22.0
West Roxbury	6.7	7.5	4.5	18.7

Background

Its also of interest to understand the percentage of income Boston residents put towards transportation costs and the trend of the cost to ride the MBTA over time as the following tables note.

Rising cost of taking the T
MBTA Subway Fare History 1918 – 2016



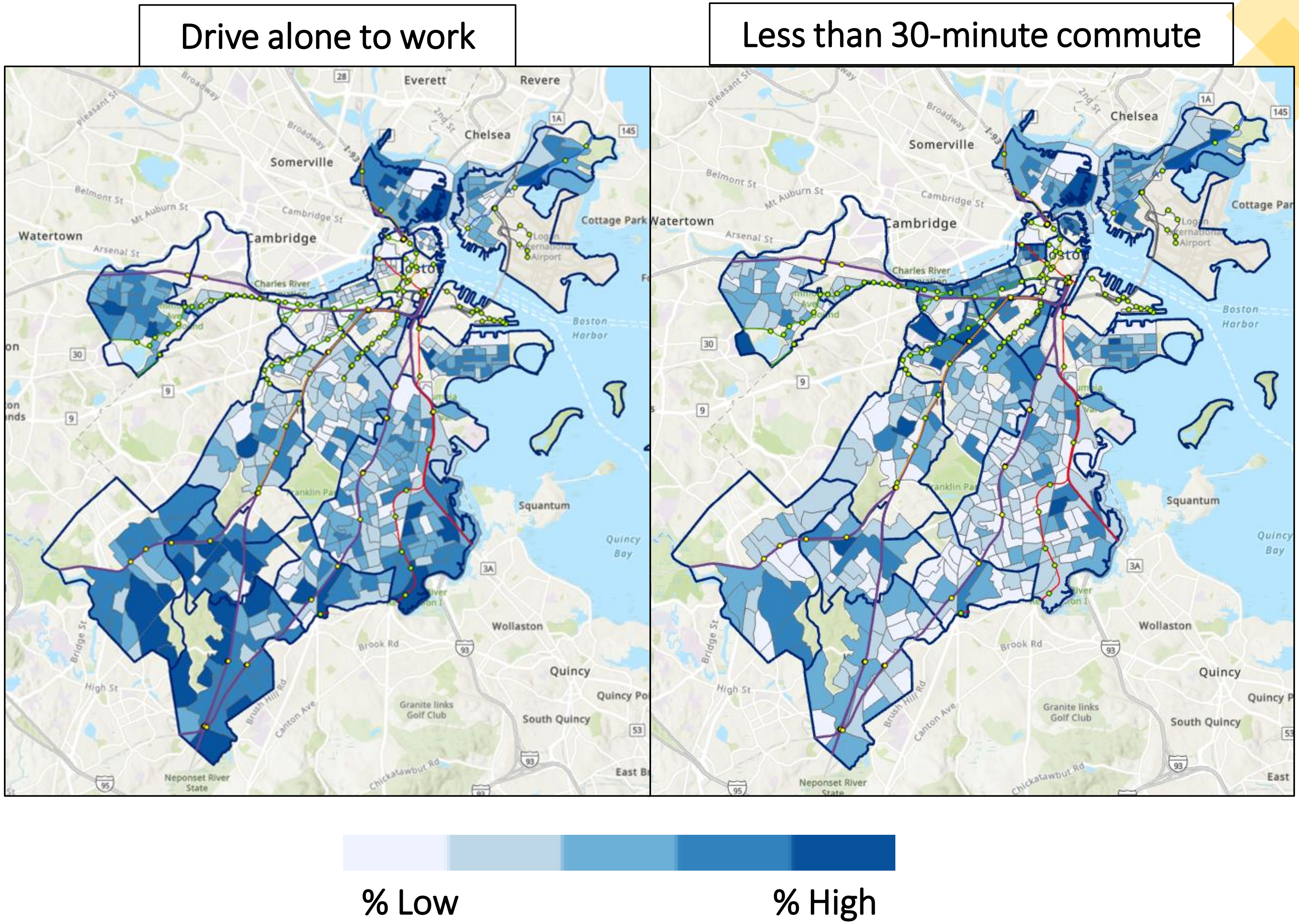
Average Transportation Costs as % of Income for a Median Income Family by Neighborhood

South Boston Waterfront	6.6%
Beacon Hill	8.0%
Fenway	9.4%
North End	10.6%
East Boston	10.7%
West End	10.8%
South End	11.5%
Back Bay	11.7%
South Boston	11.7%
Downtown	12.0%
Allston	12.2%
Charlestown	12.2%
Jamaica Plain	12.3%
Mission Hill	12.3%
Roxbury	12.4%
Mattapan	12.5%
Longwood Medical Area	12.6%
City of Boston (average)	**13.0%**
Brighton	13.7%
Dorchester	14.3%
Roslindale	15.1%
Hyde Park	16.4%
West Roxbury	16.5%

Source: Location Affordability Index

Background

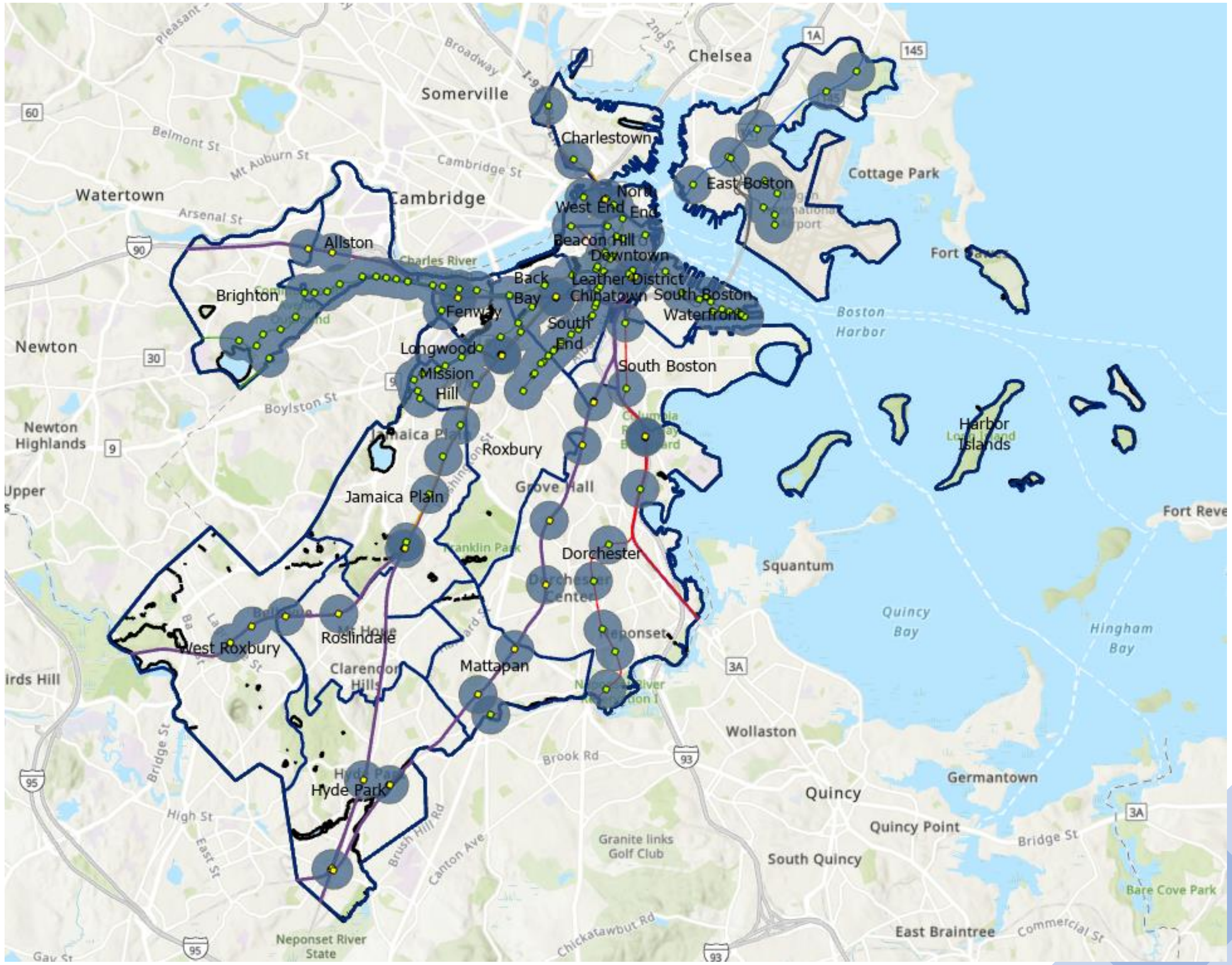
The following maps show which areas of Boston have higher percentages of personal car ownership and how many residents within certain block groups experience less than 30-minute commute times.



Research Question

Research Question:

Which socially vulnerable Block Group communities in Boston would benefit most from self-driving vehicle technology?



Analytic Strategy

Analytic Strategy

1. Find socio-economic Block Group data for Boston and run an exploratory regression report on variables that are likely to explain higher poverty rates.

2. Identify the most socially vulnerable Block Groups in Boston by running a Simple Suitability model using the chosen regression variables and specify thresholds.

3. Run a spatial join to find which of the identified blocks groups are furthest from train or subway stations. Choose 5 areas.

4. Identify intersections in the chosen areas where recommendations can be made for Pick-Up and Drop-Off points for self-driving taxis.

Analytic Strategy

When considering reliability of transportation services in Boston, bus service reliability is usually around 65-70 percent. Commuter rail service reliability usually hovers around or just under 90 percent. Subway reliability is typically the highest rated of all three and is usually at or above 90 percent

Bus service reliability is largely affected by traffic on the roads. With that in mind I have chosen to focus on identifying communities in need that are further away from the more reliable transportation services; the subway and commuter rail stations.

	Public Transit Reliability in Boston
Bus service	~ 65-70%
Subway	~ 90% or greater
Commuter Rail	~ 90% or less

Key Findings

Exploratory Regression

- **Dependent variable:**
- % HH in poverty

- **Candidate Variables:**
- % Annual HH Income under $20K
- % Public transit commuters
- % Unemployed
- % Non-white population
- % Less than high school education
- % Over 60-minute commute times
- % Non-English speakers

Choose 4 of 7 Summary

R-Squared is a statistical measure of fit that indicates how much variation of a dependent variable is explained by the independent variable(s) in a regression model. 88% is a high R^2 value and was acceptable for this study. A maximum of 5 variables was allowed but there were no passing 5-variable models.

Highest Adjusted R-Squared Results

AdjR2	AICc	JB	K(BP)	VIF	SA	Model
0.88	3552.49	0.00	0.00	1.80	0.00	+INCU20_P*** +PUB_P*** +UNEMP_P*** +NONWHI_P_2**
0.87	3558.90	0.00	0.00	1.64	0.00	+INCU20_P*** +EN_NA_P +PUB_P*** +UNEMP_P***
0.87	3559.48	0.00	0.00	1.67	0.00	+INCU20_P*** +M60O_P +PUB_P*** +UNEMP_P***

Passing Models

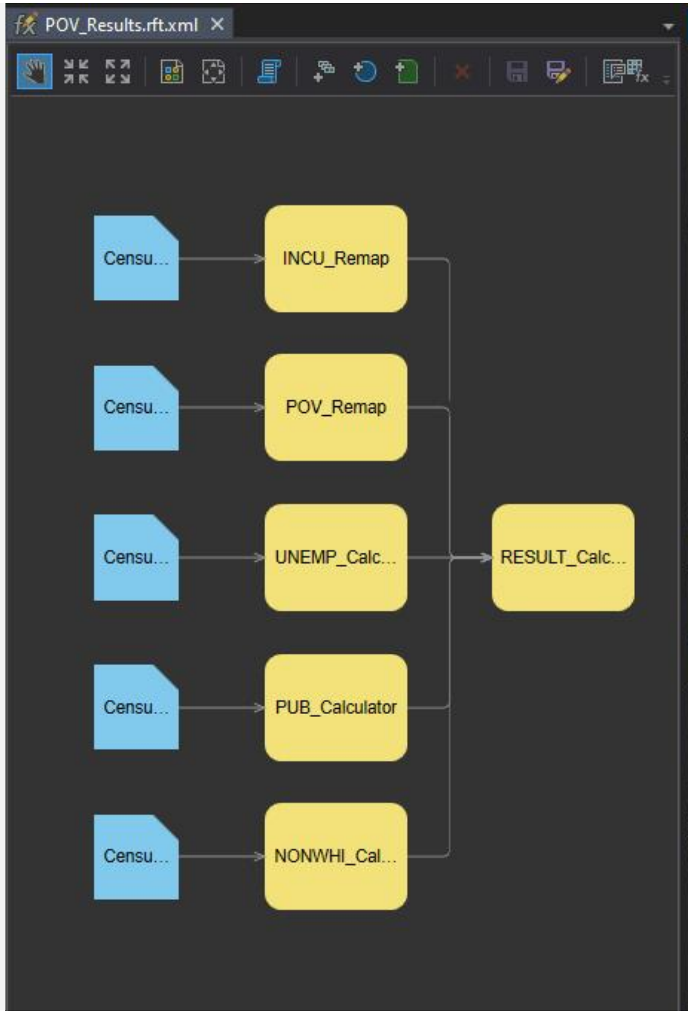
AdjR2	AICc	JB	K(BP)	VIF	SA	Model
0.875996	3552.485863	0.000000	0.000000	1.802380	0.002274	+INCU20_P*** +PUB_P*** +UNEMP_P*** +NONWHI_P_2**

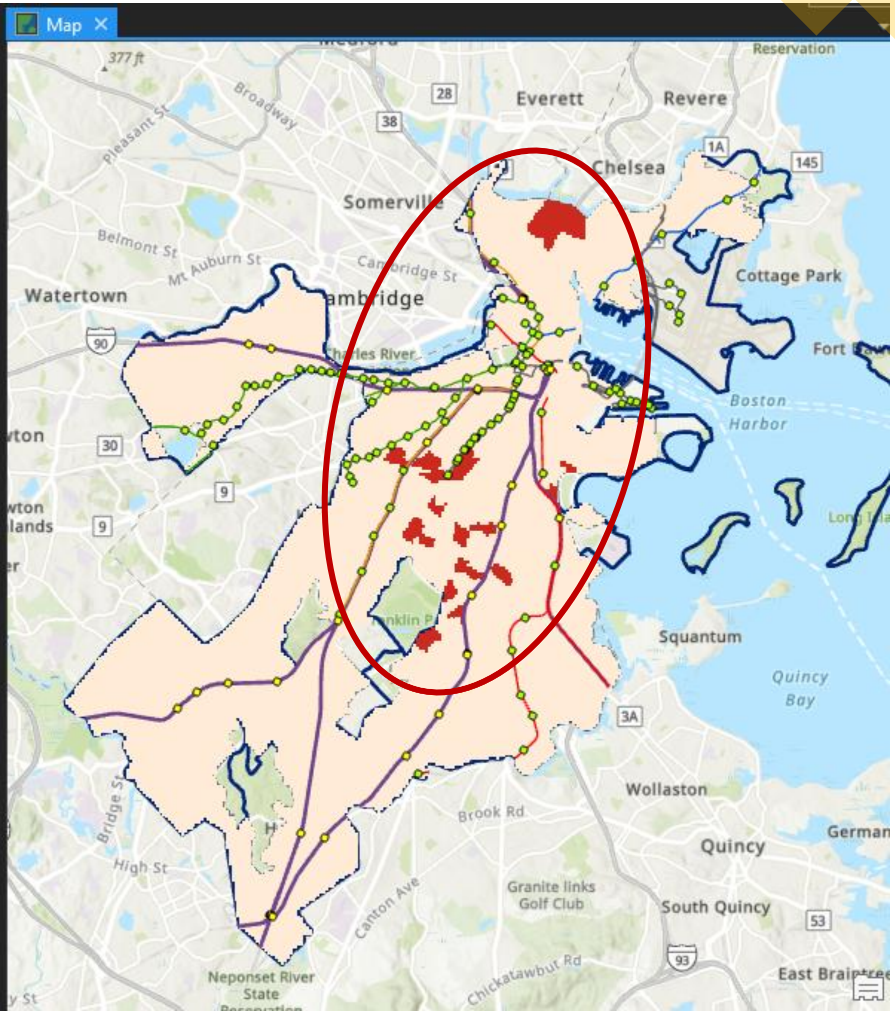
Simple Suitability Modeler

The chosen variables were converted from polygon datasets into raster datasets using the “Polygon to Raster” tool in order to run the simple suitability modeler. The following thresholds were set to make the result calculation.

- HH in Poverty > 33%
- Annual HH Income under $20K > 33%
- Public transit commuters > 20%
- Unemployed > 15%
- Non-white population > 75%

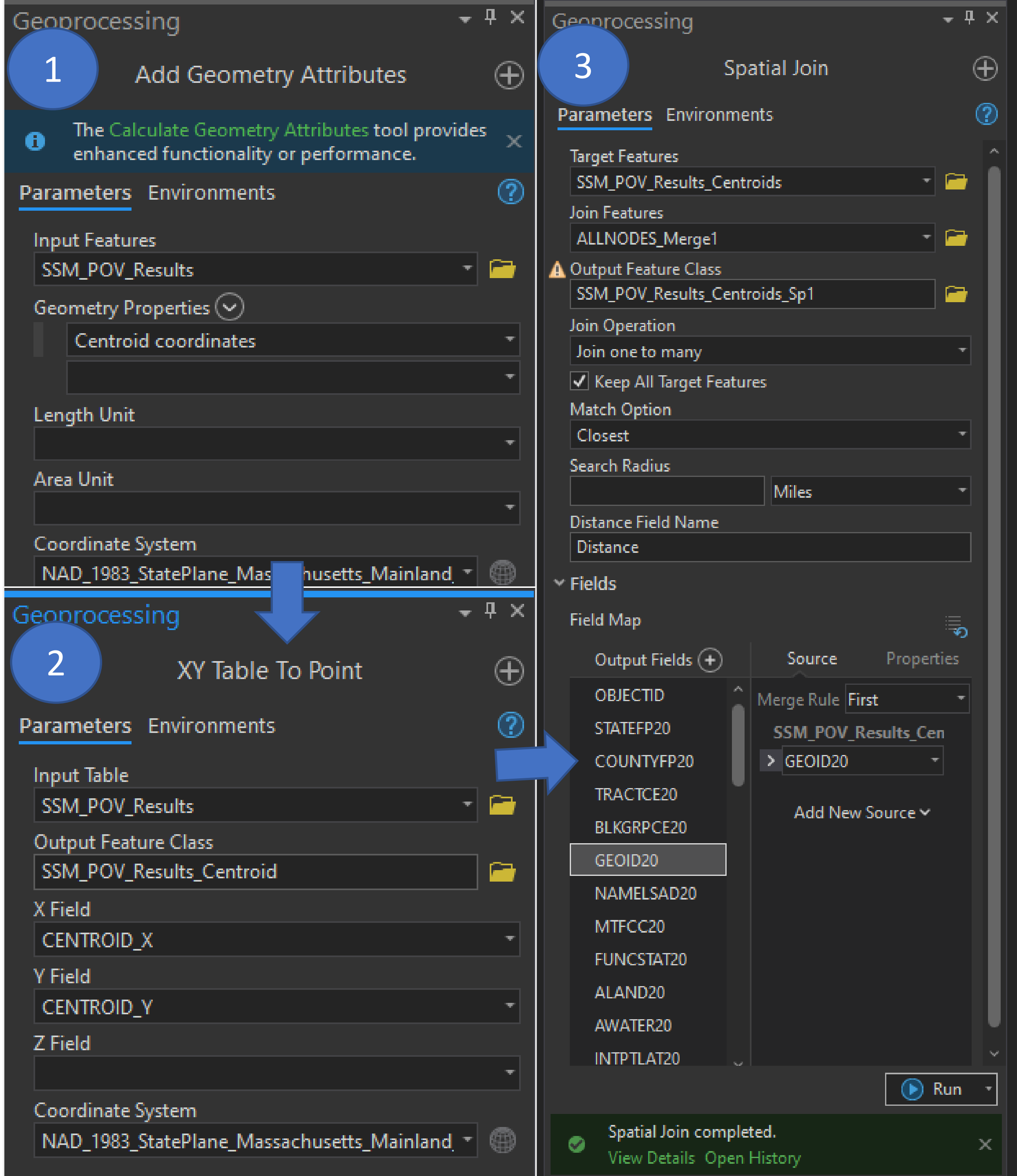
Result: 19 Block Groups





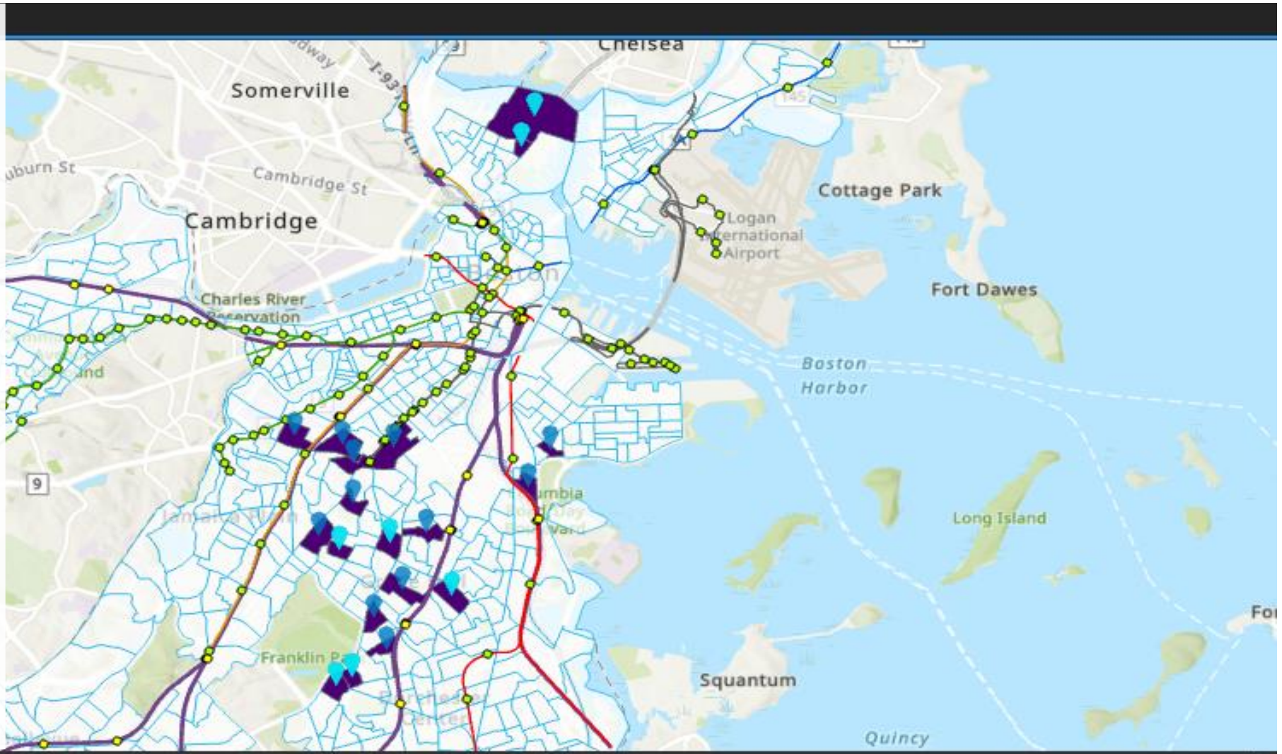
Spatial Join

In order to find which Block Groups are the furthest from public transportation I first found the centroids of the chosen Block Groups using the “Add Geometry Attributes” tool. I then turned the centroid XY coordinates into a new point layer using the “XY Table to Point” tool. Once I had that point layer of centroids, I did a spatial join with the layer “ALLNODES_Merge1” which has all the train and subway station node points in one layer. The “Spatial Join” tool can match points from one layer to the closet point in another layer using the “closest” match option. The distance calculated is a straight-line distance and is suitable for my study purposes.



Results

7 block groups were chosen because there are 2 pairs of block groups that are neighboring each other. I decided to treat these neighboring pairs as 1 candidate area. In total I have identified 5 areas to place PuDo points.



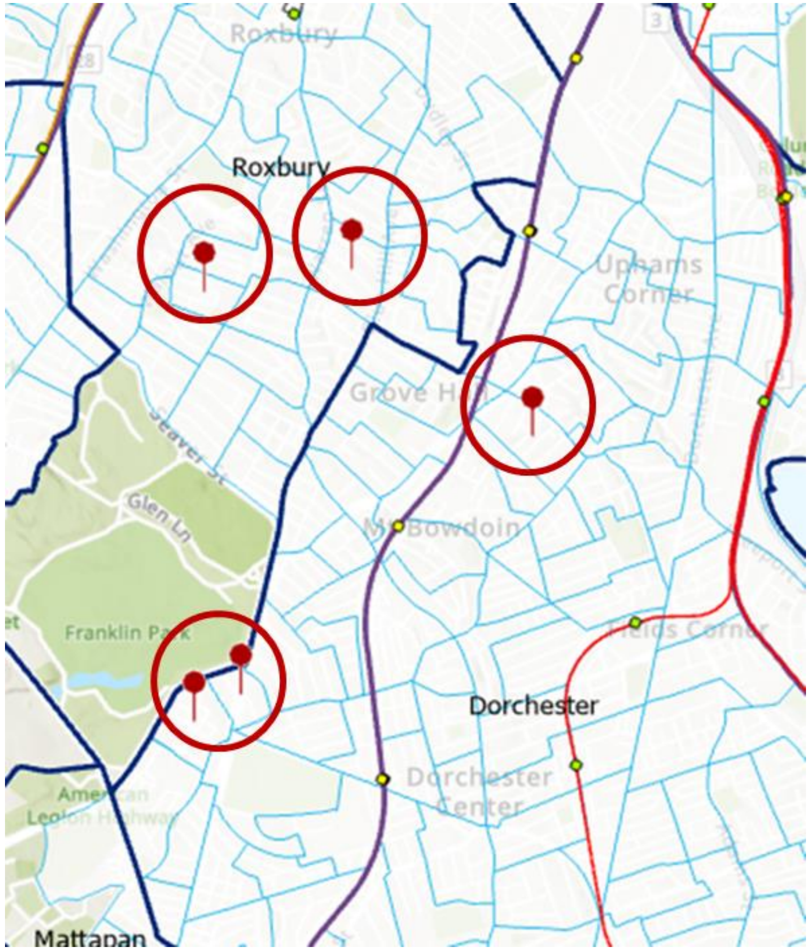
1:100,000 227,568.58E 893,023.45N m

POV_Centroids_SpatialJoin

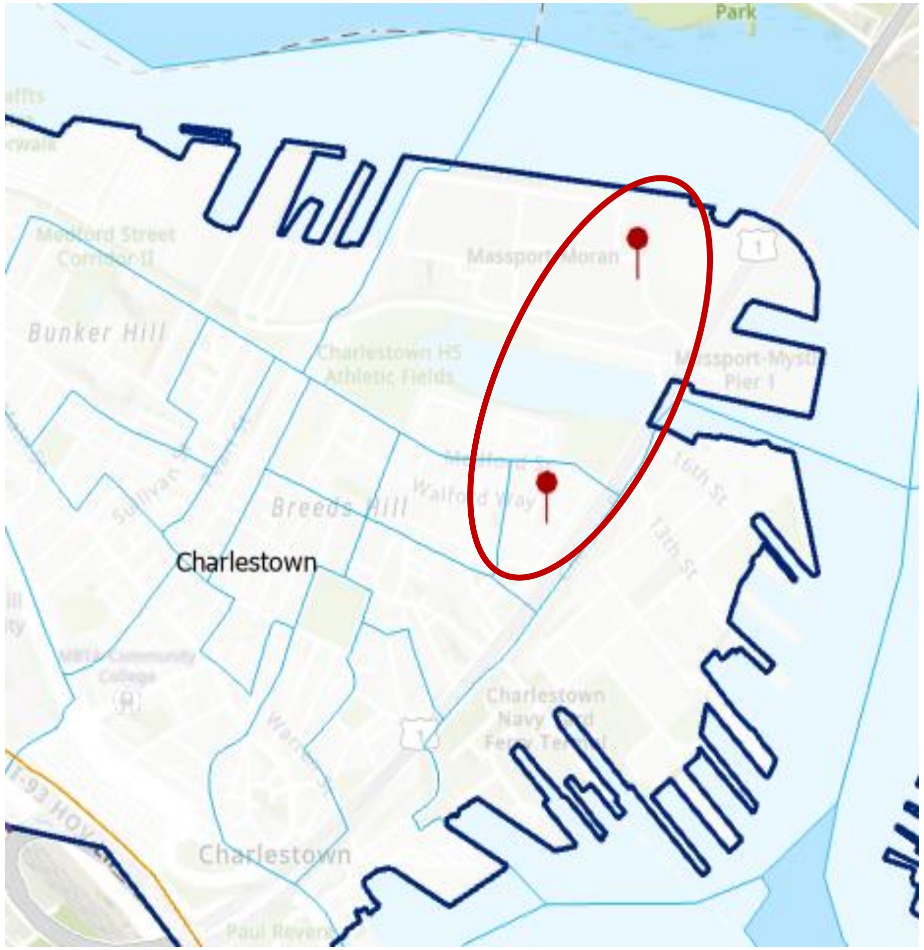
Field: Add Calculate Selection: Select By Attributes Zoom To Switch Clear Delete Copy

	OBJECTID_1 *	Shape *	Join_Count	Distance_mi	STATION	TARGET_FID	JOIN_FID	OBJECTID	STATEFP20	COUNTYFP20	TRACTCE20	BLKGRPCE20	GEOID20
1	3	Point	1	3.582454	Community College	3	72	68	25	025	040801	2	250250408012
2	7	Point	1	2.737796	Community College	7	72	237	25	025	040200	1	250250402001
3	13	Point	1	2.361364	Jackson Square	13	94	416	25	025	081900	2	250250819002
4	1	Point	1	2.132692	TALBOT AVENUE	1	57	35	25	025	092400	4	250250924004
5	5	Point	1	1.972426	UPHAMS CORNER	5	58	84	25	025	081800	3	250250818003
6	9	Point	1	1.791364	TALBOT AVENUE	9	57	327	25	025	092400	5	250250924005
7	6	Point	1	1.736923	FOUR CORNERS/GENEVA AVE	6	34	139	25	025	091800	1	250250918001
8	15	Point	1	1.560525	Dudley Square	15	162	421	25	025	081700	4	250250817004
9	14	Point	1	1.552585	Jackson Square	14	94	418	25	025	081500	2	250250815002

Close-Ups



Roxbury
Roxbury
Upham's Corner
Grove Hall
Seaver St
Glen Ln
Bowdoin
Franklin Park
Fields Corner
Dorchester
Dorchester Center
American Legion Highway
Mattapan

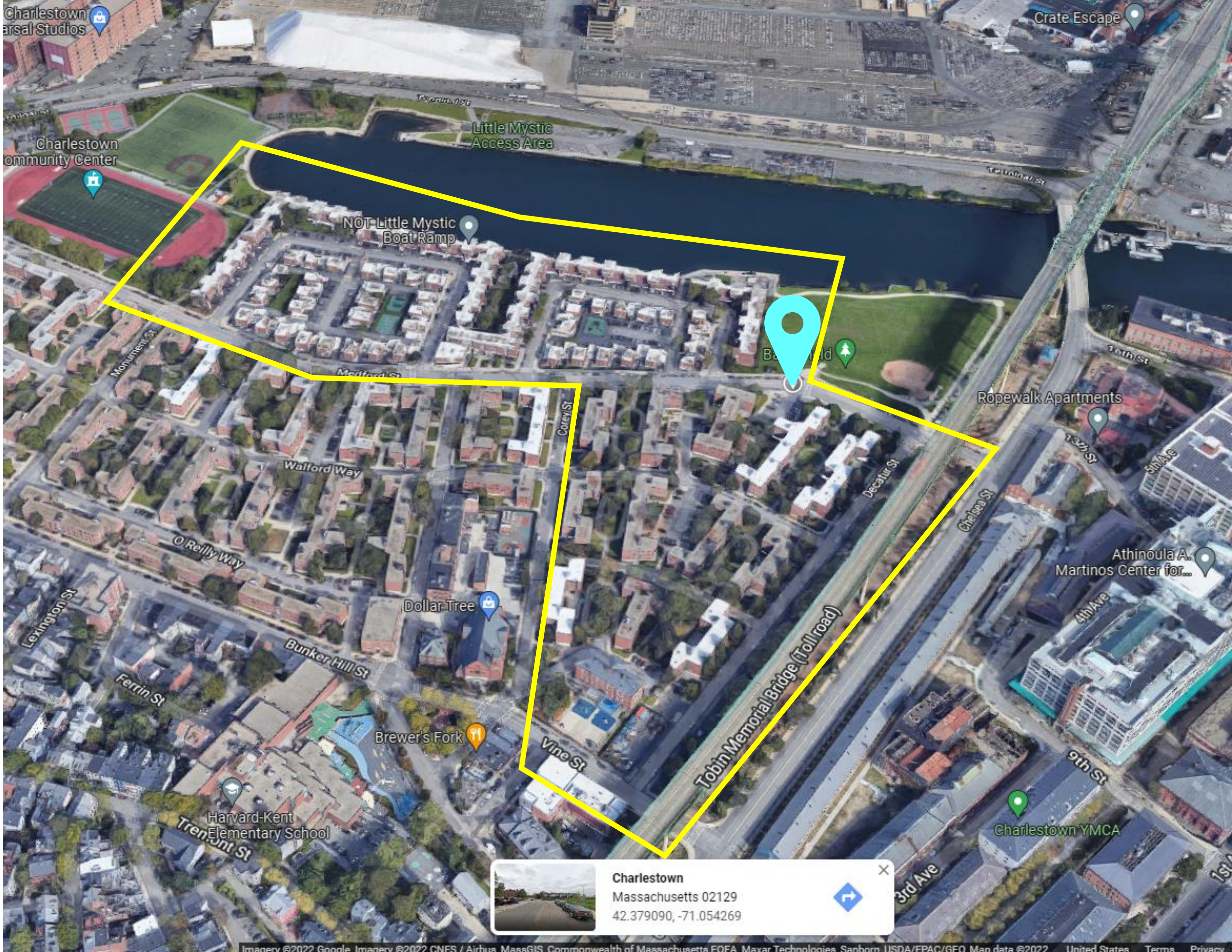


Park
Medford Street Corridor II
Massport-Moran
Bunker Hill
Charlestown HS Athletic Fields
Massport-Mystic Pier 1
Breeds Hill
Charlestown
Charlestown Navy Yard Ferry Terminal
Charlestown

Charlestown PuDo Point

Chosen location:
Medford St at Barry Field

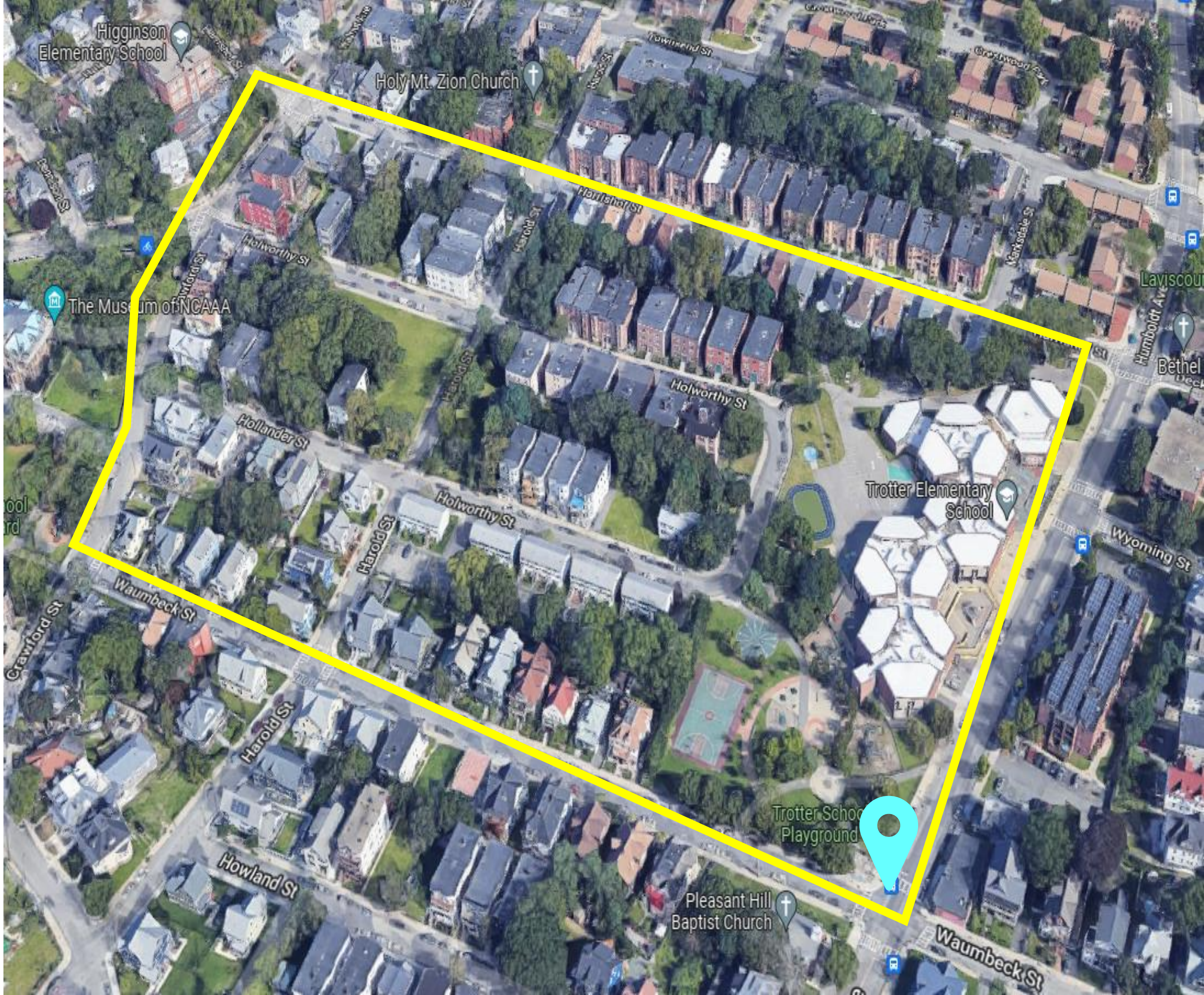
The more Northern Block Group includes industrial space, so I have narrowed the area down to only residential space.
The chosen PuDo location seems to be central between to the two block groups and it looks like a PuDo area could more easily be designed near the park.
This BG is furthest from public transportation.



Roxbury PuDo Point #1

Chosen location:
Waumbeck St and Humboldt Ave

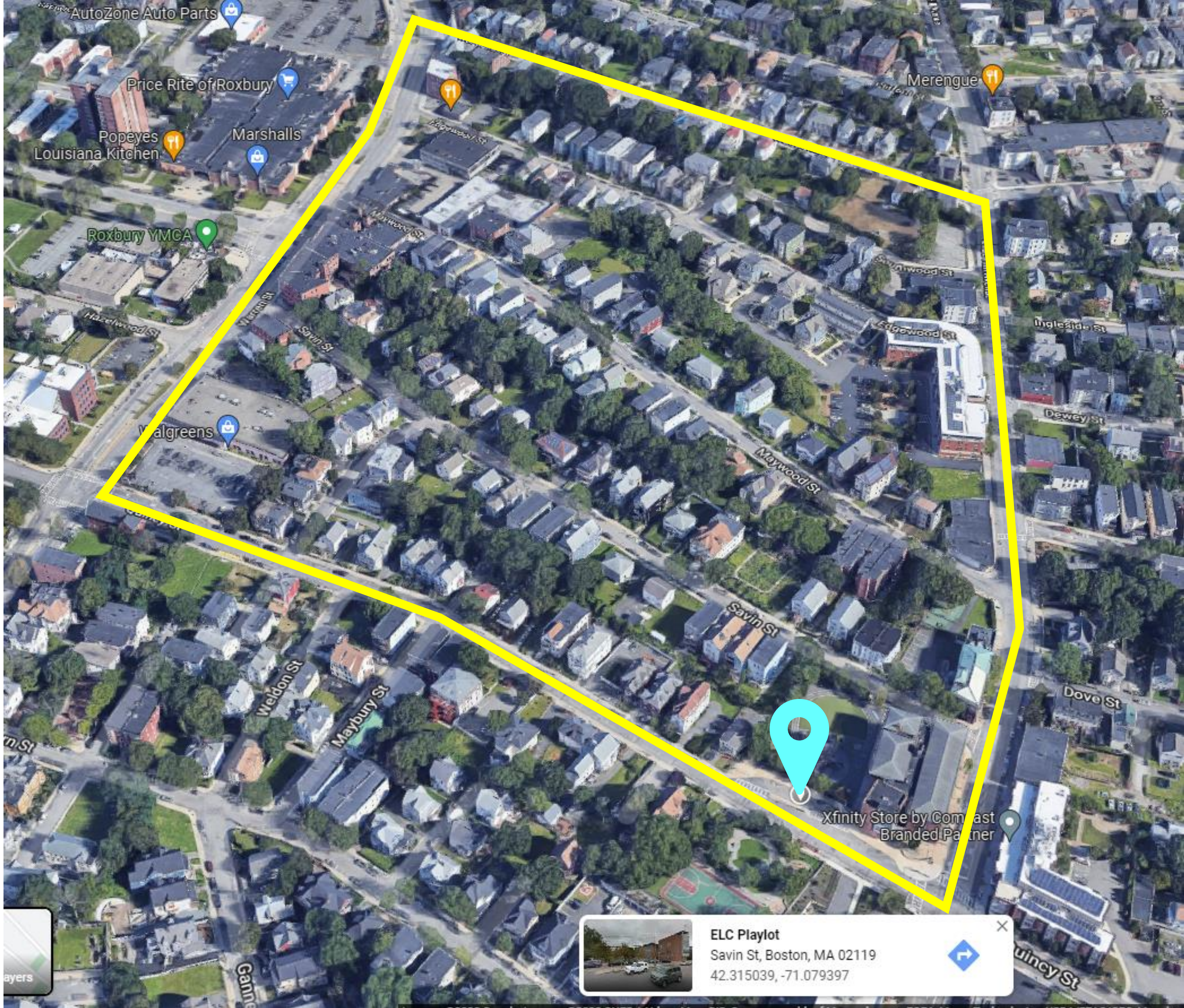
The bus stop in the Southeast corner of this Block Group would make a convenient location for a PuDo point. It is close to places of interest like schools and churches as well as the residential streets.



Roxbury PuDo Point #2

Chosen location:
Quincy St and Blue Hills Avenue

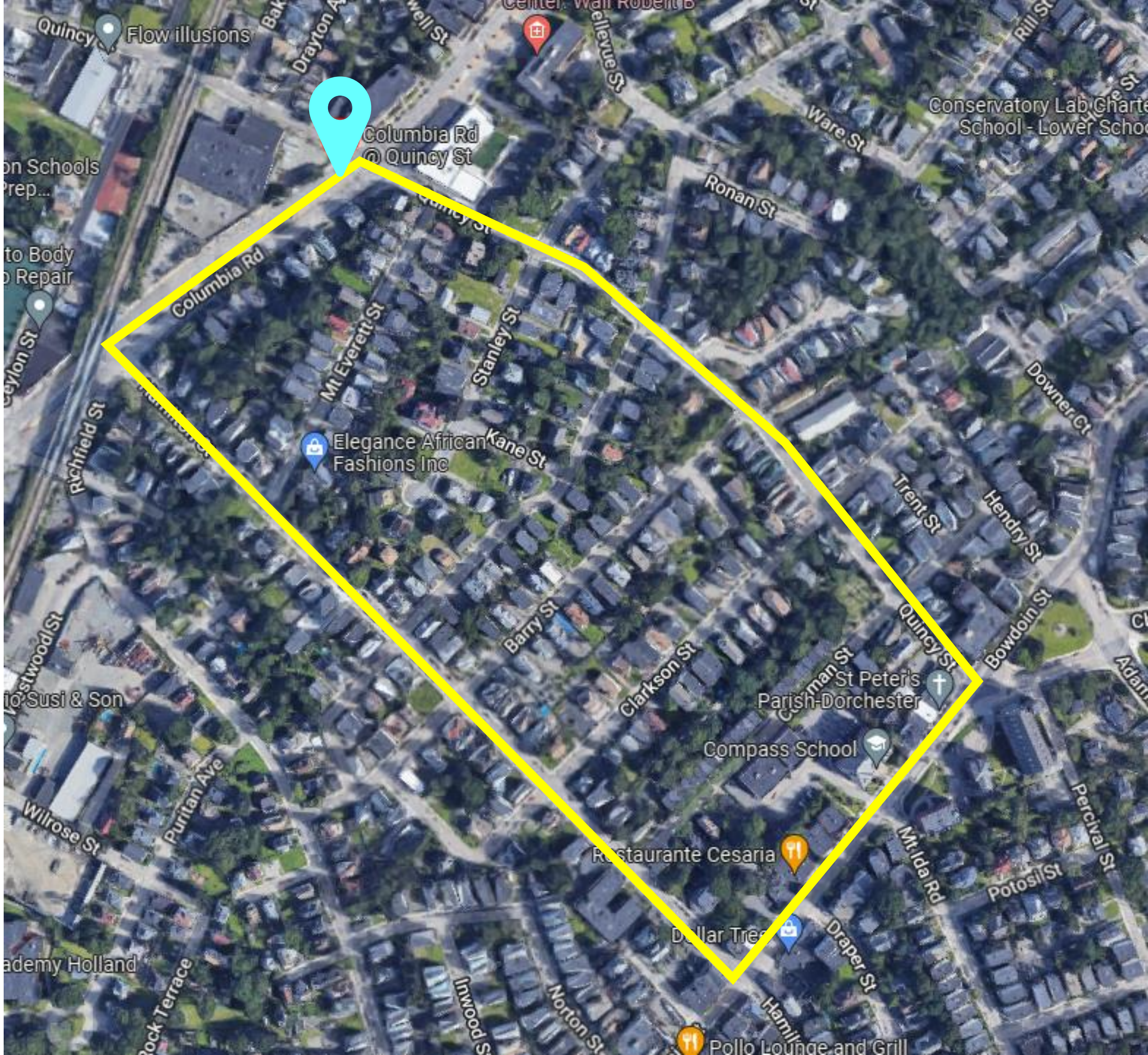
At this location, there is already a good place for an AV to safely pull over and it is conveniently located near a main intersection which makes it a good candidate for a PuDo point.



Dorchester PuDo Point #1

Chosen location:
Quincy St and Columbia Rd

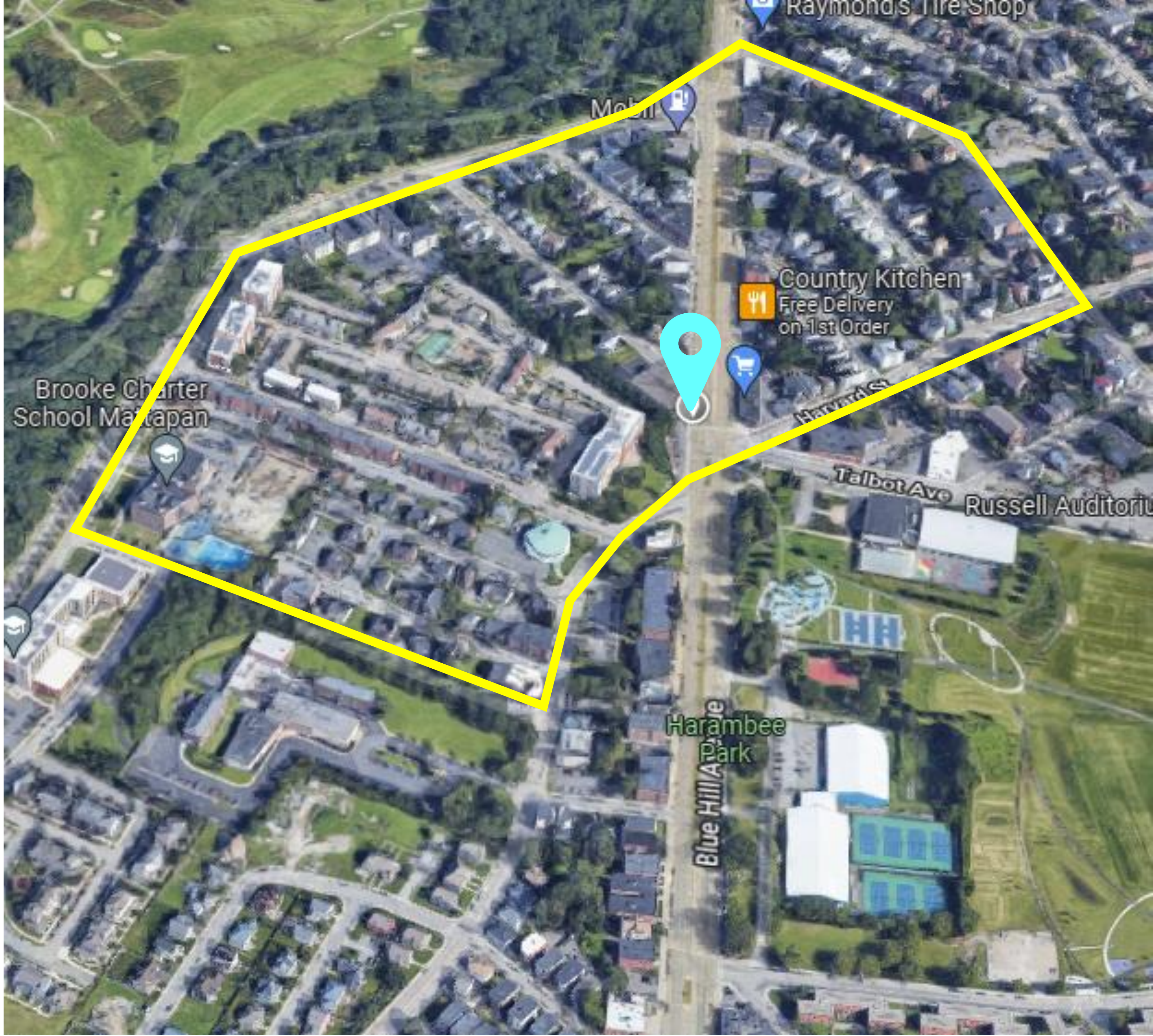
At this location there is a Bus stop that could potentially be used for safe pull-overs when exiting from the right side of the vehicle. This location is close to residential streets and local businesses.



Dorchester PuDo Point #2

Chosen location:
Blue Hills Avenue and Talbot Ave

A bus stop is located between the two neighboring Block Groups that met the search criteria in this area. The bus stop is close to residential streets, a local grocery, and other small business making it a good candidate PuDo point.



Thank you!